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 5,182 MW of hydro capacity (1,300 MW of pumped storage) 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	Reserve Margin % 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 June 1979.

[c]Includes Watts Bar Unit 2 (1177 MWe) scheduled for March 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 operators. 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	.3
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 2.9×10^{9} 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.

APPENDIX A

RESERVED FOR
COMMENTS ON DRAFT
ENVIRONMENTAL STATEMENT

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 representative 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.

5.3.4 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 three years (1973-1975) of phytoplankton collections. See Table C.2 for a list of genera identified in the three years of collections.

Of the 26 genera of Chrysophyta identified, the greater diversity (i.e., 13 different genera) was found at the TRM 528.0 station during the 1973 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 spring (~8) and lowest during fall (~5). The genus, Melosira, was found at all stations during all seasons throughout the three-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 1.4 million per liter at TRM 527.4 during spring 1975. 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 (~742,000 per liter) in the spring and least (~200,000) in the fall. See Table C.3 for a summary of the Chrysophyta diversities and concentrations during the three-year sampling period.

Of the 47 genera of Chlorophyta identified (Table C.2), the greatest diversity (i.e., 27 different genera) was found at TRM 528.0 and TRM 532.1 during the summer 1975 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 (~17) and least during the winter (~5). 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). The downstream stations show a slightly lower average diversity (~9) than that at the TRM 527.4 and TRM 529.9 stations (~10). Average diversity at TRM 528.0 and TRM 532.1 are highest (~11+). Scenedesmus and Chlamydomonas were identified at nearly all stations and seasons for the three-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 1.7 to 3.2; 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 (~520,000 per liter) during the summer and least (~61,000 per liter) during the winter. Scenedesmus spp. frequently

