NUREG–0498
Supplement No. 1

Final Environmental Statement

related to the operation of Watts Bar Nuclear Plant, Units 1 and 2

Docket Nos. 50–390 and 50–391
Tennessee Valley Authority

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

April 1995

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Abstract

The Final Environmental Statement-Operating License (FES-OL) issued in 1978 represents the Nuclear Regulatory Commission's (NRC's) previous environmental review related to the operation of Watts Bar Nuclear (WBN) Plant. The NRC staff has determined that it is appropriate to re-examine the issues associated with the environmental review before issuance of an operating license. The purpose of this NRC review is to discuss the effects of observed changes in the environment and to evaluate the changes in environmental impacts that have occurred as a result of changes in the WBN Plant design and proposed methods of operations since the last environmental review. A full scope of environmental topics has been evaluated, including regional demography, land and water use, meteorology, terrestrial and aquatic ecology, radiological and non-radiological impacts on humans and the environment, socioeconomic impacts, and environmental justice. The staff concluded that there are no significant changes in the environmental impacts since the NRC 1978 FES-OL from changes in plant design, proposed methods of operations, or changes in the environment. The Tennessee Valley Authority's (TVA's) preoperational and operational monitoring programs were reviewed and found to be appropriate for establishing baseline conditions and ongoing assessments of environmental impacts.

The staff also conducted an analysis of plant operation with severe accident mitigation design alternatives (SAMDAs) and concluded that none of the SAMDAs, beyond the three procedural changes that the TVA committed to implement, would be cost-beneficial for further mitigating environmental impacts.

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Foreword

This supplement to the Final Environmental Statement (FES) Related to the Operation of Watts Bar Nuclear Plant Units 1 and 2 was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (the staff). This supplement to the FES was prepared in accordance with the Commission's regulations in Title 10 of the *Code of Federal Regulations*, Part 51 (10 CFR Part 51), which implements the requirements of the National Environmental Policy Act of 1969 (NEPA). The *Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plants Units 1 and 2* (NRC 1978 FES-OL) was issued in 1978 as NUREG 0498. This supplement to that document was prepared to further the interests of NEPA.

NEPA states, among other things, that it is the continuing responsibility of the Federal government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may

- fulfill the responsibilities of each generation as trustee of the environment for succeeding generations
- ensure for all citizens of the United States of America safe, healthful, productive, and aesthetically and culturally pleasing surroundings
- attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences
- preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice
- achieve a balance between population and resource use that permits high standards of living and a wide sharing of life's amenities
- enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, NEPA calls for the preparation of a statement on

- the environmental impact of the proposed action
- any adverse environmental effects that cannot be avoided should the proposal be implemented
- alternatives to the proposed action

- the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity

- any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

The environmental review presented here discusses the changes (since the NRC 1978 FES-OL) in the environment and changes in the environmental impact in and around the Watts Bar Nuclear Plant as a result of changes to the plant's design and proposed methods of operation. Assessments and evaluations relating to these changes presented in this statement augment and update those described in the NRC 1978 FES-OL.

This supplement updates the NRC 1978 FES-OL by

- evaluating changes in the environment in and around the Watts Bar Nuclear Plant

- evaluating changes in facility operation and design that could potentially result in environmental impacts of operation (including those that would enhance as well as degrade the environment) different from those projected in the NRC 1978 FES-OL

- reporting the results of relevant new information that has become available since the NRC 1978 FES-OL

- factoring into this supplement new environmental policies and statutes that have a bearing on the licensing action

- reporting the results of the staff's review of the alternative of plant operation with the installation of severe accident mitigation design alternatives (SAMDAs) for the Watts Bar Nuclear Plant.

Definitions

Acanthamoeba sp.	a pathogenic amoeba that is responsible for causing primary amoebic meningoencephalitis. These microorganisms are located in surface water.
Asiatic clam (*Corbicula* sp.)	a species of clam that was introduced to North America and inhabits the Tennessee River. The Asiatic clam is considered a nuisance species.
Background radiation	the level of radiation in an area that is produced by sources of radiation (mostly natural) other than the one of specific interest. In attempting to measure radiation from a reactor, natural radiation is considered "background." Conversely, in attempting to measure natural radiation, any radiation from a reactor would be considered background.
Becquerel (Bq)	a unit of activity. Activity is defined as the number of nuclear transformations occurring in a given quantity of material per unit time. One becquerel of activity, in the International System of Units (SI), is a measurement of radioactivity equal to one transformation per second.
Benthos	a community of organisms living in and on the bottom of an aquatic ecosystem.
Biofouling	the gradual accumulation of aquatic organisms on the surfaces of engineered structures in water that contributes to corrosion of the structures and decreasing their efficiency.
Biomonitoring	monitoring of living organisms.
Blue-green algae	any of a group of photosynthetic microorganisms classified as either plants (division Cyanophyta) or bacteria (division Cyanobacteria) because they possess characteristics of both plants and bacteria.
Byssal threads	a tuft of long tough filaments by which some bivalve molluscs (as mussels) adhere to a surface.

Candidate Species	a species that is being evaluated for listing as endangered or threatened by the U.S. Fish and Wildlife Service.
Chickamauga Reservoir	the reservoir behind Chickamauga Dam in the Tennessee River. The section of the river that passes Watts Bar Nuclear Plant is considered to be a part of the Chickamauga Reservoir.
Chlorophyll *a*	one form of the green pigment that is found in plant cells, responsible for photosynthesis.
Cooling tower blowdown	water released from the cooling towers to surface waters.
Coulomb	a unit of electric charge equal in magnitude to the charge of 6.25 x 10^{18} electrons. About 100 coulombs flow through a 100-watt light bulb each second.
Curie (Ci)	the special unit of activity. Activity is defined as the number of nuclear transformations occurring in a given quantity of material per unit of time. One curie of activity is 37 billion transformations per second.
Daphnid	minute freshwater branchiopod crustaceans with antennae used as locomotor organs, of the genera *Daphnia* or *Ceriodaphnia*.
Decommissioning	removing nuclear facilities safely from service and reducing residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license.
DECON	the decommissioning alternative for a nuclear facility shortly after cessation of operation in which equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits termination of the license.
Diffuser	a system used to discharge cooling tower blowdown, or routine releases from the yard holding pond at the Watts Bar Nuclear Plant. The diffuser allows for the releases to enter the river in a diffuse manner rather than as a concentrated release in a narrow area.
Dissolved oxygen levels	a measure of the amount of oxygen that is dissolved in a liquid.
Eastern hellbender	(*Cryptobranchus a. alleganiensis*) a large aquatic, usually gray, salamander.
Effluent	waste material (as in liquid industrial refuse or sewage) discharged into the environment.

Electrofishing	a sampling method for fish using electric current.
Electromagnetic fields (EMF)	a form of non-ionizing radiation produced by the movement of electricity through wires such as in appliances or in power transmission lines.
Endangered species	species of plants or animals that have been deemed by the U.S. Fish and Wildlife service to have such low numbers of individuals that the species is in danger of becoming extinct.
ENTOMB	the decommissioning alternative of a nuclear facility in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting termination of the license.
Entrainment	drawing in or transport by flow of a fluid.
Exposure	the condition of being made subject to the action of radiation; also, a measure of the ionization produced in air by x- or gamma radiation.
Forebay	the section of the reservoir immediately above a dam.
Genetic effects of radiation	effects of radiation that alter the hereditary material and may therefore affect subsequent unexposed generations.
Gray (Gy)	a unit, in the International System of Units (SI), of absorbed dose equal to one joule per kilogram.
Intake structure	an opening through which fluids enter an enclosure.
Invertebrates	animals without backbones - such as insects, crustaceans, and molluscs.
Ion exchange	in this document, a process for selectively removing a constituent from a waste stream by reversibly transferring ions from a liquid to an insoluble solid (the ion exchange medium).
Ionizing radiation	any form of radiation that generates ions in the irradiated material.
Joule	the unit of work or energy in the mks system equal to 10,000 ergs.
Legionella sp.	the bacterium which causes Legionnaires' disease.

Low-level waste (LLW)	all radioactive waste materials that are not high-level or transuranic waste.
Macrophytes	a vascular aquatic plant, large enough to see with the naked eye.
Maximally exposed (offsite) individual	the hypothetical person who would receive the greatest possible radiation dose from a specific release. For atmospheric releases, this individual is assumed to breathe air at the offsite boundary location with the highest airborne concentration and to consume food products raised exclusively in that offsite boundary location receiving the maximum ground deposition of released radioactive material. For liquid releases, this individual is assumed to consume large quantities of river water and fish at the nearest location downstream of the plant effluent discharge.
Meteorological tower	a tower containing instruments for obtaining meteorological data such as wind speed, wind direction, humidity, and temperature.
Mks	a system of units measure; the meter-kilogram-second system.
Molluscicide	a chemical that is toxic to clams and mussels.
Mussel sanctuary	an area designated by the State of Tennessee to be a biological preserve for mussel species.
Naegleria sp.	a pathogenic amoeba that is responsible for causing primary amoebi meningoencephalitis. These microorganisms are located in surface water.
Occupational radiation exposure	the radiation exposure to which workers at a nuclear facility are sut jected during the course of their work.
Outage	a period of interruption of operation of a power plant.
Outfall	liquid waste discharge point.
pH	a measure of the hydrogen ion concentration of a solution expresse as a negative logarithm of the effective hydrogen-ion concentration in gram equivalents per liter. A pH of 7 is neutral. pH values fro 0 to 7 indicate acid conditions; those from 7 to 14 indicate alkaline conditions.
Plankton	the usually microscopic plant and animal life found free-floating in water. The plants are called "phytoplankton." The animals are called "zooplankton."

Poly-chlorinated biphenyl (PCB)	any of several compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine, have industrial applications, and are poisonous environmental pollutants which tend to accumulate in animal tissues.
Population dose	the summation of individual radiation doses received by all those individuals exposed to the radiation source or event being considered (expressed as person-rem or person-sievert). The same as collective dose.
Prefixes	used to designate fractions: centi (c) = 10^{-2} = 0.01 milli (m) = 10^{-3} = 0.001 micro (μ) = 10^{-6} = 0.000001 nano (n) = 10^{-9} = 0.000000001 pico (p) = 10^{-12} = 0.000000000001 used to designate multipliers (additions only): tera (T) = 10^{12} = 1,000,000,000,000 (trillion) giga (G) = 10^{9} = 1,000,000,000 (billion) mega (M) = 10^{6} = 1,000,000 (million) kilo (K) = 10^{3} = 1,000
Pressurized water reactor (PWR)	A nuclear power reactor that employs a dual system. The primary system contains nuclear fuel as a heat source and a pressurized coolant that does not boil. The pressurized coolant transfers heat from the nuclear fuel to a secondary system, via a heat exchanger called a steam generator. Steam from the steam generator is used to drive the turbine.
Rad	the unit of absorbed dose of radiation equal to 100 ergs per gram of absorbing material.
Radiation	energy in the form of electromagnetic rays (radiowaves, light, x-rays, gamma rays) or particles (electrons, neutrons, helium nuclei) sent out through space from atoms, molecules, or atomic nuclei as they undergo internal change. It may also result from particle and electromagnetic radiation interactions with matter.
Recruitment	a complex process incorporating adult survival, adult reproduction rate, and juvenile survival. The net rate of recruitment is the amount by which the population changes in size during one stage or over one interval of time.
Rem	a unit of radiation dose equivalent that is the product of the absorbed dose in rad and the quality factor.

Resin	ion exchange media for the purification of contaminated liquids.
Resin liners	cylindrical metal containers used for the ion exchange media (resins and/or zeolites) during purification of contaminated water by ion exchange processes.
Roentgen	a unit of exposure to ionizing radiation equal to the production by x- or gamma rays of one electrostatic unit of electrical charge in one cubic centimeter of dry air under standard conditions.
Rotenone	a crystalline compound is obtained from the roots of several tropical plants and commonly used as a fish sampling tool.
Rotifer	microscopic aquatic invertebrate.
SAFSTOR	the decommissioning alternative in which the nuclear facility is placed and maintained in such a condition that it can be safely stored, monitored, and subsequently decontaminated to levels that permit termination of the license.
Sequoyah Nuclear Plant	a Tennessee Valley Authority-owned two-unit nuclear power facility located on the Tennessee River outside of Chattanooga, Tennessee.
Sievert (Sv)	a unit, in the International System of Units (SI), of dose equivalent equal to one joule per kilogram.
Spawn	to produce or deposit eggs, especially aquatic animals.
Stratify	to divide into a series of graded statuses (e.g., temperatures of a lake are generally warmer on top than on bottom).
Tailrace	the section of a river immediately below a dam where the streambed is influenced by the water released from the dam.
Thermophilic	heat loving.
Threatened species	species that have not been listed as "endangered" by the U.S. Fish and Wildlife Service, but that occur in such low numbers of individuals that their numbers warrant Federal protection.
Transition zone	the section of the river between the tailrace and the location where the river flow is unmodified by the upstream dam.

Transuranic	radionuclides with atomic numbers greater than uranium, atomic number 92; e.g., plutonium, atomic number 94, and americium, atomic number 95.
Watts Bar Reservoir	the reservoir above Watts Bar Dam.
Watts Bar Nuclear Plant	a Tennessee Valley Authority-owned and operated nuclear power facility, specifically the buildings and facilities on the Watts Bar Nuclear Plant site.
Watts Bar Nuclear Plant Site	the area surrounding the Watts Bar Nuclear Plant.
Zebra mussel	Either of two species (*Dreissena polymorpha* or *Dreissena bugensis*) of molluscs that were accidentally introduced into the Great Lakes and are spreading to surrounding waterways where they may occur in large numbers, clog water intake pipes, and outcompete native mussels for food and space. Zebra mussel are considered a nuisance species in North America.

Abbreviations/Acronyms

ACC	averted cleanup costs
ACGIH	American Conference of Governmental Industrial Hygienists
AEC	Atomic Energy Commission
AFW	auxiliary feedwater
ALARA	as low as is reasonably achievable
AOE	averted occupational exposure
AOSC	averted onsite costs
APBs	accident progression bins
APE	averted public exposure
ARFs	air return fans
ATWS	anticipated transient without scram
BCDMH	1-bromo-3-chloro-5,5-dimethylhydantoin
BEIR	Biological Effects of Ionizing Radiation
CCPs	centrifugal charging pump
CCS	component cooling system
CDF	core damage frequency
CFR	Code of Federal Regulations
COE	cost of enhancement
CP	construction permit
CPI	containment performance improvement
CST	condensate storage tank
CVCS	chemical and volume control system
dBA	decibel (A-scale)
DC	direct current
DCH	direct containment heating
DGH	dodecylguanidine hydrochloride
DOE	U.S. Department of Energy
ECCS	emergency core cooling system
EDG	emergency diesel generator
EI	environmental information
EIS	environmental impact statement
EMF	electromagnetic fields
EPA	U.S. Environmental Protection Agency
ERCW	essential raw cooling water

ESA	Endangered Species Act
FES	final environmental statement
FES-OL	final environmental statement - operating license
FSAR	final safety analysis report
FWS	U.S. Fish and Wildlife Service
GI	generic issue
HVAC	heating, ventilation, and air conditioning
HPME	high-pressure core melt ejection
ICRP	International Commission on Radiological Protection
IPE	individual plant examination
ISLOCA	inter-system loss-of-coolant accident
KPDS	key plant damage state
KRC	key release category
LOCA	loss-of-coolant accident
LWR	light-water reactor
MG	motor generator
MIC	microbiologically induced corrosion
NAS	National Academy of Sciences
NCRP	National Council on Radiation Protection and Measurements
NESC	National Electric Safety Code
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
OL	operating license
PAME	primary amoebic meningoencephalitis
PCB	polychlorinated biphenyl
PRA	probabilistic risk assessment
PORV	power-operated relief valve
PWRs	pressurized water reactors
QA	quality assurance
Quat	n-alkyl dimethyl benzyl ammonium chloride

radwaste	radioactive waste
RCP	reactor coolant pump
RCS	reactor coolant system
RHR	residual heat removal
RWST	refueling water storage tank
SAMDA	severe accident mitigation design alternative
SAR	safety analysis report
SBO	station blackout
SER	safety evaluation report
SGTR	steam generator tube rupture
SQN	Sequoyah Nuclear
SSE	safe shutdown earthquake
TLD	thermoluminescence dosimeter
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
WBN	Watts Bar Nuclear

Summary and Conclusions

This supplemental environmental statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation, hereinafter known as "the staff."

The Tennessee Valley Authority (TVA), hereinafter known as "the applicant," has applied for a facility-operating license for the Watts Bar Nuclear (WBN) Plant. The WBN Plant is a two-unit nuclear power plant located approximately 80 kilometers (50 miles) northeast of Chattanooga at the Watts Bar Site on the Tennessee River in Rhea County, Tennessee. Each of the two identical units employs a four-loop pressurized-water reactor nuclear steam supply system furnished by Westinghouse Electric Corporation. Each of the two reactor cores is rated at 3425 megajoules per second (3425 megawatts) thermal. The net electrical output is 1160 megajoules per second (1160 megawatts) electric. Each unit will use one cooling tower that draws makeup water from the Chickamauga Reservoir.

The applicant is planning to complete the WBN Plant Unit 1 and start generating electric power by mid-1995. NRC issued the *Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant Units 1 and 2* (NRC 1978 FES-OL) in 1978. When the NRC 1978 FES-OL was published, Watts Bar Unit 1 had an expected fuel load date of December 1979; however, the completion date was extended as a result of construction delays. Unit 1 is now near completion and the applicant expects to load fuel in the spring of 1995 and initiate commercial generation in mid-1995. Unit 2 is approximately 65% complete and is being reevaluated as part of an integrated resource planning process being conducted by the applicant.

The NRC's regulations in 10 CFR 51.92 require the NRC staff to prepare a supplement to an FES if there are substantial changes in the proposed action that are relevant to environmental concerns or if there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. That same regulation permits the staff to prepare a supplement when, in its opinion, preparation of a supplement will further the interests of the National Environmental Policy Act (NEPA). This supplement documents the staff's review pursuant to 10 CFR 51.92. The staff concludes that there are no significant changes in environmental impacts as a result of changes in plant design, procedures or proposed methods of plant operation, or changes in the environment. Therefore, this document has been prepared to supplement the NRC 1978 FES-OL in the interest of furthering NEPA. The purpose of this supplement is to evaluate any changes in the environment and changes in the plant design, procedures, and proposed methods of operation since the previous evaluation of the environment by the staff in 1978.

The staff transmitted the supplement to the *Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2*, Draft Report for Comment (NUREG-0498, Supplement No. 1) to Federal, State, and local government agencies and interested members of the public. A notice of availability which requested comments on the draft supplement, was published in the *Federal Register* on December 9, 1994 (59 FR 63832). On January 10, 1995, the staff held a public meeting in Sweetwater, Tennessee, to solicit comments on the draft supplement. In addition to the comments provided during the public meeting, the staff received 26 letters. The staff has considered and responded to the comments in Section 9.0. The conclusions reached in the draft supplement did not change as a result of the comments received. A vertical bar in the margin indicates where the staff made substantive changes to the draft supplement.

The staff's conclusions are based on the evaluation of the changes in environmental impacts, since the NRC 1978 FES-OL, as a result of (1) changes in plant design and procedures, (2) changes in proposed method of plant operations, or (3) changes to the environment. These conclusions are that

- There are no changes in the design of the WBN Plant that result in a significant change in environmental impact.

- Changes in proposed WBN Plant operations have occurred. However, the changes do not result in a significant environmental impact.

- Changes in the population and demographics of the region have occurred since 1978. However, the changes are not significant (Section 2.1) and the changes in employment and in impact funds resulting from startup of Unit 1 will not have a significant socioeconomic impact on the area.

- No additional impacts were determined for land use or water use.

- There are no significant changes in the regional climatology or WBN Site meteorology.

- There are no significant changes in the terrestrial or aquatic environment in the vicinity of the WBN Site.

- There are no significant changes in the background radiological characteristics in the vicinity of the WBN Site.

- The applicant's preoperational and operational monitoring programs were reviewed and found appropriate for establishing conditions and ongoing assessments of environmental impacts.

- The operation of the WBN Plant will not result in a disproportionately high and adverse human health or environmental effect to any of the low-income communities near the WBN Plant.

- The staff analysis of the alternative of facility operation with the installation of severe accident mitigation design alternatives (SAMDAs) concluded that none of the SAMDAs beyond the three procedural changes that the applicant committed to implement would be cost beneficial for further mitigating environmental impacts.

1 Introduction

The Watts Bar Nuclear (WBN) Plant is located in Rhea County, Tennessee, approximately 80 kilometers (50 miles) northeast of Chattanooga, Tennessee (Figure 1.1). The WBN Site is a 7.1-square kilometer (1770-acre) site on the west bank of the Chickamauga Reservoir, and is located on the Tennessee River at Tennessee River Mile (TRM) 528 as measured from the mouth of the river. It is approximately 3.2 kilometers (2 miles) south of the Watts Bar Dam (TRM 529.9) and 1.6 kilometers (1 mile) downstream of the four-unit Watts Bar Steam Plant, also located on the west bank of the reservoir at TRM 529 (Figure 1.2). The Watts Bar Steam Plant is in cold standby and has not operated since 1983.

The WBN Plant is a two-unit facility. The Tennessee Valley Authority (TVA), referred to in this document as "the applicant," designed, built, and proposes to operate the WBN Plant. The facility, administrative and support facilities, and all associated parking are located on Federal property under the control of the applicant. Each of the two identical units employs a four-loop pressurized-water reactor nuclear steam supply system furnished by Westinghouse Electric Corporation. Each reactor is rated at 3425 megajoules per second (3425 megawatts) thermal. The net electrical output of each unit is 1160 megajoules per second (1160 megawatts) (TVA 1994a).

1.1 History

On May 14, 1971, the applicant submitted an application requesting the issuance of construction permits for WBN Plant Units 1 and 2. On January 23, 1973, the Atomic Energy Commission (AEC) issued Construction Permits CPPR-91 and CPPR-92 for the two WBN Plant units. These were issued following the AEC staff's environmental review of the proposed plant. The applicant released its final Environmental Impact Statement Construction Permit (EIS-CP) in November 1972 (TVA 1972). In late 1976, the applicant submitted an application containing a Final Safety Analysis Report (FSAR) and Environmental Information (EI) requesting the issuance of operating licenses for both Units 1 and 2. These documents were docketed on October 4, 1976 (FSAR), and November 23, 1976 (EI), respectively. Subsequently, the U.S. Nuclear Regulatory Commission (NRC) began the operational safety and environmental reviews. The staff issued the NRC Final Environmental Statement-Operating License (FES-OL) in December 1978 (NRC 1978) to support issuance of operating licenses for the two WBN Plant units. The NRC 1978 FES-OL relied on the applicant's earlier final environmental EIS-CP (TVA 1972) and documented changes in the plant's design and the environment since release of the applicant's 1972 EIS-CP.

About six months before completion of the NRC 1978 FES-OL, Unit 1 was approximately 85% complete, and Unit 2 was approximately 65% complete. Construction delays, however, delayed the completion schedules for both facilities. Unit 1 is currently nearing completion, and the applicant expects to start generating electricity at the unit by mid-1995. The completion of Unit 2 is being reevaluated as part of the applicant's integrated

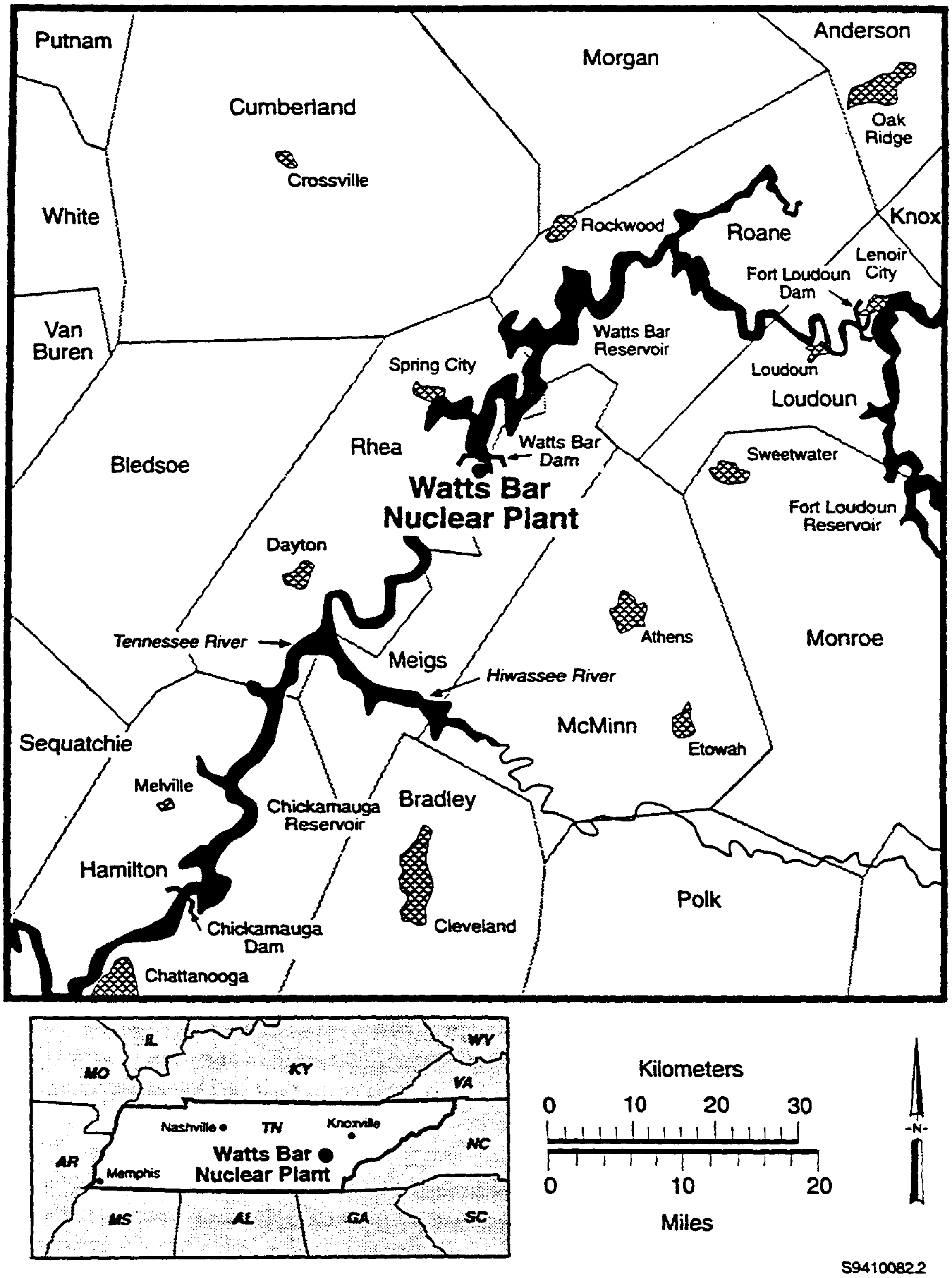

Figure 1.1 Location of the Watts Bar Nuclear Plant

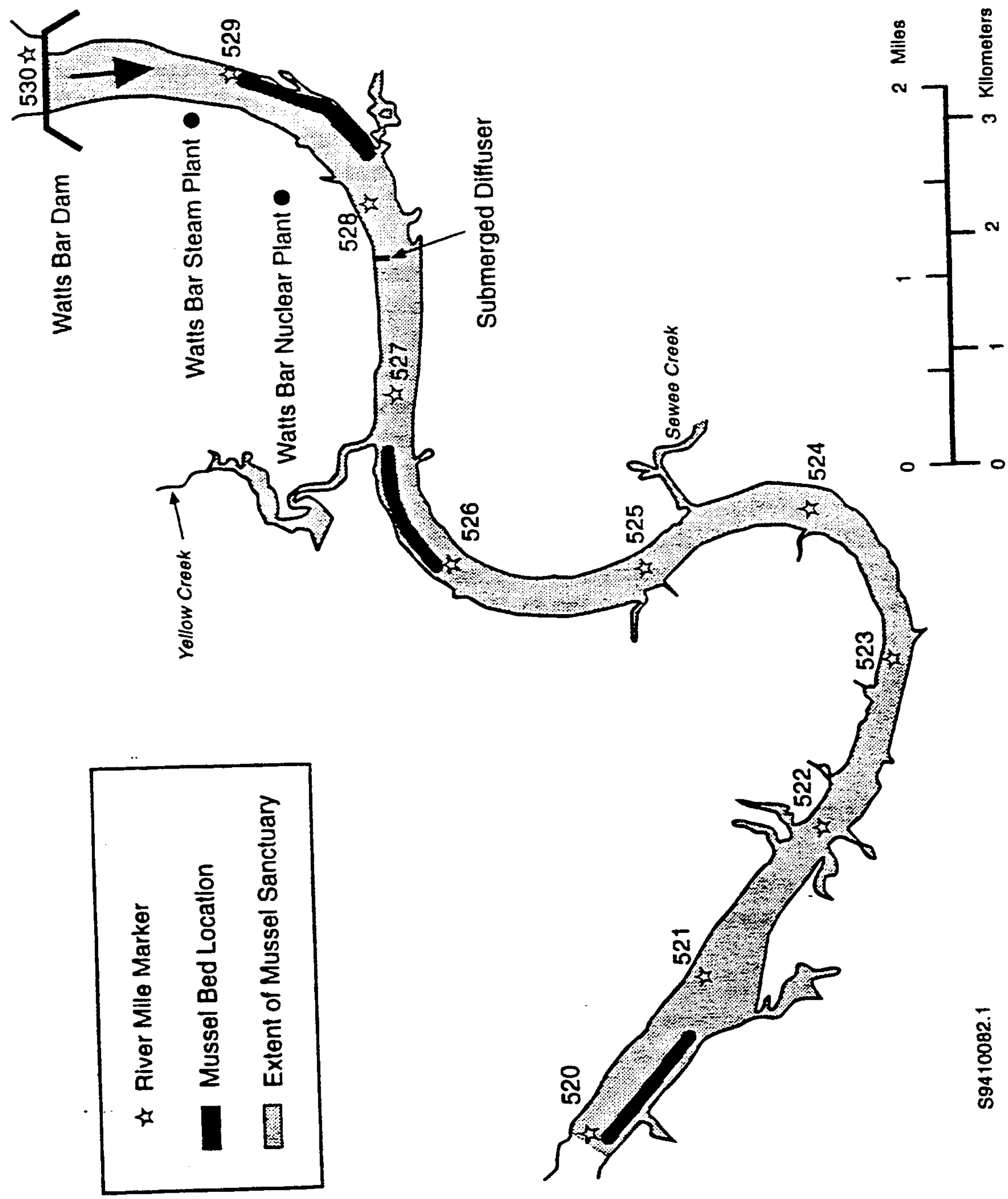

Figure 1.2 Location of the Watts Bar Nuclear Plant and Mussel Sanctuary

resource planning process. Under 10 CFR 51.92(a) the NRC is required to supplement a final environmental statement if the proposed action has not been taken, and (1) there are substantial changes in the proposed action that are relevant to environmental concerns, or (2) there are significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts. Under 10 CFR 51.92(b), the NRC may prepare a supplement when, in its opinion, preparing one will further the purposes of the National Environmental Policy Act (NEPA). To further NEPA, and because of the extended period of time since environmental impacts were last evaluated, the staff decided to prepare a supplement to the NRC 1978 FES-OL. The supplement contains an evaluation of changes to impacts as a result of changes in the environment, plant design, and proposed methods of operation since 1978.

The staff requested that the applicant provide updated environmental information in connection with the anticipated operation of WBN Unit 1 (NRC 1994a). The applicant provided a copy of a report entitled Watts Bar Nuclear Plant, Review of Final Environmental Statement (TVA 1994b). By letter, dated June 21, 1994 (NRC 1994b), the staff asked the applicant to provide additional environmental information to help determine whether the NRC 1978 FES-OL should be supplemented. The applicant responded with their August 5, 1994, submittal (TVA 1994c). The application supplied additional information on September 27, 1994 (TVA 1994d), and on November 4, 1994 (TVA 1994e), in response to the staff's requests for additional information.

The staff has reviewed the NRC 1978 FES-OL and the applicant's submittals, has conducted multidisciplinary environmental site visits, and has met with appropriate Federal and State regulatory and resource agencies. This document is a result of the staff's review. It updates the NRC 1978 FES-OL by focusing on each section of that document. For sections in which no changes have occurred, the reader is referred to the NRC 1978 FES-OL. The material in this document follows the same general order used in the 1978 FES-OL, although some modifications have been made. For issues not previously considered, new sections have been added.

1.2 Environmental Approvals and Consultations

The applicant is required to hold certain Federal, State, and local environmental permits, as well as to meet relevant Federal and State statutory requirements.

The applicant stated (TVA 1994e) that all required Federal, State, and local permits and approvals necessary for plant operation had been obtained and were being renewed as required by the applicable regulations. The permits include various State air permits, a permit for the use of underground storage tanks, a landfill permit, and a U.S. Environmental Protection Agency (EPA) hazardous waste generator permit (TVA 1994e).

In addition, the applicant holds the National Pollution Discharge Elimination System (NPDES) Permit No. TN0020168 from the State of Tennessee (State of Tennessee 1993) for the WBN Plant. The NPDES permit must be renewed every five years. This permit authorizes the discharge of process wastewater involved in, or resulting from, the generation of electric power by thermonuclear fission and associated operations, i.e., steam generator blowdown, cooling tower blowdown, sanitary wastewater, intake screen and strainer backwashes, miscellaneous flows, and storm water runoff from specific outfalls. Permit limits and monitoring requirements are specified in the NPDES permit.

As required by Section 7 of the Federal Endangered Species Act (ESA), the NRC (NRC 1994c) and the applicant have consulted with the U.S. Fish and Wildlife Service (FWS) regarding potential impacts to species listed as threatened or endangered under the ESA. Such consultation is an action separate from preparation of this supplement to the NRC 1978 FES-OL (NRC 1978). Consultation with the FWS is required for all Federal projects with the potential for impacting listed species.

The applicant and the NRC prepared a biological assessment to support consultation and facilitate discussions with the FWS on the WBN Plant (NRC 1994c). This biological assessment described pertinent project components, summarized information about the listed species known to inhabit the vicinity of the WBN Site, and described the potential impacts of the plant's operation on these species. The FWS reviewed the biological assessment and provided the NRC with a biological opinion. Appendix D includes the principal correspondence resulting from the NRC and FWS consultation process (FWS 1995).

1.3 References

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U.S. Fish and Wildlife Service (FWS). 1995. Letter from D. B. Winford, U.S. FWS, to U.S. NRC. March 8, 1995.

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U.S. Nuclear Regulatory Commission (NRC). 1994b. Letter from U.S. NRC to M. O. Medford, TVA. June 21, 1994. Subject: Final Environmental Statement Update.

U.S. Nuclear Regulatory Commission (NRC). 1994c. Letter from U.S. NRC, to L. A. Barclay, U.S. Fish and Wildlife Service. October 28, 1994. Subject: Watts Bar Nuclear Plant Biological Assessment.

2 The Site

This description of the WBN Site includes a discussion of the regional demography of the surrounding area in Section 2.1; the water use, including a description of the current water quality conditions in Section 2.2; the current meteorology of the WBN Site in Section 2.3; the terrestrial and aquatic ecology in Section 2.4; the current background dose levels in Section 2.5; the historical and archeological sites in Section 2.6; and the geology and seismology of the WBN Site in Section 2.7.

2.1 Regional Demography

Changes have been noted in the regional demography of the area surrounding the WBN Plant since the time of publication of the NRC 1978 FES-OL (NRC 1978). Changes in both the population and the region's socioeconomic characteristics are discussed in the following sections.

2.1.1 Population Changes

The estimated population within 80 kilometers (50 miles) of the WBN Plant has increased by 140,000 since the NRC 1978 FES-OL was completed (Table 2.1). The counties closest to the WBN Site, however, have lagged behind the overall population growth in the State of Tennessee (Table 2.2). Much of the population increase has occurred in the region's urban centers, which are at the far edges of the 80-kilometer (50-mile) region surrounding the plant (Figure 2.1, Table 2.1). Figure 2.2 depicts the applicant's population projection for the area surrounding the plant by the year 2040 (TVA 1994a). Appendix C, Tables C.1 and C.2, provides this information in tabular form. For the effect of population changes on radiological exposure impacts, see Section 5.5.2.

2.1.2 Changes in Regional Socioeconomic Characteristics

Per capita and median household incomes have increased in real terms in the counties closest to the WBN Site, although household and per capita incomes have continued to lag behind the Statewide average (Figure 2.3, Table 2.3). Some of the smaller towns in the WBN Site area have developed strip-mall shopping areas in the last 15 years to expand the variety of retail opportunities available to the residents.[a] The ethnic character of the population remained fairly constant between the 1980 and 1990 Censuses (Table 2.4).

(a) Site visit to the Spring City and Dayton areas, September 13, 1994.

Table 2.1 Differences Between Estimated Population in 1978 and 1990, by Distance and Direction From the WBN Plant

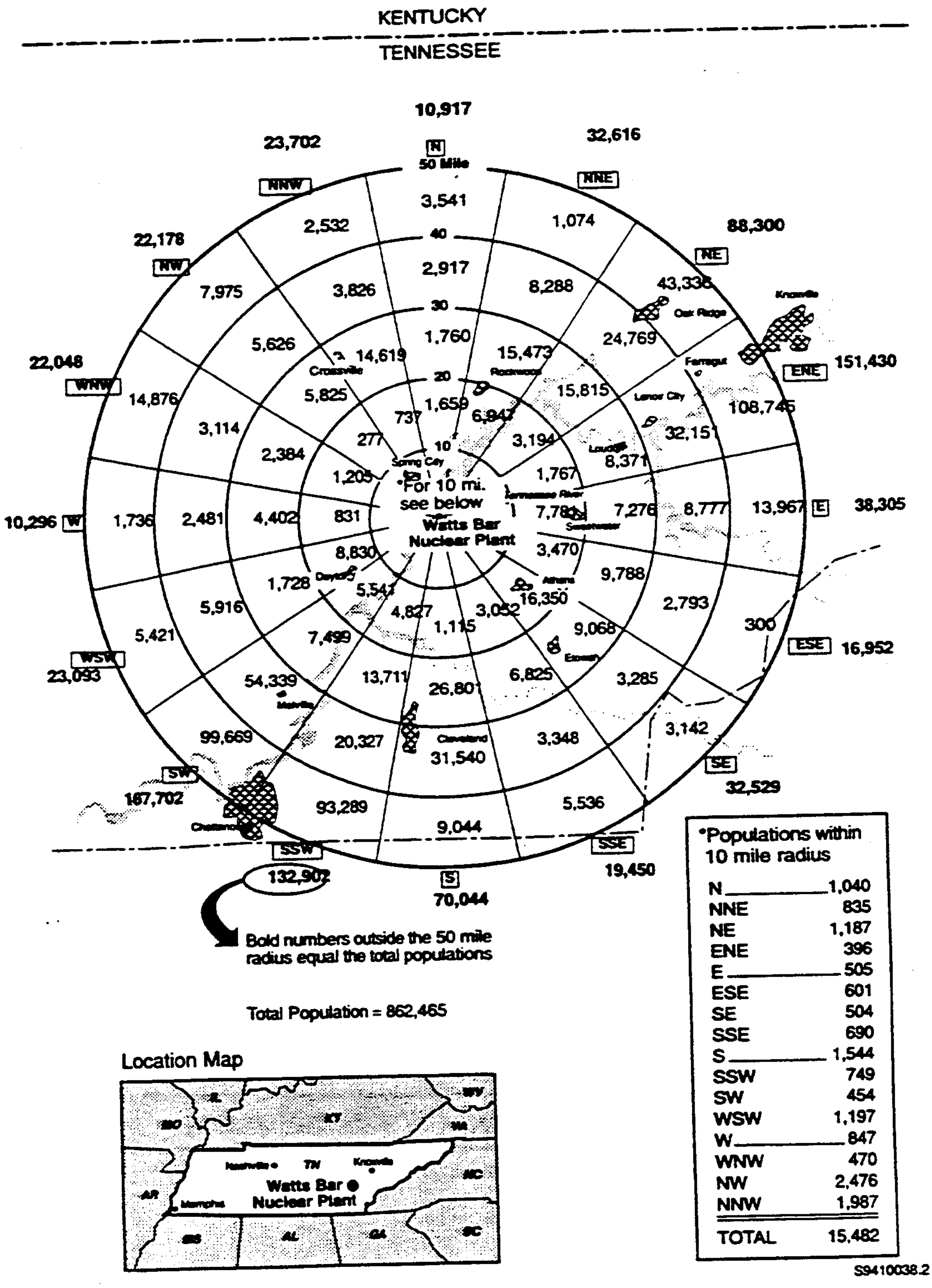
Direction	0-16 km (0-10 mi)	16-32 km (10-20 mi)	32-48 km (20-30 mi)	48-64 km (30-40 mi)	64-82 km (40-50 mi)	Total
N	620	-61	1,445	1,597	361	3,962
NNE	685	-598	-927	1423	189	772
NE	497	1,504	5,170	8,924	131	16,226
ENE	-109	307	26	12,991	27,940	41,155
E	65	931	1,936	3,602	4,837	11,371
ESE	121	755	1,983	-337	180	2,702
SE	99	-1,330	-1,567	1,575	-493	-1,716
SSE	205	292	3,140	473	-924	3,186
S	74	59	11,491	-4,530	4,134	11,228
SSW	333	3,682	6,875	10,767	-5,711	15,946
SW	64	2,971	2,699	33,964	-26,101	13,597
WSW	212	410	803	886	721	3,032
W	312	251	812	1,426	691	3,492
WNW	150	625	-22	454	2,051	3,258
NW	641	-258	4,120	1,966	2,525	8,994
NNW	492	107	3,689	376	-1,298	3,366
Total	4,461	9,647	41,673	75,557	9,233	140,571

Data Sources: 1990 Population: TVA (1994a); 1978 Population: NRC (1978).

Table 2.2 Population Data, Counties Closest to the WBN Plant

	Population			Population Changes			
Location	1980	1990	1992	Change, 1980-1990	Change, 1990-1992	% Change, 1980-1990	% Change, 1990-1992
Anderson County	67,346	68,250	70,525	904	2,275	1.34	3.33
Bledsoe County	9,478	9,669	9,779	191	110	2.02	1.14
Blount County	77,770	85,969	90,400	8,199	4,431	10.54	5.15
Bradley County	67,547	73,712	75,934	6,165	2,222	9.13	3.01
Cumberland County	28,676	34,736	36,743	6,060	11,834	21.13	3.52
Hamilton County	287,740	285,536	288,637	-2,204	3,101	-0.77	1.09
Knox County	319,694	335,749	347,583	16,055	11,834	5.02	3.52
Loudon County	28,553	31,255	33,242	2,702	1,987	9.46	6.36
McMinn County	41,878	42,383	43,552	505	1,169	1.21	2.76
Meigs County	7,431	8,033	8,412	602	379	8.10	4.72
Monroe County	28,700	30,541	31,376	1,841	835	6.41	2.73
Morgan County	16,604	17,300	17,714	696	414	4.19	2.39
Polk County	13,602	13,643	13,903	41	260	0.30	1.91
Rhea County	24,235	24,344	25,270	109	926	0.45	3.80
Roane County	48,425	47,227	48,094	-1,198	867	-2.47	1.84
Sequatchie County	8,605	8,863	9,186	258	323	3.00	3.64
Total (16 counties)	1,076,284	1,117,210	1,150,350	40,934	33,140	3.80	2.97
Tennessee	4,591,000	4,877,000	5,024,000	286,000	147,000	6.23	3.01

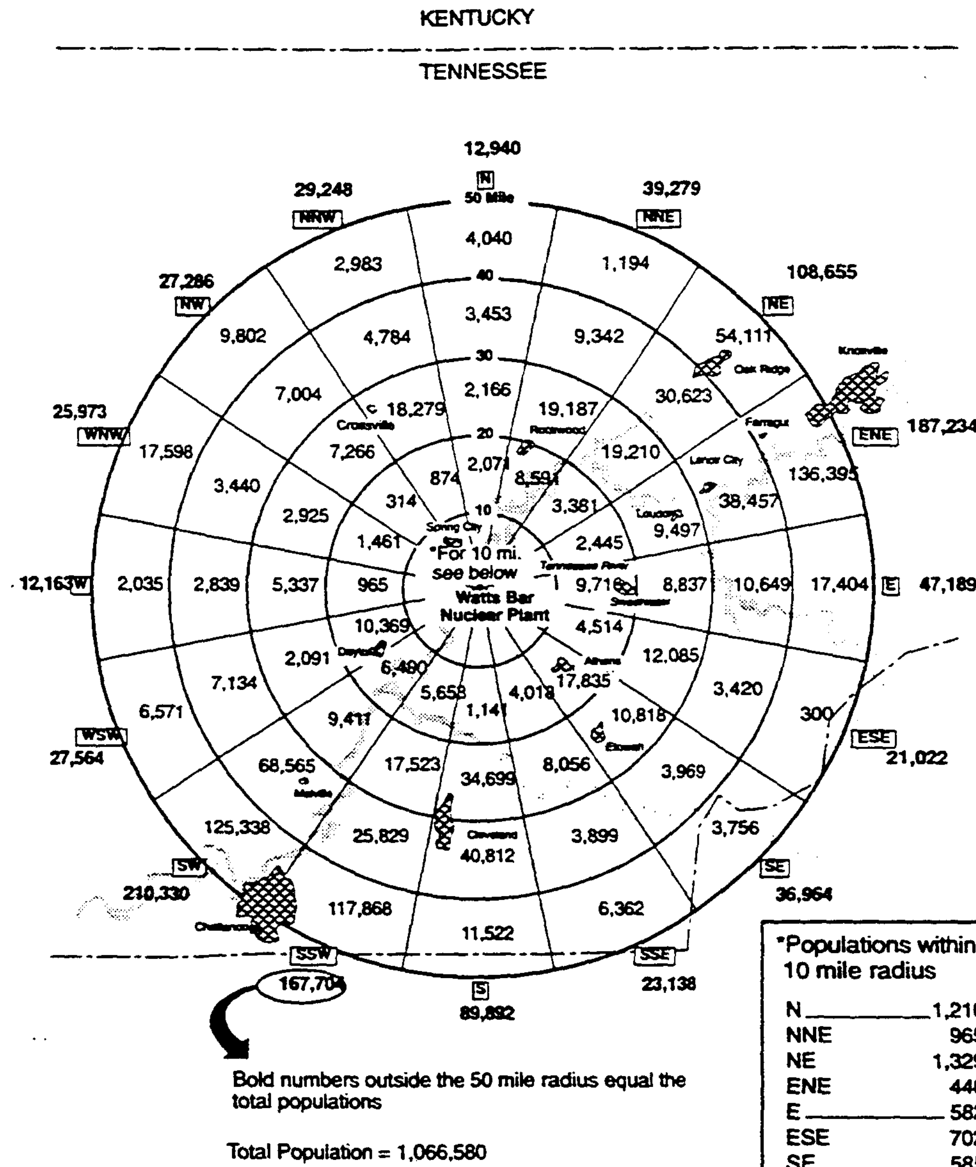
Data Sources: U.S. Department of Commerce 1983, 1992a; TVA 1994d.



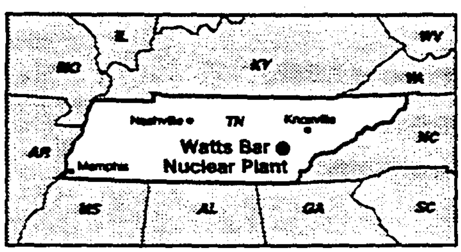
*Populations within 10 mile radius

N	1,040
NNE	835
NE	1,187
ENE	396
E	505
ESE	601
SE	504
SSE	690
S	1,544
SSW	749
SW	454
WSW	1,197
W	847
WNW	470
NW	2,476
NNW	1,987
TOTAL	15,482

Figure 2.1 Population Surrounding the WBN Plant, 1990 (TVA 1994a)



Location Map



*Populations within 10 mile radius	
N	1,210
NNE	965
NE	1,329
ENE	440
E	582
ESE	702
SE	585
SSE	803
S	1,717
SSW	831
SW	526
WSW	1,399
W	987
WNW	550
NW	2,900
NNW	2,328
TOTAL	17,854

S9410038.6

Figure 2.2 Estimated Population Surrounding the WBN Plant, 2040 (TVA 1994a)

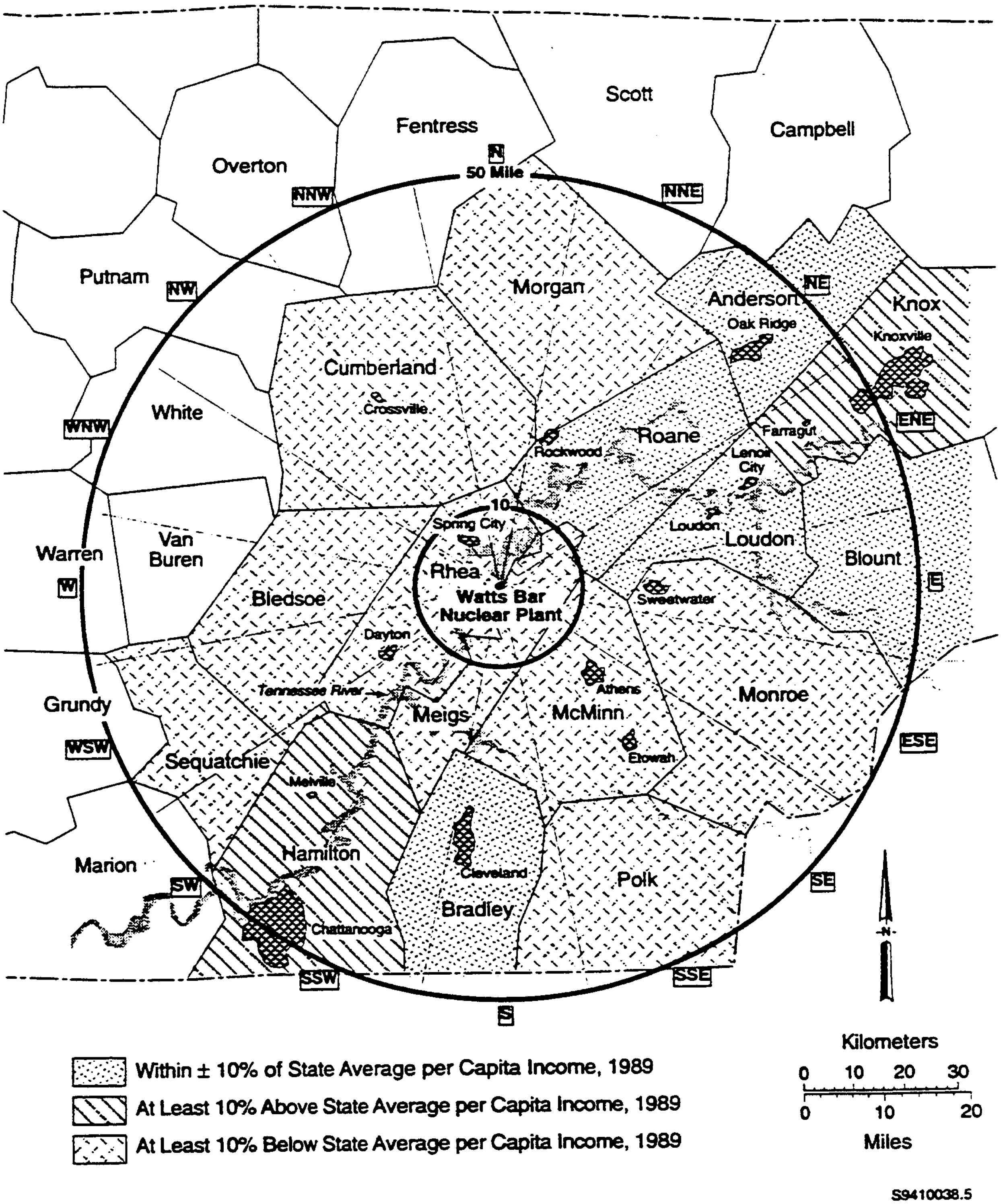


Figure 2.3 Per Capita Personal Income for Counties in the WBN Site Area Compared With the State of Tennessee Average, 1989. Source: U.S. Department of Commerce 1992b

Table 2.3 Personal Income Data, Counties Closest to the WBN Plant Relative to the State of Tennessee, 1980 to 1990

Location	1979 Per Capita Income (1989 dollars)	1989 Per Capita Income (1989 dollars)	1979 Median Household Income (1989 dollars)	1989 Median Household Income (1989 dollars)	Percent of Families Below Poverty Level, 1979	Percent of Families Below Poverty Level, 1989
Anderson County	11,934	13,182	27,478	26,496	11.3	11.5
Bledsoe County	7,677	8,053	18,137	18,250	21.4	16.3
Blount County	11,177	12,674	25,719	25,575	10.4	10.0
Bradley County	10,176	11,768	25,027	25,678	11.0	11.3
Cumberland County	8,501	9,782	19,775	20,474	17.8	14.2
Hamilton County	11,761	13,619	26,805	26,523	10.2	10.2
Knox County	11,777	14,007	25,256	26,010	10.8	10.2
Loudon County	10,294	12,006	23,686	24,258	10.3	10.7
McMinn County	9,891	10,508	23,505	21,901	13.9	14.3
Meigs County	9,413	9,237	24,026	20,181	12.3	18.5
Monroe County	8,489	9,080	20,125	19,932	16.2	15.2
Morgan County	8,118	7,722	18,552	19,280	21.6	15.8
Polk County	7,961	9,311	20,639	21,663	16.7	14.2
Rhea County	8,736	9,333	21,387	19,915	15.6	15.8
Roane County	10,736	12,015	25,929	24,210	10.1	12.2
Sequatchie County	7,794	9,377	18,740	19,223	20.5	19.9
Tennessee	10,612	12,255	24,154	24,807	13.1	12.4

Data Sources: U.S. Department of Commerce 1983, 1992b, 1993

Table 2.4 Minority Population Data, Counties Closest to the WBN Plant

Location	1980 Percent Non-White	1980 Percent Hispanic[a]	1990 Percent Non-White	1990 Percent Hispanic[a]
Anderson County	5.04	0.69	5.33	0.56
Bledsoe County	3.66	1.03	4.42	0.39
Blount County	3.53	0.68	4.03	0.43
Bradley County	4.73	0.77	4.86	0.97
Cumberland County	0.29	0.83	0.75	0.36
Hamilton County	20.12	0.73	20.36	0.68
Knox County	9.54	0.65	10.22	0.62
Loudon County	1.80	0.50	1.67	0.27
McMinn County	5.26	0.33	5.42	0.41
Meigs County	1.61	0.16	1.85	0.21
Monroe County	3.28	0.39	3.21	0.40
Morgan County	1.54	0.42	1.98	0.35
Polk County	0.15	0.53	0.53	0.26
Rhea County	3.51	0.66	3.18	0.54
Roane County	3.40	0.75	3.78	0.45
Sequatchie County	0.46	0.65	0.14	0.28
Total (16 counties)	9.73	0.66	9.91	0.58
Tennessee	16.40	0.74	17.00	0.68

Data Sources: U.S. Department of Commerce 1983, 1992a

(a) Hispanic persons can be of any race

2.2 Water Use

The regional water use (Section 2.2.1), the changes in the surface water hydrology of the plant (Section 2.2.2), and changes in the water quality (Section 2.2.3) are discussed in this section.

2.2.1 Regional Water Use

The NRC 1978 FES-OL described the downstream users of both public and industrial water supplies within 80 kilometers (50 miles) of the plant; it also detailed the water's travel time and dilution factor. According to information supplied by the applicant, the water-use information given in the NRC 1978 FES-OL is no longer current (TVA 1994b). Additional downstream water users have been identified (Table 2.5). The only water user between the WBN Plant and the Watts Bar Dam is the Watts Bar Steam Plant. The Watts Bar Steam Plant has not operated since 1983 (TVA 1994c).

2.2.2 Surface Water Hydrology

Changes related to surface-water hydrology since the NRC 1978 FES-OL include a decision to retain two temporary chemical holding ponds that are still being used to contain and treat chemicals from the turbine building (TVA 1994c). The smaller of the two ponds is lined and has a volume of 3800 cubic meters (1 million gallons). The larger pond is unlined and has a volume of almost 19,000 cubic meters (5 million gallons). The ponds discharge via Outfall 107 to the large yard holding pond. This discharge is monitored in accordance with the plant's NPDES permit (State of Tennessee 1993).

A 9500 cubic meter (2.5 million gallon) evaporation/percolation pond was constructed by the applicant and used for the treatment and disposal of spent trisodium phosphate cleaning wastes, a residual of the preoperational cleaning of Units 1 and 2 (TVA 1994c). This pond does not discharge by an outfall. The groundwater is being monitored by a well downgradient of the pond (TVA 1990a). Discharges from the ponds have not affected and are not expected to affect public water supplies. The pond is no longer used, and the applicant plans to close the pond, push in the berm walls, and cap and revegetate the area. No date has been set for closing the evaporation/percolation pond; the applicant is waiting for State approval to close the pond.

The construction runoff holding pond will remain in service, rather than being leveled and graded as indicated in the NRC 1978 FES-OL. The construction runoff holding pond is used to collect discharge water from an onsite sewage treatment plant; from the heating, ventilating, and air conditioning cooling water system at the WBN Training Center; from fire protection wastewater; and from site storm-water runoff. The discharge via Outfall 112 to an unnamed tributary of Yellow Creek is monitored in accordance with the NPDES permit (State of Tennessee 1993).

Table 2.5 Dilution Factors and Travel Times for Downstream Water Users Within an 80-Kilometer (50-Mile) Radius of the WBN Plant (TVA 1994b)

Water Users	Location	Travel Time (days)	Dilution Factor
Watts Bar Nuclear Plant	TRM 528.8R[a]	N/A	N/A
Dayton, TN	TRM 503.8R	1.8	204
Soddy-Daisy Falling Water U.D.	TRM 487.2R Soddy CK 4.0	3.0	272
Sequoyah Nuclear Plant	TRM 483.6R	3.3	282
East Side Utility	TRM 473.0	4.0	307
U.S. Army Volunteer Ammunition Plant	TRM 473.0L[b]	4.0	307
Chickamauga Dam	TRM 471.0	4.2	[c]
E. I. DuPont Company	TRM 469.9R	4.2	[c]
Tennessee-American Water	TRM 465.3L	4.6	[c]
Rock-Tennessee Mill	TRM 463.5R	4.7	[c]
Dixie Sand and Gravel	TRM 463.2R	4.7	[c]
Chattanooga Missouri Portland Cement	TRM 456.1R	5.2	[c]
Signal Mountain Cement	TRM 454.2R	5.4	[c]
Raccoon Mountain Pump Storage	TRM 444.7L	6.1	[c]
Signal Mountain Cement	TRM 433.3R	6.9	[c]
Nickajack Dam	TRM 424.7	7.5	[c]
South Pittsburgh, TN	TRM 418.0R	8.0	[c]
Bridgeport, AL	TRM 413.6R	8.3	[c]
Widows Creek Steam Plant	TRM 407.7R	8.7	[c]
Mead Corporation	TRM 405.2R	8.9	[c]

(a) Right bank
(b) Left bank
(c) River is assumed to be fully mixed downstream of the Chickamauga Dam; dilution factor equals 448.

The applicant maintains a general storm-water permit for industrial sources that contains requirements for erosion and sedimentation controls, including inspections, corrective actions, and annual sampling. The applicant has indicated (TVA 1994c) that it has implemented all requirements for erosion and sedimentation controls.

2.2.3 Water Quality

The staff reviewed the information submitted by the applicant and concludes that it provides an adequate characterization of the water quality in the Tennessee River in the vicinity of the WBN plant. In its August 5, 1994, submittal (TVA 1994c), the applicant stated that the information and analyses of water quality in the Tennessee River in the vicinity of the WBN Plant had not significantly changed from that discussed in the NRC 1978 FES-OL. The staff's review of the data supports the applicant's conclusion that there have not been any measurable changes in the water quality for this part of the river.

The NRC 1978 FES-OL characterized the water quality in the Tennessee River in the vicinity of the WBN Plant as "effluent limited." Additional data collected since 1978 support this characterization (TVA 1993). To illustrate current water quality conditions in the vicinity of the WBN Site, the following sections summarize the applicant's 1993 "Summary of Vital Signs and Use Suitability Monitoring on Tennessee Valley Reservoirs" (TVA 1993) for the Watts Bar and Chickamauga Reservoirs. Data cited in this section without reference originates with this document. Water quality conditions were commonly measured in the forebay (the section of the reservoir immediately above the dam), the tailrace (the section of the river immediately below the dam), and the transition zone (the section of the river between the tailrace and the location where the river flow is unmodified by the dam). Section 5.2.5 contains a discussion of the impact of water quality changes since the NRC 1978 FES-OL.

Because the WBN Plant is located just two miles downstream of the Watts Bar Dam (see Figure 1.1), most of the water entering and passing the plant comes from the Watts Bar Reservoir. For this reason, water quality measurements from Watts Bar Reservoir are provided below. The most relevant set of data is the Watts Bar Reservoir forebay data, as the forebay is nearest the WBN Plant. However, because the WBN Plant could potentially affect downstream biota, data measured in the Chickamauga Reservoir (where the plant is actually located) are also provided. In this case, data taken at the Chickamauga Reservoir tailrace and transition zone sites are most relevant.

Temperature

The NRC 1978 FES-OL did not address the normal range of surface-water temperature in the Tennessee River in the vicinity of the WBN Site. Surface-water temperatures, as indicated by subsequent monitoring of Watts Bar Reservoir during April-September 1993, ranged from a minimum of 18.3°C (64.9°F) in April to a maximum of 30.2°C (86.4°F) in July in the forebay and from 16.7°C (62.1°F) to 29.8°C (85.6°F) for the same months at the transition zone. The State of Tennessee's maximum water temperature criterion for the protection of fish and aquatic life is 30.5°C (86.9°F).

Monitoring of Chickamauga Reservoir surface-water temperatures during the same time period resulted in a range of 17°C (62.6°F) to 31.7°C (89.1°F) at the forebay, 16.2°C (61.2°F) to 30.1°C (86.2°F) at the transition zone, and 19.1°C (66.4°F) to 28.8°C (83.8°F) in the Hiwassee River embayment.

Dissolved Oxygen

The NRC 1978 FES-OL contained a discussion of dissolved oxygen concentrations in the Tennessee River in the vicinity of the WBN Site. Current values for Watts Bar Reservoir dissolved oxygen concentrations at the 1.5-meter (4.9-foot) depth ranged from a low of 6.5 milligrams per liter (6.5 parts per million) in September to a high of 12.6 milligrams per liter (12.6 parts per million) in April at the forebay, and from 7.1 milligrams per liter (7.1 parts per million) to 11.3 milligrams per liter (11.3 parts per million) for the same months at the transition zone. A minimum dissolved oxygen concentration of 3.9 milligrams per liter (3.9 parts per million) was recorded in September at the inflow sampling site on the Tennessee River arm of the Watts Bar Reservoir (i.e., the tailrace of the Fort Loudoun Dam). This low value is related to low oxygen levels in the water released through the dam. A minimum dissolved oxygen concentration of 6.3 milligrams per liter (6.3 parts per million) was recorded in March at the inflow sampling site on the Clinch River arm of Watts Bar Reservoir (i.e., the tailrace of Melton Hill Dam). Tennessee's minimum dissolved oxygen criterion for the protection of fish and aquatic life is 5.0 milligrams per liter (5.0 parts per million), measured at the 1.5-meter (4.9 feet) depth.

Dissolved oxygen concentrations in Chickamauga Reservoir at the 1.5-meter depth ranged from a low of 6.9 milligrams per liter (6.9 parts per million) in September to a high of 11.4 milligrams per liter (11.4 parts per million) in April at the forebay, from 5.7 milligrams per liter (5.7 parts per million) in September to 10.3 milligrams per liter (10.3 parts per million) in April at the transition zone, and from 7.3 milligrams per liter (7.3 parts per million) in August to 9.9 milligrams per liter (9.9 parts per million) in April at the sampling location in the Hiwassee River embayment. A minimum dissolved oxygen concentration of 3.7 milligrams per liter (3.7 parts per million) was recorded in August at the inflow sampling site (i.e., the tailrace of the Watts Bar Dam).

Data on temperature and dissolved oxygen show that Watts Bar Reservoir developed a moderate degree of both thermal and oxygen stratification throughout most of the summer of 1993. Data on the dissolved oxygen concentration versus the depth show that a strong gradient also develops in Watts Bar Reservoir, particularly from June through August. Near-bottom dissolved oxygen concentrations in the hypolimnion (the lowermost, noncirculating layer of cold water) were less than 2 milligrams per liter (2 parts per million) at the forebay in June and July. Additionally, the proportion of the hypolimnion with low dissolved oxygen concentrations (i.e., less than 2 milligrams per liter [2 parts per million]) averaged about 13% of the total cross-sectional area, higher than in any other Tennessee River reservoir. The minimum observed dissolved-oxygen concentration in Watts Bar Reservoir in 1993 was 0.6 milligram per liter (0.6 part per million) at the bottom of the forebay in July, but dissolved oxygen concentrations were never less than 4 milligrams per liter (4 parts per million) at the transition zone.

Chickamauga Reservoir temperature data depict seasonal warming and weak thermal stratification from May through July. Data on dissolved oxygen concentration versus depth show a strong gradient at the forebay and transition zones in June and July. In July, a minimum dissolved oxygen concentration of less than 0.1 milligrams per liter (0.1 parts per million) was measured on the bottom at the transition zone.

pH

The NRC 1978 FES-OL reported pH levels that ranged from 6.8 to 8.5 in the Tennessee River in the vicinity of the WBN Plant. Historically, the pH levels of the water in the Watts Bar Reservoir have been higher than other Tennessee River sampling sites. This is due to addition of the cool, well-oxygenated, nitrate-rich, hard water of the Clinch River, which combines with the Tennessee River (and Watts Bar Reservoir) at TRM 567.9, about 11 kilometers (7 miles) upstream from the transition zone sampling site. In the summer of 1993, pH values ranged from 6.8 to 9.0 throughout Watts Bar Reservoir. During much of the April-September sampling period, near-surface values frequently exceeded a pH level of 8.5 at both the forebay and transition zone, with dissolved oxygen saturation values commonly exceeding 100%, indicating high rates of photosynthesis. Tennessee's criterion for the protection of fish and aquatic life is a maximum pH level of 8.5.

Values of pH ranged from 6.8 to 8.8 in Chickamauga Reservoir. Near surface pH values exceeding 8.5 and dissolved oxygen saturation values exceeding 100% were observed on only two occasions (April and July), both at the forebay. Both of these periods of high pH and high oxygen saturations were also coincident with high chlorophyll *a* concentrations, indicative of periods of high photosynthetic activity.

Phosphorus

The NRC 1978 FES-OL reported total phosphorus levels ranging from less than 0.01 milligram per liter (<0.01 part per million) to 0.05 milligram per liter (0.05 part per million). The average total phosphorus concentrations observed in Watts Bar Reservoir (0.029 milligram per liter [0.029 part per million] at the forebay and 0.035 milligram per liter [0.035 part per million] at the transition zone) were among the lowest for the monitoring locations in 1993. In addition, the average dissolved ortho-phosphorus concentrations of 0.007 milligram per liter (0.007 part per million) and 0.004 milligram per liter (0.004 part per million) at the forebay and transition zones, respectively, were also among the lowest observed at any of the Tennessee River vital signs monitoring locations in 1993. Total nitrogen/total phosphorus ratios in Watts Bar Reservoir are higher than on any other Tennessee River reservoir. The low phosphorus concentrations in combination with the relatively high nitrogen concentrations (supplied by both the Clinch and Tennessee River inflows) cause the high total nitrogen/total phosphorus ratios in Watts Bar Reservoir (particularly at the transition zone) and suggest that the productivity of some aquatic vegetation may occasionally be limited by phosphorus.

Total nitrogen, total phosphorus, and dissolved ortho-phosphorus were low in the Tennessee River portion of Chickamauga Reservoir. Total nitrogen averaged only 0.37 milligram per liter (0.37 part per million) at the forebay, the lowest total nitrogen concentration measured at any of the Tennessee River sampling sites in 1993. Total phosphorus and dissolved ortho-phosphorus concentrations averaged only about 0.026 milligram per liter

(0.026 part per million) and 0.005 milligram per liter (0.005 part per million) at both the forebay and transition zone, respectively, and were among the lowest total phosphorus and dissolved ortho-phosphorus concentrations measured at any of the Tennessee River sampling sites. Because of these low concentrations and the resulting high total nitrogen/total phosphorus ratios, periods of phosphorus limitation on algal productivity were likely to have occurred.

Chlorophyll *a*

The NRC 1978 FES-OL reported the levels of chlorophyll *a* in the Tennessee River in the vicinity of the WBN Plant. In 1993, the highest chlorophyll *a* concentrations in Watts Bar Reservoir were measured in August at the forebay (10 micrograms per liter [10 parts per billion]) and in May at the transition zone (11 micrograms per liter [11 parts per billion]). Surface concentrations of chlorophyll *a* in 1993 averaged about 7 micrograms per liter (7 parts per billion) at the forebay and about 8 micrograms per liter (8 parts per billion) at the transition zone.

Chickamauga Reservoir chlorophyll *a* concentrations averaged 8.5 micrograms per liter (8.5 parts per billion), 7.8 micrograms per liter (7.8 parts per billion), and 5.5 micrograms per liter (5.5 parts per billion), at the forebay, transition zone, and Hiwassee River embayment, respectively.

Sediment

The NRC 1978 FES-OL did not address water that is mixed with the sediments in the Tennessee River in the vicinity of the WBN Plant. Chemical analysis of sediments in the Watts Bar Reservoir forebay in 1993 indicated elevated levels of non-ionized ammonia (240 micrograms per liter [240 parts per billion]) in the water that is intermixed in the sediments. Although the non-ionized form of ammonia (NH_3) is 300 to 400 times more toxic than the ionized form (NH_4^+), fish are more tolerant of its effects in high-pH conditions, such as those found in Watts Bar Reservoir. Traces of chlordane (18 micrograms per liter [18 parts per billion]) and mercury were detected at the transition zone. Mercury levels were slightly elevated (0.72 milligram per kilogram [0.72 part per million]), but they were still at a level below sediment-quality guidelines for mercury (i.e., 1.0 milligram per kilogram [1.0 part per million]). The most likely source of this contamination is past operations at Oak Ridge National Laboratory where major environmental cleanup activities are now under way (TVA 1993). Using rotifers and daphnids, toxicological screening of sediment pore water found indications of acute toxicity (40% survival for each organism) in the Watts Bar Reservoir forebay. The forebay sediment water was also found to be toxic to rotifers in 1992. Particle-size analysis showed sediments from the forebay area consisted of nearly 100% silt and clay grain-size particles. Sediments containing smaller grain-size particles are associated with higher organic content and generally bind larger amounts of trace metals; this may partly explain the high levels of contaminants found in the water located in the forebay sediments.

As in 1990, 1991, and 1992, chemical analyses of sediments from Chickamauga Reservoir in 1993 found high levels of copper (64 milligrams per kilogram [64 parts per million]) and zinc (320 milligrams per kilogram

[320 parts per million]). High levels of copper (50 milligrams per kilogram [50 parts per million]) were also found in the Hiwassee River embayment, which was sampled for the first time in 1993. Chlordane was also detected in the Chickamauga Reservoir forebay (16 micrograms per gram [16 parts per million]) and the transition zone (15 micrograms per gram [15 parts per million]). Toxicity tests indicated no acute toxicity to either daphnids or rotifers from the three sites tested, but survival of rotifers (75% survival) was reduced in the transition zone. Toxicity to rotifers was detected in both forebay and transition zone samples in 1992. Sediment particle size analysis showed sediments from the forebay were 97% silt and clay, sediments from the transition zone were 86% silt and clay and 14% sand, and sediments from the Hiwassee River embayment were 63% silt and clay and 37% sand.

Fecal Coliform Bacteria

The NRC 1978 FES-OL addressed fecal coliform levels in the Tennessee River in the vicinity of the WBN Site. These levels ranged from fewer than 10 to 20 bacteria per 100 milliliters (3.4 ounces). Fourteen swimming areas in the vicinity of the WBN Plant were tested for fecal coliform bacteria 12 times each in 1993. Four sites had one or more samples exceeding 1000 bacteria per 100 milliliters (3.4 ounces), which is Tennessee's maximum concentration allowable for a single sample. Samples from these swimming areas were collected after a rainfall when bacteria concentrations are generally higher. Only 3 of the 14 swimming areas had very low geometric mean concentrations for all samples (<20 bacteria per 100 milliliters [3.4 ounces]), a lower concentration than in other Tennessee River reservoirs.

No bacteriological studies were conducted at recreation sites in Chickamauga Reservoir in 1993. However, 1993 fecal coliform bacteria concentrations at the monthly Vital Signs locations, the forebay, transition zone, and Hiwassee River embayment were all 10 bacteria per 100 milliliters (3.4 ounces) or less, except for one sample at the Hiwassee River Embayment that had a concentration of 300 bacteria per 100 milliliters (3.4 ounces).

Poly-Chlorinated Biphenyls

The NRC 1978 FES-OL did not address poly-chlorinated biphenyls (PCBs). Fish from the Watts Bar Reservoir have been under intensive investigation for several years because of PCB contamination. The Tennessee Department of Environment and Conservation has advised the public not to eat certain species of fish from Watts Bar Reservoir and to limit consumption of other species. Four of these species (channel catfish [*Ictalurus punctatus*], sauger [*Stizostedion canadense*], white bass [*Morone chrysops*], and striped bass [*Morone saxitalis*], including striped bass/white bass hybrids) were reexamined in autumn 1992. Average PCB concentrations among sample sites ranged from 0.4 to 1.9 micrograms per gram (0.4 to 1.9 parts per million) for channel catfish (five sites), 1.0 to 1.1 micrograms per gram (1.0 to 1.1 parts per million) for striped bass (two sites), 0.2 to 0.6 microgram per gram (0.2 to 0.6 part per million) for sauger (three sites), and the average for white bass at a single location was 0.7 microgram per gram (0.7 part per million).

There are no fish consumption advisories in effect for Chickamauga Reservoir, where the WBN Plant is located. Screening studies on channel catfish were conducted in 1991 and 1992, and samples were analyzed for a broad array of contaminants, including PCBs. Average PCB concentrations in 1991 were 0.4, 0.7, and 1.2 micrograms per gram (0.4, 0.7, and 1.2 parts per million) at the forebay, transition and tailrace zones, respectively. In 1992, average PCB concentrations were 0.6, 0.7, and 0.7 microgram per gram (0.6, 0.7, and 0.7 part per million) in the respective zones. Low or nondetectable concentrations of other contaminants were found in samples collected in both years.

2.3 Meteorology

This section supplements the description of regional and local climatology and meteorology of the WBN Site contained in the NRC 1978 FES-OL using data collected by the National Weather Service and the applicant since 1978. In addition, this section presents the staff evaluation of atmospheric dispersion using 20 years of onsite meteorological data.

2.3.1 Regional Climate

The NRC 1978 FES-OL and the NRC Safety Evaluation Report (SER) (NRC 1982a) for the WBN Site describe the general climate of the Great Tennessee Valley and of the WBN Site. These descriptions are based on records that date from the beginning of the twentieth century for Chattanooga, Knoxville, and other locations. These records provide an adequate representation of regional climatic conditions; additional information is unlikely to show significant changes in such climatological parameters as prevailing wind direction, mean winc speed, or annual precipitation.

Record extreme values for minimum temperature, maximum 24-hour rain and snowfall, and monthly precipita tion have been exceeded at Chattanooga since completion of the NRC 1978 FES-OL (TVA 1994c). The appli cant concludes (TVA 1994c) that these changes do not affect the environmental impact conclusions in the NR(1978 FES-OL. The staff concurs that meteorological observations do not show a significant change in the regional or local climates since the preparation of the NRC 1978 FES-OL. Therefore, the staff concludes that the climatological description in the NRC 1978 FES-OL is adequate.

2.3.2 Severe Weather

The applicant states that severe weather statistics for the region related to hail, high winds, thunderstorms, an ice storms are consistent with those presented in the NRC 1978 FES-OL (TVA 1994c). The tornado strike probability stated in the NRC 1978 FES-OL is 0.00076 per year (76 chances in 100,000 of a tornado strikinş the WBN Site in any given year) with a recurrence interval of 1300 years. The applicant has updated its estimate of the tornado strike probability and recurrence interval. The applicant's current estimate of tornado strike probability, based on a longer period and a smaller area, is 0.00015 per year (15 chances in 100,000 c tornado striking the WBN Site in any given year) with a recurrence interval of 6,755 years (TVA 1994a). The staff independently estimates the tornado strike probability to be about 0.00018 per year (18 chances in 100,000 of a tornado striking the WBN Site in any given year) with a recurrence interval of about 5,400 years. The staff's estimate is based on the methodology of WASH-1300 (Markee, Beckerly, and Sanders 1974) as implemented in the Tornado Computer Code (Schreck and Sandusky 1982) and tornado data summarized in NUREG/CR-4461 (Ramsdell and Andrews 1986). The applicant's current estimate and the staff's estimate of tornado strike probability are lower than the estimate in the NRC 1978 FES-OL and are not significantly different.

2.3.3 Local Meteorological Conditions

The applicant submitted onsite meteorological data covering the period from January 1974 through December 1993 (TVA 1994d). Analysis of these data shows that the meteorological conditions at the WBN Site are generally consistent with conditions expected on the basis of the regional climatology. Winds tend to be light and flow up and down the Tennessee River valley. The stable atmospheric conditions that occur at night are accompanied by light winds that are driven by local conditions rather than the up and down valley flow. Neutral atmospheric stability conditions may occur at any time of the day and are prevalent during the transition between day and night. During neutral conditions, the winds at the plant tend to be aligned with the prevailing valley flow.

Analysis of the data shows that extremely unstable conditions have the highest average wind speeds during the 20-year period of onsite data collection at the WBN Site. High wind speeds are expected to be associated with neutral stability conditions. The applicant submitted information that shows the highest wind speeds during unstable conditions were associated with winds from the south-southwest (TVA 1994b). South-southwest winds have the highest frequency of occurrence of any wind direction. This information also shows that the frequencies of calm winds and winds in the 0.3 to 0.6 meter per second (0.6 to 1.4 miles per hour) wind speed class during extremely unstable atmospheric conditions (stability classes A and B) are lower than expected.

On the basis of the staff's visit to the WBN Site, a review of additional meteorological data submitted by the applicant, an examination of an aerial photograph of the plant site, and consideration of the physical processes involved, the staff concludes that the association between the high average wind speeds and extremely unstable atmospheric conditions is probably caused by two factors. The first factor is general overturning of the atmosphere during unstable conditions that prevents wind speeds from decreasing to the lowest speed classes. As a result, there are essentially no occurrences of low wind speed to reduce the average wind speeds for the extremely unstable stability classes.

The second factor is related to the performance of the parameter used to approximate atmospheric stability conditions: temperature difference. The temperature difference parameter performs satisfactorily under homogeneous atmospheric conditions. Under the condition described above, a complex atmospheric vertical structure (multiple boundary layers) sets up and the temperature measurement points reflect significantly different conditions; consequently, the parameter does not perform well.

The shift in stability class is not significant because it occurs under conditions associated with relatively good dispersion and occurs infrequently.

2.3.4 Atmospheric Dispersion

Data from the applicant's meteorological system located at the WBN Site (see Section 6.1.1) have been used to estimate atmospheric dispersion characteristics for the WBN Plant (NRC 1978, 1982a; TVA 1994a). The applicant has submitted meteorological data covering the 20-year period from January 1974 through December 1993 (TVA 1994d). Data summaries for this period show a larger fraction of calm conditions (wind speeds below the anemometer threshold) and a lower annual average wind speed than seen in data used in the dispersion calculations presented in the NRC 1978 FES-OL and the applicant's FSAR (TVA 1994a).

The staff conducted an independent evaluation of the dispersion conditions using the 20-year meteorological data set and the method described in Regulatory Guide 1.111 (NRC 1977). The evaluation assumed ground-level releases, a building cross-sectional area of 1800 square meters (20,000 square feet) and a terrain adjustment factor of 1.5. Neither deposition nor decay was considered. The results of the dispersion estimates for the exclusion area boundary (1250 meters [0.77 mile]) and the outer radius of the low population zone (4828 meters [3 miles]) to the southeast of the plant are shown in Table 2.6. The southeast sector was selected for the analysis because the applicant indicates that it is the sector with maximum normalized concentration values (TVA 1994a). Table 2.6 also compares the staff's dispersion estimates with previously reported values.

The longer periods of record for the meteorological data used in the atmospheric dispersion calculations performed by the staff and by the applicant for the FSAR (TVA 1994a) provide more representative estimates of the meteorological conditions than the two-year period of record used in atmospheric dispersion calculations fc the NRC SER (NRC 1982a) and the NRC 1978 FES-OL. The results of the staff analysis based on 20 years oi record, including the most recent five-year period, are not significantly different from the results of the

Table 2.6 Maximum-Sector Normalized Concentration Estimates for the Exclusion Area Boundary and Low Population Zone in the 22.5° Sector Southeast of the WBN Site

		Normalized Concentration (seconds per cubic meter)			
Boundary	**Period**	**Staff**	**FSAR**	**NRC WBN SER**	**NRC 1978 FES-OL**
Exclusion Area Boundary	Annual	1.1×10^{-5}	1.0×10^{-5}	N/A	5.0×10^{-5}
Low Population Zone	Annual	1.7×10^{-6}	1.5×10^{-6}	7.8×10^{-7}(a)	N/A

(a) Estimated on the basis of the 0-8 hour and 4- to 26-day values using the method described in Regulatory Guide 1.145 (NRC 1982b).

analysis presented in the applicant's FSAR. The applicant has submitted an amendment to its FSAR that incorporates dose calculations based on the full 20 years of meteorological data (TVA 1995a). The staff concludes that the applicant's meteorological data provide an adequate basis for estimating atmospheric dispersion characteristics for this supplement. The staff further concludes that the dispersion estimates are representative of the WBN Site and are acceptable for use in dose calculations.

2.4 Ecology

An understanding of the ecology of the WBN Site plays an important role in assessing the impact of the WBN Plant on the surrounding environment. The terrestrial and aquatic ecology of the area surrounding the WBN Plant are described in Sections 2.4.1 and 2.4.2, respectively.

2.4.1 Terrestrial Ecology

The NRC 1978 FES-OL stated that, prior to being acquired by the applicant, the area of the WBN Site was used for agriculture. The current environment at the station consists primarily of industrial areas surrounded by undisturbed wildlife habitat, with no areas identified as critical habitat for terrestrial species protected under the Federal ESA. Additional data (TVA 1994c) have identified several marshy forested wetlands southwest of the WBN Site. Wetlands are protected by Executive Order 11990, "Protection of Wetlands," 42 FR 26961 (1977).

