Containment Ventilation System

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

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

Ventilation Releases from Other Buildings

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

Main Condenser Air Ejector

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

Gaseous Waste Summary

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

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

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

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

Cost-Benefit Analysis of Gaseous Radwaste System Augments

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

TABLE 3.4

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

Nuclide	Waste Gas Processing System	Reactor Bldg.	Auxiliary Bldg.	Turbine Bldg.	Condenser Air Removal Vent	Total
Kr-83m	a	a	a	a	a	a
Kr-85m	a	2	3	a	2	7
Kr-85	300	46	1	a	a	350
Kr-87	a	a	1	a	a	1
Kr-88	a	2	5	a	3	10
Kr-89	a	a	a	a	a	a
Xe-131m	a	43	2	a	1	46
Xe-133m	a	40	5	a	3	48
Xe-133	a	5700	370	a	230	6300
Xe-135m	a	a	a	a	a	a
Xe-135	a	12	8	a	5	25
Xe-137	a	a	a	a	a	a
Xe-138	a	a	1	a	a	1
I-131	a	2.5(-2)[b]	3.2(-2)	6.5(-4)	6.1(-3)	6.4(-2)
I-133	a	7.5(-3)	5.1(-2)	3.9(-4)	9.7(-3)	6.9(-2)
Co-60	7(-5)	3.4(-4)	2.7(-2)	a	a	2.7(-2)
Co-58	1.5(-4)	7.5(-4)	6(-2)	a	a	6.1(-2)
Fe-59	1.5(-5)	7.5(-5)	6(-3)	a	a	6.1(-3)
Mn-54	4.5(-5)	2.2(-4)	1.8(-2)	a	a	1.8(-2)
Cs-137	7.5(-5)	3.8(-4)	3(-2)	a	a	3(-2)
Cs-134	4.5(-5)	2.2(-4)	1.8(-2)	a	a	1.8(-2)
Sr-89	3.3(-6)	1.7(-5)	1.3(-3)	a	a	1.3(-3)
Sr-90	6(-7)	3(-6)	2.4(-4)	a	a	2.4(-4)
C-14	7	1	a	a	a	8
H-3	a	460	460	a	a	920
Ar-41	a	25	a	a	a	25

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

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

TABLE 3.5

PRINCIPAL PARAMETERS USED IN THE COST-BENEFIT ANALYSIS

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

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

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

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

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

3.2.3.3 Solid Wastes

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

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

3.2.4 Chemical, Sanitary, and Other Waste Treatment

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

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

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

Anticipated Sodium Hypochlorite Injections

I. Slime Control

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

II. Asiatic Clam Control

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

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

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

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

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

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

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

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

3.2.5 Power Transmission System

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

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

The selection of a new Volunteer Substation site location approximately fifteen miles north-northeast of Knoxville (Figure 3.6) results in a relocation of the proposed Watts Bar - Volunteer 500 kV transmission line. Approximately two-thirds of this newly proposed connection will now be constructed on rights-of-way presently occupied by lower voltage lines or parallel to existing transmission facilities. The transmission line will utilize tower designs similar in appearance to those proposed originally in the FES-CP. The towers have been slightly redesigned, however, to permit the use of V-shaped insulator strings which limit the conductor swing and thereby reduce the right-of-way required by approximately 12.5 percent.[20] The line will be approximately 88 miles long and will be constructed on rights-of-way of varying widths. The land use types traversed by this new connection remains essentially the same as

TABLE 3.6 (Continued)