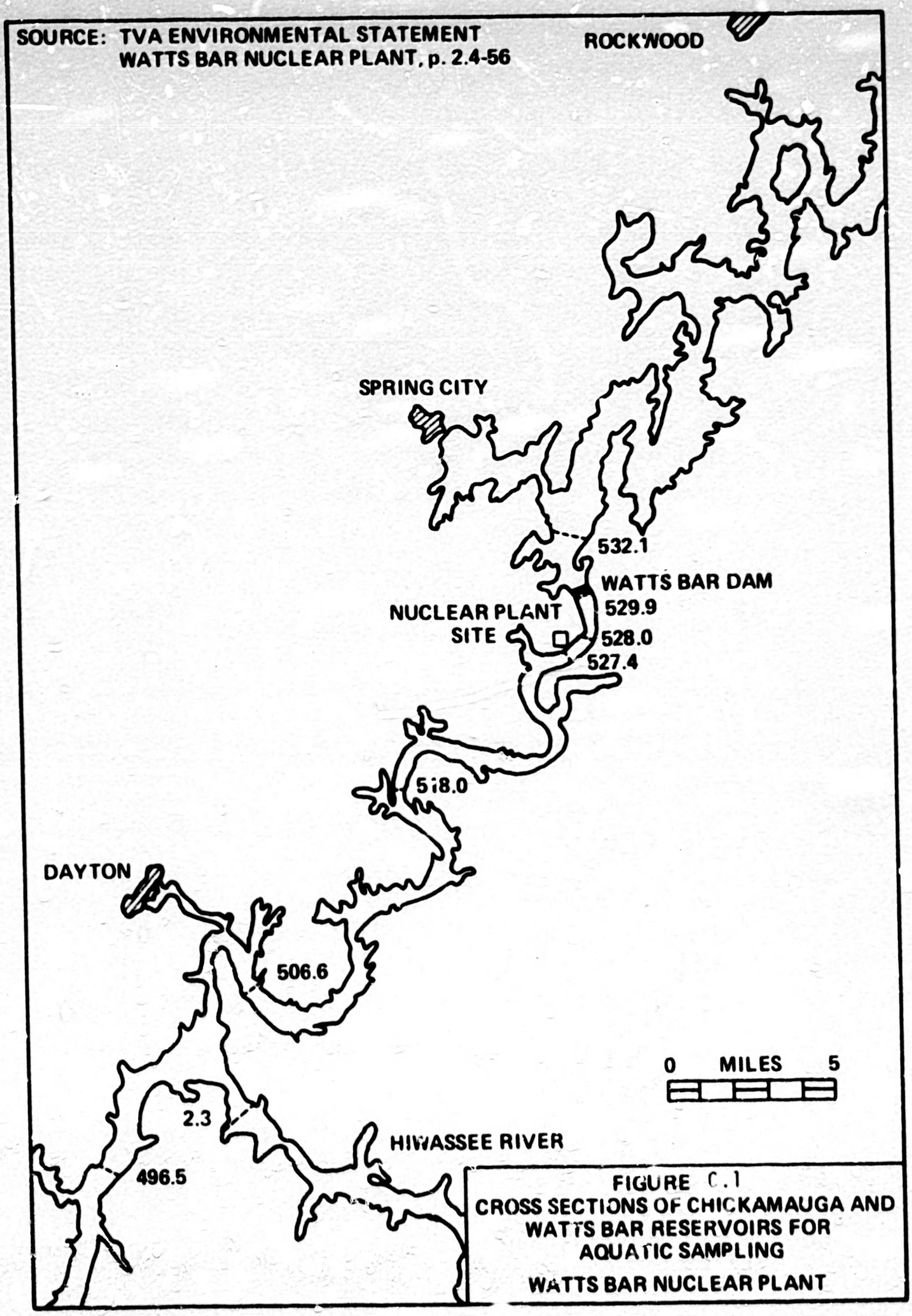

FIGURE C.1
CROSS SECTIONS OF CHICKAMAUGA AND WATTS BAR RESERVOIRS FOR AQUATIC SAMPLING
WATTS BAR NUCLEAR PLANT

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	[illegible]	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[4/]	
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 - 1975

CHRYSOPHYTA	CHLOROPHYTA		CYANOPHYTA	EUGLENOPHYTA	PYRROPHYTA
Achnanthes	Acanthosphaera	Kirchneriella	Anabaena	Euglena	Ceratium
Asterionella	Actinastrum	Micractinium	Anacystis	Phacus	Glenodinium
Attheya	Ankistrodesmus	Oöcystis	Aphanothece	Trachelomonas	Gymnodinium
Chaetoceros	Arthrodesmus	Pandorina	Chroococcus		Peridinium
Cocconeis	Botryococcus	Pediastrum	Cylindrospermum		
Cyclotella	Carteria	Planktosphaeria	Dactylococcopsis		
Cymbella	Chlamydomonas	Platydorina	Eucapsis		
Diatoma	Chlorella	Pleodorina	Gomphosphaeria		
Dinobryon	Chlorococcum	Protococcus	Merismopedia		
Eunotia	Chodatella	Pteromonas	Microcystis		
Fragilaria	Cladophora	Quadrigula	Oscillatoria		
Gomphonema	Closteriopsis	Scenedesmus	Phormidium		
Gyrosigma	Closterium	Schroederia			
Mallomonas	Coelastrum	Sphaerocystis			
Melosira	Cosmarium	Staurastrum			
Meridion	Crucigenia	Tetradesmus			
Navicula	Dactylococcus	Tetraëdron			
Nitzschia	Dictyosphaerium	Tetraspora			
Pinnularia	Elakatothrix	Tetrastrum			
Pleurosigma	Euastrum	Treubaria			
Rhoicosphenia	Eudorina	Ulothrix			
Rhizosolenia	Franceia				
Stephanodiscus	Gloeoactinium				
Surirella	Gloeocystis				
Synedra	Golenkinia				
Tabellaria	Gonium				

Table C.3
Summary of Chrysophyta Data
Preoperational Monitoring - Watts Bar Nuclear Plant

