TENNESSEE VALLEY AUTHORITY

SUPPLEMENTAL ENVIRONMENTAL REVIEW

FINAL

OPERATION OF WATTS BAR NUCLEAR PLANT

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EXECUTIVE SUMMARY

The Tennessee Valley Authority (TVA) expects to load fuel at its Watts Bar Nuclear Plant (WBN) Unit 1 in 1995 and begin commercial operation in 1996. In August 1970, TVA proposed to construct and operate WBN in order to meet forecasted power needs in the TVA region. In accordance with the requirements of the National Environmental Policy Act, TVA issued an environmental impact statement (EIS) in November 1972, which addressed the need for and the potential environmental consequences of constructing and operating WBN. In the Final EIS, TVA concluded that the environmental consequences were acceptable and that:

> *...the overall benefits of the project far outweigh the monetary and environmental costs, and that the action called for is the construction and operation of the Watts Bar Nuclear Plant.*

The Atomic Energy Commission (AEC), now the Nuclear Regulatory Commission (NRC), relied on TVA's EIS in issuance of a construction permit for WBN. In December 1978, NRC staff prepared a Final Environmental Statement (FES) in support of issuance of an operating license for the plant. The FES updated TVA's 1972 EIS and included supplemental information from 1976 and 1977 reports submitted by TVA. After NRC released its FES, TVA's WBN operations schedule was delayed in order to make safety-related modifications and to respond to changing NRC requirements.

Since 1972, TVA has conducted extensive studies and monitoring programs at the WBN facility. In 1993, an interdisciplinary team of TVA technical experts conducted an extensive review of available environmental information on the project. The team analyzed changes in WBN's design and operation plans and changes in environmental conditions which have occurred since the release of the 1972 EIS. It was concluded that:

> *Changes have occurred since the release of WBN's EIS in 1972. Most of these changes involve design modification or changes in expected operational practices which improve safety or lessen potential environment impacts. Additional information about environmental conditions in the vicinity of WBN has also been developed. None of the changes or new information materially affect impact projections in the EIS.*

TVA provided additional environmental information and analyses to NRC in 1994 and early 1995 to support the preparation of a Supplemental EIS (SEIS). NRC issued this SEIS for public comment in draft in December 1994 and in final in April 1995. Notice of availability of the final SEIS was published in the Federal Register on May 5, 1995 (60 FR 22,389). To avoid duplication and reduce paperwork, TVA has decided to adopt NRC's final SEIS. As indicated by this Supplemental Environmental Review, TVA has determined that the final SEIS is adequate and meets the standards for an SEIS.

This Supplemental Environmental Review also updates TVA's 1993 review, addressing in greater detail those changes which have occurred and environmental information which has become available since release of TVA's 1972 EIS. In addition, this review evaluates the need for electrical power which would be supplied by operating WBN Unit 1 and alternative actions to meet power demand. These issues were raised during the comment period on the final SEIS. Alternatives are: (1) continue with WBN, completing Unit 1; (2) delay WBN Unit 1 and purchase power; and (3) cancel WBN Unit 1 and purchase power.

TVA has determined that additional environmental studies and reviews support the conclusions of the 1972 EIS regarding environmental impacts of WBN, that WBN Unit 1 is needed by 1995-96 to meet power needs of the region, and completing and operating WBN Unit 1 is both the most cost effective and environmentally preferred alternative available.

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Abbreviations/Acronyms

AEC	Atomic Energy Commission
AFBC	atmospheric fluidized bed combustion
AI	autotrophic index
BAE	boric acid evaporators
BCDMH	1-bromo-3-chloro-5, 5-dimethylhydantoin
BFN	Browns Ferry Nuclear
BRS	boron recovery system
CDWE	condensate demineralizer waste evaporator
CFR	Code of Federal Regulations
CPDS	condensate polisher demineralizer system
DAW	dry active waste
DGH	dodecylguanidine hydrochloride
DRI	Data Resources Incorporated
DSM	demand-side management
E&T	endangered or threatened
EDS	environmental data station
EDTA	ethylene diamine tetra acetic
EIS	Environmental Impact Statement
EMF	electromagnetic fields
EPA	Environmental Protection Agency
ETA	ethanolamine
FEIS	Final Environmental Impact Statement
FES	Final Environmental Statement
FSAR	Final Safety Analysis Report
FWS	Fish and Wildlife Service
GDP	gross domestic product
GRP	gross regional product
GWPS	gaseous waste processing system
HVAC	heating, ventilating, and air conditioning
IPE	individual plant examination
IPEE	individual plant examination for external events
IPP	independent power producer
IRP	integrated resource planning

LVWTP	low-volume waste treatment pond
MIC	microbiologically induced corrosion
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
NRC	Nuclear Regulatory Commission
ODCM	Offsite Dose Calculation Manual
PCB	polychlorinated biphenyl
PGA	peak ground acceleration
PWR	pressurized water reactor
QUAT	n-alkyl dimethyl benzyl ammonium chloride
SAMDA	severe accident mitigation design alternative
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historical Preservation Office
SPCC	spill prevention control and countermeasure
SQN	Sequoyah Nuclear
TBSS	turbine building station sump
TRM	Tennessee River Mile
TVA	Tennessee Valley Authority
WAW	wet active waste
WBN	Watts Bar Nuclear
WET	whole effluent toxicity
WPS	waste processing system
YHP	yard holding pool

OPERATION OF WATTS BAR NUCLEAR PLANT SUPPLEMENTAL ENVIRONMENTAL REVIEW

1.0 Purpose and Need for WBN Unit 1

1.1 Introduction

The Tennessee Valley Authority (TVA) expects to load fuel at its Watts Bar Nuclear Plant (WBN) Unit 1 in 1995 and begin commercial operation in 1996. In 1970, TVA proposed to construct and operate WBN. TVA released a final environmental impact statement (EIS) in 1972 that identified the need for the proposed project and potential environmental consequences of its construction and operation. Construction of WBN Unit 1 is essentially complete and includes design modifications which further reduce environmental impacts of plant operations and resolve safety issues. TVA has determined that to meet the increasing need for electric power in the TVA region, WBN Unit 1 should begin commercial operation in 1996 and that the conclusions in the 1972 EIS about potential impacts associated with Unit 1 operation remain valid.

NRC issued a supplement to its 1978 EIS on operation of WBN in April 1995. This Final SEIS is entitled, "Final Environmental Statement related to the operation of Watts Bar Nuclear Plant Units 1 and 2, Supplement No. 1." TVA provided information and data to NRC during the preparation of the SEIS. TVA has reviewed the SEIS and has determined that it meets the standards for an adequate supplement.

1.1.1 Location of Facility

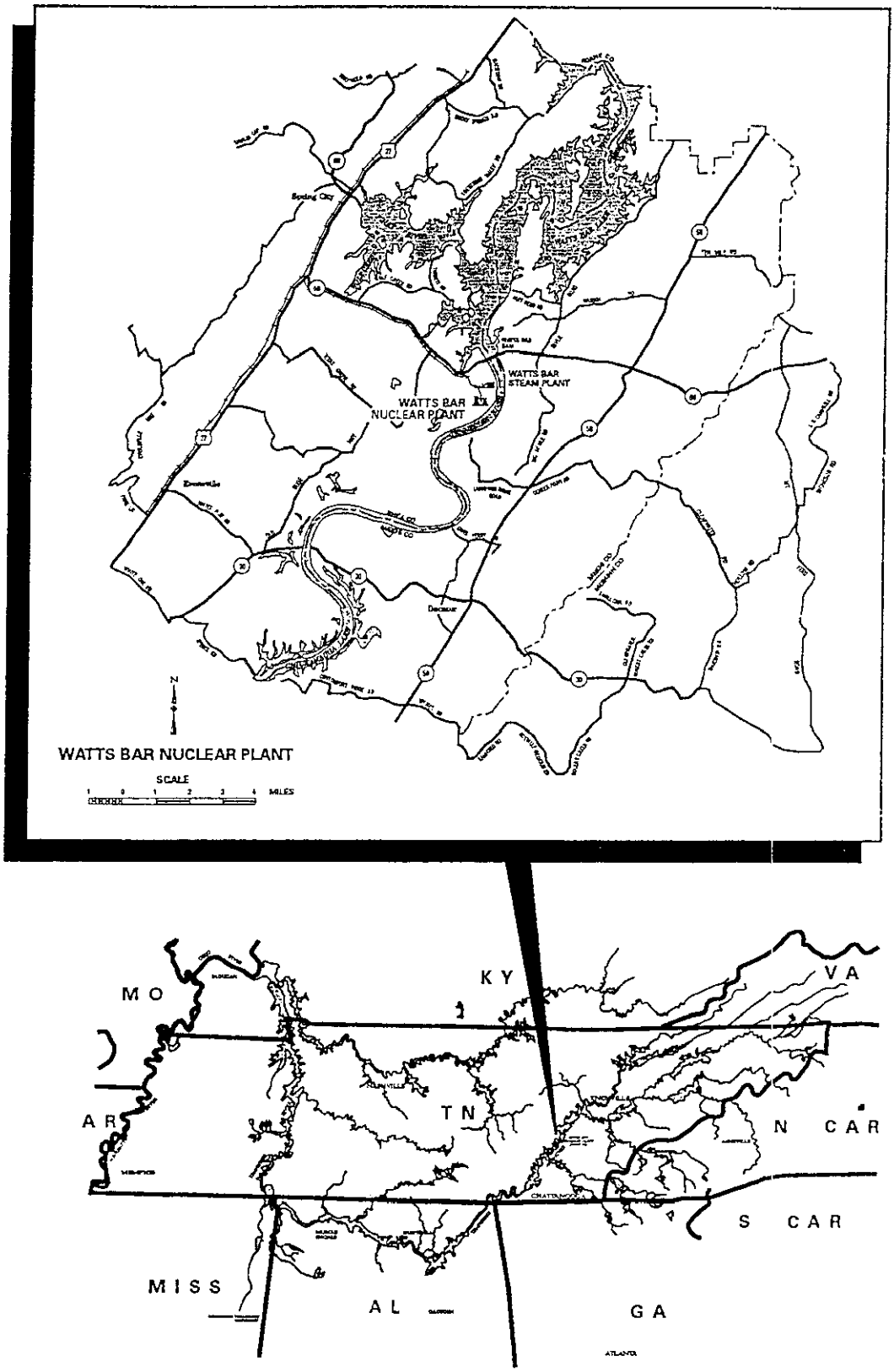
As described in the 1972 EIS and 1995 SEIS, TVA's WBN is located in Rhea County, Tennessee, approximately 13 kilometers (8 miles) southeast of Spring City, Tennessee, and 80 kilometers (50 miles) northeast of Chattanooga, Tennessee. The site is located adjacent to the TVA Watts Bar Dam Reservation at Tennessee River Mile (TRM) 528 on the west shore of Chickamauga Lake. The Watts Bar Reservation and an additional 387 hectares (967 acres) of required land, comprise the 708 hectares (1,770 acre) facility site. An additional 803 hectares (2,008 acres) of land is utilized for transmission line corridors and switchyard. Figure 1-1 of this review shows the facility location within the Tennessee Valley region and its proximity to towns, rivers, and county boundaries. SEIS Figure 1-1 also shows the location of the plant with different details.

1.1.2 Physical Characteristics of Facility

WBN site facilities have essentially been developed as planned in the 1972 EIS with the exception of an added visitor's center and training facility. WBN is a two unit

Figure 1-1

Vicinity map of the Watts Bar Nuclear Plant area, Rhea County, Tennessee



pressurized water reactor (PWR) nuclear plant with a total nameplate electrical generating capacity of 2,540 megawatts (MW). Principal plant structures include: two reactor containment buildings, diesel generator building, turbine building, service building, intake pumping station, water treatment plant, two cooling towers, transformer yard, 500-kV and 161-kV switchyard, sewage treatment plant, and associated parking facilities. The visitors center originally was to include an overlook and a freestanding visitors lobby. It is now part of the training center. Figure 1-2 shows a layout of plant structures. Section 4.0 provides more details about the plant design changes.

1.2 Background

The National Environmental Policy Act (NEPA), which became law on January 1, 1970, requires all federal agencies to consider the potentially significant environmental impacts of major federal actions which they propose to take or approve. As a federal agency, TVA is required to comply with NEPA. Consistent with NEPA and its internal policies, TVA has evaluated the environmental consequences of constructing and operating WBN.

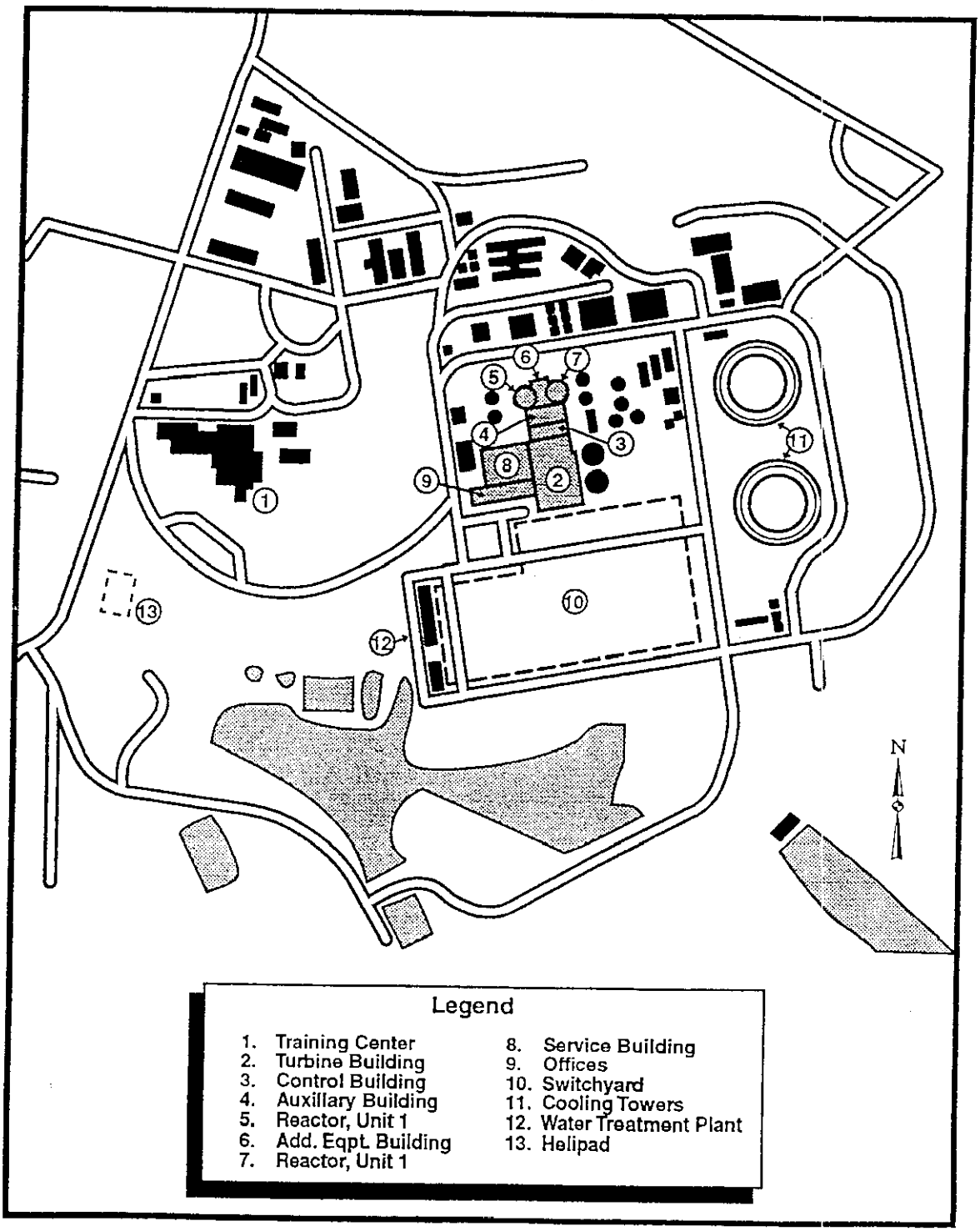
In August 1970, TVA proposed to construct and operate WBN to meet the increasing demand for electricity in the TVA region. Under NEPA, TVA evaluated the need and environmental effects of constructing and operating WBN. Study results were issued for public review and comment on May 14, 1971 in a *Draft Environmental Statement, Watts Bar Nuclear Units 1 and 2.* On November 9, 1972, TVA released the final EIS which included responses to public comments. On January 23, 1973, the Atomic Energy Commission (AEC), now the Nuclear Regulatory Commission (NRC), issued TVA Construction Permit Nos. CPPR-91 and CPPR-92 for the two WBN units. AEC relied on TVA's EIS for its actions to comply with NEPA. TVA commenced construction of WBN in the Spring of 1973.

In 1976, TVA applied to NRC for licenses to operate WBN. On November 18, 1976, as part of its application, TVA submitted to NRC an updated report entitled *Environmental Information Statement.* TVA supplemented the information described in the report on May 9, 1977 in response to specific questions asked by NRC staff. NRC conducted an independent environmental evaluation of WBN and issued for public comment a draft environmental statement in June 1978. NRC released a *Final Environmental Statement* (FES) in December 1978 to support issuance of operating licenses to the two WBN units.

During NRC's operating license review, construction of WBN Unit 1 was 85 percent complete and Unit 2 was 65 percent complete. TVA's proposed fuel loading dates for Units 1 and 2 were December 1979 and September 1980, respectively. However, licensing of the plant was delayed and the construction permits for WBN were extended. The delay was due in part to installation of NRC-mandated modifications applicable to most nuclear plants following the 1979 accident at Three Mile Island. A number of WBN-specific safety concerns also had to be addressed.

Figure 1-2

Watts Bar Nuclear Plant Layout



The need for power also varied substantially from that projected in the early 1970s. Following the Arab-oil embargo, energy consumption in the United States, including the TVA region, was much less than earlier consumption trends indicated.

TVA now projects a fuel loading date for Unit 1 in Fall 1995 with commercial generation to begin in Spring 1996. Construction of Unit 2 remains about 65 percent complete. Alternatives to Unit 2 are being reevaluated as part of an integrated resource planning process (IRP) being conducted by TVA. The IRP is a comprehensive evaluation of future demands for electric energy in the TVA region through the year 2020. TVA is also preparing an EIS in concert with the IRP. The IRP began in February 1994 and is scheduled to be completed in December 1995. In December 1994, the TVA Board announced that based on interim IRP data and analyses, it was expected that TVA would not by itself complete WBN Unit 2. In the event that WBN Unit 2 is canceled and not converted to some other generating technology, potential impacts described in this and other environmental reviews would be less.

In 1993, TVA initiated an interdisciplinary environmental review of WBN. The purpose of the review was to determine if there were any new, significant environmental impacts related to WBN that were not addressed in the 1972 EIS. Consistent with commitments in both TVA's EIS and NRC's 1978 FES, TVA conducted a number of preoperational studies and environmental monitoring programs at WBN. Information from those studies, monitoring programs, analyses of possible operational impacts, and other relevant information on environmental effects were reviewed. Review findings were documented in an August 1993 TVA report entitled *Review of Final Environmental Statement, Watts Bar Nuclear Plant Units 1 and 2.* The report was provided to NRC in May 1994 and to members of the public who requested it. TVA's 1993 review concluded that there were no new, significant environmental impacts.

In June and September 1994, NRC staff requested additional information from TVA on expected plant operations and potential environmental impacts. TVA responded to NRC's requests in reports entitled *Additional Environmental Information Watts Bar Nuclear Plant* issued in August and September 1994, respectively. NRC staff conducted site audits on July 27 and September 12-13, 1994, to collect additional environmental related information. On September 13, 1994, NRC announced at a public meeting near WBN that it intended to issue a formal supplement to its 1978 FES. NRC issued its SEIS for public comment in early December 1994 and the final SEIS in late April 1995. TVA assisted NRC in the preparation of its SEIS by providing environmental information and analyses. At a January 10, 1995 public meeting on the draft SEIS, approximately 16 people provided oral comments. Approximately 27 written comments were received.

1.3 Environmental Approvals and Consultations

Following release of TVA's 1972 EIS, permits and approvals necessary for plant construction and operation were obtained and have been renewed as required by applicable regulations. Table 1-1 gives the status of existing WBN environmental permits. Federal and state environmental agencies also conduct periodic inspections to verify that WBN is in compliance with those permits and applicable requirements. In addition, TVA conducts periodic internal audits of WBN to provide further assurance of compliance with applicable environmental regulations and TVA environmental policy.

Table 1-1

Watts Bar Nuclear Plant Environmental Permits

Source	Permit Number	Renewal Date	Expiration Date
NPDES	TN0020168	03/29/98	09/29/98
Stormwater	TNR001343	03/26/97	09/26/97
Paint Shop*	037348P	07/01/97	09/01/97
Cooling Tower 1*	019953P	None	None
Cooling Tower 2*	09954P	None	None
Fuel Oil Tanks*	033969P	07/01/96	09/01/96
Sandblast Shop*	037347P	07/01/97	09/01/97
Lube Oil Tank 1*	029535P	08/01/95	09/01/95
Lube Oil Tank 2*	029536P	08/01/95	09/01/95
Landfill (Fees Only)	721030025	09/01/95	10/01/95
Diesel Gen Uts (Fees Only)	0-610035	02/31/96	03/31/96
Auxiliary Boilers*	035170F	08/01/97	10/01/97
Hazardous Waste (Fees)	2640030035	02/01/96	03/01/96

NPDES=National Pollution Discharge Elimination System
*Air pollution permits

TVA, with assistance from NRC, also prepared a biological assessment which documented the basis for TVA's determination that operation of the plant would have no effect on a number of endangered and threatened species which are known to be located in the vicinity of the plant. The final biological assessment was jointly submitted by TVA and NRC to FWS in October 1994, and appears in Appendix D of the SEIS. FWS concurred with TVA's determination that operation of WBN would not likely affect any endangered or threatened species in a November 21, 1994 letter and in a March 8, 1995 biological opinion. A copy of FWS's biological opinion also appears in Appendix D of the SEIS.

1.4 Electric Power Supply and Demand

One of the issues raised by several individuals commenting on the SEIS is the need for WBN Unit 1. Under NRC's NEPA regulations, it does not generally address the need for a nuclear plant in a supplement at the final licensing stage. Accordingly, NRC directed those with such comments to TVA. This section of this review explains how TVA determines need for power and why WBN Unit 1 is needed.

It takes many years to plan, permit, and construct new energy sources or to plan and deploy energy conservation (demand-side management or DSM) programs. Thus, years before the demand arises, utilities must make decisions about the energy resource mix it wants on its system to meet that demand. TVA, like most utilities, projects or forecasts the future demand or need for electric power in the region it serves. Determining the future need for power depends on two factors: (1) the capabilities of currently available energy resources and (2) the projection or forecast of future need. If forecasted need exceeds available capabilities, additional energy resources must be obtained for the system--either in the form of additional capacity to produce electricity (new energy generation or purchased power) or in the form of DSM measures which reduce forecasted need to levels capable of being met by current resources.

