Final

environmental statement

related to construction of

WATERFORD STEAM ELECTRIC STATION UNIT 3

LOUISIANA POWER and LIGHT COMPANY

DOCKET NO. 50-382

March 1973

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

SUMMARY AND CONCLUSIONS

This Final Environmental Statement was prepared by the U. S. Atomic Energy Commission, Directorate of Licensing.

1. This action is administrative.

2. The proposed action is the issuance of a construction permit to the Louisiana Power and Light Company for the construction of the Waterford Steam Electric Station, Unit No. 3, a nuclear power reactor to be located on a site which will also be occupied by two oil-fueled electrical generating plants now under construction. The Site is on the Mississippi River in the State of Louisiana about 25 miles NW of New Orleans and near the town of Taft, St. Charles Parish (Docket No. 50-382).

   Unit No. 3 will employ a pressurized water reactor manufactured by Combustion Engineering, Inc. to produce 3390 megawatts thermal (MWt). A steam turbine-generator will use this heat to provide approximately 1165 MW (net) of electrical power capacity. A "stretch" power level of 3560 MWt is anticipated at a future date and is considered in the assessments contained in this statement. The exhaust steam will be cooled by once-through flow of water obtained from and discharged to the Mississippi River.

3. Summary of the environmental impact and adverse effects:

   a. Construction-related activities on the Site have disturbed about 100 acres. The portion of this land not to be used for the station facilities, parking lots, roads, etc., is to be restored by seeding and landscaping.

   b. The loss of juvenile and small finfish and river shrimp on the intake screens is estimated at about 100 lbs and $100 annually. Most losses will occur during the spring in association with high river flow.

   c. Entrainment of passing river organisms is anticipated and even if 100% mortality of these organisms during their passage through the condenser cooling system is assumed, the loss will be relatively small and total plankton populations in the area will not be appreciably affected.

   d. The heated water will be released to the river water such that the zone within which temperatures may exceed 10°F above inlet ambient is expected to have a surface extent of about

5 acres; the corresponding area within the 5.4°F isotherm would be about 70 acres. These areas correspond to downriver distances of 650 and 3,200 ft, respectively. These temperature zones are based on a temperature difference of approximately 16°F across the condensers and include the incremental effects of Units 1 and 2 upstream.

e. There will be no appreciable fish mortalities in the mixing zone of the thermal discharge, and the ecological impact of the mixing zone on drifting river organisms should be minimal.

f. The impact of small amounts of chemicals in the discharge upon living forms in the river ecosystem should be negligible either alone or in synergistic combination with thermal increases.

g. The risk associated with accidental radiation exposure is very low.

h. The estimated dose to the population within 50 miles from operation of the station is about 2 man-rem/yr.

i. Operation of the plant should have no short or long term adverse effect on sport fishing, commercial fishing or water-based recreational activity.

j. Construction of transmission lines will require the use of approximately 280 acres for rights-of-way. Land use patterns in such rights-of-way will not be changed but there will be some minor aesthetic detraction.

k. A potential thyroid dose of approximately 20 mrem/yr to a child from drinking milk from a cow pastured at the site boundary and eating vegetables grown in gardens near the site boundary has been calculated from the radioiodine in the gaseous effluent. However, a rigorous milk and vegetable sampling and monitoring program will be required so that control actions can be taken which will result in actual thyroid doses to any individual not exceeding 5 mrem/yr.

4. Principal alternatives considered:

a. Purchase of power from outside sources

b. Construction of an equivalent plant at an alternate site.

c. Abandonment of the facility, including consideration of the use of an alternative fuel as a power source rather than nuclear fuel.

d. Means of reducing the size of the mixing zone using high velocity momentum mixing or alternatively, a submerged diffuser. The alternative of utilizing a high velocity momentum mixing outfall structure has been adopted by the Applicant.

e. Open cycle systems which would dissipate sufficient reject heat to the atmosphere to reduce immediate thermal differentials at the point of release to 5°F. These included the use of a cooling pond, natural and forced draft cooling towers and the use of a spray pond.

f. Closed-cycle cooling systems which would dissipate essentially all of the reject heat to the atmosphere including forced and natural draft cooling towers and a cooling pond.

g. Discharge of the liquid chemical wastes from the plant to the river rather than to a stabilization pond and thence to the fresh water canal and ultimately to Lac des Allemands. This design change has been adopted by the Applicant.

5. The following Federal and State agencies have submitted comments on the Draft Environmental Statement (issued October 1972) and these comments have been considered in the preparation of this Final Environmental Statement.

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
The State of Louisiana, Division of Radiation Control

6. This Final Environmental Statement is being made available to the public, to the Council on Environmental Quality, and to the agencies noted above in March 1973.

7. On the basis of the analysis and evaluation set forth in this statement, after weighing the environmental, economic, technical, and other benefits of the Waterford Steam Electric Station, Unit No. 3, against the environmental costs, and considering available

alternatives, it is concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and Appendix D to 10 CFR Part 50 is the issuance of a construction permit for the facility subject to the following conditions for protection of the environment:

a. The Applicant will define a comprehensive environmental sampling, monitoring and surveillance program (biological, chemical, thermal and radiological) to be initiated two years prior to operation of the Waterford 3 Unit and continuing for at least two full years of plant operation, and considered by the Regulatory Staff to be adequate to form an ecological baseline and to determine changes which may occur in land and water ecosystems as a result of plant operation. The radiological monitoring program will include weekly monitoring and sampling of the milk from cows pasturing near the site boundary and of the leafy vegetables in the gardens of residents living adjacent to the Waterford Station, and analyses of the samples for determining the radioiodine levels. If, on the basis of these analyses, a thyroid dose in excess of 5 mrem/yr is calculated, the Applicant will take prompt actions, acceptable to the Staff, to ensure that an actual thyroid dose to any individual does not exceed the 5 mrem/yr limit (Sections V.D.1 and V.D.4).

b. The Applicant will take the necessary steps to assure that the site meteorological tower is in operating condition and that weather data are collected with a minimum of 90% recovery. During the post-construction permit period, at least one full year of meteorological data will be collected on a continuous basis and analyzed to provide a representative characterization of the Waterford site meteorology over a full annual cycle so that predictions of the potential radiation dose to the public as a result of routine or accidental release of radioactive materials to the atmosphere can be confirmed or modified to reflect the effect of site meteorology (Section V.D.4).

c. The Applicant will provide a method of treating the chemical cleaning solution wastes to remove phosphates prior to discharge to the circulating water and to the Mississippi River, thus precluding the possibility of algae buildup in the river and eliminating potential toxic concentrations which may adversely affect aquatic species in the river (Sections III.D.3 and V.C.2.d).

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FOREWORD

This Final Statement on environmental considerations associated with the proposed issuance of a construction permit for the Waterford Steam Electric Station Unit 3 (Docket 50-382) was prepared by the U.S. Atomic Energy Commission, Directorate of Licensing (Staff) in accordance with the Commission's regulation, 10 CFR Part 50, Appendix D, implementing the requirements of the National Environmental Policy Act of 1969 (NEPA).

The National Environmental Policy Act of 1969 states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

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

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

(i) The environmental impact of the proposed action,

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

(iii) alternatives to the proposed action,

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

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

Pursuant to Appendix D of 10 CFR Part 50, the AEC Directorate of Licensing prepares a detailed statement on the foregoing considerations with respect to each application for a construction permit or full-power operating license for a nuclear power reactor.