Station (TRM)	Year	Winter		Spring		Summer		Fall		Station Average (Three Years Combined)	
		No. of Genera	Concentration (1000's/liter)	No. of Genera	Concentration (1000's/liter)	No. of Genera	Concentration (1000's/liter)	No. of Genera	Concentration (1000's/liter)	No. of Genera	Concentration (1000's/liter)
496.5	1973	5	560	9	410	6	207	7	119	6.5	241
"	1974	6	67	6	348	6	130	[illegible]	85		
"	1975	5	274	8	319	10	318	5	54		
506.6	1973	12	731	9	282	5	204	5	76	6.2	211
"	1974	6	69	7	368	7	79	3	105		
"	1975	5	81	5	295	5	182	5	57		
518.0	1973	9	749	8	426	8	523	4	135	6.0	313
"	1974	6	90	8	466	6	108	3	224		
"	1975	5	99	[illegible]	736	4	105	4	100		
527.4	1973	9	517	9	777	6	677	4	206	6.2	474
"	1974	7	142	11	712	4	266	5	373		
"	1975	5	176	6	1,438	4	218	5	183		
528.0	1973	13	624	8	613	5	823	5	277	6.0	503
"	1974	6	219	9	778	5	394	6	407		
"	1975	5	161	7	1,347	4	252	4	145		
529.9	1973	10	680	11	643	7	701	9	273	6.2	476
"	1974	6	129	7	901	5	245	6	350		
"	1975	1	173	6	1,197	3	241	4	181		
532.1	1973	8	423	10	1,019	8	941	4	328	6.3	642
"	1974	6	133	8	1,126	7	712	7	400		
"	1975	5	110	5	1,389	4	1,000	4	130		
Seasonal averages (Stations Combined)		6.7	296	7.8	742	5.7	396	5.0	200		

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 (Three Years Combined) No. of Genera	Station Average (Three Years Combined) Concentration (1000's/liter)
496.5	1973	1	5	6	77	14	252	8	61	9.3	124
	1974	5	28	14	24[illegible]	10	101	3	32	-	-
	1975	7	51	10	82	24	483	10	71	-	-
506.6	1973	7	242	5	44	16	439	5	42	8.7	-
	1974	4	25	6	91	6	[illegible]60	1	23	-	132
	1975	10	110	8	44	23	400	13	67	-	-
510	1973	6	177	5	74	18	781	8	65	9.2	-
	1974	3	23	8	76	8	85	4	65	-	160
	1975	7	59	9	68	22	333	12	115	-	-
527.4	1973	5	58	3	44	17	854	8	125	9.7	189
	1974	3	70	7	118	10	205	6	115	-	-
	1975	7	75	12	201	20	269	18	183	-	-
528.0	1973	4	47	5	70	21	1094	9	151	11.2	231
	1974	3	26	10	145	14	251	7	111	-	-
	1975	9	73	15	227	27	463	11	116	-	-
529.7	1973	5	96	5	68	17	874	8	138	10.0	193
	1974	6	35	7	168	9	102	5	72	-	-
	1975	9	61	12	166	22	365	15	174	-	-
532.1	1973	1	2	6	279	19	1211	11	168	11.5	399
	1974	6	46	11	233	15	389	5	92	-	-
	1975	5	32	14	238	27	1900	10	205	-	-
Seasonal averages (Stations Combined)		5.4	61	8.5	131	17.1	520	8.8	104		

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 12 genera of Cyanophyta identified (Table C.2) the greatest diversity (i.e., 9 different genera) was found at the dam forebay station during winter 1975. 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 three-year period.

Average concentration of Cyanophytes generally increased moving upstream, the lowest being at TRM 496.5 during winter 1974 (~1000 cells per liter) and the highest at the dam forebay during summer 1974 (~1.4 million cells per liter). The seasonal average was highest for the summer (~378,000 per liter) and lowest for the winter (~22,000 per liter). Dactylococopsis or Anacystis spp. most frequently dominated the collections of blue-greens.