Approximately 300 kilometers (185 miles) of transmission lines are associated with the WBN Site (TVA 1994d), as shown in Figure 2.4. All lines were in place when the NRC 1978 FES-OL was prepared. The rights-of-way cover approximately 14.6 square kilometers (3621 acres), of which 7.2 square kilometers (1769 acres) are forested, 6.2 square kilometers (1534 acres) are agricultural, 1 square kilometer (238 acres) is urban, and the remaining areas are industrial, barren, or over water (TVA 1994d). Forested areas are those generally found within the Ridge and Valley Province, with an oak-chestnut climax type (TVA 1976). The forested and agricultural regions provide habitat for a variety of game species, including white-tailed deer (*Odocoileus virginiana*), cottontail rabbits (*Sylvilagus floridanus*), and northern bobwhite (*Colinus virginianus*).

The NRC 1978 FES-OL, on the basis of the TVA 1972 EIS-CP (TVA 1972), identified only two federally designated terrestrial species known to inhabit the station area: a spider lily (*Hymenocallis occidentalis*) and the southern bald eagle (*Haliaeetus leucocephalus*).

Prior to enactment of the ESA in 1973, the spider lily was listed by the U.S. Forest Service, Southern Region, in 1972 as a species of concern. This species, however, is not currently listed as an endangered, threatened, or candidate species under the ESA, nor is it currently listed as a species of concern by the State of Tennessee. Therefore, this species is not afforded State or Federal legal protection. Additionally, surveys conducted in

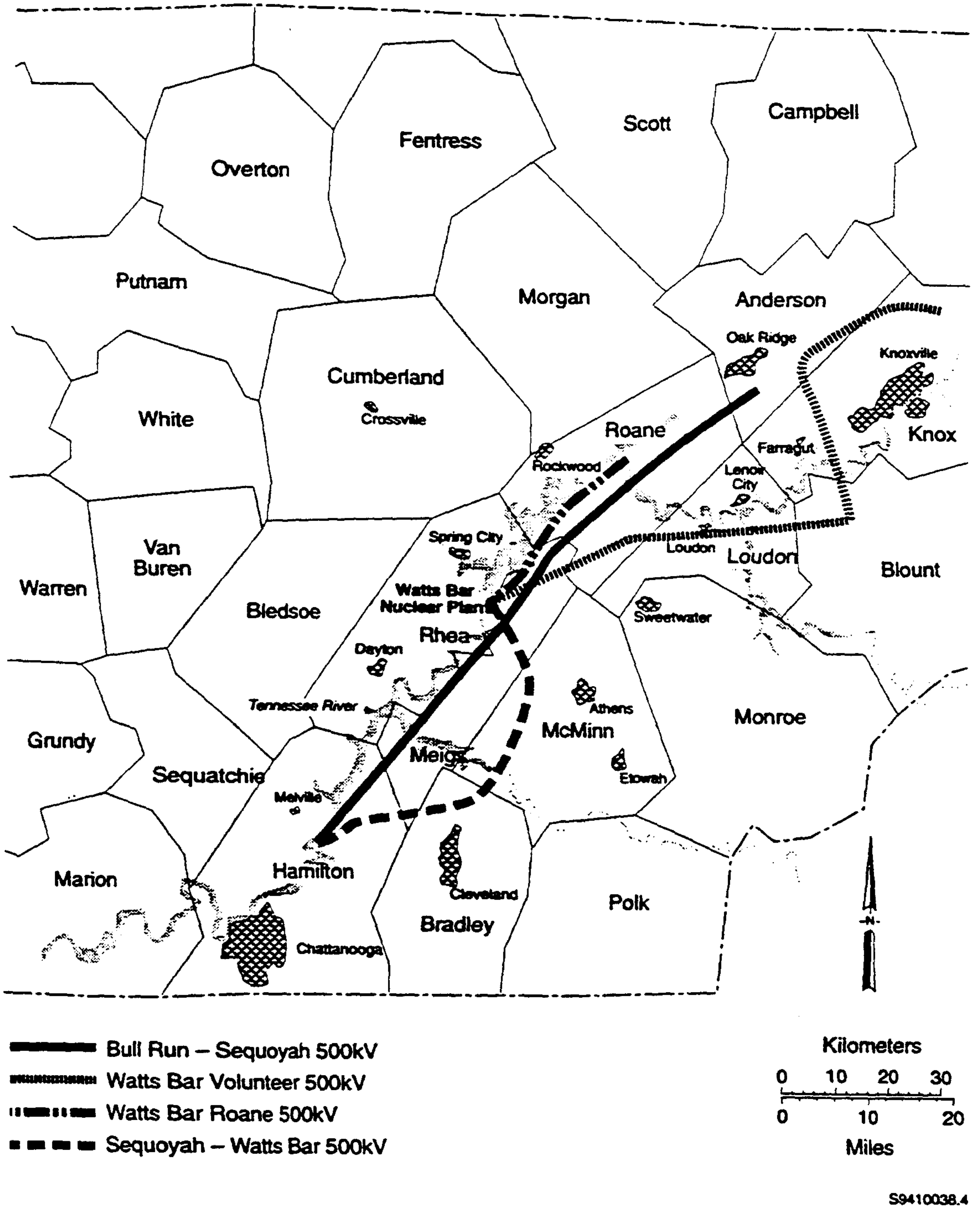


Figure 2.4 Transmission Line Corridors Associated With the WBN Plant

1978 and 1994 (TVA 1994d) failed to locate any individual members of the species on the WBN Site, and the spider lily is not known to exist in the transmission line corridors.

Currently, the bald eagle and the gray bat (*Myotis grisescens*) are the only terrestrial species near the WBN Site listed as endangered by the FWS under the ESA and by the State of Tennessee Department of Environment and Conservation. Bald eagles continue to visit the WBN Site during the winter, foraging for fish and roosting in trees near the reservoirs. In 1994, there was a documented nesting attempt about 6.4 kilometers (4 miles) south-southwest of the plant. The gray bat uses two caves within 8.0 kilometers (5 miles) of the plant, and forages for insects over the reservoir near the plant (FWS 1995).

The State of Tennessee also lists the osprey (*Pandion haliaetus*) as endangered (TVA 1994d). The osprey, which uses the Tennessee River near the WBN Site for foraging, was identified as being on or near the site during a field inspection in September 1994 (TVA 1994d).

The applicant also evaluated the TVA Regional Natural Heritage Project database to determine whether any Federal- or State-protected species occur within a ten-county area containing the WBN Site and associated transmission line corridors (TVA 1994d). This database contains locality and distribution information about known populations of Federal-listed and State-listed species on a State-wide basis.

The database evaluation identified 15 Federal- or State-listed animal species, and indicated that six of these species are known to occur within 0.8 kilometer (0.5 mile) of the transmission line corridors (Table 2.7). The six species include the bald eagle, osprey, and gray bat already mentioned as being found on or near the WBN Site. The other three species are the Cooper's hawk (*Accipiter cooperii*), the sharp-shinned hawk (*Accipiter striatus*), and the grasshopper sparrow (*Ammondramus savannarum*).

The database evaluation identified 35 Federal- or State-listed plant species. Of these 35, eleven populations of eight species listed by the State of Tennessee as threatened or endangered are known to occur within 0.8 kilometer (0.5 mile) of the transmission line corridors (Table 2.7). Four of these eight species (auriculate false foxglove [*Tomanthera auriculata*], tall larkspur [*Delphinium exaltatum*], bugbane [*Cimicifuga rubifolia*], and false foxglove [*Aureolaria patula*]) are also designated as Federal candidate-Category 2 species, and are currently being evaluated for protection under the ESA. Five of these eight plant species (false foxglove, bugbane, goldenseal [*Hydrastis canadensis*], and the two species of bush honeysuckle [*Diervilla lonicera, Diervilla sessilifolia* var. *rivularis*]) found near the transmission lines are not expected to grow within the transmission line corridors because these species only grow in forest habitats (TVA 1994d). The other three plant species (auriculate false foxglove, a goldenrod [*Solidago ptarmicoides*], and tall larkspur) are known to grow in naturally barren areas or prairie sites and could colonize the open areas created within the transmission rights-of-way. However, no known populations of these species currently grow within any of the corridors, and the corridors do not cross any of the known population locations. The effects of the WBN Site and transmission line operation on the terrestrial environment are evaluated in Section 5.3.

Table 2.7 Listed Terrestrial Species On or Near the WBN Site and Transmission Line Corridors

Common Name	Scientific Name	Listing Status		Location[a]
		Federal	State	
BIRDS				
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Endangered	1,2
Osprey	*Pandion haliaetus*	-	Endangered	1,2
Cooper's hawk	*Accipiter cooperii*	-	Threatened	2
Sharp-shinned hawk	*Accipiter striatus*	-	Threatened	2
Grasshopper sparrow	*Ammodramus savannarum*	-	Threatened	2
MAMMALS				
Gray bat	*Myotis grisescens*	Endangered	Endangered	1,2
PLANTS				
Auriculate false foxglove	*Tomanthera auriculata*	Candidate	Endangered	2
Tall larkspur	*Delphinium exaltatum*	Candidate	Endangered	2
Bugbane	*Cimicifuga rubifolia*	Candidate	Threatened	2
False foxglove	*Aureolaria patula*	Candidate	Threatened	2
Goldenrod	*Solidago ptarmicoides*	-	Endangered	2
Bush honeysuckle	*Diervilla lonicera*	-	Threatened	2
Bush honeysuckle	*Diervilla sessilifolia* var. *rivularis*	-	Threatened	2
Goldenseal	*Hydrastis canadensis*	-	Threatened	2

(a) 1 = on or near the WBN Site; 2 = within 0.8 kilometer (0.5 mile) of WBN Site transmission lines.

2.4.2 Aquatic Ecology

The characteristics of the WBN Site's aquatic environment and biota were described in the TVA 1972 EIS-CP (TVA 1972). This information was based on some site-specific data combined with a general knowledge of the Tennessee River tailrace habitats and their associated aquatic biota. Extensive supplemental information, from preoperational monitoring programs, was evaluated in the NRC 1978 FES-OL. Since publication of the NRC FES-OL in 1978, preoperational studies have continued to provide information specific to the WBN Site. These studies are listed in Section 6.1.5 of this report. A report, detailing preoperational monitoring efforts and results from 1973-1985, was published in 1986 (TVA 1986). This report, other preoperational reports, and information gathered during the September 1994 WBN Site visit, were determined to be acceptable representations of the environment and were used as a basis for the staff's review of the aquatic ecology in the vicinity of the WBN Site. The review indicated that changes had occurred either within various populations o in the staff's knowledge of the populations within the vicinity of the WBN Site. Among the specific populations are aquatic macrophytes, fish, and the mussel communities. In addition, since 1978 the listing of threatened and endangered species has changed.

The historical record shows the long-term average release of water from the Watts Bar Dam since its completion in 1942 until 1985 to be approximately 767 cubic meters per second (27,100 cubic feet per second) (TVA 1986b). Higher flows usually occur December through March, although the seasonal pattern varies. Based on the long-term average flow, water moves in one day from the dam (TRM 529.9) past the WBN Site to TRM 515 in the summer and to TRM 508 in the winter for a total of 24 and 35 river kilometers (14.9 and 21.9 river miles), respectively (TVA 1986). Velocities in the upper portion of the Chickamauga Reservoir are highly variable. Travel times are up to 50% faster in the middle of the main channel than in the slower, shallow areas. The combination of high flows, channel bends, and small cross sections found in the upper portion of the Chickamauga Reservoir creates a fully mixed flow condition on the river upstream of the Hiwassee River confluence (Figure 1.1) (TVA 1986).

Plankton

Recent studies indicate that virtually all plankton passing the WBN Site originate in the Watts Bar Reservoir and pass through the turbines at the Watts Bar Dam. There is no reason to suspect that plankton are not uniformly distributed in the water column. Through preoperational monitoring, plankton populations have been shown to vary enormously from day to day near the WBN Site. Sampling surveys during the period between 1973 and 1985 indicate that plankton populations decreased near the WBN Site, because of the swift-flowing nature of the Chickamauga Reservoir. The populations then gradually increased further downstream to levels comparable to those at the Watts Bar Reservoir forebay (TVA 1986).

Blue-green algae are rarely a major component of the phytoplankton population at the WBN Site. In this portion of the river where the water is fast flowing, phytoplankton growth is limited and their populations generally decrease downstream until the river flow slows and becomes more lake like at a distance of 40 to 48 kilometers (25 to 30 miles) below the WBN Site.

Aquatic Macrophytes

Aquatic plants in Watts Bar Reservoir have declined from about 2.8 square kilometers (700 acres) in the late 1980s to an estimated 0.04 square kilometers (10 acres) in 1993 (TVA 1993). Eurasian watermilfoil (*Myriophyllum spicatum*) and spinyleaf naiad (*Najas minor*) were the dominant species prior to the recent decline.

In Chickamauga Reservoir, the populations of aquatic macrophyte species have fluctuated over the past 25 years, primarily in response to river-flow conditions. Aquatic macrophyte populations peaked in 1988 at 30 square kilometers (7500 acres), and have been in steady decline since that time, except for an increase in 1993. Coverage of these aquatic plants increased from 1.5 square kilometers (387 acres) in 1992 to 4.7 square kilometers (1185 acres) in 1993. Spinyleaf and southern naiad were the dominant species in 1993, although small colonies of Eurasian watermilfoil, American pondweed (*Potamogeton* spp.), and American lotus (*Nelumbo lutea*) were also present (TVA 1993). These aquatic plant species can create reservoir-use conflicts, which lead to control measures in areas around recreation and public access sites, lakeshore development, and industrial water intakes because such dense aquatic weeds deteriorate water quality (by raising water temperatures and lowering dissolved oxygen concentrations) recreation and aesthetic value. Peak macrophyte coverage in Chickamauga Reservoir occurred only in relatively shallow overbank areas relatively far downstream from the WBN Plant. The WBN Site is located in the riverine tailwater area of Chickamauga Reservoir where suitable overbank habitat is rare and macrophyte levels near the plant never reached nuisance levels, even during years of peak coverage.

Fish Community

In 1993, Watts Bar Reservoir shoreline electrofishing (60 transects) and offshore gill netting (39 net-nights) sampled a total of 5174 fish representing 50 species (TVA 1994g). Three species made up the majority of the overall sample: gizzard shad (*Dorosoma cepedianum*) (37%), bluegill (*Lepomis macrochirus*) (13%), and emerald shiners (*Notropis atherinoides*) (12%). Electrofishing results showed similar catch rates in the Clinch River inflow, the Tennessee River inflow, and the forebay. The catch rate was more than twice as high at the transition zone. The higher catch rate at the transition zone was attributed mainly to the abundance of emerald shiners and bluegill. Threadfin shad (*Dorosoma cepedianum*) young-of-the-year catch rates were moderate in all sample zones except in the Tennessee River inflow, which was considered high. Gill netting catch rates were much the same in all four sample areas.

Fish data collected in the littoral (45 electrofishing transects) and offshore zones (28 net-nights) of the Chickamauga Reservoir forebay resulted in the collection of 44 species (6994 individuals). The Emerald shiner was the most abundant species (collected at a rate of 56 per 300 meter electrofishing transect), accounting for 36% of the total number of fish collected. Gizzard shad comprised 16% of the sample, followed closely by bluegill at 14%. Electrofishing results showed approximately twice as many individuals in the inflow (2624) and transition (2300) zones as the forebay (1229), due to numbers of gizzard shad and bluegill in the sample. Numbers of young-of-the-year threadfin shad followed a similar pattern with high catch rates in the forebay and transition zone, and very high catch rates in the inflow zone. Gill netting fish abundance was higher in the transition zone than the forebay. Although abundance at the inflow zone was lower because of reduced effort, catch rate was similar to the transition zone.

The NRC 1978 FES-OL discounted the previous belief that the tailrace of the Watts Bar Dam was actually a favorable fish-spawning habitat for several tailrace-spawning species, including sauger (*Stizostedion canadense*), smallmouth bass (*Micropterus dolomieui*), white bass (*Morone chrysops*), and possibly yellow perch (*Perca flavescens*). Targeted studies since that 1978 document have confirmed that the tailwater reach between the WBN Site and the dam is not an area of major spawning activity for these species. Hunter Shoals (TRM 520-522), located 10 to 11 kilometers (6 to 7 miles) below the WBN Site, has been identified as a major spawning area for white bass and as the primary spawning site for sauger in the Chickamauga Reservoir (TVA 1994c). Due to declining sauger populations, the Tennessee Wildlife Resources Agency (TWRA) released approximately 191,000 sauger fingerlings into the upper Chickamauga Reservoir in 1990. The apparent success of this effort was seen in 1991 when large numbers of 1-year-old sauger were captured during annual monitoring efforts in the reservoir (TVA 1991a).

Mussel and Clam Communities

The Tennessee River is home to both introduced and native mussel and clam species. Two non-native mussel or clam species are known to have been introduced into the Tennessee River (the Asiatic clam [*Corbicula* sp.] and zebra mussel [*Dreissena polymorpha*]). Another non-native mussel species (quagga mussel [*Dreissena bugensis*]) has the potential to invade the Tennessee River system.

At the time the NRC 1978 FES-OL was published, the Asiatic clam was the only nuisance mussel species inhabiting the Tennessee River. This species was introduced to North America in the early 1900s. Since their introduction throughout North American waters, they have spread rapidly. Asiatic clams became prominent in the benthos communities of the Tennessee River during the 1960s. The Asiatic clam is considered a pest species because its shell can obstruct pipes, fouling municipal water treatment facilities and other piping systems, including the raw water systems of nuclear generating plants. This species can outcompete many native mussel and clam species, some of which are presently listed as endangered or threatened.

The zebra mussel has recently been introduced to the Tennessee River, but it has not yet been found at the WBN Site (U.S. Army Corps of Engineers 1992). However, this mussel has been found in very small numbers in Watts Bar Reservoir and in the lock at Watts Bar Dam, upstream of the WBN Site. This organism attaches to a wide variety of firm surfaces using tough proteinaceous byssal threads. The larval stage of the zebra mussel and the Asiatic clam differ from that of native mussels in that they do not require a fish host to develop into an adult. Instead, the zebra mussel and Asiatic clam larvae are planktonic and can be drawn into raw-water piping systems of such facilities as water treatment plants, dams, fossil and nuclear generating plants, navigation locks, boat engine cooling systems, and other facilities. As the larvae settle and attach, layers of zebra mussels can build up in critical piping systems. The result is usually partial or total blockage of piping systems; this can cause damage to equipment and facilities and can require facility outage time to remove the blockage. Zebra mussels also outcompete native species for food and space.

The quagga mussel is known to intermingle with zebra mussel colonies and is expected to reach the Tennessee River and WBN Site within a few years. As yet, the quagga mussel has not been found outside the Great Lakes area; however, there is no reason to doubt its chances of becoming more widespread. The zebra mussel and quagga mussel are termed "attached biofouling mussels" with the same system-infesting behavioral characteristics; throughout this document they collectively are referred to as "zebra mussel."

The applicant has implemented onsite mussel-control methods, restricting control measures to the facility. The applicant currently uses a non-oxidizing molluscicide, Clam-Trol™[(a)] (CT-1), to inhibit infestation by Asiatic clams and plans to use the same method to deal with the potential infestation of zebra mussels, as discussed in Section 3.4.

Native species of freshwater mussels also inhabit the tailrace of the Watts Bar Dam, as described in the NRC 1978 FES-OL. Among changes in the information provided by the 1978 FES-OL are the identification of the concentration of mussels near the WBN Site, the expansion of the freshwater mussel sanctuary, and an increase in the number of mussel species identified at the WBN Site. Refer to Chapter 5 for a discussion of the significance of these changes.

Although no mussel concentrations were reported along the right bank in the vicinity of the blowdown diffuser in 1978, a concentration of mussels, or a "mussel bed," has since been documented as existing along the right (descending) shoreline of the river just downstream from the mouth of Yellow Creek and the WBN Plant discharges between TRMs 526 and 527 (TVA 1994c). The approximate location of the mussel bed is shown in Figure 1.2. In 1990, the largest numbers of mussels were found at TRM 528 while the lowest numbers of mussels were found at TRM 526 and the TRM 520 mussel bed location showed intermediate densities. Of the 31 mussel species identified in these two surveys, five species account for approximately 90% of the specimens recorded at these monitoring stations (TVA 1986). The remaining 26 mussel species are often represented by fewer than 1% of the total specimens examined. These surveys indicate that mussel populations in the Watts Bar tailwater have been in decline since the early 1940s when the Chickamauga and Watts Bar Reservoirs were filled (1940 and 1942). Prior to the impoundments, a total of 64 freshwater mussel species are thought to have occurred near the WBN Site (TVA 1986). In recent years, only 31 mussel species have been recorded in the vicinity of the WBN Site, and only 28 species were reported during the 1988 and 1990 surveys (TVA 1991b). Most of these were adults 30 or more years of age and in poor condition (emaciated soft parts and extreme shell erosion) (NRC 1994). As stated in a March 1991 preoperational mussel monitoring report (TVA 1991b), no young or juvenile mussels have been found during sampling since monitoring began in 1983. Although the reason for the mussels' lack of recruitment is not known, it is reasonable to assume that impoundment of the river and the resulting modifications to the riverine system are largely responsible (TVA 1986). Continued monitoring in the Chickamauga Reservoir is expected to show a gradual decline in mussel species abundance and diversity (see Section 6.2.5).

In 1965, the State of Tennessee established a freshwater mussel sanctuary in the Chickamauga Reservoir. The sanctuary extended 4.8 kilometers (3 miles) from TRM 529.9 to 526.9. Since 1987, the mussel sanctuary has been extended to TRM 520.0 by the TWRA, creating a total of 16 kilometers (10 river miles) in which the harvesting of mussels is illegal (TVA 1994e). The WBN Plant is situated in the middle of the mussel sanctuary at TRM 528.

(a) Trademark of Betz Laboratories, Inc., Trevoise, Pennsylvania.

Threatened and Endangered Species

The NRC 1978 FES-OL reported the presence of two endangered freshwater mussel species, federally protected under the ESA. They were the pink mucket pearly mussel (*Lampsilis abrupta* [= *L. orbiculata*]) and the dromedary pearly mussel (*Dromus dromas*), both found in the Tennessee River Chickamauga Reservoir. Since the NRC 1978 FES-OL was published, three additional species have been found in the Tennessee River and tributary streams near the WBN Site that are granted threatened or endangered status by the FWS (Table 2.8).

Table 2.8 Listed Aquatic Species Occurring On or Near the WBN Site

Common Name	Scientific Name	Listing Status		Location[a]
		Federal	State	
BIVALVES				
Dromedary pearly mussel	*Dromus dromas*	Endangered	Endangered	1
Pink mucket pearly mussel	*Lampsilis abrupta* (= *L. orbiculata*)	Endangered	Endangered	1
Pyramid pigtoe	*Pleurobema rubrum* (= *P. pyramidatum*)	Candidate	—	1
Rough pigtoe	*Pleurobema plenum*	Endangered	Endangered	1
Tennessee clubshell	*Pleurobema oviforme*	Candidate	–	1
Fanshell	*Cyprogenia stegaria*	Endangered	Endangered	1
FISH				
Blue sucker	*Cycleptus elongata*	Candidate	Threatened	1
Snail darter	*Percina tanasi*	Threatened	Threatened	1,2
AMPHIBIANS				
Eastern hellbender	*Cryptobranchus a. alleganiensis*	Candidate	NMGT[b]	2

(a) 1 = in or along mainstream of Tennessee River near WBN Site
2 = within 0.8 kilometer (0.5 mile) of WBN transmission line

(b) NMGT = in need of management

These include two endangered freshwater mussels, the fanshell (*Cyprogenia stegaria*) and the rough pigtoe (*Pleurobema plenum*), and a fish, the snail darter (*Percina tanasi*). Four additional aquatic species existing on or near the WBN Site are currently listed as Federal candidates (Category 2) and are considered active candidates for Federal protection by the FWS (TVA 1994d) under the ESA. These four species are two mussels, the pyramid pigtoe (*Pleurobema rubrum* [=*P. pyramidatum*]) and the Tennessee clubshell (*Pleurobema oviforme*); one fish, the blue sucker (*Cycleptus elongata*); and one amphibian, the Eastern hellbender (*Cryptobranchus a. alleganiensis*).

2.5 Background Radiological Characteristics

Since the staff issued the NRC 1978 FES-OL, the applicant has continued to collect data on the background radiological characteristics in the vicinity of the WBN Site. The results of these surveys are presented in annual reports, the latest of which was issued in April 1994 for calendar year 1993 (TVA 1994f). The only changes in background radiological characteristics noted by the staff were a continued gradual decrease in fallout radionuclide concentrations (e.g., strontium-90 and cesium-137 in soil and milk) and a temporary increase in the short-lived radioiodine (iodine-131) following the reactor accident at Chernobyl in the spring of 1986.

An aerial radiological survey of the WBN Site and surrounding area was performed for the NRC in April 1982 (Jobst and Semmler 1982). Figure 2.5 is a map of the radiation intensity from terrestrial sources measured during the aerial survey. The readings were corrected to represent the exposure rates at 1 meter (3.3 feet) above the ground. With one localized exception, the observed exposure rates ranged from 0.02 to 0.07 picocoulomb per kilogram per second (3 to 10 microroentgens per hour), which is within the range of typical background radiation levels. The area of highest background exposure rate observed (0.07 to 0.14 picocoulomb per kilogram per second [10 to 20 microroentgens per hour]) was over the coal ash pile located by the Watts Bar Steam Plant, reflecting the concentration of naturally occurring radionuclides in the ash.

Operations at the Oak Ridge Reservation have historically resulted in the release of radionuclides to the aquatic environment (ORNL 1995). Uranium-238 has been released from the K-25 site and the Y-12 Plant. Most of the releases occurred during the late 1950s and have declined since. Cobalt-60 and fission products including tritium, zirconium-95, iodine-131, cesium-137, and strontium-90 were released from Oak Ridge National Laboratory.

Since 1977 the applicant has monitored background radiation near the WBN Plant as part of the pre-operational environmental radiological monitoring program. This program includes sampling of surface water, river water taken from the first downstream drinking water intake, and bottom sediment. The applicant, in the 1993

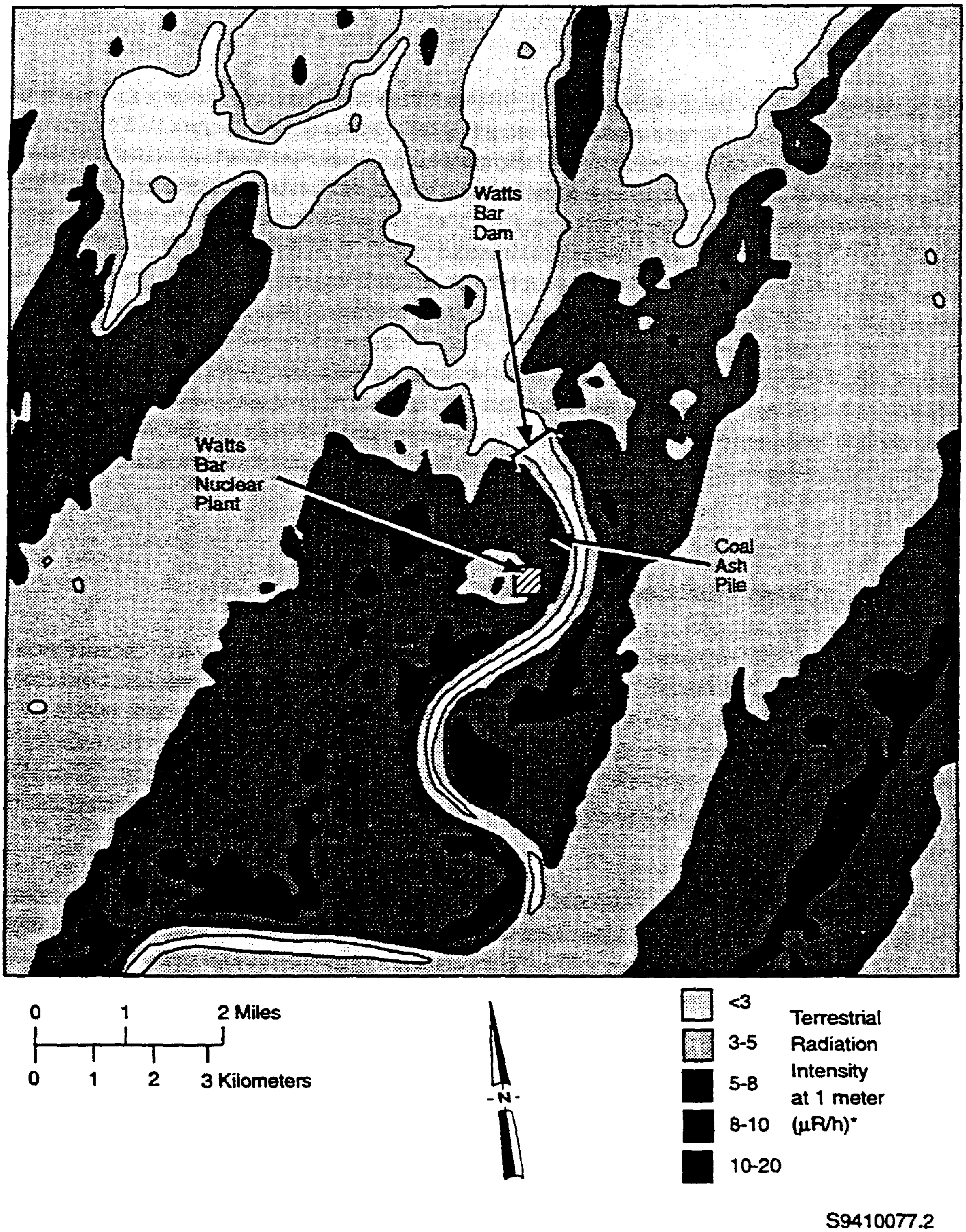


Figure 2.5 Background Exposure Rates From Terrestrial Components in the Vicinity of the WBN Plant (From Jobst and Semmler 1982)

Annual Radiological Environmental Monitoring Report (TVA 1993), indicated that the gross beta activity present in most of the surface water samples averaged 0.093 becquerel per kilogram (2.5 picocuries per liter) in upstream samples and 0.085 becquerel per kilogram (2.3 picocuries per liter) in downstream samples. The only fission or activation product that was identified in drinking water samples was strontium-90 in one sample. The concentration was only slightly higher than the lower limit of detection for the measuring instruments. Average gross beta activity in the drinking water samples was 0.10 becquerel per kilogram (2.7 picocuries per liter) at upstream stations and 0.093 becquerel per kilogram (2.5 picocuries per liter) at downstream locations. Cesium-137 and cobalt-60 (radionuclides historically released from ORNL) were identified in sediment samples. The average levels of cesium-137 were 23 becquerels per kilogram (0.62 picocurie per gram) upstream of the WBN Site and 12 becquerels per kilogram (0.32 picocurie per gram) downstream. Cobalt-60 concentrations averaged 0.7 becquerel per kilogram (0.02 picocurie per gram) upstream and 6 becquerels per kilogram (0.16 picocurie per gram) downstream. Because cesium-137 tends to bind into the sediment, the majority of this isotope is found above the Watts Bar Dam, rather than in the Chickamauga reservoir (ORNL 1995).

2.6 Historical and Archeological Sites

The NRC 1978 FES-OL did not address historical and archeological sites; however, information on such sites was provided in the TVA 1972 EIS-CP (TVA 1972). The TVA 1972 EIS-CP stated that two archeological sites existed in the WBN Site and were previously recorded by the Department of Anthropology of the University of Tennessee. However, the TVA 1972 EIS-CP indicated that there were no sites listed in the *National Register of Historic Places* or known to be under consideration for such listing. The project was also reviewed by the Tennessee Historical Commission, and no specific items of particular historical significance were identified.

The sites discussed in the TVA 1972 EIS-CP consisted of a single Early Mississippian platform mound (Leuty Mound 40RH6) and a group of five Late Woodland period Hamilton mounds (McDonald Site 40RH7). A data recovery excavation was undertaken in 1971 (Schroedl 1978). In addition, two open habitation areas adjacent to the Mississippian platform mound were noted in the 1971 excavations; a data recovery excavation was undertaken and the results were subsequently published (Calabrese 1976). Archeological sites also exist along the reservoir shoreline, downstream from the WBN Site, but they would not be affected by plant operations. Plant operations are not expected to impact any areas along the river where any additional, but still unidentified, sites may exist.

The transmission line corridors associated with the WBN Site were surveyed, and no sites were encountered that were potentially eligible for the *National Register of Historic Places*; nor were any archeological sites identified.

No further excavation or construction of the WBN Site and no additional transmission line corridors are planned. Therefore, the staff concludes that operating and maintaining the plant and the transmission line corridors will not adversely affect any potential archeological sites. Any additional excavation or construction that would result in changes to the perimeter of the WBN Site would require review by the NRC staff.

2.7 Geology and Seismology

Geology and seismology issues were not addressed in the NRC 1978 FES-OL. These topics were addressed briefly in the TVA 1972 FES-CP (TVA 1972). For a complete summary of the geological and seismological characteristics of the WBN Plant, the staff assessment is provided in Section 2.5 of the SER for the WBN Plant (NRC 1982a). The staff reviewed the information contained in the FSAR and concludes that it is an adequate description of the geological and seismological characteristics of the WBN Site.

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3 The Plant

This chapter updates information in those sections of the NRC 1978 FES-OL (NRC 1978) pertaining to the WBN Plant design and plant operation. The areas of the WBN Plant that are discussed include station and potable water systems in Section 3.1; the diffuser heat dissipation system in Section 3.2; the radioactive waste treatment system in Section 3.3; and the chemical, sanitary, and other waste treatment systems in Section 3.4. The power transmission system is briefly addressed in Section 3.5.

3.1 Plant Water Use

The applicant's plans have not changed significantly from those discussed in the NRC 1978 FES-OL (NRC 1978). Steam generator makeup water, service water, and condenser cooling water will still be drawn from the Tennessee River. Maximum station water usage from the Tennessee River for steam generator make up, service water, and condenser cooling water remains at 4 cubic meters per second (143 cubic feet per second), which is 0.7% of the mean river flow past the plant.

Potable water is still being obtained from a groundwater system; however, the groundwater system is now operated by the Watts Bar Utility District, which uses three wells located 4 kilometers (2.5 miles) northwest of the site (TVA 1994a). Two of the wells have a maximum capacity of 2730 cubic meters (720,000 gallons) per day and a third standby well has a maximum capacity of 545 cubic meters (144,000 gallons) per day. The maximum groundwater consumption for potable water after initial startup is expected to be 1140 cubic meters (300,000 gallons) per day.

The impacts of plant water use changes since the NRC 1978 FES-OL are discussed in Section 5.2.

3.2 Heat Dissipation Systems

The applicant's design and plan for the operation of the diffuser heat dissipation system have not changed significantly from those discussed in the NRC 1978 FES-OL. The WBN Plant has a closed-mode cooling system with one natural draft cooling tower for each of the two units. The cooling tower is used for heat dissipation via evaporative processes. Maximum evaporation from the cooling tower was given in the NRC 1978 FES-OL as 1.8 cubic meters per second (64 cubic feet per second). The WBN Plant is designed to route blowdown from the cooling towers to either the Tennessee River, through a multiport diffuser system (Outfall 101), or into the yard holding pond (235,000-cubic-meters [190-acre-feet]). A positive interlock is maintained with the Watts Bar Dam so that when the flow rate from the dam is less than 98 cubic meters per second (3500 cubic feet per second), the two diffuser legs are automatically closed and the blowdown flow is diverted to the yard holding pond. The yard holding pond has an overflow weir on the south side of the pond (Outfall 102) that is used as an alternate discharge when the capacity of the pond is exceeded. The diffuser is located in the Tennessee River at TRM 527.9. The overflow weir discharges into the Tennessee River at TRM 527.2.

The multiport diffuser system discharges the blowdown into the Tennessee River. The diffuser consists of two pipes that branch from a central conduit on the right (facing downstream) bank of the river and then extend perpendicularly to the river flow. Each of the two pipes is controlled by a butterfly valve. The downstream pipe segment extends 90 meters (300 feet) into the channel with a 50-meter (160-foot) long, 1.3-meter (4.5-foot) diameter diffuser section located in the deepest portion of the river channel. The upstream pipe segment extends 140 meters (450 feet) with a 25-meter (80-foot) long, 1.0-meter (3-foot) diameter diffuser section beginning where the downstream diffuser section ends. The diffuser sections are half buried in the river bottom with two rows of 2.5-centimeter (1-inch) diameter ports at 7.5 centimeters (0.25 feet) spacing, oriented at 45 degrees in the downstream direction. The maximum discharge through the diffuser system is estimated as 4.9 cubic meters per second (170 cubic feet per second) for both units, a slight increase (approximately 1%) from that reported in the NRC 1978 FES-OL. The NRC 1978 FES-OL gives a thorough description of the diffuser.

3.3 Radioactive Waste Treatment System

The applicant has made a number of changes to the design of the radioactive waste treatment system from that described in the NRC 1978 FES-OL. Neither the boron recovery system, which included boric acid evaporators, nor the condensate demineralizer waste evaporator system will be used to support operation of the WBN Plant. Liquid waste will be processed, as necessary, through a new mobile demineralizer system. The mobile demineralizer will replace the existing atmospheric demineralizer. The mobile demineralizer system will remove most soluble and suspended radioactive materials from the waste stream through filtration, media-activated carbon, and ion-exchange resin. When the resin medium is expended, it will be sluiced to a container for storage and subsequent approved offsite disposal.

Under plant procedures, as indicated in the NRC 1978 FES-OL, radioactive releases may be discharged from the plant through the cooling tower blowdown. An additional release could occur from the discharge of low-level radioactive liquid effluents from the turbine building station sump to the yard holding pond through the low-volume waste treatment pond. Such a release would occur only in the unlikely event of a primary-to-secondary leak, which is not considered a major release pathway. Monitoring of this release path is controlled in accordance with the WBN *Offsite Dose Calculation Manual* (ODCM) (TVA 1994b). Releases from the liquid-waste processing system will be controlled in compliance with 10 CFR Part 20 (Appendix B) and 10 CFR Part 50 (Appendix I) as described in the FSAR. Releases have been evaluated and are expected to be well within the limits described in 10 CFR Part 20 and 10 CFR Part 50 (Appendix I). The nonradioactive characteristics of the liquid waste processing system are controlled by the NPDES permit (Section 3.4). The gaseous radioactive waste treatment system has not changed significantly from that presented in the NRC 1978 FES-OL.

Chapter 11 of the applicant's FSAR (TVA 1994a) describes in detail the systems for processing both liquid and gaseous wastes as well as any potential radiological releases involved in such processing (see Section 5.5 for a summary of the radiological releases).

3.4 Chemical, Sanitary, and Other Waste Treatment

The NPDES permit (State of Tennessee 1993) regulates all liquid discharges of chemicals at the WBN Plant. Since the NRC 1978 FES-OL was issued, the applicant has instituted a chemical traffic control program (TVA 1994c) and has changed the planned use of chemicals. Table 3.1 summarizes the additional chemicals and their resulting chemical end-products (TVA 1994c). Those chemicals that were not included in the NRC 1978 FES-OL appear in bold type in Table 3.1; they are also summarized briefly below.

The NRC 1978 FES-OL indicated that morphaline and hydrazine would be used as additives to the steam generator feedwater. The applicant indicates (TVA 1994c) that ethanolamine and ammonia will be used for pH control, hydrazine will be used for oxygen scavenging, and boric acid will be used for controlling crevice chemistry.

The NRC 1978 FES-OL indicated that the WBN Plant would use chlorine to treat raw cooling water for Asiatic clam control. However, the raw-water treatment program has been changed to (1) control corrosion in carbon steel metals; (2) control organic fouling, including slime; (3) minimize the effect of microbiologically induced corrosion (MIC); and (4) inhibit the growth of Asiatic clams. To accomplish these tasks, the following chemicals will be used in the manner described:

- A copolymer dispersant (Betz TVA-06™)[a] will be injected on a year-round continuous basis to keep settleable solids in suspension and thereby reduce accumulations of silt and rust. The letter of agreement with the State of Tennessee indicates that the release of the copolymer is anticipated to be no more than 0.2 milligram per liter (0.2 part per million) as active product (TVA 1994d).

- Tetrapotassium pyrophosphate will be injected on a year-round continuous basis to sequester iron from existing corrosion products in raw-water piping and ancillary components. The applicant expects that it will take approximately two years to clean up the piping and components, at which point the dosage will be reduced to a level that is sufficient to maintain a clean system. The letter of agreement with the State of Tennessee indicates that the release of pyrophosphate (listed as "Betz Inhibitor 30K-30656"™)[b] at the diffuser discharge is not expected to exceed 0.2 milligram per liter (0.2 part per million) as total phosphorus (TVA 1994d).

(a) Trademark of Betz Laboratories, Inc., Trevoise, Pennsylvania.
(b) Trademark of Betz Laboratories, Inc., Trevoise, Pennsylvania.

Table 3.1 Summary of Added Chemicals and Resulting End Product Chemicals (Adapted From TVA 1994c)
(Chemicals not included in the NRC 1978 FES-OL appear in bold type.)

Item No.	System/Component	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	Estimated Maximum Annual Use (lbs)	Waste End Product Chemical	Resulting End-Product[a] Average Annual kg	Resulting End-Product[a] Average Annual (lbs)
1	Makeup Water Filter Plant	Alum	35,700	(78,800)	Al $(OH)_3$[b]	7,500	(16,510)
		($Al_2(SO_4)_3 \cdot 18H_2O$)			SO_4^{2-}	13,900	(30,600)
					Settled Solids[b,c]	32,100	(70,800)
2	Makeup Water Demineralizer	Sulfuric Acid (H_2SO_4) (93% solution)	105,000	(231,000)	SO_4^{2-}	98,400	(217,000)
		Sodium Hydroxide (NaOH) (50% solution)	195,000	(431,000)	Na^+	56,200	(124,000)
		Sodium (Na^+)[d]	4,590	(10,120)	Na^+	4,590	(10,120)
		Chloride (Cl^-)[d]	8,940	(10,700)	Cl	8,940	(10,700)
		Sulfate (SO_4^{2-})[d]	9,870	(21,750)	SO_4^{2-}	8,870	(21,750)
		Total Dissolved Solids	53,300	(117,500)	Unchanged	53,300	(117,500)
3	Secondary Steam System	Sulfuric Acid	268,000	(590,100)	SO_4^{2-}	262,000	(578,000)
	Condensate Polishing Demineralizers	Sodium Hydroxide	161,000	(353,500)	Na^+	92,200	(203,260)
		Carbonates (CO_3^{2-})[d]	11,500	(25,400)	CO_3^{2-}	11,500	(25,400)
		Metallic Salts	--[e]	--[e]		--[e]	--[e]
		Ethanolamine	**44,000**	**(97,820)**	**Unchanged**	**44,000**	**(97,820)**
		Boric Acid	**45,000**	**(100,000)**	**Unchanged**	**45,000**	**(100,000)**
4	Auxiliary Steam Generators	Ammonia (NH_3) ($H_2N_2H_2$)	1.4	(3)[f]	NH_3[f]	1.4	(3)
		Hydrazine ($H_2N_2H_2$)	4.5	(10)[g]	NH_3[g]	4.5	(10)
5	Condenser Circulating Water Systems	<<Copper (corrosion product only)[h]			Cu	2,800	(6,200)
		<<Nickel (corrosion product only)[h]			Ni	313	(690)
6	Raw Cooling Water[i]	**Pyrophosphate**	**34,100**	**(75,752)**	**$H_2PO_4^-$**	**34,100**	**(75,752)**
		Organic Co-Polymer Dispersant	**7,950**	**(17,673)**	**Unchanged**	**7,950**	**(17,673)**
		Zinc Sulfate	**18,200**	**(40,405)**	**Zn^{2+}**	**7,340**	**(16,312)**
					SO_4^{2-}	**10,800**	**(24,092)**
		Copper-Trol™	**261**	**(581)**	**Benzotriazole**	**261**	**(581)**
		Clam-Trol™	**1,390**	**(3,080)**	**Long Chain HC**[j]	**69**	**(154)**
					Polar Organic Molecule	**110**	**(246)**
		Bromo-Chloro- …thylhydantoin	**3,610**	**(8,024)**	**HOCl**	**1,280**	**(2,808)**
					HOBR	**2,350**	**(5,216)**

Table 3.1 (contd)

Item No.	System/Component	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	Estimated Maximum Annual Use (lbs)	Waste End Product Chemical	Resulting End-Product[a] Average Annual kg	Resulting End-Product[a] Average Annual (lbs)
7	Raw Service Water[i]	Pyrophosphate	3,790	(8,417)	$H_2PO_4^{1-}$	3,790	(8,417)
		Organic Co-Polymer Dispersant	883	(1,964)	Unchanged	883	(1,964)
		Zinc Sulfate	2,020	(4,489)	Zn^{2+}	815	(1,812)
					SO_4^{2-}	1,200	(2,677)
		Copper-Trol™	29	(65)	Benzotriazole	29	(65)
		Clam-Trol™	154	(342)	Long Chain HC[j]	8	(17)
					Polar Organic Molecule	12	(27)
		Bromo-Chloro-Dimethylhydantoin	401	(891)	HOCl	140	(312)
					HOBR	260	(579)
8	Essential Raw Cooling Water[i]	Pyrophosphate	151,000	(335,581)	$H_2PO_4^{1-}$	151,000	(335,581)
		Organic Co-Polymer Dispersant	35,200	(78,291)	Unchanged	35,200	(78,291)
		Zinc Sulfate	80,500	(178,994)	Zn^{2+}	32,500	(72,262)
					SO_4^{2-}	48,000	(106,728)
		Copper-Trol™	1,160	(2,574)	Benzotriazole	1,160	(2,574)
		Clam-Trol™	6,140	(13,644)	Long Chain HC[j]	307	(682)
					Polar Organic Molecule	490	(1,091)
		Bromo-Chloro-Dimethylhydantoin	16,000	(35,546)	HOCl	5,600	(12,439)
					HOBR	10,400	(23,107)

(a) Items 1, 2, 4, 5, 6, 7, and 8 are based on 365 days per year operation at rated capacity. Item 3 is based on 292 days per year operation at rated capacity.
(b) Precipitated material that will make up the water treatment sludge on a dry weight basis. Ultimately put in landfill. No discharge.
(c) Estimates based on maximum suspended solids data observed at TRM 529.9.
(d) Ionized soluble species removed by demineralizers
(e) The quantitites of ionized soluble species continuously removed by the condensate demineralizers are predicated upon a primary to secondary leak rate or a condenser tube leak. These constituents will be discharged in the form of neutral salts of sodium, oxides of iron, or suspended solids. High crud filters will treat the backwash waste before discharge.
(f) Ammonia will be added as needed to maintain pH of 9.0 in the system.
(g) Hydrazine will be added as needed as a dissolved oxygen scavenger. Hydrazine is conservatively assumed to decompose to ammonia.
(h) Although copper and nickel will not be added to the system, the values shown represent high estimates of corrosion losses. Actual losses are expected to be less.
(i) Based on chemical feed rates at maximum cooling water usage and treatment schedule.
(j) Hydrocarbon.

- Zinc sulphate will be injected on a year-round continuous basis to reduce corrosion rates of carbon-steel piping and components. The letter of agreement with the State of Tennessee (TVA 1994d) indicates that the release of zinc sulfate (Betz TVA-07™)[a] is anticipated to be maintained at 0.2 milligram per liter (0.2 part per million) zinc.

- Butyl benzotriazole (Copper-Trol™),[b] a corrosion inhibitor, will be injected periodically into the raw-water systems to reduce corrosion rates. Most of the heat exchangers cooled by the raw water systems are constructed with copper or copper-alloy tubes. The primary point of chemical injection will be at the intake pumping station.

- Dodecylguanidine hydrochloride (DGH) and n-alkyl dimethyl benzyl ammonium chloride (Quat) will be injected periodically to eradicate clams and mussels and prevent MIC. These two chemicals are also marketed under the name Clam-Trol™ (CT-1).[a]

- 1-bromo-3-chloro-5,5-dimethylhydantoin (BCDMH), an oxidizing biocide used to reduce MIC and control Asiatic clams and zebra mussels, will be injected at the intake pumping station approximately four hours each day throughout the year. Samples of river water are collected periodically during clam-spawning season to monitor the concentration of Asiatic clam larvae entering the plant. Twice a year, BCDMH will be injected continuously for at least three weeks after the peak clam-dissemination periods (unless a non-oxidizing biocide is used).

The pyrophosphate, zinc sulfate, and copolymer will be injected into the raw-water systems using flow controllers located in the intake pumping station. The BCDMH will also be injected at the intake pumping station. The primary point of chemical injection for Copper-Trol™ and Clam-Trol™ will be the intake pumping station; however, other locations may be used under special circumstances as specified by the NPDES permit.

The NRC 1978 FES-OL stated that the applicant planned to use potassium chromate for corrosion inhibition in the closed-component cooling-water system; however, as a result of advances in corrosion inhibition, WBN Plant now will use tolytriazole and sodium molybdate for corrosion and pH control. The system remains closed, and no releases to the environment are planned other than those resulting from repairs to the system or from the leakage of nonradioactive chemicals from the radioactive waste treatment system.

Plant components may still be chemically cleaned before initial startup and during plant operation to remove corrosion-product buildup. Chemicals to be used during metal cleaning include trisodium phosphate, ethylene diamine tetra acetic acid, hydrochloric acid, and hydrazine. In addition, during startup, hydrazine and ammonia will be used for oxygen scavenging and corrosion inhibition, respectively, in the oil-fired boilers.

(a) Trademark of Betz Laboratories, Inc., Trevoise, Pennsylvania.
(b) Trademark of Betz Laboratories, Inc., Trevoise, Pennsylvania.

Sodium hypochlorite is used to treat sanitary waste from the WBN Plant on site in an extended aeration plant with four separate units, having a combined treatment capacity of 450 cubic meters (120,000 gallons) per day. The treated effluent is routed to the runoff holding pond before being discharged to the river in accordance with the NPDES permit.

The plant grounds drain into a yard holding pond, which is equipped with skimming capability for removal of debris and oil.

The applicant is removing transformers containing PCB from the site or retrofilling them with mineral oil or silicon fluid. Modifications of the transformers located outside of the plant have been completed.

Nonradioactive and nonhazardous solid wastes are buried in State-approved sanitary landfills or in onsite approved landfills, depending on the waste and type (TVA 1995). Construction debris and demolition waste are disposed of in an onsite landfill, which is permitted by the State of Tennessee under permit number 721030025. The applicant has contracts to use State-approved landfills to dispose of solid and nonradioactive asbestos waste material. Hazardous waste is shipped to the TVA Muscle Shoals Storage Facility for subsequent disposal. Most of the pipe insulation that contained asbestos has been, or will be, removed from the site and replaced with asbestos-free insulation.

3.5 Power Transmission System

No changes have been made to the applicant's proposed operation of the power transmission system as described in the NRC 1978 FES-OL. The Watts Bar-Volunteer transmission line described in the NRC 1978 FES-OL was placed into service on July 19, 1981.

The operational maintenance plan (TVA 1976, 1992, 1994d) for the transmission line system involves periodic manual and chemical removal of trees and shrubs that threaten line integrity along with preventing erosion through periodic inspections and mitigation. The applicant also manages rights-of-way near waterways and wetlands with special provisions to maintain trees and vegetation cover, both to control erosion and to provide wildlife habitat.

3.6 References

10 CFR Part 20. *Code of Federal Regulations*. 1994. "Standards for Protection Against Radiation." U.S. Nuclear Regulatory Commission, Washington, D.C.

10 CFR Part 50. *Code of Federal Regulations*. 1994. "Domestic Licensing of Production and Utilization Facilities." U.S. Nuclear Regulatory Commission, Washington, D.C.

State of Tennessee. 1993. *State of Tennessee NPDES Permit No. TN0020168 Authorization to Discharge Under the National Pollution Discharge Elimination System.* 1993. For Tennessee Valley Authority, Facility located at Watts Bar Nuclear Plant, Units 1 and 2. Issued September 30, 1993. Effective Date - December 1, 1993.

Tennessee Valley Authority (TVA). 1976. *Supplemental Environmental Assessment Watts Bar- Volunteer 500 kV Transmission Line*. July 6, 1976.

Tennessee Valley Authority (TVA). 1992. *A Guide for Environmental Protection and Best Management Practices for TVA Transmission Construction and Maintenance Activities*. TVA/LR/NRM 92/1.

Tennessee Valley Authority (TVA). 1994a. *Final Safety Analysis Report, Watts Bar Nuclear Plant*. Amendment 88, August 1994.

| Tennessee Valley Authority (TVA). 1994b. *Offsite Dose Calculation Manual*, Revision 3. October 1994.

Tennessee Valley Authority (TVA). 1994c. Letter from D. E. Nunn, TVA, to U.S. NRC. August 5, 1994. Subject: Watts Bar Nuclear Plant (WBN), Units 1 and 2 - Request for Additional Information Relating to Final Environmental Statement.

Tennessee Valley Authority (TVA). 1994d. Letter from D. E. Nunn, TVA, to U.S. NRC. November 4, 1994. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Request for Additional Information to the Final Environmental Statement.

Tennessee Valley Authority (TVA). 1995. Letter from O. J. Zerinque, TVA, to U.S. NRC. March 7, 1995. Subject: Watts Par Nuclear Plant (WBN) Units 1 and 2 - Request for Additional Information Related to the Watts Bar Environmental Review.

U.S. Nuclear Regulatory Commission (NRC). 1978. *Final Environmental Statement Related to Operation of Watts Bar Nuclear Plant, Units Nos. 1 and 2*. NUREG-0498. December 1978. U.S. Nuclear Regulatory Commission, Washington, D.C.

4 Environmental Effects of Site Preparation and Plant and Transmission Facilities Construction

The conclusions related to environmental effects of WBN Site preparation and WBN Plant and transmission facilities construction as given in the NRC 1978 FES-OL (NRC 1978) have not changed. WBN Site preparation and facility construction for Unit 1 have been completed, and no additional impacts are expected. Additional construction of transmission lines is not expected (TVA 1994). Impacts are not expected for facility construction of Unit 2 that are not previously discussed in the NRC 1978 FES-OL.

4.1 References

Tennessee Valley Authority (TVA). 1994. Letter from D. E. Nunn, TVA, to U.S. NRC. August 5, 1994. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Request for Additional Information Relating to Final Environmental Statement.

U.S. Nuclear Regulatory Commission (NRC). 1978. *Final Environmental Statement Related to Operation of Watts Bar Nuclear Plant Units Nos. 1 and 2*. NUREG-0498. U.S. Nuclear Regulatory Commission, Washington, D.C.

5 Environmental Impact of Watts Bar Nuclear Plant and Transmission Facilities Operations

This chapter discusses the effects on the environment of changes in WBN Plant design and proposed plant operating practices since preparation of the NRC 1978 FES-OL (NRC 1978a). It also discusses the effects of observed changes in the environment. Sections 5.1 and 5.2 discuss potential changes in impact on land and water use, respectively. Sections 5.3 and 5.4 discuss changes in impact on the terrestrial and aquatic environment, respectively. Changes in radiological and non-radiological health impacts are discussed in Sections 5.5 and 5.6. Section 5.7 discusses changes in socioeconomic impacts. Section 5.8 discusses Environmental Justice.

5.1 Impacts on Land Use

The NRC 1978 FES-OL noted that anticipated land use during operation of the WBN Plant would not differ from prior land use, either at the plant or along the transmission lines. The plant and the transmission lines were built as planned, and there are no impacts on land use that were not identified in the NRC's previous analyses. The area around the WBN Site will be maintained as a controlled-access area, which will enhance its function as a wildlife habitat. The staff has concluded that the WBN Site and transmission lines will not adversely affect wetlands identified by the applicant (TVA 1994a).

The applicant's management plan (TVA 1992a) for transmission rights-of-way accommodates existing land uses along the various rights-of-way. Transmission lines crossing privately held lands are managed in accordance with the policies and requests of the land owners. Managing vegetation within the rights-of-way involves clearing, hand-cutting, and applying herbicides, as appropriate to the area and as required by the individual land owners (TVA 1994b). Raptors are not discouraged from utilizing the transmission lines or towers as roosts or nesting sites.

The applicant has made gates, locks, and cables available to land owners along the rights-of-way to control off-road vehicular traffic. The staff, by aerial overflight, has examined the rights-of-way and concluded that they are adequately maintained with little or no erosion along the access roads. Erosion from off-road vehicular traffic is heaviest within portions of the rights-of-way that are privately owned. The applicant's management plan for maintaining rights-of-way uses recognized best management practices for the control of vegetation and erosion (TVA 1992a). Rights-of-way near waterways and wetlands are managed with special procedures for maintaining the trees and vegetative cover, both to control erosion and to provide wildlife habitat (TVA 1992a).

5.2 Impacts on Water Use

This section describes and evaluates the impacts of design and operation of the WBN Plant on water use, including impacts from thermal discharges, operational chemical wastes, and sanitary wastes. A discussion of the State of Tennessee regulations (State of Tennessee 1993) on discharges into the Tennessee River, including heat, chemicals, and other wastes, is also included.

5.2.1 Thermal Discharges

The 1993 NPDES permit (State of Tennessee 1993) issued to the applicant by the State of Tennessee specifies limits for the WBN Plant thermal effluent that may be discharged by the WBN Plant into the Tennessee River. The permit also defines instream monitoring and reporting requirements necessary for compliance with the effluent limitations.

The NPDES permit requires that the applicant conduct a study to determine an appropriate daily average temperature limit for discharges from Outfall 101 and Outfall 102. This was completed, and a report was submitted to the State of Tennessee in December 1993 (TVA 1993a). The report proposed an upper temperature limit of 35°C (95°F) for the diffusers (Outfall 101). It also proposed an upper temperature limit for emergency overflows from Outfall 102 of 40°C (104°F).

The changes in the thermal discharge limits (adding the new upper temperature limit for the diffuser and emergency outfall discharges) do not result in a change in the environmental impact previously described in the NRC 1978 FES-OL.

5.2.2 Operational Chemical Wastes

Section 3.4 describes the changes and additions that have been made in the chemicals to be discharged from the WBN Plant. Table 3.1 lists the chemicals to be released (TVA 1994a). The concentrations of the chemicals that are released from the facility will be reduced after mixing with the river.

The WBN NPDES permit controls the chemical waste discharges to the Tennessee River. The NPDES permit limits are levels that have been shown to have no deleterious effect on aquatic biota based on sensitivity testing as discussed in Section 5.4. The NPDES permit requires that the applicant conduct confirmatory biomonitoring studies of the discharges (see Section 6.2.4).

The staff concludes that the changes in plant design and proposed operation relating to the chemical discharges do not result in a change in the environmental impact previously described in the NRC 1978 FES-OL.

5.2.3 Sanitary Wastes

The sanitary waste system for the WBN Plant is discussed in Section 3.4 of this report. The sanitary waste will be treated in an onsite extended aeration plant. Effluent is routed to the runoff holding pond and discharged to the Tennessee River. The discharges will be controlled and monitored in accordance with the NPDES permit. The staff's review of the sanitary waste system does not change the conclusions reached in the NRC 1978 FES-OL.

5.2.4 NPDES Permit

The EPA has developed regulations and procedures to implement the provisions of the Clean Water Act that apply to aquatic and water quality aspects of nuclear steam electric generating stations. The Clean Water Act procedures regulate the major features of the NRC-licensed projects that affect the aquatic environment. The NRC Atomic Safety and Licensing Appeal Board in *Yellow Creek* (8 NRC 702 [1978]) held that the NRC does not have the authority to impose non-radiological license conditions for the protection of the aquatic environment, because the Clean Water Act places full responsibility for such matters with the EPA and permitting states. Effluent limitations, water quality monitoring, and determination of the best available technology for intake structures are developed by the EPA and implemented through the NPDES permit issued for each facility. The State of Tennessee Division of Water Pollution Control administers the NPDES permit in Tennessee.

The NPDES permit must be renewed every five years. This permit authorizes the discharge of process wastewater associated with the generation of electric power by thermonuclear fission and associated operations, including steam generator blowdown, cooling tower blowdown, sanitary wastewater, intake screen and strainer backwash, miscellaneous flows, and storm water runoff from specific outfalls. The most recent permit for the WBN Plant Units 1 and 2 was issued on September 30, 1993, by the State of Tennessee, Division of Water Pollution Control (State of Tennessee 1993). The permit became effective on December 1, 1993, and expires on September 29, 1998.

5.2.5 Effects on Water Users Through Changes in Water Quality

In the NRC 1978 FES-OL, the staff concluded that changes in water quality caused by the WBN Plant are unlikely to preclude any of the current or projected uses of the Tennessee River. The conclusion has not changed, despite proposed changes in the discharges discussed in Sections 5.2.1 through 5.2.4, above.

5.2.6 Effects on Surface Water Supply

The applicant's planned water use from the Tennessee River has not changed from that discussed in the NRC 1978 FES-OL. The Chickamauga Reservoir is a multipurpose reservoir operated in accordance with established rules for purposes of navigation, flood control, and hydroelectric power generation. Because the maximum station water usage from the Tennessee River is 0.7% of the mean river flow past the plant, water use at the WBN Plant is unlikely to have a measurable impact on the stream flow through, or the pool elevation of, the Chickamauga Reservoir as it is operated. This is consistent with the staff's conclusion in the NRC 1978 FES-OL.

5.2.7 Effects on Groundwater

Groundwater consumption by the WBN Plant is discussed in Section 3.1. The design and operation of the WBN Plant is unlikely to have a measurable impact on the groundwater supply. This is consistent with the staff's conclusion in the NRC 1978 FES-OL.

5.2.8 River Recreational Use

The NRC 1978 FES-OL did not address river recreational uses. Recreation near the WBN Plant consists primarily of bank and boat fishing on the Tennessee River. Fishing berms have been developed on both the right and left banks of the river below the Watts Bar Dam (upstream from the WBN Site). A TVA boat ramp on the left bank below the dam (approximately TRM 528) provides access for tailwater boat fishing. Recreational use patterns below Watts Bar Dam are similar to those that occur at other TVA mainstream dams.

Primary impacts on river recreational use near the WBN Site are associated with the operation of the Watts Ba Dam. Power production and flood control practices, such as drawdowns, can cause inconveniences to boaters and fishermen. By contrast, influences on river recreational use from operation of the WBN Plant will have minimal effect. The staff concludes that operation of the WBN Plant is unlikely to have an adverse impact on recreational use.

5.3 Impacts on Terrestrial Environment

The impacts on the terrestrial environment are discussed in three separate sections: impacts on terrestrial animal species, impacts on terrestrial plant species, and impacts on threatened and endangered terrestrial species.

5.3.1 Impacts on Terrestrial Animal Species

Impacts to animal species due to operation and maintenance of the WBN Plant and transmission lines could result from habitat changes resulting from maintenance of transmission line corridors, effects of electromagnetic fields (EMFs), collisions with transmission lines or cooling towers, and noise from plant operations.

The applicant's transmission line maintenance procedures (TVA 1992a) will ensure that no significant long-term impacts on terrestrial animal species will occur due to maintenance of the transmission line corridors (TVA 1994b).

Numerous studies referenced in NUREG-1437 (NRC 1991) have failed to show significant EMF effects on birds or other animals. Also, no unusual occurrences of bird collisions with transmission facilities or with WBN Plant structures have been reported since the transmission lines were constructed in the late 1970s. Therefore, these features are unlikely to significantly affect local or migratory bird populations.

Expected maximum noise levels from operation of the plant were estimated by the applicant to range between 53 and 63 decibels with intermittent sound levels ranging from 84 to 103 decibels (A-weighted scale) (TVA 1980). Raptors, including bald eagles and peregrine falcons (*Falco peregrinus*), exposed to noise levels in this range may exhibit alarm response, but numerous observations have identified no adverse effects on foraging, nesting success, or reproduction (FWS 1988).

The staff concludes that activities associated with WBN Plant operations are not likely to result in significant long-term impacts on terrestrial animal species in the surrounding area. This conclusion is consistent with that reached in the NRC 1978 FES-OL.

5.3.2 Impacts on Terrestrial Plant Species

Mechanical clearing and herbicides will be used in accordance with the applicant's management procedures (TVA 1992a) to maintain the transmission line rights-of-way. The impact on terrestrial plant species is expected to be minimal.

The applicant's rights-of-way maintenance procedures (TVA 1992a) have been refined since publication of the NRC 1978 FES-OL. Mechanical clearing is preferred over chemical clearing. Sections of rights-of-way that are inaccessible for mechanical clearing are usually treated with Accord™[(a)] or Accord and Arsenal™[(b)] herbicide mixture. Other products, such as Round-up™[(c)], Spike™[(d)], and Topsite™[(e)] may also be used in certain situations. The herbicides are either aerially or manually applied, depending on the product, the terrain, and the proximity to sensitive species or habitats, and other environmental constraints (TVA 1994j).

The staff concludes, based on the review of the applicant's analysis (TVA 1980) and the staff's site visit in September 1994, that the applicant's program for forage seeding has effectively controlled erosion outside of roadways in the transmission line corridors.

(a) Trademark of Monsanto Co., St. Louis, Missouri
(b) Trademark of American Cyanamid Co., Wayne, New Jersey
(c) Trademark of Monsanto Co., St. Louis, Missouri
(d) Trademark of DowElanco Co., Indianapolis, Indiana
(e) Trademark of American Cyanamid Co., Wayne, New Jersey

The NRC 1978 FES-OL identified, as a potential environmental concern, the acid mist formed by the mergence of moist air from the WBN Plant cooling towers and combustion gases from the Watts Bar Steam Plant stacks. Based on the applicant's analysis (TVA 1980) and information developed by the staff (NRC 1991), the staff concludes that the mergence of the WBN Plant cooling tower and Watts Bar Steam Plant plumes will have negligible impact on terrestrial vegetation near the WBN Site.

5.3.3 Impacts on Threatened and Endangered Terrestrial Species

Two species listed as endangered under the Federal ESA by the FWS (Southern bald eagle and the gray bat) and several additional species listed as threatened or endangered by the State of Tennessee Department of Envi ronment and Conservation (as discussed in Section 2.4.1) use the area in the vicinity of WBN Plant and its associated transmission line corridors.

The raptor species listed by the State of Tennessee will likely nest outside the transmission line corridors in larger trees. The grasshopper sparrow will nest in low-growing herbaceous vegetation. The removal of trees and shrubs beneath the power lines is unlikely to have an impact on the nesting activities of any of these avian species (listed in Table 2.7).

Eight species of plants that are listed by the State of Tennessee as threatened or endangered (including four Federal Candidates) are known to grow within at least 0.8 kilometer (0.5 mile) of the transmission line corri-dors (Table 2.7). Of these, the tall larkspur, the goldenrod, and the auriculate false foxglove occur in naturall barren areas and prairie habitats, and could exist in the open, cleared habitats found in transmission line corri-dors. The other five plant species occur in forest habitats and are unlikely to be affected by maintenance and operation of the transmission lines. To date, none of these species is known to occur in the WBN Plant trans-mission line corridors.

Maintenance activities along transmission corridors associated with the WBN Plant are conducted according tc the applicant's procedures. Transmission line segments are reviewed for the presence of federally protected o candidate species or State-listed species before the work is performed.

A Biological Assessment (jointly prepared by NRC and the applicant) was submitted separately by the staff (NRC 1994) and the applicant to the FWS. The Biological Assessment evaluated the potential for WBN Plant operation to adversely impact Federal-listed endangered or threatened species as discussed in Section 1.2. Th staff and the applicant concluded that no radioactive, thermal, or chemical discharge would adversely affect a of the Federal-protected terrestrial species.

On March 8, 1995, the FWS issued its Biological Opinion (FWS 1995). The FWS's Biological Opinion con-cluded that the operation of the WBN Plant, as proposed, is not likely to jeopardize the continued existence o the Southern bald eagle or the gray bat. Biological Opinion addressed reporting requirements and identified a reasonable and prudent measure to minimize incidental take of the species listed under the Endangered Species Act. Principal correspondence related to consultation with the FWS is provided in Appendix D.

5.4 Impacts on Aquatic Environment

The NRC 1978 FES-OL indicated that no deleterious effects on aquatic biota were expected from plant operation. Changes since the 1978 publication were discussed in Sections 2.4.2 and 3.4 and their implications are discussed below, along with a current statement of potential aquatic environmental impacts. The potential for impact to aquatic communities from various aspects of the operation of the WBN Plant includes entrainment and impingement of aquatic biota, thermal effects, and chemical effects. The effect of the operation of the WBN Plant on endangered and threatened species as well as on nuisance species are discussed separately below.

5.4.1 Entrainment and Impingement of Aquatic Biota

The NRC 1978 FES-OL concluded that losses to phytoplankton and zooplankton communities from entrainment in the intake cooling water would be inconsequential. High concentrations of these organisms are found in the Watts Bar Dam forebay and would not readily be depleted by plant operations. Nothing has changed to alter this conclusion.

Nothing has changed to alter the conclusion in NRC 1978 FES-OL that the entrainment of larval fish will not result in a significant impact. Larval fish entrainment is expected to occur in approximately the same proportions as that of plankton (TVA 1994c). The staff concluded in the NRC 1978 FES-OL, based on preliminary findings, that the tailwater reach between the WBN Plant and the dam was not a significant spawning area for sauger, thereby decreasing any possibility for larval entrainment at the WBN Plant. This conclusion has been substantiated by additional studies (TVA 1991) designed to locate spawning sites for tailrace-spawning fish species in the WBN Site vicinity, as discussed in Section 2.4.2.

The staff has not changed its conclusion that fish impingement will be minimal due to the low intake velocity, 0.12 meter per second (0.4 feet per second) maximum near intake openings, and that limited makeup water will be required by the closed-system cooling system (maximum of 0.7% of the average river flow) (NRC 1978; TVA 1994a).

5.4.2 Thermal Effects

The expected thermal characteristics of the discharge have not changed since the NRC 1978 FES-OL. As discussed in Section 5.2.1, specific effluent limitations for thermal effluents discharged by the WBN Plant into the Tennessee River are defined and regulated by the NPDES permit.

5.4.3 Chemical Effects

Section 3.4 describes the changes in the expected chemical effluents resulting from the raw water treatment program. This program has been revised since the NRC 1978 FES-OL to include the corrosion inhibitors pyrophosphate; zinc sulfate; butyl benzotriazole (Copper-Trol™), a copolymer dispersant; and the biocides/molluscicides BCDMH and Clam-Trol™ (CT-1) (TVA 1992b). Reviews of the WBN Plant's current chemistry manuals and product fact sheets indicate that the WBN Plant's chemical additions to the raw water system are well below concentrations that cause toxic effects in standard aquatic test organisms such as rainbow trout (*Oncorhynchus mykiss*), bluegill (*Lepomis macrochirus*), sheepshead minnow (*Cyprinodon variegatus*), fathead minnow (*Pimephales promelas*), daphnids (*Daphnia magna* and *Ceriodaphnia* sp.), grass shrimp (*Paleomonetes pugio*), and American oysters (*Crassostrea virginica)* (Betz Industrial 1993; TVA 1993b, 1994d, 1994e, 1994f).

Although no heavy metals were originally to be added to the plant discharge, zinc sulfate is now being used to reduce corrosion rates of carbon steel piping and components (TVA 1992b). It is added continuously to the raw water system and is subject to the NPDES permit requirements. A year-long study involving monthly effluent toxicity tests confirms that the discharge of zinc and other corrosion inhibitors in concentrations used at the WBN Plant do not result in toxic effects to aquatic biota (TVA 1992c, 1992d, 1992e, 1993c, 1993d, 1993e, 1993f, 1993g, 1993h, 1993i, 1993j, 1993k). The applicant has committed to taking corrective action if toxic effects are observed as a result of zinc sulfate use, including reevaluation and subsequent alteration of the plant's corrosion-inhibiting methods if proven necessary (TVA 1994a).

To determine safe discharge limits for the molluscicide Clam-Trol™, (CT-1), a series of monthly static renewal tests using fathead minnows and daphnids (*Ceriodaphnia dubia*) was conducted by the applicant over a 12-month period when chemicals were being used at the plant. These tests did not identify any toxicity in undiluted Outfall 101 effluent, based on responses of either species. Both fathead minnows and daphnids are standard NPDES toxicity biomonitoring organisms (NRC 1994; TVA 1994a).

In addition, two studies evaluating the potential impact of the WBN Plant chemical use by the applicant on a representative freshwater mussel, the paper pondshell (*Anodonta imbecilis*), were conducted to compare the sensitivity of juvenile mussels with standard NPDES toxicity-testing organisms.

The first study (reported in NRC 1994) was conducted in 1991 jointly by the applicant's Toxicity Testing Laboratory and Presbyterian College, Clinton, South Carolina, using daphnids and 8- to 10-day-old juvenile paper pondshell mussels. The study examined the organisms' toxic response to chemicals added to Outfall 101 effluent. The chemicals used in the study are those intended to be used by the applicant during plant operation and included the chemicals DGH/Quat, active ingredients in a molluscicide (Clam-Trol™ CT-1) currently used at the WBN Plant to control Asiatic clams. No toxic effects were observed in juvenile mussels for any treatment during 9-day tests. Daphinid survival during the 48-hour exposure was reduced in treatments containing these chemicals added to the outfall effluent. A repeat study using DGH/Quat as the only chemical additive showed toxicity to daphnids but not to fathead minnows.

The second study (also reported in NRC 1994) tested daphnids, fathead minnows, the paper pondshell, another freshwater mussel (*Elliptio arctata*), and a rotifer (*Brachionus calyciflorus*). In this test, these non-target organisms were exposed to effluent with DGH/Quat. The results of this study were similar to those of the first study, as daphnids were again the most sensitive species. The most sensitive mussel in this experiment, the paper pondshell, was 15 times less sensitive to the molluscicide than the daphnid when silt was included in the test (silt occurs naturally in the river and is a detoxifying agent for DGH/Quat) (TVA 1994a).

All chemical discharge from the WBN Site is strictly regulated by the NPDES permit. The levels permitted under these regulations are expected to protect aquatic species. Specifically, the NPDES permit prohibits discharges through the diffuser unless water releases from the applicant's upstream Watts Bar Dam exceed 98 cubic meters per second (3500 cubic feet per second) (see Section 3.2). This system of discharge provides an added means to ensure the protection of aquatic species found near the diffuser.

Toxicity studies, along with current monitoring practices, indicate that undiluted effluent from the WBN Site will not affect mussel species residing in the diffuser mixing zone. In addition, the detoxifying effects of silt in the river and the large dilution that occurs as discharge mixes with river water results in an increased safety margin, not only for mussel species but for fish and other aquatic life as well. Although the sensitivity of endangered and threatened species in the area of the Tennessee River near the WBN Site has not been compared specifically to the sensitivity of daphnids, the existence of an order of magnitude difference in sensitivity of the daphnids compared with the fish and mussel species tested indicates that the testing of undiluted effluent required by the NPDES permit at the WBN Plant (using daphnids as a test organism) should ensure that no impact to aquatic species near or downstream from the WBN Plant discharges will occur (NRC 1994). The applicant has committed to employ a different clam-control method following appropriate effects-testing if ongoing biomonitoring indicates adverse effects on the aquatic life (TVA 1994a).

The staff concludes that the impact to aquatic life from discharges from the WBN Site will be minimal. This conclusion is consistent with that reached in the NRC 1978 FES-OL.

5.4.4 Impacts on Threatened and Endangered Aquatic Species

A Biological Assessment was prepared jointly and submitted separately by the staff (NRC 1994) and the applicant to the FWS. The Biological Assessment evaluated the potential for WBN Plant operation to adversely impact Federal-listed endangered or threatened species, as discussed in Section 1.2. After reviewing the status of the listed aquatic species, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is the FWS's biological opinion (FWS 1995) that operation of the WBN Plant, as proposed, is not likely to jeopardize the continued existence of the dromedary pearly mussel, pink mucket pearly mussel, rough pigtoe, fanshell, or snail darter. Additionally, threatened/endangered mussel species are further protected by the establishment of the mussel sanctuary. Principal correspondence related to consultation with the FWS is provided in Appendix D.

5.4.5 Nuisance Aquatic Organisms

Potential nuisance aquatic organisms found in the vicinity of the WBN Plant include various aquatic macrophytes, blue-green algae, and molluscs (see Section 2.4.2). The potential for increase in population size of nuisance organisms as a result of plant operation is minimal (TVA 1994g).

As indicated in Section 2.4.2, the WBN Plant is located in the riverine tailwater area of Chickamauga Reservoir where relatively shallow overbank habitat that is suitable for macrophyte growth is rare. Macrophyte levels near the plant have never reached nuisance levels. The Sequoyah Nuclear (SQN) Plant, located on the Chickamauga Reservoir 72 kilometers (45 miles) downstream from the WBN Plant, is in an area of more suitable aquatic macrophyte habitat than exists near the WBN Plant. However, a study (TVA 1993l) failed to show any correlation between operation of the SQN Plant and growth patterns of aquatic macrophytes in Chickamauga Reservoir. Thus, there does not appear to be any basis for expecting WBN Plant operation to affect macrophyte growth in Chickamauga Reservoir (TVA 1994g).

Conditions conducive to the development of nuisance "blooms" of blue-green algae in lakes and reservoirs can be caused by increased temperatures and/or levels of fertility. As indicated in Section 2.4.2, blue-green algae are rarely a major component of the phytoplankton population at the WBN Site. The nutrient and waste heat levels in the WBN Plant discharge will be minimal and will not encourage the growth of blue-green algae. Operational monitoring at the SQN Plant, where greater amounts of waste heat are discharged into the water, has not shown significant changes. Thus, there is no reason for concluding that increases in the abundance of blue-green algae will occur as a result of the WBN Plant operation (TVA 1994g).

The Asiatic clam occurs throughout Chickamauga Reservoir. Certain water users, including the applicant, have implemented control measures to prevent biofouling by this clam. Another species, the zebra mussel, has recently been introduced into the Tennessee River and is also expected to become a biofouling threat. No features of plant operation are known to increase the growth or reproduction of either population. Thus, increases in these organisms as a result of plant operation are not expected (TVA 1994g).

The staff concludes that the growth of nuisance aquatic organisms will not be significantly increased by operation of the WBN Plant.

5.5 Radiological Impacts

The NRC 1978 FES-OL contained an evaluation of the radiological impacts projected for 30 years of plant operation. Some of the technical bases for the NRC 1978 FES-OL evaluation have changed. Consequently, the staff has reviewed the changes to the environment, proposed operating procedures, and the WBN FSAR (TVA 1994h) to support the conclusions in this section.

Nuclear power reactors in the United States must comply with the regulatory requirements of 10 CFR Part 20, "Standards for Protection Against Radiation." These regulations set limits on levels of radiation and limits on concentrations of radionuclides in a facility's effluent releases to the air and water (above natural background). License requirements on effluents from nuclear power reactors are specified in 10 CFR 50.36a. Technical specifications are prepared by the applicant to ensure that releases of radioactive materials to unrestricted areas during normal operations, including expected operational occurrences, are maintained as low as is reasonably achievable (ALARA). Appendix I to 10 CFR Part 50 and RM-50-2 provide numerical guidance on dose-design objectives for light-water reactors (LWRs) to meet the ALARA requirement. Appendix I contains two sets of criteria. Because of the date on which the construction permit application was received, the applicant may select either set for the WBN Plant. Hence, both sets of criteria are presented in Table 5.1.

5.5.1 Changes to the Plant

Changes have been made in the WBN Plant liquid and solid radioactive waste systems but not in the gaseous radioactive waste (radwaste) systems since the NRC 1978 FES-OL was issued (see Section 3.3).

In the NRC 1978 FES-OL, it was recognized that specific radioactive waste treatment systems and waste storage and handling systems would be modified or supplemented to take advantage of technological improvements and evolving regulatory requirements. Design of the WBN radioactive waste systems has evolved to reflect the operating experience of the applicant and the nuclear industry.

5.5.2 Summary of Radioactive Effluents and Potential Exposures of Humans

Essentially all of the dose to individuals or the population surrounding the plant is accounted for by direct radiation, inhalation of radionuclides present in atmospheric releases, and ingestion of milk, fish, and water contaminated by radionuclides from atmospheric or liquid releases. The Tennessee River is not used for irrigation and invertebrates are not harvested for consumption; consequently, these pathways are not used in the dose calculations. Doses received from swimming in or boating on the Tennessee River have also not been included because these doses have been found at SQN Plant to be several orders of magnitude lower than the dose received from shoreline recreation (TVA 1994a). The staff performed an independent assessment of the projected radiation dose to individuals and the public using updated and revised NRC analytical models. The doses generated from the NRC assessment are compared with the doses in the applicant's analysis in the WBN

Table 5.1 Summary of Staff Position - Methods of Evaluating Compliance with Appendix I Annual Design Objectives

Type of Dose	Appendix I[a] Design Objectives	RM-50-2[a] Design Objectives	Point of Dose Evaluation
Liquid Effluents			
Dose to total body from all pathways	0.03 mSv per unit (3 mrem per unit)	0.05 mSv per site (5 mrem per site)	Location of the highest dose offsite[b]
Dose to any organ from all pathways	0.1 mSv per unit (10 mrem per unit)	0.05 mSv per site (5 mrem per site)	Location of the highest dose offsite[b]
Non-tritium releases	------	190 GBq per unit (5 Ci per unit)	------
Gaseous Effluents[c]			
Gamma dose in air	0.1 mGy per unit (10 mrad per unit)	0.1 mGy per site (10 mrad per site)	Location of the highest dose offsite[d]
Beta dose in air	0.2 mGy per unit (20 mrad per unit)	0.2 mGy per site (20 mrad per site)	Location of the highest dose offsite[d]
Dose to total body of an individual	0.05 mSv per unit (5 mrem per unit)	0.05 mSv per site (5 mrem per site)	Location of the highest dose offsite[b]
Dose to skin of an individual	0.15 mSv per unit (15 mrem per unit)	0.15 mSv per site (15 mrem per site)	Location of the highest dose offsite[b]
Radioiodines and Particulates[e] Released to the Atmosphere			
Dose to any organ from all pathways	0.15 mSv per unit (15 mrem per unit)	0.15 mSv per site (15 mrem per site)	Location of the highest dose offsite[f]
I-131 releases	------	37 GBq per unit (1 Ci per unit)	------

(a) Evaluated for a maximum individual, as described in Section B of Regulatory Guide 1.109 (NRC 1977)
(b) Evaluated at a location that is anticipated to be occupied during plant lifetime or evaluated with respect to such potential land and water usage and food pathways as could actually exist during the term of plant operation
(c) Calculated only for noble gases
(d) Evaluated at a location that could be occupied during the term of plant operation
(e) Doses due to carbon-14 and tritium intake from terrestrial food chains are included in this category
(f) Evaluated at a location where an exposure pathway and dose receptor actually exist at the time of licensing. However, if the applicant determines design objectives with respect to radioactive iodine on the basis of existing conditions and if potential changes in land and water usage and food pathways could result in exposures in excess of the guideline values given above, the applicant should provide reasonable assurance that a monitoring and surveillance program will be performed to determine: (1) the quantities of radioactive iodine actually released to the atmosphere and deposited relative to those estimated in the determination of design objectives; (2) whether changes in land and water usage and food pathways which would result in individual exposures greater than originally estimated have occurred; and (3) the content of radioactive iodine in foods involved in the changes, if and when they occur.