When application is made for a construction permit or a full power operating license, the applicant submits an environmental report to the AEC. The staff evaluates this report and may seek further information from the applicant, as well as other sources, in making an independent assessment of the considerations specified in Section 102(2)(C) of NEPA and Appendix D of 10 CFR Part 50. This evaluation leads to the publication of a draft environmental statement, prepared by the Directorate of Licensing, which is then circulated to Federal, State and local governmental agencies for comment. Interested persons are also invited to comment on the draft statement.

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

Single copies of this statement may be obtained by writing the Deputy Director for Reactor Projects, Directorate of Licensing, U. S. Atomic Energy Commission, Washington, D.C. 20545.

Mr. Fred J. Clark, Jr. is the AEC Environmental Project Manager for this statement. Telephone: (301) 973-7588

I. INTRODUCTION

The Louisiana Power and Light Company, also referred to as the Applicant, operating as an investor-owned utility, supplies electric power to fill the residential, industrial and commercial demands of some 1,100,000 customers within its service area of about 19,500 square miles (see Figure I-1). The Plant, to be known as the Waterford Unit 3, will occupy part of an established site where fossil-fueled, oil-burning Units 1 and 2, both of 430 MWe, are currently under construction.

This Final Statement considers the projected environmental effects of Waterford Unit 3 and the alternatives available for this unit.

Since the issuance of the Draft Environmental Statement related to the proposed construction of the Waterford Unit 3, the Applicant has committed to making several plant design modifications and changes in operating procedures to mitigate or eliminate adverse impacts on the environment which were identified and discussed in the Draft Environmental Statement. Principally, the changes made by the Applicant are: (1) a modification to the outfall structure to provide for high velocity momentum discharge, thus decreasing the possible effect of the heated discharge waters in the Mississippi River; (2) a modification of the chemical waste system to provide for discharge of liquid wastes into the Mississippi River, thus avoiding the release of demineralizer wastes and other liquid chemical wastes into this field drain system to the 40-Arpent and 80-Arpent canals and eventually toward Lac des Allemands; and (3) an augmentation of the basic gaseous radioactive effluent treatment system, mainly with additional charcoal filtering, to reduce the release of radioiodines to the environment.

This Final Statement reflects the Staff's environmental evaluation of the current design with the above modifications. Additional sections have been added to this statement (primarily in Chapters III and V) which describe the modifications made and present the staff evaluation of these design changes. Discussion of the superseded designs have been deleted.

Waterford Unit 3 will employ a pressurized water reactor manufactured by Combustion Engineering and will have an initial net electrical capacity of 1165 MW. Ebasco Services Incorporated has been retained as the architect-engineer and has also been assisting the Louisiana Power and Light Company staff in environmental matters. The Applicant,

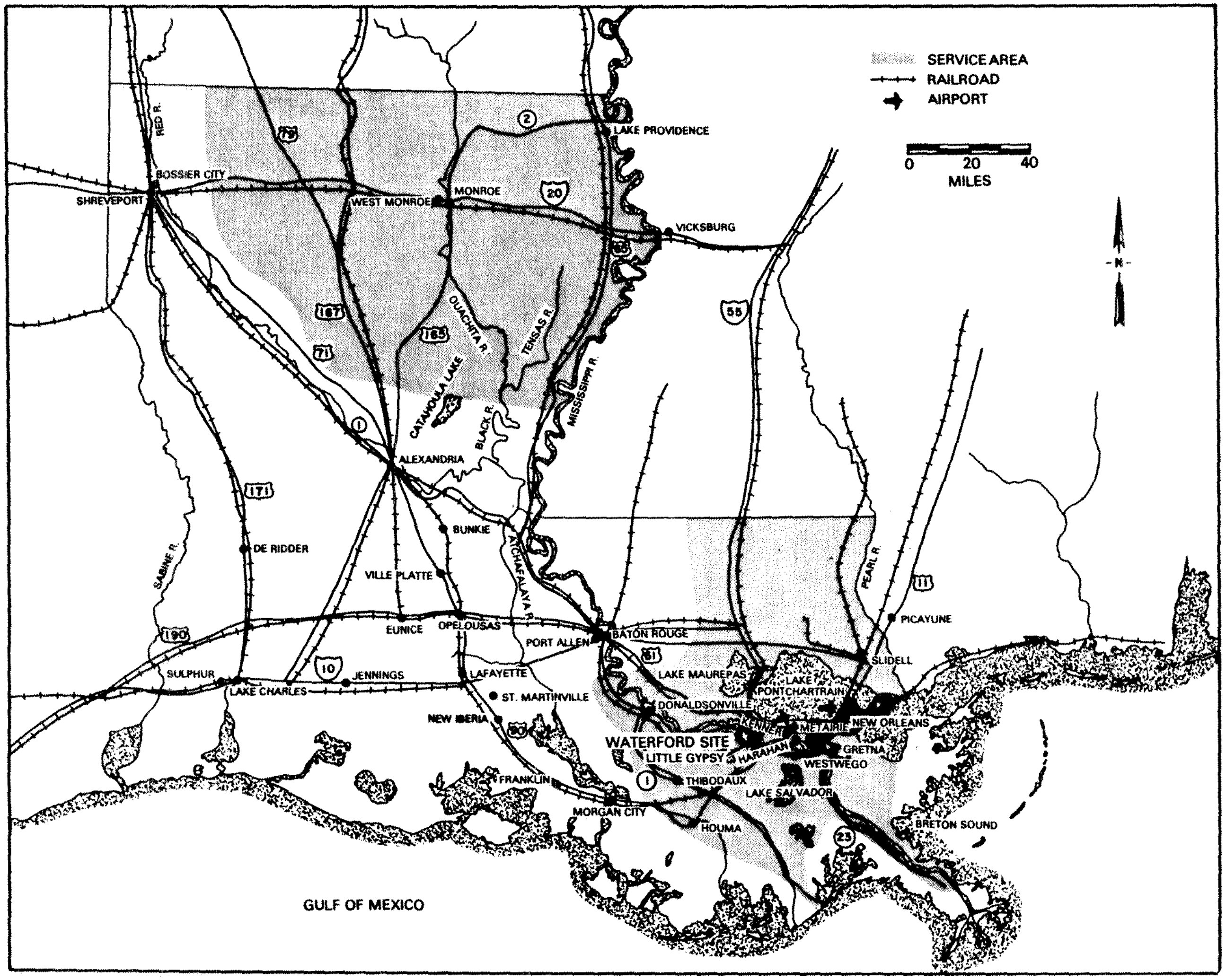


FIGURE I-1. MAP OF THE STATE OF LOUISIANA SHOWING CITIES AND LOUISIANA POWER AND LIGHT COMPANY SERVICE AREA with support from Ebasco, has prepared demographic tables and summaries of land use characteristics, meteorological descriptions (with the aid of technical personnel of Weathermeasure Corporation), environmental surveys and recommendations, analyses of the circulating water system and the temperature distribution in the river and, finally, the estimated effects of elevated temperatures on the aquatic organisms of the river.

A. SITE SELECTION

Numerous industrial sites are available for power plants along the Mississippi River between Baton Rouge and New Orleans. The flat terrain typical of the entire region is readily adaptable to nuclear facility operations and there are, in addition to the main channel of the Mississippi River, many waterways and lakes that could provide cooling water. The Applicant states that in 1967 Louisiana Power and Light and New Orleans Public Services, Inc. (NOPSI), both member utilities of the Middle South Utilities, Inc., jointly commissioned Ebasco Services to perform a reconnaissance survey of 14 sites to determine the suitability of each site for nuclear, coal or gas-fired generating units. The site study identified three sites in the Louisiana Power and Light service area as having the greatest potential for development of a nuclear generation station by 1977. Of the remaining eleven sites, five were located in the service area of NOPSI

Five other potential sites were located on lakes. An investigation was made of single site locations on Lac des Allemands, Lake Pont-Chartrain and Lake Borgne. Two sites on Lake Maurepas were also investigated. These five lake sites were eliminated as even potential sites, and therefore not alternates, on the basis of very poor access and the potential for adverse thermal effects. The one remaining site (of the eleven) was on the east bank of the Mississippi River about 10 miles south of Gretna, Louisiana. This site was discounted as an alternate due to poor foundation conditions, poor access and nearness to highly populated areas.