Three genera of Euglenophyta and four genera of Pyrrophyta were identified in the 1973-1975 collections. Of the total phytoplankton community, the Pyrrophyta contributed less than 2% at any station during the 1975 collection; 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 prior two 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 in 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. The blue-greens (Cyanophyta), which are considered a nuisance at high concentrations, contributed greater than 50% to the total phytoplankton community in only one station collection during the three-year period. The concentration in this case was only 140,000 per liter. The greatest concentration of blue-greens recorded was 1.4 million per liter at the dam forebay during the summer 1975 collection, making up 32% of the total. In the case of nuisance blue-green blooms, a concentration of billions of cells per liter might be expected. The percent contribution of blue-greens for each season of 1975 showed an increase over the two previous years and average concentrations were generally higher during the spring and fall of 1975 than for the same seasons of the previous years. The 1976 phytoplankton data, presently being analyzed by TVA, will assist in determining whether there is any significance to these observations.

Primary Production - Chlorophyll a and Carbon-14 Analysis

To complement the phytoplankton enumeration, standing stock estimates and production rates have been made using Chloropyll 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 (Three Years Combined) No. of Genera	Station Average (Three Years Combined) Concentration (1000's/liter)
496.5	1973	1	18	1	27	3	76	1	7	2.2	58
	1974	1	1	1	35	3	29	2	4		
	1975	2	16	3	39	6	424	2	18		
506.6	1973	1	44	1	8	3	224	1	8	2.3	64
	1974	1	5	1	14	2	7	2	2		
	1975	2	36	4	62	5	216	5	140		
518.0	1973	2	43	1	25	3	483	1	13	2.6	106
	1974	1	2	2	48	2	2	2	14		
	1975	1	18	4	165	7	366	5	90		
527.4	1973	1	38	1	12	4	650	1	12	2.1	108
	1974	1	7	1	30	2	4	2	21		
	1975	1	38	3	218	5	133	3	80		
528.0	1973	1	20	1	14	4	998	1	13	2.6	200
	1974	1	12	2	41	2	2	2	14		
	1975	2	35	4	475	7	696	4	86		
529.9	1973	1	44	1	12	4	929	1	34	2.1	144
	1974	1	9	1	38	2	2	2	23		
	1975	1	20	4	386	5	208	2	24		
532.1	1973	1	24	1	33	4	1033	1	29	[illegible]	230
	1974	1	9	1	21	2	16	2	25		
	1975	1	13	5	93	9	1386	4	79		
Seasonal Averages (Stations Combined)		1.2	22	2.0	86	4.0	378	2.2	35		

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	426
	1974	96	630	260	121	
	1975	356	442	1247	145	
506.6	1973	1022	334	867	126	
	1974	99	473	146	130	409
	1975	242	401	806	264	
518.0	1973	973	525	1787	213	
	1974	115	590	195	303	533
	1975	208	969	809	308	
527.4	1973	613	833	2181	343	
	1974	169	860	475	509	776
	1975	325	1858	687	460	
528.0	1973	691	697	2915	441	
	1974	257	964	647	532	940
	1975	302	2050	1425	359	
529.9	1973	820	723	2504	445	
	1974	173	1107	349	445	820
	1975	299	1752	822	395	
532.1	1973	449	1331	3185	525	
	1974	186	1380	1117	517	1282
	1975	182	1754	4330	433	
Seasonal Average		388	961	1300	343	

Table C.7

WATTS BAR NUCLEAR PLANT

CHLOROPHYLL A EXPRESSED IN mg Chl. A/m²

	1973				1974				1975				Station
TRM	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	$\bar{x}$
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
519.0	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	9.56	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/m²

	1973				1974				1975				Station
TRM	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer	Fall	$\bar{x}$
496.5	130	157	400	33	45	328	140	48	9	311	220	127	162
506.6	258	73	313	47	21	115	162	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	41	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	34[illegible]	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

Asplanchna spp.
Brachionus angularis
B. bidentata
B. budapestinensis
B. calyciflorus
B. havanaensis
B. quadridentatus
B. urceolaris
Cephalodella sp.
Collotheca sp.
C. pelagica
Conochiloides sp.
Conochilus hippocrepis
C. unicornis
Epiphanes macroura
Euchlanis sp.
Filinia spp.
Gastropus sp.
Hexarthra spp.
H. mira
Kellicottia bostoniensis
K. longispina
Keratella americana
Keratella cochlearis
K. crassa
K. earlinae
K. quadrata
K. valga
Lecane spp.
L. luna
L. stokesii
Monostyla spp.
M. quadridentata
Notholca sp.
N. limnetica
Platyias patulus
Ploesoma hudsoni
P. truncatum
Polyarthra spp.
Rotaria sp.
R. neptunia
Synchaeta spp.
S. stylata
Testudinella sp.
Trichocerca spp.
Trichotria pocillum