SUMMARY OF ADDED CHEMICALS AND RESULTING END PRODUCT CHEMICALS

Watts Bar Nuclear Plant

Item No.	System	Chemical Treatment Source Chemical And Waste Products	Estimated Maximum Annual Use kg	Estimated Maximum Annual Use (lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	Resulting End Product[a] Average Annual (lbs)	Resulting End Product[a] Mean Daily kg	Resulting End Product[a] Mean Daily (lbs)
3	Secondary Steam System Condensate Polishing Demineralizers	Sulfuric Acid	267,665	(590,100)	SO_4^{--} (Neutral pH)	262,176	(578,000)	717	(1580)
		Sodium Hydroxide NaOH	160,665	(353,500)	Na (Neutral pH)	92,197	(203,260)	254	(560)
	Ionized Soluble Species Removed by Demineralizers	-Carbonates (Co_3^{--})	11,521	(25,400)	Co_3^{--}	11,521	(25,400)	32	(70)
		-Ammonia (NH_4^+)	6,827	(15,050)	NH_4	6,827	(15,050)	19	(41)
		-Metallic Salts	d	d		d	d	d	d
4	Auxiliary Steam Generator Blowdown	Ammonia NH_3	1.4	(3)[f]	NH_3	1.4	(3)	<.05	(<0.1)
		Hydrazine $H_2N_2H_2$	4.5	(10)[g]	NH_3	4.5	(10)	<.05	(<0.1)
5	Condenser Cooling[i] Water System	Sodium Hypochlorite NaOCl	71,273	(157,130)	Na^+	44,021	(97,050)	120	(265)
		NaCl[i]	55,960	(123,370)	Cl^-	67,077	(147,880)	184	(405)
		--Copper (corrosion product only)[k]			Cu	2,812	(6,200)	8	(17)
		--Nickel (corrosion product only)[k]			Ni	313	(690)	0.9	(1.9)

TABLE 3.6

SUMMARY OF ADDED CHEMICALS AND RESULTING END PRODUCT CHEMICALS

Watts Bar Nuclear Plant

Item No.	System	Chemical Treatment Source Chemical And Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
1	Makeup Water Filter Plant	Alum $Al_2(SO_4)_3 \cdot 18\ H_2O$	35,743	(78,80[illegible])	$Al(OH)_3$[b]	7,489	(16,510)	20	(45)
		Soda Ash Na_2CO_3	10,743	(23,685)	Na^+	4,672	(10,300)	[illegible]	([illegible])
					SO_4^{--}	13,880	(30,600)	38	(84)
					Settled Solids[b,c]	32,114	(70,800)	88	(194)
		Sodium Hypochlorite $NaOCl$	349	(770)	Na^+	218	[illegible]	<2.3	<(5.0)
		$NaCl$	272	(600)	Cl	327	(722)[e]	<2.3	<(5.0)
2	Makeup Water Demineralizer	Sulfuric Acid H_2SO_4 (93% Solution)	104,780	(231,000)	SO_4^{--}(Neutral pH)	98,430	(217,[illegible]0)	270	(595)
		Sodium Hydroxide NaOH (50% Solution)	195,498	(431,000)	Na^+(Neutral pH)	56,245	(124,000)	154	(340)
	Natural Minerals Removed by Demineralizers								
		Sodium Na^+	4,590	(10,120)	Na^+	4,590	(10,120)	13	(28)
		Chloride Cl^-	8,936	(19,700)	Cl	8,936	(10,700)	75	(54)
		Sulfate So_4^{--}	9,866	(21,750)	So_4^{--}	8,866	(21,750)	27	(60)
		Total Dissolved Solids	53,297	(117,500)	Dissolved Solids	53,297	(117,500)	146	(322)

TABLE 3.6 (Continued)

SUMMARY OF ADDED CHEMICALS AND RESULTING END PRODUCT CHEMICALS

Watts Bar Nuclear Plant

Item No.	System	Chemical Treatment Source Chemical And Waste Products	Estimated Maximum Annual Use kg	(lbs)	Waste End Product Chemical	Resulting End Product[a] Average Annual kg	(lbs)	Mean Daily kg	(lbs)
6	Raw Cooling Water[i]	Sodium Hypochlorite							
		NaOCl	11,163	(24,610)	Na^+	7,065	(15,575)	20	(43)
		NaCl[j]	9,201	(20,285)	Cl^-	10,768	(23,740)	29	(65)
7	Raw Service Water[i] System	Sodium Hypochlorite							
		NaOCl	1,551	(3,420)	Na^+	982	(2,165)	2.7	(6)
		NaCl[j]	1,279	(2,820)	Cl^-	1,497	(3,300)	4.1	(9)
8	Essential Raw[i] Cooling Water	Sodium Hypochlorite							
		NaOCl	49,383	(108,870)	Na^+	30,518	(67,280)	84	(185)
		NaCl[j]	38,782	(85,500)	Cl^-	46,480	(102,470)	127	(280)