1.4.1 Power Needs

TVA is the electric supplier to an 80,000 square-mile area containing parts of seven states, including almost all of the State of Tennessee. Almost 7.5 million people live in the TVA region. TVA generates and transmits power to 160 municipalities and rural electric cooperatives (distributors) which in turn distribute this power to most of the industries, businesses, social institutions, and residences in the TVA region. TVA itself provides power directly to 54 large industries and to 10 federal installations.

The TVA power system (its generating facilities and transmission line grid) is interconnected with 13 other utility systems. These systems are interconnected to still other systems. Collectively, TVA and these other systems make up the electric power grid of the Nation. Because of these interconnections, TVA can be, and has been, called upon to provide power to assist other utilities to meet their loads in emergencies. Thus, maintaining a reliable supply of power on the TVA system is important not only to the people of the TVA region, but to other utilities and their customers from the Great Lakes to the Gulf of Mexico and from New England to Oklahoma and Texas.

Electric Power Supply. Until the end of World War II, most of TVA's generating capacity was hydroelectric. Beginning in the late 1940s following the development of most of the suitable hydroelectric sites, TVA began adding coal-fired units to meet the growing demand for electric energy in the region. In the late 1960s, TVA began

developing other forms of generation including nuclear-fueled units to meet baseload demands on the system. Gas combustion turbines and pump-storage units were added to meet increases in peak demands.

Peak demand is the maximum demand made on a utility system and can be met with energy resources deployed (operated) to meet that demand when it arises; there are daily and seasonal peak demands. The energy resources used to meet peak demand are typically referred to as *peaking* units. Normal demand (the load which typically exists) is usually met with units which are operated continuously except for periods when they are taken out of service for maintenance, repairs, or refueling. These units are generally referred to as *baseload* units.

TVA currently has 25,600 megawatts (MW) of generating capacity, including coal-fired, hydro-electric, nuclear, combustion turbines, and pumped storage hydro. Table 1-2 shows the megawatts of the types of capacity and their percentage to the TVA total. The low operating costs resources--hydro and nuclear--are used to the fullest extent possible. Coal fired capacity, the third lowest in cost, is used according to power system demand. Pumped storage is used to meet peak demand since its energy output is limited by the size of the reservoir, which must be filled with water during non-peak periods when costs are low. Combustion turbine capacity, the most costly, also is used to meet peak demand.

Table 1-2

TVA Total Capacity Mix

Type of Capacity	Megawatts	Percent
Conventional Hydro	4,404	16
Pumped Storage Hydro	1,532	6
Coal	14,743	57
Combustion turbines	1,952	8
Nuclear	3,365	13
Total	25,626	100

Other planned system capacity changes include improvements to hydro-electric facilities and some reductions in capacity for steam sales and scrubber (pollution control) additions at coal-fired plants, as shown in Table 1-3.

Table 1-3

Cumulative Capacity Changes in Megawatts (MW)

Years	Hydro Modernization*	Coal**
1996	69	- 138
1999	219	- 138

* Hydro modernization adds capacity incrementally as units are rehabilitated.
**Coal system losses: 92 MW capacity reduction for Johnsonville steam sale and 46 MW for scrubber additions.

On the demand-side, TVA has in excess of 2500 MW of industrial interruptible power contracts, which allow the agency to interrupt power to industrial customers during peak load periods. This interruptible power is utilized as part of TVA's available capacity; however, due to variations in contracts, not all of the contracted power is available for interruption. Only approximately 1700 MW of industrial load is available for interruption during peak periods.

1.4.2 TVA System Load Forecast

When the WBN FEIS was released in 1972, the demand on the TVA system was increasing approximately seven percent per year. This growth in electricity consumption required that the capacity of TVA's generating resources and transmission system be doubled every 10 years. To meet this need, TVA planned and began implementing an extensive program to add more energy resources to the TVA system, including WBN. However, contrary to expectations, energy consumption in the nation and the TVA region substantially changed following the Arab-oil embargo in the mid-1970s. The demand fell drastically compared to projections. Subsequently, TVA and other utilities developed better means of projecting future demands. Current projections are based on state-of the-art forecasting elements which use the best information, methodology, and continuous improvement processes available to evaluate key variables and explicitly treat factors of uncertainty to arrive at accurate forecasts.

Forecast Accuracy. Forecasting future electricity needs is inherently uncertain. However, TVA's load forecast accuracy since 1985 has been within plus or minus five percent over a five-year period as shown in Table 1-4. This is well within the industry standard of plus or minus eight percent accuracy. A 1991 outside review of TVA forecasts by Barakat & Chamberlin, Inc. concluded that: ... *on a comparative basis, TVA's forecasting procedures compare very favorably with the best-practice procedures in the United States utility industry.*

Table 1-4

TVA Five Year Forecast Record

Year Forecast Prepared	Target Year	Forecast Peak (MW)	Actual (MW)	Forecast Error Percent
1983	1988	22,610	20,684	9.3
1984	1989	22,546	21,149	6.6
1985	1990	21,669	21,142	2.5
1986	1991	22,348	21,810	2.5
1987	1992	21,493	22,533	-4.6
1988	1993	23,119	23,354	-1.0
Average Absolute Error				4.4

Load Forecast Uncertainty. A load forecast has a level of uncertainty because it is difficult to predict the future value of the key variables which determine the level of future electricity consumption. These variables are:

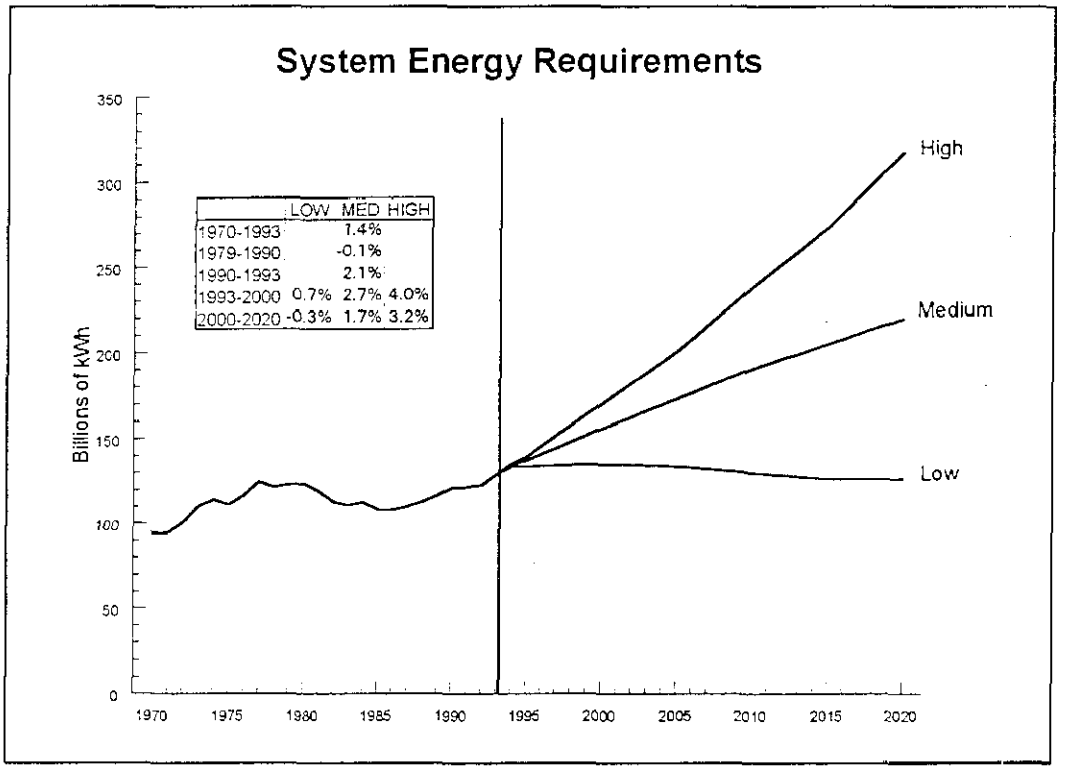
1. Economic Activity
2. Price of Electricity
3. Competitive Success
4. Directly Served Load
5. Price of Substitute Fuels

TVA produces a high-, medium-, and low-load forecast as a means of presenting the effects of these uncertainties. For the range of forecasts, probabilities are assigned to the high, medium, and low forecasts. For the high forecast it is assumed that there is

a 90 percent probability (9 out of 10 chances) that demand will be less than the forecast. For the medium forecast, the probability is 50 percent and for the low forecast the probability is 10 percent.

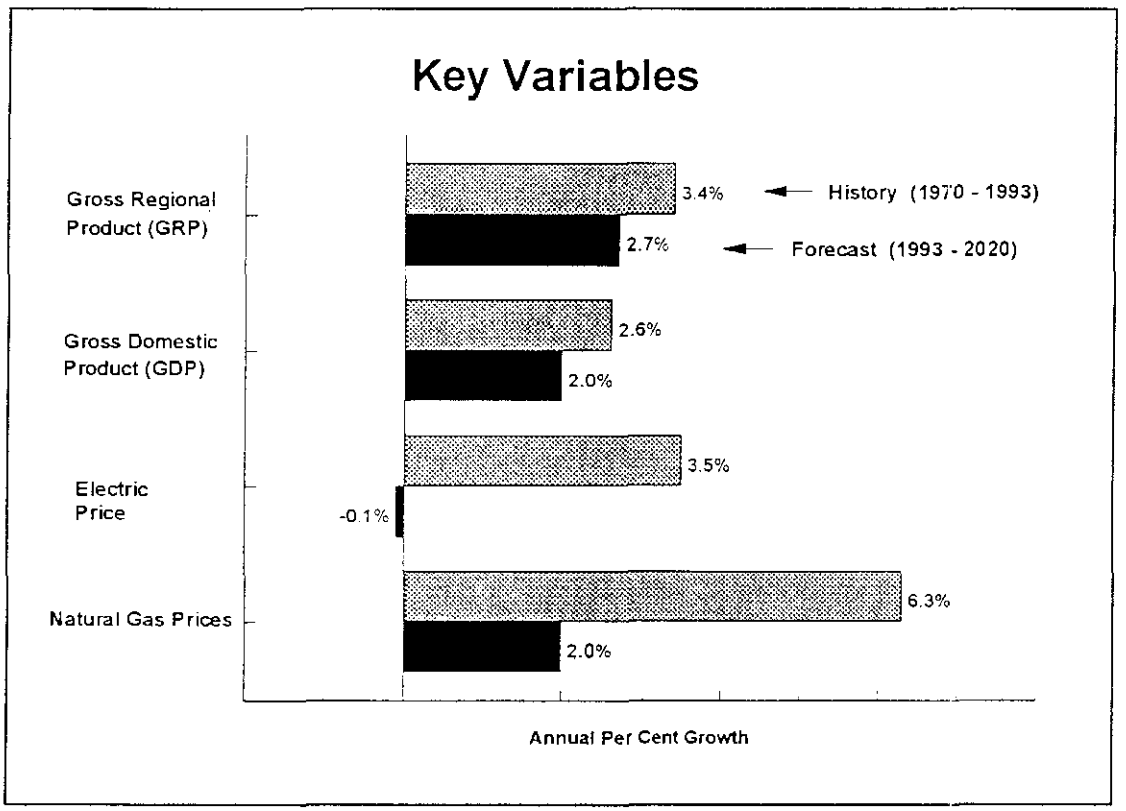
The high, medium, and low forecasts for system energy are shown in Figure 1-3. *System energy* is the total energy or electricity which the TVA system must produce to meet demand over the year. In the high forecast, system energy grows at a rate of 4 percent a year from 1993-2000 and 3.2 percent from 2000-2020, with system energy of 172 billion kWh in 2000 and 320 billion kWh in 2020. In the medium forecast, system energy is expected to grow at a 2.7 percent annual rate until 2000; from 2000 to 2020, energy requirements increase by 1.7 percent annually with system energy of 155.5 billion kWh in 2000 and 219.6 billion kWh in 2020. The growth rates for the low forecast are 0.7 percent from 1993-2000 and -0.3 percent from 2000-2020 and the energy requirements are 138 billion kWh for 2000 and 129 billion kWh for 2020.

Figure 1-3



Key Variables. TVA's forecast of electric energy requirements is driven by forecasts of key variables which influence electricity use. These variables include regional economic growth, the price of electricity, the price of substitute fuels, and TVA's competitive success. A summary of historical and forecast growth rates for the key variables is shown in Figure 1-4. The historical growth rates are shown for 1970 to 1993 and the forecast growth rates are shown for 1993 to 2020.

Figure 1-4



TVA produces its own forecasts of regional economic activity. These forecasts are derived from forecasts of the national economy by Data Resources Incorporated (DRI), an internationally recognized forecasting service. This service forecasts the Nation's Gross Domestic Product (GDP) to increase by 2.0 percent per year through 2020 compared to historical growth of 2.6 percent from 1979 to 1993.

TVA's regional forecasting model uses data and trends from the national forecast, allowing for differences inherent in the region's economic structure. The most likely scenario is for the region to continue to outperform the nation. Gross Regional Product (GRP) is forecast to grow 2.7 percent annually from 1993 to 2020.

TVA has not increased electric rates since 1987 and is committed to no rate increases through 1997. This has been achieved through a combination of efforts including controlling costs, refinancing debt, and efficiency improvements. Holding rates constant is expected to continue to have a positive impact on electricity sales.

The wholesale price of electricity in real terms (excluding inflation) is expected to decline 0.1 percent per year from 1993-2020 compared to an historical increase of 3.5 percent per year from 1970-1993.

The potential for substitution between electricity and fossil fuels, primarily oil and natural gas, will depend on relative prices and technological factors. Natural gas prices compared to electricity prices will be the major factor in determining the impacts of other fuels on the range of load forecasts. Natural gas prices, in real terms, are forecast to increase at 2.0 percent from 1993-2020 compared to an historical increase of 6.3 percent per year for 1970-1993.

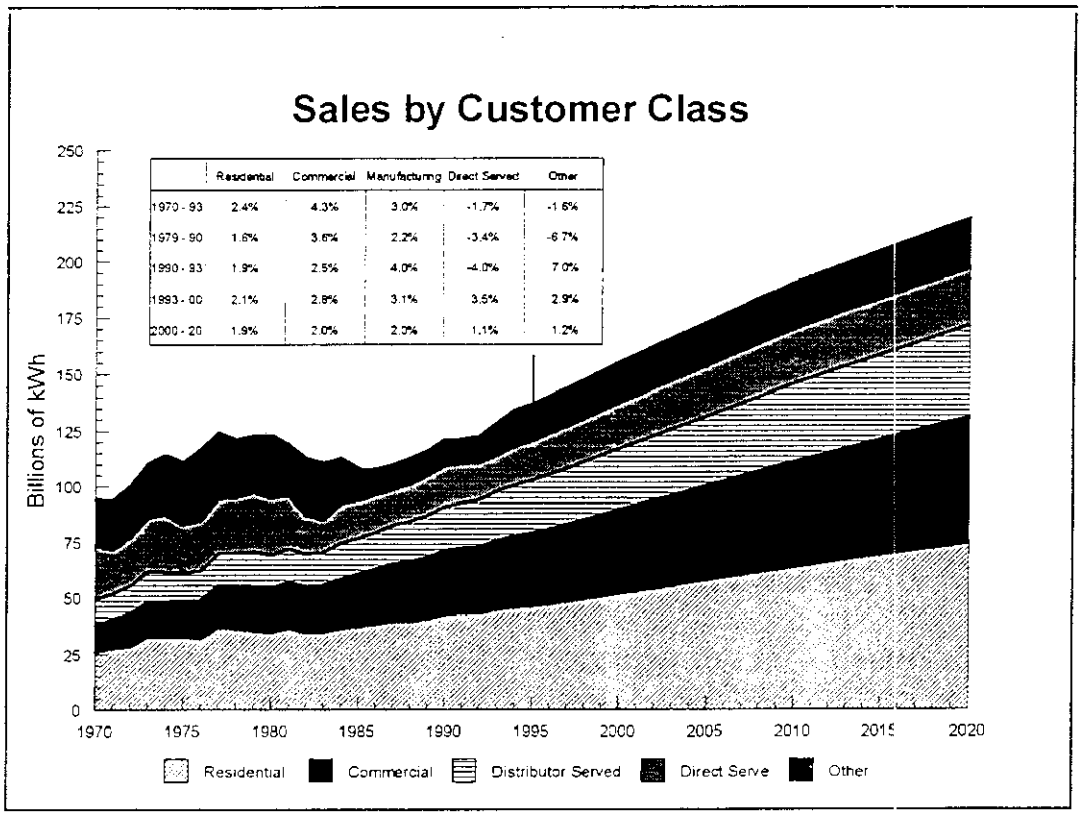
Competition is growing in the electric utility industry. Regulators are opening markets and allowing some customers to change to lower cost providers. This increases the amount of uncertainty in the forecast. In the medium forecast, the effects of competition result in a balance of potential gains or losses in sales. Increased competition increases load forecast uncertainty.

Energy Forecasts. The major components of system energy are sales to three major customer groups: residential customers, commercial customers, and manufacturing customers. To these sales, certain miscellaneous sales and the loss of energy on the transmission and distribution systems are added to produce the system energy forecast.

The residential forecasts are influenced by variations in five factors: per capita income, population, residential electric prices, residential gas prices, and appliance efficiencies. The long-term sales forecast for the residential customer class is shown in Figure 1-5. In the medium forecast, residential sales are forecast to be 51.4 billion kWh in 2000, and 74.3 billion kWh in 2020. Corresponding growth rates are 2.1 percent per year from 1993 and 2000 and 1.9 percent per year from 2000-2020.

Commercial sector sales are driven by economic activity, the price of electricity, the price of natural gas, and efficiency improvements. The long-term sales forecast for the commercial customer class is shown in Figure 1-5. In the medium forecast, commercial kWh sales are expected to be 38.2 billion kWh in 2000 and 56.4 billion kWh in 2020. Corresponding growth rates are 2.8 percent per year from 1993 to 2000 and 2.0 percent per year from 2000-2020.

Figure 1-5



	Residential	Commercial	Manufacturing	Direct Served	Other
1970 - 93	2.4%	4.3%	3.0%	-1.7%	-1.6%
1979 - 90	1.6%	3.6%	2.2%	-3.4%	-6.7%
1990 - 93	1.9%	2.5%	4.0%	-4.0%	7.0%
1993 - 00	2.1%	2.8%	3.1%	3.5%	2.9%
2000 - 20	1.9%	2.0%	2.0%	1.1%	1.2%

Manufacturing sales are influenced by five major factors: economic activity, price of electricity, price of natural gas, efficiency improvements, and technology. The manufacturing sector is particularly important to TVA because the Valley economy is more dependent on manufacturing than the U.S. as a whole. In 1993, manufacturing accounted for 19 percent of the Nation's Gross Domestic Product while it accounted for 29 percent of the Gross Regional Product. While the United States, as a whole, has been experiencing declining growth rates in industrial output, the TVA region has not.

The forecast of manufacturing sales is divided into sales to industrial customers served by distributors and to directly served industries sales. Industrial sales by distributors have increased steadily and are expected to continue to increase. In the medium forecast, sales are expected to increase 3.1 percent per year from 1993-2020 and 2.0 percent per year from 2000-2020. The forecast for the directly served industries is built up on a company-by-company basis. In the long-term medium forecast, shown in Figure 4, total energy sales for directly served industries are expected to increase from 16.2 billion kWh in 1993 to 20.5 billion kWh in 2000 and

to 24.8 billion kWh in 2020. Corresponding growth rates are 3.5 percent per year from 1993-2000 and 1.1 percent per year from 2000 to 2020.

Reserve Margin. The major factor in projecting the need for capacity is the peak load forecast, but capacity is also needed to provide a reserve margin sufficient to maintain power system reliability. TVA's projection of the necessary or desired reserve margins (desired capacity minus peak load) is based on extensive evaluation of the costs of system reliability, the performance of the TVA system, and the performance of other power systems.

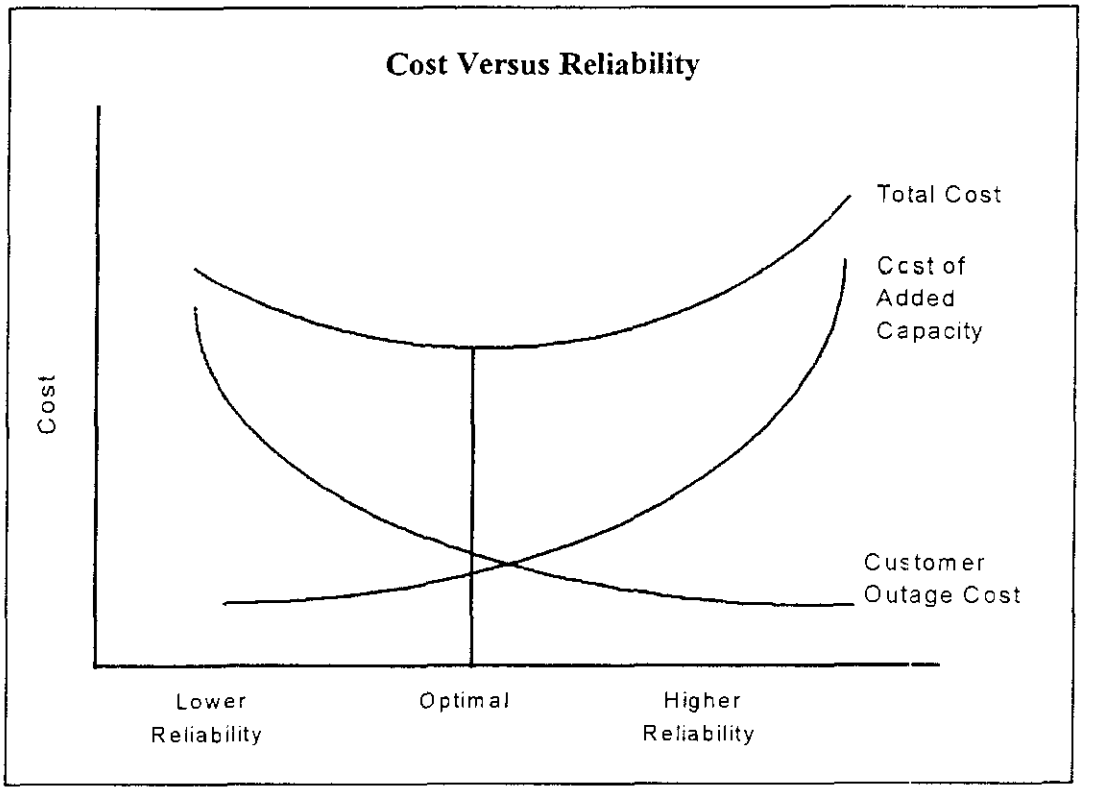
Power system reliability is determined by the ability of the system to withstand sudden equipment failure by generation or transmission facilities and changes in load caused by temperature variations or customer equipment failures. Poor reliability can result in interruptions of electric service or load to customers by uncontrolled or controlled rotating blackouts.