CLADOCERA

Alona sp.
A. quadrangularis
Alonella sp.
Bosmina logirostris
Ceriodaphnia sp.
C. lacustris
C. quadrangula
C. reticulata
Chydorus spp.
Daphnia sp.
D. ambigua
D. galeata mendotae
D. parvula
D. pulex
Daphnia pulex
Diaphanosoma leuchtenbergianum
Ilyocryptus spinifer
Latona setifera
Leptodora kindtii
Leydigia quadrangularis
Moina sp.
Moina micrura
Scapholebris kingi
Sida crystallinia
Simocephalus sp.
S. serrulatus
S. vetulus

COPEPODA

Calanoida (copepodid)
Cyclopoida (copepodid)
Harpacticoida (copepodid)
Nauplii
Argulus stizostethi
Canthocamptus robertcokeri
C. staphylinoides
Cyclops bicuspidatus thomasi
C. varicans rubellus
C. vernalis
Diaptomus mississippiensis
D. pallidus
D. reighardi
D. sanguineus
Ergasilus spp.
Eucyclops agilis
E. prionophorus
Mesocyclops edax
Nitocra lacustris
Paracyclops fimbriatus poppei
Tropocyclops prasinus

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 Chickamauga Reservoir but species and amounts are unknown. There are none harvested for human consumption.

Table C.10

Summary of Rotatoria 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	*	*	17	21.5	15	6.5	14	0.6		
	1974	14	3.6	22	29.5	14	2.4	14	4.7	15.8	10.6
	1975	16	16.3	**	**	**	**	**	**		
506.6	1973	11	23.0	15	5.5	18	13.3	13	0.6		
	1974	14	3.2	9	3.1	5	0.3	15	3.8	13.2	6.9
	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		
	1974	13	2.1	7	3.9	9	0.5	14	9.3	12.5	13.4
	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		
	1974	12	3.9	11	13.3	5	1.6	13	19.0	12.8	23.8
	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		
	1974	14	2.8	10	23.1	9	2.0	13	22.1	12.7	31.8
	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		
	1974	14	2.6	10	12.5	7	1.6	16	45.7	12.7	39.8
	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		
	1974	19	3.7	11	46.3	13	21.0	15	56.4	14.5	64.8
	1975	14	8.8	13	20.5	16	93.7	14	77.0		
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	16.6
	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	3	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	10.7		
	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: 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	*	*	35	48.6	31	17.1	30	1.9		
	1974	26	5.0	65	44.7	27	9.4	27	9.8	31.1	20.1
	1975	27	24.2	**	**	**	**	**	**		
506.6	1973	20	25.3	32	49.1	38	31.4	27	1.9		
	1974	29	4.9	23	22.5	19	7.4	23	7.8	27.8	25.6
	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	[illegible].8		
	1974	27	3.3	21	8.4	25	17.8	23	12.8	26.9	27.1
	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		
	1974	24	6.1	27	42.5	22	21.5	27	27.4	28.2	49.4
	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		
	1974	31	4.4	27	89.2	24	31.4	29	35.0	28.8	71.7
	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		
	1974	26	3.8	25	56.5	23	26.6	35	72.2	28.3	74.8
	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		
	1974	33	5.2	26	121.5	30	58.8	30	98.7	30.7	109.9
	1975	27	15.8	32	138.4	32	168.0	33	118.0		
Seasonal Avg. Stations & Yrs. Combined		24.6	15.[illegible]	30.2	93.8	39.8	79.0	29.8	35.2	X	X

* 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%

*On Department of Interior list of proposed endangered species.

From: TVA, Environmental Information, Watts Bar Nuclear Plant, November 18, 1976, p. A-18.

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 or 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-spawning season 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 these sizes should be capable swimmers, and apparently, they actively selected the deepest water area for habitation."[8]

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.

