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final

NUREG-0498

environmental statement

related to operation of

WATTS BAR NUCLEAR PLANT UNITS NOS. 1 AND 2

TENNESSEE VALLEY AUTHORITY

DECEMBER 1978

Docket Nos. 50-390 and 50-391

ry Commission • Office of Nuclear Reactor Regulation

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NUREG-0498
December 1978

FINAL ENVIRONMENTAL STATEMENT

by the

U. S. NUCLEAR REGULATORY COMMISSION

FOR

WATTS BAR NUCLEAR PLANT

Units 1 and 2

proposed by

TENNESSEE VALLEY AUTHORITY

Docket Nos. 50-390 and 50-391

SUMMARY AND CONCLUSIONS

This Environmental Statement was prepared by the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff).

1. The action is administrative.

2. The proposed action is the issuance of operating licenses to the Tennessee Valley Authority (TVA) for the startup and operation of the Watts Bar Nuclear Plant, Units 1 and 2 (the plant) located on the west shore of Chickamauga Reservoir in Rhea County, 8 miles southeast of Spring City, Tennessee. (Docket Nos. 50-390 and 50-391.)

   Each unit will employ a pressurized water reactor to produce up to 3411 MWt for a total of 6822 thermal megawatts. This heat will be used to produce steam to drive steam turbines, providing 2340 MW net (2540 MW nameplate) of electrical power capacity.

   The units will be cooled by cooling towers drawing makeup water from Chickamauga Reservoir.

3. The information in this Statement represents the second assessment of the environmental impact associated with the Watts Bar plant pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 of the Commission's Regulations. After receipt of an application, in 1971, to construct this plant, the staff carried out a review of impact that would occur during the construction and operation of this plant. This evaluation was issued as comments to the TVA issued Final Environmental Statement in November 1972. As the result of this environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and a public hearing in Dayton, Tennessee, the AEC (now NRC) issued permits, in January 1973, for construction of Units 1 and 2 of the Watts Bar plant. As of June 30, 1978 the construction of Unit 1 was 85% complete and Unit 2 was 66% complete. With a proposed fuel-loading date of December 1979 for Unit 1 and September 1980 for Unit 2, the applicant has applied for licenses to operate both units and has submitted (November 1976) the required safety report and environmental information to substantiate this application. The staff has reviewed the activities associated with the proposed operation of this plant and the potential impacts, with both beneficial and adverse effects, are summarized as follows:

   a. Two units, each with a net electrical capacity of 1170 MWe will be added to the electrical energy producing capability of the Tennessee Valley Authority. This will have a favorable effect on reserve margins and provide a cost savings of \$145 to \$225 million in production costs in 1981 if the units come on line as scheduled, and additional cost savings in subsequent years. (Sect. 9.3)

   b. The 967 acres of rural, partially wooded land owned by the applicant will be unavailable for other uses during the 40-year life of the plant. (Sect. 4.2)

   c. Approximately 2,008 acres of additional land will be utilized for transmission line corridors and/or switchyard and maintained under controlled conditions. Land-use patterns will necessarily conform to the needs of the applicant but will not be changed significantly from present usage. (Sect. 3.2.5)

   d. At full power, cooling tower blowdown water could be heated to as high as 95°F and will be discharged at a rate of up to 85 cfs. The maximum expected mixed temperature rise at the edge of the diffuser mixing zone is 2.3°F above ambient. The heated water will mix with the cooler water of Chickamauga Reservoir, where the heat will ultimately be dissipated to the atmosphere. Approximately 64 cfs of water will be lost to the atmosphere as a result of the cooling towers. (Sect. 3.2.2) The maximum blowdown is estimated as 4.8 cubic meters/sec (170 cfs), for both units operating and the holding pond discharging 2.4 cubic meters/sec (85 cfs). The area of the diffuser-induced mixing is 1.32 acres. (Sect. 5.3.1)

e. Loss of fish due to impingement on the water intake screens will occur. However, such losses are expected to be minimized due to the low intake velocity and limited make-up water volume required by the closed cycle cooling system. (Sect. 5.4.2)

f. Small amounts of chemicals will be in the liquid effluents discharged to the Chickamauga Reservoir. With the controls in the NPDES Permit, chemical discharges are not expected to create a significant effect. (Appendix E)

g. Some organisms will be entrained in the cooling water and destroyed. Reservoir plankton populations will not be adversely affected. Emerging fish larva, fry and small young of the year may also experience entrainment, but such losses should not affect the reservoir populations. (Sect. 5.4.2)

h. The three mile reach from Watts Bar Dam downstream to Tennessee River Mile 526.9 has been designated by the State of Tennessee as a mussel sanctuary. No mussel concentrations have been located on the right side of the river in the vicinity of plant diffuser discharge. No significant adverse effects on mussels are anticipated.

i. No detectable impacts are anticipated from releases of radioactive materials as a consequence of normal operation. (Sect. 5)

4. The following Federal, State, and local agencies were asked to comment on the Draft Environmental Statement issued in June 1978:

Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Energy
Department of Health, Edcuation & Welfare
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
Department of Housing and Urban Development
State of Tennessee Department of Conservation
State of Tennessee Department of Public Health
State of Tennessee Department of Highways
State of Tennessee State Planning Office
State of Tennessee Historical Commission
State of Tennessee Game and Fish Commission
Office of Planning and Budget, Atlanta, Georgia
Office of Urban and Federal Affairs, State of Tennessee
Office of Intergovernmental Relations, Raleigh, North Carolina
Southeast Tennessee Development District
Rhea County, Judge
Meigs County, County Chairman

Comments on the Draft Environmental Statement were received from the following:

U. S. Department of Agriculture, Economics, Statistics and Cooperative Service
Federal Energy Regulatory Commission
Ms. Zeila M. Jensen
U. S. Department of Commerce
U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of the Interior
Mr. Marvin L. Lewis
Chattanooga Area Council of Governments
Tennessee State Planning Office
Mr. and Mrs. Arthur Jensen
Tennessee Valley Authority
U. S. Environmental Protection Agency
Tennessee State Planning Office
Tennessee Valley Authority
Mr. Albert Bates, PLENTY
Dr. Louis G. Williams

5. This Final Environmental Statement was made available to the public, to the Environmental Protection Agency, and to other specified agencies in December 1978.

6. On the basis of the analysis and evaluation set forth in this statement, and after weighing the environmental, economic, technical and other benefits against environmental costs and after considering available alternatives at the construction stage, it is concluded that the action called for under NEPA and 10 CFR Part 51 is the issuance of operating licenses for Units 1 and 2 for the Watts Bar Nuclear Plant subject to the following conditions for the protection of the environment:

   (A) License Conditions

   Before engaging in additional construction or operational activities which may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this Environmental Statement, the applicant shall provide written notification to the Director, Division of Site Safety and Environmental Analysis.

   (B) Significant Technical Specification Requirements

   (1) The applicant will carry out the environmental (thermal, chemical, radiological, ecological) monitoring program outlined in this Statement and in the EPA NPDES Permit and in the Final Environmental Statement for the Construction Permit. (Sects. 6.2 and 6.3)

   (2) The applicant shall notify the Director, Division of Site Safety and Environmental Analysis, of all cases where the discharge limits included in the NPDES permit are exceeded, or if the limits are revised.

   (3) A limited term bird monitoring program, designed to detect and report serious episodes of bird collisions with the cooling towers, is required. (Section 6.3.6.2)

   (4) The applicant is required to submit an annual report on its program for chemical control of vegetation on transmission line rights-of-way. (Section 6.3.6.3)

   (5) If during the operating life of the plant effects or evidence of irreversible damage are detected, the applicant will provide to the staff an analysis of the problem and a proposed course of action to alleviate the problem.

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FOREWORD

This environmental statement was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff) in cooperation with the U.S. Environmental Protection Agency (EPA) in accordance with the Commission's regulation, 10 CFR 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

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

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.
- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement on:

(i) the environmental impact of the proposed action;

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented;

(iii) alternatives to the proposed action;

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and,

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Environmental information accompanies each application for a construction permit or a full-power operating license. A public announcement of the availability of this information is made. Any comments by interested persons on this information are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information provided, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet the State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations of the NEPA and 10 CFR Part 51.

This evaluation leads to the publication of a draft environmental statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to Federal, State and local governmental agencies for comment. A summary notice is published in the Federal Register of the availability of the applicant's environmental report and the draft environmental statement. Interested persons are also invited to comment on the proposed action and the draft statement. Comments should be addressed to the Director, Division of Site Safety and Environmental Analysis, at the address shown below.

In response to a Memorandum of Understanding, which governs certain interactions of the U. S. Nuclear Regulatory Commission with the U. S. Environmental Protection Agency, the staff has collaborated with the EPA in developing interim staff conclusions and positions on environmental matters of mutual interest.[1,2] In particular, the staff has conducted detailed discussions on the NPDES permit, developed by the applicant and EPA, which is provided in this statement as Appendix E.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of questions and objections raised by the comments and the disposition thereof; a final benefit-cost analysis, which considers and balances the environmental effects of the facility and the alternatives available for reducing or avoiding adverse environmental effects with the environmental, economic, technical, and other benefits of the facility; and a conclusion as to whether -- after the environmental, economic, technical, and other benefits are weighed against environmental costs and after available alternatives have been considered, the action called for, with respect to environmental issues, is the issuance or denial of the proposed permit or license or its issuance with appropriate conditions to protect environmental values.

This environmental review deals with the impact of operation of Watts Bar Units 1 and 2. Assessments that are found in this statement supplement those described in the Final Environmental Statement (FES-CP) that was issued in November 1972 in support of issuance of construction permits for the units. The information to be found in the various sections of this Statement updates the FES-CP in four ways: (1) by identifying differences between environmental effects of operation (including those which would enhance as well as degrade the environment) currently projected and the impacts that were described in the preconstruction review; (2) by reporting the results of studies that had not been completed at the time of issuance of the FES-CP; (3) by evaluating the applicant's preoperational monitoring program; and factoring the results of this program into the design of an operational surveillance program and into the development of environmental technical specifications; and (4) by identifying studies being performed by the applicant that will yield additional information relevant to the environmental impacts of operating the Watts Bar Nuclear Plant.

Introductory résumés in appropriate sections of this Statement will summarize both the extent of "updating" and the degree to which the staff considers the subject to be adequately reviewed.

Single copies of this statement may be obtained as indicated on the inside front cover.

Director of the Division of Site Safety
and Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mrs. Suzanne Keblusek is the Environmental Project Manager for this project. Mrs. Keblusek may be contacted at the above address or at (301) 492-8440.

1. "Second Memorandum of Understanding Regarding Implementation of Certain NRC Positions and

2. 40 FR 251, December 31, 1975, pp. 60118-60121.

1. INTRODUCTION

1.1 HISTORY

On May 14, 1971, the Tennessee Valley Authority (TVA) (applicant) filed an application with the Atomic Energy Commission (now Nuclear Regulatory Commission) for a permit to construct the Watts Bar Nuclear Plant, Unit Nos. 1 and 2. Construction Permits Nos. CPPR-91 and CPPR-92 were issued accordingly on January 23, 1973 following reviews by the AEC Regulatory staff and its Advisory Committee on Reactor Safeguards, as well as a public hearing before an Atomic Safety and Licensing Board in Dayton, Tennessee, on November 20, 1972. The conclusions obtained in the staff's environmental review were included as comments in the applicant's Construction Permit stage Final Environmental Statement (FES-CP) in November 1972.

As of June 30, 1978, construction of Unit 1 was approximately 85% complete and the reactor is expected to be ready for fuel loading in December 1979. Unit 2 is approximately 66% complete and has a tentative fuel-loading date of September 1980. Each unit has a pressurized-water reactor which will produce up to 3411 MWt and a net electrical output of 1170 MWe.

In October - November 1976 the Tennessee Valley Authority submitted an application including a Final Safety Analysis Report (FSAR) and Environmental Information (EI) requesting the issuance of operating licenses for Unit Nos. 1 and 2. These documents were docketed on October 4, 1976 (FSAR) and November 23, 1976 (EI), respectively, and the operational safety and environmental reviews initiated at that time.

1.2 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

The applicant has furnished a discussion of environmental approvals and consultations that will be required for the operation of the Watts Bar Nuclear Plant. This information is presented in Chapter 1, Section 1.3 of the FES-CP. The 1977 amendments to the Federal Water Pollution Control Act (FWPCA) have removed previous constraints on the states to issue Section 401 certifications for National Pollution Discharge Elimination System (NPDES) permits by the Environmental Protection Agency (EPA) and Operating Licenses by the Nuclear Regulatory Commission for federal facilities. A Section 401 certification from the State of Tennessee for the Watts Bar Nuclear Plant is appended to the NPDES permit in Appendix E.

2. THE SITE

2.1 RÉSUMÉ

The staff revisited the Watts Bar site in August 1976 and again in February 1977 to determine what changes had occurred at the site and in the surrounding environs since the preconstruction environmental review in 1972. Of interest were changes in regional demography predictions and reduced land use revealed by available new information and construction of the plant facilities respectively. Population distribution projections have been expanded and updated to indicate estimations to the year 2020. Modifications to the proposed transmission system have resulted in a reduction of rights of way easements from 3,165 acres (FES-CP) to 2,008 acres. Changes in the local economy due to construction are also discussed. The staff's assessments of these recent findings are presented in Section 2.2.

Downstream industrial water utilization estimations now indicate a decrease in such use over the FES-CP use. The temporary settling pond intended to be constructed in Twin Fork Slough was relocated nearer to the facility, effecting economies in costs and reduced environmental impact. These changes in water use are discussed in Section 2.3.

Updated meteorology data have also been provided and discussed in Section 2.4.

New aquatic ecological data have been evaluated by the staff. This information is discussed in Section 2.5 and Appendix C.

2.2 REGIONAL DEMOGRAPHY

2.2.1 Population Changes

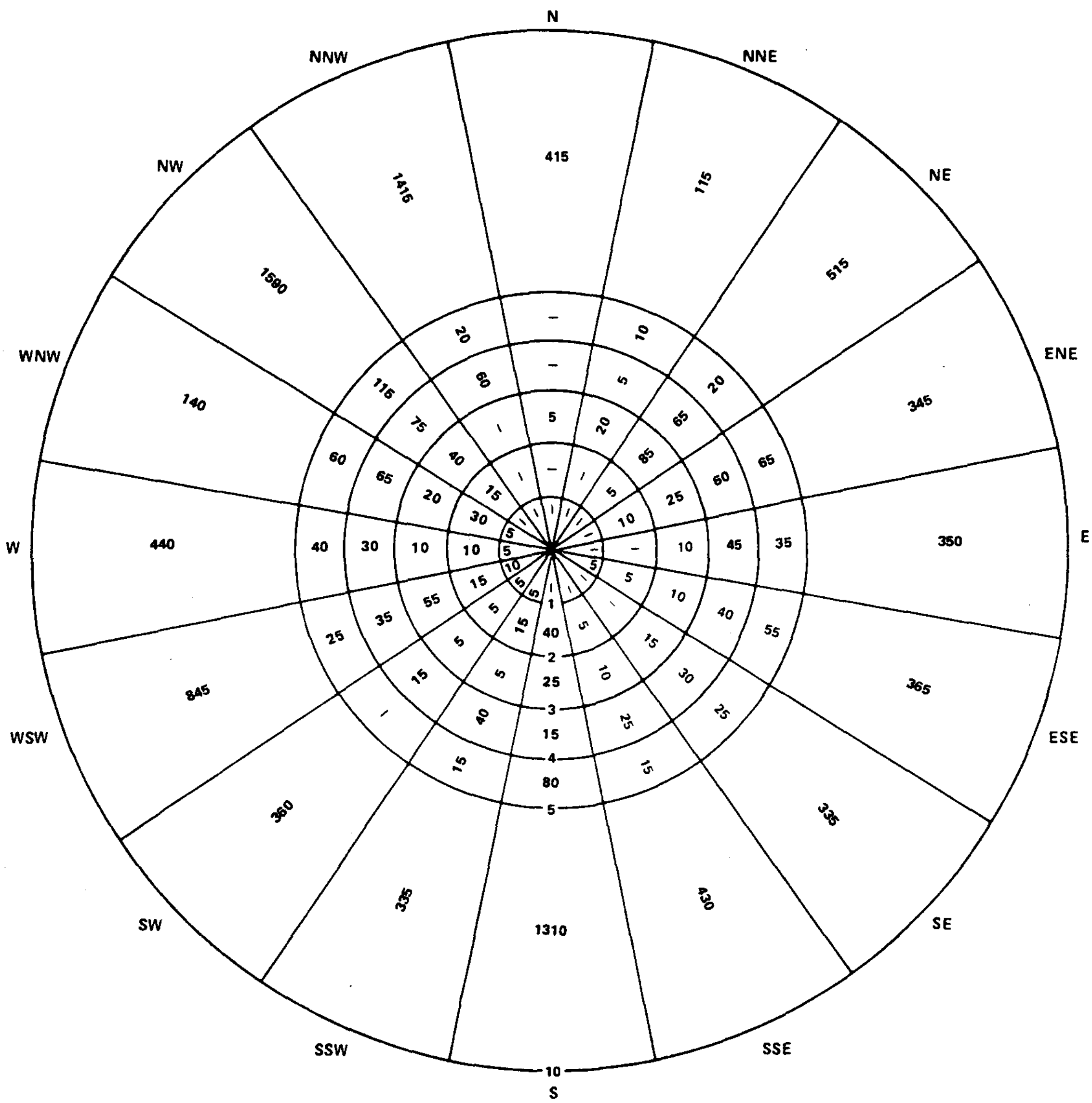
The principal population centers within 50 miles of the Watts Bar Plant were indicated by the applicant in the FES. Population distributions, based on the 1970 Census of Population. and projected population distributions were included for the area within 0-10 and 0-50 miles of the plant for the years 1970, 1980 and 2000. This information has been updated and expanded to also provide projected population distributions within 0-10 and 0-50 miles of the site for the years 1978, 1990, 2010 and 2020. These data are provided in Figures 2.1 through 2.10, which indicate the distribution of population within 22 1/2° sectors and sections of annuli.

Projected population data were based on county projections prepared by the Bureau of Economic Analysis (BEA), in cooperation with the Southern Economic Review Groups -- Georgia, Nortn Carolina and Tennessee. These projections incorporated the Census Bureau's 1972 "Series E" national population projections. The Southern Economic Review Groups are cooperative Federal-State groups formed to assist BEA in preparing county projections for planning and development purposes. Subdivisions of the county estimates and projections were made by TVA, Navigation and Regional Economics Branch. These subdivisions were based on census and other maps, on judgments from field experience, and on such factors as topography, transportation networks, and historical growth patterns.

In 1970 approximately 11,000 people lived within 10 miles of the Watts Bar plant, with 80 percent of the population located between 5 and 10 miles of the site. The remainder of the area within 10 miles is sparsely populated. The population within 10 miles of the site is projected to grow to a little over 14,000 by the year 2020. Between 0 and 50 miles of the site, the population is presently about 654,000 and is expected to increase by over 38 percent to approximately 905,000 by the year 2020. Almost 50 percent of this total growth is expected to take place in the area between 40 and 50 miles from the site.

2.2.2 Changes in Regional Socioeconomic Characteristics

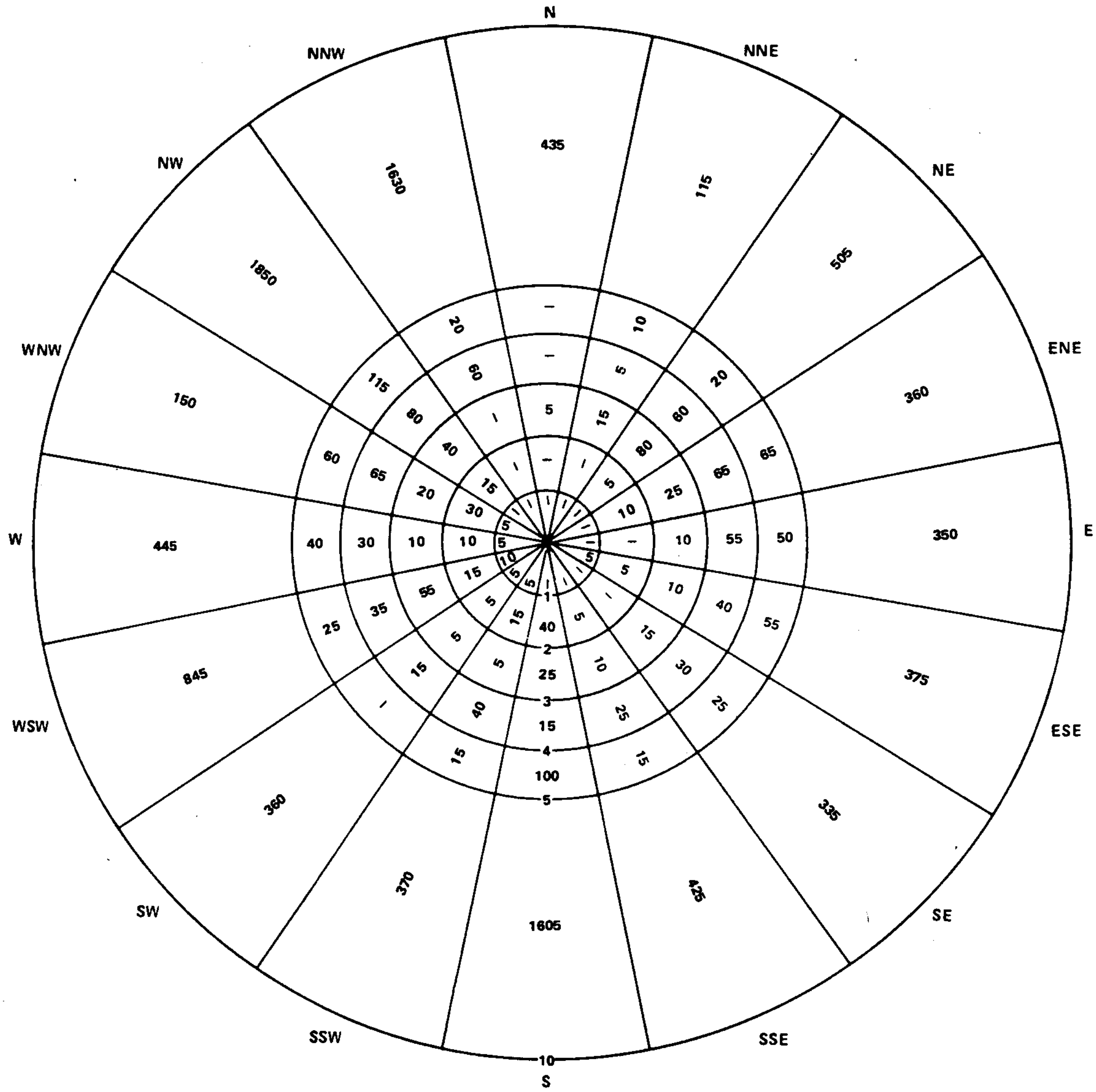
Data were collected on the present socioeconomic characteristics and probable area impacts related to the construction of Watts Bar 1 & 2 from a number of sources. These include interviews with representatives of Tennessee State Planning Office, Tennessee Department of Education and Tennessee Energy Office; planning documents from local, county and regional governments; TVA documents; and statistics from Bureau of the Census.



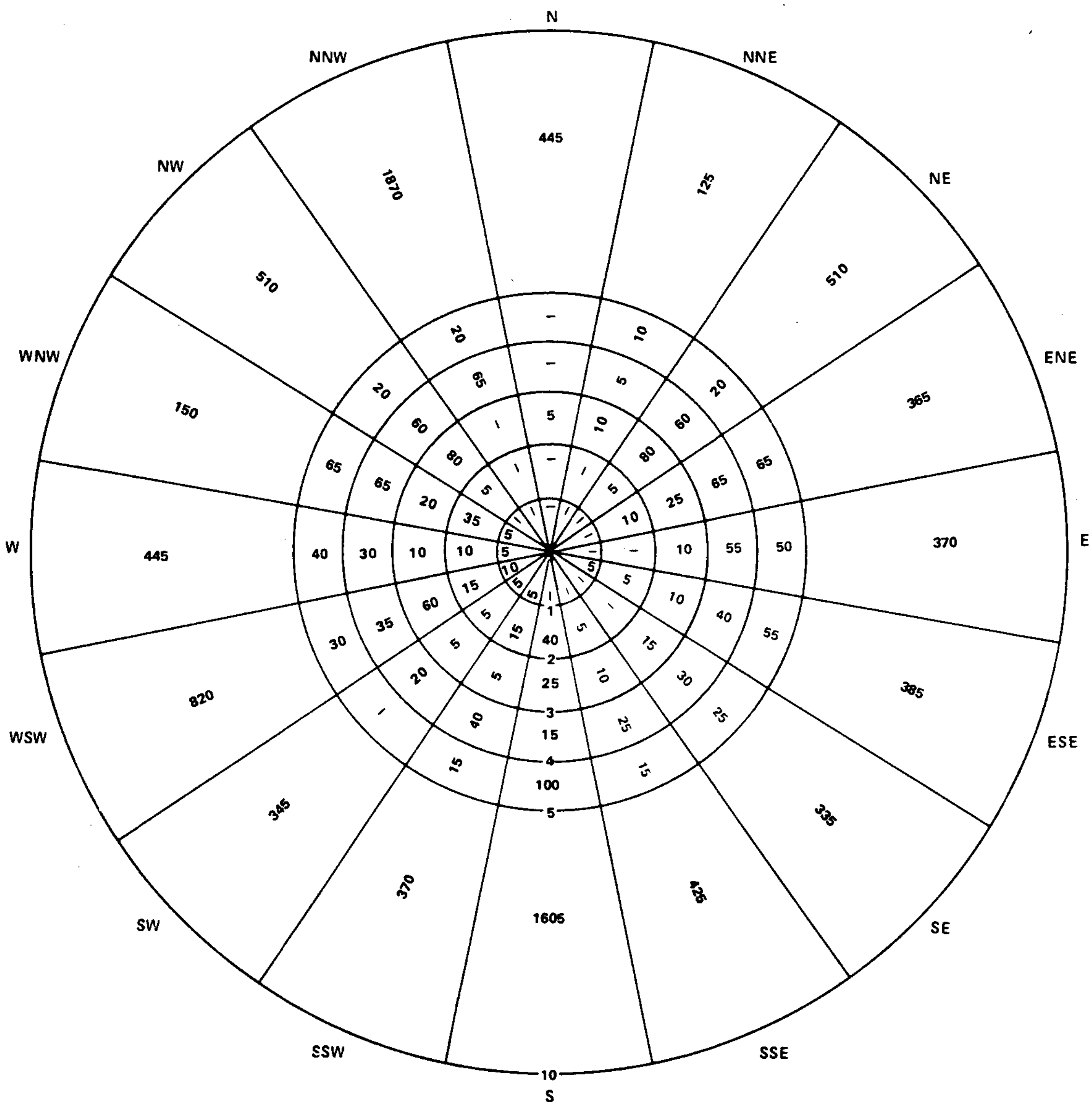
WATTS BAR NUCLEAR PLANT FINAL SAFETY ANALYSIS REPORT

1978 POPULATION DISTRIBUTION WITHIN 10 MILES OF THE SITE

Figure 2.1



WATTS BAR NUCLEAR PLANT FINAL SAFETY ANALYSIS REPORT
1990 POPULATION DISTRIBUTION WITHIN 10 MILES OF THE SITE Figure 2.2

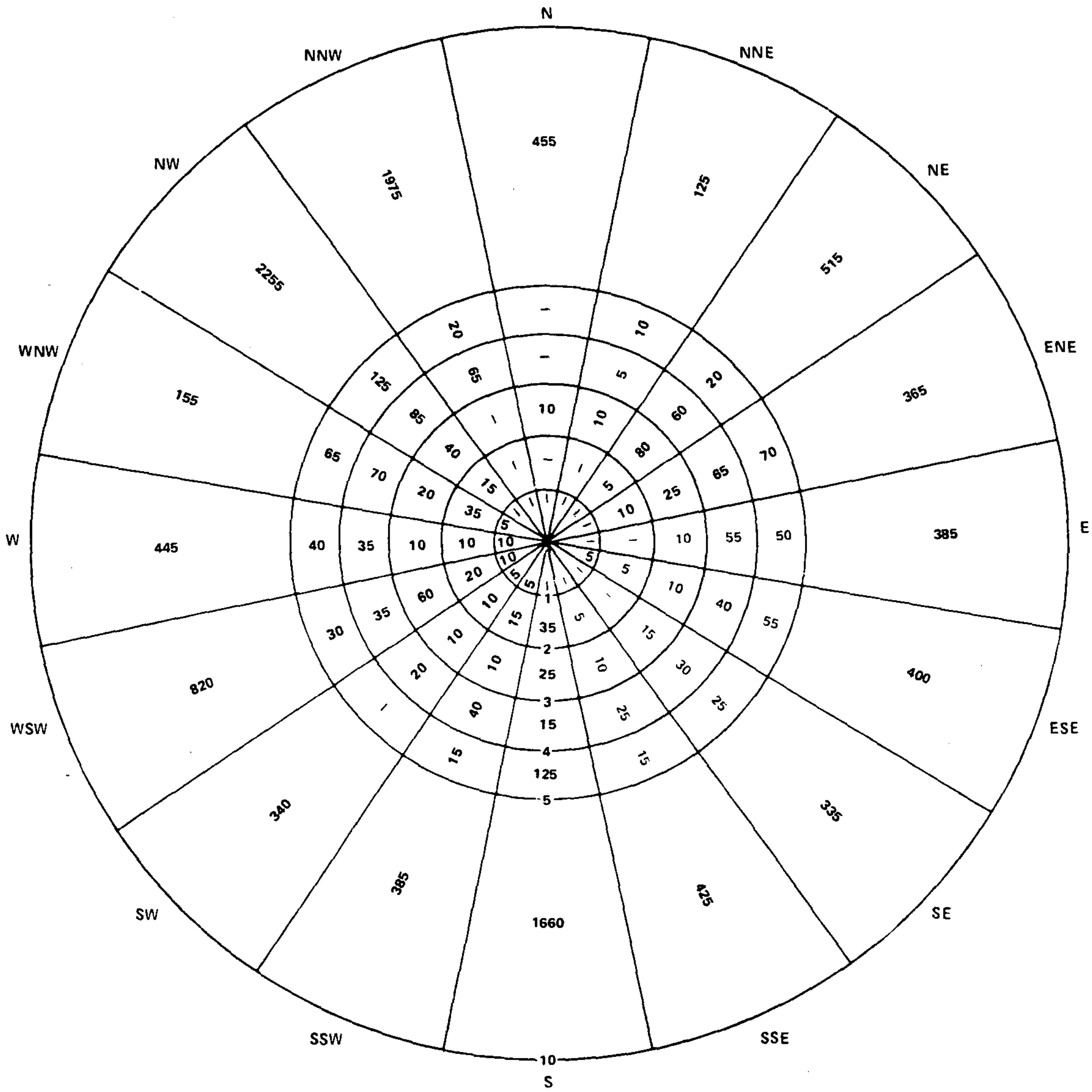


WATTS BAR NUCLEAR PLANT
FINAL SAFETY
ANALYSIS REPORT

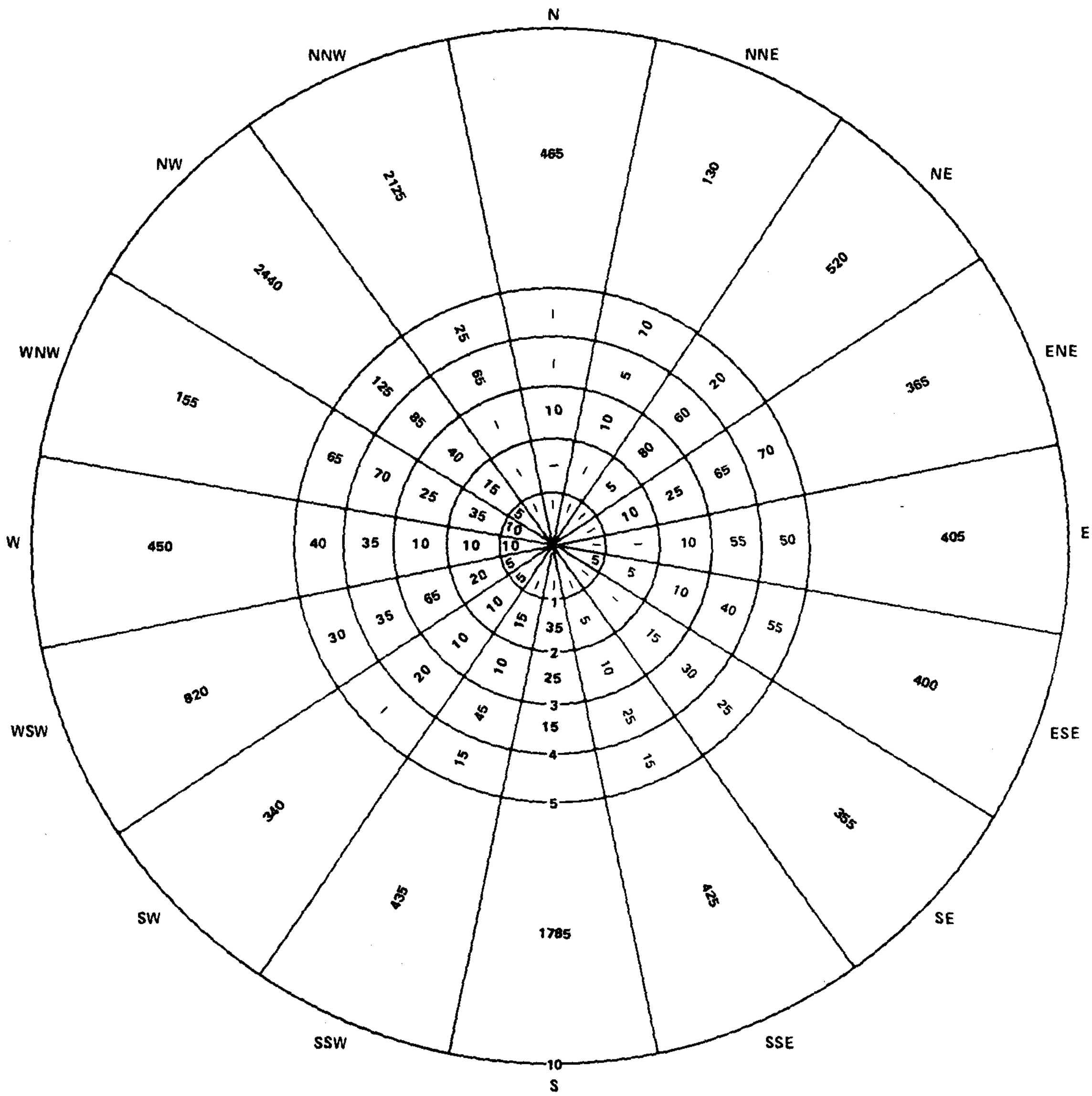
2000 POPULATION DISTRIBUTION

WITHIN 10 MILES OF THE SITE

Figure 2.3



WATTS BAR NUCLEAR PLANT FINAL SAFETY ANALYSIS REPORT
2010 POPULATION DISTRIBUTION WITHIN 10 MILES OF THE SITE Figure 2.4

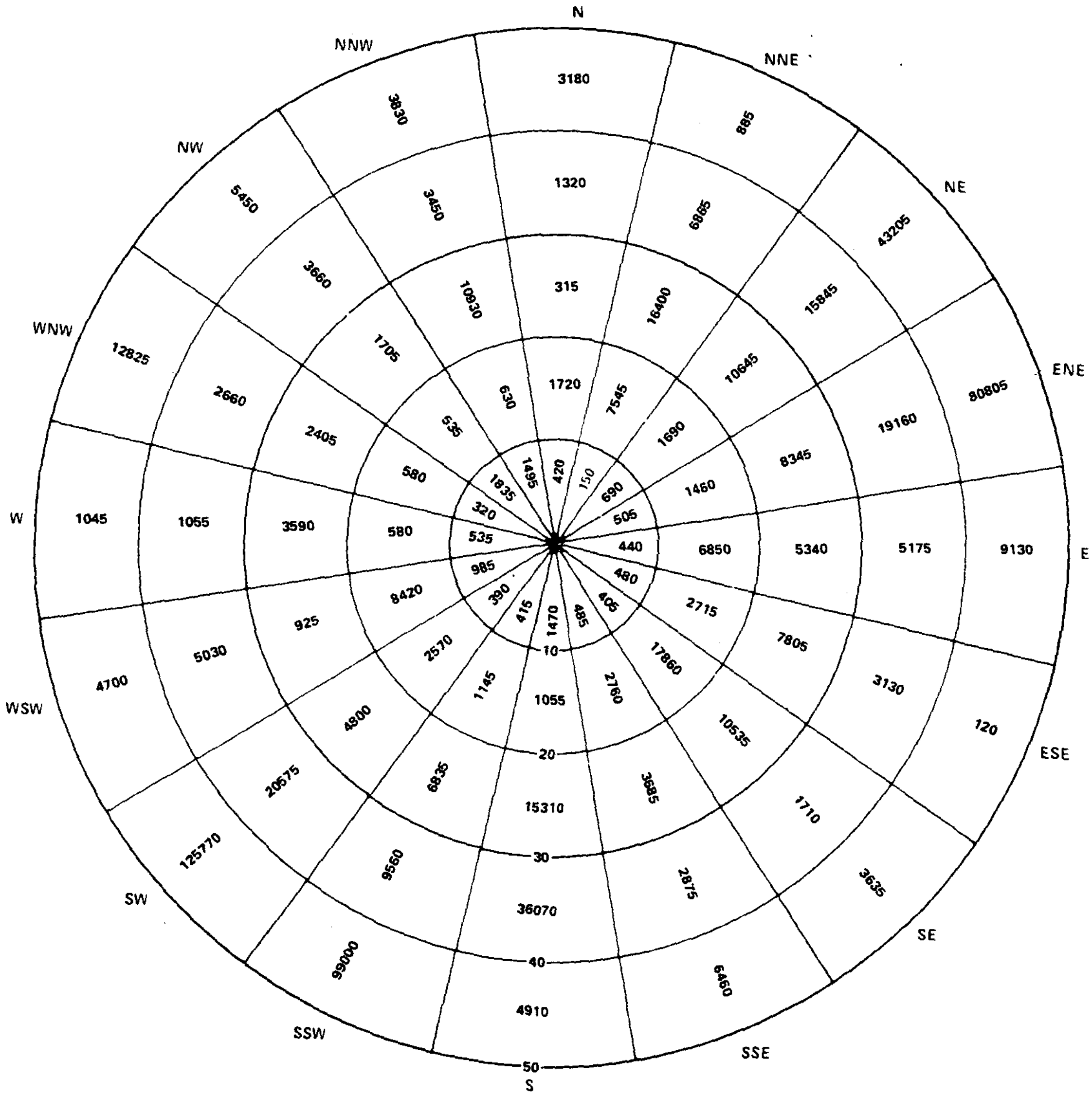


WATTS BAR NUCLEAR PLANT
FINAL SAFETY
ANALYSIS REPORT

2020 POPULATION DISTRIBUTION

WITHIN 10 MILES OF THE SITE

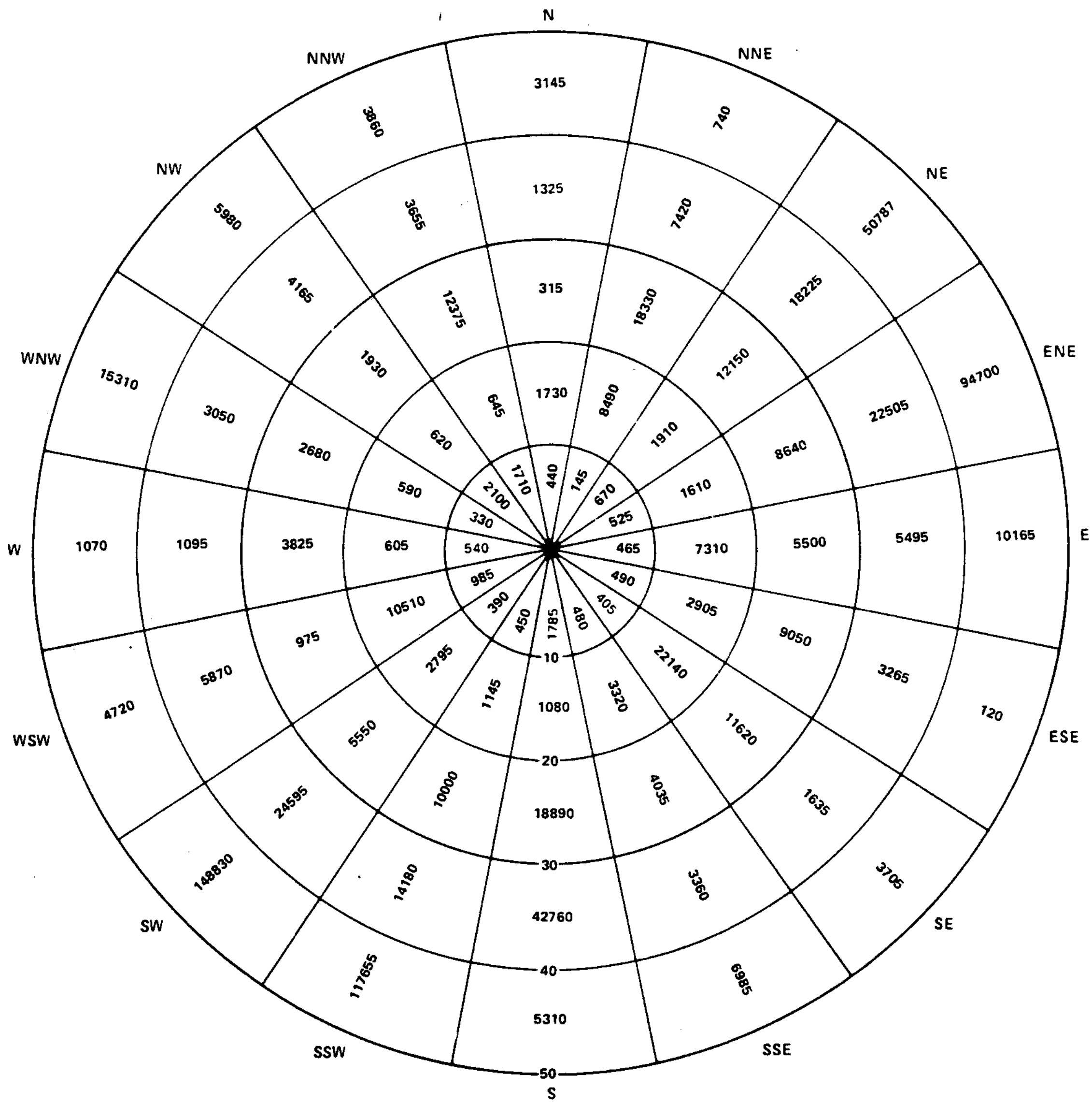
Figure 2.5



WATTS BAR NUCLEAR PLANT
FINAL SAFETY
ANALYSIS REPORT

1978 POPULATION DISTRIBUTION
WITHIN 50 MILES OF THE SITE

Figure 2.6

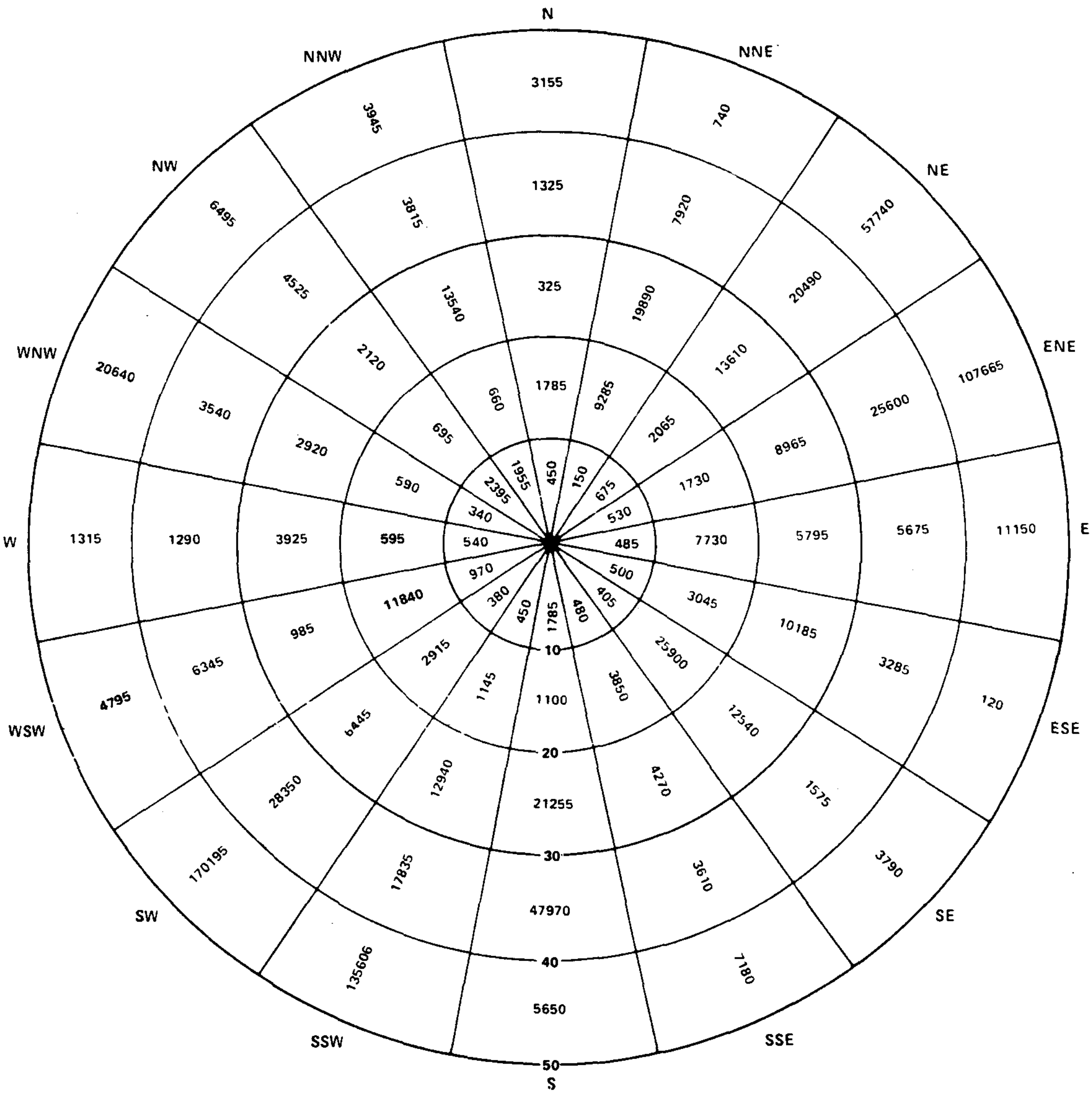


WATTS BAR NUCLEAR PLANT
FINAL SAFETY
ANALYSIS REPORT

1990 POLULATION DISTRIBUTION

WITHIN 50 MILES OF THE SITE

Figure 2.7

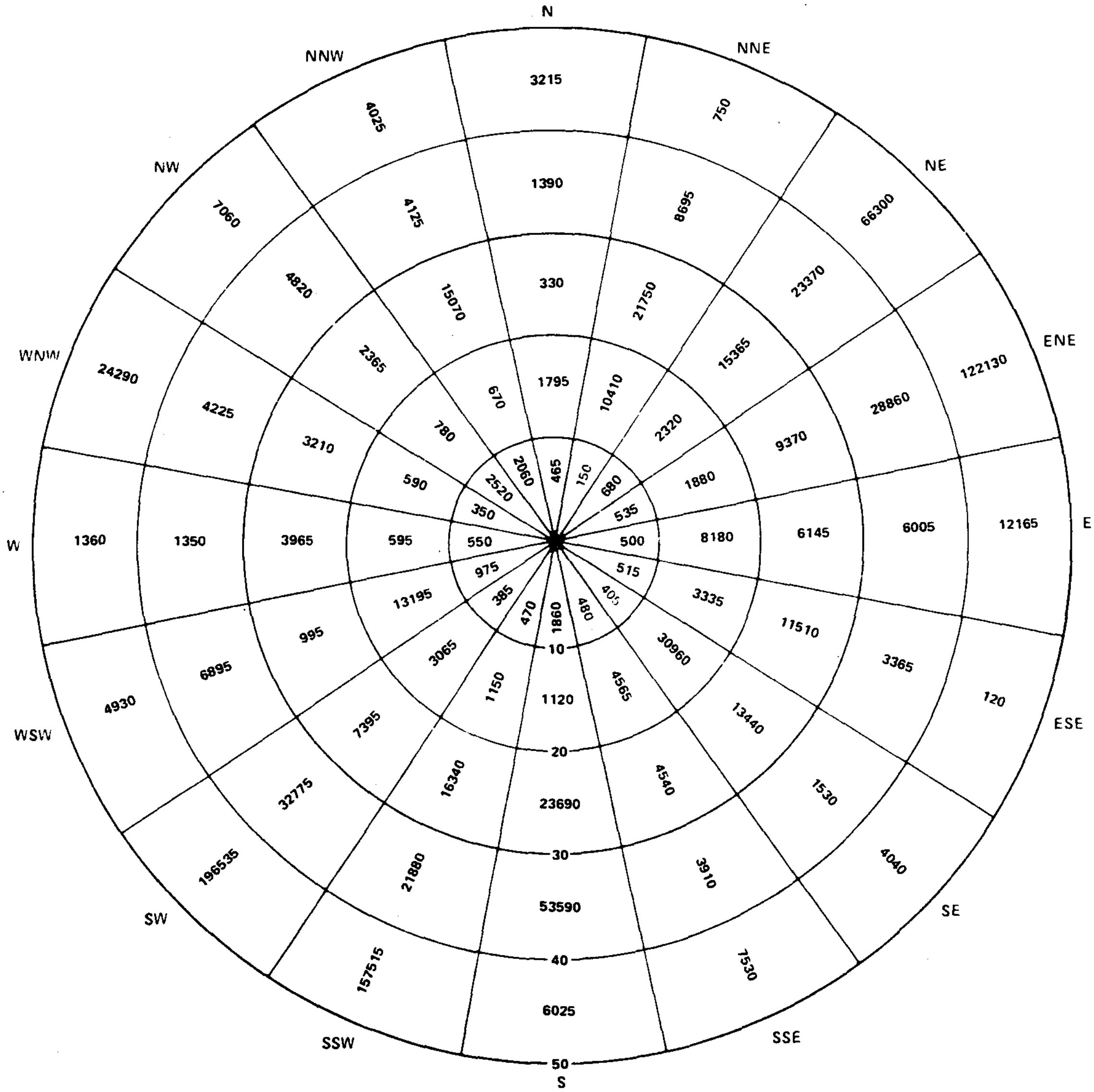


WATTS BAR NUCLEAR PLANT
FINAL SAFETY
ANALYSIS REPORT

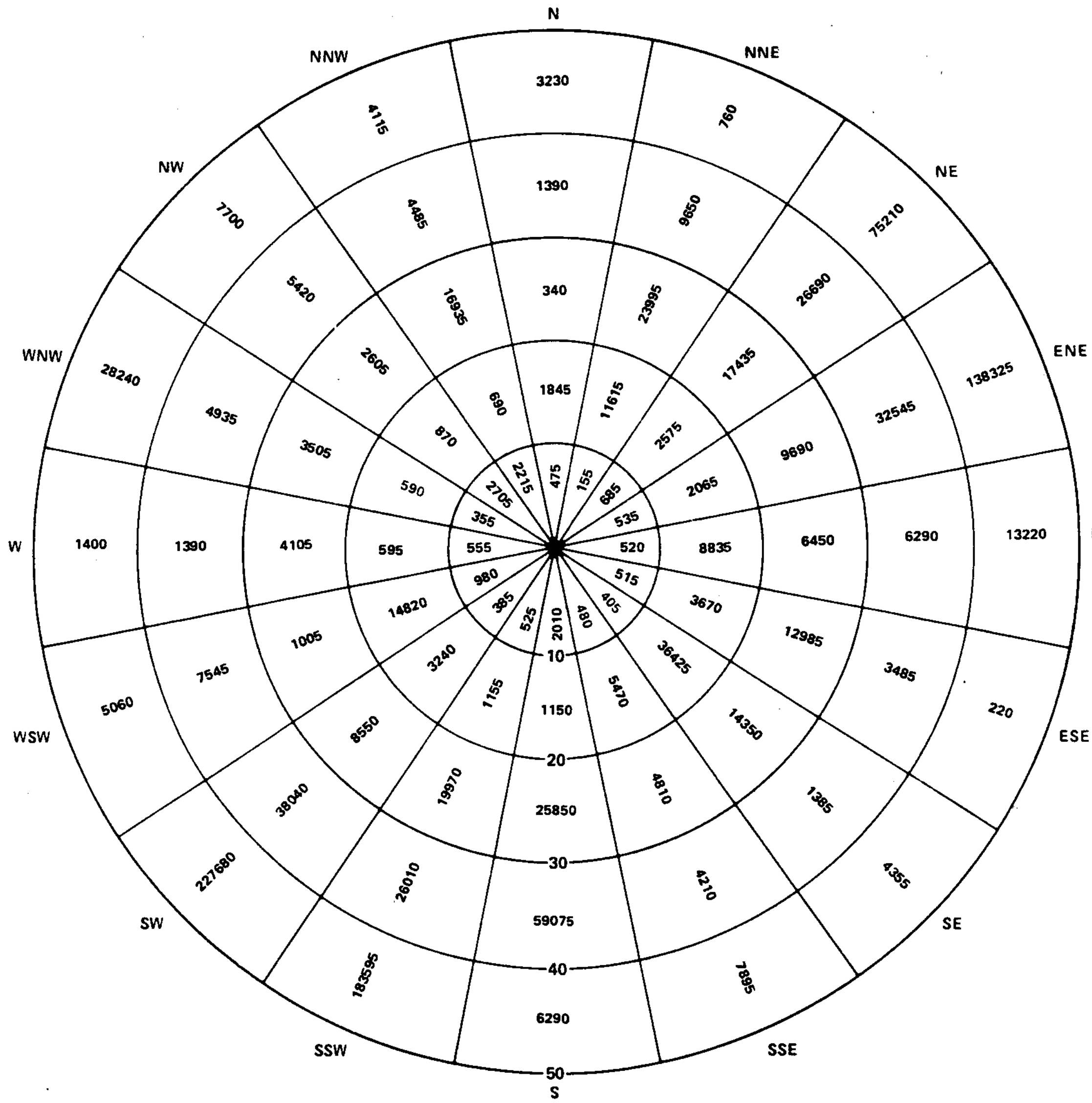
2000 POPULATION DISTRIBUTION

WITHIN 50 MILES OF THE SITE

Figure 2.8



WATTS BAR NUCLEAR PLANT FINAL SAFETY ANALYSIS REPORT
2010 POPULATION DISTRIBUTION WITHIN 50 MILES OF THE SITE
Figure 2.9



WATTS BAR NUCLEAR PLANT
FINAL SAFETY
ANALYSIS REPORT

2020 POPULATION DISTRIBUTION WITHIN 50 MILES OF THE SITE

Figure 2.10

The area receiving the preponderance of socioeconomic impact from plant construction was identified with the aid of TVA construction employee surveys taken in 1973, 1974 and 1976.[1] Approximately 31% of the labor force, 765 employees, relocated residence to work on this project. Over half the movers, 67%, or 513 employees, relocated to within a twenty mile radius of the site with Rhea and Meigs Counties absorbing most of the relocating workers. The remaining movers were scattered over a number of counties beyond Rhea and Meigs, from Chattanooga to Clinton.

Rhea and Meigs Counties rated first and second in percent change of population increase among counties in the Southeastern Tennessee Development District from 1970-75. Population changes for these counties and cities and the State of Tennessee from 1970-75 are presented in Table 2.1. The growth is a result of increasing industrialism in the area. The Tennessee State Planning Office stated, in a 1974 report, that industrial expansion along U. S. 27 in Rhea County is likely in the near future.[2] Watts Bar and Sequoyah Nuclear Power Plants are considered among these developments.

Table 2.1

1970-1975 Population Changes

(CARCOG/SETDD† Population)

	Population			Annual Rate Of Increase		
	1970	1973	1975	70-73	73-75	70-75
Meigs Co.	5,219	5,596	6,117	2.4	4.6	3.2
Decatur*	698	746	807	2.3	4.1	3.0
Rest of Co.	4,521	4,850	5,310	2.4	4.7	3.3
Rhea Co.	17,202	19,220	20,236	3.8	2.6	3.3
Dayton**	4,361	4,463	4,278	0.8	-2.1	-0.4
Graysville	951	1,155	1,220	6.7	2.8	5.1
Spring City	1,756	1,858	1,902	1.9	1.2	1.6
Rest of Co.	10,134	11,744	12,836	5.0	4.5	4.8
CARCOG/SETDD Total	509,369	538,720	548,889	1.9	1.0	1.5
Municipal Total	310,503	318,966	320,891	0.9	0.3	0.7
Rest of County Total	198,866	219,754	227,998	3.4	1.9	2.8
Tennessee	3,926,018	4,086,891	4,174,100	1.4	1.1	1.2

† Chattanooga Area Regional Council of Governments/Southeast Tennessee Development District.

* City is in two counties.

** City annexed area between 1970 and 1975 that was not included in the estimate.

Source: Current Population Reports, Series P-25, #658 and #690. U.S. Bureau of the Census.

The local economy of the region was stimulated by the creation of new jobs and the influx of construction workers associated with the project.[3] Rhea County experienced growth in the housing industry, partially due to the project.[4] Meigs County incurred increased mobile home park development directly along State Route 68. The mobile home developments are expected to be in evidence until 1980 when construction is complete and operation has reached full scale.[5] In 1976, 41% of the movers lived in houses, 37% in mobile homes, 16% in apartments and 6% in sleeping rooms.[6] The houses, both purchased and rented by in-moving construction workers, are occupied primarily by the longer term supervisory staff (60% of the "annual" workers choosing this type of residence as opposed to 33% of the "hourly" workers in 1976). The hourly wage earners were more likely to own or rent mobile homes (46% of the "hourly" employees occupied mobile homes as opposed to 22% of the "annual" employees).

Approximately 69% of the movers surveyed in 1976 brought families. Accompanying these movers were 341 school age children - an average of 0.7 children per family. In order to mitigate the impact of construction on education, TVA provided, to Rhea County, two classrooms beginning in the 1973-74 school year and one school bus in 1976-77. In addition, $75,000, the equivalent of three classrooms and one bus, was provided to Meigs county for use beginning in the 1976-77 school year. These mitigation measures were apparently successful as no overcrowding has occurred.[7]

Construction activity is expected to peak in mid-1978 when approximately 3900 workers will be at the site. Wages paid during construction are estimated to total $301,100,000. Approximately $22,500,000 is expected to be paid for goods and services in the State of Tennessee during plant construction. Of that total, an estimated $16,500,000 will be spent in the region from Chattanooga to Knoxville, primarily in and around the metropolitan centers.[8] Little impact resulting from these expenditures will be experienced in the host communities.

2.3 WATER USE

2.3.1 Regional Water Use

The public and industrial water supplies within a 32-kilometer (20-mile) radius of the plant are shown in Table 4.1-1 of Reference 12, Section 2. The estimated population served, average daily use and approximate distance from the site are given in this table for each water supply.

It was estimated at the construction permit stage that the major industrial water users downstream of the plant were withdrawing 200,000 cubic meters (53 million gallons) of process water from the Chickamauga Reservoir each day. This estimate has been revised and is now 12,000 cubic meters (3.1 million gallons) each day.[9] The reason for the 190,000 cubic meter (50 million gallon) per day reduction is the closing of the I.C.I. America (previously called the Volunteer Army Ammunition Plant).

Table 2-2 lists surface water travel times and dilution factors for downstream surface water users within an 80.5-kilometer (50-mile) radius of the plant. These values are based upon a streamflow velocity of 0.26 meters per second (0.84 feet per second) [average annual flow rate of 790 cubic meters per second (27,800 cubic feet per second) adjusted for the size of the drainage area] and the normal plant discharge rate of 1.8 cubic meters per second (62 cubic feet per second).

Table 2-2

DILUTION FACTORS AND TRAVEL TIMES FOR
DOWNSTREAM WATER USERS WITHIN AN 80.5-KILOMETER (50-MILE) RADIUS

Water User	Travel Time (days)	Dilution Factor
Dayton	1.8	204
Atlas Chemical Industries	4.0	307
E.I. Dupont	4.2	*
Chattanooga	4.5	*
South Pittsburg	8.0	*
Bridgeport	8.3	*

*River is assumed to be fully mixed downstream of the Chickamauga Dam; dilution factor equals 448.

The Watts Bar Steam Plant is located about 1 kilometer (0.6 mile) downstream of the Watts Bar Dam and about 2 kilometers (1.3 miles) upstream of the Watts Bar Nuclear Plant. When the steam plant is operating at its rated capacity, it requires 626 cubic feet per second of circulating cooling water.[13] The impact of the discharge from the steam plant has been evaluated.[10] Some of the results are presented here. It was determined that the discharge would affect the river water in the vicinity of the nuclear plant intake and discharge. Field studies indicated that the water temperatures would be increased by 0-0.6 °C (0-1 °F) during periods of releases from the Watts Bar Hydro Plant, and by 1.7-2.8 °C (3-5 °F) during and immediately following periods of no release (for the maximum expected duration of 12 hours) for the Hydro Plant. TVA has committed to take action to ensure that the thermal standards of the State of Tennessee are not exceeded as a result of the operation of the Watts Bar Nuclear Plant.[8] The action they plan to take is to temporarily discharge the blowdown to a holding pond until the accumulated steam plant discharge plume passes the nuclear plant diffuser.[11] We concur that they have the ability to do this if the holding pond is kept at a minimum level.

2.3.2 Surface Water Hydrology

This section outlines effects of changes in the plant design that have been made since publication of the FES-CP.

Two temporary chemical cleaning holdup ponds have been constructed within the main yard holding pond area. These ponds are to be used for the containment and treatment of chemicals and waste water that will be used during preoperational cleaning and testing. The small pond has a volume of approximately 2650 cubic meters (699,380 gallons) and the larger pond has a volume of approximately 26,200 cubic meters (6,919,000 gallons). The embankments of the ponds are built-up dikes that will be leveled and graded to blend with the surrounding terrain upon retirement of the ponds. TVA has not made a final decision concerning the disposition of these ponds upon completion of construction. If it is determined that future chemical cleaning operations may be required with the operating plant, TVA may elect to retain these ponds. If it is determined that future cleaning operations will not be required, then the ponds will be leveled and graded. The staff concludes that they will not have a long-term significant effect on the surface water hydrology.

The FES-CP stated that the Twin Fork Slough would be given consideration for a possible natural sedimentation pond. Actual field conditions rendered it economically more feasible to develop another settling pond area nearby since greater quantities of excavation and piping would have been required to use the Twin Fork Slough. This temporary pond holds runoff from the construction site, thus allowing some of the suspended solids from the runoff to settle out prior to release to the reservoir. The volume of this pond is about 28,000 cubic meters (1 million cubic feet). There are four 50.8-centimeter (20-inch) diameter pipes for releasing effluent from the ponds. In case of extremely high runoff, flow will be handled by a weir with its invert 0.61 meters (2 feet) above the invert of the pipes. After the pond is no longer needed, the earthen embankment will be leveled and graded to blend with the surrounding terrain.[12] We conclude that only a minor increase in sediment runoff will occur during and following regrading and that the long-term effect of the pond on the surface water hydrology will not be significant.