FSAR, the NRC 1978 FES-OL, and the 10 CFR Part 50, Appendix I Design Objectives. The staff concludes that changes in the exposure pathway analysis do not result in a measurable change in the environmental impact previously described.

Dose Commitments from Airborne Radioactive Releases

There have been no substantial changes in the described design or planned operation of the gaseous radioactive waste treatment system from those presented in the NRC 1978 FES-OL.

Table 5.2 presents the estimated annual airborne releases and resulting doses to the maximally exposed individual as reanalyzed by the NRC staff. These are compared to those presented in the WBN FSAR (TVA 1994h) and the NRC 1978 FES-OL. The current NRC dose estimates are different from the earlier estimates in the NRC 1978 FES-OL because of changes in the assumptions and analytical models. For example, in the cow-milk-pathway dose calculation, the staff assumed that the cow obtains all of its food from pasture for only 10 months of the year. Although the calculated annual releases and doses are different, they are still below the Appendix I Design Objectives. The dose to the maximally exposed member of the public will not exceed the 10 CFR Part 50, Appendix I guidelines and will be less than 0.3% of the dose from natural radiation sources.

Table 5.2 also compares the estimated population doses from airborne releases as reanalyzed by the NRC staff with the population doses reported in the WBN FSAR (TVA 1994h) and the NRC 1978 FES-OL. The NRC 1978 FES-OL estimated the population within 80 kilometers (50 miles) of the WBN Plant for the year 2000 as 1,050,000. The WBN FSAR (TVA 1994h) and the current NRC analysis estimate of population for the year 2040 is 1,100,000. Hence, the expected 80-kilometer (50-mile) population at the planned expiration of the

Table 5.2 Comparisons of Annual Airborne Releases and Doses From WBN Plant Two-Unit Operation

Radonuclide Releases/Dose	Current NRC Assessment	WBN FSAR (Tables 11.3-9, 11.3-13, and 11.3-14)	NRC 1978 FES-OL (Tables 3.4 and 5.9)	Appendix I Design Objectives	RM-50-2 Design Objectives
Noble gas releases	480 TBq (13,000 Ci)	400 TBq (11,000 Ci)	250 TBq (6,800 Ci)	—(a)	—(a)
Iodine-131	13 GBq (0.34 Ci)	11 GBq (0.30 Ci)	5 GBq (0.13 Ci)	—(a)	74 GBq(b) (2 Ci)
Total body dose(c)	0.004 mSv (0.4 mrem)	0.012 mSv (1.2 mrem)	0.01 mSv (1 mrem)	0.1 mSv (10 mrem)	0.05 mSv (5 mrem)
Organ dose(c)	0.14 mSv (14 mrem)	0.15 mSv (15 mrem)	0.04 mSv (4 mrem)	0.3 mSv (30 mrem)	(0.15 mSv (15 mrem)
Population Dose	0.044 person-Sv (4.4 person-rem)	0.039 person-Sv (3.9 person-rem)	<0.05 person-Sv (<5 person-rem)	—(a)	—(a)

(a) Not applicable
(b) The objective is no more than 1 Cuire per year per unit
(c) Maximally exposed individual

operating license is not significantly different from that used in the NRC 1978 FES-OL annual population dose estimates. These annual population doses are less than 0.002% of the annual doses from natural radiation sources.

On the basis of the annual releases and dose estimates generated from the NRC assessment, the staff concludes that the WBN Plant is capable of being operated within the 10 CFR Part 50, Appendix I criteria under the NRC-specified conditions, and actual releases and doses are expected to be lower than the criteria.

Dose Commitments From Liquid Radioactive Releases to the Hydrosphere

The WBN Plant systems for the control of liquid effluents have changed since the NRC 1978 FES-OL as described in Section 3.3.

Table 5.3 presents the estimated annual liquid releases and resulting doses to the maximally exposed individual as reanalyzed by the NRC staff. These are compared to the dose estimates reported in the WBN FSAR (TVA 1994h) and the NRC 1978 FES-OL. The current dose estimates differ from the 1978 values primarily because of differences in the source terms; the other parameter values and the models are essentially unchanged.

The provisions of 10 CFR 50.36a and of Appendix I effectively limit the dose or dose commitment to a member of the public from radioactive materials in liquid effluents. This limitation is met procedurally

Table 5.3 Comparisons of Annual Liquid Releases and Doses From WBN Plant Two-Unit Operation

Radionuclide Releases/Dose	Current NRC Assessments	WBN FSAR (Tables 11.2-7 and 11.2-11)	NRC 1978 FES-OL (Tables 3.3 and 5.9)	Appendix I Design Objectives	RM-50-2 Design Objectives
Tritium Releases	95 TBq (2,600 Ci)	95 TBq (2,600 Ci)	380 TBq (10,400 Ci)	—(a)	—(a)
Other Radionuclide Releases	0.25 TBq (6.6 Ci)	0.26 TBq (7 Ci)	0.016 TBq (0.44 Ci)	—(a)	370 GBq (10 Ci)
Total Body Dose(b)	0.008 mSv (0.8 mrem)	0.007 mSv (0.7 mrem)	0.001 mSv (0.1 mrem)	0.06 mSv (6 mrem)	0.05 mSv (5 mrem)
Maximum Organ Dose(b)	0.01 mSv (1 mrem)	0.01 mSv (1 mrem)	0.002 mSv (0.2 mrem)	0.2 mSv (20 mrem)	0.05 mSv (5 mrem)
Population Dose	0.017 person-Sv (1.7 person-rem)	<0.02 person-Sv (<2 person-rem)	<0.04 person-Sv (<4 person-rem)	—(a)	—(a)

(a) Not applicable
(b) Maximally exposed individual

through sampling of effluent streams and projecting future doses based on these releases. The applicant's Technical Specifications require that the applicant estimate the potential downstream consequences resulting form liquid effluent releases to the environment at least every 31 days according to the methodology in the applicant's ODCM (TVA 1994j). If the results of the calculation performed before release indicate that the specified acceptance criteria would be exceeded, appropriate actions will be taken to ensure that the release is not executed. The evaluation of potential effects from long-term buildup of radioactive material in liquid effluents was also performed by the applicant using design value releases and buildup in river sediment and in aquatic biota. The total body and organ dose esitmates in Table 5.3 are principally from fish consumption.

Table 5.3 also compares the estimated annual population dose from liquid releases as reanalyzed by the NRC staff with the WBN FSAR (TVA 1994h) and the 1978 FES-OL. In these analyses, doses from ingestion of water, consumption of fish, and shoreline recreation were estimated for exposures to radionuclides routinely released in liquid effluents. No credit was taken for removal of activity from the water through absorption on solids and sedimentation, by deposition in the biomass, or by processing within community water treatment systems. The annual population dose from consumption of fish was calculated using the assumption that all of the edible fish harvested from the Tennessee River, within 80 kilometers (50 miles) downstream of the WBN Plant, is consumed by humans. These annual population doses are about 0.001% of the annual dose from natural radiation sources.

On the basis of the annual releases and dose estimates generated from the NRC assessment, the staff concludes that the WBN Plant is capable of being operated within the 10 CFR Part 50, Appendix I criteria under the NRC-specified conditions, and actual releases and doses are expected to be lower than the criteria.

Direct Radiation From the Facility

The estimated plant-related direct radiation doses used in the NRC 1978 FES-OL analysis remain unchanged. The estimates of the annual radiation dose in the environment as a result of radioactivity contained within the reactor and its components continue to be less than 0.05 millisievert (5 millirems). This can be contrasted with the annual natural radiation background dose (NCRP 1987) estimated to be 3 millisieverts (300 millirems).

Occupational Radiation Exposure

Experience shows that the dose to nuclear plant workers varies from reactor to reactor and from year to year. The average annual dose can be projected by using the experience to date with modern pressurized-water reactors (PWRs). Recently licensed 1000-megajoules per second (1000-megawatt) electric PWRs are operated in accordance with the post-1975 regulatory requirements and guidance that place increased emphasis on maintaining occupational exposure at nuclear power plants ALARA. These requirements and guidance are outlined primarily in 10 CFR Part 20, Chapter 12 of the Standard Review Plan (NRC 1981), and Regulatory Guide 8.8 (NRC 1978b).

The applicant's proposed implementation of these requirements and guidelines is reviewed by the staff during the licensing process, and the results of that review are reported in the SER. The license is granted only after the review indicates that an acceptable ALARA program can be implemented. In addition, regular reviews of operating plants are performed by the staff to determine whether the ALARA requirements are being met.

In the NRC 1978 FES-OL, the annual occupational dose for the WBN Plant was estimated as 5 person-sieverts (500 person-rem) per reactor (10 person-sieverts [1000 person-rem] for the two-unit site). Since 1978, the nuclear industry has implemented a number of changes in plant design and operational features aimed at minimizing occupational exposures. These changes have resulted in a steady decrease in the average occupational dose at U.S. PWRs since the mid-1980s. The average collective occupational dose per reactor for PWRs over the most recent five-year period (from 1989 to 1993) was 2.5 person-sieverts (250 person-rem) per year. The SQN Plant is similar in design to the WBN Plant and therefore the occupational doses for both plants should be similar. The average collective occupational dose per reactor for the SQN Plant for the five-year period from 1989 to 1993 was 3.9 person-sieverts (390 person-rem). This average dose was almost 60% higher than the average dose at all PWRs during the same period, primarily because the SQN Plant required more maintenance than did the average PWR. Nevertheless, the five-year dose average for the SQN Plant was still lower than the 1978 FES annual dose estimate of 5 person-sieverts (500 person-rem) for the WBN Plant. The annual collective dose at the SQN Plant has been steadily decreasing since 1990 and the dose per reactor in 1993 and was slightly less than the 1993 overall PWR average of 1.9 person-sievert (190 person-rem) per reactor. The staff believes that the WBN Plant can be operated with an annual average collective dose similar to the annual doses for the SQN Plant in recent years and that is well under the 1978 FES annual dose estimate for the WBN Plant.

5.5.3 Radiological Impact on Animals

The staff agrees with the conclusions made in the NRC 1978 FES-OL regarding radiological impacts on biota other than man; that is, no significant radiological impacts are expected on aquatic or terrestrial biota, including endangered species, as a result of the WBN Plant operations.

5.5.4 Storage and Transportation of Radioactive Material

The NRC 1978 FES-OL provides essentially correct descriptions of both wet and dry waste handling and the forms of waste to be generated at the WBN Plant. However, in lieu of solidification, "wet" solid wastes will be transferred to approved high integrity containers and dewatered prior to shipment offsite. As discussed in Section 3.3, waste evaporators will not be utilized; thus, no evaporator bottoms will be generated at the WBN Plant and, as a result, the expected characteristics of the waste generated at the WBN Plant are changed.

The NRC 1978 FES-OL estimated that 480 cubic meters (17,000 cubic feet) of wet waste would be generated annually at the WBN Plant. Currently the staff expects 150 cubic meters (5000 cubic feet) (Table 5.4) of wet

Table 5.4 Annual Waste Generation and Storage for WBN Plant Two-Unit Operation

Waste Type	Volume Generated		Volume to be Stored		Number of Containers
	Cubic Meters	(Cubic Feet)	Cubic Meters	(Cubic Feet)	
Ion-exchange Resin/Filters	150	(5,000)	150	(5,000)	5
Dry Active Waste	850	(30,000)	40	(1,400)	11
Irradiated Components	< 3	(<100)	< 3	(<100)	-[a]

(a) In fuel pool

waste to be generated annually at the WBN Plant. The staff's revised projection for the WBN Plant is the industry average volume of wet waste generated by a two-unit PWR Plant (Tichler et al. 1994), and reflects the continued technological improvements in waste management to reduce the volume of waste generated and the associated high disposal cost.

The applicant (TVA 1995a) estimated that 850 cubic meters (30,000 cubic feet) of dry active waste would be generated, and less than 3 cubic meters (100 cubic feet) of irradiated components. These estimates are based on the industry average.

The Chem-Nuclear disposal facility near Barnwell, South Carolina, is currently used by the applicant for the disposal of low-level radwaste from its other facilities. The Barnwell facility is scheduled to close at the end of 1995. Shipments made from the WBN Plant before 1996 will go to the Barnwell facility. The replacement facility for Barnwell will be located in Wake County, North Carolina. Although the original start date for the North Carolina facility was early 1996, the current schedule for that facility calls for it to open sometime after mid-1997. This may require the WBN Plant to store low-level radwaste onsite for more than a year. To accommodate this anticipated delay, the applicant is evaluating the location and cost of an onsite storage facility to handle up to four years of WBN-generated waste.

Based on industry experience, the applicant intends to use a variety of compaction and incineration methods to reduce the volumes of low-level waste for disposal. Previously, the applicant intended to only use onsite compaction in the processing of dry solid waste. The onsite compaction method the applicant originally intended to use was expected to result in a factor of 3 reduction in the volume of dry sold waste. The compaction and incineration methods the applicant now intends to use will result in a larger reduction in the volume of dry waste. For example, incineration of waste can result in, approximately, a factor of 100 reduction in the volume of dry incinerable waste. Similarly, offsite super-compaction (at higher compaction pressure) of dry non-incinerable waste (such as metals) will result in, approximately, a factor of 5 to 8 reduction in volume. The applicant is using similar compaction and incineration methods at SQN Plant and has achieved a factor of 14 reduction in the volume of combined (incinerable and non-incinerable) dry waste.

Waste processing offsite will reduce the waste volume; however, the radionuclide content will remain unchanged.

The transportation of radioactive waste is affected by the onsite processing of the radioactive waste before disposal. Even with the predisposal shipments, the total transport of radioactive waste is now expected to be less than previously assumed. Table 5.5 shows the estimated volumes of waste expected to be shipped from the WBN Plant once the disposal site is licensed. Overall the use of onsite processing will reduce the volume of waste to be shipped for disposal. The staff concludes that the new waste management approach will reduce the already low levels of projected radiation exposure to the public during the transportation of radioactive waste.

Unlike the sophisticated processes to be used for dry waste, processing of wet waste will be simplified by the elimination of evaporators. Mobile demineralizers will be used to remove radioactive ions from water in the plant. When the resin is spent, it will be collected in storage tanks until sufficient volume of resin is collected. The resin then will be sluiced to high integrity containers inside NRC-licensed shipping casks. The resin will be dewatered to meet disposal site criteria. No other processing of the resin is planned. Ultimately, resin waste from the mobile waste demineralizer will be sent to a licensed disposal facility for disposal.

The mobile demineralizer will be located in the radwaste packaging area. Shielding and distance will be used to reduce the potential for radiation exposure to operators and others who might be in the area. Experience with similar equipment at other nuclear plants has shown that radiation exposure to operators is low and well within that expected from similar plant radwaste management systems. Resin shipping casks will be constructed of steel or steel-lead to provide shielding during packaging of the material and transport to the dispos facility or storage facility. Dose rates will be within Department of Transportation limits, and calculated dose to the public will be a small percentage of natural background radiation. The annual doses to the public will t smaller than those given in the NRC 1978 FES-OL since the volume of waste produced and the number of shipments made will be smaller than previously anticipated.

Table 5.5 Annual Volumes of Waste Shipped for WBN Plant Two-Unit Operation

Waste Type	Volume Shipped Cubic Meters	(Cubic Feet)	Frequency Shipment Per Year
Ion-exchange Resin/Filters	150	(5,000)	4 to 6
Dry Active Waste (to offsite processor)	850	(30,000)	< 30[a]
Dry Active Waste (from offsite processor)	40	(1,400)	< 35[b]
Irradiated Components	< 3	(< 100)	< 1[b]

(a) Shipped in 6.6-meter (20-foot) sea-vans at 30 cubic meters (1,040 cubic feet) each. Shipments could decrease by half if 13-meter (40-foot) containers are used.

(b) Shipped by the waste processor with the waste from other generators in multi-container shipments averaging 1.2 cubic meters (40 cubic feet) per shipment. If all waste in the shipment were from the WBN Plant, the entire annual volume would require only one or two shipments.

The NRC staff estimates that the total annual resin activity will be about 80 terabecquerels (2000 curies) and dry active waste will contain about 0.4 terabecquerels (10 curies). Most of the activity will be cobalt-58, chromium-51, iron-55, iron-59, cobalt-60, niobium-95, nickel-63, zirconium-95, cesium-134, cesium-137, and manganese-54.

The NRC 1978 FES-OL assumed that the applicant would ship spent fuel offsite for disposal and that shipments would comply with applicable transportation guidelines issued by NRC and/or the U.S. Department of Transportation. The plans for the WBN Plant spent fuel disposal remain the same. The applicant contemplates storing spent fuel on site until the U.S. Department of Energy (DOE) completes construction of permanent disposal facilities in accordance with the Nuclear Waste Policy Act of 1982. If necessary, the applicant will provide additional storage capacity onsite until DOE begins accepting spent fuel. There are several methods available for expanding onsite storage capacity, such as higher density spent fuel storage racks, fuel rod consolidation, and dry storage outside the auxiliary building. The applicant will conduct an appropriate environmental review before selecting one of these alternatives.

Occupational radiation doses during storage, monitoring, and retrieval of the waste are expected to be a small percentage of the total dose to workers who handle and work around radioactive materials each day. Occupational doses will be minimized by the use of shielding, distance, and reduced stay time around the material.

The estimated doses from the transportation of fuel and waste are unchanged from Table 5.8 of the NRC 1978 FES-OL. That table was taken from 10 CFR 51.52.

5.5.5 Health Effects of Radiation Doses From Effluents

As discussed in previous paragraphs of Section 5.5, radiation doses to the public and to workers are expected to be below the NRC dose criteria. The health effects from these doses will also be small, as discussed in the paragraphs below.

The staff used somatic (cancer) and genetic risk estimators that are based on widely accepted scientific information to estimate potential health effects from radiation exposures to workers and to the offsite populations as a result of the WBN Plant operation. Specifically, the staff's estimates are based on information compiled by the National Academy of Sciences' Committee on the Biological Effects of Ionizing Radiation, (BEIR 1990) and Publication 60 of the International Commission on Radiological Protection (ICRP 1991). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The risk estimators from Table 3 of ICRP 60 were used to estimate health effects from fatal cancers or severe heredity effects per 100 person-sieverts (or per million person-rem).

The risk of potentially fatal cancers in the exposed work force population is estimated by multiplying the plant-worker-population dose by the somatic risk estimator (4 fatal cancers per 100 person-sievert [400 fatal cancers per million person-rem]). The risk of severe hereditary effects attributable to exposure of the work force is a risk borne by the progeny of the workers, but is considered separately in ICRP 60, with a severe hereditary effect estimate of less than 1 effect per 100 person-sievert (80 effects per million person-rem) (compared to 1.3 effects per 100 person-sievert [130 effects per million person-rem] for the general population). The risk is lower for workers because a smaller fraction of their doses will be received by people of child-bearing age or younger.

Radiation and radioactive contaminants can be measured very accurately so that much smaller amounts of radionuclides can be detected than can be associated with any possible observable health effects. Furthermore, the effects of radiation on living systems have for decades been subject to intensive investigation and consideration by individual scientists as well as by select committees that are constituted to objectively and independently assess radiation dose effects. As in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation; however, conservative estimates of deleterious effects are well established and amenable to standard methods of risk analysis. Thus, the risks to the maximally exposed member of the public or to the total population outside the boundaries can be estimated. These fatal cancer and severe hereditary effect risk estimates are provided in Table 5.6.

The risk to the maximally exposed member of the public is estimated by multiplying the fatal cancer risk estimator of 5 per 100 person-sieverts (500 per million person-rem) by the estimated dose to the total body (as shown in Table 5.6). This calculation results in a risk of potential premature death from cancer to this

Table 5.6 Potential Fatal Cancers and Severe Hereditary Effects in Selected Population Groups from One Year of WBN Plant Two-Unit Operation[(a)]

Exposed Population	Dose Commitment	Estimated Fatal Cancers	Estimated Severe Hereditary Effects
WBN Occupational Work-Force	10 person-Sv (1,000 person-rem)[(b)]	0.4	0.08
Maximally Exposed Individual[(c)]	0.01 mSv (1 mrem)	0.0000005	—[(d)]
Offsite Population[(e)]	0.06 person-Sv (6 person-rem)	0.003	0.001

(a) Impacts assume year 2040 population
(b) Average person-rem dose for operating nuclear power plants (the NRC 1978 FES-OL, Section 5.5.1, Occupational Radiation Exposure, p. 5-15)
(c) A hypothetical individual receiving the maximum off-site dose (Tables 5.2 and 5.3)
(d) Not applicable
(e) General population (1.1 million) within 80 kilometers (50 miles) of the WBN Plant in year 2040 using the population doses from FSAR as amended

individual from exposure to radioactive effluents (gaseous or liquid) of approximately 5 chances in 10 million. These risks are small in comparison to cancer incidence from causes unrelated to WBN Plant operation: viz., 200,000 chances in 1 million (American Cancer Society 1994).

The risk of death from cancer resulting from exposure to radioactive effluents from the WBN Plant to an average individual living within 80 kilometers (50 miles) of the facility is much less than the risk to the maximally exposed individual. The staff calculates the probability of a single cancer death attributable to WBN Plant operation in the population within 80 kilometers (50 miles) of the WBN Site is approximately 3 in 1000. The statistically expected value is zero deaths.

The significance of this risk can be illustrated by comparing it to the total projected incidence of cancer deaths in the population living within 80 kilometers (50 miles) of the WBN Plant. Multiplying the estimated population within 80 kilometers (50 miles) of the WBN Plant assumed for the year 2040 (1.1 million people) by the incidence of eventual actual cancer fatalities of about 20% implies that about 220,000 cancer deaths not attributable to the WBN Plant are expected.

To estimate the risk of genetic disorders to the population living within 80 kilometers (50 miles) of the WBN Site, the ICRP 60 (ICRP 1991) factor of approximately 1.3 severe hereditary effects per 100 person-sieverts (130 severe hereditary effects per million person-rem) is multiplied by the dose from exposure to radioactivity attributable to WBN Plant effluents (i.e., 0.06 person-sievert [6 person-rem]). The staff estimates the probability of a single severe genetic disorder occurring across all future generations of the exposed population is less than 1 in 1000.

In the preceding analysis, the risk of potential genetic disorders from WBN Plant operations is small compared with the risk of actual genetic ill health in the population from all other causes. Multiplying the estimated population within 80 kilometers (50 miles) of the plant (about 1.1 million persons in the year 2040) by the incidence of multifactorial traits (BEIR 1990) of genetic ill health (about 12%), it is estimated that about 130,000 genetic abnormalities are expected in the population from causes unrelated to WBN Plant operations.

5.5.6 Impacts of the Uranium Fuel Cycle

The impacts of the uranium fuel cycle considered in Table 5.10 of the NRC 1978 FES-OL were based on 30 years of plant operation with annual refueling. The applicant's current plans include 40 years of operation and refueling every 18 months. The net result of these changes is a slight reduction in fuel usage. The staff estimates this reduction in uranium usage to be between 10 and 15%.

The current assessment of the environmental impacts of the uranium fuel cycle is based on Table S-3 of 10 CFR 51.51, which was amended in 1984. Table S-3 updates Table 5.10 of the NRC 1978 FES-OL; however, the changes do not alter the conclusion that the doses and potential health effects will be small compared to the effects of natural radiation sources.

5.6 Non-Radiological Human Health Impacts

Potential non-radiological health effects considered by the staff include electromagnetic fields (EMFs) and shock hazards from transmission lines, airborne pathogenic organisms, noise, and air quality. EMFs and shock hazards were discussed in the NRC 1978 FES-OL.

5.6.1 Electromagnetic Fields and Shock Hazards from Transmission Lines

Section 3.5 discusses the WBN Plant power transmission system. Two human health issues related to transmission lines are shock hazard and exposure to electric and magnetic fields (also known as electromagnetic fields). EMFs are a form of non-ionizing radiation. EMFs are produced by the movement of electrical charges through wires, such as those in household appliances and in the transmission lines associated with power plants. A number of research studies (both epidemiological and laboratory-related) have been performed to determine whether EMF exposure adversely affects human health. Numerous uncertainties surround the information obtained from these studies. Some studies suggest a statistical association between 60-hertz EMFs and specific types of cancer; however, no cause-and-effect relationship has been established between EMF exposure and cancer or other disease (EPA 1992a, 1992b). Consequently, there is no defined hazardous level for EMFs. EMF levels are known to decrease with distance from the source. EMF exposure to persons in the vicinity of elevated power transmission lines is reduced to lower levels than the EMF exposure inside the home produced by appliances and electrical wiring (NRC 1991).

Shock hazards are produced mainly through direct contact with conductors and have effects ranging from a mild tingling sensation to death (NRC 1991). The transmission line towers associated with the WBN Plant are designed to preclude direct public access to the conductors. However, secondary shock currents are produced when persons contact capacitively charged objects (such as vehicles parked near a transmission line) or magnetically linked metallic structures (such as fences near a transmission line). Shock intensity depends on the strength of the electric field, the size and location of the object, and the ground insulation. Design criteria that limit hazards from steady-state currents are based on the National Electrical Safety Code (NESC), which requires that transmission lines are designed to limit the short-circuit current to ground produced from the largest anticipated vehicle to less than 5 milliamperes (NRC 1991). The applicant's design ensures that the transmission lines exceed the requirement given in the NESC (TVA 1994b). The staff concludes that the impact of shock hazards and EMF exposure will be minimal as a result of operation of the WBN Plant.

5.6.2 Airborne Pathogenic Microorganisms

Some thermophilic microorganisms associated with cooling towers and thermal discharges can have deleteriou impacts on human health. These microorganisms include the enteric pathogens *Salmonella* sp. and *Shigella* sj as well as *Pseudomonas aeruginosa* and thermophilic fungi. Methods of testing for these microorganisms are known and their presence in aquatic environments is often controllable. Other microorganisms normally present in surface water, but not as easily detected or controlled, include the bacteria *Legionella* sp. (which causes Legionnaires' disease) and the amoebae of the genera *Naegleria* and *Acanthamoeba*, which cause a rare but very serious human infection, primary aerobic meningoencephalitis (PAME) (NRC 1991).

Legionella sp. has been found in the aerosols in the vicinity of condensers or cooling tower basins that were in the process of being cleaned. Two reported cases of infections related to *Naegleria* sp. that were associated with the cleaning of cooling towers have been reported (NRC 1991). For this reason, utilities that identify microorganisms that are responsible for PAME in the cooling tower often require respiratory protection for workers in the vicinity of the cooling towers and condensers.

The potential health effects from *Naegleria* sp. at sites such as the WBN Site, located on rivers with average flow rates less than 2830 cubic meters per second (100,000 cubic feet per second), are a public health concern (NRC 1991). These microorganisms occur in surface water where the risk of infection is always present. Increases in average water temperature due to weather or climatic conditions, or from the discharge of heat, may cause an increase in the levels of the microorganisms. Information obtained by the applicant in discussions with the Center for Disease Control in Atlanta indicated that to contract primary amoebic meningoencephalitis from *Naegleria* sp., large doses of cyst-contaminated water must enter the nasal mucosa area. A few cases have been reported in swimmers from Texas and the Carolinas during the past few years; however, these were not associated with aerosol cysts from power plant cooling towers (TVA 1994g). The Tennessee Department of Health was not aware of any cases for which either *Legionella* sp. or *Naegleria* sp. was associated with cooling towers in Tennessee (TVA 1994b). The staff concludes that the operation of the WBN Plant is not likely to result in adverse effects to human health as a result of the presence of these microorganisms.

5.6.3 Noise Levels

The principal sources of noise from plant operations are the natural draft cooling towers, the transformers, and the loudspeakers. Occasional noise sources include such auxiliary equipment as pumps and building ventilation fans. The applicant has estimated operational sound levels (TVA 1980) by using published values for noise emission from large cooling towers and the applicant's own sound survey data on noise emission from 500-kV transformers. Sound levels at the three residential locations nearest the site boundary 900 meters (3000 feet) to 1800 meters (6000 feet) from the transformers and cooling towers combined with baseline noise levels were between 53 and 63 decibels. Intermittent sound levels at the three residential locations range from 84 to 103 decibels (A-weighted scale) from air-blast circuit breakers breaking under an electrical load, and from sound generated during steam venting (TVA 1980).

There are no Federal regulations for levels of noise for public exposures. However, the Department of Housing and Urban Development uses day-night average sound levels recommended by EPA as a goal for outdoors in residential areas. The levels recommended by the EPA are not standards. The Department of Housing and Urban Development uses these guidelines as part of site acceptability standards for their programs as discussed in 24 CFR 51.101 (a)(8). Noise levels will be acceptable if the day-night average sound level outside a residence is less than 65 decibels. The noise levels from the WBN Plant are below 65 decibels (A-weighted scale).

5.6.4 Air Quality

Non-radioactive discharges to the air are controlled by Federal, State, and local statutes, regulations, ordinances. The applicant has stated that all permits and approvals necessary for plant operation have been obtained and are being reviewed as required by the applicable agencies. The applicant has also stated that periodic inspections of its facilities are conducted by Federal and State environmental agencies to verify that they are being operated in accordance with applicable requirements (TVA 1994a).

The operational impact of two oil-fired boilers used to provide building heat and startup steam was specifically addressed in the TVA 1972 EIS-CP (TVA 1972). The calculated concentrations of particulates, oxides of sulfur and nitrogen, carbon monoxide, and hydrocarbon from potential releases at the WBN Plant were two or more orders of magnitude below applicable standards. The applicant has indicated that emissions from these boilers "...will be controlled as necessary to meet applicable regulatory requirements, and resulting impacts are expected to be insignificant" (TVA 1994c).

The applicant has estimated that there will be about 0.003 cubic meter per second (0.1 cubic feet per second) of drift from each tower and concluded that the effects of the drift will not be significant (TVA 1972). There have been no changes in the design or planned operation of the cooling towers (TVA 1994a). Therefore, the conclusions in the NRC 1978 FES-OL have not changed.

5.7 Socioeconomic Impacts

The NRC 1978 FES-OL projected that the onsite workforce during commercial operation of both units would be fewer than 200 and concluded that no significant socioeconomic impacts would occur. Current projections indicate that total onsite employment at commercial operation of the WBN Plant Unit 1 in the summer of 1995 will total about 1300 (TVA 1995), including 450 personnel associated with Unit 2. Total employment at the site including operating and construction personnel was approximately 4000 in mid-1994, down from 4900 in December 1992 (TVA 1994g). The level of operations employment, while significantly larger than originally expected, is significantly less than current employment. If the employment level is expected to fall to approximately to 1300 at the beginning of operations (TVA 1995), a loss of 2700 additional jobs, it is most likely tha any socioeconomic impacts would arise from the downturn rather than from the remaining employees (who ar already onsite). However, socioeconomic impacts are still not expected for a variety of reasons discussed below.

Total WBN Site employment during the early period of operation of WBN Plant Unit 1 will depend on resolving the status of Unit 2, where there is currently no construction activity. According to the applicant, Unit 2 is about 65% complete; Construction Permit CPPR-92 expires in 1999. The schedule for the completion of Unit 2 will be resolved as part of the applicant's 1995 Integrated Resource Plan. Until then, there is no basis for projecting the magnitude or timing of the future onsite construction workforce. Because the impacts are likely to be greatest if Unit 2 construction activity either is not restarted or is restarted with considerable delay, it is assumed that 2700 additional jobs (3600 total jobs relative to December 1992) will be lost immediately upon completion of Unit 1. If Unit 2 construction activity is restarted, however, fewer jobs would be lost.

Socioeconomic impacts of large-scale employment changes primarily occur when such changes are concentrated in a handful of communities. However, the construction employees have been spread thinly among a group of over 50 communities within a radius of 80 to 100 kilometers (50 to 60 miles) of the WBN Site. In 1990, the population of this area was over 1,000,000 people, with a labor force of 550,000 (TVA 1994g). Although some outmigration may be expected, the dynamics of the large labor market in the region and the extended period over which layoffs will occur make it likely that those workers who choose to stay will be able to find employment. The wide dispersal of employees reduces the likelihood of impact in any particular community's labor pool, housing market, or utility system revenues as a result of finishing Unit 1. While no current information is available on the geographic distribution of the WBN Plant employees, the applicant believes that the current distribution is still similar to that during the peak of construction in the mid-1980s, shown in Table C.3 in Appendix C. This is the latest available data on residences of the WBN Plant workforce.

In accordance with this distribution of employees, the applicant implemented a socioeconomic impact mitigation program early in the construction period. The NRC 1978 FES-OL described the initial stages of the program, which began in 1973 and continued until 1984. During that program, the applicant provided $1,600,000 directly to local governments of the two nearest counties, Meigs and Rhea, to assist in the provision of services and facilities. Law enforcement and educational areas received the largest amounts of assistance at $698,000 and $675,000, respectively. The remaining $237,000 was distributed among a number of other functional areas such as fire protection, solid waste, and health recruitment (TVA 1994a). The public service capacities built up during the construction period still remain in place and will not be adversely affected.

Under Section 13 of the TVA Act, the applicant has made tax-equivalent payments to the State of Tennessee, determined 50% by book value of the applicant's property and 50% by value of the applicant's power sales in the State (TVA 1994g). Tennessee redistributes 35% of its payments to local governments by two different mathematical formulas. For the counties, shares are based on relative population, total acreage in the county (42.8%), and the applicant's acres in the county (14.4%). City payments are based on population. These tax-equivalent payments are expected to continue after WBN Plant Unit 1 begins operation. The State also currently pays an allocated share (3%) of its payment in excess of the base amount ($55,000,000) to cities and counties impacted by the applicant's major construction activities. For example, in fiscal year 1992, eight designated counties and 34 cities within these counties located near the WBN Site shared a portion of these impact funds, shown in the third column of Table C.4 in Appendix C. The maximum amount that a county and its incorporated cities can receive is 10% of the total impact funds. The Tennessee impact funds are more than 1% of the total funds available for only a handful of these local governments, shown by an asterisk in the last column of Table C.4. Immediate loss of these funds might have been a short-term concern for these few communities; however, an amendment to Tennessee law provides for a three-year phase-out period for the impact funds following the completion of construction, leaving time for the governments to adjust.

Finally, the area has a great deal of experience accommodating large changes in employment at the WBN Plant. One potential problem associated with downturns in employment at the end of construction is that some people will leave the area in search of employment elsewhere. This could put temporary downward pressure on local real estate values, assessed valuation, and tax base. However, contacts in the local real estate community suggest that the story is more complex. Currently, the housing market in the area is a "seller's market" with houses moving off the market at about 95% of the asking price and within the initial term of the sales contract (TVA 1994g). This view is also supported by recent history. Local realtors report that larger (temporary) job losses associated with the shutdown of construction in 1990 did not result in serious softening of real estate prices. Information supplied by local realtors suggests that market prices probably declined 2 to 5%, about the current rate of annual increase. In 1990 the market was supported by the movement of new manufacturing jobs into the general area of the WBN Site. At the present time, connection of the Dayton area to Chattanooga has improved dramatically with the opening of a four-lane highway link. The consequent suburbanization of Chattanooga into the Dayton area offers similar support for housing prices in the WBN Site region.[a]

5.8 Environmental Justice

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations"; 59 FR 7629 (1994) directs Federal agencies in the Executive Branch to consider environmental justice so that their programs and activities will not have "disproportionately high and adverse human health or environmental effects...on minority populations and low income populations...." The NRC, although an independent agency, indicated its willingness to comply with the Executive Order and to participate with an Interagency Working Group in developing guidelines to implement it. Those guidelines are still being developed and, therefore, are not available for use in the preparation of this supplement.

Although the siting decision on the WBN Plant was made over 20 years ago, and the TVA 1972 EIS-CP and the NRC 1978 FES-OL do not explicitly address environmental justice, the NRC staff, in preparing this supplement, reviewed the WBN regional[b] characteristics to identify the proportions of low income or minority populations that could be potentially affected by plant operations. The data reviewed by the staff indicate that the WBN Plant is located in a predominately non-minority, low-income area.

(a) Informal interviews with local realtors, Dayton, Tennessee, September 13, 1994

(b) The WBN region is the region within an 80-kilometer (50-mile) radius of the WBN Site (See Figures 2.1, 2.2, 2.3).

Table C.5 in Appendix C provides (1) the per capita income and median household income averages for the counties within the WBN Site region, (2) the per capita income and median household income as a percentage of the Tennessee State average, and (3) the percentage of persons below poverty level as a percentage of the Tennessee State average. The WBN Site region is a relatively poor section of the State, with per capita and median household income both below the State average. The counties to the northeast of the plant (Roane, Knox, and Anderson) and to the South (Hamilton and Bradley) generally have incomes above the Tennessee average (See Figures 2.1 and 2.2 for county location). The sub-county areas located closest to the WBN Site in Rhea and Meigs counties generally have incomes from slightly below the State average to more than 20% below the State average (see Table C.5).

The minority populations within the WBN Site region are provided in Table C.6 in Appendix C. The minority populations in the WBN region mostly reside in Hamilton, Bradley, and Knox counties, well away from the WBN Plant. The minority populations in Rhea and Meigs counties are relatively small--approximately 2%, and 4% of the county population, respectively.

Chapter 2 provides a description of the current environmental conditions and describes the changes since the NRC 1978 FES-OL; Chapter 5 discusses any change in environmental impacts from those previously disclosed (in the TVA 1972 EIS-CP and the NRC 1978 FES-OL). The human health and socioeconomic environmental impacts to the low-income populations located closest to the site are the same as those discussed in Sections 5.2 (impact on water use), 5.5 (radiological health effects), 5.6 (non-radiological health effects), and 5.7 (socioeconomic).

The environmental impacts from plant operations decrease with increased distance from the WBN Site. Thus, the staff concludes that the low-income population located close to the WBN Site has the potential to receive a greater environmental impact than other groups. However, in the NRC 1978 FES-OL, the NRC concluded that only minimal environmental impacts will result from operation of the WBN Plant. On the basis of the staff's evaluation of changes in plant design, proposed plant operation, and the environment, the staff has determined that there is no significant change in environmental impacts that would alter the conclusion reached in the NRC 1978 FES-OL. Therefore, the impacts on the low-income population located close to the WBN Site are minimal, notwithstanding the fact that those impacts likely will be greater than for those populations located further away.

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6 Environmental Monitoring Program

Changes in the preoperational and operational monitoring programs have been evaluated. The preoperational monitoring programs are discussed in Section 6.1 and the operational monitoring studies are discussed in Section 6.2.

6.1 Preoperational Monitoring Program

Preoperational monitoring studies, covering meteorology, water quality, groundwater, aquatic ecology, terrestrial ecology, and radiological studies, were initiated in stages beginning in the 1970s.

6.1.1 Preoperational Onsite Meteorological Program

Collection of onsite meteorological data began in 1970 with installation of a temporary 40-meter (130-foot) instrumented meteorological tower. A permanent 91-meter (300-foot) instrumented meteorological tower and environmental data collection station began operation in May of 1973 at a location approximately 760 meters (2500 feet) south-southwest of the Unit 1 reactor building (TVA 1994a). Meteorological instrumentation in the permanent system initially included wind direction and speed at 10 meters (33 feet) and 93 meters (305 feet) (the measurements were made at a point above the top of the meteorological tower by placing instruments on a boom); temperature at 1 meter (3 feet), 10 meters (33 feet), 46 meters (150 feet), and 91 meters (300 feet); and dewpoint, solar radiation, atmospheric pressure, and rainfall at 1 meter (3 feet). Several changes were made to the instrumentation between September 1976 and April 1981. These changes led to the current system which includes wind and temperature sensors at 10 meters (33 feet), 46 meters (150 feet), and 91 meters (300 feet); dewpoint at 10 meters (33 feet); and solar radiation and rainfall at 1 meter (3 feet). The current system is described in the NRC Safety Evaluation Report (NRC 1982) and in detail in the applicant's FSAR (TVA 1994b).

The onsite meteorological data collection program conforms to the guidance in Regulatory Guide 1.23 (AEC 1972). Data recovery rates for wind direction, wind speed, and temperature difference exceed 95% for each parameter and 94% for the parameters combined from 1974 through 1993. The staff considers these data recovery rates, which exceed the minimum data recovery rate criterion in Regulatory Guide 1.23, to be acceptable.

6.1.2 Preoperational Water Quality Studies

Preoperational water quality studies were described in the NRC 1978 FES-OL (NRC 1978), and the results are presented in the preoperational monitoring report (TVA 1986). An additional study (discussed in Section 5.2.1) of the thermal effluent releases was also conducted (TVA 1993a).

6.1.3 Preoperational Groundwater Studies

Preoperational groundwater studies were described in the NRC 1978 FES-OL. An additional study was performed to analyze the impacts of the evaporation/percolation pond (described in Section 2.2.2) (TVA 1990a).

6.1.4 Preoperational Aquatic Biological Monitoring

Preoperational aquatic biological monitoring was described in the NRC 1978 FES-OL. Additional baseline monitoring was performed from 1982 through 1985, and a number of special studies focusing on specific issues were performed from 1983 through 1994 (TVA 1986, 1989, 1990b, 1991a, 1991b, 1993c, 1994a, 1994c). These monitoring efforts are summarized below in Tables 6.1 and 6.2 (TVA 1994a); related information for the SQN Plant is included.

6.1.5 Preoperational Terrestrial Monitoring

The NRC 1978 FES-OL described a monitoring program consisting of an aerial survey using color infrared and/or multispectral or multiband photography to be compared with similar surveys performed during plant operation. These aerial surveys were meant to detect changes in local vegetation that could result from the

Table 6.1 Summary of WBN Plant Baseline Preoperational Aquatic Monitoring Programs (1970-1993)

Study	Type of Sampling	Years Conducted
Adult Fish	Rotenone, electrofishing, gill-nets, hoop-nets	1970-1993
		1976-1979, 1982-1985
Larval Fish	Trawling	1976-1979, 1982-1985
Benthos	Dredges, artificial substrates, Hess Samples	1973-1977, 1982-1985
Zooplankton	Plankton nets	1973-1977, 1982-1985
Phytoplankton	Plankton nets	1973-1977, 1982-1985
Periphyton	Artificial substrates	1973-1977, 1982-1985
Chlorophyll	Artificial substrates	1973-1977, 1982-1985
Primary Productivity	–[a]	1973-1977, 1982-1985
Autotrophic Index	–[a]	1973-1977, 1982-1985

(a) Not applicable

Table 6.2 Summary of WBN Plant/SQN Plant Special Aquatic Monitoring Program

Study	Type of Sampling	Years Conducted
Mussels	Diver	1983-1992 (biennially)
Sauger Populations	Electrofishing, gillnetting larval sampling	1986-1991 1987
White Crappie	Larval netting, light traps, electrofishing, trapnetting	1986-1989 1987-1989
White Bass Population	Electrofishing, tagging, larval sampling	1990-1992 1990-1991
Channel Catfish	Literature review	1990-1992
Dissolved Oxygen	Direct measurements	1987-1989

mergence of the WBN Plant cooling tower drift and the Watts Bar Steam Plant stack plume. This monitoring program was never implemented because the WBN Plant and the Watts Bar Steam Plant never operated at the same time. In addition, subsequent analyses (TVA 1979; NRC 1991) indicate that the effects of the mergence of these plumes would be negligible.

6.1.6 Preoperational Radiological Monitoring

The staff reviewed the preoperational radiological monitoring program as described in the 1993 annual report (TVA 1994d) and the ODCM (TVA 1994e).

Only minor changes to the preoperational radiological environmental monitoring program have been made since the NRC 1978 FES-OL. In 1984, some of the meteorological and air quality monitoring stations were relocated to provide better local (site boundary and perimeter) and remote coverage based on meteorological data. In addition, the air sample collection systems were modified to provide for simultaneous collection of atmospheric particulates and radioiodines. The air quality monitoring network has local, perimeter, and remote monitors. In 1993, five thermoluminescence dosimeter (TLD) stations were added to the program in the area between 3 kilometers (2 miles) and 6 kilometers (4 miles) from the plant, and in June 1993 a new dairy farm (6.6 kilometers [4.1 miles] east-southeast of the plant) was added to the program, doubling the respective coverages within 8 kilometers (5 miles) of the plant.

In March 1984, two local monitors (located within or near the plant boundary) were added, for a total of four local monitors. There were six perimeter monitors prior to March 1984. At that time two were deactivated and the equipment was used to establish two additional local monitors. One remote monitoring station was discontinued and the equipment was used to establish another remote station in Alloway, 23.8 kilometers (14.9 miles) north-northwest of the plant.

Changes made in 1984 to the atmospheric particulate and iodine sampling systems included the installation of cone-shaped filter holders, located on the outside of the monitoring stations, that were protected from rain by a metal overhang housing the gum paper fallout tray. These systems were modified at seven of the ten monitoring stations, incorporating 4.8-centimeter (1-7/8-inch) diameter glass fiber filters for collection of air particulates and 5.7-centimeter (2-1/4-inch) diameter, 2.5-centimeter (1-inch) thick tetraethyldiamine-impregnated charcoal for collection of radioiodine.

The staff considers these changes to the preoperational radiological environmental monitoring program to be acceptable. In addition to the applicant's environmental monitoring program, the NRC maintains a TLD monitoring program surrounding the WBN Plant in conjunction with the State of Tennessee.

6.2 Operational Monitoring Program

The operational monitoring programs are continuations of the preoperational monitoring programs discussed i Section 6.1. The operational monitoring programs will begin when the WBN Unit 1 Plant begins operation. The operational programs include meteorological monitoring, water quality monitoring, groundwater monitoring, chemical effluent monitoring, aquatic biological monitoring, terrestrial monitoring, and radiological monitoring.

6.2.1 Operational Onsite Meteorological Program

The applicant will continue the onsite meteorological program during the operation of the plant (TVA 1994a). The staff reviewed the applicant's onsite meteorological system in September 1994. The instrumentation and data collection are consistent with the guidelines in Regulatory Guide 1.23 (AEC 1972). Problems in determining stability class were described in Section 2.3.3. These problems are unimportant in dose determination because they pertain primarily to unstable conditions. There does not appear to be an alternate location in the vicinity of the plant where more representative conditions could be measured. The staff concludes that the tower is located in an appropriate position relative to the plant and surrounding topographi features to provide meteorological data that are generally representative of the conditions in the vicinity of th plant.

6.2.2 Operational Water Quality Monitoring

The operational water quality monitoring program, described in the NRC 1978 FES-OL, has changed as a result of changes to the NPDES permit issued by the State of Tennessee (State of Tennessee 1993).

The NPDES permit specifies water quality monitoring at the outfalls. The NPDES permit also requires that thermal plume modeling and temperature modeling be conducted.

6.2.3 Operational Groundwater Monitoring

The groundwater monitoring program has not changed from that described in the NRC 1978 FES-OL except for the sampling frequency. Samples will be obtained from two wells tapping into the Conasauga Shale Aquifer. One well will be downgradient and one upgradient of the plant. The samples will be taken quarterly. The staff continues to find the operational groundwater monitoring program acceptable.

6.2.4 Operational Chemical Effluents Monitoring

The operational chemical effluent monitoring program described in the NRC 1978 FES-OL has changed as a result of changes to the NPDES permit issued by the State of Tennessee (State of Tennessee 1993). The NPDES permit requires that the applicant conduct chronic toxicity testing on daphnids and fathead minnows with effluents from Outfalls 101, 102, and 112.

6.2.5 Operational Aquatic Biological Monitoring

In light of the additional information accumulated in preoperational monitoring efforts since publication of the NRC 1978 FES-OL, the 1978 operational monitoring plan was revised. The operational monitoring plan revision was submitted to the State of Tennessee in a letter dated September 8, 1993 (TVA 1993b). Subsequently, this plan was approved by the State and incorporated as a requirement into the WBN Plant NPDES permit (State of Tennessee 1993). The elements of the current Operational Aquatic Biological Monitoring Plan (TVA 1994a) are described below. Monitoring will commence when Unit 1 becomes operational.

Fish Impingement

During the period from December through May, the number of fish impinged on the intake screens on the Tennessee River in a 24-hour period will be determined once each week. From June through November, the number of fish impinged will be determined once every two weeks. Appropriate modifications will be made in the sampling program as dictated by the results.

Larval Fish Entrainment Sampling

Samples will be collected biweekly March through August at five stations along a transect perpendicular to flow at TRM 528, adjacent to the intake. Samples will also be collected in the WBN Plant cooling water intake channel.

WBN Plant Vicinity Creel Survey

The catch rate, average weight, and percent composition of each species harvested will be estimated by collecting angler harvest data three days each week in the river reach between Watts Bar Dam (TRM 529.9) and Yellow Creek (TRM 526.8). The surveys will be conducted by the applicant on a year-round basis. They will be designed to provide a comparison with preoperational data and to assess the tailwater in terms of fisherman success and satisfaction. The surveys will document any effects of plant operation on the sport fishery below Watts Bar Dam. They also provide an indication of sportfish attraction to the WBN Plant intake and discharge areas.

Reservoir-Wide Creel Survey

The Wildlife Resources Agency will conduct surveys during five randomly selected days each week. Total catch, fishing pressure, and success for Chickamauga Reservoir will be estimated by counting and interviewing fishermen.

Cove Rotenone Sampling

Five coves in Chickamauga Reservoir will be sampled every other year to document long-term trends in the stock and species composition of reservoir fish. The cove rotenone sampling will add to a long-term database on reservoir fish populations that is a part of both the WBN Plant and SQN Plant operational monitoring.

Water Quality

Water quality sampling in support of the aquatic biological monitoring program will be performed six times between March and August during appropriate flow and operational conditions at four locations in the vicinity of the WBN Plant. Three of the surveys will evaluate selected trace metal concentrations in the water, along with the general water quality and biological support parameters evaluated in all the surveys.

Plankton

Sampling for chlorophyll *a*, as an indication of phytoplankton biomass, will be conducted six times per year a four stations, one upstream of the WBN Plant and three downstream.

Benthic Macroinvertebrates

Sampling for benthic macroinvertebrates will be conducted using Hess samplers at five stations between TRM 521.0 and 528.8 during summer and fall quarters.

Mussel Surveys

All endangered and threatened mussel species populations will continue to be closely monitored to ensure that no measurable impacts are taking place. The applicant has committed to taking the necessary corrective steps to amend the situation should such an impact occur (TVA 1994a).

Biennial surveys by divers in the tailwater mussel sanctuary will be continued. Additionally, quadrat samples will be taken to document mussel reproductive success. Following operation of WBN Plant Unit 2, an assessment and evaluation of bioaccumulation of selected trace metals by molluscs will be implemented and will continue for a minimum of three years after commercial operation.

6.2.6 Operational Terrestrial Monitoring

The NRC 1978 FES-OL identified three operational terrestrial monitoring programs: effects of cooling tower drift and plume interactions, effects of bird collisions with the cooling towers, and maintenance of transmission lines. Based on subsequent analyses (TVA 1979; NRC 1991), the staff concludes that monitoring for plume interactions is no longer necessary. The staff concludes that further monitoring of bird collisions with the cooling towers is not necessary because there have been no recorded serious episodes of birds colliding with cooling towers.

The applicant has committed to survey transmission line corridors for the presence of federally protected or candidate species before maintenance activities are conducted (NRC 1994).

6.2.7 Operational Radiological Monitoring

The radiological environmental monitoring program will be continued once the WBN Plant becomes operational; a full description of the program is contained in the ODCM (TVA 1994e). The NRC and the State of Tennessee jointly conduct a monitoring program in the vicinity of the WBN Plant.

6.3 References

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7 Accident Analysis

7.1 Realistic Accident Analysis

The staff reviewed the realistic accident analysis in the NRC 1978 FES-OL (NRC 1978). With the exception of a change in the population projection between 2020 and 2030, the technical bases and assumptions have not changed. Resin use in the waste handling process was not considered in the NRC 1978 FES-OL. The applicant performed an assessment of an accident involving the failure of the spent fuel resin storage tank and of the transfer resins in the Railroad Bay. In this analysis, a bounding calculation was performed for spill of the resins from the WBN Plant spent resin storage tank. The limiting calculation assumed the tank (8.5 cubic meters [300 cubic feet]) was full and that the resin spill would result in an immediate release of all noble gases contained in the tank to the outside environment. The offsite dose was projected to be less than the criteria of 5 mSv (500 mrem) for (a) 2 hours at the exclusion area boundary and (b) 30 days at the low population zone boundary. The mobile demineralizer system resin storage tank has only a 5.7-cubic meter (200-cubic foot) capacity; consequently, the spent resin storage tank accident assessment bounds all other accidents involving spent resins.

7.2 Severe Accident Mitigation Design Alternatives (SAMDAs)

7.2.1 Introduction

The NRC considers the alternative of plant operation with the installation of severe accident mitigation design alternatives (SAMDAs) in the environmental impact review that is now performed as part of every operating license application. The purpose of this consideration is to ensure that plant design changes with the potential for improving severe accident safety performance are identified and evaluated.

The applicant submitted an initial assessment of SAMDAs for WBN Plant Unit 1 on June 5, 1993 (TVA 1993). This assessment was based on the original individual plant examination (IPE) for the WBN Plant (September 1, 1992), which reported an annual total core damage frequency (CDF) for the WBN Plant of 3.3E-4[(a)] per year. Based on this assessment, the applicant concluded that none of the candidate SAMDAs considered were cost effective for the WBN Plant.

The applicant subsequently revised the IPE to reflect plant design changes, procedure upgrades, and training enhancements. The revised IPE (TVA 1994b) reported a total mean CDF of 8.0E-5 per year, which is about a factor of 4 smaller than the CDF reported in the original IPE submittal. (The staff's evaluation of the revised

(a) 3.3E-4 is equivalent to 3.3×10^{-4} and 0.00033.

WBN Plant IPE is described in an IPE evaluation report dated September 29, 1994 [NRC 1994a]). The applicant also updated the WBN Plant SAMDAs analysis to reflect the results of the revised IPE, and to include evaluation of additional, plant-specific design improvements identified through the IPE. The revised SAMDAs analysis, entitled "Watts Bar Nuclear Plant Unit 1 Value Impact Analysis of Potential Plant Improvements," was submitted to NRC on June 30, 1994 (TVA 1994b). As a result of the revised analysis, two of the additional, plant-specific design improvements were determined by the applicant to be risk and cost beneficial. The applicant committed to incorporate the procedural change improvements in the WBN Plant operating procedures before initial criticality.

Based on a review of the revised SAMDAs submittal, NRC issued requests for additional information to the applicant on September 2, 20, and 27, 1994, and October 17, 1994 (NRC 1994b, 1994c, 1994d, 1994e). After discussions with NRC, the applicant decided to rebaseline the IPE to take credit for the two procedure changes committed to in the June 30, 1994 submittal (TVA 1994b), plus one additional procedure change that was also identified but not committed to in the previous IPE and SAMDAs analyses. The procedure changes involve (1) stopping one train of containment spray to delay the time of switch-over to recirculation, (2) cross-tying the 500-kV power system at Unit 2 to the 161-kV power system at Unit 1, and (3) using a spare 6900-V to 480-V transformer to supply the 480-V shutdown boards. The assumptions and bases for rebaselining of the value impact analysis are listed in Tables 1 through 3 of the Executive Summary of Revision 1 of the SAMDAs evaluation. The applicant committed to implement each of these changes.

The applicant submitted the results of the rebaselining and updated risk reduction estimates for the remaining SAMDAs to the NRC on October 7, 1994 (TVA 1994c). The rebaselined analysis, referred to here as the "final" SAMDAs submittal, further reduces the CDF to 5.8E-5 per year. In the final submittal, the applicant estimated the total offsite risk to the population within 80 kilometers (50 miles) of the WBN Site to be about 2.1 person-sievert (210 person-rem) over the 40-year plant life. The staff's assessment of SAMDAs for the WBN Plant is presented below; this assessment is based largely on the review of the applicant's final evaluation of potential design improvements.

7.2.2 Estimate of Risk for Watts Bar Nuclear Plant

TVA Risk Estimates

The applicant did not perform a plant-specific risk assessment of offsite consequences (Level 3 probabilistic risk assessment [PRA]) for the WBN Plant. Instead, the applicant made extensive use of the NUREG-1150 (NRC 1990a) analysis of the Sequoyah Nuclear (SQN) Plant to generate the risk profile for the WBN Plant. Specifically, the WBN Plant PRA Level 2 results, taken from the WBN Plant IPE submittal, were mapped into SQN Plant Level 3 accident progression bins (APBs) and release categories. The SQN Plant consequence results were then scaled to compensate for differences in population and meteorology between the SQN and WBN Sites.

The various TVA SAMDAs submittals and the corresponding reported values for CDF and total offsite risk are summarized in Table 7.1. In the original SAMDAs analysis (TVA 1993), the applicant estimated the total offsite risk to the population within 80 kilometers (50 miles) of the WBN Site to be about 23 person-sievert (2300 person-rem) over the 40-year plant life. This was based on direct use of SQN Site characteristics (meteorology, population data, and evacuation modeling) and consequence analysis results. In the revised SAMDAs submittal (TVA 1994b), the applicant estimated the total offsite risk to be about 2 person-sievert (200 person-rem) over the 40-year plant life. The factor of 10 reduction in risk that distinguishes the original from the revised SAMDA stems from both a reduction in CDF and a scaling of the SQN Site consequence results to compensate for differences in population and meteorology between the SQN and WBN Sites (an approximate factor of 4 reduction).

In the final SAMDAs submittal (TVA 1994c), the applicant estimated the total offsite risk to be about 0.053 person-sievert (5.3 person-rem) per year, or 2.1 person-sievert (210 person-rem) over the plant life. In addition to rebaselining the CDF to reflect the three procedure changes mentioned earlier, the applicant increased the risk (and risk reduction) estimates by approximately 34% to reflect the expected growth in the number of persons living within 80 kilometers (50 miles) of the WBN Site over the 40-year license. The population change increased the total estimated risk for the WBN Plant, but was partly compensated for by the reduction in CDF afforded by the procedure changes.

The breakdown of the population dose by initiating event is given in Table 7.2. The breakdown of the population dose in terms of the containment failure modes and NUREG-1150 (NRC 1990a) APBs into which the WBN Plant Level 2 results were mapped is given in Table 7.3. The bulk of the risk is attributed to containment bypass events, such as steam generator tube rupture (SGTR) and other events which lead to early containment failure.

Table 7.1 Summary of WBN Plant IPE and SAMDAs Submittals

History	Date	CDF	Total Offsite Risk Person-Sievert (Person-Rem)
Original SAMDAs, based on original IPE	6/5/93	3.3E-4	23 (2,300)
Revised SAMDAs, based on updated IPE	6/30/94	8.0E-5	2 (200)
Final SAMDAs, based on procedural modifications & population adjustment	10/7/94	5.8E-5	2.1 (210)

Table 7.2 Initiating Event Contribution to Population Dose

	Risk Contribution	
Initiating Event	**Person-Sievert (Person-Rem)**	**Percent of Total**
SGTR[a]	0.89 (89)	42
Loss of Offsite Power	0.40 (40)	19
Simple Transients	0.13 (13)	6
Loss of Shutdown Board	0.13 (13)	6
Flood in ERCW[b] Pump Rooms	0.10 (10)	5
Other LOCAs[c]	0.13 (13)	6
Non-isolable LOCAs	0.06 (6)	3
Other	0.27 (27)	13
Total	2.1 (210)	100

(a) SGTR - Steam Generator Tube Rupture
(b) ERCW - Essential Raw Cooling Water
(c) LOCA - Loss of Coolant Accident

Table 7.3 Accident Progression Bin Contribution to Population Dose

	Risk Contribution	
Accident Progression Bin	**Person-Sievert (Person-Rem)**	**Percent of Total**
Containment Bypass (APB 7)	1.2 (120)	58
Early Containment Failure (APB 1-4, 9)	0.49 (49)	23
Late Containment Failure (APB 5)	0.38 (38)	18
Basemat Failure (APB 6)	0.02 (2)	1
Total	2.1 (210)	100

Review of TVA's Risk Estimates

The applicant's estimate of offsite risk at the WBN Plant is based on the following four major elements of analysis:

- the Level 1 and 2 PRAs for the WBN Plant that form the basis for the May 2, 1994, (revised) IPE submittal (TVA 1994a)

- the rebaselining of the IPE results to incorporate credit for three procedure modifications discussed previously

- the extension of the Level 2 IPE to a Level 3 assessment

- the updating of the population in the vicinity of the WBN Plant.

The staff reviewed each of these analyses/processes to provide a basis for making a conclusion on the acceptability of the applicant's risk estimates, as summarized below.

The staff's review of the WBN Plant IPE is described in an evaluation report dated September 29, 1994 (NRC 1994a). In that review, the staff evaluated the methodology, models, data, and assumptions used to estimate CDF and characterize containment performance and source term releases. The staff concluded that the applicant's analysis met the intent of Generic Letter 88-20 (NRC 1988); that is, the IPE properly assessed and depicted core damage, severe accident progression, and containment response, together with the contributions from initiators and the failure of front-line safety and support systems. A further review of the Level 2 PRA performed as part of the SAMDAs evaluation also supports this finding. Accordingly, the staff concludes that results of the revised IPE provide an acceptable platform for assessing the risk reduction potential of SAMDAs.

An extensive evaluation of the rebaselining of the IPE results to incorporate the three procedure modifications previously discussed was not performed as part of the present review. However, the staff notes that the applicant used the same methodology as in the IPE submittal, and that the rebaselined CDF and risk estimates are consistent with independent PRA assessments performed for similar plants. Furthermore, because the principal role of the rebaselined IPE results is to screen potential SAMDAs, precise CDF and risk estimates are not critical to the analysis. Therefore, the staff concludes that the results of the rebaselined IPE analysis are adequate for purposes of meeting the SAMDAs evaluation requirement.

The staff reviewed the process used by the applicant to extend the Level 2 IPE to a Level 3 assessment. This process was carried out in two steps: (1) converting the WBN Plant release categories into the release categories or APBs used in the NUREG-1150 (NRC 1990a) study for the SQN Site and (2) scaling the meteorology and population distribution factors to account for the differences in the two sites.

The accident sequences from the WBN Plant IPE were first mapped into key plant damage states (KPDSs) using a spreadsheet developed by the applicant. The KPDSs were transformed into key release categories (KRCs) using the containment matrix developed during the updated IPE. The KRCs were then transformed into the SQN Plant APBs using another spreadsheet developed by the applicant. In the applicant's analysis, 42 WBN Plant release categories were mapped into the 10 APBs used in the SQN Plant analysis. As an example, five release categories with common characteristics were mapped into APB 4, i.e., a vessel breach with vessel failure pressure at less than 1400 kPa (200 pounds per square inch) and containment failure occurring at vessel failure or soon afterward. The mapping process is documented in detailed spreadsheets in the applicant's revised SAMDAs submittal (TVA 1994a). Based on a review of the information in these spreadsheets, the staff concludes that the conversion of the WBN Plant release categories into the SQN Plant APBs appears tc have been performed properly and is, therefore, acceptable.

The frequencies of the APBs were transformed into population dose by using population dose conversion factors calculated for the SQN Plant and by scaling population dose to account for population and meteorology differences between the SQN and WBN Sites. The scaling results in a factor of 4 reduction in the risk estimates. That is, given the same accident source terms at the WBN and the SQN Sites, the consequences for the WBN Site would be one-fourth the consequences at the SQN Plant for each release category and, therefore, foı the overall risk (in person-rem). This would be the case despite the fact that the total population within an 80-kilometer (50-mile) radius surrounding the WBN Site is greater than the total population surrounding the SQN Site (based on 1980 census data). The factor of 4 arises from the differences in the distribution of population and the differences in the meteorology between sites. The key "distribution" difference is that, within a 32-kilometer (20-mile) radius (the area that would be most affected by a release from the containment), the population surrounding the WBN Site is less than one-fourth the population surrounding the SQN Site. This is primarily because the WBN Site is farther away from the Chattanooga metropolitan area than is the SQN Site. Although uncertainties exist in this scaling factor, the significance of these uncertainties is not large relative to other uncertainties and assumptions considered in this evaluation. The staff concludes that the scaling process is sound and that the value used (factor of 4) is appropriate.

The risk (and risk reduction) values reported in the June 30, 1994, SAMDAs submittal (TVA 1994b) were based on the population in the vicinity of the WBN Site in 1980. The applicant's rebaselined estimates of risk reflect an upward adjustment from the earlier analyses to account for the time-averaged population that would be expected over the life of the plant, specifically, between the years 1995 and 2035. This results in a 34% increase in risk. Recognizing the uncertainty in projecting the population and distribution of the population within the 80-kilometer (50-mile) region, the staff based its estimates of offsite risk on the projected populatio at the end of plant life rather than on the average population over the 40-year period. This is equivalent to a 41% increase in population and offsite risk from the 1980 values.

In conclusion, the staff considers that the methodology used by the applicant to estimate the offsite risk for the WBN Plant provides an appropriate and sound basis from which to proceed with an assessment of risk reduction potential for candidate SAMDAs. The staff based its assessment of offsite risk on the rebaselined values reported by the applicant, but increased these values (by about 6%) to account for a higher population at the end of plant life. It is important to note that, although the WBN Plant IPE and risk estimation techniques may include some conservatisms, the values for CDF, risk, and the various risk contributors are best estimates rather than conservative estimates. Typically, the 95th percentile values for person-sievert (person-rem) risk would be about a factor of 4 higher than these "mean" values. The overall impact of uncertainties is discussed below.

7.2.3 Potential Design Improvements

Process for Identifying Potential Design Improvements

The applicant identified a set of potential SAMDAs for the WBN Plant through a systematic assessment of (1) the key contributors to risk at the plant, and (2) the means by which these contributors could be further reduced. The process for identifying design improvements included three major steps:

- review and characterization of residual risk at WBN Plant based on the IPE and Level 3 extension
- identification of potential design improvements from the plant-specific assessments
- identification of additional design improvements from generic studies and SAMDAs analyses for other plants, including Comanche Peak and Limerick.

An evaluation was made to determine the risk contributors for the WBN Plant, in terms of initiating events, dependencies in safety systems or support systems, and containment failure characteristics. These evaluations focused attention on the improvements that would have the greatest impact.

Plant-specific design enhancements were identified through a systematic process. The process included screening each sequence and top event from the Level 1 and Level 2 WBN Plant IPE analyses for potential improvements, and conducting importance analyses using the WBN Plant model and computer code spreadsheets. Generic design improvements were identified through a systematic process of review and assessment of potential candidates assessed as part of (1) previous SAMDAs reviews for other LWRs, such as Limerick; (2) the NRC Containment Performance Improvement (CPI) Program; (3) Generic Letter 88-20 (NRC 1988); Supplement 2 (NRC 1990b), and (4) previous IPEs for plants having the same containment design (i.e., ice condenser) as the WBN Plant.

Screening criteria were developed and applied, as described in Section 3 of the applicant's value impact analysis report (TVA 1994b). Those enhancements that passed the screening (i.e, that were classified as having a "high" risk reduction potential) were selected for further cost-benefit analysis. On the basis of this screening process, the applicant selected 26 SAMDAs for further analysis. Of these 26, three have been selected for implementation. The complete set of enhancements considered for the WBN Plant is described in

Appendix B of the applicant's value impact analysis report (TVA 1994b), along with the assessment/ classification of potential risk significance. The SAMDAs selected for further analysis and a summary of the corresponding value/impact results are listed in Table 7.4 and described below.

Design Improvements Evaluated in Detail by TVA

A brief summary of the 26 improvements evaluated quantitatively by the applicant and the anticipated benefits of each is provided in the discussion below. The numbers in parentheses correspond to the design alternative number in the applicant's submittal.

Category I - Improve Availability of ECCS Recirculation

This category of enhancements is intended to reduce the likelihood of failure of the emergency core cooling system (ECCS) in the recirculation mode, which is one of the dominant contributors to CDF for the WBN Plant. The applicant committed to implement a procedural enhancement to secure one train of sprays for those events where two trains of spray are not needed, such as small loss-of-coolant accidents (LOCAs) (Design Improvement I.1). This would improve the availability of ECCS recirculation by delaying the time of switch over to recirculation, thereby reducing the potential for related human errors.

- Install Containment Spray Throttle Valves (I.2) - install additional valves in the containment spray system to allow throttling of spray flow, and provide procedures to support their use. This would provide additional time for operator recovery actions and further reduction in the susceptibility of the plant to ECCS recirculation failures.

- Redesign to Delay Containment Spray Actuation (I.3) - redesign the containment spray actuation system to delay (or eliminate unnecessary) system actuation in small LOCA events. This would extend the time to depletion of the refueling waste storage tank and to provide additional time to cool down without ECCS recirculation.

- Install Automatic High-Pressure Recirculation (I.4) - automate the alignment of ECCS recirculation to the high-pressure charging and safety injection pumps. This would reduce the potential for related human errors made during manual realignment.

Category II - Improve Availability of AC Power

Loss of offsite power is a sizeable contributor to core damage and population dose. This category of enhancements is intended to improve the availability of AC power by providing access to alternate, AC power sources. The applicant committed to implement a procedure to cross-tie the Unit 2 500-kV grid to the 161-kV power system at Unit 1 (Design Improvement II.1).

Table 7.4 Summary of Value/Impact Study Results

Design Improvement	TVA Estimates			Staff Estimates		
	Cost ($$10^6$)	Averted Risk[a] Person-Sievert (Person-rem)	$/Person-Sievert ($/Person-rem)	Cost-AOSC[b] ($$10^6$)	Averted Risk[a] Person-Sievert (Person-rem)	$/Person-Sievert ($/Person-rem)
I. Improve Availability of ECCS Recirculation						
1. Procedure change to stop one train of sprays	(c)	(c)	(c)	(c)	(c)	(c)
2. Install containment spray throttle valves	0.20	0.011 (1.1)	1800 (180,000)	0.13	0.041 (4.1)	320 (32,000)
3. Redesign to delay containment spray actuation	0.41	0.011 (1.1)	3700 (370,000)	0.33	0.041 (4.1)	830 (83,000)
4. Install automatic high pressure recirculation	2.1	<0.011 (<1.1)	19,000 (1,900,000)	2.0	0.041 (4.1)	5000 (500,000)
II. Improve Availability of AC Power						
1. Procedure change to cross-tie 500-kV and 161-kV AC power	(c)	(c)	(c)	(c)	(c)	(c)
2. Accelerate availability of fifth diesel generator	0.43	0.049 (4.9)	890 (89,000)	0.41	0.06 (6.0)	680 (68,000)
III. Improve Ability to Cope with Loss of AC Power and SBO						
1. Procedure change to utilize existing spare 6900-V/480-V transformers	(c)	(c)	(c)	(c)	(c)	(c)
4. Install accumulators for turbine-driven AFW pump flow control valves	0.32	0.22 (22)	150 (15,000)	0.14	0.31 (31)	460 (4,600)
5. Provide DC load shed analysis and procedure	0.11	0.14 (14)	820 (8,200)	0.059	0.17 (17)	350 (3,500)
6. Provide portable battery charger	0.11	0.14 (14)	770 (7,700)	0.053	0.17 (17)	310 (3,100)
7. Install AC-independent coolant injection system	3.5	0.9 (90)	390 (39,000)	2.5	1.4 (140)	180 (18,000)
IV. Improve Ability to Cope with Loss of RCP Seal Cooling						
1. Install improved RCP seals[d]	0.16	0.085 (8.5)	190 (19,000)	0.025	0.15 (15)	170 (1,700)
1a. Install independent RCP seal cooling system (with new EDG)[f]	3.5	0.095 (9.5)	370 (370,000)	3.3	0.17 (17)	2000 (200,000)
2. Install independent RCP seal cooling system (without new EDG)	2.4	0.11 (11)	220 (220,000)	2.2	0.19 (19)	1200 (120,000)
3. Modify charging pump cooling from CCS to ERCW	0.30	0.19 (19)	160 (16,000)	0.043	0.30 (30)	140 (1,400)

Table 7.4 (contd)

Design Improvement	TVA Estimates: Cost ($$10^6$)	TVA Estimates: Averted Risk[a] Person-Sievert (Person-rem)	TVA Estimates: $/Person-Sievert ($/Person-rem)	Staff Estimates: Cost-AOSC[b] ($$10^6$)	Staff Estimates: Averted Risk[c] Person-Sievert (Person-rem)	Staff Estimates: $/Person-Sievert ($/Person-rem)
V. Improve Containment Performance						
1. Install deliberate ignition system	6.1	0.19 (19)	3200 (320,000)	6.1	0.2 (20)	3100 (310,000)
2. Install reactor cavity flooding system	8.8	0.9 (90)	980 (98,000)	8.8	0.95 (95)	930 (93,000)
3. Install filtered containment venting system	20	0.9 (90)	2200 (220,000)	20	0.95 (95)	2100 (210,000)
4. Install core retention device	45	0.61 (61)	7200 (720,000)	45	0.65 (65)	6800 (680,000)
5. Install containment inerting system	11	0.19 (19)	5800 (580,000)	11	0.20 (20)	5500 (550,000)
6. Install additional containment bypass instrumentation	2.3	0.009 (0.9)	2700 (2,700,000)	2.3	0.009 (0.9)	25,000 (2,500,000)
7. Install reactor depressurization system	4.6	0.19 (19)	2400 (240,000)	4.6	0.21 (21)	2200 (220,000)
8. Install independent containment spray system	5.8	0.61 (61)	940 (94,000)	5.8	0.65 (65)	890 (89,000)
9. Install AC-independent Air Return Fan power supplies	1.0	0.19 (19)	530 (53,000)	1.0	0.2 (20)	500 (50,000)
VI. Miscellaneous Improvements						
1. Install MG[g] set trip breakers in control room	0.14	0.028 (2.8)	520 (52,000)	0.054	0.064 (6.4)	910 (9,100)
2. Improve procedures for temporary HVAC during loss of room cooling	0.025	0.004 (0.4)	650 (65,000)	0.015	0.008 (0.8)	190 (19,000)

(a) Based on a 40-year plant life and projected average population over plant life. Does not include averted occupational exposure.
(b) Includes averted onsite costs, in accordance with NUREG/BR-0058 (NRC 1983).
(c) The sum of averted offsite risk and averted occupational exposure. Based on a 40-year plant life and projected population at end of plant life
(d) Design improvement will be implemented and is credited in the risk reduction estimates. The cost to implement each procedural change was estimated by the applicant to be approximately $25,000.
(e) Identified as Option III.2 and Option IV.1 in TVA analysis.
(f) Identified as Option III.3 in TVA analysis.
(g) Motor Generator.

- Accelerate Availability of Fifth Emergency Diesel Generator (EDG) (II.2) - provide a fifth EDG as a backup to the two Unit 1 EDGs, and the two Unit 2 EDGs that will be transferred to Unit 1 with the licensing of Unit 1. This would increase the availability of AC power, further reducing the frequency of station blackout.

Category III - Improve Ability to Cope With Loss of AC Power and Station Blackout

The following are options for improving the WBN Plant's ability to cope with an extended loss of offsite power or station blackout. The applicant committed to implement a procedure to use spare 6900-V to 480-V transformers to supply shutdown boards (Design Improvement III.1).

Design Improvements III.2 and III.3 are discussed under Category IV Design Improvements.

- Install Accumulators for Turbine-Driven Auxiliary Feedwater (AFW) Pump Flow Control Valves (III.4) - provide control air accumulators for the turbine-driven AFW flow control valves, the motor-driven AFW pressure control valves, and the steam generator pressurizer power operated relief valves (PORVs). This would eliminate the need for local manual action to align nitrogen bottles for control air during loss of offsite power.

- Provide DC Load Shed Analysis and Procedure (III.5) - provide detailed engineering analyses and procedures to extend battery life by shedding additional DC loads under station blackout conditions (in addition to the loads that would be shed under the existing load shed procedure). This would permit operation of the turbine-driven AFW pump for a longer period of time and would facilitate restoration of offsite power after 4 hours by extending availability of breaker control power.

- Provide Portable Battery Charger (III.6) - provide a portable, diesel-driven battery charger to ensure that DC power would remain available under station blackout conditions. This would permit operation of the turbine-driven AFW pump for a longer period of time and would facilitate restoration of offsite power after 4 hours by ensuring availability of breaker control power.

- Install AC-Independent Coolant Injection System (III.7) - install an AC-independent coolant injection system capable of providing feed and bleed cooling of the reactor coolant system (RCS) under station blackout conditions.

Category IV - Improve Ability to Cope With Loss of RCP Seal Cooling

This category of enhancements includes items that would either improve reactor coolant pump (RCP) seal performance under loss of RCP seal cooling or prevent failure of the seals entirely.

- Install Improved RCP Seals (III.2 and IV.1) - install replacement RCP O-ring seals constructed of improved materials. The replacement seals would be capable of withstanding higher temperatures and would have a higher likelihood of remaining intact under loss of seal cooling conditions.

- Install Independent RCP Seal Cooling System (with new EDG) (III.3) - install a non-safety-grade, manually actuated seal injection pump that is independently cooled (non-component cooling system [non-CCS]/essential raw cooling water [ERCW]) and independently powered (from a separate, small EDG). This would reduce the frequency of RCP seal LOCA in scenarios where the normal means of seal cooling (centrifugal charging pumps [CCPs]) fail or is unavailable, including both station blackout and non-station blackout events.

- Install Independent RCP Seal Cooling System (without new EDG) (IV.2) - install a non-safety-grade manually actuated seal injection pump that is independently cooled (non-CCS/ERCW), but powered from the existing emergency bus. This would reduce the frequency of RCP seal LOCA in sequences where the normal means of seal cooling (CCS/ERCW) fail or are unavailable, but would not be effective in station blackout events.

- Modify Charging Pump Cooling from CCS to ERCW (IV.3) - add a cross-connect to permit cooling chemical and volume control system (CVCS) Pump B with ERCW in the event that CCS is lost. (CCP A already has the capability to be cooled by ERCW; this enhancement involves providing ERCW cooling capability for the CCP B.) This would improve the ability to prevent RCP seal LOCAs in sequences involving loss of the Component Cooling System (CCS).

Category V - Improve Containment Performance

These design changes would improve the ability of the containment to withstand the challenges associated with late hydrogen burn, late overpressurization, basemat melt-through, and containment bypass.

- Install Deliberate Ignition System (V.1) - provide an AC- and DC-independent system to promote ignition of combustible gases generated within the containment during severe accident scenarios. This would reduce the likelihood of containment failure from hydrogen combustion events during station blackout, when the existing hydrogen igniter system would be unavailable.

- Install Reactor Cavity Flooding System (V.2) - provide the capability to flood the reactor cavity of the containment. This would reduce the possibility of direct contact of molten core debris with the containment liner, and could potentially mitigate the effects of direct containment heating and corium-concrete interactions.

- Install Filtered Containment Vent System (V.3) - provide the capability to vent the containment through a vent path routed to an external filter. This would reduce the frequency and offsite consequences of late containment over-pressure failures.

- Install Core Retention Device (V.4) - provide a control device to prevent the direct impingement of core debris onto the steel shell of the primary containment during a high-pressure core melt ejection (HPME) event. The device would prevent the molten core material from contacting the containment shell by providing a barrier between the seal table and the containment shell in the seal table room. This would reduce the likelihood of containment failure resulting from HPME.

- Install Containment Inerting System (V.5) - install a containment inerting system to provide an inert containment atmosphere during power operation. This would reduce the threat to containment integrity from flammable gases, by preventing the combustion of hydrogen and carbon monoxide produced during core damage scenarios.

- Install Additional Containment Bypass Instrumentation (V.6) - install additional pressure-monitoring instrumentation between the first two isolation valves on the low-pressure injection lines, residual heat removal (RHR) suction lines, and high-pressure injection lines. This would improve the ability to detect valve leakage or open valves, and would decrease the frequency of inter-systems loss-of-coolant accidents (ISLOCAs).

- Install Reactor Depressurization System (V.7) - provide the capability to rapidly depressurize the reactor coolant system and allow injection from low-pressure systems. This would reduce the threat of direct containment heating (DCH) and induced failures of steam generator tubes in high-pressure core melt sequences.

- Install Independent Containment Spray System (CSS) (V.8) - provide an independent CSS to cool core debris and provide containment heat removal. This would prevent over temperature and long-term overpressure by steam, and thus reduce the likelihood of containment failure.

- Install AC-Independent Air Return Fan Power Supplies (V.9) - provide independent power supplies to the air return fans (ARFs) to preserve ARF functions for accident scenarios in which normal operation is not possible, e.g., during station blackout. This would maximize the pressure-suppression capabilities of the ice condenser and prevent the accumulation of detonable concentration of hydrogen in the containment.

Category VI - Miscellaneous Enhancements

- Install Motor Generator (MG) Set Trip Breakers in Control Room (VI.1) - provide trip breakers for the MG sets in the WBN Plant control room. In the current design, an anticipated transient without scram (ATWS) would require an immediate action outside the control room to trip the MG sets. This would simplify that action and decrease the risk of an ATWS event.

- Improve Procedures for Temporary Heating Ventilation and Air Conditioning (HVAC) During Loss of Room Cooling (VI.2) - develop procedures for providing temporary means of room cooling in the event of loss of room cooling, such as would occur in station blackout sequences. This would delay overheating and failure of ECCS, electrical, and other key support equipment that require room cooling to ensure component availability.

Staff Evaluation of Potential Design Improvements

The staff reviewed the set of potential design improvements identified by the applicant in Appendix B to the applicant's value impact analysis (TVA 1994b), and finds it comprehensive. The set includes the major improvements identified as part of the NRC CPI program, the accident management strategies identified by NRC in Generic Letter 88-20, Supplement 2 (NRC 1990b), and the NRC review of SAMDAs for Comanche Peak and Limerick (NRC 1989a, 1989b) that would be applicable to the WBN Plant. The set also includes potential design improvements oriented toward reducing the CDF and risk from major contributors specific to the WBN Plant.

The set of design improvements selected by the applicant for detailed evaluation also appears to be reasonable. The improvements considered include a filtered containment vent and flooded rubble bed core retention device; these improvements are cited specifically in NUREG-0660 (NRC 1980) for evaluation as part of Three Mile Island Task Action Plan Item II.B.8.

The staff noted that the set of design improvements evaluated in detail by the applicant was not all inclusive, in that (1) less expensive design improvements could be postulated that provide the same level of risk reduction potential afforded by several of the design options and (2) the set did not include improvements to address the major contributors to risk at the WBN Plant, specifically SGTR events. In this regard, the staff requested further justification for not including several design improvements, including

- enhancements to reduce the risk from SGTR events, such as (1) improved instrumentation for responding to SGTR events, (2) improved depressurization capabilities or procedures to terminate releases in non-isolable SGTR events, and (3) additional systems to scrub fission product releases or to route these releases back to the containment

- provision for alternate power to the existing igniters from an existing onsite power source rather than the dedicated system considered by the applicant

- use of manual RCS depressurization using existing plant hardware rather than the dedicated system considered by the applicant

- use of the fire water system as a backup to either the CCS or other systems that provide injection pump cooling

- use of a hydrostatic test pump as a backup for RCP seal injection/cooling

- use of additional Unit 2 systems and components to support the Unit 1 response to potential severe accidents, including the Unit 2 refueling water storage tank (RWST) and condensate storage tank (CST).