In general, it is not possible to have a power system that is 100 percent reliable. There is always some probability that an equipment failure or an unforeseen event will cause an interruption or outage to a customer. Reliability can be increased by adding additional capacity, but this increases the cost to customers. Likewise, a decrease in reliability increases the chance of interruption to customers. These interruptions also cost the customer, in terms of lost production from industrial facilities or as an annoyance from the loss of air conditioning on a hot summer afternoon.

Optimum reliability balances the cost of adding new capacity with the cost of outages. This principle is illustrated in Figure 1-6. For the TVA system, optimum reliability is in the range of 10-15 hours per year of outages. The desired or optimum level of reserves (desired capacity minus peak load) is dependent on not only the optimum level of reliability but also on several other factors. These factors include forced outages (equipment failure) at generating plants, maintenance at plants, variation in load due to temperatures, hourly load shapes (daily and seasonal), purchase power availability, emergency procedure and operating reserves.

TVA uses a standard reliability model to estimate desired reserve margins based on maintaining power system reliability. This model considers key reliability inputs, including plant availability. The projected desired reserve margin is 16 percent in 1995 and 13 percent in 1998 and beyond.

Figure 1-6



Forecasted Needs Results. Current peak demand on the TVA system is approximately 23,000 MW. As stated, because of the inherent uncertainty in forecasting future power needs, TVA produces low, medium, and high projections. Figure 1-7 shows the range of long-term load forecasts with actual demands shown for 1970 to the present. For the medium forecast, peak loads are expected to increase 2.5 percent per year from 1993 to 2000 and then drop to about 2 percent per year from 2000 to 2020. The high- and low-load forecasts show a 3.3 percent and 0.2 percent growth rate, respectively, per year from 1993 to 2020.

Long Term Capacity Requirements and Supply. Figure 1-8 shows the expected capacity surplus/deficit for low, medium, and high projections through 2010. The difference between the supply and capacity requirements indicates the surplus or deficit of capacity. Supply, which is indicated by the solid line, is defined by TVA's current system capacity and additions to capacity as noted in Tables 1-1 and 1-2. This includes WBN Unit 1 and the return to service of Browns Ferry Nuclear (BFN) Unit 3. Capacity requirements represent the annual peak load forecasts plus reserve margins.

Figure 1-7

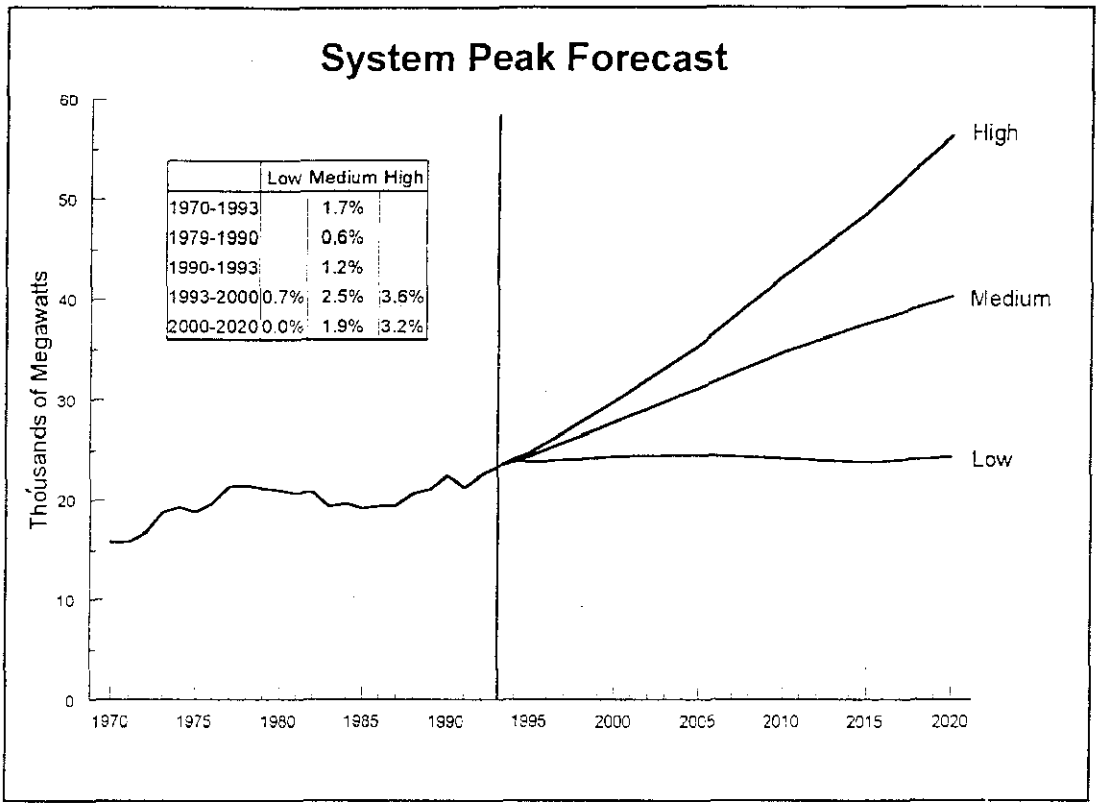
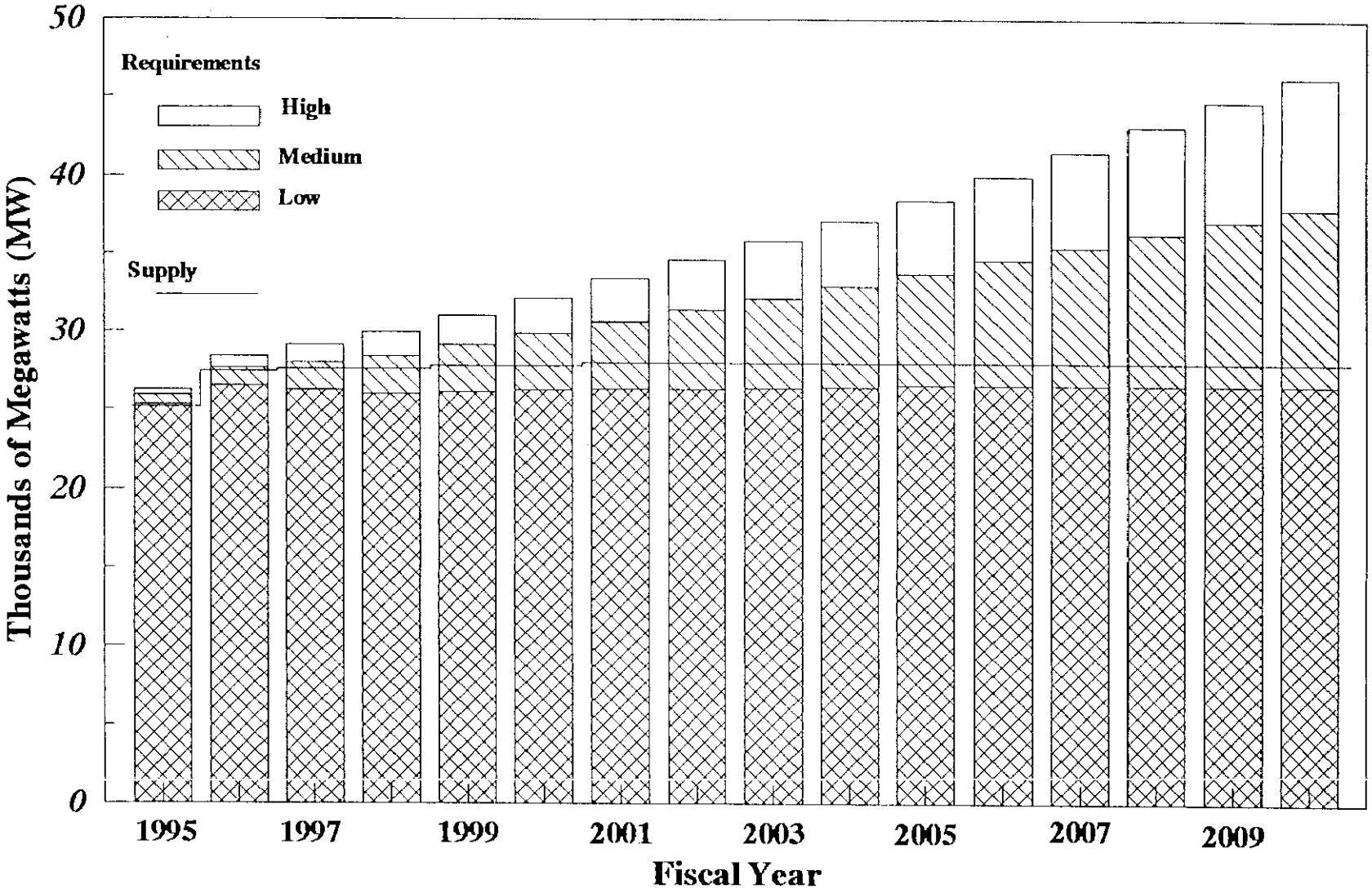


Figure 1-9 shows the capacity situation through 1999 if WBN Unit 1 commenced operation in October 1995 and if TVA did not return BFN Unit 3 to service. TVA would need 850 MW of additional capacity in 1996 based on medium load requirements, available interruptible power, and improvements to the existing TVA existing generating system. The need for additional capacity increases to 2200 MW by 1999. Based on the high load forecast, additional capacity of 1500 MW is needed by 1996. For the low load forecast, TVA would not need additional capacity during the forecast period (2020) with WBN 1 operating. Without the 1170 MW capacity of the WBN Unit 1 available, TVA would need 1700 MW of additional capacity in 1996, increasing to about 3100 MW by 1999 under the medium load forecast (Table 1-5). Table 1-6 shows the capacity situation based on the low- and high-load forecasts. In the high load forecast, additional capacity of 2375 MW would be required by 1996. Under the low-load forecast, additional capacity of about 500 MW would be required by 1996. Tables 1-5 and 1-6 also show the energy consequences of delaying WBN Unit 1 by one year.

Figure 1-8

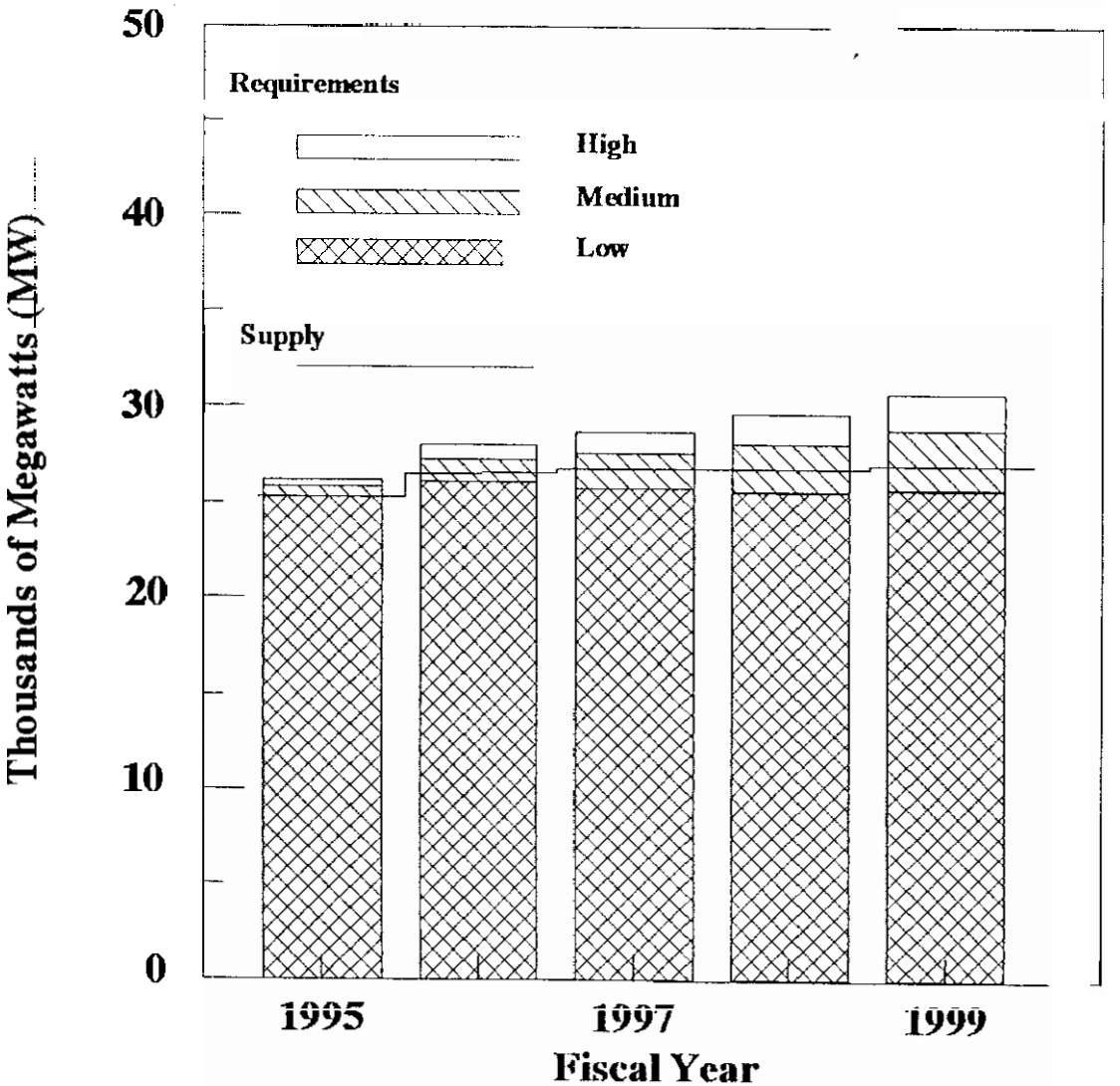
Long Term Capacity Requirements and Supply

High, Medium, & Low Load Forecast



Note: (1) Requirements equal peak load plus desired reserves.
(2) Operate WBN Unit 1 October 1995 and return of BFN Unit 3 to service.

Figure 1-9
Long Term Capacity Requirements and Supply
High, Medium, & Low Load Forecast



Note: (1) Requirements equal peak load plus desired reserves.
(2) Operate WBN Unit 1 in October 1995 and cancel BFN Unit 3.

Table 1-5

Consequences of Delaying Watts Bar Nuclear Plant Unit 1

	With Watts Bar Unit 1 in 10/95	With One Year Delay in Watts Bar Unit 1 to 10/96	Without Watts Bar Unit 1
1996	-850	-1700	-1700
1997	-1075	-1075	-1925
1998	-1525	-1525	-2375
1999	-2225	-2225	-3075

Units in megawatts

Table 1-6

TVA Capacity Situation Based on Low and High Load Forecasts

	High Load Growth			Low Load Growth		
	With WB1 in 10/95	With One Year Delay in WB1 to 10/96	Without WB1	With WB1 in 10/95	With One Year Delay in WB1 to 10/96	Without WB1
1996	-1525	-2375	-2375	325	-525	-525
1997	-2150	-2150	-3000	725	725	-125
1998	-3075	-3075	-3925	925	925	-75
1999	-4125	-4125	-4975	825	825	-25

2.0 Description of Action

TVA expects to operate WBN Unit 1 in accordance with its earlier decision. As explained in section 1.4 above, generation from WBN Unit 1 continues to be needed.

TVA has invested approximately $6.4 billion into constructing Unit 1 and shared facilities at the plant. Since these costs have already been incurred, changing TVA's course of action and deciding not to operate the plant would not avoid these costs. TVA would still have to recover the incurred costs in its power rates. If TVA does not complete the plant, it would have to write-off approximately $200 million to $600 million in costs annually for WBN depending on the period allowed for the write-off. Operating the plant would allow TVA to begin earning a return on agency investment in the form of generation from Unit 1 and allow TVA to recover the costs of building the facility over a longer period of time (40 years versus the traditional write-off period of 10 years).

TVA is scheduled to load fuel in WBN Unit 1 in Fall 1995. Commercial operation is expected to be achieved in Spring 1996.

Alternatives to completion and operation of Unit 2 are being evaluated as part of TVA's Integrated Resources Planning (IRP) process. In February 1994, TVA initiated the IRP process in concert with the preparation of an EIS to evaluate alternative means of meeting the electric energy needs of the TVA region through the year 2020. The EIS on the IRP process will be available for public review and comment in 1995.

3.0 Alternative Actions and Their Impacts

TVA considered a number of alternatives to constructing and operating WBN in its 1972 FEIS. Among those alternatives were construction of coal-fired units, hydroelectric units, gas-fired units, and oil-fired units. These alternatives were either deemed not feasible, more costly, and/or more environmentally detrimental than construction and operation of WBN. TVA also considered purchasing firm power from neighboring utilities. However, TVA projected that neighboring utilities would not be able to supply sufficient firm power to meet its needs and concluded that the environmental impacts of a neighboring utility generating that power would likely be similar to or greater than those impacts associated with operation of WBN.

WBN Unit 1 is now essentially complete and the alternatives available to TVA in light of the status of WBN Unit 1 and the need for the unit are limited. Those alternatives are described below. TVA has determined that completing and operating WBN 1 is both the most cost effective and environmentally preferable alternative available.

3.1 Description of Alternative Actions

TVA has identified and evaluated three alternatives: continue with WBN Unit 1, delay WBN Unit 1 and purchase power, and cancel WBN Unit 1 and purchase power. TVA identified a number of other alternatives but these were dismissed from further consideration as infeasible.

3.1.1 Continue with WBN

Continuing with WBN Unit 1 would involve completing and operating the unit. TVA expects to load fuel in September 1995, after receiving approval from NRC. Commercial operation of the unit is scheduled for Spring 1996. WBN Unit 1 would add 1,170 MW of baseload capacity to the TVA system. Because this alternative involves not changing TVA's current course of action, it would be tantamount to the "No Action Alternative" in an EIS.

3.1.2 Delay WBN Unit 1 and Purchase Power

TVA could delay operating WBN Unit 1 and purchase power from neighboring utilities, independent power producers, or other sources to meet any shortfall in available generation. To ensure that the power is available when needed, TVA would have to purchase it on a firm-power basis. This would involve paying a demand (reservation) charge and a price for the energy itself. Assuming firm power is available from neighboring utilities, TVA could purchase it for a number of years and delay operation of WBN Unit 1 for this period. For purposes of this analysis, TVA assumed that WBN Unit 1 would be delayed only one year; longer delays would have consequences similar to cancellation. While WBN Unit 1 could be delayed, the added cost of power purchases would be borne by TVA ratepayers along with completion

costs of the unit. At the same time, some risk is inherent in depending on other utilities for peak load supply.

Obtaining power from cogenerators and independent power producers has become a common practice in the utility industry. Contracts for outside power are now usually procured through a bidding process. In 1994, TVA requested bids for power on an option basis. If TVA purchased a power option, it would have the right but not the obligation (with a "call" option) to take the power. TVA is evaluating the bids it has received, and the initial results of this evaluation have been factored into this review.

3.1.3 Cancel WBN Unit 1 and Purchase Power

Canceling WBN Unit 1 would require that power be purchased for an extended period of time. As with Alternative 2, the purchase of firm power would require the payment of both a demand charge and an energy price. Assuming it is available, power would have to be purchased until another means of meeting system needs could be deployed.

3.1.4 Non-Viable Alternatives

Constructing another generating source would take a number of years to complete and would result in additional environmental impacts. Table 3-1 identifies alternative generating methods and the time required to implement these alternatives. Those methods which are considered demonstrated and available now include: supercritical pulverized coal, recirculating atmospheric fluidized bed combustion, simple cycle combustion turbines, gas-fired combined cycle turbines, small combined cycle turbines, and compressed air storage. There are other generating methods, but these have not been demonstrated commercially and are not considered available.

Table 3-1

Alternative Generating Methods

GENERATING METHOD	LEAD TIME	EARLIEST OPERATION DATE
Supercritical Pulverized Coal	8 years	2004
Circulating AFBC*	8 years	2004
Simple Cycle Turbine	5 years	2001
Gas-Fired Combined Cycle	5 years	2001
Small Combined Cycle	4.5 years	2000
Compressed Air Storage	10 years	2006
Fuel Cell	4 years	2005
Advanced Battery	3 years	2015
Light Water Reactor	10 years	2008
Co-Gen/Combined Cycle	4 years	2000

* Atmospheric Fluidized Bed Combustion

These generation alternatives could be constructed and operated either by TVA or by an independent power producer (IPP). However, the lead time required to bring on another generating source would not be appreciably faster if an IPP undertook the project. Because of the need for power in 1995, none of these alternative methods of generating power are considered viable.

There are also a large number of energy conservation (demand-side management or DSM) options which could reduce the need for power on the TVA system. These include such things as replacing less-efficient electric heating with electric heat pumps, envelope tightening measures (for example, home insulation programs, energy-efficient standards for new homes, the use of more energy-efficient materials in manufactured homes), the use of more energy-efficient lighting, the use of more energy-efficient appliances, and the use of more energy-efficient motors by industries. Most of these DSM measures have some associated environmental impacts (for example, the disposal of old appliances and lighting waste) but, compared to the construction and operation of new generating sources, their associated impacts would be less.

TVA's analyses indicate that it would take a number of these DSM programs to achieve sufficient energy savings to offset the demand that is intended to be met by operating WBN Unit 1. It also takes from 3 to 5 years to put in place DSM programs and to begin to achieve noticeable energy savings. The combination of sufficient DSM programs to offset WBN Unit 1 is estimated to cost approximately 7.0 cents per kWh which substantially exceeds the cost of completing and operating WBN Unit 1 (about 2.2 cents/kWh). For these reasons, DSM alternatives are not considered viable to meet the near term demand previously described.

3.2 Comparison of Viable Alternatives

TVA has compared the potential environmental and economic consequences associated with the viable alternatives which have been identified. Because of the uncertainties associated with purchasing replacement power for WBN 1, projecting the impacts and costs of purchased power involves some degree of speculation.

3.2.1 Environmental Consequences

The environmental impacts associated with completing and operating WBN 1 are set forth in a number of environmental documents including TVA's 1972 EIS, Chapter 5 of the NRC SEIS, and Chapter 5 of this document. As indicated in these analyses, most of the environmental impacts associated with WBN 1 were expected to occur in connection with the construction of the plant. These impacts have already been experienced. Operating impacts identified in TVA's 1972 EIS include: (1) releases of small quantities of radioactivity to the air and water, (2) release of minor quantities of heat and non-radioactive waste waters to Chickamauga Reservoir and major quantities of heat and water vapor from the plant's cooling towers to the atmosphere,

and (3) the conversion of the site from an agricultural use to an industrial use. These remain the impacts associated with completing and operating WBN 1 and TVA does not consider them to be significant.

The operating impacts associated with operating WBN 1 would be avoided either for the period in which it was delayed or completely if the unit is canceled and power is purchased from other utilities to replace WBN 1's output. However, there would be environmental impacts associated with the generation of power by the utility or other sources from which it is purchased; albeit most of these impacts would be experienced in the vicinity of plants producing the power and not necessarily in the TVA region.