2.3.3 Water Quality

The State of Tennessee has declared that for the purpose of establishing water quality criteria for the section of the Tennessee River in the vicinity of the Watts Bar Nuclear Plant the following water use shall be protected:[13]

1. Domestic Raw Water Supply
2. Industrial Water Supply
3. Fish and Aquatic Life
4. Recreation
5. Irrigation
6. Livestock Watering and Wildlife
7. Navigation

Water quality in the Tennessee River near the site is well documented by data collected over a period of about 15 years.[14,15] Water quality data collected since publication of the FES-CP is shown in Table 2-3.[14] The quality of the water is generally good. It is slightly hard, with hardness values ranging between 31 and 79 mg/l for the 1973-1975 sampling period. This is within the range reported by the earlier studies.[15]

Table 2.3

SUMMARY OF WATER QUALITY DATA
TENNESEE RIVER MILE 529.9

Parameter	Number of Observations	Observed Concentrations[a]			Number of Observations	Observed Concentrations[b]		
		Maximum	Minimum	Mean[c]		Maximum	Minimum	Mean[c]
Alkalinity (total, as $CaCO_3$), mg/l	38	82	36	54	8	59	57	57
Aluminum, μg/l	23	1800	<200	705	-	-	-	-
Arsenic, μg/l	24	5	<5	5	1	0	0	0
Barium, μg/l	23	<100	<100	-	-	-	-	-
Beryllium, μg/l	22	<10	<10	<10	-	-	-	-
BOD (5-day), 20°C), mg/l	22	3.7	<1.0	1.4	-	-	-	-
Boron, μg/l	20	<1000	<100	<386	-	-	-	-
Cadmium, μg/l	23	13	<1	2	1	0	0	0
Calcium, mg/l[d]	39	23	8	19.2	10	23	19	21
Chloride, mg.l[d]	40	35	4	6.8	7	7.9	3.4	5.7
Chromium, μg/l	23	5	<5	5	1	<10	<10	<10
Cobalt, mg/l	4	<5	<5	<5	1	1	1	1
COD, mg/l	40	11	3	5.9	-	-	-	-
Color, PCU	40	30	5	12.2	-	-	-	-
Copper, μg/l	23	90	<10	20.5	1	11	11	11
Focal Coliform, no. per 100 ml	16	20	<10	11	6	82	3	29
Fluoride, mg/l	38	0.1	0.04	0.08	10	0.3	0.0	0.14
Hardness (Ca + Mg), mg/l	39	79	31	67	10	77	66	71
Iron (total), μg/l	39	1300	190	498	1	670	670	670
Iron (dissolved), μg/l	24	200	<50	75	1	30	30	30
Lead, μg/l	23	130	<10	15.5	1	26	26	26
Lithium, μg/l	17	<10	<10	<10	-	-	-	-
Magnesium, mg/l[d]	39	5.6	2.7	4.6	10	5.0	4.4	4.6
Maganese, (total), μg/l	39	120	40	64	-	-	-	-
Maganese, (dissolved), μg/l	24	40	<10	20	1	23	23	23
Mercury, μg/l	24	1.0	<0.2	0.3	1	0	0	0
Nickel, μg/l	23	290	<50	67	-	-	-	-
Nitrogen (ammonia), mg/l	40	0.18	<0.01	0.06	-	-	-	-
Nitrogen (Kjeldahl), mg/l	-	-	-	-	7	0.33	0.18	0.25
Nitrogen (nitrate plus nitrite), mg/l	38	0.79	0.11	0.39	7	0.53	0.18	0.41
Nitrogen (organic), mg/l	38	0.45	<0.03	0.17	-	-	-	-

Table 2.3 (Continued)

Parameter	Number of Observations	Observed Concentrations[a] Maximum	Minimum	Mean[c]	Number of Observations	Observed Concentrations[b] Maximum	Minimum	Mean[c]
pH, units	36	8.5	6.8	7.4	11	7.7	6.7	7.3
Phosphorus (total), mg/l	18	0.05	<0.01	0.03	8	0.05	0.02	0.04
Phosphorus (dissolved), mg/l	24	0.040	<0.010	0.017	-	-	-	-
Potassium, mg/l[d]	39	2.4	0.9	1.5	10	1.6	1.2	1.4
Selenium, µg/l	24	<2	<1	<2	-	-	-	-
Silica (total), mg/l	27	7.2	4.1	5.2	-	-	-	-
Silica (dissolved), mg/l	13	5.6	3.1	4.7	7	6.0	4.0	5.3
Silver, µg/l	23	<10	<10	<10	-	-	-	-
Sodium, mg/l[d]	39	50.0	2.3	6.4	10	7.3	2.9	4.6
Solids (dissolved), mg/l	36	180	60	94	7	116	79	92
Specific Conductance, µmhoe	36	320	97	161	11	180	140	160
Sulfate, mg/l[d]	40	18.0	9.0	12.4	8	15.0	9.9	12.5
Titanium, µg/l	15	<1000	<1000	<1000	-	-	-	-
Total Organic Carbon, mg/l	19	4.7	1.6	2.4	1	3.1	3.1	3.1
Turbidity, JTU	92	60	<1	12.5	7	20	3	8.5
Zinc, µg/l	23	70	<10	20.5	-	-	-	-

a. Samples collected and analyzed by the Tennessee Valley Authority, January 1973-December 1973.
b. Samples collected and analyzed by the U.S. Geological Survey October 1974-September 1975.
c. Arithmetic mean, detection limit values averaged as real numbers.
d. TVA data represents analyses performed on an unfiltered sample; USGS data represents analyses performed on a filtered (0.45 µ filter) sample.

Several metals (e.g., aluminum, cadmium, copper, mercury, zinc) have been measured at concentrations which are within the range where toxic effects have been observed by others.[16,17,18] These substances may represent an existing stress to aquatic life.

Watts Bar Nuclear Plant is located within a stretch of the Tennessee River which has been classified as being "effluent limited".[19] This is based on the fact that the river does not meet the dissolved oxygen (DO) criterion for the protection of fish and aquatic life. TVA has summarized weekly observed DO concentrations in the tailrace of Watts Bar Dam to illustrate the relative frequency of days during which the DO criterion of 5.0 mg/l is not met.[20] The summary is reproduced here as Table 2.4. The "effluent limited" designation of the State of Tennessee normally denotes that standards will be met after application of secondary treatment for municipalities and best practicable treatment for industries. Although this would imply that provision of waste treatment facilities would remove this stress to aquatic life, the DO deficiency in the Tennessee River is further complicated by low oxygen releases from Cherokee and Douglas reservoirs upstream from Knoxville. According to the State Water Quality Management Plan for the Upper Tennessee River Basin attainment of the DO criteria will require that the TVA develop structural or operational methods to mitigate the low oxygen releases. In the FES-CP TVA reported that it was investigating methods of increasing the DO levels in the releases from its headwater reservoirs.[21] This investigation is still in progress.[22] This stress is likely to continue to exist at least through the initial years of operation of the Watts Bar Nuclear Plant. (See Section 5.4.2)

2.4 METEOROLOGY

2.4.1 Regional Climatology

The Great Valley of Tennessee, located between the Cumberland Plateau to the west and Appalachian Mountains to the east, is an area of complex local terrain. This results in localized variations in temperatures and winds.[23]

The area as a whole experiences a moderate climate with cool winters averaging one to two degrees Celsius (two to four degrees Fahrenheit) warmer than plateau areas to the west, because of the sheltering effect of the neighboring mountains. In winter, the weather is changeable, with an occasional cold spell, but severe weather is rare. On an average, temperatures fall below freezing on about 75 days per year. Temperatures below minus 18 degrees Celsius (0 degrees Fahrenheit) have been recorded only 14 times in the past 98 years. Snowfall is quite variable from year to year, with some winters experiencing none and others having heavy snowfall, but with appreciable accumulations seldom lasting more than a few days. Ice storms are not uncommon and occasionally may be severe enough to cause some damage.[23]

Summers in the area are quite warm, ranging from about 30 to 35 degrees Celsius (high 80 to low 90 degrees Fahrenheit). Temperatures above 38 degrees Celsius (100 degrees Fahrenheit) are not frequent and have occurred in less than one-fourth of the years since 1900. Temperatures of 32 degrees Celsius (90 degrees Fahrenheit) or above occur an average of 48 days per year. Summertime thunderstorms frequently reduce afternoon temperatures by 5 to 8 degrees Celsius (10 to 15 degrees Fahrenheit).[23]

Precipitation is fairly uniform throughout the year with a wintertime maximum resulting from cyclonic storms moving northward from the Gulf of Mexico. Thunderstorm activity results in a summer maximum, typically in July. During an average summer, there are usually a few severe thunderstorms which result in hail and damaging winds.[23]

2.4.2 Local Meteorology

Long-term weather records are available from Chattanooga, Tennessee, about 70 kilometers (45 miles) south-southwest of the Watts Bar site. A maximum temperature of 41 degrees Celsius (106 degrees Fahrenheit) occurred in July 1952 and a minimum of minus 23 degrees Celsius (minus 10 degrees Fahrenheit) in January 1966. Maximum precipitation and snowfall recorded within a 24 hour period at Chattanooga were 166 millimeters (6.53 inches) in March 1973 and 226 millimeters (8.9 inches) in December 1963. These extremes have been exceeded elsewhere in the Chattanooga area. In March 1886, 193 millimeters (7.61 inches) of precipitation fell in a 24-hour period and in December 1886, 305 millimeters (12.0 inches) of snow fell within 24 hours. The maximum monthly rainfall and snow at Chattanooga were 351 millimeters (13.8 inches) in March 1973 and 264 millimeters (10.4 inches) in February 1960, respectively. The maximum recorded monthly precipitation in the area was 388 millimeters (15.29 inches) in April 1911 and the maximum monthly snowfall was 401 millimeters (15.8 inches) in January 1893. During an average year, heavy fog reduces visibility to 400 meters (one-fourth mile) or less on 36 days.[26] Relative humidity averages about 70 percent annually.[24]

Table 2.4

SUMMARY OF WEEKLY OBSERVED DISSOLVED OXYGEN

CONCENTRATIONS IN THE TAILRACE OF WATTS BAR DAM

1960-75

Year	Observed Dissolved Oxygen Concentrations mg/l		Number of Days Dissolved Oxygen Less than Stated Concentration			
	Minimum	Maximum	3.0 mg/l Days	4.0 mg/l Days	5.0 mg/l Days	6.0 mg/l Days
1960	3.3	10.5	0	6	47	101
1961	4.7	11.8	0	0	3	73
1962	2.9	11.6	4	30	77	144
1963	2.3	11.5	11	50	98	121
1964	3.2	11.4	0	25	39	116
1965	2.7	10.7	6	46	95	131
1966	2.1	12.6	32	43	82	120
1967	3.9	13.5	0	2	23	71
1968	3.3	12.4	0	25	78	133
1969	2.2	11.0	10	66	96	122
1970	2.9	11.6	2	66	116	148
1971	3.0	10.8	0	36	86	146
1972	4.1	11.3	0	0	34	87
1973	4.2	11.5	0	0	26	56
1974	5.2	10.7	0	0	0	50
1975	3.9	13.3	0	2	21	47

Onsite wind data representative of the Watts Bar site were collected at the 10-meter (30-foot) and 46-meter (150-foot) levels between July 1973 and July 1975. A summary of the lower level data is presented in Figure 2.1. During this period, the predominant wind flow was from the south-southwest with a 15 percent frequency occurrence. The median wind speed at the 10-meter (30-foot) level is approximately 1.5 meters per second (three miles per hour).[25]

2.4.3 Severe Weather

In the summer, eastern Tennessee is subjected to severe weather generated by diurnal thunderstorm activity. Some thunderstorm activity occurs in the winter as a result of cyclonic storm activity originating from the Gulf of Mexico. Freezing rain and glaze are not an uncommon wintertime phenomena.[23]

Between 1953 and 1974, 59 tornadoes were reported in a 160 kilometer (100 mile) square containing the Watts Bar site.[26] The calculated resultant tornado frequency and the recurrence interval of a tornado striking any selected point in the 25,600 square kilometer (10,000 square mile) area containing the site is 7.6×10^{-4} tornadoes per year and 1300 years, respectively.[27] Hail 20 millimeters (three-fourths of an inch) in diameter or larger was recorded on 10 days and winds 26 meters per second (58 miles per hour) were reported on 20 days during the period from 1955 through 1967 within the one-degree latitude-longitude rectangle containing the Watts Bar site.[29] The maximum "fastest mile" of wind reported in Chattanooga was 37 meters per second (82 miles per hour) in March 1947.[23]

On an annual average, thunderstorms may be expected to occur on about 50 days per year.[28,29] Freezing precipitation (ice storms) may be expected to occur about one year out of every two, and storms resulting in an accumulation of 13 millimeters (one-half inch) or more are expected one year in five.[30] Sixty-five cases of air stagnation within the site area lasting four or more days occurred during the period from 1936 through 1970.[31]

2.4.4 Dispersion

The Tennessee Valley Authority has submitted two full years (July 1973 through June 1975) of onsite joint frequency distributions at the 10-meter (30-foot) and 91-meter (300-foot) levels by atmospheric stability (defined by the vertical temperature gradient) between 91 meters (300 feet) and 10 meters (30 feet)[25] in accordance with the recommendations of Regulatory Guide 1.23, "Onsite Meteorological Programs."[32] Data recovery was 90 and 85 percent for the 10-meter (30-foot) and 91-meter (300-foot) levels, respectively.[25] The staff used the 10-meter (30-foot) data, adjusted to representative heights of release, to provide relative concentration (X/Q) and deposition (D/Q) values for the site. A "Straight-Line Trajectory Model," as described in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors,"[33] was used in evaluating atmospheric transport and dispersion characteristics. Partial elevated releases were considered when exit velocities and building configurations met the criteria established in Regulatory Guide 1.111. Table 5.3 summarizes the relative concentration and deposition values used in the dose assessment.

2.5 ECOLOGY

2.5.1 Terrestrial Ecology

The Watts Bar station area was characterized in the FES-CP (Appendix I) as being a 967 acre tract which prior to TVA acquisition was primarily used for agriculture. The spider-lily (Hymenocallis occidentialis) had been classified in the U. S. Forest Service - Southern region list of rare and endangered species. Several spider-lilies were found in the plant site area, but none were found in areas to be cleared or altered by construction (FES-CP). Therefore, no adverse effects to this species are expected due to construction of the plant. No other endangered or threatened floral species have been identified on-site.

The southern Bald Eagle (Haliacetus l. leucocephalus) is a relatively common visitor to Watts Bar and Chickamauga Lake. However, the site contains no special characteristics, such as critical habitat for threatened or endangered species or pristine ecosystems and therefore, in the staff opinion, no species of terrestrial animal protected by the Endangered Species Act of 1973 will be further threatened or endangered by the operation of the station.

The staff has viewed the construction area in preparation for the operating license stage review. The site is fully excavated for construction and laydown areas, and those biological systems previously present in these areas are now eliminated. Terrestrial biological communities

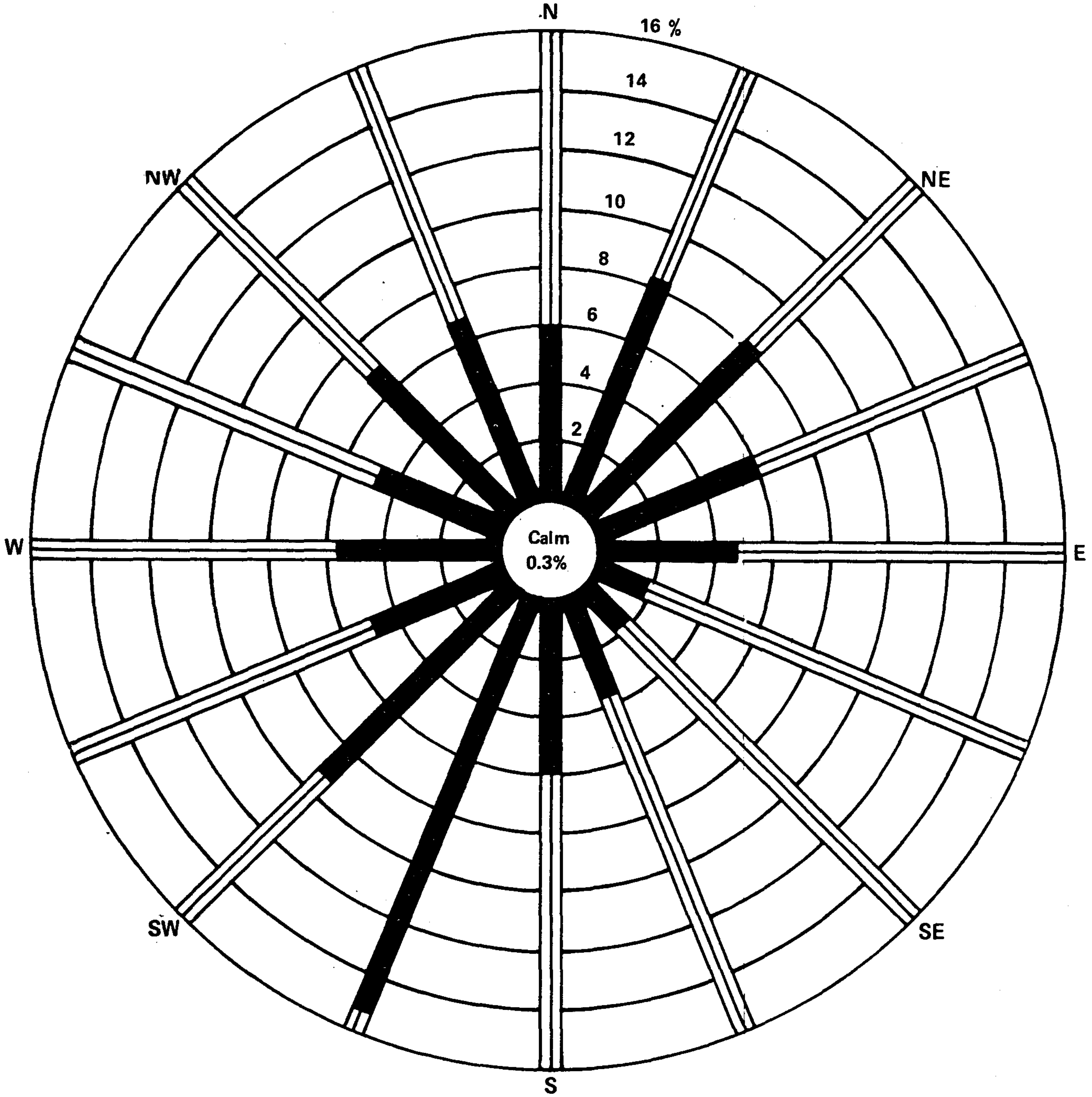


Figure 2.11 Onsite Wind Data, 10-Meter (33-Foot) Level July 1973-June 1975. Wind Frequency by Direction in Percentage of Occurrence

outside of the excavation zone, however, appear not to have been impacted and are in good condition. No further expansion of excavated areas is expected during the remaining construction period and the staff expects that natural areas of the site will not be further disturbed.

It is the staff's opinion that the non-excavated portion of the plant site will function as an informal preserve for the common species of the region provided that no further disturbance takes place after construction.

Common procedures for safe management of power plant sites such as restrictions on fire arms, offroad traffic, burning, farming and lumbering have a benefit to wildlife in addition to their primary purpose. If such procedures are implemented, the undisturbed areas of the plant site

2.5.2 Aquatic Ecology

Characteristics of the site aquatic biota had been described in TVA's FES-CP[34] based on a general knowledge of the Tennessee River tailrace habitats and their associated biota but with little site-specific data. TVA's preoperational monitoring program has produced extensive supplemental information on the site biota.[35,36,37] Elements of this program will be continued into 1978, at which time, TVA will present an analysis of all data in their Preoperational Monitoring Report (scheduled for completion three months before commercial operation).

Since the available information is not presented in a single document, such as the customary Environmental Report, the staff has determined the need to include a summary of the data in this statement (see Appendix C). The discussion in this section extracts from Appendix C only that information on site biota pertinent to our evaluaton of potential impacts (see Section 4.3.2 and Section 5.4.2).

The site (at Tennessee River Mile 528.0) is located in the riverine portion of the Chickamauga Reservoir, approximately 3.2 km (2 miles) downstream of the Watts Bar Dam. The historical record indicates an annual average (mean daily) discharge at the Dam of 750 m^3/sec (26,480 ft^3/sec) with average flow of $\sim$609 m^3/sec (21,500 ft^3/sec) during the summer months and 1006 m^3/sec (35,500 ft^3/sec) during the winter months. At these average summer and winter flow rates, channel velocities at the site have been estimated at 0.3 m/sec (1.0 ft/sec) and 0.7 m/sec (2.3 ft/sec), respectively.

The quality of the water released from Watts Bar Reservoir is generally good; however, the concentrations of certain metals and the depressed DO concentration during summer and fall may present an existing stress to the site biota (also see Section 2.3.3).

The diversity and abundance of phytoplankton and zooplankton communities also suggest a condition of good water quality. A general trend of increasing productivity from downstream to upstream sampling locations is indicated by the plankton data, as well as carbon-14 and chlorophyll *a* analyses. The cyanophytes (blue-green algae) showed a marked increase in the summer 1976 collections of phytoplankton.

The tailrace stretch provides favorable habitat for several species of mussels. At the time of DES preparation, TVA had identified 13 species in the area, including *Lampsilis orbiculata* which is listed as endangered by the U. S. Fish and Wildlife service.[38] During a more recent survey (June 1978), two specimens of *Dromus dromas*, also included on the Federal list of endangered species, were collected at a location 7.6 miles downstream of the Watts Bar Nuclear Plant site. Additional specimens of *L. orbiculata* were found at this same location in the June 1978 survey. The 3-mile reach from the Watts Bar Dam (TRM 529.9) downstream to TRM 526.9 has been designated by the State of Tennessee as a mussel sanctuary, making harvesting within the reach illegal. *Pleurobema cordatum*, a listed species of Special Concern by the Tennessee Heritage Program, is the third most abundant species of mussel in the Chickamauga Reservoir, according to TVA. Surveys of the mussel beds conducted by TVA in 1975 and 1976 indicate that the most suitable habitat is along the left bank (looking downstream) in the reaches from TRM 520.5 to 521.3 and TRM 527.6 to 528.5. Greater concentration was found in the TRM 520.5 to 521.3 reach. No mussel concentrations were located on the right side of the river in the vicinity of the blowdown diffuser location.

The life cycle for a representative mussel species (*Pleurobema cordatum*) is provided in TVA's FES (p. 2.7-19). A key feature of the cycle is the parasitic stage. The mature larvae, called glochidia, are shed into the water where they come into contact and attach to suitable host fishes. The glochidia are encysted by host tissue and continue development for varying periods depending on species. At the end of this parasitic phase, the immature mussel drops from the host and continues development as a free-living form. The glochidia infection, appears to induce an immunity in the fish, strengthening the host against repeated infections and attack by copepods.

Such mutualism is further displayed in that those fishes which prey heavily upon mussels, e.g., freshwater drum, are hosts for the glochidia of several mussel species.[39]

In TVA's FES, the area immediately downstream of the Dam was considered favorable spawning habitat for migratory (tailrace) spawners, including sauger, white bass, smallmouth bass, and possibly yellow perch. Ichthyoplankton data for 1976-77 suggest that the area may be less favorable than earlier expected. Of 10,873 larvae collected in 1976, only eight were representatives of the tailrace spawners. The clupeids, freshwater drum, and Lepomis spp. made up 91.5%, 5.5%, and 1.9% of the 1976 collections of larvae, respectively. Larvae of the Clupeidae were sufficiently abundant to conclude that the horizontal distribution, across the river at the intake location, was essentially uniform throughout the spawning season.

Based on relative abundance of captured larvae by transect station, channel catfish appeared to prefer the middle channel station; however, other taxa did not demonstrate a well-defined preference and/or ability to concentrate at a particular station across the river transect.

2.6 BACKGROUND RADIOLOGICAL CHARACTERISTICS

The Environmental Protection Agency[40] has reported average background radiation dose equivalents for Tennessee as 100.8 millirem/person/year. Of this total (for Chattanooga, Tennessee, the average background is 106.7 millirem/person/year) for Tennessee, 43.4 millirem/person/year was attributed to cosmic radiation. External gamma radiation (primarily from K-40 and the decay products of the uranium and thorium series) was estimated at 39.4 millirem/person/year. The remainder of the whole body dose is due to internal radiation (mostly H-3, C-14, K-40, Ra-225, and Ra-226 and their decay products) which was estimated to average 18 millirem/person/year.

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39. Fuller, Samuel L. H., "Clams and Mussels," Chapter 8 in Hart, C. W., Jr., and Samuel L. H. Fuller, eds., Pollution Ecology of Freshwater Invertebrates, Academic Press, New York, 1974.

40. Oakley, Donald T., Natural Radiation Exposure in the United States, ORP/SID 72-1, Office of Radiation Programs, Environmental Protection Agency, Washington, DC, June 1972.

3. THE PLANT

3.1 RÉSUMÉ

At the time of this Operating License review, construction of the Watts Bar Plant was proceeding at the scheduled pace with the most obvious indication of progress evidenced by the near completion of the hyperbolic natural draft cooling towers, Unit No. 1, the intake structure and channel, turbine building, switchyard and other major structures.

Estimates of cooling tower evaporation and makeup and blowdown flows have been revised. The blowdown diffusers have been relocated 305 meters (1000 feet) upstream of the original location proposed in the FES-CP, requiring some design changes in the discharge system. These changes are discussed and evaluated in Sections 3.2.1 and 3.2.2.

The design for the radioactive waste systems has been finalized by the applicant. These systems have been evaluated by the staff in accordance with the new criteria in Appendix I to 10 CFR 50 and are discussed in Section 3.2.3.

Changes in planned use of chemicals at the station, including the use of additives to the steam generator feedwater, are indicated. These changes and those provided to control biological growth in the cooling systems using river water and for corrosion inhibition in the component cooling water system are discussed and evaluated in Section 3.2.4.

The Watts Bar-Volunteer 500 kV transmission line route was relocated since issuance of the FES-CP. This change is discussed in Section 3.2.5.

3.2 DESIGN AND OTHER SIGNIFICANT CHANGES

3.2.1 Water Use

The planned station water use has not changed significantly from that described in the FES-CP. Steam generator make up, service water, and condenser cooling water will be obtained from the Tennessee River at a maximum rate of 4.0 cubic meters/sec (143 cfs).[22] A ground water system has been developed to provide the potable water supply for the station.[2] Operational ground water use will approximate 0.0007 cubic meters/sec (16,000 gallons per day).[1]

The two natural draft cooling towers will evaporate water at a maximum rate of about 1.8 cubic meters/sec (64 cfs)[3] or an average rate of 1.4 cubic meters/sec (50 cfs). This average rate is equivalent to 45,000,000 cubic meters/year. The peak blowdown flow from the cooling towers will be about 2.4 cubic meters/sec (85 cfs) for two units.[23] When the rate of release of water from the Watts Bar Dam is less than 99 cubic meters/sec. (3500 cfs), cooling tower blowdown will be retained in a holding pond. Subsequently, when blowdown to the river is resumed, station discharge flow rate will be about double as water which has been withheld is released. A plant water use diagram is included as Figure 3.1.

The concentration factor in the condenser circulating water system will average 1.9 based on the flows in Figure 3.1. That concentration factor is the ratio of concentration in the cooling tower blowdown to the concentration of the same substance in the cooling tower makeup. The concentration increase comes about due to the evaporation of water in the cooling towers. Since makeup is provided by the discharge from the raw cooling water systems, the concentration factor is essentially established by the water flow requirements of those systems.

3.2.2 Heat Dissipation System

Estimates of cooling tower evaporation and makeup and blowdown flows have been revised since the publication of the FES-CP. Maximum station water usage is reported as 4.0 cubic meters/sec (143 cfs)[22] as compared to 3.8 cubic meters/sec (133 cfs) reported previously.[4] Maximum evaporation is reported as 1.80 cubic meters/sec (64 cfs) as compared to 1.75 cubic meters/sec (62 cfs) reported previously. Blowdown maximum is estimated as 4.8 cubic meters/sec (170 cfs)[23] for both units and holding pond discharge, as compared to 1.75 meters/sec (62 cfs) reported previously.[1,5]

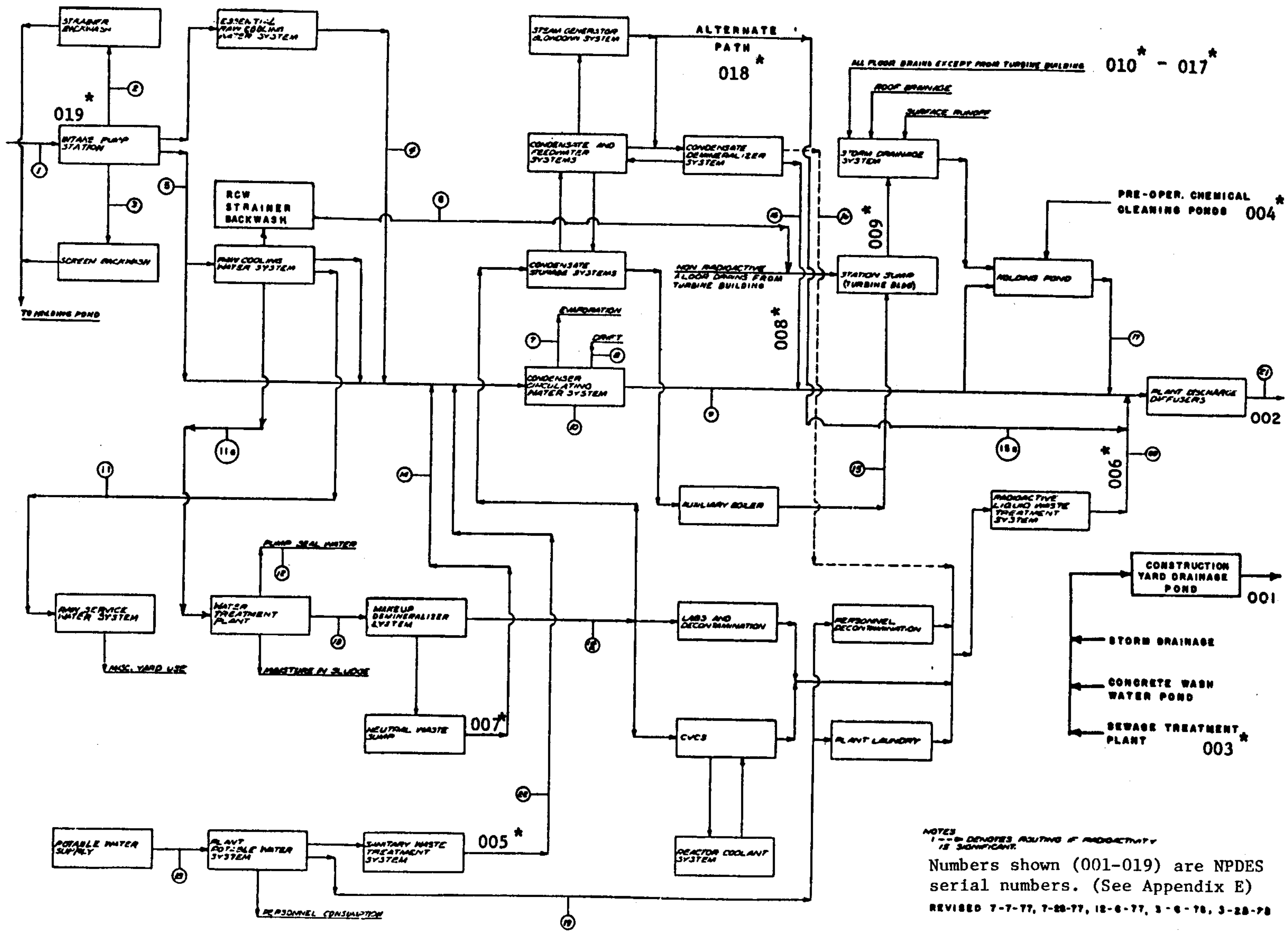


FIGURE 3.1 WATTS BAR NUCLEAR PLANT - WATER USE DIAGRAM

NOTES
1 - - - DENOTES ROUTING IF RADIOACTIVITY IS SIGNIFICANT.

Numbers shown (001-019) are NPDES serial numbers. (See Appendix E)

REVISED 7-7-77, 7-28-77, 12-6-77, 3-6-78, 3-28-78

* Serial numbers assigned for identification and monitoring purposes.

Notes to Figure 3.1

FLOWS ASSOCIATED WITH PLANT WATER USE DIAGRAM*

WATTS BAR NUCLEAR PLANT

Node Point Plant Water Use Diagram	A Flow-Normal Full Load Operation of Two Units	B Flow - Full Load Operation of One Unit with Other Unit Shutdown	C Flow - Both Units Shutdown
1. Intake	64,280 (abs max) 59,800 (nor max)	51,480 (abs max) 41,300 (nor max)	16,800 (nor max)
2. Strainer Backwash	1,800 gpm (Continuous)	Same as A	Same as A
3. Screen Backwash	480 (intermittent)	Same as A	Same as A
4. Essential Raw Cooling Water	31,000 gpm (abs max) 30,000 gpm (nor max)	32,000 gpm (abs max) 23,500 gpm (nor max)	15,000 gpm (avg)
5. Raw Cooling Water System	31,000 gpm (abs max) 28,000 gpm (nor max)	20,000 gpm (abs max) 16,000 gpm (nor max)	0
6. Raw Cooling Water Strainer Backwash	800 gpm	Same as A	0 0
7. Cooling Tower Evaporation Rate	28,800 gpm (max) 22,590 gpm (avg) 19,860 gpm (min)	14,400 gpm (max) 11,295 gpm (avg) 9,930 gpm (min)	0 0
8. Cooling Tower Drift Rate	90 gpm (avg)	45 gpm (avg)	0
9. Cooling Tower Blowdown Flow	38,740 (abs max) 20,000-35,500 gpm (nor range)	37,400 (abs max) 28,160 gpm (avg)	0 0
10. Condenser Circulating Water System (flow through towers)	820,000 gpm	410,000 gpm	0
11. Raw Service Water System	1,000 gpm (max)	1,400 gpm (max)	1,400 gpm (max)
11a. Water Treatment Plant Supply	556 gpm (max)	Same as A	Same as A
12. Pump Seal Water	32 gpm (avg)	16 gpm (avg)	0

NOTES (continued)
FLOWS ASSOCIATED WITH PLANT WATER DIAGRAM

Node Point See Plant Water Use Diagram	A Flow - Normal Full Load Operation of Two Units	B Flow - Full Load Operation of One Unit with Other Unit Shutdown	C Flow - Both Units Shutdown
13. Treated Water Supply to Makeup Demineralizer	480 gpm (max) 400 gpm (avg)	Same as A	Same as A
14. Demineralizer Spent Regenerants	25 gpm (avg)	Same as A	Same as A
14.a Demineralizer Water Supply	320 gpm (max)	Same as A	Same as A
15. Auxiliary Boiler Blowdown	1.4-3 gpm	Same as A	3 gpm (max)
15.a Steam Generator Blowdown (Alternate)	20-120 gpm	Same as A	Same as A
16. Condensate Demineralizer Spent Regenerants	30 gpm (avg)	Same as A	Same as A
17. Holding Pond Discharge	38,150 gpm (max)	38,150 gpm (avg)	0
18. Potable Water Supply	16,000 gpd (max)	Same as A	Same as A
19. Potable Water Supply to Hot Showers and Laundry	4,000 gpd (max) 1,500 gpd (avg)	Same as A	Same as A
20. Radioactive Liquid Treatment System Discharge	5.7 gpm (avg)	Same as A	Same as A
21. Plant Discharge	76,300 gpm (nor max) 20,000-35,500 gpm (nor range)	66,310 (max) 28,160 (avg)	16,800 gpm (avg)
22. Sanitary Waste Discharge	12,000 gpd (max) 6,000 gpd (avg)	Same as A	Same as A

* All average flow rates are yearly averages.

Blowdown Diffusers (NPDES 002)

The original location of the blowdown diffuser at about Tennessee River Mile 527.6 was determined to be infeasible because of insufficient river depths in that area. Therefore, the applicant has relocated the diffusers approximately 305 meters (1000 feet) upstream of the original location.[6]

The diffuser system will consist of two pipes branching from a central conduit at the right bank of Chickamauga Lake and extending in a direction perpendicular to the river flow into the Tennessee River. Each pipe will be controlled by a 137-centimeter (54-inch) diameter butterfly valve, located a short distance from the wye with the central conduit.

The downstream leg will consist of approximately 91 meters (297 feet) of 1.37-meter (4.5-foot) diameter paved corrugated steel approach pipe connected to 49 meters (160 feet) of unpaved 2.5 x 7.6-centimeter (1 x 3-inch) corrugated steel diffuser pipe of the same diameter. The diffuser pipe section will be half buried in the river bottom and will contain two 2.5-centimeter (1-inch) diameter ports per corrugation. The centroid of the ports will be oriented at an angle of 45° above horizontal in a downstream direction. Figures 3.2 and 3.3 illustrate the diffuser system and its geometry.

The upstream leg will consist of approximately 139 meters (457 feet) of 1.07-meter (3.5 foot) diameter paved corrugated steel approach pipe connected to 24 meters (80 feet) of unpaved 2.5 x 7.6-centimeter (1- x 3- inch) corrugated steel diffuser pipe of the same diameter. The upstream diffuser pipe section will also be half buried in the river bottom and will extend its entire length of 24 meters (80 feet) beyond the dead end of the downstream diffuser pipe section. The port diameter, spacing and orientation of the upstream leg will be the same as that of the downstream leg.[24]

During different modes of operation, either or both of the diffusers will be discharging. The upstream leg is used when either Unit 1 or Unit 2 is operated alone. The downstream leg is used only when both units are operated simultaneously or when only stored blowdown is discharged from the holding pond. Both legs discharge blowdown when either or both units are operated at the same time as stored blowdown is discharged from the holding pond.[25] See Table 3.1 for details on flow rates.

3.2.3 Radioactive Waste Treatment Systems

During the operation of the Watts Bar Nuclear Plant, Unit Nos. 1 and 2, radioactive material will be produced by fission and by neutron activation of corrosion products in the reactor coolant system. From the radioactive material produced, small amounts of gaseous and liquid radioactive wastes will enter the waste streams. These streams will be processed and monitored within the station to minimize the quantity of radioactive nuclides ultimately released to the atmosphere and to the Chickamauga Reservoir and the Tennessee River.

The waste handling and treatment systems to be installed at the station are discussed in the applicant's Final Safety Analysis Report (October 4, 1976), in the FES-CP prepared by TVA and in information submitted to meet the requirements of Appendix I to 10 CFR 50 (May 17, 1976).[7,8,9] In these documents, the applicant has presented an analysis of the radioactive waste treatment systems and has estimated the annual release of radioactive waste materials in liquid and gaseous effluents resulting from normal operation.

In the following paragraphs, the radioactive waste treatment systems are described, and an analysis is given based on the staff's model of the applicant's proposed radioactive waste treatment systems. The staff's model has been developed from a review of available data from operating nuclear power plants, adjusted to apply over a 30-year operating life. The reactor coolant activities and flow rates used in the staff's analyses are based on experience and data from operating reactors. As a result, the parameters used in the model and the calculated releases vary somewhat from those used in the applicant's evaluation.

On April 30, 1975, the Nuclear Regulatory Commission announced its decision in the rulemaking proceeding (RM 50-2) concerning numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as is reasonably achievable" for radioactive material in light-water-cooled nuclear power reactor effluents. This decision is implemented in the form of Appendix I to 10 CFR Part 50.[10] To effectively implement the requirements of Appendix I, the NRC staff has reassessed the parameters and mathematical models used in calculating releases of radioactive materials in liquid and gaseous effluents in order to comply with the Commission's requirements.

TABLE 3.1

SUMMARY OF MODES OF OPERATION BLOWDOWN DIFFUSER SYSTEM
WATTS BAR NUCLEAR PLANT

	Mode of Operation	Diffuser System Flow Rate		Distribution of Flow			
				Minimum		Maximum	
		Minimum (cfs)	Maximum (cfs)	Upstream Leg (cfs)	Downstream Leg (cfs)	Upstream Leg (cfs)	Downstream Leg (cfs)
1	One unit only	22.3	50.0	22.3	----	50.0	----
2	Two units only or Holding pond discharge only	44.6	85.0	----	44.6	----	85.0
3	Either or both units + Holding pond discharge	82.5	170.0	27.5	55.0	56.7	113.3

Blowdown rate for one unit: 22.3 - 50.0 cfs
Blowdown rate for two units: 44.6 - 85.0 cfs
Holding pond discharge rate: 60.2 - 85.0 cfs

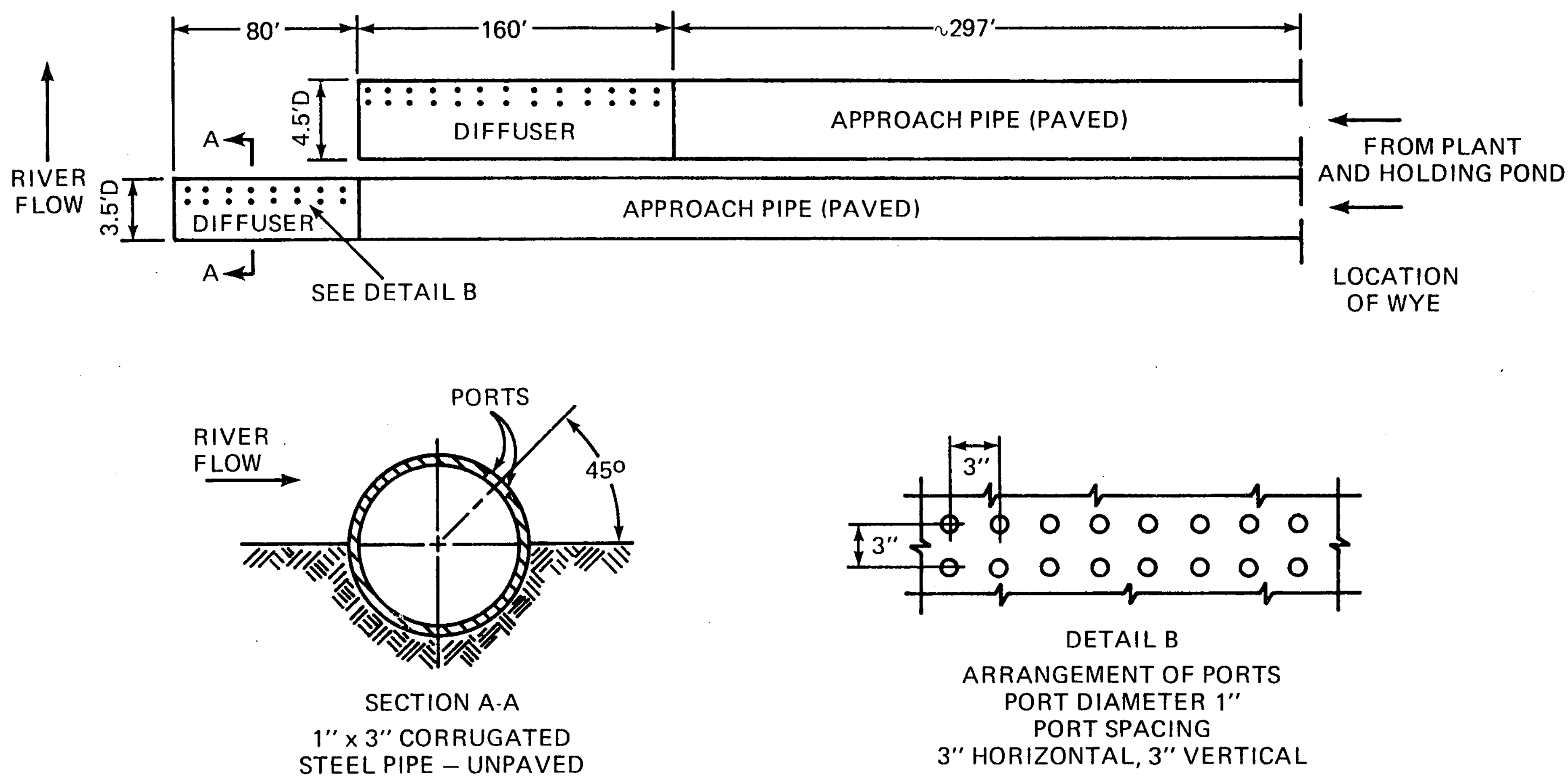


Figure 3.2 Diffuser Geometry

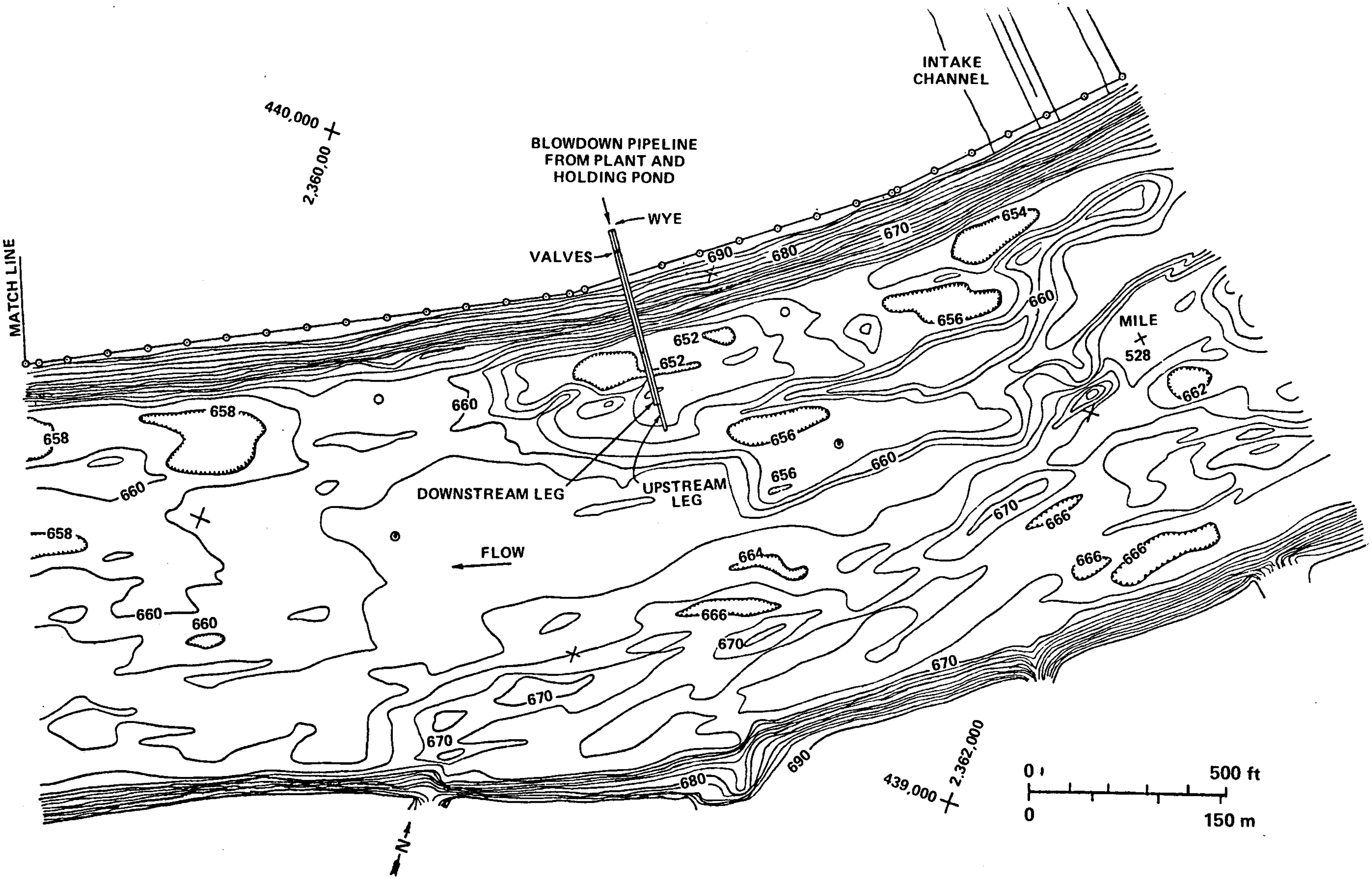


Figure 3.3 Location of Multiport Diffuser System

The requirements directed that current operating data, applicable to proposed radwaste treatment and effluent control systems for a facility, be considered in the assessment of the input parameters. These parameters, models, and their bases are given in NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code), April 1976."[11]

By letter of October 6, 1975, the applicant was requested to submit additional information concerning the means proposed to be employed to keep levels of radioactive materials in effluents from the Watts Bar Nuclear Plant, Unit Nos. 1 and 2, to unrestricted areas "as low as is reasonably achievable," in conformance with the requirements of Appendix I to 10 CFR Part 50. The applicant was also given the option of providing either a detailed cost benefit analysis or demonstrating conformance to the guidelines given in the September 4, 1975 Annex to Appendix I. The applicant responded with an evaluation contained in a submittal dated May 17, 1976. In that submittal, TVA chose to perform the cost-benefit analysis required by Section II.D of Appendix I to 10 CFR Part 50.

The staff performed an independent evaluation of the applicant's proposed methods to meet the requirements of Appendix I. The evalution consisted of: (1) a review of the information provided by the applicant, (2) a review of the applicant's proposed radwaste treatment and effluent control systems, (3) the calculation of new source terms based on models and parameters as given in NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code), April 1976," and (4) a cost-benefit analysis to determine the cost-effectiveness of proposed augments to the liquid and gaseous radwaste treatment systems.

Based on the following evaluation, the staff concludes that the liquid and gaseous radioactive waste treatment systems for Unit Nos. 1 and 2 are capable of maintaining releases of radioactive materials in liquid and gaseous effluents to "as low as is reasonably achievable" levels in accordance with 10 CFR Part 34a, and meet the requirements of Sections II.A, II.B, II.C, and II.D of Appendix I to 10 CFR Part 50.

3.2.3.1 Liquid Radioactive Waste Treatment System

The liquid radioactive waste treatment system, which is shared by Unit Nos. 1 and 2, will consist of equipment and instrumentation necessary to collect, process, monitor, recycle or dispose of potentially radioactive liquid wastes generated during normal operation including anticipated operational occurrences. Liquid radioactive waste will be processed on a batch basis to permit optimum control of releases. Prior to release, samples will be analyzed to determine the types and amounts of radioactivity present; on the basis of the results, the waste will be recycled for reuse in the plant, retained for further processing, or discharged under controlled conditions to the Chickamauga Reservoir and the Tennessee River, via the cooling tower blowdown discharge. A radiation monitor will automatically terminate liquid waste discharge if radiation measurements exceed a predetermined level in the discharge line. A schematic diagram of the liquid radioactive waste treatment system is given in Figure 3.4.

The liquid radioactive waste treatment system will consist of the boron recycle system, the tritiated waste system, the floor drain (dirty waste) system, and the laundry and hot shower system.

The boron recycle system is shared by Unit Nos. 1 and 2, and will process shim bleed and equipment drain wastes collected inside the reactor containment. The principal system components will be two recycle holdup tanks, two evaporator feed demineralizers, one evaporator, two polishing demineralizers, and one monitor tank.

The tritiated waste system will process equipment drain wastes and tank overflow wastes from components outside reactor containment. The basic composition of these inputs will allow treatment and recycle for use in the reactor coolant system. The principal tritiated waste system components will consist of one waste holdup tank, an evaporator, an optional polishing demineralizer, and three recycle condensate monitor tanks, which are shared with the floor drain (dirty waste) system. The staff's evaluation assumed the use of the optional polishing demineralizer.

The floor drain (dirty waste) system will process non-reactor grade liquid wastes, including floor drains, equipment drains containing non-reactor grade water, and building sumps. After treatment these wastes will be transferred to the waste monitor tanks for reuse in the plant or for discharge to the Chickamauga Reservoir and the Tennessee River via the cooling tower blowdown line. The principal floor drain system components will consist of one collection tank, an

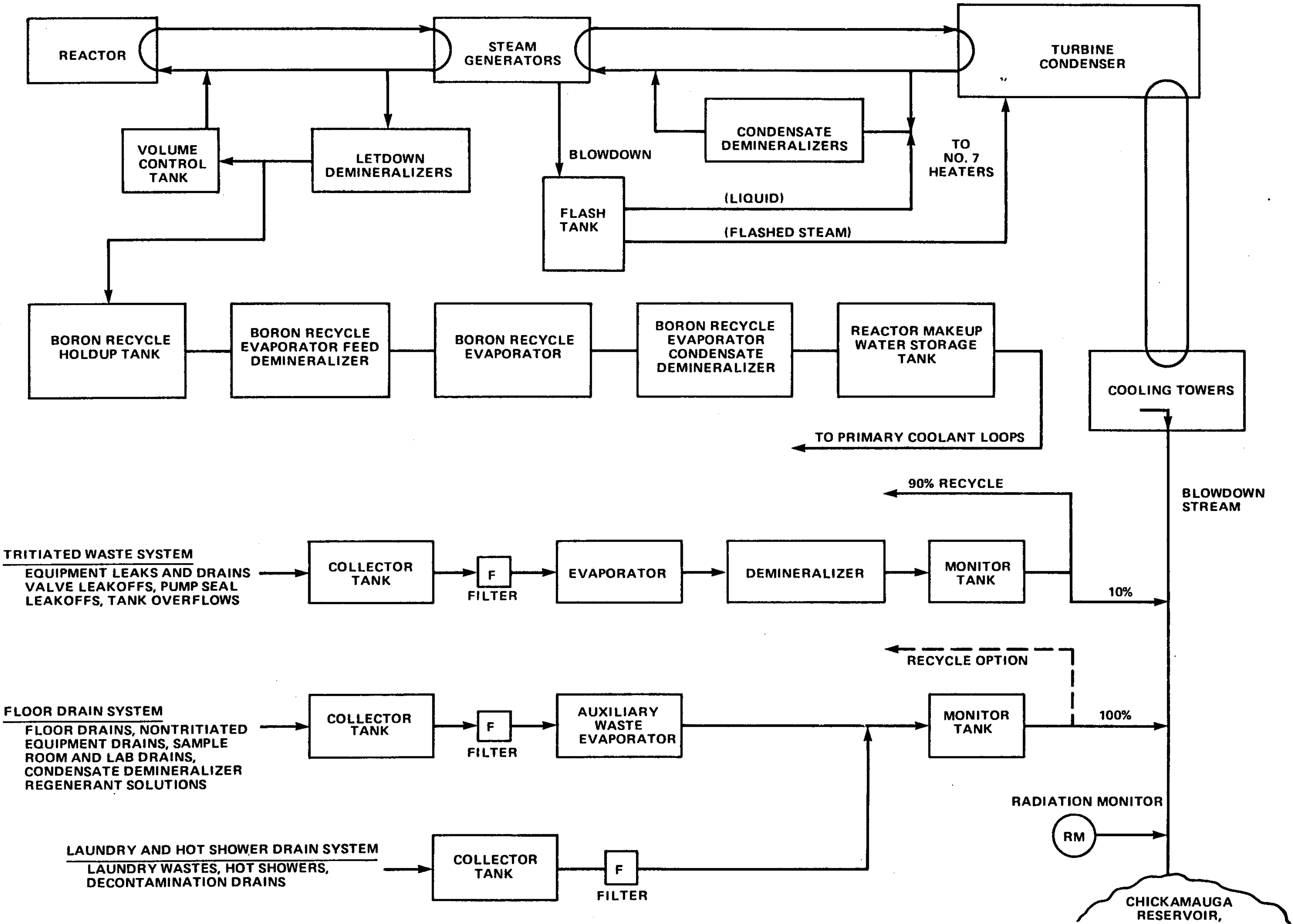


Figure 3.4 Watts Bar Nuclear Plant, Unit Nos. 1 and 2 Liquid Radwaste Treatment Systems

evaporator, and three recycle condensate monitor tanks, which are shared with the tritiated waste system. Treated liquid may be recycled through the evaporator if radiation measurements indicate additional treatment is required.

The steam generator blowdown will be processed continually through a flash tank, with the liquid being mixed with water from the main condenser and pumped to the condensate demineralizers, and the flashed steam being utilized in the No. 7 heaters. The processed water will be reused in the plant, but may be discharged through the cooling tower blowdown line under certain circumstances provided that radioactivity concentrations are below predetermined values.

Boron Recycle System (BRS)

Primary coolant will be withdrawn from the reactor coolant system at approximately 110 gpm and processed through the chemical and volume control system (CVCS). The letdown stream will be cooled, reduced in pressure, filtered, and processed through one of two mixed bed demineralizers. Approximately 10% of the time this letdown stream will be passed through an additional cation demineralizer to remove excess lithium and cesium. Radionuclide removal by the CVCS was evaluated by assuming 110 gpm letdown flow at primary coolant activity (PCA) through one mixed bed demineralizer (Li_3BO_3 form), and a continuous 11 gpm flow through one cation demineralizer in series with the mixed bed. The CVCS will be used to control the primary coolant boron concentration by diverting a side stream of approximately 3300 gpd/reactor of the treated letdown stream to the shared Boron Recycle System (BRS) as shim bleed.

The shim bleed from the letdown stream will be processed through one of two mixed bed demineralizers (Li_3BO_3 form) and routed to the recycle holdup tanks. Valve leakoffs and equipment drain wastes in the reactor containment as well as excess spent fuel pit water will be transferred to the recycle holdup tank where it will be combined with the shim bleed. These streams will form the inputs to the BRS and will be processed batchwise from the recycle holdup tank. The staff calculated the collection time in one of the two 256,000 gallon recycle holdup tanks to be approximately 28 days, based on a combined input flow rate of 7200 gpd from Unit Nos. 1 and 2. The wastes will be processed through an evaporator and a condensate demineralizer and collected in the reactor makeup water storage tank for reuse in the plant as reactor grade water. Based on an assumption of 80% tank capacity and a process flow rate of 30 gpm, the staff calculated the decay time during processing to be approximately 4.7 days. If the radioactivity is below a predetermined value, the treated stream may be pumped to the waste monitor release tank and discharged. The staff assumed that 10% of the treated stream will be discharged to the Chickamauga Reservoir and the Tennessee River due to anticipated operational occurrences and for tritium inventory control. The decontamination factors listed in Table 3.2 were applied for radionuclide removal in the BRS. The concentrated bottoms from the evaporator and the spent resins from the demineralizers will be transferred to the radioactive solid waste system for disposal by burial offsite.

Tritiated Waste System

The tritiated waste system of the liquid radioactive waste treatment system is designed to collect and treat tritiated and non-aerated sources of reactor grade water for reuse within the plant from the equipment in the CVCS, BRS, and liquid radioactive waste treatment system, the sampling system sink, the excess letdown, safeguard components, refueling canal drainage, and gaseous waste treatment condensation. These wastes will be collected in a 24,000 gallon waste holdup tank at an input flow rate of approximately 270 gallons per unit per day. The staff calculated the collection time to be approximately 36 days. The wastes will be processed through a waste evaporator and an optional condensate demineralizer and collected in a 1,500 gallon test tank. The staff calculated the decay time during processing to be approximately 6.9 days. The decontamination factors listed in Table 3.2 were applied for radionuclide removal in the tritiated waste system of the liquid waste treatment system. The contents of the treated stream will be periodically sampled, recycled for further treatment, transferred to the reactor makeup water storage tank, or discharged. The staff assumed that 10% of the treated stream will be released to the Chickamauga Reservoir and the Tennessee River.

Evaporator bottoms and spent resins will be transferred to the radioactive solid waste system for disposal by burial offsite.

TABLE 3.2

PRINCIPAL PARAMETERS AND CONDITIONS USED IN CALCULATING RELEASES OF RADIOACTIVE MATERIAL IN LIQUID AND GASEOUS EFFLUENTS FROM WATTS BAR NUCLEAR PLANT, UNIT NOS. 1 AND 2

Reactor Power Level (MWt)	3600
Plant Capacity Factor	0.80
Failed Fuel	0.12%[a]
Primary System	
Mass of Coolant (lbs)	5×10^5
Letdown Rate (GPM)	110
Shim Bleed Rate (gpd)	3.3×10^3
Leakage to Secondary System (lbs/day)	100
Leakage to Containment Building	b
Leakage to Auxiliary Building (lbs/day)	160
Frequency of Degassing for Cold Shutdowns (per year)	2
Secondary System	
Steam Flow Rate (lbs/hr)	1.5×10^7
Mass of Liquid/Steam Generator (lbs)	9.5×10^4
Mass of Steam/Steam Generator (lbs)	8.5×10^3
Secondary Coolant Mass (lbs)	2.1×10^6
Rate of Steam Leakage to Turbine Building (lbs/hr)	1.7×10^3
Fraction of Feedwater Processed through Condensate Demineralizers	0.56
Containment Building Volume (ft^3)	1.1×10^6
Annual Frequency of Containment Purges (shutdown)	4
Annual Frequency of Containment Purges (at power)	20
Iodine Partition Factors (gas/liquid)	
Leakage to Auxiliary Building	0.0075
Leakage to Turbine Building	1.0
Main Condenser/Air Ejector (volatile species)	0.15

[a]This value is constant and corresponds to 0.12% of the operating power fission product source term as given in NUREG-0017 (April 1976).

[b]1%/day of the primary coolant noble gas inventory and 0.001%/day of the primary coolant iodine inventory.

TABLE 3.2
(continued)

Liquid Radwaste System Decontamination Factors (DF)

	Boron Recovery System (BRS)	Tritiated Waste System	Floor Drain Wastes, Inorganic Chemical Waste	Laundry and Hot Shower Drains
I	1×10^4	1×10^4	1×10^3	1
Cs,Rb	2×10^4	1×10^5	1×10^4	1
Others	1×10^5	1×10^5	1×10^4	1

	All Nuclides Except Iodine	Iodine
Radwaste Evaporator DF	10^4	10^3
BRS Evaporator DF	10^3	10^2

	Anions	Cs,Rd	Other Nuclides
Boron Recycle Feed Demin. DF (H_3BO_3)	10	2	10
Primary Coolant Letdown Demin. DF (Li_3BO_3)	10	2	10
Evaporator Condensate Polishing Demineralizer ($H{+}OH^-$)	10	10	10
Mixed Bed Condensate Demineralizer	10	2	10
Containment Bldg. Purge System Charcoal Filter with 2" Charcoal Bed Depth DF (Iodine Removal)			3.3
Turbine Air Removal System with 2" Charcoal Bed Depth DF (Iodine Removal)			3.3

Floor Drain (Dirty Waste) System

The floor drain (dirty waste) system of the liquid radioactive waste treatment system is designed to collect and treat non-reactor grade liquid wastes from floor drains, equipment drains containing non-reactor grade leakage, laboratory drains and regenerant solutions. These wastes will be collected in one 23,000 gallon floor drain tank and sampled and analyzed. If the radioactivity concentration is below a predetermined value, the wastes will be pumped to the waste monitor tanks for discharge to the Chickamauga Reservoir and the Tennessee River via the cooling tower blowdown; otherwise, the wastes will be treated through the floor drain system evaporator prior to entering the waste monitor tanks. The staff assumed 100% of the non-reactor grade liquid wastes will be processed through the evaporator and that 100% of the processed waste will be discharged to the Chickamauga Reservoir and the Tennessee River. The staff calculated the collection time to be approximately 2 days, based on an input flow of approximately 1,100 gpd per unit, and a decay time during processing of approximately 0.8 day.

Laundry and Hot Shower System

Waste from the laundry and hot showers will be collected in two 600 gallon laundry tanks. The waste will be transferred to a waste monitor tank, sampled and analyzed, and released to the Chickamauga Reservoir and the Tennessee River if radioactivity levels are below predetermined limits. Optionally, these wastes may be processed through the floor drain system if radioactivity levels exceed predetermined limits. The staff assumed an input flow rate of approximately 450 gpd per reactor and that the wastes will be discharged without processing.

Turbine Building Drains

The turbine building drains will be released through a radiation monitor to the Chickamauga Reservoir and the Tennessee River via the cooling tower blowdown without treatment. The monitor will automatically terminate liquid discharge if radioactivity exceeds a predetermined level. The staff assumed a release of 7200 gpd per reactor and that the wastes will be discharged without processing.

Steam Generator Blowdown (SGB)

The SGB system for Unit Nos. 1 and 2 will continuously process steam generator blowdown at an average flow rate of 86,000 gpd per reactor (design flow rate is 120 gpm). The blowdown from the four steam generators for each unit will be directed to a common flash tank. The liquid will be mixed with water from the main condenser and will be pumped to the condensate demineralizer system downstream of the main condenser. The flashed steam will be utilized in the No. 7 heaters and condensed in the main condenser hotwell. The staff did not consider any direct releases from this system to the environment.

Liquid Waste Summary

Based on the staff's evaluation of the radioactive liquid waste treatment systems and the parameters listed in Table 3.2, the staff calculated the release of radioactive materials in liquid waste effluent to be approximately 0.22 Ci/yr/reactor, excluding tritium and dissolved gases. The staff estimates that approximately 520 Ci/yr/reactor of tritium will be released to the Chickamauga Reservoir and the Tennessee River. In comparison, the applicant estimated a release of radioactive material in liquid effluent, exclusive of tritium, to be approximately 0.16 Ci/yr/reactor and a tritium release of 73 Ci/yr/reactor. The differences between the staff's values and those of the applicant lie principally in assumptions as to the quantities of liquid released. Also, the applicant calculates a lower annual production of tritium, with a correspondingly smaller annual release. The staff's calculations of the radionuclides expected to be released annually from Watts Bar, Units Nos. 1 and 2, are given in Table 3.3.