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

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

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

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

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

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

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

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

[i] Basis for calculated values are shown elsewhere.

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

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

TABLE 3.7

WATTS BAR TRANSMISSION SYSTEM DESCRIPTION

STEP I

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

STEP II

Line Name	Voltage (kV)	Approximate Length of New Construction (Miles)	Approximate Date Required
Watts Bar-Volunteer	500	88.0	June 1979
Watts Bar-Roane	500	40.0	In Service
Watts Bar-Sequoyah No. 2	500	40.0	In Service

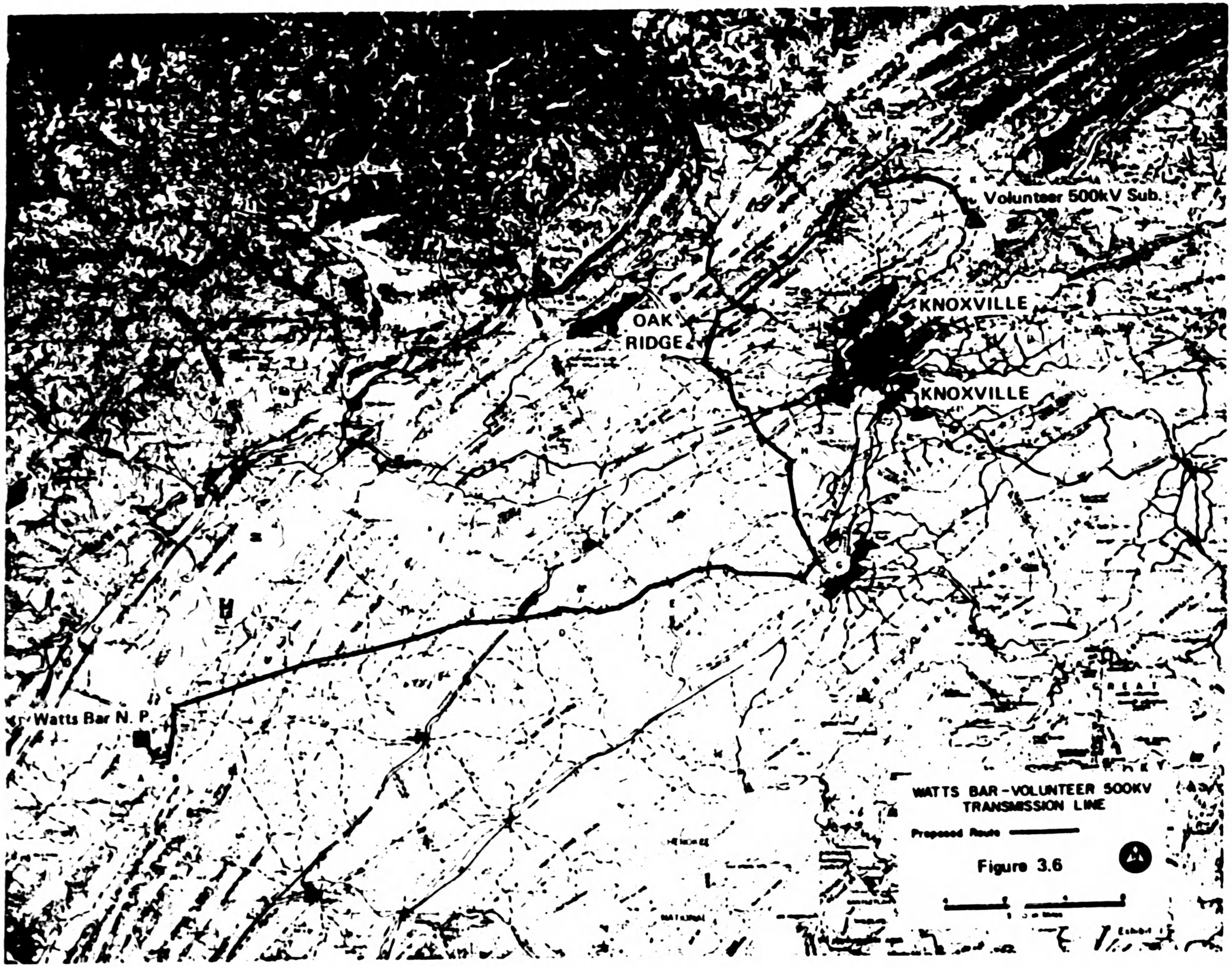

Volunteer 500kV Sub.
KNOXVILLE
OAK
RIDGE
KNOXVILLE
Watts Bar N. P.
WATTS BAR-VOLUNTEER 500KV
TRANSMISSION LINE
Proposed Route

Figure 3.6

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

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

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

REFERENCES FOR SECTION 3

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

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

3. Ibid, p. B-29

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

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

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

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

8. Op. Cit. Ref. 6.

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

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

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

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

13. Op. Cit., Ref. 6

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

15. Ibid, p. A-24

16. Ibid, p. A-25

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

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

19. Ibid, pp. A26-27

20. Op. Cit. Ref. 2

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

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

23. Ibid, p. 13

24. Ibid, pp. 7-10

25. Ibid, pp. 10-13

4. ENVIRONMENTAL IMPACT OF THE SITE PREPARATION AND CONSTRUCTION

4.1 RESUME AND STATUS OF CONSTRUCTION

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

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

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

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

4.2 IMPACT ON TERRESTRIAL ENVIRONMENT

4.2.1 Facility Construction

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

4.2.2 Transmission Facility Construction

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

The Volunteer Substation

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

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

Newly Proposed Watts Bar-Volunteer Transmission Line

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

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

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

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

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

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

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

4.3 IMPACTS ON AQUATIC ENVIRONMENT

4.3.1 Effects on Water Use

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

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

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

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

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

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

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

4.3.2 Effects on Aquatic Biota