It is very difficult to project the potential environmental impacts of purchasing power because there are a number of different kinds of sources that could be used to provide this power depending on the utility system or sources from which it is obtained. This power could be from TVA's neighboring utilities or those directly connected to its neighbors. With the exception of those utilities on the Gulf Coast (Louisiana Power & Light, Mississippi Power & Light, and Florida Power & Light) generation comes primarily from coal sources with some nuclear and hydro (Table 3-2). Incremental sales from these systems to TVA would likely be from these utilities' coal units with a minimal amount from nuclear, oil, and gas because coal units are the marginal units which are operated to meet intermediate demands.

Table 3-2

Fuel Sources of Tennessee Valley Authority Neighboring Utilities
(Percent Generation, 1993)

COMPANY	COAL	OIL	GAS	NUC	HYDRO	OTHER
Alabama Power	73.7	0.1	0.5	19.2	6.6	
Appalachian Power Co.	96.7	0.3		3.0		
Alabama Power & Light	51.6	0.2	8.9	39.0	0.6	
Big Rivers	99.9	0.1	0.04			
Carolina Power & Light	62.0	0.2	0.1	35.9	1.8	
Duke Power	40.5	0.1	0.1	57.4	1.9	
East Kentucky Power Co.	99.9	0.1				
Florida Power & Light	4.3	40.7	18.0	33.0		4.2
Florida Power Company	52.1	24.7	0.2	23.0		
Georgia Power Company	67.8	0.2	0.1	29.6	2.3	
Gulf Power	98.3	0.2	1.5			
Gulf States	12.4	0.03	64.1	17.5	1.2	4.8
Kentucky Power	99.7	0.3				
Kentucky Utilities	99.5	0.1		0.4		
Louisiana Power & Light		1.0	51.7	47.3		
Louisiana Gas & Electric	97.4	0.2	0.1		2.3	
Mississippi Power & Light	40.4	6.6	53.1			
Ohio Power	99.2	0.3			0.6	
Virginia Electric Power Co.	50.4	3.9	3.9	41.6	0.1	

Source: Resource Data International, Boulder, Colorado

The kinds of impacts associated with possible purchased power sources are set forth in Section 4.1 of TVA's 1972 EIS. In summary, coal-fired units result in substantially greater amounts of air pollution (sulfur dioxide, nitrogen oxides, particulates, and toxics) than would WBN Unit 1. A gas-fired unit would produce substantially greater amounts of nitrogen oxides and carbon dioxide than WBN Unit 1. Coal- and gas-fired units would still result in the discharge of varying amounts of heated water from their plant sites. Operation of another nuclear unit would likely produce similar or greater environmental impacts than WBN Unit 1, which is a closed-cycle unit. Consequently, it is likely that completing and operating WBN Unit 1 would result in similar or lessor impacts than purchasing power from neighboring utilities or from independent power producers.

3.2.2 Economic Consequences

Including 1994 and 1995 expenditures, completing WBN Unit 1 is estimated to cost $800 million. With fuel and operating costs added to interest and depreciation on the remaining costs to complete the unit, first year cost of generating power at WBN Unit 1 is estimated to be 2.2 cents per kWh (Table 3-3). This compares very favorably to the estimated cost of purchasing baseload power -- 3.4 to 3.6 cents per kWh. Over the life of WBN Unit 1, assuming a capacity factor of 67 percent, generating cost is estimated to be approximately 4.4 cents per kWh. These cost estimates account for the costs to complete WBN Unit 1 as well as already-incurred costs. TVA has already spend approximately $6.4 billion on the construction of the unit and shared facilities. These costs have to be recovered whether or not the unit operates. WBN Unit 1 should be among TVA's lowest-cost generating sources. The cost of operating the unit is projected at approximately 1.7 cents/kWh. The costs TVA would incur for the operation of alternative generating sources range from 2.0 to 6.0 cents/kWh.

Table 3-3

Power Cost Comparison

Watts Bar Unit 1	2.2 ¢ per kWh
Purchase with Reservation Charge	3.4 - ¢ 3.6 per kWh
Purchase without Reservation Charge	2.0 - 3.0 ¢ per kWh

3.3 The Preferred Alternative

As concluded in the EIS, based on the need for power, the lack of sufficiently viable alternatives, and the economics and other limitations of purchasing versus completing WBN Unit 1, TVA's preferred alternative is the completion and commercial operation of WBN Unit 1. The ability to purchase power in the short term would not obviate the need for power in the long term, nor is the price of purchasing power, comparable to that capable of being generating by WBN Unit 1 over its life, from other systems or independent power producers under the control of TVA. Because completion and operation of WBN Unit 1 would most likely result in lesser environmental impacts than purchasing power; it is also the environmentally preferred course of action.

4.0 Changes in Plant Design and Operational Systems

Construction of WBN Unit 1 is essentially complete and systems are being tested in preparation for fuel load in the Fall of 1995. TVA has made some changes in specific plant systems and operations since the release of its 1972 EIS. Most of the changes were made to resolve safety concerns or to reduce potential environmental impacts. The changes are not expected to affect impact projections in TVA's EIS. Chapter 3 of the NRC SEIS and this section identify the changes that have occurred.

4.1 Plant Water Use

WBN's planned water use has not changed significantly since release of the TVA EIS. Steam generator makeup, service water, and condenser cooling water will still be obtained from the Tennessee River. Potable water continues to be obtained from groundwater supplies provided by a local utility, Watts Bar Utility District.

4.2 Heat Dissipation Systems

Assumptions for heat dissipation and cooling tower blowdown as described in TVA's 1972 EIS continue to be valid. In the EIS, TVA staff described a closed-mode cooling water system using two natural draft cooling towers for dissipating waste heat. Later engineering and laboratory studies resulted in design and operations modifications to meet the State of Tennessee water temperature criteria. Based on the results of hydrothermal model tests, TVA requested and received a variance to allow operation when the upstream temperature approached or exceeded 30.5°C (86.9°F); however, a follow-up evaluation indicated that the variance was not needed. The Environmental Protection Agency (EPA) issued TVA a National Pollutant Discharge Elimination System (NPDES) in 1978. The NPDES Permit limited the instantaneous discharge temperature to 35°C (95°F).

WBN heat dissipation systems are designed to operate in closed-mode using one natural draft cooling tower per nuclear unit. The water losses due to evaporation and blowdown are replenished with makeup water supplied via an intake channel and pumping station at Tennessee River Mile (TRM) 528.0. The average and maximum intake flow rates for full two-unit operation are 133 cubic feet per second (cfs) and 143 cfs, respectively, which represents less than one percent of the average river flow of 26,300 cfs past the plant.

Cooling tower blowdown is water discharged to maintain the concentration of solids in the cooling tower at approximately twice that found in the Tennessee River. The blowdown from the closed-mode operation is discharged into the Tennessee River through a multiport diffuser system, located 2.2 miles below Watts Bar Dam at TRM 527.9. WBN is designed to route the blowdown either to the diffusers or to a 234,390 cubic meter (190 acre-foot) yard holding pond for temporary storage. The maximum discharge through the multiport diffusers is approximately 173 cfs during periods when the pond is being drained along with the discharge of cooling tower blowdown.

The WBN NPDES Permit, renewed in December 1993, identifies the diffuser discharge as Outfall 101 and an emergency overflow as Outfall 102. These outfalls are located at TRM 527.9 and 527.2, respectively. The permit stipulates that the discharge diffusers may operate only when releases from Watts Bar Hydro Plant are greater than 99 cubic meters per second or cms (3,500 cfs). When releases drop below 99 cms (3,500 cfs), the diffuser discharge is automatically closed and blowdown flow is diverted to a yard holding pond. An overflow weir on the south side of the pond allows discharge to the Tennessee River via Outfall 102, the emergency overflow. Discharge from the emergency overflow should be infrequent.

The 1993 NPDES Permit stipulated that TVA must conduct temperature modeling studies to determine the appropriate daily average discharge temperature limit from Outfalls 101 and 102. In response, TVA completed a review of current information and modeling studies and reported this to the State in December 1993. The report, *Discharge Temperature Limit Evaluation for Watts Bar Nuclear Plant,* identified a daily average discharge temperature limit of 35°C (95°F) for the diffuser discharge with a mixing zone 240 feet wide, extending 240 feet downstream. TVA also identified a pond emergency overflow temperature limit of 40°C (104°F) which would be measured by grab samples once a day during overflows at the weir. A mixing zone for the overflow discharge was defined as being 1,000 feet wide and extending 3,000 feet downstream. TVA's analyses showed that these discharge limits would ensure the receiving water temperature criteria are met. Those criteria are:

> *The receiving water shall not exceed (1) a maximum water temperature change of 3°C (5.4° F) relative to an upstream control point, (2) a maximum temperature of 30.5°C (86.9° F), except when upstream [ambient] temperatures approach or exceed this value, and (3) a maximum rate of change of 2°C (3.6° F) per hour outside of a mixing zone.*

4.3 Radioactive Waste Treatment Systems

Both TVA and NRC evaluated changes in the design and operation of WBN's radioactive waste treatment systems to determine whether potential radiological impacts were affected by those changes. Additionally, records documenting radioactive effluents and the result of the offsite radiological monitoring program at TVA's Sequoyah Nuclear Plant were examined.

TVA concluded that modifications in radioactive waste treatment systems made after 1972 focused primarily on upgrading the plant and decreasing the likelihood of events that could cause undesirable radiological consequences. Changes were also made to reduce the undesirable radiological consequences following a potential accident. Procedural changes and modifications to systems that process normal plant effluents were made to incorporate lessons learned from operating experience.

Based on systems operation data from Sequoyah Nuclear Plant, TVA expects that the modified waste treatment systems at WBN will result in radioactive releases and resulting doses less or no greater than those projected in its EIS, which represent less than one percent of those called for in NRC guidelines.

4.3.1 Liquid Radioactive Waste Treatment Systems

The liquid waste processing system collects and processes potentially radioactive wastes before effluents are released to the Tennessee River. Batch type releases are sampled, analyzed, and released to the river only during periods of hydro plant operations. Based on laboratory tests, these wastes are either released under controlled conditions through the cooling tower blowdown or retained for further processing. A simplified flow diagram is shown in Figure 4-1.

The TVA EIS and the 1976 Information Supplement reported on TVA's plans to use a boron recovery system (BRS) which included boric acid evaporators (BAE) and condensate demineralizer waste evaporator system (CDWE) in the liquid waste, processing system. Both the BRS and the CDWE are installed and connected to the waste disposal system but are not planned for use in support of Unit 1 operation. Liquid waste will be processed, as necessary, through the demineralizer. A new mobile demineralizer system is being installed to replace the existing atmospheric demineralizer. The new mobile system removes most soluble and suspended radioactive materials from the waste stream via filtration, media activated carbon, and ion exchange resin. Once the resin media is expended, it is sluiced to a container for storage and subsequent off-site disposal.

The liquid waste processing system (WPS) consists of two sub-systems processing tritiated and non-tritiated water. A system is provided for handling laboratory samples that may be tritiated and may contain chemicals. Capability for handling and storage of spent demineralizer resins is also provided.

Separation of Tritiated and Non-Tritiated Liquids. Waste liquids are normally separated into tritiated and non-tritiated liquids. Waste liquid, which are high in tritium content (reactor coolant leakage/loss) are routed to the tritiated drain collector tank, while liquids low in tritium content (non-reactor coolant/raw water) are routed to the floor drain collector tank. Both tritiated and non-tritiated liquids are processed for release to the Tennessee River. Liquids whose tritium concentration is greater than or equal to 10 percent of the primary coolant tritium concentration are to be processed as tritiated liquids. Liquids having a tritium concentration of less than 10 percent of the primary coolant concentration are to be processed as non-tritiated liquids.

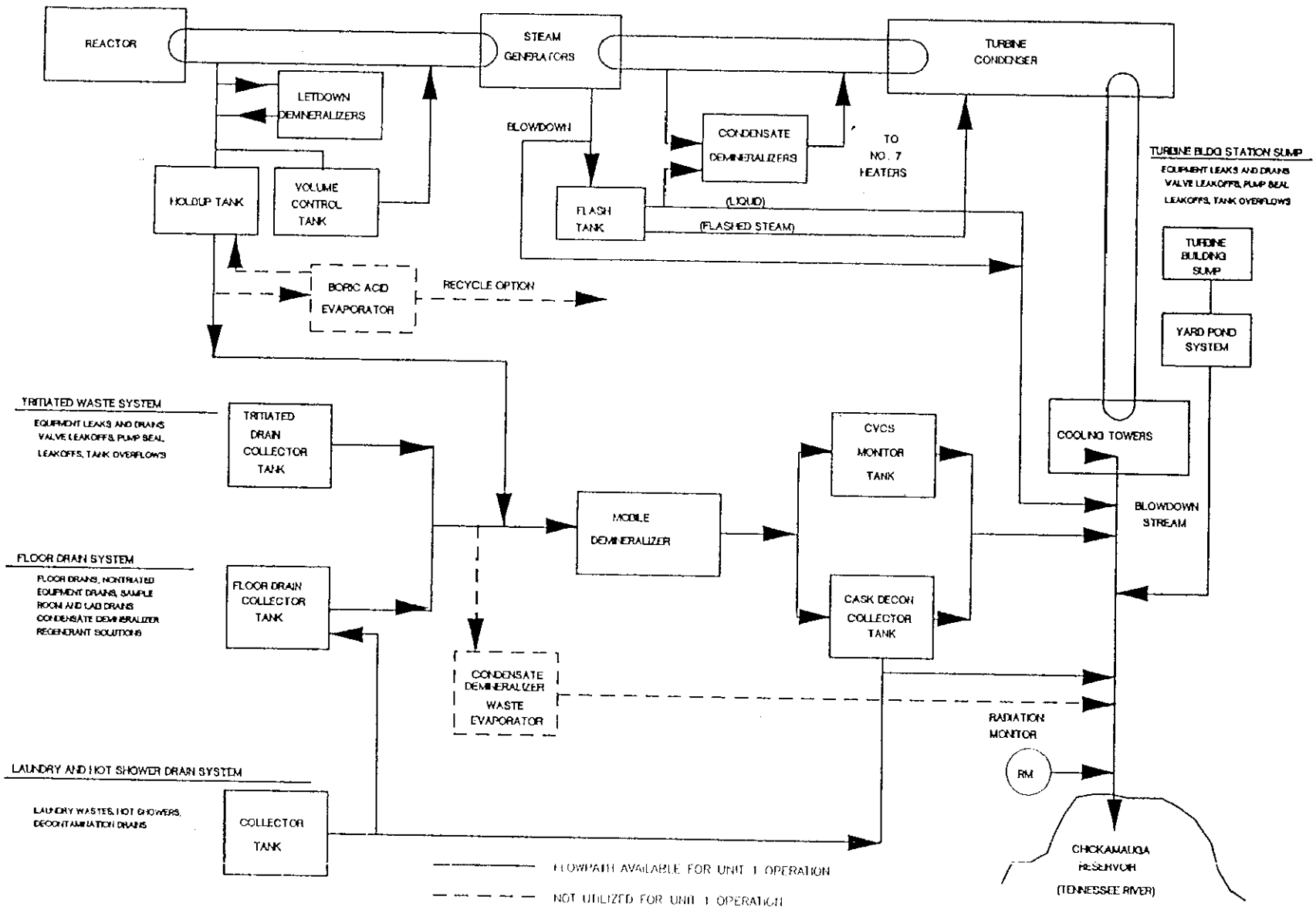


Figure 4-1. Watts Bar Nuclear Unit 1 and 2 Liquid Radwaste Treatment System

Tritiated Water Processing. Tritiated water enters the waste disposal system from equipment leaks and drains, valve leakoff, pump seal leakoffs, tank overflows, and other tritiated and aerated water sources. Leakoff is a controlled release of small amounts of reactant coolant. The disposal system consists of a tritiated drain collector tank, pumps and filter, mobile demineralizer, reactor coolant drain tank and pumps; the containment pit sump and pump; the reactor building floor and equipment drain sump and pumps; the reactor building floor and equipment drain pocket sump; tritiated equipment drain sump, pumps and filter, and tritiated drain collector tank which provides sufficient surge capacity for the waste processing equipment. The waste is primarily processed by the mobile demineralizer system or can be processed by the CDWE for Unit 1 operation.

Non-Tritiated Water Processing. Non-tritiated water sources include floor drains, equipment drains, certain sample room and radiochemical laboratory drains, laundry and hot showers drains, and other sources. The system consists of a floor drain collector tank, pumps and filter; laundry and hot shower tanks and pump; laundry tank basket strainer; waste condensate tanks, pumps and filter; mobile demineralizer; chemical drain tank and pump; cask decontamination collector tank, pump and filters; the Auxiliary Building floor and equipment drain sump and pumps; the additional equipment building floor and equipment drain sump and pumps (at each unit); and condensate demineralizer waste evaporator.

Liquids entering the floor drain collector tank are normally from low activity sources and are usually processed through either a mobile demineralizer system or the condensate demineralizer waste evaporator.

The laundry and hot shower drains normally need no treatment for removal of radioactivity. This water is collected in the laundry and hot shower drain tanks. These tanks may be discharged directly to the cooling tower blowdown via the laundry tank strainer or may be transferred to either the waste condensate tanks or the cask decontamination collector tank via the laundry tank strainer and waste condensate tank filter before discharge to the cooling tower blowdown. Prior to discharge, a sample is taken and analyzed in accordance with plant procedures and the water is discharged if the activity level is below acceptable limits.

Mobile Demineralizer System Processing of Tritiated and Non-Tritiated Waste. Flow from both the tritiated and non-tritiated tanks is routed to a Mobile Demineralizer System by use of the floor drain collector tank and tritiated drain collector tank pumps. Process water from the system is routed to either the chemical volume control system monitor tank or the cask decontamination collector tank. The contents of these tanks are discharged as described in the two previous sections or processed further, as necessary, to meet acceptance limits. The mobile demineralizer system removes most soluble and suspended radioactive materials from the waste stream via ion exchange and filtration. Once the resin and filter

media is expended, the resin is sluiced to a vendor-supplied container to accumulate enough resin for off-site disposal. The filters are stored in an appropriate container. The spent resin is then sluiced to the railroad bay where it is dewatered to meet the disposal site criteria for spent resins.

Laboratory Sample Processing. The chemical drain tank receives liquids from the laboratory and the decontamination room. If the radioactive level is low and the chemical content is suitable for release, the tank contents are discharged to the cooling tower blowdown line for release to the environment. In the event that the radioactivity level is high and/or an analysis shows that chemical content is not suitable for release, the liquid is sent to the floor drain collector tank for processing. The tank contents may also be sent directly to the mobile demineralizer if required.

Processing of Waste from Regeneration of Condensate Polishing Demineralizer. Wastes produced in the regeneration of the condensate polishing demineralizers are processed for discharge or reuse. High crud, low conductivity waste (contains no regenerative chemicals) is filtered and discharged when the radioactive level does not exceed discharge limits. When limits are exceeded, the high crud waste is processed by a vendor or in the condensate demineralizer waste evaporator (CDWE) (not required for Unit 1 operation). Low crud, high conductivity waste is neutralized. If it contains radioactive material above discharge limits, it is processed by a vendor or in the CDWE. Distillate is discharged or recycled to the condensate system. Evaporator concentrates are solidified.

Spent Resin Processing. Spent resin is stored in the spent resin storage tank. To remove spent resins from the storage tank for packaging, the resin is loosened by nitrogen sparging through the six sparging nozzles located in the bottom of the tank. Resin is slurried from the tank by nitrogen pressure to the auxiliary building railroad bay where it is received in liners and dewatered before shipment to the disposal site.

Under plant procedures, minor 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 (TBSS) to the yard holding pond (YHP) via the low-volume waste treatment pond (LVWTP). This release would occur only in the unlikely event of a primary to secondary leak and is not considered a major release pathway. Monitoring of this release path is controlled in accordance with the WBN Offsite Dose Calculation Manual (ODCM), which was approved by NRC on July 26, 1994.

Releases from the liquid waste processing system meet the requirements of the NPDES permit and 10 CFR 20, Appendix B. Releases have been evaluated and are expected to be well within the limits described in the NPDES permit, and 10 CFR 50, Appendix I, and 40 CFR 190 (see section 5.10).

4.3.2 Gaseous Radioactive Waste Treatment Systems

The gaseous waste processing system (GWPS) is designed to remove fission product gases from the nuclear steam supply system and to permit operation with periodic discharges of small quantities of fission gases through the monitored plant vent. This is accomplished by internal recirculation of radioactive gases and holdup in the nine waste gas decay tanks to reduce the concentration of radioisotopes in the released gases. The system has not changed significantly from that depicted in the TVA EIS.

Gaseous effluent releases during normal operation of the plant are limited at the site boundary not to exceed 10 CFR 50, Appendix I, 10 CFR 20 and 40 CFR 190 limits. The 10 CFR 50 Appendix I limits provide assurance that the exposures to individuals in unrestricted areas are as low as reasonably achievable. Radiological releases from the GWPS are discussed and evaluated in Section 5.10.

4.3.3 Solid Radioactive Wastes

Solid wastes are divided into two categories: (1) dry active waste (DAW) and (2) wet active waste (WAW). DAW and WAW are products of the plant operation and maintenance. DAW is further subdivided into compactible and noncompactible wastes. Solid compactible wastes include paper, clothing, rags, mop heads, rubber boots, and plastic. Noncompactible wastes include tools, mop handles, lumber, glassware, pumps, motors, valves, and piping.

WAW is primarily composed of spent resins. The sources for spent resins are the spent resin storage tank, the mobile demineralizer, and Condensate Polisher Demineralizer System (CPDS). As discussed in Section 4.3.1, waste evaporators will not be utilized in support of Unit 1 operation, and therefore evaporator concentrates will not be generated.

The TVA EIS notes that tritiated water will be generated and trucked in tankers to a disposal facility for solidification and burial. However, current plans are that tritiated water will not be treated offsite but will be released to the Tennessee River in accordance with NRC regulations in 10 CFR Part 20. The EIS also notes that DOT 17H drums will be used as packaging for most waste. Because of decreased handling and changes in the type of packaging equipment, *Sea-Land* type cargo containers and standard *B-25* type boxes will be primarily used for dry waste, and polyethylene high integrity containers will be used for resins and other *wet* wastes.

The TVA EIS assumes that miscellaneous dry solids will be compacted at the plant site using a standard drum compactor (obtaining about a 3-to-1 reduction ratio) and noncompactible materials (metal, large pieces of wood, equipment, etc.) would be packaged as-is with no volume reduction. However, improvements have been made in the area of offsite volume reduction of low-level radwaste. Currently available techniques, such as incineration, metal melt, and supercompaction, now produce

volume reduction ratios as high as 200-to-1. Coupled with continuing initiatives to reduce the sources of radioactive waste at the plant site, this results in drastically lower burial volumes for nuclear plants.

The TVA EIS assumed that resins and evaporators concentrates would be solidified using cement and vermiculite. Evaporator concentrates will likely not now be generated, but if generated, they would be solidified in cement or other approved binder if disposed. Resins will be dewatered (dried) inside a polyethylene high integrity container and shipped in an NRC-licensed shielded cask as needed to meet DOT and NRC shipping regulations and to reduce occupational and public radiation exposures during transport.