Based on the staff's evaluation, the radioactivity in liquid effluents from the Watts Bar Nuclear Plant, Unit Nos. 1 and 2, will not result in total body doses greater than 3 mrem/yr or any organ doses greater than 10 mrem/yr, in accordance with Section II.A of Appendix I to 10 CFR Part 50.

Cost-Benefit Analysis of Liquid Radwaste System Augments

The staff evaluated potential liquid radwaste system augments based on a study of the applicant's system designs, the population dose information provided in Table 5.7 of this draft environmental statement, a value of $1,000 per total body man-rem and $1,000 per man-thyroid-rem

TABLE 3.3

CALCULATED RELEASES OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENTS
FROM WATTS BAR NUCLEAR PLANT, UNIT NOS. 1 AND 2
Ci/yr/reactor

Nuclide	Ci/yr	Nuclide	Ci/yr
Corrosion & Activation Products		Fission Products (continued)	
Cr-51	8(-5)[a]	Te-127m	1(-5)
Mn-54	1(-3)	Te-127	1(-5)
Fe-55	9(-5)	Te-129m	5(-5)
Fe-59	5(-5)	Te-129	3(-5)
Co-58	4.8(-3)	I-130	1.6(-4)
Co-60	8.8(-3)	Te-131m	3(-5)
Zr-95	1.4(-3)	I-131	8.6(-2)
Nb-95	2(-3)	Te-132	4.2(-4)
Np-239	2(-5)	I-132	1.4(-3)
Fission Products		I-133	4.2(-2)
Br-83	4(-5)	Cs-134	1.9(-2)
Rb-86	1(-5)	I-135	7.9(-3)
Sr-89	2(-5)	Cs-136	1.7(-3)
Mo-99	1.6(-3)	Cs-137	2.8(-2)
Tc-99m	1.3(-3)	Ba-137m	4.2(-3)
Ru-103	1.4(-4)	Ce-144	5.2(-3)
Ru-106	2.4(-3)	All Others[b]	6(-5)
Ag-110m	4.4(-4)	Total (except H-3)	2.2(-1)
		H-3	5.2(+2)

a - Exponential notation; 8.5(-5) = 8.5 x 10^{-5}

b - Nuclides whose release rates are less than 10^{-5} Ci/yr are not listed individually, but are included in the category "all others".

for reductions in dose by the application of augments, and the methodology presented in Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water Cooled Nuclear Power Reactors."[12]

The calculated total body and thyroid doses from liquid releases to the projected population within a 50 mile radius of the station, when multiplied by $1,000 per total body man-rem and $1,000 per man-thyroid-rem, resulted in cost-assessment values of $200/yr/unit and $220/yr/unit, respectively. Potential radwaste system augments were selected from the list given in Regulatory Guide 1.110. The most effective augment was the addition of a 50 gpm demineralizer to the floor drain treatment system; however, the calculated total annualized cost of $37,900 for the augment exceeded the cost-assessment values of $200/unit for the total body man-rem dose and $220/unit for the man-thyroid-rem dose. The staff concludes, therefore, that there are no cost-effective augments to reduce the cumulative population dose at a favorable cost-benefit ratio, and that the proposed liquid waste management system meets the requirements of Section II.D of Appendix I to 10 CFR Part 50.

The staff concludes that the liquid waste management system is capable of reducing releases of radioactive materials in liquid effluents to "as low as is reasonably achievable" levels in conformance with 10 CFR Part 50.34a and meets the requirements of Appendix I to 10 CFR Part 50. The staff, therefore, concludes that the proposed system is acceptable.

3.2.3.2 Gaseous Radioactive Waste Treatment System

The gaseous radioactive waste treatment and building ventilation exhaust systems will be designed to collect, store, process, monitor, recycle, and/or discharge potentially radioactive gaseous wastes which will be generated during normal operation including anticipated operational occurrences. The systems will consist of equipment and instrumentation necessary to reduce releases of radioactive gases and particulates to the environment.

The principal source of radioactive gaseous waste will be gases stripped from the primary coolant in the CVCS and BRS. Additional sources of gaseous wastes will be main condenser vacuum pump offgases, ventilation exhausts from the auxiliary, radwaste, fuel handling, and turbine buildings, and gases collected in the reactor containment building. The principal system for treating gaseous wastes stripped from the primary coolant will be the gaseous waste processing system (GWPS). The GWPS will be a nitrogen loop containing two compressors and has nine pressurized storage tanks. The offgas from the main condenser air ejector, and ventilation exhaust air from the containment will be processed through HEPA filters and charcoal adsorbers prior to release to the environment. Ventilation exhaust air from the auxiliary building, the waste disposal area, and the fuel handling area will be released to the environment without treatment. The turbine building ventilation exhaust air will be released to the environment without treatment. The gaseous waste and ventilation treatment systems are shown schematically in Figure 3.5.

Gaseous Waste Processing System (GWPS)

The GWPS will be designed to collect and process gases stripped from the primary coolant in the CVCS, BRS, and miscellaneous tank cover gases. The GWPS is shared between Unit Nos. 1 and 2. The GWPS will contain an inventory of nitrogen and hydrogen which will act as a carrier gas to transport radioactive gases removed from the primary coolant. Hydrogren and nitrogen cover gases from the volume control and reactor coolant drain tanks, and gases stripped in the BRS degasifier will be collected, compressed, and stored in one of nine pressurized storage tanks. The storage tanks will collect and store gases to allow short-lived radionuclide decay. After holdup, the gases will be discharged to the environment or utilized as makeup gas to the cover gas system for the boron recycle system holdup tanks.

In its evaluation, the staff assumed six tanks for storage, with two tanks held in reserve for back-to-back shutdowns, and one tank in the process of filling. Each tank has a volume of 600 ft^3 and operates at 105 pounds psig. The staff assumed that stored gases would not be returned to the BRS holdup tank cover gas system. On this basis, the staff calculated a holdup time of 90 days prior to discharge of gases to the environment.

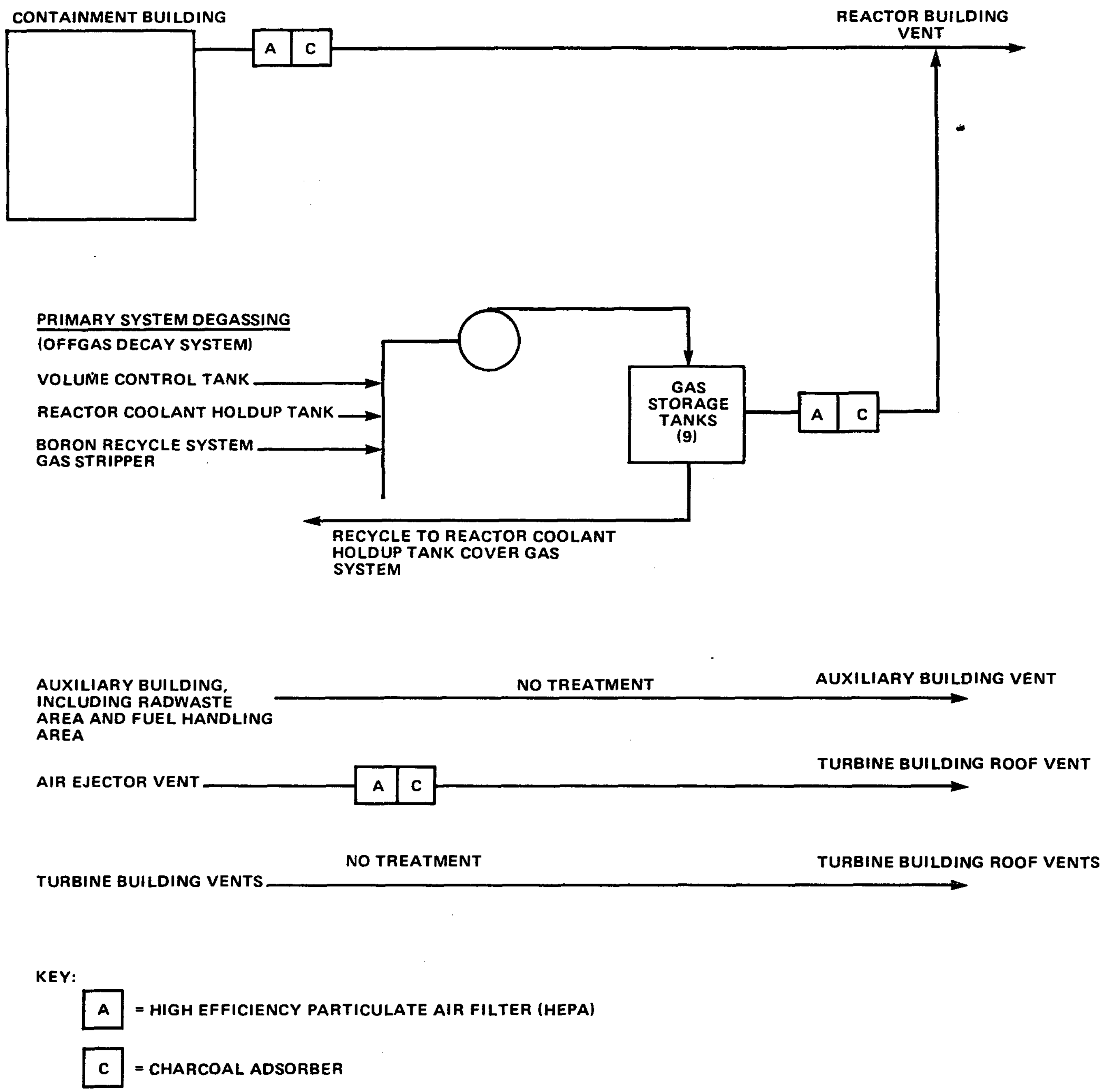


Figure 3.5 Gaseous Waste and Ventilation Treatment Systems

Containment Ventilation System

Radioactive material will be released inside the containment when primary system components are opened or when primary system leakage occurs. During normal operation, the gaseous activity will be sealed within the containment but will be released during containment purges. The staff assumed that the containment will be purged 24 times per year.

For purge operation, the staff assumed radionuclide removal based on a particulate DF of 100 for HEPA filters and an iodine DF of 3.3 for charcoal adsorbers.

Ventilation Releases from Other Buildings

Radioactive materials will be released into the plant atmosphere due to leakage from equipment transporting or handling radioactive materials. The staff estimated that 160 lbs of primary coolant per day will leak to the auxiliary building with an iodine partition factor of 0.0075. Small quantities of radionuclides will be released to the turbine building atmosphere based on an estimated 1700 lbs/hr of steam leakage. Normal ventilation releases from the auxiliary building, the waste disposal area, the fuel handling area, and the turbine building will not be filtered and will be released directly to the environment.

Main Condenser Air Ejector

Offgas from the main condenser air ejectors will contain radioactive gases as a result of primary to secondary leakage. In its evaluation, the staff assumed a primary to secondary leak rate of 100 lbs/day. Noble gases and iodine will be contained in steam generator leakage and released to the environment through the main condenser air ejectors in accordance with the partition factors listed in Table 3.2. The air ejector exhaust will be released to the environment through HEPA filters and charcoal adsorbers.

Gaseous Waste Summary

Based on the staff's evaluation of the gaseous radioactive waste treatment and building ventilation systems and the parameters listed in Table 3.2, the staff calculated the release of radioactive materials in gaseous effluents will be approximately 7000 Ci/yr for noble gases and 0.064 Ci/yr for iodine-131. In comparison, the applicant estimated a total release of 3500 Ci/yr for noble gases and 0.15 Ci/yr for iodine-131. The staff's higher estimated value for noble gas releases is due mainly to the assumption of more frequent purging of the containment.

The applicant's higher estimated value for iodine-131 releases is attributed to the assumption of operating with an operating power fission product source term of 0.25% whereas the staff assumed a value of 0.12%.

The staff's calculated annual releases of radioactive materials in gaseous effluents from radionuclides expected to be released annually from Watts Bar, Unit Nos. 1 and 2, are given in Table 3.4.

Based on the staff's evaluation, the expected releases of radioactive materials in gaseous effluents from Watts Bar Nuclear Plant, Unit Nos. 1 and 2, will not result in a total body dose greater than 10 mrads/yr for gamma radiation or 20 mrads/yr for beta radiation, and an organ dose greater than 15 mrem/yr for radioiodine and radioactive particulates in accordance with Section II.B and II.C of Appendix I to 10 CFR Part 50.

Cost-Benefit Analysis of Gaseous Radwaste System Augments

The staff has evaluated potential gaseous radwaste system augments based on a study of the applicant's system designs, the population dose information provided in Table 5.5 of this environmental statement, a value of $1,000 per total body man-rem and $1,000 per man-thyroid-rem for reductions in dose by the application of augments, and the methodology presented in Regulatory Guide 1.110.

TABLE 3.4

CALCULATED RELEASES OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS FROM WATTS BAR NUCLEAR PLANT, UNIT NOS. 1 AND 2
Ci/yr/reactor

Nuclide	Waste Gas Processing System	Reactor Bldg.	Auxiliary Bldg.	Turbine Bldg.	Condenser Air Removal Vent	Total
Kr-83m	a	a	a	a	a	a
Kr-85m	a	2	3	a	2	7
Kr-85	300	46	1	a	a	350
Kr-87	a	a	1	a	a	1
Kr-88	a	2	5	a	3	10
Kr-89	a	a	a	a	a	a
Xe-131m	a	43	2	a	1	46
Xe-133m	a	40	5	a	3	48
Xe-133	a	5700	370	a	230	6300
Xe-135m	a	a	a	a	a	a
Xe-135	a	12	8	a	5	25
Xe-137	a	a	a	a	a	a
Xe-138	a	a	1	a	a	1
I-131	a	2.5(-2)[b]	3.2(-2)	6.5(-4)	6.1(-3)	6.4(-2)
I-133	a	7.5(-3)	5.1(-2)	8.9(-4)	9.7(-3)	6.9(-2)
Co-60	7(-5)	3.4(-4)	2.7(-2)	a	a	2.7(-2)
Co-58	1.5(-4)	7.5(-4)	6(-2)	a	a	6.1(-2)
Fe-59	1.5(-5)	7.5(-5)	6(-3)	a	a	6.1(-3)
Mn-54	4.5(-5)	2.2(-4)	1.8(-2)	a	a	1.8(-2)
Cs-137	7.5(-5)	3.8(-4)	3(-2)	a	a	3(-2)
Cs-134	4.5(-5)	2.2(-4)	1.8(-2)	a	a	1.8(-2)
Sr-89	3.3(-6)	1.7(-5)	1.3(-3)	a	a	1.3(-3)
Sr-90	6(-7)	3(-6)	2.4(-4)	a	a	2.4(-4)
C-14	7	1	a	a	a	8
H-3	a	460	460	a	a	920
Ar-41	a	25	a	a	a	25

[a]Negligible compared to overall source term, e.g., less than 1.0 Ci/yr noble gases, less than 1(-4) Ci/yr iodine, less than 1% of total for particulates.

[b]Exponential notation; 2.4(-3) = 2.4×10^{-3}

TABLE 3.5

PRINCIPAL PARAMETERS USED IN THE COST-BENEFIT ANALYSIS

Labor Cost Correction Factor, FPC Region III[a]	1.0
Indirect Cost Factor[a]	1.75
Cost of Money[b]	11%
Capital Recovery Factor[a,b]	0.1150

[a]From Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors (March 1976).

[b]From Applicant's Appendix I submittal (May 17, 1976).

The calculated total body and thyroid doses from gaseous releases to the population within a 50 mile radius of the station, when multiplied by $1,000 per total body man-rem and $1,000 per man-thyroid-rem, resulted in cost-assessment values of $4,500/yr/unit and $7,000/yr/unit, respectively. Potential radwaste system augments were selected from the list given in Regulatory Guide 1.110. The most effective augment considered was an increase in the charcoal bed depth of the air ejector vent gaseous waste treatment system from two inches to four inches. The total annualized cost of this augment was calculated to be $2,000; however, the calculated effect of the proposed augment was a net reduction of 0.2 man-thyroid-rem with a corresponding cost-assessment value of $200/yr per unit. The resultant cost-benefit ratio was $10,000 per man-thyroid-rem of benefit and, therefore, was not cost-beneficial. The next most effective augment was the addition of a 30,000 cfm HEPA-charcoal ventilation exhaust treatment system for the auxiliary building; however, the total annualized cost of $69,000 for the augment exceeded the cost assessment values of $4,500/yr/unit for the total body man-rem dose and $7,000/yr/unit for the man-thyroid-rem dose. The staff concludes, therefore, that there are no cost-effective augments to reduce the cumulative population dose at a favorable cost-benefit ratio, and the proposed gaseous waste treatment and ventilation systems meet the requirements of Section II.D of Appendix I to 10 CFR Part 50.

The staff concludes that the gaseous radwaste system for Unit Nos. 1 and 2 is capable of maintaining releases of radioactive materials in gaseous effluents to "as low as is reasonably achievable" levels in accordance with 10 CFR Part 50.34a and meets the requirements of Appendix I to 10 CFR Part 50. The staff, therefore, concludes that the proposed system is acceptable.

3.2.3.3 Solid Wastes

The solid waste system will be designed to process two general types of solid wastes: "wet" solid wastes which require solidification prior to shipment, and "dry" solid wastes which require packaging and, in some cases, compaction prior to shipment to a licensed burial facility. "Wet" solid wastes will consist mainly of spent filter cartridges, demineralizer resins, and evaporator bottoms which contain radioactive materials removed from liquid streams during processing. "Dry" solid wastes will consist mainly of low-activity ventilation air filters, contaminated clothing, paper, and miscellaneous items such as laboratory glassware and tools. Spent resins from the demineralizers will be collected in the spent resin storage tank. When the resin is to be packaged, it will be sluiced to shipping containers but will not be solidified prior to shipment offsite for disposal. Concentrated evaporator wastes will be pumped to an evaporator bottoms tank, and then pumped batchwise to a shipping container for solidification using a mixture of vermiculite and portland cement. On the basis of its evaluation and on recent data from operating plants, the staff has determined that approximately 17,000 ft^3/unit of "wet" solid wastes, containing approximately 2,000 Ci of activity, will be shipped offsite annually. The principal radionuclides in the solid wastes will be long-lived fission and corrosion products, mainly Cs-134, Cs-137, Co-58, Co-60 and Fe-55. The applicant estimated the production of solid wastes from Unit Nos. 1 and 2 to be 28,000 ft^3/yr of dewatered or solidified wastes, 2,250 ft^3/yr of miscellaneous compressible wastes, and 2150 ft^3/yr of condensate demineralizer waste. The applicant did not provide an estimate of the total curie content of these solid wastes. The waste containers will be stored in a shielded area, as required, to reduce contact radiation levels.

Dry solid wastes will be packaged in cardboard boxes, wooden boxes, and special DOT-approved containers. Compressible wastes such as clothing and rags will be compressed prior to packaging. The staff estimates the dry solid wastes to total 4,100 ft^3 per year with a total activity content of less than 5 Ci.

3.2.4 Chemical, Sanitary, and Other Waste Treatment

There have been several changes in planned use of chemicals at the station. The original design would have used sodium phosphate, ammonia, and hydrazine as additives to the steam generator feedwater.[13] Based on the recommendation of the reactor manufacturer "all volatile treatment", consisting of morphaline and hydrazine, will be used in place of the phosphate treatment.[14]

It was planned initially that acrolein would be used to control Asiatic clam populations in the systems using river water. Since acrolein has not been registered with EPA for this purpose, TVA will use sodium hypochlorite instead.

The proposed use of chlorine at the station is tabulated below.[15]

Anticipated Sodium Hypochlorite Injections

I. Slime Control

Condenser Cooling Water (CCW) system - shock treatment, chlorinate 1 hr/day with total free chlorine residual of 0.2 mg/l at condenser outlet.

II. Asiatic Clam Control

Essential Raw Cooling Water (ERCW) systems - 32,000 gpm system flow, low-level continuous chlorination (May-October) with total free chlorine residual of 0.6 - 0.8 mg/l.

Raw Cooling Water (RCW) systems - 31,000 gpm system flow, two three-week periods of continuous treatment annually (beginning and end of Asiatic clam spawning season).

Raw Service Water (RSW) systems - 1000 gpm system flow, low-level continuous chlorination (May-October) with total free chlorine residual of 0.6 - 0.8 mg/l.

The most significant use of chlorine will occur during two three-week periods at the beginning and end of the Asiatic clam spawning season when the Essential Raw Cooling Water (ERCW) systems, the Raw Cooling Water (RCW) systems, and Raw Service Water (RSW) systems are all being chlorinated continuously and the Condenser Cooling Water (CCW) system is being chlorinated intermittently. Since the CCW system receives makeup from the ERCW and RCW systems, concentration of free residual chlorine could build up in this system to a concentration of 1.3 mg/l due to the concentrating effect of evaporation. Chemical and biological interactions within the CCW system will reduce the actual concentration of free residual chlorine in the blowdown by some unpredictable but significant amount. TVA has estimated the concentration in the tower blowdown will be 0.8 mg/l during periods of chlorine usage for clam control. When the RCW system is not being chlorinated, chemical reduction of chlorine in the CCW system should result in a very low concentration in the discharge. During such periods of usage, TVA should meet the discharge limit of 0.1 mg/l total residual chlorine as indicated in the NPDES permit (No. 002).

TVA currently plans to use potassium chromate for corrosion inhibition in the component cooling water system. There are no planned releases from this system.[18]

A current listing of planned chemical usage is included in Table 3.6.[19]

Low volume wastes will be treated by sedimentation, or removal and/or pH control as required to meet conditions of the NPDES permit. These waste streams include: neutral waste sump (neutralizer waste tank), condensate demineralizer system, turbine building station sump, hypochlorite building drain, service building sump, diesel generator building drains, additional equipment building drains, auxiliary building sumps, CCW pump station sump, and cooling tower desilting basin effluents. (NPDES 007-017).

Steam generator blowdown may be discharged directly to the cooling tower blowdown line when radioactivity levels permit direct discharge. (NPDES 018).

3.2.5 Power Transmission System

The transmission system lines for the Watts Bar Plant are summarized in Table 3.7.

A relocation of the Watts Bar Volunteer 500 kV transmission line became necessary because of the selection of a more desirable substation location for the tie-in of this line.[20] All other lines are described in the FES-CP.

The selection of a new Volunteer Substation site location approximately fifteen miles north-northeast of Knoxville (Figure 3.6) results in a relocation of the proposed Watts Bar - Volunteer 500 kV transmission line. Approximately two-thirds of this newly proposed connection will now be constructed on rights-of-way presently occupied by lower voltage lines or parallel to existing transmission facilities. The transmission line will utilize tower designs similar in appearance to those proposed originally in the FES-CP. The towers have been slightly redesigned, however, to permit the use of V-shaped insulator strings which limit the conductor swing and thereby reduce the right-of-way required by approximately 12.5 percent.[21] The line will be approximately 88 miles long and will be constructed on rights-of-way of varying widths. The land use types traversed by this new connection remains essentially the same as

TABLE 3.6

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 Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
1	Makeup Water Filter Plant	Alum	35,743	(78,800)	$Al(OH)_3$[b]	7,489	(16,510)	20	(45)
		$Al_2(SO_4)_3 \cdot 18 H_2O$							
		Soda Ash	10,743	(23,685)	Na^+	4,672	(10,300)	13	(28)
		Na_2CO_3							
					SO_4^{--}	13,880	(30,600)	38	(84)
					Settled Solids[b,c]	32,114	(70,800)	88	(194)
		Sodium Hypochlorite							
		NaOCl	349	(770)	Na^+	218	(480)[e]	<2.3	<(5.0)
		NaCl	272	(600)	Cl	327	(722)[e]	<2.3	<(5.0)
2	Makeup Water Demineralizer	Sulfuric Acid	104,780	(231,000)	SO_4^{--}(Neutral pH)	98,430	(217,000)	270	(595)
		H_2SO_4 (93% Solution)							
		Sodium Hydroxide	195,498	(431,000)	Na^+(Neutral pH)	56,245	(124,000)	154	(340)
		NaOH (50% Solution)							
	Natural Minerals Removed by Demineralizers								
		Sodium Na^+	4,590	(10,120)	Na^+	4,590	(10,120)	13	(28)
		Chloride Cl^-	8,936	(19,700)	Cl	8,936	(10,700)	75	(54)
		Sulfate So_4^{--}	9,866	(21,750)	So_4^{--}	8,866	(21,750)	27	(60)
		Total Dissolved Solids	53,297	(117,500)	Dissolved Solids	53,297	(117,500)	146	(322)

TABLE 3.6 (Continued)

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 Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
3	Secondary Steam System Condensate Polishing	Sulfuric Acid	267,665	(590,100)	SO_4^{--}(Neutral pH)	262,176	(578,000)	717	(1580)
	Demineralizers	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^{--})	11,521	(25,400)	Co_3^{--}	11,521	(25,400)	32	(70)
		-Ammonia (NH_4^+)	6,827	(15,050)	NH_4	6,827	(15,050)	19	(41)
		-Metallic Salts	d	d		d	d	d	d
4	Auxiliary Steam Generator Blowdown	Ammonia NH_3	1.4	(3)[f]	NH_3	1.4	(3)	<.05	(<0.1)
		Hydrazine $H_2N_2H_2$	4.5	(10)[g]	NH_3	4.5	(10)	<.05	(<0.1)
5	Condenser Cooling[i] Water System	Sodium Hypochlorite NaOCl	71,273	(157,130)	Na^+	44,021	(97,050)	120	(265)
		NaCl[i]	55,960	(123,370)	Cl	67,077	(147,880)	184	(405)
		<<Copper (corrosion product only)[k]			Cu	2,812	(6,200)	8	(17)
		<<Nickel (corrosion product only)[k]			Ni	313	(690)	C.9	(1.9)

TABLE 3.6 (Continued)

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 Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
6	Raw Cooling Water[i]	Sodium Hypochlorite							
		NaOCl	11,163	(24,610)	Na^+	7,065	(15,575)	20	(43)
		NaCl[j]	9,201	(20,285)	Cl^-	10,768	(23,740)	29	(65)
7	Raw Service Water[i]	Sodium Hypochlorite							
	System	NaOCl	1,551	(3,420)	Na^+	982	(2,165)	2.7	(6)
		NaCl[j]	1,279	(2,820)	Cl^-	1,497	(3,300)	4.1	(9)
8	Essential Raw[i]	Sodium Hypochlorite							
	Cooling Water	NaOCl	49,383	(108,870)	Na^+	30,518	(67,280)	84	(185)
		NaCl[j]	38,782	(85,500)	Cl^-	46,480	(102,470)	127	(280)

[a]Items 1, 2, 4, 5, 6, 7, and 8 are based on 365 days/year operation at rated capacity. Item 3 based on 292 days/year operation at rated capacity.

[b]Precipitated material that will make up the water treatment sludge on a day weight basis. Ultimately put in landfill. No discharge.

[c]Estimates based on maximum suspended solids data observed at TRM 529.9.

[d]The quantities of ionized soluble species continuously removed by the condensate demineralizers are predicated upon a primary to secondary leak rate or a condenser tube leak. These constituents will be discharged in the form of neutral salts of sodium, oxides of iron, or suspended solids. High crud filters will treat the backwash waste prior to discharge.

[e]The residual chlorine and sodium consumed by the makeup demineralizers and ultimately discharged.

[f]Ammonia will be added as needed to maintain pH of 9.0 in the system.

[g]Hydrazine will be added as needed as a DO scavenger. Hydrazine conservatively assumed to decompose to ammonia.

[h]Under radioactive conditions, this waste will be treated in the plants radwaste system.

[i]Basis for calculated values are shown elsewhere.

[j]For each kilogram of equivalent chlorine as sodium hypochlorite produced, 0.785 kilogram of sodium chlorine are in the product solution.

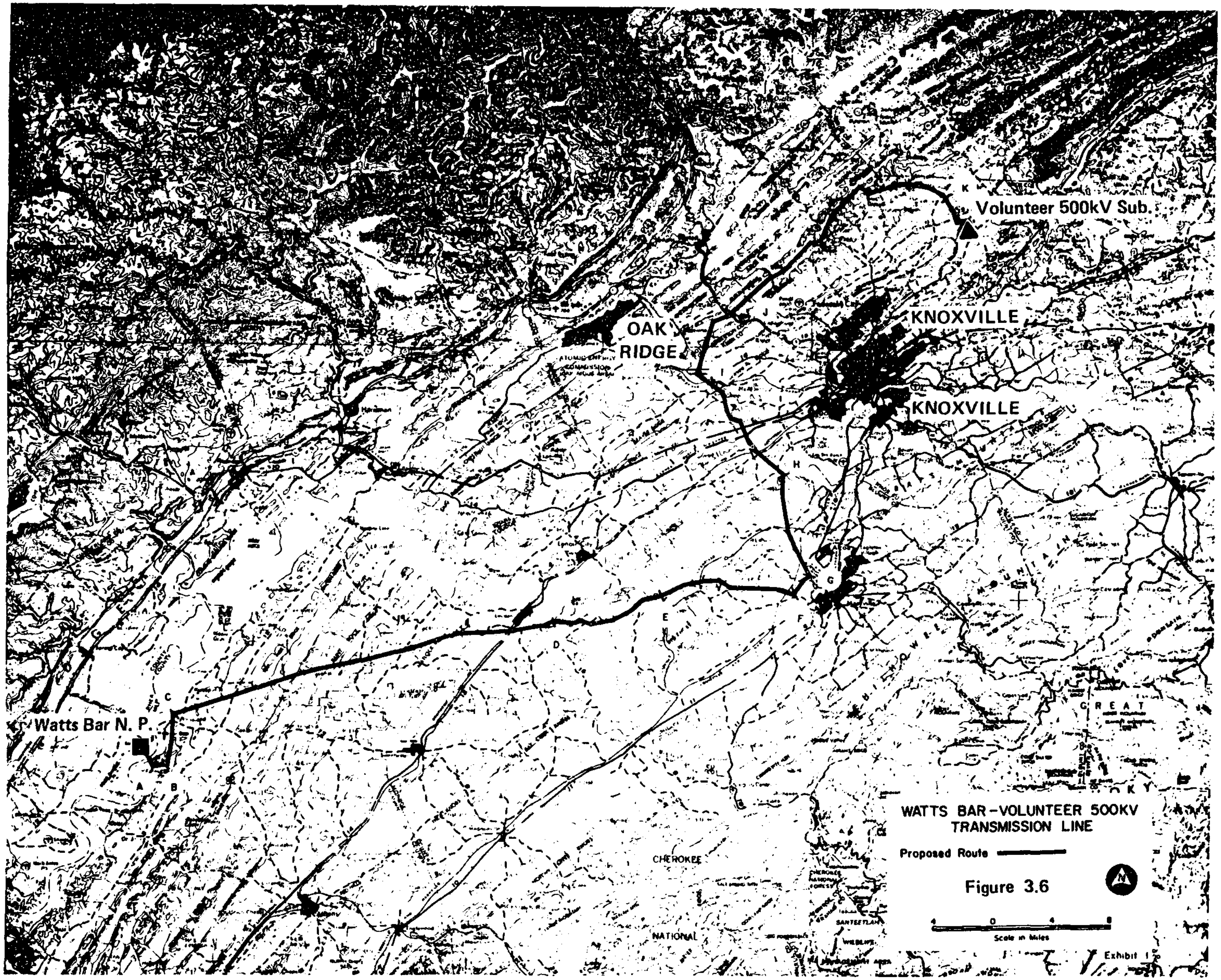
[k]Although copper and nickel will not be added to the systems, the values shown represent high estimates of corrosion losses. Actual losses are expected to be immeasurable.

TABLE 3.7

WATTS BAR TRANSMISSION SYSTEM DESCRIPTION

STEP I

Line Name	Voltage (kV)	Approximate Length of New Construction (Miles)	Approximate Date Required
Bull Run-Sequoyah, Loop into Watts Bar Nuclear Plant	500	10.0	In Service
Watts Bar Hydro-Watts Bar Nuclear No. 1	161	1.0	In Service
Watts Bar Hydro-Watts Bar Nuclear No. 2	161	1.0	In Service
STEP II			
Watts Bar-Volunteer	500	88.0	June 1979
Watts Bar-Roane	500	40.0	In Service
Watts Bar-Sequoyah No. 2	500	40.0	In Service



WATTS BAR-VOLUNTEER 500KV TRANSMISSION LINE

Figure 3.6

outlined in the FES-CP, i.e., 25 percent woodland, 25 percent farming and pasture, and the remainder uncultivated openland. A complete description and impact analysis for the Watts Bar - Volunteer 500 kV transmission line has been prepared by TVA (Final Environmental Statement - Volunteer, Tennessee 500 kV Substation and Transmission Line Connections. July 6, 1976).

The staff has viewed this line from the air (February 23, 1977) and found no obvious potential or actual conflicts between the proposed facility and other activities of the environs. This new route which will greatly rely on utilizing existing corridors does not inhibit or interfere with other land uses such as transportation, housing or recreation.

Approximately 2,008 acres of new right of way easements will be required to construct the 180 miles of transmission line connections into the Watts Bar Nuclear Plant. Although the number of miles of transmission lines and number of acres required are now different from those originally given in the FES-CP, the land-use types given in the FES-CP remain essentially the same.

REFERENCES FOR SECTION 3

1. NPDES Standard Form C Application for Discharge Permit as ammended by letter from P. Krendkel, TVA, to H. Zeller, EPA, June 27, 1977.

2. Tennessee Valley Authority, Environmental Information, Watts Bar Nuclear Plant, Units, 1 and 2, 1976, p. B-6.

3. Ibid, p. B-29

4. Tennessee Valley Authority, Final Environmental Statement for Watts Bar Nuclear Plant, Units 1, 2, and 3, TVA-OHES-EIS-72-9, Chattanooga, Tennessee, November 9, 1972, p. 1.1-13.

5. Op. Cit. Ref. 6, p. 2.5-2

6. Tennessee Valley Authority, Environmental Information, Watts Bar Nuclear Plant, Units 1 and 2, Supplement 1, 1977, pp. 4-15 through 4-16.

7. Tennessee Valley Authority Final Safety Analysis Report, Watts Bar Nuclear Plant, Unit Nos. 1 and 2, Chattanooga, Tennessee. October 4, 1976.

8. Op. Cit. Ref. 6.

9. Tennessee Valley Authority Appendix I Information, Watts Bar Nuclear Plant, Unit Nos. 1 and 2, Chattanooga, Tennessee. Docket Nos. 50-390 and 50-391, May 17, 1976.

10. 10 CFR Part 50, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water Cooled Nuclear Power Reactor Effluents, May 5, 1975, and as amended September 4, 1975, and December 17, 1975. U.S. Nuclear Regulatory Commission, Washington, DC 20555.

11. Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code), NUREG-0017. U.S. Nuclear Regulatory Commission, Washington, DC, April 1976.

12. Regulatory Guide 1.110, Cost-Benefit Analysis for Radwaste Systems for Light-Water-Cooled Nuclear Power Reactors, U.S. Nuclear Regulatory Commission, Washington, DC, March 1976.

13. Op. Cit., Ref. 6

14. Op. Cit. Ref. 2, p. A-23

15. Ibid, p. A-24

16. Ibid, p. A-25

17. Op. Cit, Ref. 6, p. 2.5-11

18. Op. Cit. Ref. 2, p. A-25

19. Ibid, pp. A26-27

20. Op. Cit. Ref. 2

21. Tennessee Valley Authority, Final Environmental Statement, Volunteer Tennessee 500 kV Substation and Transmission Line Connections, July 6, 1976.

22. Tennessee Valley Authority, Effect of Watts Bar Nuclear Plant and Watts Bar Steam Plant Discharge on Chickamauga, Lake Water Temperature, WM28-1-85-00, Norris, Tennessee, February 1977, p. 7.

23. Ibid, p. 13

24. Ibid, pp. 7-10

25. Ibid, pp. 10-13

4. ENVIRONMENTAL IMPACT OF THE SITE PREPARATION AND CONSTRUCTION

4.1 RESUME AND STATUS OF CONSTRUCTION

As of June 30, 1978, the construction of Unit No. 1 was 85 percent complete and that of Unit No. 2 was 66 percent complete. On that date an area of approximately 266 acres had undergone significant transformation from the moderately to lightly wooded to generally cleared area with rolling hills that existed before construction began. Extensive clearing, grading and excavation has been required for the major components of the site: power plant, intake structure and channel, yard drainage pond, holding pond for cooling tower blowdown, cooling towers, switchyard, plant waste excavation disposal and areas occupied by temporary structures and roads. The impacts at the plant site on the terrestrial environment were as anticipated, and thus the assessment presented in the FES-CP remains valid and unchanged. However, the construction impacts of the new transmission route for the Watts Bar-Volunteer 500 kV line are assessed in Section 4.2.2.

The settling pond for siltation control for construction runoff was built at a different location from that originally proposed in the FES-CP. Also, two temporary ponds were constructed within the main yard holding pond for chemical containment and treatment from preoperational cleaning and testing. These changes are discussed in Section 4.3.1.

The blowdown diffuser was relocated from the original proposed site indicated in the FES-CP. The construction impacts on the aquatic biota of this relocation are discussed in Section 4.3.2.

Construction of an off-load facility, considered in the FES-CP, was found unnecessary. Use was made, instead, of the existing coal-handling dock of the Watts Bar Steam Plant.

4.2 IMPACT ON TERRESTRIAL ENVIRONMENT

4.2.1 Facility Construction

The assessment of terrestrial environmental impacts resulting from plant facility construction has not changed since the CP stage review. Thus, the assessment presented in the FES-CP remains valid.

4.2.2 Transmission Facility Construction

TVA's FES-CP discusses construction impacts and associated practices to minimize and/or avoid these impacts. In addition, TVA has submitted data in connection with the Bellefonte Nuclear Plant Project which details TVA's clearing and maintenance methods (Report Transmission Line Right of Way Clearing and Maintenance Methods. Bellefonte Nuclear Plant Project. TVA. January 1977). The assessment presented in the FES-CP remains valid for those lines considered. The recently proposed relocation of the Watts Bar-Volunteer line was not analyzed in TVA's FES-CP.

The Volunteer Substation

No unusual problems of construction will be encountered at the Volunteer Substation site. The proposed Volunteer site contains approximately 88 acres of which 16 acres are encompassed in the rights-of-way of existing transmission lines. There will not be any dislocation of people from their homes and the nearest residence is approximately 0.25 mile (.40 km) from the 500 kV transformer bank location. The overall description of the area adjacent to the substation site is rural with land ownership patterns ranging from one to two acres (0.4 to 0.8 ha) to farms of several hundred acres in size.[1] Buffer zones and vegetative cover will be maintained around the periphery of the site. Erosion prevention and drainage control measures will be incorporated into the detailed grading plan. Following completion of construction activities, the substation site will be landscaped to present an attractive appearance.

The extent of the noise problems during construction will be directly related to the quantity of rock to be removed in the grading process. Although some noise and dust will be caused by construction activities, the staff concurs with the applicant's assessment that no adverse effects are anticipated.

Newly Proposed Watts Bar-Volunteer Transmission Line

The principal sources of impact along newly constructed corridors are clearing of vegatation, soil erosion, and minor loss of habitat. Approximately two-thirds of this proposed connection will be constructed on rights-of-way presently occupied by lower voltage lines or parallel to existing transmission facilities. 17.6 miles of the total 88 mile long corridor will require no new additional right of way. Substantial paralleling of the proposed line will reduce total clearing required.

The applicant will use a combination of shear clearing and selective clearing. Although TVA's policy basically calls for the removal of all vegetation on wooded rights-of-way, a policy was established in 1969 to retain certain select species of slow-growing trees. Specifically included in these species are dogwood, red bud, and cedar.[2] In addition, TVA has developed the following policies to minimize actual and potential erosion problems.

1. Lines are sited to minimize the need of vegetation removal consistent with local land use commitments, visual prominence, and economic line length.

2. Construction practices - Select access road routes to minimize damage to existing growth, grading requirement, and excessive steepness. In conjunction with initial clearing, immediately cut drainage ditches, terraces, and install water breaks and culverts. Retain buffer vegetation at stream crossings. Limit construction vehicle access where soil erosion potential is great. Retain existing vegetation on the land as long as possible before tower construction begins. Schedule construction activities in swampy or wet areas to coincide with favorable dry weather conditions. Retain existing low vegetation at stream crossing and bridges or use culverts to eliminate damage to stream banks by construction activities and provide inspection until complete cover is obtained.

3. As clearing progresses, TVA inspectors daily monitor contractor performance and compliance with project specifications and provide additional equipment operators with right-of-way access directions to comply with prior property owner requests.

These practices as well as TVA clean up and disposal procedures[3] are consistent with published guidelines and are acceptable to the staff.

TVA has consulted The National Register of Historic Places and the Tennessee State Historical Preservation Officer and no known historical resources were identified as potential conflicts. Final historical and archaeological coordination has been completed. The Tennessee State Historic Preservation Officer has concurred with TVA's determination that the subject transmission line will not affect any historical or architectural properties included in or eligible for inclusion in the National Register of Historic Places.[4] TVA is committed, where necessary, to take measures to protect, recover, or otherwise mitigate the impact on any affected archeological resources.

4.3 IMPACTS ON AQUATIC ENVIRONMENT

4.3.1 Effects on Water Use

TVA provided construction runoff control measures essentially as described in the FES-CP.[5] For economic and other reasons, the settling pond (NPDES 001) for siltation control was built in a different location than originally planned.[6] However, the original design intent of positive construction runoff control was achieved.

The FES-CP[7] indicated that TVA would "initiate a monitoring program designed to determine existing turbidity and siltation levels to measure siltation rates and turbidity levels during construction, and, consequently, to minimize increase in levels due to construction effects." From January 1973 to September 1973, TVA monitored the effects of construction activities on the suspended solids concentration of the Tennessee River. No impact on turbidity or suspended solids could be detected during this period; therefore, this aspect of the monitoring program was discontinued in September 1973.[8]

At the time of the FES-CP, the chemical cleaning program had not been finalized; thus only tentative plans for waste control were described.[9] Since that time, two temporary ponds were constructed within the main yard holding pond area to contain and treat chemicals and water from preoperational cleaning and testing.[10] A small polyvinyl lined pond will receive the more concentrated cleaning chemicals. A large pond will hold the more diluted flushing water. Wastes will be treated within the ponds to meet applicable effluent limitations prior to discharge to the Tennessee River. Cleaning chemicals will include trisodium phosphate, hydrazine, ammonia, and detergents (e.g., Trition X-100 and QS30) and possibly less significant amounts of others.[10] The cleaning process will pick up small amounts of oils, metals, and dirt.

Effluent limitation guidelines for metal cleaning wastes [40 CFR 423.12(b)(5)] are as follows:

Effluent Characteristic	Daily Maximum	Average of daily values for thirty consecutive days
Total Suspended Solids	100 mg/l	30 mg/l
Oil and Grease	20 mg/l	15 mg/l
Total Copper	1.0 mg/l	1.0 mg/l
Total Iron	1.0 mg/l	1.0 mg/l

The NPDES permit also limits the concentration of phosphorus in the discharge to 1.0 mg/l (NPDES permit No. TN0020168, Outfall Serial No. 004). Compliance with the applicable Tennessee Water Quality Standards should not result in the need for any more stringent limitations on the discharge of the substances for which effluent limitation guidelines are given.

The addition of a small amount of phosphate and ammonia to the Tennessee River on a one time basis should not result in an unacceptable impact.

4.3.2 Effects on Aquatic Biota

As indicated in the FES-CP,[11] the undesirable effects on the reservoir quality associated with the removal of the intake canal dike was the only major concern. In their comments on the FES-CP, the State of Tennessee and the U.S. Army Corps of Engineers expressed concern over the siltation effects on mussels during construction of both the intake and discharge systems.

TVA has found it necessary to relocate the blowdown diffuser from the originally proposed site to an area approximately 1,000 feet upstream. The orginally proposed site was determined to be infeasible due to insufficient water depth. Both the original site and the new location are within the designated mussel sanctuary, but both are located on the opposite side of the river from the identified mussel bed (see Section 2.5.2). The required dredging activity was expected to be essentially the same for either site. In correspondence from the two commenting agencies (COE and State of Tennessee) regarding the proposed diffuser relocation, neither offered objections to the action provided that disposal of spoil was onshore[12] and that strict supervision by TVA field personnel was exercised to insure that sedimentation is held to a minimum.[13] Both provisions were incorporated in TVA's construction plan. The use of silt screens for additional siltation control as suggested by the Army Corps of Engineers was considered but rejected. In evaluation of this control technique, TVA concluded that the high velocity of the Tennessee River in this area would offset any advantages that might be gained from the use of silt screens which have been found effective in slack water situations. In discussions between TVA and the Corps of Engineers, the latter agreed with this evaluation.[14]

The NRC staff has contacted the Fish and Wildlife Service, U.S. Department of the Interior, on the matter of the diffuser location due to the presence of the endangered mussel, *Lampsilis orbiculata*, in the site vicinity.[15] In their response, the Fish and Wildlife Service states that:

> "It appears that locating the plant's blowdown diffusers 1,000 feet upstream of the originally proposed location would not have a significant adverse effect on fish and wildlife resources of the area. The mussel beds in that area are located on the opposite side of the streambed from the plant."[16]

Excavation in the river for the diffuser pipes has been completed. Detailed quantitative monitoring of siltation rates during dredging was judged impractical due to the small volume of material involved (approximately 1600 cubic yards) and the anticipated short duration of the activity (approximately three days).

During excavation a thick limestone rock lens was encountered in the last 75 feet of the upstream diffuser foundation. A rock drill was used to line drill through the lens; a battering ram was used to further fracture the rock; and, excavation was completed using a "shovel front." Although the time spent in the dredging operation was longer than anticipated (nearly two months), the volume of material removed was unchanged and small portions of the total volume were handled at any given time. The spoil material was loaded on barges, off-loaded to trucks at the coal docking facility at the Watts Bar Steam Plant and used for fill and grading onsite. Observation of the dredging effects was included in the preoperational water quality survey. Additionally, a full-time TVA inspector provided supervision during the dredging operation, as will also be the case during excavation of the intake channel.

Control measures for minimizing siltation effects during intake channel construction include:

(1) Excavation of the channel in the dry - leaving a temporary dike at the reservoir end.

(2) Flooding the channel by pumping water from the reservoir over the dike - equalizing water levels across the dike before removing dike.

(3) Disposal of dredge spoil in an upland area.

Monitoring during removal of the intake channel dike will be more extensive than that performed during the diffuser excavation, including qualitative observations, photographic documentation and quantitative sampling of the potential suspended sediment plume. Effects on the mussel bed across the river are not anticipated since the currents will direct the suspended sediments along the right side of the river.

The construction of an off-load docking facility, which was being considered at the time of FES-CP preparation, was found unnecessary; rather, use has been made of the existing coal-handling dock associated with the Watts Bar Steam Plant.

There is no change in the plan for the construction sewage treatment plant. With the NPDES permit (outfall serial number 003) there will be no adverse effects due to the sewage treatment plant. These limits are based on EPA Guideline for Secondary Treatment of Domestic Waste Water (40 CFR 133). The State of Tennessee has provided a certification including more stringent limitations (see Appendix E, Attachment C to NPDES permit). The staff concludes the facility will meet the more stringent limitations and no effects are expected on the biota.

REFERENCES FOR SECTION 4

1. Tennessee Valley Authority, Final Environmental Statement, Volunteer, Tennessee - 500-kV Substation and Transmission Line Connections, July 6, 1976.

2. Tennessee Valley Authority, Report of Transmission Line Right of Way Clearing and Maintenance Methods. Bellefonte Nuclear Plant Project, January 1977.

3. Ibid.

4. Letter from J. E. Gilleland, Tennessee Valley Authority to Edson G. Case (USNRC), dated May 19, 1978 with enclosures.

5. Op. Cit., Ref. 4, p. 2.3-7.

6. Tennessee Valley Authority, Environmental Information, Watts Bar Nuclear Plant, Units 1 and 2, 1976, p. A-29.

7. Op. Cit., Ref. 4, p. 2.8-13.

8. Op. Cit., Ref. 6, p. C-89.

9. Op. Cit., Ref. 4, p. 2.8-11.

10. Op. Cit., Ref. 6, p. A-28.

11. Op. Cit., Ref 4., p. 2.8-10.

12. Op. Cit., Ref. 6, p. A-13.

13. Ibid., p. A-14.

14. Ibid., p. A-8.

15. Letter from William H. Regan, Jr. (USNRC) to Kenneth Black, Regional Director, Fish and Wildlife Service (USDOI), Atlanta, Ga., dated March 23, 1977.

16. Letter from Ray R. Vaugh, Fish and Wildlife Service (USDOI) to William H. Regan, Jr. (USNRC), dated April 1977.

5. ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 RÉSUMÉ

The staff has evaluated the effects of the finalized diffuser design and the new discharge location. The evaluation of the effects of chemical usage has been updated in light of changes in both systems and proposed chemicals to be utilized. Also, the NPDES permit has been provided by EPA. These staff evaluations of impacts on water use are provided in Section 5.3.

In accordance with the requirements of the Federal Water Pollution Control Act Amendments of 1972, TVA on October 19, 1976, filed a Section 402 NPDES permit application (Standard Form C) with the Regional Administrator, EPA, Region IV, Atlanta, Georgia, for the operational discharges from the Watts Bar Nuclear Plant. The final NPDES permit specifies the specific effluent limitations for the thermal, chemical, specific effluent and instream (abiotic and biotic) monitoring and reporting requirements necessary to determine compliance with the effluent limitations.[2] The NPDES permit and State certification and EPA Determination are included herein as Appendix E.

Local fogging, icing and drift from the natural draft cooling towers has been re-examined as well as any possible interaction of the cooling tower plumes with the atmospheric effluents of the fossil-fueled Watts Bar Steam Plant. These effects are discussed in Section 5.4.1.

An updated discussion of aquatic impacts, based on information obtained since the FES-CP, is provided in Section 5.4.2.

Radiological effects are re-examined in light of new Appendix I to 10 CFR 50 criteria, using realistic models, and are discussed in Section 5.5.

The environmental effects of the uranium fuel cycle, not treated in the FES-CP, are also evaluated and discussed in Section 5.5.

Socio-economic effects of station operation have been evaluated in Section 5.6.

5.2 IMPACTS ON LAND USE

The assessment made in the FES-CP remains valid.

5.3 IMPACTS ON WATER USE

5.3.1 Thermal

The thermal standards proposed by the Tennessee Water Quality Control Board and approved by the Environmental Protection Agency for the reach of the Tennessee River in which the Watts Bar Plant is located are as follows: maximum temperature for warmwater fisheries, 30.5°C (86.9°F); maximum allowable water temperature change, 3°C (5.4°F); and maximum allowable rate of change, 2°C (3.6°F) per hour. The temperature of impoundments where stratification occurs will be measured at a depth of 1.52 meters (5 feet) or middepth, whichever is less.[1] Conformance with these conditions is required by the NPDES Permit (NPDES 002).

In accordance with the requirements of the Federal Water Pollution Control Act Amendments of 1972, TVA on October 19, 1976, filed a Section 402 NPDES permit application (Standard Form C) with the Regional Administrator, EPA, Region IV, Atlanta, Georgia, for the operational discharges from the Watts Bar Nuclear Plant. The final NPDES permit specifies the specific effluent limitations for the thermal, chemical, specific effluent and instream (abiotic and biotic) monitoring and reporting requirements necessary to determine compliance with the effluent limitations.[2] The NPDES permit and state certification are included herein as Appendix E.

There will be periods when the river temperature approaches or exceeds 30.5°F (86.9°F) due to high ambient temperature and/or discharge from Watts Bar Steam Plant. If the blowdown temperature for the Watts Bar Nuclear Plant is greater than 30.5°F at such times, the State of Tennessee maximum temperature standard will be exceeded even though the temperature rise at the edge of the mixing zone is only about 0.6°C (1.0°F) or less. In submitting its NPDES permit application for the Watts Bar Nuclear Plant, TVA requested that the application be processed under section 316a of the Federal Water Pollution Control Act (PL 92-500), specifically requesting that continued discharge of blowdown from the closed-cycle cooling system be allowed in the event that river temperatures in Chickamauga Lake at or upstream from the mixing zone approach or exceed the maximum temperature standard of 30.5°C (86.9°F). Section 316a of the Act allows EPA to impose such alternatives and less stringent limitations after demonstration that the proposed effluent limitations are more stringent than necessary to assure the protection and propagation of a balanced indigenous population of shellfish, fish and wild life in and on the body of water into which the discharge would be made. The EPA Region 4 Director, Enforcement Division, acting under delegation from the Regional Administrator has tentatively determined that the continued discharge of blowdown under conditions when upstream temperatures approach or exceed 30.5°C (86.9°F) are consistent with Section 316a of the Act so long as the discharge temperature does not exceed 35°C (95°F) nor a mixing zone of dimensions of 240 feet width and 240 feet downstream length. (See NPDES 002, in Appendix E).

The analytical methods used by the applicant for the diffuser design are presented in References 3 and 4. The concept of an equivalent slot width was used to model the submerged multiport diffusers. A series of submerged discharge ports were assumed to be equivalent to a submerged slot of equal length and port area, provided the port spacing was less than the water depth. The analytical expression for the dilution induced by a submerged slot diffuser in shallow water was developed by Adams.[3] The predicted dilution of the diffuser system is 16 at a minimum Tennessee River flow of 99 cubic meters per second (3500 cubic feet per second) and a maximum diffuser discharge of 4.8 cubic meters per second (170 cubic feet per second). The two dimensional structure of the discharge plume was predicted using the method of Jirka which is based on the theory of Adams.[4] For this diffuser system, the variety of discharge conditions can result in either fully mixed or stratified conditions downstream of the discharge.

The applicant compared the predicted dilution for a physical model diffuser using this two-dimensional theory of Adams and measured dilutions for the model diffuser.[5] This comparison (analogous to the prototype series of submerged discharge ports) in shallow water was primarily a two-dimensional phenomenon and that the resulting dilution could be reasonably predicted by a two-dimensional theory. The applicant further concluded that because the predicted dilutions based on the two-dimensional theory of Adams never overestimated the measured dilutions in the model, this theory could be used to conservatively predict the performance of the multiport diffuser system at the Watts Bar Nuclear Plant.

The results of the model tests showed that the expected diffuser-induced dilution was achieved approximately one diffuser length downstream. Thus, the area of diffuser-induced mixing extends approximately 49 meters (160 feet) downstream when the downstream leg of the diffuser system is discharging; approximately 24 meters (80 feet) downstream when the upstream leg of the diffuser system is discharging; and 73 meters (240 feet) downstream when both legs of the diffuser system are discharging.[34] The mixing zone proposed in the NPDES Permit 002 provides a zone of 73 meters (240 feet) downstream over the entire river depth and diffuser system width (73 meters) and should encompass all of operation.

Based upon the analytical method used for the diffuser design and its agreement with physical model results, we conclude that the applicant's thermal analyses are acceptable, and their applicable water quality standards will be met.

5.3.2 Operational Chemical Wastes

Table 3.5 listed chemical usage at the station. The major addition to the Tennessee River will be dissolved salts. These will include 987 kilograms (2175 pounds) per day of sulfate, 630 kilograms (1389 pounds) per day of sodium, and 344 kilograms (759 pounds) per day of chloride. The increases in concentration of these chemical species after mixing with the lowest flow into which releases will be made (99 cubic meters/sec) would be 0.1 mg/l, 0.07 mg/l, and 0.04 mg/l respectively. A comparison to ambient values (Table 2.17) shows that these concentration changes are negligible. The evaporation of water in the cooling towers will increase the concentration of naturally occurring substances in the river by an average of about 0.25%. Thus evaporation will increase sulfates, sodium, and chloride by 0.03 mg/l, 0.002 mg/l and 0.002 mg/l respectively.

The station will also add about 6 kilograms (13 pounds) of ammonia per year (including that added as hydrazine) from the auxiliary steam generator blowdown. This would be primarily in the ionized form in the normal discharge pH range and therefore would not pose a toxic threat even if discharged over a short time period. The nutrient effect in the river after mixing with the 99 cubic meters/sec (3500 cfs) flow would also be negligible even if released over a short time period.

Using a high estimate of corrosion rate, about 8 kilograms (17 pounds) of copper and 0.9 kilograms (1.9 pounds) of nickel per day could be discharged (see Table 3.5). The actual corrosion rate is expected to be significantly less with losses too small to be measured. The NPDES permit requires a study regarding actual corrosion-erosion rates. At normal blowdown flow of 2.4 cubic meters/sec (85 cfs) the concentration in the discharge of these two elements would be about 0.03 ppm and 0.003 ppm respectively. These concentrations will be reduced by a factor of 16 in the discharge mixing zone at a minimum river flow and maximum diffuser discharge. At the edge of the mixing zone, copper will be increased by about 10% of its mean ambient value (see Table 2.17) and nickel will be increased by about three times the mean value. The nickel concentration is negligible. However, since the ambient concentration of copper approaches toxic levels, the discharge should be monitored for copper. High flows in the river will deter significant accumulations of these metals in bottom sediments. Since there are no shellfish beds in the mixing zone, there should be no effect to this population.

As noted in Section 3.2.4, chlorine could be discharged at potentially toxic levels. For continuous exposure to residual chlorine a concentration limit of 0.01 mg/l will generally protect aquatic life.[7] During the two three-week periods where the CWCS system is being chlorined to control Asiatic clam growth, chlorine concentration may exceed this value in the discharge. Since the diffusers are located in an area which is swept by the river flow, no organism will be in contact with water at the discharge concentration for an extended time period. Therefore, it is appropriate to recognize the diluting effect of the diffuser and to apply the toxicity criterion to the concentration produced in the river immediately downstream of the diffuser rather than to the concentration in the discharge. Chlorine residuals will also be reduced chemically as mixing with river water occurs. Although the extent of the chemical reduction is not readily predicted, it will be significant. The proposed chlorination for clam control will operate near the toxic limit. Exceedance of the limit allows the possibility for loss of aquatic organisms. Such loss would be considered a potentially unacceptable impact. The NPDES permit limits the concentration of total residual chlorine in the discharge to 0.1 mg/l, with dilution at the diffuser of 10:1. Compliance with the NPDES limit will assure that a toxic condition does not occur.

5.3.3 Sanitary Wastes

There is no change in the plan for the sanitary waste treatment system.[8,9] With the controls in the NPDES permit (outfall serial number 005) there will be no adverse effects due to the sanitary waste system. These limits are based on EPA Guideline for Secondary Treatment of Domestic Waste Water (40 CFR 133). The State of Tennessee has provided a certification proposing more stringent limitations (see Appendix E, Attachment C to NPDES Permit). The staff concludes the facility will meet the more stringent limitations.

5.3.4 EPA Effluent Guidelines and Limitations

The Watts Bar Nuclear Plant is classified as "Generating Unit" for the purpose of establishing effluent limitations in compliance with Section 301 of the Federal Water Pollution Control Act. As Generating Unit, the station shall achieve effluent limitations which require the applications of the best practicable control technology currently available [P.L. 92-500, ¶301 (b) (1) (A)] as defined in 40 CFR 423.12. The station shall also meet more stringent limitations, including those necessary to meet water quality standards, treatment standards, or schedules of compliance established pursuant to any State law or regulation (under authority preserved by Section 510) or any other Federal law or regulation or required to implement any applicable water quality standard established pursuant to P.L. 92-500.

The Effluent Limitation Guidelines are summarized in Table 5.1.

Because TVA is a Federal agency, a discharge permit under the provisions of Section 402 of the Federal Water Pollution Control Act must be obtained from the Environmental Protection Agency (EPA). A copy of the EPA permit and the state certification are included in Appendix E. The permit requires monitoring to assure compliance with the effluent limitation guidelines.

Other effluent limitations necessary to meet water quality standards or other regulations are also included in the NPDES Permit. The concentration of total residual chlorine in the combined station discharge is limited to a maximum value of 0.1 mg/l in order to meet toxicity requirements of the Tennessee water quality standards. The concentration of phosphorus resulting from initial metal cleaning wastes is limited to a maximum of 1.0 mg/l as elemental phosphorus. The discharge of polychlorinated biphenyl (PCB) compounds is prohibited by the permit.

5.3.5 Effects on Water Users Through Changes in Water Quality

As described under Subsections 5.3.1, 5.3.2, and 5.3.3 above, changes in water quality due to the Watts Bar Nuclear Plant will not preclude any of the current or projected uses of the Tennessee River.

TABLE 5.1

EFFLUENT GUIDELINES AND STANDARDS FOR STEAM-ELECTRIC GENERATING POINT SOURCE CATEGORY[a]

Regulations	Limitation[b]: Maximum 1-Day Concentration	Limitation[b]: Maximum 30 Consecutive-Day Daily Avg.
All discharges Part 423.12(b)(1) and (2)		
pH (Standard Units)	6.0-9.0 (range)	
Polychlorinated biphenyl compounds	None	
Low-volume waste sources Part 423.12(b)(3)		
Total suspended solids	100 mg/l	30 mg/l
Oil and grease	20 mg/l	15 mg/l
Metal-Cleaning waste discharges Part 423.12(b)(5)		
Total suspended solids	100 mg/l	30 mg/l
Oil and grease	20 mg/l	15 mg/l
Total copper	1.0 mg/l	1.0 mg/l
Total iron	1.0 mg/l	1.0 mg/l
Cooling tower blowdown discharges Part 423.12 (b)(8)		
Free available chlorine	0.5 mg/l (max)[c]	0.2 mg/l (avg)[c]
Periodic chlorine discharges Part 423.12(b)(9)	Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or residual chlorine at any time, unless the utility can demonstrate that the units in a particular location cannot operate at or below this level of chlorination.[c]	
Combining waste streams Part 423.12(b)(10)	In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant properly controlled in paragraphs a through j of the section attributable to each controlled waste source shall not exceed the specified limitation for that waste source.	

[a]39 FR 36186, October 8, 1974.

[b]Quantity of pollutants discharged shall not exceed the quantity determined by multiplying the flow by the concentration.

[c]Instantaneous maximum and 2-hour average. Continuous discharge of total residual chlorine has been proposed in the draft NPDES permit with a maximum instantaneous limitation of 0.1 mg/l to assure protection of aquatic organisms.

5.3.6 Effects on Surface Water Supply

The plant will withdraw a maximum of about 351,000 cubic meters (92,600,000 gallons) of water each day from the Chickamauga Reservoir. Of this withdrawal, a maximum of 157,000 cubic meters (41,500,000 gallons) per day will be evaporated.[10] Essentially, all of the balance will be returned to the Chickamauga Reservior. This mean annual flow past the site is estimated to be 65 million cubic meters (17.2 billion gallons) of water per day[11]. Thus, the plant use would be only 0.64 percent of mean annual flow past the site. The major industrial users downstream from the plant site withdraw a total of about 621,000 cubic meters (164 million gallons)[35] of process water from the Chickamauga Reservoir each day. The most popular use of the Chickamauga Reservoir in the Watts Bar area is for recreation.

Chickamauga Reservoir is a multipurpose reservoir which is operated in accordance with an established rule curve for purposes of navigation, flood control, and hydroelectric power generation. The staff agrees with the applicant's conclusion that consumptive water use at Watts Bar Nuclear Plant would have no measureable impact on the streamflow through, or the pool elevation of, Chickamauga Reservoir as it is operated in accordance with its statutory purposes.

5.3.7 Effects on Groundwater

A groundwater system was developed to serve the Watts Bar Nuclear plant, the Watts Bar Hydroplant and a nearby resort. The groundwater system, located about 3.2 kilometers (two miles) from the site, consists of two wells with a maximum capacity of 2730 cubic meters (720,000 gallons) per day and a standby well with a maximum capacity of 545 cubic meters (144,000 gallons) per day. The maximum groundwater consumption of the plant which will occur at initial startup is expected to be 1140 cubic meters (300,000 gallons) per day [42 percent of the 2730 cubic meters (720,000 gallons) per day capacity]. The Watts Bar Hydroplant and nearby resort will be furnished a maximum of 757 cubic meters (200,000 gallons) per day (28 percent) of the 2730 cubic meters (720,000 gallons) per day capacity.[36]

The three wells are withdrawing water from the Knox Dolomite aquifer. Pumping tests conducted at these wells, using a nearby abandoned well as an observation well, were used to estimate the radius of influence. It was determined to be considerably less than 122 meters (400 feet) for a discharge rate of 2180 cubic meters (576,000 gallons) per day, with a stable drawdown in the discharging well. Since the closest domestic well is 305 meters (1000 feet) south of the Watts Bar groundwater system, the staff concludes that this system will not affect local groundwater users.[36]

The use of groundwater at the Watts Bar station may be altered if a proposed regional water system is developed for the cities of Decatur and Spring City.[12] The regional system includes an intake on Watts Bar Reservoir about four miles upstream from the site.