The Waterford site, located on the banks of the Mississippi River and already held by Louisiana Power and Light was one of the three sites identified above. The other two sites are located on the banks of the Mississippi River across the river from one another about 26 miles upstream from the Waterford site. These two sites have tentatively been identified as Site "A" and Site "B".

A summarized description of the three sites is provided in Table I-1. In general, the sites are similar in that they lie on the banks of

TABLE I-1

SITE COMPARISON

Feature	Waterford Site	Site A	Site B
Geology-Seismology	Nearest salt dome is 6 miles. Nearest active fault is 29 miles.	Nearest salt dome is 3 miles. Nearest active fault is 29 miles.	Nearest salt dome is 3 miles. Nearest active fault is 29 miles.
Foundation	Recent alluvium 45 to 55 ft deep with stiff to very stiff clays and silty clay extending beyond for about 2000 ft. Requires excavation to about 60 ft.	Recent alluvium 25 to 50 ft deep with stiff to very stiff clays and silty clays extending beyond for about 2000 ft.	Recent alluvium 25 to 50 ft deep with stiff to very stiff clays and silty clays extending beyond for about 2000 ft.
Land Use	Agricultural and timbered swamp with high industrialization along the Mississippi River.	Agricultural and timbered swamp, minimal industrialization.	Agricultural and timbered swamp, minimal industrialization.
Site Acquisition Cost	---	Differential Cost over Waterford about $3,750,000.	Differential Cost over Waterford about $3,750,000.
Transmission Line Requirements	23 miles of 230 kV	26 miles of 500 kV 1 mile 500 kV river-crossing	26 miles of 500 kV
Population Distribution	Low population density.	Low population density.	Low population density.
Access	Road - good Railroad - good Water - good	Road - good Railroad - good Water - good	Road - good Railroad - good Water - good

the Mississippi River, have good road, rail and water access, and are in areas of moderately low to low population density. The geology, seismology and terrain of the three sites are about equal. Because of shallower depth of the Pleistocene sediments at Sites A and B, these sites require slightly less foundation work than the Waterford site. On the other hand, development of the Waterford site for nuclear generation appears to be slightly more compatible with existing land uses than Sites A or B because of the present industrialized character of the area and the placement of Waterford Units 1 and 2 onsite. Land acquisition and transmission line costs favor the Waterford site. In general, the Waterford site appears to be as acceptable as either Site A or Site B.

B. APPLICATIONS AND APPROVALS

The Applicant applied[2] for licenses or permits for certain actions to the following listed agencies on the dates shown:

CONSTRUCTION

1. Atomic Energy Commission - Application for Construction Permit submitted December 31, 1970.

2. Board of Commissioners - Lafourche Basin Levee District - no objection to soil boring test, September 29, 1970.

3. Louisiana Department of Highways - On March 17, 1972 an application was submitted to the Department of Highways for permit which would authorize the raising of Highway 18 over the circulating water lines and to temporarily bypass the highway while the lines are being constructed. The proposed action was approved and Permit No. 84197 was issued on August 16, 1972 by the Department.

4. Louisiana State Department of Health - Discussions have been held with several members relating to requirements for sanitary facilities at the Site.

5. U.S. Army Corps of Engineers (USACE) - Meetings were held with the Corps on November 20, 1970, February 18, 1971, and December 7, 1971. These meetings were held to discuss revetments and design details of Unit 3 before submitting a permit application. Eng. Forms 4345 and 4345-1, Application for Permit to Discharge or Work in Navigable Waters and their Tributaries, was submitted on March 25, 1972.

6. Louisiana Wild Life and Fisheries - no objection to plans for the intake and discharge structures and pipelines into the river, provided the volume and quantity of the discharge is approved by the Louisiana Stream Control Commission, March 28, 1972.

7. State of Louisiana, Stream Control Commission - no objection to proposed dolphins, intake and discharge structures, and pipelines, April 4, 1972.

8. Atomic Energy Commission - statement of Reasons for Continuin Activities (Site Preparation) April 20, 1972.

9. U.S. Army Corps of Engineers (USACE) - no objection to plans for dewatering and excavation at Site, May 24, 1972.

10. Louisiana Division of Radiation Control - Numerous meetings have been held with the Director of the Division of Radiatior Control. The meetings were primarily in conjunction with emergency plans.

11. Atomic Energy Commission - Application for Construction Exemption, May 11, 1972.

12. Atomic Energy Commission - Information Supplement to Application for Construction Exemption (updated load and capability forecast for 1971) LPL841, June 13, 1972.

13. Atomic Energy Commission - Information Supplement to Application for Construction Exemption (updated construction schedule) June 15, 1972.

14. Atomic Energy Commission - Information Supplement to Application for Construction Exemption (additional exemption work schedules and expenditures), July 18, 1972.

15. Board of Commissioners, Lafourche Basin Levee District - Construction Permit No. 479, granting permit for the purpose of excavation work on landside toe of levee, May 31, 1972.

16. U.S. Army Corps of Engineers (USACE) - Applicant submitted request for authorization to install and maintain cooling-water structures, May 22, 1972.

17. Louisiana Wild Life and Fisheries Commission - no objection to the request for authorization to install and maintain cooling-water structures, June 28, 1972.

18. Environmental Protection Agency - sent USACE recommendations of conditions to include in the permit, June 26, 1972.

19. Received permit from Army Corps of Engineers, dated July 7, 1972, under the Provisions of the Act of Congress approved March 3, 1899 (33 U.S.C. 403) "To install and maintain intake and discharge structures, protective dolphins, and appurtenant works, in the Mississippi River, right descending bank, at a location about 129.4 miles above Head of Passes, near Taft, La., in St. Charles Parish.

DISCHARGE

1. U.S. Army Corps of Engineers (USACE) - Meetings were held with the Corps on November 20, 1970, February 18, 1971, May 13, 1971, and December 7, 1971. These meetings were held to discuss revetments and design details of Unit 3 before submitting a permit application. Eng. Forms 4345 and 4345-1, Application for Permit to Discharge or Work in Navigable Waters and Their Tributaries, was submitted on March 25, 1972.

2. Louisiana Wild Life and Fisheries - no objection to plans for the intake and discharge structures and pipelines into the river, provided the volume and quantity of the discharge is approved by the Louisiana Stream Control Commission, March 28, 1972.

3. State of Louisiana, Stream Control Commission - Stream Control Commission Form SCC1 for permit to discharge industrial wastes from Unit 3 was submitted to the Stream Control Commission on October 5, 1971. The permit was delayed at a public hearing January 27, 1972, pending submittal of additional information. The application was approved on May 31, 1972.

4. Louisiana Air Control Commission - No meetings have been held and no permit application has been filed.

5. Louisiana Division of Radiation Control - Meetings have been held with the Director of the Division of Radiation Control. The meetings were primarily in conjunction with emergency plans.

6. Environmental Protection Agency - sent USACE recommendations of conditions to include in the permit, June 26, 1972.

7. Louisiana Stream Control Commission - LSCC, in approving discharges, also certified compliance with Section 21(b) of the Federal Water Quality Improvement Act of 1970. This certification was given by letter to the Applicant dated June 21, 1972. With the modification made by the applicant to discharge chemical wastes to the Mississippi River, the validity of the water quality certificate appears to be uncertain at this time.