The EIS also assumed that a low-level waste disposal facility in Morehead, Kentucky, would be used to dispose of WBN low-level radwaste. That facility is now closed. The disposal facility near Barnwell, South Carolina, would be used for disposal of low-level radwaste until the new disposal facility at Wake County, North Carolina, is opened (expected in mid-1998). If the Barnwell facility should close before the North Carolina facility is opened, WBN will provide onsite storage of low-level radwaste. Use of a sheltered concrete pad or building is currently planned. The shipping distance assumed from WBN to Barnwell is approximately 310 miles, and the distance from WBN to Wake County, North Carolina, is approximately 430 miles.

A comparison of the annual EIS waste burial volumes and anticipated number of shipments against expected values based on Sequoyah data are given below. As can be seen from Table 4-1, the expected radwaste burial volume is reduced by more than a factor of seven from 1972 values in the TVA EIS. The number of shipments is also greatly reduced. Based on the number of miles to the waste reduction processor (50 miles) and the distance to the Wake County disposal facility, the calculated number of miles traveled annually in the EIS (13,850) is reduced to about 5,500 miles (a factor of 2.5 reduction).

Calculated radiation exposures to the truck drivers and to the population along the route are assumed to be negligible for dry solids (trash) due to very low dose rates. The calculated exposure in the 1972 EIS from resins and concentrates during transport is given as 15 millirem per shipment or about 0.75 man-rem per year to truck drivers and 0.5 millirem per shipment or 0.125 man-rem to nearby public. For expected shipments using the same methodology, calculated exposures of about 0.215 man-rem (occupational) and 0.036 man-rem (nearby public) would result, which is a factor of 3.5 less than the values in the EIS.

Radiation exposure to the public along the route is given as 0.012 man-rem per year based on a 300-mile distance and 25 shipments in the 1972 EIS. For a 430-mile distance with 5 expected shipments, the population exposure is calculated as 0.0034 man-rem, a factor of 3.5 reduction. As stated in the EIS, radiation exposures are a small fraction of the population dose from natural background radiation.

The only other radiation dose addressed in the 1972 EIS resulted from an accidental release of tritiated water during transport to the disposal facility. This dose was given as 0.05 man-rem to the population within 50 miles. Since tritiated water will not be taken to the disposal facility, there will be no impact from this type of accident.

Table 4-1

Radwaste Types, Burial Volume, and Number of Shipments for Sequoyah Nuclear Plant

Waste Type	WBN ES Values		Expected Values	
	Volume Cu Ft	Shipments	Volume Cu Ft	Shipments
Waste evap. concentrates	1,050	15	0	0
Spent demineralizer resins	350	10	580	5
Misc. dry solids (To offsite processor)	N/A	N/A	N/A	<20
Misc. dry solids (To disposal facility)	350	5-10	1,400	4 (equiv.)
Radioactive components	Low	Low	<100	<1
Tritiated water (volume doubled for solidification)	13,369 (50,000 gal)	13	0	0
Totals	15,119	43-48	2,080	30

The EIS concluded that an insignificant environmental risk will result from the transportation of low-level waste to offsite disposal grounds. This conclusion is not changed as a result of currently expected shipments of low-level waste. In its SEIS, NRC concluded: "[T]he new waste management approach [at WBN] will reduce the already low levels of projected radiation exposure to the public during the transportation of radioactive waste." (SEIS, p. 5-18).

4.4 Chemical, Sanitary, and Other Waste Treatments

There have been several changes in planned use of chemicals at WBN since the 1972 EIS. The potential sources of chemicals and chemical quantities are now controlled by a site Chemical Traffic Control Program. Potential discharges of chemicals at WBN are controlled by the NPDES permits. Information regarding WBN's chemical uses is provided in Table 4-2 and described below. The NRC SEIS addresses this in Section 3.4.

Steam Generator Feedwater Treatment. As stated in TVA's EIS, WBN's original design would have used sodium phosphate, ammonia, and hydrazine as additives to the steam generator feedwater. Based on the latest advances in pure water treatment, ethanolamine (ETA) and ammonia for pH control, hydrazine for oxygen scavenging, and boric acid for crevice chemistry control will be used in place of the phosphate treatment.

Raw Water Treatment. WBN has a comprehensive chemical treatment program for treating raw water systems. This treatment is a major part of the WBN Raw Water Corrosion Program. Chemical treatment is used to control corrosion in carbon steel and yellow metals, to control organic fouling, including slime, to minimize the effect of microbiologically induced corrosion (MIC) and inhibit growth of Asiatic clams. Raw water treatment chemicals currently used at WBN consist of:

- Copolymer dispersant to control deposition and fouling;
- Tetrapotassium pyrophosphate, a corrosion inhibitor and sequestrant, to remove existing corrosion deposits;
- Zinc sulphate to control carbon steel corrosion;
- Butyl benzotriazole to protect yellow metal;
- Dodecylguanidine hydrochloride (DGH) and n-alkyl dimethyl benzyl ammonium chloride (quat) to kill clams and prevent MIC; and
- 1-Bromo-3-chloro-5, 5-dimethylhydantoin (BCDMH) - a biocide to reduce MIC and control clams.

Component Cooling Water Treatment. Sodium nitrite will not be used as a corrosion inhibitor in the closed component cooling water system as stated in the 1976 Information Statement. Because of advancements in corrosion inhibition, WBN will use tolytriazole and sodium molybdate for corrosion control and pH adjustment.

Reactor Coolant System Treatment. TVA still plans to use boric acid, lithium hydroxide, hydrogen peroxide, and hydrazine during plant startup, operation, and shutdown to treat the reactor cooling system.

Auxiliary Steam Generator System Treatment. Current plant design still calls for the use of two (2) 40,000 pounds per hour oil-fired boilers to supply building heat and steam for unit startup. Hydrazine, ammonia, and/or ethanolamine will be used for oxygen scavenging and corrosion inhibition, respectively, in these boilers.

Table 4-2

Summary Of Added Chemicals And Resulting End Product Chemicals
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 Products[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
1	Makeup water filter plant	Alum $Al_2(SO_4)_3$ "$18H_2O$	35,743	(78,800)	$Al(OH)_3$[b]	7,489	(16,510)	20	(45)
					SO_4^{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_4^{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_4^{2-}	9,866	(21,750)	SO_4^{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_4^{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_3^{2-})	11,520	(25,400)	CO_3^{2-}	11,521	(25,400)	32	(70)
		Metallic Salts	d	d	+	d	d	d	d
		Ethanolamine	44,019	(97,820)	$EtONH_2$	44,019	(97,820)	121	(268)
		Boric Acid	45,000	(100,000)	H_3BO_3	45,000	(100,000)	122	(273)
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)

Table 4-2

Summary Of Added Chemicals And Resulting End Product Chemicals
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 Products[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
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	Pyrophosphate	34,088	(75,752)	$H_2PO_4^{1}$	34,088	(75,752)	93	(207)
		Organic Co-Polymer Dispersant	7,953	(17,673)	N/A	7,953	(17,673)	22	(48)
		Zinc Sulface	18,182	(40,405)	Zn^{2+}	7,340	(16,312)	20	(45)
					SO_4^{2-}	10,841	(24,092)	30	(66)
		Coppertrol	261	(581)	Benzotriazole	261	(581)	22	(48)
		Clamtrol	1,386	(3,080)	OGH	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[9]	Pyrophosphate	3,787	(8,417)	H_2PO^{4-}	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_4^{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)

Table 4-2

Summary Of Added Chemicals And Resulting End Product Chemicals
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 Products[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
8	Essential Raw Cooling[9] Water	Pyrophosphate	151,011	(335,581)	$H_2PO_4^{1-}$	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_4^{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 a 365 days/year operation at rated capacity. Item 3 is based on a 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 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 too low to measure.

Miscellaneous Treatment. As planned, plant components may be chemically cleaned prior to initial startup and during plant operation to remove corrosion product buildup. Various chemicals may be utilized as metal cleaning compounds (e.g., trisodium phosphate, ethylene diamine tetra acetic acid (EDTA), hydrochloric acid, and hydrazine). Wastewater from cleaning processes may be discharged to holding ponds on site for treatment in compliance with the NPDES permit, or processed by approved vendors.

Sanitary Waste Treatment. Sanitary waste from WBN is treated in an extended aeration plant with four separate units which have a combined treatment capacity of 120,000 gallons per day. Treated effluent is routed to the runoff holding pond and eventually discharged to the river. Discharge is controlled and monitored in accordance with the NPDES permit.

Water Filtration, Demineralization, and Condensate Polishing. Water processing, including clarification, demineralization, and condensate polishing (including waste neutralization), continues to be feasible for steam system water makeup requirements at WBN. The basic engineering theory employed in the nuclear industry today for processing and treatment of raw water closely parallels the methods anticipated by the TVA EIS and Information Supplement.

Yard Drainage System. Plant grounds drain into a yard holding pond. This pond serves as an intermediate collection point and is equipped with skimming capability to facilitate removal of floating debris and oil.

Erosion Control and Storm Water Monitoring Program. The goal of the WBN Erosion/Stormwater Pollution Prevention Plan is to improve water quality by reducing pollutants contained in storm water discharges. Appropriate management practices are applied to site areas to control erosion and sediment runoff. Runoff from the site is sampled and monitored in accordance with the NPDES General Industrial Storm Water Permit.

Transformers and Electrical Machinery. Consistent with applicable regulations, WBN has prepared a Spill Prevention Control and Countermeasure (SPCC) plan which addresses potential spills into waters of the United States from equipment or machinery at the plant. Such spills could include diesel fuel oil, gasoline, insulating oil, lube oil, and other lubricating oils.

Earlier environmental reviews contemplated that PCB transformers would be used at the plant; however, such equipment is being removed from the site or retrofilled with mineral oil or silicon fluid. The remaining transformers that still contain PCBs are indoors and located in secondary containments. The retrofill project is scheduled to be complete in late 1995. Upon completion of the retrofill project, there will no longer be PCB transformers on site.

Nonradioactive Wastes. Nonradioactive and nonhazardous solid waste, including construction debris, office waste, and any asbestos waste that may be generated at the plant are disposed in State-approved sanitary landfills or in onsite approved landfills depending on the waste and type. Most of the pipe insulation containing asbestos has been or will be removed from WBN and has been replaced with asbestos-free insulation. Hazardous wastes are disposed of or treated offsite at State- or EPA-approved treatment/disposal facilities.

4.5 Power Transmission System

The TVA EIS description of the transmission system lines into and out of WBN remains accurate. The Watts Bar Volunteer transmission line was placed into service on July 19, 1981. No additional transmission lines into or out of WBN are currently planned. Section 3.5 of the NRC SEIS addresses this subject.

5.0 Changes in the Affected Environment and Environmental Consequences

Since the 1972 EIS, TVA has conducted a number of comprehensive environmental monitoring programs and major environmental studies to further evaluate potential adverse effects of WBN operations and, as necessary, to identify mitigative actions to further reduce potential effects. Evaluation of the results of these efforts, focusing on new environmental information and changes in environmental concerns occurring since 1972, support the conclusions of the 1972 EIS. TVA has also obtained required environmental permits (see Section 1.3, Table 1-1) which specify monitoring and reporting requirements that further ensure that WBN Unit 1 operations are environmentally acceptable.

5.1 Seismology

The EIS provides a general description of seismology for the WBN vicinity. WBN was designed based on the largest historic earthquake to occur in the Southern Appalachian Tectonic Province - the 1897 Giles County, Virginia earthquake. This earthquake is estimated to have had a body wave magnitude of 5.8. The largest earthquake to occur in the southern Appalachians since the 1972 EIS occurred on November 30, 1973, at Alcoa, Tennessee. This earthquake had an equivalent body wave magnitude of 4.6.

The seismic design basis for WBN was defined at the time of the 1972 EIS as a design basis earthquake (now called safe shutdown earthquake). The Safe Shutdown Earthquake has a peak ground acceleration (PGA) of 18 percent of the force of gravity (0.18g). The WBN plant was evaluated in 1989-1992 for the effects of a site-specific earthquake model previously developed for Sequoyah, Watts Bar, and Bellefonte nuclear plants. The site-specific earthquake model was developed to represent a large hypothetical earthquake occurring near the site (within 25 kilometers). The site-specific earthquake had a PGA of 0.215g. Some structures, systems, and components were upgraded as a result of these evaluations.

Since the 1972 EIS was issued, the nuclear utility industry has extensively studied the performance of actual structures and components that have experienced large earthquakes. These earthquake experience studies have consistently shown that structures and components similar or identical to those at WBN and other TVA nuclear plants have performed very well in earthquakes much larger than WBN seismic design basis.

An additional evaluation of WBN is scheduled to occur in mid-1997 as part of the NRC's program for Individual Plant Examination for External Events (IPEEE). Structures, systems, and components are to be evaluated for a Review Level Earthquake with a PGA of 0.30g. This Review Level Earthquake shaking would be expected from a nearby earthquake having a body wave magnitude of approximately 6.8. The IPEEE evaluation utilizes methods based on the behavior of structures, systems, and components in actual large earthquakes on a world-wide basis. Although WBN-specific

results will not be available until completion of the IPEEE study, a preliminary assessment of results from a similar IPEEE study nearing completion for the Sequoyah nuclear plant indicates that the existing structures and components at WBN have sufficient margin to withstand an earthquake of magnitude 6.8 (PGA of 0.30g). The Sequoyah results may be extrapolated to WBN because many of the structures and systems are similar or identical to WBN.

TVA participates in and financially supports a seismic research and improved design and evaluation methods. For example, during the mid-1980's the Electric Power Research Institute conducted state of the art, probabilistic seismic hazard assessments of all nuclear plants in the eastern United States. WBN upgrades are implemented when warranted by new research findings and earthquakes experiences world-wide.

The discussion of regional seismology in the 1972 EIS remains valid. This conclusion is based on: (1) the 1989-1992 seismic assessment of WBN, (2) the IPEEE study of WBN's sister plant, Sequoyah, and (3) TVA's continuing participation in industry research activities.

5.2 Climatology and Meteorology

The WBN onsite meteorological program is presented in Appendix A. Meteorological facilities have been in operation since 1971 when a temporary 40-meter instrumented tower was installed to collect wind speed, wind direction, and temperature data at the 10-meter and 40-meter levels. This tower was decommissioned in September 1973 following the installation of a permanent facility. The permanent facility consists of a 91-meter instrument tower and an environmental data station. Data collection at the permanent facility began in May 1973 and has continued uninterrupted since that time.

5.2.1 Regional Climatology

The regional climate description in the TVA EIS remains valid. This conclusion is based on information contained in the Local Climatology Data Annual Summary with Comparative Data for Chattanooga, Tennessee, for 1993 and the regional climate discussion in section 2.3.1 of the WBN Final Safety Analysis Report (FSAR). NRC in the SEIS also concluded that there have been no significant changes in regional climatology or WBN site meteorology.

Temperature data for the 1961-90 period of record for Chattanooga, Tennessee, indicate an average annual temperature of 59.3°F, with monthly averages ranging from 37.4°F in January to 77.9°F in July. The range of extreme temperatures, from 106°F in July to -10°F in January, is 116°F. The maximum rainfall in 24-hours at Chattanooga is 6.62 inches in September 1977. The maximum snowfall in 24-hours at Chattanooga is 20.0 inches in March 1993. Wind speed data from Chattanooga for the 1961-90 period indicate an average wind speed of 6.0 miles per hour.

5.2.2 Local Meteorology

The one year of data collected from the temporary WBN meteorological is supplemented with more representative data from the 20-year period from 1974-93. These data were collected from the permanent meteorological facility. On an annual basis, the most frequent wind directions at 10 meters are south southwest and north northeast at 15.8 % and 8.4 %, respectively. The annual average wind speed is 4.1 mi/h at the 10-meter level. The annual frequency of calms, which is defined as wind speeds less than 0.6 mi/h is 3.0 %.

5.2.3 Severe Weather

Based on section 2.3.1.3 of the WBN Final Safety Analysis Report (FSAR), the severe weather information in the TVA EIS remains valid, except for the following update. During the 73-year period of 1916-88, one tornado has been reported in Rhea County, in which the plant is located. The FSAR estimate of the probability of a tornado striking the site is 1.48E-04 with a recurrence interval of 6755 years. This is based on tornado data from 1950 through 1986 with a 30 nautical mile radius of WBN.

5.2.4 Dispersion

Section 5.10, Table 5-9 presents the estimated annual airborne doses from the WBN FSAR. Section 5.12 discusses the impact of postulated accidents. These analyses use the 20-year period of meteorological data from 1974-93 discussed in section 5.2.2. Use of the 20-year period does not alter the conclusions drawn in sections 5.10 and 5.12.

5.3 Air Quality

Two oil-fired boilers used for building heat and startup steam emit small amounts of air pollutants as addressed in the TVA EIS. These emissions are controlled as necessary to meet applicable regulatory requirements, and resulting impacts are expected to be insignificant.

5.4 Hydrology and Water Quality

Since the 1972 EIS, under the requirements of the Tennessee Water Quality Control Act of 1977 and the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977, the State of Tennessee has authorized TVA to discharge process wastewater to the Tennessee River at Chickamauga Lake and an unnamed tributary to Yellow Creek. In 1976, TVA filed an application for a National Pollution Discharge Elimination System (NPDES) Permit which identified aquatic monitoring and reporting

requirement for WBN. The current NPDES permit (No. TN 0020168) establishes specific effluent limitations for thermal, chemical, and sanitary waste discharges originating from the WBN facilities as well as specific effluent and instream monitoring and reporting requirements necessary to determine compliance with the effluent limitations.

5.4.1 Groundwater

The information on groundwater in the 1972 EIS was based on exploratory drilling while the following description is based on more recent information.

The plant site is underlain by unconsolidated terrace and alluvial deposits consisting of gravel, sand and clay. These surficial deposits average approximately 12.2 meters (40 feet) in thickness, and are generally poorly water-bearing. The hydraulic conductivity of the terrace deposits is estimated to be 14.6 meters per day (48 feet/day) and porosity is estimated at 0.15. The average depth to groundwater in the surficial deposits is approximately 5.2 meters (17 feet) indicating an average saturated thickness of 7.0 meters (23 feet).

The Conasauga Formation, which is of Middle Cambrian age, forms the bedrock foundation of the plant. The bedrock formation is composed of several hundred feet of interbedded limestones and shales. The general strike of the Conasauga is N30W and the overall dip is to the southeast. The formation is poorly water-bearing with groundwater occurring in small fractures and bedding planes. Packer testing in the exploratory boreholes at pressures of 35,200 kg/m^2 (50 psi) consistently showed little or no water acceptance. Examination of 1677 meters (5500 feet) of core logs for borings completed primarily in the power block area indicated only one cavity, approximately 0.18 meters (0.6 feet) in thickness.

Groundwater system recharge at the plant site occurs from infiltration of local precipitation at the plant site, which averages around 127 cm per year (50 inches per year), and from lateral underflow from the area north of the plant site. Approximately 20 to 25 cm (8 to 10 inches) of this precipitation enters groundwater storage. In this region, groundwater levels normally reach peak elevation in February and March and are at minimum levels in late summer and early fall. The depth to the water table is generally less than 6.1 meters (20 ft) throughout the plant site. All groundwater originating at the site ultimately discharges to Chickamauga Lake, either directly or via Yellow Creek.

5.4.2 Surface Water

Since the TVA EIS was issued, two temporary chemical cleaning ponds have been constructed within the main yard holding pond. These ponds were designed for the containment and treatment of chemical and waste water used during preoperational

cleaning and testing. TVA has made the decision to retain the two chemical holding ponds which are still being used to contain and treat wastewater from the turbine building. The small lined pond and the large unlined pond have volumes of approximately 1 million and 5 million gallons, respectively. The discharges from these ponds are monitored in accordance with the plant's NPDES permit for metal cleaning wastes.

In addition, a 2.5 million gallon evaporation/percolation pond was constructed and approved by the State of Tennessee. This pond was used for the treatment and disposal of spent trisodium phosphate cleaning wastes which resulted from the preoperational cleaning of Units 1 and 2. It is no longer being used and TVA plans to close it. The pond was constructed by excavating approximately 18 inches below the original surface and then building a three to four-foot berm around its perimeter. Groundwater is being monitored by a well downgradient of the pond. Discharges from the pond have not and are not expected to impact public water supplies. When the water is eventually emptied from the pond, TVA plans to push in the berm walls and then cap and revegetate the area.

The runoff holding pond that was originally built for construction will remain in service. Presently, it collects discharge water from WBN's onsite sewage treatment plant; the heating, ventilating, and air conditioning (HVAC) cooling water system at the WBN Training Center; fire protection wastewater; and site storm water runoff. The discharge from the pond is monitored in accordance with the NPDES permit.

Point source discharges and storm water runoff points are currently being monitored in accordance with the NPDES permit. As required by the amendments to the Clean Water Act and EPA regulations, the State of Tennessee recently adopted storm water control regulations. Under the general storm water permit for industrial sources, requirements for erosion and sedimentation controls (that is, inspection, corrective actions, and annual sampling) have been implemented at WBN. In addition, biotoxicity sampling is conducted semiannually at the main diffuser discharge and the runoff holding pond in accordance with the NPDES permit.

5.4.3 Water Use

Information and water use projections in the TVA EIS have not materially changed. WBN expects to use an average of 86 million gallons of water daily with a maximum daily use expected to be approximately 91 million gallons. The average amount of water returned to the reservoir daily is highly variable depending on the water level in the holding ponds, precipitation, etc. The maximum amount of water that will be returned to the reservoir daily is expected to be approximately 121 million gallons.

5.5 Ecology

5.5.1 Terrestrial Ecology

The WBN site is characterized as a 387 hectare (967 acre) tract which was primarily used for agriculture. As indicated in the TVA EIS, extensive clearing of the WBN site occurred during the construction phase which converted the area to an industrial site. Terrestrial biological communities outside the immediate construction area have not been materially impacted. This includes several wetland areas which have been identified since the TVA EIS was released. Based on TVA staff observations and the U.S. Fish and Wildlife Service National Wetlands Inventory maps, several small wetlands have been identified in the WBN vicinity; however, no actions are anticipated that would impact these areas.

Two endangered terrestrial animals occur in the WBN vicinity: the southern bald eagle, *Haliaeetus leucocephalus* and gray bat, *Myotis grisescens*. These species are addressed in section 5.5.3 of this report. The spider-lily, *Hymenocallis occidentialis*, was reported as occurring in the plant site vicinity outside the construction area in NRC's 1978 FES. A TVA botanist was unable to locate this species during a 1994 field survey.

The WBN plant vicinity functions as an informal preserve and continues to support a variety of terrestrial plant and animal communities. No further expansion of the construction area is expected and plant operations area not expected to significantly impact terrestrial communities. NRC addresses potential impacts on terrestrial species in Section 5.3 of the SEIS.

5.5.2 Aquatic Ecology

The 1972 EIS identified certain aspects of plant operation as having potential for impacts on aquatic communities, and concluded that such impacts are not likely to be significant. Aquatic ecological studies at the WBN site since then essentially support that conclusion. NRC addresses this subject in Section 5.4 of the SEIS.