5.4 ENVIRONMENTAL IMPACTS

5.4.1 Terrestrial Environment

The Station

The principal source of impact on terrestrial environs from the station stems from the operation of the natural draft cooling towers. Local fogging and icing, drift, aesthetics and noise were considered in the FES-CP. The applicant has re-examined drift and plume-interaction effects in response to staff questions.

The applicant's analyses indicate that there will be no significant occurrence of icing attributable to the operation of two natural draft cooling towers. Because of the height of the natural draft cooling towers, direct contact icing, if any, will be limited to the Walden Ridge area northwest of the plant on rare occasions. The staff has considered the available information and concurs with this assessment.

Conservative drift estimates were established by the applicant indicating a maximum rate of about 10.08 kg/ha/yr (~9-lbs/acre/yr). This rate is much less than the amounts now thought to cause damage to salt sensitive vegetation.[13] The staff concludes that no significant impacts on vegetation are likely to occur from cooling tower drift.

Acid mists and acid fly ash due to mergence of cooling tower plumes and the Watts Bar coal-fired plant stacks were discussed in the FES-CP and it was concluded that effects should be minimal.

The plume from a fossil-fuel plant already contains all of the ingredients needed to cause acid droplets and acid rain; particulates to act as catalysts; water vapor from the hydrogen in the fuel; and in cool weather conditions, water droplets from the condensation of the water vapor.[14] For most coal deposits, about 0.5 kg of water vapor is created for each kilogram of fuel burned. Limited data collected in England indicates that acid droplets observed in a natural-draft cooling tower plume were due mostly to ambient SO_2 entrained in the plume and not to merging of the plant's stack and tower effluents. The applicant has indicated that routine terrestrial surveillance programs will be expanded to include inspection of vegetation for any evidence of damage from acid mist and/or acid fly ash. The applicant does not expect that there will be any significant effects, especially offsite.

Because of limited operating experience under such circumstances, the staff believes it is prudent to undertake a limited term inspection program because a margin of uncertainty exists in the foregoing conclusion. The staff's requirement for a limited term operational monitoring program is given in Section 6.3.6 of this statement.

Operating data from two natural draft cooling towers indicates that to date bird collisions on cooling towers result in relatively few mortalities each year and that this cannot be regarded as a threat to populations at large.[15,16] Some uncertainty exists, however, as to whether significant episodes might occur on cooling towers, as they are known to occur on tall television or radio towers. In some cases with other tower types, episodic bird kills may account for hundreds or thousands of mortalities in a single overnight occurrence. This has not yet been reported for cooling towers. It is the staff's opinion, however, that enough uncertainty exists on this question to warrant a limited term of surveillance of cooling towers for the purpose of detecting and reporting episodic occurrences, if any take place. A bird monitoring requirement is, therefore, given in Section 6.3.6 of this statement.

5.4.1.2 Transmission Lines

Sources of impact associated with operation of transmission lines are (1) ozone production, (2) induced electrical currents and electric fields, (3) communications interference, and (4) corridor maintenance and herbicide use. The evaluation of effects of ozone production, communications interference, corridor maintenance and herbicide use was covered in the FES-CP. This evaluation remains valid. The staff includes below its evaluation of induced electrical currents and electrical fields which was not previously presented for the transmission lines of the Watts Bar facility.

There is a possibility that electrical fields set up around transmission lines could affect persons in the field. Studies have been performed by members of the staff of the Johns Hopkins Hospital to determine whether exposure to electrostatic fields such as those existing in transmission line substations result in adverse effects on humans, and were reported by Kouwenhaven, et al.[17] The Kouwenhaven study gives the results of physical and medical examinations of eleven linemen over a period of 42 months during the time they were performing live-line maintenance work on a 345-kV transmission system. Measurements of currents induced in a man's body when doing typical work on a 345-kV system such as on transmission towers and in buckets were reported on. In the former case, the man is grounded while in the electric field and in the latter, he is at line potential (barehand work). Body currents of 100 to 400 microamperes for the tower work and from 85 to 840 microamperes for barehand work were measured, depending on degree of bucket shielding used. Field intensities also were determined at various parts of the bodies for men doing barehand work. These ranged from 0.4 kV/in (20 kV/m) to 12 kV/in (470 kV/m) at the top of the head to 0 to 4 kV/in (200 kV/m) at the knees, depending on whether full or partial bucket shields were used.

As a result of this study, the authors reported that:

> "Considering the period of observation (3-1/2 years) and the method of study, it can be reported that the health of the eleven observed linemen was unchanged by their exposure to HV lines. Also no evidence of malignancy was found. There was a decrease in the sperm count of two of the 11 subjects. The significance of this is not clear and warrants further study; but no correlation has been found between exposure to HV lines and any effect on the health of individuals in this investigation. Among the 11 men tested, there were four who had had many hours of barehand work during the period of this investigation. Not a single one of these men showed any change in his physical, mental, or emotional characteristics. Their laboratory studies remained entirely normal. No evidence was found that an adequately shielded lineman is endangered in any way by working barehanded in an HV AC electric field, within the limits of this study."

Studies of this nature were also carried on in the Soviet Union and their results were reported at the 1972 International Conference on Large High Tension Electric Systems, Paris, France, in a paper by Korobkova, et al.[18] In this study, a systematic medical examination of about 250 persons working in 500-kV substations for a long time was undertaken. Measurements were also made of field strengths in various areas where these persons worked in 500-kV substations and similar locations in 750-kV substations. Field potentials up to 25 kV/m were indicated in the 500kV substations.

The Korobkova report stated that "the examination showed that long-time work at 500-kV substations without protective measures results in shattering the dynamic state of the central nervous system, heart and blood vessel system and in changing blood structure. Young men complained of reduced sexual potential." It was also concluded that "the depth of these functional diseases or troubles directly depends on the time of stay in the field." Criteria for permissible duration of personnel stay in electric fields were given and ranged from five minutes per day at 25 kV/m to unlimited time at 5 kV/m.

In a follow-on report by the Johns Hopkins staff members, results were given for the continued examination of ten of the previously examined lineman who were still employed by the power companies.[19] The report covers a period of nine years ending June 1973 during which the men were examined completely seven times. There were no significant changes of any kind found in the physical examinations, nor were there any significant abnormalities in any of the laboratory studies. No disease states were found that could be in any way related to the exposure of the men to high-voltage lines.

The investigators were aware of the Russian paper and specifically looked for disorders described in it. In particular, no disorders in the functional states of the nervous and cardiosvascular systems of the workers reported by the Russians were found. The report cautioned, however, that in view of the two diverse populations examined, with entirely different cultures, working conditions and environments, comparison of the two studies should be "viewed with great caution." The report of the follow-on examinations, therefore, did not change the conclusions reached in the earlier study.

A recent Russian paper, discussed during a US/USSR symposium on high voltage transmission reiterated that extra high voltage (EHV) substation workers had experienced problems.[20] In this discussion the Russians state, "If the exposure is of brief duration, the effect disappears. If the exposure is on an extended daily basis, the effects appear to be cumulative but ill effects disappear in one month after removal from exposure." A second Russian paper stressed that present Russian standards apply only to maintenance personnel working on electrical installations.[21] Standards permitting higher voltage gradients for local populations and agricultural workers are currently being considered by the Russians since these populations will be exposed only infrequently.

The staff is not aware of any reported observable effects resulting from human exposure to electric fields radiated from operating high voltage power lines. The physiological effects reported by the Russians were observed on workers in EHV substations, not on individuals below transmission lines.

Currently a number of carefully designed studies of the biological effects of electric fields are underway and additional studies are planned. These studies are being monitored by the staff for any resultant guidelines.

The applicant has calculated a maximum electric field strength at one meter above ground for the 500 kV transmission line connections to the Watts Bar Nuclear Plant of 9.1 kV (RMS)/meter. Along the edge of the right-of-way, the calculated value of electric field strength at one meter is 1.75 kV (RMS)/meter.[22]

If these gradients occur, using the more conservative Russian study, a man could daily spend three hours working beneath the lines with no adverse effects. The general public is not expected to spend significant amounts of time in the transmission line right-of-way corridors.

The line will be designed to meet or exceed the clearance requirements of the National Electrical Safety Code. In general, the following clearance will be maintained:

Open Ground	35 feet
Secondary Roads	37 feet
Main highways	40 feet
Foreign lines	20 feet
Railroads	45 feet

The staff has analyzed data on the effects of high voltage electric lines on plants and animals and has found no evidence to date indicating hazardous effects to plants or animals from present levels of fields generated from existing transmission line technology.[23]

Based upon the data summarized above, the staff believes there should be no changes in the applicant's proposed design.

Induced currents are unlikely to ignite fuel vapors, but currents capable of shocking people could be induced in vehicles without grounding straps. Any stationary structure with metal parts in the right-of-way should be grounded by the applicant, especially such objects as metal fences or rail lines that run parallel to the right-of-way. In such objects that are ungrounded, shock causing involuntary muscle reaction may occur, but no permanent physiological harm is likely.[24] The staff believes grounding measures will reduce the likelihood of shock to a level which is of no concern. The applicant is committed to investigate during the operational life of the lines, all reports of induced voltages and use corrective equipment and materials necessary to eliminate the induced voltages in the right-of-way and off the right-of-way with the permission of the land owner.

It is the staff's assessment that the 500 kV transmission lines for Watts Bar will not produce a maximum induced current in excess of 5 milliamperes (RMS) under conditions of maximum line sag when a large truck or bus under the line is short-circuited to ground. The maximum induced current of 5 milliamperes is a safety guideline in the National Electric Safety Code (ANSI C2, 1977 Edition).

5.4.2 Aquatic Environment

The assessment of impacts on aquatic resources associated with the operation of the Watts Bar Nuclear Plant are essentially the same as presented in the FES-CP. The data obtained in preoperational monitoring (See Section 2.5.2 and Appendix C) provide a baseline for confirmatory assessment of these potential impacts during plant operation.

Although an entrainment loss estimate for phytoplankton and zooplankton could be made, it is our conclusion that such an estimate is unnecessary, and probably meaningless, in light of the high variability in the observed data. The high concentrations in the Watts Bar Dam forebay indicate a major source of input, which obviates any consideration of possible depletion of these populations in the site vicinity. Population changes outside the thermal plume mixing zone are not expected.

Recently acquired data for ichthyoplankton in the vicinity of the Watts Bar site during the 1976 spawning period (See Appendix C, Table C-16) indicate uniform distribution of the early life stages across a river transect. Therefore, ichthyoplankton entrainment approximates hydraulic entrainment. TVA has estimated that, for 1976, approximately 0.2 million eggs and 21.8 million larvae would have been entrained if the plant had been operational. These estimated losses represent 0.32 percent of the eggs and 1.08 percent of the larvae transported past the Watts Bar site. For 1977, losses were estimated at 0.92 percent of the eggs and 0.62 percent of the larvae. Table 5.2 shows the estimated entrainment for each family of fish collected. Freshwater drum (Sciaenidae) represented all of the 1976 collection of eggs and two thirds in 1977. Clupeidae, including gizzard and threadfin shad, contributed approximately 91.5 percent of the total larvae collected. Freshwater drum and Lepomis spp. larvae contributed 5.5% and 1.9%, respectively. The clupeids, freshwater drum, and Lepomis are not restricted to the tailrace habitat for spawning success.

The importance of the tailrace as a spawning site for the migratory spawners was not demonstrated by the ichthyoplankton data. These taxa represented less than one tenth of one percent of the total larvae collected. The sauger, Stizostedion canadense, which would be expected to spawn in the tailrace area, is also one of only two identified host fishes for the glochidial stage of the endangered mussel, Lampsilis orbiculata. The ichthyoplankton data indicates limited abundance of sauger, e.g., only one larva was collected in 1976. The other identified host is the freshwater drum which would have sustained entrainment losses during 1976 of 0.32% and 0.61% for eggs and larvae, respectively.

Based on two years of ichthyoplankton data, it is concluded that the losses of ichthyoplankton due to entrainment will be at acceptably low levels and that neither the reservoir fishes nor endangered mussel will be significantly impacted by such losses. The 1977 ichthyoplankton data suggest that the 1976 year was not atypical with regard to tailrace spawning. Data for 1978 have been collected but are unavailable for staff review. These will be presented in the applicant's preoperational monitoring report.

Impingement of fishes at the Watts Bar plant is expected to be minimal due to the low intake velocity (i.e., maximum near intake openings of about 0.4 feet per second) and limited make-up water required by the closed-cycle cooling system (i.e., maximum of 0.7% of the average river flow).

Potential effects of plant operation on mussels in the immediate vicinity of the plant are minimized; the mixing zone is on the right side of the river while the mussel bed is located along the left side. Mussels downstream of the plant should not experience any deleterious effects since plant discharges are rapidly diluted, initially, by the diffuser and further diluted over the seven to eight mile distance to the identified mussel bed between TRM 520.5 and

TABLE 5.2

ESTIMATED SEASONAL ENTRAINMENT (%) OF FISH FAMILIES COLLECTED IN THE TENNESSEE RIVER

AT WATTS BAR NUCLEAR PLANT, 1976 AND 1977

Family	1976 Number Transported	1976 Number Entrained	1976 Percent Entrainment	1977 Number Transported	1977 Number Entrained	1977 Percent Entrainment
Sciaenid Eggs	6.62×10^7	2.15×10^5	0.32	4.46×10^7	2.59×10^5	0.60
Clupeidae	2.26×10^9	2.50×10^7	1.13	1.08×10^{10}	6.64×10^7	0.61
Hiodontidae	-	-	-	3.28×10^6	1.03×10^4	0.31
Cyprinidae	1.18×10^7	7.76×10^4	0.67	1.34×10^7	2.28×10^5	1.70
Catostomidae	3.73×10^5	-	-	3.26×10^7	8.07×10^4	0.25
Ictaluridae	1.37×10^7	2.52×10^4	0.18	1.80×10^7	1.78×10^5	0.99
Percichthyidae	2.45×10^6	3.85×10^4	1.55	4.34×10^7	2.89×10^5	0.67
Centrarchidae	6.23×10^7	6.30×10^5	1.01	2.81×10^8	2.53×10^6	0.90
Percidae	1.65×10^5	-	-	3.73×10^6	2.70×10^4	0.72
Sciaenidae	1.61×10^8	9.82×10^5	0.61	3.18×10^8	1.73×10^6	0.54
Total Eggs	6.87×10^7	2.15×10^5	0.32	7.56×10^7	6.96×10^5	0.92
Total Fish	2.51×10^9	2.18×10^7	1.08	1.15×10^{10}	7.15×10^7	0.62

From: TVA, "Comments on Draft Environmental Statement."

TRM 521.3. Both endangered species, Lampsilis orbiculata and Dromus dromas, collected in Chickamauga Reservoir were found at this downstream location. L. orbiculata was found also in the mussel bed opposite the plant site. Neither the species nor the habitat where the specimens have been found are expected to be adversely affected by the plant operation. Pleurobema cordatum, which is listed as a species of special concern by the Tennessee Heritage Program, is abundant in both the upstream mussel bed (18% of the total specimens collected during July and August 1975) and the downstream bed (24% of total collected during the same survey period). This species will receive the same protection as provided to the two endangered species.

Assessment of other impacts associated with plant operation as described in TVA's FES remain valid.

5.5 RADIOLOGICAL IMPACT

5.5.1 Radiological Impact on Man

The models and consideration for environmental pathways leading to estimates of radiation dose commitments to individuals are discussed in detail in Regulatory Guide 1.109. Similarly, use of these models and additional assumptions for population dose estimates are described in Appendix B of this statement.

Exposure Pathways

The environmental pathways which were considered in preparing this section are shown in Figure 5.1. Estimates were made of radiation doses to man at and beyond the site boundary based on NRC staff estimates of expected effluents as shown in Tables 3.3 and 3.4, site meteorological and hydrological considerations, and exposure pathways at the Watts Bar Nuclear Power Station.

Inhalation of air and ingestion of food (and water) containing tritium, C-14, radiocesium and radioiodine are estimated to account for essentially all of total body radiation dose commitments to individuals and the population within 50 miles of the station.

Dose Commitments from Radioactive Releases to the Atmosphere

Radioactive effluents released to the atmosphere from the Watts Bar facility will result in small radiation doses to the public. NRC staff estimates of the expected gaseous and particulate releases listed in Table 3.3 and the site meteorological considerations discussed in Section 2.4 of this statement and summarized in Table 5.3 were used to estimate radiation doses to individuals and populations. The results of the calculations are discussed below.

Radiation Dose Commitments to Individuals

The predicted dose commitments to "maximum" individuals at the offsite locations where doses are expected to be largest are listed in Table 5.4. A maximum individual is assumed to consume well above average quantities of the foods considered (see Table A-2 in Regulatory Guide 1.109). The standard NRC models were used.

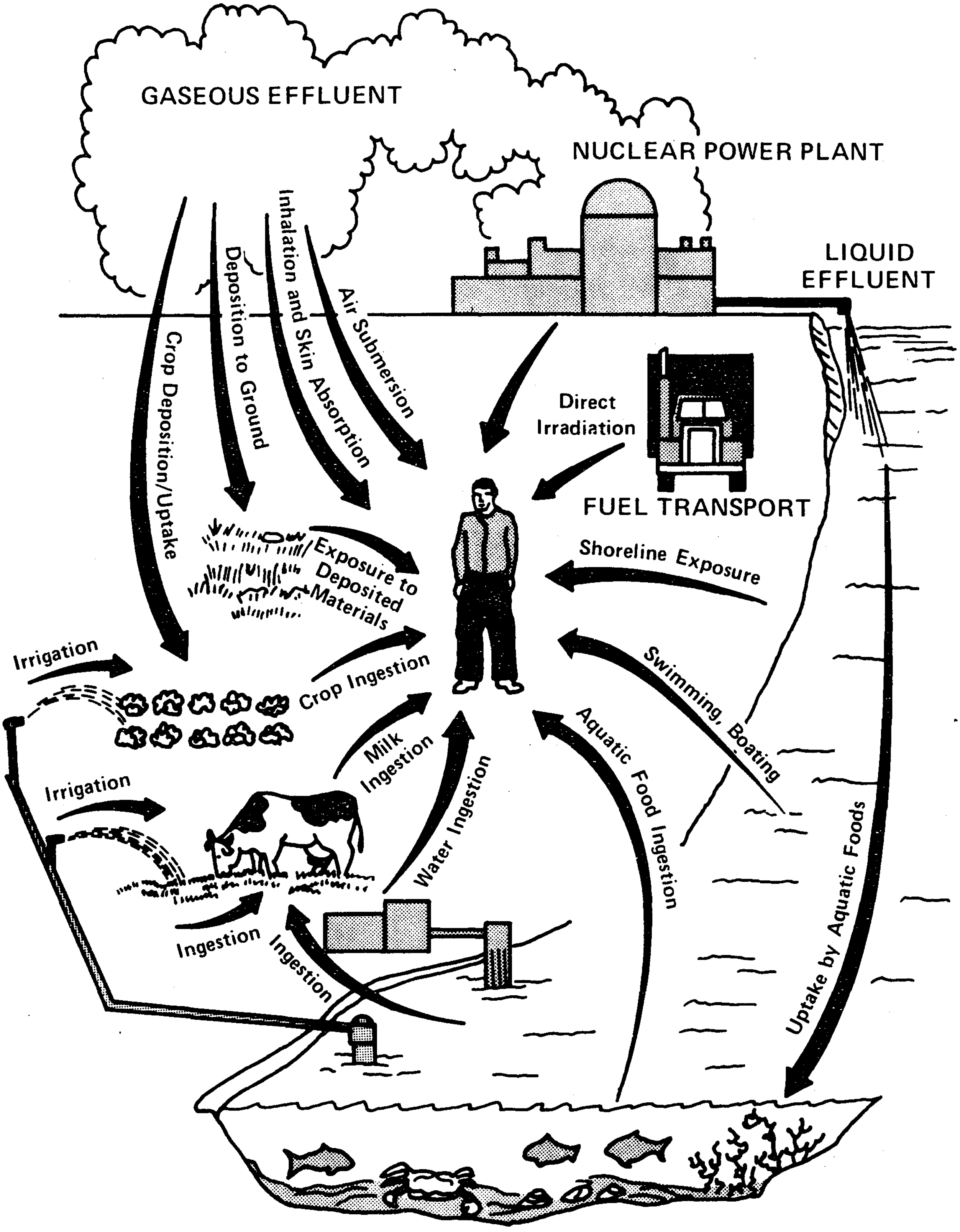
Radiation Dose Commitments to Populations

The calculated annual radiation-dose commitments to the population for the year 2000 within 80 km (50 mi.) of the Watts Bar Nuclear Plant from gaseous and particulate releases are presented in Table 5.5. Estimated dose commitments to the U.S. population are also presented in this table and were calculated using the average population densities discussed in Appendix B. Background radiation doses are provided for comparison.

Within 80 km (50 mi.) of the Watts Bar plant site, specific meteorological, populational and agricultural data for each of 16 compass sectors around the plant were used to evaluate dose. Beyond 80 km (50 mi.) meteorological models were extrapolated by assuming uniform dispersion of noble gases and continued deposition of radioiodines and particulates until no suspended radionuclides remained. Dose was evaluated using average population densities and production values. The doses from atmospheric releases from the Watts Bar facility during normal operation represent an extremely small increase in the normal population dose from background radiation sources.

Dose Commitments from Radioactive Liquid Releases to the Hydrosphere

Radioactive effluents released to the hydrosphere from the Watts Bar facility during normal operation will result in small radiation doses to individuals and populations. NRC staff



EXPOSURE PATHWAYS TO MAN

Figure 5.1

TABLE 5.3

SUMMARY OF ATMOSPHERIC DISPERSION FACTORS AND DEPOSITION VALUES FOR SELECTED LOCATIONS NEAR THE WATTS BAR NUCLEAR POWER STATION*

LOCATION	SOURCE	X/Q (sec/m^3)	RELATIVE DEPOSITION (m^{-2})
Nearest** Site	A	7.8 E-06	1.8 E-08
Land Boundary	B	5.0 E-05	7.1 E-08
(0.75 mi. SSE)	C	2.0 E-05	2.8 E-08
	D	2.7 E-05	2.8 E-08
Nearest Residence	A	1.9 E-05	3.8 E-08
and Garden	B	3.5 E-05	4.9 E-08
(0.87 mi. SE)	C	1.4 E-05	1.9 E-08
	D	1.9 E-05	1.9 E-08
Nearest Farm and	A	1.8 E-06	7.6 E-09
Milk Animal	B	9.9 E-06	1.9 E-08
(1.39 mi. SSW)	C	3.6 E-06	6.9 E-09
	D	4.4 E-06	6.9 E-09

*The doses presented in the following tables are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," March 1976.

**"Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.

Source A is reactor building 24-16 hr. releases/yr.
Source B is waste decay tank 15-8 hr. releases/yr.
Source C is auxiliary building.
Source D is turbine building and air ejector.

TABLE 5.4 MAXIMUM ANNUAL DOSE COMMITMENTS TO AN INDIVIDUAL DUE TO GASEOUS AND PARTICULATE EFFLUENTS

(BOTH UNITS)

		DOSE (mrem/yr)						
LOCATION	PATHWAY	TOTAL BODY	GI-TRACT	BONE	LIVER	THYROID	LUNG	SKIN
Nearest*	Plume	1.9	1.9	1.9	1.9	1.9	2.0	6.1
Residence	Ground Deposit	0.055	0.055	0.055	0.055	0.055	0.055	0.055
(0.87 mi.)	Inhalation (adult)	1.2	1.2	**	1.2	2.1	1.2	1.2
	Vegetation (child)	4.2	4.2	1.9	4.2	5.6	4.2	4.1
Nearest Milk	Plume	0.21	0.21	0.21	0.21	0.21	0.22	0.81
Animals	Ground Deposit	0.015	0.015	0.015	0.015	0.015	0.015	0.015
(1.39 mi. SSW)	Inhalation (Adult)	0.20	0.20	**	0.20	0.36	0.20	0.20
	Milk (Infant)	0.47	0.47	0.45	0.50	7.5	0.47	0.47
Nearest* Land	Plume	2.6	2.6	2.6	2.6	2.6	2.7	8.2
Site Boundary	Ground Deposit	0.077	0.077	0.077	0.077	0.077	0.077	0.077
(0.75 mi. SSE)	Inhalation (Adult)	1.7	1.7	**	1.7	2.9	1.7	1.7

*"Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.
**Less than 0.01 mrem/yr.

TABLE 5.5 ANNUAL POPULATION DOSE COMMITMENTS IN THE YEAR 2000

Category	Population Dose Commitment (man-rem) 50 miles	U.S. Population
Natural Radiation Background[a]	106,050[b]	25,000,000[c]
Watts Bar Nuclear Power Plant Operation		
Plant Work Force	**	1000
General Public (Total)	9.0	65.
Noble Gases Submersion	1.7	3.5
Inhalation	2.2	4.0
Ground Deposition	*	*
Terrestrial Foods	*	25.
Drinking Water	*	*
Aquatic Foods	*	*
Recreation	*	*
Transportation of Nuclear Fuel and Radioactive Wastes	**	6

*Less than 1 man-rem/yr

**Included in the U.S. population, since some exposure is received by persons residing outside 50 mile radius.

(a) "Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID 72-1 (June 1972).

(b) Using the average Tennessee state background dose (101 mrem/yr) in (a), and year 2000 projected population of 1,050,000.

(c) Using the average U.S. background dose (102 mrem/yr) in (a), and year 2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Dept. of Commerce, Bureau of the Census, Series P-25, No. 541 (Feb. 1975).

estimates of the expected liquid releases listed in Table 3.4 and the site hydrological considerations discussed in Section 2.3 of this statement and summarized in Table 5.6 were used to estimate radiation dose commitments to individuals and populations. The results of the calculations are discussed below.

Radiation Dose Commitments to Individuals

The estimate dose commitments to individuals at selected offsite locations where exposures are expected to be largest are listed in Table 5.7. The standard NRC models given in Regulatory Guide 1.109 were used for these analyses.

Radiation Dose Commitments to Populations

The estimated population radiation dose commitments to 50 miles for the Watts Bar facility from liquid releases, based on the use of water and biota from the Chickamauga Reservoir, are shown in Table 5.5. Dose commitments beyond 50 miles were based on the assumptions discussed in Appendix B.

Background radiation doses are provided for comparison. The dose commitments from liquid releases from the Watts Bar facility represent small increases in the population dose from background radiation sources.

Direct Radiation

Radiation from the Facility

Radiation fields are produced in nuclear plant environs as a result of radioactivity contained within the reactor and its associated components.

Doses from sources within the plant are primarily due to nitrogen 16, a radionuclide produced in the reactor core. Since the primary coolant of pressurized water reactors is contained in a heavily shielded area of the plant, dose rates in the vicinity of PWR's are generally undetectable (less than 5 mrem/yr).

Low level radioactivity storage containers outside the plant are estimated to contribute less than 0.01 mrem/year at the site boundary.

Occupational Radiation Exposure

Based on a review of the applicant's safety analysis report, the staff has determined that the applicant is committed to design features and operating practices that will assure that individual occupational radiation doses (occupational dose is defined in 10 CFR Part 20) will be within the limits of 10 CFR Part 20 and that individual and total plant population doses will be as low as is reasonably achievable.[25] For the purpose of portraying the radiological impact of the plant operation on all onsite personnel, it is necessary to estimate a man-rem occupation radiation dose. For a plant designed and proposed to be operated in a manner consistent with 10 CFR Part 20, there will be many variables which influence exposure and make it difficult to determine a quantitative total occupational radiation dose for a specific plant. Therefore, past exposure experience from operating nuclear power stations[26] has been used to provide a widely applicable estimate to be used for all light water reactor power plants of the type and size for Watts Bar. This experience indicates a value of 500 man-rem per year per reactor unit.

On this basis, the projected occupational radiation exposure impact of the Watts Bar Station, Units 1 and 2 is estimated to be 1000 man rem per year.

Transportation of Radioactive Material

The transportion of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the NRC report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants." The environmental effects of such transportation are summarized in Table 5.8.

Comparison of Dose Assessment Models

The applicant's site and environmental data provided in the environmental statement[27] and in subsequent answers to NRC staff questions was used extensively in the dose calculations.

TABLE 5.6 SUMMARY OF HYDROLOGIC TRANSPORT AND DISPERSION FOR LIQUID RELEASES FROM THE WATTS BAR NUCLEAR PLANT*

LOCATION	TRANSIT TIME (Hours)	DILUTION FACTOR
Nearest Drinking Water Intake (Dayton, Tennessee)	43	200
Nearest Sport Fishing Location (Discharge Plume)	1.0	66
Nearest Shoreline (Chickamauga Reservoir)	1.0**	1.0

*See Regulatory Guide 1.112, "Analytical Models for Estimating Radioisotopes Concentrations in Different Water Bodies," (1976).

**Assumed for purpose of an upper limit estimate.

TABLE 5.7 ANNUAL INDIVIDUAL DOSE COMMITMENTS DUE TO LIQUID EFFLUENTS

LOCATION	PATHWAY	DOSE (merm/yr)					
		TOTAL BODY	BONE	LIVER	THYROID	LUNG	GI TRACT
Nearest River Water Use (Dayton, Tennessee)	Drinking Water	**	**	**	**	**	**
Nearest Fish Production	Fish (Outfall Area)	0.071	0.056	0.097	0.019	0.011	0.013
Nearest Shoreline	Sediments (Outfall Area)	**	**	**	**	**	**

**Less than 0.01 mrem/yr

TABLE 5.8 ENVIRONMENTAL IMPACT OF TRANSPORTATION OF FUEL AND WASTE TO AND FROM ONE LIGHT-WATER-COOLED NUCLEAR POWER REACTOR[a]

Normal Conditions of Transport

Heat (per irradiated fuel cask in transit)	250,000 Btu/hr
Weight (governed by Federal or State restrictions)	73,000 lbs. per truck; 100 tons per cask per rail car
Traffic density	< 1 per day
Rail	< 3 per month

Exposed population	Estimated number of persons	Range of doses to exposed individuals (millirems per reactor yr)	Cumulative dose to exposed population (man-rems per reactor yr)[c]
Transportation			
Worker	200	0.01 to 300	4
General Public			
Onlookers	1,100	0.003 to 1.3	
Along Route	600,000	0.0001 to 0.06	3

Accidents in transport

Radiological effects	Small[d]
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year

[a] Data supporting this table are given in the Commission's Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, WASH-1238, December 1972, and Supp. I, NUREG 75/038, April 1975.

[b] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirems/year for individuals as a result of occupational exposure and should be limited to 500 millirems/year for individuals in the general population. The dose to individuals due to average natural background radiation is about 102 millirems/year.

[c] Man-rems is an expression for the summation of whole-body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirems) each, the total man-rem in each case would be 1 man-rem.

[d] Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

Evaluation of Radiological Impact

The radiological impact of operating the proposed Watts Bar Nuclear Power Plant is presented in terms of individual dose commitments in Tables 5.4 and 5.7. The annual individual dose commitments resulting from routine operation of the plant are a small fraction of the dose limits specified in 10 CFR Part 20. The population dose commitments are small fractions of the dose from natural environmental radioactivity. As a result, the staff concluded that there will be no measurable radiological impact on man from routine operation of the Watts Bar plant.

Comparison of Calculated Doses with NRC Design Objectives

Table 5.9 shows a comparison of calculated doses from routine releases of liquid and gaseous effluents from the Watts Bar plant with the design objectives of Appendix I to 10 CFR 50. In order to determine compliance with Section II.D of Appendix I to 10 CFR 50, the staff also calculated the total body and thyroid dose commitments to the population within 80 km (50 mi.) of the plant. The doses were estimated at 9.0 man-rem and 12.0 man-thyroid-rem, respectively. A detailed discussion of the staff's cost-benefit analysis for radioactive waste treatment and effluent release systems is presented in Section 3.2.3 of this statement.

5.5.2 Radiological Impacts on Biota Other Than Man

Depending on the pathway and the radiation source, terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than man receives. Although guidelines have not been established for acceptable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species of most ecosystems suffer rather high mortality rates from natural causes. While the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions with other stresses (e.g., heat, biocides, etc.), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the Watts Bar Nuclear Power Plant. Furthermore, in all the plants for which an analysis of radiation exposure to biota other than man has been made, there have been no cases of exposures that can be considered significant in terms of harm to the species, or that approach the exposure limits to members of the public permitted by 10 CFR Part 20.[28] Since the BEIR Report[29] concluded that the evidence to date indicates that no other living organisms are very much more radiosensitive than man, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this plant.

5.5.3 Uranium-Fuel-Cycle Impacts

On March 14, 1977, the Commission presented in the Federal Register (42 FR 13803) an interim rule regarding the environmental considerations of the uranium fuel cycle. It is effective through March 14, 1979* and revises Table S-3 of Paragraph (e) of 10 CFR § 51.20.** In a subsequent announcement on April 14, 1978 (43 FR 15613), the Commission further amended Table S-3 to delete the numerical entry for the estimate of radon releases and to clarify that the table does not cover health effects. The revised table, shown here as Table 5.10, replaces Table 5.25 of the Shoreham FES. The interim rule reflects new and updated information relative to reprocessing of spent fuel and radioactive waste management as discussed in NUREG-0116, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle,[38] and NUREG-0216 which presents staff responses to comments on NUREG-0116.[39] The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low and high level wastes. These are described in the AEC report WASH-1248, Environmental Survey of the Uranium Fuel Cycle.[40]

Specific categories of natural resource use are included in Table S-3 of the interim rule. These categories relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high and low level wastes, and radiation doses from transportation and occupational exposures. The contributions in Table S-3 for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle), that is, the cycle that results in the greater impact is used.

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*The rule was originally effective through September 13, 1978, but the Commission, in an action effective September 14, 1978, extended the rule to this date.

**A notice of final rulemaking proceedings was given in a Federal Register of May 26, 1977 (42 FR 26987) that calls for additional public comment before adoption or final modification of the interim rule.

TABLE 5.9 MAXIMUM COMPARISON OF CALCULATED DOSES TO AN INDIVIDUAL FROM WATTS BAR OPERATION WITH APPENDIX I DESIGN OBJECTIVES[a]

CRITERION	APPENDIX I DESIGN OBJECTIVE	CALCULATED DOSES
Liquid Effluents		
Dose to total body from all pathways	3 mrem/yr	0.10 mrem/yr
Dose to any organ from all pathways (Adult-Liver)	10 mrem/yr	0.097 mrem/yr
Noble Gas Effluents (at site boundary)		
Gamma dose in air	10 mrad/yr	0.80 mrad/yr
Beta dose in air	20 mrad/yr	3.1 mrad/yr
Dose to total body of an individual	5 mrem/yr	0.90 mrem/yr
Dose to skin of an individual	15 mrem/yr	3.1 mrem/yr
Radioiodines and Particulates[b]		
Dose to any organ from all pathways (Child-Thyroid)	15 mrem/yr	3.9 mrem/yr

[a]Appendix I Design Objectives from Sections II.A, II.B, II.C of Appendix I, 10 CFR Part 50; considers doses to maximum individual per reactor unit. From Federal Register V. 40, p. 1942, May 5, 1975.

[b]Carbon-14 and tritium have been added to this category.

TABLE 5.10

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS FOR THE URANIUM FUEL CYCLE[1] [NORMALIZED TO MODEL LWR ANNUAL FUEL REQUIREMENT (WASH-1248) OR REFERENCE REACTOR YEAR (NUREG-0116)]

Natural resource Use	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
Land (acres):		
Temporarily committed[2]	94	
Undisturbed area	73	
Disturbed area	22	Equivalent to 110 MWe coal-fired powerplant.
Permanently committed	7.1	
Overburden moved (millions of MT).	2.8	Equivalent to 95 MWe coal-fired powerplant.
Water (millions of gallons):		
Discharged to air	159	=2 pct of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	124	
Total	11,373	<4 pct or model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of megawatt hours).	321	<5 pct of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT).	117	Equivalent to the consumption of a 45 MWe coal-fired powerplant.
Natural gas (millions of scf)	124	<0.3 pct of model 1,000 MWe energy output.
Effluents—chemical (MT):		
Gases (including entrainment):[3]		
SO_x	4,400	
NO_x[4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F^-	0.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HCl	0.014	
Liquids:		
$SO_4^{=}$	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are:
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	NH_3—600 ft^3/s.
Na^+	12.1	NO_3—20 ft^3/s.
NH_3	10.0	Fluoride—70 ft^3/s.
Fe	0.4	
Tailings solutions (thousands of MT).	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.
Effluents—radiological (curies):		
Gases (including entrainment):		
Rn-222	–	Presently under reconsideration by the Commission.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	0.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	0.83	
Fission products and transuranics.	0.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included in tailings liquor and returned to ground = no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 pct of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow).	11,300	9,100 Ci comes from low-level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground ~60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^7	Buried at Federal repository
Effluents—thermal (billions of British thermal units)	3,462	<4 pct of model 1,000 MWe LWR
Transportation (person-rem): Exposure of workers and general public.	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

[1] In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle. These issues which are not addressed at all by the Table may be the subject of litigation in individual licensing proceedings. Data supporting this Table are given in the "Environmental Survey of the Uranium Fuel Cycle", WASH-1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle", NUREG-0116 (Supp. 1 to WASH-1248); and the "Discussion of Comments Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle", NUREG-0216 (Supp. 2 to WASH-1248). The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the 2 fuel cycles (uranium only and no-recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of sec. 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A–E of Table S-3A of WASH-1248.

[2] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services 1 reactor for 1 yr. or 57 reactors for 30 yrs.

[3] Estimated effluents based upon combustion of equivalent coal for power generation.

[4] 1.2 pct. from natural gas use and process.

The following assessment of the environmental impacts of the fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 and the staff's analysis of the radiological impact from radon releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000 MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff conclusions would not be altered if the analysis were to be based on the net electrical power output of the proposed project.

The staff's analysis and conclusions are as follows:

A. Land Use

The total annual land requirement for the fuel cycle supporting a model 1000 MWe LWR is about 41 hectares (101 acres). Approximately 3 hectares (7 acres) per year are permanently committed land, and 38 hectares (94 acres) per year are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant, e.g., mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 38 hectares per year of temporarily committed land, 29 hectares are undisturbed and 9 hectares are disturbed. Considering common classes of land use in the U.S.,* fuel-cycle land-use requirements to support the model 1000 MWe LWR do not represent a significant impact.

B. Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000 MWe LWR is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43 x 10^6 m^3 (11,373 x 10^6 gal), about 42 x 10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 0.6 x 10^6 m^3 per year and water discharged to ground (e.g., mine drainage) of about 0.5 x 10^6 m^3 per year.

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4% of the model 1000 MWe LWR discharges using once-through cooling. The consumptive water use of 0.6 x 10^6 m^3 per year is about 2% of the model 1000 MWe LWR consumption using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of the model 1000 MWe LWR consumption using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

C. Fossil Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel-cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5% of the annual electrical power production of the model 1000 MWe LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3% of the electrical output from the model plant. The staff finds that the direct and indirect consumption of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

D. Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents with fuel-cycle processes are given in Table S-3. The principal species are SO_x, NO_x, and particulates. Based on data in a Council on Environmental Quality report,** the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with these emissions from the stationary fuel-combustion and transportation sectors in the U.S., i.e., about 0.02% of the annual national releases for each of these species. The staff believes such small increases in releases of these pollutants are acceptable.

*A coal-fired power plant of 1000 MWe capacity using strip-mined coal requires the disturbance of about 81 hectares per year for fuel alone.

**The Seventh Annual Report of the Council on Environmental Quality, September 1976. Figures 11-27 and 11-28, pp. 238-239.

Liquid chemical effluents produced in fuel-cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. Table S-3 specifies the flow of dilution water required for specific constituents. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in an NPDES permit issued by an appropriate state or Federal regulatory agency.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

E. Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste management activities and certain other phases of the fuel-cycle process are set forth in Table S-3. Using these data, the staff has calculated the 100-year involuntary environmental dose commitment* to the U.S. population. These calculations estimate that the overall involuntary total body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be approximately 400 man-rem per year of operation of the model 1000 MWe LWR (RRY). Based on Table S-3 values, the additional involuntary total body dose commitment to the U.S. population from radioactive liquid effluents due to all fuel-cycle operations other than reactor operation would be approximately 100 man-rem per year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is approximately 500 man-rem (whole body) per year RRY.

At this time Table S-3 does not address the radiological impacts associated with radon-222 releases. Principal radon releases occur during mining and milling operations and, following completion of mining and milling, as emissions from stabilized mill tailings and from unreclaimed open-pit mines. The staff has determined that releases from these operations per RRY are as follows:

Mining: (during active mining)[41]	4060 Ci
Mining: (unreclaimed open pit mines)[42]	30 to 40 Ci/yr
Milling and Tailings: (during active milling)[43]	780 Ci
Inactive Tailings: (prior to stabilization)[43]	350 Ci
Stabilized Tailings: (several hundred years)[43]	1 to 10 Ci/yr
Stabilized Tailings: (after several hundred years)[43]	110 Ci/yr

The staff has calculated population dose commitments for these sources of radon-222 using the RABGAD computer code described in NUREG-0002, Section IV.J of Appendix A.[44] The results of these calculations for mining and milling activities prior to reclamation of open-pit uranium mines and tailings stabilization are as follows:

Radon-222 Releases		Estimated 100-Year Environmental Dose Commitment (man-rem) per Year of Operation of the Model 1000 MWe LWR		
		Total Body	Bone	Lung (Bronchial Epithelium)
Mining	4100 Ci	110	2800	2300
Milling and active tailings	1100 Ci	29	750	620
Total		140	3600	2900

*The environmental dose commitment (EDC) is the integrated population dose for 100 years, i.e., it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

When added to the approximately 500 man-rem total body dose commitment for the balance of the fuel cycle, the overall estimated total body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000 MWe LWR is approximately 600 man-rem. Over this period of time, this dose is equivalent to 0.00002% of the natural background dose of about 3,000,000,000 man-rem to the U.S. population.*

The staff has considered health effects associated with the releases of radon-222, including both the short-term effects of mining, milling and active tailings and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. After completion of active mining, the staff has assumed that underground mines will be sealed with the result that releases of radon-222 from them will return to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore was produced from open-pit mines, releases from them would be 110 Ci/year per RRY. However, since the distribution of uranium ore reserves available by conventional mining methods is 66.8% underground and 33.2 open pit,[45] the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 0.332 x 110 or 37 Ci/year per RRY.

Based on the above, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37000 Ci per RRY, respectively. The total dose commitments for a 100-1000-year period would be as follows:

Time Span	Curies	Population Dose Commitments in Man-rem		
		Total Body	Bone	Lung (Bronchial Epithelium)
100 years	3,700	96	2,500	2,000
500 years	19,000	480	13,000	11,000
1,000 years	37,000	960	25,000	20,000

The above dose commitments represent a worst-case situation since no mitigating circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines and it is very probable that similar reclamation will be required for uranium open-pit mines. If so, long-term releases from such mines should approach background levels.

For long-term radon releases from stabilized tailings piles the staff has assumed that these tailings would emit, per RRY, 1 Ci/yr for 100 years, 10 Ci/yr for the next 400 years and 100 Ci/yr for periods beyond 500 years. With these assumptions, the cumulative radon-222 release from stabilized tailings piles per RRY will be 100 Ci in 100 years, 4,090 Ci in 500 years and 53,800 Ci in 1000 years.[46] The total body, bone and bronchial epithelium dose commitments for these periods are as follows:

Time Span	Curies	Population Dose Commitments in Man-rem		
		Total Body	Bone	Lung (Bronchial Epithelium)
100 years	100	2.6	68	56
500 years	4,090	110	2,800	2,300
1,000 years	53,800	1,400	37,000	30,000

Using risk estimators of 135, 6.9 and 22.2 cancer deaths per million man-rem for total body, bone and lung exposures, respectively, the estimated risk of cancer mortality due to mining, milling and active tailings emissions of radon-222 would be about 0.11 cancer fatalities per RRY. When the risk due to radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities is estimated over a 1000-year release period per RRY. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon induced cancer fatalities per RRY would range as follows:

*Based on an annual average natural background individual dose commitment of 100 mrem and a stabilized U.S. population of 300 million.

0.11-0.19 fatalities for a 100-year period
0.19-0.57 fatalities for a 500-year period
1.2 -2.0 fatalities for a 1000-year period.

To illustrate: A single model 1000 MWe LWR operating at an 80% capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 years, 5.7 and 17 in 500 years, and 36 in 60 in 1000 years as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP),[47] the average radon-222 concentration in air in the contiguous United States is about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 mrem. For a stabilized future U.S. population of 300 million, this represents a total lung dose commitment of 135 million man-rem per year. Using the same risk estimator of 22.2 lung cancer fatalities per million man-lung-rem used to predict cancer fatalities for the model 1000 MWe LWR, estimated lung cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year or 300,000 to 3,000,000 lung cancer deaths over periods of 100 and 1,000 years, respectively.

In addition to the radon-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that 0.08 to 0.12 additional cancer deaths may occur per RRY (assuming that no cure or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

The latter exposures can also be compared with those from naturally-occurring terrestrial and cosmic-ray sources. These average about 100 mrem. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million man-rem per year or 3 billion man-rem and 30 billion man-rem for periods of 100 and 1000 years, respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural background sources.

F. Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a Federal Repository, and that no release to the environment is associated with such disposal. NUREG-0116,[38] which provides background and context for the high-level and transuranic Table S-3 values established by the Commission, indicates that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is anticipated from such disposal.

G. Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000 MWe LWR is about 200 man-rem. The staff concludes that this occupational dose will not have a significant environmental impact.

H. Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small and is not considered significant in comparison to the natural background dose.

I. Fuel Cycle

The staff's analysis of the uranium fuel cycle did not depend on the selected fuel cycle (no recycle or uranium-only recycle), since the data provided in Table S-3 include maximum recycle option impact for each element of the fuel cycle. Thus, the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

5.6 SOCIOECONOMIC IMPACTS

Plant operation, which will reach full scale in 1980, will employ 200 operating personnel. The projected annual payroll for 1980 is $4.1 million in 1980 dollars.[30] It is expected that the residential distribution of operating personnel for the facility will be similar to that of the Watts Bar Steam Plant's 200 operating personnel with a projected minimum of 53% of the operating personnel residing within 20 miles of the site.[31] Affected communities will include Spring City (pop. 1,902), Dayton (pop. 4,278), Decatur (pop. 807), and Athens (pop. 12,685). It is improbable that there will be any significant population influx directly associated with operation, as many of the new jobs required in the operation and maintenance of the plant will be filled by persons already permanently residing in the area.

The communities which experienced population growth due to the construction of Watts Bar will see some decline in population as the construction phase nears completion. This will be most evident in areas with transient housing such as apartments and mobile home park development. According to one state official, local merchants are anticipating a decline in business activity due to construction wind down.[32] The exodus of construction labor will occur gradually over four years with the decline in population being offset by the inmovement of operating personnel, the increased industrialization and its associated populations, and the growth of small resorts in the area.

TVA projects expenditures of approximately $100,000 per year on purchases in the local area during operation. These expenditures will be widely dispersed and are not likely to have significant impact in any one area.

TVA average annual in-lieu-of-tax payments over the life of the plant are estimated to be $7 million. The State of Tennessee will receive an allocation of approximately $4.2 million annually from the total. An additional $4.9 million average annual total is estimated to accrue to state and local governments from tax and tax equivalent payments by local distributors of TVA power.[33]

Benefits accruing to the area from plant operation include the creation of 200 new permanent jobs with an average annual payroll of $4.2 million. There will be increased local personal income created by local spending by plant personnel. At least half the operating personnel are expected to live within a 20 mile radius of the facility. The local areas will benefit from the redistribution of a percentage of the $4.2 million annual in-lieu-of-tax payments allocated to Tennessee from the sale of electricity generated by the Watts Bar plant, in addition to tax and tax equivalent payments paid by distributors of TVA power to State and local governmental units which are approximately $4.9 million annually.

No significant adverse social or economic effects are anticipated from plant operations.

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34. Tennessee Valley Authority, Effects of Watts Bar Nuclear Plant and Watts Bar Steam Plant Discharges on Chickamauga Lake Water Temperature, WM28-1-85-00, Norris, Tennessee, February 1977, p. 30.

35. Op. Cit., Ref. 9, p. 1.1-13.

36. Op. Cit., Ref. 2, p. 4-18.

37. U.S. Atomic Energy Commission, Environmental Survey of the Uranium Fuel Cycle, WASH-1248, April 1974.

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43. U.S. Nuclear Regulatory Commission, In the Matter of Duke Power Company (Perkins Nuclear Station), Docket No. 50-488, Testimony of P. Magno, filed April 17, 1978.

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45. U.S. Department of Energy, Statistical Data of the Uranium Industry, GJO-100(78), January 1, 1978.

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47. National Council on Radiation Protection and Measurements, Publication 45, 1975.

6. ENVIRONMENTAL MONITORING

6.1 RÉSUMÉ

Preoperational and operational monitoring programs have been evaluated. The preoperational monitoring programs are discussed in Section 6.2 and include meteorology, NPDES related water quality studies, groundwater monitoring, terrestrial and aquatic ecological studies and radiological monitoring, which the applicant began conducting in December 1976. The operational monitoring programs are discussed in Section 6.3. The operational meteorological and radiological monitoring programs will be extensions of the preoperational programs. Limited operational water quality and effluent monitoring would be performed in conjunction with biological monitoring and NPDES permit requirements. The aquatic monitoring program will include baseline studies on adult fish populations in the vicinity of the site. The staff also requires additional ichthyoplankton data to provide an estimate of the annual variation in use of the Watts Bar Dam tailrace area by migratory spawners. Operational terrestrial monitoring will be required for three aspects of potential impact: cooling tower drift and plume interaction with Watts Bar Steam Plant; bird collisions with cooling towers; and maintenance of transmission lines.

6.2 PREOPERATIONAL MONITORING PROGRAMS

6.2.1 Preoperational Onsite Meteorological Program

In June 1971, a temporary 40-meter (130-foot) tower was installed about 800 meters (0.5 miles) west-southwest of the Unit 1 reactor building location at the Watts Bar site. Temperature, wind direction, and wind speed were measured at the 9-meter (30-foot) and 40-meter (130-foot) levels. In May 1973 the permanent onsite meteorological measurements tower became operational. Its location is about 800 meters (0.5 miles) south-southwest of the Unit 1 reactor building location. Wind speed and direction are measured at the 10-meter (33-foot), 46-meter (150-foot) and 91-meter (300-foot) levels. Temperature measurements are made at 1, 10, 46, and 91 meters (4, 33, 150, and 300 feet, respectively). Solar radiation, atmospheric pressure, and rainfall are measured at one meter (four feet). A dew point sensor is operational at the 10-meter (33-foot) level.[5] The current onsite meteorological program at the Watts Bar site meets the recommendations and intent of Regulatory Guide 1.23.

6.2.2 Preoperational Water Quality Studies

The preoperational monitoring program conducted by TVA gave adequate attention to water quality. Because of the limited impact of the station on water quality, extensive additional preoperational water quality studies should not be required, other than those routinely performed to support analysis of biotic sampling.

6.2.3 Preoperational Groundwater Monitoring

There were six preoperational groundwater monitoring wells tapping the Conasauga Shale Aquifer. The data collected from these wells are provided in Reference 2. These data confirm the applicant's statement in the construction permit stage Environmental Statement that the groundwater gradient slopes toward the Chickamauga Reservoir.

6.2.4 Preoperational Aquatic Biological Monitoring

The applicant's program for preoperational monitoring of aquatic biota (non-fish) was implemented in February 1973 and is scheduled for continuation through 1977. Results will be described in the applicant's preoperation report which is scheduled for completion three months before commercial operation. Baseline ichthyoplankton data have been collected during 1976 and 1977 with additional data to be obtained during the 1978 spawning season. Baseline monitoring of adult fish populations in the vicinity of the plant was initiated in March 1977 and will continue through March 1979.

This section addresses those elements of the program not previously described in Section 2.5.2 or Appendix C and concludes with the staff's evaluation of the overall program.

Periphyton

The periphyton community is sampled using artificial substrates, i.e., plexiglass plates, set for two 2-week colonization periods during the summer months. Sample treatment includes composition analysis and enumeration of periphytic algae (Average number of cells per cm^2 of slide). Additionally, the relative "health" of the community is analyzed in terms of the autotrophic index (AI):

$$AI = \frac{\text{Ash-free organic weight } (mg/m^2)}{\text{Chlorophyll } \underline{a} \ (mg/m^2)}$$

High values of AI indicate greater production by the heterotrophic component of the periphytic community, made up of bacteria, fungi, algae, protozoans, rotifers and other small animals. Lower values would indicate greater production by the autotrophic component, i.e., the algae. High values suggest that the total community is experiencing some level of stress (e.g., turbidity or toxicity).

Results for 1974 through 1976 indicate healthy autotrophic growth with Chrysophyta dominating the periphyton community in terms of number of genera for each sampling period and highest relative abundance for all but the Spring 1974 period. This program has been continued into 1977 with results to be incorporated in TVA's preoperational monitoring report.

Ichthyoplankton

Details and results of the site monitoring for ichthyoplankton during 1976 are described in Section 2.5.2 and Appendix C. For the 1977 spawning year, sampling was initiated approximately one week earlier, i.e., March 16, 1977 vs March 24, 1976. For 1978, sampling will begin around March 1 to insure the detection of any early spawning by tailwater species such as sauger.

In 1976 sampling design included biweekly collections from March 24 through September 9 with samples stratified by time of day (dawn, day, dusk, and night). For 1977-78, the frequency of collection has been revised to weekly from the date of initiation through the end of June and biweekly thereafter into September; stratification within the sampling day (24-hr) has been reduced from four to two strata, i.e., day and night.

Adult Fish

The following preoperational program has been initiated by TVA to verify the baseline condition of the fisheries resources.

1. Objectives and Scope

   The objective of this 2-year study (March 1977-March 1979) is to obtain baseline information on the adult fish populations in the vicinity of Watts Bar Nuclear Plant which is located in the tailwater of Watts Bar Dam. The program is designed to provide general population data on species composition, relative abundance, reproductive characteristics, and movement of dominant species in the affected area. A creel survey will provide additional information on the sport fish pressure and harvest in the area.

   It is anticipated that these data will verify the condition of the fisheries resources as discussed in the TVA Watts Bar Final Environmental Impact Statement. At present, no operational monitoring of thermal effects on fish populations is planned; however, this decision will be reviewed upon completion of the baseline monitoring program.

2. Description of Sampling Area

   The plant is located on the right bank of Chickamauga Reservoir (TRM 528) approximately two miles downstream from Watts Bar Dam. Two stations will be established. Station A is located at the plant site and will lie between TRM 527.4 and 528.4. The bottom substrate along the right bank of this station consists of washed sand with scattered stumps and constitutes a shallow to deep overbank area. The left bank substrate varies from mainly rock riprap in the upper reaches of the station to rock and coarse sand in lower portion.

Station B, located downstream of the plant, will extend from TRM 524.2 to TRM 524.9. The lower portion of the right bank consists of a sandy bottom with scattered stumps, and the water depth is shallow. The upper section of shoreline consists of a rocky bluff and deep water. The left bank has a washed sandy bottom with numerous tree stumps in the shallow areas and drops off quickly to a depth of approximately 12 m.

3. Methods and Procedure

Five fish sampling methods will be used to obtain data on adult fish populations (i.e., gill and hoop netting, electrofishing, shoreline seining, and creel survey). Rotenone samples will not be taken because suitable coves do not exist near the plant site.

a. Gill Netting

Experimental gill nets will be used to assess the spatial and temporal distributions of fish populations at the two sampling stations. The nets will be 37.9 m long by 2.4 m. deep and consist of five mesh-size panels. The mesh sizes will be 1.27 cm., 2.54 cm., 3.18 cm., 5.08 cm., and 6.55 cm. in consecutive order.

Gill nets will be set perpendicular to shore in pairs approximately 100 m. apart with the mesh sizes running in opposite directions. A pair will be set on each bank at both stations A and B and will be fished for a total of four nights every two months of the study period. The mesh size order of the nets will be reversed each time they are reset (once each 24-hour period). Information on the number of each species caught in each mesh size will be obtained. Length-weight and gonadal maturity stage of selected species (sauger, channel and blue catfish, white bass, white crappie, carp, and largemouth bass) will be recorded. Gonadal condition will be designated as immature, mature, ripe, or spent.

b. Hoop Nets

A maximum of four hoop nets per station (two on each bank) will be fished up to four nights on a bimonthly basis. The nets will have a mouth diameter of 1.19 m., length of 4.75 m., and a mesh size of .05 m. with seven hoops and two throats. The number of each species collected at each bank will be recorded. Also, lengths, weights, and maturity stage of selected species will be taken, as described above for gill netting.

c. Electrofishing

A boat-mounted electrofishing unit will also be used in determining the distribution of adult fish populations in the study area. Samples will be collected on both left and right banks of each station. Five, three-minute samples will be taken on each bank. Samples will always be taken in an upstream direction to maintain a relatively consistent amount of shoreline fished. Sampling will be conducted one day each month, and all fish collected will be identifed to species and enumerated. Length-weight and maturity data on the selected species will also be collected.

d. Shoreline Seining

Six to twelve seine hauls will be taken once each month. A 10.9 m. x 1.8 m. bag seine or a 3.6 m. x 1.2 m. minnow seine will be used. Hauls will be made in overbank areas and the mouths of streams located between TRM 524 and TRM 529. Fish will be identified to species and enumerated.

e. Sport Harvest of Fish

Primary creel information will be gathered by a full-time creel survey conducted by the Tennessee Wildlife Resources Agency on Chickamauga Reservoir. This information will be supplemented by a TVA creel clerk who will interview fishermen in the power plant area one day each week. These two sources of information will be combined to describe the sport fishery pressure and harvest in the Watts Bar Nuclear Plant area.

Staff Evaluation of Pre-Operation Program

The applicant's monitoring of the non-fish components of the aquatic biota will provide nearly five years of baseline data for comparison with operational data. The staff concludes that these data are adequate for detecting gross changes due to plant-induced stress, e.g., the localized change in abundance and species composition of phytoplankton (and possibly zooplankton) in the immediate diffuser mixing zone. The effect on the aquatic biota due to this stress has been judged insignificant. The selection of stations provides for comparison of upstream (control) with downstream (potentially stressed) during plant operation.

The applicant's monitoring of the ichthyoplankton will provide three years of baseline data on abundance and species composition. The 1977 ichthyoplankton data suggest that the 1976 year was not atypical with regard to tailrace spawning. Data for 1978 have been collected but are unavailable for staff review. These will be presented in the applicant's preoperational monitoring report.

The pre-operational monitoring of adult (and juvenile) fish will provide additional information on spawning activities through identification of gonadal condition for selected species, including both cold and warm water spawners. The scope and duration of this program should be sufficient to identify any unique characteristics of the fish community near the site.

6.2.5 Preoperational Terrestrial Monitoring

The staff requires a one year preoperational aerial remote survey using color infrared and/or multispectral or multiband photography.

6.2.6 Preoperational Radiological Monitoring

The applicant began conducting an offsite preoperational radiological monitoring program in December 1976 to provide for measurement of background radiation levels and radioactivity in the plant environs. The preoperational program, which is needed to obtain an effective operational radiological monitoring program, will also permit the applicant to train personnel and evaluate procedures, equipment, and techniques.

A summary description of the applicant's program is presented in Table 6.1. The program description is not intended to be a complete technical specification of the program; monitoring and analytical techniques are developing and are likely to improve before the program is put into effect. More detailed information on the applicant's radiological monitoring program is presented in Section 2.4 of the applicant's final environmental statement, construction permit stage.

6.3 OPERATIONAL MONITORING

6.3.1 Operational Onsite Meteorological Program

The onsite meteorological program will continue during the operation of the Watts Bar plant. Wind speed and direction measured at the 10-meter (33-foot) and 46-meter (150-foot) levels, vertical temperature gradient measured between these two levels and between 46 meters (150 feet) and 91 meters (300 feet), and 10-meter (33-foot) temperature and dew point measurements will be displayed in the reactor control room.[1]

6.3.2 Operational Water Quality Studies

Because of the limited impact of the station on water quality as indicated in Section 5.3, extensive operational water quality studies need not be conducted. Shortly after startup, TVA should collect enough data in the river to demonstrate that the diffuser performance meets design objectives as required in the NPDES permit. TVA should also provide a technical study that correlates operating experience with condenser tubes from Units 1 and 2 and demonstrates a sufficiently low corrosion/erosion rate to assure protection of aquatic organisms. This is also required by the NPDES permit.

Some water quality data must be collected in conjunction with biotic sampling. This may be limited to temperature, pH, dissolved oxygen, and suspended solids. EPA approved, with NRC concurrence, an operational monitoring program submitted by TVA.

TABLE 6.1

PREOPERATIONAL RADIOLOGICAL PROGRAM

Sample Type	Sampling Frequency	Sample Analysis
Air Filter	Continuous collection change filter weekly	Gross β and γ - isotopic analysis; Iodine from charcoal filter weekly
Rainwater	Composite monthly sample	Gross β and γ - isotopic analysis; Sr 89/90 and H-3 determination
Heavy Particle Fallout	Composite monthly sample	Gross β
Soil	Quarterly collection	Gross β and γ - isotopic analysis
Vegetation	Quarterly collection	Gross β, α, γ - isotopic analysis, and Sr 89/90 determination
Pasturage Grass	Monthly	Gross β, γ - isotopic, and Sr 89/90 determination
Milk	Monthly	γ - isotopic and Sr 89/90 determination
River Water	Monthly	Gross β, Gross α, γ - isotopic, and Sr/ 89/90 and H-3 determination
Well Water	Monthly	Gross β and γ - isotopic analysis
Public Water	Monthly	Gross β, γ - isotopic analysis, and H-3 determination
Food Crops	Twice each year	Gross β, γ - isotopic analysis, Sr 89/90 determination
Fish	Quarterly	Gross β, Gross α, γ - isotopic analysis, and Sr 89/90 determination
Sediment	Quarterly	Gross β, Gross α, γ - isotopic analysis, and Sr 89/90 determination
Plankton	Quarterly	Gross β, Gross α, γ - isotopic analysis, and Sr 89/90 determination
Benthos	Quarterly	Gross β, Gross α, γ - isotopic analysis, and Sr 89/90 determination

Based on Tables 2.4-4 & 2.4-6 of Applicant's Environmental Statement

6.3.3 Operational Groundwater Studies

The operational groundwater monitoring program will consist of samples taken from two wells tapping the Conasauga Shale Aquifer, one downgradient and one upgradient from the plant. The well downgradient from the plant will be equipped with an automatic sequential-type sampler from which a composite sample will be analyzed monthly for radioactivity. The well upgradient from the plant will be used as a control station, and at least one sample will be collected from it on a monthly basis. The final design of this operational monitoring program will be set forth in the Environmental Technical Specifications.

6.3.4 Operational Chemical Effluents Monitoring

The effluent monitoring requirements are specified in the NPDES permit (See Appendix E).

6.3.5 Operational Aquatic Biological Monitoring

The applicant has submitted to the EPA a conceptual operational monitoring plan for the non-fisheries aquatic biota and a proposed operational monitoring plan for impingement and entrainment of fishes.[3] The two plans include components, the details of which may be modified by the applicant upon completion of the pre-operational monitoring report. The detailed program will be subject to staff review prior to station operation and will be incorporated in the Environmental Technical Specifications (ETS), as applicable. It should be noted that the applicant's submittal responds both to the informational needs of the NRC and the EPA through that agency's NPDES permitting authority. To the extent that the applicant's operational monitoring plan as set forth in the NPDES permit satisfies NRC's information needs, such monitoring requirements will not be duplicated in the ETS. However, duplication in reporting of program results will likely be required.