REFERENCES

1. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit No. 3, Environmental Report, Supplement 3, Docket 50-382, December 15, 1972.

2. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit No. 3, Environmental Report, Supplement 2, Docket No. 50-382, pp. XI 1-3, August 15, 1972.

II. THE SITE

A. LOCATION OF PLANT

The Waterford site, shown on Figure II-1, is located on the Mississippi River at a point approximately 25 miles northwest of New Orleans and approximately 50 miles SSE of Baton Rouge, Louisiana. The Site has about 7500 ft of river frontage at approximately river mile 129.6 and comprises more than 3600 acres of flatland extending from State Road 18 at the river back to the St. Charles drainage canal. The land is in the northwest part of St. Charles Parish and is on the former Waterford Plantation and part of the Killona Plantation on the west bank of the river near the town of Taft, Louisiana. The Texas and Pacific Railroad crosses the property at approximately 3400 ft from the river levee and a highway is planned to cross the property approximately 6500 ft from the river. The northern half of the property is in cultivated sugar cane while the southern part is uncultivated and densely wooded.

The Waterford Steam Electric Station, consisting of two fossil units and one nuclear unit, will be in the northernmost 200 acres of the Site. The Plant is just upstream of a highly industrialized area and across the river from the Louisiana Power and Light Company Little Gypsy Steam Electric Station and other chemical plants and oil storage areas (Fig. II-4).

B. REGIONAL DEMOGRAPHY AND LAND USE

The immediate area around the Site is sparsely populated. The total number of residents within a 1-mile radius is approximately 408. The 1970 census shows that the population density within a 5-mile radius is about 205 people per square mile and within a 10-mile radius about 122 people per square mile. Figure II-3 shows the 1970 and estimated 1980 population within 5, 10, 25, and 50 miles (projected for 50-mile radius of Waterford site, St. Charles Parish[1]). The populations of nearby towns are shown in Table II-1.

Within a 5-mile radius there are two towns with a population of 4,000 people or more, Norco (4 miles east) and La Place (5 miles north). In a 10-mile radius, Reserve (7 miles northwest) also has a population exceeding 4,000 and Kenner (10 miles east) has almost 30,000 people. All of these towns are on the east (descending) bank of the river and across from the Waterford Station. Downstream from the Waterford site and on the same side of the river, at a distance of 2-3 miles, is a random clustering of residences. This area is known as Taft and has a population of about 70.

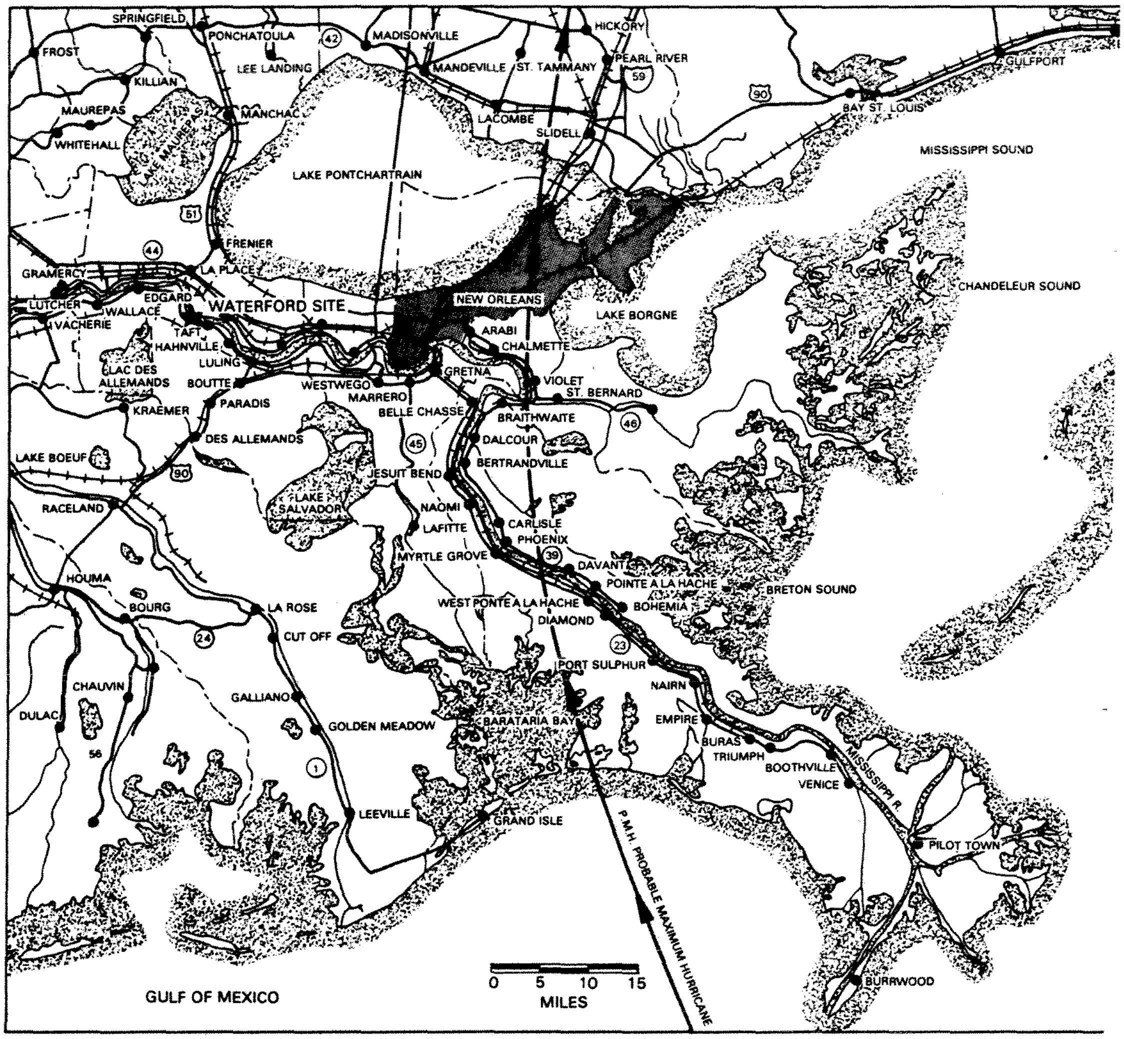


FIGURE II-1. MAP OF THE AREA AROUND THE WATERFORD SITE

FIGURE II-2. AERIAL VIEW OF THE SITE AND IMMEDIATE SURROUNDINGS

TABLE II-1

POPULATION CENTERS IN THE AREA OF THE WATERFORD SITE[(a)]

	1970 Population	General Direction	Approximate Distance, Mil
Norco	4,770	E	4
Laplace	5,953[(b)]	N	5
Hahnville	2,362[(b)]	SE	4
Lucy	400[(b)]	NW	7
Reserve	6,381[(b)]	NW	7
Luling	3,255	SE	4
Metairie	140,000[(b)]	E	16
Harahan	13,037	ESE	14
Little Farms	15,713	E	15
Lutcher	3,911	W	10
Kenner	29,858	E	10
Jefferson Heights	16,489[(b)]	E	18
New Orleans	587,000	E	20
Westwego	11,402	ESE	17
Harvey	6,347	E	20
Marrero	29,015	ESE	20
Terrytown	13,832	ESE	30
Gretna	24,875	ESE	26
Thibodaux	15,028	SW	12
Raceland	4,880	SSW	21
Lockport	2,398	S	24
Houma	30,922	SSW	32
Hammond	12,487	N	36
Ponchatoula	4,545	N	32
Bayou Cane	9,077	SSW	32
Larose	4,267	SSE	26
Donaldsonville	7,367	W	30
Gonzales	4,512	WNW	36
Mandeville	2,571	NE	34
Morgan City	16,586	WSW	52
Slidell	16,101	ENE	44
Covington	7,170	NNE	40
Baton Rouge	168,000[(b)]	NW	52
Berwick	4,168	WSW	52
Plaquemine	7,739	WNW	56
Denham Springs	6,752	NW	48
Amite	3,593	N	52
Golden Meadow	2,681	SSE	44
Gramercy	2,567	WNW	18

(a) Projected population for 50 mile radius of Waterford Plant Site St. Charles Parish, Gulf South Research Institute, July 24, 197

(b) Rand-McNally Atlas, 1971 edition.