The baseline data for assessing actual operational impacts of the WBN plant are summarized in a 1986 report entitled *Preoperational Assessment of Water Quality and Biological Resources of Chickamauga Reservoir, Watts Bar Nuclear Plant. 1973-1985*. Table 5-1 lists the individual studies included in that report along with other special aquatic studies carried out in connection with WBN since 1985.

Table 5-1

Summary of Preoperational And Special Aquatic Monitoring Programs

Project	Type of Sampling	Years Conducted
Watts Bar Nuclear Plant Baseline Preoperational Aquatic Monitoring Programs: 1972-1993		
Adult Fish (Results through 1985 in TVA 1986; through 1993 in TVA 1994a)	Population Inventory using fish toxicant (rotenone)	1970-93
	Fish (electrofishing, gill-netting, hoop-netting	1976-79, 1982-85
(Results of the following projects are reported in TVA 1986)		
Larval Fish	Trawling	1976-79, 1982-85
WBN Benthic	Bottom-dwelling organisms	1973-77, 1982-85
WBN Zooplankton	Planktonic animal life	1973-77, 1982-85
WBN Phytoplankton	Planktonic plant life (algae)	1973-77, 1982-85
WBN Periphyton	Attached algae	1973-77, 1982-85
WBN Chlorophyll	Phytoplankton biomass	1973-77, 1982-85
WBN Primary Productivity	Phytoplankton photosynthesis	1973-77, 1982-85
WBN Autotrophic Index (AI)	Indicator of organic pollution	1973-77, 1982-85
Watts Bar and Sequoyah Nuclear Plants Chickamauga Special Aquatic Monitoring Program Issues - Directed Studies		
WBN Mussel Survey (TVA 1989b, 1991b)	Diver conducted pollution survey (biennial)	1983 - 1992
Sauger Population Study (TVA 1988, 1989a, 1990a, 1991a)	Electrofishing, Gillnetting	1986 - 1991
	Larval sampling	1987
White Crappie Investigation (TVA 1990c)	Larval netting, Light Traps	1986 - 1989
	Electrofishing, Trapnetting	1987 - 1989
White Bass Population Study (TVA 1994a)	Electrofishing, Tagging	1990 - 1992
	Larval Sampling	1990 - 1991
Channel Catfish Study (TVA 1994b)	Review of available data	1990 - 1992
Dissolved Oxygen Study (TVA 1990b)	Reservoir-wide O_2 Dynamics	1987 - 1989

Entrainment of Phytoplankton and Zooplankton. Studies indicate that plankton passing WBN originates upstream in Watts Bar Reservoir and passes through the turbines in Watts Bar Dam. Entrainment losses are expected to be proportional to hydraulic entrainment, which will be a maximum of 0.7 percent of the long term average flow past the plant. Plankton populations around WBN show extreme short term variability, and losses of less than one percent will be statistically undetectable. This supports the conclusion of the TVA EIS and the NRC SEIS that entrainment of phytoplankton and zooplankton in the intake cooling water will not result in irretrievable losses to the aquatic ecosystem in the vicinity of WBN.

Extensive entrainment studies at Sequoyah Nuclear Plant, where hydraulic entrainment is much higher than at WBN, have detected measurable effects on the plankton population only during periods of low flows coupled with maximum plant operations. Even then recovery occurs a short distance below the discharge with no demonstrable adverse effects.

Entrainment of Fish Larvae. The tailwater area of Chickamauga Reservoir in general is important in reproduction and early growth of fish. However, studies completed since the 1972 EIS have shown that little reproduction occurs in the 2.2 mile reach between WBN and Watts Bar Dam. When the TVA EIS was issued, the significance of that reach as a spawning area for migratory spawners such as sauger and white bass was unknown. Targeted studies have since confirmed that the primary spawning site for these species in Chickamauga Reservoir is at Hunter Shoals located at Tennessee River Mile (TRM) 520-522, some 6 to 7 miles downstream from the WBN site. Hunter Shoals is also a major white bass spawning area. There is no major spawning activity by either species in the tailwater reach from Watts Bar Dam to Hunter Shoals.

Most fish eggs and larvae passing WBN originate in Watts Bar Reservoir and pass through the dam. The entrainment and destruction of those eggs and larvae at WBN will occur in essentially the same proportion as other planktonic organisms (less than 1% of the total passing the plant). All studies undertaken since the 1972 EIS tend to reinforce the original conclusion that such entrainment will not result in a significant ecological impact.

Impingement of Juvenile and Adult Fish. Based on available information, impingement of juvenile and adult fish on the cooling water intake screens continues to be insignificant, as concluded in the TVA EIS. The NRC SEIS concluded that "fish impingement will be minimal." (SEIS, p. 5-7).

Thermal characteristics and resulting effects. Thermal characteristics and resulting effects due to discharge of heated cooling tower blowdown water from multiport jet diffusers have not changed. Thermal effects should be largely limited to the discharge mixing zone, which extends less than 100 meters downstream, from the diffusers and influences less than 40% of the cross-sectional area of the river at normal summer elevations.

Mussel Beds. Since 1972, TVA aquatic biologists and others have conducted a great deal of mussel field work in the Tennessee River downstream from Watts Bar Dam, much of which has been done as part of preoperational monitoring for WBN. Also during this period, the mussel sanctuary in the area has been extended nearly seven miles downstream to Tennessee River Mile 520 by the Tennessee Wildlife Resources Agency. Starting in 1983, TVA began monitoring the status of mussel stocks in three relatively dense areas (*mussel beds*) located just upstream, just downstream, and several miles downstream from the WBN discharges.

Native mussel resources are now known to occur in various concentrations throughout the Watts Bar Tailwater. One Mussel Bed exists along the right (descending) shoreline between TRM 526 and 527, just downstream from the mouth of Yellow Creek and the WBN discharges. Since 1972 a total of 31 freshwater mussel species has been reported from the tailwater. The most abundant of these are the elephantear (*Elliptio crassidens*), Ohio pigtoe (*Pleurobema chordatum*), and pimpleback (*Quadrula pustulosa*). The results of several recent studies indicate that very few mussel species have successfully reproduced in this river reach during the last 30 or more years. In order to ensure that plant operations have minimum adverse effects on those species and the mussel population in general, TVA will continue to monitor the mussel beds.

Concentration of Heavy Metals. The TVA EIS stated that no heavy metals would be added to the plant discharge and that concentration of metals already existing in the raw intake water would be the only factor involved; however, zinc sulfate is now being added to control corrosion of carbon steel. TVA conducted a number of studies designed specifically to address toxicity of chemical use described in Section 4.4, which includes zinc sulfate. These studies included a year of monthly whole effluent toxicity (WET) testing of NPDES Permit Outfall 101 effluent to the Tennessee River during chemical use by the facility. Based on these studies, applicable NPDES limits should be fully protective and the levels of these chemicals in the discharge are not expected to have adverse impacts.

Special studies also were conducted to compare the sensitivity of organisms used regularly in NPDES biomonitoring with the sensitivity of freshwater mussels (*Anodonta imbecillis*, juvenile freshwater mussels) which are part of the benthic community downstream from the facility. Results indicate that *Ceriodaphnia dubia*, a daphnid included in NPDES toxicity biomonitoring, is significantly more sensitive than any other species evaluated, including juvenile mussels. Additionally, the EPA Ambient Water Quality Criteria Document for zinc, which lists 35 genus mean acute values for zinc, ranks *Ceriodaphnia* as the most sensitive genus, consistent with TVA's study results.

Monthly WET testing has failed to show any deleterious lethal or sublethal effects to either daphids or *Pimephales promelas* (fathead minnows) exposed to undiluted effluent from Outfall 101 (permitted toxicity limit: 96-h LC50=9.8% effluent, 7-day

NOEC=2.9% effluent). WET testing of Outfalls 101 and 112 (runoff holding pond) is currently being conducted and reported semiannually under NPDES biomonitoring requirements. These requirements are to ensure that chemicals discharged from WBN, including zinc sulfate, are not present in toxic amounts in the receiving water.

Use of Molluscicides. A number of chemicals are used at WBN (identified in Section 4.4, Table 4-2) including the molluscicide ClamTrol [active ingredients: dodecylguanidine hydrochloride (DGH) and n-alkyl dimethyl benzyl ammonium chloride (QUAT)], used to kill Asiatic clams and prevent microbiologically induced corrosion (MIC). This molluscicide would likely be used in the future to control Zebra Mussels.

TVA has conducted toxicity assessments of this molluscicide alone and in combination with other chemical additives used at WBN and has concluded that significant effects on aquatic life are not anticipated due to the amounts used, the frequency of use, and the rapid dilution once this material reaches the river. These studies also have shown that ClamTrol is 15 times more toxic to *Ceriodaphnia dubia* than to the most sensitive juvenile life-stage freshwater mussel tested when silt was present in the test. ClamTrol also was more toxic to *Ceriodaphnia dubia* than to other non-target species evaluated, including fathead minnows, and rotifers (*Brachionus calyciflorus*). Because of the sensitivity of the WET biomonitoring organism, *Ceriodaphnia dubia*, to this molluscicide, it is concluded that ongoing biomonitoring is sufficient for evaluating continued use of ClamTrol If adverse effects do occur, a different molluscicide would be employed following appropriate effects testing. NRC concluded in its SEIS that "the impact to aquatic life from discharges from the WBN site will be minimal." (SEIS, p. 5-9).

5.5.3 Endangered and Threatened Species

Following the enactment of the Endangered Species Act in 1973, several Tennessee River freshwater mussels, a few large-river fish, and several primarily terrestrial species have been listed by the U.S. Fish and Wildlife Service as endangered or threatened (E&T). Information collected since release of the 1972 EIS and the 1976 Information Supplement indicate that one threatened fish (snail darter, *Percina tanasi*), and four endangered freshwater mussels (fanshell, *Cyprogenia stegaria*; dromedary pearly mussel, *Dromus dromas*; pink mucket, *Lampsilis orbiculata*; and rough pigtoe, *Pleurogema plenum*) occur in the first ten miles of the Tennessee River downstream from Watts Bar Dam. Two endangered terrestrial animals (bald eagle, *Haliaetus leucocephalus*; and gray bat, *Myotis grisescens*) also occur in the vicinity of WBN plant.

As indicated in a biological assessment which TVA prepared with the assistance of NRC, operation of WBN is not likely to affect individuals or populations of any endangered or threatened species. While releases of radioactive, thermal, and chemical discharges have the potential to impact these species, NPDES and

radiological regulatory requirements establish limits that will protect sentive aquatic species. Estimates and sister-plant monitoring data indicate that there should be no impacts from radioactive discharges, increases in water temperature will be minor and within natural fluctuations, and chemical discharges, which have been shown to be non-toxic, will continue to be tested using aquatic species more sensitive than fish or freshwater mussels. FWS concurred with the determination that operation of WBN will likely have no adverse effect on any endangered or threatened species. The biological assessment and FWS's biological opinion are included in Appendix D of the NRC SEIS. Several commenters questioned the adequacy of the toxicity testing that TVA employs to ensure that endangered mussel species are not impacted by discharges from the plant. NRC appropriately and adequately responded to these concerns in the SEIS at pp. 9-13 to 9-15.

5.6 Land Use

Onsite Impacts. The 1972 EIS evaluated the impact of converting the WBN site area of 387 hectares (967 acres) to industrial use. Site boundaries have not changed and development has essentially occurred as planned with the exception of the visitors center and a training center for nuclear plant operators. The visitors center originally was to include an overlook and a freestanding visitors lobby. The visitors center, which is now called the Energy Connection Center, is a small part of the 90,000 square foot training center which has been in use for approximately seven years. The training center now includes an overlook outside the Energy Connection Center looking over the plant.

Offsite Impacts. Offsite land use includes approximately 803 hectares (2,008 acres) utilized for transmission lines. These lines were built as planned. They produce the only direct offsite land use impacts, which were evaluated in the TVA EIS. See section 5.11 for discussion of impacts of transmission line operations and maintenance.

5.7 Historical and Archaeological Sites

Information on archaeological and historical sites in the 1972 EIS continues to be valid. A December 1970 archaeological reconnaissance survey identified areas of potential archaeological significance on the WBN site. These areas consisted of a single Early Mississippian platform mound (Leuty Mound 40RH6) and a group of five Late Woodland period Hamilton mounds (McDonald site 40RH). Mitigation of potential adverse project impacts to these mounds was undertaken in 1971 and described in a 1978 report entitled *Excavation of the Leuty and McDonald Site Mounds* by G. F. Schroedl. Two open habitation areas adjacent to the Mississippian platform mound were noted in the 1971 excavations and mitigation of potential adverse project impacts. Excavation of these areas was undertaken in 1972 (Calabrese, F. A. 1976). Results of both data recovery excavations were coordinated with and concurred in by the Tennessee State Historical Preservation Office (SHPO). Section 2.6 of the SEIS addresses these resources.

Archaeological sites exist along the reservoir shoreline, downstream from the plant construction area. These sites were avoided by plant construction activities and will not be impacted by plant operations. TVA continues to preserve and protect these sites.

Transmission line corridors associated with the project were surveyed and no sites were encountered that were potentially eligible for the National Register of Historic Places. No-effect results regarding transmission line construction and subsequent maintenance and operation impacts were concurred with by the Tennessee SHPO.

No unknown archaeological sites and structures of historical significance were encountered during any phase of WBN construction.

5.8 Regional Demography

5.8.1 Populations Changes

Population projections in the TVA EIS have been updated based on the 1990 Census of Population and new projections by the Bureau of Economic Analysis (WBN Final Safety Analysis Report, Amendment 83). Revised population distribution data based on the 1990 Census of Population show that approximately 15,500 and 862,500 people lived within 10 miles and 50 miles, respectively, of the Watts Bar site in 1990. The 10-mile population is projected to grow to about 17,900 by the year 2040. The 50-mile population is projected to reach slightly more than 1 million by the year 2040. This is consistent with the EIS projections for the year 2020 of more than 14,000 for the 10-mile population and more than 900,000 for the 50-mile population.

The nearest population center is Cleveland, Tennessee, which had a 1990 population of 30,354. Cleveland is located approximately 30 miles south of the Watts Bar site. Additional detail and discussion regarding regional demography are found in NRC's SEIS. General population changes are presented in section 2.1.1; general socioeconomic changes are presented in section 2.1.2; the effects of the population changes on dose calculations are found in section 5.5.2; and Appendix C of the SEIS provides a more complete presentation of the population data. The most important observation by NRC staff was that there was no significant change in the projected population within 50 miles at the planned expiration of the operating license.

5.9 Socioeconomics

The TVA EIS projected a commercial operations workforce of fewer than 200 employees and concluded that no significant impacts were likely to occur. Current projections of commercial operations employment for the summer of 1995 include about 1300 personnel, which includes 450 associated with Unit 2. Socioeconomic impacts are still not likely to be significant for the following reasons.

First, TVA implemented a socioeconomic impact mitigation program in 1973 that continued until 1984. During the course of that program, TVA provided $1.6 million directly to Rhea and Meigs Counties to assist in the provision of local government services and facilities. The two counties received financial assistance for law enforcement and education in the amounts of $698,000 and $675,000, respectively. The remaining $237,000 was distributed among a number of other service functions such as fire protection, solid waste, and health recruitment.

Second, TVA makes tax-equivalent payments to the State of Tennessee. A portion of these payments are redistributed to local governments in the Watts Bar area. For example, in fiscal year 1992, local governments in Rhea County received a total of $808,000 in redistributed tax-equivalent payments. Similarly, local governments in Meigs County received a total of $593,000. These payments have increased substantially since 1980 when Tennessee implemented its current redistribution formula. Payments in 1980 totaled $216,000 to Rhea County and $138,000 to Meigs County. Section 5.7 and Appendix C of NRC's SEIS contain additional data and discussion on how the payments were calculated, the type and amounts paid to the local governments in the eight counties around WBN, and the total revenue of these governments for fiscal year 1992.

Third, the 1,300 operating personnel have been largely integrated into the surrounding local communities. Most of these employees have been onsite since late 1992. Some minor, short-term economic impacts may occur as the construction employment, totaling about 3,600 in December 1992, is phased out prior to WBN operation. However, the area's economy has experienced a number of similarly sized employment swings over the project's extended construction period with essentially no adverse effects. Employees at the project are distributed widely in the region, and that distribution contributes to the lack of significant impacts resulting from the reduction of construction employment. In particular, past employment reductions have not caused a serious softening of the real estate market so none is expected as a result of this reduction. In addition, a four-lane highway linking the Dayton area with Chattanooga has recently been opened which is likely to create additional demand for local real estate. Therefore, no adverse impact on the tax base is expected. Section 5.7 and Appendix C of NRC's SEIS contain additional detail on this issue. NRC determined that there should be no socioeconomic effects associated with operation of WBN. See SEIS, pp. 5-24 to 5-26.

Although WBN was initiated in the early 1970's, NRC considered the potential effect that plant operations would have on "environmental justice" under Executive Order No. 12,898. That executive order was issued in 1994 and does not apply directly to TVA. However, TVA has reviewed NRC's analysis and agrees that any impact on low-income populations in the vicinity of WBN should be minimal. See SEIS, pp. 5-26 to 5-27.

5.10 Radiological Effects

Based on operational data from TVA's Sequoyah Nuclear Plant (SQN), TVA expects that the WBN dose data to be of the same magnitude as those projected in its 1972 EIS. TVA has determined that the doses to the public resulting from the discharge of radioactive

effluents from WBN will likely be less than 2% of the NRC guidelines given in 10 CFR 50, Appendix I, and that there will be no new or different effects on the surrounding environment due to these releases than those discussed in the EIS. NRC addressed potential radiological effects in detail in its SEIS at pp. 5-11 to 5-21. TVA's assessment of their potential impacts agrees with NRC's.

5.10.1 Radiological Impacts on Man

Radionuclides in Liquid Effluents. The exposure pathways to man used in the TVA EIS analysis remain valid. The pathways considered are illustrated in Figure 5-1. Several of the pathways included in the TVA EIS analysis are not considered in the current analysis of the impact of the release of radioactivity in liquid effluents to the area around the WBN site. These pathways are doses received from swimming in and boating on the Tennessee River. These pathways are no longer considered because they have been found at Sequoyah Nuclear Plant (SQN) to be several orders of magnitude lower than the dose received from shoreline recreation. The exclusion of these external dose pathways from the analysis does not significantly change the calculated dose commitments to individuals or populations since essentially all of the total body dose due to the release of radioactive material is accounted for by fish and water ingestion.

Doses to terrestrial vertebrates from the consumption of aquatic plants, and doses to aquatic plants, aquatic invertebrates, and fish have not been reassessed in the current analysis of the impact of radioactivity in liquid effluents. As indicated by the TVA EIS, doses to these organisms are less than or equal to the doses to humans.

Current analyses, contained in the WBN FSAR, of potential doses to members of the public due to releases of radioactivity in liquid effluents are calculated using the models presented in NUREG-0133 and Regulatory Guide 1.109, Revision 1. These models are essentially those used in the TVA EIS, and are based on the International Commission of Radiological Protection Publication 2. Changes in the model assumptions since the release of the EIS include: the calculation of doses to additional organs (kidney and lung); river water use (ingestion, fish harvest, and recreational data have been updated using more recent information (Table 5-2)); a decay time between the source and consumption is handled as described in Regulatory Guide 1.109; only those doses within a 50-mile radius of Watts Bar are considered in the population doses; and the population data are updated and projected through the year 2040. Transfer coefficients, consumption rates, and bioaccumulation factors used are those presented in the documents listed above, or more recent data, if available. The models and input variables used are those presented in the Watts Bar Offsite Dose Calculation Manual, which was approved by the NRC on July 26, 1994. The estimated radioactive releases used in the analysis are given in Table 5-3. A companion figure, illustrating the release points for radioactive effluents from WBN is presented in Figure 5-2. A tabulation of the resulting calculated doses is given in Table 5-4.

Figure 5-1

WATTS BAR NUCLEAR PLANT
PATHWAYS FOR EXPOSURE TO MAN

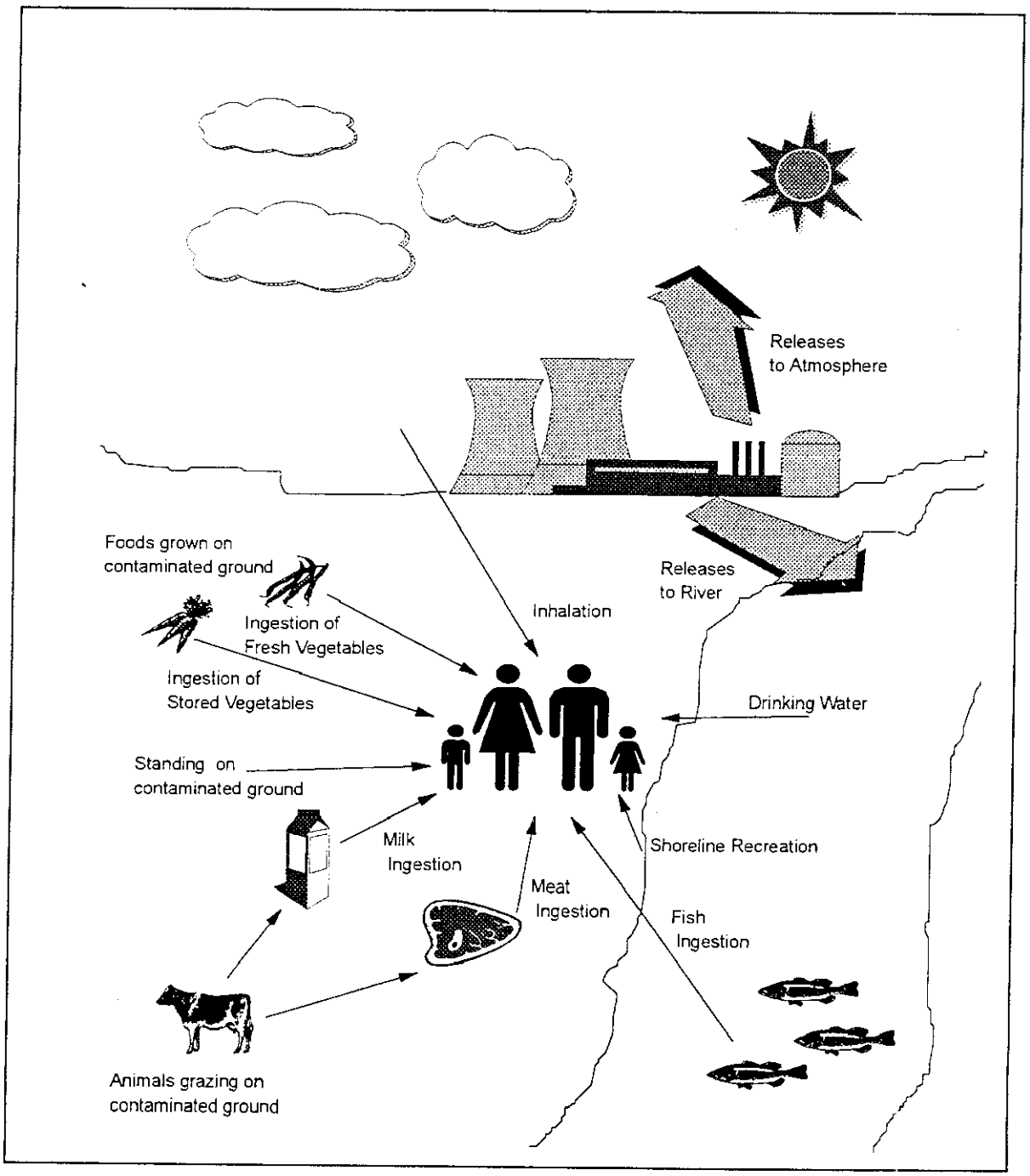


Table 5-2

Watts Bar Nuclear Plant River Water Usage Data
Tennessee River Reaches Within 50 Mile Radius Downstream of WBN

Name	Beginning TRM	Ending TRM	Size (acres)	Estimated 2040 Recreation visits/year
Chickamauga Lake below WBN	528.0	510.0	4799	105,650
Chickamauga Lake above Sequoyah Nuclear Plant	510.0	484.0	22101	1,133,360
Chickamauga Lake below Sequoyah Nuclear Plant	484.0	471.0	9889	6,481,100
Nickajack Lake (Part 1)	471.0	460.0	1799	248,000

Public Water Supplies Within 50 Mile Radius Downstream of WBN

Name	TRM	Estimated 2040 Population
Dayton, TN	503.7	16,740
E. I. DuPont	469.9	43,400
Chattanooga, TN	465.3	207,700

Estimated Fish Harvest for Year 2040: 3.77 lbs/acre
TRM - Tennessee River Mile

Table 5-5 compares the estimated annual liquid releases and resulting doses as presented by the TVA EIS, the WBN FSAR (Amendment 89), and recent historical data from TVA's SQN (as submitted in the Semi-Annual Radioactive Effluent Reports to the NRC). The SQN data is relevant since the WBN plant radioactive waste system design is essentially the same as SQN and the WBN radwaste systems are expected to be operated in much the same manner as those at SQN. A simplified diagram of the WBN radwaste system is shown in Figure 5-4. The period chosen most closely represents expected WBN operation of its liquid radwaste system (that is, the use of demineralizers versus evaporators to treat liquid radwaste).