The applicant's description of the operational monitoring plans follows:

> Section 316(b) Intake Evaluation - The 316 non-fisheries studies at Watts Bar Nuclear Plant will include monitoring of the phytoplankton and zooplankton communities during different hydrological flow regimes with special emphasis during the primary fish spawning period, April through June. The spatial distribution of the two plankton communities within the vicinity of the plant will be of primary concern. Such data should provide an estimation of that portion of the plankton communities being entrained in the condenser cooling waters, and consequently lost as both viable constituents of the reservoir biota and as an essential food resource to larval and other planktivorous fishes.
>
> Plankton sampling will be conducted along transects established both upstream from and in line with the intake basin. Simultaneous hydrological studies will determine the source of the water entering the condenser cooling water system. These studies will accurately define the effects of the intake structure on the phytoplankton and zooplankton communities.
>
> Bioaccumulation Studies - The accumulation or biomagnification of chemicals in the tissues of freshwater organisms represents an effective *in situ* method to evaluate the effect of an effluent on representative aquatic organisms. *Corbicula manilensis* (Asiatic clams) and/or other freshwater mussels will be placed in holding devices at appropriate stations upstream and downstream of Watts Bar Nuclear Plant. In addition, clams or mussels will be placed specifically within the area of defined mussel beds. After appropriate lengths of time the clams or mussels will be subsampled and the tissue will be analyzed for selected trace metals and other appropriate chemical parameters.
>
> This particular methodology was not part of the preoperational monitoring program; however, the lack of a data base will not impair the use of this method. The test organisms will be collected from a source population (i.e., a population with sufficient numbers to assure the use of a similar gene pool throughout the monitoring program) and the background levels will be determined. The incubation of the test organisms at the Watts Bar Stations will permit the exact exposure history to be known and, with appropriate control stations upstream of Watts Bar Nuclear Plant, parametric statistical techniques can be utilized to determine effects.

Supportive Water Quality Monitoring - Concentrations of selected trace metals in the water will be determined on a minimum basis to support bioaccumulation studies. Additional instream water quality monitoring is not contemplated, except for analyses which may be necessary to support ecosystem status biological monitoring.

Ecosystem Status - The use of cooling towers at Watts Bar Nuclear Plant reduces the environmental concern of thermal effects. The level of effort devoted to instream ecosystem studies during the pre-operational program is not justifiable in the operational phase. However, based on the analysis of the pre-operational monitoring data, "most sensitive" parameters, if they exist, may be identifiable. Based on this identification, an appropriate instream biological and associated water quality monitoring program would be implemented. This program would serve as an indicator of the ecosystem status which could be compared with the results of the pre-operational program.

Impingement - Fish impingement studies on the intake screens will commence when Watts Bar Nuclear Plant becomes operational. The number of fish impinged on each intake screen during a 24-hour period will be determined once each week. At the beginning of the test period, screens will be cleaned and at the end of the 24-hours, each of the screens will be individually washed. The impinged fish from each screen will be separated by species into 25 mm length classes. The total number and weight for each length class and species will then be determined.

Entrainment - To determine the spatial and temporal concentrations and distributions of ichthyoplankton in the vicinity of Watts Bar Nuclear Plant, samples will be taken along a transect adjacent to the intake at Tennessee River Mile 528.0. Full-stratum samples will be taken at five equidistantly spaced stations during both day and night. Sampling will begin on March 1 to assure monitoring of early spawners (e.g., *Stizostedion*). Samples will be taken weekly until the end of June when a biweekly schedule will be initiated.

All samples will be taken with an 0.5 m beam net (0.5 mm mesh) towed at 1.0 m/sec in an upstream direction. Flow is recorded with a General Oceanics large-vane flowmeter mounted in the net mouth. All tows are of 10 minutes duration and filter approximately 150 m^3 of water.

To determine levels of ichthyoplankton entrainment, intake sampling at other TVA plants has been accomplished using 0.5 m diameter stationary nets suspended in a 3 x 3 array in front of the intake structure. Unless an improved gear type or sampling design is developed, this method of intake sampling will be employed at Watts Bar Nuclear Plant. Sampling frequency will be the same as transect sampling and sample duration will be sufficient to filter approximately 150 m^3 of water through each net.

Staff Evaluation of Plans for Operational Monitoring of Aquatic Biota

The staff finds the applicant's conceptual plan for confirmatory operational monitoring to be responsive to its informational needs. Details of the plan will be established in the Environmental Technical Specifications after coordination with EPA.

6.3.6 Operational Terrestrial Monitoring

Monitoring of the terrestrial environment will be required for three aspects of potential impact. These are:

(1) effects of cooling tower drift and plume interactions;

(2) effects of bird collisions with the cooling tower; and

(3) maintenance of transmission lines.

6.3.6.1 Cooling Tower Drift and Plume Interaction

The applicant has committed to monitor the potential terrestrial effects of plume interaction and cooling tower drift from the Watts Bar Steam Plant operation and Watts Bar Nuclear Plant cooling towers. The proposed program is as follows:

During the growing season, at least three site visits will be made by qualified TVA personnel to inspect vegetation for any evidence of damage from acid mist and/or acid fly ash. Spring has been suggested as the optimum time for inspection.

The staff requires that a limited term aerial remote sensing program be undertaken as part of the applicant's proposed monitoring program. This program may use color infrared and/or multi-spectral or multiband photography. This combined program of aerial remote sensing and ground inspection on an annual basis for a limited term would be highly sensitive in the rapid detection of any terrestrial effects due to cooling tower drift or plume interactions.

6.3.6.2 Bird Collisions with Cooling Towers

The staff requires a bird monitoring program be designed to detect and report serious episodes of bird collisions as contrasted with occasional random collisions. The staff recommends a limited term monitoring program during migratory periods capable of reporting unusual and important episodes of massive bird collisions.

6.3.6.3 Transmission Lines

The applicant is required to submit an annual report on its program for chemical control of vegetation on transmission line rights-of-way. This report may be submitted in a format similar to Appendix C of the Volunteer FES.[4]

6.3.7 Operational Radiological Monitoring

The operational offsite radiological monitoring program is conducted to measure radiation levels and radioactivity in plant environs. The program assists and provides backup support to the detailed effluent monitoring (as required by Regulatory Guide 1.21) which is needed to evaluate individual and population exposures and verify projected or anticipated radioactivity concentrations.

The applicant plans essentially to continue the proposed preoperational program during the operating period, with the exception of a few modifications or additions. Further changes in the program may be made as necessary to reflect changes in land use or preoperational experience.

Review of the proposed environmental radiological monitoring program by the staff will continue during the preoperational phase and the details of the required monitoring program will be incorporated into the Environmental Technical Specifications included as part of the operating license.

REFERENCES FOR SECTION 6

1. Tennessee Valley Authority, "Watts Bar Final Safety Evaluation Report", U.S. Nuclear Regulatory Commission, Docket Nos. 50-390/391, 1976.

2. Enclosure 2 to letter from J. E. Gilleland (TVA) to Director of Nuclear Reactor Regulation, NRC, dated July 1, 1977.

3. Tennessee Valley Authority letter from P. Krenkel to C. Kaplan, (USEPA, Atlanta, Georgia) dated August 31, 1977, Enclosures 1 & 3.

4. Tennessee Valley Authority, Final Environmental Statement, Volunteer, Tennessee - 500kv Substation and Transmission Line Connections, July 6, 1976, Appendix C.

5. Tennessee Valley Authority, "Enclosure II - TVA Comments on Specific Descriptions in the NRC Staff DES" of July 31, 1978 memorandum from J. Gilleland to D. Muller.

7. REALISTIC ACCIDENT ANALYSIS

7.1 RESUME

The realistic accident analysis has been updated from that presented in the FES-CP using new projected population figures to the year 2020.

7.2 ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Watts Bar Unit Nos. 1 and 2 will be provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as is considered in the Commission's Safety Evaluation. System transients that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, even though they may be extremely unlikely; and engineered safety features will be installed to mitigate the consequences of those postulated events which are judged credible.

The probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. For site evaluation in our safety review, extremely conservative assumptions are used for the purpose of comparing calculated doses resulting from a hypothetical release of fission products from the fuel against the 10 CFR Part 100 siting guidelines. Realistically computed doses that would be received by the population and environment from the accidents which are postulated are significantly less than those presented in the Safety Evaluation Report.

The Commission issued guidance to applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits.

The applicant's information has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate and those on the low potential consequence end have a higher occurrence rate. The examples selected by the applicant for these cases are shown in Table 7.1. These examples are reasonably homogeneous in terms of probability within each class.

Our estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 7.2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 7.2. The man-rem estimate was based on the projected population within 50 miles of the site for the year 2020.

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operations; and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; but events of this type could occur sometime during the 40-year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighted by probabilities, the environmental risk is very low.

The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protective systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued

TABLE 7.1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	NRC Description	Applicant's Examples
1.	Trivial incidents	Under routine releases.
2.	Small releases outside containment	Under routine releases.
3.	Radioactive waste system failure	Leakage from waste gas tank, radwaste secondary tank leakage, release of waste gas tank contents, and release of radwaste secondary tank contents.
4.	Fission products to primary system (BWR)	Not applicable.
5.	Fission products to primary and secondary systems (PWR)	Off-design transients that induce fuel failure above those expected with steam generator tube leak and steam generator tube rupture.
6.	Refueling accident	Fuel assembly drop and heavy object drop onto fuel in core.
7.	Spent fuel handling accident	Fuel assembly drop in fuel storage pool, heavy object drop onto fuel rack, and fuel cask drop.
8.	Accident initiation events considered in design basis evaluation in the Safety Analysis Report	Reactor coolant system pipe breaks, rod ejection accident, and steam line breaks outside containment.
9.	Hypothetical sequence of failures more severe than Class 8	Not evaluated.

TABLE 7.2

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS[1]/

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[2]/	Estimated Dose to Poulation in 50-Mile Radius, Man-Rem
1.0	Trivial incidents	3/	3/
2.0	Small releases outside containment	3/	3/
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.006	0.52
3.2	Release of waste gas storage tank contents	0.024	0.06
3.3	Release of liquid waste storage contents	0.002	0.215
4.0	Fission products to primary system (BWR)	N.A.	N.A.
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	3/	3/
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.004	0.040
5.3	Steam generator tube rupture	0.028	2.38
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.004	0.32
6.2	Heavy object drop onto fuel in core	0.065	5.25
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	0.001	0.08
7.2	Heavy object drop onto fuel rack	0.061	0.34
7.3	Fuel cask drop	0.061	5.15

TABLE 7.2 (Cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[2]/	Estimated Dose to Poulation in 50-Mile Radius, Man-Rem
8.0	Accident initiation events considered in design basis evaluation in the SAR		
8.1	Loss-of-coolant accidents		
	Small break	0.002	0.32
	Large break	0.057	27.39
8.1(a)	Break in instrument line from primary system that penetrates the containment	N.A.	N.A.
8.2(a)	Rod ejection accident (PWR)		
8.2 (b)	Rod drop accident (BWR)	N.A.	N.A.
8.3(a)	Steamline breaks (PWRs outside containment)		
	Small break	0.0001	0.012
	Large break	0.0003	0.024
8.3(b)	Steamline break	N.A.	N.A.

1/ The doses calculated as consequences of the postulated accidents are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. Our evaluation of the accident doses assumes that the applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to a liquid release incident detected by in-plant monitoring) would detect the presence of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure from other potential pathways to man.

2/ Represents the calculated fraction of a whole body dose of 500 mrem, or the equivalent dose to an organ.

3/ These radionuclides released are considered in developing the gaseous and liquid source terms presented in Section 3 and are included in the doses in Section 5.

surveillance and testing, and conservative design are all applied to provide and maintain a high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

The NRC has performed a study to assess more quantitatively these risks. The initial results of these efforts were made available for comment in draft form on August 20, 1974[1] and related in final form on October 30, 1975.[2] This study, called the Reactor Safety Study, is an effort to develop realistic data on the probabilities and consequences of accidents in water-cooled power reactors, in order to improve the quantification of available knowledge related to nuclear reactor accident probabilities. The NRC organized a special group of about 50 specialists under the direction of Professor Norman Rasmussen of MIT to conduct the study. The scope of the study has been discussed with EPA and described in correspondence with EPA which has been placed in the NRC Public Document Room (letter, Doub to Dominick, dated June 5, 1973).

As with all new information developed which might have an effect on the health and safety of the public, the results of these studies will be assessed within the Regulatory process on generic or specific bases as may be warranted.

Table 7.2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary which are less than or comparable to those which would result from a year's exposure to the maximum permissible concentration (MPC) of 10 CFR Part 20. The table also shows the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident. Any of these integrated exposures would be much smaller than that from naturally occurring radioactivity. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small and need not be considered further.

REFERENCES FOR SECTION 7

1. "Reactor Safety Study: An Assessment of Accident Risks in Nuclear Power Plants, Draft," WASH-1400, August 1974.

2. "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," WASH-1400 (NUREG-75/014), October 1975.

8. CONSEQUENCES OF THE PROPOSED ACTION

8.1 ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

The staff has assessed the physical, social and economic impacts that can be attributed to the Watts Bar Nuclear Plant. Inasmuch as the facility is currently under construction, many of the predicted and expected adverse impacts of the construction phase are evident. The TVA has committed to a program of restoration and redress of the station site that will begin at the termination of the construction period. The staff has not identified any additional adverse effects that will be caused by operation of the station. Consequently, the operation phase of the plant will consist of restoration and maintenance with the possibility of enhancing the environs as they existed prior to construction.

8.2 SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The staff has reevaluated the assessment (FES-CP) of the use of land for the site of the Watts Bar Nuclear Plant and associated transmission lines and finds that with the exception of the reduced land requirements and environmental impacts related to the new Watts Bar-Volunteer 500kV line, there have been no changes since the issuance of the FES-CP. The presence of this plant in Rhea County, Tennessee will continue to influence the future use of other land in its immediate environs as well as the continued removal of county land from agricultural use as the result of any increased industrialization.

8.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The staff has evaluated the earlier assessment of this impact and concludes that there has been no change except for the continuing escalation of costs which have increased the dollar values of the materials used for constructing and fueling the station.

Uranium is the principal natural resource irretrievably consumed in facility operation. Other materials consumed, for practical purposes, are fuel-cladding materials, reactor-control elements, other replaceable reactor core components, chemicals used in processes such as water treatment and ion-exchanger regeneration, ion-exchange resins, and minor quantities of materials used in maintenance and operation. Except for the uranium isotopes U-235 and U-238, the consumed resource materials have wide-spread usage; therefore, their use in the proposed operation must be reasonable with respect to needs in other industries. The major use of the natural isotopes of uranium is for production of useful energy.[1]

In view of limited demand in the alternative uses, quantities of materials in natural reserves, resources, and stockpile, the expenditures of such material for the power facility are justified by the benefits from the electrical energy produced.

8.4 DECOMMISSIONING AND LAND USE

A license to operate a nuclear power plant is issued for a period of forty years, beginning with the issuance of the construction permit. At the end of the 40-year period the operator of a nuclear power plant must renew the license for another time period or apply for termination of the license and for authority to dismantle the facility and dispose of its components.[3] If, prior to the expiration of the operating license, technical, economic or other factors are unfavorable to continued operation of the plant, the operator may elect to apply for license termination and dismantle authority at that time. In addition, at the time of applying for a license to operate a nuclear power plant, the applicant must show that he possesses "or has reasonable assurance of obtaining the funds necessary to cover the estimated costs of permanently shutting the facility down and maintaining it in a safe condition."[4] These activities, termination of operation and plant dismantling, are generally referred to as "decommissioning."

NRC regulations do not require the applicant to submit decommissioning plans at the time the construction permit and operating license is obtained, consequently, no definite plan for the decommissioning of the station has been developed. At the end of the station's useful lifetime, the applicant will prepare a proposed decommissioning plan for review by the Nuclear Regulatory Commission. The plan will comply with NRC rules and regulations then in effect.

The decommissioning of reactors is not new. Since 1960, five licensed nuclear plants, four demonstration nuclear power plants, six licensed test reactors, 28 licensed research and 22 licensed critical facilities have been or are in the process of being decommissioned.[5] The primary method of decommissioning consists of mothballing, entombing, dismantling, or a combination of these three alternatives. The three primary methods are defined below in terms of the definitions provided in Regulatory Guide 1.86.[6]

Mothballing is the process of placing a facility in a nonoperating status. The reactor may be left intact except that all reactor fuel, radioactive fluids and nonfixed radioactive wastes such as ion exchange resins, contaminated scrap materials and contaminated chemicals are removed. The existing license is amended to a "possession only" status and continues in effect until residual radioactivity decays to levels acceptable for release to unrestricted access or until residual radioactivity is removed. The "possession only" license is a reactor facility license that permits a licensee to possess the facility but prohibits operation of the facility as a nuclear reactor.

Entombment consists of removing all fuel assemblies, radioactive fluids and wastes followed by the sealing of remaining radioactive material within a structure integral with the biological shield or by some other method to prevent unauthorized access into radiation areas. A program of inspection, facility radiation surveys and environmental sampling is required for a licensed facility that has been entombed.

Dismantling is defined as removal of all fuel, radioactive fluids and waste, and all radioactive structures. Surface contamination levels have been established in Table 1 of Regulatory Guide 1.86 which must be met prior to termination of the facility license. In addition to meeting the surface contamination levels, the acceptability of the presence of materials which have been made radioactive by neutron activation would be evaluated on a case-by-case basis prior to termination of the license. If the facility owner so desires, the remainder of the reactor facility may be dismantled and all vestiges removed and disposed of.

For a single nuclear reactor, the mothballing alternative costs about $2.45 million initially plus an annual maintenance and surveillance cost of $167,000. If a 24-hour manned security force is not required (e.g., a site with continuing operations) the annual cost could be reduced to $88,000. Translating these costs into unit cost of generating electricity, the 30-year levelized unit cost* would be about 0.04 mills/KWh and if a manned security force is not required, about 0.03 mills/KWh.[7]

The entombing alternative costs about $7.58 million initially for a single unit facility plus an annual maintenance and surveillance cost of $58,000 for the duration of the entombment period.[7] These costs, when translated to a 30-year levelized unit cost* bases, amount to about 0.06 mills/KWh.

The dismantling alternative for a single nuclear power reactor costs about $26.3 million to remove the radioactive structures associated with NRC requirements for terminating a possession only license. An additional $4.8 million would be needed to remove the nonradioactive structures (cooling towers, administrative buildings, etc.) to below grade.[7] There are no annual costs associated with this alternative. When the dismantling costs are translated to a 30-year levelized unit cost* bases, this amounts to about 0.18 mills/KWh.

Combinations of mothballing and delayed (about 100 years) dismantling have 30-year levelized unit costs that are about the same as the mothballing alternative costs. Likewise, the costs for the entombing delayed dismantling combinations are about the same as the entombing cost. In both instances the annual maintenance cost for mothballing and entombing alternatives, on a present value basis, is sufficient to cover all the delayed dismantling cost for the mothballing alternative and about 80% for the entombing alternative.

Although the above costs are for a one-unit station, the savings associated with multi-unit stations are small, thus the unit cost (mills/KWh) is essentially the same for a single unit station or multi-unit station. For the Watts Bar Nuclear Plant, the decommissioning costs would be about double that indicated above for all of the decommissioning one-unit alternatives.

Studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts.[7]

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*Based on a 1200 MWe generating unit beginning operation in 1978, a capacity factor of 60%, an escalation rate of 5%, and a discount rate of 10%.

Also, studies indicate that occupational radiation doses can be controlled to levels comparable to occupational doses experienced with operating reactors through the use of appropriate work procedures, shielding and remotely controlled equipment.[7]

The applicant may retain the site for power generation purposes indefinitely after the useful life of the station. The degree of dismantlement would be determined by an economic and environmental study involving the value of the land and crop value versus the complete demolition and removal of the complex. In any event, the operation will be controlled by rules and regulations in effect at the time to protect the health and safety of the public.

Units 1 and 2 of the Watts Bar Nuclear Plant are designed to operate for about 30 years, and the end of their useful life will be approximately in the year 2011. The applicant has made no firm plans for decommissioning, but assumes that the following steps would be taken as minimum precautions for maintaining a safe condition.

1. All fuel would be removed from the facility and shipped offsite for disposition.

2. All radioactive wastes -- solid, liquid, and gas -- would be packaged and removed from the site insofar as practical.

A decision as to whether the station would be further dismantled would require an economic study involving the value of the land and scrap value versus the cost of complete demolition and removal of the complex. However, no additional work would be done unless it is in accordance with rules and regulations in effect at the time.

In addition to personnel required to guard and secure the station, concrete and steel would be used to prevent ingress into any building, particularly the radioactive areas.

REFERENCES FOR SECTION 8

1. U.S. Atomic Energy Commission, "Survey of U.S. Uranium Marketing Activity," Report WASH-1196 (74), April 1974.

2. U.S. Nuclear Regulatory Commission, Rules and Regulations, 10 CFR 50, "Licensing of Production and Utilization Facilities," §50-51, "Duration of License, Renewal."

3. Ibid., §50-82, "Applications for Termination of Licenses."

4. Ibid., §50-33, "Contents of Applications; General Information."

5. Erickson, P. B., and G. Lear, "Decommissioning and Decontamination of Licensed Reactors Facilities and Demonstration Nuclear Power Plants" presented at Conference on Decontamination and Decommissioning in Idaho Falls, Idaho, August 19-21, 1975.

6. Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." USNRC, Washington, D.C.

7. "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives," Atomic Industrial Forum, Inc. AIF/NESP-009.

9. NEED FOR PLANT

9.1 RÉSUMÉ

When the FES-CP was issued, in November of 1972, Watts Bar Units 1 and 2 were scheduled to begin operation in May 1977 and February 1978. At the time of the FES-CP, the plant was needed to meet the projected winter 1977-78 peak demand. Since 1972, the occurrence of several unforeseeable events has led to a decline in the growth of electrical energy and peak demands in the nation. The TVA service area is not expected to maintain the historical rates experienced prior to the 1973 Arab oil embargo. Currently, TVA is projecting a 1978-79 winter peak demand of 23,950 MW - a 17% reduction from the 1972 forecast of 28,800 MW. In addition, construction delays have occurred such that Watts Bar Units 1 and 2 have been rescheduled to begin operation in December 1979 and September 1980, respectively.

9.2 APPLICANT'S SERVICE AREA AND REGIONAL RELATIONSHIPS

TVA supplies the electric power needs of an 80,000 square mile area covering practically all of Tennessee (principal exception being Kingsport), portions of Southwestern Kentucky, Northeastern Mississippi, Northern Alabama and Georgia, and small sections of North Carolina and Virginia. This service area has a total population of about 6.7 million. The major load centers on the TVA system are Memphis, Nashville, Columbia, Chattanooga, Knoxville - all in Tennessee - and Paducah, Kentucky, and Huntsville, Alabama.

TVA is primarily a wholesaler of electric power to three major groups of customers: (1) municipal electric systems and rural electric cooperatives, (2) directly-served industries, and (3) directly-served Federal agencies. TVA is not a member of any power pool. However, TVA is a winter-peaking system involved in diversity interchange agreements which allow exchange of power with summer-peaking systems such as Mississippi Power and Light. TVA is a member of the Southeastern Electric Reliability Council (SERC), which is one of the nine members of the National Electric Reliability Council (NERC).

9.3 BENEFITS OF OPERATING THE PLANT

The Watts Bar Nuclear Plant, Units 1 and 2, is being constructed for the purpose of assuring an adequate and low cost supply of electrical energy for the TVA service area needs. At the operation stage, the plant will serve to (1) increase total system generating capacity in order to meet increased system electrical demands, and (2) meet increased system electrical demands in a least cost way. At the operating stage, consideration of alternatives only involves the decision whether the plant should operate or not. This decision is based on a weighing of the benefits of operation, and environmental impacts (costs) and operating (production) costs. Even in the absence of demand growth, there are significant cost savings to be realized by bringing the Watts Bar units on-line as scheduled. No other alternatives other than to operate or not to operate the plant exist, and thus no other alternatives are considered.

9.3.1 Minimization of Production Costs

The TVA has estimated the total system production costs with and without the Watts Bar units, assuming zero load growth from fiscal year 1976. The analysis for the year 1981 is presented in Table 9.1. For the worst case assumption of zero load growth, significant cost savings will be realized by bringing the plant on-line as scheduled. With zero load growth, the applicant estimates that the 1981 annual production cost savings with the Watts Bar units on-line will amount to $145 million. The staff estimates that this savings is equivalent to approximately 1.26 mills/kWh for a 1981 production of 114 billion kWh. For the projected growth in energy between now and 1981, the cost savings would be even larger because it would permit phasing out even more costly units.

The production cost savings realized by bringing the Watts Bar units on-line derive from the fact that these units are relatively efficient low cost units which would serve the base load. Only Browns Ferry Units 1 and 2, and approximately 3900 MW of hydro capacity would have lower operating costs than the Watts Bar units.[2] Without Watts Bar, a less efficient and more costly mix of generating capacity would have to be relied on to meet the TVA's service area needs. This more expensive mode of generating electricity without Watts Bar is reflected in the analysis presented above and in Table 9.1.

9.3.2 Energy Demand

Although savings in system production costs are a sufficient basis to justify the operation of Watts Bar in the absence of any countervailing impacts, the plant will also be required to meet the expected load growth and provide for an adequate level of system reliability.

Table 9.2 shows the TVA's most recent forecasts of energy and peak demand from 1980 to 1983. Energy requirements and TVA peak load are projected to grow at average annual compound rates of 6.0 and 5.5%, respectively, through the period 1976-1983 (compounded from a 1976 total system energy of 113,641 million kWh and peak load of 20,381 MW).[3] In its forecasts, the TVA has considered, among other things, the likely effects which energy conservation and substitution of alternate energy sources and forms will have on forecasts of energy and peak system demand. Some of the specific phenomena and efforts analyzed by the TVA are as follows: price conservation; nonprice conservation effects due to insulation programs and appliance energy efficiency targets; effects of more stringent environmental regulations; effects of a decreasing availability of natural gas; and the effects of a direct substitution of electricity for other fossil fuels.[1]

Table 9.2 also shows the annual dependable system capacity (Watts Bar included) and corresponding reserve margins projected to be on-line at the time of the TVA system peak load. Reserve margins with the Watts Bar units operating are slightly above or within the FPC's minimum reliability range of 15 to 25 percent through 1983. Without the Watts Bar units, reserve margins would fall to unacceptably low levels by 1983 as shown in Table 9.2. Therefore, the Watts Bar Nuclear Plant is required to meet demand as well as to assure an adequate and low cost supply of electrical energy for the TVA service area needs.

TABLE 9.1

COMPARISON OF 1981 SYSTEM PRODUCTION COSTS WITH AND WITHOUT WATTS BAR NUCLEAR PLANT[a]

	With Watts Bar	Without Watts Bar
ASSUMING ZERO LOAD GROWTH		
Total energy production, millions of kWh[b]	114,415	114,415
Estimated system production costs[c]		
Millions of dollars	780	925
Mills per kWh	6.82	8.08
1981 production cost savings with Watts Bar	$145 million (1.26 mills/kWh)	

a. Supplement 2 to Watts Bar Nuclear Plant Environmental Information, unless indicated otherwise.

b. Phipps Bend Nuclear Plant, Units 1 and 2, ER Revision 5, STN 50-553, 50-554.

c. Includes fuel, operation and maintenance expenses.

TABLE 9.2

Forecasted Energy, Peak Demand, Capacity, and Reserve Margins
For the TVA System, 1980-1983

Year	Energy (Millions of kWh)	Peak Load (MW)	Interchange Agreement (MW)	Peak Load[a] Responsibility (MW)	Dependable Capacity (MW)	Reserve Margin %	
						With Watts Bar	Without Watts Bar
1980	148,860	25,350	1580	23,770	31,044[b]	30.6	25.6
1981	154,950	26,650	1100	25,550	33,434[c]	30.8	21.6
1982	162,390	28,100	1100	27,000	34,647	28.3	19.6
1983	170,480	29,650	1100	28,550	34,647	21.3	13.1

[a]Peaks occur in winter months, e.g., 1980 peak occurs in the winter of 1979-80.

[b]Includes Watts Bar Unit 1 (1177 MW) scheduled for December 1979.

[c]Includes Watts Bar Unit 2 (1177 MWe) scheduled for September 1980.

SOURCE: U.S. Nuclear Regulatory Commission, Final Environmental Statement Related to Construction of Yellow Creek Nuclear Plant, Units 1 and 2, November 1977.

REFERENCES FOR SECTION 9

1. Tennessee Valley Authority, Watts Bar Nuclear Plant Environmental Information, Supplement 2.
2. Ibid.
3. U. S. Nuclear Regulatory Commission, Final Environmental Statement Related to Construction of Yellow Creek Nuclear Plant, Units 1 and 2, Washington, D.C., November 1977.

10. BENEFIT-COST ANALYSIS

10.1 RESUME

The following sections summarize the economic, environmental, and social benefits and costs associated with the operation of Watts Bar Units 1 and 2. Table 10.1 summarizes all benefits and costs of plant operation. Reduced generating costs are presented for the no load growth situation. The environmental costs are calculated for an assumed worst case situation.

10.2 BENEFITS

10.2.1 Primary Benefits

The direct benefits of the plant include the approximately 12 to 14 billion kWh of electrical power the plant will produce on an annual basis (assuming a plant capacity factor of between 60% and 70%), the increase in system reliability brought about by the addition of 2354 MW of generating capacity to the TVA system, and the saving at a minimum of $145 million in annual production costs in 1981 and subsequent years.

10.2.2 Other Benefits

This enumeration is for informational purposes. Operation of the Watts Bar Plant will require 200 full time operating personnel. The projected annual payroll for 1980 is $4,200,000. During operation, TVA projects expenditures of approximately $100,000 per year on purchases in the local area.

The TVA annual average in-lieu-of-tax payments over the estimated life of the plant is presently estimated to be $7,000,000. Of that, approximately $4,200,000 is expected to be allocated to the State of Tennessee; the remaining portion being allocated to six other states. In addition to payments made by the TVA, the local distributors of TVA power are estimated to make average annual tax and tax equivalent payments of $4,900,000. These monies will be allocated to State and local units of government.

10.3 SOCIETAL COSTS

No significant socio-economic costs are expected from either station operation or station personnel and their families living in the area.

10.4 ECONOMIC COSTS

The capital cost for the completion of Watts Bar Units 1 and 2 is presently estimated to be $985 million. Fuel costs for the first full year of operation of Unit 1 are estimated to be $28 million or 3.8 mills/kWh; Unit 2 fuel costs are estimated to be $30 million or 3.9 mills/kWh for the first year of operation. Total present value fuel costs for the Watts Bar Plant are approximately $790 million. The annualized cost over 30 years would be approximately $84 million. Decommissioning costs for the complete restoration of the site are estimated to be $59 million (1975 dollars).

10.5 ENVIRONMENTAL COSTS

The environmental cost of land use, water use and biological effects previously evaluated have not increased or otherwise adversely changed. The applicant has revised the transmission line route for the Watts Bar-Volunteer 500 kV line, resulting in a reduction of required acreage for rights-of-way of 1,157 acres. Also, the applicant has redesigned and relocated the discharge structure for the cooling tower blowdown, to lessen any impact on the Chickamauga Reservoir.

TABLE 10.1

BENEFIT-COST SUMMARY

Primary impact and population or resource affected	Unit measure	Magnitude of Impact
	Direct Benefits	
Energy	Kwh/yr x 10^6	14,000
Capacity	Kw x 10^3	2354
Reduced generating costs (1981) (assuming no load growth)	$/year	145,000,000
	Indirect Benefits*	
1. Taxes:		
1.1 TVA	$/year	7,000,000
1.2 Local Distributors	$/year	4,900,000
2. Employment:		
2.1 New jobs, annual operation	number	200
2.2 New income, annual operation	$/year (1980)	4,200,000
	Economic Costs	
Operating:		
Fuel	annual$/year	58,000,000
Operation & Maintenance	annual$/year	13,000,000
		71,000,000
Decommissioning	$ (1975)	59,000,000

TABLE 10.1 (Continued)

BENEFIT-COST SUMMARY

Primary impact and population or resource affected	Unit measure	Magnitude of Impact
	Environmental Costs	
1. Impact on water		
1.1 Consumption	m^3/year	45,000,000
1.2 Heat discharge to natural water body		
1.2.1 Cooling capacity of water body	BTU/hr	2.9×10^8 (maximum)
1.2.2 Aquatic biota		Insignificant
1.2.3 Migratory fish		Insignificant
1.3 Chemical discharge to natural water body		
1.3.1 People		Not discernible
1.3.2 Aquatic Biota		Not discernible
1.3.3 Water quality		Not discernible
1.3.4 Chemical discharge	Kilograms/year	780,000
1.4 Radionuclide contamination of natural surface water body (all except tritium)	Ci/yr/reactor	0.22
	tritium	520

TABLE 10.1 (Continued)

BENEFIT-COST SUMMARY

Primary impact and population or resource affected	Unit measure	Magnitude of Impact
1.5 Chemical contamination of groundwater		
1.5.1 People		Not discernible
1.5.2 Plants		Not discernible
1.6 Radionuclide contamination of groundwater		
1.6.1 People		Not discernible
1.6.2 Plants and animals		Not discernible
1.7 Raising/lowering of groundwater levels		
1.7.1 People		Not discernible
1.7.2 Plants		Not discernible
1.8 Effects on natural water body of intake structure and condenser cooling systems		
1.8.1 Primary producers and consumers		Negligible
1.8.2 Fisheries		Insignificant

TABLE 10.1 (Continued)

BENEFIT-COST SUMMARY

Primary impact and population or resource affected	Unit measure	Magnitude of Impact
1.9 Natural water drainage		
1.9.1 Flood control		No damage
1.9.2 Erosion control		Insignificant
2. Impact on air		
2.1 Chemical discharge to ambient air		
2.1.1 Air quality, chemical		
2.1.1.1 CO_2	lb/yr	None
2.1.1.2 SO_2	lb/yr	None
2.1.1.3 NO_x	lb/yr	None
2.1.1.4 Particulates	lb/yr	None
2.1.1.5 Other	lb/yr	None
2.1.2 Air quality, odor		None
2.2 Radionuclides discharged to ambient air.		
2.2.1 Noble gases	Ci/yr/reactor	7020

TABLE 10.1 (Continued)

BENEFIT-COST SUMMARY

Primary impact and population or resource affected	Unit measure	Magnitude of Impact
2.2.2 Radioiodines	Ci/yr/reactor	0.104
2.2.3 Particulates	Ci/yr/reactor	0.104
2.2.4 Carbon-14	Ci/yr/reactor	8
2.2.5 Tritium	Ci/yr/reactor	920
2.3 Fogging and icing		
2.3.1 Ground transportation		Negligible
2.3.2 Air transportation		None
2.3.3 Water transportation		Neglibible
2.3.4 Plants		Negligible
2.4 Salt discharge from cooling system		
2.4.1 People		Negligible
2.4.2 Plants	Kg/ha/yr	10.0
2.4.3 Property		Not discernible

TABLE 10.1 (Continued)

BENEFIT-COST SUMMARY

Primary impact and population or resource affected	Unit measure	Magnitude of Impact
3. Total body dose commitments to U.S. population		
General public, unrestricted area	man-rem/yr	65
Societal Costs		
1. Operational fuel disposition		
1.1 Fuel transport (new)	trucks/yr	10
1.2 Fuel storage		Inbuilding storage
1.3 Waste products (spent fuel)	rail shipments/yr	13
2. Plant labor force	200	No significant societal costs are anticipated
3. Historical and Archaeological Sites		No effect

*This enumeration is for informational purposes.

The design of the radioactive waste systems has been finalized. Under normal operation, the station will be in conformance with Appendix I to 10 CFR 50 and discharge annually a total of 1040 curies of tritium and 0.44 curies of all other radionuclides to the Chickamauga Reservoir. The station will also discharge annually approximately 1040 curies of noble gases, 0.2 curies of radioiodines, 0.2 curies of radioactive particulates, 16 curies of carbon-14 and 1840 curies of tritium into the atmosphere surrounding the Watts Bar facility. These effluents will result in a total body dose commitment to the general public of the U.S. population in the unrestricted area of 65 man-rem per year. This dose commitment will have no discernible effect on the population.

Chemical usage will result in a discharge into the Chickamauga Reservoir of a maximum of 780,000 kilograms per year of chemicals. This discharge should not result in any adverse effects to the environment.

The heat discharge system will result in a total water consumption of 45,000,000 cubic meters a year from evaporation and other uses. A maximum of 2.9 x 10^8 Btu/hr will be rejected from the reactors as heat into the Chickamauga Reservoir.

10.6 ENVIRONMENTAL COSTS OF THE URANIUM FUEL CYCLE

The contribution of environmental effects associated with the uranium fuel cycle is indicated in Table 5.10 and described in Section 5.5.3. The staff has evaluated the environmental impacts of the fuel cycle releases presented in Table 5.10 and has found these impacts to be sufficiently small so that, when they are superimposed upon the other environmental impacts assessed with respect to the construction and operation of the plant, they do not affect the benefit-cost balance.

10.7 ENVIRONMENTAL COSTS OF URANIUM FUEL TRANSPORTATION

The contribution of environmental effects associated with the transportation of fuel and waste to and from the facility are summarized in Section 5.5.1 and Table 5.8. These effects are sufficiently small as not to affect the benefit-cost balance.

10.8 SUMMARY OF BENEFIT-COST

As a result of the analysis and review of potential environmental, technical, economic, and social impacts, the staff has been able to forecast more accurately the effects of the station's operation. No new information has been acquired that would alter the overall balancing of the benefits of this station versus the environmental costs. Consequently, the staff has determined that it is possible to operate the station with only minimal environmental impacts. The staff finds that the primary benefits of providing 2354 MW of electrical energy, minimizing system production costs and increasing system reliability through the addition of 2354 MW base-load capacity greatly outweigh the environmental, social, technical, and economic costs. Benefit-costs are summarized in Table 10.1, which is explained in Appendix D.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR Part 51, the Draft Environmental Statement for the Watts Bar Nuclear Plant, Units 1 and 2, was transmitted, with a request for comments, to:

Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Energy
Department of Health, Education & Welfare
Department of Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
Department of Housing and Urban Development
State of Tennessee Department of Conservation
State of Tennessee Department of Public Health
State of Tennessee Department of Highways
State of Tennessee State Planning Office
State of Tennessee Historical Commission
Office of Planning and Budget, Atlanta, Georgia
Office of Urban and Federal Affairs, State of Tennessee
Office of Intergovernmental Relations, Raleigh, North Carolina
Southeast Tennessee Development District
Rhea County, Judge
Meigs County, County Chairman

In addition, The NRC requested comments on the Draft Envirnmental Statement from interested persons by a notice published in the Federal Register on June 9, 1978 (43 FR 25183). In response to the request referred to above, comments were received from:

U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service (USDA/ESC)
U.S. Department of Agriculture, Soil Conservation Service (USDA/SCS)
U.S. Department of Commerce, National Oceanic and Atmospheric Administration (DOC)
U.S. Environmental Protection Agency, Region IV (EPA)
Federal Energy Regulatory Commission (FERC)
U.S. Department of Housing and Urban Development, Region IV (USHUD)
Department of the Interior (DOI)
Area Regional Council of Governments, Southeast Tennessee Development District (CARCOG/SETDD)
Tennessee Historical Commission (THC)
Tennessee Wildlife Resources Agency (TWRA)
Tennessee Department of Conservation (TDC)
Mr. Albert Bates (AB)
Dr. Louis G. Williams (LW)
Mr. and Mrs. Arthur Jensen (AJ)
Mrs. Zelia M. Jensen (ZJ)
Mr. Marvin Lewis (ML)
Tennessee Valley Authority (TVA)

The comments are reproduced in this statement as Appendix A. The staff's consideration of the comments received and its disposition of the issues involved are reflected in part by changes in the text in the pertinent sections of this Final Environmental Statement and in part by the discussion in Section 11. The comments are categorized by subject and are referenced by the use of the abbreviations indicated above. The organization of Section 11 corresponds to the ordering of sections in the body of the FES, e.g., discussion pertinent to Section 5 would be presented in Section 11.5. The pages in Appendix A on which copies of the respective comments appear are indicated by each subject title relating to the comment, and in the index to Appendix A.

11.1.1 Summary and Conclusions (ZJ, A-3; AJ, A-9; TVA, A-10)

This statement in the summary and conclusions regarding land use refers to the exclusion zone surrounding the nuclear plant. TVA controls all activity within this area, and there will be no residences, unauthorized commercial operations, or recreational areas within the exclusion zone. This area includes 967 acres of land.

11.1.2 NRC Jurisdiction over Environmental Monitoring Programs. (TVA, A-10)

TVA indicated that the Staff has no authority to establish monitoring conditions to the extent that those monitoring conditions might overlap conditions in the NPDES permit. To license a nuclear power plant, the Nuclear Regulatory Commission under the National Environmental Policy Act must evaluate the aquatic impacts in a particular proceeding, especially where those impacts may affect the overall cost-benefit balance. The Commission decided in Public Service Company of New Hampshire, et.al. (Seabrook Station, Units 1 and 2), CLI-78-1, 7 NRC 1 (1978) that it may accept and use without independent inquiry EPA's determination of the magnitude of the marine environmental impacts from the cooling system in striking an overall cost-benefit balance for the facility. The Commission summarized the relationship between itself and EPA as: "EPA determines what cooling system a nuclear power facility may use and NRC factors the impacts resulting from the use of that system into the NEPA cost-benefit analysis."

The NRC environmental evaluation which leads to issuance of an operating license is influenced by the fact that the environmental impact statement for Watts Bar Nuclear Plant is a joint document published by the Nuclear Regulatory Commission with the concurrence and cooperation of EPA in this instance pursuant to the Second Memorandum of Understanding. Accordingly, the cooling system approved by EPA for Watts Bar will be sensitive to aquatic impacts and controlled by them. The aquatic monitoring conditions set forth and evaluated in the draft environmental impact statement are reviewed and found acceptable by EPA. EPA jointly sponsors the document and it serves as a basis for their NPDES decision. Similarily, environmental (including aquatic), monitoring conditions are a part of this environmental assessment and NPDES determination.

11.2.1 Wind Speed (DOC, A-3)

The text has been modified to indicate that the 1.5 meters per second wind speed at Watts Bar represents the median, rather than the average wind speed. The Watts Bar site is located in eastern Tennessee in an area of the United States which frequently experiences low wind speeds. The 1.5 meter per second median wind speed measured on site at the 10-meter level is comparable with data collected at other proposed nuclear power plant sites in eastern Tennessee (e.g., median 10-meter wind speeds measured at Sequoyah and Phipps Bend are 1.7 meters per second and 1.3 meters per second, respectively). The median wind speed measured at Oak Ridge during the period from 1947 through 1964 was 2.0 meters per second (U. S. Department of Commerce, Environmental Data Service, "Local Climatological Data Annual Summary with Comparative Data-Oak Ridge, Tennessee." 1976).

Figure 2.11 has been modified to indicate that the data are wind frequency by direction in percentage of occurrence at the Watts Bar site.

11.2.2 Background Radiological Characteristics (ML, A-6)

Section 2.6, "Background Radiological Characteristics," presents a succinct yet comprehensive discussion of the background radiological characteristics of the Watts Bar/Tennessee site. Dose impacts associated with natural background radiation and a discussion of health effects can be found in Section 5.5. Annual population dose commitments from background radiation are listed for both the 50 mile radius population and U.S. population in Table 5.5. Health effects, which are directly related to dose magnitude, are presented on pages 5-23/25.

11.2.3 Downstream Industrial Water Usage (TVA, A-10)

This comment corrects information on page 1.1-13 of TVA's "Environmental Information, Watts Bar Nuclear Plants Units 1 and 2." The statements in Section 2.1 and 2.3 that were based on the incorrect information have been revised.

11.2.4 Disturbance of Osprey Nest (TDC, A-24)

Osprey are classified by the Tennessee Wildlife Resources Agency as endangered in Tennessee. The original osprey nesting site was located in the Yellow Creek Wildlife Management Area which borders the site. There are no plans to alter land use in this area and, therefore, detrimental impacts on local osprey populations and the old Yellow Creek nest site are not expected. The applicant erected artificial nesting platforms in various locations within the Watts Bar Steam Plant Reservation during early spring 1976. Neither these new nest sites nor the old Yellow Creek nest site have been used by osprey for several years.

11.3.1 Use of Different Units (ML, A-6)

One set of units, cubic meters/sec, is used consistently throughout Section 3.2.1. This is in keeping with the Commission's policy to use metric units. The units that appear in parentheses following the metric units are the commonly used English units.

11.3.2 Gaseous Waste Summary (ML, A-6)

The table below shows the reported noble gas and iodine-131 gaseous releases for Millstone, Unit No. 2, and for Turkey Point, Units Nos. 3 and 4, for the calendar years 1976 and 1977. Millstone, Unit No. 2, was still in the startup phase of commercial operation through May 1976. Turkey Point, Unit Nos. 3 and 4 gaseous releases were reported as combined release for the two units; for comparison purposes, the combined releases were averaged to a per unit value.

Comparison of Calculated Gaseous Releases for Watts Bar, Unit Nos. 1 and 2, with Calculated and Reported Annual Releases for Millstone, Unit No. 2, Turkey Point Unit Nos. 3 and 4

	Gaseous Release, Ci/Yr/Reactor						
	Watts Bar DES	Millstone 2 Appendix I Evaluation	Millstone 2 Reported 1976	Millstone 2 Reported 1977	Turkey Pt 3&4 FES	Turkey Pt. 3&4 Reported 1976	Turkey Pt. 3&4 Reported 1977
Noble Gases	7000	5600	1470	2300	3650	800	460
Iodine-131	0.041	0.13	0.0048	0.0041	0.8	0.02	0.042

*NOTE: Millstone, Unit No. 2 was in the startup phase of operation through May 1976.

Source of data: Semi-Annual Release Reports for Millstone, Unit No. 2, and Turkey Point, Unit Nos. 3 and 4, for the calendar years 1976 and 1977.

Since the values given for Watts Bar releases are based on engineering calculations, the corresponding calculated values for Millstone 2 and Turkey Point 3 and 4 were included in the table above. Calculated releases are proportional to the rated thermal power level of each reactor; therefore, a correction should be made to the listed values to equate them to the power level of Watts Bar. It can be seen that the calculated releases for all three plants are quite similar when equated to the same power level. It can also be seen that the reported releases for both Millstone 2 and Turkey Point 3 and 4 are lower than the calculated values; the difference can be attributed to better fuel performance than was assumed in the calculations.

11.3.3 Containment Ventilation System (TVA, A-10)

In the staff's Appendix I evaluation presented in the DES, it was assumed that the containment would be purged 24 times per year, with a purge duration of 2 hours each time, and that an additional 10 cfm continuous purge would take place. The applicant assumed six purges, of 24 hours duration each, per year, as well as a 10 cfm continuous purge. The staff's assumption of 24 2-hour purges per year is the staff's standard assumption for PWR containment purges and is based on operating data. The 24 purges are assumed to include four shutdown purges and 20 purges with the reactor at power. The 10 cfm continuous purge was assumed by the staff in the DES on the basis of the applicant's use of it in his Appendix I evaluation;

however, the applicant has since stated that the assumption of a 10 cfm continuous purge rate does not represent a true continuous purge but is only a mathematical model used to represent the effects of frequent short purges employed for temperature and pressure control. Since the staff's assumption of 20 purges per year with the reactor at power fulfills the same purpose as the applicant's assumption of a 10 cfm continuous purge, the staff has revised the calculated releases by deleting the 10 cfm continuous purge and has revised the calculated doses in accordance with the new source term. The revised gaseous effluent source term and the revised doses are presented in this FES and the SER.

TVA commented that the 16,000 cfm containment clean-up system and the auxiliary building HEPA filter have been deleted. The clean-up system and the HEPA filters were deleted by the applicant subsequent to the preparation of the staff's Appendix I evaluation. As a result of these design changes, the staff's evaluation has been revised; the revision appears in this FES and in the Safety Evaluation Report.

11.3.4 Sensitivity of Cost-benefit Analysis (ML, A-6)

The cost benefit analysis procedure considers variables in wind direction and other meteorological conditions, as well as considering upset conditions or unplanned spills which the staff calls "anticipated operational occurrences." Since the procedure considers such occurrences, the cost benefit analysis is not sensitive to changes in wind direction or to unplanned spills.

11.3.5 Water Treatment Plant Outfall Pipe Location and Length (EPA, A-22)

There is no separate outfall pipe for the water treatement plant. The water treatment plant discharges into the condenser cooling water system and is discharged to the river via the diffuser.

11.5.1 Interim S-3 Rule (ML, A-6)

The Nuclear Regulatory Commission is presently considering amending the Rn-222 portion of Table S-3. The NRC staff has performed an updated detailed analysis and is presently using the radon 222 release numbers listed on page 5-23 of this Final Environmental Statement to estimate radiological impact. The staff concludes that any reasonable expected changes to Table S-3 would not change the staff's conclusions with respect to the impact of the uranium fuel cycle and thus the impact of the Watts Bar facility.

It should be noted that on July 14, 1978, in its Partial Initial Decision, Environmental Consequences of the Uranium Fuel Cycle, and Perkins Licensing Board found that releases of radon-222 associated with those releases, are insignificant compared with background radon releases or in striking the cost-benefit balance for the Perkins Nuclear Power Station. (Perkins supra, slip op., p. 29.)

11.5.2 Table S-3 Radon Data (TVA, A-10)

As noted in Table 5.10 (S-3), a Commission ruling on radon 222 health effects is necessary before any new information can be incorporated into this table. However, as previously noted, the new information has been incorporated in this Final Environmental Statement. The updated analysis does not change the conclusions of the staff.

11.5.3 Radon-222 Figure Correctness (ML, A-6)

The estimates of radon releases and associated environmental dose commitments from milling operations listed on page 5-23 of the Watts Bar DES do not agree with Dr. Kepford's deposition in the Perkins hearing (6/8/78). The NRC staff, in arriving at its independent estimates as described in Section 5, has evaluated Dr. Kepford's analysis and does not agree with his methodology or conclusions. The response to comment 11.5.1 discusses the hearing board's findings.

11.5.4 Occupational Radiation Exposure (AJ, A-9)

The Nuclear Regulatory Commission is presently considering a petition from the Natural Resources Defense Council (NRDC), which references the Mancuso study, to reduce occupational radiation exposure standards ten-fold. The Commission will base its decision on a large amount of information pertaining to the question of how much risk is associated with radiation exposure. With regard to the Mancuso study, specifically, an NRC review committee has found, "much of the analysis questionable, deficient and ambiguous"(Ref. Memorandum for J. Kastner, SD, from M. Parsont, SD, 5/15/78). The committee did, however, stress the need for analyses to determine the relationship of cancer to low-level radiation exposure. In recommendations sent to the Commissioners, the NRC staff has suggested; (1) retaining annual dose standards and quarterly standards, but with values higher than one-fourth of the current annual standards, (2) deletion of the dose averaging formula 5(N-18), thus reducing maximum occupational exposure from 12 rems per year to 5, (3) deletion of the preconditional requirement for obtaining radiation dose histories, (4) retention of requirements to assure control of doses to transient and moonlighting workers and (5) revision of personnel monitoring requirements to specify numerical limits, in terms of percentage of the annual standards, which are equal to or slightly lower than existing requirements. The NRC staff has also recommended that 10 CFR Parts 20, 30, 40, 50 and 70 be amended to require licensees to implement individual occupational ALARA programs with guidance on the program content to be given in regulatory guides tailored for the various types of licensed activities.

11.5.5 Low-level Radiation Discharges to Public Waterways (LW, A-29)

Dr. Williams stated that rivers, bays, and oceans change low-level radiation (nuclear fission products) into high-level concentrations. In fact; rivers, bays, and oceans have just the opposite effect on concentrations. As liquid effluents are discharged into large bodies of water, natural dispersion characteristics and increased volume dilute the concentration of radioactivity considerably. Bioaccumulation of radioactivity in food chains leading to man is carefully considered in dose analyses performed by the NRC staff.

11.5.6 Liquid Radwaste Treatment System (AB, A-25)

A detailed analysis of the potential radiological impact of the liquid radwaste discharged to the Tennessee River has been performed by the NRC staff (See Table 5.9 FES). The estimated dose to the maximum individual was conservatively calculated to be 0.1% of natural background and is considered to be an insignificant increase to background dose.

11.5.7 Effuent Limitations and Monitoring Requirements-Liquid Radwaste System (AB, A-25)

As a point of reference Part I, Section A, page 7, Effluent Limitations and Monitoring requirements -- Liquid Radwaste System of the Watts Bar NPDES permit is presented on page E-6 of the FES.

The proposed discharge limits of 15 mg/l average and 20 mg/l maximum refer to the quantity of suspended or dissolved non-radioactive solids which may be present in liquid discharges. The notation mg/l is a measure of mass per unit volume and is not a dilution factor, as implied in the comment. Calculations which estimate radiation dose from liquid effluents express radioactivity content in terms of curies per liter. The assessment of potential damage to biota detailed in Section 5 of the FES fully considers the factors of activity, persistence, and biological effectiveness as explained in Regulatory Guide 1.109.

An "actinide" is defined as any of a series of 15 elements of increasing atomic number beginning with actinium and ending with the element of atomic number 103. The only actinide occasionally reported in nuclear power plant effluents is neptunium-239, which has been reported in trace quantities at some plants. The word which was apparently intended to be used is "nuclide".

Table 3.3 of the FES lists the nuclides which are calculated to be present in the liquid effluents from the Watts Bar plant. Table 3.3 includes one actinide, Np-239, which is a neutron activation product and which has been detected in trace quantities in liquid discharges from operating nuclear power plants. Table 3.3

also includes a number of other corrosion or activation product nuclides and fission product nuclides. Additionally, tritium, which is both an activation product nuclide and a fission product nuclide, is expected to be present.

The Nuclear Regulatory Commission (NRC) has been granted the authority to license and regulate the commercial use of nuclear energy by the Atomic Energy Act of 1954, 42 U.S.C. §§ 011 et seq. (1970; Supp. V, 1975) and the Energy Reorganization Act of 1974, 42 U.S.C. §§ 5801 et seq. (Supp. V, 1975). The regulatory procedures adopted by the NRC to provide for participation by members of the public have been determined to be fully sufficient to protect individual, public participation in the NRC's review process.

To the best of our knowledge, the routine radiological releases from commercial nuclear power plants have not resulted in a single mortality. Accordingly, comments that liquid radwaste discharges to the biosphere constitute "intentional poisoning" or "humanicide" are highly speculative and highly subjective statements without a reasonable basis.

The NRC staff has made an independent estimate of the radiation dose to the maximally exposed individual due to liquid effluents from the Watts Bar Nuclear Plant. This estimate of 0.1 mrem/yr utilizes site and plant specific information and assumes that the maximally exposed individual eats fish caught at the plant outfall and drinks water drawn at Dayton, Tennessee. It should be noted that the dose to the maximum individual (in units of mrem/yr), which is 0.1% of natural background, should not be confused with the dose received by the general population (in units of man-rem/yr). The implication that operation of the Watts Bar Plant will result in a 1% increase in deleterious health effects is erroneous. The EPA estimate of 22,224 health effects per year is based on a total natural background dose of 25×10^6 man-rem distributed to the U.S. population. Table 5.5 of the FES estimates the dose commitment to the U.S. population from Watts Bar liquid effluents at less than 3 man-rem. This is an increase of 0.00001%, not 1.0%, of natural background dose.

11.5.8 Liquid Radwaste Control and Limitation Details (EPA, A-22)

The concerns that are addressed in this comment are reviewed as part of the staff's Safety Evaluation Report for the Watts Bar Nuclear Plant. Since the concerns are not part of the environmental review, they are not addressed in the Environmental Statement. Applicable information for these issues will be contained in the Safety Evaluation Report (to be issued), and the Technical Specifications that will be part of the Operating License for the Watts Bar Nuclear Plant.

11.5.9 Environmental Dose Commitment Calculations (EPA, A-22)

Section 5.5.3 of the FES has been modified to include the long term environmental effects associated with carbon-14, krypton-85, and tritium releases of the fuel cycle excluding the reactor releases. These modifications were added to the earlier discussion which focused largely on the radon-222 impacts.

Staff estimates of the longer term effects of carbon-14, tritium, krypton-85 and releases of the reactor contribute less than 30% of the total fuel cycle impacts presented in Section 5.5.3 of the FES. Health effects reported in the FES on a "per reactor year" basis can be multiplied by the reactor operating time (i.e., 30 years) to obtain the total or integrated estimate.

Nevertheless, the staff is in the process of modifying its calculational methodology to automatically consider the radiological impacts of effluent releases of the entire nuclear fuel cycle.

It is important to note that the FES results conservatively include the impacts of both uranium and plutonium recycle even though such operations are not currently permitted. Thus, the FES results are conservative for any recycle option, especially the "throw-away" cycle, the option currently allowed.

11.5.10 Prime Farmland Loss (USDA/SCS, A-4)

Based upon its review of the Soil Survey of Rhea County, Tennessee (March 1948) and the list of soils in Tennessee that qualify for prime farmland (provided by the Soil Conservation Service, Nashville, Tennessee Office), the staff estimates that most of the soils on the Watts Bar site occupying terraces and bottom lands qualify as potential "prime farmland." Examples of these soils are Waynesboro, Holston and Sequatchie. Final determination of "prime farmland" classification would depend upon the evaluation of these soils based upon slope and flooding frequency characteristics. The staff for its analysis assumed that over half the 967-acre site contains soils classifiable as prime farmland. These soils would not be used for agricultural purposes during the life of the plant (30 years). The loss of this potentially classifiable prime farmland represents less than a 1% loss of nonforested farmland resources for Rhea and nearby Meigs County.

11.5.11 Fish Survival (AJ, A-9)

The Watts Bar Nuclear Plant cooling system is designed to minimize potential thermal effects. This design includes closed-cycle cooling towers and a submerged discharge diffuser. Further operational control of the blowdown discharge is provided via the holding pond when the release rate from the Hydroelectric Plant (Watts Bar Dam) is less than 99 m^3/sec (3500 cfs). When discharging, the diffuser provides a minimum dilution factor of 10. The proposed mixing zone of 240-foot width by 240-foot downstream length occupies a maximum of 38% of the river cross-sectional area at water surface elevation 683 feet (MSL), the normal surface elevation during summer.

Thermal effects due to the Watts Bar Nuclear Plant will be localized in the area of the diffuser and mixing zone. Juvenile and older fish would most probably avoid the diffuser and earlier life stages would be displaced quickly by the high velocity associated with the diffuser "jets." The mixing zone will not cause a thermal barrier to the movement of the fish into the Watts Bar Dam tailrace area.

For the worst case combination of (1) the highest observed tailrace water temperature = 30.5°C (86.9°F), (2) 12-hour suspension in Hydroelectric Plant operation, and (3) maximum expected thermal additions from both the steam plant (fossil) and nuclear plant, the temperature at the downstream edge of the mixing zone will be 32.4°C (90.4°F). The probability of occurrence for this worst case is low as shown by the historical data; e.g., tailrace temperature exceeded 28.3°C (83.0°F) in only 8 of 1320 weekly observations in the period February 1950 to September 1977 and has not exceeded that level since August 1955. The diffuser can assure compliance with the State maximum thermal criterion of 30.5°C (86.9°F) if the river temperature at the upper edge of the mixing zone is $\leq$ 30.0°C (86.0°F). These discharge temperatures have been reviewed and found acceptable by the EPA pursuant to Section 316(a) of the FWPCA. The State concurs in this determination as does the NRC staff. No deleterious effects on the survival of reservoir fishes are expected.

Radiological impacts on aquatic biota are discussed in Section 5.5.2 of this FES. The staff concludes that no measurable radiological impact on aquatic biota is expected as a result of the routine operation of this plant.

11.5.12 Location of Radioactive Waste Offsite Burial (AJ, A-9)

TVA plans to bury the radioactive solid waste at the licensed facility at Barnwell, South Carolina.

11.5.13 Public Knowledge of Routine Radioactive Releases (AJ, A-9)

There are numerous published documents available to the public which discuss the impacts to the environment of radioactive releases. These include both TVA's and NRC's environmental statements.

11.5.14 Significance of Sauger Fishery (TWRA, A-8)

The discussion in Section 5.4.2 of this FES should not be interpreted as concluding that sauger are insignificant to the sport creel in the tailrace area. Available data as noted by the comment indicate that a significant sauger fishery does exist. TVA has provided creel census data specific to the tailwater (TRM 503.3 to TRM 529.9) for the first half of 1977. These data have been incorporated in Appendix C of this FES. The six-month harvest of sauger was 13.6% of the total number (988) and 19.8% of the total weight (454.1 pounds).

The purpose of the discussion in Section 5.4.2 is to describe the available ichthyoplankton data. The limited abundance of sauger early life stages in the 1976 data was highlighted because of the previous statements concerning the favorability of the tailrace as spawning habitat for this species (e.g., see TVA's FES at pp. 1.1-21 and 8.2-4). TVA data for the 1977 year demonstrates similarly low abundance of ichthyoplankton for the migratory spawners. Appendix C has been revised to incorporate the 1977 data.

11.5.15 Fish Production - Ichthyoplankton (TWRA,A-8)

It was not the staff's intent to imply that a final conclusion on the significance of the tailrace habitat for migratory spawners could be based on one year of ichthyoplankton data. The conclusion reached in Section 5.4.2 is qualified as based on the one year of data and the need for additional data is explicitly stated.

TVA has provided a second year of data (1977 spawning season) which demonstrates similarly low abundance of ichthyoplankton for the migratory spawners. Section 5.4.2 and Appendix C have been revised to include the 1977 data. Based on two years of data, we reach the same conclusion on the acceptability of potential intake entrainment losses. A third year of ichthyoplankton data has now been collected and will be presented in TVA's preoperational monitoring report.

It is possible that the 1978 data may be "atypical" of the 1976-1977 results, showing significantly higher abundance. We agree that "...many factors may influence fish spawning in a given year"; therefore, several years of data will be required to establish the range of variability in spawning success for tailrace spawners.

Based on the available data and intake system design information, we conclude that entrainment will be minimized. Preoperational and operational monitoring programs are being required by the NPDES permit. The aquatic biological components of these programs are described in Section 6.2.4 and 6.3.5 of this FES. Results of operational monitoring in the vicinity of the intake will form a basis for EPA's determination pursuant to Section 316(b) of the FWPCA as to whether the intake reflects best available technology for minimizing adverse environmental impact.

11.5.16 Plant's Impact on Mussel Habitat (TDC, A-24)

The endangered species, Lampsilis orbiculata, is discussed in Section 2.5.2, Section 5.4.2 and Appendix C of this FES. The text of Appendix C has been revised to include information on Pleurobema cordatum and Dromus dromas, the latter species having been collected downstream of the Watts Bar Plant site during a June 1978 survey conducted by TVA. Dromus dromas is listed as endangered by the Department of Interior. We have determined that the proposed operation of Watts Bar Nuclear Plant will not affect D. dromas or its habitat and that consultation is not required pursuant to Section 402.04 of the Endangered Species Act of 1973.

11.5.17 Plant's Impact on Dissolved Oxygen Levels (TDC, A-24)

Operation of the Watts Bar Nuclear Plant is not expected to alter the oxygen balance in the river.

11.5.18 Concentration of Plant Effluents During Periods of Low Flow (TDC, A-24)

As noted in Section 5.3.2, the increase in the ambient concentration of three chemical substances will be small even during the lowest flow into which discharges will be made. The three substances are not considered harmful to aquatic life at the expected concentrations even under these conditions of maximum concentration.

11.5.19 <u>EPA Transfer of NPDES Authority to Tennessee (TVA, A-25)</u>

Authority to "permit" Federal facilities has not as yet been delegated to the State of Tennessee by EPA.

11.6.1 <u>Hydraulic Characteristics of the Aquifer (DOI, A-5)</u>

The aquifer tapped by preoperational and operational monitoring is the Conasauga Shale. No attempt has been made to measure the hydraulic properties of the Canasauga Shale Aquifer because of the limited occurrence of ground water and the heterogeneity and anistropy of the materials underlying the site (Watts Bar FSAR, Section 2.4.13.2). See revised Section 6.2.3 and 6.3.3.

11.6.2 <u>Meterological Measurements (TVA, A-10)</u>

Based on information provided in the Watts Bar FSAR, lower level temperature, wind speed, and wind direction measurements on the temporary tower were made at a height of 30 feet. The lower level measurement of wind speed and direction, temperature and dew point on the permanent tower is given as the 10-meter level. The correct conversion from 10 meters is to 33 feet and from 30 feet is to 9 meters. The appropriate conversion modifications have been made in the text. We have modified the text to reflect the change in dew point sensor location.