In response to the staff's request, the applicant provided additional justification for these potential enhancements as not cost effective for the WBN Plant, and were, therefore, not considered further. Key points raised by the applicant in its responses were that

- It would be difficult to further reduce risk from SGTR events since the dominant SGTR sequences involve failures caused by human actions, and human error rates assumed for these actions are already low (about 1E-4). Furthermore, the SGTR-related improvements identified would entail significant modifications or analyses, and would far exceed the value of the risk associated with SGTR events.

- Hydrogen combustion related failures of containment account for less than 10% of the total risk at the WBN Plant, due in large part to the existing AC-powered hydrogen ignition system. Since the majority of the remaining loss of offsite power risk is due to long-term (i.e., battery depletion) type station blackout events, the value of using existing station batteries to supply backup power to the igniters would not generally be effective. The cost of other alternate power supplies would also not be justified because of the low remaining level of risk.

- Based on thermal-hydraulic analyses performed for the applicant, the existing PORVs and head vents do not have sufficient capacity to effectively depressurize the RCS. Although manual depressurization may moderate the pressure in the RCS and thus moderate post-failure containment loads, the applicant indicates that pressures sufficient to allow low pressure injection to discharge or to prevent debris dispersal from the reactor would not be reached, and that manual depressurization may preclude thermally induced creep-rupture of the hot leg, which is more desirable. Thus, manual actions to depressurize were not considered further.

- The benefit of using the fire water system as a backup for either containment spray or injection pump cooling would be very limited because all of the WBN Plant high-pressure fire pumps are AC powered and, therefore, would not be available in station blackout events.

- Although a hydrostatic pump is available, the complications that would be involved in making the proper connections in the allotted time reduce the effectiveness of this option and preclude this from being simply a "procedural" modification.

- Use of additional Unit 2 systems for Unit 1 would not result in a significant reduction in total risk. Watts Bar Unit 1 already relies on the use of several support systems that are either common to both Units 1 and 2, or part of Unit 2 but capable of being cross-connected to Unit 1, including

  - 161-kV switchyard and station service transformers
  - Unit 2 diesel generators (including fuel oil transfer, 6900-kV and 480-V shutdown boards, 120-V AC vital instrument power boards, and associated ventilation systems)
  - Unit 2 DC power system (including the 125-V DC vital battery boards and the 250-V DC vital battery boards)
  - Essential Raw Cooling Water System (ERCW)
  - Component Cooling Water System (CCS)
  - Nonessential Control Air System (CAS)
  - Auxiliary Control Air System (ACAS).

  The use of these support systems is covered in the Technical Specifications for Watts Bar Unit 1, and considered in the IPE (TVA letter dated December 27, 1993). Use of the Unit 2 RWST and CST was further assessed by TVA and found to offer less than a 20% reduction in total risk, at an estimated cost of approximately $750,000 (TVA letter dated March 8, 1995). As such, these design options would be more than an order of magnitude from being cost effective.

The staff has reviewed the applicant's rationale for no further consideration of these design options and finds it to be reasonable.

The staff concludes that the applicant has used a systematic and comprehensive process for identifying potential design improvements for the WBN Plant, and that the set of potential design improvements identified and evaluated by the applicant is reasonably comprehensive and, therefore, acceptable.

7.2.4 Risk Reduction Potential of Design Improvements

TVA Evaluation

Those design enhancements which passed the preliminary screening process were further defined by the applicant in terms of specific hardware or procedural enhancements that would be involved, so that quantitative estimates of risk reduction potential and costs could be developed.

The general process used by the applicant to determine the risk reduction potential for each enhancement involved determining the approximate effect that the design change would have on top-events on the related event tree, reflecting that impact by modifying the associated spreadsheets, and calculating a new value of CDF and total risk. A spreadsheet showing plant damage state was used to total the plant damage states resulting from the various sequences and to transfer the frequencies to the Level 2 portion of the PRA. A Level 2 spreadsheet was used to translate the plant damage state frequency to radiological release category frequencies.

A release category spreadsheet was used to translate the release category frequencies into APB frequencies. Based on the updated frequencies, the new dose to the public and the difference from the base case were calculated.

The applicant's basis for estimating the risk reduction for each design improvement is given in Section 4 of the applicant's value impact analysis (TVA 1994b) and is summarized in Table 7.5. The corresponding risk reduction estimates are in Table 7.4 ("Summary of Value/Impact Study Results"). The staff's review of the applicant's risk reduction estimates is given in the section below.

Staff Evaluation

The staff has reviewed the applicant's bases for estimating averted risk for the various design improvements. The staff noted one significant deviation from the NRC's guidance for estimating the benefit of potential design changes. Specifically, the applicant estimated the benefit of each enhancement only in terms of the averted offsite risk. The applicant did not consider averted occupational exposures or averted onsite property damage in evaluating the cost effectiveness of proposed enhancements that reduce CDF.

The staff notes that the applicant used considerable judgment in assessing the impact of each design change with regard to estimating averted offsite risk on the WBN Plant risk profile, and that the rationale and assumptions on which the risk reduction estimates are based (summarized in Table 7.5) are reasonable and generally conservative. The staff based its estimates of averted offsite risk for the various SAMDAs on the applicant's rebaselined risk reduction estimates, but conservatively increased these values (by about 6%) to account for a higher population at the end of plant life.

The staff estimated the averted occupational exposures (and averted onsite property damage) for design improvements that reduce CDF and included this risk reduction in the staff estimates of averted risk for the relevant SAMDAs. The basis for these estimates is described in Section 7.2.5. The staff estimates for averted risk, which reflect a sum of averted offsite and onsite risk, are presented in Table 7.4 for each of the candidate design improvements. These risk reduction estimates are used as the basis for the staff's cost benefit comparison described in Section 7.2.6.

7.2.5 Cost Impacts of Candidate Design Improvements

Applicant Evaluation

The applicant's method for determining costs for each potential design improvement is documented in Section 3.2.1 of the June 30, 1994 value impact submittal (TVA 1994b). The applicant developed cost estimates for each implementation option from either a site-specific engineering estimate or, for the major modifications, from industry and/or NRC cost data. The site-specific estimates consider four major cost categories (engineering, material, construction, and equipment maintenance) with subcategories (e.g., development of

Table 7.5 Summary of TVA's Assessment of Risk Reduction for Candidate Design Improvements

Potential TVA Design Modification	TVA's Basis for Estimating Risk Reduction
I.1 Procedure change to stop one train of sprays	Reduce operator error rates for recovery of failed valves
II.1 Procedure change to facilitate cross-tie of 500-kV and 161-kV AC power	Increase probability of recovering offsite power
III.1 Procedure change to use existing spare 6900-V/ 480-V transformers	Reduce the frequency of failure of the 480-V shutdown boards associated with unavailability during transformer maintenance
I. Improve Availability of ECCS Recirculation	
I.2 Install containment spray throttle valves	Reduce operator error rates for recovery of failed valves
I.3 Redesign to delay containment spray actuation	Reduce operator error rates for recovery of failed valves
I.4 Install automatic high pressure recirculation	Use risk reduction benefit associated with Design Improvement I.1
II. Improve Availability of AC Power	
II.2 Complete fifth emergency diesel generator	Ensure all four 6900-V shutdown boards are supported by an operable EDG, even when one is in maintenance
III. Improve Capability to Cope with Loss of AC Power and Station Blackout	
III.2 Install improved RCP seals	Reduce the probability of RCP seal failure by a factor of 4 Increase the likelihood of recovery of offsite power by a factor of 10 to reflect the additional time available to recover power before a seal LOCA
III.3 Install independent RCP seal cooling system (with new EDG)	Increase the likelihood of recovery of offsite power to reflect the additional time available to recover offsite power given a seal LOCA was avoided
III.4 Install accumulators for turbine-driven AFW pump flow control valves	Eliminate dependence of AFW pump flow control valves on the essential control air system, and reduce the operator error rate for SBO conditions
III.5 Provide DC load shed analysis and procedure	Extend battery life, and ensure availability of breaker control power
III.6 Provide portable battery charger	Extend battery life indefinitely, and ensure availability of breaker control power
III.7 Install AC-independent coolant injection system	Similar to Design Improvement III.5, except that core uncovery would occur in 8 hours as a result of the loss of primary system inventory because of RCP seal LOCA

Table 7.5 (contd)

Potential TVA Design Modification	TVA's Basis for Estimating Risk Reduction
IV. Improve Capability to Cope with Loss of RCP Seal Cooling	
IV.1 Install improved RCP seals	Same as Design Improvement III.2
IV.2 Install independent RCP seal cooling system (without new EDG)	Similar to Item III.3, except this applies only to non-SBO seal LOCAs Add an operator action to initiate
IV.3 Modify charging pump cooling from CCS to ERCW	Eliminate all core damage sequences involving loss of CCS cooling
V. Improve Containment Performance	
V.1 Install deliberate ignition system	Eliminate all containment failures due to hydrogen burns
V.2 Install reactor cavity flooding system	Eliminate containment failures that result from direct contact of melt, CCI[a], and DCH[b]
V.3 Install filtered containment vent system	Eliminate containment failures that result from direct contact of melt, CCI, and DCH
V.4 Install core retention device	Eliminate all containment failures except those associated with bypass events (APB 7) and containment failures that occur with the reactor vessel intact (APB 1 and 2)
V.5 Install containment inerting system	Eliminate all containment failures due to hydrogen burns
V.6 Install additional containment bypass instrumentation	Reduce the frequency of ISLOCA scenarios by a factor of 2
V.7 Install reactor depressurization system	Eliminate all containment failures associated with reactor vessel breach at high RCS pressure (APB 3)
V.8 Install independent containment spray system	Eliminate all containment failures except those associated with bypass events (APB 7) and containment failures that occur with the reactor vessel intact (APB 1 and 2)
V.9 Install AC-independent air return fan power supplies	Eliminate all containment failures due to hydrogen burns
VI. Miscellaneous Enhancements	
VI.1 Install MG set trip breakers in control room (ATWS)	Eliminate all failures to trip the reactor
VI.2 Improve procedures to provide temporary HVAC during loss of room cooling	Requantify assuming room cooling not needed for equipment operability

(a) CCI - Core Concrete Interactions
(b) DCH - Direct Containment Heating

training modules, bulk commodities, trade labor) defined by the requirements of the proposed enhancement. For certain design improvements, the applicant also cited a more detailed analysis of similar scope prepared for the SQN Plant as evidence that its cost estimate is biased low.

In the original value impact study submitted on June 30, 1994 (TVA 1994b), the applicant failed to discount recurring costs for two design improvements. However, the cost estimates reported for these design options in the final SAMDAs submittal (TVA 1994c) were revised to include appropriate discounting. The applicant's cost estimates are reported in Table 7.4, based on the final SAMDAs submittal (TVA 1994c).

Staff Evaluation

The staff reviewed the bases for the applicant's cost estimates. For certain improvements, the staff also compared TVA's cost estimates with estimates developed elsewhere for similar improvements, even though the bases for some of these cost estimates were different. The staff considered the cost estimates developed as part of the evaluation of design improvements for Limerick (NRC 1989c) and Comanche Peak (NRC 1989d) and for the evolutionary advanced light-water reactors.

Except for the few exceptions noted below, the applicant's cost estimates are judged to reflect valid bases and assumptions, and their accuracy is considered sufficient to provide a reasonable and appropriate basis for the SAMDAs analyses, given the uncertainties surrounding the underlying cost estimates and the level of precision necessary considering the greater uncertainty inherent on the benefit side, with which these costs were compared. The exceptions involve

- use of fully burdened labor rates in estimating the costs of the proposed enhancements
- apparent over estimates of the costs associated with two specific design improvements.

The staff based its estimates of the costs of the various candidate improvements on the applicant's cost estimates, with consideration of these concerns, as discussed below.

Use of fully burdened labor rates is appropriate when the work will be performed by a contractor rather than by the applicant's personnel. However, where the applicant's personnel are expected to perform specific functions (notably engineering, quality assurance/quality control,and training functions), the costs incurred by the applicant will likely only be the marginal labor costs. For most of the enhancements evaluated by the applicant, reestimation of the costs to reflect the applicant's marginal labor costs would not make a significant difference in the overall evaluation and, therefore, was not considered further in the staff's assessment. However, as discussed below, use of alternative cost assumptions could impact the overall evaluation for three SAMDAs, specifically, Install Improved RCP Seals (Design Improvements III.2 and IV.1), Modify Charging Pump Cooling from CCS to ERCW (Design Improvement IV.3), and Provide DC Load Shed Analysis and Procedures (Design Improvement III.5).

Install Improved RCP Seals (Design Improvements III.2 and IV.1)

The applicant's estimate for installing improved RCP seals is $162,800, based on an estimate of $2800 for the engineering approval and $160,000 for the replacement seal cartridges. No construction or maintenance costs are attributed to the design improvement by the applicant, as its estimate assumes that the improved RCP seals would be installed and/or replaced as part of routine seal re-builds during future outages.

The applicant did not clearly state whether this improvement would be accomplished prior to plant startup or during future outages. If it is completed before plant startup, then the estimate appears to be low because it does not include the labor costs that would be incurred in installing the improved seals. Normally, labor costs for installation are roughly equal to material costs; an estimate of about $320,000 appears to be appropriate for this enhancement if the change is to be made prior to plant startup.

Alternatively, if the improvement is implemented during future outages, then the attribution of the total costs of the improved seals ($40,000 per cartridge) will be high. If the change is made only after the existing seals reach the end of their service life, the cost will be only the minor engineering costs for change approval plus the incremental cost of the improved seals. Assuming that $40,000 per cartridge provided by the applicant is the total cost per cartridge, an estimate of $18,800 to $34,800 (10 - 20% surcharge for the improved seals) for this enhancement at a future date would appears to be reasonable. Estimated benefits would need to be adjusted to reflect remaining plant life to accurately evaluate the cost/benefit to implement this enhancement at a future date.

The staff based its assessment of this design option on the cost estimates submitted by the applicant and considered the impact of potentially lower installation costs in reaching conclusions on improvements in this area.

Modify Charging Pump Cooling From CCS to ERCW (Design Improvement IV.3)

The applicant's estimate to modify the charging pump cooling configuration to allow cooling by ERCW is $295,200. This estimate is derived from an engineering analysis that considers the need to evaluate the current design for the intended application, the physical changes to piping systems and new hardware that will be required, and the need to develop procedures and provide additional training for operators.

Although the applicant's estimate provides few details of the labor hours and costs assumed for this improvement, the estimate of $295,200 appears to be reasonable considering the scope of the analyses and physical modifications that need to be performed. However, it is not clear from the applicant's SAMDAs analysis (TVA 1994b) why contractor engineering support (estimated by the applicant at $159,000—more than one-half of the total costs) is needed for performing this analysis. If in-house staff is used, the real cost of the improvement may only be the marginal labor costs.

The staff based its assessment of this design option on the cost estimates submitted by the applicant and considered the impact of potentially lower installation costs in reaching conclusions on improvements in this area.

Provide DC Load Shed Analysis and Procedures (Design Improvement III.5)

The applicant's estimate of the costs to provide DC load shed analysis and procedures is $113,200. This improvement would involve performing an engineering analysis that considers the need to revise the station blackout coping analysis and associated procedures and providing additional training for operators and licensing support.

Although the applicant's estimate provides few details of the labor hours and costs assumed in costing this improvement, the estimate of $113,200 appears to be reasonable considering the scope of the analyses that need to be performed. However, the need for contractor support (estimated by the applicant at $75,000 or two-thirds of the total costs) to perform this analysis is not apparent from the applicant's SAMDAs analysis (TVA 1994b). If in-house staff are used, the real cost of the improvement may only be the marginal labor costs.

The staff based its assessment of this design option on the cost estimates submitted by the applicant and considered the impact of potentially lower installation costs in reaching conclusions on the need for any improvements in this area.

In addition to the concerns related to use of fully burdened labor rates in estimating the costs of the proposed enhancements, the costs associated with two specific design improvements may be overestimated in the applicant's analysis, specifically with regard to the "install additional containment bypass instrumentation" (Design Improvement V.6) improvement and the "install MG set trip breakers in control room" (Design Improvement VI.2) improvement. The impact is discussed below.

Install Additional Containment Bypass Instrumentation (Design Improvement V.6)

The applicant's estimate of the cost to install additional containment bypass instrumentation is $2.3 million This value was taken from the estimate made by Texas Utilities for a similar design improvement at Comanche Peak. The Comanche Peak estimate of $2 million (in 1989 dollars) includes $100,000 for equipment, material, and subcontracts; $1.3 million for installation; $300,000 for engineering and QA; an $300,000 for "owner's support cost."

With no details given to support the Comanche Peak estimate, it is difficult to evaluate its reasonableness. Given the relatively modest scope of the improvement (installing pressure sensors on the low pressure safety injection, RHR suction, and high pressure safety injection lines) the estimated costs (particularly fo installation) may be considerably lower. However, the cost-benefit ratio for this design change is several orders of magnitude greater than the $10 per person-sievert ($1000 per person-rem) screening criterion, as discussed in Section 7.2.6. Thus, this option would not be cost beneficial even if the costs were significantly lower.

Install MG Set Trip Breakers in Control Room (Design Improvement VI.1)

The applicant's estimate of the cost to install MG set trip breakers in the WBN Plant control room is $142,500. This estimate is based on an engineering estimate of $34,400 for engineering, $11,700 for materials, $71,200 for construction, and $25,200 for procedural changes and training.

Given the relatively minor scope of this improvement, the applicant's estimates of the necessary engineering support and construction labor appear high. Engineering is estimated to require 615 hours, which is significantly higher than the estimates for Design Improvements III.2 (50 hours), III.4 (410 hours), and III.6 (300 hours). Construction, which the applicant states involves three 150-meter (500-foot) cabling runs, an additional relay panel, and mounting several relays, is estimated to require 2327 hours of trade labor. Although these estimates may be high, the cost-benefit ratio for this design change is about an order of magnitude greater than the $10 per person-sievert ($1000 per person-rem) screening criterion, as discussed in Section 7.2.6. Thus, this option would not be cost beneficial even if the costs were substantially lower (e.g., by a factor of 2).

A final note concerns the applicant's cost estimates for completing the fifth emergency diesel generator (Design Improvement II.2). In its October 7, 1994, revision to the SAMDAs analysis (TVA 1994c), the applicant makes it clear that the issue for this improvement is whether or not to provide a fifth emergency diesel generator, rather than when such a generator would be available, as is implied in their June 30, 1994, submittal (TVA 1994b). On that basis, the revised cost estimate provided by the applicant in its final SAMDAs submittal (TVA 1994c) is judged to be reasonable and appropriate.

7.2.6 Cost-Benefit Comparison

Applicant Evaluation

Once the costs and benefits of the candidate design improvements were developed, the applicant calculated the cost-benefit ratio for each design improvement by dividing the dollar cost of it by the estimated offsite dose averted. The applicant's estimates of the cost per person-rem averted for the various design and procedural improvements are presented in Table 7.4. These values are based on the applicant's estimates of averted offsite risk and, for design changes that reduce CDF, do not reflect the impact of averted onsite risk and averted onsite costs.

Consistent with current NRC practice (NRC 1983), the applicant used a screening criterion of $10 per person-sievert ($1000 per person-rem) averted to identify whether any of the design improvements could be cost effective. On this basis, none of the remaining 23 design improvements (beyond the three procedure improvements already committed to by the applicant) are judged by the applicant to be cost effective.

This conclusion is based on the WBN Plant PRA model, which incorporates credit for three procedure modifications which, in an earlier SAMDAs assessment, showed "cost per person-rem averted" in the range of $600 to $5000 (or $6 to $50 cost per person-sievert averted). Thus cost-effective modifications have already been made, in part motivated by the SAMDAs process.

Of the 23 potential design improvements, the applicant estimates that 2 have cost/benefit ratios between $10 and $100 per person-sievert ($1000 and $10,000 per person-rem); 10 have cost-benefit ratios between $100 and $1000 per person-sievert ($10,000 and $100,000 per person-rem), and the remaining 11 have cost-benefit ratios greater than $1000 per person-sievert ($100,000 per person-rem).

Staff Evaluation

As noted previously, the applicant estimated the benefit of each improvement only in terms of the averted public (offsite) dose, and did not consider averted onsite costs (AOSC) or averted occupational exposures (on-site risk) in evaluating the cost effectiveness of the proposed enhancements. Accordingly, the staff developed estimates of the cost effectiveness of the SAMDAs; these estimates were developed in terms of both dollars per person-rem and value/impact ratios.

The dollars per person-sievert (person-rem) estimates reflect net costs and are calculated as

$$\text{Dollars per person-sievert (person-rem)} = (\text{COE} - \text{AOSC}) / (\text{APE} + \text{AOE})$$

where COE = cost of enhancement ($)
AOSC = averted onsite costs ($)
APE = averted public exposure (person-sievert [person-rem])
AOE = averted occupational exposure (person-sievert [person-rem]).

The value/impact (V/I) estimates also reflect net costs and are calculated as

$$V/I = (\$APE + \$AOE + AOSC) / COE$$

where COE and AOSC are as defined above and

$APE = monetized value of averted public exposure ($)
$AOE = monetized value of averted occupational exposures ($).

In both the dollars per person-sievert (person-rem) and value/impact calculations, future costs have been discounted at 7%. In calculating the value/impact ratios, averted exposures are monetized using a value of $10 per person-sievert ($1000 per person-rem), with no discounting of future exposures.

The calculated value/impact ratios and dollars per person-sievert (person-rem) estimates for each of the proposed enhancements accounting for averted offsite costs and averted onsite property damage and occupational exposure are presented below. In computing these ratios, the estimated change in CDF and the estimated cost for the enhancement are taken directly from the applicant's final SAMDAs submittal (TVA 1994c). The averted offsite risk estimates are also based on the applicant's estimates with a conservative adjustment to account for the population at the end of plant life.

The estimates of AOE are calculated as

AOE = Annual CDF reduction
x occupational exposure per core-damage event
x number of years of plant life remaining

The estimates of averted occupational exposure are based on the best estimate of 210 person-sievert per event (21,000 person-rem per event) given in NUREG/BR-0184 (NRC 1993b) and assume 40 years of plant life remaining. The lower and upper bounds provided in NUREG/BR-0184 are 0 and 410 person-sievert per event (0 and 41,000 person-rem per event).

The estimates of AOSC include cleanup and power replacement costs. Averted cleanup costs (ACC) are calculated as

ACC = Annual CDF reduction
x present value of cleanup costs per core-damage event
x discount factor accounting for plant life remaining

The estimated cleanup cost for severe accidents is given as $1.5 billion in NUREG/BR-0184. This cost is the sum of equal annual costs over a 10-year cleanup period. At a 7% discount rate, the present value of this stream of costs is $1.1 billion. A discount factor of 13.33 accounts for the 40-year lifetime of the plant, yielding an integrated cleanup cost of $14 billion.

The estimated integrated cost of replacement power is $6.2 billion. This value is taken from the individual plant calculations performed to derive the estimates of long-term replacement power presented in NUREG/CR-6080 (NRC 1993a).

Summing the integrated cleanup cost of $14 billion and the integrated power replacement cost of $6.2 billion yields an "at risk value" of $20 billion for onsite costs. This "at risk value" of $20 billion, multiplied by the estimated change in CDF for a given enhancement, yields the expected AOSC for each enhancement.

The resulting staff cost-benefit ratio values are reported in Table 7.4. Consistent with the results of the applicant's assessment, the NRC staff assessment indicates that none of the design or procedural improvements fall below the $10 per person-sievert ($1000 per person-rem) criterion. However, several of the candidates (the five improvements indicated in bold in Table 7.4) fall within a factor of 5 of the $10 per person-sievert ($1000 per person-rem) criterion. Additional cost-benefit elements are provided in Table 7.6 for these five SAMDAs. The fourth and fifth columns show the staff's estimates of averted offsite (public) and onsite (occupational) risk. The last two columns show the impact of treating AOSC either as a cost offset, as in the current staff approach, or as a benefit, as in a proposed staff approach that is currently under consideration. In the latter case, value/impact ratios of 1 or greater would be judged cost beneficial. None of the SAMDAs have a value/impact greater than 1.

A more detailed assessment for the five SAMDAs was performed, recognizing the uncertainties inherent in the cost/benefit analysis and the screening nature of the assessment. This assessment was based on both probabilistic and deterministic considerations and is summarized below.

Table 7.6 Value/Impact Ratios for Selected Design Improvements

				Averted Risk Person-Sievert (Person-Rem)		Value/Impact Ratio	
	Design Improvement	Cost[a] ($)	AOSC[b] ($)	Offsite	Onsite	AOSC as a Cost Offset[c] $/person-sievert ($/person-rem)	AOSC as a Benefit[d] (Dimensionless)
III.4	Install accumulators for AFW pump flow control valves	325,000	180,000	0.23 (23)	0.08 (8)	46 (4600)	0.66
III.5	Provide DC load shed analysis and procedure	113,000	54,000	0.15 (15)	0.02 (2)	35 (3500)	0.63
III.6	Provide portable battery charger	107,000	54,000	0.15 (15)	0.02 (2)	31 (3100)	0.66
IV.1	Install improved RCP seals	163,000	140,000	0.09 (9)	0.06 (6)	17 (1700)	0.94
IV.3	Modify charging pump cooling from CCS to ERCW	295,000	250,000	0.2 (20)	0.1 (10)	14 (1400)	0.96

(a) Values reported by TVA. Values do not include averted onsite costs (AOSC)

(b) Staff values for Watts Bar based on: AOSC = [$2E10] x [Δ CDF/y]

(c) Current practice: $/person-sievert ($/person-rem) = [cost - AOSC] / [averted risk]

(d) Proposed practice: V/I = [(averted risk) x $10/person-sievert ($1000/person-rem) + AOSC] / [cost]

Install Accumulators for Turbine Driven AFW Pump Flow Control Valves and Steam Generator PORVs (Design Improvement III.4)

This proposed design alternative involves installing control air accumulators for the turbine-driven AFW flow control valves, the motor-driven AFW pressure control valves, and the steam generator PORVs. This would eliminate the need for local manual action to align nitrogen bottles for control air during loss of offsite power. The applicant estimated that a total of about 0.22 person-sievert (22 person-rem) or 10% of the risk at the WBN Plant would be eliminated through this modification.

The staff has considered the benefits provided by backup accumulators for these air-operated valves and concludes that such an improvement is not justified at the WBN Plant. For a complete loss of AC power and for certain 10 CFR Part 50 Appendix R fire scenarios, air to the flow control valves for the turbine driven AFW pump could be lost. Operator action outside the control room is acceptable under these conditions. The operator actions required at the WBN Plant involve manually isolating the compressed air from the control valves and then aligning nitrogen bottles to supply motive force for the valves. All of these actions are via locally operated manual valves. Such operator actions are not uncommon for coping with complete station blackout and certain fire scenarios at many of the existing nuclear plants. The staff considers reliance on these manual actions adequate for meeting the station blackout rule and the fire protection requirements and, therefore, acceptable. Accordingly, modifications to install backup accumulators are not needed at the WBN Plant.

Provide DC Load Shed Analysis and Procedure (Design Improvement III.5)

This proposed design alternative involves performing a detailed, time-dependent analysis of all DC loads and developing a detailed load shed procedure to eliminate all loads that could possibly be shed. Additional sequencing of systems (on and off) to provide additional reductions in battery loads would be considered. The applicant estimated that a total of about 0.14 person-sievert (14 person-rem) or 7% of the risk at the WBN Plant would be eliminated through this modification, based on the assumption that improved load shed procedures would extend the life of the station batteries indefinitely.

As noted in Section 7.2.5, the cost of this design improvement may be significantly less than estimated by the applicant if the work is performed by the applicant's staff rather than by a contractor. Nonetheless, the NRC staff does not believe that risk can be significantly reduced through this improvement since the applicant has already committed to implement a load shed procedure to comply with the station blackout rule. The staff approved the applicant's station blackout coping analyses for the WBN Plant. The staff found that the DC power system will have adequate capacity for a station blackout duration of 4 hours by shedding nonessential loads (the applicant identified the loads that will be shed after 30 minutes during a station blackout event). The staff stated that the applicant should ensure that the loads that are needed for coping with station blackout and that are needed by the operators for monitoring important parameters are not shed. As part of the coping analysis, the extension of battery duty cycle (battery capacity available beyond 4 hours) by shedding additional non-required loads was reviewed by the applicant and determined to be ineffective. The staff agrees with that assessment based on the following considerations: (1) few additional loads can be shed, (2) more elaborate load shed procedures may unnecessarily burden operators to shed additional loads individually, and (3) the ability to cope with station blackouts lasting significantly longer than 4 hours would be limited by long-term availability of condensate inventory, containment isolation, and reactor inventory.

The staff concludes that this improvement is not warranted because of the practical limitations on the effectiveness of this improvement, combined with the relatively small estimated risk reduction both in absolute terms and as a fraction of the total risk.

Provide Portable Battery Charger (Design Improvement III.6)

This proposed design alternative involves providing a portable, diesel-driven battery charger to ensure that DC power would remain available under station blackout conditions. This would permit operation of the turbine-driven AFW pump for a longer period of time and would facilitate restoration of offsite power after 4 hours by ensuring availability of breaker control power. The applicant estimated that a total of about 0.14 person-sievert (14 person-rem) would be eliminated through this modification, based on the assumption that a portable battery charger would extend the life of the station batteries indefinitely.

The staff agrees that a portable, diesel-driven battery charger will ensure the availability of DC power for a longer period of time. However, for the same reasons as cited above, batteries alone do not ensure the ability to cope with a station blackout of longer duration. The continued availability of condensate inventory, compressed air, HVAC, containment isolation, and reactor inventory would also need to be ensured. The staff concludes that this improvement is not warranted because of the practical limitations on the effectiveness of this design improvement and the relatively small estimated risk reduction.

Install Improved RCP Seals (Design Improvement III.2)

This proposed design alternative involves replacement of the current RCP O-ring seals with seals constructed of improved materials. The replacement seals would be capable of withstanding higher temperatures and would have a higher likelihood of remaining intact under loss of seal cooling conditions. The applicant estimated that about 0.9 person-sievert (9 person-rem) or 4% of the total risk would be eliminated through this modification, based on the assumption that installation of improved seals would reduce seal LOCA frequency by a factor of 4.

The staff believes that improved RCP seals would not be as effective in reducing the frequency of seal LOCA as represented in the applicant's assessment. A study, documented in NUREG/CR-5167 (NRC 1991), explored the benefits of improved seal materials. This study found that while improved elastomers will extend the time to seal failure and thereby increase the probability of cooling recovery, improved elastomers in the secondary seals would have little or no effect on the probability of primary seal failure by the "popping open" mode under loss of cooling conditions. "Popping open" failures are primarily induced by two-phase flow instabilities in the seals and are not directly related to secondary seal materials. Based on information developed in the study, the probability of core uncovery due to seal failure would be reduced by less than a factor of 2 using the improved seals.

NRC Generic Issue 23 (GI-23) addresses concerns related to RCP seal LOCA. The results of that study have indicated that currently operating PWRs provide adequate protection to the public health and safety without additional requirements. A proposed rule addressing loss of integrity of RCP seals is being considered for public comment and is intended to be viewed as a safety enhancement. The staff-proposed rule is performance-based and would allow licensees to demonstrate that no further actions are needed to address RCP seal vulnerabilities on the basis that the risk of core damage attributable to such vulnerabilities is sufficiently low. The staff anticipates that licensees would evaluate potential corrective or mitigative actions to reduce the frequency of seal failure if the estimated mean value of CDF from seal LOCA falls in the range 1E-5 to 1E-4, and that licensees would implement corrective or mitigative actions if the mean value is estimated to be greater than 1E-4. The frequency of RCP seal failure due to loss of seal cooling at the WBN Plant is about 1E-5 (16% of the total CDF). Thus, the WBN Plant falls in the range in which licensees would be expected to consider appropriate corrective or mitigative actions, but is below the level at which we would expect licensee implementation of corrective or mitigative actions.

On the basis of the estimated CDF due to seal LOCA, combined with the relatively small estimated risk reduction associated with this improvement, the staff concludes that imposition of applicants actions to address the RCP seal issue are not justified for further mitigating environmental concerns. The staff notes that the WBN Plant will be undergoing a more detailed evaluation of RCP seal integrity when the final resolution of GI-23 is implemented, and that, as a result of that activity, the staff's position can change.

<u>Modify Charging Pump Cooling From CCS to ERCW (Design Improvement IV.4)</u>

This proposed design alternative involves adding a cross-connect to permit cooling CVCS Pump B with ERCW in the event that CCS is lost. Centrifugal charging Pump A (CCP A) already has the capability to be cooled by ERCW; this enhancement involves providing ERCW cooling capability for the CCP B. This would improve the ability to prevent RCP seal LOCAs in sequences involving loss of CCS. The applicant estimated that about 0.19 person-sievert (19 person-rem) or 9% of the total risk would be eliminated through this modification.

The applicant's risk reduction estimate for this design improvement is considered reasonable. (The aforementioned concern related to seals "popping open" is not relevant to this design improvement, since two-phase flow would not occur in sequences in which this design option is successfully implemented.) However, as noted in Section 7.2.5, if the work is performed by the applicant's staff rather than by a contractor, the cost of the design improvement may be considerably less than estimated by the applicant. This would render the improvement cost beneficial in accordance with the NRC value impact analysis guidelines.

The staff notes that this design improvement has a relatively low cost and favorable impact on CDF and risk. According to the applicant's estimates, total CDF would be reduced by about 20% (to 4.5E-5 per year), and offsite risk would be reduced by about 10%. However, NRC will not require further action by the applicant to address this issue prior to the resolution of GI-23. The staff expects that the WBN Plant would undergo a more detailed evaluation of RCP seal integrity when the final resolution of GI-23 is implemented, and that this modification as well as other improvements would be further evaluated as part of that activity.

In summary, the staff concludes that none of the five design improvements discussed above warrant implementation for the WBN Plant. With one possible exception, none of the design improvements would be cost beneficial based on the staff's cost-benefit analysis. The one exception involves the modification of the charging pump cooling piping configuration to reduce support system dependencies and is expected to be further evaluated by the applicant as part of the resolution of the generic issue concerning integrity of reactor coolant pump seals. Furthermore, the largest risk reduction estimated for any of the five improvements is about 0.2 person-sievert (20 person-rem) or approximately 10% of the total risk at the WBN Plant. Thus, even if these design changes could be shown cost beneficial on the basis of lower installation costs, risk at the WBN Plant would not be significantly impacted through implementation of any of the design improvements.

All of the remaining SAMDAs have a cost-benefit ratio of about an order of magnitude or more greater than the $10 per person-sievert ($1000 per person-rem) criterion, and were not evaluated further. The factor of 10 is considered to provide ample margin to cover uncertainties in risk and cost estimates, given that, in general, estimates for these factors were conservatively evaluated.

7.2.7 Conclusions

The applicant completed a comprehensive, systematic effort to identify and evaluate potential plant enhancements to mitigate the consequences of severe accidents at the WBN Plant. As a result of this assessment, the applicant identified and committed to implement three enhancements to the WBN Plant operating procedures. These procedural changes involve (1) stopping one train of containment spray to delay the time of switch-over to recirculation, (2) cross-tying the 500-kV power at Unit 2 to the 161-kV power system at Unit 1, and (3) using a spare 6900-V to 480-V transformer to supply the 480-V shutdown boards. The applicant conclude that no additional design enhancements are cost effective for the WBN Plant, i.e., there are no candidate improvements with a cost benefit ratio below the $10 per person-sievert ($1000 per person-rem) screening criterion.

Based on its review of SAMDAs for the WBN Plant, the staff estimated the cost-benefit ratio for five candidat SAMDAs to be within a factor of 5 of the $10 per person-sievert ($1000 per person-rem) criterion. Recogniz ing uncertainties and issues inherent in the determination of the averted risk values and cost estimating methodology, a more detailed assessment for the five SAMDAs was performed, based on both probabilistic and deterministic considerations.

The staff concludes that none of the five design improvements warrant implementation for the WBN Plant for the purpose of further mitigating severe accidents. One of the design changes related to RCP seal integrity has a low cost and favorable impact on CDF and risk. However, the CDF due to RCP seal LOCA at the WBN Plant is less than the value at which applicant implementation of corrective or mitigative actions is clearly justified. Furthermore, the largest risk reduction estimated for any of the five improvements is about 0.2 person-sievert (20 person-rem) or approximately 10% of the total risk at the WBN Plant. Thus, even if these design changes could be shown cost beneficial on the basis of lower installation costs, risk at the WBN Plant would not be significantly reduced through implementation of any of the design improvements.

All of the remaining SAMDAs have a cost-benefit ratio of about an order of magnitude or more greater than the $10 per person-sievert ($1000 per person-rem) criterion, and were not evaluated further. The factor of 10 is considered to provide ample margin to cover uncertainties in risk and cost estimates given that, in general, estimates for these factors were conservatively evaluated.

The staff considered the robustness of this conclusion relative to critical assumptions in the analysis, specifically, the impact of uncertainties in the averted offsite risk estimates, and the use of alternative cost-benefit screening criteria. The staff concludes that the findings of the analysis would be unchanged even considering these factors.

7.3 References

Tennessee Valley Authority (TVA). 1993. Letter from W. J. Museler, TVA, to U.S. NRC. June 5, 1993. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Severe Accident Mitigation Design Alternatives (SAMDAs).

Tennessee Valley Authority (TVA). 1994a. Letter from W. J. Museler, TVA, to U.S. NRC. May 2, 1994. Subject: Watts Bar Nuclear Plant (WBN) Unit 1 and Common - Generic Letter 88-20 - Individual Plant Examination (IPE) - Update of Level 1 and 2 Analysis.

Tennessee Valley Authority (TVA). 1994b. Letter from D. E. Nunn, TVA, to U.S. NRC. June 30, 1994. Subject: Watts Bar Nuclear Plant (WBN) Unit 1 and 2 - Severe Accident Mitigation Design Alternatives (SAMDAs) Evaluation from Updated Individual Plant Evaluation (IPE).

Tennessee Valley Authority (TVA). 1994c. Letter from D. E. Nunn, TVA, to U.S. NRC. October 7, 1994. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Severe Accident Mitigation Design Alternatives (SAMDAs) - Response to Request for Additional Information (RAI).

U.S. Nuclear Regulatory Commission (NRC). 1978. *Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant Units Nos. 1 and 2*. NUREG-0498. U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1980. *NRC Action Plan Developed As a Result of TMI-2 Accident*. NUREG-0660, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1983. *A Handbook for Value-Impact Assessment*. NUREG/CR-3568, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1983. *Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission*. NUREG/BR-0058. U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1988. Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities." November 23, 1988.

U.S. Nuclear Regulatory Commission (NRC). 1989a. *Final Environmental Statement Related to Operation of Comanche Peak Steam Electric Station, Units 1 and 2*. NUREG-0775, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1989b. Letter from S. A. Varga, U.S. NRC, to G. A. Hunger, Jr., Philadelphia Electric Company. August 16, 1989. Subject: Supplement to the Final Environmental Statement - Limerick Generating Station, Units 1 and 2.

U.S. Nuclear Regulatory Commission (NRC). 1989c. *Supplement Final Environmental Statement Related to the Operation of Limerick Generating Station, Units 1 and 2*. NUREG-0974, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1989d. *Supplement Final Environmental Statement Related to the Operation of Comanche Peak Steam Electric Station, Units 1 and 2*. NUREG-0775, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1990a. *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*. NUREG-1150, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1990b. Letter from J. G. Partlow, U.S. NRC, to All Holders of Operating Licenses and Construction Permits for Nuclear Power Reactor Facilities. April 4, 1990. Subject: Accident Management Strategies for Consideration in the Individual Plant Examination Process - Generic Letter 88-20, Supplement No. 2.

U.S. Nuclear Regulatory Commission (NRC). 1991. *Cost Benefit Analysis for Generic Issue 23: Reactor Coolant Pump Seal Failure*. NUREG/CR-5167, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1993a. *Replacement Energy, Capacity, and Reliability Costs for Permanent Nuclear Reactor Shutdowns*. NUREG/CR-6080, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1993b. *Regulatory Analysis Technical Evaluation Handbook, Draft Report*. NUREG/BR-0814, U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1994a. Memorandum from J. Murphy, Office of Nuclear Regulatory Research, to S. A. Varga, Office of Nuclear Reactor Regulation. September 29, 1994. Subject: Review of Watts Bar, Unit 1, Nuclear Plant Individual Plant Examination (IPE) Submittal - Internal Events.

U.S. Nuclear Regulatory Commission (NRC). 1994b. Letter from U.S. NRC to O. D. Kingsley, Jr., TVA. September 2, 1994. Subject: Watts Bar Nuclear Plant - Severe Accident Mitigation Design Alternatives.

U.S. Nuclear Regulatory Commission (NRC). 1994c. Letter from U.S. NRC to O. D. Kingsley, Jr., TVA. September 20, 1994. Subject: Watts Bar Nuclear Plant - Severe Mitigation Design Alternatives.

U.S. Nuclear Regulatory Commission (NRC). 1994d. Letter from U.S. NRC to O. D. Kingsley, Jr., TVA. September 27, 1994. Subject: Watts Bar Nuclear Plant - Severe Mitigation Design Alternatives.

U.S. Nuclear Regulatory Commission (NRC). 1994e. Letter from U.S. NRC to O. D. Kingsley, Jr., TVA. October 17, 1994. Subject: Watts Bar Nuclear Plant - Severe Mitigation Design Alternatives.

8 Consequences of Proposed Actions

Possible consequences of the actions proposed have been evaluated with respect to changes in WBN Plant operation, design, and the environment. Unavoidable adverse environmental effects are discussed in Section 8.1, short-term uses and long-term productivity issues are discussed in Section 8.2, resource commitments are discussed in Section 8.3, and decommissioning and land use are discussed in Section 8.4.

8.1 Unavoidable Adverse Environmental Effects

The staff has assessed the environmental, physical, social, and economic impacts attributed to the operation and maintenance of the WBN Plant. Site preparation was completed prior to 1978. Since the major portion of construction of the facility is also complete, and the remaining construction of Unit 2 can be accomplished with minimal effect on the environment, the construction effects discussed in the NRC 1978 FES-OL (NRC 1978) are no longer pertinent. The staff has not identified any additional adverse environmental effects that will be caused by the operation or maintenance of the WBN Plant.

8.2 Short-term Uses and Long-term Productivity

The staff has evaluated the short-term uses and long-term productivity of the WBN Site and has determined that there are no changes since the issuance of the NRC 1978 FES-OL. The presence of the WBN Plant in Rhea County, Tennessee, will continue to influence the future use of other land in its immediate environs as well as the continued removal of county land from agricultural use as the result of any increased industrialization.

8.3 Irreversible and Irretrievable Commitments of Resources

The staff has evaluated the commitment of resources in the NRC 1978 FES-OL and concludes that there are no changes except for the continuing escalation of costs, which have increased the dollar values of materials used for fueling the station.

As discussed in the NRC 1978 FES-OL, uranium is the principal natural resource irretrievably consumed in facility operation. Other materials consumed, for practical purposes, are fuel-cladding materials, reactor control elements, other replaceable reactor core components, chemicals used in water treatment, ion-exchange resins, and minor quantities of materials used in maintenance and operation. Except for the isotopes uranium-235 and uranium-238, the consumed resource materials have widespread usage; therefore, their use in the proposed operation is reasonable with respect to needs in other industries. The principal use of the uranium isotopes is for production of useful energy.

8.4 Decommissioning

Information provided in Section 8.4, "Decommissioning and Land Use," of the NRC 1978 FES-OL has been superseded as a result of a rule on decommissioning (10 CFR 50.75 and 10 CFR 50.82), which became effective on July 27, 1988 (NRC 1988). These regulations set forth technical and financial criteria for decommissioning licensed nuclear facilities. These regulations address decommissioning, planning needs, timing, funding methods, and environmental review requirements.

The Commission's rule on decommissioning specifically addresses three decommissioning alternatives: DECON, SAFSTOR, and ENTOMB.

- DECON is the decommissioning alternative in which equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits termination of the license.

- SAFSTOR is the decommissioning alternative in which the nuclear facility is placed and maintained in a condition that allows the safe storage of radioactive components of the nuclear plant and subsequent decontamination to levels that permit termination of the license. Benefits include a reduction in occupational exposure and possibly in waste volume.

- ENTOMB is the decommissioning alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete. The entombed structure is appropriately maintained and continued surveillance is carried out until the radioactivity decays to a level permitting termination of the license.

The decommissioning rule also indicates that continuing authority to possess a reactor in a decommissioned status is governed by the provisions of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." Requirements for limits on both occupational and offsite exposure related to decommissioning activities are contained in 10 CFR Part 20, "Standards for Protection Against Radiation."

The decommissioning rule requires that license holders of commercial nuclear power reactors submit a plan to ensure that funds will be available to decommission the facility. The decommissioning funding plan addresses the financial aspects of decommissioning. Financial assurance is guaranteed by prepayment, an external sinking fund (into which deposits are made periodically), or surety, insurance, or some other method. Prepayment may be in the form of deposits of cash or liquid assets, sufficient to pay decommissioning cost, into an account segregated from the licensee's assets and outside the licensee's administrative control. It may also be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. An external sinking fund is established and maintained by setting funds aside periodically in an account segregated from licensee assets and outside the licensee's administrative control, in which the total amount of funds would be sufficient to pay decommissioning costs. An external sinking fund may also be in the form of a trust, escrow account, government fund, certificate of deposit, or deposit of government securities. The surety or insurance method would guarantee that decommissioning costs will be paid should the licensee default. A surety method may be in the form of a surety bond, letter of credit, or line of credit. Any surety or insurance method used to provide financial assurance for decommissioning must meet specific conditions; for example, it must be payable to a trust established for decommissioning costs and it must remain in effect until the license has been terminated. Federal government licensees are permitted to provide a statement of intent providing a cost estimate for decommissioning and indicating that funds for decommissioning will be obtained when necessary.

The decommissioning rule requires that a preliminary decommissioning plan containing a site-specific cost estimate for decommissioning and an up-to-date assessment of the major technical factors that could affect planning for decommissioning be submitted at or about five years before the projected end of operation. In addition, the decommissioning rule requires that an application to decommission a facility be submitted within two years following the decision by the licensee to permanently cease operations. The application for the termination of the license must be accompanied or preceded by a proposed decommissioning plan. The rule requires that the proposed decommissioning plan include (1) the choice of the alternative for decommissioning with a description of the activities involved; (2) a description of controls and limits on procedures and equipment to protect occupational and public health and safety; (3) a description of the planned final radiation survey; (4) an updated cost estimate, a comparison of that estimate with the then current funds set aside for decommissioning, and a plan for ensuring the availability of adequate funds for completion of decommissioning; and (5) a description of technical specifications, quality assurance provisions, and physical security plan provisions in place during decommissioning.

With its application for a license amendment to authorize decommissioning, 10 CFR 51.53(b) requires the licensee to submit a document entitled, "Supplement to Applicant's Environmental Report - Post Operating License Stage." This document would update the "Applicant's Environmental Report - Operating License Stage" to reflect any new information or significant environmental change associated with the proposed decommissioning activities.

8.5 References

10 CFR Part 50. *Code of Federal Regulations*. 1994. "Domestic Licensing of Production and Utilization Facilities." U.S. Nuclear Regulatory Commission, Washington, D.C.

10 CFR Part 51. *Code of Federal Regulations*. 1994. "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." U.S. Nuclear Regulatory Commission, Washington, D.C.

10 CFR Part 20. *Code of Federal Regulations*. 1994. "Standards for Protection Against Radiation." U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1978. *Final Environmental Statement Related to Operation of Watts Bar Nuclear Plant Units No. 1 and 2*. NUREG-0498. U.S. Nuclear Regulatory Commission, Washington, D.C.

U.S. Nuclear Regulatory Commission (NRC). 1988. *Decommissioning Criteria for Nuclear Facilities*. 53 *Federal Register*, 24018-24056 (June 27, 1988). U.S. Nuclear Regulatory Commission, Washington, D.C.

9 Discussion of Comments on the Draft Supplement

Pursuant to 10 CFR Part 51 the staff transmitted the *Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant, Units 1 and 2, Draft Report for Comment* (NUREG-0498, Supplement No. 1) to Federal, State, and local government agencies and interested members of the public. A notice of availability, which requested comments on the draft supplement, was published in the *Federal Register* on December 9, 1994 (59 FR 63,832). On January 10, 1995, the staff held a public meeting in Sweetwater, Tennessee, to solicit comments on the draft supplement. In addition to the comments recorded during the public meeting, the staff received 28 comment letters. The staff has reviewed each of the 28 comment letters received and the relevant portions of the public meeting transcript, and reproduced them in Appendix A of this Final Supplement. The NRC staff response to these comments is given in this chapter.

The staff received a number of comments and questions that are outside the scope of the supplement and, therefore, responses are not given for these comments. For those comments that are outside the scope of the supplement, but that are within the regulatory authority of the NRC and pertain to the WBN Plant, the staff has prepared Table 9.1, which lists references that address the issues raised.[a] Comments concerning harassment of whistleblowers and other alleged wrongdoing by TVA and the NRC have been forwarded to the appropriate NRC office for further investigation and are not addressed in this Final Supplement. Comments relating to economic costs of the WBN Plant are not under the jurisdiction of the NRC and should be referred directly to TVA.

Sections 9.1 to 9.10 correspond generally to the subject material in the text of the supplement (purpose and scope, conclusions, site description, environmental approvals and consultations, plant design, environmental impact, environmental monitoring program, accident analysis decommissioning, and miscellaneous). Within each section, similar comments are grouped together for ease of reference, and a summary description of the comments is given, followed by the staff's response. Where the comment or question resulted in a change in the text of the draft report, the corresponding response refers the reader to the appropriate section of this report where the change was made. All substantive revisions in the text (including those made in response to comments) are designated by vertical lines beside the text.

To assist the reader in finding a particular comment in either the meeting transcript or the comment letters (both located in Appendix A), the staff assigned a specific identifier (marker) to each comment. Comments made at the meeting are identified by the page number of Appendix A in which they appear. Comments made in letters are identified by an alphabetic desginator assigned to the letter (see Appendix A for a listing of the letters by alphabetic designator) and by the page number of the letter, not by the page number of Appendix A.

(a) All the documents cited can be obtained by (1) calling the NRC Local Public Document Room Program 1-800-634-8081; (2) visiting the NRC Local Public Document Room at the Chattanooga-Hamilton County Library, 101 Broad Street, Chattanooga, Tennessee; or (3) visiting the NRC Headquarters Public Document Room at 2120 L Street, N.W., Washington D.C.

Table 9.1 References for Issues That Are Not Within the Scope of the Supplemental Environmental Statement

Topic	Document
Emergency Preparedness	Watts Bar Safety Evaluation Report (NUREG-0847), Supplement 13 (NRC 1994)
Quality Assurance Program	Watts Bar Safety Evaluation Report (NUREG-0847) and Supplements 2 (NRC 1984), 5 (NRC 1990), and 10 (NRC 1992)
Quality Assurance Problems	See listing of documents on Pages 1-14 and 1-15 of Watts Bar Safety Evaluation Report, Supplement 14 (NRC 1994)
Hearing	"Notice of Opportunity for Hearing," 41 *Federal Register* 56244 (December 27, 1976) *Tennessee Valley Authority* (Watts Bar Nuclear Plant, Units 1 and 2), LBP-77-36, 5 NRC 1292 (May 25, 1977) "Order Denying Petition for Leave to Intervene of Jeannine W. Honicker" *Tennessee Valley Authority* (Watts Bar Nuclear Plant, Units 1 and 2), ALAB-413, 5 NRC 1418 (June 20, 1977), decision affirming on appeal the ASLB's denial of Jeannine W. Honicker's intervention petition
Construction Delays	Watts Bar Safety Evaluation Report (NUREG-0847), Supplement 14, Section 1.13 (NRC 1994)

9.1 Purpose and Scope of the Supplement and the Regulatory Process

9.1.1 Purpose and Need of Proposed Action

One commenter indicated that the document should contain a clearer description of the purpose and need for the proposed action. Specifically the commenter wanted information on the demand for electricity, TVA's long-term strategy for meeting electrical demand, and innovative demandside management strategies. A second commenter wanted information on cost and alternatives (A-32, D-1).

Response: The NRC 1978 FES-OL describes the purpose and need for the proposed action in a detailed cost benefit analysis. The NRC environmental regulations in 10 CFR Part 51 describe the agency's policy for addressing the purpose and need for the proposed action and alternatives to the proposed action in a suppleme to a final environmental statement at the operating license stage (10 CFR 51.95). This regulation states, "Unless otherwise determined by the Commission, a supplement on the operation of a nuclear power reactor will not include a discussion of need for power or alternative energy sources or alternative sites...." Therefore, any related information, such as the need for electricity, TVA's long-term strategy for meeting electrical demand, and innovative demandside management strategies is not addressed in this supplement.

Reference: 10 CFR Part 51. *Code of Federal Regulations*. 1994. "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions."

9.1.2 Timing of Environmental Assessment

One commenter expressed frustration over the absence of any kind of environmental assessment regarding Watts Bar since 1978 (Y-2).

Response: Typically, the NRC prepares two final environmental statements, one just prior to initial construction and another prior to initial operation. The latter is prepared to ensure that the conclusions about the environmental impacts of plant operation are based on reasonably current environmental conditions. At the time the NRC prepared the 1978 FES-OL, WBN Plant Unit 1 was expected to start operation in 1979 with Unit 2 beginning operation in 1980. As a result of construction delays, neither unit began operation. Although plant operation did not begin, TVA continued to monitor the environmental conditions near the WBN Plant. In 1994, as WBN Plant Unit 1 approached completion, the NRC re-examined the environmental conditions near the WBN Site and the impacts of plant operation on the environment to ensure that its conclusions would be based on reasonably current information. This Supplement, which contains the staff's conclusions, relies on the environmental data that were obtained since 1978. The purpose of this Supplement is to discuss the changes (since the NRC 1978 FES-OL) in the environment and in the environmental impact in and around the WBN Plant as a result of changes to the plant's design and proposed methods of operation (see Foreword, Summary and Conclusions, Section 1.1). Any environmental impact statement prepared in the interim would not have been of great value because it would not have assessed the impacts of proposed plant operation on the environmental conditions reasonably current to initial operation.

9.1.3 Role of the NRC in the Proposed Action

One commenter recommended that the NRC try to develop an energy production alternative that is superior to existing gas turbine/solar/wind/ocean technologies (X-1).

Response: The Nuclear Regulatory Commission was established by the Energy Reorganization Act of 1974, as amended. This Act abolished the Atomic Energy Commission (AEC) and transferred all the licensing and related regulatory functions assigned to the AEC to the NRC, and the AEC's research and development functions were transferred to the Energy Research and Development Agency (ERDA). ERDA subsequently became part of the U.S. Department of Energy. Therefore, the development of alternative energy technologies is not a part of the NRC's charter.

9.2 Conclusions

9.2.1 Conclusion of Draft Supplement

Three individuals indicated that the finding of no significant impact should be reevaluated. A fourth commenter, the applicant, indicated that it was pleased that the Supplement confirmed TVA's determination that there are no significant impacts associated with operating WBN Plant (A-25, A-29, E-1, R-1, W-6).

Response: The staff did not reach a finding of "no significant impact." The staff's finding in the draft and this Final Supplement is that the changes in the design of the WBN Plant, the proposed operations, the population and demographics, land use, water use, regional climatology meteorology, background radiation, and the terrestrial or aquatic environment since the publication of the 1978 FES-OL are not significant and, therefore, do not result in a significant change in the environmental impacts described in the 1978 FES-OL. The staff has reevaluated its findings in response to comments received on the Draft Supplement, and concludes that these conclusions are unchanged.

9.2.2 Potential Conflict With Previous NRC Conclusion

One commenter indicated that, according to previous NRC investigations, the WBN Plant is unsafe and a serious threat to the environment (J-1).

Response: The staff is not familiar with any previous NRC investigations that concluded that the WBN Plant was unsafe or a serious threat to the environment. The only two NRC evaluations of the environment around the WBN Site are the reviews by the Atomic Energy Commission's (AEC's) regulatory staff and the AEC Advisory Committee on Reactor Safeguards that were published as comments in the applicant's Construction Permit Stage Final Environmental Statement in November 1972 (TVA 1972) and the NRC's 1978 FES-OL (NRC 1978). The NRC's 1978 FES-OL concluded that there would be no detectable impacts anticipated from release of radioactive materials as a consequence of normal operation, no adverse effects on mussels, no significant effect from chemical discharges, and no effect on reservoir populations from losses due to entrainment of fish larvae, fry, and small young-of-the-year.

References: Tennessee Valley Authority (TVA). 1972. *Final Environmental Statement, Watts Bar Nuclear Plant Units 1 and 2*. Tennessee Valley Authority - Office of Health and Environmental Science. November 1972.

U.S. Nuclear Regulatory Commission (NRC). 1978. *Final Environmental Statement Related to Operation of Watts Bar Nuclear Plant Units Nos. 1 and 2*. NUREG-0498. U.S. Nuclear Regulatory Commission, Washington, D.C.

9.3 Environmental Approvals and Consultations

9.3.1 Request for Biological Assessment in an Appendix

One commenter indicated that the Biological Assessment (of potential impacts on endangered species) should be included in the Final Supplement (D-2).

Response: The Biological Assessment, which was prepared jointly by the NRC and the applicant to support consultation and facilitate discussions with the U.S. Fish and Wildlife Service (FWS) has been included in Appendix D. The staff has also included the Biological Opinion, which is the FWS's assessment of the impacts on the endangered/threatened species, in Appendix D.

9.3.2 Recovery Plan for Endangered Species

Four individuals asked about designating critical habitat and developing a recovery plan for the endangered populations and habitats (A-15, A-27, A-29, W-2, Z-1).

Response: Under the regulations implementing the Endangered Species Act, designation of critical habitat for species protected under the Act is the responsibility of the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service, depending on which resource agency holds responsibility for the species (see 50 CFR Part 424). Neither the NRC nor the applicant can identify critical habitat, nor can actions that affect species protected under the Act be implemented without consultation with the responsible resource agency.

With regard to plans for recovery of endangered species, under the Endangered Species Act legislation, these are to be developed by the Secretary of the Interior (delegated to the U.S. Fish and Wildlife Service [FWS]) or the Secretary of Commerce (delegated to the National Marine Fisheries Service) (16 U.S.C 1536 Sec. 4[f][1]). The Biological Assessment for WBN Plant referenced the recovery plans for each of the seven species federally listed as endangered or threatened. A consultation with the FWS, the applicant, and the NRC was initiated under Section 7 of the Endangered Species Act. A Biological Opinion has been issued by the FWS (FWS 1995), which included a number of conservation recommendations. Implementation of the recommendations will be addressed through discussions between the applicant and FWS. This is discussed in more detail in Section 5.3.3. A copy of the Biological Opinion is provided in Appendix D.

Reference: 50 CFR Part 424. *Code of Federal Regulations*. 1994. "Listing Endangered and Threatened Species and Designating Critical Habitat," U.S. Fish and Wildlife Service, Washington, D.C.

9.4 The Site

9.4.1 Water Use

9.4.1.1 Surface Water Hydrology - Use of Chemical Holding Ponds

The applicant indicated that the chemical holding ponds referred to in Section 2.2.2 would be used on a continuing basis, rather than primarily during plant outages (R-4).

Response: The applicant has stated that these ponds are used for containing and treating chemical effluents from the turbine building. The use of the ponds is governed by the WBN Plant's National Pollution Discharge Elimination System permit that imposes limits on effluent discharges from the WBN Plant outfalls, irrespective of the frequency of pond use. Section 2.2.2 has been revised as appropriate.

9.4.1.2 Water Quality - Data for Chickamauga Reservoir

The applicant recommended that information on the Chickamauga Reservoir be included in the Final Supplement, rather than information regarding the water quality and aquatic ecology of the Watts Bar Reservoir (R-1, R-4, R-5, R-6).

Response: The information from the Watts Bar Reservoir water quality and aquatic ecology was presented in the draft supplement, because the Watts Bar Site is located immediately on the downstream side of the Watts Bar Dam. However, for completeness, the information on the water quality and aquatic ecology of the Chickamauga reservoir has been included in Sections 2.2.3 and 2.4.2.

9.4.2 Meteorology

9.4.2.1 Severe Weather - Tornado Frequency

One individual indicated that the tornado frequency reported in the draft supplement was "undervalued." A second individual indicated that tornadoes were common to the area and that it is impossible for almost any building to stand up to tornado-type winds. The first individual indicated that a tornado in February 1993 came very close to the Y-12 Plant at Oak Ridge and had winds ranging between 130 and 200 miles per hour (23 and 34 meters per second). The second individual indicated that there was a tornado near Oak Ridge during the last year (A-20, A-26).

Response: Tornado statistics on which the staff analysis was based do not include the recent tornadoes referenced in the comments. However statistics based on 30 years of data (1954-1983) indicate that on the average about one tornado per year (0.93 per year) will occur in the one degree square (10,063 square kilometers or

3887 square miles) in which the WBN Plant (35° 30'N, 84° 36'W) and the Y-12 Plant at Oak Ridge (35° 59'N, 84° 14'W) are located. The staff analysis does not attempt to predict where tornadoes will strike within this area. The statistics also indicate that the estimated frequency of any tornado striking the WBN Site is about once in 5400 years.

Safety-related structures are designed to withstand the effects of the high wind speeds and pressure drops associated with tornadoes. The design-basis tornado for the WBN Plant reactor shield building and other safety-related structures has maximum wind speed of 160 meters per second (360 miles per hour). The frequency of a tornado with wind speeds exceeding 160 meters per second (360 miles per hour) striking the plant is estimated to be on the order of once in 10,000,000 years (AEC 1974a, 1974b). The comment indicates that the maximum wind speeds associated with the recent tornadoes were about 89 meters per second (200 miles per hour). Therefore, the staff concludes that recent tornadoes in the area do not invalidate the results of its analysis.

References: U.S. Atomic Energy Commission (AEC). 1974a. *Technical Basis for Interim Regional Tornado Criteria*. WASH-1300, U.S. Atomic Energy Commission, Office of Regulation, Washington, D.C.

U.S. Atomic Energy Commission (AEC). 1974b. *Design Basis Tornado for Nuclear Power Plants*. Regulatory Guide 1.76, U.S. Atomic Energy Commission, Washington, D.C.

9.4.2.2 Local Weather - Wind Speed

One set of comments requested references for two sentences in Section 2.3.3 relating to the wind speed distribution at the applicant's site and the staff's expectation related to the distribution (R-6).

Response: In boundary layer flows, increasing the wind speed near the surface has the effects of increasing the mechanical turbulence and causing the temperature lapse rate to approach the adiabatic lapse rate. The adiabatic lapse rate is the change of temperature with height of air that ascends or descends without exchanging heat with the surrounding air. The stability typing scheme used by the NRC staff and the applicant is based on temperature lapse rate. Neutral stability conditions exist when the temperature lapse rate is near adiabatic. Therefore high wind speeds are expected to be associated with neutral stability conditions. The method of estimating stability classes from routine weather observations developed by Gifford (1961) explicitly considers wind speed. This method has stability approaching neutral as wind speed increases.

Using the reasoning outlined above, the average wind speed during unstable stability conditions is expected to be lower than the average speed for neutral conditions. Similarly, the staff expected to see a large fraction of occurrences of unstable conditions under very low wind speed conditions. In a number of cases the data provided by the applicant (TVA 1994) did not comport with the expected relationships. Consequently, the staff presented a more detailed evaluation of the data and found physical conditions that explain the departure of the applicant's data from NRC staff expectations. Therefore the staff concluded that the data are acceptable.

References: Gifford, F. A., Jr. 1961. "Use of Routine Meteorological Observations for Estimating Atmospheric Dispersion." *Nuclear Safety.* 2(4)47:51.

Tennessee Valley Authority (TVA). 1994. Letter from D. E. Nunn, TVA, to U.S.NRC. September 27, 1994. Subject: Watts Bar Nuclear Plant (WBN) - Response to NRC's Request for Additional Information Related to the Watts Bar Environmental Review.

9.4.3 Aquatic Ecology

9.4.3.1 Mussel Populations and Restoration

The comments on mussel populations dealt primarily with sampling methods and mussel recovery. Several individuals were concerned that the river was not being surveyed thoroughly and that new methods of restoration ecology were not being considered (A-15, A-27, A-29, E-1, W-1, Z-1).

Response: The decline in the mussel population is due primarily to impoundment of the Tennessee River. Dams create large areas of relatively still water (reservoirs) where most native mussel and clam species can survive, but not reproduce. These species need fast-flowing, riverine stretches of water to propagate.

Mussel surveys were conducted annually from 1983 to 1986, and biennially from 1986 to the present. Divers spend a total of at least 9 hours bottom time searching for mussels during each survey. While under water, divers collect every freshwater mussel they encounter. After being sorted, identified, and measured, all mussels are returned to the substrate at the survey site from which they were collected. The number of mussels that divers find at each site has declined every year. For example, a total of 991 mussels were found in 1990. This is 62% less than the 1610 mussel specimens found in 1988. All mussels collected were large, mature specimens, indicating no recruitment. Results of these surveys support previous conclusions that the mussel fauna in the upper Tennessee River near the WBN Site is very old and probably has had little or no reproduction since the closure of Watts Bar Dam in 1942.

All mussels known to inhabit the Tennessee River surrounding the WBN Site that were included in the 1978 Federal listing of endangered and threatened species were discussed in the NRC 1978 FES-OL. Since the NRC's 1978 FES-OL was published, several mussel species have been added to the Federal list of endangered, threatened, and candidate species. Each of these mussels was found during mussel surveys in the vicinity of the WBN Site in 1978, previous to their listing. This does not indicate that surveying methods are inadequate; the species in question were simply not given any special recognition in the 1978 report because they were not on the Federal list at the time.

Methods of restoration ecology have been considered (TVA 1995). In 1991, the applicant began the Large-River Mussel Restoration Project. This involved resuming mussel propagation research and working in cooperation with others to select an initial reintroduction location. However, work on the project was deferred in

1992 because reservoir release improvements had not yet been made at the dams upstream from potential reintroduction sites. The project has never been resumed due in part to the Tennessee River invasion of the zebra mussel. The zebra mussel competes with native mussels for space and food and is expected to decimate native mussel populations in locations just downstream from large impoundments, the precise area the restoration project was originally designed to enhance. Although several reservoir release improvement projects have been completed since 1992, the potential for zebra mussel impacts has persisted or worsened. The U.S. Fish and Wildlife Service (FWS) is now meeting with the applicant and others interested in the protection of native mussels to focus mussel protection efforts on identifying or establishing refuges from zebra mussels. On March 8, 1995, the FWS issued a Biological Opinion (FWS 1995), which contained several conservation recommendations (see Appendix D).

References: Tennessee Valley Authority (TVA). 1995. Letter from O. J. Zeringue, TVA, to U.S. NRC. March 7, 1995. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Request for Additional Information Related to the Watts Bar Environmental Review.

U.S. Fish and Wildlife Service (FWS). 1995. Letter from D. B. Winford, FWS, to U.S. NRC. March 8, 1995. Subject: Biological Opinion for the Proposed Operation of the Watts Bar Nuclear Plant, Rhea County, Tennessee.

9.4.3.2 Zebra Mussels

The applicant recommended a change in the definition of the zebra mussel (R-4).

Response: The zebra mussel definition has been changed in the FES Supplement.

9.4.4 Background Radiological Characteristics in the Tennessee River

One commenter indicated that information should be included regarding the pre-operational radiation background conditions, sediment and channel radioactive contamination in the Watts Bar Reservoir upstream from the Watts Bar Dam as a pre-operational background condition (D-2).

Response: Additional information on the pre-operational radiation background conditions in the Tennessee River has been added to Section 2.5.

9.4.5 Archaeological Sites - Excavation

The applicant recommended a revision of the wording regarding the regulation of future excavation that could potentially affect archaeologic or historic sites (R-7).

Discussion

Response: The wording of the last sentence in Section 2.6 was revised to more appropriately define the area that would be of concern for future excavation and construction.

9.4.6 Geology and Seismology - Fault Lines

One individual specified that studies at the University of North Carolina indicated suspected fault lines running down the Tennessee Valley. A second individual also commented on the fault lines. The commenter inquired as to the impact these fault lines would have on the operation of the Sequoyah Nuclear Plant and the Watts Bar Nuclear Plant (A-31, V-1, W-3).

Response: The staff is familiar with the recently published article, "A Seismotectonic Model for the 300-Kilometer-Long Eastern Tennessee Seismic Zone," *Science*, Vol. 264, April 29, 1994, pp. 686-688, written by C. A. Powell of the University of North Carolina and others. The article actually deals with a model for the seismicity in eastern Tennessee near the North Carolina border rather than "fault lines running down the Tennessee Valley" as suggested by the commenter.

The NRC staff maintains an active geological and seismological confirmatory research program and has supported seismographic networks in the region discussed in the article. The scientific literature is reviewed routinely to determine whether new insights would have a bearing on the design and licensing bases of nuclear power plants. The staff reviewed and evaluated the *Science* article when it was published. A great amount of the material in this article had been published previously in journal articles and in NRC reports in the NUREG/CR category.

The largest historical earthquake in the eastern Tennessee seismic zone had a magnitude of 4.6. Because the NRC recognized that the seismicity in this region is higher than in other regions in the eastern U.S., it conservatively required that the "Safe Shutdown Earthquake" (SSE) for the nuclear power plants be based on the assumption that a magnitude 5.8 earthquake could occur near each of the plants. A magnitude 5.8 earthquake radiates over 60 times more seismic energy than does a magnitude 4.6 earthquake.

Based on the seismic and geologic investigations performed for the licensing of eastern Tennessee sites, the seismic design basis for the plants has a very low probability of being exceeded. In addition, the plants have design margins well in excess of the earthquake design bases. The *Science* article stated that the potential for a large earthquake may be higher than the historical record suggests; as discussed above, the design bases were set far in excess of the historical record. The staff review and evaluation indicate that no new information was presented in the article that would alter the conclusions in the NRC 1978 FES-OL. Additional information is presented by the staff in Section 2.5 of the SER for the WBN Plant (NRC 1982).

Reference: U.S. Nuclear Regulatory Commission (NRC). 1982. *Safety Evaluation Report Related to the Operation of the Watts Bar Nuclear Plant, Units 1 and 2*. NUREG-0847.

9.5 The Plant

9.5.1 Plant Status

One commenter asked whether updated technology was used in the WBN Plant (A-5).

Response: Since the publication of the 1978 FES-OL, there have been several changes in plant design and proposed operation at WBN Plant. The majority of these changes were made to take advantage of improvements in technology. Chapter 3 discusses the actual changes in plant design and proposed operation that impact the environment and Chapter 5 discusses the resulting impact that these changes have on the environment. For example, Section 3.4 discusses the chemicals that the applicant now intends to use during plant operation and Section 5.4.3 discusses the effects of these new chemicals on the environment.

9.5.2 Radioactive Waste Treatment System - Evaporators

One commenter requested further information on the use of waste evaporators to reduce the offsite low-level waste shipments (D-2).

Response: Waste evaporators and the new mobile demineralizer system do not reduce the quantity of low-level waste, but rather remove radioactive material from water and the water is re-used or released to the environment. Most pressurized water reactors use demineralizer systems, rather than waste evaporators. The switch from evaporators to demineralizers was primarily based on economic considerations and technical problems with the solidification of evaporator bottoms.

9.5.3 Chemical Treatment - Molluscicides

One individual requested that the use and release of certain chemicals (specifically the molluscicides) be reconsidered, and that alternative be examined for treating intake water, and for chemical disposal (other than dumping into the river) (C-1).

Response: Biofouling of intake pipes at nuclear power plants by exotic mussel species has been a problem for many years. The nuclear industry previously used chlorine to control biofouling. However, because chlorine is not specific in its toxicity and does not rapidly biodegrade, the industry has more recently turned to specifically designed molluscicides to keep piping systems free of mussels. The use of these molluscicides is an advancement in technology and an improvement on past practices. The plant is in compliance with Federal and State regulations governing the application and disposal of molluscicides and other potentially harmful chemicals. Monitoring of the mussel populations is ongoing, and will be continued in even greater detail after the plant begins operation (see Section 6.2.5).

9.5.4 Power Transmission System - Application of Herbicides

One commenter inquired as to the types of herbicides and pesticides that are used in clearing of transmission line rights-of-way, and the changes in TVA's maintenance procedures (D-2).

Response: Specific herbicides used for chemical maintenance of the transmission line rights-of-way are continuously under review as new products are introduced and as the regulatory status of other products change. Currently, the primary herbicides that will be used by the applicant are Accord™[(a)] or Accord and Arsenal™[(b)] mixture. Additional information on the applicant's maintenance procedures has been provided in Section 5.3.2.

9.5.5 Pollution Prevention

One commenter inquired as to the design of waste minimization and water and energy conservation measures into the plant functions. The commenter requested a description of planned and ongoing pollution prevention efforts (D-1).

Response: The regulations implementing Section 102(2) of the National Environmental Policy Act (NEPA) of 1969, as amended, does not require an evaluation of whether the design of a nuclear plant includes conservation and pollution prevention. The staff, in its evaluation of the plant's design and proposed methods of operation, did not find any areas where waste minimization, conservation measures, or pollution prevention efforts would cause an environmental impact not already addressed in the 1978 FES-OL.

9.6 Environmental Impact of Watts Bar Nuclear Plant

9.6.1 Definition of Minimal Impact

One individual asked for further definition of "minimal impact." The commenter was concerned that there had already been a number of impacts on the streams and rivers as a result of the dams. The commenter indicated that it would be optimum to be able to determine (for instance) the number of mussels that would be detrimentally affected by the plant (A-9).

Response: An impact that is termed "minimal" or "insignificant" is below the threshold of detectability. For this reason (as indicated in the transcript from the Public Meeting in response to this comment) it is difficult to quantify a "minimal" or "insignificant" impact. Although it would be desirable to be able to measure the results of all impacts, it is not always possible to measure change in the level of impact when the level is small.

(a) Trademark of American Cyanamid Co., Wayne, New Jersey.
(b) Trademark of Monsanto Co., St. Louis, Missouri.

9.6.2 Impacts on Water Use

9.6.2.1 NPDES Permit

The applicant recommended several minor changes in the text to clarify information given in the NPDES permit (R-4, R-8).

Response: Revisions were made to Sections 3.4 and 5.2 to reflect the State of Tennessee's NPDES permit for the WBN Plant.

9.6.2.2 Effects on Water Users Through Changes in Water Quality

One commenter inquired as to the effects of the WBN Plant on human populations, water quality, and the drinking water supply (W-3).

Response: The effects of the WBN Plant on human populations are discussed in Sections 5.5 and 5.6. The effects on the water quality and drinking water supply are addressed in Section 5.2.

9.6.3 Impacts on Aquatic Environment

9.6.3.1 Toxicity Testing of Mussel Species

Questions were also asked about the adequacy of toxicity testing on local mussel species. The primary concern was that testing is not species specific (A-15, A-23, A-29, E-2, R-9, W-1).

Response: Toxicity testing on endangered and threatened species is not appropriate or permitted under the Endangered Species Act of 1973. Additionally, the endangered mussel species are not part of a reproducing population and have not been successfully propagated in the laboratory. The loss of individuals needed for these kinds of studies would be unacceptable. Thus, a representative indicator freshwater mussel species, *Anodonta imbecillis*, was tested because of resource constraints and a lack of approved testing methods for the species in question. The method for testing *A. imbecillis* (recently published by EPA in its Inland Testing Manual [EPA 1994] as an approved test procedure) was previously developed by the applicant and used in joint studies with the Tennessee Wildlife Resources Agency.

The results of the studies performed by the applicant demonstrated that another EPA-approved indicator species, the daphnid *Ceriodaphnia dubia*, is more sensitive to toxic substances than either adult or juvenile *A. imbecillis* mussels. In fact, *C. dubia* is 15 times more sensitive to molluscicides used at the WBN Plant than *A. imbecillis* when silt is present (silt occurs naturally in the Tennessee River). Separate monthly testing of undiluted WBN Plant outfall effluent at 100% concentration for one year had no toxic effects on *C. dubia*. The applicant stated that the discharge is expected to be only 2.93% of the total river flow even during low flow conditions. Furthermore, native mussel species will be in the presence of silt, providing a significant margin of safety between test results and actual effects.

After analyzing the applicant's testing methods and data, and considering its explanation and justification of the methods used, the staff was satisfied that this margin of safety should easily account for any differences in the sensitivity of the indicator species used in the test procedure and native mussel species. This includes differences between the testing of endangered/threatened mussel species and the indicator species used in the applicant's toxicity tests.

Reference: U.S. Environmental Protection Agency (EPA). 1994. *Evaluations of Dredging Materials Proposed for Discharge into Waters of the United States - Testing Manual (Draft); Inland Testing Manual.* EPA-823-B-94-002. U.S. Environmental Protection Agency, Washington, D.C.

9.6.3.2 Effects of Molluscicides on Native Mussel Populations

Several individuals expressed concerns about the effects of molluscicides and the WBN Plant on native mussel populations (A-15, A-22, V-1).

Response: The combination of low concentration and quick breakdown rate of the toxic compound in the molluscicide used at the plant, Clam-Trol™, provides protection to mussels in the river. The purpose of adding the molluscicide to system water at the intake structure is to control fouling by mussels in piping systems inside the plant. Only that portion of the Tennessee River water drawn into the plant (approximately 4 cubic meters per second [140 cubic feet per second]) is treated. The active ingredient in Clam-Trol™ consists of a long-chain hydrocarbon "tail" attached to a charged "head." Head and tail portions must remain together to exert a toxic effect. Because it is unstable, the molluscicide begins to break down while still inside the plant. Once they separate, the charged portion of the molecule is neutralized by the naturally occurring clays found in the Tennessee River sediment. The long-chain hydrocarbon portion of the molecule is biodegraded to nontoxic substances by bacteria found in the river. Testing using radioactive tracing has shown that the molecules biodegrade by 92% within two weeks. Testing also shows that clays containing adsorbed molecules do not harm organisms living in the sediment.

The concentrations of molluscicides that do enter the river are regulated by the National Pollution Discharge Elimination System (NPDES) permit and strictly monitored. Under the provisions of the permit, numerical limits are placed on the toxicity of the discharges. Toxicity testing (using organisms with proven sensitivity to the compound being tested), is required at each outfall to verify that the concentrations of pollutants released are not harmful to aquatic life. In addition to limiting the concentration of molluscicides, the NPDES also limits other plant discharges to the river (see Sections 5.2.4 and 5.4).

9.6.3.3 Effect of Bioaccumulation on Aquatic Species

Two commenters expressed concern about the possibility of chemical bioaccumulation and the effects that chemical discharges would have as they passed through the ecosystem or accumulated in river sediments (A-23, C-1).

Response: Chemical bioaccumulation is not likely at this site due to the nature of the chemicals being discharged to the river. For bioaccumulation to occur, there must first be a persistent chemical present in the lower trophic levels that becomes more concentrated at higher levels in the food chain. The chemicals used for the control of corrosion, microbiologically induced corrosion (MIC), and nuisance aquatic organisms in plant piping systems are purposefully designed to react quickly upon entering the water and then rapidly degrade. After the initial reaction when the toxic compounds are effective, the chemicals are neutralized by suspended river sediments. The active agent is labile (unstable) and typically degrades almost completely within several days. This rapid rate of degradation does not allow aquatic organisms to build up large amounts of the chemicals in their bodies. These chemicals are added to system water at the intake structure, where the water is then forced through plant water circulating systems. The chemicals are designed to react inside the plant so that the concentrations of toxic elements are negligible when the treated water is allowed into the river.

Also, the concentrations of these chemicals as they are released to the river are less than those allowed under the NPDES permit, which are at levels determined not to harm aquatic species. Subsequent dilution in the river water further increases the safety factor to these organisms.

See also the response in Section 9.6.3.2.

9.6.3.4 Cumulative Impacts

One individual repeatedly expressed concern over the potential for cumulative impacts from activities occurring at the WBN Plant and activities or threats from other areas outside of the site that may not be associated with the WBN Plant. For example, concerns were raised about spraying the river with herbicides, water pollution and deforestation, and also the impacts from other facilities that release chemicals into the Tennessee River (A-29, A-30, W-2, W-3, W-4).

Response: Cumulative effects of the WBN Plant and other outside influences on the environment were considered. It was determined that the only synergistic effects of concern would come from potential plume interaction between the Watts Bar Steam Plant and the WBN Plant (discussed in Section 5.3.2). However, the staff concluded that this would have a negligible impact. Furthermore, the Watts Bar Steam Plant is in cold standby and has not operated since 1983. Monitoring requirements, permit limits, and consequences of noncompliance are covered by the National Pollution Discharge Elimination System (NPDES) permit. The design of the WBN Plant operational monitoring program discussed in Section 6.2 is such that if there is a significant synergistic effect resulting from the activity at the WBN Plant, the results of the effect would be observable as a result of the monitoring program. Fish populations, plankton biomass, benthic macroinvertebrates, mussel species, and water quality have been documented as a result of the preoperational monitoring program (Section 6.1), and will be monitored and compared periodically after the plant has initiated operation (Section 6.2).

The applicant has not used herbicides for aquatic plant control on Watts Bar Reservoir since 1990 (TVA 1995). However, when herbicides were used, applications were restricted to areas designated for aquatic plant control along developed shoreline. Currently, the applicant has no plans to use herbicides for aquatic plant control on either Watts Bar Reservoir or Chickamauga Reservoir because aquatic plant colonization is at a low level. However, as discussed in Section 2.4.2, aquatic macrophyte populations fluctuate with changing river flow conditions. Should aquatic plant populations increase to nuisance levels in aquatic plant control areas and create reservoir use conflicts, control options would be reevaluated.

Reference: Tennessee Valley Authority (TVA). 1995. Letter from O. J. Zeringue, TVA, to U.S. NRC. March 7, 1995. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Request for Additional Information Related to the Watts Bar Environmental Review.

9.6.3.5 Effect of UVB Radiation on Mussels

One commenter requested that the FES Final Supplement address the acid rain problem and the effect of UVB radiation on mussel populations. (A-29)

Response: The operation of the WBN Plant does not contribute to acid rain or ozone depletion (which in turn affect the amount of UVB radiation reaching the earth's surface). The operation of the WBN Plant may replace power generated by the operation of a fossil fuel plant (such as a coal or oil burning plant). Operation of fossil fuel plants contributes to acid rain as a result of the release of sulfur compounds. Therefore, operation of the WBN Plant may result in an overall decrease in acid rain. Ozone depletion is assumed to be caused by the release of chlorofluorocarbons, which is not expected during operation of a nuclear plant.