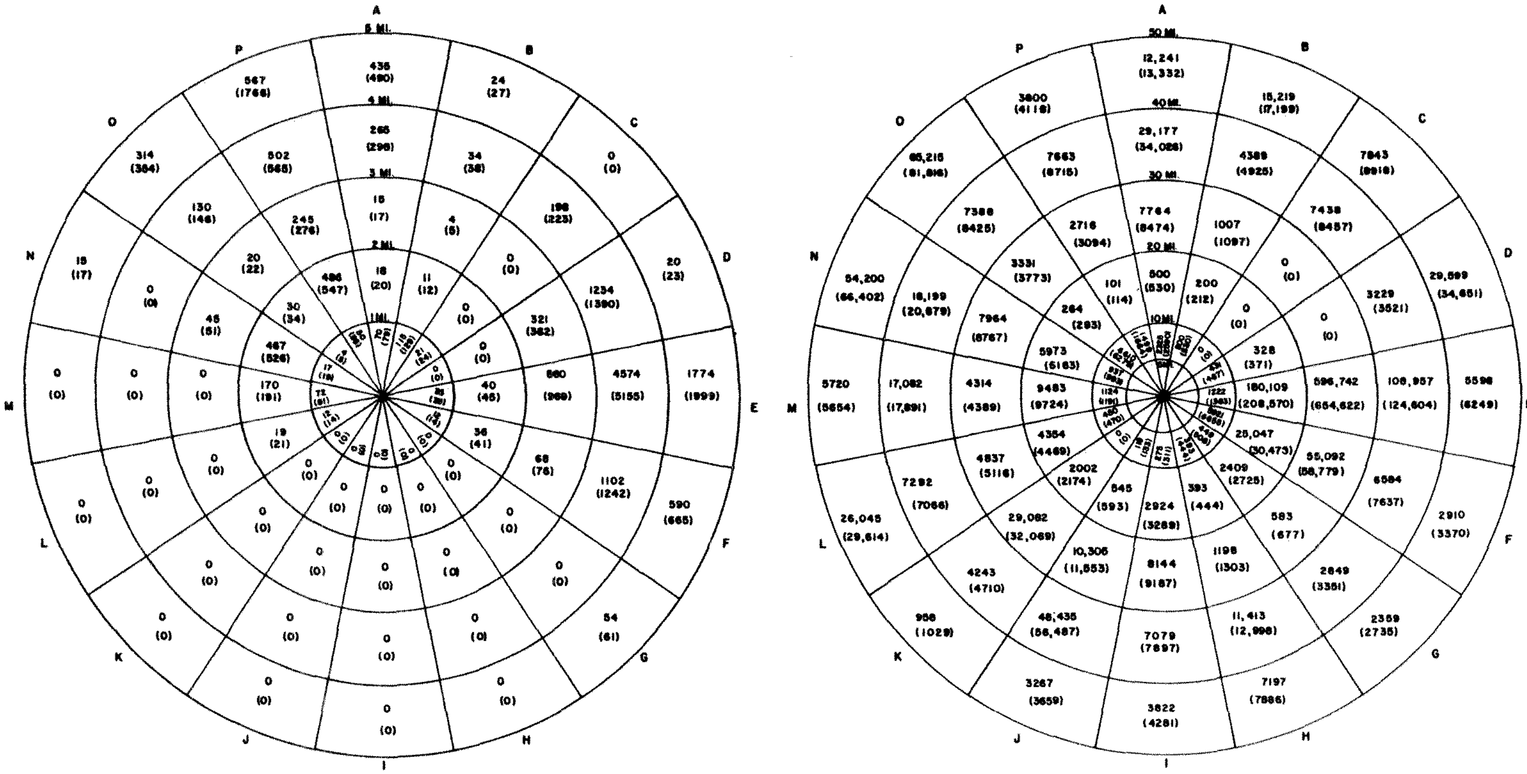


FIGURE II-3. 1970 AND ESTIMATED 1980 POPULATIONS BY SECTORS AROUND THE WATERFORD PLANT SITE

About 27% of the acreage in the parishes of St. Charles and St. John the Baptist is devoted to farm use. There are approximately 221 farms; average size is about 415 acres. The farm type is listed in Table II-2.

TABLE II-2

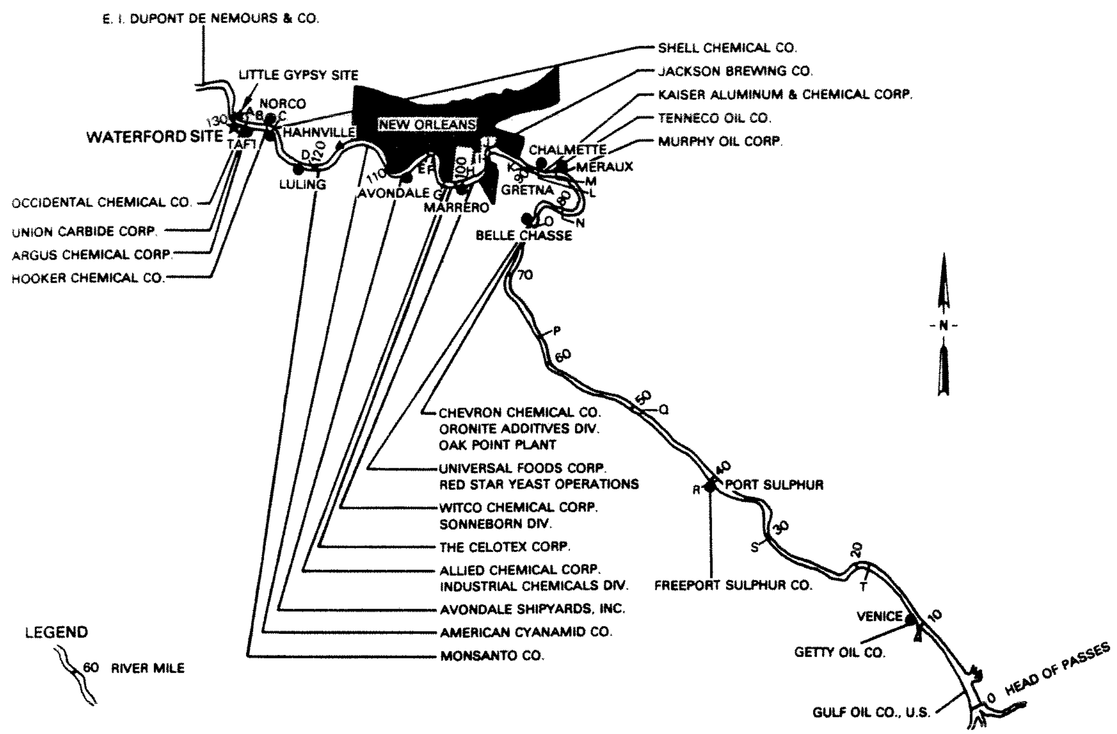
FARM TYPES IN ST. CHARLES AND ST. JOHN THE BAPTIST PARISHES

	St. Charles	St. John the Baptist
Field crop farms (other than vegetable, fruit or nut)	18	52
Vegetable farms	25	24
Fruit & nut farms	-	-
Poultry farms	3	2
Dairy farms	-	-
Livestock farms (other than poultry or dairy)	45	20
Misc. & unclassified farms	13	19

One school and two playgrounds are located within a 1-1/2-mile radius of the Site. Across the river in Montz is the Montz Community Playground and about 5000 ft west of the Site is the Killona Elementary School and Playground.