11.6.3 <u>Reporting Requirement for Chemical Vegetation Control (TVA, A-10)</u>

To the extent a reporting requirement is necessary to allow the NRC staff to complete its cost-benefit analysis with respect to the proposed action, that requirement will be made a condition of a license under NEPA.

11.6.4 <u>Aerial Remote Sensing Program for Effects of Plume Interactions (TVA, A-25)</u>

The staff understands that the applicant is currently undertaking investigations of potential terrestrial effects of cooling tower and smoke plume interactions. Based upon their investigation, a recommendation will be made by the applicant on the necessity of implementing terrestrial effects monitoring program. The staff would certainly consider any additional data assessing potential terrestrial impacts from cooling tower operation and methods of monitoring such impacts including possible off-design problems; however, because of limited operating experience, especially long-term the staff believes it is prudent to undertake a limited term inspection program because a margin of uncertainty still exists. This inspection program would certainly not require chemical analyses of soils, plants, and animals as might be required in a full-scale drift impact study.

11.6.5 <u>Reporting Requirements of Chemical Control of Vegetation Along Transmission Line (TVA, A-25)</u>

To the extent a reporting requirement is necessary to allow the NRC staff to complete its cost-benefit analysis with respect to the proposed action, that requirement will be made a condition of a license under NEPA.

11.7.1 <u>Cumulative Environmental Effects of Three Nuclear Plants Along The Tennessee River, Especially Effects of Accidents (CARCOG/SETDD, A-6)</u>

The staff does not discuss cumulative impacts in the environmental statement because no environmental impact is sufficiently large that its interaction with similar impacts of another nuclear plant within a 50 mile radius would result in a significant impact. The most obvious area for cumulative effects is the common water body used for the plant cooling systems. The staff has considered the possible cumulative impacts of the three plants on the aquatic ecology of the Tennessee River but has determined that because there is no significant impact beyond the diffuser mixing zone for the single plant, there cannot be an important cumulative impact on the biological community.

The cumulative effect of potential accidents is similarly so small that it need not be discussed in the environmental impact statement. This conclusion has been reached by the staff for the following three reasons. First, the calculated consequences from accidents as shown in Table 7.2 are low, even though the probability of the accident is not factored into the calculations.. Secondly, the fifty mile radius is an arbitrary impact area. In fact, the individual impact with respect to accident consequences decreases significantly with increasing distance from the site due to atmospheric dispersion and dilution of the radioactivity. For example, Table 7.2 shows individual doses received at the nearest site boundary, but an individual five miles from the reactor would receive only about 5% of those values. And finally, the staff has determined that a discussion of cumulative effects from accidents at multi-unit sites is not warranted because the environmental impacts are very small. If it is considered unnecessary to discuss this aspect in the instance of reactors sitting side by side at a two unit site, it follows that it is unnecessary to discuss it for the three sites along the Tennessee River.

11.8.1 Decommissioning and Land Use (EPA, A-22)

The NRC staff is in the process of reappraising its regulatory position relative to the decommissioning of nuclear facilities.[1] As part of this activity, NRC has initiated or will initiate several studies to develop specific background information to support the preparation of new standards covering decommissioning.

These studies will describe decommissioning alternatives and will evaluate the safety and costs associated with them. The plan is to cover all major types of nuclear facilities over the next several years. Current studies by Battelle Pacific Northwest Laboratories are directed at decommissioning of light water reactors (LWRs) and their associated fuel cycle facilities. The first report in this series covered a fuel reprocessing plant.[2] The second report of the series deals with a pressurized water reactor.[3]

11.C.1 Blue-Green Algae Concentration and Percent Contribution to the Phytoplankton Community (TVA, A-25)

The text of Appendix C has been revised to reflect the 1976 phytoplankton data. Of interest is the increase of blue-greens (both concentration and percent contribution to the phytoplankton community) during the summer collection period. Station concentrations are 10 to 20 times greater than the station average for the previous three years. The highest station concentration of 13.3 million/liter was recorded at TRM 532.1, the Watts Bar Dam forebay station. Concentrations at the other six stations were less than one-half that recorded at the Dam Forebay. The contribution of blue-greens to the total phytoplankton averaged 76% over the seven stations (range = 71.7% to 82.1%). During the previous three-year period, there had been only one observation (Fall 1975 at TRM 506.6) where blue-greens contributed over 50%. The dominant blue-green in all Summer 1976 collections was *Anacystis* spp.

The Winter 1976 collections also demonstrate a noticeable increase in phytoplankton concentrations, compared to concentrations during the winter season of the previous three years. The chrysophyta contributed 85% to 93% of the total community with the one genus *Melosira* spp. making up 80% to 88% of the total concentration.

As further demonstrated by the 1976 data, large variations in the phytoplankton community are to be expected. We agree that it is difficult to ascribe any significance to such changes. Changes, if any, which may result from plant operation will be localized to the mixing zone.

11.C.2 Impact of Plant on Endangered Species of Mussel (TVA, A-25)

The text has been revised to reflect the new information (see Section 2.5.2, Section 5.4.2 and Appendix C). We have determined that the endangered species, *Dromus dromas*, and its habitat will not be affected by the proposed operation of the Watts Bar Nuclear Plant and that consultation with the Fish and Wildlife Service regarding this species is not required.

References for Section 11

[1]Plan for Reevaluation of NRC Policy on Decommissioning of Nuclear Facilities, NUREG-0436, March 1978.

[2]Technology, Safety and Costs of Decommissioning a Reference Nuclear Fuel Reprocessing Plant, NUREG-0278, October 1977.

[3]Technology, Safety and Cost of Decommissioning a Reference Pressurized Water Reactor Power Station, NUREG-CR-0130, June 1978.

APPENDIX A

COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT

CONTENTS

50-390
391

U.S. DEPARTMENT OF AGRICULTURE
ECONOMICS, STATISTICS, and COOPERATIVES SERVICE
WASHINGTON, D.C. 20250

June 14, 1978

SUBJECT: Draft Environmental Statement

TO: William H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis

We have no comments on the Draft Environmental Statement related to operation of Watts Bar Nuclear Plant, Units 1 and 2.

Melvin L Cotner
MELVIN L. COTNER
Director
Natural Resource Economics Division

731670045

C002
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1/0

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

50-390
391

June 29, 1978

Mr. William Regan, Jr.
Chief
Environmental Projects Branch
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

I am replying to your request of June 2, 1978 to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement for the Watts Bar Nuclear Plant Units 1 and 2. This Draft EIS has been reviewed by appropriate FERC staff components upon whose evaluation this response is based. We have no comments on this EIS.

Thank you for the opportunity to review this statement.

Sincerely,

JMHeinemann
Jack M. Heinemann
Advisor on Environmental Quality

781880106

C002
ES
1/0

U.S. Nuclear Regulatory Commission

Washington, D.C. 20555

Attention: Director, Division of Site, Safety and Environmental Analysis

In the Draft Environmental Statement for Watts Bar Nuclear plant, Unit 1 and 2 Tennessee Valley Authority, page 1, Summary and conclusions No.3 (b) states "The 967 acres of rural, partially wooded land owned by the applicant will be unavailable for other uses during the 40 year life of the plant".

Will you please explain what unavailable for other uses means? This is one of the many questions people are now asking in the Watts Bar vicinity. This is our reason for asking for a public hearing for the concerned citizens.

Thank you for your time and patience. The [illegible] book is very interesting.

Sincerely,

Celia M. Jensen R.N.

Route 1

[illegible], Tn. 37[illegible]

UNITED STATES DEPARTMENT OF COMMERCE [illegible]

50-390/391

July 10, 1978

Director, Division of Site
Safety and Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

This is in reference to your draft environmental impact statement entitled, "Watts Bar Nuclear Plant, Units 1 and 2, Tennessee Valley Authority, Rhea County, Tennessee." The enclosed comment from the National Oceanic and Atmospheric Administration is forwarded for your consideration.

Thank you for giving us the opportunity to provide this comment, which we hope will be of assistance to you. We would appreciate receiving ten (10) copies of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure memo from: Mr. Douglas M. LeComte
Special Projects
NOAA

A-2

JUL 6 1978

July 3, 1978

TO: William Aron, Director
Office of Ecology and Environmental Conservation

FROM: Douglas M. Le Comte
Special Projects

SUBJECT: EDS Review of DEIS 7806.02 - Watts Bar Nuclear Plant, Units 1 and 2 Tennessee Valley Authority, TN

Page 2-11, Section 2.4.2: The text states that wind speeds at the 10-meter level averaged only 1.5 meters per second. If the wind measuring equipment is properly exposed, this is an improbably low wind speed. The data should be checked to determine if this is accurate. Additionally, the data summary presented in Figure 2.1 should have a caption which explains the data shown.

675 U. S. Courthouse, Nashville, Tennessee 37203

July 11, 1978

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commissions
Washington, D. C. 20555

Dear Mr. Regan:

The Draft Environmental Impact Statement - Watts Bar Nuclear Plant, Units 1 and 2, TVA - was referred to the Soil Conservation Service for review and comments on June 2, 1978.

We have reviewed the draft statement and offer the following comment for your consideration:

1. We see no deficiencies relating to our areas of responsibility except for lack of treatment of prime farmland loss.

We appreciate the opportunity to review this draft environmental impact statement.

Sincerely,

Donald C. Bivens
State Conservationist

cc: R. M. Davis
Director, Office of Federal Activities, Environmental Protection Agency

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

50-390/391

PEP ER-78/500

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

Thank you for your letter of June 2, 1978, transmitting copies of the Nuclear Regulatory Commission's draft environmental statement for the operation of Watts Bar Nuclear Plant, Units 1 and 2, Rhea County, Tennessee. Our comments are arranged by subject.

Hydrology

Section 5.3.7 states that the radius of influence of the supply wells has been calculated to be 400 feet on the basis of discharging-well tests. The final statement should specify the well discharge rate corresponding to the given radius of influence. The final statement should also specify the elapsed time, that is, whether the radius of influence is calculated as 400 feet for the life of the project or for a short term.

The hydraulic characteristics of the aquifer used in the computations should be given and the aquifer(s) tapped by the preoperational and operational monitoring, listed on pages 6-1 and 6-6, should be identified.

Mineral Resources

The proposed project will have no adverse effects on mineral resources and may benefit mineral resources by providing electrical power for potential mineral development within the Tennessee Valley Authority service area.

We hope these comments will be helpful to you in the preparation of a final environmental statement.

Sincerely,

Heather L. Ross

Deputy Assistant SECRETARY

7810090325

A002
S/10

50-390/391

[illegible] Bradford Terrace
[illegible]
July 13, 1978

Mr. [illegible]
Director Div of Site Safety & Env Analysis
Office of Nuclear Reactor Regulation
U S N.R.C.
Wash., D.C. 20555

Sir: Please accept my comments below on the "DES of the Watts Bar Nuclear Plant, Units 1 & 2 TVA"

¶2.6 Background Radiological Characteristics. This is a very short ¶ on an immensely important subject. Clearly, some elaboration of health effects from background is needed.

¶3.2.1 Constant switching from one set of units to several others makes difficult reading. Use one set of units, gallons per day, and give the conversion factors.

P3-18 Gaseous Waste Summary. How does this summary compare to similar plant presently in operation? Please compare Millstone and Turkey Point with Watts.

P3-21 How sensitive is this analysis of $1000/man rem.

P5-17 If the direction of major winds or unplanned spills occur, what happens to this analysis? Interesting.

P5-21 Table 5-10. This is the interim S-3 rule. It is presently in hearings and may be eliminated or changed drastically. How will change of S-3 effect this DES?

P5-23 These numbers do not seem to agree with the Morton Ranch DES or Chauncey Kepford's deposition on Jun 8, 72 in the Perkins Nuke Case at NRC, Bethesda, MD. Pls recheck the numbers and its agreement with Kepford's deposition.

I cannot go into all the questionable areas in this DES. Pls do not think I agree with areas on which I am not commenting.

Very truly yours,

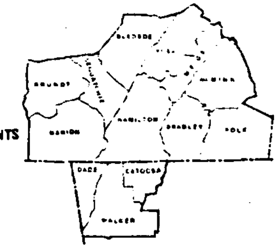
Marvin I. Lewis

P.S. Pls send copy of [illegible]
[illegible]

 C002 ES/10

CHATTANOOGA AREA REGIONAL COUNCIL OF GOVERNMENTS

JAMES M. CANTRELL
Chairman



SOUTHEAST TENNESSEE DEVELOPMENT DISTRICT

C. L. THRAILKILL
Executive Director

July 17, 1978

Wm. H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: Docket Nos. 50-390 and 50-391 - Tennessee Valley Authority, Draft Environmental Statement for Watts Bar Nuclear Plant, Unit Nos. 1 and 2

Dear Mr. Regan:

In accordance with the Office of Management and Budget Circular A-95 this office, as the areawide clearinghouse, has reviewed the subject proposal.

Our review of the draft environment impact statement indicates that most initial review comments which this office raised have been satisfactorily answered. The notable exception is the issue of cumulative impacts from the series of nuclear plants in various stages of development along the Tennessee River. The enclosed map provides an overview of possible areas of cumulative impacts based on the 50 mile radius utilized throughout the impact statement. The primary cumulative impacts addressed were those of radiological impact. Other cumulative impacts and the relations of cumulative potentials were not adequately addressed or taken into consideration in analysis of various factors.

As an example of this oversite page 7-1 deals with Realistic Accident Analysis for the Watts Bar facility. Section 7.2 on this page states that "the probability of occurance of accidents and the spectrum of their consequences to be considered from an environmental effect standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions". We are satisfied that in this example the estimates and assumptions of probabilities for accidents and consequences concerning the Watts Bar facilities are acceptable. We question if the assumptions and estimates of probabilities are reliable with respect to the impact area when one considers the cumulative fact that there are several nuclear plants in the same general vacinity. In essence the sum of the cumulative potential is likely to be greater than the individual potentials, estimates, probabilities, and impacts. This example we have cited is not unique but merely representative of the basic short coming of the EIS in not properly addressing cumulative impacts.

 C002 ES/11

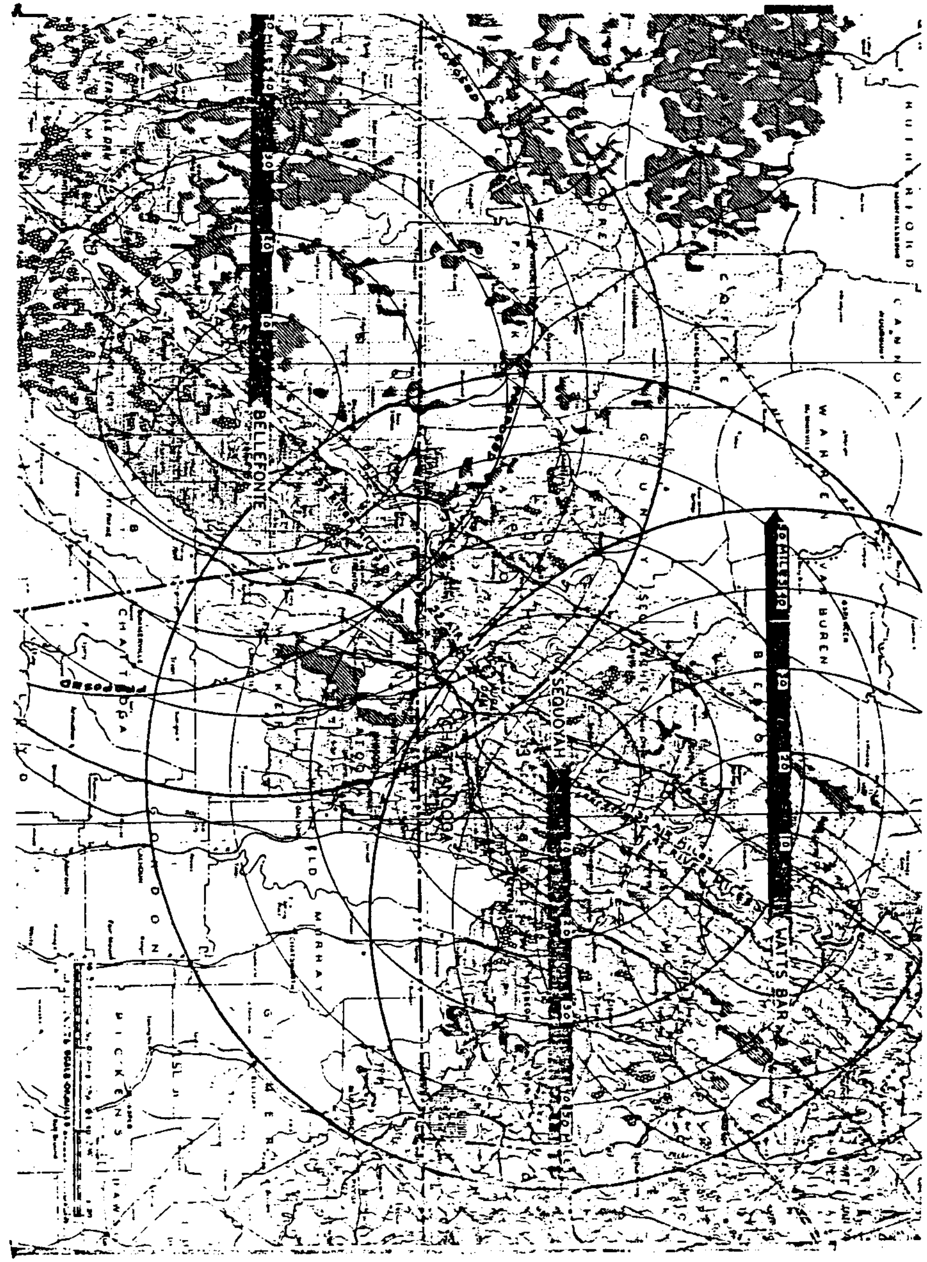
Mr. Wm. H. Regan, Jr.
July 11, 1978
Page 2

Should there be any question, or if we may be of further assistance, please contact this office.

Sincerely,

Charles L. Thrailkill
Executive Director

CLT:HCB:cud



TENNESSEE
STATE PLANNING OFFICE

660 CAPITOL HILL BUILDING
301 SEVENTH AVENUE, NORTH
NASHVILLE, TENNESSEE 37219
615/741-1676

50-390
391

July 19, 1978

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental
Analysis
Nuclear Regulatory Commission
Washington D.C. 20555

RE: DEIS - Watts Bar Nuclear Plant, Units 1 and 2, TVA

Dear Mr. Regan:

The Tennessee State Clearinghouse has coordinated an agency review of the above referenced Draft EIS. I am submitting the enclosed comments from the Tennessee Wildlife Resources Agency and the Historical Commission for your consideration. If we receive additional comments from other agencies, I will forward them to you upon receipt.

Sincerely,

Bette A. Osborne
Bette A. Osborne
Natural Resource Staff

BAO/fe

Enclosure

TENNESSEE WILDLIFE RESOURCES AGENCY

P. O. BOX 40747
NASHVILLE, TENNESSEE 37204

July 11, 1978

Ms. Bette Osborne
Natural Resource Staff
State Planning Office
660 Capitol Hill Building
Nashville, Tennessee 37219

Dear Bette:

Re: <u>DEIS - Watts Bar Nuclear Plant, Units 1 and 2 TVA</u>

We have completed our review of the referenced document and offer the following comments:

Page 5-5, under 5.4.1 <u>Terrestrial Environment</u> <u>The Station</u> - Part of the last paragraph is missing.

Page 5-8, 5.4.2 <u>Aquatic Environment</u>, paragraph four - This infers that the sauger is not a significant species in the Watts Bar Tailrace. Creel census data for Chickamauga Reservoir, which includes the Watts Bar tailwater, indicates that a significant sauger fishery exists. In the 1976-1977 creel an estimated 15,758 sauger averaging .75 lbs. were taken. This comprised 8.4% of the fishing pressure on Chickamauga.

Page C-19 <u>Fish Production - Ichthyoplankton</u> - This section draws the conclusion that the Watts Bar Tailwater is not a favorable spawning area for migratory spawners. This conclusion is based on a series of ichthyoplankton samples taken between March 29, and September 9, 1976. Since many factors may influence fish spawning in a given year, we do not agree with these findings.

Thank you for this opportunity for comment.

Sincerely,

TENNESSEE WILDLIFE RESOURCES AGENCY

James F. Sharber, Jr.
James F. Sharber, Jr.,
Environmental Planner

JFS:ss

cc: Mr. Reid Tatum

7802080020

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ES11

TENNESSEE HISTORICAL COMMISSION
... SECOND AVENUE NORTH
NASHVILLE, TENNESSEE 37201
TELEPHONE 615 741 2371

HERBERT L. HARPER Executive Director
State Historic Preservation Officer

July 10, 1978

Ms. Bette Osborne
State Planning Office
660 Capitol Hill Bldg.
Nashville, Tennessee 37219

Re: DES (Operations) Watts Bar Nuclear Plant, TVA

Dear Bette:

The STate Historic Preservation Officer and his staff have reviewed the above document and find that due to the nature of the undertaking, the operation of Watts Bar Nuclear Plan will not affect any historical or archaeological properties. Consequently it will not affect the plans or priorities of this agency.

Sincerely,

Herbert L. Harper

HLH:11

RAY BLANTON, Governor

B. R. ALLISON, Commissioner of Conservation

Route 1 Box 36 A
Grandview, Tn 37337
July 23, 1978

Mrs. Suzanne Neblusek
Environmental Project Manager
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mrs. Neblusek

Thank you for accepting our additional comments.

Specifically, in the Draft Environmental Statement relating to operation of Watts Bar Nuclear Plant Docket Nos. 50 - 390 and 50 - 391 page one, summary and conclusions, 3 (b)

a. Please define "unavailable for other uses during 40 year life of the plant."

b. how will the fish survive in the warm water of Chickamauga Reservoir and Tennessee River and be kept free of contamination ?

c. Where is the burial off-site for the radioactive solid waste ?

d. Is the general population living within 2 miles radius of the Nuclear Plant aware of the "radioactive effluents released to the hydrosphere from the Watts Bar facility during normal operation" ?

Dr. Thomas Mancuso states that so-called "safe Standards" should be reduced ten fold. Does the Nuclear Regulatory Commission agree with this statement ?

Sincerely your's

Zelia Jensen
Arthur Jensen

Mr. & Mrs. Arthur Jensen

782120003

C 02

TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
830 Power Building

July 31, 1978

Mr. Daniel Muller, Acting Director
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Muller:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

In accordance with the provisions for review and comment indicated in the Federal Register on June 9, 1978, the Tennessee Valley Authority (TVA) has reviewed the Nuclear Regulatory Commission's (NRC) Draft Environmental Impact Statement (EIS) for the TVA Watts Bar Nuclear Plant and we have the following general comments.

Water quality and effluent monitoring requirements are within the Environmental Protection Agency's (EPA) jurisdiction under the Federal Water Pollution Control Act, 33 U.S.C. §§ 1251 et seq. (Supp. V, 1975), as amended by Clean Water Act of 1977, 91 Stat. 1566 (FWPCA). Section 511(c)(2) of the FWPCA specifically precludes NRC from imposing or reviewing, as a condition in a construction permit (CP), any effluent limitation or other requirement other than those established pursuant to the FWPCA. In re Tennessee Valley Authority (Yellow Creek Nuclear Plant Units 1 and 2), partial initial decision, slip. op. at 31 (Feb. 7, 1978). EPA-NRC Second Memorandum of Understanding (40 FR 60115 (1975)). See A Legislative History of the Water Pollution Control Act Amendments of 1972, 93d Cong., 1st Sess., vol. 1, at 183 (1973) (remarks of Sen. Muskie). Accordingly, TVA takes the position that the water quality and monitoring issues are adequately addressed in the draft NPDES permit and that those items need only be reported to EPA in accordance with the NPDES permit.

We do not believe NRC has the jurisdictional authority to include these requirements in the environmental technical specifications. However, TVA will supply the NRC with copies of all data submitted to EPA pursuant to the requirements of the NPDES permit but not as a duplication of a reporting requirement.

Mr. Daniel Muller

July 31, 1978

The NRC draft EIS references TVA's Final Environmental Statement (FES) as a construction permit stage FES. However, in accordance with the lead agency agreement, TVA consulted with the Regulatory Staff of the AEC (now NRC) in the preparation of the FES and responded to all AEC concerns in the FES, which was submitted to the CEQ and made available to the public on November 9, 1972. This FES evaluated the environmental impacts resulting from operation as well as construction of the Watts Bar Nuclear Plant units 1 and 2. Accordingly, references to the FES should indicate that it addressed the construction and operation impacts and is not merely a CP stage EIS.

The two enclosures contain additional specific comments on the draft environmental statement. The comments in Enclosure 1 are directed toward various commitments and conclusions formulated by the NRC staff which TVA thinks are inappropriate or unwarranted. Enclosure 2 contains comments on specific descriptions in the NRC draft statement that we recommend be corrected in the staff's final statement.

Very truly yours,

J. E. Gilleland

J. E. Gilleland
Assistant Manager of Power

Enclosures
cc (Enclosures):
Ms. Suzanne Keblusek, Project Manager
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, DC 20555

782140114

Enclosure I

TVA RESPONSES TO COMMITMENTS AND CONCLUSIONS IDENTIFIED IN THE NRC STAFF DRAFT ENVIRONMENTAL STATEMENT

I. NPDES Permit

1. P. ii, item 6B-1

The staff requires TVA to carry out environmental (thermal, chemical, radiological, ecological) monitoring programs outlined in the NPDES permit as an environmental technical specification requirement.

TVA Comment

Operational nonradiological effluent and aquatic monitoring programs will be conducted in accordance with the terms of the NPDES Permit. TVA objects to the implications of this paragraph that the monitoring programs in the NPDES Permit will be duplicated in the environmental technical specifications for the Watts Bar Nuclear Plant.

2. P. iii, item 6B-2

The staff requires TVA to notify the Director, Division of Site Safety and Environmental Analysis, of all cases where all NPDES Permit discharge limits are exceeded as a requirement of the environmental technical specifications.

TVA Comment

TVA objects to the separate reporting requirements for matters regulated by the NPDES Permit. Part II, Section A-2 on page E9 of the draft NPDES Permit contained in Appendix E of this document requires the notification of the regional administrator and the State within a five-day period of any noncompliance with those matters regulated by the Permit.

3. P. 2-13, item 2.5.2, first paragraph

The staff indicates TVA will submit their Preoperational Aquatic Monitoring Report in November of 1978.

TVA Comment

As discussed with Ms. Keblusek of the NRC staff on June 21, 1978, TVA anticipates to submit the Preoperational Aquatic Monitoring Report in accordance with the schedule identified in the NPDES Permit Part III, Section J (i.e., three months prior to the commercial operation of Unit 1).

4. P. 5-3, first paragraph

The staff believes it prudent to conduct limited monitoring for copper in the downstream mussel beds.

TVA Comment

TVA objects to the staff's recommended monitoring requirements for copper. The corrosion-erosion studies required by Part III, Item M of the NPDES Permit should be sufficient to document any copper losses within the system. The only other source of copper within the discharge would be that which occurs in the makeup water.

5. P. 6-1, third line of Section 6.2.4

It is again stated that TVA Preoperational Aquatic Monitoring Reports are scheduled for completion in November 1978.

TVA Comment

See response to Item 3.

6. P. 6-4, Section 6.3

The staff requires TVA to submit their Operational Aquatic Monitoring Program to the staff for their review before station operation and the incorporation of the program into the environmental technical specifications, as applicable.

TVA Comment

With respect to the operational nonradiological aquatic monitoring programs, (effluent and instream), it is TVA's opinion that NRC's inclusion of matters regulated by the FWPCA and contained in the NPDES Permit are outside of NRC's jurisdiction and cannot be reflected in environmental technical specifications as conditions of an operating license. Therefore, TVA objects to the proposed staff requirements and recommendations concerning aquatic monitoring as identified in the Section 6.3. In Section 6.3.5, the NRC staff's acknowledged intent that duplicate reporting requirements are likely to be required is an unwarranted example of dual regulation. Furthermore, the "Staff Evaluation of Plans for the Operational Monitoring of Aquatic Biota" fails to recognize that the regulating document for aquatic matters is the NPDES Permit requirements and not the environmental technical specifications. The NRC staff will have the opportunity to receive, review, and comment on plans and reports concerning matters regulated under the FWPCA as identified in Part III, Section O of the NPDES Permit. NRC's comments on the plans and reports should be forwarded to EPA for consideration by EPA in their evaluation and approval of the plans and reports required by the permit. Beyond this level of involvement, the NRC staff has no authority for the establishment and regulation of matters concerning the aquatic environment.

II. Transmission Facilities

1. P. iii, item 6B-4, and p. 6-8, Section 6.3.6.3

The staff requires TVA to submit an annual report on the program chemical control of vegetation on transmission line rights of way.

TVA Comment

TVA objects to the staff requirement of an annual report on pesticide usage on transmission line rights of way. The use of herbicides is regulated by the Federal Insecticide, Fungicide, and Rodenticide Act which requires the registration of all pesticides and that all subsequent uses must be within the label restrictions. In the case of hard core pesticides the Act also requires that the application must be made by certified applicators. In TVA's opinion the proposed NRC reporting requirement is outside NRC's jurisdiction and is unwarranted.

III. Cooling Towers

1. P. iii, item 6B-3, and P. 6-8, Section 6.3.6.2

The staff requires a bird monitoring program be designed to detect and report serious episodes of bird collisions with cooling towers as contrasted with occasional random collisions.

TVA Comment

TVA will conduct a bird monitoring program to detect and report serious episodes of bird collisions with the cooling towers. The bird monitoring will be conducted during peak periods of avian use for a period of time not to exceed two years. The data collected from this program will determine what the future monitoring requirements of the other TVA nuclear plants should be.

2. P. 6-8, Section 6.3.6.1, last paragraph

The staff requires that a limited term aerial remote sensing program be undertaken as part of the applicant's proposed monitoring program. This program may use color infrared and/or multispectral or multiband photography. This combined program of aerial remote sensing and ground inspection on an annual basis for a limited term would be highly sensitive in the rapid detection of any terrestrial effects due to cooling tower drift or plume interactions.

TVA Comment

Potential terrestrial effects of cooling tower and smoke plume interaction are being investigated through the use of vapor plume and drift models, atmospheric and plume chemistry relationships, and observational experience. The result of this investigation will be a recommendation on the necessity of implementing the

terrestrial effects monitoring program. It is anticipated that this recommendation will be made before the end of 1978.

The remote sensing approach for delineating effects of air pollution on vegetation is still in the experimental stage. In general, those experiments which have reported definitive results have included extensive controlled environment studies in support of the aerial reconnaisance and were concerned with less complex situations. TVA believes the on-the-ground vegetation surveillance program will be more objective and will not be dependent on results from the remote sensing program.

IV. Terrestrial

1. Page i, Item 3b

The staff concludes that the 967 acres of rural, partially wooded land owned by the applicant will be unavailable for other uses during the 40-year life of the plant.

TVA Comment

Item 1, on page 2.10-1, of the TVA FES states the following: "The major impact on land will be the conversion of approximately 967 acres of land to industrial use. That portion of this land which will be occupied by the buildings housing the nuclear steam supply system must be considered irretrievable for the foreseeable future. However, there are no anticipated routine operations of the plant which would prohibit attaining full use of the surrounding land."

Any future land use proposals by TVA would preclude the use of the 1200 meter exclusion area as defined in Section 2.1.2.2 of the Watts Bar Nuclear Plant Final Safety Analysis Report (FSAR).

2. P. 6-4, Section 6.2.5

The staff requires a one-year preoperational aerial remote survey using color infrared and/or multispectral or multiband photography.

TVA Comment

We feel that the requirements dictated in this section, which involve one-year preoperational aerial remote survey using color infrared and/or multispectral or multiband photography, are costly and unnecessary. The NRC staff provides no explanation of the purpose for conducting such a survey, and we believe that NRC should provide TVA with its rationale for such a requirement prior to our initiating the photographic work.

ENCLOSURE II
TVA COMMENTS ON SPECIFIC DESCRIPTIONS
IN THE NRC STAFF
DRAFT ENVIRONMENTAL STATEMENT

1. Table of Contents, Page v, 3.2.5 Underdrain System

   Change "Underdrain" to "Power Transmission"

2. P. 2-1, Section 2.1, second paragraph

   It is stated that a threefold increase in industrial water utilization downstream from Watts Bar Nuclear Plant is now projected. Based on the assessment in Section 2.3, it is TVA's opinion, that this is an inaccurate statement and reflects an incorrect understanding and usage of basic information. The TVA Watts Bar environmental impact statement included information on the current water supply withdrawals at the time the statement was prepared and not the projected water uses. This information did not include future water supply withdrawals for Sequoyah or Watts Bar Nuclear Plants. The water supply data provided in the "Environmental Information-Supplement I" included the identification of the future water use withdrawals for Watts Bar and Sequoyah Nuclear Plants even though these withdrawals had not been initiated. It further identified reactivation of the Watts Bar Steam Plant and the potential water use by the Volunteer Army Ammunition Plant if it were reactivated. This latter installation was in operation at the time of the preparation of the FES however, it has subsequently been placed in layby status. Based on the data provided in the Environmental Information Supplement I, it is TVA's assessment that the current industrial water use withdrawals from Chickamauga Reservoir are approximately 3 million gallons per day. The NRC estimate of 164 million gallons per day appears to include 50 MGD for Volunteer Ordinance which is currently inactive, 111 MGD future water withdrawal for the Watts Bar Nuclear Plant and 3 MGD for C. F. Industries (formerly Farmer's Chemical).

3. P. 2-5, Section 2.2.2, first sentence on page

   We recommend the following sentence be substituted:

   > Rhea and Meigs Counties rated first and second in percent change of population increase among counties in the Southeast Tennessee Development District from 1970-1975.

4. P. 2-1, Section 2.2.1

   We recommend the following paragraphs be substituted for Section 2.2.1 in the draft EIS:

   2.2.1 Population Changes

   > The principal population centers within 50 miles of the Watts Bar Plant were indicated by the applicant in the FES. Population distributions, based on the 1970 Census of Population, and projected population distributions were included for the area within 0-10 and 0-50 miles of the plant for the years 1970, 1980, and 2000. This information has been updated and expanded to also provide projected population distributions within 0-10 and 0-50 miles of the site for the years 1978, 1990, 2010, and 2020. These data are provided in the Watts Bar Nuclear Plant Final Safety Analysis Report, Tables 2.2 through 2.15, which tabulate the distributions within $22\frac{1}{2}^{\circ}$ sectors and sections of annuli.
   >
   > Projected population data were based on county projections prepared by the Bureau of Economic Analysis (BEA), in cooperation with the Southern Economic Review Groups - Georgia, North Carolina, and Tennessee. These projections incorporated the Census Bureau's 1972 "Series E" national population projections. The Southern Economic Review Groups are cooperative Federal-State groups formed to assist BEA in preparing county projections for planning and development purposes. Subdivisions of the county estimates and projections were made by TVA, Navigation and Regional Economics Branch. These subdivisions were based on census and other maps, on judgments from field experience, and on such factors as topography, transportation networks, and historical growth patterns.
   >
   > In 1970 approximately 11,000 people lived within 10 miles of the Watts Bar Plant, with 80 percent of the population located between 5 and 10 miles of the site. The remainder of the area within 10 miles is sparsely populated. The population within 10 miles of the site is projected to grow to a little over 14,000 by the year 2020. Between 0 and 50 miles of the site, the population is presently about 654,000 and is expected to increase by over 38 percent to approximately 905,000 by the year 2020. Almost 50 percent of this total growth is expected to take place in the area between 40 and 50 miles from the site.

5. P. 2-1, last sentence on page

   Change "Canton" to "Clinton"

6. P. 2-5, Table 2.7 "1970-1975 Population Changes"

Please see the attached Table 2.7 which has been revised.

7. P. 2-6, first complete paragraph, first sentence

The construction activity peak has been revised to mid-1978 with approximately 3900 workers at the site.

8. P. 2-7. Section 2.3.2, second paragraph

It is noted that two temporary chemical cleaning holding ponds have been constructed in the yard holding pond area. TVA has not made a final decision concerning the disposition of these ponds upon completion of construction. If it is determined that future chemical cleaning operations may be required with the operating plant, TVA may elect to retain these ponds. If it is determined that future cleaning operations will not be required then the ponds will be leveled and graded in accordance with TVA's original plan as stated in the draft EIS.

9. P. 2-11, Section 2.4.3, paragraph 2

The reference to J. L. Marshall, Lightning Protection (reference number 31), at the end of the second sentence does not appear to be correct.

10. P. 2-11, Section 2.4.3, paragraph 2

We suggest the second sentence be rewritten as follows:

"The calculated resultant tornado frequency and the recurrence interval of a tornado striking any selected point in the 25,600 square kilometer (10,000 square miles) area containing the site is 7.6×10^{-4} tornadoes per year and 1,300 years, respectively."

This statement more accurately describes the results of the calculations by the Thom Method.

Table 2.7

1970-1975 POPULATION CHANGES

(CARCOG/SETDD* Population)

	Population			Annual Rate of Increase		
	1970	1973	1975	70-73	73-75	70-75
Meigs County	5,219	5,596	6,117	2.4	4.6	3.2
Decatur**	698	746	807	2.3	4.1	3.0
Rest of County	4,521	4,850	5,310	2.4	4.7	3.3
Rhea County	17,202	19,220	20,236	3.8	2.6	3.3
Dayton***	4,361	4,463	4,278	0.8	-2.1	-0.4
Graysville	951	1,155	1,220	6.7	2.8	5.1
Spring City	1,756	1,858	1,902	1.9	1.2	1.6
Rest of County	10,134	11,744	12,836	5.0	4.5	4.8
CARCOG/SETDD Total	509,369	538,720	548,889	1.9	1.0	1.5
Municipal Total	310,503	318,966	320,891	0.9	0.3	0.7
Rest of County Total	198,866	219,754	227,998	3.4	1.9	2.8
Tennessee	3,926,018	4,086,891	4,174,100	1.4	1.1	1.2

*Chattanooga Area Regional Council of Governments/Southeast Tennessee Development District.

**City is in two counties.

***City annexed area between 1970 and 1975 that was not included in the estimate.

Source: Current Population Reports, Series P-25, #658 and #690. U.S. Bureau of the Census.

11. P. 3-1, Section 3.2.1, last paragraph, first sentence

The concentration factor in the condenser circulating water system will average 1.9, not 1.6 and should be revised.

12. P. 3-18, "Containment Ventilation System"

(a) The containment ventilation system description assumes that the containment will be purged 24 times per year plus a 10 cfm continuous purge. We have assumed 6 containment purges per year plus a 10 cfm continuous purge.

(b) The 16,000 cfm containment cleanup system which was to operate for 16 hours before containment purge has been deleted.

(c) The auxiliary building HEPA filter has been deleted.

13. P. 3-21, Section 3.2.3.3

The statement, "When the resin is to be packaged, it will be sluiced to shipping containers but will not be solidified prior to shipment offsite for disposal." is incorrect and should be replaced by the following sentence:

> Spent resins will be combined with a suitable binding agent to form a solid matrix prior to offsite shipment for disposal.

TVA is preparing a response to WBNP FSAR NRC question 321.17, and will commit to solidification of spent resins prior to offsite shipment for disposal.

14. P. 3-22, second paragraph

The first sentence should be revised to read as follows: "TVA currently plans to use potassium chromate for corrosion inhibition in the component cooling water system."

15. P. 3-26, Table 3.7

The "Approximate Date Required" section of this table should be revised as follows:

TABLE 3.7

WATTS BAR TRANSMISSION SYSTEM DESCRIPTION

STEP I

Line Name	Voltage (kV)	Approximate Date Required
Bull Run-Sequoyah, Loop into Watts Bar Nuclear Plant	500	In Service
Watts Bar Hydro-Watts Bar Nuclear No. 1	161	In Service
Watts Bar Hydro-Watts Bar Nuclear No. 2	161	In Service
STEP II		
Watts Bar-Volunteer	500	June 1979
Watts Bar-Roane	500	In Service
Watts Bar-Sequoyah No. 2	500	In Service

16. P. 4-2, "Newly Proposed Watts Bar- Volunteer Transmission Line"- last paragraph

(a) First sentence change ". . . Tennessee State Historical Preservation Offices. . ." to ". . . Tennessee State Historic Preservation Officer. . ."

(b) Second sentence should be replaced with the following two sentences:

> Final historical and archaeological coordination has been completed. The Tennessee State Historic Preservation Officer has concurred with TVA's determination that the subject transmission line will not affect any historical or architectural properties included in or eligible for inclusion in the National Register of Historic Places."

This information was provided to the NRC by letter from J. E. Gilleland to Edson G. Case dated May 19, 1978.

17. P. 4-5, Reference 1

Change ". . . Volunteer Tennessee 500 kV. . ." to ". . . Volunteer, Tennessee - 500-kV. . ."

18. P. 5-3, Section 5.3.4, third paragraph, first sentence

In light of recent amendments to the Federal Water Pollution Control Act, made by the Clean Water Act, 91 Stat. 1567 (1977), which now subject Federal agencies to state administrative authority in the area of water pollution abatement, this statement is incorrect. To be correct, the statement should read:

> Even though the State of Tennessee now administers the NPDES in Tennessee, the NPDES permit for this facility will be issued by EPA because the NPDES permit drafting had already progressed substantially by the time the NPDES authority was transferred to Tennessee by EPA.

19. P. 5-3, Section 5.3.4, last paragraph, third sentence

The concentration of phosphorus resulting from initial metal cleaning wastes is limited to a maximum of 1.0 mg/l as elemental phosphorus, not as phosphate and should be clearly noted in the DES.

20. P. 5-5, Section 5.3.6, first paragraph

The plant intake and evaporation rate figures appear to be inconsistent with the figures in the table on page 3-3 and should be revised accordingly.

21. P. 5-5, last line on page

The discussion from the bottom of page 5-5 is not continued onto page 5-6, the discussion on page 5-5 should be completed.

22. P. 5-7, Section 5.4.1.2, eighth paragraph, last line

The word "spent" should be changed to "spend"

23. P. 5-9, Table 5.2

This table has been updated and should be replaced with the attached revised table.

24. P. 5-8, Section 5.4.2

Paragraphs three through six should be rewritten as follows:

Data for ichthyoplankton in the vicinity of the Watts Bar site during the 1976 spawning period (See Appendix C, Table C-16) indicate uniform distribution of the early life stages across a river transect. Therefore, ichthyoplankton entrainment approximates hydraulic entrainment. TVA has estimated that, for 1976, approximately 0.2 million eggs and 21.8 million larvae would have been entrained if the plant had been operational. These estimated losses represent 0.32 percent of the eggs and 1.08 percent of the larvae transported past the Watts Bar site. For 1977, losses were estimated at .69 percent of the eggs and .62 percent of the larvae. Table 5.2 shows the estimated entrainment for each family of fish collected. Only the freshwater drum (Sciaenidae) was represented in the collection of eggs. Clupeidae, including gizzard and threadfin shad, contributed approximately 91.5 percent of the total larvae collected. Freshwater drum and *Lepomis* supp. larvae contributed 5.5 percent and 1.9 percent, respectively. The clupeids, freshwater drum, and *Lepomis* are not restricted to the tailrace habitat for spawning success.

The importance of the tailrace as a spawning site for the migratory spawners was not demonstrated by the ichthyoplankton data. These taxa represented less than one tenth of one percent of the total larvae collected. The sauger, *Stizostedion canadense*, which would be expected to spawn in the tailrace area, is also one of only two identified host fishes for the glochidial stage of the endangered mussel, *Lampsilis orbiculata*. The ichthyoplankton data indicate limited abundance of sauger, i.e., only one larva was collected in 1976. The other identified host is the freshwater drum which would have been sustained entrainment losses during 1976 of 0.32 percent and 0.61 percent for eggs and larvae, respectively.

Based on the two years of ichthyoplankton data, it is concluded that the losses of ichthyoplankton due to entrainment will be at acceptably low levels and that neither the reservoir fishes nor endangered mussel will be significantly impacted by such losses. Additional monitoring of the ichthyoplankton passing the site indicated that the 1976 year was not atypical with regard to tailrace spawning. Data for 1978 will be collected and presented in the applicant's preoperational monitoring report.

Table 5.2

Estimated Seasonal Entrainment (%) of Fish Families Collected in the Tennessee River at Watts Bar Nuclear Plant, 1976 and 1977

	1976			1977		
Family	Number Transported	Number Entrained	Percent Entrainment	Number Transported	Number Entrained	Percent Entrainment
Sciaenid Eggs	6.62×10^7	2.15×10^5	0.33	4.46×10^7	2.59×10^5	0.60
Clupeidae	2.26×10^9	2.50×10^7	1.13	1.08×10^{10}	6.64×10^7	0.61
Hiodontidae	-	-	-	3.28×10^6	1.03×10^4	0.31
Cyprinidae	1.18×10^7	7.76×10^4	0.67	1.34×10^7	2.28×10^5	1.70
Catostomidae	3.73×10^5	-	-	3.26×10^7	8.07×10^4	0.25
Ictaluridae	1.37×10^7	2.52×10^4	0.18	1.80×10^7	1.78×10^5	0.99
Percichthyidae	2.45×10^6	3.85×10^4	1.55	4.34×10^7	2.89×10^5	0.67
Centrarchidae	6.23×10^7	6.30×10^5	1.01	2.81×10^8	2.53×10^6	0.90
Percidae	1.65×10^5	-	-	3.73×10^6	2.70×10^4	0.72
Sciaenidae	1.61×10^8	9.82×10^5	0.61	3.18×10^8	1.73×10^6	0.54
Total Eggs	6.87×10^7	2.15×10^5	0.32	7.56×10^7	5.20×10^5	0.69
Total Fish	2.51×10^9	2.18×10^7	1.08	1.15×10^{10}	7.11×10^7	0.62

25. P. 5-21, Table 5.10

(a) The section for gaseous effluents includes a comment that the maximum effect of Rn-222 is "presently under consideration by the Commission." The DES presents data on page 5-23 which could be incorporated into Table 5.10.

(b) At the bottom of the page in the table title "(NUREG-0016)" should be "(NUREG-0116)"

26. P. 5-25, Section 5.6

All discussions of "operators" should be revised to "operating personnel."

27. P. 6-1, Section 6.2.1

(a) In this section the 10-meter level is converted to 30 feet, however, the correct conversion is 33 feet.

(b) The dew point is not measured at the one-meter level which is not indicated in the third from the last sentence in this section.

(c) The next to the last sentence in this section should be changed to read "A dew point sensor is operational at the 10-meter (33-foot) level."

28. P. 6-1, Section 6.2.4, first paragraph, last sentence

Baseline monitoring of adult fish populations in the vicinity of the plant will be continued through to March of 1979. The last sentence should be revised accordingly.

29. P. 6-2, "1. Objectives and Scope"

The first sentence should be revised to read, "The objective of this 2-year study (March 1977 - March 1979). . . "

30. P. 604, Section 6.3.1

The second sentence is not clear and should be changed to read, "Vertical temperature gradients between the 10- to 46-meter (33- to 150-foot) and the 10- to 91-meter (33- to 300-foot) levels, and the 10-meter (33-foot) temperature and dew point measurements will be displayed in the reactor control room."

31. P. 6-9, Reference 4, second line

Change ". . . Line Connection, . . ." to ". . . Line Connections,..."

32. P. 8-2, Footnote

The date "1958" should be revised to "1978"

33. P. 9-1, Section 9.1, last two sentences

The Watts Bar Nuclear Plant operation delay has been due to construction delays, not forecast reductions as indicated in the draft EIS and Watts Bar units 1 and 2 are now scheduled to begin operation in December of 1979 and September 1980, respectively.

34. P. 9-2, Section 9.3.1

The 1,300 MW of pumped-storage capacity should not be included with hydro and Browns Ferry Nuclear Plant units 1 and 2 as having lower operating cost than the Watts Bar units. All the capacity used to pump the pumped-storage units will have higher costs than Watts Bar units 1 and 2, and therefore the pumped-storage cost would also be higher.

35. P. 10-1, Section 10.2.2, first paragraph, second sentence

Change ". . . full time operators." to ". . . full time operating personnel."

36 Appendix C, P. C-7, third complete paragraph, line fourteen

The sentence beginning "The percent contribution . . .". The generally higher numbers of blue-green algae in the spring and fall of 1975 referred to in this sentence were not found in the 1976 samples. Therefore, it would be difficult to ascribe any significance to the high numbers obtained in 1975. (The 1976 phytoplankton data was submitted to NRC by letter from J. E. Gilleland to O. D. T. Lynch dated January 3, 1978.

37. Appendix C, P. C-13, "Secondary Production - Benthos"

A recent mussel survey in Chickamauga Reservoir in the vicinity of TRM 520.2 has revealed the presence of Dromus dromas, a species of mussel on the Department of Interior's list of threatened and endangered species. A brief statement summarizing this finding is as follows:

> During a June 7-8, 1978, mollusk survey conducted in Chickamauga Reservoir for other TVA program activities, two specimens of Dromus dromas were collected. This represents the first reported occurrence of this mussel species in Chickamauga Reservoir. This species is listed on the Department of threatened and endangered species. During the survey specimens of D. dromas and L. orbiculata were collected between Tennessee River Mile (TRM) 520.0 and TRM 521. This is the first record of L. orbiculata being collected at a location other than near TRM 527.7. This collection verifies that L. orbiculata is more widely distributed in Chickamauga Reservoir than previous data had indicated. The area where D. dromas was collected is located on the left overbank of the reservoir, 7.6 miles downstream from the Watts Bar Nuclear Plant. Because of the initial rapid mixing to be provided by the Watts Bar discharge diffuser and the subsequent additional mixing which will occur in the 7.6-mile reach of the river, the area of collection will not be subjected to plant induced stresses.

38. Appendix E, Draft NPDES Permit

Attached for your information is a copy of the two letters which were submitted to EPA containing the comments generated from TVA's review of the draft NPDES permit.

39. Appendix E, P. E-15, draft 401 Certification from the State of Tennessee.

When available TVA will provide the NRC a copy of the letter sent to the State of Tennessee containing the comments generated from TVA's review of the draft 401 certification.

April 14, 1978

Mr. John C. White
Administrator, Region IV
Environmental Protection Agency
345 Courtland Street, NE.
Atlanta, Georgia 30308

Re: Watts Bar Nuclear Plant
NPDES Permit No. TN0020168

Dear Mr. White:

We have reviewed the draft NPDES permit and Draft 316(a) Tentative Determination for the referenced facility, and have the following comments and requests.

The permit as drafted will expire on September 30, 1980, thus limiting the effective period to approximately two years. Although regulations do not require that the NPDES permits be issued for five-year terms this has been the practice for permits issued to date and is based on sound policy and legal considerations. Section 101(f) of the Federal Water Pollution Control Act states that it is the national policy to make the best use of available manpower and funds in implementing the Act. Significant costs and manpower resources are involved in obtaining an NPDES permit for a nuclear plant. We can see no benefit for requiring that the permit process, and resulting expenditure of funds and commitment of resources by TVA and EPA, be reported within two years.

Part III., section P suggests that the permit shall be modified or revoked and reissued to comply with applicable effluent limitations promulgated pursuant to the settlement agreement in Natural Resources Defense Council v. Train, 8 ERC 2120 (D.D.C. 1976). It is our view that neither the consent decree nor the FWPCA require or authorize the conditions specified in Part III., section P.

We also have the following comments and requests related to specific permit effluent requirements.

Part I, page 3, Serial 002

The mixing zone dimension indicated in the draft permit is 225 feet for both width and length. As shown in the TVA report WM28-1-85-100, February 1978, the dimensions for both length and width should be 240 feet.

Monitoring for suspended solids, settleable solids, total dissolved solids, ammonia nitrogen, copper, iron manganese, and zinc have been included for this serial discharge and the plant intake, Serial 019. The plant will operate with low cooling cycles of concentration and there will be no additions of the listed constituents to the cooling water. Any additions

of these constituents through inclusion of low-level wastes below detectable amounts in the discharge. Additionally, there is no justification for these requirements included in the guidelines for this category. We request that this monitoring requirement be deleted.

Part I, page 8, Serial 007

The source listed as a "neutral waste sump" is a neutralizer waste tank; however, we did not revise the flow diagram to indicate this change, nor do we request that the permit language be changed. The comment is included to clarify any misunderstanding.

Part III.A., page 20

The Serial 005 referred to in this section should be changed to Serial 004.

In addition to the draft permit and Draft 316(a) Tentative Determination, we have reviewed the March 24, 1978, letter from Mr. George L. Harlow to Mr. Jack McCormick, Tennessee Department of Public Health. The letter states that "any conditions felt warranted by your office can be included in your certification for this project and will be appended to the NPDES permit." Under the Clean Water Act of 1977, TVA is no longer exempt from state certification pursuant to Section 401. This section specifies that the certification must set forth limitations and requirements necessary to ensure compliance with Sections 301, 302, 303, 306, and 307 of the FWPCA. However, it does not provide that a state can include "any condition felt warranted" in a certification and provide that the condition becomes an NPDES permit condition.

Pursuant to discussions with Mr. Charles H. Kaplan of your staff, we have enclosed two copies of a revised Water Use Diagram and supplemental thermal data which was developed in response to specific questions from Mr. Kaplan. Two copies of the Water Use Diagrams of reproduction quality were sent directly to Mr. Kaplan.

If you have any questions concerning these comments and requests, please let me know.

Sincerely yours,

Harry G. Moore, Jr., Ph.D.
Acting Director of Environmental
Planning

June 30, 1978

Mr. John C. White
Administrator, Region IV
Environmental Protection Agency
345 Courtland Street, N.E.
Atlanta, Georgia 30308

Re: Watts Bar Nuclear Plant
NPDES Permit No. TN0020168

Dear Mr. White:

We have reviewed the Public Notice, and Notice of Proposed Section 316(a) Determination for the above-referenced facility and have the following comments.

The letter from Mr. George L. Harlow to me, in response to TVA's previous comments concerning the expiration and language of Part III.P., stated that these requirements are in conformance with present headquarter's directives. However, we wish to reiterate TVA's previous comments.

The permit as drafted will expire on September 30, 1980, thus limiting the effective period to approximately two years. Although regulations do not require that the NPDES permits be issued for five-year terms, this has been the practice for permits issued to date and is based on sound policy and legal considerations. Section 101(f) of the Federal Water Pollution Control Act states that it is the national policy to make the best use of available manpower and funds in implementing the Act. Significant costs and manpower resources are involved in obtaining an NPDES permit for a nuclear plant. We can see no benefit for requiring that the permit process, and resulting expenditure of funds and commitment of resources by TVA and EPA, be repeated within two years.

Part III., section P suggests that the permit shall be modified or revoked and reissued to comply with applicable effluent limitations promulgated pursuant to the settlement agreement in Natural Resources Defense Council v. Train, 8 ERC 2120 (D.D.C. 1976). It is our view that neither the consent decree nor the FWPCA require or authorize the conditions specified in Part III., section P.

We also have the following comments and requests related to specific permit requirements.

Part I, Serial 002

We wish to reiterate our comment included in my April 14, 1978, letter concerning the monitoring required for this serial discharge and Serial 019.

The plant will operate with low cooling cycles of concentration and there will be no additions of the listed constituents to the cooling water. Any additions of these constituents through inclusion of low-level wastes should be below detectable amounts in the discharge. Additionally, there is no justification for these requirements included in the guidelines for this category. We request that this monitoring requirement be deleted.

This serial discharge together with Serial 001 contain Serial Discharge 003, 004 and 008 at the point of discharge, and both 001 and 002 have applicable pH limits. We therefore request that the pH limit for 003, 004 and 008 be omitted.

Part I, Serial 005

We request that the monitoring requirements of the parameters chlorine residual and fecal coliforms be deleted. With this deletion, the monitoring requirements in the permit would be consistent with the monitoring requirements established by the State of Tennessee in the Section 401 Certification.

Part I, Serial 008

We request that a footnote be added stating that the limitations and monitoring are not applicable when discharge is to be the radwaste treatment system.

Part III, Item J

The preoperational nonradiological aquatic monitoring programs referred to in this section have already been implemented, and portions have been completed. Detailed descriptions of these programs were submitted to Mr. Charles H. Kaplan, of EPA, by letter from Dr. Peter A. Krenkel, dated August 31, 1977. It is our understanding that this item would reflect EPA's approval for these programs in the final permit.

Part III, Item K

The operational nonradiological aquatic monitoring programs have already been submitted to Mr. Kaplan by letter from Dr. Krenkel dated August 31, 1977. We understand this section will reflect EPA's approval of these programs in the final permit.

In addition to these comments, we are sending to the State of Tennessee and to you under separate cover TVA comments on the Tennessee draft certification.

Mr. John C. White June 30, 1978

If you have any questions concerning these comments and requests, please let me know.

Sincerely yours,

JLh III

Harry G. Moore, Jr., Ph.D.
Acting Director of Environmental Planning

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV

345 COURTLAND STREET
ATLANTA, GEORGIA 30308

50-390
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AUG 1 1978

Mr. William H. Regan, Jr.
Chief, Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

We have reviewed the Draft Environmental Impact Statement on the Watts Bar Nuclear Plants, Units 1 and 2, and have determined that the facility is capable of meeting the environmental radiation standards for nuclear power operations, 40 CFR 190 as well as the dose design objectives of 10 CFR 50, Appendix I.

There are, however, a number of areas which should be addressed in further detail in the Final Statement, i.e., the limits and control of all radionuclide plant effluent covered under the technical specifications for plant operation; the discharge of liquid radwaste; sensitivities of radiation monitors at the various effluent release points in terms of their ability to measure radioactivity concentration limits and discharge, and the radio-chemical toxicity of releases.

SPECIFIC COMMENTS

Pg. 5-23 Radioactive Effluents

The application of 100-year environmental dose commitment (EDC) for radioactive effluents such as Radon-222 is appropriately noted. We are encouraged that NRC is calculating EDC's as this is a big step toward evaluating the total EDC which EPA has urged for several years. Assessment of the total impact of the nuclear fuel cycle should incorporate the projected releases over the lifetime of the plant rather than just the annual release and be extended to consider for several half-lives or 100 years beyond the period of release.

Pg. 8-1 Decommissioning and Land Use

Upon completion of power generation a commercial nuclear power plant possesses waste characteristics quite different from those generated during operation. The environmental

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effects of a plant's considerable value and radioactive inventory should receive consideration in its decommissioning plan before the end of the reactor's useful life. Considering the size, complexity and number of commercial nuclear power plants, it would appear prudent to begin planning for decommissioning in an ALRRA fashion as early in plant life as possible. For example, it may be necessary to institute plant design changes to facilitate future dismantling. In addition, evaluation of social impacts and resource commitment on present and future generations should be considered. We believe an orderly decommissioning procedure should be developed for each site containing a LWR nuclear power plant well before its retirement.

Relative to non-nuclear discharges, it should be noted that the NPDES permits for the sewage treatment plant (Pages E-2 and E-3) must be consistent with the more stringent State permit (Page E-15) for fecal coliform and chlorine residual effluent characteristics. It would also be advantageous to show in Figure 3.3 the approximate location and length of the water treatment plant outfall pipe. This pipe must be extended to an adequate length into the river to guarantee proper dilution and mix.

On the basis of the above, the facility was rated LO-2, i.e., no significant environmental objections, however, additional information is requested. As soon as the final statement is available, we will need five copies for our review.

If we can be of further assistance, feel free to call on us.

Sincerely yours,

John A. Little, Deputy

for John C. White
Regional Administrator

TENNESSEE
STATE PLANNING OFFICE

RAY BLANTON
Governor

STEPHEN H. NORRIS
Director

660 CAPITOL HILL BUILDING
301 SEVENTH AVENUE, NORTH
NASHVILLE, TENNESSEE 37219
615-741-1676

August 7, 1978

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 2
Division of Site Safety and Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

RE: DEIS - Watts Bar Nuclear Plant, Units 1 and 2, TVA

Dear Mr. Regan:

Please find enclosed comments from the Tennessee Department of Conservation concerning the above referenced EIS.

If I may be of further assistance, please contact me.

Sincerely,

Bette A. Osborne

Bette A. Osborne
Natural Resource Staff

BAO/fe

Enclosure

7822?0080

Tennessee Department of CONSERVATION

Division of Planning and Development

2611 West End Ave. Nashville, TN 37203 [615] 741-1061

MEMORANDUM

TO: Bette Osborne

FROM: Walter L. Criley WLC

DATE: August 1, 1978

SUBJECT: Draft Environmental Statement
Operation of Units 1 & 2 Watts Bar
Nuclear Plant TVA

The Tennessee Department of Conservation has reviewed the above referenced proposed project and submits the following comments:

The data base of the Tennessee Heritage Program shows the following reported occurrences of significant elements of natural diversity near the site of the Watts Bar Nuclear Plant:

Lampsilis orbiculata (Pink Mucket Pearly Mussel) Listed as an Endangered species on Federal Lists[1], State Lists[2], and Lists of the Tennessee Heritage Program. Collected 1.0 mile below Watts Bar Dam - 1975.

Pleurobema cordatum Lea (Pigtoe Pearly Mussel) Listed as a species of Special Concern by the Tennessee Heritage Program. Collected 1.0 mile below Watts Bar Dam - 1975.

Pandion haliaetus (Osprey) Listed as an Endangered species on State Lists and Threatened on Lists of the Tennessee Heritage Program. Old nest site on Yellow Creek about 0.5 kilometer from the Tn. R. A pair of mature birds seen at site in April of 1974.

This Environmental Statement acknowledges the existence of an Osprey nest within the project area and states that the species is not classified as threatened or endangered by the U.S. Fish and Wildlife Service. This may be true; however, the Tennessee Wildlife Resources Agency has classified the bird as Endangered in Tennessee and the Tennessee Heritage Program lists it as Threatened. Care should be taken to protect this nest site from disturbance or destruction since it may once again be utilized in the future. The Tennessee Heritage Program data base shows only five active Osprey nests in the State of Tennessee in 1978.

This plant is on a section of the Tennessee River which has been designated as a mussel sanctuary (control area) by the Tennessee Wildlife Resources Agency. This section of the river serves as habitat for one known Federally endangered species and another which is of Special Concern to the Tennessee Heritage Program due to its limited distribution.

While the report indicates that the aquatic biota will not be significantly impacted, care should be taken to prevent continued degradation of this section of the Tennessee River since it is already classified as "effluent - limited" due to the fact that it does not meet dissolved oxygen criteria for the protection of aquatic biota[3].

The Tennessee Valley Authority anticipates occasions when the river temperature will exceed the 30.5°C (86.9°F) which has been set as a maximum acceptable level by the Tennessee Water Quality Control Board and the Environmental Protection agency. Such a situation would most likely occur during summer months when the river's flow rates are low and power generating demands are high. The low flow rates could result in increased concentrations of the estimated 987 kg/day of Sulfate, 630 kg/day of Sodium and 344 kg/day of Chloride contained in the plant effluent. This situation would represent a significant stress to the aquatic biota in the river downstream of the plant.

1
USDI/FWS 1976 U.S. Federal Register 41 (115) June 14, 1976 .

2
Tennessee State List - Enabling Authority - "Tennessee Nongame and Endangered or Threatened Wildlife Species Act of 1974 (Public Chapter 769)"

3
Water Quality Management Plan for the Upper Tennessee River Basin, Tennessee Department of Public Health, Nashville, October 30, 1975

pm

cc: Bill Yambert

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

830 Power Building

SEP 8 - 1978

Mr. Daniel Muller, Acting Director
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Muller:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

Please refer to TVA's submittal to you on July 31, 1978, regarding TVA's comments on the Nuclear Regulatory Commission's (NRC) Draft Environmental Impact Statement (EIS) for the TVA Watts Bar Nuclear Plant (WBNP).

Item 13 on page 5 of Enclosure II was submitted in error and should be deleted. The statement on p. 3-21, Section 3.2.3.3 of the aforementioned EIS regarding spent resin packaging is correct as written. TVA is preparing a response to WBNP, FSAR, NRC question 321.17 which will restate TVA's position on this matter. Mr. O.D.T. Lynch of your staff was notified by telephone of this correction on August 23, 1978.