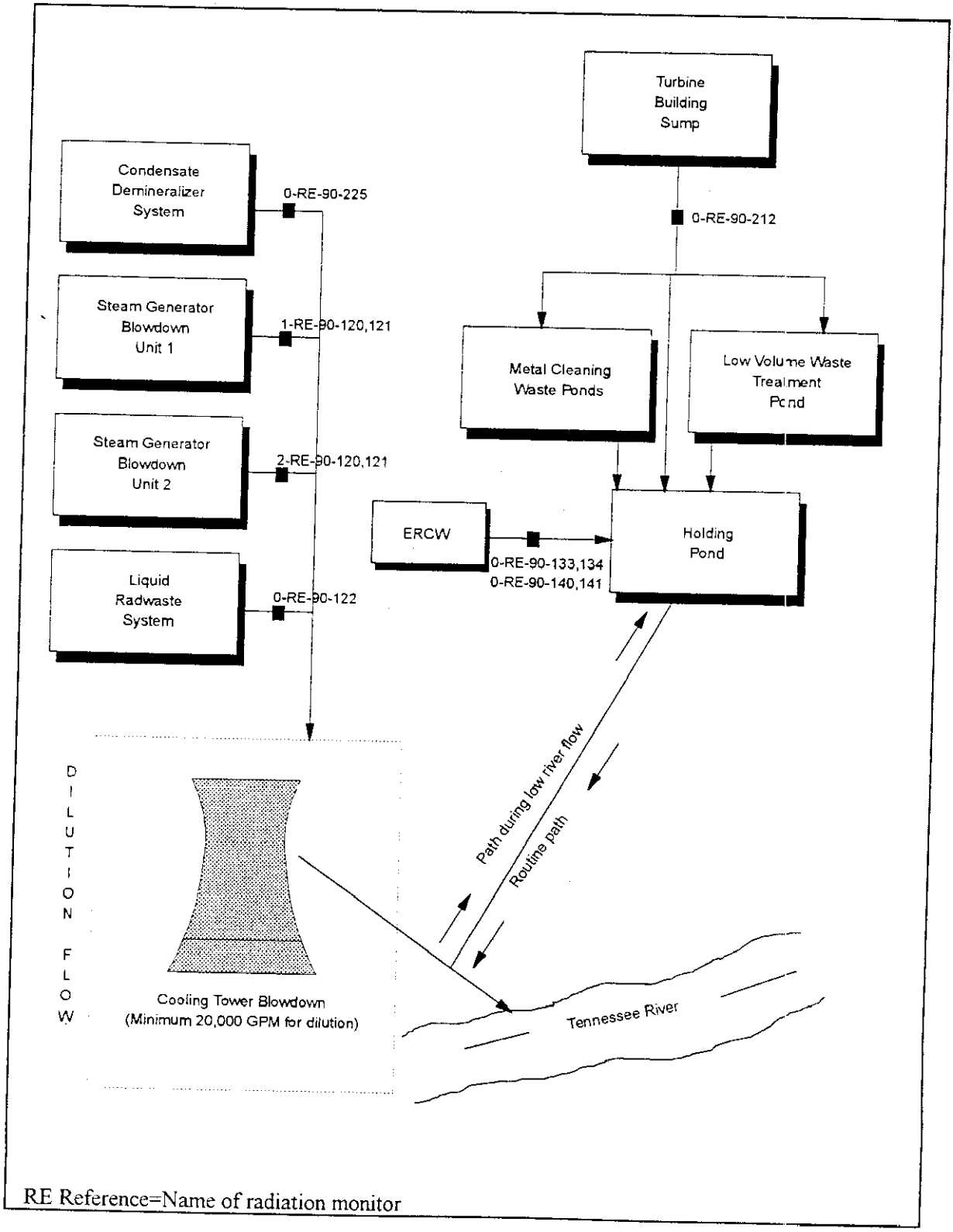
Table 5-3

Watts Bar Nuclear Plant Total Annual Discharge - Liquid Waste Processing System (for two unit operation)

Nuclide	Total
Br-84	7.39E-04
I-131	9.42E-01
I-132	1.11E-01
I-133	7.76E-01
I-134	3.32E-02
I-135	4.25E-01
Rb-88	1.44E-02
Cs-134	1.90E-01
Cs-136	1.86E-02
Cs-137	2.53E-01
Na-24	1.80E-01
Cr-51	8.66E-02
Mn-54	4.98E-02
Fe-55	4.64E-02
Fe-59	1.19E-02
Co-58	1.56E-01
Co-60	4.22E-02
Zn-65	1.32E-02
Sr-89	3.77E-03
Sr-90	3.47E-04
Sr-91	2.28E-03
Y-91m	1.34E-03
Y-91	4.14E-04
Y-93	1.04E-02
Zr-95	1.22E-02
Nb-95	1.12E-02
Mo-99	8.62E-02
Tc-99m	7.74E-02
Ru-103	1.95E-01
Ru-106	2.37E+00
Te-129m	4.77E-03
Te-129	6.04E-03
Te-131m	1.14E-02
Te-131	2.25E-03
Te-132	2.52E-02
Ba-140	2.92E-01
La-140	4.22E-01
Ce-141	4.22E-03
Ce-143	2.29E-02
Ce-144	1.12E-01
Np-239	2.71E-02
H-3	2.58E+03
Total (w/o H-3)	7.05E+00

Figure 5-2

Watts Bar Nuclear Plant
Liquid Effluent Release Points



RE Reference=Name of radiation monitor

Table 5-4

Watts Bar Nuclear Plant
Doses From Liquid Effluents for Year 2040

Individual Dose (mrem)							
ADULT							
Total Body	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
0.72	0.57	0.19	0.72	0.96	0.36	0.14	0.038
TEEN							
Total Body	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
0.43	0.60	0.15	0.67	0.98	0.36	0.16	0.038
CHILD							
Total Body	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
0.20	0.74	0.093	0.77	0.87	0.32	0.14	0.038
INFANT							
Total Body	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
0.043	0.047	0.049	0.23	0.047	0.045	0.043	0.038
Population Dose (Person-rem)							
Total Body	Bone	GIT	Thyroid	Liver	Kidney	Lung	Skin
1.98	2.11	2.98	9.67	2.36	1.86	1.49	1.533

Several conclusions can be drawn from the data in Table 5-5: (1) the WBN FSAR estimates, even though based on very conservative (worst-case) assumptions, indicate that estimated doses continue to meet the dose guidelines given in 10 CFR Part 50, Appendix I; and (2) recent SQN operational data for liquid effluents indicates that actual releases and resulting dose estimates to the public are a small fraction of the Appendix I guidelines (averaging about 2% or less). Based on these conclusions, the analyses of radiological impact to man from liquid releases in the TVA EIS continue to be valid.

Table 5-5

Comparison of Estimated Annual Liquid Releases and Resulting Doses

	WBN EIS (Table 2.4-2)	WBN FSAR	SQN History (1987-93 Average)	10 CFR 50 Appendix I Guidelines
Tritium Released	1.46E+02 Ci	2.58E+03 Ci	8.7E+02 Ci	
Activity Released	3.2E-01 Ci	8.83E+01 Ci	4.8E-01 Ci	10 Ci
Total Body Dose	1.7E-02 mrem	7.2E+00 mrem	8.0E-02 mrem	3 mrem
Maximum Organ Dose	5.5E-02 mrem	9.8E+00 mrem	1.0E-01 mrem	10 mrem

Radionuclides in Gaseous Effluents. The exposure pathways used in current analyses of the impact of radioactive material released in gaseous effluents are expanded from those used in the 1972 EIS. The pathways considered are illustrated in Figure 5-1. These pathways include external doses due to noble gases, and internal doses from particulates due to inhalation, and the ingestion of milk, meat and vegetables from the area around WBN. Changes in the model assumptions since the publication of the TVA EIS include: the calculation of internal doses to additional organs (bone, liver, total body, GI tract, kidney and lung); actual land use survey results are used (shown in Table 5-6); and the population data are updated and projected through the year 2040. Current analyses of potential doses to members of the public due to releases of radioactivity in gaseous effluents are calculated using the models presented in NUREG-0133 and Regulatory Guide 1.109, Revision 1. These models are those used in the TVA EIS, and are based on the International Commission of Radiological Protection Publication 2. Transfer coefficients, consumption rates, and bioaccumulation factors used are those presented in the documents listed above, or more recent data, if available. The models and input variables used are those presented in the Watts Bar Offsite Dose Calculation Manual, which was approved by the NRC in July 1994. The estimated radioactive releases used in the analysis are given in Table 5-7. A companion figure, illustrating the release points for radioactive effluents from Watts Bar is presented in Figure 5-3. A tabulation of the resulting calculated doses is given in Table 5-8.

Figure 5-3

Watts Bar Nuclear Plant
Gaseous Effluent Release Points

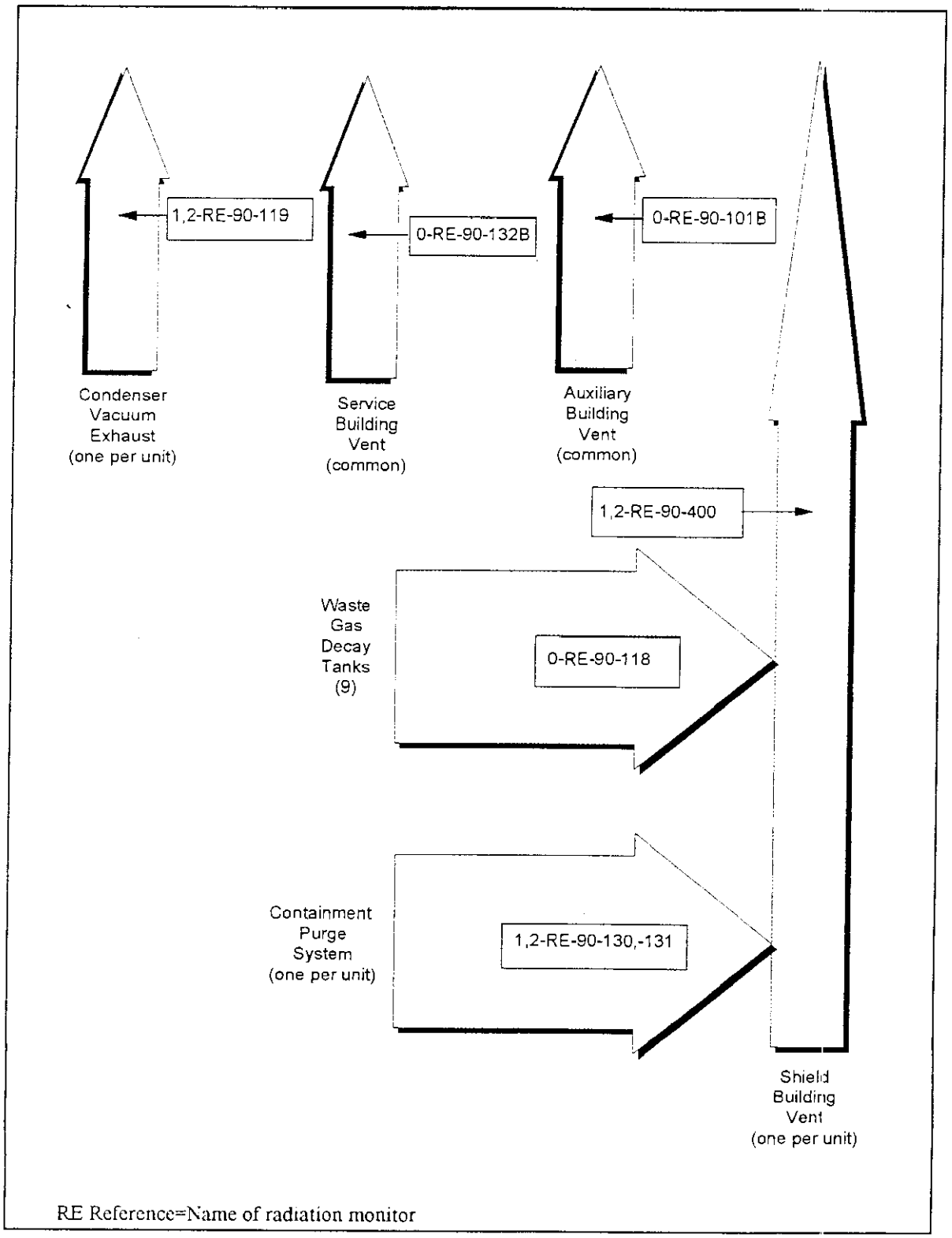


Table 5-6

Watts Bar Nuclear Plant
Receptors Used For Gaseous Releases

Point	Sector	Distance (meters)	Point	Sector	Distance (meters)
Site Boundary	N	1550	Garden	N	4572
Site Boundary	NNE	1980	Garden	NNE	3962
Site Boundary	NE	1580	Garden	NE	3810
Site Boundary	ENE	1370	Garden	ENE	2896
Site Boundary	E	1280	Garden	E	3139
Site Boundary	ESE	1250	Garden	ESE	4633
Site Boundary	SE	1250	Garden	SE	7620
Site Boundary	SSE	1250	Garden	SSE	1676
Site Boundary	S	1340	Garden	S	1829
Site Boundary	SSW	1550	Garden	SSW	2073
Site Boundary	SW	1670	Garden	SW	8100
Site Boundary	WSW	1430	Garden	WSW	2743
Site Boundary	W	1460	Garden	W	3200
Site Boundary	WNW	1400	Garden	WNW	1584
Site Boundary	NW	1400	Garden	NW	3170
Site Boundary	NNW	1460	Garden	NNW	4572
Nearest Resident	N	2134	Milk Cow	E	8839
Nearest Resident	NNE	3656	Milk Cow	ESE	5791
Nearest Resident	NE	3353	Milk Cow	ESE	6553
Nearest Resident	ENE	2926	Milk Cow	ESE	7620
Nearest Resident	E	3139	Milk Cow	SSW	2438
Nearest Resident	ESE	4700	Milk Cow	SSW	2073
Nearest Resident	SE	1400	Milk Cow	WNW	7925
Nearest Resident	SSE	1524	Milk Goat	WSW	6553
Nearest Resident	S	1585			
Nearest Resident	SSW	2100			
Nearest Resident	SW	4300			
Nearest Resident	WSW	2100			
Nearest Resident	W	2900			
Nearest Resident	WNW	1500			
Nearest Resident	NW	3000			
Nearest Resident	NNW	4400			

Table 5-7

Watts Bar Nuclear Plant
Total Annual Discharge - Gaseous (Ci/year/reactor)

Nuclide	Containmen Building	Auxiliary Building	Turbine Building	Total per Unit
Kr-85m	1.99E+01	4.53E+00	1.23E+00	2.57E+01
Kr-85	6.90E+02	7.05E+00	1.86E+00	6.99E+02
Kr-87	1.09E+01	4.27E+00	1.09E+00	1.62E+01
Kr-88	2.83E+01	7.95E+00	2.13E+00	3.84E+01
Xe-131m	1.17E+03	1.73E+01	4.53E+00	1.19E+03
Xe-133m	4.63E+01	1.90E+00	5.21E-01	4.88E+01
Xe-133	3.12E+03	6.70E+01	1.77E+01	3.20E+03
Xe-135m	3.85E+00	3.68E+00	9.80E-01	8.51E+00
Xe-135	1.55E+02	2.40E+01	6.46E+00	1.85E+02
Xe-137	3.18E-01	9.67E-01	2.58E-01	1.54E+00
Xe-138	3.32E+00	3.42E+00	9.06E-01	7.65E+00
Ar-41	3.40E+01	0.00E+00	0.00E+00	3.40E+01
Br-84	6.00E-05	5.01E-02	4.81E-04	5.07E-02
I-131	7.29E-03	1.39E-01	7.08E-03	1.53E-01
I-132	1.60E-03	6.56E-01	1.70E-02	6.74E-01
I-133	3.55E-03	4.35E-01	2.03E-02	4.58E-01
I-134	1.66E-03	1.06E+00	1.47E-02	1.08E+00
I-135	3.16E-03	8.10E-01	3.13E-02	8.45E-01
H-3	1.37E+02	0.00E+00	0.00E+00	1.37E+02
Cr-51	9.21E-05	5.00E-04	0.00E+00	5.92E-04
Mn-54	5.30E-05	3.78E-04	0.00E+00	4.31E-04
Co-57	8.20E-06	0.00E+00	0.00E+00	8.20E-06
Co-58	2.50E-04	2.29E-02	0.00E+00	2.32E-02
Co-60	2.61E-05	8.71E-03	0.00E+00	8.74E-03
Fe-59	2.70E-05	5.00E-05	0.00E+00	7.70E-05
Sr-89	1.30E-04	2.85E-03	0.00E+00	2.98E-03
Sr-90	5.22E-05	1.09E-03	0.00E+00	1.14E-03
Zr-95	4.80E-08	1.00E-03	0.00E+00	1.00E-03
Nb-95	1.80E-05	2.43E-03	0.00E+00	2.45E-03
Ru-103	1.60E-05	6.10E-05	0.00E+00	7.70E-05
Ru-106	2.70E-08	7.50E-05	0.00E+00	7.50E-05
Sb-125	0.00E+00	6.09E-05	0.00E+00	6.09E-05
Cs-134	2.53E-05	2.24E-03	0.00E+00	2.27E-03
Cs-136	3.21E-05	4.80E-05	0.00E+00	8.01E-05
Cs-137	5.58E-05	3.42E-03	0.00E+00	3.48E-03
Ba-140	2.30E-07	4.00E-04	0.00E+00	4.00E-04
Ce-141	1.30E-05	2.64E-05	0.00E+00	3.95E-05
C-14	2.80E+00	4.50E+00	0.00E+00	7.30E+00

Figure 5-4

Watts Bar Nuclear Plant
Liquid Radwaste System

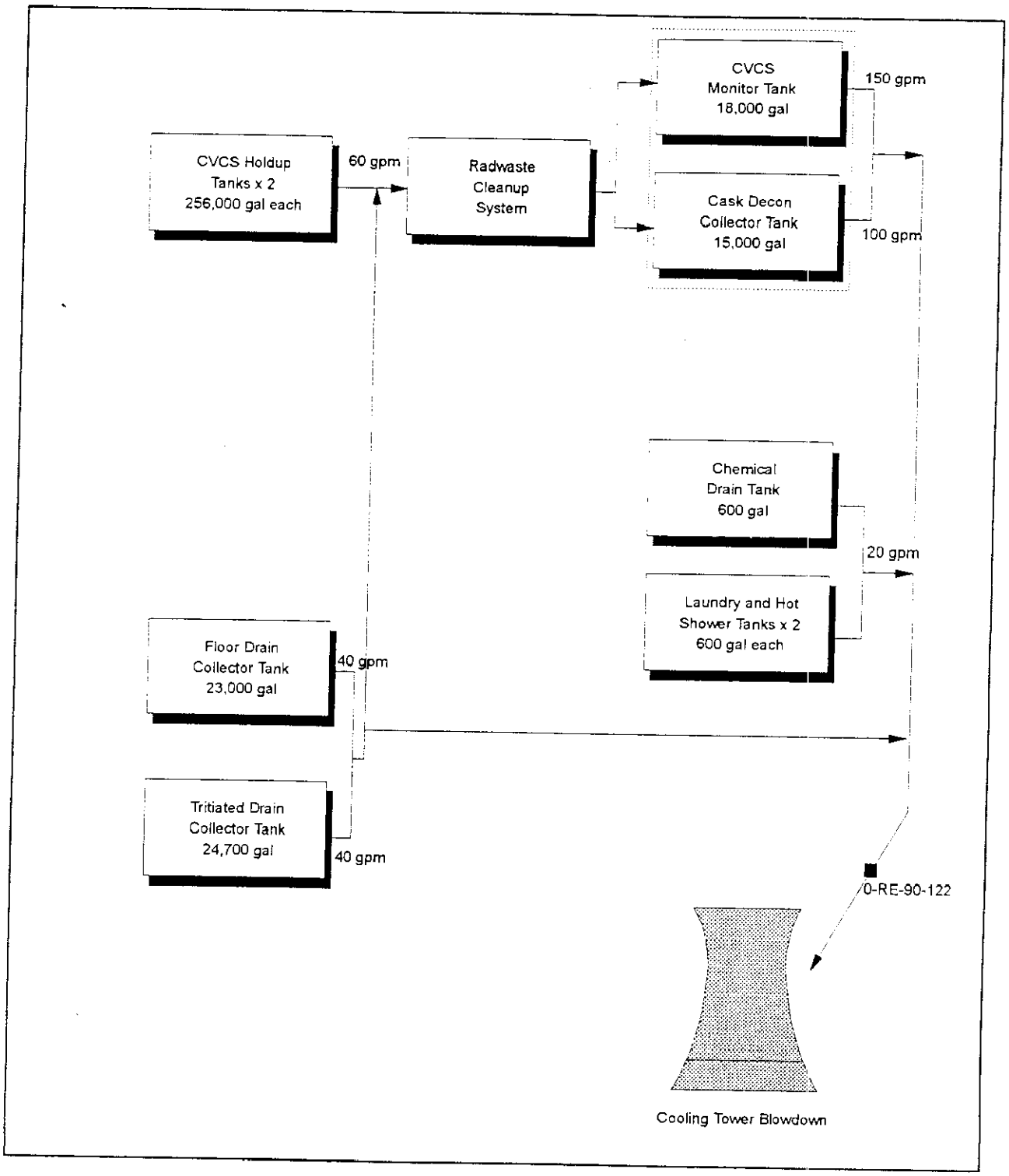


Table 5-8

Watts Bar Nuclear Plant
Doses (Per Unit) from Gaseous Effluents

Effluent	Pathway	Guideline	Point	Dose
Noble Gases	g Air Dose	10 mrad	Maximum Exposed Individual[1]	1.7 mrad/yr
	b Air Dose	20 mrad	Maximum Exposed Individual[1]	4.7 mrad/yr
	Total Body	5 mrem	Maximum Residence[2,3]	1.2 mrem/yr
	Skin	10 mrem	Maximum Residence[2,3]	3.4 mrem/yr
Iodines/ Particulates	Thyroid	15 mrem	Maximum Real Pathway[4]	15.0 mrem/yr

Breakdown of Iodine/Particulate Doses (mrem/year)	
Cow Milk with Feeding Factor of 0.7	14.0
Inhalation	0.6
Ground Contamination	0.2
Submersion	0.2
Beef Ingestion[1]	0.0
Total	15.0 mrem/year

* Guidelines are defined in Appendix I to 10 CFR Part 50.
[1] Maximum exposure point is at 1250 meters in the SE sector.
[2] Dose from air submersion.
[3] Maximum exposed residence is at 1400 meters in the SE sector.
[4] Maximum exposed individual is an infant at 2438 meters in the SSW sector.