In addition, there is no information available that would indicate (nor any reason to assume) that mussel species are affected by UVB radiation. Therefore, UVB radiation and acid rain are not significant issues for this report and are not discussed in the body of the report.

9.6.4 Radiological Impacts

9.6.4.1 Cow-Milk Pathway

A commenter asked about the vegetation-cow-milk pathway for transport of radionuclides to humans. The commenter was specifically interested in the transport of strontium-90 through this pathway to children (A-3).

Response: The cow-milk pathway is included in the dose estimates.

The isotopes that are expected to contribute the largest fraction of the cow-milk pathway dose are iodine-131 and cesium-137. The isotope strontium-90 does not contribute significantly to the estimated dose from the cow-milk pathway. Operating experience (Tichler et al. 1994) has shown that releases of strontium-90 to the environment from power reactors has been extremely small and therefore has not been a significant contributor to the dose.

Reference: Tichler, J., K. Doty, and J. Congemi. 1994. *Radioactive Materials Released from Nuclear Power Plants*. Annual Report 1991, NUREG/CR-2907, Vol. 12. Brookhaven National Laboratory, Upton, New York.

9.6.4.2 Dose Limits for the Public

A commenter asked for additional information on dose limits for infants, the limits for the general public and the ratio of the limits to the dose resulting from the WBN Plant (A-9, A-10).

Response: Dose limits are set as a maximum to any person (regardless of age). The annual limits were chosen conservatively to protect the most sensitive individual who could be exposed even if the exposure continues throughout the life of the individual. There are no lifetime dose limits. The Environmental Protection Agency (EPA) sets limits for the radiation dose to the public (e.g., 40 CFR Part 190, Environmental Radiation Protection Standards for Nuclear Power Operations). The NRC limits, as presented in 10 CFR Part 20, Subpart D, Radiation Dose Limits for Individual Members of the Public, are consistent with those of the EPA, requiring that a licensee conduct operations to limit the total effective dose equivalent to individual members of the public to not exceed 1 millisievert (mSv) (0.1 rem) in a year (exclusive of the dose contribution from the licensee's disposal of radioactive material into sanitary sewers), and that the dose in any unrestricted area from external sources not exceed 0.02 mSv (0.002 rem) in any one hour (10 CFR Part 20). The NRC also provides dose design objectives for nuclear power plants in 10 CFR Part 50, Appendix I, as shown in Table 5.1 (Section 5.5) of this Supplement. The expected doses from operation of the WBN Plant are shown in Tables 5.2 and 5.3 for the maximum individual. These projected doses are a fraction of the dose design objectives cited in 10 CFR Part 50, Appendix I.

References: 10 CFR Part 20. *Code of Federal Regulations*. 1994. "Standards for Protection Against Radiation." U.S. Nuclear Regulatory Commission, Washington, D.C.

10 CFR Part 50. *Code of Federal Regulations*. 1994. "Domestic Licensing of Production and Utilization Facilities." U.S. Nuclear Regulatory Commission, Washington, D.C.

40 CFR Part 190. *Code of Federal Regulations*. 1994. "Environmental Radiation Protection Standards for Nuclear Power Operations." U.S. Environmental Protection Agency, Washington, D.C.

9.6.4.3 Dose Calculation Methodology

One commenter said that the guidelines for calculating doses had been changed after the assessment of the Hartwell Plant (Hartsville) and that the new guidelines were found by the University of Heidelberg to underestimate the doses by a factor of 500 (A-4).

Response: The construction permits for all four Hartsville units were issued in May 1977, prior to publication of new guidelines for calculating doses (NRC 1977). New guidelines for calculating doses were based on new data and changed the old models. If the Hartsville plants had been built, they would have been required to operate in accordance with new requirements (10 CFR Part 50) using the new dose calculation guidelines. The assessment of the Wyhl Nuclear Power Plant (Bruland et al. 1978) commonly called the "Heidelberg Report," was published almost a year later. The Heidelberg Report basically used the NRC dose models but assumed values for several parameters that were higher than the values used by the NRC. Accordingly, the Heidelberg Report's calculated doses were higher than the doses calculated by the NRC. The NRC staff reviewed the Heidelberg Report and concluded that actual measurements in and near operating reactors showed the assumptions used in that report to be unrealistic and that the Heidelberg Report did not provide any basis for revising the NRC models (Congel et al. 1980). A principal basis for these conclusions was that measured releases of the principal nuclides in the Heidelberg Report from operating reactors were less than 1% of the assumed values. Furthermore, the staff found that the Heidelberg Report values were unrealistically large for the following:

- the soil-to-plant transfer factors for cesium and strontium
- the kidney dose conversion factor from the ingestion of cesium-137
- the bone dose conversion factor from the ingestion of strontium-90.

Additional support for the staff's conclusions were provided by environmental measurements made in the vicinity of nuclear power plants, which consistently show the Heidelberg Report assumptions to be unrealistic. Therefore, neither the NRC models nor the NRC parameter values have been revised.

References: U.S. Nuclear Regulatory Commission (NRC). 1977. "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50 Appendix I," Nuclear Regulatory Commission Regulatory Guide 1.109, Rev. 1. U.S. Nuclear Regulatory Commission, Washington, D.C.

10 CFR Part 50. *Code of Federal Regulations*. 1994. "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington, D.C.

Bruland, W., T. Erhard, B. Franke, H. Grupp, C. W. v.d. Lith, P. Matthis, W. Moroni, R. Rathea, H. v.d. Sand, U. Sonnhot, B. Steinhilber-Schrab, D. Teulel, G. Ulfert, and T. Weber. 1978. "Radiological Assessment of the Wyhl Nuclear Power Plant," Department of Environmental Protection, University of Heidelberg, Heidelberg, Federal Republic of Germany.

Congel, F. J., F. P. Cardile, B. Zalcman, W. J. Pasciak, and A. Chu. 1980. "Staff Review of 'Radio-ecological Assessment of the Wyhl Nuclear Power Plant'," Nuclear Regulatory Commission Report NUREG-0668, U.S. Nuclear Regulatory Commission, Washington, D.C.

9.6.4.4 Impact of Tritium Release

One commenter made several requests for additional information on the environmental impacts of batch releases of tritium (A-31, W-3).

Response: The environmental impact of releases of radionuclides into the river is discussed in Section 5.5.2 for humans and 5.5.3 for animals. Tritium was included in this analysis, and the estimate of the amount of tritium released is given in Table 5.3. The resulting dose to the maximally exposed individual from all radionuclides (including tritium) is also given in Table 5.3. Liquid wastes are analyzed for radionuclides (including tritium) and for chemicals before they are released to the river at a controlled flow rate. Batch releases, like continuous releases, are limited so that offsite concentrations do not exceed applicable limits. The limits ensure that releases from nuclear power plants do not make the water unsafe for drinking, even with more than one plant discharging to the same stream.

9.6.4.5 Liquid Pathway Dose Estimates

The applicant supplied the results of the reanalysis of the liquid radioactive release pathways that were requested by the NRC and referred to in Section 5.5.1 of the Draft Supplement (R-10).

Response: The applicant's revised assumptions and calculation methods for the dose resulting from liquid releases (TVA 1995) have been reviewed by the staff. The radiation doses specified in the comment letter have been either accepted or revised to correspond to a two-unit plant and incorporated in Section 5.5.2, as appropriate. The staff also performed an independent assessment of the liquid releases and the resulting dose. The doses are also given in Section 5.5.2.

Reference: Tennessee Valley Authority (TVA). 1995. Letter from D. E. Nunn, TVA, to U.S. NRC. February 17, 1995. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Response to NRC's Concerns from Review of FSAR Chapter 11, Radwaste Management Systems and 10 CFR 50, Appendix I Releases.

9.6.4.6 Gaseous Pathway Dose Estimates

The applicant supplied the results of a reanalysis of the airborne dose estimates in response to a request for additional information from the NRC on the data provided in Chapter 11 of the WBN FSAR (R-10).

Response: The staff's analysis of the applicant's assumptions and calculation methods for radiation doses resulting from airborne releases as given in Chapter 11 of the WBN FSAR (TVA 1995) indicates that the applicant's analysis is appropriate and within the NRC's regulatory requirements. The changes have been made as appropriate in Section 5.5.2.

Reference: Tennessee Valley Authority (TVA). 1995. Letter from D. E. Nunn, TVA, to U.S. NRC. February 17, 1995. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Response to NRC's Concerns from Review of FSAR Chapter 11, Radwaste Management Systems and 10 CFR 50, Appendix I Releases.

9.6.4.7 Dose Associated with Mining, Mill Tailings, and Processing of Uranium for Fuel

A commenter requested information on the dose that is associated with the mining and processing of uranium that is used in the fuel for the WBN Plant and a second commenter indicated that the radon from uranium required to fuel a single reactor for one year would result in 400 fatalities (A-11, A-12).

Response: Section 5.5.3 of the 1978 FES-OL discusses the uranium fuel cycle impacts. The long-term doses from radon associated with the mining and processing of uranium were dominated by releases from mill tailings. The staff's assessment of these impacts has not changed greatly except that more stringent stabilization requirements for uranium mill tailings are now in effect. Using conservative risk estimations, the Environmental Protection Agency (EPA 1993) has assessed the risk associated with 19 non-operational tailings impoundments where the new requirements are imposed and concluded that the total risk in the next 70 years is only 0.035 fatal cancers (i.e., about one chance in 28 of there being even 1 fatal cancer) resulting from these facilities. Thus, the staff expectation is that less than one fatal cancer will result from the radon emitted from obtaining the uranium for a single year of reactor operation. See also Section 5.5.6 for a discussion of the impacts of the uranium fuel cycle.

Reference: U.S. Environmental Protection Agency (EPA). 1993. "Technical Support for Amending Standards for Management of Uranium Byproduct Materials—40 CFR 192 Subpart D," Environmental Protection Agency Report EPA 402R-93-085, Washington, D.C.

9.6.4.8 Dose Associated with Disposal of Radioactive Waste

One commenter asked about the dose from nuclear waste, long-term considerations, and who had the responsibility for the waste after it left the WBN Plant (A-10).

Response: The dose estimates in Section 5.5 do not include the dose from waste after disposal. The applicant will be responsible for the nuclear waste until it is accepted by the repository (for high-level waste) or the disposal facility (for low-level waste). Transportation of the waste is discussed in Section 5.5.4. Other NRC analyses indicate that offsite doses from waste after disposal will be small compared to the doses from reactor effluents. The Nuclear Waste Policy Act of 1982 charges the U.S. Department of Energy with the responsibility of providing a facility for disposal of high-level waste. Any doses associated with that facility will be discussed in the environmental impact statement prepared in connection with its licensing.

The Low-Level Radioactive Waste Policy Amendments Act of 1985 charges each State with the responsibility for disposing of low-level waste generated within its borders. Any dose associated with facilities licensed by the states will be considered in the states' licensing proceedings.

Long-term considerations are reflected in the requirements for disposal facilities because certain radionuclides, like many hazardous chemicals, retain their toxicity essentially forever.

9.6.4.9 Radiological Impacts on Animals

One individual asked about the effects of "batch releases" of "slightly" radioactive materials on the mussel populations and aquatic ecology in general (W-2).

Response: The effect of the release of radioactive material is addressed in Section 5.5.3.

9.6.4.10 Quantity of Radioactive Waste Generated

The applicant provided updated estimates of volume generated for dry active waste in response to a request for additional information on Chapter 11 of the FSAR (R-11).

Response: The staff's analysis of the applicant's updated estimates indicate that they are appropriate, and the requested change has been made in Section 5.5.4.

9.6.4.11 Incineration of Radioactive Waste

One commenter questioned the use of incineration of low-level waste to reduce waste volume (B-1).

Response: This is not a new technology. Radioactive waste has been incinerated at nuclear sites for over 40 years. For a typical incinerator, the off-gas flows to a water quencher, and a venturi scrubber or a cyclone separator. Filter stages located downstream may include aqueous scrubbers, electrostatic devices, and HEPA filters (Burger 1995). The owner/operators of waste incinerators are required to comply with the NRC regulations for airborne releases of radioactive material. Radiation monitors are placed on the incinerators and in the surrounding areas to ensure that the effluents and resulting exposures are within the NRC limits.

Reference: Burger, L. L. 1995. *A Chemical Basis for Partitioning of Radionuclides in Incinerator Operation.* PNL-10364, Pacific Northwest Laboratory, Richland, Washington.

9.6.4.12 Availability of Site for Disposal of Low-Level Waste

A commenter questioned whether the low-level waste site at Barnwell, South Carolina, was still open for out-of-state waste. A second commenter asked for the basis of assuming a four-year timeframe for potential onsite storage of low-level waste. Both commenters asked about contingencies for waste storage if the regional compact site was further delayed (B-1, D-2).

Response: Although the low-level waste site in Barnwell, South Carolina, closed to waste from much of the United States, it is still accepting waste until the end of 1995 from the eight states (including Tennessee) in the Southeast Compact. The replacement facility in Wake County, North Carolina, is scheduled to open in mid-1997. Although this will result in only 1.5 years of low-level waste storage, the applicant has planned additional onsite storage for an extra 2.5 years (a total of four years). The basis for the selection of the four-year capacity is the applicant's judgment. The staff concurs largely because increasing the storage capacity, if necessary, would have no significant impact. If the replacement site in North Carolina is delayed beyond four years, the applicant will be required to add additional storage for low-level radioactive waste. It is not uncommon for nuclear plants to expand their waste storage capacity without adverse environmental impact.

9.6.4.13 Availability of Storage Site for Disposal of Spent Fuel

Several commenters indicated that the nuclear waste issue needs to be more adequately addressed since there is not, and may never be, storage site for high-level radioactive waste and since high level radioactive waste remains radioactive for long periods of time (A-20, B-1, L-1, T-1, W-5).

Response: The NRC environmental regulations (10 CFR Part 51) describes the agency's policy for addressing the storage of spent fuel in a supplement to a final environmental impact statement at the operating license stag (10 CFR 51.95). This regulation states, "Unless otherwise determined by the Commission, a supplement on the operation of a nuclear power reactor will not include...any aspect of the storage of spent fuel for the nuclear power reactor..." The basis for this statement is found in 10 CFR 51.23, which states, "The Commission has made a generic determination that, if necessary, spent fuel generated in any reactor can be stored safely and without significant environmental impacts for at least 30 years beyond the licensed life for operation...Further, the Commission believes there is reasonable assurance that at least one mined geologic repository will be available within the first quarter of the twenty-first century, and sufficient repository capacit will be available within 30 years beyond the licensed life for operation of any reactor to dispose of the commercial high-level waste and spent fuel originating in such reactor and generated up to that time."

Reference: 10 CFR Part 51. *Code of Federal Regulations.* 1994. "Environmental Protection Regulations fo Domestic Licensing and Related Regulatory Functions." U.S. Nuclear Regulatory Commission, Washington, D.C.

9.6.4.14 Transportation of Radioactive Waste and Potential for Accidents

A commenter asked whether the transportation of waste and potential accidents from the transportation were discussed in the FES (as supplemented) (A-10, A-11).

Response: The transportation of low-level waste was discussed in the 1978 FES-OL. An update of this discussion is presented in Section 5.5.4 of this Supplement as a result of changes in the waste form. Transportation accidents discussed in the 1978 FES-OL (page 5-18) are consistent with Table S-4 of 10 CFR 51.52. The results given in the FES-OL bound the accident analysis in the Supplement, so there is no need for further discussion in this supplement.

Reference: 10 CFR Part 51. *Code of Federal Regulations*. 1994. "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions." U.S. Nuclear Regulatory Commission, Washington, D.C.

9.6.4.15 Use of Dry Cask Storage for Spent Fuel

One commenter requested additional information regarding whether the WBN Plant would be allowed to store spent fuel at other TVA sites as an alternative to building their own dry cask storage facility (D-2).

Response: If necessary, the applicant could build and use dry cask storage at any of its facilities, including the WBN Plant. Spent fuel generated at WBN Plant could be stored at other TVA sites if its application satisfies all applicable NRC requirements.

9.6.4.16 Health Effects

One commenter indicated that the health effect information given in the Draft Supplement was not correct since those numbers exist "in an ideal world." The commenter stated that higher numbers of persons will receive cancer, leukemia, and birth defects. The commenter also stated that a number of people from Oak Ridge were unable to have children. The commenter indicated that they understood that you have a 300% increased chance of getting cancer if you live in the same county as a nuclear power plant, even if you live at the far end of the county. A second commenter indicated that nuclear power facilities without exception dramatically and statistically significantly increase the incidence of fatal and terminal cancers among humans, with cancer incidence directly proportional both to proximity and to years of operation (A-25, A-26, Y-1).

Response: The risk estimates are not based on "ideal world" assumptions. These estimates involve extrapolations from health effects at high doses because the health effects of low doses (i.e., 0.25 sievert [25 rem] or less) are too small to be detected. All studies to date that have been reported in the peer-reviewed literature indicate that there are no detrimental health effects as a result of living next to a nuclear power plant. The definitive study on this issue was provided by the National Cancer Institute (NCI) concludes there is no evidence of ill effects of radiation in the vicinity of any nuclear power plant or other nuclear facility in the U.S.A.

(Jablon et al. 1990). The *Journal of Nuclear Medicine* had a follow up to the NCI communication in its Newsline, pp. 11A-18A and 25A, entitled "Latest Studies Do Not Support Link Between Cancer Mortality and Radiation Discharges," Vol. 31, No. 11, November 1990. The National Research Council's "Health Effects of Exposure to Low Levels of Ionizing Radiation" (BEIR 1990) further supports these conclusions.

The estimates for cancer and birth defects that are given in the FES are based on the best data available. The risk estimates were developed from studies of populations that received higher exposures of radiation than are expected from the WBN Plant. The data received from these studies were then extrapolated linearly to estimate the risk from the lower levels of radiation that are expected from the WBN Plant. These risks include both cancer (including leukemia) and birth defects (hereditary effects).

In 1982 it was estimated that approximately 2.4 million married American couples (8.4% of those couples in which the wives were of childbearing age) were unintentionally infertile (unable to have children). This does not count couples where one or both partners were surgically sterilized. This infertility rate has not changed since the 1960s (OTA 1988) and has never been directly linked to the operation of a nuclear power plant or nuclear facility.

References: BEIR. 1990. *Health Effects of Exposure to Low Levels of Ionizing Radiation*. BEIR V. National Research Council. National Academy Press, Washington, D.C.

Office of Technology Assessment Task Force. 1988. Reproductive Health Hazards in the Workplace. Science Information Resource Center. J. B. Lippincott Company, Philadelphia, Pennsylvania.

Jablon, S., Z. Hrubec, J. D. Boice, Jr., and B. J. Stone. 1990. "Cancer in Populations Living Near Nuclear Facilities," National Cancer Institute Report, NIH Publication, No. 90-874.

9.6.4.17 Health Effects Resulting From Accidents

One commenter indicated that accidents have occurred at a number of nuclear facilities that resulted in an increased number of cancers and birth defects for the surrounding population. In addition, the commenter stated that there were thousands and thousands of people who had cancer as a result of the accident at Three Mile Island (TMI) and referred to accidents at other facilities (A-25).

Response: The accidents that have occurred at NRC-regulated facilities have never resulted in offsite doses that exceeded the variation in doses from nature to the local population. A report published by the Pennsylvania Department of Health (Tokuhata 1985) indicated that the long-term health effects from the TMI, Unit 2 radiation exposure to the approximately 2.2 million persons living within 80 kilometers (50 miles) of the plant at the time of the accident were predicted to be less than one extra fatal cancer and less than one extra nonfatal cancer. In addition, a study performed by Columbia University (and supported by the Three Mile Island Public Health Fund) indicated that during the period from 1979 to 1990, there was no convincing evidence that radiation releases from the Three Mile Island nuclear facility influenced cancer risk within the approximately 160,000 residents living within a 16-kilometer (10-mile) radius of the Three Mile Island nuclear plant as a result of releases of radiation during the March 28, 1979, accident as well as from routine plant emissions (Hatch et al. 1990).

Human birth defects (congenital abnormalities) were attributed to the effects of radiation during the 1920s. Since then radiation teratogenesis has been extensively studied in laboratory animals. From the animal studies, it seems evident that high doses of radiation can cause birth defects even though the human data are inconclusive. The only effects that could be related to radiation in the 1630 *in utero* exposed survivors of the atomic bombs were small head size and mental retardation. Even these effects were evident only where doses exceeded 500 mSv (50,000 mrems) (UNSCEAR 1988, and BEIR 1990). Thus, on the basis that U.S. nuclear power plants are limited to 0.05 mSv (5 mrems), the staff concludes that the likelihood of birth defects from offsite doses is low.

References: Hatch, M. C., J. Beyea, J. W. Nieves, and M. Susser. 1990. "Cancer Near the Three Mile Island Nuclear Plant: Radiation Emissions." *Journal of Epidemiology* 132(3): 397-412.

National Academy of Sciences. 1990. Committee on the Biological Effects of Ionizing Radiation, *Health Effects of Exposure to Low Levels of Ionizing Radiation. BEIR-V*, National Research Council, National Academy Press.

Tokuhata, G. K. 1985. "Three Mile Island Nuclear Accident and Its Effect on the Surrounding Population." In *Management of Radioactive Materials and Wastes: Issues and Progress*. S. K. Majumdar and E. Willard Miller (eds). The Pennsylvania Academy of Science.

UNSCEAR 1988. United Nations Scientific Committee on the Effects of Atomic Radiation, *Sources, Effects and Risks of Ionizing Radiation*, New York: United Nations.

9.6.4.18 Effect of Radiation on Living Tissues

One commenter indicated that the WBN Plant would have "deathly effects on all life forms in the Tennessee State" since "nuclear waste harms you by breaking down your cell wall" (P-1).

Response: The effect of radiation on living tissue is fairly well documented (e.g., Pizzarello 1975). The specific effect varies with the radiation type (for instance, whether it is alpha, beta, neutron, or photon radiation), the dose, the dose rate, the organ irradiated, etc. Radiation results in widely varied effects such as increased permeability of membranes, gross structural chromosome changes, and subtle chemical changes in the structure of DNA molecules which may result from transformation of the nuclear material. Such effects do not result from the doses permitted by the NRC. Human and animal tissues do not contain cell walls; these are only present in plant cells. The effect of radiation on the human and non-human life forms in the State of Tennessee are given in Section 5.5 of the Final Supplement.

Reference: Pizzarello, Donald J. 1975. *Basic Radiation Biology*. Lea and Febiger, London.

9.6.4.19 Health Effects Resulting From Accidents

A commenter asked whether the information on health effects in the Draft Supplement included catastrophic accidents (A-7).

Response: The analysis of the radiological impacts to the population that was contained in Section 5.5 of the Draft Supplement related only to routine releases, and did not include accidents. Section 7.1 discusses the staff's review of the realistic accident analysis in the NRC 1978 FES-OL. Dose estimates were made for 17 postulated accidents in the NRC 1978 FES-OL. These accidents ranged in severity from a small steam line break to a large scale loss-of-coolant accident. The analysis in this Supplement has been updated to include an assessment of an accident involving the failure of the spent fuel resin storage tank and of the transfer resins in the railroad bay. The projected dose to the offsite population resulting from such postulated accidents is cited in Chapter 7. Furthermore, there has never been an accident in a U.S. nuclear power plant that had discernible offsite health effects.

9.6.5 Non-Radiological Impacts - Noise Levels

One commenter indicated that the Department of Housing and Urban Development (HUD) had noise guidelines for residential areas. The commenter also inquired as to whether there were residences that would be affected by elevated noise levels and if levels at these residences should be predicted and mitigated. The commenter also asked if there were provisions for notifying of the surrounding communities of upcoming large noise events (D-2, D-4).

Response: The Department of Housing and Urban Development noise guidelines given in 24 CFR 51.101 (a) (8) are based on average day-night sound levels. These levels (less than 65 decibels) are met for routine noise at the nearest residential locations based on a preoperational analysis of sound levels near the plant (TVA 1980). Intermittent noise levels at these locations occur infrequently and irregularly and will be 84 to 103 decibels near the plant (based on the same analysis). This noise level is equivalent to that produced by a lawn mower or a motorcycle. Because the intermittent noises are associated with events for which the timing is not predictable, there are no provisions for notification of surrounding communities of the timing of these intermittent noises.

Additional information on noise levels has been included in Section 5.6.3.

References: 24 CFR Part 51. *Code of Federal Regulations*. 1994. "Regulations Relating to Housing and Urban Development." Department of Housing and Urban Development, Washington, D.C.

Tennessee Valley Authority (TVA). 1980. Letter from Mills, TVA, to U.S NRC. April 22, 1980. Subject: In the Matter of Application of TVA.

9.6.6 Socioeconomic Impacts - Definitions

Two individuals requested that the "troubled history" of the plant (including documented cases of harassment of whistleblowers, concerns of quality assurance, quality control, high rate of manager turnover, and concerns with documentation of problems) be included in the socioeconomic description contained in the Supplement (A-27, W-5).

Response: The history of the plants, and the concerns regarding harassment of whistleblowers, quality assurance and quality control are not socioeconomic issues. Socioeconomics deals with the economic changes that would occur in the surrounding society as a result of operation of the facility. See the introduction to this section for the disposition of comments concerning harassment of whistleblowers and other alleged wrongdoing.

9.7 Environmental Monitoring Program

9.7.1 Groundwater Monitoring

The applicant indicated that the sampling frequency for the radiological groundwater monitoring is quarterly (R-11).

Response: The applicant is correct; the text in Section 6.2.3 has been revised.

9.7.2 Chemical Effluent Monitoring

One individual indicated that testing exists for only five to six hundred chemicals, and the concern was expressed that the WBN and Sequoyah Plants may be releasing chemicals that cannot be measured (A-31).

Response: Testing of chemicals released from Sequoyah Nuclear Plant is outside the scope of this Supplement since Sequoyah is located downstream of the WBN Plant, and the routine releases from Sequoyah will not affect the environment around the WBN Site. The WBN Plant has a chemical traffic tracking system, so that all chemicals brought onto the site are logged, and traced until they are no longer on site. The chemicals that are routinely used at the WBN Plant for plant operation can be measured, and monitoring for these chemicals in the plant discharge is required by the NPDES permit.

9.7.3 Chemical Effluent and Solid Waste Monitoring

One individual asked which organization within the State of Tennessee is responsible for monitoring the chemical aspects of the plant and whether there were safeguards in place to ensure that the monitoring results were accurate (A-8, A-9).

Response: As indicated in the transcript from the public meeting, the chemical effluents from the WBN Plant are monitored in accordance with the National Pollution Discharge Elimination System permit that is issued by the Division of Water Pollution Control, State of Tennessee. This information is given in Section 5.2.4 of the Supplement. Questions regarding any monitoring of chemical releases from the site by the State of Tennessee should be addressed to the State of Tennessee.

Section 3.4 has been updated to describe the disposal of solid, non-radioactive waste from the WBN Plant (TVA 1995). Construction and demolition wastes are disposed of in a Tennessee State-approved onsite landfill. Commercial solid waste and nonradioactive hazardous wastes, used oil, and asbestos-containing material are disposed of by contract in State-approved landfills. Questions regarding monitoring of landfills should be addressed to the State of Tennessee.

Although the applicant does not routinely monitor the shipments of solid waste to the landfills, the hazardous constituents are controlled by a chemical traffic tracking system instituted by the applicant. Site personnel receive training that describes a chemical traffic control program and their responsibilities regarding safe handling of chemicals.

Reference: Tennessee Valley Authority (TVA). 1995. Letter from O. J. Zeringue, TVA, to U.S. NRC. March 7, 1995. Subject: Watts Bar Nuclear Plant (WBN) Units 1 and 2 - Request for Additional Information Related to the Watts Bar Environmental Review.

9.7.4 Radiological Monitoring Program

9.7.4.1 Milk

One commenter asked about the monitoring program for milk, specifically, who monitors the milk, the frequency of the monitoring program, and the location(s) where the milk is collected (A-3).

Response: The applicant is responsible for the monitoring program as defined in Table 9.1 of the Offsite Dose Calculation Manual (TVA 1994). The applicant's milk sampling program consists of collecting milk at each of one to three downwind farms where the doses are calculated to be the highest, as well as one sample from an upwind control location. The farms from which milk samples are collected are based on the required annual land use census. If samples are not available from a milk animal in one of the designated downwind farms, doses at that location are estimated by projecting the doses from concentrations detected in milk in other sectors, or from samples of vegetation. The sampling frequency is at least once every 15 days. A gamma isotopic analysis and an analysis for iodine-131 is performed for each sample. An analysis for strontium-89 and strontium-90 is performed once a quarter on composite milk samples from each location. This less frequent analysis for strontium is to improve the sensitivity of the analyses. Section 6.2.7 contains additional information on the applicant's radiological environmental monitoring program.

The NRC and the State of Tennessee monitor the applicant's environmental program. Additionally, the applicant prepares annual radiological environmental reports summarizing its assumptions and analyses.

Reference: Tennessee Valley Authority (TVA). 1994. *Watts Bar Nuclear Plant Offsite Dose Calculations Manual (ODCM)*. Rev. 3.

9.7.4.2 NRC/State of Tennessee Radiological Monitoring Program

One commenter asked for additional information regarding the scope of the State of Tennessee environmental radioactivity monitoring program around the WBN Site, whether the program will include pressurized ionization chambers (PICs) and whether monitoring locations are based on wind and/or population (D-3).

Response: The NRC and the State of Tennessee monitor several primary exposure pathways near the WBN Plant on a routine basis.

Thermoluminescence dosimeters (TLDs) are located in a series of rings around the plant in each of the 16 compass sectors. The NRC audits licensee compliance with applicable regulations by its independent assessment of monitoring data that is collected independent of the licensee's program. At this time, the NRC is not aware of the use of PICs in the State of Tennessee monitoring program.

9.8 Accident Analysis

9.8.1 Realistic Accident Analysis

9.8.1.1 Accidents Involving Chemicals

One commenter indicated that the EIS does not address unplanned discharges into the river for minor accidents. The commenter gave an example of an incident at the Sequoyah Nuclear Site, which resulted in the leakage of poly-chlorinated biphenyls (PCBs) into a holding pond. The commenter inquired as to the effect of such accidents on the aquatic and terrestrial ecosystems (W-3).

Response: Unplanned discharges of chemicals were not addressed in this Supplement. In the case of an unplanned discharge, the location of the discharge would play a major role in whether the discharge could have an adverse affect on the environment. If the discharge occurred within a system where the waste flowed directly to the yard holding pond, then it would not be expected to have an adverse effect since any releases from the holding pond would be regulated by the National Pollution Discharge Elimination System (NPDES) permit. However, accidental system leaks from the auxiliary building could bypass the yard holding pond directly to the cooling tower blowdown, without going to the yard holding pond. In these cases the releases would not be covered by the NPDES permit. Any potential environmental effect would depend on the quantity and type of chemical released, although the dilution of the chemical in the cooling tower blowdown would be instrumental in ameliorating adverse impacts.

9.8.1.2 Potential for Nuclear Accident Before Fuel Loading

A commenter questioned whether uranium was currently on site at the WBN plant, and whether an accident could occur (A-13).

Response: As indicated in the transcript of the public meeting, unirradiated uranium fuel is currently stored on site at the WBN Plant. The unirradiated fuel is stored in metal covered rods ("cans"), and it is in a configuration such that it can not achieve criticality (initiate a nuclear reaction). For this reason, the fuel itself could not cause an accident and thus there is no possibility of a nuclear accident occurring at this time at the WBN Plant. Because the fuel has not achieved criticality, it does not contain fission products (radioactive isotopes that are produced by fissioning material). Thus, if the metal covering on the uranium fuel was inadvertently breached, the resulting problems would be chemical in nature (relating to the presence of uranium metal) rather than nuclear.

9.8.2 Severe Accident Mitigation Design Alternatives

9.8.2.1 Probability of a Core Melt Accident at Watts Bar

Numerous commenters expressed concern regarding the estimated probability of a core meltdown accident at the WBN Plant. Several comments referred to a study released by TVA on September 1, 1992, that rated the WBN Plant with the highest probability of a core melt accident of any plant in the United States (0.00033 per year). Other commenters asserted that there is a 45% probability of a core melt accident at the WBN Plant over the next 20 years if the plant is operated (A-7, A-29, F-1, G-1, I-1, L-1, N-1, S-1, T-1, U-1, AA-1, BB-1).

Response: The applicant's original estimate of the probability of a core melt accident at the WBN Plant was among the highest in the country. However, that analysis was found to be overly conservative in that it did not provide appropriate credit for successful operation of certain installed plant equipment. In addition, several improvements to plant operating procedures and operator training programs that have subsequently been implemented at the plant were not considered in the original estimate. As described in Chapter 7 of the Supplement, the probability of a core melt accident at the WBN Plant has been updated to more realistically account for these factors. The updated core melt frequency is about a factor of 5 lower than the original probability estimate, and is consistent with the core melt probability estimates for other plants of similar design.

The updated probability of a core melt accident over the (40 year) life of the plant is 0.2%, as opposed to the original estimate of 1%. These values are considerably less than the 45% value cited in several of the comments.

9.8.2.2 Consideration of Safety/Core Damage Frequency in the FES Supplement

One commenter noted that the safety/risk for the WBN Plant (relative to other plants) was not considered in the draft FES Supplement (A-29).

Response: The staff considered the potential for severe accidents (Class 9 Accidents) in Section 7.2 of the NRC 1978 FES-OL. The conclusion reached was that, although the consequences of such accidents could be severe, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design were cited as factors that provide a high degree of assurance that potential accidents in this class are, and would remain, sufficiently small in probability that the environmental risk is extremely low. Quantitative information from available risk studies, most notably the "Reactor Safety Study", was also considered in reaching this conclusion.

Although the risk associated with Class 9 Accidents at the WBN Plant is not explicitly revisited in the FES Supplement, the core damage frequency and risk estimates developed as part of the WBN Plant Individual Plant Examination (IPE) and SAMDA evaluations fit well within the range of estimates for operating plants, and meet the Commission's quantitative safety goals for severe accidents. Thus, the findings reported in the NRC 1978 FES-OL regarding Class 9 Accidents are considered to remain applicable.

9.8.2.3 Greater Use of Unit 2 Systems for Unit 1

One commenter claimed that as a result of Unit 2 cancellation, additional Unit 2 systems and components could be used to support the Unit 1 response to potential severe accident events (A-16).

Response: The applicant has not withdrawn the application for an operating license for Unit 2; however, the staff agrees that given the expected delay and possible cancellation of Unit 2, additional Unit 2 systems and components (beyond those already considered in the SAMDA analysis) could be used to support Unit 1 response, at least on an interim basis. In response to a staff request, the applicant provided a further assessment of the risk reduction that could be achieved by making additional Unit 2 systems available to Unit 1, including the refueling water storage tank and the condensate storage tank. The costs associated with the necessary hardware changes were also estimated. This assessment indicates that design changes to make use of additional Unit 2 systems would not significantly reduce risk, and would be more than an order of magnitude from being cost effective. Section 7.2.3 of this Supplement has been modified to reflect this further assessment.

9.8.2.4 Use of the $1000/Person-Rem Criterion

One commenter claimed that the $1000 per person-rem conversion factor used in the staff's evaluation is outdated, and suggested that something closer to $5,000 to $10,000 per person-rem be used (A-16).

Response: The staff is currently in the process of evaluating the need for updating and codifying the dollar per person-rem conversion factor and its application in the NRC decisionmaking process.

It is important to recognize that in the SAMDA analysis the dollar per person-rem conversion factor was used as a screening criterion rather than as a decision criterion. The value-impact ratio (in terms of dollars per person-rem averted) was estimated for each design alternative to identify and rank those design alternatives offering the greatest risk reduction for the dollar. All design alternatives having a value-impact ratio within a factor of 10 of the $1000 per person-rem were "screened in," and considered further on the basis of deterministic as well as probabilistic considerations. Because all design alternatives within a factor of 10 have already been evaluated and dispositioned on deterministic bases, the results of the SAMDA evaluation would not be altered if the higher dose conversion factor suggested by the commenter were used.

9.8.2.5 Failure to Include External Events

One commenter noted that the IPE on which the SAMDA evaluation was based did not consider the risk from externally initiated events, such as fire and earthquakes, and that failure to include these events renders the draft FES Supplement and SAMDA evaluation incomplete (A-17, A-20, A-26).

Response: Although consideration of externally initiated events would provide for a more complete evaluation of design alternatives, the staff does not consider such an expansion of scope to be warranted for the purpose of discharging the agency's responsibilities under NEPA. The staff notes that many of the preventive and mitigative measures that result in an acceptably low risk for internally initiated events would also be effective in externally initiated events, and thereby reduce to some degree the risk reduction potential for externally initiated events. Although additional design alternatives specific to external events could be identified through a more complete evaluation, other regulatory programs are in place to ensure that design improvements which would significantly reduce the risk associated with externally initiated events are identified and evaluated. Specifically, each nuclear reactor plant licensee has been asked to perform an Individual Plant Examination for Externally Initiated Events (IPEEE) to identify vulnerabilities and, if appropriate, to modify hardware and procedures to further prevent or mitigate severe accidents. The IPEEEs will be used by the NRC to identify modifications to the plant where warranted via the NRC's backfit rule.

9.8.2.6 Procedural Versus Hardware Changes

One commenter noted that most of the reductions in the WBN Plant core damage frequency have been achieved through changes in analysis and plant procedures rather than hardware changes.

The commenter claimed that TVA had the opportunity to further reduce risk through hardware changes but did not choose to do so based on costs (A-17).

Response: The commenter is correct that most of the reductions in core damage frequency were not achieved through hardware changes. Rather they were the result of modelling improvements/corrections and additional credit for improved operating procedures and operator training enhancements. The staff reviewed these changes as part of its evaluation of the IPE and SAMDAs and concluded that they were appropriate and acceptable. With regard to the second comment, the staff considers the cost of hardware changes to be a valid consideration in selecting among alternatives for reducing risk.

9.8.2.7 Costs of the Three SAMDAs to be Implemented at Watts Bar

One commenter requested that the costs of the three design alternatives that TVA has committed to implement be reported in the FES Supplement (A-33).

Response: Cost estimates for each design alternative considered are reported in Section 4 of the applicant's "Value Impact Analysis of Potential Plant Improvements," dated June 30, 1994. The cost to implement each procedure change was estimated, by the applicant, to be approximately $25,000. This information has been added to Table 7.4 of the FES Supplement.

9.8.2.8 Schedule and Mechanism for Ensuring Implementation of the Three SAMDAs

Two commenters inquired whether there are any schedule commitments for completing implementation of the three design improvements credited in the SAMDA evaluation, and whether there are any requirements or other mechanisms in place to ensure that TVA implements these improvements (A-34, D-3).

Response: The applicant has committed to implement the three design improvements prior to initial criticality; however, a specific calendar date for completing implementation has not been established. The applicant's commitments are being tracked in the applicant's Tracking and Reporting of Open Items. Meanwhile, the staff tracks implementation of these items. The implementation of these commitments will be audited by the NRC prior to issuing the operating license for the WBN Plant.

9.8.2.9 Validity of Conclusions Considering Safety Record to Date

One commenter questioned the conclusion of the SAMDA evaluation that "additional plant improvements to further mitigate severe accidents are not required at Watts Bar," considering the fact there have been numerous accidents at the facility during construction and that the WBN Plant failed the "hot test run" in 1993 (E-2).

Response: Probabilistic safety assessment studies, such as the IPE, attempt to provide a realistic picture of the capabilities of a plant design and operating staff to respond to a spectrum of accidents initiated at full reactor power. Construction-related accidents and plant performance during hot testing are outside the scope of probabilistic safety assessment studies, and do not represent significant risk to the public since core damage and fission product releases could not occur unless reactor criticality has been achieved (i.e., fission products have been generated).

9.9 Decommissioning

9.9.1 Proposed Rule on Decommissioning

One commenter asked about the effect on the WBN Plant of the recently proposed rule on radiological criteria for decommissioning of NRC-licensed nuclear facilities. The commenter also asked whether NEPA documentation would be prepared on decommissioning following the submittal of the "Supplement to Applicant's Environmental Report" (D-3).

Response: Should the proposed rule become a final rule, then TVA would be required to meet the requirements specified in the rule upon decommissioning of the WBN Plant. Furthermore the licensee would need to meet any NEPA requirements specified in the final rule.

9.9.2 Decommissioning Cost Estimates

One commenter indicated that decommissioning was not fully addressed in the FES. Two individuals questioned whether funding would be available to decommission the WBN Plant since decommissioning costs at other plants are exceeding the original estimates and since the NRC has developed new regulations and standards for decommissioning. One commenter warned that a typical nuclear plant can cost more to decommission than to build (A-20, A-30, O-1).

Response: The decommissioning plan and its review are discussed in Section 8.4 of the Supplement. Decommissioning cost estimates are not included in the Supplement. Cost estimates for decommissioning a nuclear reactor vary among reactors and decommissioning alternatives. However, the decommissioning rule given in 10 CFR 50.75 specifies the minimum amounts required to demonstrate reasonable assurance of funds for the decommissioning of reactor facilities. These funds will be used to remove the facility from service and reduc residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. They do not include the costs necessary for removing nonradioactive structures or returning the site t a pristine state.

The decommissioning rule requires that license holders of commercial nuclear power reactors submit a plan t ensure that funds will be available. It also requires the license holder to submit a proposed decommissioning plan at or about five years before the projected end of operation. This plan requires (among other things) an updated cost estimate, a comparison of that estimate with the then current funds set aside for decommissionin and a plan for assuring the availability of adequate funds for completion of decommissioning.

Reference: 10 CFR Part 50. *Code of Federal Regulations.* 1994. "Domestic Licensing of Production and Utilization Facilities." U.S. Nuclear Regulatory Commission, Washington, D.C.

9.9.3 Specific Decommissioning Plan and Decommissioning Funding Plan for WBN Plant

Two individuals asked for details about TVA's decommissioning process and the decommissioning funding plan. In addition, the applicant clarified that the NRC regulations on decommissioning in 10 CFR 50.75 (a)(C)(3)(iv) specifically provide that Federal Government utility licensees may provide a statement of intent containing a cost estimate or an amount based on an NRC formula, indicating that adequate decommissioning funds will be available when necessary. The applicant indicated that it will provide a statement of intent to ensure adequate funding for decommissioning WBN Plant Unit 1 (A-27, R-12).

Response: The decommissioning plan and its review are discussed in Section 8.4 of the Supplement. The regulations in 10 CFR 50.75 (e)(3)(iv) do allow Federal Government utility licensees to provide a statement of intent stating that adequate decommissioning funds will be available at the time of decommissioning. The appropriate clarifying statements have been added to Section 8.4.

Reference: 10 CFR Part 50. *Code of Federal Regulations.* 1994. "Domestic Licensing of Production and Utilization Facilities." U.S. Nuclear Regulatory Commission, Washington, D.C.

9.9.4 Availability of Funds for Decommissioning

One commenter expressed a concern over the funds for decommissioning. The individual was specifically concerned with cuts in TVA and DOE (Oak Ridge) funding by the U.S. Congress and how that would affect future decommissioning activities (A-26).

Response: The applicant, as an entity of the United States Federal Government, will need to satisfy the requirement for financial assurance for decommissioning of the WBN Plant by submitting to NRC a letter of intent that states that adequate decommissioning funds will be available at the time of decommissioning. The full weight of the Federal Government is behind the commitment to make funds available. The U.S. DOE has oversight responsibility for the cleanup of the Oak Ridge National Laboratory.

9.10 Miscellaneous

9.10.1 Use of Metric/English Units

One commenter recommended that the NRC use only non-International System (SI or System International) units in the main text of the Supplement, such as rems and curies, rather than the SI units such as sieverts and bequerels (D-1).

Response: The NRC issued a policy statement in 1992 (57 *FR* 46,202) that stated the NRC will publish all new regulations, major amendments to existing regulations, regulatory guides, policy statements, information notices, generic letters, bulletins, NUREG-series documents, and all written communication directed to the public with dual units (i.e., both SI and English units).

9.10.2 Regulation of Nuclear Material

One commenter indicated that nuclear facilities should be responsible for the nuclear material from the time that it is mined until through the time that it is buried ("from the cradle to the grave") (A-29).

Response: The NRC does regulate the entire fuel cycle "from cradle to grave" and there are environmental standards to cover each stage of the fuel cycle. NRC provides review and oversight of all stages in the life of nuclear material.

9.10.3 Hearing [process]

Several individuals requested more public hearings to address the construction permit and operating license of the WBN Plant (A-5, A-35, W-6).

Response: The construction permit, on which a public hearing is required by the Atomic Energy Act and the NRC's regulations, has already been issued, and the plant has been constructed. The NRC placed a notice in the *Federal Register* announcing an opportunity for a hearing on the WBN Plant operating license application in 1976 (41 *FR* 56244). An Atomic Safety and Licensing Board (ASLB) denied the sole petition for interv[illegible]tion on the basis that the petitioner did not meet the criteria required for standing (5 NRC 1292 [1977]). In response to the petitioner's appeal, the Atomic Safety and Licensing Appeal Board affirmed the ASLB's decision (5 NRC 1418 [1977]). Pursuant to 10 CFR 2.105, the NRC has already offered an opportunity for hearing on the operating license application and is not required to provide additional opportunities for hearing

References: 10 CFR Part 2. *Code of Federal Regulations*. 1994. "Rules of Practice for Domestic Licensing Proceedings and Issuance of Orders." U.S. Nuclear Regulatory Commission, Washington, D.C.

Tennessee Valley Authority (Watts Bar Nuclear Plant, Units 1 and 2) 5 NRC 1292 (May 25, 1977). "Order Denying Petition for Leave to Intervene of Jeannine W. Honicker."

41 *Federal Register* 56,244. "Notice of Opportunity for Hearing." December 27, 1976.

Tennessee Valley Authority (Watts Bar Nuclear Plant, Units 1 and 2). ALAB-413, 5 NRC 1418. (Decision affirming on appeal ASLB's denial of Jeannine W. Honicker's intervention petition.) June 20, 1977.

9.10.4 Editorial Comments

A number of editorial comments were received from the applicant. They included suggested comments on the aquatic ecology, meteorology, and the SAMDA section (R-4, R-5, R-6, R-7, R-8, R-11, R-12).

Response: The staff has considered and incorporated the recommended revisions as appropriate. Changes were made to the "Definitions" section and Sections 2.2.3, 2.3.4, 2.4.2, 5.4.3, 5.9, and 7.2.

Appendix A

Comments on the Draft Supplement to the Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant

Appendix A

Comments on the Draft Supplement to the Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant

The comment letters that we sent in response to the draft supplement FES are reproduced in this appendix in the approximate chronological order in which they were received. A redacted transcript of the public meeting held in Sweetwater, Tennessee on January 10, 1995 preceeds the letters. The date of the public meeting and the date that each comment letter was received is given in the second column. The transcript and each comment letter were assigned an alphabetic designator, given in column three. These alphabetic designators are used in Section 9.0 to identify the sources of the comments addressed in the comment letters and the transcript. The page number where the comment letter or transcript first appears in this appendix is shown in the fourth column.

Source	Date Received	Comment Letter or Transcript Identification Code	Page
Public Meeting Transcript, Sweetwater, TN	1/10/95	A	A.3
Thomas Anderson, Minneapolis, MN	1/13/95	B	A.37
Wilma McNabb, Lenoir City, TN	1/18/95	C	A.38
U.S. Environmental Protection Agency Heinz J. Mueller, Chief Environmental Policy Section	2/6/95	D	A.38
Linda Ewald, Knoxville, TN	1/30/95	E	A.40
Elizabeth Yanaua	2/8/95	F	A.41
Marion Hourdequin, Princeton, NJ	2/8/95	G	A.42
Vincent Vespole, Brooklyn, NY	2/8/95	H	A.42
Lenny Gaines, Princeton, NJ	2/8/95	I	A.43
A. Bergenfeld, Forest Hills, NY	2/8/95	J	A.43
Mark Higgins, Princeton, NJ	2/8/95	K	A.44
Marlene Haas, Princeton, NJ	2/8/95	L	A.44
Kathy McArdle, Jersey City, NJ	2/8/95	M	A.45
Amy Mair, Princeton, NJ	2/8/95	N	A.45
Therese Clorum, Jersey City, NJ	2/8/95	O	A.46

Source	Date Received	Comment Letter or Transcript Identification Code	Page
Jonas Wood, New York, NY	2/8/95	P	A.46
Mickey Zweig, New York, NY	2/8/95	Q	A.47
Watts Bar Nuclear Plant, Vice President, New Plant Completion, Tennessee Valley Authority, Dwight E. Nunn	2/27/95	R	A.47
Barbara Jordan (and 8 co-signers)	2/13/95	S	A.53
Susan Switzer	2/13/95	T	A.54
C. Rose	2/13/95	U	A.54
Jim Snell, Nashville, TN	2/22/95	V	A.55
John Johnson, Chattanooga, TN	2/22/95	W	A.55
John van der Hurst, Nashville, TN	2/23/95	X	A.58
David E. Brown, Dandridge, TN	2/23/95	Y	A.59
Olivia Lim, Hixson, TN	2/23/95	Z	A.60
Jason Smail	2/23/95	AA	A.61
Dave Hedgepeth	3/2/95	BB	A.62
Tennessee State Planning Office, Charles W. Brown, Director, State Clearinghouse	3/2/95	CC	A.62

Numbers written in the margins of the comment letters (or the transcript) refer to the section in Chapter 9 of this supplement where the comment is addressed or the question is answered.

The numbers at the bottom of each page of a letter or transcript are used in Chapter 9.0 for ease of reference.

The sections of the transcript that appear in Appendix A were taken from the comment response portion of the Watts Bar Environmental Review Public Meeting held on January 10, 1995, in Sweetwater, Tennessee. The comments made by members of the public are reproduced in their entirety. Efforts have been made to include the pertinent information from any responses that were made to the comments and questions. Where discussions corresponding to the meeting format occurred, the word discussion is given in brackets, [Discussion].

The original meeting transcript is a court recorder's transcript and is not certified as correct. For this reason, editorial errors may be found in the portions of the transcript duplicated in this appendix.

LETTER A (Transcript)

Transcript of the Public Meeting on January 10, 1995 in Sweetwater, Tennessee

[Discussion]
Ms. Honicker: Becky, I want to ask you about the cow milk child pathway. 9.6.4.1

I noticed that you did not mention cow milk child pathway in any of your monitoring, and at the Hartwell nuclear plant, I was an intervenor against that plant, and I have a paper specifically that says that cow milk child pathway is a critical pathway to man, every cow within a fifty-mile radius should be identified, and monitoring should be done. You ignore it completely, the food pathway.

The Hartwell plant clearly shows that the effluents will fall on the grass and will be eaten by the cows, and taken up in the milk.

Strontium 90 acts like calcium when it is taken into the body, and to ignore that completely is criminal--there's no other word for it, it's criminal.

Ms. Harty: I am familiar with the cow milk pathway, but I would like to refer this question to Dale Denham because he was the health physicist that actually worked on the radiological impact section and is a little more familiar with this area than I am.

Mr. Denham: Let me just speak to you, I hope you can hear me, and obviously you might have an interest.

What you have expressed is a concern, but unfortunately what Becky showed, we have taken that into account. That is part of that impact shown for the individual, that kind of maximum individual that was considered in looking at the impact.

Ms. Honicker: Who will monitor the milk? 9.7.4.1

Mr. Denham: The monitor will be monitoring the milk.

Ms. Honicker: How often will the milk be collected? Where will it be collected from? Who will actually do the milk monitoring? 9.7.4.

Mr. Denham: If I could just share with you just for a moment the program, I can't describe the program here at the plant in total detail, but in general cows within five miles of a plant, of a nuclear plant, are (1) surveyed annually--that's a requirement by the NRC that survey be done by the utility--and then those animals, not every one of the animals, but I mean selected dairy, the close-in ones are sampled by the plant, and the milk analyzed.

Ms. Honicker: Once a year?

Mr. Denham: No, no. These are done monthly during the season, you know, the season when cattle will be out on the pasture land and the primary concern--you shared strontium 90--yes, that is a long-term concern, but in general the concern and the impact, the gross impact is coming from iodine 131, short-lived and AK half-life, and that's where the major concern would be, and that is also factored into the numbers that you saw.

Ms. Honicker: I just have one other question before we leave this.

9.6.4.3 I know for the Hartwell plant the guidelines were changed when you calculated the dose. Before the Hartwell plant was designed or the construction permit was granted the guideline 1.42 had been used to calculate the dose.

At that time from the Hartwell plant the dose was calculated to be 335 milligrams of iodine to a one-year-old child drinking milk from a cow grazing from that plant.

The new revised guidelines which we'll call 1.1, or I can't remember the number, but anyone, 1.1 milligrams was the result of changing the guidelines with pencil. There was an erasure rather than actually installing equipment.

The new guideline was looked at by the University of Heidelberg and was found to underestimate the perimeters by 500-fold.

So you can sit here all day long and tell us that it's not going to hurt anybody, it's all calculations, and until it actually operates and you see the corridors that you see in Hanford or in any of these other facilities will you actually be able to say, and then it will be denied.

But I think that people need to know that calculations are as accurate as the figures you put in there, and that it can be changed, and it means nothing.

(Scattered applause.)

Mr. Newberry: Ma'am, do you want to identify yourself?

Ms. Honicker: I'm Jeanine Honicker.

Mr. Newberry: Thank you for your comments. Are there any more questions before we get into statements? Ma'am.

Ms. Morgan: I'm Dixie Ann Morgan.

I just wondered why it's taken so long to build this plant, and because of my own personal background it just seems like the technology would have had to change so many times over the years that I just--could somebody just explain this to me?

Mr. Newberry: I think I'm going to turn to my left and ask Fred to respond to that, but our focus here was the environmental review.

Table C.6 (contd)

Location	Total	White	Black	American Indian, Eskimo, Aleut	Asian or Pacific Islander	Other	Hispanic Origin
Hamilton County	285,536	227,413	54,477	585	2,479	582	1,946
Chattanooga	152,466	99,057	51,338	329	1,478	264	974
East Brainerd	11,594	10,788	665	20	93	28	86
East Ridge	21,101	20,686	112	52	240	11	96
Harrison	7,191	6,796	293	35	42	25	58
Middle Valley	12,255	12,002	90	15	137	11	59
Red Bank	12,322	11,464	673	18	108	59	137
Soddy-Daisy	8,240	8,145	64	9	17	5	24
Walden	1,523	1,514	0	2	7	0	6
Lookout Mountain	1,901	1,831	51	4	14	1	5
Collegedale	5,048	4,612	171	10	121	134	246
Ooltewah	4,903	4,372	473	20	30	8	44
Fairmount	1,578	1,569	1	1	5	2	10
Signal Mountain	7,034	6,977	17	1	34	5	36
Knox County	335,749	301,421	29,603	797	3,327	601	2,067
Farragut	12,793	12,242	181	18	322	30	115
Halls	6,450	6,405	14	10	19	2	18
Karns	1,454	1,445	0	5	4	4	10
Knoxville	165,121	136,604	26,053	399	1,725	340	1,099
Powell	7,534	7,374	100	15	31	14	27
Mascot	2,138	2,069	52	9	1	7	7
Loudon County	31,255	30,732	400	52	50	21	83
Lenoir City	6,147	6,086	25	27	7	2	20
Loudon	4,026	3,872	142	2	8	2	10

Table C.6 Population Distribution by Race and Ethnicity Around the WBN Plant (Counties and Places Over 1,000 People) 1990

Location	Total	White	Black	American Indian, Eskimo, Aleut	Asian or Pacific Islander	Other	Hispanic Origin
Anderson County	68,250	64,615	2,763	243	547	82	381
Clinton	8,972	8,629	289	40	6	8	50
Oak Ridge	27,310	24,409	2,180	97	562	62	266
Lake City	2,166	2,141	3	7	13	2	16
Norris	1,303	1,301	0	0	0	2	12
Oliver Springs	3,433	3,295	114	14	8	2	9
Bledsoe County	9,669	9,242	375	42	3	7	38
Pikeville	1,771	1,683	76	10	0	2	3
Blount County	85,969	82,503	2,783	195	409	79	368
Maryville	19,208	18,340	603	40	204	21	102
Alcoa	6,400	5,053	1,307	5	24	11	35
Eagleton Village	5,169	5,099	35	21	11	3	16
Rockwood	5,348	4,990	334	8	11	5	16
Seymoor	7,026	6,930	24	12	38	22	44
Bradley County	73,712	70,132	2,900	200	232	248	712
Cleveland	30,354	27,790	2,177	81	143	163	436
East Cleveland	1,249	1,216	26	7	0	0	24
South Cleveland	5,372	5,277	58	15	10	12	33
Hopewell	3,569	2,508	46	4	4	7	20
Cumberland County	34,736	34,475	42	137	49	33	124
Crossville	6,930	6,868	2	31	19	10	25
Fairfield Glade	3,209	2,194	11	2	2	0	3

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Kingston City	$13,196	$26,958	13.0%	108%	109%	83%
Oak Ridge City (pt)	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
Oak Ridge Div.	$15,085	$34,558	11.1%	123%	139%	71%
Oak Ridge City (pt)	$24,922	$63,046	1.9%	203%	254%	12%
Oliver Springs Town (pt)	$9,972	$12,905	29.3%	81%	52%	187%
Rockwood Div.	$10,637	$20,681	19.4%	87%	83%	124%
Harriman City (pt)	$15,520	$28,750	—[a]	127%	116%	—[a]
Rockwood City	$9,654	$17,024	23.5%	79%	69%	150%
Sequatchie County	$9,377	$19,223	22.9%	77%	77%	146%
Center Point Div.	$10,290	$23,996	14.9%	84%	97%	95%
Dunlap Div.	$9,053	$17,797	25.9%	74%	72%	165%
Dunlap City	$8,928	$17,920	24.3%	73%	72%	155%

Data source: 1990 Census of Population, Summary Social, Economic, and Housing Characteristics (Tennessee).

(a) Not reported

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Harriman City (pt)	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
Oaksdale Town	$8,137	$17,500	16.5%	66%	71%	105%
Sunbright Div.	$6,722	$16,884	24.6%	55%	68%	157%
Wartburg Div.	$8,175	$17,461	19.2%	67%	70%	122%
Wartburg City	$8,601	$14,395	26.1%	70%	58%	166%
Polk County	$9,311	$21,663	18.3%	76%	87%	117%
Benton Div.	$9,753	$22,245	17.1%	80%	90%	109%
Benton Town	$8,423	$17,500	30.0%	69%	71%	191%
Ducktown Div.	$8,800	$18,937	18.2%	72%	76%	116%
Copperhill City	$11,411	$17,266	15.5%	93%	70%	99%
Ducktown City	$8,432	$13,295	21.1%	69%	54%	134%
Parksville Div.	$10,793	$25,308	14.6%	88%	102%	93%
Turtletown Div.	$6,124	$16,348	28.9%	50%	66%	184%
Rhea County	$9,333	$19,915	19.0%	76%	80%	121%
Dayton Div.	$9,005	$19,489	20.4%	73%	79%	130%
Dayton City	$8,946	$18,355	20.8%	73%	74%	132%
Graysville Town	$8,394	$20,673	21.9%	68%	83%	139%
Spring City Div.	$9,990	$20,529	16.0%	82%	83%	102%
Spring City Town (pt)	$9,412	$19,757	21.1%	77%	80%	134%
Roane County	$12,015	$24,210	16.0%	98%	98%	102%
Barnard Div.	$11,911	$25,424	13.3%	97%	102%	85%
Harriman Div.	$10,029	$20,253	20.3%	82%	82%	129%
Harriman City (pt)	$8,772	$16,077	27.0%	72%	65%	172%
Kingston Div.	$13,691	$28,905	11.9%	112%	117%	76%

(a) Not reported

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Calhoun Town	$10,298	$24,750	4.4%	84%	100%	28%
Englewood Div.	$8,692	$17,905	18.8%	71%	72%	120%
Englewood Town	$7,843	$14,722	23.3%	64%	59%	148%
Eltowah Div.	$10,248	$21,134	15.5%	84%	85%	99%
Eltowah City	$9,853	$18,703	20.0%	80%	75%	127%
Meigs County	$9,237	$20,181	22.3%	75%	81%	142%
Big Springs-East View Div.	$7,991	$19,071	26.3%	65%	77%	168%
Decatur Div.	$9,971	$21,935	19.6%	81%	88%	125%
Decatur Town	$9,330	$21,312	23.3%	76%	86%	148%
Ten Mile Div.	$9,571	$19,375	21.5%	78%	78%	137%
Monroe County	$9,080	$19,932	17.8%	74%	80%	113%
Madisonville Div.	$9,146	$20,226	17.8%	75%	82%	113%
Madisonville Town	$9,911	$19,314	15.1%	81%	78%	96%
Sweetwater Div.	$10,001	$20,397	16.4%	82%	82%	104%
Sweetwater City (pt)	$10,061	$19,865	16.2%	82%	80%	103%
Tellico Plains Div.	$7,727	$18,106	21.0%	63%	73%	134%
Tellico Plains Town	$7,141	$14,904	24.4%	58%	60%	155%
Venore Div.	$8,974	$20,788	15.3%	73%	84%	97%
Venore Town	$8,484	$16,354	21.5%	69%	66%	137%
Morgan County	$7,722	$19,280	20.2%	63%	78%	129%
Coalfield Div.	$7,950	$20,769	19.2%	65%	84%	122%
Oliver Springs Town (pt)	$5,796	$8,523	51.7%	47%	34%	329%
Lancing Div.	$6,951	$14,797	25.3%	57%	60%	161%
Oakdale Div.	$8,176	$22,068	15.7%	67%	89%	100%

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Knoxville City (pt)	$5,796	$26,250	—(a)	47%	106%	—(a)
Knoxville Div.	$13,684	$23,924	16.2%	112%	96%	103%
Knoxville City (pt)	$12,113	$19,920	20.8%	99%	80%	132%
Powell Div.	$13,081	$26,262	8.7%	107%	106%	55%
Powell CDP	$13,985	$31,113	7.2%	114%	125%	46%
Skaggston Div.	$8,708	$20,587	17.1%	71%	83%	109%
Mascot CDP	$7,881	$19,097	19.1%	64%	77%	122%
Loudon County	$12,006	$24,258	13.6%	98%	98%	87%
Greenback Div.	$13,003	$23,983	10.9%	106%	97%	69%
Greenback City	$11,366	$21,364	12.8%	93%	86%	82%
Lenoir City Div.	$12,068	$24,413	13.9%	98%	98%	89%
Farragut Town (pt)	$4,667	$13,750	N/A	38%	55%	N/A
Lenoir City (pt).	$9345	$18,014	21.2%	76%	73%	135%
Loudon Town (pt)	—(a)	—(a)	—(a)	—(a)	—(a)	—(a)
Loudon Div.	$11,878	$23,768	14.2%	97%	96%	90%
Loudon Town (pt)	$10,140	$19,460	18.1%	83%	78%	115%
Philadelphia Div.	$10,467	$25,281	13.2%	85%	102%	84%
Philadelphia City	$9,809	$18,375	20.8%	80%	74%	132%
McMinn County	$10,508	$21,901	17.2%	86%	88%	110%
Athens Div.	$10,726	$21,951	18.5%	88%	88%	118%
Athens City	$10,286	$19,259	23.3%	84%	78%	148%
Nioata City	$11,226	$21,797	12.5%	92%	88%	80%
Sweetwater City (pt)	—(a)	—(a)	—(a)	—(a)	—(a)	—(a)
Calhoun-Riceville Div.	$11,296	$27,598	13.6%	92%	111%	87%

(a) Not reported

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Sale Creek Div.	$11,893	$28,423	11.8%	97%	115%	75%
Soddy-Daisy City (pt)	$10,749	$26,000	8.0%	88%	105%	51%
Signal Mountain Div.	$20,719	$44,164	4.1%	169%	178%	26%
Fairmount CDP	$15,482	$34,635	6.5%	126%	140%	41%
Signal Mountain Town (pt)	$23,893	$49,821	1.1%	195%	201%	7%
Walden Town (pt)	$26,980	$50,955	4.4%	220%	205%	28%
Snow Hill Div.	$13,119	$32,330	9.9%	107%	130%	63%
Soddy-Daisy Div.	$11,602	$27,494	12.9%	95%	111%	82%
Lakeside City	$14,735	$42,000	8.3%	120%	169%	53%
Soddy-Daisy City (pt)	$10,814	$21,875	16.7%	88%	88%	106%
Knox County	$14,007	$26,010	14.1%	114%	105%	90%
Concord Div.	$21,844	$54,410	3.3%	178%	219%	21%
Farragut Town (pt)	$22,560	$61,486	1.8%	184%	248%	11%
Knoxville City (pt)	$3,904	$18,750	—(a)	32%	76%	—(a)
Carryton Div.	$11,007	$25,991	11.0%	90%	105%	70%
Gibbs Div.	$11,386	$30,527	10.6%	93%	123%	68%
Halls Div.	$12,586	$30,521	8.5%	103%	123%	54%
Halls CDP	$14,109	$32,864	6.2%	115%	132%	39%
Hardin Valley Div.	$14,915	$32,752	9.9%	122%	132%	63%
Farragut Town (pt)	$12,534	$32,153	3.4%	102%	130%	22%
Karns CDP (pt)	$17,749	$31,840	1.3%	145%	128%	8%
Knoxville City (pt)	—(a)	—(a)	—(a)	—(a)	—(a)	—(a)
Karns Div.	$15,567	$37,005	4.3%	127%	149%	27%
Karns CDP (pt)	$12,462	$35,185	1.3%	102%	142%	8%

(a) Not reported

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Collegedale (pt)	$17,875	$60,250	—[a]	146%	243%	—[a]
East Brainerd CDP (pt)	$17,511	$48,072	3.5%	143%	194%	22%
East Ridge City (pt)	$15,676	$33,859	8.7%	128%	136%	55%
Harrison CDP	$14,819	$35,606	3.6%	121%	144%	23%
Middle Valley CDP (pt)	$15,063	$48,864	3.1%	123%	197%	20%
Ooltewah CDP (pt)	$15,924	$30,582	10.2%	130%	123%	65%
Red Bank City	$13,662	$25,015	9.9%	111%	101%	63%
Ridgeside City	$36,476	$57,036	4.8%	298%	230%	31%
Signal Mountain Town (pt)	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
Soddy-Daisy City (pt)	$9,384	$21,312	15.3%	77%	86%	97%
Walden Town (pt)	$35,280	$75,000	—[a]	288%	302%	—[a]
East Ridge Div.	$13,788	$26,258	7.5%	113%	106%	48%
East Ridge City (pt)	$13,788	$26,258	7.5%	113%	106%	48%
Lookout Mountain Div.	$19,604	$30,991	8.3%	160%	125%	53%
Chattanooga City (pt)	$11,949	$26,196	10.0%	98%	106%	64%
Lookout Mountain Town (pt)	$41,079	$64,266	3.1%	335%	259%	20%
Middle Valley Div.	$14,403	$41,151	3.8%	118%	166%	24%
Chattanooga City (pt)	$11,648	$23,750	—[a]	95%	96%	—[a]
Middle Valley CDP (pt)	$13,513	$39,123	3.9%	110%	158%	25%
Soddy Daisy City (pt)	$11,145	$25,729	23.6%	91%	104%	150%
Ooltewah Div.	$13,373	$30,324	8.6%	109%	122%	55%
Collegedale City (pt)	$10,432	$27,964	8.1%	85%	113%	52%
Ooltewah CDP (pt)	$9,612	$18,259	16.4%	78%	74%	104%

(a) Not reported

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
South Bradley Div.	$12,330	$28,256	7.7%	101%	114%	49%
Cleveland City (pt)	$11,975	$23,958	—(a)	98%	97%	N/A
South Cleveland CDP(pt)	$11,731	$24,883	5.3%	96%	100%	34%
Wildwood Lake CDP (pt)	$10,527	$28,187	6.8%	86%	114%	43%
Southeast Bradley Div.	$11,090	$26,599	9.5%	90%	107%	61%
Wildwood Lake CDP (pt)	$12,007	$25,272	14.9%	98%	102%	95%
West Bradley Div.	$12,848	$29,163	9.7%	105%	118%	62%
Cleveland City (pt)	$16,704	$31,250	8.3%	136%	126%	53%
Hopewell CDP	$13,582	$30,244	9.8%	111%	122%	62%
Cumberland County	$9,782	$20,474	18.1%	80%	83%	115%
Crab Orchard Div.	$7,601	$17,543	19.9%	62%	71%	127%
Crab Orchard City (pt)	$7,117	$14,022	28.5%	58%	57%	182%
Crossville Div.	$9,744	$19,247	20.3%	80%	78%	129%
Crab Orchard City (pt)	—(a)	—(a)	—(a)	—(a)	—(a)	—(a)
Crossville City	$8,895	$16,081	28.6%	73%	65%	182%
Crossville North Div.	$11,832	$24,215	11.4%	97%	98%	73%
Fairfield Glade CDP	$17,323	$29,031	3.3%	141%	117%	21%
Lantana Div.	$9,758	$21,560	16.4%	80%	87%	104%
Maryland- Pleasant Hill Div.	$8,123	$18,824	22.1%	66%	76%	141%
Pleasant Hill Town	$10,907	$19,667	15.5%	89%	79%	99%
Hamilton County	$13,619	$26,523	13.1%	111%	107%	83%
Chattanooga Div.	$13,082	$24,599	15.7%	107%	99%	100%
Chattanooga City (pt)	$12,345	$22,040	18.5%	101%	89%	118%

(a) Not reported

Table C.5 (contd)

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Blount County	$12,674	$25,575	12.4%	103%	103%	79%
Binfield Div.	$11,903	$27,045	14.4%	97%	109%	92%
Friendsville Div.	$15,690	$29,407	10.3%	128%	119%	66%
Friendsville City	$12,070	$30,000	7.9%	98%	121%	50%
Maryville City (pt)	$44,429	$127,308	—[a]	363%	513%	—[a]
Lanier Div.	$12,116	$28,091	8.7%	99%	113%	55%
Maryville-Alcoa Div.	$12,766	$25,016	12.9%	104%	101%	82%
Alcoa City	$12,876	$22,398	14.0%	105%	90%	89%
Eagleton Village CDP	$11,593	$23,363	11.2%	95%	94%	71%
Maryville City (pt)	$13,397	$25,206	13.9%	109%	102%	89%
Rockford City (pt)	$11,817	$28,036	10.1%	96%	113%	64%
Townsend Div.	$9,482	$21,128	14.0%	77%	85%	89%
Townsend City	$10,428	$16,625	15.6%	85%	67%	99%
Wildwood Div.	$12,000	$28,870	10.8%	98%	116%	69%
Seymour CDP	$13,534	$32,989	8.4%	110%	133%	54%
Bradley County	$11,768	$25,678	13.8%	96%	104%	88%
Charleston Div.	$12,566	$32,360	9.5%	103%	130%	61%
Charleston City	$11,225	$24,500	19.1%	92%	99%	122%
Cleveland City (pt)	$14,518	$38,914	8.4%	118%	157%	54%
Cleveland Div.	$11,040	$21,743	19.1%	90%	88%	122%
Cleveland City (pt)	$11,554	$20,951	19.6%	94%	84%	125%
East Cleveland CDP	$7,407	$11,932	35.2%	60%	48%	224%
South Cleveland CDP	$10,246	$27,338	13.0%	84%	110%	83%
Wildwood Lake CDP (pt)	$10,659	$28,229	12.5%	87%	114%	80%

(a) Not reported

Table C.5 Income Status Around the WBN Plant, 1989

Location	Per Capita Income (1989 dollars)	Median Household Income	Percent of Households Below Poverty Level, 1989	Per Capita Income as Percent of State Average	Median Household Income as Percent of State Average	Percent of Persons Below Poverty Level as A Percent of State Average
Tennessee	$12,255	$24,807	15.7%	100%	100%	100%
Anderson County	$13,182	$26,496	14.3%	108%	107%	91%
Clinton Div.	$12,963	$26,549	15.7%	106%	107%	100%
Clinton Town (pt)	$13,691	$24,597	17.9%	112%	99%	114%
Oak Ridge City (pt)	$27,541	$67,732	1.8%	225%	273%	11%
Clinton S. Div.	$11,765	$27,413	13.2%	96%	111%	84%
Clinton Town (pt)	$11,470	$23,056	7.0%	94%	93%	45%
Oak Ridge City (pt)	—[a]	—[a]	—[a]	—[a]	—[a]	—[a]
Lake City E. Div.	$8,640	$19,144	21.2%	71%	77%	135%
Lake City Town (pt)	$7,671	$13,686	31.5%	63%	55%	201%
Lake City W. Div.	$6,411	$17,746	27.7%	52%	72%	176%
New River Div.	$5,195	$9,708	33.3%	42%	39%	212%
Norris Div.	$11,338	$26,256	14.6%	93%	106%	93%
Norris City	$15,325	$31,406	8.8%	125%	127%	56%
Oak Ridge Div.	$16,860	$30,589	10.3%	138%	123%	66%
Oak Ridge City (pt)	$16,860	$30,589	10.3%	138%	123%	66%
Walden Ridge Div.	$9,593	$22,099	18.4%	78%	89%	117%
Oliver Springs (pt)	$10,179	$22,933	14.0%	83%	92%	89%
Bledsoe County	$8,053	$18,250	19.2%	66%	74%	122%
Cumberland Plateau Div.	$6,705	$19,936	20.4%	55%	80%	130%
Sequatchie Valley Div.	$9,141	$17,881	18.3%	75%	72%	117%
Pikeville Town	$9,065	$15,217	26.6%	74%	61%	169%
Walden Ridge Div.	$7,740	$17,721	19.7%	63%	71%	125%

(a) Not reported

Table C.4 (contd)

Local Entity	Redistributed from State	State Allocated Impact Funds	Direct from TVA	Total from TVA	Total Revenue from All Sources	TVA Percent of Total	TVA Impact Percent of Total
	Importance of TVA Impact Funds to Local Entities Near WBN Plant, Fiscal Year 1992						
Englewood	$9,362	$7,532		$16,894	$829,000	2.04%	0.91%
Etowah	$19,350	$17,836		$37,186	$14,104,000	0.26%	0.13%
Niota	$5,699	$3,923		$9,622	$466,000	2.06%	0.84%
Meigs Co.	$296,027	$245,042	$3,713	$544,782	$7,770,000	7.01%	3.15%[a]
Decatur	$6,903	$41,516		$48,419	$783,000	6.18%	5.30%[a]
Monroe Co.	$666,232	$217,765	$29,543	$913,540	$22,119,000	4.13%	0.98%
Madisonville	$15,384	$21,626		$37,010	$2,698,000	1.37%	0.80%
Sweetwater	$26,173	$36,122		$62,295	$16,969,000	0.37%	0.21%
Tellico Plains	$4,395	$6,125		$10,520	$762,000	1.38%	0.80%
Vonore	$3,500	$4,920		$8,420	$217,000	3.88%	2.27%[a]
Rhea Co.	$466,358	$206,067	$6,349	$678,774	$32,800,000	2.07%	0.63%
Dayton	$32,594	$50,137		$82,731	$16,648,000	0.50%	0.30%
Graysville	$3,292	$11,741		$15,033	$275,000	5.47%	4.27%[a]
Spring City	$12,524	$18,614		$31,138	$1,617,000	1.93%	1.15%[a]
Roane Co.	$675,233	$199,218	$20,787	$895,238	$45,164,000	1.98%	0.44%
Harriman	$39,107	$30,030		$69,137	$41,083,000	0.17%	0.07%
Kingston	$25,908	$19,202		$45,110	$2,919,000	1.55%	0.66%
Oak Ridge	$141,804	$10,575		$152,379	$62,970,000	0.24%	0.02%
Oliver Springs	$17,413	$4,130		$21,543	$1,660,000	1.30%	0.25%
Rockwood	$27,126	$23,403		$50,529	$21,674,000	0.23%	0.11%
Total	$6,465,637	$2,292,465	$175,934	$8,934,036	$1,419,395,000	0.63%	0.16%

Data source: TVA Response to Question 32, Tax Equivalent Payments to Designated Entities, Fiscal Year 1992, NRC Docket 50-390 and 50-391, September 27, 1994.

(a) Indicates where Tennessee impact funds are more than 1 of the total funds available for the local government.

Table C.4 Tax-Equivalent Payments to Designated Counties and Cities in the WBN Site Vicinity Fiscal Year 1992

	Importance of TVA Impact Funds to Local Entities Near WBN Plant, Fiscal Year 1992						
Local Entity	Redistributed from State	State Allocated Impact Funds	Direct from TVA	Total from TVA	Total Revenue from All Sources	TVA Percent of Total	TVA Impact Percent of Total
Bradley Co.	$362,521	$201,486	$30,181	$594,188	$59,403,000	1.00%	0.34%
Charleston	$3,312	$1,785		$5,097	$280,000	1.82%	0.64%
Cleveland	$155,311	$83,287		$238,598	$83,108,000	0.29%	0.10%
Hamilton Co.	$1,308,715	$164,835	$24,839	$1,498,389	$211,994,000	0.71%	0.08%
Chattanooga	$816,351	$88,016		$904,367	$534,789,000	0.17%	0.02%
Collegedale	$25,604	$2,914		$28,518	$4,324,000	0.66%	0.07%
East Ridge	$107,028	$12,181		$119,209	$7,439,000	1.60%	0.16%
Lakesite	$4,159	$473		$4,632	$118,000	3.93%	0.40%
Lookout Mtn.	$9,642	$1,097		$10,739	$2,061,000	0.52%	0.05%
Red Bank	$62,499	$7,113		$69,612	$3,411,000	2.04%	0.21%
Ridgeside	$2,029	$231		$2,260	$173,000	1.31%	0.13%
Signal Mtn.	$35,678	$4,061		$39,739	$4,189,000	0.95%	0.10%
Soddy-Daisy	$41,795	$4,757		$46,552	$2,085,000	2.23%	0.23%
Walden	$7,725	$879		$8,604	$451,000	1.91%	0.19%
Loudon Co.	$542,186	$210,540	$21,256	$773,982	$22,380,000	3.46%	0.94%
Greenback	$3,292	$4,372		$7,664	$125,000	6.13%	3.50%[(a)]
Lenoir City	$32,703	$41,407		$74,110	$67,292,000	0.11%	0.06%
Loudon	$23,693	$27,120		$50,813	$26,140,000	0.19%	0.10%
Philadelphia	$2,348	$3,119		$5,467	$53,000	10.32%	5.88%[(a)]
McMinn Co.	$360,385	$198,153	$39,266	$597,804	$48,938,000	1.22%	0.40%
Athens	$61,477	$56,534		$118,011	$46,840,000	0.25%	0.12%
Calhoun	$2,800	$2,581		$5,381	$275,000	1.96%	0.94%

(a) Indicates where Tennessee impact funds are more than 1% of the total funds available for the local government.

Table C.3 (contd)

Local Entity	Responding Employees 7/30/82	Responding Employees 4/30/84	Percent of Total Responses 7/30/82	Percent of Total Responses 4/30/84
Knoxville	121	141	4.69%	5.35%
Oak Ridge	11	8	0.43%	0.30%
Benton	12	10	0.47%	0.38%
Birchwood	5	6	0.19%	0.23%
Coppermill	6	—[(a)]	0.23%	0.00%
Dunlap	9	10	0.35%	0.38%
East Ridge	8	7	0.31%	0.27%
Harrison	26	23	1.01%	0.87%
Lake City	6	6	0.23%	0.23%
Loudon	19	14	0.74%	0.53%
Oakdale	8	7	0.31%	0.27%
Oliver Springs	10	6	0.39%	0.23%
Ooltewah	11	18	0.43%	0.68%
Pikeville	14	17	0.54%	0.65%
Powell	10	12	0.39%	0.46%
Salt Creek	18	20	0.70%	0.76%
Tellico Plains	26	22	1.01%	0.83%
Vonore	8	8	0.31%	0.30%
Clinton	15	15	0.58%	0.57%
Maryville	17	18	0.66%	0.68%
Other	264	252	10.24%	9.56%
Total	2579	2635	100.00%	100.00%

Data source: Tennessee Valley Authority, Watts Bar Nuclear Plant Construction and Operation Employee Survey Results and Mitigation Summary, July 30, 1982, and April 30, 1984.

(a) Not reported

Table C.3 Residential Distribution of WBN Plant Workforce

Local Entity	Responding Employees 7/30/82	Responding Employees 4/30/84	Percent of Total Responses 7/30/82	Percent of Total Responses 4/30/84
Crossville	67	78	2.60%	2.96%
Athens	145	143	5.62%	5.43%
Chattanooga	164	152	6.36%	5.77%
Cleveland	125	99	4.85%	3.76%
Dayton	139	149	5.39%	5.65%
Decatur	151	128	5.85%	4.86%
Englewood	23	21	0.89%	0.80%
Etowah	26	28	1.01%	1.06%
Evensville	35	39	1.36%	1.48%
Grandview	13	19	0.50%	0.72%
Graysville	23	24	0.89%	0.91%
Harriman	93	93	3.61%	3.53%
Hixson	70	84	2.71%	3.19%
Kingston	103	110	3.99%	4.17%
Lenoir City	54	48	2.09%	1.82%
Madisonville	44	43	1.71%	1.63%
Niota	19	20	0.74%	0.76%
Oliver Springs	10	15	0.39%	0.57%
Philadelphia	—[a]	9	0.00%	0.34%
Riceville	20	18	0.78%	0.68%
Rockville	—[a]	50	0.00%	1.90%
Rockwood	100	62	3.88%	2.35%
Soddy Daisy	56	79	2.17%	3.00%
Spring City	316	333	12.25%	12.64%
Sweetwater	47	64	1.82%	2.43%
Ten Mile	112	107	4.34%	4.06%

(a) Not reported

Table C.2 Year 2040 Population Distribution in the Watts Bar Region

Direction	(0-16 km) [0-10 mi]	(16-32 km) [10-20 mi]	(32-48 km) [20-30 mi]	(48-64 km) [30-40 mi]	(64-82 km) [40-50 mi]	Total
N	1,210	2,071	2,166	3,453	4,040	12,940
NNE	965	8,591	19,187	9,342	1,194	39,279
NE	1,329	3,381	19,210	30,623	54,111	108,655
ENE	440	2,445	9,497	38,457	136,395	187,234
E	582	9,716	8,837	10,649	17,404	47,189
ESE	702	4,514	12,085	3,420	300	21,022
SE	585	17,835	10,818	3,969	3,756	36,964
SSE	803	4,018	8,056	3,899	6,362	23,138
S	1,717	1,141	34,699	40,812	11,522	89,892
SSW	831	5,653	17,523	25,829	117,868	167,704
SW	526	6,490	9,411	68,565	125,338	210,330
WSW	1,399	10,369	2,091	7,134	6,571	27,564
W	987	965	5,337	2,839	2,035	12,163
WNW	550	1,461	2,925	3,440	17,598	25,973
NW	2,900	314	7,266	7,004	9,802	27,286
NNW	2,328	874	18,279	4,784	2,983	29,248
Total	17,854	79,840	187,386	264,220	517,279	1,066,580

Data source: Tennessee Valley Authority, Watts Bar Final Safety Analysis Report.