Very truly yours,

J. E. Gilleland
Assistant Manager of Power

cc: Ms. Suzanne Keblusek, Project Manager
Environmental Projects Branch 2
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, DC 20555

PLENTY

ENFORCEMENT DIVISION

THE FARM – 156 DRAKES LANE – SUMMERTOWN, TENNESSEE 38483 – PHONE (615) 964-3574

RE: Application No. TN0020168
Public Notice No. 78TN006
NPDES Permit Application
Tennessee Valley Authority
Watts Bar Units 1 and 2

June 28, 1978

Enforcement Division
Environmental Protection Agency
345 Courtland Street, NE
Atlanta, Georgia 30308
ATTN: Mona Ellison

Dear MS. Ellison,

I received Notice 78TN006 on June 26, 1978. I am submitting this comment before the close of the thirty day period on July 1, 1978. I wish the contents of this comment to be fully addressed before the NPDES permit is issued for this application.

My name is Albert Bates. I reside at 156 Drakes Lane, Summertown, TN, 38483. I make this comment on behalf of PLENTY, a world charitable relief organization, by virtue of our interest in the State of Tennessee and the North American continent as a suitably safe and healthy habitat.

I agree to be subject to examination on all matters contained herein at our own expense. Areas which I contest are those set out in the Application's section 1.e., page 1, Proposed Pollution Abatement Facilities--neutralization and/or sedimentation of plant operating wastes: and PART I, Section A, page 7, EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS--Liquid Radwaste System. The part of the system I am concerned with is outlined on the diagram I enclose.

1. e. Description of Proposed Pollution Abatement Facilities

COMMENT:

The proposed radioactive liquid waste treatment system is one which allows some portion of the radwaste to be discharged into the Tennessee River. This system cannot be considered effective in eliminating radioactive liquid waste from the waste water discharge. Unless an alternate system with proven effectiveness is substituted, all unnaturally radioactive waste water should be gathered and stored for permanent isolation from the biosphere.

The proposed pollution abatement system would certainly result in loss of life and serious debilitating diseases to the population downstream, and within the water-currents of the air-ocean world, now and in ages to come. Permanent degradation of the life-cycle--by permitting sedimentation of persistent, highly toxic radionuclides in the fresh water channels which sustain life--is criminally irresponsible.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS--Liquid Radwaste System

COMMENTS:

(1) Applicant-permittee proposes to limit discharges to the Tennessee River to 15 mg/l average and 20 mg/l maximum liquid radwaste daily. Dilution factors--the mg/l notation--make no indication of the weight, activity, persistence, or biological effectiveness of the suspended solids comprising the liquid radwaste discharge. Such indications are necessary for any realistic assessment of potential damage to biota.

(2) Several hundred different actinides may be contained in the discharge, principal among them being H-3, Ra-226, Cs-137, Sr-90, and I-131 by volume; Y-90,91, Rn-222, Ra 224,225, Th-234, and Cm-242 by activity; Ni-59, Rb-87, I-129, Cs-135, U-233,234,235 236,238, Np-237, Pu-242,244, and Cm-247 by persistence; and C-14, K-42, Po-210, Pu-236, 238, 239, 240, 241, and Am-241 by biological effectiveness. The permit neglects to specify any breakdown of these radionuclides, each of which presents a characteristic individual hazard to health.

(3) The proposed radwaste discharge is carcinogenic, teratogenic, mutagenic, and has non-specific immunity-reducing and life-shortening effects possible at doses well below that expected in drinking water downstream of this discharge. NRC and EPA have calculated health effects, including cancers and genetic diseases, expected in the general population, and found this acceptable. NRC does not have constitutional authority to accept health effects on behalf of unconsenting private citizens. Recent EPA public forums have demonstrated strong public opposition to the imposition of radioactive poisons on future generations. Recent acts of Congress have expressly forbidden release of cancer-causing material to the population. The Tennessee Code forbids intentional poisoning under penalty of life imprisonment.

(4) Health, physical security, and life are rights and privileges secured by the federal and state constitutions to all citizens. They may not be deprived without due process, meaning individual legal proceedings against any citizen to be deprived. Issuance of the permit as presently written would serve to deprive unspecified citizens of these rights and privileges and would thereby constitute "state action" within the meaning of § 42 U.S.C.A. 1981-5, the Civil Rights Acts. Moreover, this deprivation would fall unequally upon those with greatest susceptibility or who experienced the greatest exposure by virtue of geographic location or personal lifestyle. Such discrimination would run contrary to the Equal Protection Clause of the U.S. Constitution. EPA and the State of Tennessee are specifically forbidden from awarding the permit.

(5) Deaths to present and future generations projected by EPA and NRC to result from liquid radwaste discharges to the biosphere, insofar as they are committed intentionally by TVA, EPA, and State Public Health are humanicide within the meaning of the Nuremburg proceedings, the U.N. Declaration of Human Rights and subsequent covenants, and international treaties to which the United States is signatory. Humanicide is a crime of state for which individual officers, acting in their official capacity, may be held personally responsible.

(6) EPA and TVA have estimated the dose to an individual maximally exposed to the liquid radwaste discharge after dilution in the Tennessee River to be less than 1 millirem (mrem) per year. While this figure is extremely unrealistic and non-conservative, it can be accepted momentarily for the sake of argument. Recent scientific evidence based upon human experience and laboratory work in vitro at low dose ranges (not mathematically extrapolated downward from A-bomb doses as the older data had been) indicates that 0.1 to 1 mrem increases cellular damage 1%. EPA estimates that radiation causes 22,224 health effects/yr. in the U.S.. Background

radiation is postulated now to be the cause of a very large percentage of all non-accidental deaths in the world population. Increases of even a single mrem yearly can therefore be seen to have significant impact on the public health. This impact is undesired by the majority of its victims. While EPA and State permissible limits are constantly revising downward in light of new evidence of serious risks previously unrecognized, the long-term genetic ramifications of past error are yet multiplying. Where radiation is concerned, there is no safe dose, and no known human tolerance.

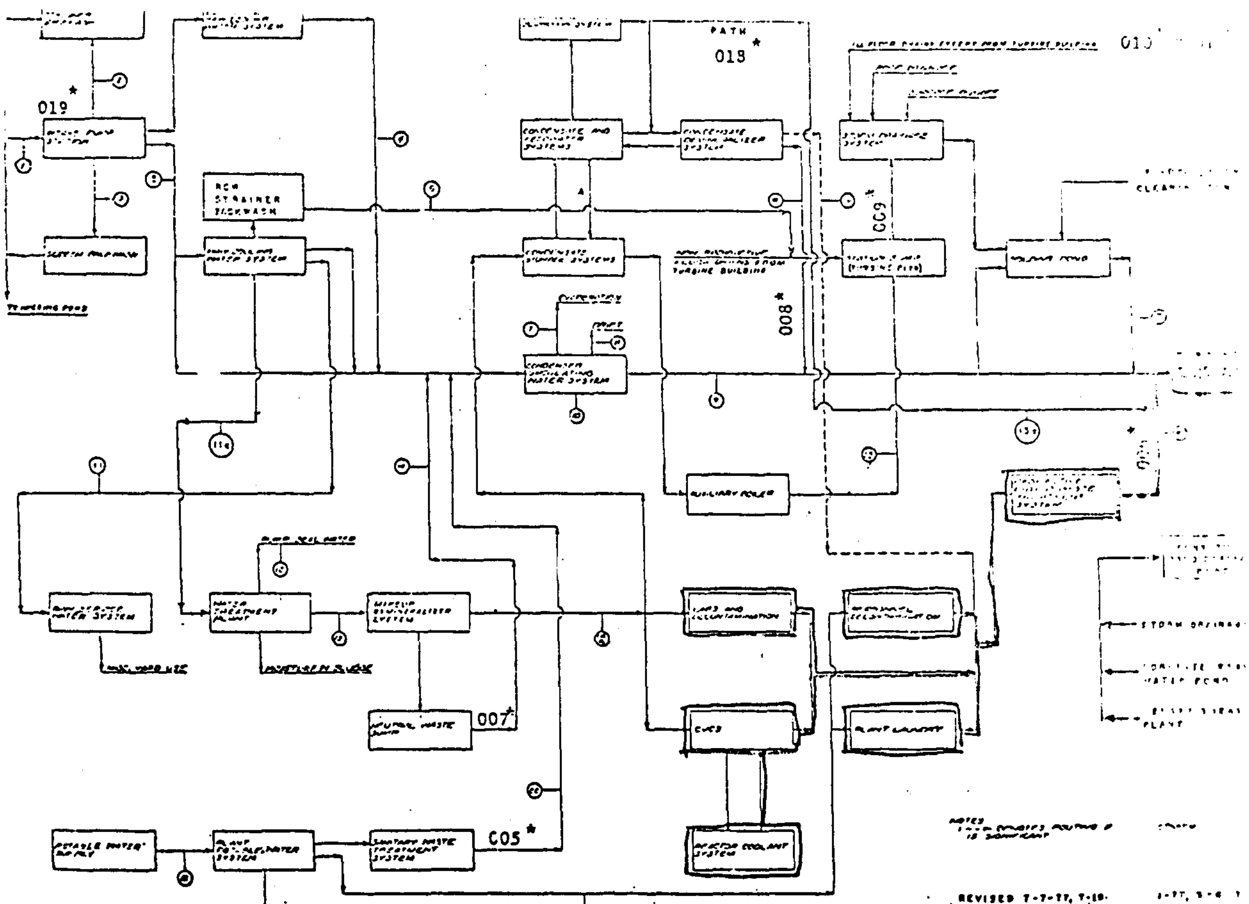
Respectfully submitted,

Albert Bates

cc:f

Water Quality Control Board
Tennessee Department of Public Health
621 Cordell Hull Building
Nashville, TN 37219

Mr. David Freeman
Tennessee Valley Authority
TVA Towers
Knoxville, TN



* Serial numbers ... [illegible] identification ... [illegible]

WATTS BAR NUCLEAR PLANT – WATER USE DIAGRAM

Rivers, bays and oceans change low-level radiation (nuclear fission products) into high-level concentrations and, therefore, high human risks for cancers and unwanted genetic changes. These fission products also bring about unhealthy changes in the natural aquatic biota from biological magnification in aquatic food webs. These kind of changes tend to make humans the endangered species of our planet, the earth.

PUBLIC HEARING DEMOCRACY

TVA's Draft Environmental Statement concerning the construction of Yellow Creek Nuclear Plant near Iuka, Miss. (Docket numbers STN 50-566 and STN 50-567, as of June 1977, NRC.

To:— Second phase of this hearing dealing with radiological health and safety, July 6, 1978, at Tishomingo County Court-house, Iuka, Mississippi.

And to:— U. S. Environmental Protection Agency, Region IV, Water Enforcement Branch, 345 Courtland Street, Atlanta, Ga. 30308.

Regarding the proposal for issuance of Pollutant Discharge System Permit for Yellow Creek Nuclear Plant (and Watts Bar-NPDES TN0020168).

From:— Louis G. WILLIAMS, Ph. D., Aquatic Ecologist, Dept. of Biology, P. O. Box 1927, University, Alabama 35486.

In the United States nuclear power plants are allowed to discharge low-level liquid radwastes and radioactive gases respectively into public waterways and the atmosphere. The intermediate liquid radwastes must be shipped to NRC-approved sites for burial (however, some sites have been closed since they were found badly leaking). The high-level radwastes, such as spent reactor fuels and wastes from atomic weapons development and production are not buried. These are stored in water in tanks at nuclear plants or at special storage sites. At this time there is no approved method for their permanent disposal for the U. S.

This statement concerns the discharge of low-level liquid radwastes to the Tennessee River and its tributaries and my own radio-analysis of river samples which show high concentrations of fission products by aquatic organisms and bottom sediments in the Tennessee River, particularly into Pickwick Lake. This reservoir would receive more radwastes from the proposed Yellow Creek Nuclear Plant.

Many managers of liquid wastes operate under the assumption that dilution is the solution to pollution. However, many substances do not stay diluted but instead tend to build to high concentrations in sediment fractions and in aquatic food webs by biological magnification. The organisms have not read the impact statements. This phenomenon is particularly the situation for fission products ^{90}strontium and ^{137}cesium, having physical half lives of about 3 decades and variable biological half lives.

My studies at the Oak Ridge National Laboratory and at the R. A. Taft Sanitary Engineering Center in Cincinnati, prior to 1966 and at the University of Alabama since 1967 clearly indicate that many radionuclides from various terrestrial radioactive waste burial sites do move into waterways, such as from the Conasauga shale burial sites at Oak Ridge, Tenn.

These intermediate level wastes from sites such as these at Oak Ridge and low-level liquid radwastes from current operating nuclear power plants of the Tennessee River pose a threat to human health because they can get into humans when their high concentrations following concentration in the waterway are released into public drinking water supplies, following dieoff of dense populations of phytoplankton-zooplankton communities, or from eating fishes with high concentrations of fission products.

Impact statements simply have not addressed this problem. Studies of many people with today's cancers have been recently correlated with low-level exposures 15 to 30 years ago. Cancers from X-radiation in hospitals have payoff benefits, but there are no benefit from drinking, eating, or inhaling radioactive substances from the environment from radwastes.

The kind of radionuclides, such as ^{60}cobalt, uranium, radium, and plutonium, are quite different from the fission products from current nuclear reactors. Their half lives are very long, such as 24,000 years for the most toxic substance on earth PLUTONIUM. The cycling of nuclear waste products in land, water, air, and biomass is very complex, especially when the wastes have been buried with chelating agents, such as EDTA such as the burial sites at Oak Ridge.

Even though the cooling system is "closed" current nuclear plants normally discharge a lot of radwaste water to waterways that contain unwanted radionuclides formed as products of fission of ^{235}uranium and from becoming radioactive following neutron bombardment while a part of the reactor core or the cooling system. The practise of using EDTA chelation for cleaning or decontamination, because of its strong metal-bonding properties, also contributes to the radionuclides becoming more hazardous when they are discharged into public waterways.

I was the senior author of an article published on November 25, 1960, dealing with organic materials as monitoring tools for radionuclides in the public waterways. This article reports on methods developed to detect trace levels of radionuclides.

MORE ON THE REVERSE SIDE

This article in SCIENCE and several others in Limnology & Oceanography and in Ecology and other journals demonstrate methods of analysis of the raw water itself for dissolved radionuclides. In concentrating trace amounts of nuclides from large volumes of sample, particularly where evaporation, precipitation, or ion-exchange techniques are used, the stable salt concentrations in the diluting medium interfere with the subsequent separation of the specific radionuclides. To avoid these difficulties a technique utilizing dead organic and living biological concentrations under natural stream conditions was investigated. Radio-analysis of algae from natural aquatic habitats has shown a greater variety and higher concentration of radionuclides than an analysis of the water in which the algae live. Average concentration factors are about 7000 times, but under ideal or optimum conditions they may concentrate several hundred thousand times.

This technique for working with radionuclides in natural waterways was modified to measure the methylation uptake of low trace mercury in the Tennessee River. Presently bottom sediments and ooze deposits in Pickwick Lake are loaded with both nonradioactive mercury, and several fission products. These have an adverse effect on this aquatic ecosystem.

Shortly after the first commercial nuclear power plant went into operation at [illegible] Shipping Port, Pa., on the Ohio River, I was able to detect fission products in the river. This was also done in the Hutson and the Columbia Rivers in the early days of nuclear power development.

The Nuclear Regulatory Commission allows current nuclear plants to dispose of low-level liquid radwastes to rivers, lakes and oceans, but no monitoring of their fate (to my knowledge) is done to determine their fate in the aquatic ecosystem, where many of them become concentrated to hazardous levels to both humans and the aquatic organisms when the ecosystem is distrubed.

A large filamentous green alga, Pithophora, with a high toleration for most freshwater environments, was grown free of silt and interfering radionuclides, packaged into liter-size polyethylene bags, with each bag having 400 evenly spaced pores about [illegible] micrometers in diameter. Phytoplankton was also used, but the small size of the pores, 70 micrometers, necessary to retain them, reduced the rate of water exchange, but [illegible] [illegible], because of the ratio of the [illegible] [illegible] to water, do [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] this.

The proposed Yellow Creek Nuclear Plant would be adding more producers of waste fission products to the Tennessee River, while taking out some of the river and putting it into the atmosphere for cooling a nuclear plant can only magnify a system of too much production of nuclear garbage than the aquatic ecosystems of the Tennessee River and downstream Ohio and Mississippi can bear.

Recent studies by others indicate that about 90 percent of cancers have environmental causes. Should we wait for 10 to 20 years to establish that low-level liquid radwastes will greatly increase the incidence of cancer?

For environmental purposes when dealing with radiological problems the public must be told that we should talk less about radiation and more about radioactive substances that get in the bodies of living organisms where they continually put out ionizing radiation, which should not be compared with small dose of X-radiation, which are of short durations, while radioactive substances inside of organisms have biological half lives that may be of long-term duration.

Ionizing radiations do produce unwanted hereditary changes, which are irreversible and accumulative. There is no threshold below which there is not an effect. Do we have a right to give future generations an environment that will be intolerable? Isn't the problem that mankind is becoming the endangered species? How can we estimate the costs of medical care from cancers and genetic defects? These are not included in impact statements, but they do result in large medical expenses to some people. How can an impact statement quantify the potential cause of cancer and birth defects?

When some flagellate protozoa substitute the fission product, 90strontium for calcium, their motile organelles fail to properly develop and their survival is greatly reduced. Since the advent of fission products in waterways from air test fallout, and nuclear power plants, the diversity of river planktonic organisms has been greatly reduced. How much of this is a result of low-level radwastes?

The Fire at [illegible] Ferry [illegible] [illegible]

APPENDIX B

NEPA POPULATION DOSE ASSESSMENT

Population dose commitments are calculated for all individuals living within 50 miles of the facility employing the same models used for individual doses (see Regulatory Guide 1.109 in preparation). In addition, population doses associated with the export of food crops produced within the 50-mile region and the atmospheric and hydrospheric transport of the more mobile effluent species such as noble gases, tritium, and carbon-14 have been considered.

5.B.1 Noble Gas Effluents

For locations within 50 miles of the reactor facility, exposures to these effluents are calculated using the atmospheric dispersion models in Regulatory Guide 1.111 and the dose models described in Section 5.1 and Regulatory Guide 1.109. Beyond 50 miles, and until the effluent reaches the northeastern corner of the United States, it is assumed that all the noble gases are dispersed uniformly in the lowest 1,000 meters of the atmosphere. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than one year (e.g., Kr-85) were assumed to completely mix in the troposphere of the world with no removal mechanisms operating. Transfer of tropospheric air between the northern and southern hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemispheric mixing.

Since this time constant is quite short with respect to the expected midpoint of plant life (15 yrs), mixing in both hemispheres can be assumed for evaluations over the life of the nuclear facility. This additional population dose commitment to the U.S. population was also evaluated.

5.B.2 Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind, which continuously reduces the concentration remaining in the plume. Within 50 miles of the facility, the deposition model in Regulatory Guide 1.11 was used in conjunction with the dose models in Regulatory Guide 1.109. Site specific data concerning production, transport and consumption of foods within 50 miles of the reactor were used. Beyond 50 miles, the deposition model was extended until no effluent remained in the plume. Excess food not consumed within the 50-mile distance was accounted for, and additional food production and consumption representative of the eastern half of the country was assumed. Doses obtained in this manner were then assumed to be received by the number of individuals living within the direction sector and distance described above. The population density in this sector is taken to be respresentative of the eastern United States, which is about 160 people per square mile.

5.B.3 Carbon-14 and Tritium Released to the Atmosphere

Carbon-14 and tritium were assumed to disperse without deposition in the same manner as Krypton-85 over land. However, they do interact with the oceans. This causes the carbon-14 to be removed with an atmospheric residence time of four to six years with the oceans being the major sink. From this, the equilibrium ratio of the carbon-14 to natural carbon in the atmosphere was determined. This same ratio was then assumed to exist in man so that the dose received by the entire population of the U.S. could be estimated. Tritium was assumed to mix uniformly in the world's hydrosphere, which was assumed to include all the water in the atmosphere and in the upper 70 meters of the oceans. With this model, the equilibrium ratio of tritium to hydrogen in the environment can be calculated. The same ratio was assumed to exist in man, and was used to calculate the population dose, in the same manner as with carbon-14.

5.B.4 Liquid Effluents

Concentrations of effluents in the receiving water within 50 miles of the facility were calculated in the same manner as described above for the Appendix I calculations. No depletion of the nuclides present in the receiving water by deposition on the bottom of the Chickamauga Reservoir was assumed. It was also assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the Appendix I evaluation. However, food consumption values appropriate for the average individual, rather than the maximum, were used. It was assumed that all the sport and commercial fish and shellfish caught within the 50 mile area were eaten by the U.S. population.

Beyond 50 miles, it was assumed that all the liquid effluent nuclides except tritium have deposited on the sediments to make no further contribution to population exposures. The tritium was assumed to mix uniformly in the world's hydrosphere and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

APPENDIX C

AQUATIC BIOTA

Characteristics of the site aquatic ecology have been described in TVA's FES-CP.[1] More recent data obtained through preoperational monitoring and supplemental information requested from TVA are presented herein to the extent that this new information alters the earlier description of the site ecology.[2,3,4] Pertinent new information has been presented for primary production, zooplankton, benthos, ichthyoplankton, and fishes. Evaluations of construction and potential operational impacts on these aquatic resources are presented in Section 4.3.2 and Section 5.4.2, respectively. Information pertinent to these evaluations is summarized in Section 2.5.2.

Primary Production - Phytoplankton Enumeration and Composition Analysis

The phytoplankton community at the Watts Bar site had been described in the FES-CP as extrapolated from limited sampling at the Watts Bar Dam forebay and downstream of the site. The preoperational monitoring program, which was implemented in February 1973, includes quarterly sampling and analysis of phytoplankton at seven stations (see Figure C.1), i.e., TRM (Tennessee River Mile) 496.5, TRM 506.6, TRM 518.0, TRM 527.4 (0.3 mile downstream of diffuser location), TRM 528.0 (intake area), TRM 529.9 (Watts Bar Dam tailrace) and TRM 532.1 (Watts Bar Dam forebay). At each station, collections were made at a minimum of three depths (see Table C.1). The following summary is based on four years (1973-1976) of phytoplankton collections. See Table C.2 for a list of genera identified in the four years of collections.

Of the 27 genera of Chrysophyta identified, the greater diversity (i.e., 14 different genera) was found at the TRM 496.5 station during the 1976 winter collection. In contrast, only one genera (Melosira spp.) was identified at the TRM 529.9 station during the 1975 winter collection. The average number of different genera for all stations and years was highest during winter (~8) and lowest during fall (~6). The genus, Melosira, was found at all stations during all seasons throughout the four-year period. Other ubiquitous genera, in descending frequency of occurrence, were Synedra, Navicula and Stephanodiscus.

Concentrations (number per liter) of Chrysophyta generally increased moving upstream. The lowest reported was 54,000 per liter at TRM 496.5 during fall 1975 and the highest 2.3 million per liter at TRM 528.0 during winter 1976. Melosira was, in general, the dominant in concentration, followed by Synedra. Fragilaria dominated the summer 1975 collection at the Dam forebay station (TRM 532.1). Seasonally, the average concentration of Chrysophyta is greatest (~723,000 per liter) in the winter and least(~251,000) in the fall. See Table C.3 for a summary of the Chrysophyta diversities and concentrations during the four-year sampling period.

Of the 51 genera of Chlorophyta identified (Table C.2), the greatest diversity (i.e., 33 different genera) was found at TRM 496.5 during the summer 1976 collections. (See Table C.4 for a summary of the Chlorophyta data.) Only one taxon was identified at TRM 496.5 and TRM 532.1 during the winter 1973 and at TRM 506.6 during fall 1974; Scenedesmus spp. was identified at the first station and Chlamydomonas spp. at the latter two stations. The average number of different genera for all stations and years was highest during the summer (~20) and least during the winter (~7). Spring and fall average diversities were similar (~8 to 9); however, diversities for these two seasons were high at some stations (e.g., 15 genera at TRM 528 in spring 1975 and 18 genera at both TRM 527.4 and 532.1 in fall 1975). Average diversity at TRM 528.0 and TRM 532.1 are highest (~12+). Scenedesmus and Chlamydomonas were identified at nearly all stations and seasons for the four-year period. Other taxa frequently occurring at certain stations were Dictyosphaerium spp., Chlorella spp. and Pandorina spp.

Concentrations (number per liter) of Chlorophyta generally increased from TRM 496.5 (last station downstream) to the dam forebay station at TRM 532.1. At the forebay station, average concentration exceeded that of the other six stations by factors of 1.6 to 2.8; however, the range of variation was also greatest at the dam forebay, i.e., from 2000 cells per liter during winter 1973 collections to 1.9 million cells per liter during the summer 1975 collections. Seasonally, the average concentrations of Chlorophyta is greatest (~655,000 per liter) during the summer and least (~71,000 per liter) during the winter. Scenedesmus spp. frequently

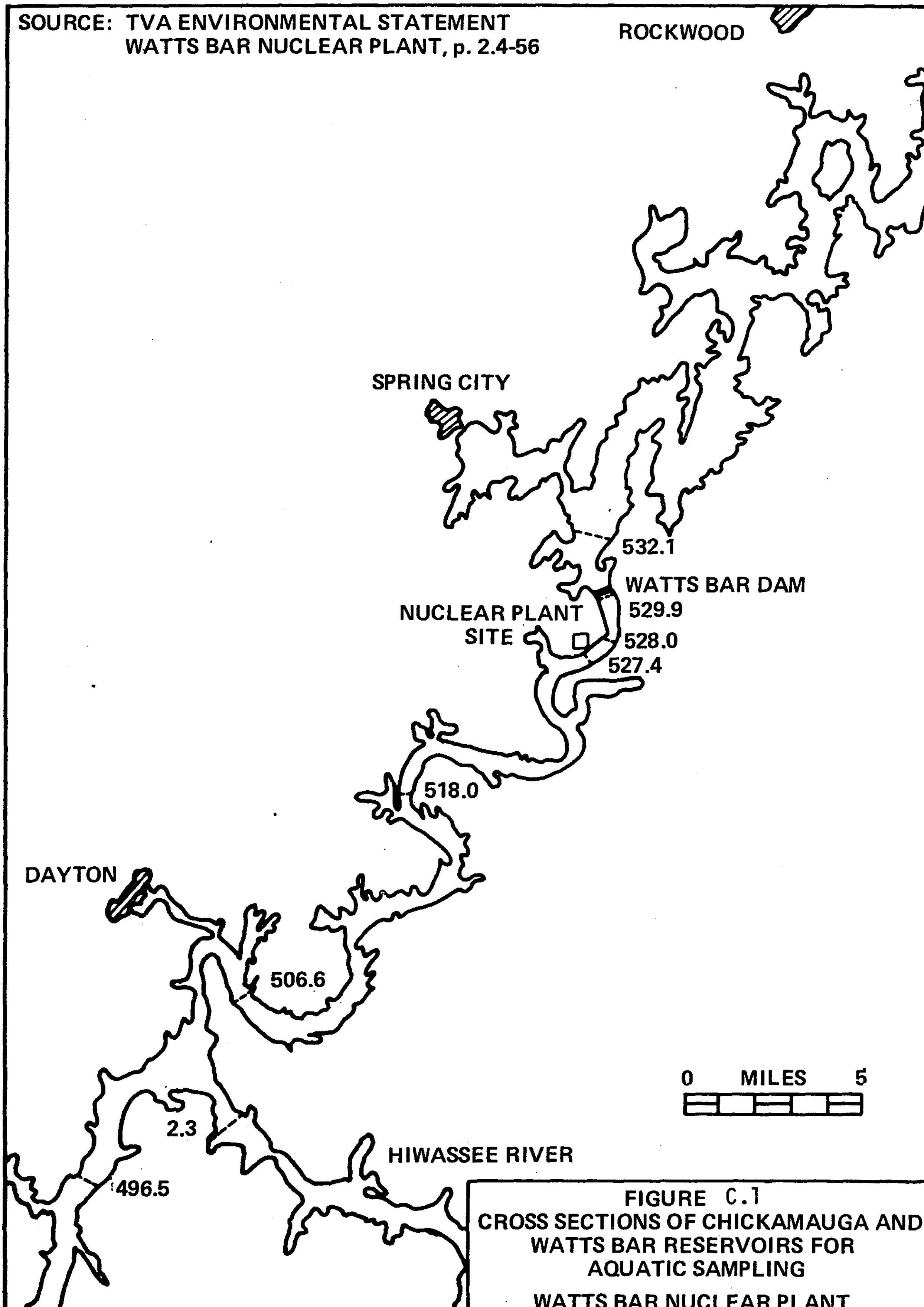


FIGURE C.1
CROSS SECTIONS OF CHICKAMAUGA AND WATTS BAR RESERVOIRS FOR AQUATIC SAMPLING
WATTS BAR NUCLEAR PLANT

Table C.1

Summary of Quarterly Preoperational Aquatic (Nonfish) Monitoring Program (Nonradiological)

Watts Bar Nuclear Plant

Station or TRM	Horizontal Location 1/	Depths Sampled for Chlorophyll, Phytoplankton, & Carbon-14(meters) 2/	Zooplankton Vertical Tows from Bottom to Surface (duplicate tows)	Artificial Benthos Substrates Colonization Period 3 mths (No. Baskets Set/Sta.)	Periphyton Autotrophic-Heterotrophic Indices and Enumeration Colonization Period 1 mth (No. Racks Set/Sta.) 3/
532.1	R-LM	0,1,3,5	X	3	2
529.9 4/	R-LM	0,1,3,5	X	3	2
528.0 5/	R-LM	0,1,3,5	X	3	2
527.4	R-LM	0,1,3,5	X	3	2
518.0	R-LM	0,1,3,5	X	3	2
506.6	R-LM	0,1,3,5	X	3	2
496.5	R-LM	0,1,3,5	X	3	2
527.7-528.2				X 5/	
520.5-521.3				X 5/	

1/ Horizontal location looking downstream; R-LM = area from right shore to left middle of stream

2/ These depths sampled if applicable; otherwise, surface, middle, and near bottom

3/ Five plexiglas plates per rack - approximate colonization period one month

4/ Tailrace

5/ Mussel bed investigations by SCUBA divers initiated in 1975

NOTE: This program reflects the program underway as of September 1976. However, the complete program is subject to periodic review and revision.

Table C.2
PHYTOPLANKTON GENERA IDENTIFIED IN
TENNESSEE RIVER COLLECTION NEAR WATTS BAR NUCLEAR PLANT
1973 - 1976

CHRYSOPHYTA	CHLOROPHYTA		CYANOPHYTA	EUGLENOPHYTA	PYRROPHYTA
Achnanthes	Acanthosphaera	Kirchneriella	Anabaena	Cryptoglena	Ceratium
Asterionella	Actinastrum	Micractinium	Anacystis	Euglena	Glenodinium
Attheya	Ankistrodesmus	Mougeotia	Aphanothece	Phacus	Gymnodinium
Chaetoceros	Arthrodesmus	Oöcystis	Calothrix	Trachelomonas	Peridinium
Cocconeis	Botryococcus	Pandorina	Chroococcus		
Cyclotella	Carteria	Pediastrum	Ceolosphaerium		
Cymbella	Chlamydomonas	Planktospaheria	Cylindrospermum		
Diatoma	Chlorella	Platydorina	Dactylococcopsis		
Dinobryon	Chlorococcum	Pleodorina	Eucapsis		
Eunotia	Chlorogonium	Protococcus	Gloeothece		
Fragilaria	Chodatella	Pteromonas	Gomphosphaeria		
Gomphonema	Cladophora	Quadrigula	Lyngbya		
Gyrosigma	Closteriopsis	Scenedesmus	Merismopedia		
Mallomonas	Closterium	Schroederia	Microcystis		
Melosira	Coelastrum	Selenastrum	Oscillatoria		
Meridion	Cosmarium	Sphaerocystis	Phormidium		
Navicula	Crucigenia	Staurastrum	Rhabdoderma		
Nitzschia	Dactylococcus	Tetradesmus			
Pinnularia	Dictyosphaerium	Tetraëdron			
Pleurosigma	Elakatothrix	Tetraspora			
Rhoicosphenia	Euastrum	Tetrastrum			
Rhizosolenia	Eudorina	Treubaria			
Stephanodiscus	Franceia	Trochiscia			
Surirella	Gloeoactinium	Ulothrix			
Synedra	Gloeocystis				
Synura	Golenkinia				
Tabellaria	Gonium				

Table C.3
Summary of Chrysophyta Data
Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter No. of Genera	Winter Concentration (1000's/liter)	Spring No. of Genera	Spring Concentration (1000's/liter)	Summer No. of Genera	Summer Concentration (1000's/liter)	Fall No. of Genera	Fall Concentration (1000's/liter)	Station Average (Three Years Combined) No. of Genera	Station Average (Three Years Combined) Concentration (1000's/liter)
496.5	1973	5	560	9	410	6	207	7	119	7.4	342
"	1974	6	67	6	348	6	130	5	85		
"	1975	5	274	8	319	10	318	5	54		
"	1976	14	1993	10	229	10	240	7	117		
506.6	1973	12	731	9	282	5	204	5	76	6.6	332
"	1974	6	69	7	368	7	79	3	105		
"	1975	5	81	5	295	5	182	5	57		
"	1976	10	2157	4	61	11	333	6	237		
518.0	1973	9	749	8	426	8	523	4	135	6.6	407
"	1974	6	90	8	466	6	108	3	224		
"	1975	5	99	7	736	4	105	4	100		
"	1976	12	1668	5	129	8	575	8	376		
527.4	1973	9	517	9	777	6	677	4	206	6.9	559
"	1974	7	142	11	712	4	266	5	373		
"	1975	5	176	6	1,438	4	218	5	183		
"	1976	13	1775	5	189	8	807	9	491		
528.0	1973	13	624	8	613	5	823	5	277	6.5	619
"	1974	6	219	9	778	5	394	6	407		
"	1975	5	161	7	1,347	4	252	4	145		
"	1976	7	2307	6	257	7	827	7	468		
529.9	1973	10	680	11	643	7	701	9	273	6.8	600
"	1974	6	129	7	901	5	245	6	350		
"	1975	1	173	6	1,197	3	241	4	181		
"	1976	11	2202	7	264	7	873	8	540		
532.1	1973	8	423	10	1,019	8	941	4	328	6.9	736
"	1974	6	133	8	1,126	7	712	7	400		
"	1975	5	110	5	1,389	4	1,000	4	130		
"	1976	10	1928	8	289	9	1,253	7	598		
Seasonal averages (Stations Combined)		7.8	723	7.5	607	6.4	473	5.6	251		

Table C.4
Summary of Chlorophyta Data
Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter No. of Genera	Winter Concentration (1000's/liter)	Spring No. of Genera	Spring Concentration (1000's/liter)	Summer No. of Genera	Summer Concentration (1000's/liter)	Fall No. of Genera	Fall Concentration (1000's/liter)	Station Average (Four Years Combined) No. of Genera	Station Average (Four Years Combined) Concentration (1000's/liter)
496.5	1973	1	5	6	77	14	252	8	61	11.1	149
	1974	5	28	14	247	10	101	3	32	-	-
	1975	7	51	10	82	24	483	10	71	-	-
	1976	7	71	14	172	33	541	12	109	-	-
506.6	1973	7	242	5	44	16	439	5	42	9.9	157
	1974	4	25	6	91	6	60	1	23	-	-
	1975	10	110	8	44	23	400	13	67	-	-
	1976	14	37	6	39	31	843	3	13	-	-
518.0	1973	6	177	5	74	18	781	8	65	9.9	185
	1974	3	23	8	76	8	85	4	65	-	-
	1975	7	59	9	68	22	333	12	115	-	-
	1976	11	78	2	8	30	907	5	41	-	-
527.4	1973	5	58	3	44	17	854	8	125	10.9	237
	1974	3	70	7	118	10	205	6	115	-	-
	1975	7	75	12	201	20	269	18	183	-	-
	1976	14	107	7	44	31	1271	7	49	-	-
528.0	1973	4	47	5	70	21	1094	9	151	12.1	271
	1974	3	26	10	145	14	251	7	111	-	-
	1975	9	73	15	227	27	463	11	116	-	-
	1976	16	177	6	87	29	1188	8	110	-	-
529.7	1973	5	96	5	68	17	874	8	138	10.6	230
	1974	6	35	7	168	9	102	5	72	-	-
	1975	9	61	12	166	22	365	15	174	-	-
	1976	13	93	5	95	26	1047	6	131	-	-
532.1	1973	1	2	6	279	19	1211	11	168	12.1	425
	1974	6	44	11	233	15	389	5	92	-	-
	1975	5	32	14	238	27	1900	18	205	-	-
	1976	11	95	5	88	29	1635	10	194	-	-
Seasonal averages (Stations Combined)		7.1	71	8.0	118	20.3	655	8.4	101		

dominated the Chlorophyta collections. For some stations and seasons, Chlamydomonas, Ulothrix, Dictyosphaerium, Pediastrum, Coelastrum and Eudorina either dominated or made up a large proportion of the total. The peak concentration at TRM 532.1 during summer 1975 was dominated by Dictyosphaerium (15.4%), Coelastrum (12.6%) and Pediastrum (11.8%).

Of the 17 genera of Cyanophyta identified (Table C.2) the greatest diversity (i.e., 10 different genera) was found at TRM 496.5 during summer 1976. Only one genera was found at several stations as shown by Table C.5. Diversity was highest during the summer and lowest during the winter. Dactylococopsis spp. was present at all stations for all seasons during the four-year period.

Average concentration of Cyanophytes increased moving upstream, and was highest at the dam forebay during summer 1976 (~13.3 million cells per liter). The seasonal average was highest for the summer (~1.8 million per liter) and lowest for the winter (~53,000 per liter). Dactylococopsis or Anacystis spp. most frequently dominated the collections of blue-greens.

Four genera of Euglenophyta and four genera of Pyrrophyta were identified in the 1973-1976 collections. Of the total phytoplankton community, the Pyrrophyta contributed less than 2% at any station during the 1975-76 collections; the highest percent contribution was during the winter and the highest concentration was during the summer. The percent contribution of the euglenophytes was greater for 1975 than for the other three years, making up 10.3% of the average phytoplankton concentration during the winter collections. The highest concentration (~44,000 cells per liter) was found at the tailrace station (TRM 529.9). Euglena spp. was the dominant genera found in all collections of Euglenophytes.

The average concentrations of the total phytoplankton community are summarized by station, season, and year in Table C.6. By this presentation of the phytoplankton data, the trend of increasing productivity from the downstream to the upstream stations is reiterated. The higher productivity of the reservoir habitat, as shown by the dam forebay station average, is as expected. The stations downstream of the Watts Bar Dam exhibit taxa of reservoir origin and taxa to be expected in riverine habitats, as well as epiphytic and periphytic taxa which have become detached and suspended by the turbulent flow in the tailrace stretch of the river. The composition of the phytoplankton community suggests a condition of good water quality; however, the concentrations and percent contribution of blue-greens showed marked increases in the summer 1976 collections. The blue-greens (Cyanophyta), which are considered a nuisance at high concentrations, contributed 71.7% to 82.1% of the total phytoplankton community during the summer 1976 period. The greatest concentration of blue-greens recorded was 13.3 million per liter at the dam forebay during the summer 1976 collection, making up 82% of the total. In the case of nuisance blue-green blooms, a concentration of billions of cells per liter might be expected. Large variations in the phytoplankton community are to be expected due to the dynamics of the system. Conditions in Watts Bar Reservoir will largely influence the character of the phytoplankton community at the plant site.

Primary Production - Chlorophyll a and Carbon-14 Analysis

To complement the phytoplankton enumeration, standing stock estimates and production rates have been made using Chlorophyll a (Chl a) extractions and Carbon-14 uptake, respectively. Chlorophyll a concentrations (Table C.7) show the same trend of increasing production moving upstream. However, the seasonal averages obtained by combining stations and years are somewhat different than that seen in the numerical concentrations. The highest standing stock is indicated for the fall season (17.0 mg Chl a/m^2), followed by summer (15.3), winter (13.74) and spring (10.33). The production rates using Carbon-14 uptake measurements (Table C.8) compare more favorably with the results of the phytoplankton enumeration, showing both the production rates increasing upstream of the TRM 496.5 station and similar seasonal trends, i.e., highest in summer (657 mg $C/day/m^2$) and lowest in winter (127 mg $C/day/m^2$).

Secondary Production - Zooplankton

The zooplankton community at the Watts Bar site had been described in the FES-CP as extrapolated from limited sampling at the Watts Bar Dam forebay. Preoperational monitoring, implemented in February 1973, includes quarterly sampling of zooplankton at the same stations as in the phytoplankton studies. At each station, duplicate tows were made from bottom to the surface using a 1/2-meter net with No. 20-mesh bolting cloth. The following discussion is based on three years of zooplankton collections. See Table C.9 for list of taxa identified in the collections of zooplankton.

Table C.5
Summary of Cyanophyta Data
Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter No. of Genera	Winter Concentration (1000's/liter)	Spring No. of Genera	Spring Concentration (1000's/liter)	Summer No. of Genera	Summer Concentration (1000's/liter)	Fall No. of Genera	Fall Concentration (1000's/liter)	Station Average (Four Years Combined) No. of Genera	Station Average (Four Years Combined) Concentration (1000's/liter)
496.5	1973	1	18	1	27	3	76	1	7	3.3	313
	1974	1	1	1	35	3	29	2	4		
	1975	2	16	3	39	6	424	2	18		
	1976	4	164	7	217	10	3,704	6	229		
506.6	1973	1	44	1	8	3	224	1	8	2.8	249
	1974	1	5	1	14	2	7	2	2		
	1975	2	36	4	62	5	216	5	140		
	1976	3	170	3	29	7	3,001	3	11		
518.0	1973	2	43	1	25	3	483	1	13	2.9	399
	1974	1	2	2	48	2	2	2	14		
	1975	1	18	4	165	7	366	5	90		
	1976	3	210	2	5	8	4,845	3	52		
527.4	1973	1	38	1	12	4	650	1	12	2.5	456
	1974	1	7	1	30	2	4	2	21		
	1975	1	38	3	218	5	183	3	80		
	1976	2	23	2	25	8	5,911	3	44		
528.0	1973	1	20	1	14	4	998	1	13	3.2	558
	1974	1	12	2	41	2	2	2	14		
	1975	2	35	4	475	7	696	4	86		
	1976	4	139	4	23	9	6,064	4	291		
529.9	1973	1	44	1	12	4	929	1	34	2.6	471
	1974	1	9	1	38	2	2	2	23		
	1975	1	20	4	386	5	208	2	24		
	1976	3	87	1	2	9	5,672	4	44		
532.1	1973	1	24	1	33	4	1,033	1	29	3.0	1028
	1974	1	9	1	21	2	16	2	25		
	1975	1	13	5	93	9	1,386	4	79		
	1976	3	230	2	5	8	13,341	3	118		
Seasonal averages (Stations Combined)		1.6	53	2.3	75	5.1	1802	2.6	54		

Table C.6

Average Concentrations of Phytoplankton

Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter (1000's/liter)	Spring (1000's/liter)	Summer (1000's/liter)	Fall (1000's/liter)	Station Average (Years Combined) (1000's/liter)
496.5	1973	583	514	535	187	810
	1974	96	630	260	121	
	1975	356	442	1247	145	
	1976	2253	625	4511	456	
506.6	1973	1022	334	867	126	
	1974	99	473	146	130	744
	1975	242	401	806	264	
	1976	2421	131	4183	264	
518.0	1973	973	525	1787	213	
	1974	115	590	195	303	994
	1975	208	969	809	308	
	1976	1958	142	6330	472	
527.4	1973	613	833	2181	343	
	1974	169	860	475	509	1254
	1975	325	1858	687	460	
	1976	1908	260	7997	592	
528.0	1973	691	697	2915	441	
	1974	257	964	647	532	1452
	1975	302	2050	1425	359	
	1976	2634	367	8086	871	
529.9	1973	820	723	2504	445	
	1974	173	1107	349	445	1307
	1975	299	1752	822	395	
	1976	2390	362	7603	717	
532.1	1973	449	1331	3185	525	
	1974	186	1380	1117	517	2201
	1975	182	1754	4330	433	
	1976	2265	384	16268	914	
Seasonal Average		857	802	2938	410	

Table C.7

WATTS BAR NUCLEAR PLANT

CHLOROPHYLL A EXPRESSED IN mg Chl. A/m²

TRM	1973 Winter	1973 Spring	1973 Summer	1973 Fall	1974 Winter	1974 Spring	1974 Summer	1974 Fall	1975 Winter	1975 Spring	1975 Summer	1975 Fall	Station $\bar{x}$
496.5	-	4.06	3.04	6.76	1.69	14.02	5.80	7.86	9.06	4.27	-	8.57	6.51
506.6	13.69	2.30	19.01	10.05	10.16	6.00	3.28	15.60	11.13	2.62	9.19	3.33	8.86
518.0	15.63	6.39	19.92	7.02	10.95	9.93	9.80	27.02	15.04	4.26	9.22	4.89	11.76
527.4	18.85	9.58	20.97	11.57	16.08	13.65	15.39	35.24	14.38	6.19	11.15	10.46	15.29
528.0	16.46	11.10	18.01	18.72	12.68	19.36	17.63	36.79	10.90	5.25	10.22	11.34	15.70
524.9	16.52	10.18	31.45	15.59	9.89	17.90	14.27	34.05	16.05	2.80	10.37	12.89	16.00
532.1	15.91	26.87	-	17.82	12.10	32.26	37.00	37.87	12.24	7.68	26.03	23.64	22.67
Season $\bar{x}$	16.34	10.07	18.73	12.49	12.20	16.20	14.74	27.78	12.68	4.72	12.70	10.73	

From: TVA, Environmental Information, Watts Bar Nuclear Plant Units 1 and 2, November 18, 1976.

Table C.8

WATTS BAR NUCLEAR PLANT

PHYTOPLANKTON PRODUCTIVITY EXPRESSED IN mg C/day/m^2

TRM	1973 Winter	1973 Spring	1973 Summer	1973 Fall	1974 Winter	1974 Spring	1974 Summer	1974 Fall	1975 Winter	1975 Spring	1975 Summer	1975 Fall	Station $\bar{x}$
496.5	130	157	400	33	45	328	140	48	9	311	220	127	162
506.6	258	75	313	47	21	115	182	50	58	733	240	123	185
518.0	329	157	842	98	33	176	380	151	67	502	246	100	229
527.4	359	210	1488	159	36	313	575	242	73	588	290	361	391
528.0	322	214	1359	243	36	298	728	267	72	553	327	349	397
529.9	255	181	1074	241	28	229	498	261	59	253	268	391	311
532.1	375	558	1590	419	40	468	1356	322	71	211	1294	387	591
Season $\bar{x}$	290	222	1009	177	34	275	551	192	58	448	412	263	
Langleys/Day on Incubation Date	336	345	499	232	226	98	185	271	62	421	295	254	
Secchi Disc Visibility	1.10M	1.50M	1.50M	1.25M	0.80M	125M	2.40M	1.15M	0.55M	1.80M	1.75M	1.15M	
Water Temp. @ 1 Meter (°F)	44.3	67.7	77.7	58.2	46.8	66.3	78.1	59.6	47.3	65.0	81.2	63.8	

From: TVA, Environmental Information, Watts Bar Nuclear Plant, Units 1 and 2, November 18, 1976.

Table C.9

Zooplankton Taxa Identified in Tennessee River Collections Near Watts Bar Nuclear Plant
Preoperational Monitoring 1973-1975

ROTATORIA		CLADOCERA		COPEPODA
Asplanchna spp.	Keratella cochlearis	Alona sp.	Daphnia pulex	Calanoida (copepodid)
Brachionus angularis	K. crassa	A. quadrangularis	Diaphanosoma leuchtenbergianum	Cyclopoida (copepodid)
B. bidentata	K. earlinae	Alonella sp.	Ilyocryptus spinifer	Harpacticoida (copepodid)
B. budapestinensis	K. quadrata	Bosmina logirostris	Latona setifera	Nauplii
B. calyciflorus	K. valga	Ceriodaphnia sp.	Leptodora kindtii	Argulus stizostethi
B. havanaenis	Lecane spp.	C. lacustris	Leydigia quadrangularis	Canthocamptus robertcokeri
B. quadridentatus	L. luna	C. quadrangula	Moina sp.	C. staphylinoides
B. urceolaris	L. stokesii	C. reticulata	Moina micrura	Cyclops bicuspidatus thomasi
Cephalodella sp.	Monostyla spp.	Chydorus spp.	Scapholebris kingi	C. varicans rubellus
Collotheca sp.	M. quadridentata	Daphnia sp.	Sida crystallinia	C. vernalis
C. pelagica	Notholca sp.	D. ambigua	Simocephalus sp.	Diaptomus mississippiensis
Conochiloides sp.	N. limnetica	D. galeata mendotae	S. serrulatus	D. pallidus
Conochilus hippocrepis	Platyias patulus	D. parvula	S. vetulus	D. reighardi
C. unicornis	Ploesoma hudsoni	D. pulex		D. sanguineus
Epiphanes macroura	P. truncatum			Ergasilus spp.
Euchlanis sp.	Polyarthra spp.			Eucyclops agilis
Filinia spp.	Rotaria sp.			E. prionophorus
Gastropus sp.	R. neptunia			Mesocyclops edax
Hexarthra spp.	Synchaeta spp.			Nitocra lacustris
H. mira	S. stylata			Paracyclops fimbriatus poppei
Kellicottia bostoniensis	Testudinella sp.			Tropocyclops prasinus
K. longispina	Trichocerca spp.			
Keratella americana	Trichotria pocillum			

Of the 46 taxa of Rotatoria identified, average diversity remained relatively constant by season and by station (See Table C.10). The greatest diversity (19 different taxa) was recorded at TRM 527.4 during summer 1973. Polyarthra spp. were found at all stations, seasons, and years. Dominating the rotifer concentrations were Conochilus unicornis, Brachionus angularis, several species of Keratella, Asplancha sp., and Synchaeta stylata. Increasing production moving upstream follows the same trend observed in phytoplankton data. Highest concentrations were found during the summer (~48,800 per m^3) and lowest during winter (11,600 per m^3). At the dam forebay station (TRM 532.1) during summer 1973. approximately 265,100 rotifers per cubic meter represented peak production with Brachionus angularis, Asplanchna sp., and Ploesoma truncatum dominating the collection.

Of the 27 taxa of Cladocerans identified in the zooplankton collections, average diversity ranged between 3.4 taxa in winter to 8.6 taxa in summer (See Table C.11). Average concentrations for these seasons were between 600 to 18,000 per cubic meter. The greatest average concentration was observed during spring (~53,600/m^3). The highest average production by station (30,300/m^3) was found at TRM 528.0 followed closely by the forebay station (27,700/m^3). The cladoceran group was dominated by the single species, Bosmina longirostris, which comprised 97% of the 147,000 per cubic meter peak concentration observed at TRM 528.0 during spring 1975. B. longirostris dominated the winter, spring and fall collections. Diaphanosoma leuchtenbergianum and several Daphnia species dominated the summer collections of Cladocerans.

Immature forms dominated the Copepoda, i.e. calanoid and cyclopoid copepodids and nauplii. Increasing concentrations were observed moving upstream. Highest production was during the summer, similar levels during spring and fall and lowest during winter (See Table C.12). The greatest concentration (29,600/m^3) was found at TRM 529.9 during fall 1977, with ~90% contributed by nauplii and cyclopoid copepodids.

A summary of the zooplankton diversity and concentrations is provided by Table C.13. To be noted is the general decline in zooplankton production during all seasons of 1974 and the general rebound of the 1975 production toward the 1973 levels. The trend of increasing production moving upstream can again be observed in the average for total zooplankton concentrations.

Secondary Production - Benthos

Included in the preoperational monitoring program was the placing of artificial substrates for analyzing colonization by macrobenthos. No information on this aspect of the benthic community was presented in the FES-CP. In 1973 and 1974, the substrates were incubated for 90-day periods. Starting in 1975 and continuing to the present, 30-day incubation periods have been used. Due to the different methodology, direct comparisons cannot be made for the 1973-1975 period.

The 90-day incubation sets were dominated by Chironomidae, Psychomyiidae, and Cheumatopsyche sp. In the 30-day sets, Chironomous sp., Stenonema sp. and Cyrenellus sp. dominated. Diversity and numbers of organisms per substrate were low in all samples, as expected for this stretch of the river.

The natural bedrock substrate with gravel, rock, clay and other sediment interspersed provides favorable habitat for mussel fauna. In the FES-CP, TVA identified the 3-mile reach from the Watts Bar dam (TRM 529.9) downstream to TRM 526.9 as being a designated mussel sanctuary by the State of Tennessee. Harvesting within the sanctuary reach is illegal.

At the time of TVA's FES-CP preparation, eight species of mussels were suspected in the sanctuary reach. Based on the results of surveys in July and August 1975 and May and August 1976, TVA has identified 13 species in the area (see Table C.14) including Lampsilis orbiculata, a species declared endangered by the U.S. Fish and Wildlife Service.[5] The survey results indicate that the most suitable mussel habitat is on the left bank (looking downstream) in the reaches from TRM 520.5 to 521.3 and TRM 527.6 to 528.5. Number per unit effort (by SCUBA divers) indicated greater density in the 520.5 to 521.3 reach, but also a good localized population density in the TRM 527.7 area. No mussel concentrations were located on the right side of the river in the general vicinity of the diffuser location. Most frequently taken were Pleurobema cordatum, Elliptio crassidens, Quadrula pustulosa and Cyclonaias tuberculata. This same order of abundance was found by Isom in his 1964 study.[6] In that study, Isom reported finding Lampsilis orbiculata from the Kentucky Dam tailwater to the Watts Bar Dam tailwater. The species' known distribution, according to the Federal Register Notice, includes the Green River (Kentucky), the Kanawha River (West Virginia), the Muskingum River (Ohio), and the Tennessee River (Alabama and Tennessee). L. orbiculata has recently been collected by TVA in the Cumberland River, also. Information for recent years, 1973-1975, indicate that a few mussels were harvested in

Table C.10

Summary of Rotatoria Data
Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter No. of Taxa	Winter 1000's per Cubic Meter	Spring No. of Taxa	Spring 1000's per Cubic Meter	Summer No. of Taxa	Summer 1000's per Cubic Meter	Fall No. of Taxa	Fall 1000's per Cubic Meter	Station Average (Seasons & Years Combined) No. of Taxa	Station Average (Seasons & Years Combined) 1000's per Cubic Meter
496.5	1973	*	*	17	21.5	15	6.5	14	0.6	15.8	10.6
	1974	14	3.6	22	29.5	14	2.4	14	4.7		
	1975	16	16.3	**	**	**	**	**	**		
506.6	1973	11	23.0	15	5.5	18	13.3	13	0.6	13.2	6.9
	1974	14	3.2	9	3.1	5	0.3	15	3.8		
	1975	15	11.0	16	9.3	14	6.9	13	2.8		
518.0	1973	12	25.2	12	25.9	16	57.8	12	1.1	12.5	13.4
	1974	13	2.1	7	3.9	9	0.5	14	9.3		
	1975	12	8.8	17	13.1	14	6.7	12	5.9		
527.4	1973	12	31.7	11	53.5	19	69.0	12	1.8	12.8	23.8
	1974	12	3.9	11	13.3	5	1.6	13	19.0		
	1975	11	13.1	15	14.4	17	31.7	16	32.8		
528.0	1973	12	22.4	14	105.3	17	119.3	14	3.8	12.7	31.8
	1974	14	2.8	10	23.1	9	2.0	13	22.1		
	1975	10	5.6	12	13.9	14	20.0	13	41.7		
529.9	1973	10	11.2	13	71.2	15	244.6	12	6.2	12.7	39.8
	1974	14	2.6	10	12.5	7	1.6	16	45.7		
	1975	14	7.6	14	11.3	14	12.7	13	50.5		
532.1	1973	11	25.7	15	139.6	18	265.1	15	19.1	14.5	64.8
	1974	19	3.7	11	46.3	13	21.0	15	56.4		
	1975	14	8.8	13	20.5	16	93.7	14	77.3		
Seasonal Avgs. (Stations & Years Combined)		13	11.6	13	31.6	13	48.6	14	20.3		

* No data collected
** Data unavailable

Table C.11

Summary of Cladocera Data

Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter No. of Taxa	Winter 1000's per Cubic Meter	Spring No. of Taxa	Spring 1000's per Cubic Meter	Summer No. of Taxa	Summer 1000's per Cubic Meter	Fall No. of Taxa	Fall 1000's per Cubic Meter	Station Average (Season & Years Combined) No. of Taxa	Station Average (Season & Years Combined) 1000's per Cubic Meter
496.5	1973	*	*	9	24.4	9	8.3	7	0.8		
	1974	4	0.3	11	13.6	5	3.5	6	2.9	6.9	6.8
	1975	4	0.5	**	**	**	**	**	**		
506.6	1973	1	0.2	9	42.1	11	15.2	7	1.0		
	1974	4	0.4	6	17.0	7	4.1	3	3.5	6.2	16.0
	1975	3	0.6	10	106.0	7	8.6	6	1.1		
518.0	1973	3	0.2	7	45.8	9	8.8	8	1.2		
	1974	5	0.2	5	3.9	7	9.7	4	3.1	6.1	11.1
	1975	3	0.6	7	52.0	8	5.6	7	2.2		
527.4	1973	2	0.5	7	41.2	10	10.4	8	3.2		
	1974	5	0.4	7	26.6	9	8.6	5	6.6	6.8	19.0
	1975	3	1.6	8	91.6	8	30.5	9	7.0		
528.0	1973	3	0.5	9	77.9	9	20.9	8	5.2		
	1974	6	0.4	7	57.6	8	14.4	6	8.3	7.1	30.3
	1975	3	1.0	8	147.0	10	21.6	8	8.8		
529.9	1973	2	0.2	7	64.1	9	40.4	8	4.7		
	1974	4	0.2	6	37.5	8	8.9	7	16.2	6.5	22.1
	1975	4	1.2	6	59.0	9	21.8	8	11.1		
532.1	1973	2	0.7	8	14.7	11	51.8	9	8.8		
	1974	4	0.3	6	57.4	9	19.3	7	23.6	7.1	27.7
	1975	4	1.0	9	92.0	8	46.8	8	15.7		
Seasonal Avg. Station & Years Combined		3.4	0.6	7.6	53.6	8.6	18.0	7.0	6.8		

* No data collected
** Data unavailable

Table C.12

Summary of Copepoda Data
Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter		Spring		Summer		Fall		Station Average (Stations & Years Combined)	
		No. of Taxa	1000's per Cubic Meter	No. of Taxa	1000's per Cubic Meter	No. of Taxa	1000's per Cubic Meter	No. of Taxa	1000's per Cubic Meter	No. of taxa	1000's per Cubic Meter
496.5	1973	*	*	9	2.6	7	2.4	9	0.4	8.4	2.7
	1974	8	1.2	12	1.7	8	3.6	7	2.2		
	1975	7	7.4	**	**	**	**	**	**		
506.6	1973	8	2.2	8	1.5	9	2.8	7	0.3	8.4	2.1
	1974	11	1.3	8	2.4	7	3.0	5	0.4		
	1975	8	3.8	11	1.8	9	3.3	10	2.0		
518.0	1973	8	1.7	9	2.0	8	3.4	11	0.5	8.3	2.6
	1974	9	1.0	9	0.6	9	7.6	5	0.4		
	1975	7	2.6	9	3.8	7	4.5	9	3.3		
527.4	1973	7	3.8	9	3.8	9	7.3	9	1.6	8.6	6.6
	1974	7	1.8	9	2.6	8	11.3	9	1.9		
	1975	8	7.4	9	8.4	9	18.0	10	10.9		
528.0	1973	7	4.5	9	9.2	8	12.2	9	2.8	9.0	9.6
	1974	11	1.3	10	8.4	7	15.0	10	4.5		
	1975	7	4.6	8	13.8	11	12.0	11	27.3		
529.9	1973	8	1.8	9	13.6	7	28.4	9	7.4	9.1	12.9
	1974	8	1.0	9	6.6	8	16.0	12	10.2		
	1975	9	4.7	11	15.2	9	20.6	10	29.6		
532.1	1973	7	4.9	10	25.6	9	27.4	10	12.6	9.1	17.4
	1974	10	1.2	9	17.8	8	18.5	8	18.7		
	1975	9	6.0	10	25.8	8	26.0	11	25.0		
Seasonal Avg. Stations & Yrs. Combined		8.2	3.2	9.4	8.4	8.2	12.2	9.0	8.1		

* No data collected
** Data unavailable

Table C.13

Summary of Zooplankton Data
Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter		Spring		Summer		Fall		Station Average (Seasons & Years Combined)	
		No. of Taxa	1000's per Cubic Meter	No. of Taxa	1000's per Cubic Meter	No. of Taxa	1000's per Cubic Meter	No. of Taxa	1000's per Cubic Meter	No. of Taxa	1000's per Cubic Meter
496.5	1973	*	*	35	48.6	31	17.1	30	1.9	31.1	20.1
	1974	26	5.0	45	44.7	27	9.4	27	9.8		
	1975	27	24.2	**	**	**	**	**	**		
506.6	1973	20	25.3	32	49.1	38	31.4	27	1.9	27.8	25.6
	1974	29	4.9	23	22.5	19	7.4	23	7.8		
	1975	26	15.3	37	117.1	30	18.9	29	5.8		
518.0	1973	23	27.2	28	73.7	33	70.0	31	2.8	26.9	27.1
	1974	27	3.3	21	8.4	25	17.8	23	12.8		
	1975	22	12.0	33	69.0	29	16.3	28	11.5		
527.4	1973	21	36.0	27	98.6	38	86.8	29	6.6	28.2	49.4
	1974	24	6.1	27	42.5	22	21.5	27	27.4		
	1975	22	22.2	32	114.5	34	80.2	35	50.6		
528.0	1973	22	27.5	32	192.4	34	152.5	31	11.9	28.8	71.7
	1974	31	4.4	27	89.2	24	31.4	29	35.0		
	1975	20	11.2	28	85.5	35	53.6	32	77.9		
529.9	1973	20	13.2	29	148.9	31	313.4	29	18.4	28.3	74.8
	1974	26	3.8	25	56.5	23	26.6	35	72.2		
	1975	27	13.6	31	174.7	32	55.1	31	91.3		
532.1	1973	20	31.3	33	180.0	38	344.4	34	40.5	30.7	109.9
	1974	33	5.2	26	121.5	30	58.8	30	98.7		
	1975	27	15.8	32	138.4	32	168.0	33	118.0		
Seasonal Avg. Stations & Yrs. Combined		24.6	15.4	30.2	93.8	39.8	79.0	29.8	35.2		

* No data collected
** Data unavailable

Table C.14

COMPOSITION OF MUSSEL POPULATION BELOW WATTS BAR DAM COLLECTED (ALL METHODS)

JULY AND AUGUST 1975

Name	Number from TRM 527.6 to 528.5	Number from TRM 520.5 to 521.3	Total	% of Total
Amblema plicata	6	2	8	5%
Quadrula pustulosa	9	20	29	19%
Quadrula metanevra	1	3	4	3%
Tritogonia verrucosa	2	1	3	2%
Cyclonaias tuberculata	5	15	20	13%
Pleurobema cordatum**	12	21	33	22%
Elliptio crassidens	16	14	30	20%
Obliquaria reflexa	1	1	2	1%
Actinonaias carinata	1	0	1	<1%
Plagiola lineolata	2	7	9	6%
Proptera alata	6	3	9	6%
Ligumia recta	3	0	3	2%
Lampsilis orbiculata*	2	0	2	1%
Total	66	87	153	100%

Note: Dromus dromas* was found in the downstream reach (~7.6 miles downstream of plant site) during a June 1978 survey.

(TVA Comments on Watts Bar DES, July 31, 1978, Enclosure I, p. 13).

* On Department of Interior list of proposed endangered species.
** On Tennessee Heritage Program list as species of Special Concern.

From: TVA, Environmental Information, Watts Bar Nuclear Plant, November 18, 1976, p. A-18.

Chickamauga Reservoir but species and amounts are unknown. There are none harvested for human consumption.

During a more recent survey (June 1978), TVA collected two specimens of Dromus dromas between TRM 520.0 and TRM 521. This species is also listed as endangered by the Department of Interior. TVA indicates this occurrence of D. dromas to be the first reported for Chickamauga Reservoir. The known distribution at the time of listing was the Powell and Clinch Rivers in Virginia and Tennessee. Additional specimens of L. orbiculata were collected at this same location which is ~7.6 miles downstream of the Watts Bar Nuclear Plant site. TVA believes this occurrence of L. orbiculata verifies that the species is more widely distributed in Chickamauga Reservoir than previous data had indicated.