The area immediately adjacent to the Site is moderately industrializ Both banks of the river downstream of the Site are lined with indust facilities, primarily chemical plants (see Figure II-4). Next to an downriver from the Site is the Hooker Chemical Company with 2925 ft of river frontage; next downstream is the Union Carbide Company. Tw Shell Oil Company plants, one a chemical plant and one a refinery, are located on the opposite bank approximately 1-1/2 miles downriver It is expected that the area near the Waterford site, especially alc the Mississippi River, will show increased industrialization in the future with a markedly diminishing residential use.

The Mississippi River is used extensively for commercial traffic, domestic and industrial water supply (see Figure II-4), and municipa and industrial waste disposal. Principal commerce consists of barge



Compiled from "Industrial Pollution of the Lower Mississippi River in Louisiana", U.S. Environmental Protection Agency, Region VI, Dallas, Texas, April 1972.

DOWNSTREAM WATER INTAKES

A	UNION CARBIDE CORP.	K	AMERICAN SUGAR COMPANY
B	SHELL OIL CO.	L	KAISER ALUMINUM & CHEMICAL CORP.
C	ST. CHARLES PARISH WATER WORKS DISTRICT # 1	M	ST. BERNARD PARISH WATER WORKS DISTRICT # 1
D	ST. CHARLES PARISH WATER WORKS DISTRICT # 2	N	DALCOUR WATER WORKS DISTRICT
E	JEFFERSON PARISH WATER WORKS DISTRICT # 1	O	BELLE CHASE WATER WORKS DISTRICT
F	S&WB NEW ORLEANS CARROLLTON PLANT	P	GULF OIL CORP., ALLIANCE REFINERY
G	CITY OF WESTWEGO WATER DISTRICT	Q	POINTE-A-LA-HACHE WATER DISTRICT
H	JEFFERSON PARISH WATER WORKS DISTRICT # 2	R	FREEPORT SULPHUR CO.
I	CITY OF GRETNA WATER DISTRICT	S	BURAS WATER WORKS DISTRICT
J	S&WB NEW ORLEANS ALGIERS PLANT	T	BOOTHVILLE-VENICE WATER WORKS

FIGURE II-4. MAJOR INDUSTRIES ON THE MISSISSIPPI RIVER DOWNSTREAM OF THE SITE traffic of gasoline, fuel oil, sulfur, grains, coal and coke, nonmetallic minerals, metal products of all types, logs, building materials and a variety of wood products, sand and gravel, salt and basic chemicals.

There is very little commercial fishing in the Mississippi River between La Place and Hahnville. There are about 20,000 lb of fresh-water fish taken annually from that area, about 80% of which are catfish and the remainder are sheephead. There is limited sport fishing in the Mississippi River within this area, but considerable sport fishing occurs in Lac des Allemands.

There are no national or state parks or wildlife preserves within a 5-mile radius of the Site. Recreational areas (other than school playgrounds) within a 5-mile radius are the Bonnet Carre Floodway Public Recreation Area and the undeveloped Lac des Allemands. There are a few tourist attractions and historical sites in the area. These include a snake farm, four plantations and Louisiana Power and Light's Little Gypsy Steam Electric Station. These are shown in Figure II-5.

C. HISTORICAL SIGNIFICANCE

A portion of the Site was once part of the Killona Plantation cane fields, but the part concerned is of no historical significance. A check of the National Register of Historical Places[2] indicates there is one historic landmark within 5 miles of the Site. This is the Keller (Homeplace) Plantation House in Hahnville, Lousiana, some 4-miles south east of the Site. The Plant will not detract from this historic landmark.[3] Neither the nuclear facilities nor the new transmission rights-of-way will affect any historical area or landmark. (See Section XII-10, para. 20 and Appendix C.)

The local office of the Archaeological Institute of America in New Orleans has stated, according to the Applicant[4], that there are no known or suspected archaeological values connected with the Site.

D. ENVIRONMENTAL FEATURES

1. Geology

The Law Engineering Testing Company investigated the Site for the Applicant during September, October, and November 1970. This investigation indicated a uniform stratigraphy, no abrupt changes, no salt dome or possibility of local faulting, and no surface expression of known or hypothetical faults.