Table C.1 Year 1990 Population Distribution in the Watts Bar Region

Direction	(0-16 km) [0-10 mi]	(16-32 km) [10-20 mi]	(32-48 km) [20-30 mi]	(48-64 km) [30-40 mi]	(64-82 km) [40-50 mi]	Total
N	1,040	1,659	1,760	2,917	3,541	10,917
NNE	835	6,947	15,473	8,288	1,074	32,616
NE	1,187	3,194	15,815	24,769	43,336	88,300
ENE	396	1,767	8,371	32,151	108,745	151,430
E	505	7,781	7,276	8,777	13,967	38,305
ESE	601	3,470	9,788	2,793	300	16,952
SE	504	16,530	9,068	3,285	3,142	32,529
SSE	690	3,052	6,825	3,348	5,536	19,450
S	1,544	1,115	26,801	31,540	9,044	70,044
SSW	749	4,827	13,711	20,327	93,289	132,902
SW	454	5,541	7,499	54,539	99,669	167,702
WSW	1,197	8,830	1,728	5,916	5,421	23,093
W	847	831	4,402	2,481	1,736	10,296
WNW	470	1,205	2,384	3,114	14,876	22,048
NW	2,476	277	5,825	5,626	7,975	22,178
NNW	1,987	737	14,619	3,826	2,532	23,702
Total	15,482	67,763	151,343	213,695	414,182	862,465

Data source: Tennessee Valley Authority, Watts Bar Final Safety Analysis Report.

Appendix C

Socioeconomics

This appendix provides additional population and socioeconomic data in the Watts Bar region. Included are (1) population distribution around the WBN Plant for 1990 and projected for 2040 (Tables C.1 and C.2), (2) the residential distribution of the WBN Plant workforce in the mid-1980s (Table C.3), (3) the distribution of tax-equivalent payments to local entities in the WBN Site vicinity by the applicant and State of Tennessee (Table C.4), and (4) data on the income, economic status, race, and ethnicity of the population around the WBN Plant (Tables C.5 and C.6).

Appendix C

Socioeconomics

Name	Affiliation	Function or Expertise
Pacific Northwest Laboratory[(a)]		
Rebekah Harty	Health Protection Department	Task Leader
James V. Ramsdell, Jr.	Earth and Environmental Sciences	Meteorology
Dillard B. Shipler	Occupational and Environmental Risk	Senior Peer Reviewer
Joseph K. Soldat	Health Risk Assessment Department	Health Physics/Reviewer
Dale H. Denham	Health Protection Department	Health Physics
Colbert E. Cushing	Earth and Environmental Science	Aquatic Ecology
Susan L. Blanton	Earth and Environmental Science	Aquatic Ecology
Charles A. Brandt	Earth and Environmental Science	Terrestrial Ecology
Michael R. Sackschewsky	Earth and Environmental Science	Terrestrial Ecology
Michael J. Scott	Technology Planning and Analysis	Socioeconomics
Eva E. Hickey	Health Protection Department	Health Physics
David Baker	Health Risk Assessment Department	Dose Assessment
Sallie J. Ortiz	Technical Communications	Technical Editor
Robert A. Buchanan	Technical Communications	Technical Editor
Donald J. Hanley	Technical Communications	Technical Editor
Other Contractor Support		
David Goldin	Sanford Cohen & Assoc.	Severe Accident Mitigation Design Analysis
Jim Meyer	Scientech, Inc.	Severe Accident Mitigation Design Analysis

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute.

Appendix B

Contributors to the Supplement

The overall responsibility for the preparation of this supplement was assigned to the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission (NRC). The statement was prepared by members of the Office of Nuclear Reactor Regulation with assistance from other NRC organizations, the Pacific Northwest Laboratory, Scientech, Inc., and Sanford Cohen & Associates.

Name	Affiliation	Function or Expertise
Nuclear Regulatory Commission		
Scott F. Newberry	Nuclear Reactor Regulation	Branch Chief
Frank M. Akstulewicz	Nuclear Reactor Regulation	Section Chief
Scott C. Flanders	Nuclear Reactor Regulation	Project Manager
Barry Zalcman	Nuclear Reactor Regulation	Technical Monitor
Michael T. Masnik	Nuclear Reactor Regulation	Aquatic Ecology
James H. Wilson	Nuclear Reactor Regulation	Aquatic/Terrestrial Ecology
Steven A. Reynolds	Nuclear Reactor Regulation	Environmental Engineer
Charles A. Willis	Nuclear Reactor Regulation	Health Physics
John L. Minns	Nuclear Reactor Regulation	Health Physics
Robert L. Palla	Nuclear Reactor Regulation	Severe Accident Mitigation Design Alternatives Analysis
Peter S. Tam	Nuclear Reactor Regulation	Watts Bar, Project Manager
Richard L Emch, Jr.	Nuclear Reactor Regulation	Section Chief
Clark W. Prichard	Nuclear Regulatory Research	Severe Accident Mitigation Design Alternatives Analysis
Rayleona F. Sanders	Publications	Technical Editor

Appendix B

Contributors to the Supplement

LETTER BB

Dear Nuclear Regulatory Commission,

I understand you are open to citizen comments until Feb. 14 concerning the Watts Bar Nuclear Power plant. These are just a small sample of reasons why I am against the completion of the plant.

•TVA is currently pouring in about $1 million a day in construction costs.

•It has a terrible track record for safety; there were three accidents last year, one involving a fire in the control room.

•In 1992, TVA itself released a study rating Watts Bar with the highest probability of a core meltdown of any plant in the United States.

9.8.2.1

Watts Bar is unsafe, uneconomical, and unnecessary.

Sincerely,

Dave Hedgepeth

NRC
Chief, Rules Review and
Directives Branch
US Nuclear Regulatory
Commission
Washington, D.C. 20555-

BB-1

LETTER CC

TENNESSEE STATE PLANNING OFFICE

NED McWHERTER, GOVERNOR
RICHARD L. LEWIS, DIRECTOR

OFFICE OF THE GOVERNOR
SUITE 309, JOHN SEVIER BUILDING
500 CHARLOTTE AVENUE
NASHVILLE, TENNESSEE 37243-0001

January 17, 1994 94-0707

Mr. Scott Flanders
Chief Rules Review & Directives Branch
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

CHTN011894-020, Final Environmental Statement Related to the Operation of Watts Bar Nuclear Plant, Units 1 & 2

Dear Mr. Flanders:

In accordance with Presidential Executive Orders 12372 and 12416 and with Gubernatorial Executive Order 38, this office serves as the designated State Clearinghouse for federal activities and grants review.

State and local government evaluation of submitted materials has indicated no conflicts with existing or planned activities. Therefore, we are recommending that this proposal be approved based on the descriptive information made available to us. However, should additional information come to the attention of this office, we may wish to comment further.

This letter should be attached to the application and become a permanent part of the project file. Any involved federal agency should respond in writing to this office if there are problems in complying with this approval. The above State Clearinghouse Identification Number should be placed in the appropriate block on the federal application form.

The appropriate funding agency will now be reviewing our recommendation. If we can be of further assistance, please do not hesitate to contact us.

Sincerely,

Charles W. Brown
Director, State Clearinghouse

CWB:mcp

cc: All Development Districts
All Congressional Districts

THE STATE OF TENNESSEE IS AN EQUAL OPPORTUNITY, EQUAL ACCESS, AFFIRMATIVE ACTION EMPLOYER

CC-1

LETTER AA

return it back to the river beings and let the forest reclaim it as their own. Please do not allow it to operate.

As long as the utilities and government continue to pursue with further development of nuclear power, the more the anti-nuke movement will grow. You will see more mass demonstrations and with that direct action will grow in number and size.

For the future of all life on this precious planet I demand you not give TVA an operating license for Watts Bar

For the Wild

Olivia [signature]

Z-2

Dear Nuclear Regulatory Commission,

I understand you are open to citizen comments until Feb. 14 concerning the Watts Bar Nuclear Power plant. These are just a small sample of reasons why I am against the completion of the plant:

*TVA is currently pouring in about $1 million a day in construction costs.

*It has a terrible track record for safety; there were three accidents last year, one involving a fire in the control room.

*In 1992, TVA itself released a study rating Watts Bar with the highest probability of a core meltdown of any plant in the United States.

Watts Bar is unsafe, uneconomical, and unnecessary.

Sincerely,

[signature]

JASON SMALL

NRC
Chief, Rules Review &
Directives Branch
US Nuclear Regulatory
Commission
Washington, D.C., 20555-0001

9.8.2.1

AA-1

the callous slow murder of countless millions of humans by the nuclear power systems stands the history and continued nose-thumbing affront to the creation and to its Creator witch is currently embodied in the irreverent disregard for endangered species which would be lost forever until Kingdom Come, here in this region if this facility under consideration is allowed to operate. All species hereabouts and the Tennessee River itself are threatened in terms of health & safety by the Watts Bar facility. To further aggravate the callousness and absurdity evident
9.1.2 in considering the operation, the E.I.R. and its supplement were written in 1972 and 1978-- almost twenty (20) years since even nominal assessment has been carried out. The human life and the environment would appear to not merit very careful consideration, as though too much work to bother with. But the consequences of our abuse and destruction shall surely balance out the convenience afforded by such sloth.

Today I called your office and was told that although you do not accept telephone comments, that this comment will be accepted if mailed out today. Therefore it is my expectation if your office possesses any integrity or decency, that I shall find this comment included.

Thank you for any conscientious regard and consideration for our lives in this region and for what remains of the Creator's awesome living world.

Sincerely,
David E. Brown

Y-2

LETTER Z

[illegible] Lim
1055 Hillcrest Rd
Hixson TN 37343

Chief, Rules Review and Directives
U.S. Nuclear Regulatory Commission
Washington, DC. 20555-0001

Dear Chief,

I have reviewed the final Environmental Statement Draft (FESD) regarding the Watts Bar Nuclear Facility in Spring City TN. It would be a huge mistake to grant TVA an operating license for Watts Bar. Several key points and questions were not adequately addressed by the NRC in the Watts Bar EIS supplement.

In 1978 2 species of [illegible] mussels have been identified at the Watts Bar site. Since then, two additional species of endangered mussels have been identified. How thorough has the evaluation of mussel populations been? No plans to recover or protect the endangered species are discussed. If this loss is predicted and documented, why aren't there efforts to recover the species? This could include the designation of critical habitat, restoration ecology, and reestablishing population. Again the EIS is not thorough. [illegible] suggestion for the Watts Bar facility is to turn it into an alternative energy center used for a vocational school for the economically disadvantaged. Turn it into a commercial park recreational area (Mickey's Wonderland?!!!) or 9.4.3.1 9.3.2

Z-1

THAT IS SUPERIOR TO EXISTING GAS TURBINE, SOLAR, WIND/OCEAN TECHNOLOGIES. NUCLEAR POWER ONLY EXISTED TO BEGIN WITH BECAUSE AN ALTERNATIVE TO COAL WAS DESIRED.

INFERIOR ASPECTS OF PRESENT NUCLEAR POWER INCLUDE 1) LAND WASTAGE DUE TO THE DECOMISSIONED PLANTS HAVING LONG LIVES 2) LARGE MINING WASTE TONNAGE. 3) WASTE DISPOSAL PROBLEMS 4) THREAT OF TERRORISTS DUE TO THE NATURE OF THE FUEL AND WASTE, AND 5) HIGH COST RELATIVE TO AS YET ~~[illegible]~~ UNIMPLEMENTED CONSERVATION-ORIENTED STRATEGIES.

UNTIL UTILITIES LIKE TVA BEGIN ACHIEVING CONSUMPTION REDUCTION, I WILL OPPOSE NEW GENERATING CAPACITY.

SINCERELY,

John van der Horst
1407 Roberts Ave.
Nashville TN 37206

615/227-3479

X-2

LETTER Y

David E. Brown
2620 Amber Way
P.O. Box 1182
Dandridge, Tennessee 37725

February 14, 1995

Chief, Rules and Directives Branch
United States Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear sir or madam,

This is a comment on the current Environmental Impact Statement and draft supplement of the Watts Bar Nuclear Facility.

It is incredible and callously irresponsible that this licensing procedure is being considered for approval. The health impact of nuclear power facilities for surrounding communities wherever these have operated has proven without exception to dramatically and highly significantly (statistically) increase the incidence of fatal and terminal cancer among humans in the vicinities of the plants, with cancer incidence directly proportional both to proximity and to years of operation. It is high time the State of Tennessee joined the prudent and responsible states of the rest of the union in protecting the health of its people, but if the State will not act then it is the responsibility of United States government, especially the Nuclear Regulatory Commission, to protect the people from massive needless suffering. It has also been already established and proven that dangerous and murderous nuclear power is not necessary to meet the people's power needs. 9.6.4.16

The health and well-being of the people should sufficiently stand alone to preclude the consideration of further jeopardy, but even beyond

Y-1

Who will pay for it? How will it be stored safely?

In closing, I would like to thank you for your effort to update the 1978 EIS in light of the fact that the TVA has refused to do so. Please reconsider your
9.2.1 finding of "no significant impact". WBN has the potential to significantly effect human and non-human life in this region. Do NOT give it an operating license! The [illegible] at the TVA are inept, bungling fools and WBN is unsafe, uneconomical and unnecessary. Please hold new
9.10.3 public hearings to address the construction permit and operating license of WBN Nuclear.

Thank you for your time and consideration.

For the EARTH

John Johnson
PO Box 281
Chattanooga, TN 37[illegible]
615-624-3939

W-6

LETTER X

February 13, 1995

NRC

Chief, Rules Review & Directives Branch

U.S. Nuclear Regulatory Commission

Washington, DC 20555-0001

Dear Chief:

I heard that you are receiving comments from citizens until February 14, 1995 regarding the Watts Bar, TN plant. That is why I am writing.

I used to support nuclear power. I don't now. I feel that Watts Bar unit #1, if permitted, would extend the period through which the present generation of nuclear plant designs would exist to be a target for citizens to vent their anger about. We need to get beyond this period. With Watts Bar #1's track record among the [illegible] in this, I feel that it would pose a relatively high risk of maximizing the length of time during which citizens would want to beat up on NRC, to try to end all involvement with any technology related to present nuclear plants.

If NRC wants to continue to be a major player 9.1.3
in the energy debate, I would suggest that NRC try to develop an energy production alternative

X-1

and how this would effect operations at WBN and other sites. It is my understanding that the TVA is or has commissioned the University of North Carolina to conduct a study of a suspected fault line running the length of the valley and awfully close to WBN and Sequoyah N. The NRC should demand that this information (even if the study is incomplete) be shared and open to public scrutiny.

9.6.3.4 A major failing in the NRC's WBN DEIS is that it fails to address the concept of Cumulative Impacts. TVA itself set a precedent for this with its 1993 Chip Mill EIS. Considering cumulative + off site impacts is also required by the National Environmental Policy Act (NEPA - sorry, can't quote the right CFR # for you). Areas involving cumulative impacts that need to be addressed include: sediment + pollution from the Clinch river (Oak Ridge National Labs + associated activities) (re 2-[illegible]) that have built up in the WB reservoir and continue to degrade the TN river ecosystem; other chemicals in the TN river especially Eastman Kodak discharges, DuPont, Knoxville Sewage discharges, dioxin from the Pigeon River and other discharges, cumulative impacts on H_2O quality re. 2.10); ~~etc.~~; TVA herbicide program etc.

W-4

You also need to address the cumulative impacts of general habitat destruction in the TN Valley, Cumberland Plateau, and Southern Appalachian Mtns. How will operations at WBN contribute to the cumulative effects on species, their habitat and the ecology that this general pattern of environmental degradation is having on this bioregion. You also need to consider the cumulative impacts that operations at WBN will have when combined with acid rain, ground level ozone and increased UV-B radiation (due to a depleted ozone layer in the stratosphere). The overall ecological health of the whole watershed must be considered!

(margin: especially endangered species like eagles, bats and [illegible]!)

9.6.6 In the area of socioeconomic impacts, the DEIS fails to address the likelihood of an accident considering WBNs poor safety record and the documented intimidation of workers who bring up safety concerns. How can you speak of environmental justice when "whistleblowers" are harassed and the NRC signed a 1991 "Memo of Understanding" with the TVA Inspector General Norman Zigrossi that allows the NRC to turn over the issues of whistle blowers?

9.6.4.13 The NRC also fails to address the issue of nuclear waste created by the WBN. Where will this waste be stored?

W-5

Mussels that were used in the tests.
The accuracy and reliability of these
tests is therefore in question. (p. 5-8)
It is expected that continuing declines
of mussels will show a "gradual decline
in mussel species abundance and diversity."
9.3.2 The Endangered Species Act mandates
plans to recover endangered species
populations and their habitats. No plans
to recover or protect the endangered
mussel species are described. If the loss
of species is predicted, how do we [illegible]
ly what the efforts to recover
these species and their respective habitats?
These efforts for recovery must
occur and must include the
designation of critical habitat, restoration,
ecology, and reestablishment of populations.
There is also a need to discuss
9.6.3.4 the cumulative impacts of environmental
degradation on the existing mussel populations.
The mussel beds around the Watts Bar Nuclear
site do not exist in a vacuum. What
will the cumulative effect of activities
upstream have on these species when
combined with activities such as
molluscicide use at the WB site? You
also need to consider what effects
9.6.4.9 "batch releases" of "slightly" radioactive
materials will have on mussel populations
and the aquatic ecology in general.
Please also consider the cumulative

W-2

impacts on the TN river ecosystem that
batch releases will have when combined
with batch releases from the Sequoyah
nuclear site and other industrial + municipal
sewage discharge sites. What will the effects
be on human populations, H_2O quality and 9.6.2.2
the drinking water supply? I don't believe
the issue of "batch" releases of Tritium 9.6.4.4
and other materials has been adequately
addressed in this EIS. The EIS also
does not address unplanned discharges 9.8.1.1
into the river from these "industrial
incidents" that are bound to occur
at the WBN site. For example,
in 1984 a transformer fire occurred
at the Sequoyah Nuclear site. Subsequently,
Poly-chlorinated biphenyls (PCBs) leaked into
a holding pond at the site. It was
later discovered by TVA that this
holding pond was inadequately lined and
the PCBs had been steadily flowing
into the Chickamauga Reservoir. Watts Bar
Nuclear is plagued by fires, accidents
and other "industrial incidents". What effects
will these have on the aquatic and
terrestrial ecosystems surrounding the
facility? Again, cumulative impacts on 9.6.3.4
the area ecology and drinking water supply
need to be addressed.
The DEIS does not adequately
address the possibility of seismic 9.4.6
activity in the TN river valley

W-3

LETTER V

Chief, Rules Review
and Directives Branch
USNRC
Washington, DC 20555-0001

To Whom It May Concern:

I am writing to express my deep reservations about the potential opening of the TVA's Watts Bar Unit 1 reactor. First and most importantly, the plant appears to me to be completely unsafe. The quality of the construction and materials from the very beginning was of inferior quality, and despite what the TVA would have us believe, quality CAN NOT be engineered in after the fact. The Watts Bar plant has had so many whistle blower complaints in its 20+ years of construction that it seems completely insane to me that either TVA officials or anyone at the NRC could possibly face the public and say that the plant is "safe" for operation. If the very people who work there do not have faith in the plant, why does the TVA continue to try and force this accident waiting to happen down the throats of the valley ratepayers? And this point brings another closely related safety aspect to mind; namely, the NRC's current policy of giving the TVA the names of whistle blowers is a blatantly cooperative action designed to suppress any further complaints from workers. It creates an atmosphere of fear in which workers do not report problems for fear of TVA retribution. So who knows how many additional complaints have gone unreported?

Secondly, as I understand it, the Watts Bar plant is located on a
9.4.6 fault line which is due for a major earthquake (5+ on the Richter Scale) at some time within the next one hundred years. The destructive capability of such a quake alone is enough for concern, but in combination with the poor construction at Watts Bar, the potential for a major disaster is undeniable.

Finally, the Watts Bar facility would threaten already endangered species of fresh water mussels. The TVA would like to downplay
9.6.3.2 this fact and pretend that the plant would have no effect on aquatic life downstream. I do not want to take that chance.

In close, I firmly believe that Watts Bar is unsafe and would threaten both human and non-human life if allowed to come on line. Please keep this preventable tragedy from happening.

A Concerned Ratepayer

Jim Snell
122 21st Ave. S. #3
Nashville, TN 37203
(615)329-1659

V-1

LETTER W

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

To: Staff Assisting and others involved with the 1994 Watts Bar Draft EIS,

First of all, thank you for extending the comment period for the WB DEIS. I'm sorry this letter is not typed, but my typewriter is broken and I can't afford to fix it [illegible].
I have reviewed the Draft EIS. I would like you take the following into consideration when preparing the Final EIS. As you know, 4 species of endangered mussels have been confirmed at the Watts Bar site. Two additional species of mussels that are candidates for listing under the Endangered Species Act also exist. New mussel beds that were not described in 1978 have since been documented. The discovery of additional endangered species
at the Watts Bar site leads to questions 9.4.3.1
about the accuracy of the survey. How thorough has the evaluation of mussel populations been? What assurances are there that these are the only existing mussel beds and populations? Molluscicides and chemicals that would be used and released at the site are tested on [illegible]
aquatic organisms. However, NONE of the [illegible] 9.6.3.1
endangered and threatened mussels at Watts Bar were in the same genera as the

W-1

LETTER T

Dear Nuclear Regulatory Commission;

I understand you are open to citizen comments until Feb. 14 concerning the Watts Bar Nuclear Power plant. These are just a small sample of reasons why I am against the completion of the plant:

•TVA is currently pouring in about $1 million a day in construction costs.

•It has a terrible track record for safety; there were three accidents last year, one involving a fire in the control room.

9.8.2.1 •In 1992, TVA itself released a study rating Watts Bar with the highest probability of a core meltdown of any plant in the United States.

Watts Bar is unsafe, uneconomical, and unnecessary. The cost of storing the waste has been inadvertently forgotten to be added into the cost of the energy!

Sincerely,

Susan Switzer

9.6.4.13 Also, there [illegible] storage for the waste for 100's of 1000's of years!

NRC
Chief, Rules Review and
Directives Branch –
US Nuclear Regulatory
Commission
Washington, D.C. 20555-

T-1

LETTER U

Dear Nuclear Regulatory Commission,

I understand you are open to citizen comments until Feb. 14 concerning the Watts Bar Nuclear Power plant. These are just a small sample of reasons why I am against the completion of the plant:

•TVA is currently pouring in about $1 million a day in construction costs.

•It has a terrible track record for safety; there were three accidents last year, one involving a fire in the control room.

•In 1992, TVA itself released a study rating Watts Bar with the highest probability of a core meltdown of any plant in the United States.

Watts Bar is unsafe, uneconomical, and unnecessary.

Sincerely,

[illegible]

NRC
Chief, Rules Review &
Directives Branch
US Nuclear Regulatory
Commission 9.8.2.1
Washington, D.C., 20555-0001

U-1

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

9.10.4	7.2.4	7-17	25	Table 7.5 - Delete "indefinitely" because a battery life can be extender through controlled used but cannot be extended indefinitely.
9.10.4	7.2.4	7-18	11	Table 7.5 (cont'd) - Add close parenthesis to last line in paragraph.
9.10.4	7.2.6	7-24	23	Suggest adding "conservative" in the sentence before adjustment. Sentence would read: "...with a slight conservative adjustment..."
9.10.4	7.2.6	7-28	16	Add "s" to the end of PWR. Plural use.
9.10.4	7.2.6	7-29	1-2	"Containment spray system (CSS)" should be "component cooling water (CCS).
9.10.4	7.2.7	7-30	2	Suggest revising "...delay the need to switch over..." to "...delay the time at switch-over..." The procedure change is not necessarily because there is a "need to."
9.9.3	8.4			Decommissioning - In addition to the discussion of various funding mechanisms such as an external sinking fund or surety method, NRC regulations in 10 CFR 50.75(e)(C)(3)(iv) specifically provide that Federal Government utility licensees may provide a statement of intent containing a cost estimate or an amount based on an NRC formula, indicating that adequate decommissioning funds will be available when necessary. In July 1990, TVA notified NRC of its intent to have adequate funds available for decommissioning the Browns Ferry and Sequoyah Nuclear Plant units. In accordance with NRC regulations, TVA will also provide a statement of intent to ensure adequate funding for decommissioning Watts Bar Unit 1.

E1-9

R-12

LETTER S

NRC
Chief, Rules Review and
Directives Branch
US Nuclear Regulatory
Commission
Washington, D.C. 20555-

Dear Nuclear Regulatory Commission,

I understand you are open to citizen comments until Feb. 14 concerning the Watts Bar Nuclear Power plant. These are just a small sample of reasons why I am against the completion of the plant:

•TVA is currently pouring in about $1 million a day in construction costs.

•It has a terrible track record for safety; there were three accidents last year, one involving a fire in the control room.

•In 1992, TVA itself released a study rating Watts Bar with the highest probability of a core meltdown of any plant in the United States. 9.8.2.1

Watts Bar is unsafe, uneconomical, and unnecessary. Use that money for education!

Sincerely,

Shalini Goel
Urmila Malwadkar
Barbara Jordan
Sidhartha Sen
Carolyn Bloodworth
Jasmine S. Ali

S-1

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

				margin of safety should easily account for any difference in the sensitivity of the indicator species used in the test procedure and native mussel species.
9.6.4.5	5.5.1	5-11		TVA has performed a reanalysis of the liquid radioactive releases, and the resulting source term and dose estimates will be included in Amendment 89 to the WBN FSAR and in response to NRC's request for additional information (RAI) concerning FSAR Chapter 11. Sections 5.5.1 and 5.5.4 should be revised to reflect that new information.
9.6.4.6	5.5.2	5-13	23	Change "180" person-millisieverts and "18" person-rem to "38.5" person-millisieverts and "3.85" person-rem to reflect the new numbers that are being provided in response to FSAR Chapter 11 RAI.
9.6.4.6	5.5.2	5-13	31-34	Table 5.2 - The WBN FSAR column should be revised as follows to reflect the revised analysis data that is being provided in response to FSAR Chapter 11 RAI. Noble gas releases: 404 TBq (10,910 Ci) Total body dose: 0.01 millisievert (0.84 millirem) Organ dose: 0.15 millisievert (15 millirem)
9.6.4.5	5.5.2	5-14	25-31	Table 5.3 - The WBN FSAR column should be revised as follows to reflect the revised analysis data that is being provided in response to FSAR Chapter 11 RAI. Tritium Releases: 95 TBq (1289 Ci) Other Radionuclide Releases: 0.26 TBq (3.5 Ci) Total Body Dose: 0.01 millisievert (0.72 millirem) Maximum Organ Dose: 0.01 millisievert (0.98 millirem)
9.6.4.5	5.5.2	5-15	32	Change "36 person-millisieverts (3.6 person-rem)" to "<19.8 person-millisieverts (<1.98 person-rem)" to reflect the new numbers that are being provided in response to FSAR Chapter 11 RAI.

E1-7

R-10

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

5.5.4	5-18	7	Table 5.4 - Under Volume Generated for Dry Active Waste change "570" to "850" and "(20,000)" to "(30,000)." This reflects the new numbers that are being provided in response to FSAR Chapter 11 RAI.	9.6.4.10
5.5.4	5-18	13-14	Change "570 cubic meters (20,000 cubic feet)" to "850 cubic meters (30,000 cubic feet)." This reflects the new numbers that are being provided in response to FSAR Chapter 11 RAI.	9.6.4.10
6.2.4	6-5	11	Add "except for sampling frequency" at end of the sentence. This is the only change from the NRC 1978 FES-OL discussion on radiological groundwater monitoring.	9.7.1
6.2.4	6-5	13-14	Strike "monthly" and replace with "quarterly." Strike "NRC 1978 FES-OL" and replace with "WBN ODCM and analyzed for radioactivity." This change will make the statement consistent with the NRC approved changes in the WBN Offsite Dose Calculation Manual (ODCM).	9.7.1
7.2.1	7-2	12	Suggest revising "...delay the need to switch over..." to "..delay the time at switch-over.." The procedure change is not necessarily because there is a "need to."	9.10.4
7.2.3	7-8		Table 7.4 - The term "d/" used in the table should be defined.	9.10.4
7.2.3	7-10	21	Suggest changing "eliminate" to "reduce the potential for related..."	9.10.4
7.2.3	7-12	8	The acronym "CSS" should be "CCS" as stated previously in the paragraph.	9.10.4
7.2.3	7-14	6-10	This paragraph should be put in past tense because this has been completed as noted in paragraph beginning on Line 28. See marked up page in Enclosure 2.	9.10.4
7.2.3	7-14	18	Replace "...more elaborate system" with " ...a dedicated system."	9.10.4
7.2.4	7-16	24	Insert "conservatively" in the following manner: "...but has conservatively increased these values..."	9.10.4

E1-8

R-11

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

9.6.2.1	3.4	3-7	22	Add to the end of the sentence, the following: "Any changes to the raw water treatment chemicals must be approved by the State of Tennessee in accordance with the NPDES Permit."
9.6.2.1	3.4	3-7	27	Add to this sentence "...other than system repairs/leakage to the radioactive waste treatment system as identified in WBN NPDES permit application." The NPDES permit controls the nonradioactive discharge parameters from the radioactive waste treatment system. Any leakage of these chemicals via the primary and secondary systems has been identified by TVA in the NPDES permit application.
9.6.2.1	5.2.1	5-2	15	Strike "previous" and replace with "present." The requirement to conduct a water temperature study is found only in the present WBN NPDES permit
9.6.2.1	5.2.2	5-2	34-35	Revise this sentence to indicate that the NPDES permit requires the applicant to conduct confirmatory biomonitoring studies (plural) of the discharges rather than a single study.
9.10.4	5.4.3	5-8	20-27	Suggest rewriting as follows: "The first study (Hudson and Barton 1994) was conducted using 8 to 10-day old juvenile paper pondshell mussels. A study was conducted of the organism's toxic response to chemicals added to Outfall 101 effluent. The chemicals used in the study are those intended to be used by the applicant during plant operation and contained the chemicals DGN/Quat, active ingredients in a molluscicide (Clam-Trol CT-1), currently used at WBN to control Asiatic Clams. No toxic effects were observed in juvenile mussels for any treatment during the 9-day test. A split sample also was analyzed for toxic effects to the daphnid, Ceriodaphnia dubia (TVA 1994a). Daphnid survival was impacted during the initial 24 hours of the test in treatments containing the molluscicide."
9.10.4	5.4.3 5.9	5-8 5-28	29	The second study was conducted by multiple laboratories. Change the reference, (EMPE 1994), to also include two references that were docketed in TVA's August 26, 1994 submittal concerning documents supporting review of environmental information, page E3, Reference 24 by TVA Water Management and Reference 26 by Presbyterian

E1-5

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

College. These two references should also be added in Section 5.9.

At NRC's public meeting held on January 10, 1995 to solicit comments and answer questions about the SFES, a concern was raised by a member of the public regarding the use of mussel as a representative mussel in TVA's chemical toxicity testing process. Ideally, assessing chemical toxic risks would involve testing every trophic level, taxonomic order, family, genus, and species of concern. However, toxicity testing typically involves the use of indicator species because it is not feasible or possible to test every potentially-impacted organism. There are resource constraints that preclude testing all organisms. Some organisms simply can not survive exposure to the tested. Thus, when toxicity test procedures are developed, entities such as EPA use only a few sensitive organisms. 9.6.3.1

The mussel toxicity test procedure developed by TVA uses as a indicator species the freshwater mussel, Anodonta imbecillis. This procedure has been used in joint studies with the Tennessee Wildlife Resources Agency and was recently published by EPA in its Inland Testing Manual as an approved test procedure. Other than the TVA mussel test procedure, there is no other nationally-approved testing procedure. Hence, the option of testing a variety of other freshwater mussels using an approved testing procedure does not exist. The toxicity testing done for WBN uses this procedure.

The result of the WBN testing demonstrates that Ceriodaphnia dubia, another indicator species used in this and other EPA test procedures, is more sensitive than Anodonta imbecillis. The tests indicate that Ceriodaphnia dubia is 15 times more sensitive to molluscicides used at WBN than the indicator mussel species when silt is present. Monthly testing of undiluted WBN effluent (100 percent concentration) for one year had no toxic effects on Ceriodaphnia dubia. Because instream effluent concentrations are expected to be only 2.93 percent even during low flow conditions and native mussel species will exist in the presence of silt, there is a significant margin of safety between test results and actual effects. This

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

				in 1991 and 1992, and amples were analyzed for a broad array of contaminants, including PCBs. Average PCB concentrations in 1991 were 0.4, 0.7, and 1.2 micrograms per gram (0.4, 0.7, and 1.2 parts per million) at the forebay, transition and inflow zones, respectively. In 1992, average PCB concentrations were 0.6, 0.7 and 0.7 micrograms per gram (parts per million) in those same respective zones. Low or nondetectable concentrations of other contaminants were found in samples collected in both years."
9.4.2.2	2.3.3	2-15	34-35	The statement that "High wind speeds are expected to be associated with neutral stability conditions" should have a technical reference.
9.4.2.2	2.3.3	2-15	37-40	The statement that "...frequencies of calm winds and winds in the 0.3 to 0.6 meters per second (0.6 to 1.4 miles per hour) wind speed class during extremely unstable atmospheric ..." should have a technical reference.
9.10.4	2.3.4	2-16	34-37	Suggest this sentence be revised to read, "Longer periods of record...provide more representative..." This revision is needed because different periods of record are used by the NRC for this supplement and by TVA in the Final Safety Analysis Report (FSAR).
9.10.4	2.3.4	2-17	6	Table 2.6 - The value for the FSAR at the Exclusion Area Boundary should be 1.0 x 10^{-3}. This is based on the value in Table 11.3-10 of the WBN FSAR for the southeast sector at 1250 meters.
9.4.1.2	2.4.2	2-21		Much of the information in this section details the aquatic ecology of Watts Bar Reservoir, one reservoir upstream from the WBN Site. Because WBN is on the Chickamauga Reservoir and the area of potential impact for aquatic communities is in the vicinity and downstream of WBN, this section should describe conditions in Chickamauga Reservoir.
9.4.1.2	2.4.2	2-22	12-27	Although aquatic macrophyte abundance in Watts bar Reservoir has little or no bearing on WBN, the acreage data provided in the discussion for Watts Bar Reservoir (5,600 acres in 1985) appears to represent abundance levels in Chickamauga Reservoir. Hydrilla has never been found in Watts Bar Reservoir, but was found in Chickamauga in the

E1-3

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

			late 1980s. The 1986 preoperational monitoring report does not discuss changes in Watts Bar Reservoir. It specifically discusses Chickamauga Reservoir and the numbers referred to in Line 19 are true for Chickamauga, not Watts Bar Reservoir.	
2.4.2	2-23	15-18	Suggest this paragraph read as follows: "The Tennessee River is home to both native and introduced mussel and clam species. There are two non-native mussel or clam species known to be introduced into the Tennessee River (the Asiatic clam (Corbicula manilensis) and Zebra mussel (Dreissena polymorpha)). In addition, another non-native mussel species (quagga mussel (Dreissena bugensis)) is likely to be found in the Tennessee River system in the near future."	9.10.4
2.4.2	2-23	20-27	Correct this paragraph to read as follows: "At the time of publication of the NRC 1978 FES-OL, the Asiatic clam was the only nuisance mollusk inhabiting the Tennessee River. This species was introduced to North America in the 1930s and has spread across the continent. Asiatic clams became prominent in benthic communities on the Tennessee River during the 1960s. The Asiatic clam is considered a pest species because its shell can obstruct pipes and foul water treatment facilities, including the raw water systems of nuclear generating plants."	9.10.4
2.4.2	2-23	39	Suggest that the last sentence of this paragraph reads as follows: "Zebra mussels also settle on native mussel species and can interfere with their feeding and survival."	9.10.4
2.4.2	2-25 2-26	18 12	The correct spelling should be "P. pyramidatum."	9.10.4
2.6	2-28	26	Strike "within the WBN Site, or any changes in" and replace with "which would result in changes to." The WBN NPDES General Storm Water permit number TNR001343 controls routine maintenance excavation. Only expanded construction of the WBN perimeter would require NRC review.	9.4.5
2.8	2-31	5-6	The words "Nashville District and Tennessee Valley Authority" are part of this document's title and should also be italicized.	9.10.4

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

TVA's offers the following comments on the Draft Supplement to the WBN Final Environmental Statement (SFES) for the operating license (OL) as solicited by the NRC and noticed in the Federal Register Vol. 59, No 236 (59 FR 63832) on December 9, 1994. When appropriate, markup pages are provided in Enclosure 2 for your convenience.

	SECTION	PAGE	LINE(S)	COMMENT
9.10.4		xviii	18	Here and throughout, change spelling to Naegleria.
9.4.3.2		xx	29-34	Change the definition of zebra mussel to read as follows: "*Either of two species* (*Dreissena polymorpha or Dreissena bugensis*) of molluscs that were accidentally introduced into the Great Lakes and are spreading to surrounding waterways where they may occur in large numbers, clog pipes, and adversely impact native mussels. Zebra mussels are considered nuisance species in North America."
9.4.1.1	2.2.2	2-9	20	Strike "during plant outages, rather than during routine operation of the plant," and end sentence on Line 19. Routine use of theses ponds to treat metal cleaning waste in compliance with the WBN NPDES permit is necessary. (See TVA letter dated August 5, 1994)
9.6.2.1	2.2.2	2-9	28	Strike "in the NPDES Permit (State of Tennessee 1993)" and add "in 1978." The State of Tennessee approved the use *of the evaporation/percolation* pond only in letters dated September 11, 1978 and October 12, 1978. *This has never be in the NPDES* permit.
9.4.1.2	2.2.3	2-11		The water quality information and vital signs data presented in this section are derived from TVA monitoring data on sites in the Watts Bar Reservoir, one reservoir upstream from the WBN site, instead of the Watts Bar forebay and the Chickamauga Reservoir inflow and transition zones. Since WBN is located on the Chickamauga Reservoir and the area of potential impact for water quality is in the vicinity and downstream of WBN, this section should also describe conditions in the Chickamauga Reservoir. (See subsections Temperature, Dissolved Oxygen, pH, Phosphorus chlorophylla, Sediment, Fecal Coliform Bacteria, and Poly-Chlorinated Biphenyls.)

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ENCLOSURE 1

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2
FINAL ENVIRONMENTAL STATEMENT FOR OPERATION
NUREG-0498, DRAFT SUPPLEMENT 1 COMMENTS

SECTION	PAGE	LINE(S)	COMMENT	
2.2.3	2-11	16-21	This indicates there is a misunderstanding that the Watts Bar "tailrace" and "transition" stations are located below Watts Bar Dam. Actually, all Watts Bar Reservoir vital sign stations are located in Watts Bar Reservoir, and the only one that is particularly relevant to an analysis of conditions in the vicinity of WBN is the forebay station. For such an analysis, a set of stations that includes the Watts Bar Reservoir forebay station and the Chickamauga Reservoir tailrace and transition zone stations would be most appropriate.	9.4.1.2
2.2.3	2-11	17	Change "Stability" to "Suitability."	9.10.4
2.2.3	2-11	26-30	Temperature - The implication is that the data cited comes *from the "vicinity of the WBN site,"* but the discussion cites vital signs data from Watts Bar Reservoir, most of which was taken *from* 30 to 70 miles upstream from WBN. Data from the Chickamauga Reservoir stations, which are in the immediate vicinity of the WBN site should be supplied here.	9.4.1.2
2.2.3	2-13		Water Quality, Sediment - Appropriate information representing conditions in Chickamauga Reservoir and in the tailrace area downstream from Watts Bar Dam should be in this section. The discussion of toxicity and high levels of non-ionized ammonia in Watts Bar Reservoir raises issues that have no bearing on conditions relevant to the operation of WBN. Velocity of water discharged from Watts Bar Dam prevents accumulation of fine sediment particles near WBN. Evaluation of sediment in the transition zone (where sediments first begin to *accumulate) on* Chickamauga Reservoir showed no toxicity and relatively low levels of contaminants (metals, ammonia, organochlorine pesticides, and PCBs) in sediment interstitial water in 1993. Similar results were observed in 1994 data (TVA draft report in preparation, not yet docketed with NRC).	9.4.1.2
2.2.3	2-14	11	Should be "saxicilis" instead of "saxicalis."	9.10.4
2.2.3	2-14	13-15	Change "liter" to "gram." Micrograms per gram is equivalent to parts per million. Also add "There are no fish consumption advisories in effect for Chickamauga Reservoir, where WBN Plant is located. Screening studies on channel catfish were conducted	9.10.4 9.4.1.2

E1-2

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Again, TVA appreciates the opportunity to comment on the draft SFES. If you should have any questions, please telephone John Vorees at extension (615)-365-8819.

Sincerely,

Dwight E. Nunn
Vice President
New Plant Completion
Watts Bar Nuclear Plant

Enclosures
cc (Enclosures):
U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

NRC Resident Inspector
Watts Bar Nuclear Plant
Rt. 2, Box 700
Spring City, Tennessee 37381

Mr. P. S. Tam, Senior Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

Mr. S. C. Flanders, Environmental Project Manager
U.S. Nuclear Regulatory Commission
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852

U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

R-2

ENCLOSURE 1

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
DRAFT FINAL ENVIRONMENTAL STATEMENT
NUREG-0498, SUPPLEMENT 1 COMMENTS

R-3

LETTER Q

168 West 77th St
NY, NY 10024
Nov. 22, 1994

Nuclear Regulatory Commission
Attn: Scott Newberry
Watts Bar EIS
Wash., D.C. 20005

Dear Mr. Newberry:

I have several questions.

In regard to Watts Bar, why is it taking so long for start-up? What are the safety provisions?

On another project, whatever happened to Clinch River? Was it ever finished. Former Senator Howard Baker was heavily involved with Clinch River. Environmentalists were concerned about the state of the Snail Darter... what finally happened?

Finally, David Lilienthal favored the breeder reactor, but with reservations, what were his reservations?

Thank you.

Yours truly
Mickey Zborig

Q-1

LETTER R

TVA

Tennessee Valley Authority Post Office Box 2000 Spring City Tennessee 37381

Chief, Rules Review and Directives Branch
Division of Freedom of Information and Publications Services
Office of Administration
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

WATTS BAR NUCLEAR PLANT (WBN) UNITS 1 AND 2 - REQUEST FOR COMMENT ON DRAFT SUPPLEMENTAL ENVIRONMENTAL STATEMENT (NUREG-0498, SUPPLEMENT 1) CONCERNING THE OPERATIONS OF WATTS BAR NUCLEAR PLANT (TAC NO. M88691, M88692, AND M77222)

The Tennessee Valley Authority (TVA) is pleased to provide comments on the subject draft Supplement to the Final Environmental Statement (SFES). The availability of this SFES was noticed in the December 9, 1994 Federal Register (59 FR 63832).

TVA considers the SFES to be prepared in a quality manner which clearly summarizes a large amount of information updating the NRC's 1978 FES. The SFES analysis adequately addresses the pertinent environmental issues associated with operation of WBN. TVA is especially pleased that the SFES confirms TVA's determination that there are no significant impacts associated with operating WBN. 9.2.1

TVA offers the comments in Enclosure 1 for your consideration. Many are editorial in nature and some in Chapter 5 are based upon resolution of the Final Safety Analysis Report (FSAR) Chapter 11 request for additional information from the NRC. Sections 2.2.3 and 2.4.2 of the SFES should be revised to focus on information from the Chickamauga Reservoir rather than that associated with the Watts Bar Reservoir. In order to address a concern expelled by a member of the public regarding potential impact of WBN chemical use on a representative freshwater mussel, TVA has provided a discussion of the toxicity testing procedures in the comments regarding Section 5.4.3. Enclosure 2 provides marked up pages where appropriate. 9.4.1.2

R-1

LETTER O

11/29/94

Nuclear Regulatory Commission
Scott Newberry
Watts Bar EIS
Washington DC 20005

Mr Newberry

Do not license Watts Bar nuclear plant! Congress, as well as your agency, + even the TVA itself, have conceded its dubious distinction as the riskiest, most expensive + highest in terms of employee harassment/intimidation charges in the nation.

9.9.2 Its 20+ years under construction render it virtually obsolete; a typical nuclear plant costs more to decommission than to build, & the radioactivity poses dangers for longer than the average 30-year plant lifespan.

It's a matter of life + death - on a large scale

Please respond

Sincerely,
Theresa [illegible]
46 Glenwood Ave #2E
Jersey City NJ 07306

O-1

LETTER P

37. West 93st.
New York, NY 10025
11/22/94

Nuclear Regulatory Commission
Scott Newberry
Watts Bar EIS
Washington, DC 20005

Dear Mr. Newberry,

The TVA is building a nuclear power plant (Watts Bar) that started construction in 1972. The construction of this plant, which is not finished yet is costing American tax payers about one million dollars a day. There have been [redacted] that the plant is not safe. Any nuclear plant is extremely hazardous to the environment. Watts Bar is located right near [redacted] for [redacted] wastes which will cause deadly effects on all life forms in the Tennessee state. Nuclear Waste harms you by breaking down your cell wall. 9.6.4.18 [redacted] if it operates it will be endangering the lifes of others, and the health of the Earth. Do not give Watts Bar approval to open. The prevention of this plant will prevent harm to all forms of life.

Sincerely,
Jonas Wood
Jonas Wood

P-1

LETTER M

Kathy McArdle
313 Fifth St. #4
Jersey City, N.J.
07302

November 22, 1994

Nuclear Regulatory Commission
Attn: Scott Newberry
Watts Bar EIS
Washington, D.C 20005

Dear Mr. Newberry,

It is obvious after 22 years of delays, cost-overruns, and ~~significants~~ safety factors not addressed by ~~the Tennessee~~ Valley Authority, that this Watts Bar Nuclear Plant is not a viable project. This plant is totally unsafe, uneconomical, and poses a grave threat to public health and the environment.

I must urge you to not issue an operating license for Watts Bar.

Sincerely,
Kathy McArdle

M-1

LETTER N

313 Dod Hall
Princeton U.
Princeton, NJ 085
November 23, 1994

Nuclear Regulatory Commission
Attn: Scott Newberry
Watts Bar EIS
Washington, DC 2005

Dear Scott Newberry,

Nuclear power energy is not a viable solution to America's energy needs. I am particularly concerned about the opening of the Watts Bar Nuclear Power Plant. The reported problems with quality assurance and quality inspection make the opening of this plant seem highly ~~[illegible]~~ dangerous. This is especially true in light of the fact that the Nuclear Regulatory Commission has predicted 9.8.2.1
a 45% possibility of a meltdown accident and the Watts Bar plant was rated with the highest probability. Therefore, aside from making your commission look extremely environmentally ignorant, licensing the Watts Bar Plant may lead to a local catastrophe.

Sincerely,
Amy Mau

N-1

NRC
Attn: Scott Newbury
Watts Bar EIS
Washington, DC, 20005

Mark Hyman
37 Spelman Hall
Princeton University
Princeton, NJ 08544.

Dear Mr. Newbury,

Nuclear power seems, currently, to be at best a questionable means of generating the energy needed by the American public. Operation of a plant with the atrocious record of the Tennessee Valley Authority's Watts Bar facility is beyond consideration. 21 years of construction rife with safety concerns do not seem to suggest safety; neither does the degree of harassment & intimidation of employees complaining of this same lack of safety (25% of all registered NRC complaints!) I strongly suggest that you do not reauthorize this plant.

[signature]
Mark Hyman

K-1

LETTER L

13 Campbell
Princeton, NJ 085
November 22, 1994

Nuclear Regulatory Commission
Attn: Scott Newberry
Watts Bar EIS
Washington, DC 20005

Dear Mr Newberry:

I am writing to ask you to put serious consideration
into your decision about the Watts Bar Nuclear Plant
license. Perhaps it would seem a relief to finally license
the plant after 21 years of seemingly endless money-suck
disasters, to finally have something positive to come out of
this plant. No! I promise you this is just the beginning
of the problems. This plant was a failure since the beg-
inning. It is considered the most dangerous plant in the 9.8.2.1
country, with a 45% chance of a meltdown accident in
the next 20 years if opened. The plant has already cost
$9 billion to date & it has hardly begun to meet safety
standards. TVA has turned away from its purpose to
provide services to the people of Tennessee Valley while
preserving natural resources. This project runs counter to all 9.6.4.13
that. Human health is at stake. Don't fool around with
toxic waste that no one knows how to dispose safely. It will
continue to be a money drain & fear will instigate people
to fight the plant at every opportunity. This is what you
can look forward to if you grant the license. Please think
about it.

Sincerely, Marlene Haas

L-1

LETTER I

22 NOVEMBER '94

Dear the Nuclear Regulatory Commission -

I was very surprised to discover that plans on building the Watts Bar Nuclear Power plant are going ahead as usual.

Considering:

1 - The site is located conveniently between Knoxville & Chattanooga
2 - The project is 16 years behind schedule
3 - TVA rated The Watts Bar Plant the ~~highest~~ plant
9.8.2.1 with the highest probability of a meltdown.
4 - Safety concerns have been a continuous problem in the building process

the Watts bar plant should NOT be licensed.

Watts Bar plant is a bad & dangerous idea & it should NOT be licensed.

Sincerely,
Lenny Gamas

52 MAGIC APARTMENTS
PRINCETON, NJ 08540

I-1

LETTER J

68-19 Burns St
Forest Hills, NY
11375
November 22, 1994

Nuclear Regulatory Commission
Attn.: Scott Newberry
Watts Bar E/S
Washington, D.C. 20005

Dear Mr Newberry,

I am writing to ask you to urge the Nuclear Regulatory Commission to not license the Watts Bar nuclear plant in Spring City, Tennessee.

This plant is unsafe and is a serious threat to the environment according to previous N.R.C. investigations and remains to be at present. 9.2.2

Thank you for your attention.

Sincerely,
A. Bergenfeld
A. Bergenfeld

J-1

LETTER G

November 22, 1994

Nuclear Regulatory Commission
Attention: Scott Newberry
Watts Bar EIS
Washington, DC

Dear Mr Newberry.

I am writing to express concern about the construction and liscensing of the Watts Bar Nuclear Power Plant in Spring City, TN. In light of the numerous safety problems and excessive expense, I believe that construction should be halted and the plant should not be liscensed

Watts Bar, which was projected to cost $325 million, has now cost taxpayers $9 billion. In addition, Watts
9.8.2.1 Bar has the highest probability of a core melt down accident of all U.S. nuclear power plants, according to a 1992 TVA study

In summary, Watts Bar is unsafe, uneconomical and unnecessary. It does not deserve a license

Thank you for your attention to this issue

Sincerely,

Marion Hourdequin
236 Henry Hall
Princeton University
Princeton, NJ 08544

G-1

LETTER H

November 23, 1994

25 Van Dam Street
Brooklyn NY 11222

Nuclear Regulatory Commission
Watts Bar E.I.S
Washington, DC 20005
Attn: Scott Newberry

Dear Scott Newberry:

I am writing to urge you not to issue an operating license to TVA to begin operation of the Watts Bar nuclear plant.

Watts Bar is not ready to operate due to the numerous significant safety concerns expressed by employees and identified by TVA.

Our health and safety, as well as that of endangered species and the enviroment will be in jeopardy if this plant is allowed into operation.

Sincerely,

Vincent A. Vespole

H-1

to questions of accuracy and thoroughness of the surveys

There are also questions concerning
9.6.3.1 the adequacy of the toxicity tests of mollisicides and other chemicals that would be released at the site.

9.8.2.9 And Finally I question the conclusion of the SAMDA evaluation that "additional plant improvements to further mitigate severe accidents are not required at Watts Bar" considering the fact that there have been numerous accidents at the facility and last year Watts Bar failed the "hot test run" conducted by you all at the NRC.

There are many other questions and issues that were raised at the hearing that I also support.

Thank-you for the chance to comment.

Sincerely,
Linda Ewald

E-2

LETTER F

Dear Nuclear Regulatory Commission,

I understand you are open to citizen comments until Feb. 14 concerning the Watts Bar Nuclear Power plant. These are just a small sample of reasons why I am against the completion of the plant:

TVA is currently pouring in about $1 million a day in construction costs.

•It has a terrible track record for safety; there were three accidents last year, one involving a fire in the control room.

•In 1992, TVA itself released a study rating Watts Bar with the highest probability of a core meltdown of any plant in the United States.

Watts Bar is unsafe, uneconomical, and unnecessary

Sincerely,

NRC
Chief, Rules Review & Directives Branch
US Nuclear Regulatory Commission 9.8.2.1
Washington, D.C., 20555-000

F-1

EPA POLICY STATEMENTS ON NOISE LEVELS

Maximum noise levels EPA has identified to protect the public health and welfare

HEARING LOSS	LEVEL (at ear)	AREA
Hearing Loss	$L_{eq(24)} < 70$ dB	All areas
Outdoor activity interference and annoyance	$L_{dn} < 55$ dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq(24)} < 55$ dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} < 45$ dB	Indoor residential areas
	$L_{eq(24)} < 45$ dB	Other indoor areas with human activities such as schools, etc.

9.6.5

SOURCE: Ref. 5, p. 3.[a]

Explanation:

- $L_{eq(24)}$ represents the sound energy averaged over a 24-hour period while L_{dn} represents the L_{eq} with a 10 dB nighttime weighting.
- The hearing loss level identified here represents annual averages of the daily level. (These are energy averages, not to be confused with arithmetic

D-4

LETTER E

Linda Ewald
949 Ponder Rd
Knoxville, TN
37923

Chief Rules Review and Directives Branch
US Nuclear Regulatory Commission USNRC
Washington, DC 20555-001

I attended the public meeting in Sweetwater Tennessee Jan 10, 1995 and am writing to comment on the draft supplement to the Watts Bar environmental impact statement. I disagree with 9.2.1
the finding that changes do not result in a significant environmental impact. For example in 1978 two species of endangered mussels had been identified at the Watts Bar site. Since then two additional species of endangered mussels, as well as two species that are candidates for listing, have been identified. This leads 9.4.3.1

E-1

Page Two

designed into all plant operations - including maintenance, landscaping, training and office facilities, as well as the more obvious Plant functions? The Final supplement should include a description of planned and ongoing pollution prevention efforts.

Page 1-1, lines 35-36: Construction delays are given as the reason for the ten to fifteen year delay in operation of WBN Plant. Other reasons such as employee concerns, mission changes, and the shutdown in 1985 of the K-25 Gaseous Diffusion Plant in Oak Ridge may have been more the reason for the long years of delay, not just construction problems or retrofits.

9.4.4 Page 2-25, lines 25-31: The supplement does not describe, in the pre-operational radiation background conditions, sediment and channel radioactive contamination in the Watts Bar Reservoir upstream from the Watts Bar Dam. TVA, the Department of Energy at Oak Ridge, and EPA have been investigating the cesium and mercury contamination in and around the Watts Bar Reservoir from the Clinch River down to the Watts Bar Dam. Most of the contamination is in the deep channels as far south as the Watts Bar Dam. The Final supplement should include a description of this contamination as a pre-operational background condition.

9.5.4 Page 5-5, lines 22-23: What herbicides are used in clearing of transmission line rights-of-way? Are other pesticides used? Has TVA's maintenance procedure changed over the last fifteen years? The Final supplement should contain a brief description of TVA transmission line maintenance procedures.

9.3.1 Page 5-6, lines 25-29: The Biological Assessment should be included in the Final supplement.

9.5.2 Page 5-11, lines 7-17: It is assumed here and later in the text that waste evaporators are not used to reduce the offsite low-level waste shipments. Is this true for Sequoyah, Browns Ferry, and other pressurized water reactors nationwide?

9.6.4.12 Page 5-17, lines 26-27: What is the basis for the 4-year timeframe for potential onsite low-level waste storage? Based on expected future low-level waste disposal siting delays, should there be contingencies for at least 10 years?

9.6.4.15 Page 5-20, lines 1-6: Will WBN Plant be able to use current or future dry cask storage at other TVA Nuclear Plant Sites as an alternative to building their own?

9.6.5 Page 5-24, line 36. While it is true that there are no Federal regulations for public noise level exposures, there are many guidelines and recommended levels. A summary of EPA guidelines for public health and welfare is attached. In

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Page Three

general, the threshold level for outdoor activity interference and annoyance is 55 decibels (dBA). The Department of Housing and Urban Development has noise guidelines for residential areas: acceptable if the day-night sound level is less than 65 dBA; normally unacceptable if greater than 65 dBA and less than 75 dBA; and unacceptable if greater than 75 dBA. Are there residents close to WBN Plant who could be affected by elevated noise levels? If so, noise levels at these residences should be predicted, and mitigation proposed, if necessary. Are there any provisions for notification of the surrounding communities of upcoming large noise events (e.g., steam venting)?

Page 6-4, lines 17-19: It is stated here that the State will be monitoring radiation around the site pre-operationally and during operation. Will this be just thermoluminescent dosimeters? Are there any plans for installing pressurized ionization chambers similar to Alabama and Illinois? Also, are the locations based on wind rose, populations, or both? 9.7.4.2

Page 7-16, lines 13-32: Are there any requirements or other mechanisms in place to ensure WBN implements these improvements or enhancements for safety? Are there any schedule commitments? 9.8.2.8

Page 8-2, section 8.4: What effects will the recently proposed rule on radiological criteria for decommissioning of NRC-licensed nuclear facilities have on WBN Plant? Will NEPA documentation be prepared on decommissioning, following submission of the "Supplement to Applicant's Environmental Report" (Page 8-3, line 22)? 9.9.1

Based on our comments, we rate this Draft supplement "EC-2." That is, we have environmental concerns about the project and more information is needed to fully assess the impacts. If you have any questions about our review, you may contact Marion Hopkins of my staff at 404/347-3776.

Sincerely,

Heinz Mueller

Heinz J. Mueller, Chief
Environmental Policy Section

Attachment

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LETTER C

304 Hill Street
Lenoir City, Tennessee 37771

January 11, 1995

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Ref: Final Environmental Statement (FES) and Supplement for TVA Watts Bar Nuclear Plant

Dear Sir or Madam:

9.5.3 Please reconsider the issue of several threatened or endangered species of mussels which will be seriously impacted by the use and release of certain chemicals (molluscicides) during the planned operation of the TVA Watts Bar facility. There may be alternatives for treating intake water, and surely there are alternatives for chemical disposal other than dumping into the river. The FES does
9.6.3.3 not even address the impact on aquatic species of accumulation of these chemicals in river sediments.

While it is not my intention to see the U.S. nuclear power industry "dead in the water", I would hope to have pollutants kept from the habitats of endangered (potentially "dead in the water") species according to the law.

Sincerely,

Wilma A. McNabb

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LETTER D

January 17, 1995

4-PM-PA/mb

Chief, Rules Review and Directives Branch
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: Draft Report for comment of the Final Environmental Statement related to the operation of Watts Bar Nuclear Plant Units 1 and 2, Supplement 1

Dear Sir or Madam:

We have reviewed the subject document in accordance with Section 102(2)(C) of the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. The Tennessee Valley Authority (TVA) has applied for an operating license for the Watts Bar Nuclear (WBN) Plant. This supplement updates NRC's Final Environmental Statement (FES) on WBN Plant, written in 1978. We assume this supplement is equivalent to a Draft Environmental Impact Statement Supplement, as described in Council on Environmental Quality NEPA regulations.

The supplement uses International System (SI, or Systême International) units such as sieverts and becquerels, with non-SI 9.10.1
units such as rems and curies shown in parentheses. We recommend that NRC use only non-SI units (with perhaps a conversion chart in an appendix) most importantly because all current regulations (NRC's, EPA's, and the State's) are in non-SI units. But also because the SI units are confusing, not compatible with the non-SI units, and the public is not likely to be familiar with them.

The supplement does not address the purpose and need of the proposed action. Presumably the need for the project was 9.1.1
described in the FES and was a perceived future demand for electricity. How has this need changed in the past sixteen years? What is TVA's long-term strategy for meeting electrical demand in its service area? Does it include innovative demand-side management strategies (utility-influenced reduced power consumption by consumers)? The supplement refers to TVA's Integrated Resource Planning process. The final supplement would benefit from a brief description of this process. The document should also contain a clearer description of project purpose and need.

In such a large project, there should be numerous opportunities for pollution prevention. Have waste 9.5.5
minimization and water and energy conservation measures been

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LETTER B

Thomas Anderson
212 3rd Ave. N. Suite 35C
Minneapolis, MN 55401
7 January 1995

Chief, Rules Review and Directives
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chief,
I have reviewed the Final Environmental Statement Draft
(FESD) regarding the Watts Bar Nuclear Facility. My previous fears
about this installation have intensifed even further. It would be a
colossal mistake to grant TVA an operating license for Watts Bar.
The FESD is vague about the storage of nuclear waste from
Watts Bar. If there is anything to be learned from attempts to store
nuclear waste in this country (in Minnesota, Massachusetts, New
Mexico, and elsewhere) it is that the American public demands
specificity, safety, and full disclosure, not merely hunches about
where the waste MIGHT end up. In his letter to me dated 22
November 1994, Scott Newberry of your Commission told me, "The
NRC has determined that high-level radioactive waste, such as spent
fuel, can be safely stored on site with minimal environmental impact,
for at least 30 years beyond the licensed operating life of a nuclear
9.6.4.13 power plant." Assuming that to be true (a stretch in itself, given
Watts Bar's history of ineptitude), what about the subsequent 9,970
years that this waste remains deadly? What if the D.O.E. never
succeeds in establishing a nuclear dump at Yucca Mountain, or
elsewhere, as U.S. Senator Paul Wellstone (D-MN) and others believe?
Finding storage space for the waste piling up at EXISTING nuclear
facilities is proving difficult if not impossible. Can blind faith in a
process acknowledged by most as flawed lead to anything BUT a vast
radioactive logjam to be shouldered by hundred of generations to
come? What kind of legacy is this to leave behind for our children?
Mr. Newberry stated in his 22 November letter that "low level
9.6.4.12 wastes generated at the Watts Bar plant will be buried at the
Barnwell, South Carolina site." But isn't this site now closed to out-
of-state waste? Also, the FESD asserts (p.5-17) that incineration of
low-level waste will reduce waste volume. INCINERATION OF
9.6.4.11 NUCLEAR WASTE? Is this not madness?
The FESD also suggests that waste can be stored at the Wake
County, North Carolina site, which is experiencing its own delays and
other problems, and may never open. Then what? It is folly to build
9.6.4.12 a nuclear waste-producing facility without a place lined up to put the

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waste. Mr./Ms. Chief, would you go fishing before buying your bait,
or a fishing license? Buy a telephone and expect it to work before
having your service connected? Go on a trip expecting to buy gas
each time your car sputters to a stop, completely empty? Planning is
called for here. Not wishful thinking, but planning.
Nobody seems to want nuclear waste in their back yard or,
increasingly, in anyone else's back yard. To authorize Watts Bar in
the face of such uncertainty would be like starting your car inside a
tightly sealed garage, and then waiting for someone to come by and
open the door for you before you're killed by the carbon monoxide.
The first (and in fact, only) step toward resolving this dilemma is to
stop Watts Bar from producing the waste in the first place. Period.
If Watts Bar were privately funded and faced shareholder
scrutiny, construction would have stopped years ago. That TVA can
subsidize its deficiencies with billions of taxpayer dollars is not
merely prevarication. It is criminal. Though fiscal viability may not
be your concern, the lesson is clear. Such irresponsibility should not
be tolerated. TVA's passion for throwing good money after bad at
Watts Bar begs the question of its technical credibility, and thus
safety. Your own inspections have uncovered many cases of shoddy,
unsafe workmanship. Have you found them all? Many infractions
and incidents have been reported. Does the public know about them
all? Does the N.R.C.? Can we afford to find out the hard way?
The writing is on the wall. Watts Bar is a lemon. TVA's recent
cancellation of its other nuclear projects, its long history of problems
at Watts Bar, and growing public opposition has rendered the
completion of the Watts Bar Nuclear Facility (much less its licensing
and operation!) INDEFENSIBLE.
Do TVA and the American public a favor and deny, once and
for all, the authorization to continue wasting our money on this
debacle. Turn it into an alternative energy center. Use it as a
vocational school for this economically disadvantaged area. Seal off
the area, throw open the doors, and let the beings of the river and
forest (re)claim it as their own. Please don't allow it to operate.
I would appreciate specific responses to questions I've raised
here. I've circled the question marks for this reason. Thank you.

Sincerely,
Thomas Anderson

cc: Vice President Al Gore
Various Tennessee media
TVA

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Mr. Newberry: With that, I thank you for coming. I will close the meeting.

(At 9:45 p.m., Tuesday, January 10, 1995, the meeting was closed.)

I think another thing that we should insist on is that everybody that ever worked on this plant, that ever made a buck from it, that's making a buck from it now, live within a five-mile radius of it for ever and ever and ever.

Thank you.

(Scattered applause.)

Mr. Newberry: That concludes the comments.

We certainly have quite a bit to take back with us, and we will do that.

[Discussion]

Voice: Will there be any follow-up, any more future meetings? 9.10.3
Are there going to be any public hearings about for instance like a licensing date or anything like that?

Mr. Tamby: Once again I have to address this. Today as I said, this is an environmental meeting. However, a major, major part of NRC's effort is called safety review, and that is not what we are addressing tonight.

We have a series of reports, and in fact I just found a copy in which we address in great detail about emergency preparedness, especially evacuation.

I would like to give you a copy, since you were the first one that asked for it, and for those who want a copy of this report where it talks about emergency preparedness and evacuation, please leave me your address. I will give the only copy to this lady who first asked for it.

I did ask for people to give me their names and addresses. There is another thing I would like to give you. Not being a lawyer, I don't want to talk about the hearing aspect, but the mechanism that exists for people to request hearings in the NRC regulations. But I don't want to go into the legal aspect of it.

I have a letter which is in the public domain. If you give me your address, I'll send you a copy of the letter that will tell you exactly how to request a hearing. Otherwise, the details are in the NRC regulations.

Ms. Honicker: That's 2006, something like that. None have ever been granted.

Mr. Tamby: That's also under the original regulations, but I'll get you a copy of the letter.

Ms. Honicker: People have requested it, but none have ever been granted.

Mr. Tamby: Obviously, ma'am, we are following the administrative procedure law, and we all have to follow the law, and in order to request you have to go through the procedure.

Ms. Honicker: We can request, but it won't be granted. That's what I'm saying.

Ms. Honicker: You see, it bothers me when cost is not an issue. Cost is an issue.

We might as taxpayers prefer to feed the hungry and house the homeless instead of pouring more money down a nuclear plant that you've been pouring money into for 22 years. And we say it's not going to operate, so cost is an issue.

9.8.2.8 How much longer do you say it's going to take to do these three? And what about the other 23? You know, and what about all of those problems that the whistleblowers found, and that the Nuclear Safety Review Team found? Have they been publicly admitted to, and each one addressed and solved? Is that what you've been doing for 22 years, or have you simply been using a pencil and paper and harassing people and scaring them and telling them to shut up and be quiet or you'll lose your job, and many of them really losing their jobs, and then replaced by people that made ten times more money, or three times more money.

You know, I think that there are some grave questions that need to be asked, and finally this plant needs to be put to rest right now, that the best way to save money is to never make it radioactive. Once you've turned on the switch, it's going to cost us more money than it would cost us if we quit right now, even if $8 billion has been poured down the drain. Just write it off, and go on to do something productive.

The people who have had jobs building the plant have learned good trades. Let the pipefitters become plumbers. I know that most of us would like to be able to hire a good plumber. My plumber vacations in the Bahamas, so I think there's good money to be made in plumbing.

The people who have poured concrete can pour sidewalks. We've got things that we need to do to improve our infrastructure and, you know, the only good thing that I can see that has happened is that maybe some people have learned some trades that they can use to improve the economy and improve the way of life.

But to turn this plant on is absolutely outrageous and unforgivable, and shall never happen. I'm just convinced that it will never happen.

I look at the faces of young people out here and I know that you are concerned about your lives and the future of your plant and your Tennessee.

And when you're asking about the evacuation plan, it's not enough to just have general ideas. Tell every person where they are to go. You know, if you don't know where you are to go, what good is an evacuation plan? And it has to have some contingencies. Which way is the wind blowing? If the wind is blowing one way, you're to go the other way.

You know, who's going to pay for this? The Price-Anderson Act says that there's a limit to the liability. Your own insurance is no good because the insurance companies got real smart real fast and made an exception. You cannot buy insurance to cover your property against a nuclear accident--I'm sure you all knew that.

So I'm sure that you all don't live within the 50-mile radius of the Watts Bar plant either.

Michele brought up an interesting alternative use for the site, and that is to store the uranium from the bombs. You know we're taking apart 2,000 nuclear bombs a year, and the stuff is being stored at Oak Ridge in old wooden buildings that were built before the second World War, not in containment buildings.

So I propose that TVA sell the Watts Bar Unit 1 and Unit 2 to the DOE for $26 billion, and look what it would do to you if they did. Your bills would immediately go down by a third. That would have a very good impact on the region, because then we could attract industry, and we could be the leading area that we were told we would be in 1975 when they said that the use of electricity would double in ten years, and in 1985 it was less than it had been in 1975.

So I think that TVA needs to be creative and look at ways to sell, but the price must be $26 billion. And the DOE says that cost is no object, so it would be easy to do, it would just simply be like assuming a mortgage. DOE could assume the debt that TVA has made, which we have already paid for. You know, they got most of the money from the Federal Financing Bank--that means us, the taxpayers--so that's the way to write the thing off. So I applaud you for coming up with that, Michele.

There are other things that I would like to question. What about the three SAMDA improvements 9.8.2.7
recommended to improve safety? Are those listed?

Mr. Newberry: Yes.

Mr. Honicker: Where are they listed? I didn't see those. 9.8.2.7

Okay. Does it say how much they will cost?

Mr. Newberry: Yes.

Ms. Honicker: How much is that, please? Can you just not tell me quickly? I don't have my glasses with me 9.8.2.7
tonight.

Mr. Palla: Let me just state the three procedures that were committed to were not looked at in terms of cost, because there was an agreement already.

Ms. Honicker: Can you tell me how much that is? 9.8.2.7

Mr. Palla: I don't recall.

Ms. Honicker: Is it here? Is it listed, the cost listed? 9.8.2.7

Mr. Palla: We did not report the cost for those.

Ms. Honicker: Why not? 9.8.2.7

Mr. Palla: Because cost was not an issue, because these procedures were already going to be implemented.

TVA has proven that it cannot build a nuke plant safely or economically, it cannot conduct an investigation of so-called terrorist groups, and I really doubt that it's got the ability to come up with competent escape plans if there is a severe accident at Watts Bar, and I think you should look into that, too.

And I think that you all need to look into the faulty wiring problems with the cables, and the whole issue of the splicing problems that are going on there, and how that increases the likelihood of a severe accident.

I just want to finish up to let you all know that we are taking steps and making an effort to educate the general public to the truth about the Watts Bar Nuclear Plant, and despite the deliberate attempts at confusion by the TVA board in December, people will know the truth that the last nuclear plant under construction in this country is still going on.

You know, you in the NRC and the TVA know, and I hope you realize this, that you're under closer scrutiny than ever before. We're watching you, everybody else is watching you. We don't want this plant to come on line, and in closing, if you insist on licensing Watts Bar, and if TVA insists on finishing it, I think that you'll find that the civil disobedience and nonviolent civil resistance that will ensue will make July 11th look like a tea party.

Thank you.

(Scattered applause)

Mr. Newberry: Jeanine, you're the last one. Is there anyone else before Jeanine makes her comments here?

(No response)

Mr. Newberry: Go ahead.

Ms. Honicker: I wanted to talk to you all. The NRC is going to do what they are going to do. I think it's wonderful that all of you care enough to come.

Some of the questions that I had probably are not to be addressed by the NRC, but maybe by the TVA, and you know they hold a board meeting frequently. If you're not on their agenda notice list, it's easy to call the public information office at TVA and get an agenda notice and go to their board meetings.

Every board meeting should be filled with people who have these questions and these concerns, because ultimately the power to stop the plant rests with the TVA and the board.

9.1.1 The TVA act says that TVA shall produce electricity at the lowest feasible cost. I believe the environmental impact statement is supposed to talk about cost and alternatives.

The question that I would have is what is the reserve capacity now, and are you considering the Watts Bar steam plant as part of the reserve capacity. How much electricity has been used, and if you are over the reserve capacity you have no financial reason or obligation to license this plant or to let it run.

I think an $8 billion boondoggle that is the most unsafe facility in the country poses a risk of compromising the needs and the health and safety of future generations.

This council is supposed to recommend policy options to the president to deal with this whole issue of sustainable development, and they're going to be told in no uncertain terms that no more nuclear power is a part of any kind of sustainable development, because simply nuclear power is unsustainable, it always has been, and it always will be.

I also want to mention that if you give Watts Bar a license and an accident occurs, you will be held accountable, all of you with the TVA and with the NRC. I don't care what the law says, you will be held accountable, and it will be on your conscience the loss of life and the loss of species and diversity of habitat that will occur here if a severe accident occurs there.

It is also my opinion that you should extend the comment period another thirty days to give those of us who don't have quite an excellent technical background some extra time to read and sort through the jargon and try to decipher it.

Let's see. I've got a few more things.

It is also my opinion that you should not give this facility a license because I think history has proven that Watts Bar was designed by idiots and is being built by fools.

Now, this is something I may have missed because, like I said, I didn't read the whole thing, but I did not find any assessment of the environmental impacts of batch releases of tritium and other things that I know that the Sequoya Nuclear Plant releases into the Tennessee River, so I think you need to address this, and I would really appreciate it if TVA would stop batch releases, because I'm poor and I have to drink the water from the Tennessee American Water Company like most of Chattanooga, and I can't afford to go to the health food store and buy bottled water at 36 cents a gallon. So I don't appreciate drinking that stuff. 9.6.4.4

We have had meetings with Tennessee American over different issues, and they can only test for five to six hundred chemicals, and there's, you know, thousands in the river, and I don't know if they're testing for anything that Sequoya is releasing, or that Watts Bar may potentially release through these batch releases. 9.7.2

Let's see. Back to the issue of nuclear waste, I think it is an example of the continuing attitudes against people who are non-white in this country that you have seen fit to try to pay off native Americans to get them to hold the nuclear waste on their land, and I think that that kind of thing needs to stop.

Most people who live on reservations who aren't associated with the BIA-controlled tribal council don't want the nuclear waste on their property.

I'm also curious if you've looked into new studies coming out of the University of North Carolina dealing with suspected fault lines running down the Tennessee Valley, and how that is going to impact the operation of Sequoya and Watts Bar. 9.4.6

9.6.3.4 Also the other threats to this region include water pollution and deforestation.

9.6.3.4 I also want to know how you want to deal with the cumulative impact of if molluskicides are used how are these things going to mix with herbicides that TVA used to spray in the reservoir system because in their whatever, they're so smart they thought it was a good way to deal with water plants, and ended up decimating the bass populations in the Chickamauga and Nickajack reservoirs, and there is residue of that stuff still in the reservoirs, so what are going to be the synergistic effects of those chemicals in the water.

At the November 30th management meeting that the NRC and TVA had--I wish I could have gone, I got the paper about it--and the NRC expressed a total lack, this is a quote "A total lack of confidence in TVA and its quality assurance/quality control program." This is something you need to address in this draft environmental impact statement.

9.9.2 Also you don't deal with decommissioning costs adequately, since we're finding that as old nuclear plants are decommissioned across the country the costs are far above and beyond what was originally planned.

Basically, you know, a lot of us feel like you should just not give this facility a license, because it is unsafe, it is uneconomical, and it's unnecessary.

We don't want any more nuclear plants in East Tennessee, or North America, or on the whole planet.

(Scattered applause)

Thanks. I don't think I need to go into detail about the sordid history of nuclear power in this country and in other countries.

Now, I know that you all are trying to do your job and make this, you know, trying to be a good regulatory agency and whatever, but the fact of the matter is that TVA is not doing its job, and Watts Bar is simply a facility that does not need to come on line.

Somebody mentioned the three accidents in 1994. I'm just curious if no environmentalists were protesting Watts Bar, would these accidents have ever come to light in the mainstream media.

It is my opinion that you need to pass it on to your superiors in the Nuclear Regulatory Commission that you need to give another stop work order because the TVA obviously cannot live up to your inspections.

And I just want to mention that the President's Council on Sustainable Development is meeting in Chattanooga this week, and during their public comment session on Friday they are going to hear about what's going on with TVA and the Watts Bar Nuclear Plant.

The Council on Sustainable Development has a mandate to present a definition of sustainable development, which at this time is development that meets the needs of the present without compromising the needs of future generations.

As far as the draft environmental impact statement goes, for the record I'd like to ditto what Dr. McKinney had to say, and ditto what Daniele had to say. You all need to reevaluate your finding of no significant impact. 9.2.1

I think it is pathetic that you don't have to deal with the nuclear waste issue. I can't remember the name of the law that was passed that basically absolved you and the TVA of that responsibility, but it's basically the classic case of passing the buck, and I think that if a nuclear facility is going to utilize uranium that was mined, then it needs to be responsible for that material from the cradle to the grave. 9.10.2

Just to mention a few things that have already been said, the discovery of additional mussel beds and additional endangered species lends to questions on the accuracies of your studies. I'm wondering is the mussel study thorough enough, are these the only populations that are there. I think these are questions I would like you to take into consideration throughout the comment period. 9.4.3.1

And once again, none of the six endangered mussels are in the same genus as those that were tested, and you all need to deal with that. 9.6.3.1

The Endangered Species Act mandates plans to recover endangered populations and habitats. Where are these plans? You don't have them. Especially in light of your documentation of the gradual decline in mussel species, abundance and diversity, you need to designate critical habitat and plans for restoration, et cetera, et cetera. 9.3.2

We all know that Watts Bar is the most unsafe nuclear facility in the country, and you don't deal with this at all in the draft environmental impact statement. 9.8.2.1 9.8.2.2

I noticed you had a section on environmental justice. I think that's great that you had that, but you totally do not deal with justice issues dealing with employees at the facility who are harassed and intimidated when they come forward to tell the truth about safety concerns with the plant.

And I recently have been given documents concerning the murder of Judy Pendley, and I don't think that was ever resolved and, you know, other people who were coming forward with concerns back in 1985 were receiving death threats and stuff like that when they spoke at TVA board meetings, and I think that's an issue, a justice issue that you all need to deal with.

Let's see. Also, you know, when you have the scoping hearing for this thing--I got here late and everything, but quite a few of us ask that you look at the cumulative impacts of this facility. 9.6.3.4

I'll be honest with you, I did not read the impact statement from back to cover, from front to back, but I didn't find anything in there that dealt with the cumulative impacts of like everything in this region and how Watts Bar adds to those cumulative impacts. 9.6.3.4

The woman over there was mentioning the ripple effect, and you all just didn't deal with that as far as I could tell. You need to deal with the fact that we have an acid rain problem in this region, we're suffering ozone depletion, which most scientists believe leads to increased UVB radiation. What kind of effect does increased UVB radiation have on mussel populations, for example? 9.6.3.5

Mr. Newberry: Thanks for those comments. [Discussion]

Becky Heim.

Ms. Heim: I think they have addressed the environmental part pretty good. I just wanted to make a couple of statements.
Last night my husband and I had dinner at the City Cafe in Brentwood--by the way, there are four of us from the general Nashville area, I figure we represent approximately 150,000 people each.

At the City Cafe last night a young couple with a almost one-year-old child was sitting behind my husband, and she started making eyes at me and him, and did the general baby-type things of laughing, and waving, and wanting to play.

And it was a long time before I noticed the bib she had on had a comic-strip-type balloon upside down, but the writing was upright, and it said "Spit happens."

Well, I hope I don't offend anybody, but you're all familiar with the bumper sticker "Shit happens." Shit and spit, friends, are natural results of bodily human functions, they're not accidents, they are completely controllable, they can be taken care of, they're environmentally friendly.

Nuclear proliferation, nuclear energy, nuclear waste, nuclear accidents, whatever, are that, they are accidents. I don't think you can put a diaper on them, a potty under them, or clean them up in two minutes.

I think maybe what's lacking in the industry is a little motherly instinct, or motherly caring.

That's all I have to say.

(Scattered applause.)

Mr. Newberry: John, you're next.

Mr. Johnson: My name is John Johnson, I live downstream from Sequoya and Watts Bar nuclear sites in Chattanooga, Tennessee, with a semi-organization called Catooa Earth First.

For those of you who don't know, Catooa is the old Cherokee name for the Southern Appalachian bioregion within which we are now in, the most biologically diverse place on the North American continent, and I think one of the most beautiful places which is currently threatened by people who can't see through the error of their ways and want to continue to build nuclear plants.

The first thing I would like to say is that the NRC and the TVA being agencies of the federal government have a mandate from the Clinton administration to use recycled paper. This doesn't feel like recycled paper, and you only used one side, and I think that's a really big insult to whatever piece of national forest died so you could put this information out and give it to us. You need to start using recycled paper, and you need to use both sides.

Mr. Newberry: Thanks for those comments. I think we'll consider those for addressing in the final.

Mary Ann Heine.

Ms. Heine: I believe the issue here is changes in the plant, or changes in the environment that should be addressed in this environmental impact statement, and I just have a couple of quick points that I would like to make, things that I don't believe that were addressed here that should have been addressed.

First biologically and socio-economically. First of all, biologically I realize this falls under more of the domain of the Fish & Wildlife Service, but you are required when a species is listed as endangered to come up with some type of recovery plan, and that was not indicated in this environmental impact statement, not only for the species that were previously listed, but for those that have been added, and I would like to request that that information be somehow provided whether you're going to be designating critical habitat, whether you're going to be relocating the species, or whether you're just going to leave them to their own devices, we would like to be provided with that information. 9.3.2 9.4.3.1

Socio-economically, again the issue is what has changed in operations of the plant, or in the environment that should be addressed here, and the troubled history of the plant was not addressed. I'm sure you're aware that there are more whistleblower complaints on file about Watts Bar than about any other nuclear plant in the country. 9.6.6

There's also--last summer it was very detailed in the newspaper accounts of the Nuclear Regulatory Commission turning over the names of whistleblowers to TVA. There have been lots of documented cases of harassment, workers are afraid to come out with safety concerns.

I would like the troubled history of the plant to be addressed, I would like the--basically the reluctance of workers to come up with their safety concerns because of the documented harassment by TVA of whistleblowers who have addressed their concerns to TVA, as well as the--as Daniele was mentioning earlier, quality assurance, quality control, the high rate of turnover of managers, the lack of faith that the NRC has in documentation of problems at Watts Bar. So I would like that to be addressed, I would like the troubled history of the plant to somehow be addressed to the people within the context of the environmental impact statement.

And finally decommissioning. In the draft environmental impact statement it details the process of decommissioning, of what a utility has to do for decommissioning and the expenses, but it doesn't give any details about TVA specifically, and I think we're all familiar with TVA's financial woes in these times. 9.9.3

I really would like somehow more specifically in this draft environmental impact statement for changes in how TVA is going to come up with money for decommissioning now that the economic situation at TVA has really become pretty sketchy.