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			[illegible]
Lepomis sp.	2.27	1.39	2.00	1.61	2.2[illegible]
Pomoxis sp.	0.17	0.25	0.25	0.22	0.19
Stizostedion sp.			0.03		
Aplodinotus grunniens	[illegible]	5.53	7.13	3.84	3.72

Reference 1.

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

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 (2[illegible] pounds per acre). The upstream cove (TRM 508.0) was nearly [illegible] 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). The catch by species is given in Table C.25. The annual average sport harvest for the four-year survey was 66,040 kg.

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	8.0
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	3.0	.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	-	.2
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	3.19	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	521.9
	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	595,000
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 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.25 Estimated catch by species, January 1, 1972, through December 31, 1975, Chickamauga Reservoir, Tennessee.

Species	Number				Biomass (Kg)			
	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	7,346
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	1,167	753
Redear sunfish	6,494	3,449	10,416	6,916	1,007	510	1,630	1,348
Spotted bass	5,508	3,434	4,025	4,537	1,845	1,427	2,554	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	341	259	273	53	123	21	33
Yellow perch	564	909	566		73	179	111	
Yellow bass	390	225	475	747	70	79	93	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	238,647	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

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2. Tennessee Valley Authority, Environmental Information for Watts Bar Nuclear Plant, Units 1 and 2, November 18, 1976.

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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 3.3.2).

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 transhipments 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

DRAFT NPDES PERMIT

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.

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Permit No. TN0020168
Application No. TN0020168

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

DRAFT

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

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 day of

Paul J. Traina, Director
Enforcement Division

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-m³/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/l)	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

DRAFT

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 identification and monitoring purposes.
2/ Geometric mean.

. 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-m³/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

DRAFT

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 within five days after any occurrance.

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 location(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 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
Chlorine Residual	N/A	N/A	1/day	Grab
Fecal Coliform (organisms/100 ml)	N/A	N/A	1/month	Grab

DRAFT

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.

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Permit No. TN0020168

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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/l)	15	20	2/	Grab
Total Suspended Solids (mg/l)	30	100	2/	8-hr. composite
Copper, Total (mg/l)	1.0	1.0	2/	8-hr. composite
Iron, Total (mg/l)	1.0	1.0	2/	8-hr. composite
Phosphorus, as P (mg/l)	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.

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Permit No. TN0020168

DRAFT

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/1)			
	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) 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/1)	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) 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

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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 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				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
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

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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.

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-m³/Day (MGD)	N/A	N/A	1/month	Instantaneous
Oil and Grease (mg/1)	15	20	1/month	Grab
Total Suspended Solids (mg/1)	30	100	1/month	Grab
Copper, Total (mg/1)	1.0	1.0	1/month	Grab
Iron, Total (mg/1)	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.

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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.

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-m³/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.

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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 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-m³/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.

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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 - one year prior to fuel loading date of Unit 1
      (2) Report - three months prior to commercial operation date of Unit 1

   c. PCB Control Report (III.C.) - 9/30/78
   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) Implement - commercial operation date of Unit 1
      (2) First report - 15 months after implementation date
      (3) Subsequent reports - annually after the first report

   f. Plume report (III.G.) - 15 months after commercial operation date of Unit 2

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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
Atlanta, Georgia 3

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.

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 maxi discharge means the total discharge by weight during any calendar da,

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.

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.

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.

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 recor... 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.

* Continuation of present reporting frequency

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

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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 September 30, 1978.

D. The company shall notify the Director, Enforcement Division in 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 U01).

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. Not later than one year prior to the fuel loading date of Unit 1, permittee shall implement the pre-operational non-radiological aquatic monitoring program approved by the Director, Enforcement Division on   to reestablish baseline data on water quality and biotic conditions in the Tennessee River. A report on this study shall be submitted not later than three months prior to the commercial operation date of Unit 1.

K. By the commercial operation date of Unit 1, permittee shall implement the non-radiological aquatic monitoring program approved by the Director, Enforcement Division on   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.