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

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

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

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

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

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

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

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

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

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

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

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

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

REFERENCES FOR SECTION 4

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

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

3. Ibid.

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

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

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

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

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

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

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

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

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

13. Ibid., p. A-14.

14. Ibid., p. A-8.

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

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

5. ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 RÉSUMÉ

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

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

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

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

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

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

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

5.2 IMPACTS ON LAND USE

The assessment made in the FES-CP remains valid.

5.3 IMPACTS ON WATER USE

5.3.1 Thermal

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

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

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

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

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

The results of the model tests showed that the expected diffuser-induced dilution was achieved approximately one diffuser length downstream. Thus, the area of diffuser-induced mixing extends approximately 49 meters (160 feet) downstream when the downstream leg of the diffuser system is discharging; approximately 24 meters (80 feet) downstream when the upstream leg of the diffuser system is discharging; and 73 meters (240 feet) downstream when both legs of the diffuser system are discharging.[3,4] The mixing zone proposed in the NPDES Permit 002 provides a zone of 73 m[illegible]s (240 feet) downstream over the entire river depth and diffuser system width (73 meters) [illegible] should encompass all of operation.

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

5.3.2 Operational Chemical Wastes

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

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

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

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

5.3.3 Sanitary Wastes

There is no change in the plan for the sanitary waste treatment system.[3,9] With the controls in the NPDES permit (outfall serial number 005) there will be no adverse effects due to the sanitary waste system. These limits are based on EPA Guideline for Secondary Treatment of Domestic Waste Water (40 CFR 133). The State of Tennessee has provided a certification proposing more stringent limitations (see Appendix E, Attachment C to NPDES Permit). The staff concludes the facility will meet the more stringent limitations.