So those are the things that I believe have changed that I really would like to see addressed within the environmental impact statement.

9.6.4.16

So even though these figures might exist in an ideal world, the ideal world doesn't exist, so lots more people are going to get cancer than are listed in this study, and leukemia, and all kinds of other things, as well as birth defects.

I mean I have met people from Oak Ridge that can't have children, and you probably all have met people, too, so this is something to consider that we're not only affecting us, but we're affecting future generations.

Okay. Now, when you talk about setting up this evacuation plan, does that mean that we get to have some fire drills? Are the people here actually going to try evacuating? Because I mean you really should try it, because how do you know if it ever works if you don't try it?

In an emergency everybody would be in such a state of panic they wouldn't be able to evacuate very safely and, you know, if you have enough fire drills maybe they will be able to, I don't know, but I mean it endangers the whole area. Not just this area, but the whole area around us, the states around us, and I don't know where we would evacuate to. If the highways were not here, where would we go? So it's really wishful thinking, I guess.

The other thing is that the congress right now is trying to balance the budget, and I think you could really help balance the budget if you didn't operate the plant. But considering it's already cost six to eight billion dollars and it has so many overruns, and so many problems, it would probably help the budget by not operating it.

And I don't really understand why TVA gets to build plants in the red, because most businesses wouldn't be able to do that. So that's kind of an odd thing.

9.9.4 And then the other thing is that the present congress wants to cut all funds for clean-up, so they may not want to continue clean-up of Oak Ridge, and they may not want to clean up here, and they may not want to clean up anywhere else, so who will be doing the clean-up?

In the history of looking at Oak Ridge, the companies that did the work during the war have all left, and they're not held responsible, so who will really be responsible if the congress doesn't put up the money?

I mean as the citizens that are going to be using this, we have to think about this.

Okay. Tornados and all these natural disasters compound the accidents that could happen, so you can have a compounding effect from the natural and the accidents within the plant to make it an untenable situation.

9.4.2.1 They had big tornados also last year near Oak Ridge, and they seem to be a fact of life here that we just have
9.8.2.5 to, you know, work with, and it's impossible for almost any building to stand up to tornado type of winds.

Anyway, like I said, while these figures might exist in an ideal world, our world is not ideal, and unfortunate we're going to be in big trouble.

I guess that's it.

These buildings seem to be more sound, so perhaps this would be a better storage facility, which would be a good use of the facility.

Considering that there's already been lots of accidents here and the plant hasn't opened, it doesn't really make us feel very reassured that more accidents wouldn't occur. I mean there were already three accidents this year, including a fire in the control room. And what can I say?. I mean that just doesn't make you feel like that the plant would be very safe to operate.

There's been so many complaints from people working on the plant that the electrical systems are not properly done, and the welds are not done up to codes that why expose it to more danger.

Then I wondered why TVA is the only utility in the U.S. that's still trying to get a nuclear plant on line. I mean it's like are we slow or something?

If everybody else has found them not feasible to continue operating, perhaps we should see why they think that, and maybe we should follow their suit.

The life of a nuclear plant is very short, and then you have all this problem with decommissioning them, and then what do with the waste that's going to last for 200,000, 300,000, 500,000 years, I mean more years than we can even imagine in our minds. And that's something that you have to figure in.

You can't say "Well, okay, we made automobiles," and the waste from the automobiles, you know, now it's causing all this problem with acid rain. Well, all this nuclear pollution is going to be causing damage for so many thousands of years on so many generations that you really have to put that in as part of the equation, which really makes it unfeasible.

I appreciate the work that you've done on this, and it seems to me that a lot of the studies about not affecting the biology and the aquatic creatures in the area might be possible in an ideal world, and it probably would be 9.2.1
true if you didn't operate, so to reach these statistics I think you would have to not operate the plant, to be actually truthful. The health effects for this two cancers in ten--well, some of the statistics that I've looked at by people that have followed nuclear plants are that if you even live in the county of a nuclear you have a 300 percent increased chance of getting cancer, if you even live in the same county, at the far end of the county. So you have a lot more chance of getting cancer by living near by. 9.6.4.16

And then when you think of all the plants that are already operating--I mean I'm sure that the people at Oak Ridge had very good intentions, and had no idea that they were going to be contaminating all the waters and the streams there, and that now people can't fish, or eat the fish there, or, you know, that it's such a big mess to clean up--and when you think of all the nuclear plants, I mean every one I can think of has had some kind of serious accident.

You know, the Fermi plant they almost lost Detroit; Browns Ferry has had all kinds of fires; Three Mile Island was a mess, and I'm sure there's thousands and thousands of people that have cancer from that; Chernobyl was a major disaster; San Onofre had electrical fires; the Hanford Plant is closed, and I mean how many trillions of years that will take to clean up I don't even know; Rocky Flats is closed; Barnwell is contaminated. 9.6.4.17

When we do our testing at Oak Ridge National Laboratory we will have organisms X, Y and Z. Z may react terribly, X and Y will be fine. Well, does that mean "Oh, well, okay, X and Y are fine so, you know, we can just go ahead and dump it out there"? No, it doesn't, because Z is part of that ecosystem too.

This needs to be readdressed before this plant is opened for operation, if it becomes open for operation, because the testing that has been done, as I said, is totally inadequate, and I think it--I mean you would think that a system like the TVA, I know the TVA has toxicity testing in place because we have worked with them on this Clinch River project, and so I know they've got this kind of stuff in place and, like I said, this really needs to be addressed more strongly because you're not even beginning to look at the actual impact on this ecosystem.

Yeah, it's very interesting to know what these molluskicides do to these genus of mussels that don't even exist in this ecosystem. That's good information to have if you should ever decide to pollute an ecosystem that has those mussels in it, but we need to look at what's in this river now and how it's going to affect that. That's all I have to say.

(Scattered applause.)

Mr. Newberry: [Discussion]

Thank you for your comments.

The next individual, first initial M., and Cassoulet, or--Is that you? What's your name, ma'am?

Ms. Cassoulet: Michele.

First of all, since we're the people that are really paying for the plant, and we're the customers that are going to receive the electricity, I think it's reasonable that if people are interested enough to want more input that perhaps you could have more hearings and allow input, because there are people in other areas of the state that couldn't attend tonight, and they would very much like to, and the fact that they're interested I would think you might be honored, and if you could have more hearings for them in other areas of the state I think that would be very appropriate.

The other thing is after working on this plant for 22 years I believe it is actually rather outdated, and I'm sure it's gone through lots of different design changes over the years, but it's like once you have--I don't know, it would be like trying to teach a dinosaur to drive a car or something like that. You know, it's almost an impossible task to make it operate safely.

Actually we have a good contingency plan perhaps for the use of it. Since Oak Ridge is collecting all of this uranium from all over the world, from Russia and from dismantling bombs and stuff, perhaps this would be an ideal storage facility, because your buildings here are much better built than the ones that are at Oak Ridge presently in use for storage. The ones there are like so old from the forties that a good tornado I'm sure could blow them over and expose all that uranium.

What happens in the native species end up getting killed off, and the zebra mussels and the Asiatic clams are still there.

I agree with Mike when he says that I find it very difficult to believe that the level of mulloskicides required to weed out these exotic organisms is not going to have any kind of impact on these already damaged and weakened mussel beds.

That is the problem, they're already weakened, and they're susceptible to any type of input like this.

I mean we're talking--not only are we talking about--I also want to address the sediment issue. Not only are we talking about mussels, but let's say for some reason the molluskicides don't affect the mussel beds, even though they're already extremely weakened. 9.6.3.3

Let's say by some act of God they don't do that. These contaminates are still--from my work on the Clinch River I have seen decontaminants not only stay in the water, but they bind to the sediment, and sediment doesn't just go down to the bottom of the river and lay there. Sediment is an active part of the ecosystem, just like alga is, just like the water is.

There are detrovores that graze along the bottom, and they're going to--you've got snails down there--they're going to graze. They're going to graze, they're going to pick up the contaminants, and they're going to be eaten by something else, which is going to be eaten by something else, and the next thing you know you've got bio-accumulation.

It doesn't get less and less and you go through the food web to larger and larger organisms as some people would think it would, it gets more and more and more, and that's something that we really need to address, because the study that I did on the Clinch River showed that there has been a build-up of contamination in the Clinch River.

We're not talking about necessarily the same chemicals here because we're talking about radiation output from Y-12 Oak Ridge National Laboratory, that sort of thing, but the effect is still there, and sediments I tested from the Clinch River are toxic. They're toxic--okay. You know, yeah, you're saying we're not talking about the same thing, but it's the same effect, and what happens if they're toxic to alga, if they're toxic to fish larvae, if they're toxic to little arthropods, why aren't they going to be toxic on a larger scale as that kind of chemical moves up through the food web?

Another thing that I wanted to also reiterate from what Mike said is the toxicological testing that was done on this was totally inadequate. 9.6.3.1

When we do toxicity testing at Oak Ridge National Laboratory on sediment and on aquatic systems we use a variety of organisms, and we generally try to get ones that might actually occur in the system that we're looking at.

This needs to be readjusted completely. There needs to be more extensive toxicity testing done on this. You cannot even begin to relate the impact of two entirely different species to a chemical.

It's true that the IPE that was used as the basis for estimating core damage frequency was in fact just for internally-initiated events, and one could have a more complete assessment if you did consider the whole slew of external events that can be postulated at plants.

I think it's a pretty safe statement, though, to say if you've looked at plants, if you've looked at all the internally-initiated events and you've developed a reasonably complete and adequate way of responding to internally-initiated events, then in the event of an external event these same methods and procedures that you might use basically to keep the core cool would be effective in externally-initiated events as well.

So you're trying to reduce risk as best you can for internally-initiated events, and in doing so you improve the ability to deal with external events.

I'm not saying that we shouldn't consider it, we could be more complete, but I'm thinking we get a lot of the mileage out of just looking at internal events.

That's it.

Mr. Newberry: I think Daniele indicated she was going to provide written comments, and I think we would be obligated to address them in the final.

The next individual is Jill McAfee.

Ms. McAfee: My name is Jill McAfee, I'm environmental toxicologist at the Oak Ridge National Laboratory Environmental Sciences Division.

I just completed my master's in ecology with a focus on sediment and sediment contamination in the Clinch River system, and I also have publications in both World Book Encyclopedia and the Encyclopedia of the Environment concerning exotic species, as well as being an adjunct faculty at Pellassippi State.

Basically what I am addressing tonight is the effect of--we've been talking about the impact on the species in the system due to the presence of Watts Bar.

What people don't seem to realize is there's a ripple effect produced in an ecosystem. If one species is damaged, there's a ripple effect just like dropping a stone in the water, and it gets bigger, and bigger and bigger.

When population levels change, it also opens up the prospect for exotic species such as the zebra mussel and Asiatic clam to come into the system and, as it's well know, if you look at the system in the Great Lakes these things can really wreak havoc not only on the ecosystem, but also on the industry that's there.

9.6.3.2 Introducing molluskicides into the water to kill these--these are extremely hardy organisms. I mean like I said, I wrote a paper for World Book about zebra mussels, these are very, very hardy, they don't fall to the normal things that you would think that they would.

say, primarily electrical power systems; these are the ones that I'm aware of. There may be some fluid systems as well, but I'm not sure about that.

Two of the procedures, as someone indicated early in the presentation, TVA has committed to implement three additional improvements--these were of a procedural nature--as a result of the SAMDA evaluation. Two of those three procedure changes do in fact make use of systems that are in Unit 2, and there will be cross-connects and things of that nature that would allow those systems to be used for Unit 1, and to further reduce core damage frequency.

The second point that you raised was that the $1,000 per person-rem number is outdated.

I want to make it clear that we didn't use the $1,000 per person-rem value as a decision criteria, we used it as a basis for screening things out. You have to have some kind of a basis or point of reference by which you can try to judge fixes, improvements to plants, and judge whether these are worth the money that they do cost.

I mean everything costs some money, and you want to have the biggest bang for the buck when you're making some changes. If you have a limited budget, you're going to want to pick the fixes that give you the best risk reduction.

So we try to use a figure emeritus value impact ratio.

Again, we use it as a screening criteria, we use it to try to identify those things that are most cost beneficial, and then we go from there.

We use the value of $1,000 per person-rem. It's been the value that's been on record for many years. One would think that, yeah, we ought to get back to that, relook at it, everything else has gone up in cost, why shouldn't that go up as well.

To that let me just say that there is an activity that's underway, there will be a Federal Register notice issued--I don't know when, these things sometimes take a lot longer that you'd expect--but it is in effect codifying the value that would be used.

And the number there--there's been a pretty major effort to revisit the bases for the value--it's not significantly different, it's within a factor of a couple.
I probably shouldn't say what it is, but it's on the order of a couple, so that's not significant.

We looked at all of these design alternatives that were within a factor of ten. We found that there were five that were within a factor of five of $1,000 per person-rem, and we looked at them more closely.

I think if you changed the value from $1,000 per person-rem to $2,000 per person-rem you would not pick up any additional design improvements that--you know, we wouldn't have missed anything in doing that.

You raised the point about IPE not considering external events and, as such, the FES is incomplete.

I want a couple of things to be addressed in the environmental review.

9.9.2 I don't feel the decommissioning, decontamination/decommissioning was adequately reviewed. I don't understand where decommissioning can cost between 500 million and a billion dollars. Currently NRC is looking at different standards for clean-up activities in terms of how much workers will deal with radiation, et cetera, and I want to understand how the new NRC regulations are going to deal with maybe an increase in the amount of decommissioning and decontamination.

9.6.4.13

Secondly, I think the nuclear waste issue was not addressed adequately in terms of the fact that we do not understand in this country yet where we're going to store the hazardous waste, and, you know, how much is going to be produced, do we have a place to store it in the case that places out in Nevada is not going to work out.

9.4.2.1 The last thing is that I believe that the tornado frequency, the potential of tornadoes I think might have been undervalued, and I'm not sure if you all have addressed the fact that in February 1993 there was a tornado that came very close to the Y-12 plant that there were winds of 130 to 200 miles per hour that needed to be addressed in this particular document in terms of the frequency, and once again as I mentioned before, the
9.8.2.5 frequency of tornados and external events like earthquakes should be addressed in the individual plant examination.

So that's pretty much what I have to say. Thank you.

(Scattered applause.)

Mr. Newberry: The gentleman that worked on the SAMDA evaluation is raising his hand over there. It looks like he has some comments, so I'm going to ask him to talk for a second, but just let me ask Daniele, I think you did have some good comments there. I would encourage you to send them in to the NRC.

Mr. Palla: Bob Palla with the PRA group at NRC. I was responsible for the severe accident mitigation design alternative evaluation.

You raised a couple of good points, and I just wanted to try to clarify how we saw those same issues.

You pointed out that shared systems, or some of the Unit 2 systems could be used in Unit 1, and I don't know if you had a chance to review the SAMDA write-up or not.

If you did, you would see that some of the--in fact, we may not have gone into a lot of detail about the extent to which Unit 1 does take credit for the Unit 2 systems, but there are some shared systems primarily in the area of electric power supply where components that were originally placed there for Unit 2 will be dedicated to Unit 1.

There will be tech spec controls placed on them, and they will be just as if they were dedicated and put there for the exclusive purpose of Unit 1, so they will be covered by the full suite of regulatory requirements. As I

"Most of the recent construction work at Watts Bar involves correction, correcting preexisting problems. Because TVA devoted inadequate attention to the identification of root causes and implementation of effective recurrence controls, TVA has had to develop and implement additional corrective actions to ensure the design output will be met."

"TVA personnel exhibited little sense of ownership and accountability for the quality of plant construction. Independent reviews of engineering modifications and activities have demonstrated that management expectations have not reached the working level uniformly, and assumption of responsibility by the lower levels of line organization has not been universal."

"This is compounded in the electrical area by a tendency to focus on the completion of specific subtasks while neglecting to view the actions of plant personnel as part of the whole to resolve the fundamental problem."

"If a sense of ownership were instilled in the line organizations, people involved with work would ensure that problems were solved."

And lastly the quality assurance and quality control at this plant. "Quality assurance and quality control should serve as a safety net at Watts Bar and ensure its quality levels have been achieved. However, the recently identified...problems cast doubt on recent performance of QC because NRC uncovered the problems after QC failed to find inadequate implementation of the electrical and cable CAPs and some other defects."

"TVA management has not effectively utilized the quality organization and its role in assuring that Watts Bar is constructed in accordance with applicable standards and commitments."

"The Watts Bar quality organization has not been given a commanding visible role in setting the standards and assuring quality performance at Watts Bar."

"As a result, the quality organization has lacked aggressiveness in ensuring appropriate QC or line verification activities are specified for important safety-related work. The staff noted during several CAP and SP inspections that QA reviews had been inadequate."

"Watts Bar was extensively inspected by the NRC staff. One unfortunate aspect of extensive inspection is that the NRC staff has tended to become the mechanism for setting quality standards for Watts Bar to varying degrees supplanting TVA's quality organization."

Mr. Newberry: [Discussion]

Daniele: So I mean I've got copies, I can get copies of this to people, but you can see that there is a serious doubt by the NRC that this plant is where it should be.

And I recognize that this particular, you know, session focus isn't on this, but you can recognize from the public's perspective this is the only opportunity for us to actually go to the NRC and say "Hey, guys, we're really concerned about this plant."

This is what the NRC believes about site management: "The staff believes that at Watts Bar both site and corporate management place disproportionate emphasis on the rate of work accomplished as compared to the emphasis that's placed on quality verification."

"This imposes a scheduler pressure"--schedule pressure, of course--"which although a normal aspect of construction completion, must be controlled to ensure that quality is not compromised."

"In several instances TVA declared that major construction activities such as corrective action programs and special programs were ready for inspection in accordance with the scheduled date, only to be later found deficient either by the NRC during inspection, or by TVA just prior to the NRC inspection."

"The staff concluded that the TVA's management disproportionate emphasis on work performance resulted in some degradation of long-term quality accountability on the part of TVA staff at the site."
"Short-term goals and tasks were emphasized by TVA management, but a sense of individual and personal responsibility seemed lacking at many points in the organization. Such activities as the corrective action programs and special programs had groups of owners (?) resulting in diffused responsibility and lessened accountability."

"Continual turnover of the middle management and supervisory levels has contributed to a lack of accountability. It has been a lack of continuity and change of direction which has not been conducive to consistency of purpose, and could result in mixed expectations at the line of level."

"Most TVA managers lack longevity at Watts Bar. Since the construction restart in 1991, with the exception of the vice president, new plant completion all senior managers have changed. These changes include, but are not limited to, the site vice president, start-up manager, plant manager, licensing manager, QA manager, modification manager and project manager."

"The ability to license Watts Bar depends largely on TVA's successfully implementing numerous corrective commitments made between 1986 and 1989. Implementation of these corrective actions in turn depends on management's detailed awareness of and strong commitment of these requirements."

"The continuing management changes have contributed to instances where the same mistakes have been repeated and the original problems have not been corrected. As management at the site has changed, the reasons for some corrective actions and programs appear to be no longer well understood. This makes successful completion of the older corrective actions and prevention of recurrence very difficult."

Under engineering modifications, "Engineering modifications and major line organizations working to complete construction at Watts Bar. Although the majority of CAPs and SPs"--corrective action programs and special programs--"have conducted acceptability to 75 percent goal and proceeding on track toward completion, several failures to achieve required quality levels have occurred, especially in the implementation of electrical CAPs."

"The fact the NRC inspections reveal any significant problems in what is essentially corrective action work is disturbing. Some specific electrical work has been poorly implemented."

per person-rem, and the impact of that would be, well, significant to the use of, or the design improvements in the plant, and it would be warranted based on a value impact analysis, so I think that ought to be looked at.

The other thing is that we were talking a little bit about the Watts Bar individual plant evaluation, and we were talking about--that was the IPE, or the PRA, the probabilistic risk assessment kind of looks at his broad risk of a severe accident, and right now we believe that the IPE and the subsequent SAMDA studies do not consider external initiating events such as fire, earthquakes, external flooding, and so on. 9.8.2.5

External events are potentially important, and in some cases dominant contributors of risk arising from severe accidents.

Failure to include these external events renders the draft environmental impact statement and SAMDA considerations incomplete.

So I guess those are some broad issues.

I also would like to make a note that we're talking about the IPE being reduced. We have not at our office made a significant look at why the--the original IPE was extremely high, and TVA made subsequent changes to reduce that risk number, but it's our understanding--and I'm not completely sure about this yet--that the majority of that risk was in a system, in a certain system of the plant that was not addressed by the IPE. 9.8.2.6

In fact, it is our understanding that most of the reductions were made on paper, that they just changed procedures, or they generally changed procedures and they had an opportunity to reduce that risk even further by changing specific components in the plant, but they did not choose to do that, because of course it would cost too much.

[Discussion]

Daniele: I would also like to address the fact that the quality--the assertion here is that the risk at Watts Bar is, as long as all the regulations, the quality assurance and quality control regulations are being followed at Watts Bar then the risks of a severe accident which does have an impact on the local environment because of the radiation, that the risk is low.

But what I'm trying to make a point about is that the current, the public's assessment of where this plant is in terms of its safety and its compliance with the plan is fairly low.

In a recent--the Nuclear Regulatory Commission on December 22nd, 1994 released their overall assessment of Watts Bar. This is where they think Watts Bar stands today, and I will finish my statement after I read this, but this is what you all are saying about Watts Bar yourselves, and this is what we're seeing, and this is why we're very concerned this evening:

"There are three main functional areas that define construction performance at Watts Bar. Site management, engineering modifications, and quality assurance and quality control."

I think that part of the reason that we have been attempting to get a hearing such as the one this evening is because the last time the public even had an opportunity to comment on this plant was in 1978, and I think that really has been ignored by the Nuclear Regulatory Commission more than it should be.

I realize that the people here tonight are addressing a specific focus, but I think that people here want to address the plant and where things are going with this plant, because since 1978 there has been enormous changes at this plant.

There have been stop work orders, they have stopped the construction at this plant. There has been enormous changes inside the facilities or the structures, the systems components are radically different, and all we're talking about is how the environmental impact and what's being discharged in the air, and we're talking about a plant here, and I think that the--I think people are basically asking for a reopening of the construction permit, and I recognize that legally the NRC isn't going to allow that, but I think the public is warranted to ask that happen.

There's a couple of broad areas that I think that were not addressed in the environmental impact statement that I would like to address right now, and specifically I would like to look at SAMDA which is the Severe Accident Mitigation Design Alternative.

Basically I think the most important problem here is that the cost-effective risk reduction measures are no longer valid. There exists a very real possibility that additional cost-beneficial risk reduction can be identified.

9.8.2.3 The circumstances result as a result on an announcement that TVA made that they're going to cancel Unit 2 at Watts Bar, and this cancellation means that Unit 2 systems can be used to support Unit 1 response, potential severe accident initiating events, and thereby reduce the severe accident frequency.

And I think that it's enough that, you know, while we don't know necessarily which systems in Unit 2 that could support Unit 1, I think that it's enough at this stage to observe the potential for using Unit 2 systems to reduce the risk at Unit 1 has not been explored by the TVA or the Nuclear Regulatory Commission.

The viability of such changes depends entirely on the degree of the completion of Unit 2, and the differential cost of making the modifications, you know, it just depends here. But there's a principle here, and it should be explored.

9.8.2.4 The other major issue that I think that ought to be addressed is the fact that the NRC continues to utilize the NRC standard for $1,000 per person-rem, and that is basically outdated, and it's undervaluing the risk reduction measures that could be used and what are cost-effective.

It is clear that the $1,000 per person-rem aversion criterion is outdated, and the NRC is currently under an examination of reviewing the $1,000 per person-rem, and it's our understanding that while we know that there is going to be a change, we don't know the degree to which that will change, the magnitude upon which that will change. That should have an impact.
We are suggesting that the NRC changes its use, and that they may actually use something closer to what the actual U.S. nuclear industry is using, or even what some other utilities are using, which is 5,000 to $10,000

The message I get when you talk about the fact that these are non-reproducing populations seems to be "Well, they're goners, so we can't do anything about it."

To that I would like to make the statement that there is a new science of restoration ecology where you can 9.4.3.1
transplant populations. It's being done in Nashville right now.

I don't see why some of these--and I want to mention the number--there are six endangered species or candidates--why some of these six species can't be transplanted, or at least that could be looked at.

So the idea that these are so-called living dead as we call them in conservation biology, "Let's write them off and forget about them," that seems very tenuous to me, and I'd like to say that.

The other point that bothers me is where you conclude that the plant operation will have no significant impact.

Specifically you talk about putting heavy metals, thermal effluents and so on. Again I understand the necessity
of doing this and mitigating factors. I would like to mention, though, that the Endangered Species Act does 9.3.2
say, it's the law that you need to set aside critical habitat. I realize you can't do that because this plant is there,
but again when you're putting molluskicides into the water which are supposed to kill mollusks, I find it rather 9.6.3.
surprising that it wouldn't kill some of the endangered species which are mollusks, the clams.

I would also mention I've done some scientific research and looked at the literature, and there are studies that show that some of the molluskicides named do have an impact on native clams.

This was supposed to be covered by the toxicity testing. You used two species of clams, you used juveniles
which is good--I agree, I think that's a really good thing--my kind of statement or comment here is that 9.6.3.1
unfortunately neither one of these species belonged to even the genus of the six endangered species, and it's one of the primary rules of toxicology that when you perform toxicological testing you have to worry about species-specific effects.

In other words, two closely-related species may react very differently, even if they're in the same genus, to certain toxicity tests.

Here you're using test critters that are not even in the same genus, so I would suggest that those test results really don't extrapolate very well, certainly don't lead to the conclusion that these molluskicides will have no impact on the native clams. I just don't see it, it's just not in the toxicological principles.

I guess that's all I've got to say.

Mr. Newberry: Thank you for that comment. [Discussion]

Daniele: I would like to just quickly address the fact that the people here are trying to address issues that are outside the purview of the environmental impact statement.

Mr. Newberry: Two questions. The first question, I did say that the estimates for the likelihood of an accident at Watts Bar were in the range of the other plants, and I also said they were very low. The quantitative estimates are in the report.

I didn't hear all of your question with respect to the emergency planning.

Mr. Irwin: The evacuation plan. You can't present us with one tonight, apparently you'll put it in the mail for her and she'll receive it in a few days or a few weeks.

Well, if the plant does happen to go up tomorrow and I have fifteen minutes to get out, may I have your phone number?

Mr. Newberry: [Discussion]

Mr. Hebdon: The other gentleman had the question on the emergency plan. If you're interested, we can get the information to you also, but understand the plant is not operating yet.

Mr. Irwin: When it does--

Mr. Hebdon: I mean we can get the information to you within a few weeks of today, and the plant is not going to operate within a few weeks from today, so the information would be to you before the plant would operate.

Ms. Honicker: Does it say where each person is supposed to go?

Mr. Tamby: Regarding emergency preparedness, in the voluminous amount of information that we do have, those residents that are within the vicinity of the plant will be given information about evacuation, about emergency planning, et cetera. They don't have to wait.

Now, offhand since I'm not an expert on that I don't want to just arbitrarily answer your question, but I know that the plan is there and that at the right time the information will be given to the residents in the vicinity.

I'm not trying to be evasive, it's just that tonight we are not prepared to answer that, and I don't have that information. We don't have an expert to answer that question.

Meanwhile the plant is not operating. Tomorrow it's not going to have an accident, it's not going to have a nuclear accident.

Voice: Is uranium on site right now at Watts Bar? 9.8.1.2

Voice: Yes.

Voice: Could there potentially be an accident right now because of the uranium at Watts Bar? 9.8.1.2

Mr. Newberry: [Discussion]

Mr. Tamby: The nuclear fuel has been on site since the eighties, 1980. However, since the fuel has not been irradiated and is not being used there is no fission product in the fuel, so it cannot cause a nuclear accident like the kind that you have in mind.

The plant is not operating, the fuel is not in a configuration where it can reach what we call criticality, so the fuel is very safe.

Mr. Newberry: [Discussion]

Ms. Hines: This is not a question, this is a statement.

To say that the plant isn't responsible if it's in storage to me seems a complete abrogation of responsibility. That's like saying to me the advertisements that say don't blame the thief if you leave your car unlocked, or it's not really the cigarettes that cause your lung cancer, it's the smoke that is in your lungs, the cigarette is not responsible.

I'm Becky Hines from Brentwood, Tennessee.

Mr. Newberry: Thank you.

I want to move on to the folks that have requested some time here to make comments. [Discussion]

Michael McKinney was the first person. Could you raise your hand?

Mr. McKinney: I'm Michael McKinney, I'm Associate Professor of Ecology and Geology at the University of Tennessee. I teach ecology and geology at the University of Tennessee, I teach conservation biology, and I have written a number of articles and books on extinctions and the topic of environmental science.

My basic statement is that I've read this review quite thoroughly on the biotic impacts, the aquatic biological impacts, and I remain very skeptical.

I do think you've done a really good job, I think you're really serious about it, but I have a lot of questions. I think some of the tests you've done don't stand up to close scrutiny when you look at the environmental science of what goes on.

I want to focus on the mussels because mussels are what we call indicator species, they indicate the health of the aquatic system, they tell us what's going on, and as a lot of people here probably know the mussels in the Tennessee River are very, very sick, they have been sick for a long time, and they're in rapid decline. I think the report mentions that they've gone from 64 species to 28, or something like that.

Admittedly that's not the fault of Watts Bar, that's mainly from the dams, but to some extent the logic seems to be that "Well, since these things are sick and in decline, let's kind of forget about them."

I'm not saying that whoever is running Watts Bar would be corrupt enough to do that kind of thing, but it has happened.

Ms. Harty: I'm not familiar with that.

Back to your previous question, there is a table in the original FES, in the 1978 FES which is a summary of environmental considerations for the uranium fuel cycle, and it also--it's Table 5.10.

For the most part, however, the impacts as far as doses from facilities that mine and mill are part of their environmental statement as opposed to the environmental statement for this plant.

You would kind of have to dig all these environmental statements out from the different locations.

Pardon?

9.6.4.7 **Voice**: Nobody adds all that up?

Ms. Harty: They do to some extent in the sup, yes. For instance, they talk abou· the number of curies that would be released during mining, and milling, and the radon doses. They don't go into a lot of detail. They did come up with some population doses that I mentioned, but it's not in the detail that you have for the rest of the report.

Ms. Honicker: May I respond to that statement?

The memorandum came out shortly after the Hartwell Nuclear Plant hearings, and it was said--Dr. Walter
9.6.4.7 Jordan was a retired director of the Oak Ridge National Laboratory so that you'll know that he's not an anti-nuclear activist--he said that the radiation released from radon from the uranium required to fuel a single reactor for a single year can run into the hundreds.

Luke Adams (?), who was the congressman from the Nashville district had some correspondence with Dr. Jordan, an that was quantified to be 400. That's not 400 deaths today and tomorrow, but 400 deaths over the long term from the radiation released from the radon from the uranium required to fuel a single reactor for one year.

Mr. Newberry: I think we can do a better job than that in the final. We have your comment here, we'll do something with that. Thank you.

Mr. Irwin: My name is Chris Irwin, and I'd like to jump back to something the woman brought up previousl about the initial studies showing that Watts Bar was more likely than most facilities to blow the hell up, and th response was that it was found that it was as likely as the other facilities, and that response didn't particularly assure me or make me feel any better that it's as likely as any of the other ones to go.

As for the evacuation plan, you'll get back to us in a couple of days by mail. What if it blows up and we hav fifteen minutes to get out? Are you going to get back to us by mail afterwards?

Ms. Harty: The doses resulting from the transport of the waste to the waste repository was accounted for in the report.

Once it's at the waste repository, it's no longer considered to be an impact from the Watts Bar nuclear plant, but it's considered to be an impact of the waste repository, so that was not accounted for in this supplement.

Voice: What about accidents of transportation? 9.6.4.14

Ms. Harty: I don't think we addressed the accidents of transportation in this report.

They were addressed in the FES, weren't they? and there weren't any changes from the FES impact, so it was not addressed in further detail in here.

You would have to refer to the 1978 FES.

Pat: Okay. My name is Pat.

Okay. Along the lines of that gentleman's question, what about the mining of the uranium and the processing of the uranium, and the tailings of the uranium to the people who still live in those areas? Whose responsibility is that? I mean I guess I'm addressing the question towards your answer to the last question. 9.6.4.7

Mr. Newberry: Let me just put one thing in perspective here.

The way we looked at this, Pat, was the FES was completed in 1978, and we concentrated on changes to the plant, the way the plant was operated, the plant design or the environment that occurred since 1978. There were no changes in that and many other areas as far as we are aware of.

In terms of the scope--

Pat: Therefore the numbers are much higher about, you know, people actually involved with the radioactive material which will eventually and would produce energy at Watts Bar. The total amount of radiation is much larger than the amount of radiation you're actually looking at, because it's spread out. 9.6.4.7

Ms. Harty: The only thing that was really addressed in the FES and in the supplement was the fact that the uranium would be used, and it was a resource that was--how do you say, nonretrievable--and so we had to look at that. It's not recycled.

However, the rest of your--let me check one thing in here real quick--

Voice: While you're looking, about the milk pathway, I know there was at least one situation where around some sort of nuclear facility the cows were just taken away and new cows were brought in. And I mean I'm sure that some people in this room are aware of that incident, but that has been done.

There is a dose--and I'm not sure if this is what you're thinking of--for radiation workers they assign a specific dose. They assign another dose to radiation workers who are pregnant, or who have declared that they are pregnant. That's the only difference in the dose to an infant or to a child.

Dale, do you want to address the limits that there are for the off-site population?

You're talking about the limits, not what's going to happen as a result of Watts Bar; correct? The limits that are set by the NRC?

9.6.4.2 **Ms. Cowan**: I was concerned about the limits to the general public and the impact of Watts Bar to the general public.

Mr. Hebdon: Let me see if I can help just a little.

There are limits that the NRC has set on exposure to members of the general population, and they're small, but then there are also the amounts of exposure that would result from the operation of Watts Bar, and that's even smaller by probably about three orders of magnitude.

Are you referring to the limits that are set? There are specific numbers, and I think we can probably get those for you.

9.6.4.2 **Ms. Cowan**: I was concerned about the ratios of the two limits, the limit to the general population and the allowable dosage to--

Ms. Harty: Table 5.1 in the report provides a list of the limits, and actually what they give here are the design objectives for when they designed the plant, and they vary depending on what pathway you're looking at.

And then in Tables 5.2 and 5.3 there's a comparison of the releases that you would expect from those releases. Do you want to add to that at all, Dale?

Do you want me to run through them for the record, or--?

Ms. Cowan: That's okay.

Ms. Harty: All right.

9.6.4.14 **Voice**: I'm a student at U.T. Knoxville, and I'm concerned about the transportation of waste, and I was wondering if that was taken into account in the report.

9.6.4.8 And also the waste is going to be around for thousands of years, and is that taken into account that people are not just going to be affected today and tomorrow, but for, you know, the half-life I don't even remember, but it's going to be way past when I'm dead.

This is a copy of the permit here by the State of Tennessee, and it's issued by the Division of Water Pollution Control, and it's actually called the National Pollution Discharge Elimination System.

Does that answer your question?

Mr. Clayton: Not really. I was wondering if it fell under the Department of Solid Waste Management. That's what I was wondering. 9.7.3

Ms. Harty: No. It's under the Division of Water Pollution.

Mr. Newberry: [Discussion]

Ms. Cowan: I was wondering--my name is Ruth Cowan--and I was concerned about what exactly is a minimal impact to our ecology, considering that we have already made so many impacts on our streams and rivers by damming them. 9.6.1

I'm also concerned about what is the minimal dosage for a baby. Is it measured for adults, or children? 9.6.4.2

Ms. Harty: When we talk about minimal impact, or insignificant impact, it's hard to actually quantify those terms.

What we looked at was an impact that would not be seen in the arena that we were discussing.

For instance, if we talked about an impact to the mussels, it's not something that we could go out and measure and say that yes, there was, or there was not an impact. It just would disappear in the noise of the situation. Does that make sense to you?

Ms. Cowan: That makes sense, but I can understand that it may not be able to be measured, but I also understand that as scientists we try to measure things like that, and I think that there should be a way to say "Well, this many mussels are going to die." 9.6.1

Ms. Harty: That's right, as scientists we do try to measure the impact, but it's like if you put one or two grains of dust in this room it would be basically impossible to measure with the equipment that we now have, compared to all the other grains of dust in the room. It's that kind of idea.

Your second question I'm a little unclear as to what you were asking. You were asking about the minimal dose to infants?

Ms. Cowan: The allowable dose to infants. What is the allowable dose, and would an infant exceed it in their lifetime? 9.6.4.

Ms. Harty: Infants are not--there's not a separate dose to infants than there is to the average person in the population. It's just given as one dose.

Voice: In case of one, what are your evacuation plans for Knoxville and Chattanooga?

Mr. Hebdon: I know emergency planning is an area that's addressed as part of the review. Unfortunately I'm not an expert in that area, and we don't have experts in that area with us because it's really outside the scope of the environmental review which is what we're trying to discuss.

But there are plans that are developed by the licensee, there are rules as to how those plans work, and those plans have to be in place and tested before the plant can operate.

Mr. Newberry: Before we leave, I want to see if we can get you a better answer to that question. Maybe there's somebody here that can answer it. I cannot.

Mr. Tamby: As far as emergency preparedness is concerned, we have a very detailed safety evaluation based on TVA's also very, very detailed emergency plan that was submitted to us, and we have reviewed that; we have documented our review results.

If you leave me your name and address, I'll be happy to send you a copy of our evaluation. I believe that will answer all of your questions.

But like Fred said, tonight we do not have any emergency preparedness experts here to answer your questions.

Ms. Honicker: Would that be part of the environmental control?

Mr. Tamby: It's what we normally classify as safety evaluation, and we are not prepared to answer it, but we do have that information. It's a voluminous amount of information, including evacuation.

So if you will give me your name and address after the meeting, I will be happy to send you that information.

Mr. Newberry: [Discussion]

Mr. Clayton: My name is Ron Clayton with the *Free Press*, Chattanooga.

9.7.3 You had mentioned that the state will be monitoring some of the chemical aspects and so on and so forth of the plant.

I was wondering what department will do that, and judging from some of the state's past decisions regarding landfills are there any safeguards in place that will ensure their findings will be truthful?

Ms. Harty: Let me take the second part first.

As far as the landfills go, Watts Bar nuclear plant has its own landfill--okay--so that's not handled at a landfill off site.

I think we got the gist of your concerns, very clear concerns on the hearing process, and being responsible for the environmental review we can take those, but they are clearly outside the scope of this meeting.

I'm here to manage and ensure that we get your input on the environmental review, and I seriously can't make a commitment with respect to the hearing process and those issues.

I acknowledge them, and we'll take them back, and I think I would just like to move on now to see if there's any questions with respect to the presentation or the draft supplement with respect to environmental matters.

[Discussion]

Ms. Baldry: My name is Heather Baldry, and I was just wondering how many of your statistics concerning the exposure to radiation and health concerns took into account a catastrophic accident at Watts Bar. 9.6.4.19

Mr. Newberry: The term "catastrophic accident," I think what you mean there is the term I used which was "severe accident." The consequences of a severe accident could potentially, if you postulate failure on failure, be catastrophic. They are extremely unlikely.

That study was--that was explicitly considered, that was the intent of the study to look at those sorts of situations to see if any additional design procedural changes should be made to further reduce the likelihood of those events or, even if they should occur, to reduce the consequences of the events.

Does that answer your question?

Ms. Baldry: I still don't have an answer to my question. According to the NRC how probable is that? 9.8.2.1
because I've read some of the NRC reports, and I know that they think that the NRC foresees that to be more possible at Watts Bar than most other nuclear facilities.

Mr. Newberry: The initial studies--and I know we received some letters on this, and I think it's clarified in the report, but let me try to answer your question, then Mr. Palla can help me out if you need more--but the initial studies that were done to look at the likelihood of those accidents indicated that the likelihood at Watts Bar was higher than what you would expect from the studies of the other plants, that's true.

Two points on that. That's not unusual for preliminary studies which make first order assumptions before you look at the plant closer.

A closer look reduced the estimate and brought it in range with other plants in the United States, and the modifications I was talking about further brought in the range with the other plants.

We have looked at that, and Watts Bar is that I would call in line with the estimates for those sorts of accidents, which are very low.

Yes, ma'am.

Mr. Tamby: I'm Peter Tamby, NRC Project Manager for Watts Bar. This is not really the topic of today, but since we have people who are interested. I'd like to give you some idea.

In 1976 when TVA submitted an application to operate the plant, we did advertise in the Federal Register for opportunity for hearing, and we have gone through that process. There were people who petitioned, and there was no hearing as a result of that.

Now, if you need any more detail, we do have our attorney here who can answer this if you are interested. Ann Hodgdon, are you there?

Ms. Hodgdon: I'm here, Peter, but I don't have anything to add to that. There was no time limit--

Ms. Honicker: I'm sorry, there was. I have with me the petition that I filed to intervene, it was timely filed, and there was a prehearing conference, and I have the results of that, and my petition to intervene was denied because I was not a scientist or a technician, and the statement was made that the only thing a hearing would do would be delay the plant.

There was no hearing--that was in 1977--and here you say you hope to operate in 1995.

My question is how much would you have saved if you had stopped right then.

(Scattered applause.)

Mr. Hebdon: I wasn't involved with the process at that time, but I know that there are procedures that we followed, and those procedures were followed then, and with the benefit of hindsight whether a different path might have been better, I don't know. I really can't comment on that.

Ms. Honicker: I think it was premature, that the plant was not ready to operate, and now is the time to readvertise and reopen it up and let these people who are concerned now have an opportunity to comment.

Mr. Newberry: I think we are getting a little bit off the subject.

The purpose of the meeting was to discuss the environmental impact statement, and there has been quite a bit of discussion over the last couple of years on the issue of hearings, and we have researched it, and I know different people within the area have researched it, and we reviewed what was supposed to be done by the procedures of the NRC, and I think that's probably a subject that would be best for a different discussion, because we're trying to give people an opportunity to review the information that we developed as part of our review of the environmental statement.

Voice: It seems like they should have an opportunity also. If we could talk about it another time, maybe we could set up another meeting where we can talk about it, because this is the only point we can talk about it.

Mr. Newberry: [Discussion]

But given you're new to the area, Fred, do you want to just take a couple of minutes?

Mr. Hebdon: The plant has been under construction for a long period of time, you're certainly correct.

The plant was very close to completing construction and close to being ready to operate in 1985, which is almost ten years ago.

At that point there were a number of problems identified with the way the plant had been constructed and some of the work that had been done, and TVA has been working since that time to resolve those problems to the satisfaction of the NRC, and they're continuing to work on that, and when they have resolved them, and if they reach the point where they've been resolved to the satisfaction of the NRC, then at that point they would be allowed to operate.

But you're right, it has taken a long time. The plant was virtually completed almost ten years ago.

Ms. Morgan: Has the technology become upgraded, updated? 9.5.1

Mr. Hebdon: There have been a lot of changes to the plant, there have been a lot of upgrades to the plant to include more modern technology.

For example the reactor protective system which was an older design is much more modern electronics now than was in the plant at the time when the plant was being considered for licensing in 1985.

Ms. Morgan: One more.

Do you have any idea how much longer or how much it's going to cost? Do you know?

Mr. Hebdon: It's difficult to determine the cost, because a lot of the cost is a financial interest on the debt that was used to pay for the construction of the plant in the first place.

I think TVA would probably be in a better position to comment on that than we would.

Mr. Newberry: [Discussion]

Voice: Well, there are a lot of people in Nashville that are real interested in the hearings, and we were hoping 9.10.3
to have a hearing in Nashville, because not everybody could come at this particular date.

And I'm guessing that the plant is up for licensing, and this is why you're having public input?

Mr. Newberry: The reason for this meeting is to receive comments on the draft supplement, the environmental review which I talked about.

I believe the licensing hearings have been completed and are closed. I don't know.

Table C.6 (contd)

Location	Total	White	Black	American Indian, Eskimo, Aleut	Asian or Pacific Islander	Other	Hispanic Origin
McMinn County	42,383	40,085	2,051	96	121	30	174
Athens	12,054	10,825	1,136	18	61	14	60
Sweetwater	5,066	4,621	403	7	26	9	15
Englewood	1,611	1,605	0	2	4	0	10
Etowah	3,815	3,635	142	18	16	4	18
Meigs County	8,033	7,884	118	28	2	1	17
Decatur	1,361	1,346	13	2	0	0	2
Monroe County	30,541	29,561	833	48	71	28	123
Madisonville	3,033	2,854	161	5	7	6	13
Morgan County	17,300	16,957	265	46	25	7	60
Harriman	7,119	6,507	574	15	13	10	27
Polk County	13,643	13,571	0	25	42	5	36
Rhea County	24,344	23,571	581	62	53	77	132
Dayton	5,671	5,269	350	10	23	19	23
Graysville	1,301	1,272	1	11	5	12	23
Spring City	2,199	2,037	145	7	5	5	15
Roane County	47,227	45,444	1,456	95	191	41	212
Kingston	4,552	4,316	194	5	27	10	26
Sequatchie County	8,863	8,851	2	4	5	1	25
Dunlap	3,731	3,724	2	2	2	1	15

Data sources: 1990 Census of Population, General Population Characteristics (Tennessee).

Appendix D

Principal Correspondence Related to the NRC and FWS Consultation Process

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

October 28, 1994

Dr. Lee A. Barclay, Supervisor
Ecological Services Office
U.S. Fish and Wildlife Service
446 Neal Street
Cookerville, Tennessee 38501

Dear Dr. Barclay:

SUBJECT: WATTS BAR NUCLEAR PLANT BIOLOGICAL ASSESSMENT

Currently, the Nuclear Regulatory Commission (NRC) is reviewing the Tennessee Valley Authority (TVA) operating license application for Unit 1 of the Watts Bar Nuclear Plant (WBN). TVA expects to initiate commercial operation of Unit 1 in the spring of 1995. To ensure that the NRC complies with its statutory requirements in Section 7 of the Endangered Species Act of 1973 (ESA), we are submitting a biological assessment (enclosure) completed by TVA for the threatened and endangered species in the vicinity of WBN.

A number of species listed as threatened or endangered are known to exist near WBN: four species of freshwater mussels, the snail darter, the bald eagle, and the grey bat. The enclosed biological assessment includes an evaluation of the likely effects operation, of both Units 1 and 2 at WBN, will have on the listed species. In the biological assessment, TVA concludes that the operation of WBN is not likely to affect individuals or populations of any of the listed species or their critical habitats.

Although the NRC agrees with the "no effect" determination made in the biological assessment, we have concluded that our regulatory interests would best be served by requesting formal consultation. Therefore, we are requesting formal consultation.

If you have any questions about the information in the biological assessment, please call James H. Wilson, (301) 504-1108, or Scott Flanders, (301) 504-1172.

Sincerely,

W. T. Russell

William T. Russell, Director
Office of Nuclear Reactor Regulation

Docket Nos: 50-390
and 50-391

Enclosure:
Biological Assessment

WATTS BAR NUCLEAR PLANT

BIOLOGICAL ASSESSMENT

Tennessee Valley Authority
Nuclear Regulatory Commission

October 1994

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INTRODUCTION

The Tennessee Valley Authority (TVA) is a regional resource development agency of the United States. Among its activities are the generation and transmission of electric energy. TVA is responsible for providing electricity to parts of seven states, an area inhabited by almost eight million people.

In 1970, TVA proposed to build and operate Watts Bar Nuclear Plant (WBN) to help meet an increasing demand for electricity. WBN is a two-unit plant, located on the Tennessee River just downstream from Watts Bar Dam. TVA issued a final environmental impact statement (EIS) in 1972 that evaluated the potential environmental impacts of constructing and operating WBN. That EIS mentioned the bald eagle (Haliaeetus leucocephalus) as a relatively common visitor to the WBN area and addressed potential impacts on freshwater mussel species. Endangered and threatened species were not discussed as they would be today because the Endangered Species Act (ESA) was not passed and signed into law until 1973.

The Nuclear Regulatory Commission (NRC) is the federal agency which licenses and regulates commercial nuclear power plants in this country, including those operated by TVA. In 1978, NRC issued a final environmental statement (FES) that evaluated the potential environmental impacts of completing and operating WBN. That FES addressed the bald eagle and two endangered freshwater mussel species (pink mucket, Lampsilis orbiculata; and dromedary pearly mussel, Dromus dromas). Bald eagles had been seen in the area and both mussel species were known to occur approximately seven river miles downstream from WBN. NRC concluded that operation of WBN would not affect these species.

Completion of WBN has taken longer than anticipated. Since the release of the TVA EIS and the NRC FES, the U.S. Fish and Wildlife Service (FWS) has added species to the federal lists of endangered and threatened wildlife and plants, and some other listed species have been found in the vicinity of WBN. Today, seven federal endangered or threatened animal species are known to exist near WBN.

This biological assessment has been prepared to support TVA and NRC consultations with FWS on the WBN project. The assessment presents a description of pertinent project components, summarizes information about the seven listed species known to occur in the vicinity of WBN, and describes the potential impacts of plant operation on these species. The discussions and impact determinations presented in this assessment are based upon information contained in the large number of reports and other documents listed as references.

PROJECT DESCRIPTION

Watts Bar Nuclear Plant (WBN) is located on the west (right descending) bank of Chickamauga Reservoir near Tennessee River Mile (TRM) 528. This two-unit nuclear generating plant is designed for an electrical output of about 2,540 megawatts. WBN is situated approximately two river miles downstream of Watts Bar Dam (TRM 529.9) and one mile downstream from the four-unit Watts Bar Fossil Plant (WBF), also located on the west bank of Chickamauga Reservoir (TRM 529). WBF was placed in "Long Term Standby for Restart" status in March 1983. Figure 1 shows the locations of these TVA facilities along the river.

Construction of all major exterior facilities at WBN and associated transmission lines was completed during the 1970s. Unit 1 is now essentially complete and TVA expects to initiate operation of this unit in the spring of 1995. Unit 2 is approximately 65 percent complete, and its completion is being reevaluated by TVA.

Five off site transmission lines were built as part of the WBN project. Two of these lines (loops to connect with the Bull Run - Sequoyah line) were less than 9 kilometers (5.5 miles) long; two others (Watts Bar - Roane and Watts Bar - Sequoyah #2) were approximately 65 kilometers (40 miles) long, and the remaining line (Watts Bar - Volunteer) was nearly 150 kilometers (90 miles) long. The routes of these lines are indicated on Figure 2.

WBN will be operated in a closed cycle cooling mode, using one natural draft cooling tower for heat dissipation for each nuclear generation unit. Makeup water and other water supply requirements will be obtained from an intake channel and pumping station now in place on the river at TRM 528.0. Blowdown from the cooling towers will be discharged through a multiport diffuser system now in place in the river channel at TRM 527.9 (Outfall 101). These intake and discharge structures are indicated on Figure 1.

The intake channel has a cross sectional area of approximately 155 m^2 (1650 ft^2) at Chickamauga Reservoir winter pool elevation 206 m (675 ft) mean sea level, and 293 m^2 (3159 ft^2) at summer pool elevation 208 m (682.5 ft). Corresponding average velocities into the intake channel are 0.03 m/s (0.1 ft/s) and 0.016 m/s (0.05 ft/s). Maximum intake pumping flowrate for two-unit operation will be approximately 4.0 m^3/s (143 cfs). This pumping flowrate represents about 0.5 percent of the long-term average flow past the plant (736 m^3/s or 26,300 cfs).

Blowdown is discharged directly to the diffuser system in the river or into a holding pond for later release through the diffusers. As required by the current National Pollutant Discharge Elimination System (NPDES) permit for this site, discharges will be stored in the holding pond when releases from Watts Bar Dam are less than 98 m^3/s (3,500 cfs). In emergency situations, overflow from this pond will be discharged to the river using a drainway with a mouth at TRM 527.2 (Outfall 102). Blowdown from the cooling towers will be discharged at a rate of between 1.3 and 2.4 m^3/s (45 and 85 cfs). Releases for normal two-unit operation will be 2.4 m^3/s (85 cfs), approximately 0.3 percent of the long-term average flow. The maximum discharge through the diffusers will be approximately 4.8 m^3/s (173 cfs) on occasions when the holding pond is being drained while the blowdown discharge from the cooling towers is being routed directly to the diffusers. This would represent about 0.7 percent of the long-term average flow in the river.

The diffuser system consists of two pipes extending into the main river channel (Figure 3). The downstream pipe segment extends 90 m (300 ft) into the channel with a 50 m (160 ft) long, 1.3 m (4.5 ft) diameter diffuser section located in the deepest portion of the river channel. The upstream pipe segment extends 140 m (450 ft) with a 25 m (80 ft) long, 1.0 m (3 ft) diameter diffuser section beginning where the downstream diffuser section ends. The diffuser sections are half buried in the river bottom with two rows of 2.5 cm (1 in) diameter ports at 7.5 cm (0.25 ft) spacing, oriented at 45° in the downstream direction. The exit jet velocity will vary depending on operational mode, from 2 to 5 m/s (6 to 16 ft/s). The expected discharge temperature will depend on cooling tower performance and is projected to vary from 17°C (63°F) in January to 35°C (95°F) in July.

All WBN point source discharges and storm water runoff points are required to comply with conditions established in the current NPDES permit for the site (now Permit No. TN0020168, Tennessee Water Pollution Control, 1993). This permit also requires substantial chemical and toxicity monitoring of WBN discharges.

Under current WBN procedures, minor releases of radioactive materials may be discharged from the plant through the discharge diffusers. Liquids potentially containing radioactive wastes will be collected, tested, and, if necessary, processed before being released to the Tennessee River via the discharge diffusers. Additional releases could occur from the discharge of low level radioactive liquid effluents from the turbine building station sump to the yard holding pond via the low volume waste treatment pond. Such a release would occur only in the unlikely event of a primary-to-secondary leak. Releases from the liquid waste processing system are controlled by NRC regulations and discharged in accordance with the NPDES permit.

TVA also has developed a Radiological Emergency Plan to protect the health and safety of plant personnel and the public in the event of a radiological emergency at a nuclear plant. This plan has been developed in accordance with NRC and Federal Emergency Management Agency regulations and guidelines. The TVA plan addresses organizational responsibilities, capabilities, actions, and guidelines to be followed by agency staff during a radiological emergency. State and local agencies are responsible for ordering and implementing actions to protect the health and safety of the public off site.

A variety of chemicals are used for different purposes at WBN. These chemicals are used to control corrosion in various kinds of metals, control slimes and other organic fouling materials, inhibit growth of Asiatic clams, and for a variety of other purposes. Table 1 lists the chemicals being used at WBN and the anticipated quantities of their resulting end products which will be discharged. The potential sources and quantities of these chemicals are controlled by a site Chemical Traffic Control Program. All chemical discharges at WBN are controlled by the NPDES permit.

LISTED SPECIES

Information collected in recent years indicates that the Tennessee River and tributary streams near WBN contain representatives of one threatened fish (snail darter, Percina tanasi) and four endangered freshwater mussels [fanshell, Cyprogenia stegaria; dromedary pearly mussel, Dromus dromas; pink mucket, Lampsilis abrupta (= orbiculata); and rough pigtoe, Pleurobema plenum]. Two endangered terrestrial species (bald eagle, Haliaeetus leucocephalus; and gray bat, Myotis grisescens) also are known to occur in the vicinity of this site. No endangered or threatened species are known to occur along WBN-related transmission line corridors which do not occur adjacent to the site.

Aquatic Species

Since 1973, TVA aquatic biologists have conducted substantial field work on aquatic life in the Tennessee River downstream from Watts Bar Dam, primarily associated with preoperational monitoring for WBN. Starting in 1983, TVA has monitored the status of mussel stocks in three areas of relatively high density (i.e., "mussel beds") located just upstream, just downstream, and several miles downstream from the WBN discharges (Figure 4).

Native mussel resources are now known to occur in various concentrations throughout the Watts Bar tailwater. Since 1978, a total of 31 freshwater mussel species has been reported from this tailwater (Gooch, et al., 1979; TVA, 1986; Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). The most abundant species are the elephantear (Elliptio crassidens), Ohio pigtoe (Pleurobema cordatum), and pimpleback (Quadrula pustulosa). The results of several recent studies (primarily TVA, 1986;

and Ahlstedt, 1994) indicate that very few mussel species have reproduced successfully in this river reach during the last 30 or more years. The causes of this reproductive failure are unknown.

Recent mussel surveys in the Watts Bar tailwater provide information about the local distribution of the four endangered mussel species (Table 2). The dromedary pearly mussel (Dromus dromas), listed as endangered in 1976 (FWS, 1976), is the most uncommon of these species. Only four specimens of this species have been collected from this river reach -- three in 1978 and one in 1983 (Gooch, et al., 1979; TVA, 1986). No other specimens have been found in subsequent surveys (Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). All four specimens were encountered on Hunter Shoals, between River Miles 520 and 521 (approximately seven miles downstream from the WBN site). Surviving populations of this mussel species occur in the Cumberland River in middle Tennessee and in the Clinch and Powell Rivers in northeast Tennessee and southwest Virginia (FWS, 1984a). Critical habitat has not been designated for this or any of the other endangered mussel species included in this assessment.

The fanshell (Cyprogenia stegaria) and rough pigtoe (Pleurobema plenum) were both found consistently in very low numbers (1 to 3 per year) in the Watts Bar tailwater between 1983 and 1985 (TVA, 1986); however, neither species has been encountered during any subsequent survey (Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). Both species were found more consistently on Hunter Shoals, but a few specimens of each species also were found between River Miles 528 and 529. Reproducing populations of the fanshell persist in the Green River, central Kentucky; the Licking River, eastern Kentucky; and the Clinch River, northeast

Tennessee and southwest Virginia (FWS, 1991). The rough pigtoe persists in the Green and Barren Rivers, central Kentucky; the Cumberland River, central Tennessee; and the Clinch River, northeast Tennessee and southwest Virginia (FWS, 1984b). The rough pigtoe was added to the list of endangered species in 1976 (FWS, 1976) but the fanshell was not added to that list until 1990 (FWS, 1990).

The pink mucket [Lampsilis abrupta (= orbiculata)] was listed as endangered in 1976 (FWS, 1976). At least a few specimens of this species have been found during each mussel survey conducted in the Watts Bar tailwater since 1978 (Gooch, et al., 1979; TVA, 1986; Ahlstedt, 1989; 1991; 1994; Jenkinson, 1991). Representatives of this species have been found on all three beds involved in the preoperational monitoring program as well as upstream toward the dam and at intermediate sites. In terms of relative abundance, the pink mucket consistently accounts for 0.3 to 0.7 percent of the mussel community encountered. Besides the Watts Bar tailwater, the pink mucket is known to exist at scattered locations from the Kanawha River, West Virginia; west to the Osage and Meramec Rivers, Missouri; south to the Black River, Arkansas; and east to the Tennessee and Cumberland Rivers in Tennessee. The most upstream site in the Tennessee River watershed where this species has been found is the Clinch River, northeast Tennessee (FWS, 1985).

So far as is known, each of these endangered mussel species has similar feeding and reproductive requirements. Adult members of these species live embedded in cobble or gravel river bottoms where water currents prevent excessive silt accumulation. They feed by filtering small food particles (detritus, algae, etc.) out of the water. Reproduction involves a stage when the larvae (glochidia) must become temporary parasites on certain fish species in order to complete their development. The required "fish hosts" are unknown for most of these species; however, the pink mucket is reported to parasitize sauger (Stizostedion canadense) and freshwater drum (Aplodinotus grunniens) (FWS, 1985). Members of these mussel species may live for 40 years or more.

The only other federally-protected aquatic species known to occur near WBN is the snail darter (Percina tanasi). This small fish was listed as endangered in 1975 (FWS, 1975) based on the assessment that its natural habitat would be destroyed by impoundment. In 1976, two snail darters were observed at Tennessee River Mile 515 and, in 1981, snail darters were discovered in Sewee Creek, a small stream which enters the Tennessee River at River Mile 524.6 (FWS, 1983). The Sewee Creek population is now one of six known snail darter populations, all of which occur in direct tributaries of the Tennessee River between Huntsville, Alabama, and Knoxville, Tennessee. The core of each population apparently exists in the smaller stream, but young snail darters routinely drift down into the river during their first year of life. As the name implies, these fish eat primarily snails, but aquatic insects also contribute to their diet. The snail darter was reclassified to threatened status in 1984 (FWS, 1984c), largely based on the increased number of known populations. No critical habitat is currently identified for this species.

Three aquatic species known to occur near WBN have been identified as candidates for federal endangered or threatened status. Two of these species (Tennessee clubshell mussel, Pleurobema oviforme, and blue sucker, Cycleptus elongatus) have been found occasionally in the

Tennessee River near WBN. The third species (eastern hellbender, Cryptobranchus a. alleganiensis) has been observed upstream in Sewee Creek. The blue sucker is a relatively widespread, large river fish which is seldom collected. The Tennessee clubshell is known to occur in a number of smaller streams across the Tennessee River system while the hellbender occurs more widely across the eastern United States.

Terrestrial Species

Two federally-protected terrestrial species are known to occur near WBN: the bald eagle (Haliaeetus leucocephalus) and gray bat (Myotis grisescens). In 1972, when bald eagles were described as fairly common visitors to Watts Bar and Chickamauga Reservoirs, the wintering population in this area was probably no more than six to eight birds. Since 1972, the Watts Bar/Chickamauga bald eagle population has increased substantially to about 30 birds (Tennessee Wildlife Resources Agency, unpublished data), as has been the case elsewhere across the range (FWS, 1994). The first bald eagle nesting observed in this area was in 1994, when a pair built, then abandoned a nest about 6 kilometers (4 miles) south-southwest of the WBN site (Hatcher, 1994; R. M. Hatcher, Tennessee Wildlife Resources Agency, personal communication).

Bald eagles living south of the 40th parallel were listed as endangered in 1967 (under the Endangered Species Protection Act of 1966) because of declines resulting from pesticide poisoning, habitat loss, and shooting. No critical habitat has been designated for this species. Recovery Plan objectives for this species in the southeastern states (FWS, 1984d; 1989) include a goal of 15 occupied breeding territories in Tennessee. Now that many rangewide eagle recovery objectives have been met, the FWS has recently proposed to reclassify most of the eagle population in the lower 48 states from endangered to threatened status (FWS, 1994). If adopted, this reclassification would apply to bald eagles living in Tennessee.

Bald eagles feed primarily on fish which are either caught live or found dead. They also eat a variety of other vertebrates, especially waterfowl. Bald eagles usually build their nests in large trees on the edge of a woodland within 3 kilometers (2 miles) of water. When not nesting, these birds roost on wooded slopes near water (FWS, 1989).

Gray bats (Myotis grisescens) occur throughout most of the limestone cave areas of the United States south and east of Missouri, southern Illinois, and southern Indiana (FWS, 1982). These bats roost in caves throughout the year, all together from late summer through mid-spring but separated into bachelor caves and maternity caves while females are caring for the young. Gray bats feed over water on adult aquatic insects, primarily mayflies, and often travel 20 kilometers (12 miles) or more from their roost caves to feeding sites. The species was listed as endangered in 1976 because of population declines due mostly to habitat loss and human disturbance of caves (FWS, 1982). While several caves are known to be important to gray bat survival, critical habitat has not been designated for this species.

The nearest cave in which gray bats have been found is located about 6 kilometers (4 miles) downstream from WBN. This cave is visited by male bats during the summer. The cave also receives heavy human visitation, which probably prevents its regular occupancy by bats (Harvey and Pride, 1986). Three other caves regularly occupied by gray bats occur between 15 and 30 kilometers (10 and 20 miles) from WBN. No significant change in the bat population of these caves has occurred in recent years. Gray bats from these caves probably forage over the reservoir adjacent to and downstream from WBN.

No other listed endangered or threatened terrestrial species are known to occur regularly in the WBN area. The 1972 TVA EIS mentioned five other terrestrial animals, now listed as endangered, which once occurred in east Tennessee and might be found near WBN. Three of these species (red-cockaded woodpecker, Picoides borealis; Bachman's warbler, Vermivora bachmanni; and Kirtland's warbler, Dendroica kirtlandii) have never been observed near WBN. The other two species (peregrine falcon, Falco peregrinus; and Indiana bat, Myotis sodalis) migrate or range through the general vicinity of Watts Bar and Chickamauga Reservoirs but are not known to occur regularly near WBN.

Several plant species which have been listed as endangered or threatened in recent years are known to occur in east Tennessee; however, none of them have been found during plant surveys in the vicinity of WBN or on WBN-related transmission line corridors. A plant candidate for possible federal endangered or threatened status (a bugbane, Cimicifuga rubifolia) has been found as close as 6 kilometers (4 miles) from WBN. This bugbane, which lives on rich, forested slopes over limestone bedrock, occurs from western Virginia to northern Alabama and at a few sites in western Tennessee and Kentucky. Populations are known from 13 eastern Tennessee counties.

IMPACT ASSESSMENT

Construction Impacts

Construction of the intake channel, discharge diffusers, and other in-water facilities at WBN, as well as major exterior land-based facilities and transmission lines, have been completed. No additional major exterior construction is proposed, and no new construction effects on endangered or threatened species are anticipated.

Operational Impacts

Operational impacts from WBN on listed aquatic species could occur through the release of radioactive, thermal, or chemical discharges to the river. Those discharges could affect bald eagles and gray bats if the fish and insects they feed upon were affected. Endangered or threatened terrestrial species also could be affected by encounters with the cooling towers, transmission lines, and other structures built as part of the WBN project or with activities and chemicals used to maintain those structures. A variety of studies have been conducted to evaluate the risk of adverse environmental impacts from these potential operational impacts, the results of which are presented in the following sections.

Radiological Impacts. While there are no current radioactive releases from WBN, the potential for eventual releases of radioactive materials from the plant has been estimated at various times. Table 3 compares the estimated annual WBN liquid radioactive releases and resulting doses presented in the TVA EIS, the WBN Final Safety Analysis

Report (FSAR) Amendment 77, the NRC FES, and recent data from the TVA Sequoyah Nuclear Plant (as submitted in semi-annual radiological effluent reports). Data from Sequoyah are relevant because that plant uses essentially the same radiological waste system design as WBN and the two systems are expected to operate in much the same manner. The Sequoyah monitoring period chosen for this comparison most closely represents expected operation of the WBN liquid radwaste system (i.e., when demineralizers were being used to treat liquid radwaste). This comparison indicates that the WBN FSAR estimates, even though based on very conservative (worst-case) assumptions, continue to be well within the NRC dose guidelines given in 10 CFR Part 50, Appendix I.

The radiological monitoring TVA conducts around both Sequoyah and Watts Bar nuclear plants also provides some specific information on radioactivity levels in fish and Asiatic clams. Data collected in 1993 (TVA, 1994a; 1994b) indicate that concentrations of Cesium-137 and Strontium-90 found in fish were essentially equivalent upstream and downstream from Sequoyah, suggesting fallout or other sources unrelated to nuclear plant operation. Only naturally occurring radioisotopes were identified in the Asiatic clams.

Based on these conclusions, TVA and NRC have determined that the doses to the public resulting from the discharge of radiological effluents from WBN will be less than two percent of the NRC guidelines given in 10 CFR 50, Appendix I. Nothing in the estimates or existing plant monitoring data suggest any radioactive impact on mollusks, fish, or species which might prey on them.

Thermal Impacts. The NPDES permit establishes monitoring requirements and/or limits for the WBN discharges into the Tennessee River. The current NPDES permit for this site required that TVA conduct temperature modeling studies to determine the appropriate daily average discharge temperature limit from the diffusers (Outfall 101) and emergency overflow (Outfall 102). These studies were completed and a report submitted to the state of Tennessee in December 1993 (Lee et al., 1993). Modeling results presented in that report indicate the maximum temperature of the WBN diffuser discharge (assuming both units were operating during hot weather conditions) could be as high as 36.3°C (97.3°F). At the downstream end of the mixing zone, the model results predicted a maximum river temperature (also under hot weather conditions) of 28.1°C (82.6°F) and a maximum temperature rise (two units, cold weather conditions, and low dam releases) of 1.0 C° (1.8 F°). Average downstream river temperatures are predicted to be lower than 25°C (77°F), and the average temperature rise is predicted to be less than 0.2 C° (0.3 F°). Mixing zone sizes used in these model studies were 75 x 75 m (240 x 240 ft) of full river depth for the discharge diffuser and 300 x 900 m (1000 x 3000 ft), largely on the surface, for the emergency overflow.

Upper temperature limits are not known for any of the endangered mussel species or the snail darter; however, water temperature data (presented in Lee et al., 1993) indicate that releases from Watts Bar Dam have exceeded 27°C (80°F) relatively often during the last 15 years. Temperature data from several Tennessee River watershed locations which support diverse mussel and fish communities (Poppe and Fehring, 1986) include a number of maximum temperatures above 32°C (88°F).

The small volumes of water discharged from WBN will have very little effect on temperature in the Tennessee River. The possible maximum temperature of the discharge, which would occur rarely, would exist only in a small part of the mixing zones near the diffusers. Warmed water coming out of the 45°-angled jets on the diffusers (Figure 3) would rise in the water column, without effect on bottom-dwelling species such as mussels or snail darters. Average and maximum temperatures at the downstream ends of the mixing zones will be only very slightly different from existing conditions in the river and well within the range of temperatures endangered and threatened aquatic species in the area encounter naturally. Based on this information, TVA and NRC have concluded that thermal discharges from WBN will not impact listed mussels, the snail darter, or prey of the bald eagle or gray bat.

Chemical Impacts. The NPDES permit also controls the discharge of chemicals from WBN. However, it is possible that listed species living in or near the discharge mixing zone could be affected by levels of some plant effluents allowed under typical NPDES permit limits. TVA has been aware of this potential effect for some time and has been working with the state of Tennessee to better determine safe discharge concentrations for the chemicals used at WBN.

Monthly chronic toxicity tests were conducted on WBN discharges over a year-long period when chemicals were being used by the plant. These test results (presented in Table 4) did not identify toxicity in undiluted Outfall 101 effluent based on the responses of either daphnids (*Ceriodaphnia dubia*) or fathead minnows (*Pimephales promelas*). Both species are standard NPDES toxicity biomonitoring organisms.

In addition, two studies have been conducted to evaluate the potential impact of chemical use by WBN on the paper pondshell, Anodonta imbecillis, as a representative freshwater mussel. An initial study, conducted in 1991 jointly by the TVA Toxicity Testing Laboratory and Presbyterian College, Clinton, South Carolina, evaluated toxic responses of daphnids and 8-10 day old juvenile freshwater mussels to Outfall 101 effluent including the mixture of chemicals used at WBN. The results (also presented in Table 4) indicate that daphnid survival was reduced during the first 24 hours of the 7-day exposure period in treatments containing the active ingredients in a molluscicide being used to control Asiatic clams at WBN (dodecylguanidine hydrochloride - "DGH", and alkyldimethylbenzylammonium chloride - "QUAT"). In contrast, juvenile mussels were not affected by any treatment during their 9-day tests. A repeat of the study using WBN effluent including various amounts of DGH/QUAT in combination with other chemicals used at WBN showed toxicity to daphnids but not to fathead minnows (Table 4, also).

A second study was conducted by TVA and two laboratories (EMPE, Nashville, Tennessee, and Presbyterian College) under contract with the Tennessee Wildlife Resources Agency (TVA, 1994c). This study evaluated the impact of synthetic water containing DGH/QUAT on non-target species [daphnids, fathead minnows, paper pondshell, Elliptio angustata (another freshwater mussel), and Brachionus calyciflorus (a rotifer)]. Results from this study (Table 5) were similar to the effluent test in that daphnids were the most sensitive organisms tested. The 96-hour LC_{50} for daphnids was 0.07 mg/L (whole product, without silt), compared with the 9-day LC_{50} for the pondshell of 0.14 mg/L without silt, and 1.07 mg/L with silt present (silt is a detoxifying agent for DGH/QUAT). The

9-day LC_{50} for *E. angustata* was 8.74 mg/L with silt present. In this study, the daphnids were 15 times more sensitive to DGH/QUAT than the more sensitive mussel species (paper pondshell) tested under conditions comparable to those which would occur in the river (*i.e.*, when silt was included in the test).

These monitoring and experimental data indicate that mussels and fish would not be affected if they were exposed to the undiluted chemical effluent from WBN. In addition, the large dilution which occurs as the discharge mixes with water and silt in the river will provide a further margin of safety to mussels and fish outside of the mixing zone. To ensure that plant operations have minimal adverse effects on mussel populations, TVA will continue to monitor area mussel beds and perform toxicity tests. If adverse effects are detected, steps will be taken to eliminate the effects, including altering plant chemical uses.

Although the sensitivity of listed mussels and the snail darter are not known, the available toxicity data can be used to indicate if they could be affected. The order of magnitude greater sensitivity of daphnids compared to the fish and mussels which have been tested indicates that the whole effluent toxicity biomonitoring requirement at WBN (using daphnids as a test organism) will provide an ample margin of safety for listed species occurring both near and downstream from the WBN discharges.

Chemical discharges from WBN also are not likely to have any effect on bald eagles or gray bats. The toxicity testing data indicate that survival and growth of prey for these species are unlikely to be affected by the levels of chemicals released into the river.

Impacts of Structures. The possibility exists that bald eagles and gray bats might collide with buildings and cooling towers on the WBN site, and with lines and towers along the transmission corridors. Bald eagle mortality is extremely unlikely from collisions with buildings because of their sharp vision and daylight habits. Impacts with less-visible transmission lines could be more likely. When the WBN transmission lines were built they conformed with applicable routing and engineering standards to reduce collisions and bird electrocutions (Olendorff, et al., 1981). The routes for those lines minimized water crossings and avoided waterfowl concentration areas. The presence of vibration dampers and/or aircraft warning markers on lines which do cross wide expanses of water further reduce the risk of eagle accidents. No eagle collisions have ever been reported on the WBN site or along any TVA transmission line.

Gray bats are extremely unlikely to be affected by collisions with structures or transmission lines. Bats are adept at avoiding stationary objects and this type of bat mortality is extremely rare (Griffin, 1970). The portions of WBN transmission lines which cross water are higher than normal gray bat foraging altitude (FWS, 1982) and none of the WBN-related structures occur in major bat flight corridors, such as between roosting caves and reservoir foraging areas. Given this information, TVA and NRC have concluded that the presence of the various WBN structures will not impact bald eagles or gray bats.

Maintenance Impacts. Endangered or threatened species could be impacted if they were present where mechanical or chemical measures are used to maintain WBN-related structures, including transmission lines.

On the WBN site, bald eagles and gray bats are the only listed species likely to be present. They are not likely to be attracted to this built-up area and, therefore, would not be affected by on-site maintenance activities. In the Tennesee River adjacent to WBN, the snail darter and mussel species would not be affected by maintenance chemicals because those chemicals will be routed to holding ponds on site and subjected to periodic toxicity testing before being released to the river. No listed animal or plant species are known to occur on WBN-related transmission line corridors. Maintenance of TVA transmission lines is covered by procedures and instructions in the TVA Transmission Line Maintenance Manual (TVA, 1985 and revisions) and conformance to established best management practices. In addition, each line segment is reviewed for the presence of listed or sensitive species before maintenance activities are performed. On the basis of this information, TVA and NRC have concluded that WBN-related maintenance activities will not impact endangered and threatened animal or plant species.

SUMMARY

All major construction activities at the Tennessee Valley Authority (TVA) Watts Bar Nuclear Plant (WBN) have been completed for some time. TVA is now preparing for the plant to start generating power.

Six current endangered species and one threatened species are now known to exist in the general vicinity of WBN. No additional listed animal or plant species are known to occur on WBN-related transmission line corridors. Five of these species are aquatic (four endangered freshwater mussels and the snail darter, a threatened fish); the other two (bald eagle and gray bat, both endangered) are terrestrial. Regional bald eagle and snail darter populations are increasing, while the gray bat population in this part of its range appears to be relatively stable. All four endangered mussel species found in the Tennessee River adjacent to WBN are represented by relatively few, old individuals. They and most other mussel species present in this area apparently have not reproduced successfully in this part of the Tennessee River during the last 30 or more years.

WBN operational impacts to endangered or threatened aquatic species could occur through the release of radiological, thermal, and/or chemical discharges to the river. Bald eagles and gray bats could be affected if the fish or aquatic insects they prey upon were impacted. Endangered or threatened terrestrial species also could be affected by encounters with the cooling towers, transmission lines, or other structures built as part of the WBN project or with activities and chemicals used to maintain those structures.

Conservative estimates indicate that estimated radiological discharges from WBN would have no impacts on mollusks, fish, or species which prey on them. Monitoring data from the similar, operating Sequoyah Nuclear Plant (40 river miles downstream) found fish and clams showed no increases in the concentrations of a variety of radioactive elements above background levels.

Thermal and chemical discharges from WBN are controlled by a National Pollutant Discharge Elimination System (NPDES) permit. Most discharges would enter the river through a diffuser system located in the river channel; emergency discharges would enter via a drainway along the shore. Modeling studies indicate the maximum predicted temperature rise (under cold weather conditions) would be 1.0°C (1.8°F) while the average temperature rise at the downstream edge of the diffuser or emergency mixing zone would be less than 0.2°C (0.3°F). These temperature increases would not impact endangered or threatened species which live in the river or prey upon aquatic life.

A number of chemicals are used at WBN, including molluscicides to prevent fouling by Asiatic clams. Twelve successive monthly tests have shown that undiluted WBN effluent was not toxic to standard toxicity testing animals (a daphnid, Ceriodaphnia dubia, and fathead minnow, Pimephales promelas). Targeted experiments indicated that this daphnid is much more sensitive to the active ingredients in the molluscicide used at WBN than a fish or two species of juvenile freshwater mussels. When silt is present (a natural condition in the river), the daphnid is at least nine times more sensitive to the molluscicide than the fish or mussels tested. The NPDES permit for WBN requires periodic whole effluent toxicity testing using daphnids as a test organism. This requirement will provide a very conservative way to ensure that endangered mussel species, the snail darter, and prey of the bald eagle and gray bat are not impacted by these discharges.

The structures on the WBN site and the related transmission lines might result in collisions or other impacts to bald eagles or gray bats. Eagle and gray bat mortality is extremely unlikely from collisions with buildings because eagles see extremely well and bats are adept at avoiding stationary objects. The transmission lines were located to avoid impacts with waterfowl and are marked to minimize impacts with flying objects.

Maintenance of on-site structures and the transmission lines also might impact listed species. Chemicals used for on-site maintenance will be handled in compliance with the NPDES permit. While no listed animal or plant species are known to occur on WBN-related transmission line corridors, maintenance activities in those areas are conducted according to TVA procedures and line segments are reviewed for the presence of listed or sensitive species before the work is performed.

Considered as a whole, operation of WBN is not likely to affect individuals or populations of any endangered or threatened species. While materials in the radioactive, thermal, and chemical discharges from WBN have the potential to impact these species or their prey, adherence to plant procedures and NPDES permit requirements (especially toxicity testing) will ensure that those effects do not occur.

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WMC0289o

Table 1. Summary of added chemicals and resulting end products, Watts Bar Nuclear Plant

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
1	Makeup water filter plant	Alum	35,743	(78,800)	$Al(OH)$[b]	7,489	(16,510)	20	(45)
		$Al_2(SO_4)_3 \cdot 18H_2O$							
					SO^{2-}	13,880	(30,600)	38	(84)
					Settled Solids[b,c]	32,114	(70,800)	88	(194)
2	Makeup water demineralizer	Sulfuric Acid H_2SO_4 (93% solution)	104,780	(231,000)	SO^{2-} (Neutral pH)	98,430	(217,000)	270	(595)
		Sodium Hydroxide NaOH (50% solution)	195,498	(431,000)	Na^+ (Neutral pH)	56,245	(124,000)	154	(340)
	Natural Minerals Removed by Demineralizers	Sodium Na^+	4,590	(10,120)	Na^+	4,590	(10,120)	13	(28)
		Chloride Cl^-	8,936	(10,700)	Cl	8,936	(10,700)	75	(54)
		Sulfate SO^{2-}	9,866	(21,750)	SO^{2-}	8,866	(21,750)	27	(60)
		Total Dissolved Solids	53,298	(117,500)	Dissolved Solids	53,297	(117,500)	146	(322)
3	Secondary Steam System Condensate Polishing Demineralizers	Sulfuric Acid	267,665	(590,100)	SO^{2-} (Neutral pH)	262,176	(578,000)	717	(1580)
		Sodium Hydroxide NaOH	160,665	(353,500)	Na^+ (Neutral pH)	92,197	(203,260)	254	(560)
	Ionized Soluble Species Removed by Demineralizers	Carbonates (CO^{2-})	11,521	(25,400)	CO^{2-}	11,521	(25,400)	32	(70)
		Metallic Salts	d	d		d	d	d	d
			44,019	(97,820)	Ethanolamine $EtOHH_2^+$	44,019	(97,820)	121	(268)
		Boric Acid	45,000	(100,000)	H_3BO_3	45,000	(100,000)	122	(273)

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Table 1. (Continued)

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	Estimated Maximum Annual Use (lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	Resulting End Product[a] Average Annual (lbs)	Resulting End Product[a] Mean Daily kg	Resulting End Product[a] Mean Daily (lbs)
4	Auxiliary Steam Generators	Ammonia NH_3	1.4	(3)[e]	NH_3	1.4	(3)	<.05	(<0.1)
		Hydrazine $H_2N_2H_2$	4.5	(10)[f]	NH_3	4.5	(10)	<.05	(<0.1)
5	Condenser Circulating Water Systems	<<Copper (corrosion product only)[h]			Cu	2,812	(6,200)	8	(17)
		<<Nickel (corrosion product only)[h]			Ni	313	(690)	0.9	(1.9)
6	Raw Cooling Water[g]	Pyrophosphate	34,088	(75,752)	H_2PO^{1-}	34,088	(75,752)	93	(207)
		Organic Co-Polymer Dispersant	7,953	(17,673)	N/A	7,953	(17,673)	22	(48)
		Zinc Sulfate	18,182	(40,405)	Zn^{2+}	7,340	(16,312)	20	(45)
					SO^{2-}	10,841	(24,092)	30	(66)
		Coppertrol	261	(581)	Benzotriazole	261	(581)	22	(48)
		Clamtrol	1,386	(3,080)	DGH	69	(154)	14	(31)
					Quat	110	(246)	22	(49)
		Bromo-Chloro-Hydantoin	3,611	(8,024)	HOCl	1,264	(2,808)	3.5	(7.69)
					HOBR	2,347	(5,216)	6.4	(14.3)
7	Raw Service Water[g]	Pyrophosphate	3,787	(8,417)	H_2PO^{1-}	3,787	(8,417)	10	(23)
		Organic Co-Polymer Dispersant	883	(1,964)	N/A	883	(1,964)	2.4	(5.4)
		Zinc Sulfate	2,020	(4,489)	Zn^{2+}	815	(1,812)	2.3	(5.0)
					SO^{2-}	1,204	(2,677)	3.3	(7.3)
		Coppertrol	29	(65)	Benzotriazole	29	(65)	2.4	(5.3)
		Clamtrol	154	(342)	DGH	8	(17)	1.5	(3.4)
					Quat	12	(27)	2.5	(5.5)
		Bromo-Chloro-Hydantoin	401	(891)	HOCl	140	(312)	0.4	(0.9)
					HOBR	260	(579)	0.7	(1.6)

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Table 1. (Continued)

Item No.	System	Chemical Treatment Source Chemical and Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
8	Essential Raw Cooling[g] Water	Pyrophosphate	151,011	(335,581)	H_2PO^{1-}	151,011	(335,581)	413	(919)
		Organic Co-Polymer Dispersant	35,231	(78,291)	N/A	35,231	(78,291)	97	(215)
		Zinc Sulfate	80,547	(178,994)	Zn^{2+}	32,518	(72,262)	89	(198)
					SO^{2-}	48,028	(106,728)	131	(292)
		Coppertrol	1,158	(2,574)	Benzotriazole	1,158	(2,574)	96	(214)
		Clamtrol	6,139	(13,644)	DGH	307	(682)	61	(136)
					QUAT	490	(1,091)	98	(218)
		Bromo-Chloro-Hydantoin	15,996	(35,546)	HOCl	5,598	(12,439)	15	(34)
					HOBR	10,398	(23,107)	28	(63)

a Items 1, 2, 4, 5, 6, 7, and 8 are based on 365 days/year operation at rated capacity. Item 3 based on 292 days/year operation at rated capacity.
b Precipitated material that will make up the water treatment sludge on a day weight basis. Ultimately put in landfill. No discharge.
c Estimates based on maximum suspended solids data observed at TRM 529.9.
d The quantities of ionized soluble species continuously removed by the condensate demineralizers are predicated upon a primary to secondary leak rate or a condenser tube leak. These constituents will be discharged in the form of neutral salts of sodium, oxides of iron, or suspended solids. High crud filters will treat the backwash waste prior to discharge.
e Ammonia will be added as needed to maintain pH of 9.0 in the system.
f Hydrazine will be added as needed as a DO scavenger. Hydrazine conservatively assumed to decompose to ammonia.
g Based on chemical feed rates at maximum cooling water usage and treatment schedule.
h Although copper and nickel will not be added to the system, the values shown represent high estimates of corrosion losses. Actual losses are expected to be immeasurable.