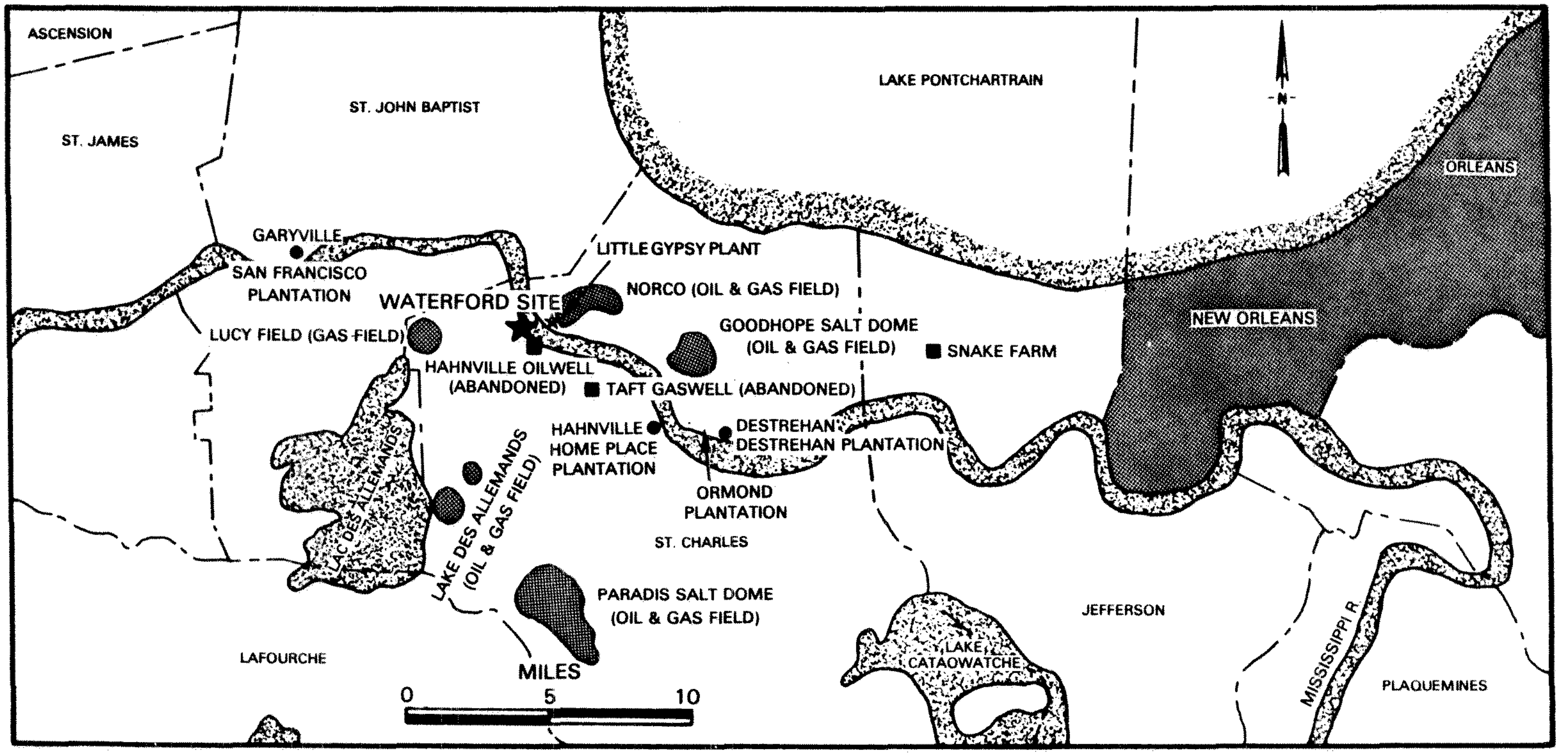


FIGURE II-5. IMMEDIATE SURROUNDINGS OF THE SITE

The Gulf Coastal Plain, wherein the Site is located, is a roughly 300-mile coastal band from the Rio Grande River to the western border of Florida. The Central Gulf Coastal Plain has a long geological history of sedimentary deposition.

The Louann Salt Formation, near the base of the sedimentaries and under their increasing pressure, flows upward at isolated points and produces localized structures (from small low relief anticlines to very large, steeply dipping salt dome intrusions). Associated with these structures are oil and gas fields (see Figure II-5) and local faulting.

The regional faults are normal faults dipping and down-thrown to the south. The only one known to be active is the Baton Rouge Fault All others are subsurface faults with thick uninterrupted deposits above the top of the fault trace indicating no activity for the last 13 million years. The Baton Rouge Fault, 29 miles north of the Site shows evidence of contemporary activity. However, its movements have not been associated with local seismic activity; apparently any movement occurs slowly and gradually.

Development of Vacherie Fissure (April 1943) was not accompanied by ground tremors beyond the immediate vicinity of the crack, a distance of about 1/4 mile.[5] It is located 18 miles northwest of the Site. The Staff evaluation concludes that the fissure was formed by local salt dome movement and settling and that its occurrence was not due to tectonic activity. Further, all available evidence indicates that there is no association between the fissure and the Waterford site.

Historical records and instrumented data covering the past 271 years show that earthquake activity in the Central Gulf Coastal Plain has been infrequent,[5] with only five earthquakes reported within 250 miles of the Site. Three of these were reported as intensity V Modified Mercalli and two as intensity VI. The largest historical earthquake which may have affected the Site occurred on October 19, 1930, near Donaldsonville, 33 miles west of the Site. It was reported to have had an intensity VI Modified Mercalli but the exact location of the earthquake is not known.

The closest salt dome is the Good Hope, 6 miles east of the Site, 9580 ft deep. Associated with the dome are two subsurface faults. The faults have no surface expression and give no evidence of having any movement within the last 13 million years. Another dome is the Paradis, 10 miles south of the Site, 13,500 ft deep. A subsurface fault is associated with the dome, but it also shows no sign of movement within a long time.

Borings at the Site reveal deposits of recent alluvium 45 to 55 ft deep consisting of clays and silty clays containing occasional sand lenses and thin zones of shell fragments. Underlying these recent deposits are Upper Pleistocene deposits of clays and silty clays, and very dense silty sands. Boring logs, electric logging, and seismic traverses all indicate a uniform stratigraphy and no evidence of abrupt irregularities in the top of the Pleistocene or the top of the very dense silty sands.

The effects of the site geology, including local and regional seismicity, are being evaluated by the Staff and will be covered in the Commission's Safety Evaluation Report.

2. Climatology and Meteorology

The climate in the vicinity of the Plant is classified as humid subtropical. It is influenced to a large degree by the water surfaces provided by the many lakes and streams and by the proximity of the Gulf of Mexico. From meteorological observations taken at the Moisant International Airport near New Orleans, the mean monthly temperature at the Site can be expected to range from 54.6°F in January to 81.9°F in August. Generally there are only about 7 days/yr when the temperature rises to 95°F or higher, while 102°F is the highest recorded temperature. On the average, temperatures below freezing can be expected 12 days/yr, with 6°F the lowest recorded temperature. Precipitation expected at the Site would be in the form of frequent rain and averages about 54 in./yr. July has the largest mean monthly amount of rainfall with nearly 7 in. while October has a mean value of about 3 in. Since the Site is on the Mississippi River and near the Gulf of Mexico, relative humidity of the Site is high and there are frequent occurrences of heavy fog. The mean relative humidity is near 80% while heavy fog is expected 32 days/yr.[6]

The wind rose for Moisant International Airport indicates that prevailing winds tend to be from the south (9% of the total hours). But 8 of the remaining 15 directions have a frequency of 6-8% so wide variation in wind direction is possible. The mean annual speed is 8.1 mph; the record maximum wind speed is 98 mph.[6] Based on 2 years of data from the airport station, inversions and isothermal lapse rates can be expected 21.9% of the time.

The Site may be affected by several types of severe weather, including tornadoes, hurricanes and thunderstorms. Climatological records for the region show the mean number of days with thunderstorms to be 68/yr. July has the highest mean number of days with 16, while November has the lowest with only 1.

Since 1886, there have been 20 hurricanes (wind $\geq$ 74 mph) and 21 tro ical storms within 100 nautical miles of the Site. One of these hur ricanes produced tides 12.4 ft above mean sea level near New Orleans

The Probable Maximum Hurricane (PMH)[(a)] enters[8] the Louisiana coast about 15 miles west of Buras (see Figure II-1) and proceeds inland in a NNE direction passing 32 miles east of Waterford. It has a forward speed of 4 knots (4.6 mph) and a 30 nautical mile maximum wind radius.

The PMH is of interest because, on the assumption of its occurrence[9] simultaneously with certain river flood and Gulf of Mexico tidal conditions, high water levels at Waterford could top or breech the levee. The Applicant believes, however,[9] that the low land behind the Plant receiving flood waters from a breached levee and the Plant grade of 17.5 ft MSL (versus 23.6 for the level expected from a long break) would result in a water level of only about 6 ft at those buildings housing essential safety equipment. The Staff concurs in the Applicant's design which would protect the safety-related buildi up to a water level of 30 feet MSL (about 13 feet above ground at th buildings). The Staff will, however, require further design considerations which will provide for structures to meet a uniform dynamic loading on exposed building surfaces due to flood surges and waves. Detail on the effects of flooding on plant safety will be contained in the Safety Evaluation Report.

Tornadoes can be generated by hurricanes.[10,11] Based on data from August 1955 to September 1961, the average number of tornadoes per hurricane is 9, although some have generated more than 20.[11] Other sources report that Louisiana had the third highest incidence of suc tornadoes during the past decade.[12] Additional findings show there is a 94% probability that a tornado generated by a hurricane will be in the tropical cyclone sector from 10 degrees clockwise to 120 degrees azimuth, and that the formation of tornadoes tends to be between 60 and 210 miles of the hurricane center, depending on the size of the hurricane.

Thom[13] has calculated that the area near the Waterford Site should average one tornado per year. The probability of a tornado actually

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[(a)] Probable Maximum Hurricane is defined by the U.S. Army Corps of Engineers and the U.S. Weather Bureau as "a hypothetical hurrican having that combination of characteristics which will make it the most severe that can probably occur in the particular region involved. The hurricane should approach the point under study alon a critical path and at an optimum rate of movement."

striking the Site is 6.3 x 10^{-5}, while the recurrence interval is 1585 years. With respect to plant safety, these effects will be evaluated in the Safety Evaluation Report.