5.3.4 EPA Effluent Guidelines and Limitations

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

The Effluent Limitation Guidelines are summarized in Table 5.1.

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

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

5.3.5 Effects on Water Users Through Changes in Water Quality

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

TABLE 5.1

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

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

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

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

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

5.3.6 Effects on Surface Water Supply

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

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

5.3.7 Effects on Groundwater

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

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

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

5.4 ENVIRONMENTAL IMPACTS

5.4.1 Terrestrial Environment

The Station

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

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

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

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

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

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

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

5.4.1.2 Transmission Lines

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

5.4.2 Aquatic Environment

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

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

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

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

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

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

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

TABLE 5.2

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

AT WATTS BAR NUCLEAR PLANT, 1976 AND 1977

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

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

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

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

5.5 RADIOLOGICAL IMPACT

5.5.1 Radiological Impact on Man

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

Exposure Pathways

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

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

Dose Commitments from Radioactive Releases to the Atmosphere

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

Radiation Dose Commitments to Individuals

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

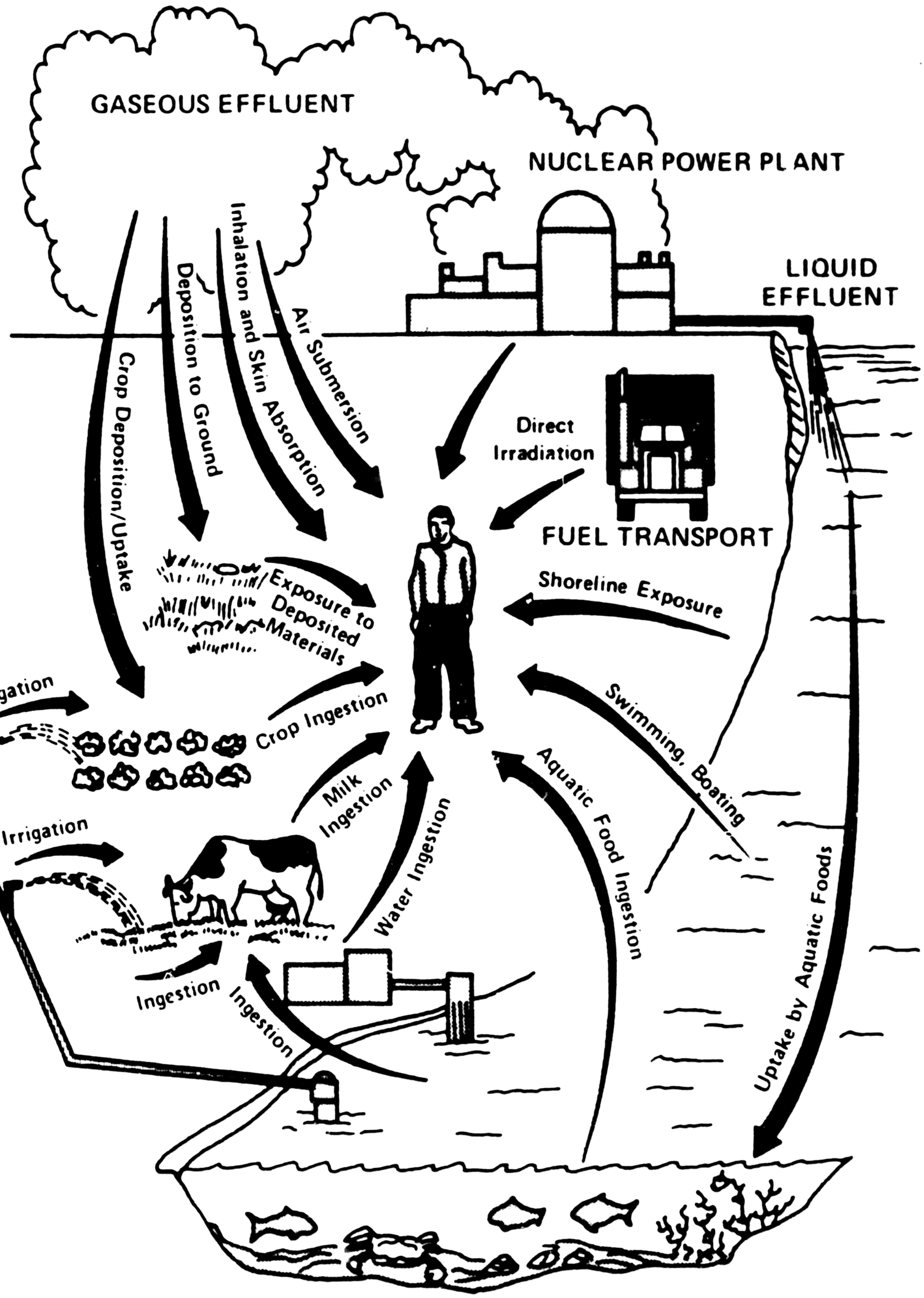
Radiation Dose Commitments to Populations