WHC0358o

Table 2. Recent endangered mussel records from Watts Bar Dam tailwater. Entries include the total number of each species found during each survey, the River Mile intervals from which they came, and the number found there (if more than one).

Year	*Dromus dromas* dromedary		*Cyprogenia stegaria (= irrorata)* fanshell		*Pleurobema plenum* rough pigtoe		*Lampsilis abrupta (= orbiculata)* pink mucket	
	No.	River Mi.	No.	River Mi.	No.	River Mi.	No.	River Mi.
1978 (random survey)	**3**	520(3)	**4**	520 521(2) 524	[NR]		**19**	516 518 520(5) 521(5) 525 527 528(5)
1983	**1**	520	**3**	520 528(2)	**2**	520(2)	**10**	520(2) 526 528(7)
1984			**1**	520	**2**	520(2)	**8**	520 526(3) 528(4)
1985			**1**	520	**1**	528	**8**	520(2) 528(6)
1986							**8**	520(4) 526 528(3)
1988							**12**	526(2) 528(10)
1990							**4**	526 528(3)
1990 (lock survey)							**6**	528(2) 529(4)
1991 (Mead survey)							**2**	525(2)
1992							**6**	526(2) 528(4)

NR - species may have been present but was not recognized.

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Table 3. Comparison of estimated annual liquid radioactive releases from Watts Bar Nuclear Plant (WBN) and actual releases from Sequoyah Nuclear Plant (SQN).

	WBN EIS (Table 2.4-2)	WBN FSAR (Table 11.2-7 & Table 11.2-11)	WBN FES (Table 3.3 & Table 5.9)	SQN History (1987-93 Average)	10 CFR 50 Appendix I Guidelines
Tritium Released	1.46E+02 Ci	5.2E+03 Ci	1.04E+03 Ci	8.7E+02 Ci	
Activity Released	3.2E-01 Ci	2.2E+01 Ci	4.4E-01 Ci	4.8E-01 Ci	10 Ci
Total Body Dose	1.7E-02 mrem	1.1E+00 mrem	2.0E-01 mrem	8.0E-02 mrem	3 mrem
Maximum Organ Dose	5.5E-02 mrem	1.3E+00 mrem	1.9E-01 mrem	1.0E-01 mrem	10 mrem

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Table 4. Summary of toxicity biomonitoring results fro Watts Bar Nuclear Plant, January 1991 - March 1994

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
Jan. 11-18, 1991					Initial baseline test of Outfall 101. Isco composite 24-h samples.
<u>Outfall 101</u>*	*Pimephales promelas*	TR†	Not toxic, s & g§	100, 50	
	Ceriodaphnia dubia	TR	Not toxic, s & r§	100, 50, 25	
	Selenastrum capricornutum	TR	Not toxic, g§	100, 50, 25	
Apr. 9-21, 1991 <u>Outfall 101</u>*					Test conducted during discharge of ice melt water w/ 2,000 ppm sodium tetraborate (20 gpm). Boron concentration range = 0.22-2.20 mg/L. Also effluent spiked with 9.0 ppm boron (nominal concentration). Isco composite 24-h samples.
	Pimephales promelas	TR	Not toxic, s & g	100, 30, 9, 2.7	9.0 ppm boron not toxic (12-d embryo-larval test).
	Ceriodaphnia dubia	TR	Not toxic, s & r	100, 30, 9, 2.7	9.0 ppm boron toxic (reproduction only)
	Selenastrum capricornutum	TR	Toxic (NOEC = 9%), g	100, 30, 9, 2.7	*Intake source of toxicity*, 9.0 mg B/L was not toxic.
Jul. 31- Aug. 9, 1991 <u>Outfall 101</u>*					Tested 100% Outfall 101 alone (treatment 2) and with respective high & low concentrations each of: A. TVA06#, TVA07#, Betz 30K# (treatments 3 & 4) B. TVA06, TVA07, Betz 30K, Copper-Trol# (treatments 5 & 6) C. TVA06, TVA07, Betz 30K, Clam-Trol# (treatments 7 & 8) Treatments 5-8 were exposed to Copper-Trol & Clam-Trol only during the initial 24 hours of testing.
	Ceriodaphnia dubia	WBN Intake/ Outfall 101	Acute (24-h) toxicity of treatments 7 & 8 Chronic toxicity of treatments 5 (s) and 3 (r)	See Study Comments	100% mortality in 24-h for treatments 7 & 8. Only high concentrations of A & B affected.

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Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
(Cont.)	*Anodonta imbecillis* (Juvenile freshwater mussels, Paper Pondshell, 8-9 days old post transformation, 9-day test exposure)	WBN Intake/ Outfall 101	Not toxic, s	See Study Comments	9-day survival in ranged from 89% (reference) to 98% (treatment 7). All treatments contained ~ 600-800 mg silt/L (dry weight).
Sept. 19-26, 1991 Outfall 101*					Follow up study that Tested 100% Outfall 101 alone (treatment 2) and with respective high & low concentrations each of : A. TVA06, TVA07, Betz 30K (treatments 3 & 4) B. TVA06, TVA07, Betz 30K, Clam-Trol (5 & 6) Treatments 5 & 6 were exposed to CT-1 only during the initial 24 hours of testing.
	Pimephales promelas	WBN Intake/ Outfall 101	Not toxic, s, g.	See Study Comments	
	Ceriodaphnia dubia	WBN Intake/ Outfall 101	Acute (24-h) toxicity of treatment 5 and chronic (6-day) toxicity of treatment 6 (s)	See Study Comments	CT-1 toxic at both high and low concentrations tested. No other toxicity observed.
Apr. 9-16, 1992 Outfall 101*	*Pimephales promelas* *Ceriodaphnia dubia* *Selenastrum capricornutum*	WBN Intake WBN Intake WBN Intake	Toxic (NOEC < 50%), s Not toxic, s, r Toxic (NOEC = 50%; IC25 = 63%), g 100%-spiked Outfall 101 not toxic, g	100 & 50 100, 75, 50, 25 100, 75, 50, 25 Also, with Copper-Trol®-spiked & trsted @ 100, 30, 9	Second baseline evaluation of Outfall 101 alone and spiked w/ Copper-Trol® for the algal test. *Intake source of toxicity.* Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:83 minimum for the study).

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Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
June 25-July 2, 1992					Third baseline assessment of Outfall 101.
Outfall 101*	*Pimephales promelas*	WBN Intake	Not toxic, s, g	100, 50	
	Ceriodaphnia dubia	WBN Intake	Not toxic, s, r	100, 75, 50, 25	
	Selenastrum capricornutum	WBN Intake	Toxic (NOEC = 75%), g	100, 75, 50, 25	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:117 minimum for the study).
Oct. 15-22, 1992					First operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	TR	Not toxic, s, g	100, 50, 25, 12.5	
	Ceriodaphnia dubia	TR	Not toxic, s, r	100, 50, 25, 12.5	
Nov. 18-25, 1992					Second operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	TR	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	TR	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:404 minimum for the study).
Dec. 16-23, 1992					Third operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Jan. 15-22, 1993					Fourth operational assessment during injection of anti fouling chemicals. *CT-1 injected during study.*
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	

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Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
Feb. 11-18, 1993					Fifth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:831 minimum for the study).
Mar. 19-26, 1993					Sixth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Apr. 16-23, 1993					Seventh operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
May 12-19, 1993					Eighth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	Intake/TR	Toxic (NOEC = 2%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:159 minimum for the study).
Jun. 9-16, 1993					Ninth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	

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Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT		COMMENTS
			RESPONSE	CONC. (%)	
(Cont.)	*Ceriodaphnia dubia*	Intake/ Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Jul. 15-22, 1993					Tenth operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Aug. 19-26, 1993					Eleventh operational assessment during injection of anti fouling chemicals.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
	Selenastrum capricornutum	Synthetic water	Toxic (NOEC = 1.1%), g	100, 50, 25, 2	Instream acute and chronic (CMC & CCC) toxicity criteria not exceeded due to dilution (1:424 minimum for the study).
Sep. 25-Oct. 2, 1993					Twelfth operational assessment during injection of anti fouling chemicals. *CT-1 injected during study.*
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 50, 25, 2	Growth reduction in 25% & 50% treatments but not in undiluted Outfall 101.
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 50, 25, 2	
Feb. 2-9, 1994					First semi-annual compliance monitoring of Outfalls 101 and 112 under renewed NPDES permit TN0020168.
Outfall 101*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 9.8, 7.8, 2.9, 2.3	
	Ceriodaphnia dubia	Synthetic water	Toxic (NOEC = 9.8%), r	100, 9.8, 7.8, 2.9, 2.3	*Permit limit not exceeded.*
Outfall 112*	*Pimephales promelas*	Synthetic water	Toxic (NOEC = 25%), s	100, 80, 50, 25, 12.5	*Permit limit exceeded.*

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Table 4. (Continued)

TEST DATE	ORGANISM	CONTROL/ DILUTION	TREATMENT RESPONSE	TREATMENT CONC. (%)	COMMENTS
(Cont.)	*Ceriodaphnia dubia*	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	
Feb. 18-25, 1994					Repeat test of Outfall 112 due to fish toxicity exceeding permit limit.
Outfall 112*	*Pimephales promelas*	Synthetic water	Toxic (NOEC = 25%), g	100, 80, 50, 25, 12.5	*Permit limit exceeded* (based on 0.1 μg of fish weight in 100% Outfall 112 treatment).
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	
Mar. 23-30, 1994					Repeat test due to fish toxicity exceeding permit limit in the previous test.
Outfall 112*	*Pimephales promelas*	Synthetic water	Not toxic, s, g	100, 80, 50, 25, 12.5	
	Ceriodaphnia dubia	Synthetic water	Not toxic, s, r	100, 80, 50, 25, 12.5	

Test types: 3-brood ***Ceriodaphnia dubia*** **chronic test (EPA protocol), 7-day** ***Pimephales promelas*** **chronic test (EPA protocol), 9-day** ***Anodonta imbecillis*** **acute test (TVA protocol).**

*Outfall 101 = Diffuser pipe at TRM 527.9; Outfall 112 = Runoff holding pond to unnamed tributary to Yellow Creek

†TR = Non-toxic dilution water collected from outdoor channels at TVA's Toxicity Testing Laboratory, Wheeler Reservoir once-through water pumped from upstream of the Browns Ferry Nuclear Plant (TRM 293).

§s = survival (fish, daphnids, & mussels), g = growth (fish & algae), r = reproduction (daphnids).

#Chemical additives:
- TVA06 = HPS-1 copolymer dispersant
- TVA07 = zinc sulfate
- Betz 30K = tetra potassium pyro phosphate
- Copper-Trol = tolyltriazole
- Clam-Trol = CT-1 (DGH/QUAT).

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Table 5. DGH/QUAT toxicity to non-target organisms

CT-1 (mg/L)	TOXICITY IN LABORATORY WATER WITHOUT SILT				TOXICITY WITH SILT PRESENT†		
	C. dubia 3-brood test	*P. promelas* 7-day test	*A. imbecillis* 9-day test	*B. calyciflorus.* 24-hour test	*A. imbecillis* 9-day test	*A. imbecillis* 9-day test	*E. angustata* 9-day test
	EMPE* (Survival)	EMPE* (Survival)	TVA* (Survival)	TVA* (Survival)	TVA* (Survival)	PC* (Survival)	PC* (Survival)
Control	NOEC-r (100%)	(100%)	(97.5%)	(100%)	(97.6%)	(97.6%)	(97.5%)
0.05	NOEC-s (100%)						
0.07	96-h LC_{50}						
0.10	(0%)	NOEC-s,g (100%)	(67.5%)	(100%)	(95%)	(87.8%)	(97.5%)
0.12			9-d EC_{50}				
0.14			9-d LC_{50}				
0.20	(0%)						
0.40	(0%)	(85%)	(0%)	(100%)	(97.5%)	(82.5%)	(100%)
0.67		96-h LC_{50}					
0.80	(0%)						
0.96					9-d EC_{50}		
1.07					9-d LC_{50}		
1.60	(0%)	(0%)	(0%)	(60%)	(25%)	(90%)	(97.5%)
1.80§				24-h LC_{50}			
2.85						9-d LC_{50}	
3.20				(0%)			
6.40		(0%)	(0%)	(0%)	(0%)	(0%)	(97.5%)
8.74							9-d LC_{50}
12.80		(0%)	(0%)		(0%)	(0%)	(0%)
26.00					(0%)	(0%)	(0%)

*Testing conducted by EMPE, Inc., Nashville, Tennessee; Tennessee Valley Authority (TVA), Water Management; and Presbyterian College (PC), Clinton, South Carolina. Species tested were < 24-h old *Ceriodaphnia dubia* (daphnids), *Pimephales promelas* (fathead minnows), and *Brachionus calyciflorus* (rotifers), and 8-9 day old *Anodonta imbecillis* and *Elliptio angustata* (freshwater mussels).

†Silt provided by TVA from non-toxic reference site. Include in test at 600-800 mg dry wt/L.

§Graphically determined.

[single-line box] = Concentration tested. [double-line box] = Toxicity test endpoint.

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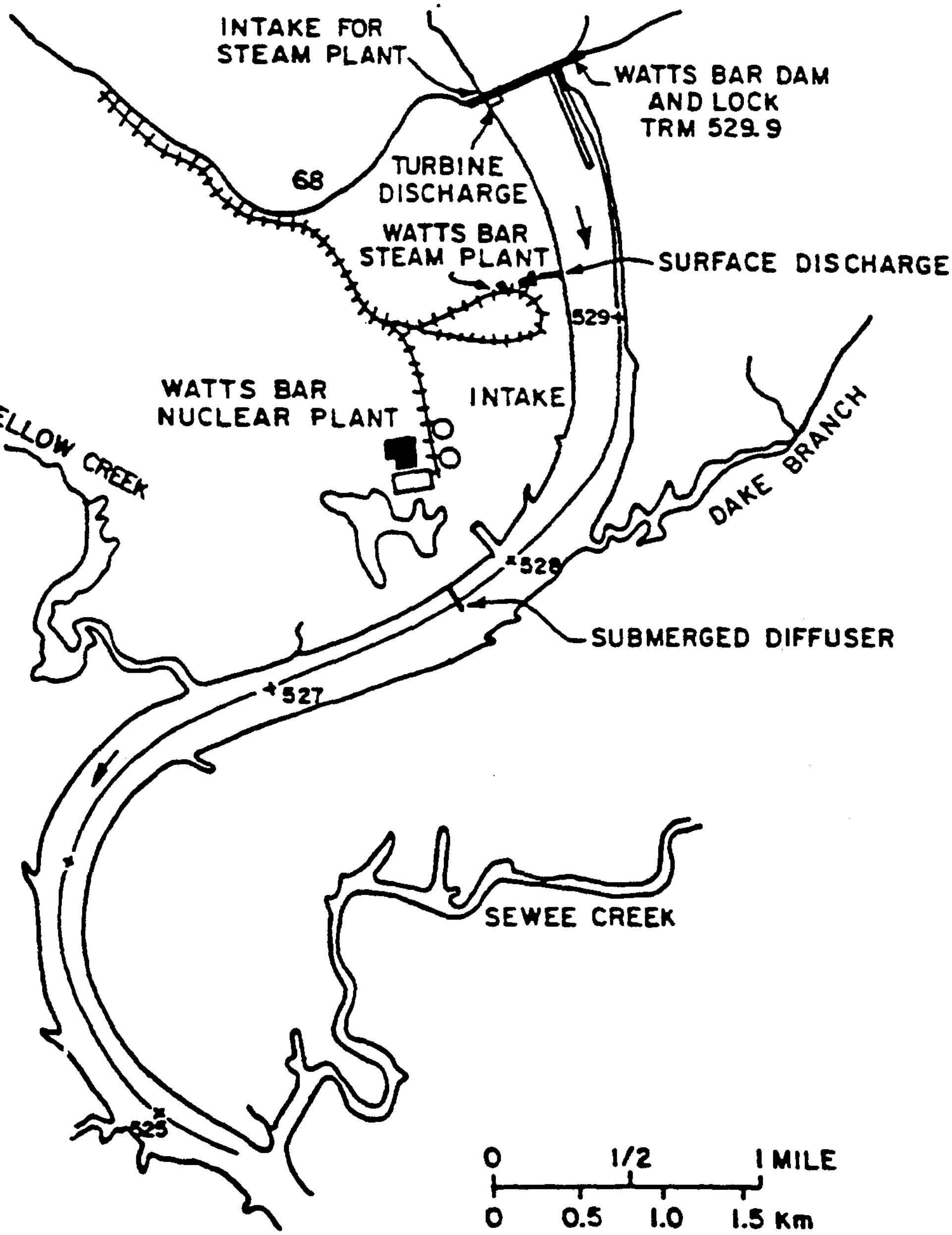

Figure 1. Tennessee River (upper Chickamauga Reservoir), indicating the locations of various facilities associated with the Watts Bar Nuclear Plant

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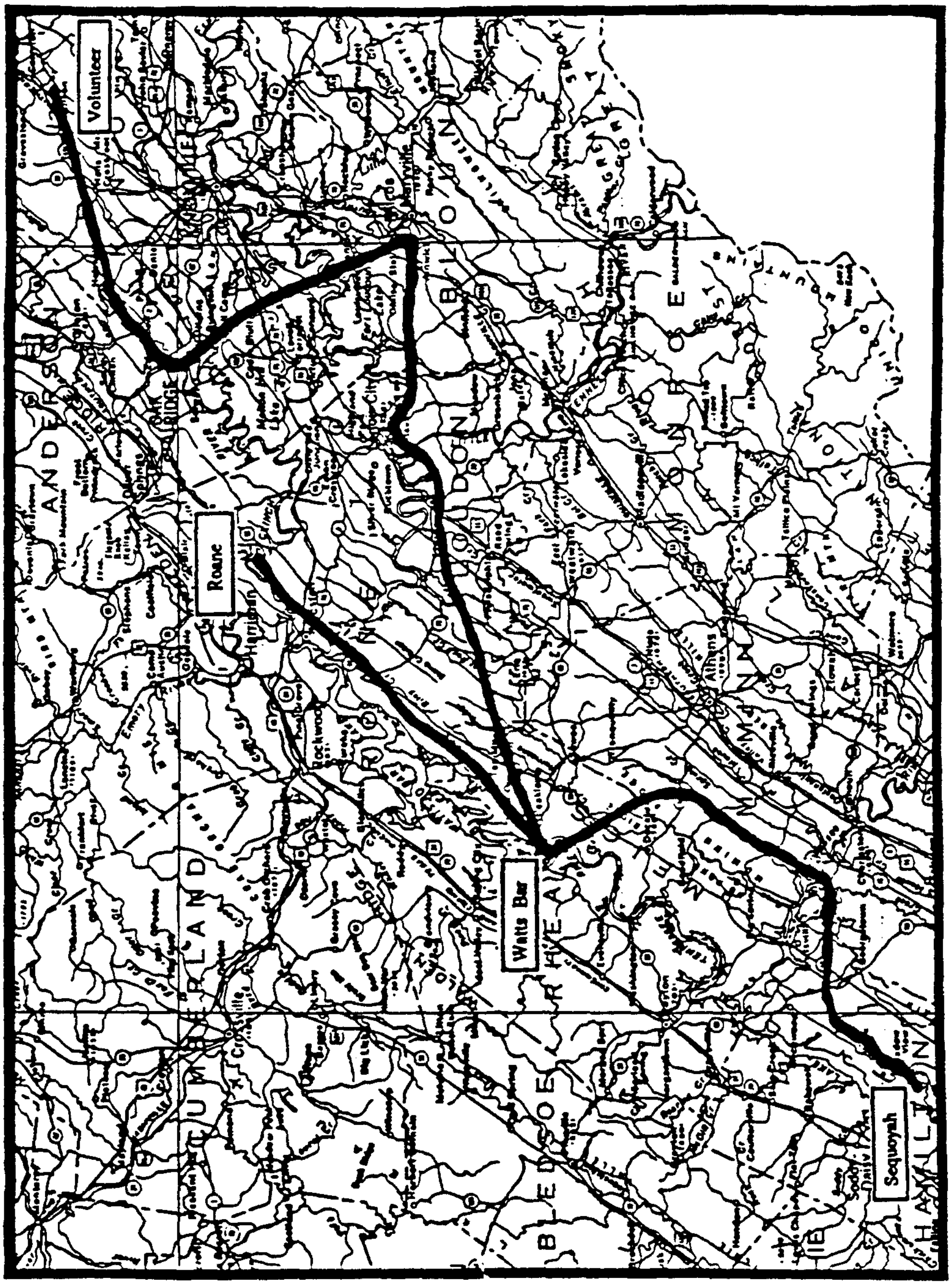

Figure 2. Portion of eastern Tennessee showing the routes of Watts Bar Nuclear Plant-related transmission lines.

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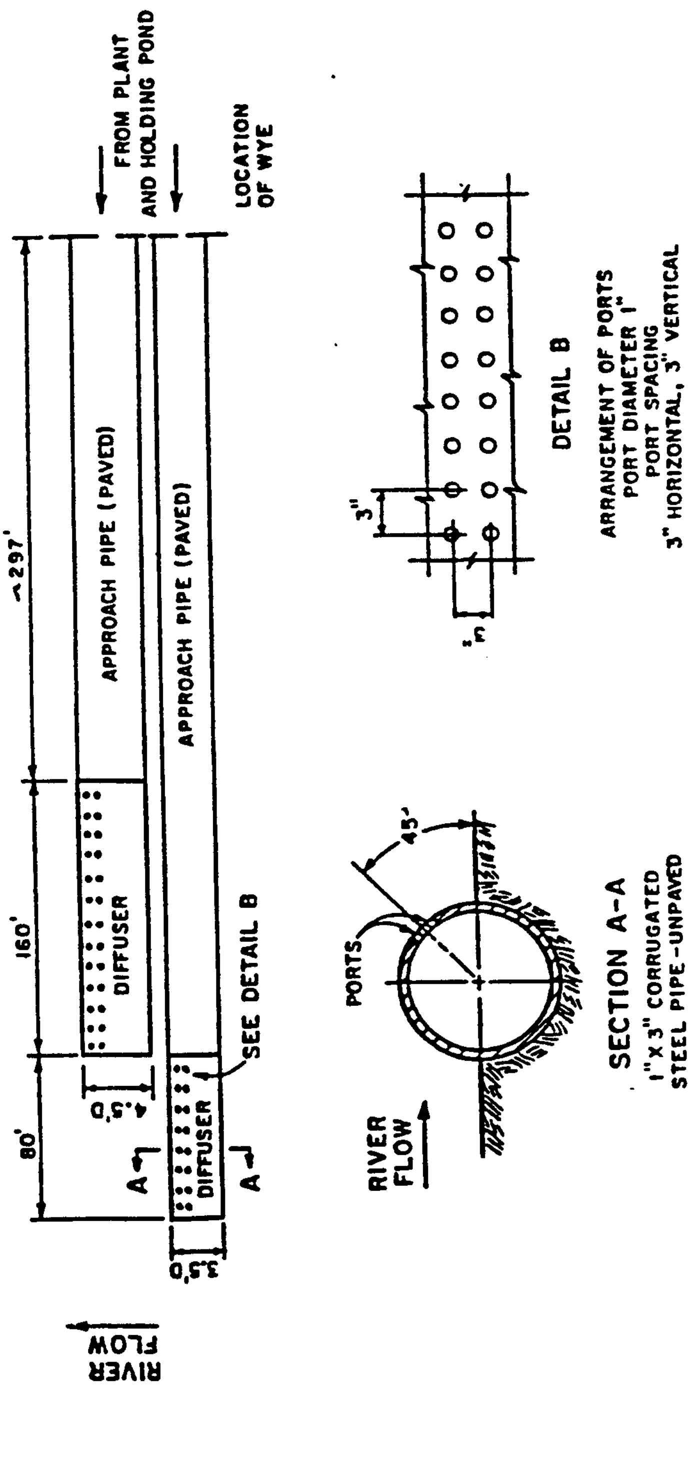

Figure 3. Details of Watts Bar Nuclear Plant multiport diffuser system.

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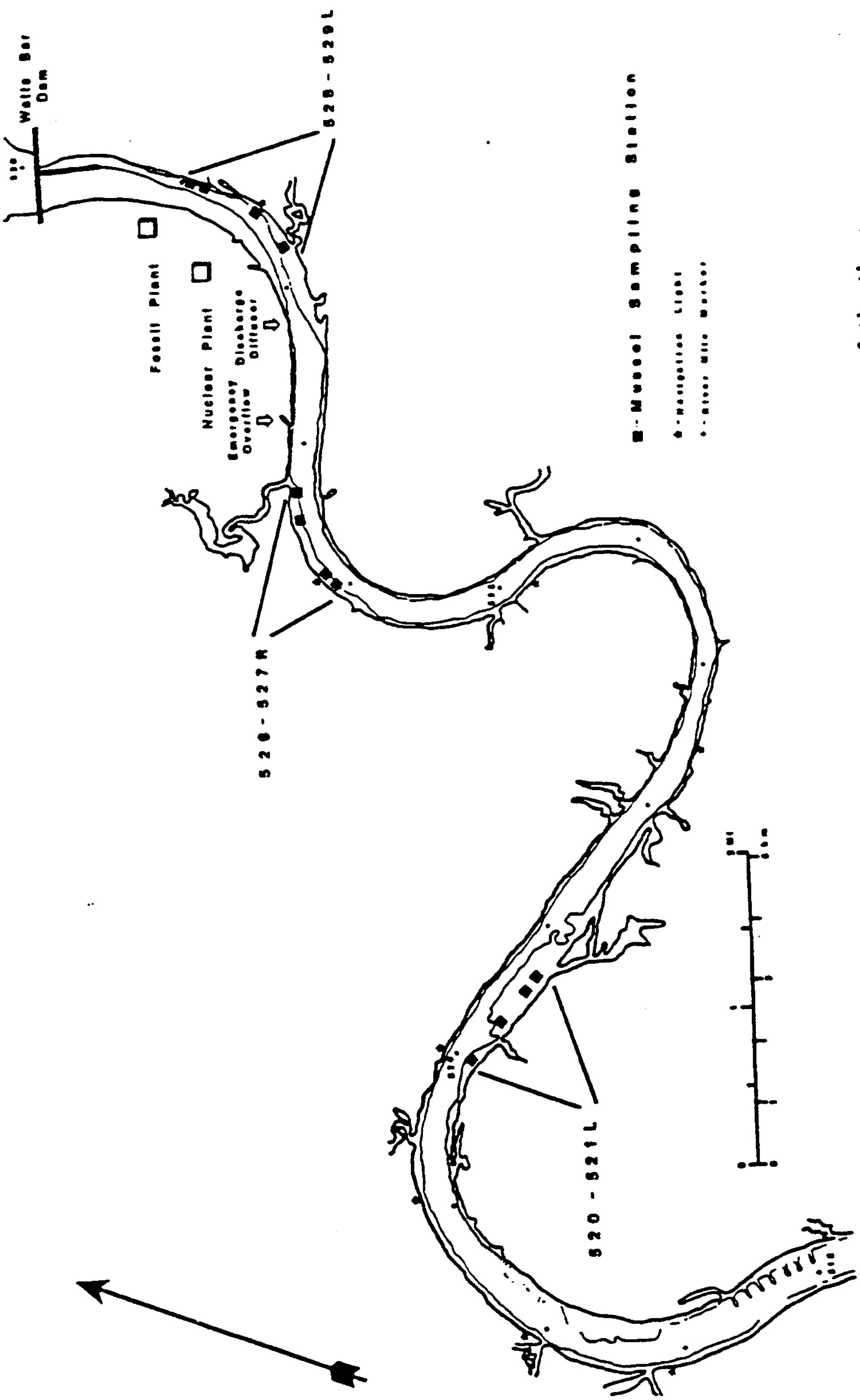

Figure 4. Tennessee River downstream from Watts Bar Dam showing the locations of the three mussel beds and their relationships to the Watts Bar Nuclear Plant discharges.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

January 25, 1995

Dr. Lee A. Barclay, Supervisor
Ecological Services Office
U.S. Fish and Wildlife Service
446 Neal Street
Cookeville, Tennessee 38501

SUBJECT: WATTS BAR NUCLEAR PLANT BIOLOGICAL ASSESSMENT

Dear Dr. Barclay:

By letter dated October 28, 1994, the Nuclear Regulatory Commission (NRC) staff transmitted its biological assessment concerning the environmental impacts of commercial operation of Watts Bar Nuclear Plant (WBN) on seven aquatic and terrestrial species listed as endangered by the Fish and Wildlife Service (FWS) under the Endangered Species Act (ESA) that are known to occur on or near the WBN site. These include four species of freshwater mussels, the snail darter, the bald eagle, and the gray bat.

The biological assessment also identified three additional aquatic species known to occur on or near the WBN site that have been designated as active candidates (Candidate Category 2) by FWS under the ESA. These were a mussel, the Tennessee clubshell (Pleurobema oviforme), a fish, the blue sucker (Cycleptus elongatus), and an amphibian, the eastern hellbender (Cryptobranchus a. alleghaniensis).

The biological assessment was jointly prepared by Tennessee Valley Authority (TVA) and NRC and supported both agencies' conclusion that operation of WBN is not likely to affect individuals or populations of any of the Federally-listed or candidate species or their critical habitat.

Although not mentioned in the biological assessment, the staff and TVA are aware of another candidate species, the pyramid pigtoe mussel (Pleurobema rubrum [=pyramidatum]), that also occurs in the Tennessee River near WBN. It is the position of both agencies that the conclusions in the biological assessment apply to the pyramid pigtoe as well as the three candidate species mentioned above.

The staff concludes that the presence of a fourth candidate species, the pyramid pigtoe, that was not mentioned in the biological assessment, does not alter the conclusion that operation of WBN is not likely to affect individuals or populations of any of the Federally-listed or candidate species or their critical habitat. We would be interested in receiving your views on this matter.

Dr. Lee A. Barclay - 2 -

If you have any questions about the information in the biological assessment or in this letter, please call James H. Wilson, (301) 504-1108 or Scott C. Flanders, (301) 504-1172.

Sincerely,

Original Signed By
WILLIAM T. RUSSELL

William T. Russell, Director
Office of Nuclear Reactor Regulation

United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, TN 38501

March 8, 1995

Mr. William T. Russell
Director
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: FWS #95-0234

Dear Mr. Russell:

Thank you for your letter and enclosure of October 28, 1994, transmitting a copy of the biological assessment prepared jointly by the Nuclear Regulatory Commission and Tennessee Valley Authority and requesting initiation of formal consultation regarding the proposed operation of the Watts Bar Nuclear Plant in Rhea County, Tennessee. Your supplemental letter, dated January 25, 1995, informed us of an additional Federal candidate species that might occur in the project area, but did not alter the findings made by the Tennessee Valley Authority or the Nuclear Regulatory Commission in their joint biological assessment. Enclosed is the final Fish and Wildlife Service biological opinion with a determination of whether or not the proposed action is likely to jeopardize the continued existence of seven Federally listed endangered and threatened species.

According to new policy, the Service is required to recommend that you provide a copy of this biological opinion to appropriate State agencies (i.e., Tennessee Wildlife Resources Agency) unless confidentiality is necessary for reasons of national security, or if the opinion contains classified information. Therefore, we request that, within 10 days of receipt, you send a copy of this biological opinion to:

Mr. Robert Hatcher
Tennessee Wildlife Resources Agency
P.O. Box 40747
Ellington Agricultural Center
Nashville, Tennessee 37204

If you can not, and if we do not hear otherwise from you, we will provide Mr. Hatcher with a copy.

Thank you for the opportunity to comment. If you have questions or if we can be of further assistance, please contact me or Jim Widlak of my staff at 615/528-6481.

Sincerely,

Douglas B. Winford
Acting Field Supervisor

xc: Mr. Jon Loney, TVA, Knoxville, TN
Mr. John Jenkinson, TVA, Chattanooga, TN
Mr. Bruce Schofield, TVA, Spring City, TN
Assistant Regional Director, ES, FWS, Atlanta, GA
(Attention: Mr. Richard Hannan)

BIOLOGICAL OPINION FOR THE PROPOSED OPERATION OF THE WATTS BAR NUCLEAR PLANT RHEA COUNTY, TENNESSEE

Prepared by:

James C. Widlak
Ecological Services Field Office
Cookeville, Tennessee

MARCH 1995

BIOLOGICAL OPINION FOR THE PROPOSED OPERATION OF THE WATTS BAR NUCLEAR PLANT RHEA COUNTY, TENNESSEE

A. INTRODUCTION

This presents the biological opinion of the U.S. Fish and Wildlife Service (Service) regarding impacts to Federally-listed endangered and threatened species from operation of the Watts Bar Nuclear Plant in Rhea County, Tennessee. It responds to a letter from Mr. William T. Russell, Director of the Office of Nuclear Reactor Regulation, dated October 28, 1994, and received on November 1, 1994, officially requesting initiation of formal consultation. This biological opinion only fulfills the requirements of Section 7 of the Endangered Species Act (Act) of 1973, as amended, and does not address issues relevant to other Federal environmental statutes. Upon completion of a biological assessment prepared jointly with the Tennessee Valley Authority (TVA), the Nuclear Regulatory Commission (NRC) and TVA have determined that the proposed action is not likely to adversely affect the following Federally listed species:

Gray bat - Myotis grisescens (E)
Bald eagle - Haliaeetus leucocephalus (E)
Snail darter - Percina tanasi (T)
Dromedary pearly mussel - Dromus dromas (E)
Pink mucket pearly mussel - Lampsilis abrupta (=L. orbiculata)(E)
Rough pigtoe (mussel) - Pleurobema plenum (E)
Fanshell (mussel) - Cyprogenia stegaria (E)

However, NRC believes that its regulatory interests would be best served by initiating formal consultation.

A copy of this consultation is on file and available for review during normal business hours at the Service's Cookeville Field Office, 446 Neal Street, Cookeville, Tennessee 38501; telephone 615/528-6481; FAX 615/528-7075.

B. PROJECT DESCRIPTION

The Watts Bar Nuclear Plant (WBN) is located on the west bank of Chickamauga Reservoir near Tennessee River Mile 528, approximately two river miles below Watts Bar Dam and one mile downriver from the Watts Bar Fossil Plant. The facility consists of two nuclear-generating units designed to produce over 2,500 megawatts of electricity. Construction of all of the major exterior facilities and associated transmission lines was completed in the 1970's. Unit 1 is essentially complete and Unit 2 is approximately 65 percent complete. The proposed action involves the operation of Units 1 and 2. The Tennessee Valley Authority proposes to initiate operation in the Spring of 1995 and is currently re-evaluating completion of Unit 2.

The Watts Bar Nuclear plant will be operated in a closed cycle cooling mode, using one natural draft cooling tower for each nuclear unit. An intake channel constructed in the adjacent channel of the Tennessee River will provide makeup water and water for all other needs at the facility. Blowdown from both units will be discharged through a diffuser system in the river channel at Mile 527.9 or will be stored in a holding pond for later release into the diffuser. Water will be stored when releases from Watts Bar Dam are less than 3,500 cubic feet per second (cfs). Maximum discharge through the diffusers will be 173 cfs.

A variety of chemicals will be used for various purposes at WBN, the end products of which will be disposed of or discharged into the Tennessee River. Substances that will be used or produced during operation of WBN include: alum, sulfuric acid, sodium hydroxide, chloride, sulfate, carbonates, boric acid, ammonia, hydrazine, copper, nickel, pyrophosphate, coppertrol, an organic co-polymer dispersant, clamtrol (molluscicide), zinc sulfate, and bromo-chloro-hydantoin.

Another part of the WBN project involved construction of five off-site transmission lines. Two of the lines are less than 5.5 miles in length, two are approximately 40 miles long, and the remaining line is almost 90 miles long.

C. <u>CONSULTATION HISTORY</u>

Construction of the Watts Bar Nuclear Plant was initiated prior to passage of the Endangered Species Act, and all major facilities were completed in the 1970's. However, operation of the facility requires a license by the Nuclear Regulatory Commission, thus requiring compliance with Section 7 provisions. A final environmental statement for the project was issued in 1978, along with a determination that the proposed operation of the facility would not adversely affect endangered species.

The Tennessee Valley Authority transmitted a draft biological assessment to the Service on August 25, 1994. The draft assessment concluded that the project would not affect any endangered species. The Service reviewed the draft assessment and requested, by letter of September 6, 1994, that TVA address questions regarding discharge of heated water, radioactive materials, and hazardous materials into the Tennessee River.

A final biological assessment, jointly prepared by TVA and NRC, concluded that operation of WBN was not likely to adversely affect individuals or populations of any of the seven endangered and threatened species known to occur in the project area. The joint biological assessment was submitted, consultation initiated, and Service concurrence requested by TVA on October 5, 1994. The Service concurred with the "not likely to adversely effect" finding by letter of November 21, 1994. A subsequent letter by the Service submitted on November 22, withdrew concurrence and stated that Section 7 consultation could not be concluded at that time, because of the pending formal consultation with NRC.
The Nuclear Regulatory Commission, although agreeing with the determination made by TVA in the assessment jointly prepared by both agencies, concluded that its regulatory interests would best be served by initiating formal consultation. An official request for formal consultation was submitted to the Service, along with a copy of the joint NRC/TVA biological assessment, on October 28, 1994. Consultation under Section 7 of the Endangered Species Act for operation of the Watts Bar Nuclear Plant will officially be concluded with issuance of this biological opinion.

The Nuclear Regulatory Commission submitted a supplemental letter to the Service on January 25, 1995. The letter informed the Service that an additional candidate species (the pyramid pigtoe mussel) might occur in the vicinity of the proposed project. Although this species was not considered in the biological assessment, NRC and TVA concluded that the conclusions reached in the assessment applied to this additional species as well as three other candidate species included in the assessment. Consequently, the presence of this species did not alter the "no effect" finding made by TVA and NRC.

D. BACKGROUND INFORMATION

The Tennessee River and Cumberland River historically supported one of the most diverse and abundant aquatic faunas in the world. Since neither of these drainages were subjected to glaciation, they have developed unique habitats and aquatic communities over millions of years and are thought to be centers of speciation for some faunal groups, particularly freshwater mussels and fish. These two river systems support populations of species with relatively wide distributions throughout their respective drainages as well as species endemic to particular streams within each river system.

The aquatic habitat in the project area is a large river/reservoir habitat, consisting of the Tennessee River and its larger tributary streams, as well as artificially impounded reservoirs (Chickamauga Lake and Watts Bar Lake). All of the Federally listed aquatic species addressed in this biological opinion--as well as the bald eagle and gray bat--are known to inhabit, or are closely associated with, this habitat type. The Tennessee River consisted historically (i.e., before impoundment) of free-flowing habitat not unlike that in its large creek and small river tributaries. Currently, most of the free-flowing habitats in the Tennessee and Cumberland River drainages have been replaced by more lentic conditions as a result of construction of impoundments. Riffle and pool habitats over sand, gravel, boulder, and bedrock substrates that supported diverse aquatic communities now consist of permanent pool (lake) habitat with a completely different faunal composition. For the most part, the pre-impoundment fauna now exists in remnant populations immediately below the dams or in the free-flowing reaches at the extreme headwaters of the reservoirs.

FRESHWATER MUSSELS (NAIADES)

- Pink mucket pearly mussel, rough pigtoe, fanshell, dromedary pearly mussel

Large streams, as well as large and small rivers in and around the project area, have evolved the most diverse freshwater mussel (naiad) fauna in the world. Over 100 species historically existed in these productive waters. Presently, over sixty species still exist as scattered, isolated, remnant populations in the remaining river reaches that still provide suitable habitat for these animals. A number of species are endemic to particular streams or watersheds.

Freshwater mussels are filter feeders; algae, detritus, and plankton suspended in the water column are brought in during normal siphoning activity and filtered from the water through the gills. Some researchers have reported that these animals accumulate certain pollutants (e.g., pesticides, heavy metals)(Imlay, 1982; Hanly and George, 1977; Salanki and Varanka, 1976). Consequently, freshwater mussels may be good biological indicators of water quality (Imlay, 1982; Foster and Bates, 1978; Adams et al., 1981). However, some malacologists believe that contaminant levels do not accumulate, but rather fluctuate, in freshwater mussel tissues; and because some mussel species persist in moderately polluted streams, mussels may not provide good indications of changes in water quality (John Jenkinson, TVA, personal communication).

Freshwater mussels become sexually mature at three or four years of age and exhibit a unique reproductive strategy. Males release sperm into the water column that are taken in by females during normal siphoning activities. Eggs are fertilized and held in modified gill pouches (marsupia) where they develop into the larval form (glochidia). Fully developed glochidia are released into the water and drift with stream currents. Although glochidia may survive for up to three or four days and may drift for relatively long distances (Howard and Anson, 1922; Widlak, 1982), glochidia not attaching to suitable fish hosts within six hours of release from the female may not survive (John Jenkinson, TVA, personal communication). Glochidia of some mussel species are able to metamorphose on several species of fish while high degrees of host specificity have been observed for others; glochidia of these host-specific species will successfully metamorphose on only certain groups or single species of fish. Those glochidia successfully attaching to the fins or gills of an appropriate host encyst and, after a certain period (depending on water temperature and other factors), metamorphose, drop from the fish and settle to the stream bottom as free-living juvenile mussels.

Two reproductive modes have been identified for North American freshwater mussels; fertilization of eggs, release of glochidia, and metamorphosis on fish hosts occur during a short period in spring and early summer in short-term (tachytictic) breeders. The eggs of long- term (bradytictic) breeders are fertilized during the summer, but glochidia are retained in the marsupia and released during the next breeding season. In streams supporting several species of bradytictic breeders, glochidia may be present in the water column year-round except for the period of gametogenesis due to seasonal differences in release of glochidia. Depending on the size of the female mussel, up to several hundreds of thousands of glochidia may be released by a single female mussel annually.

High mortality is thought to occur at two stages in the life cycle of freshwater mussels. Glochidia failing to attach to suitable fish hosts settle to the stream bottom and eventually perish or serve as prey for fish or invertebrate predators. Those attaching to unsuitable hosts are sloughed off and perish. Also, because of their size, metamorphosed juvenile mussels probably drift for certain distances, depending on stream currents; those that settle onto unsuitable substrate likely do not survive. Nonetheless, because mussels are long-lived (50 years or more)(Moyer, 1984) and have a high reproductive capacity, low annual recruitment is probably sufficient to maintain healthy populations.

Three of the four Federally endangered mussel species addressed in this biological opinion, the pink mucket pearly mussel (Lampsilis abrupta [=L. orbiculata]), fanshell (Cyprogenia stegaria), and rough pigtoe (Pleurobema plenum), are known to have been widely distributed in large river habitats in the Ohio, Tennessee, and Cumberland River drainages (U.S. Fish and Wildlife Service, 1983a, 1984, 1985, 1991). These species inhabit areas with moderate to swift current velocities with clean-swept sand and gravel substrates.

Reproducing populations of the fanshell are presently known to occur only in the Clinch River (Tennessee and Virginia), Green River (Kentucky), and Licking River (Kentucky). Smaller remnant populations are known to exist in the Tennessee, Cumberland, Barren, Kanawha, Tippecanoe, East Fork White, Wabash, Walhonding, and Muskingum Rivers, and Tygarts Creek, in Tennessee, Ohio, Indiana, West Virginia, and Kentucky (U.S. Fish and Wildlife Service, 1991).

The rough pigtoe presently occurs in the Tennessee, Cumberland, Clinch, Green, and Barren Rivers in Tennessee, Kentucky, Alabama, and Virginia (U.S. Fish and Wildlife Service, 1984). The pink mucket pearly mussel has the widest distribution of the four endangered large river mussel species addressed in this biological opinion. It is presently known to occur downstream from each Tennessee River impoundment, in the Kanawha River and Ohio River (West Virginia), and in two rivers in Missouri. Its historic distribution included the Tennessee River (Tennessee and Kentucky), Flint River and Limestone Creek (Alabama), Duck River, Holston River, French Broad River (Tennessee), Clinch River (Tennessee and Virginia), Cumberland River (Tennessee and Kentucky), Obey River (Tennessee), Ohio River, Allegheny River and Monongahela River (Pennsylvania), Elk River and Kanawha River (West Virginia), Scioto River and Muskingum River (Ohio), White River (Indiana), Wabash River (Indiana and Illinois), Mississippi River, Illinois River (Illinois), Ouachita River and Old River (Arkansas), Black River, Sac River, and St. Francis River (Missouri) (U.S. Fish and Wildlife Service, 1985). Although both species are relatively widespread, the reproductive status of many of the known populations of the rough pigtoe and pink mucket is not known.

The pink mucket pearly mussel may be more tolerant of a wider variety of habitat types than the other large river mussels. It has been found in the headwaters of several reservoirs in lentic conditions considered unsuitable for the other riverine mussel species. Although it is widespread, the pink mucket is rare where it occurs. (U.S. Fish and Wildlife Service, 1985)

The dromedary pearly mussel (Dromus dromas) is a Cumberlandian species--i.e., it is endemic to streams on the Cumberland Plateau. This species is presently known to occur in the Cumberland, Powell, and Clinch Rivers in Tennessee, Kentucky, and Virginia (U.S. Fish and Wildlife Service, 1983a). A single live specimen collected downstream from Watts Bar Dam is the only recent record for D. dromas in the project area, but the species is still known to be reproducing in the Clinch River in Tennessee (Steve Ahlstedt, USGS, personal communication). Like the other three species, the dromedary pearly mussel inhabits areas with moderate to swift current over mixed sand/gravel/cobble substrate.

The rough pigtoe mussel is a short-term breeder; the dromedary and pink mucket are long-term breeders. The fanshell is also a long-term breeder (Ortmann, 1919). To date, no fish hosts for the four mussel species addressed in this biological opinion have been identified or confirmed. However, the sauger has been reported to be the host for glochidia of a mussel species (Higgin's eye pearly mussel) closely related to the pink mucket (U.S. Fish and Wildlife Service, 1985). Since the sauger also occurs in streams supporting populations of the pink mucket pearly mussel, it may serve as a glochidial host for that species as well.

- FISH
  - Snail darter

The snail darter, Percina tanasi, is a threatened species that is restricted to the upper Tennessee River drainage. The species may once have occurred in suitable habitats in the Tennessee River and its major tributaries from north-central Alabama to northeastern Tennessee. Presently, the species is known to occur in the mainstem of the Tennessee River (Watts Bar Lake, Chickamauga Lake, Nickajack Lake, Guntersville Lake), Sewee Creek, Sequatchie River, Hiwassee River, Paint Rock River and South Chickamauga Creek in Tennessee, Alabama, and Georgia (U.S. Fish and Wildlife Service, 1983b). The Hiwassee River population is the result of a successful transplant effort undertaken by TVA in 1975 and 1976. Snail darters were also transplanted into the Nolichucky River (NRM 18.0), Holston River (HRM 14.4), and Elk River (ERM 41.0). During routine fish surveys in 1988 and 1989, TVA biologists found snail darters in the lower Holston River (HRM 5.0) and the lower French Broad River in Knox County, Tennessee, indicating that the transplanted population in the Holston River may have reproduced and expanded. However, neither the Nolichucky River or Elk River transplants have resulted in successfully reproducing populations.

Percina tanasi spawns in shoal areas. Males arrive on spawning shoals from November through mid-January. Females arrive shortly after that and lay their eggs in gravel or on rocks through the middle of March. However, female snail darters in spawning condition have been observed in the Little Tennessee River as late as April and mid-May (Hickman and Fitz, 1978). The newly hatched fry may drift downstream to nursery areas in slackwater or pool habitats and remain there for six to seven months, at which time they (juveniles) move back into shoal habitats (Hickman and Fitz, 1978; Etnier and Starnes, 1993). Food habits of larval and post-larval snail darters are unknown, but zooplankton may comprise the bulk of the diet (Etnier and Starnes, 1993); adults feed primarily on aquatic snails, as well as other aquatic macroinvertebrates (Hickman and Fitz, 1978; Etnier and Starnes, 1993).

BIRDS

o Bald eagle

The bald eagle, Haliaeetus leucocephalus, is a large North American raptor, attaining body lengths of approximately three feet, with wingspans of almost seven feet. Adults are easily identified by the distinctive white plumage on the head and tail. Juvenile birds may be mistaken for adult golden eagles, but can be identified by the white feathers on the wing linings and the absence of feathers on the legs. Two subspecies of bald eagles are presently recognized, the northern (H. l. alascanus) and southern (H. l. leucocephalus). However, the distinction between the two may not be tenable because there is apparently a continuous gradient in size and weight of birds geographically from north to south. Nevertheless, for recovery and Section 7 consultation purposes, the Service recognizes five distinct sub-populations, and this biological opinion will determine if the proposed project will jeopardize the continued existence of the Southeastern sub-population of bald eagles, the range of which includes the states of Kentucky, Tennessee, Arkansas, Mississippi, Alabama, Georgia, Florida, South Carolina, North Carolina, Louisiana, Texas (east of the 100th meridian), and West Virginia (west of the 80th meridian). (U.S. Fish and Wildlife Service, 1989)

Bald eagles historically nested throughout the southeastern United States. The species was considered to be a common resident in Florida, Georgia, North Carolina, South Carolina, and Texas, but Kentucky and Tennessee did not historically have abundant eagle populations. Until recently, the last nesting activity in either state was reported from the 1950's (Kentucky) and early 1960's (Tennessee). For about thirty years, there had been no confirmed nesting activity in Kentucky or Tennessee, but substantial populations of eagles continued to winter along the Ohio River and Reelfoot Lake. In 1986, an eagle nest was discovered on the Ballard County Wildlife Management Area in western Kentucky. Despite failure of the nest in 1986, four additional nests have been constructed and several eaglets have been fledged. In addition, several nests have been reported recently along the Mississippi and Ohio Rivers west of Ballard County and one was recently found at an inland reservoir in eastern Kentucky (Laurel River Lake). The nest at Laurel River Lake failed in 1991 (the nest tree blew down during a storm) and, although no new nests have been discovered, a pair of adult bald eagles was observed at Laurel River Lake in 1992 and 1993. No nests are known to occur in the vicinity of the Watts Bar Nuclear Plant, but a nesting attempt was made by a pair of eagles in 1994, approximately 4 miles south-southwest of WBN. The nearest known successful bald eagle nest exists on Tellico Lake, and other nests are known to exist at Cordell Hull Lake and at a number of locations in western Tennessee. Bald eagles also likely winter along the Tennessee River below Watts Bar Dam and around the reservoir.

Although the bulk of the bald eagle's diet consists of fish, the species is opportunistic and will feed on a variety of prey depending on its availability. Remains of catfish, turtles, coot, mullet, gallinule, and small mammals have been observed in nests and apparently supplement the eagle's diet (U.S. Fish and Wildlife Service, 1989).

Bald eagles begin to arrive at wintering areas in late October (depending on the severity of the weather in the northern portions of the range) and generally remain through March. Food availability may be the most important factor in maintaining wintering populations, but suitable perching and roosting sites also determine the degree of use (Steenhof, 1978). Preferred diurnal perch trees are near shore or within unobstructed view of the water and have stout, horizontal branches and adequate open area to facilitate hunting. Communal roost trees are usually protected from wind and may be bordered by open area, but are not necessarily near open water.

Depending on the area, nesting activity in the Southeastern states may begin as early as September or as late as December. At those times, mated pairs begin constructing nests or repairing existing nests. The female completes much of the nest construction with some help from the male. At times, however, bald eagles have been known to take over the nests of other large birds (e.g., ospreys). Eggs are laid between late October and December, and are incubated for approximately 35 days. Clutch size is generally two, but sometimes three eggs are hatched. Fledging takes ten to twelve weeks, and parental care may extend for an additional four to six weeks. Bald eagles require roughly four to five years before reaching breeding age, and mature adults generally return to the areas from which they were fledged to establish breeding territories. Eagles may use the same nest year after year, or the breeding pair may construct several additional nests within its territory and alternate use from one year to the next. Nesting territories encompass an area of up to one mile around the nest (however, territories are not necessarily circular around the nest) and are actively defended during the nesting season (U.S. Fish and Wildlife Service, 1989). In Tennessee, nesting activity may not begin until October. However, numerous observations indicate that egg laying takes place from late January through April, peaking in mid-February.

There appears to be significant variability among individual bald eagles in their sensitivity to disturbance. Some birds occur in areas having relatively high levels of disturbance. These birds are generally more tolerant of human activity than birds raised in isolated localities with low levels of activity and/or use. Disturbance of a nesting pair may result in abandonment of a territory, or if the nest site is not abandoned, the birds may respond to disturbance by reducing annual production. Some pairs are known to nest close to areas that undergo heavy human use, exhibiting tolerance to a certain degree of disturbance. Other active nests are located in relatively isolated, inaccessible areas. It is probable that the birds using these isolated areas are extremely sensitive to even minor disturbance.

<u>MAMMALS</u>

o <u>Gray bat</u>

The gray bat was listed as an endangered species on April 28, 1976. It is the largest species in the genus <u>Myotis</u> in the eastern United States, weighing 7 to 16 grams and having forearm lengths of 40 to 46 millimeters. The gray bat is easily distinguished from all other bats throughout its range by its unicolored dorsal fur. (U.S. Fish and Wildlife Service, 1982)

The species has a limited geographic range in karst areas of the southeastern United States. Populations occur primarily in Alabama, Kentucky, Missouri, Tennessee, and northern Arkansas; but smaller populations are known from northwestern Florida, western Georgia, southeastern Kansas, southern Illinois and Indiana, northeastern Oklahoma, northeastern Mississippi, and western Virginia. Distribution within the species' range has always been patchy, but increasing population isolation and fragmentation has been reported. (U.S. Fish and Wildlife Service, 1982)

Historically, individual hibernating gray bat populations numbered from 100,000 to 1,500,000 or more; summer colonies (in Alabama and Tennessee) averaged from 10,000 to 50,000 individuals, but some contained up to 250,000 bats. However, drastic declines in hibernating and maternity colony sizes as well as cave abandonment have been reported recently. The overall species decline, based on hibernating populations, is at least 50 percent during the past 50 years (U.S. Fish and Wildlife Service, 1982). Annual gray bat surveys in Alabama, Tennessee, Missouri, and Kentucky indicate that an average decline of 46 percent was occurring every 6 years during the 1960's and 1970's (the range was from 32 to 57 percent). If gray bat populations continue to decline at an average rate of 46 percent every 6 years, the species' population would be approximately 100,000 individuals by the year 2000. A population of that size scattered over six states may not be large enough to sustain itself, and the species would likely face extinction (Tuttle, 1975; U.S. Fish and Wildlife Service, 1982).

The gray bat is among the most habitat-restricted mammals in the United States. With rare exception, the species roosts in caves throughout the year and, because of highly specific habitat requirements, less than 5 percent of available caves provide suitable environmental conditions. Gray bat colonies migrate seasonally from 17 to 525 kilometers between warm (14-25 degrees C) and cold (6-11 degrees C) caves. (U.S. Fish and Wildlife Service, 1982)

Myotis grisescens feeds almost exclusively over water. Caves used by maternity colonies are usually located within 1 kilometer of, and rarely more than 4 kilometers from, rivers or reservoirs over which the bats feed. A variety of aquatic insects (adult stage) are consumed, but the gray bat appears to prefer adult mayflies, stoneflies, and caddisflies (LaVal et al., 1977).

Relatively undisturbed forest canopy also appears to be an important component of gray bat habitat. Young often feed and take shelter in the forest surrounding the cave opening and gray bats of all ages fly in the canopy between the cave and foraging areas. Forest cover also provides a measure of protection against predators. Consequently, gray bat feeding areas are generally not found along sections of river or reservoir shoreline where adjacent forest canopy has been removed (LaVal et al., 1977).

Gray bats breed upon arrival at hibernacula. Females store sperm through the winter and become pregnant soon after emergence in late March to early April. Summer colonies occupy traditional home ranges that often contain several roosting caves near rivers or reservoirs. Members of the colony are extremely loyal to their home range, but may disperse to different caves within that range. Females congregate in maternity colonies, usually the warmest cave in the home range, and give birth (each female bears a single young) in late May to early June. Growth rates and survival of young are dependent upon the size of the colony and the distance of the cave from foraging areas (Tuttle, 1975; Tuttle, 1976). Most young begin to fly within 20 to 35 days of birth and are apparently not taught how or where to hunt.

Human disturbance has been identified as a major factor in the decline of the gray bat, particularly at two times of the year. Disturbance of bats at the hibernaculum from mid-August through April awakens the bats, resulting in excessive expenditure of energy reserves stored by individual bats. Repeated disturbance may cause the bats to emerge from hibernation before prey becomes available, resulting in high mortality. Intrusion into caves used

1'

by maternity colonies between late May and mid-July may result in the death of hundreds or thousands of flightless young. (U.S. Fish and Wildlife Service, 1982)

Other causes of decline in gray bat populations include improper use of pesticides that may cause direct mortality to the bats or secondary poisoning from feeding on contaminated insects. Natural calamities (such as flooding of caves and collapse or fill-in of entrances), commercialization, and improper gating of gray bat hibernacula and summer caves also are contributory factors in the recent decrease in population numbers. Even if the bats escape initial destruction or alteration of the cave, survival of displaced populations is questionable due to the species' strong site attachment and highly specific habitat requirements. In addition, pollution and siltation of foraging areas, as well as deforestation along waterways and between caves and foraging areas, reduce foraging area and overall habitat quality. (U.S. Fish and Wildlife Service, 1982)

In the past 15 years, efforts to protect and recover the gray bat have shown some success. Populations in high priority hibernacula and maternity caves have stabilized or undergone moderate increases as a result of protection measures such as acquisition, signing, fencing, and gating. Gray bat numbers are now thought to be stable (at lower than historic levels) in Alabama and Arkansas, but declines are still reported throughout some portions of the species' range (Robert Currie, FWS, personal communication).

E. PROJECT IMPACTS

Direct/Indirect Effects

Impacts to listed species resulting from operation of the Watts Bar Nuclear Plant are likely to occur primarily as a result of heated water discharge from the plant or from inadvertent or accidental spills of radioactive or hazardous materials into the river. These materials could cause direct mortality to individuals, or could adversely affect normal behavior or reproduction. Over time, low-level contamination could result in adverse chronic effects.

Heated water will be discharged through a diffuser constructed in the river. This will facilitate mixing and dilution with the river water and should not result in any significant reduction in dissolved oxygen level or in temperature shock. Discharge of non-radioactive materials will not exceed levels contained in the existing State-issued National Pollution Discharge Elimination System (NPDES) permit. Release of radioactive materials will be in accordance with provisions of 10 CFR, Part 20, for release to unrestricted areas.

Chemicals and other substances to be used at WBN include alum, sulfuric acid, sodium hydroxide, chloride, boric acid, metallic salts, carbonates, ammonia, hydrazine, copper, nickel, pyrophosphate, zinc sulfate, coppertrol, clamtrol, bromo-chloro-hydantoin, and an organic co-polymer dispersant. Waste products from use of alum in the makeup water filter plant will not be discharged into the Tennessee River, but will be disposed of in a landfill. Copper and nickel will not be added to the system at WBN, however, corrosion will result in these metals entering the river at certain concentrations. Waste products from the remaining chemicals will be discharged into the river. Some, such as zinc and ammonia, are known to be detrimental to aquatic organisms and could have significant adverse effects on fish and mussels, including endangered species, in the action area. Improper use of substances such as clamtrol, a molluscicide, could result in high mortality of non-target molluscs in the river. However, in order to minimize the effects of discharged chemical end products, WBN will operate in accordance with a State-issued NPDES permit. Standards established in that permit are designed to prevent water quality degradation that would result from unregulated discharge of pollutants into the river. Various extensive testing and monitoring efforts will be implemented by WBN to ensure that the plant remains in compliance with the NPDES permit.

Impacts to listed species may also result from activities associated with maintenance of the five transmission line rights-of-way. Use of herbicides to maintain these areas could result in direct mortality to non-target terrestrial species or stress-related mortality resulting from chronic effects.

Cumulative Effects

Cumulative effects are those effects of future State and private activities on endangered and threatened species or critical habitat that are reasonably certain to occur within the action area of the Federal action subject to consultation. Future Federal actions will be subject to the consultation requirements established in Section 7 and, therefore, are not considered cumulative in the proposed action.

At the present time, there are no known State or private activities proposed that are reasonably certain to occur in the vicinity of the Watts Bar Nuclear Plant as a result of the plant operation. Therefore, cumulative effects, as defined by the Act, are not anticipated to occur. However, businesses or industries, particularly of the support-type (i.e., those that provide services to plant employees) may be attracted to the area in the future.

F. BIOLOGICAL OPINION

The Nuclear Regulatory Commission is proposing to issue a license to the Tennessee Valley Authority to operate the Watts Bar Nuclear Plant. Determinations of "not likely to adversely affect" were made by TVA and NRC for the gray bat, bald eagle, snail darter, rough pigtoe, pink mucket pearly mussel, fanshell, and dromedary pearly mussel. Although agreeing with the findings made by TVA, NRC chose to initiate formal consultation for issuance of the license.

o BALD EAGLE

The jeopardy standard for the bald eagle is based on consideration of impacts to one of five identified sub-populations. In order to determine jeopardy for bald eagles in Tennessee, the Service must conclude that a proposed action will threaten the continued existence of the species over the entire southeastern United States. The Service is presently evaluating current nesting data to determine if the bald eagle should be downlisted from endangered to threatened status. However, of the five sub-populations, all but the Southeastern population have achieved the recovery objectives described in the respective species' recovery plans. The recovery goals for the Southeastern sub-population are based on establishment and success of a designated number of nesting pairs in each state. To date, not all of the Southeastern states have reached the designated number of nesting eagles. The recovery objective for Tennessee, which has been achieved, is fifteen nesting pairs. In 1993, there were 18 occupied nests, fifteen of which successfully fledged young. Consequently, actions that result in abandonment or failure of the nests in Tennessee would adversely affect the recovery of the species in the State and the Southeastern sub-population, but would not necessarily threaten the survival and recovery of the species throughout the Southeast.

After review of the status of the bald eagle, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that operation of the Watts Bar Nuclear Plant, as proposed, is not likely to jeopardize the continued existence of the bald eagle. No critical habitat has been designated for this species; therefore, none will be affected. However, there is a potential for impacts to bald eagles in the vicinity of the Watts Bar Nuclear Plant as a result of operation and associated activities. This area apparently provides suitable wintering habitat and potential nesting habitat and, although the bald eagle may be considered "recovered" in the State, this habitat may become more important to the bald eagle in Tennessee as the species expands its range. Loss of the habitat along the Tennessee River below Watts Bar Dam through project-related disturbance could impede full recovery of the Southeastern sub-population.

o <u>FISH</u>

Only the Sewee Creek snail darter population occurs within the project impact area, which constitutes one of several reproducing snail darter populations known to exist throughout the species' range. Because the species is sensitive to changes in its habitat, pollution of the river in the form of heated water discharge, release of radioactive materials, or accidental spills of radioactive or hazardous materials resulting from operation of the facility could have adverse impacts on the species or its habitat. However, after reviewing the status of the snail darter, the environmental baseline, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that operation of the Watts Bar Nuclear Plant, as proposed, is not likely to jeopardize the continued existence of the snail darter. Critical habitat for this species was designated in the Little Tennessee River at the time the species was listed; however, the designation of critical habitat was withdrawn when the snail darter was downgraded to threatened status in 1984. Therefore, this action will not result in destruction or adverse modification of critical habitat.

o <u>MUSSELS</u>

Freshwater mussel populations have been affected by a variety of activities. Impoundment of the Tennessee River, and other rivers, has altered miles of free-flowing riverine habitat. Agriculture. mining, road construction, development, and forestry operations have all contributed to siltation of streams and rivers and degradation of water quality. Point and non-point pollution from agricultural, industrial, and urban sources have directly resulted in population declines, and have indirectly affected mussels by eliminating essential fish hosts. Recent die-offs of undetermined cause throughout the Southeast have also contributed to significant declines in mussel populations.

Introduction of exotic species is undoubtedly another cause of decline in native mussel populations in the United States. In the 1930's, the Asian clam (<u>Corbicula fluminea</u>) was introduced into North American waters in the Pacific Northwest and the species spread throughout the United States by the mid-1970's. The zebra mussel (<u>Dreissena polymorpha</u>) was probably introduced into the Great Lakes from Europe sometime in the mid-1980's. It has recently been found in the Mississippi, Ohio, Cumberland, and

Tennessee Rivers and has the potential to spread throughout the Southeast. Both of these species have tremendous reproductive capacities, reaching densities of tens of thousands of individuals per square meter. At high densities, both species have the ability to filter tremendous quantities of water and plankton, thus reducing the availability of food for native species. Corbicula fluminea has been attributed as a cause of decline in native mussel populations in some streams due to its competitive advantages. Dreissena polymorpha has been present in North American waters for approximately 10 years, and it has been known to adversely affect or eliminate many species of native mussels in the Great Lakes and the rivers of the Northeast and Midwest. The remaining populations of native, large-river mussels in the Southeast are thus in danger of extirpation as the zebra mussel continues to spread.

After reviewing the current status of the dromedary pearly mussel, fanshell, pink mucket pearly mussel, and rough pigtoe, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that, because the populations of the four endangered mussel species in this reach of the Tennessee River are small and none are presently known to be reproducing, operation of the Watts Bar Nuclear Plant, as proposed, is not likely to jeopardize the continued existence of the dromedary pearly mussel (Dromus dromas), rough pigtoe (Pleurobema plenum), fanshell (Cyprogenia stegaria), or pink mucket pearly mussel (Lampsilis orbiculata). No critical habitat has been designated for these species; therefore, none will be affected.

o MAMMALS

At present, there are two known caves within five miles of the Watts Bar Nuclear Plant that are occupied by gray bats during the summer. The reach of the Tennessee River adjacent to the Plant may therefore provide foraging habitat for the species. After reviewing the current status of the gray bat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that, although operation of the facility and associated activities may impact the Tennessee River, operation of the Watts Bar Nuclear Plant, as proposed, is not likely to jeopardize the continued existence of the gray bat. No critical habitat has been designated for this species; therefore, none will be affected.

G. INCIDENTAL TAKE

NOTICE: While the incidental take statement provided in this consultation satisfies the requirements of the Endangered Species Act, as amended, it does not constitute an exemption from the prohibitions of take of listed migratory birds under the more restrictive provisions of the Migratory Bird Treaty Act.

Section 9 of the Endangered Species Act, as amended, prohibits any taking (=harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in such activities) of listed species without a special exemption. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered taking within the bounds of the Act, provided that such taking is in compliance with the incidental take statement.

This section of the biological opinion addresses incidental take of the dromedary pearly mussel, rough pigtoe, fanshell, pink mucket pearly mussel, snail darter, gray bat, and bald eagle resulting from project activities, and presents the Service's estimates of the anticipated amount or extent of take. In meeting the provisions of Section 7(b)(4) of the Endangered Species Act, we have reviewed the biological information and other available information relative to this action.

Given the ranges and present statuses of some of the species (e.g., dromedary pearly mussel, fanshell) involved in this consultation, it is possible that incidental take could reach levels that would be in violation of Section 7(a)(2). Although there is a substantial amount of quantitative data regarding the fish and mussel resources below Watts Bar Dam, it would be difficult to locate a dead mussel or snail darter given the size of the Tennessee River, or to attribute the death to operation of WBN. In addition, there is a general lack of data regarding use of the river and adjacent terrestrial habitat by bald eagles and gray bats. Therefore, it is not possible to estimate the number of individuals that might be taken or the amount of habitat that might be affected as a result of plant operation. Therefore, the NRC should contact the Service's Cookeville Field Office if incidental take of one individual of any of the species listed in this section attributable to operation of, or associated activities at, the Watts Bar Nuclear Plant occurs to determine if reinitiation of consultation is needed. Operation of the plant may continue during these discussions. The incidental take of bald eagles is not authorized by the Bald and Golden Eagle Protection Act. Therefore, such take is not authorized by this incidental take statement.

Reasonable and Prudent Measures

As a reasonable and prudent measure to minimize incidental take of the endangered and threatened species addressed in this biological opinion, with the exception of the bald eagle, the NRC should:

1. Ensure that adequate procedures are in place to prevent degradation of water quality in the Tennessee River from operation of the Watts Bar Nuclear Plant.

Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the Act, the following terms and conditions, which implement the reasonable and prudent measure described above, must be complied with:

1. The NRC should ensure that adequate plans are in place, which contain measures that will be implemented in the event of a spill or other accident involving radioactive, hazardous, or toxic materials, prior to operation of the Watts Bar Nuclear Plant. The plans should contain measures that employ the latest technology in containment and/or clean-up of hazardous materials. The plans should provide for rapid reporting of and response to spills and accidents. The plans should be reviewed and updated as needed to ensure that the latest techniques and methodologies are incorporated.

2. Any license and subsequent renewal will contain a clause giving NRC the option to revoke the license if TVA does not maintain and comply with a valid NPDES permit. If the temperature and/or contaminant limits contained in the State-issued permit are exceeded, this office will be contacted to determine if reinitiation of consultation is necessary. Plant operation may continue during these discussions. Water quality monitoring will be an integral and ongoing part of the operation of WBN to ensure early detection of problems. Reports of water quality monitoring will be submitted to NRC and the Service's Cookeville Office at least annually. Since at least four endangered mussel species are likely to occur in the Tennessee River in the project area, toxicity testing using freshwater mussels would provide TVA and the Service an early warning mechanism regarding adverse changes in water quality resulting from discharges from the Watts Bar Nuclear Plant. Mussels are presently being held and propagated at TVA's Browns Ferry Nuclear Plant for toxicity testing purposes at that facility. Portions

of that stock could be used at the Watts Bar facility. Toxicity testing with juvenile mussels would be particularly valuable since that life stage is likely more sensitive to changes in water quality than adult mussels or some of the standard bioassay organisms. However, since Ceriodaphnia has been shown to be more sensitive, it will also be used as a test organism. An appropriate testing schedule will be developed. Results of these tests will be submitted to this office and the NRC.

Upon locating a dead, injured, or sick specimen of an endangered or threatened species, initial notification must be made to this office and the appropriate Fish and Wildlife Service Law Enforcement Agent in Nashville, Tennessee (Mike Elkins; 615/736-5532). Care should be taken in handling sick or injured specimens to ensure effective treatment and care and in handling dead specimens to preserve biological materials in the best possible state for later analysis of cause of death. In conjunction with the care of sick or injured endangered species or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence intrinsic to the specimen is not unnecessarily disturbed.

If, during the course of the action, incidental take occurs as a result of plant operation, NRC should contact the Cookeville Office to determine if reinitiation of consultation is needed. If it is determined that further consultation is needed and that the impact of additional taking will cause an irreversible and adverse impact on the species, as per Section 402.14(i) (50 CFR), plant operations must be stopped in the interim period between the initiation and completion of the new consultation. The Nuclear Regulatory Commission or Tennessee Valley Authority should provide an explanation of the causes of the taking.

H. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Endangered Species Act states that "All other Federal agencies shall, in consultation with and with the assistance of the Secretary [of Interior], carry out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act." We believe that this provision of the Act places an obligation on all Federal agencies to implement positive programs to benefit listed species. A number of recent court cases appear to support that belief. Agencies have some discretion in choosing conservation programs, but Section 7(a)(1) places a mandate on agencies to implement some type of programs. And although candidate species are not legally protected by the Endangered Species Act, provisions of Section 4(B)(3) of the

Act (1988 amendments) direct the Service to monitor the status of those species and to conduct "pre-listing recovery actions." In keeping with the intent of Sections 7(a)(1) and 4(B)(3), the Service recommends that the Nuclear Regulatory Commission and/or Tennessee Valley Authority implement the following measures, or other measures of their choosing, to promote the conservation of the listed species involved in this consultation, and the candidate species included in the biological assessment:

1. NRC and TVA should initiate an active program to conduct, or become cooperators (e.g., provide research funds) in research to develop techniques for cryopreservation of freshwater mussels. Because of the magnitude of threats to this faunal group, successful cryopreservation of adult mussels, juveniles, glochidia, or gametes may be the only means of preserving mussels, particularly large-river species, for future reintroduction. A recent Service-funded study investigated the feasibility of cryopreservation, but did not successfully achieve development of techniques for long-term preservation.

2. NRC and TVA should initiate an active program to conduct research, or become cooperators (e.g., provide research funds) in other ongoing research, regarding artificial propagation of freshwater mussels. TVA has been directly involved in such research in the past and still has the facilities and expertise to resume such an effort. Successful propagation of mussels would be of great benefit in that it would provide stocks of mussels that could be used for augmenting existing mussel populations, reestablishing populations in areas that have recovered from past degradations, or for cryopreservation. Given the rarity of some of the listed mussel species and the high potential for loss of the native large-river mussel fauna resulting from invasion of the exotic zebra mussel, maintenance of stocks of these species may be the only means of preserving and recovering this unique fauna.

3. NRC and TVA should provide funds for the construction, operation, and maintenance of a facility to hold and rear freshwater mussels. The facility could consist of raceways with a flow-through system using river water, or it could be a series of shallow ponds. This facility would serve as a refuge for native large-river mussels, including endangered species. Mussels brought to this facility should be used to conduct research for propagation, rearing, cryopreservation, and to provide a stock of mussels for reintroduction into rivers in the future. The facility could ultimately be used as a hatchery and refuge for large-river mussels throughout

the Tennessee and Cumberland River drainages. A prime consideration in construction and operation of the facility would be to ensure that it remains free of zebra mussels. This would be accomplished by incorporation of adequate filtration of river water, quarantine of mussels brought in, and other means.

4. NRC and TVA should conduct, or become cooperators (e.g., provide research funds) in ongoing studies regarding, long-term research to determine the best means of transplanting freshwater mussels. Past efforts in this area have met with variable success with regard to survival of transplanted mussels. In addition, there is a virtual lack of information regarding growth and reproduction of transplanted mussels.

5. NRC and TVA should conduct, or become cooperators (e.g., provide research funds) in ongoing research regarding, life history studies on Tennessee River mussel species, including endangered species. Of the over 100 species that historically existed in the Tennessee River drainage, only 40-50 species remain. Detailed life history information is available for less than 15 percent of those species. Basic life history information is critical to successful recovery of endangered species and management of all remaining mussel species. Studies should examine, among other things, various aspects of the life cycle, including growth, reproduction, fish hosts, and habitat requirements (physical, chemical, etc.). These studies should also attempt to determine the sensitivity and/or susceptibility of various species to disturbance of their habitat. Some species (e.g., species in the genus Epioblasma) appear to be declining throughout their ranges while others inhabiting the same rivers and streams remain stable (John Jenkinson, TVA, personal communication). This may indicate that certain species are sensitive to even minor disturbances to the habitat or changes in water quality. Results of these studies should be published in appropriate scientific journals and disseminated to appropriate agency and university personnel.

6. NRC and TVA should develop an educational program (e.g., audio/visual presentation, pamphlets, brochures, teaching aids, etc.) that could be distributed or made available to area schools and organizations. The program should describe the fauna and flora found in the eastern portion of the Tennessee River Valley, the changes in the flora and fauna from historic times to the present, endangered

and threatened plants and animals, unique habitats and the wildlife and plants that utilize those habitats, and the importance of protecting this unique flora and fauna.

In order for the Service to be kept informed of actions that either minimize or avoid adverse effects or benefit listed species or their habitats, the Service requests notification of the implementation of the above-listed conservation recommendations or any other conservation measures implemented by your agency in conjunction with the proposed project.

I. CONCLUSION

This concludes formal consultation between the Service and NRC for the operation of the Watts Bar Nuclear Plant. Consultation should be reinitiated if: (1) incidental take of listed species resulting from plant operation occurs and it is determined (through discussions with the Service) that additional take would have irreversible adverse effects on the species, (2) new information reveals that the proposed project may affect listed species in a manner or to an extent not previously considered, (3) the proposed project is subsequently modified to include activities which were not considered during this consultation, or (4) new species are listed or critical habitat designated that might be affected by the proposed project.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 11, 1995

Dr. Lee A. Barclay, Supervisor
Ecological Services Field Office
U.S. Fish and Wildlife Service
446 Neal Street
Cookeville, TN 38501

Dear Dr. Barclay:

Thank you for the Biological Opinion, prepared by the Fish and Wildlife Service (Service) and transmitted to the NRC by letter dated March 8, 1995. The Biological Opinion concluded that operation of the Watts Bar Nuclear Plant (WBN) is not likely to jeopardize the continued existence of the seven Federally listed endangered and threatened species of concern. The purpose of this letter is to inform you of how the NRC intends to implement the "Terms and Conditions" included in Section G of the Biological Opinion.

Section G, "Incidental Take," includes subsections captioned "Reasonable and Prudent Measures" and "Terms and Conditions," which contain terms and conditions that implement the "reasonable and prudent measures." Several items in your "terms and conditions" are covered by the National Pollution Discharge Elimination System (NPDES) permit. Our regulations in Section 50.54(aa) of Title 10 of the Code of Federal Regulations (10 CFR 50.54(aa)) state that "whether stated therein or not, every license issued shall be subject to all conditions deemed imposed as a matter of law by Sections 401(a)(2) and 401(d) of the Federal Water Pollution Control Act, as amended (33 USCA 1341(a)(2) and (d))." Further, the staff has incorporated, as appropriate, other sections of the terms and conditions that are not included in the NPDES permit into the draft Environmental Protection Plan (EPP), which is Appendix B of the WBN Unit 1 operating license. Appendix B is in draft form and will not become final until issued as a part of the license for WBN Unit 1. Upon your request, the NRC will provide you with a copy of the draft EPP.

The draft EPP requires the Tennessee Valley Authority (TVA) to notify the Service of any unusual or important event resulting in the taking of or possible adverse impact on any species protected by the Endangered Species Act of 1973. The draft EPP also requires that TVA provide annually to the Service the Environmental Operating Report which will include a summary of the results from NPDES-required monitoring. The remaining terms and conditions not included in the EPP or the NPDES permit are governed by other NRC regulations or required monitoring programs.

Dr. L. Barclay - 2 -

If you have any questions, please contact the Environmental Project Manager, Scott Flanders, at (301) 415-1172.

Sincerely,

William T. Russell, Director
Office of Nuclear Reactor Regulation

cc: See next page

FORM 335 U.S. NUCLEAR REGULATORY COMMISSION

A 1102, 3202

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC. Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-0498 Supp. 1

TLE AND SUBTITLE

.nal Environmental Statement Related to the Operation of
.tts Bar Nuclear Plant, Units 1 and 2

3. DATE REPORT PUBLISHED

MONTH	YEAR
April	1995

4. FIN OR GRANT NUMBER

ITHOR(S)

6. TYPE OF REPORT

7. PERIOD COVERED *(Inclusive Dates)*

RFORMING ORGANIZATION – NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide ne and mailing address.)*

;sociate Director of Advanced Reactors and License Renewal
:fice of Nuclear Reactor Regulation
S. Nuclear Regulatory Commission
ıshington, DC 20555-0001

DNSORING ORGANIZATION – NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, ' mailing address.)*

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JPPLEMENTARY NOTES

›cket Nos. 50-390 and 50-391

BSTRACT *(200 words or less)* The Final Environmental Statement (FES) issued in 1978 represents the ıclear Regulatory Commission's (NRC's) previous environmental review related to the ›eration of Watts Bar Nuclear (WBN) Plant. The purpose of this NRC review is to dis-ıss the effects of observed changes in environment and to evaluate the changes in en-.ronmental impacts that have occurred as a result of changes in the WBN Plant design ıd proposed methods of operations since the last environmental review. A full scope : environmental topics has been evaluated, including regional demography, land and ıter use, meteorology, terrestrial and aquatic ecology, radiological and nonradiologi-ıl impacts on humans and the environment, socioeconomic impacts, and environmental ıstice. The staff concluded that there are no significant changes in the environmental ıpacts since the NRC 1978 FES-OL from changes in plant design, proposed methods of ›eration, or changes in the environment. The applicant's preoperational and operation-. monitoring programs were reviewed and found to be appropriate for establishing base-.ne conditions and ongoing assessments of environmental impacts. The staff also con-ıcted an analysis of plant operation with severe accident mitigation design alterna-.ves (SAMDAs) and concluded that none of the SAMDAs, beyond the three procedural ıanges that the applicant committed to implement, would be cost-beneficial for further .tigating environmental impacts.

:Y WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

ıtts Bar Nuclear Plant
ıpplemental Environmental Statement

13. AVAILABILITY STATEMENT

Unlimited

14. SECURITY CLASSIFICATION

(This Page) Unclassified

(This Report) Unclassified

15. NUMBER OF PAGES

16. PRICE

ORM 335 (2-89)

Printed on recycled paper

Federal Recycling Program