The validity of the site boundary dispersion data used for the dose estimate is discussed in Section 5.2.4.

Table 5-9 compares the estimated annual airborne releases and resulting doses as presented by the TVA EIS, the WBN FSAR (Amendment 89), and recent historical data from TVA's SQN (as submitted in the Semi-Annual Radioactive Effluent Reports). The SQN data is relevant since the WBN plant radioactive waste system design is essentially the same as SQN and the WBN radwaste systems are expected to be operated in much the same manner as those at SQN.

Table 5-9

Comparison of Estimated Annual Airborne Releases and Resulting Doses

	WBN EIS (Table 2.4-2)	WBN FSAR	SQN History (1987-93 Average)	10 CFR 50 Appendix I Guidelines
Particulate Activity	3.0E-01 Ci	7.6E+00 Ci	0.48 Ci	10 Ci
Noble Gas Activity	7.0E+03 Ci	1.4E+04 Ci	840 Ci	N/A
External Dose	6.6E+00 mrad	6.2E+00 mrad	1.3E-01 mrad	10 mrad
Organ Dose	3.5E+00mrem (inhalation and milk only)	1.1E+01 mrem (all pathways)	2.0E-02 mrem (all pathways)	15 mrem

Several conclusions can be drawn from the data in Table 5-9: (1) the WBN FSAR estimates, even though based on very conservative (worst-case) assumptions, indicate that estimated doses continue to meet the dose guidelines given in 10 CFR Part 50, Appendix I; and (2) recent SQN operational data for airborne effluents indicates that actual releases and resulting dose estimates to the public are a small fraction of the Appendix I guidelines (averaging about 1% or less). Based on these conclusions, the analyses of radiological impact from airborne releases in the TVA EIS continue to be valid.

Population Doses. The estimated year 2000 50-mile population used in the EIS analyses was 1,050,000. Estimates used in current dose analyses estimate the year 2030 50-mile population as 1,100,000. These values indicate that the expected 50-mile population at the expiration of the operating license has not significantly changed from that used in the original analyses. Table 5-10 below presents the estimated population doses as presented by the TVA EIS, the WBN FSAR

and recent historical data from TVA's SQN (as submitted in the Semi-Annual Radioactive Effluent Reports).

The SQN operational data, which is based on similar operation and population distributions as WBN, supports the EIS conclusions.

Releases to Sanitary Sewers. Releases to sanitary sewage systems from WBN will be sampled for radioactivity. Any identified radioactivity will be evaluated for its source. If the source of the radioactivity is determined to be from plant operation, the sewage will be not be released to the sewer system, but will be treated as radioactive waste.

Table 5-10

Estimated Total Population Doses for Year 2040

WBN EIS (Table 2.2-4)	WBN FSAR	SQN History (1987-93 Average)	10 CFR 50 Appendix I Guidelines
3.1E+01 man-rem	2.2E+01 man-rem	5.0E+00 man-rem	N/A

5.11 Transmission Line Operations and Maintenance

5.11.1 Right-of-Way Maintenance

The transmission lines into and out of WBN have been constructed and energized. The transmission line right-of-way maintenance program for the Watts Bar transmission lines is governed by the owner's existing land use, the vegetation type existing on the right-of-way, growth rates and the terrain along the line route. Transmission lines which cross privately held land are managed in as much as is possible in accordance with the requests of the landowner. Transmission line corridor maintenance is typically performed by mowing or herbicide spraying on a 3- or 4-year cycle. Both types of maintenance eliminate living vegetation over a few centimeters in height and greatly reduce the food and cover available to the local wildlife populations. As regrowth of vegetation occurs, wildlife including local bird populations increase and become dominated by species inhabiting shrubs and woodland edges. Although the habitat changes due to cyclic maintenance impact local populations, these impacts are not regionally significant because of the staggered maintenance cycles of different transmission lines. Toxic effects of properly applied herbicides have not been identified as significant. Based on TVA's transmission line maintenance procedures no significant impacts are expected to any animal species and no impacts are expected to any threatened or endangered species.

The NRC SEIS considers potential impacts from operation and maintenance of the transmission lines associated with operation of WBN at pp. 5-1, 5-5, and 5-22. NRC specifically addressed the potential risks associated with electromagnetic fields and shocks. TVA concurs with these discussions.

5.11.2 Electromagnetic Fields and Shock Hazard

TVA recognizes that concerns exist about the possible effects of EMF on human health. Research is continuing which is devoted to determining if there are effects and what impact any effects may have on health. TVA is aware of and ensures that it stays aware of the published research and study results. A number of studies have been performed to date, both epidemiological and laboratory-related. Numerous uncertainties surround the information obtained from these studies. Some studies suggest a statistical association between 60-hertz EMF and specific types of cancer, however other studies have not shown such a relationship, and no cause-and-effect relationship has been established between EMF exposure and cancer or other disease.

TVA's design criteria for its transmission lines include a minimum clearance above ground which varies depending upon the underlying land use. These clearances exceed the requirements of the National Electric Safety Code and ensure that the shock hazard associated with TVA's lines is minimized.

5.12 Environmental Impact of Postulated Accidents

The 1972 EIS evaluated the potential impacts of various accident scenarios (including those caused by successive failure of the plant's engineered safety features) resulting in severe accidents with serious environmental impacts. The EIS concluded that the risk of such accidents was extremely low. Since the EIS was issued, NRC has required licensees to consider the risk of severe accidents in more detail, including accident mitigation design alternatives. These design alternatives are possible plant design modifications that are intended to lessen the impact of severe accidents. This more detailed review is entitled *Severe Accident Mitigation Design Alternative (SAMDA)* Analysis and is developed in the context of an *Individual Plant Examination (IPE)*. TVA completed the WBN IPE, which was submitted to NRC for approval on September 30, 1992, and updated on June 30, 1994. In accordance with NRC regulations, this process will continue to ensure that the risk of significant impacts for severe accidents will be extremely low. In its 1995 SEIS, NRC concluded that, except for three procedural changes which TVA has committed to make, two operator procedure enhancements and one procedural change to enhance risk protection, none of the SAMDAs would be cost beneficial for further mitigating the risk of severe accidents. NRC's analysis of SAMDAs and potential accidents is set forth at pp. 7-1 to 7-3 of their SEIS.

TVA's current analyses for design basic accidents are described in the WBN Final Safety Analysis Report (FSAR), Chapter 15. The probability of beyond design basis core damage (Class 9) events have been conservatively estimated to be 8.0×10^{-5} per reactor year. This probability estimate applies to core damage and does not constitute the probability of impact to the environmental or general population. Mitigation factors that determine ultimate environmental consequence include site meteorology, population density, containment failure probability, fission product retention time, and release fractions for various isotopes. The likelihood of large accident with fission product release remains extremely low.

6.0 Decommissioning

Post-operational impact considerations were addressed in the 1972 EIS under short-term versus long-term productivity and irreversible and irretrievable commitment of resources.

At the end of the operating life of WBN, termination of its operating license by the NRC is a desired objective. Such termination requires that the units be decommissioned. This means that the units will be safely removed from service and that any residual radioactivity will be reduced to a level that permits release of the site for unrestricted use. A number of factors will influence how WBN will be decommissioned. These include:

- Potential use of the site for other purposes.
- Cost of alternative decommissioning approaches.
- Minimization of radiation exposure.
- Availability of low-level nuclear waste disposal space.
- Availability of high-level waste repository.
- Regulatory requirements.
- Public preferences.

TVA has not proposed a decommissioning plan for WBN at this time. This decision will be made in accordance with the NRC decommissioning requirements. Deciding on a decommissioning approach will be preceded by an appropriate environmental review.

In 1988, NRC released a *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*. This EIS assessed the potential decommissioning impact of a number of different kinds of nuclear facilities, including pressurized water reactors which includes WBN Unit 1. Among its conclusions, NRC stated on pages x-xi of its EIS:

> *The technology for decommissioning nuclear facilities is well in hand and while technical improvements in decommissioning techniques are to be expected decommissioning at the present time can be performed safely and at reasonable cost. Radiation dose to the public due to decommissioning activities should be very small and be primarily due to transportation of decommissioning waste to waste burial facilities. Radiation dose to decommissioning workers should be a small fraction of their exposure experienced over the operating lifetime of the facility and be well within the occupational exposure limits imposed by regulatory requirements . . . . . .*
>
> *Decommissioning of a nuclear facility generally has a positive environmental impact. At the end of the facility life, termination of a nuclear license is the goal. Termination requires decontamination of the facility so that the level of any residual radioactivity remaining in the facility or on the site is low enough to allow unrestricted use of the facility and site. Commitment of resources, compared to operational aspects, is generally small. The major environmental impact of decommissioning is the commitment of small amounts of land for waste burial in exchange for reuse of the facility and site for other purposes.*

TVA concurs with these determinations. The methods for decommissioning reactors are well known. The three basic options are:

1. The **DECON** Option involves the prompt removal of fuel assemblies, source material, radioactive fission and corrosion products, and all other radioactive and contaminated materials, above NRC unrestricted release levels, from the plant. The reactor pressure vessel and internals would be removed along with removal and demolition of the remaining systems, structures, and components with contamination control employed as required. The site may then be released for unrestricted use. This is the most expensive of the three options.

2. The **SAFSTOR** Option involves removing all fuel assemblies, nuclear source material, radioactive liquid, and solid wastes from the plant. The remaining physical structure would then be secured and mothballed. External doors and hatches would be locked and secured to prevent unauthorized entry. Systems needed to monitor the facilities would be used throughout the dormancy period. A full-time security force would have to be maintained at the plant. After a time period of up to 60 years, the facility would then be decontaminated to NRC unrestricted release levels and the site would be released for unrestricted use. This option is essentially deferred decontamination, which takes advantage of the natural dissipation of almost all of the radiation. Dismantling of structures would occur after the dormancy period.

3. The **ENTOMB** Option consists of sealing or entombing residual radioactive or contaminated materials and components within a structure that prevents access by unauthorized personnel. All nuclear source material, fuel assemblies, radioactive liquid wastes, and solid wastes would be removed prior to entombment. The entombment boundary would normally contain those portions of the reactor building above certain levels of radioactivity. A structurally long-lived material, such as concrete, would be used to seal the building . The objective of entombment is to keep the contaminated material and structure encased until NRC's unrestricted access levels are reached. This would likely take up to 100 years to achieve and for a few radioactive isotopes associated with nuclear reactors, a longer period could be necessary. Although NRC considers entombment and the other two options to be acceptable, its regulations presently require that decommissioning be completed with 60 years of shutdown. Absent a change in the regulations, it would therefore be necessary to institute some level of decontamination activities at the end of the entombment period to return the site to unrestricted use. In such an event, the SAFSTOR option would resemble the ENTOMB option.

These methods are subject to extensive regulation and pose no significant risks to human health or the environment. The potential impacts of disposing of high-level and low-level nuclear waste are discussed in section 5.10.3 The absence of significant risks is not expected to change over time.

TVA also agrees with NRC's determination in its decommissioning EIS that the costs of decommissioning are reasonable although industry cost estimates are higher than NRC's.

NRC currently estimates that it will cost up to $200 million to decommission a pressurized water reactor like WBN Unit 1. A survey of industry decommissioning cost estimates indicated that the average cost assumed in the industry for a decommissioning a pressurized water reactor is $300 million. TVA has established a nuclear decommissioning fund for all of its operating nuclear reactors. As of June 1994, $50 million had been accumulated in this fund. An additional $323 million is to be added to the fund in fiscal year 1996 to cover the decommissioning of TVA's Sequoyah and Browns Ferry units. With the initiation of operations at WBN Unit 1, payments into the fund will have to be increased to conform to regulatory limits.

The NRC SEIS addresses decommissioning at pp. 8-2 to 8-3. It also provided several detailed responses to comments about decommissioning at pp. 9-34 to 9-35 of the SEIS.

7.0 Conclusions

This supplemental environmental review reflects the manner in which TVA has incorporated changes in environmental considerations into the planning and decisionmaking process for operation of WBN Unit 1. TVA concluded in its 1972 EIS that construction and operation of WBN would affect the environment in several ways:

- Release of small quantities of radioactivity to air and water.
- Release of minor quantities of heat and non-radioactive waste waters to TVA's Chickamauga Reservoir and major quantities of heat and water vapor from WBN's cooling towers into the atmosphere.
- Change in site land use from farming to industrial.

Adverse effects to the environment as described in the 1972 EIS associated with plant construction have already occurred. Likewise, construction of WBN and Unit 1 has already resulted in certain irretrievable commitment of resources in the form of the materials and energy used to build the facility. Operation of WBN Unit 1 will irretrievably consume certain amounts of nuclear fuel and other materials such as chemicals. Considering decommissioning times, it should be assumed that operating WBN will essentially irreversibly commit the site to energy generation and industrial use . However, depending on future decisions about decommissioning requirements and methods, it is likely that only a small portion of the site would be irrevocably lost to any other use.

The studies and monitoring programs conducted on WBN since 1972 support the conclusion of the 1972 EIS. An interdisciplinary review of the 1972 EIS and subsequent environmental studies and monitoring programs concluded that:

> *Changes have occurred since the release of WBN's EIS in 1972. Most of these changes involve design modification or changes in expected operational practices which improve safety or lessen potential environment impacts. Additional information about environmental conditions in the vicinity of WBN has also been developed . None of the changes or new information materially impact projections in the EIS.*

This further review confirms these conclusions.

Based on results of environmental studies and analyses, environmental impacts associated with operation of WBN Unit 1 are not expected to be significant. TVA has obtained required environmental permits and established environmental monitoring programs that will help ensure that the environmental impacts of WBN operations are acceptable. Operation of WBN will provide a long-term source of environmentally safe electric energy for the TVA region.

TVA has also carefully reviewed the NRC SEIS. Much of the data and information presented in the SEIS was provided by TVA. TVA has determined that the NRC SEIS is adequate and meets the requirements for an SEIS.

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Appendix A

OPERATIONAL MONITORING PROGRAMS

Onsite Meteorological Program

The onsite meteorological monitoring program will continue during the operation of the plant. The permanent meteorological facility consists of a 91-meter instrumented tower and an environmental data station (EDS) that houses the data processing and recording equipment. A system of lighting and surge protection circuitry and proper grounding is included in the facility design. This facility is located approximately 760 meters south-southwest of the Unit 1 reactor building and has a base elevation of 217 meters above mean sea level.

Data collection at the permanent facility began May 23, 1973. Wind speed and direction are measured at 10 and 93 meters; temperature is measured at 1, 10, 46, and 91 meters; and dewpoint, solar radiation, atmospheric pressure, and rainfall are measured at 1 meter. Measurements of wind speed and direction at 46 meters and of dewpoint temperature at 10 meters began on September 16, 1976. The 1-meter dewpoint measurements were discontinued September 30, 1977, and the 93-meter wind sensors were moved to their present height on May 18, 1978. Measurements of 1-meter temperature and atmospheric pressure were discontinued on April 2, 1981.

Water Quality Studies

This remains unchanged from the 1972 EIS except that the demonstration of sufficiently low corrosion/erosion rate to assure protection of organisms will be accomplished by the toxicity testing program required by the NPDES permit.

Groundwater Studies

The information and analysis has not materially changed from that stated in the 1972 EIS.

Chemical Effluents Monitoring

The effluent monitoring requirements are specified in the NPDES permit.

Aquatic Biological Monitoring

The operational aquatic biological monitoring plan as outlined in the TVA EIS has been revised in light of additional information obtained from extensive biological studies conducted in Chickamauga Reservoir. Those studies are listed in Section 5.5.2, Table 5-1 of this document. The revised plan was submitted to the State of Tennessee in a letter dated September 8, 1993. The plan was subsequently approved and incorporated as a requirement of the WBN NPDES permit. The two components of the approved plan is described below.

I. Fishery Monitoring

Fish Impingement. Monitoring will commence when Unit 1 becomes operational. Numbers and species of fish impinged on the intake screens during a 24-hour period will be determined once each week during the period December through May, and once every two weeks during the period June through November. The low volume of water entering the intake combined with low intake velocity considerable reduces the possibility that fish impingement will be a problem at WBN. Appropriate modifications will be make in the sampling program as results dictate.

Larval Fish Entrainment Sampling. Samples will be collected biweekly March through August at five stations along a transect perpendicular to flow at Tennessee River Mile (TRM) 528. Samples will also be collected in the WBN cooling water intake channel.

Reservoir-Wide Creel Survey. Total catch, and fishing pressure and success for Chickamauga Reservoir will be estimated by counting and interviewing fisherman during five randomly selected days per week. These surveys are conducted by Tennessee Wildlife Resources Agency.

WBN Vicinity Creel. Catch rate, average weight and percent composition of each species harvested, fishing pressure and distribution of fishing effort will be estimated by collecting angler harvest data three days per week in the river reach between Watts Bar Dam (TRM 526.8). This survey will be conducted by TVA. The purpose of this survey will be to document any effects from operation of WBN on the popular sport fishery below Watts Bar Dam and to provide an indication of sport fish attraction to the WBN intake and discharge areas. It will be designed to provide comparison with preoperational data and assess the tailwater fishery in terms of fisherman success and satisfaction.

Cove Rotenone Sampling. Five coves in Chickamauga Reservoir will be sampled every other year to document long-term trends in reservoir fish standing stocks and species composition. The cove rotenone sampling contributes to a long term data base on reservoir fish populations that is a part of WBN and Sequoyah operation monitoring.

II. Water Quality and Aquatic Ecology (Non-Fish) Monitoring

Water Quality. Water Quality samples will be taken at four location in the vicinity of WBN six times between March and August during appropriate flow and operation conditions. Three of the surveys will include an evaluation of selected trace metal concentrations in the water, along with general water quality and biological support parameters.

Plankton. Preoperational monitoring showed extreme natural variation in phytoplankton plankton and zooplankton numbers in this tailwater location. Since hydraulic entrainment in to the cooling water system will be less than 1% of the mean

summertime flow past the plant, changes in numbers of plankters below the plant will be statistically undetectable. For that reason only chlorophyll samples will be taken as an indication of effects on phytoplankton biomass.

316(b) Intake Evaluation. The previous operational monitoring plan included provisions for a special study of the phytoplankton and zooplankton communities during different hydrological flow regimes to provide an estimate of the portion of the plankton communities being entrained in the WBN condenser cooling water. Because (1) WBN will be operating in closed mode, (2) the amount of cooling water used will be very small relative to river flow, and (3) there is not rational for assuming that plankton is not uniformly distributed throughout the water mass, the value of such a study was considered questionable and was deleted by the State of Tennessee.

Benthic Macroinvertebrates. Benthic macroinvertebrate sampling using Hess samplers will be conducted during summer and fall quarters at five stations between TRM 521.0 and 528.8.

Mussel Surveys. Biennial surveys in the tailwater mussel sanctuary will be continued with the addition of some quadrate samples to document reproductive success. Following two unit operation, an assessment and evaluation of bioaccumulation of selected trace metals by mollusks will be done. This will continue for at least three years after Unit 2 commercial operations.

Terrestrial Monitoring

Based upon supplemental information provided to NRC by letter dated April 22, 1980, TVA does not believe that operational monitoring of the cooling tower drift or a monitoring program for chemical control of vegetation on transmission line rights-of-way is necessary.

Over the many years since the cooling towers were constructed, WBN has not recorded any serious episodes of bird collisions, during migratory periods or otherwise. Accordingly, TVA does not expect any significant episodes of bird collisions with the site cooling tower.

Radiological Monitoring

WBN plans to continue the preoperational radiological monitoring program during the operating period. A full description of the program is contained in the Offsite Dose Calculation Manual, section 9, and is summarized in the Table A-1.

Table A-1

PREOPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Sample Types	Sampling Frequency	Sample Analysis
Air Filter	Continuous collection change filter weekly	Gross beta weekly, gamma on monthly composite, SR-89,90 on quarterly composite
Charcoal Filter	Same as air filter	Gamma for I-131 weekly
Heavy Particle Fallout	Monthly	Gross beta
Rainwater	Monthly	Gamma and SR-89,90
Soil	Annually	Gamma and SR-89,90
Surface Water	Monthly	Gross beta, gamma & I-131(2) monthly, SR-89,90 & tritium on quarterly composite samples
Well Water	Monthly	Gamma monthly, tritium on quarterly composite samples
Public Water	Monthly	Gross beta, gamma & I-131(3) monthly, SR-89,90 & tritium on quarterly composite samples
Sediment	Semiannually	Gamma & SR-89,90
Shoreline Sediment	Semiannually	Gamma & SR-89,90
Asiatic Clam Flesh	Semiannually	Gamma
Plankton	Semiannually	Gross beta, gamma & SR-89,90 (analysis performed if quantities are sufficient)
Milk	Semiannually	I-131 semimonthly, gamma & SR-89,90 monthly
Vegetation	Quarterly	Gamma & SR-89,90
Fish	Semiannually	Gamma & SR-89,90 on commercial species, and gamma on game species
Food Crops	Annually at time of harvest	Gamma
Meat and Poultry	Annually	Gamma
LTD	Quarterly	Direct Radiation

(1) Monthly implies every 4 weeks. Semimonthly implies every 2 weeks.
(2) I-131 performed only on sample from TRM 529.3 location.
(3) I-131 performed only on samples from Dayton and C. F. Industries locations