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

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

Dose Commitments from Radioactive Liquid Releases to the Hydrosphere

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



EXPOSURE PATHWAYS TO MAN

Figure 5.1

TABLE 5.3

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

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

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

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

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

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

(BOTH UNITS)

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

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

TABLE 5.5 ANNUAL POPULATION DOSE COMMITMENTS IN THE YEAR 2000

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

*Less than 1 man-rem/yr

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

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

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

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

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

Radiation Dose Commitments to Individuals

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

Radiation Dose Commitments to Populations

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

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

Direct Radiation

Radiation from the Facility

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

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

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

Occupational Radiation Exposure

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

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

Transportation of Radioactive Material

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

Comparison of Dose Assessment Models

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

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

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

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

**Assumed for purpose of an upper limit estimate.

TABLE 5.7 ANNUAL INDIVIDUAL DOSE COMMITMENTS DUE TO LIQUID EFFLUENTS

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

**Less than 0.01 mrem/yr

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

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

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

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

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

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

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

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

Evaluation of Radiological Impact

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

Comparison of Calculated Doses with NRC Design Objectives*

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

5.5.2 Radiological Impacts on Biota Other Than Man

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

5.5.3 Uranium-Fuel-Cycle Impacts

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

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

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

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

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

CRITERION	APPENDIX I DESIGN OBJECTIVE	CALCULATED DOSES
Liquid Effluents		
Dose to total body from all pathways	3 mrem/yr	0.10 mrem/yr
Dose to any organ from all pathways (Adult-Liver)	10 mrem/yr	0.097 mrem/yr
Noble Gas Effluents (at site boundary)		
Gamma dose in air	10 mrad/yr	0.80 mrad/yr
Beta dose in air	20 mrad/yr	3.1 mrad/yr
Dose to total body of an individual	5 mrem/yr	0.99 mrem/yr
Dose to skin of an individual	15 mrem/yr	3.1 mrem/yr
Radioiodines and Particulates[b]		
Dose to any organ from all pathways (Child-Thyroid)	15 mrem/yr	3.9 mrem/yr

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

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

TABLE 5.10

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

Natural resource Use	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
Land (acres):		
Temporarily committed[2]	94	
Undisturbed area	73	
Disturbed area	22	Equivalent to 110 MWe coal-fired powerplant.
Permanently committed	7.1	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired powerplant.
Water (millions of gallons):		
Discharged to air	160	=2 pct of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	124	
Total	11,373	<4 pct of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of megawatt-hours)	321	<5 pct of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	117	Equivalent to the consumption of a 45 MWe coal-fired powerplant.
Natural gas (millions of scf)	124	<0.3 pct of model 1,000 MWe energy output.
Effluents—chemical (MT):		
Gases (including entrainment):[3]		
SO_x	4,400	
NO_x[4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F^-	0.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HCl	0.014	
Liquids:		
$SO_4^{=}$	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are:
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	NH_3—600 ft^3/s.
Na^+	12.1	NO_3—20 ft^3/s.
NH_3	10.0	Fluoride—70 ft^3/s.
Fe	0.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.
Effluents—radiological (curies):		
Gases (including entrainment):		
Rn-222	—	Presently under reconsideration by the Commission.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	0.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	0.83	
Fission products and transuranics	0.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included in tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 pct of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low-level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. ~60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^7	Buried at Federal repository.
Effluents—thermal (billions of British thermal units)	3,462	<4 pct of model 1,000 MWe LWR.
Transportation (person-rem): Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