The Asiatic clam, Corbicula manilensis, has become prominent in the benthos in the vicinity of the Watts Bar site during the past decade. Densities reach hundreds per square meter. This species is of engineering concern due to their colonization on surfaces of cooling water systems.

Fish Production - Ichthyoplankton

In TVA's FES, the tailwater area was considered favorable spawning habitat for sauger, white bass, smallmouth bass, and possibly yellow perch which had recently invaded the reservoir from the Hiwasee River.[7] No specific site data on ichthyoplankton were available at preparation of the FES-CP.

Recent data for the 1976 and 1977 spawning seasons suggest that the area may not be as favorable for the tailrace spawners as previously noted. Following is a description of the methodology and study results as presented by TVA:

> "To determine the spatial and temporal concentrations and distributions of ichthyoplankton in the vicinity of Watts Bar Nuclear Plant Site, samples were taken along a transect adjacent to the intake construction site at Tennessee River Mile 528.0. Five stations equidistantly spaced, were sampled biweekly from March 29, 1976 through September 9, 1976. At each station, full-stratum samples were taken four times a day (dawn, day, dusk, night) during each sampling period. All samples were taken with a 0.5 m beam net (0.5 mm mesh) towed at 1.0 m/sec. Flow was recorded with a General Oceanics large-vane flowmeter mounted in the net mouth. All tows were of 10 min duration, and approximately 150 m^3 of water was filtered with each tow. All tows were in an upstream direction.
>
> "Samples were preserved in the field in 10 percent Formalin and returned to the Laboratory. Fish early life stages were identified to the lowest possible taxon using polarized stereomicroscopy and available taxonomic keys. Level of identification depended upon taxon in question, developmental stage and condition of specimens. Mutilated specimens were termed "unidentified" and those identifiable only to the family level were termed "unspecified".
>
> "Fish larvae of 16 taxa belonging to 8 families were collected (Table C.15). Unspecified clupeids were the most abundant taxon overall (91.17 percent relative abundance). The only other taxa which exceeded 1.0 percent relative abundance were Aplodinotus grunniens (freshwater drum) and Lepomis spp.
>
> "Few larvae were collected which were produced by migratory (tailrace) spawners. These were six Morone spp., two Minytrema melanops, and a single Stizostedion spp. The combined relative abundance of these taxa was less than one tenth of one percent of the total catch. If the Watts Bar tailrace had been an important spawning area in 1976, we would have expected their young to have occurred in considerably higher numbers.
>
> "Of the taxa collected, only clupeids were abundant enough to merit close scrutiny of their spatial distribution. During sampling period 3-11 clupeids were collected at all stations and in no instance was there more than an order-of-magnitude difference between concentrations at the five stations. Also, there was no consistent pattern of high or low concentrations at any one station; therefore, the horizontal distribution of clupeids was essentially uniform throughout the season. Uniformity of horizontal distributions of most taxa is also apparent upon examination of percent relative abundance of all taxa collected by station (Table C.16). Ictalurids were most abundant at the middle channel station (the deepest water station). All ictalurids captured were alevins ranging in size from 17-40 mm total length. Ictalurids of

TABLE C.15

Total Number Captured and Relative Abundance (%) of Fish Larvae

Taxon	No. Collected	Percent Relative Abundance
Clupeidae		
Unspecified clupeids	9913	91.17
Dorosoma cepedianum	2	0.02
Dorosoma petenense	32	0.29
Sciaenidae		
Aplodinotus (grunniens)	601	5.53
Centrarchidae		
Lepomis spp.	209	1.92
Pomoxis spp.	24	0.01
Ictaluridae		
Ictalurus furcatus	1	0.01
Ictalurus punctatus	45	0.41
Pylodictis olivaris	1	0.01
Cyprinidae		
Unspecified cyprinids	7	0.06
Pimephales group	1	0.01
Cyprinus carpio	27	0.25
Percicthyidae		
Morone sp.	1	0.01
Morone (not *suxatillis*)	5	0.05
Catostomidae		
Minytrema melanops	2	0.02
Percidae		
Stizostedion sp.	1	0.01
Unidentified	1	0.01

Reference 1, Section 2, page 3-11.

Table C.16 Percent Relative Abundance of Fish Larvae Captured at 5 Stations-Watts Bar Nuclear Site - 1976.

Taxon	Left Shoreline	Left Channel	Middle Channel	Right Channel	Right Shoreline
Unidentified Fish	0.06				
Unspecified clupeids	90.23	91.83	89.10	93.54	92.93
Dorosoma cepedianum	0.06				0.05
D. petenense	0.17	0.37	0.25	0.28	0.42
Unspecidied cyprinids	0.06	0.18	0.03	0.06	0.05
Pimephales group			0.03		
Cyprinus carpio	0.52	0.25	0.19	0.17	0.19
Minytrema melanops	0.12				
Ictalurus furcatus			0.03		
I. punctatus	0.12	0.12	0.94	0.28	0.09
Pylodictis olivaris			0.03		
Morone sp.	0.06				
Morone (not saxatilis)		0.12			0.14
Lepomis sp.	2.27	1.35	2.00	1.61	2.21
Pomoxis sp.	0.17	0.25	0.25	0.22	0.19
Stizostedion sp.			0.03		
Aplodinotus grunniens	6.16	5.53	7.13	3.84	3.72

Reference 1.

these sizes should be capable swimmers, and apparently, they actively selected the deepest water area for habitation."[8]

The potential entrainment, based on 1976-77 data, is evaluated in Section 5.4.2.

Fish Production - Reservoir Fishery

Cove rotenone data for 1970, presented in the FES-CP, indicated an average total of 203.6 kilograms of fish per hectare (181.6 pounds per acre) with highest biomass in a 3-acre cove in the area between TRM 505 to 509. Represented in the 1970 samples were 37 species of fish with yellow perch appearing for the first time in reservoir inventories. Table C.17 presents the percent species composition by number and weight.

Cove data for 1972 show an increase in the average production, i.e. 316.2 kilograms per hectare (282.1 pounds per acre). The sample nearest the Watts Bar site (TRM 508.0), again showed significantly greater populations (573.1 kilograms per hectare). Treadfin shad, Dorosoma petenense, made up a greater percentage of the total number and weight than in 1970 (See Table C.18).

Cove data for 1973 show an intermediate level of production between 1970 and 1972, i.e. 289 kilograms per hectare (258 pounds per acre). The upstream cove (TRM 508.0) was nearly 3 times as productive as the other three coves sampled. Threadfin shad contributed 50 percent of the total number for all samples. Gizzard shad (Dorosoma cepedianum) dominated the weight as in the previous years of collection (See Table C.19). A comparison of the cove results for the years 1970 through 1973 is presented in Table C.20.

A list of species identified in cove rotenone samples from Chickamauga Reservoir is provided in Table C.21. TVA has indicated that all of these fish species can be considered as important using a liberal interpretation of the definition given in NRC Reg. Guide 4.2.

Commercial harvest of fish from Chickamauga Reservoir for the 1971-1973 period has been estimated at 373,000 pounds per year. Comparison with other TVA reservoirs shows that Chickamauga Reservoir contributed approximately 5 percent of the Tennessee Valley - wide estimate (Table C.22). The most recent commercial harvest data for Chickamauga (1972) are given in Table C.23. Catfish, buffalo, and carp made up over 99 percent of the total 1972 harvest.

A survey of sport fishing in Chickamauga Reservoir for the period 1972 through 1975[9] indicates an average sport harvest of 4.2 kg per hectare per year [Table C.24(a)]. The catch by species is given in Table C.25. The annual average sport harvest for the four-year survey was 66,040 kg.

The tailwaters of the Watts Bar Dam support a significant sport fishery for sauger although data collected to date suggest limited spawning success by this species and other migratory spawners. Creel data, specific to the tailwater, are limited since previous reporting has been for the total reservoir. Data for the first six months of 1977 [Table C.24(b)] show that sauger contributed 13.6% by number and 19.8% by weight of the tailwater harvest. White crappie ranked first in the creel by both number and weight. Channel catfish harvest was on the same order as the sauger harvest. During this period, the calculated number and weight (kg) of fish harvested per hour was 0.96 and 0.20, respectively. These rates may be compared with the annual harvest rates for the entire reservoir during the period 1972-1975 [Table C.24(a)].

Table C.17 SPECIES COMPOSITION OF COVE POPULATION, CHICKAMAUGA RESERVOIR, 1970

Species	Percent of total number	Percent of total weight
Threadfin shad	29.9	3.2
Gizzard shad	27.6	29.0
Bluegill	15.3	5.7
Assorted minnows	12.2	.6
Drum	5.2	13.7
Largemouth bass	3.3	2.4
Other sunfish	1.8	1.8
Spotted bass	1.7	.3
White crappie	..9	1.4
White bass	.5	.1
Smallmouth buffalo	.4	23.7
Channel catfish	.2	1.7
Yellow perch	.2	.1
Spotted sucker	.2	.2
Bigmouth buffalo	.1	8.8
Golden redhorse	.1	1.6
Blue catfish	.1	.9
Skipjack herring	.1	.2
Carp	.1	3.2
Flathead catfish	.1	.3
Black redhorse	T	.5
Spotted gar	T	T
Longnose gar	T	T
Quillback	T	.4
Sauger	T	.1
Black crappie	T	T
Mooneye	T	T
Black buffalo	T	.1
Rock bass	T	T

T = less than 0.05 percent

Table C.18 Species Composition of Cove Populations, Chickamauga Reservoir, 1972.

Species	Percent of Total Number	Percent of Total Weight
Threadfin shad	49.7	10.3
Bluegill	20.2	6.5
Miscellaneous minnows	14.9	1.0
Gizzard shad	5.1	35.3
Drum	3.4	9.1
Longear sunfish	2.0	.7
Redear sunfish	.9	2.4
Spotted bass	.8	.3
Largemouth bass	.6	2.6
White crappie	.4	.8
Channel catfish	.3	2.8
Smallmouth buffalo	.2	13.9
Spotted sucker	.2	2.0
Yellow perch	.2	.2
Warmouth	.2	.1
Yellow bass	.2	.1
Carp	.1	8.8
Skipjack	.1	.3
Orangespotted sunfish	.1	t
Flathead catfish	t	.2
Golden redhorse	t	1.2
Green sunfish	t	t
Black crappie	t	t
Hogsucker	t	.1
River redhorse	t	.1
Longnose gar	t	.3
White bass	t	t
Sauger	t	.1
Black redhorse	t	.2
Black bullhead	t	t
River carpsucker	t	.1
Blue catfish	t	.3
Total	99.6	99.8

t = Less than .05

Table C.19 Species composition of Cove Population, Chickamauga Reservoir, 1973.

Species	Percent of Total Number	Percent of Total Weight
Threadfin shad	40.8	7.7
Bluegill	24.7	5.9
Gizzard shad	6.4	31.1
Drum	4.8	10.7
Redear sunfish	4.8	2.4
Bullhead minnow	3.9	.2
Longear sunfish	3.6	.7
Brook silversides	1.6	.1
Emerald shiner	1.4	.1
Blackstriped topminnow	1.3	.1
Largemouth bass	1.1	2.4
Spotted sucker	1.1	2.4
Warmouth	1.0	.3
Spotted bass	.6	.2
Logperch	.6	.3
White crappie	.4	.8
Channel catfish	.4	3.3
Yellow perch	.3	.3
Smallmouth buffalo	.2	14.5
Carp	.2	14.1
Yellow bass	.2	.1
Green sunfish	.2	.1
White bass	.1	.1
Skipjack herring	.1	.3
Golden shiner	.1	.1
Spotfin shiner	.1	-
Flathead catfish	-	.6
Golden redhorse	-	.6
River carpsucker	-	.2
Shorthead redhorse	-	.1
Sauger	-	-
Blue catfish	-	-
Spotted gar	-	-
Longnose gar	-	-
Orangespotted sunfish	-	-
Mooneye	-	-
Mosquitofish	-	-
Hogsucker	-	-
Bluntnose minnow	-	-
Total	100.0	99.8

- = Less than .05

Table C.20 Comparison of Rotenone Survey Results in Coves of Chickamauga Reservoir - 1970-1973.

Cove Area	Year	Sample Area Size (ac)	No. Fish per Acre	Lb Fish per Acre
Nance Hollow	1970	2.20	2,910	216.6
	1971	3.10	2,574	251.4
	1972	3.10	4,701	319.2
	1973	3.10	3,519	252.0
Chigger Point	1970	2.24	3,709	200.6
	1971	2.40	1,159	167.8
	1972	2.40	6,396	205.5
	1973	2.40	3,581	176.3
Sale Creek	1970	1.50	3,094	200.7
	1971	2.30	3,734	88.7
	1972	2.30	4,427	206.9
	1973	2.30	4,621	179.9
TRM 508.0	1971	1.05	5,549	321.9
	1972	1.05	10,728	511.3
	1973	1.05	12,919	633.5

TABLE C.21

Fish Species List from Cove Rotenone Samples in Chickamauga Reservoir

Number	Common Name	Scientific Name
1	Chestnut lamprey	*Icythyomyzon castaneus* (Girard)
2	Spotted gar	*Lepisosteus oculatus* (Winchell)
3	Longnose gar	*L. osseus* (Linnaeus)
4	Shortnose gar	*L. platostomus* (Rafinesque)
5	Skipjack herring	*Alosa chrysochloris* (Rafinesque)
6	Gizzard shad	*Dorosoma cepodianum* (Lesueur)
7	Threadfin shad	*D. petenense* (Gunther)
8	Mooneye	*Hiodon tergisus* (Lesueur)
9	Stoneroller	*Campostoma anomalum* (Rafinesque)
10	Rosyside dace	*Clinostomus funduloides* (Girard)
11	Carp	*Cyprinus carpio* (Linnaeus)
12	Silver chub	*Hybopsis storeriana* (Kirtland)
13	Golden shiner	*Notemigonus crysoleucas* (Mitchill)
14	Emerald shiner	*Notropis* atherinoides (Rafinesque)
15	Ghost shiner	*N. buchanani* (Meek)
16	Spotfin shiner	*N. spilopterus* (Cope)
17	Striped shiner	*N. chrysocephalus* (Rafinesque)
18	Bluntnose minnow	*Pimephales notatus* (Rafinesque)
19	Bullhead minnow	*P. vigilax* (Baird and Girard)
20	River carpsucker	*Carpiodes carpio* (Rafinesque)
21	Quillback carpsucker	*C. cyprinus* (Lesueur)
22	Highfin carpsucker	*C. velifer* (Rafinesque)
23	Northern hog sucker	*Hypentelium nigricans* (Lesueur)
24	Smallmouth buffalo	*Ictiobus bubalus* (Rafinesque)
25	Bigmouth buffalo	*I. cyprinellus* (Valencinnes)
26	Black buffalo	*Ictiobus niger* (Rafinesque)
27	Spotted sucker	*Minytrema melanops* (Rafinesque)
28	Silver redhorse	*Moxostoma anisurum* (Rafinesque)
29	Shorthead redhorse	*M. macrolepidotum* (Lesueur)
30	River redhorse	*M. carinatum* (Cope)

TABLE C.21 (continued)

Number	Common Name	Scientific Name
31	Black redhorse	M. duquesnei (Lesueur)
32	Golden redhorse	M. erythrurum (Rafinesque)
33	Blue catfish	Ictalurus furcatus (Lesueur)
34	Black bullhead	I. melas (Rafinesque)
35	Channel catfish	I. punctatus (Rafinesque)
36	Flathead catfish	Pylodictis olivaris (Rafinesque)
37	Blackstripe topminnow	Fundulus notatus (Rafinesque)
38	Blackspotted topminnow	F. olivaceus (Storer)
39	Mosquitofish	Gambusia affinis (Baird & Girard)
40	White bass	Morone chrysops (Rafinesque)
41	Yellow bass	M. mississippiensis (Jorden and Eigenma
42	Rock bass	Ambloplites rupestris (Rafinesque)
43	Warmouth	Lepomis gulosus (Cuvier)
44	Redbreast sunfish	L. auritus (Linnaeus)
45	Green sunfish	L. cyanellus (Rafinesque
46	Orangespotted sunfish	L. humilis (Girard)
47	Bluegill	L. macrochirus (Rafinesque)
48	Longear sunfish	L. megalotis (Rafinesque)
49	Redear sunfish	L. microlophus (Gunther)
50	Smallmouth bass	Micropterus dolomieui (Lacepede)
51	Spotted bass	M. punctulatus (Rafinesque)
52	Largemouth bass	Micropterus salmoides (Lacepede)
53	White crappie	Pomoxis annularis (Rafinesque)
54	Black crappie	P. nigromaculatus (Lesueur)
55	Rainbow darter	Etheostoma caeruleum (Storer)
56	Yellow perch	Perca flavescens (Mitchill)
57	Logperch	Percina caprodes (Rafinesque)
58	Sauger	Stizostedion canadense (Smith)
59	Freshwater drum	Aplodinotus grunniens (Rafinesque)
60	Brook silverside	Labidesthes sicculus (Cope)

Table C.22 Estimated annual harvest from TVA reservoirs - 1971-1973.

Reservoir	Annual Pounds Harvested
Guntersville	1,938,000
Wheeler	1,938,000
Wilson	806,000
Fort Loudon	593,000
Nickajack	491,000
Douglas	422,000
Chickamauga	373,000
Watts Bar	107,000
Cherokee	40,000

Table C.23 1972 Chickamauga Reservoir commercial fisherman survey (actual catch of 24.32 percent of fisherman).

Species	Pounds Caught	Pounds sold to dealers	Pounds sold to individuals
Catfish	45,409	23,858	21,141
Buffalo	34,870	31,400	3,320
Carp	10,180	7,000	3,080
Drum	160	160	-
Spoonbill	160	160	-
Others	-	-	-
Total	90,779	62,578	27,541

Table C.24(a)

Harvest rate of sport fish, January 1, 1972, through December 31, 1975, Chickamauga Reservoir, Tennessee

	Harvest per hour of fishing		Harvest per hectare	
	Number	Biomass (Kg)	Number	Biomass (Kg)
1972	0.85	0.23	18.3	5.0
1973	0.97	0.36	15.5	5.8
1974	0.94	0.21	13.0	3.0
1975	0.76	0.19	11.4	2.9

Table C.24(b)

Fish harvest in Watts Bar Tailwater, TRM 505.3 to TRM 529.9, 1032.4 total hours fishing from January 1 to June 30, 1977

Species	No.	%	Wt. (lbs)	%	Av. Wt. (lb)
White crappie	426	43.1	139.9	30.8	0.33
Black crappie	7	0.7	10.2	2.3	1.46
Largemouth bass	8	0.8	10.2	2.3	1.28
Spotted bass	2	0.2	2.9	0.6	1.45
Smallmouth bass	6	0.6	6.5	1.4	1.08
White bass	26	2.6	20.8	4.6	0.80
Yellow bass	10	1.0	2.8	0.6	0.28
Bluegill	83	8.4	36.3	8.0	0.44
Redear sunfish	14	1.4	4.8	1.1	0.34
Other sunfish	3	0.3	0.8	0.2	0.27
Walleye	1	0.1	0.3	0.1	0.30
Sauger	134	13.6	89.7	19.8	0.67
Channel catfish	184	18.6	75.3	16.6	0.41
Flathead catfish	1	0.1	1.3	0.3	1.30
Blue catfish	21	2.1	24.1	5.3	1.10
Drum	52	5.3	21.7	4.8	0.42
Yellow perch	7	0.7	1.9	0.4	0.27
Rockfish	1	0.1	1.7	0.4	1.7
Paddlefish	1	0.1	1.2	0.3	1.2
Spotted sucker	1	0.1	1.5	0.3	1.5
TOTAL	988		454.1		0.46

(Source: TVA, Letter from J. Gilleland to E. Case, dated May 19, 1978)

Table C.25 Estimated catch by species, January 1, 1972, through December 31, 1975, Chickamauga Reservoir, Tennessee.

	Number				Biomass (Kg)			
Species	1972	1973	1974	1975	1972	1973	1974	1975
White crappie	99,838	143,392	55,873	66,444	23,764	33,145	11,441	13,265
Bluegill	73,845	38,102	75,749	46,348	8,913	5,980	9,994	6,942
White bass	29,108	12,005	13,779	10,850	10,470	3,857	4,340	2,571
Channel catfish	20,901	13,517	14,213	15,370	9,501	10,541	6,805	7,546
Drum	17,414	4,557	4,229	544	6,311	1,479	1,292	127
Largemouth bass	15,972	10,066	12,295	16,916	8,425	5,286	5,684	9,076
Skipjack herring	3,304	1,378			1,336	210		
Blue catfish	5,746	5,106	3,108	2,360	2,432	24,947	1,147	753
Redear sunfish	6,494	3,449	10,446	6,916	1,007	610	1,630	1,348
Spotted bass	5,508	3,434	4,025	4,537	1,845	1,427	1,554	1,526
Smallmouth bass	4,283	97	163	362	1,827	42	91	101
Black crappie	1,874	2,068	4,215	4,234	440	474	948	1,072
Sauger	1,410	3,679	4,737	3,502	981	1,374	1,651	887
Other sunfish*	398	841	259	273	53	123	21	33
Yellow perch	564	909	566		73	179	111	
Yellow bass	390	225	475	747	70	79	98	84
Flathead catfish	633	286	30	497	364	216	14	955
Rockbass	323	564			138	103		
Bullhead	142		110		86		107	
Carp	270	96	28		704	185	57	
Walleye	68		137		124		188	
Smallmouth buffalo	42	7			103	8		
Longnose gar	90				90			
Rockfish	12	842	33		16	1,243	62	
Mooneye	18				7			
Minnows		76				7		
Paddlefish			48				44	
Total	288,647	244,696	204,518	179,900	79,080	91,515	47,279	46,286

*Includes longear sunfish, green sunfish, warmouth, etc.

REFERENCES FOR APPENDIX C

1. Tennessee Valley Authority, Final Environmental Statement for Watts Bar Nuclear Plant, Units 1 and 2, TVA-OHES-EIS-72-9, Chattanooga, Tenn., November 9, 1972.

2. Tennessee Valley Authority, Environmental Information for Watts Bar Nuclear Plant, Units 1 and 2, November 18, 1976.

3. Tennessee Valley Authority, Environmental Information, Watts Bar Nuclear Plant, Units 1 and 2, Supplement 1, 1977.

4. Tennessee Valley Authority, Aquatic Biota, (Non-fish), April 1977.

5. Federal Register 41 (115) June 14, 1976.

6. Fuller, Samuel L. H.. "Clams and Mussels." Chapter 8 in C. W. Hart, Jr. and Samuel L. H. Fuller, eds. Pollution Ecology of Freshwater Invertebrates. Academic Press, Inc., New York, 1974.

7. Op. Cit., Ref. 1, page 1.1-21.

8. Op. Cit., Ref. 3, page 3-10.

9. Mitchell, Vester P., Jr., and Billy B. Carroll, Survey of Sport Fishing, Chickamauga Reservoir, January 1, 1972 through December 31, 1975, Tennessee Valley Authority, Div. Forestry, Fisheries and Wildlife Development, Muscle Shoals, Alabama, 1976.

APPENDIX D

EXPLANATION OF BENEFIT-COST SUMMARY, TABLE 10.1

ECONOMIC IMPACT OF PLANT OPERATION

DIRECT BENEFITS - The staff has evaluated the effect of the Watts Bar Nuclear Plant production of baseload energy for no load growth situation (Section 9.3.2).

INDIRECT BENEFITS - See Section 5.6.

ECONOMIC COSTS

Operating costs - Supplied by Applicant.[6]

Decommissioning costs - The staff has estimated decommissioning costs in 1975 dollars at $59 million.

1. Deactivating the reactors.

2. Decontaminating of process systems and areas of plant.

3. Removing all nuclear fuel from the site for recovery of fuel materials and ultimate disposal of radioactive wastes.

4. Sealing of building or portion of building containing activated process piping and components by means of blocking, bolting, or welding plates over openings, etc.

5. Dismantling and sealing of all gaseous and liquid waste systems and effluent lines.

6. Maintaining some security and fire systems.

7. Ultimate dismantling of station.

ENVIRONMENTAL IMPACT OF PLANT

(The index numbers used in this and the next section correspond to those used in Table 10.1.)

Item 1.1 - CONSUMPTION (nuclear station consumption) - The amount of water consumed by the applicant is estimated at 1.4 cubic meters for operation. This consumption amounts to 45,000,000 cubic meters/year.

Item 1.2 - HEAT DISCHARGE TO NATURAL WATER BODY.

Item 1.2.1 - Cooling capacity of water body - Btu/hr rejected heat = 9×10^8 (max).

Item 1.2.2 - Aquatic biota - Insignificant.

Item 1.2.3 - Migratory fish - Insignificant.

Item 1.3 - CHEMICAL DISCHARGE TO NATURAL WATER BODY. (Includes items 1.3.1, 1.3.2, 1.3.3 and 1.3.4)

Chemicals will be discharged to the Chickamauga Reservoir.

Item 1.4 - RADIONUCLIDE CONTAMINATION OF NATURAL WATER BODY. Radionuclides will be released to the condenser cooling water. Radioactivities are expected to be 0.22 Ci/year (total) for all radionuclides except tritium and 520 Ci/year (total) for tritium. No detectable effect is expected from these releases (Sections 3.2.3, 5.5.1 and 5.5.2).

Item 1.5 - CHEMICAL CONTAMINATION OF GROUNDWATER. See item 1.3, above.

Item 1.6 - RADIONUCLIDE CONTAMINATION OF GROUNDWATER. See item 1.4, above.

Item 1.7 - RAISING/LOWERING OF GROUNDWATER LEVELS. (Includes items 1.7.1 and 1.7.2). No effect is expected.

Item 1.8 - EFFECTS ON NATURAL WATER BODY OF INTAKE STRUCTURE AND CONDENSER COOLING SYSTEMS - Unknown (Section 5.4).

Item 1.9 - NATURAL WATER DRAINAGE.

Item 1.9.1 - Flood Control - No damage to station or immediate vicinity.

Item 1.9.2 - Erosion control - No significant erosion is expected.

Item 2. - IMPACT ON AIR

Item 2.1 - CHEMICAL DISCHARGE TO AMBIENT AIR

Item 2.1.1 - Air Quality -- chemical - No impact.

Item 2.1.2 - Air Quality -- odor - No impact.

Item 2.2 - RADIONUCLIDES DISCHARGED TO AMBIENT AIR

Item 2.2.1 - Section 3.2.3.

Item 2.3 - FOGGING AND ICING - The added evaporation will increase the amount of fogging in the vicinity of the plant, but the extra vapor discharged to the atmosphere does not appear to be such that the fogging will be severe to excessive.

Item 2.4 - Section 5.4.1.

Item 3. - See Section 5.5.

SOCIETAL IMPACT OF PLANT

Item 1. - OPERATIONAL FUEL DISPOSITION

Item 1.1 - FUEL TRANSPORT - ten truck shipments of new fuel plus 13 train shipments of radioactive spent fuel assemblies per year.

Item 1.2 - FUEL STORAGE - the staff assumes storage of new fuel to be provided for in plant design within the reactor building.

Item 1.3 - WASTE PRODUCTS - Onsite storage of spent fuel assemblies is normal and is assumed for Watts Bar.

Item 2. - LABOR - Negligible impact (Section 5.6).

APPENDIX E.

NPDES PERMIT

United States
Environmental Protection
Agency

Region 4
345 Courtland Street NE
Atlanta GA 30308

Alabama, Georgia, Florida,
Mississippi, North Carolina,
South Carolina, Tennessee,
Kentucky

EPA

NOV 27 1978

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Dr. Harry G. Moore, Jr.
Acting Director of Environmental
Planning
Tennessee Valley Authority
268 401 Building
Chattanooga, Tennessee 37401

RE: Watts Bar Nuclear Plant
NPDES Permit No. TN0020168

Dear Dr. Moore:

Enclosed is a National Pollutant Discharge Elimination System permit and a copy of my 316(a) findings for the above referenced facility. This NPDES permit constitutes my determination under Title 40, Code of Federal Regulations, Section 125.35, as amended (30FR27080, July 24, 1976).

In accordance with the Environmental Protection Agency regulations found in 40 CFR 125 (as amended July 24, 1974 39FR27076), this permit will become effective on the date noted, provided that no request for an adjudicatory hearing is filed with the Agency. In the event that such a request is filed, the contested provisions of the permit will be stayed and will not become effective until the administrative review process is complete. All uncontested portions of the permit will be considered operative on the effective date and must be complied with by the facility.

If you wish an adjudicatory hearing, a request must be submitted to the Regional Hearing Clerk within 10 days from receipt of this letter. The request will be timely if mailed by Certified Mail within the ten (10) day period. For the request to be valid, it must conform to the requirements of 40 CFR 125.36(b) as noted above.

Responses to your letter of June 30, 1978 relative to the Public Notice and Draft Permit are included as Attachment A. Responses have been provided in the same sequence as your comments.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978 — 740-732/1364

If you have any questions about the permit, please contact the Coordinator, Thermal Analysis Unit at 257-2328. Information on the request for procedures and legal matters may be obtained by contacting the Chief, Legal Support Branch at 257-3506.

Sincerely yours,

Howard Zeller /for
Paul J. Traina
Director
Enforcement Division

Enclosures

cc (Attachments):

Mr. Elmo Lunn, Director
Division of Water Quality Control

Mr. Jack McCormick
Regional Engineer
Chattanooga Regional Office

Mr. Jim Morris
Tennessee Valley Authority

✓Ms. Susie Keblusek
Nuclear Regulatory Commission

Attachment A

Responses to TVA Letter of June 30, 1978

Watts Bar Nuclear Plant

1. Short duration of permit and Part III.P. These items have been discussed with Mr. James Burger and support material provided.

2. Part I, Serial 002. We have reviewed your request for reduced monitoring; however, as indicated in our letter of April 20, 1978 we do feel that this monitoring should be conducted. Subsequent to establishment of a data base, a request for reduction or elimination of monitoring may be submitted in accordance with Part III.B.

3. Part I, Serials 003, 004 and 008 - ph limitations. We feel that the limitations should be retained for the facility for the following reasons: 003-required by State Certification. 004-mute since wastes are to be ponded, and 008-necessary to achieve adequate treatment of condensate demineralizer wastes.

4. Part I, serial 005. Requested deletions have been made.

5. Part I, serial 008. Requested foot note has been added.

6. Part III.J. Requested approval given.

7. Part III.K. Requested approval given.

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Federal Water Pollution Control Act, as amended, (33 U.S.C. 1251 et. seq; the "Act"),

Tennessee Valley Authority
268 401 Building
Chattanooga, Tennessee 37401

is authorized to discharge from a facility located at

Watts Bar Nuclear Plant
Units 1 and 2
Spring City, Tennessee

to receiving waters named Tennessee River (RM 527.8) and Yellow Creek from discharge points enumerated herein as serial numbers 001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 012, 013, 014, 015, 016, 017, and 018

during the effective period of this permit

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof.

This permit is a modification of the NPDES permit issued for this facility on December 5, 1973, and replaces that permit in its entirety. This modified permit shall become effective January 1, 1979.

This modified permit and the authorization to discharge shall expire at midnight, September 30, 1980. Permittee shall not discharge after the above date of expiration without prior authorization. In order to receive authorization to discharge beyond the above date of expiration, the permittee shall submit such information, forms, and fees as are required by the Agency authorized to issue NPDES permits no later than 180 days prior to the above date of expiration.

Signed this 27th day of November, 1978

Howard Zeller (acting for)
Paul J. Traina, Director
Enforcement Division

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 002 - Diffuser Discharge to the Tennessee River

Such discharges shall be limited and monitoring by the permittee as specified below:

Effluent Characteristic	Discharge Limitations	Monitoring Requirements	
	Instantaneous Maximum	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	Continuous	Recorder
Temperature °C(°F)	35.0(95.0) 1/	Continuous	Recorder
Total Chlorine Residual	See Below	1/week 2/	Multiple grabs
Additional Monitoring	See Below	1/month	8-hour composite

Chlorine may be discharged continuously, however, total residual chlorine shall not exceed a maximum instantaneous concentration Of 0.10 mg/l. In the event that the units cannot be operated at or below this level of chlorination, the permittee may submit a demonstration, based on biological toxicity data, that discharge of higher levels of chlorine are consistant with toxicity requirements of the Tennessee Water Quality Standards. Effluent limitations will be modified consistant with an acceptable demonstration.

Direct overflow from the yard holding pond to the Tennessee River is allowed under emergency conditions to protect dike stability, but only to the minimum extent necessitated by the emergency. Notification of such overflow shall be provided to the Director, Enforcement Division and to the State Director within five days after any occurrence. On each occurrence, a grab sample shall be collected for suspended solids analysis and the results of such analysis shall be reported either with the notification of overflow or within 15 days of the occurrence.

Additional monitoring shall include total suspended, settleable and total dissolved solids; ammonia nitrogen; and total copper, iron, manganese and zinc.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week on a grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following locatiðn(s): plant discharge prior to entry into the Tennessee River.

1/ 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 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 which shall not exceed (1) a maximum width of 240 feet nor (2) a 240- foot linear downstream length.

2/ During the first two-month period of substantially full power operation, analyses shall follow each application of chlorine until sufficient operating experience has been obtained to assure compliance with limitations and then analysis frequency may be reduced to one day per week.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on effective date and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 001 - Point source(s) runoff from construction (includes treated domestic waste and concrete washing wastes) to Yellow Creek

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristics	Discharge Limitations	Monitoring Requirements	
	Instantaneous Maximum	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	1/week	Grab
Total Suspended Solids (mg/l)	1/	1/week	Grab
Settleable Solids (ml/l)	N/A	1/week	Grab
Turbidity	N/A	1/week	Grab

1/ Pending repromulgation of effluent guidelines for this waste category, limitations on total suspended solids shall not be applicable. Within 90 days of repromulgation, permittee shall submit a proposed implementation schedule and shall expeditiously complete necessary facilities, if any, to assure compliance with such repromulgated regulations. In the interim, construction practices and control of site runoff shall be consistent with sound engineering practices such as those contained in "Guidelines for Erosion and Sediment Control Planning and Implementation," EPA-R2-72-015 (August, 1972) or "Processes, Procedures and Methods to Control Pollution Resulting from all Construction Activity," EPA-430/9-73-007 (October, 1973). Where an impoundment is utilized by permittee, it shall be capable of containing a 10-year, 24-hour rainfall event.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Point(s) of discharge from the construction yard drainage pond prior to mixing with any other waste streams.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on effective date and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 004 1/ - Preoperational Metal Cleaning Wastes

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	1/day	Weir or pump log
Oil and Grease (mg/1)	15	20	2/	Grab
Total Suspended Solids (mg/1)	30	100	2/	8-hr. composite
Copper, Total (mg/1)	1.0	1.0	2/	8-hr. composite
Iron, Total (mg/1)	1.0	1.0	2/	8-hr. composite
Phosphorus, as P (mg/1)	1.0	1.0	2/	8-hr. composite

Metal cleaning wastes shall mean any cleaning compounds, rinse waters, or any other waterborne residue derived from cleaning any metal process equipment.

The quantity of pollutants discharged in metal cleaning wastes shall not exceed the quantity determined by multiplying the above concentrations, times the volume of metal cleaning wastes.

1/ Serial number assigned for identification and monitoring purposes.
2/ On start of discharge and once/week thereafter until termination of discharge with one sample taken immediately prior to termination of discharge.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/day.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the metal cleaning wastes treatment facility(s) prior to mixing with any other waste stream discharging through Serial Number 002.

NOTE: In the event that the permittee provides land disposal or spray irrigation of these wastes, the above limitations and monitoring requirements shall not be applicable. Notification of proposed disposal in this manner shall be provided to EPA and the State Director. Permittee must obtain approvals from the Tennessee Division of Water Quality Control and EPA prior to any land disposal or spray irrigation of these wastes. Said approvals shall be based upon site inspections and review of appropriate engineering submittals.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on effective date and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 003 1/ - Construction Sewage Treatment Plant Effluent

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations mg/l except as noted		Monitoring Requirements	
	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	136(0.036)		1/day	Grab
BOD 5	30	60	1/2 weeks	Grab
Total Suspended Solids	30	60	1/2 weeks	Grab
Settleable Solids (ml/1)	1.0	1.0	1/day	Grab
Chlorine Residual	N/A	N/A	1/day	Grab
Fecal Coliform 2/ (organisms/100 ml)	N/A	N/A	1/2 weeks	Grab

Effluent shall be aerobic at all times.

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Sewage treatment plant effluent prior to mixing with any other waste stream discharging through Serial Number 001.

1/ Serial number assigned for identicication and monitoring purposes.
2/ Geometric mean.

NOTE: See Certification Requirement 4.c. (Attachment C) for more stringent limitations and monitoring requirements.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 006 1/ – Liquid Radwaste System

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow-m 3/Day (MGD)	N/A	N/A	1/batch	Calculation
Total Suspended Solids (mg/l)	15	20	1/batch	Grab

Limitations and monitoring requirements shall be applicable only when liquid radwaste system effluent is directed to any waste stream which discharges to Waters of the United States.

1/ Serial number assigned for identification and monitoring purposes.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from radwaste treatment system prior to mixing with any other waste stream.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 005 1/ - Operational Sewage Treatment Plant Effluent

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations mg/l except as noted		Monitoring Requirements	
	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	45 (0.012)		1/day	Grab
BOD 5	30	60	1/month	Grab
Total Suspended Solids	30	60	1/month	Grab

Effluent shall be aerobic at all times.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Sewage treatment plant effluent prior to mixing with any other waste stream.

1/ Serial number assigned for identification and monitoring purposes.

NOTE: See Certification requirement 4.c. (Attachment C) for more stringent limitations and monitoring requirements.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 008 1/ - Condensate Demineralizer System

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations 2/				Monitoring Requirements 2/	
	Kg/day (lbs/day)		Other Units (mg/l)			
	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	N/A	N/A	N/A	2/week	Grab
Oil and Grease	2.5(5.4)	3.3 (7.2)	15	20	2/week	Grab
Total Suspended Solids	4.9(10.8)	16.4(36.1)	30	100	2/week	Grab

The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/week on a grab sample.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): effluent from condensate demineralizer system prior to mixing with any other waste stream.

1/ Serial number assigned for identification and monitoring purposes.

2/ Limitations and monitoring requirements are not applicable during period when discharge is to the radwaste treatment system (serial number 006).

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 007 1/ - Neutral Waste Sump (neutralizer waste tank)

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (mg/l)			
	Daily Avg	Daily Maximum	Daily Avg	Daily Maximum	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	N/A	N/A	N/A	2/week	Grab or pump logs
Oil and Grease	2.0 (4.5)	2.7 (6.0)	15	20	2/week	Grab
Total Suspended Solids	4.1 (9.0)	13.6 (30.0)	30	100	2/week	Grab

1/ Serial number assigned for identification and monitoring purposes.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): individual discharges prior to mixing with any other waste streams.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 010 1/- Hypochlorite Building Drains, 011 1/ - Service Building Sump, 012 1/ - Diesel Generator Building Drains, 013 1/ Additional Equipment Building Drains, 014 1/and 015 1/- Auxiliary Building Sumps, 016 1/- CCW Pump Station Sump, and 017 1/- Cooling Tower Desilting Basin Effluent

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	N/A	2/week	Grab or pump logs
Oil and Grease (mg/1)	15	20	2/week	Grab
Total Suspended Solids (mg/1)	30	100	2/week	Grab

The quantity of pollutants discharged from each serial number shall not exceed the quantity determined by multiplying the flow from that waste source times the concentrations listed above.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from each source prior to discharge to the yard drainage system.

1/ Serial numbers assigned for identification and monitoring purposes.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 009 1/ - Turbine Building Station Sump

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	Kg/day(lbs/day)		Other units (mg/l)			
	Daily Avg	Daily Max	Daily Avg.	Daily Max	Measurement Frequency	Sample Type
Flow-m^3/Day (MGD)	N/A	N/A	N/A	N/A	2/week	Grab or pump logs
Oil and Grease	62(140)	220(480)	15	20	2/week	Grab
Total Suspended Solids	120(280)	1090(2400)	30	100	2/week	Grab

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): station sump discharge prior to mixing with any other waste stream.

1/ Serial number assigned for identification and monitoring purposes.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee shall monitor serial number(s) 019 1/ - Plant Intake

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	Continuous	Pump logs
Temperature °C(°F)	N/A	N/A	Continuous	Recorder
Additional Monitoring	See Below		1/month	8-hour composite

Additional monitoring shall include total suspended, settleable, and total dissolved solids; ammonia nitrogen; and total copper, iron, manganese, and zinc.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Plant Intake

1/ Serial number assigned for identification and monitoring purposes.

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning on start of discharge and lasting through expiration the permittee is authorized to discharge from outfall(s) serial number(s) 018 1/ - Steam Generator Blowdown

Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations		Monitoring Requirements	
	Daily Average	Daily Maximum	Measurement Frequency	Sample Type
Flow—m^3/Day (MGD)	N/A	N/A	1/month	Instantaneous
Oil and Grease (mg/l)	15	20	1/month	Grab
Total Suspended Solids (mg/l)	30	100	1/month	Grab
Copper, Total (mg/l)	1.0	1.0	1/month	Grab
Iron, Total (mg/l)	1.0	1.0	1/month	Grab

Limitations and monitoring requirements are not applicable if blowdown is discharged to the condensate demineralizer system.

The quantity of pollutants discharged shall not exceed the quantity determined by multiplying the flow of steam generator blowdown times the concentration listed above.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the blowdown prior to mixing with any other waste stream.

1/ Serial number assigned for identification and monitoring purposes.

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule.

   a. Compliance with effluent limitations - effective date or start of discharge as applicable (001 through 017)
   b. Preoperational aquatic monitoring program (III. J.)
      (1) Implement - Under way
      (2) Report - January 31, 1980
   c. PCB Control Report (III.C.) - 1/31/79
   d. Condenser tube report (III. M.)
      (1) Study plan - one year prior to commercial operation date of Unit 1
      (2) Reports - frequency to be developed after submission of study plan
   e. Operational aquatic monitoring program (III. K.)
      (1) Details of program submitted September 30, 1979.
      (2) Implement - commercial operation date of Unit 1
      (3) First report - 15 months after implementation date
      (4) Subsequent reports - annually after the first report
   f. Plume report (III.G.) - 15 months after commercial operation date of Unit 2

2. No later than 14 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

C. MONITORING AND REPORTING

1. *Representative Sampling*

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. *Reporting*

Monitoring results obtained during the previous 3 months shall be summarized for each month and reported on a Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on * . Duplicate signed copies of these, and all other reports required herein, shall be submitted to the Regional Administrator and the State at the following addresses:

Chief, Water Enforcement Branch Environmental Protection Agency 345 Courtland Street, N.E. Atlanta, Georgia 30308	AND	Director, Division of Water Quality Control Tenn. Dept. of Public Health 621 Cordell Hull Building Nashville, Tennessee 37219

3. *Definitions*

   a. The "daily average" concentration means the arithmetic average (weighted by flow) of all the daily determinations of concentration made during a calendar month. Daily determinations of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the daily determination of concentration shall be the arithmetic average (weighted by flow) of all the samples collected during that calendar day.

   b. The "daily maximum" concentration means the daily determination of concentration for any calendar day.

   c. "Weighted by flow" means the summation of each sample concentration times its respective flow in convenient units divided by the summation of the flow values.

   d. "Nekton" means free swimming aquatic animals whether of freshwater or marine origin.

   e. For the purpose of this permit, a calendar day is defined as any continuous 24-hour period.

* Continuation of present reporting frequency

f. The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

g. The "daily maximum" discharge means the total discharge by weight during any calendar day.

4. ***Test Procedures***

Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(g) of the Act, under which such procedures may be required.

5. *Recording of Results*

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The dates the analyses were performed;

c. The person(s) who performed the analyses;

d. The analytical techniques or methods used; and

e. The results of all required analyses.

6. *Additional Monitoring by Permittee*

If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (EPA No. 3320-1). Such increased frequency shall also be indicated.

7. *Records Retention*

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the State water pollution control agency.

A. MANAGEMENT REQUIREMENTS

1. *Change in Discharge*

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. *Noncompliance Notification*

If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

3. *Facilities Operation*

The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

4. *Adverse Impact*

The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

5. *Bypassing*

Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Regional Administrator and the State in writing of each such diversion or bypass.

6. *Removed Substances*

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

7. *Power Failures*

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. In accordance with the Schedule of Compliance contained in Part I, provide an alternative power source sufficient to operate the wastewater control facilities;

or, if such alternative power source is not in existence, and no date for its implementation appears in Part I,

b. Halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of the primary source of power to the wastewater control facilities.

B. RESPONSIBILITIES

1. *Right of Entry*

The permittee shall allow the Regional Administrator, and/or his his authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. *Transfer of Ownership or Control*

In the event of any change in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Regional Administrator and the State water pollution control agency.

3. *Availability of Reports*

Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public

inspection at the offices of the State water pollution control agency and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

4. *Permit Modification*

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

5. *Toxic Pollutants*

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. *Civil and Criminal Liability*

Except as provided in permit conditions on "Bypassing" (Part II, A-5) and "Power Failures" (Part II, A-7), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

7. *Oil and Hazardous Substance Liability*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

8. *State Laws*

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

9. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected hereby.

PART III

OTHER REQUIREMENTS

A. There shall be no discharge of metal cleaning wastes (except as noted for Serial 004) as defined in 40 CFR Part 432.11(j) to any plant waste stream which discharges to Waters of the United States.

B. If the permittee, after monitoring for at least 12 months, determines that he is consistently meeting the effluent limits contained herein, the permittee may request of the Director, Enforcement Division that the monitoring requirements be reduced to a lesser frequency or be eliminated.

C. There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid. In the event that PCB containing equipment is used on site, administrative procedures shall be instituted to (1) maintain a detailed inventory of PCB use, (2) assure engineering design and construction to preclude release of PCB's to the environment, and (3) effectively detect the loss of PCB's from equipment. Detail of such procedures shall be submitted by January 31, 1979.

D. The company shall notify the Director, Enforcement Division is writing not later than sixty (60) days prior to instituting use of any additional biocide or chemical used in cooling systems, other than chlorine, which may be toxic to aquatic life other than those previously reported to the Environmental Protection Agency. Such notification shall include:

1. name and general composition of biocide or chemical,
2. 96-hour median tolerance limit data for organisms representative of the biota of the waterway into which the discharge shall occur,
3. quantities to be used,
4. frequencies of use,
5. proposed discharge concentrations, and
6. EPA registration number, if applicable.

E. Concrete washing wastes shall be directed to the construction yard drainage pond (Serial Number 001).

F. Intake screen backwash and strainer backwash shall be discharged to the holding pond unless results of operational aquatic monitoring program indicate the need for rerouting. Material removed from the bar racks shall not be returned to the Tennessee River.

G. Effluent diffuser shall be designed to assure a minimum dilution factor of 10 at all river flow conditions. Subsequent to commercial operation of Unit 2 field measurements (supplemented as necessary with modeling results) shall be conducted to determine three dimensional configuration of the thermal plumes, substantiate the dispersion modeling, and assure conformance with the assigned thermal mixing zone. The report on thermal plume and dispersion characteristics shall be submitted not later than 15 months after commercial operation date of Unit 2.

H. There shall be no discharge through the plant diffuser system when Tennessee River flows are less than 3500 cubic feet per second. Positive interlocks with the Watts Bar Hydroelectric Plant shall be provided to assure compliance with this requirement.

I. Discharge of blowdown from the cooling tower system shall be limited to the minimum discharge practicable, consistant with requirements of the once through raw cooling water systems.

J. Permittee shall continue and complete the pre-operational non-radiological aquatic monitoring program submitted to EPA on August 31, 1977. A report on this study shall be submitted not later than January 31, 1980.

K. By the commercial operation date of Unit 1, permittee shall implement the non-radiological aquatic monitoring program submitted to EPA on August 31, 1977. Specific details of this program shall be finalized and submitted for review and approval by the Director, Enforcement Division not later than September 30, 1979. Reports shall be submitted annually, not more than three months following completion of the reporting period with the first report due 15 months after implementation of the program. The program shall continue for a period of not less than one year after commercial operation of Unit 2.

L. Permittee shall comply with applicable requirements of 40 CFR Part 112, OIL POLLUTION PREVENTION.

M. The permittee shall provide a technical study that correlates operations experience with condenser tubes from Units 1 and 2 and demonstrates a sufficiently low corrosion/erosion rate to assure protection of aquatic organisms. A study plan shall be submitted not later than one year prior to commercial operation date of Unit 1. Report period will be developed upon submission of the study plan.

N. Copies of all routine liquid effluent and water quality monitoring reports submitted to NRC shall be submitted to EPA and the State Director.

O. Copies of all plans, and reports submitted in accordance with Parts III. C, D, G, J, K, and M herein shall be forwarded by the permittee as follows:

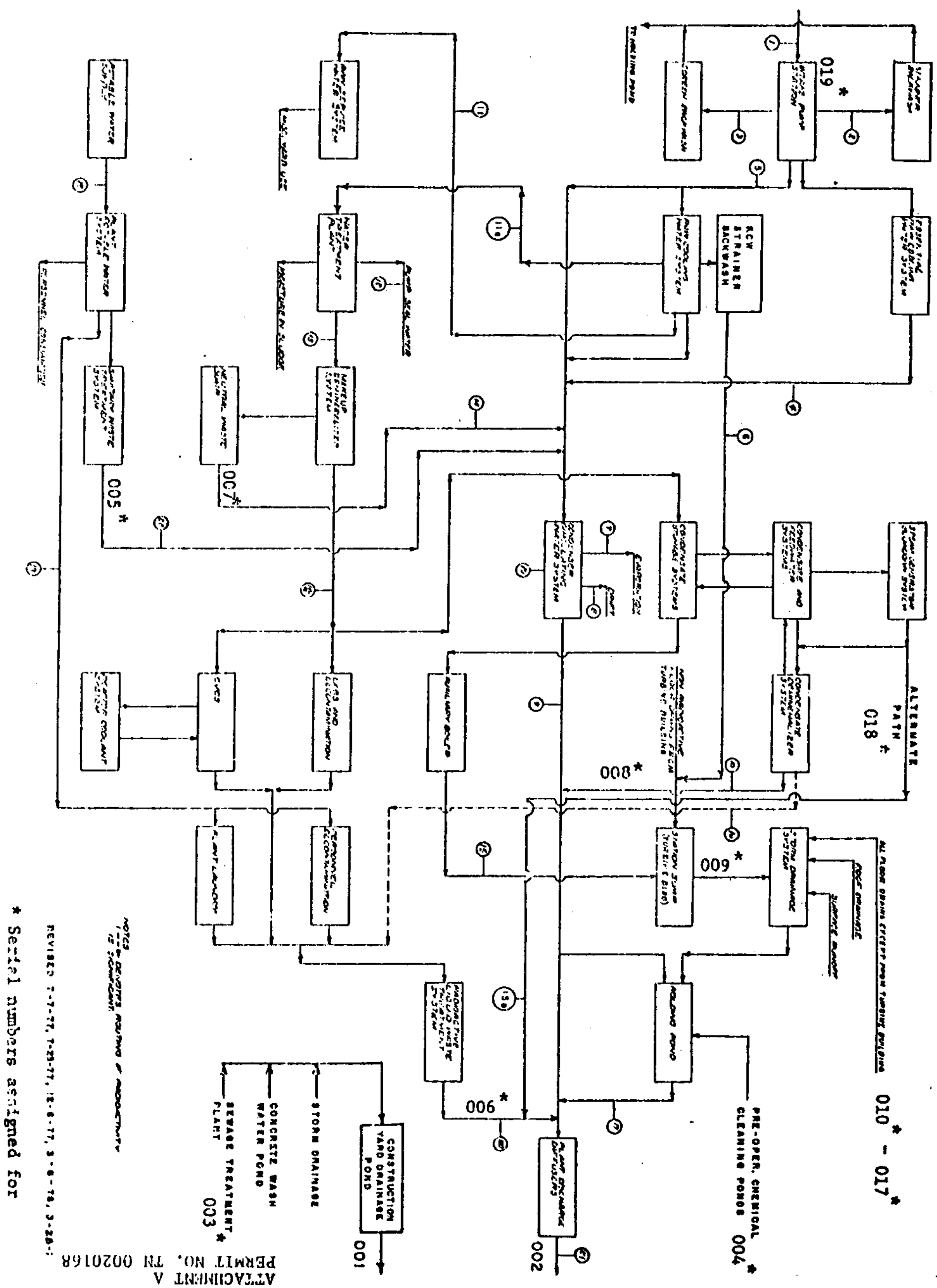
Number of Copies	Addressee
4	Director, Enforcement Division, EPA (Atlanta)
1	Chief, Ecology Branch, EPA (Athens)
2	Director for Environmental Projects, NRC (Bethesda)
2	Regional Director, Fish and Wildlife Service (Atlanta)
1	Director, Tennessee Division of Water Quality Control (Nashville)
1	Regional Engineer, Tennessee Division of Water Quality Control (Chattanooga)

P. This permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable effluent standard or limitations issued or approved under sections 301(b)(2) (C), and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act, if the effluent standard or limitation so issued or approved:

(1) Contains different conditions or is otherwise more stringent than any effluent limitation in the permit; or
(2) Controls any pollutant not limited in the permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

Q. The Tennessee Department of Public Health has certified the discharges covered by this permit with conditions (See Attachment "C"). Section 401 of the Act requires that conditions of certification shall become a condition of the permit. The monitoring and sampling shall be as indicated for those parameters included in the certification. Any effluent limits, and any additional requirements, specified in the attached state certification which are more stringent supersede any less stringent effluent limits provided herein. During any time period in which the more stringent state certification effluent limits are stayed or inoperable, the effluent limits provided herein shall be in effect and fully enforceable.



* Serial numbers assigned for identification and monitoring

ATTACHMENT C
Permit No. TN 0020168

STATE OF TENNESSEE
DEPARTMENT OF PUBLIC HEALTH
CORDELL HULL BUILDING
NASHVILLE, TENNESSEE 37219

621 Cordell Hull Building

October 13, 1978

Mr. Paul J. Traina
Director
Enforcement Division, Region IV
Environmental Protection Agency
345 Courtland Street
Atlanta, Georgia 30308

RE: State Certification
NPDES Permit No. TN0020168
Watts Bar Nuclear Plant, Units One and Two
Spring City, Rhea County, Tennessee
Receiving Waters - Tennessee River, Mile 527.8, and Yellow Creek, Mile 1.3

Dear Mr. Traina:

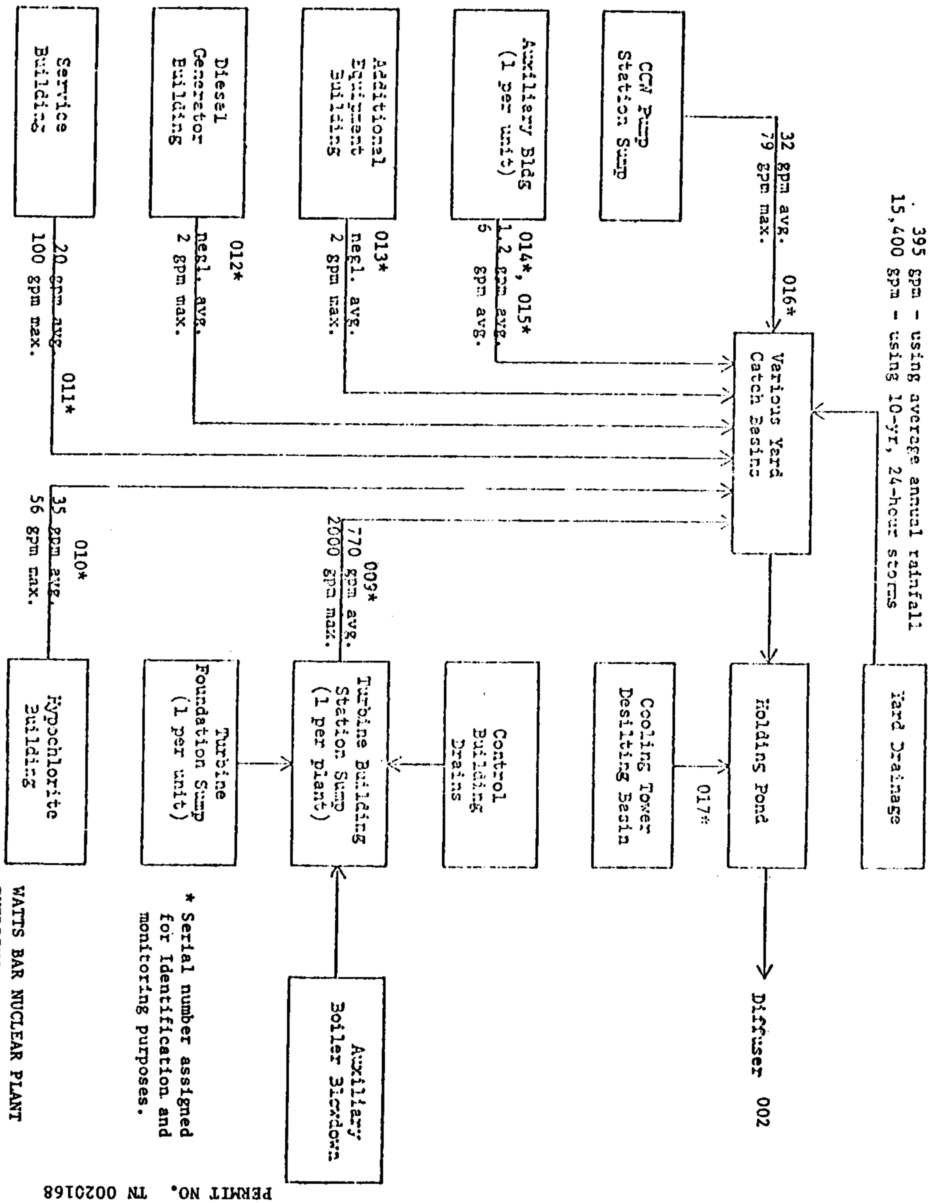
Pursuant to Section 401 of the Federal Water Pollution Control Act (as amended by the Clean Water Act of 1977), 33 U.S.C. 1251, 1341, the State of Tennessee hereby issues certification to the subject applicant for a National Pollutant Discharge Elimination System (NPDES) Permit for a wastewater discharge.

The State of Tennessee is not aware of any condition or limitation under Section 301, Section 302, or Section 303 of the Federal Act that would be violated by issuance of the proposed NPDES Permit; additionally, the State of Tennessee is not aware of any standard of performance under Section 306 or Section 307 that would be violated by issuance of the proposed Permit.

This certification is contingent upon the following conditions:

1. Permittee is in no way relieved from any liability for damages which might result from the discharge of wastewater.

2. Permittee must additionally comply with all requirements, conditions, or limitations which may be imposed by any provision of the Tennessee Water Quality Control Act (T.C.A. Sections 70-324 through 70-342) or any regulations promulgated pursuant thereto.



WATTS BAR NUCLEAR PLANT
BUILDING DRAINAGE

ATTACHMENT B
PERMIT NO. TN 0020168

3. The State of Tennessee reserves the right to modify or revoke this certification or to seek revocation or modification of the NPDES Permit issued subject to this certification should the State determine that the wastewater discharge violates the Tennessee Water Quality Control Act, or any applicable Water Quality Criteria, or any rules or regulations which may be promulgated pursuant to the Clean Water Act of 1977, Public Law 95-217.

4. The State requests that the following discharge limitations, criteria, and requirements be included in the NPDES Permit:

a. With regard to Serial Number 002, the State requests the following wording to govern direct overflows from the yard drainage holding pond to the Tennessee River:

> "Direct overflow from the yard holding pond to the Tennessee River is allowed under emergency conditions to protect dike stability, but only to the minimum extent necessitated by the emergency. Notification of such overflow shall be provided to the Director, Enforcement Division, and to the State Director within five days after any occurrence. On each occurrence, a grab sample shall be collected for suspended solids analysis and the results of such analysis shall be reported either with the notification of overflow or within 15 days of the occurrence.

b. With regard to Serial Number 001, 002, 003, 004, 005, 006, 007, 008, 009, 010, 011, 012, 013, 014, 015, 016, 017, and 018, the State requests that the following statement be included to govern discharge floating materials:

> "The wastewater discharge must contain no distinctly visible floating scum, oil sheen, or other floating matter."

c. With regard to Serial Number 003, the State requests that the discharge limitations and monitoring requirements set out in Attachment A to this certification be included in the NPDES Permit.

d. With regard to Serial Number 004, the State requests that the following additional language be included to govern the possible disposal of this wastewater by means of land application or spray irrigation:

> "Permittee must obtain approvals from the Tennessee Division of Water Quality Control and EPA prior to any land disposal or spray irrigation of these wastes. Said approvals shall be based upon site inspections and review of appropriate engineering submittals."

e. With regard to Serial Number 005, the State requests that the discharge limitations and monitoring requirements set out in Attachment B to this certification be included in the NPDES Permit.

f. With regard to Part I B.1.c., and Part III C., control of polychlorinated biphenyl materials, the State requests that the PCB Control Report be submitted no later than thirty (30) days from the effective date of the NPDES Permit.

g. With regard to all wastewater discharges from the facility, the effluent quality as relates to radioactive constituents shall meet the requirements specified in the operational technical specifications issued by the U.S. Nuclear Regulatory Commission for this facility under 10 CFR 20.

5. With regard to the various studies and reports required of the applicant pursuant to Part I B. of NPDES Permit, the State reserves the right to modify or revoke the certification or to seek revocation or modification of the NPDES Permit issued subject to the certification as may be required to protect water quality based upon the results of these studies and reports.

Very truly yours,

D. Elmo Lunn / by ngw

D. Elmo Lunn
Director
Division of Water Quality Control

DEL/ljc 5/6

cc: Dr. Harry Moore, Tennessee Valley Authority
Mr. Jack McCormick, Division of Water Quality Control
Rhea County Health Department
Southeast Regional Health Office

Attachment B
Serial Number 005

Effluent Characteristic	Discharge Limitations						Monitoring Requirements	
	Daily Average		Weekly Average		Daily Maximum		Measurement Frequency	Sample Type
	mg/l	kg/day (lbs/day)	mg/l	kg/day (lbs/day)	mg/l	kg/day (lbs/day)		
Flow-M^3/day (MGD)				45 (0.012)			1/day	Instantaneous
BOD_5	30	1.4 (3.0)	40	1.8 (4.0)	45	2.0 (4.5)	1/2 weeks	Grab
Suspended Solids	30	1.4 (3.0)	40	1.8 (4.0)	45	2.0 (4.5)	1/2 weeks	Grab
Fecal Coliform (#/100 ml)				N/A			N/A	
Total Chlorine Residual				N/A			N/A	
Settleable Solids (ml/l)				N/A			N/A	
pH				N/A			N/A	
Dissolved Oxygen				N/A			N/A	

The wastewater discharge must contain no distinctly visible floating scum, oil sheen, or other floating matter.

Any sludge or other materials removed by any treatment works must receive disposal adequate to prevent their entrance into or pollution of any surface or subsurface waters.

Attachment A
Serial Number 003

Effluent Characteristic	Discharge Limitations						Monitoring Requirements	
	Daily Average		Weekly Average		Daily Maximum		Measurement Frequency	Sample Type
	mg/l	kg/day (lbs/day)	mg/l	kg/day (lbs/day)	mg/l	kg/day (lbs/day)		
Flow - M^3/day (MGD)				136 (0.036)			1/day	Instantaneous
BOD_5	30	4.1 (9.0)	40	5.4 (12)	45	6.4(14)	1/2 weeks	Grab
Suspended Solids	30	4.1 (9.0)	40	5.4 (12)	45	6.4 (14)	1/2 weeks	Grab
Fecal Coliform - (#/100ml)		See below					1/2 weeks	Grab
Total Chlorine Residual		See below					1/day	Grab
Settleable Solids (ml/ l)		See below					1/day	Grab
pH		See below					1/week	Grab
Dissolved Oxygen		See below					1/day	Grab

The pH of the wastewater discharge must, at no time, be less than 6.0 nor greater than 9.0.

The concentration of settleable solids in the wastewater discharge must, at no time, exceed 1.0 ml/l as measured by the standard one-hour Imhoff cone test.

The wastewater discharge must contain no distinctly visible floating scum, oil sheen, or other floating matter.