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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 limitation promulgated pursuant to the order of the United States District Court for the District of Columbia issued on June 8, 1976, in "Natural Resources Defense Council, Inc. et.al. v. Russell E. Train," 8 ERC 2120 (D.D.C. 1976), if the effluent limitation so issued:

1. Is different in conditions or more stringent than any effluent limitation in the permit; or
2. Controls any pollutant not limited in the permit.

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.

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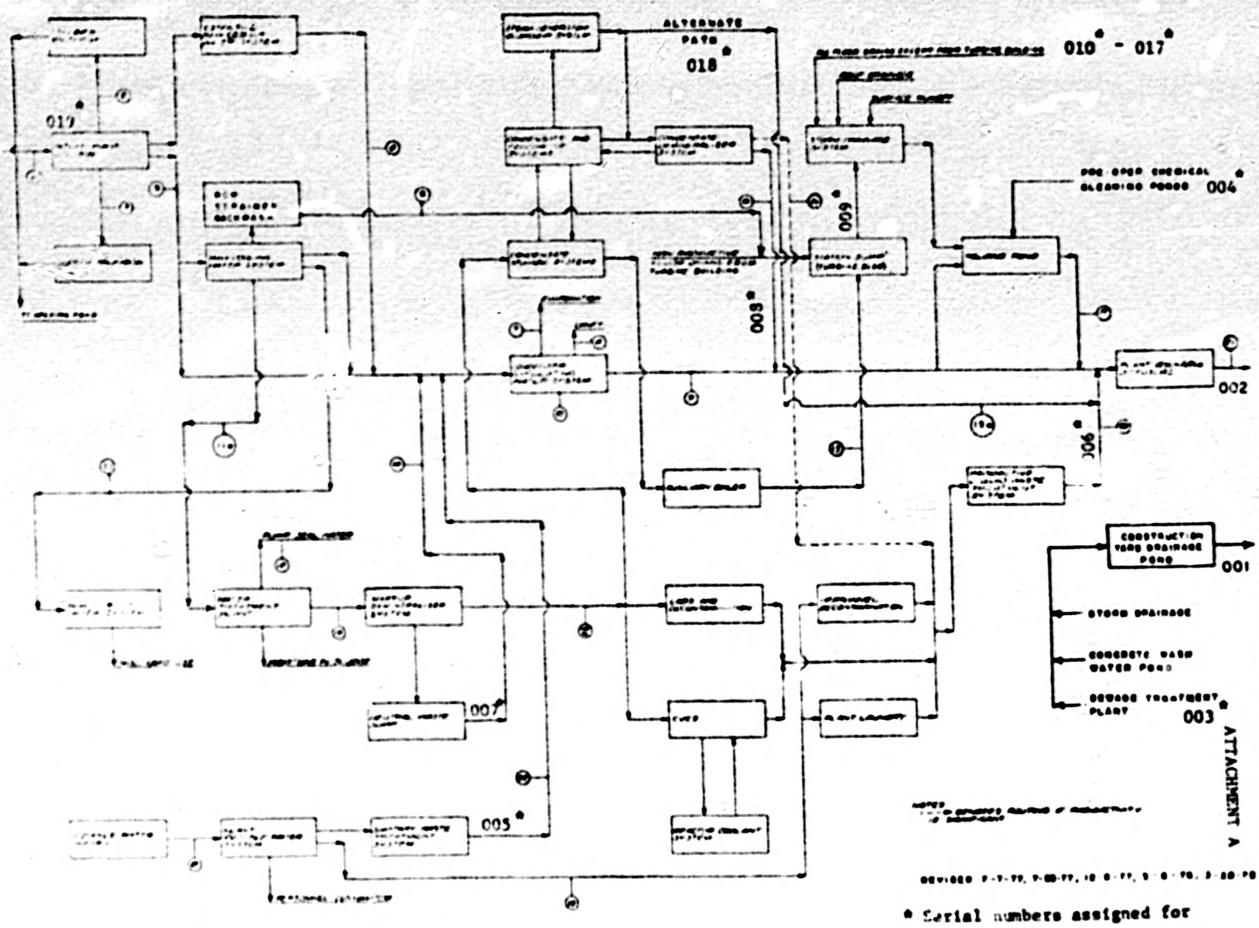
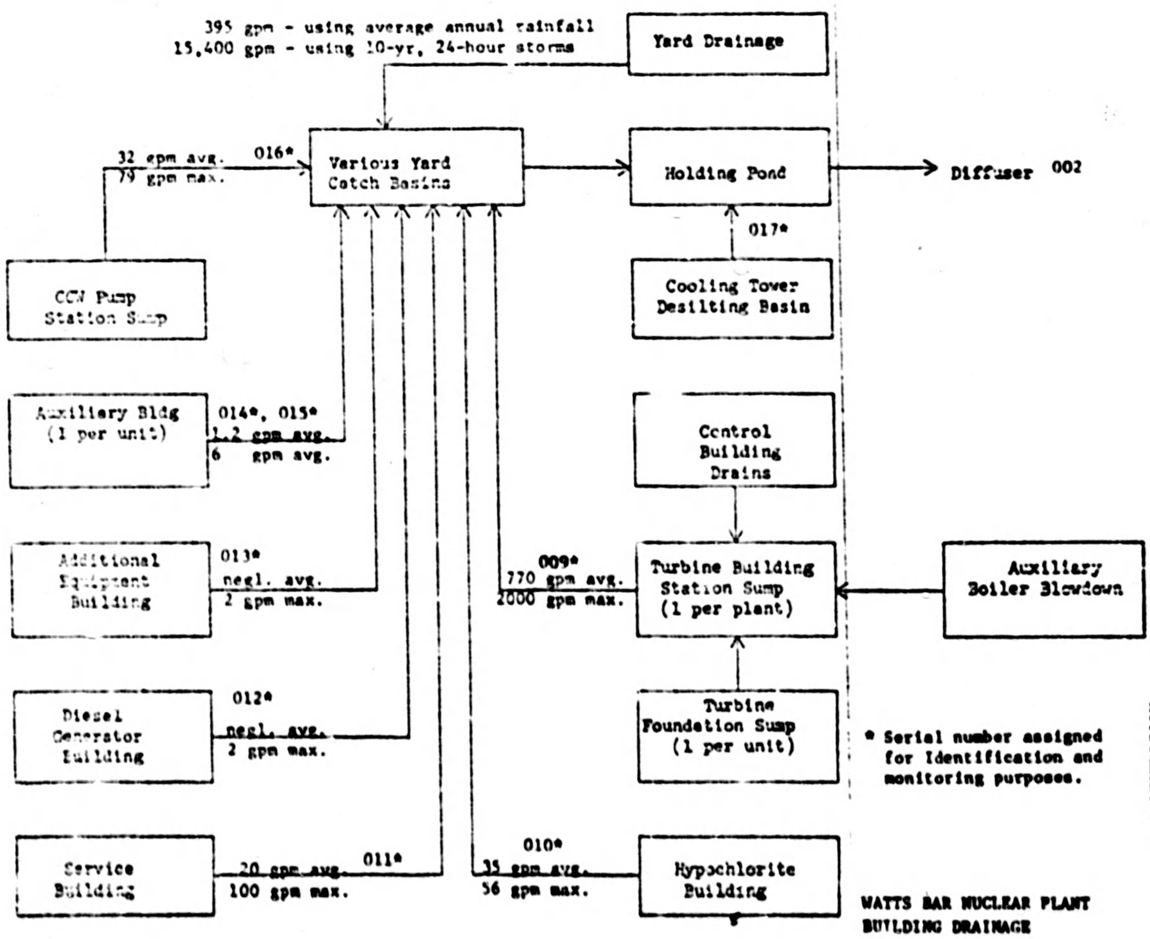


* Serial numbers assigned for identification and monitoring purposes.

WATTS BAR NUCLEAR PLANT - WATER USE DIAGRAM

NPDES NO. TN0020168
ATTACHMENT A



* Serial number assigned for Identification and monitoring purposes.

WATTS BAR NUCLEAR PLANT
BUILDING DRAINAGE

NPDES No. TN0020168
Attachment B