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

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

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

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

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

The staff's analysis and conclusions are as follows:

A. Land Use

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

B. Water Use

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

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

C. Fossil Fuel Consumption

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

D. Chemical Effluents

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

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

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

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

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

E. Radioactive Effluents

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

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

Mining: (during active mining)*1	4060 Ci
Mining: (unreclaimed open pit mines)*2	30 to 40 Ci/yr
Milling and Tailings: (during active milling)*3	780 Ci
Inactive Tailings: (prior to stabilization)*3	350 Ci
Stabilized Tailings: (several hundred years)*3	1 to 10 Ci/yr
Stabilized Tailings: (after several hundred years)*3	110 Ci/yr

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

F. Radioactive Wastes

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

G. Occupational Dose

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

H. Transportation

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

I. Fuel Cycle

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

5.6 SOCIOECONOMIC IMPACTS

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

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

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

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

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

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

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6. ENVIRONMENTAL MONITORING

6.1 RÉSUMÉ

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

6.2 PREOPERATIONAL MONITORING PROGRAMS

6.2.1 Preoperational Onsite Meteorological Program

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

6.2.2 Preoperational Water Quality Studies

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

6.2.3 Preoperational Groundwater Monitoring

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

6.2.4 Preoperational Aquatic Biological Monitoring

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

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

Periphyton

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

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

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

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

Ichthyoplankton

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

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

Adult Fish

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

1. Objectives and Scope

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

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

2. Description of Sampling Area

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

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

3. Methods and Procedure

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

a. Gill Netting

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

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

b. Hoop Nets

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

c. Electrofishing

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

d. Shoreline Seining

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

e. Sport Harvest of Fish

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

Staff Evaluation of Pre-Operation Program

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

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

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

6.2.5 Preoperational Terrestrial Monitoring

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

6.2.6 Preoperational Radiological Monitoring

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

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

6.3 OPERATIONAL MONITORING

6.3.1 Operational Onsite Meteorological Program

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

6.3.2 Operational Water Quality Studies

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

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

TABLE 6.1

PREOPERATIONAL RADIOLOGICAL PROGRAM

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

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

6.3.3 Operational Groundwater Studies

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

6.3.4 Operational Chemical Effluents Monitoring

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

6.3.5 Operational Aquatic Biological Monitoring

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

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

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

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

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

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

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

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

To determine levels of ichthyoplankton entrainment, intake sampling at other TVA plants has been accomplished using 0.5 m [illegible] ter stationary nets suspended in a 3 x 3 array in front of the intake structure. [illegible] s an improved gear type or sampling design is developed, this method of intake [illegible] will be employed at Watts Bar Nuclear Plant. Sampling frequency will be the sa[illegible] nsect sampling and sample duration will be sufficient to filter approximate[illegible] of water through each net.

Staff Evaluation of Plans for Operatio[illegible] Monitoring of Aquatic Biota

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

6.3.6 Operational Terrestrial Monitoring

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

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

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

(3) maintenance of transmission lines.

6.3.6.1 Cooling Tower Drift and Plume Interaction

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

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

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

6.3.6.2 Bird Collisions with Cooling Towers

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

6.3.6.3 Transmission Lines

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

6.3.7 Operational Radiological Monitoring

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

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

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

REFERENCES FOR SECTION 6

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

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

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

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

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