3. Hydrology

The Plant is located on the Mississippi River Alluvial Plain on the Coastal Plain Province. There are no major tributaries of the Mississippi below the Site.

North of the Site about 7 miles is Lake Pontchartrain which is a deltaic levee lake. Hutchinson[14] has cited Lake Pontchartrain as "a very fine example of a lake held between the levee of an outgrown distributary, Bayou Sauvage, and the higher country north of the flood plain of the Mississippi." The lake is nominally connected with the Mississippi 3/4 mile downstream of the Site by the Bonnet Carre spillway and floodway.

Sand and gravel aquifers in the older deltaic deposits provide the main groundwater supply in the region. In the New Orleans area the major aquifers identified are the "200-ft," "400-ft," "700-ft," and "1200-ft" sands.[15] Most of the pumped supply comes from the "400-ft" and "700-ft" sands which have been correlated throughout the St. Charles Parish area. The aquifers of the New Orleans area extend westward into the Reserve-La Place area. Pointbar deposits afford hydraulic connection between the Mississippi River and the older deposits and also serve as a source of groundwater. The "400-ft" is the major aquifer in the Waterford area and there are a number of wells to this aquifer. The Applicant states that there are 19 wells within a 2-mile radius of the Site. Five of these wells are currently in use. The Applicant states that at Norco, pumpage from the "400-ft" sand was about 15,000,000 gal/day in 1970 while the "700-ft" sand yielded about 4,000,000 gal/day. Well water analysis has indicated that groundwater in the area of the Site ("400-ft" sand) contains approximately 230 ppm chloride, over 0.3 ppm iron, and about 900 ppm dissolved solids at a temperature of about 70°F. These concentrations are similar to those obtained in the New Orleans area.

The Applicant cites records of groundwater levels[16] which indicate that the piezometric surface of groundwater in the 700-ft sand aquifer was 24.5-28.0 ft below MSL (ground elevation is about 12 ft above MSL) in the St. Charles Parish area in 1964.[16-18] This aquifer is artesian, confined by the overlying clay layers. At the Site, soil borings indicate groundwater at about 1.5 ft below ground level during September. Noticeable regional declines have been observed in the "400-ft" and "700-ft" aquifers. Water level records show a drop of over five feet between 1960 and 1964.

4. The River

The lower Mississippi River has undergone physical and chemical chan from two major processes as a result of man's activities; flood cont or channelization and industrial development with associated waste discharge.[19-25] The levee system along the river, under mandate of the U. S. Army Corps of Engineers, is now 2,130 miles long and there are more than 60 major industries on the River between Baton Rouge and New Orleans, Louisiana.[26]

The Mississippi River is at its lowest level during the midsummer and fall, when its flow rate is about one-tenth of its maximum during spring and early summer. The average discharge of the Mississippi River, as reported by the Applicant, over the period fro 1900 to 1969 was 493,000 cfs. Since 1927, the maximum discharge was 1,520,000 cfs in 1945, and the minimum was 75,000 cfs in 1939. As a result of the upstream control system in effect since 1939, the Corp of Engineers now estimates the minimum Mississippi River flow at the Waterford Site to be not less than 100,000 cfs.[27]

The major floods on the lower Mississippi River generally result from large floods on the Ohio River augmented by contributions from other major tributaries to the lower Mississippi River. The flood season on the Mississippi River is usually from the middle of December through July.

On the basis of studies in the middle Mississippi River[28] there is an increase in turbidity, solids and carbon dioxide content, a lowered and more uniform temperature, and decreased dissolved oxygen and photosynthetic activity during periods of high discharge; opposit effects occur at periods of low discharge. The sediment load of the lower Mississippi River has been estimated at up to 1 and 2 million tons per day,[29] and this load reduces biological productivity.

Table II-3 shows the average and extreme values of the flow for the Mississippi River in the vicinity of the Waterford site for the year 1960 through 1969.

Maximum, minimum and mean water temperatures of the Mississippi River at a point about 25 miles downstream of the Site are shown in Table II-4. Maximum temperatures during the year occur in August and minimum temperatures in February. Monthly temperatures are equal to or less than 82.5°F about 80% of the time and equal to or less than 49°F about 20% of the time.

TABLE II-3

STREAM FLOW IN THE MISSISSIPPI RIVER
1960-1969[a]

Year	Discharge (1000 cfs) Maximum	Minimum	Mean
1960	826	148	409
1961	1107	183	514
1962	1081	151	475
1963	881	123	268
1964	1015	119	366
1965	936	168	417
1966	1154	155	372
1967	803	180	384
1968	857	160	434
1969	1064	186	460

(a) 1960-1963 Discharge at Red River Landing, Louisiana and 1964-1969 Discharge at Tarbert Landing, Mississippi.

TABLE II-4

MISSISSIPPI RIVER AVERAGE TEMPERATURES[b]

Month	Temperature (°F) Maximum	Minimum	Mean
January	50	41	46
February	50	40	46
March	56	46	51
April	63	57	59
May	78	67	71
June	83	77	79
July	87	81	84
August	90	81	86
September	87	76	83
October	78	71	74
November	71	57	63
December	57	47	52

(b) Measurements taken by LP&L at Ninemile Point Generating Station, near Westwego, Louisiana (25.6 miles downstream of Waterford).

Water quality parameters were measured by the Applicant at various depths at stations shown in Figure II-6. Surface water samples were also taken at both the intake and discharge of the Little Gypsy Power Plant across the river for conductivity, dissolved oxygen and temperature determinations. The results agree closely with those obtained from the records of the U. S. Geological Survey for the sam general area for the years 1968, 1969 and 1970. The latter, togethe with some of those obtained by the Applicant are shown in Table II-5 The dissolved oxygen content was rather constant at most stations an in general, decreased with increasing depth. No evidence of saltwat intrusion was found by the Applicant during the study of the Site.[30]

The levee at the Waterford site has a top elevation 30 ft above MSL, a crown width of 10 ft and a base width of 124 ft. The river side and land side levee slopes are 1 on 4 and 1 on 5-1/2 respectively.

River sediments have been collected and classified. A very fine grained brown clayey ooze is present on the west shore of the river from Station UC (Figure II-6) to just upstream of Station ND. At the former station this brown ooze extended at least 600 ft offshore and was present downriver to FD 500 where a heavy grey clay was encountered. Downstream from Station FD, the clay occurred nearer to shore, and at Station ND formed the river bank. From ND to D2, the river bottom consisted of grey clay from the shoreline to 500 ft offshore.

Studies at the Site showed that a definite upstream flow of water begins near Station FD (see Figure II-6) and continues approximately 2500 ft upstream.[31] "The upstream movement of water occurs from the shoreline to a distance of 250 ft offshore, and to a depth of 10 ft." Upstream velocity of 0.3 fps was measured at a depth of 10 ft, at both 200 and 250 ft offshore. At 300 ft offshore, water movement at 10 and 16 ft depths is oscillatory, while a downstream current occurs at depths of 20 and 40 ft. At 400 ft offshore, a distinct downstream current occurs throughout the entire water column.

Table II-6 and Figure II-4 show intakes of potable water at points downstream of the Plant discharge.

E. ECOLOGY AND SITE ENVIRONS

1. Terrestrial

The Waterford site is composed of two distinct terrestrial component 1400 acres of sugar cane and 2200 acres of wooded swamp. The crop-land has been cultivated for many years and provides a habitat for doves, quail, some rabbits, snipe and abundant numbers of various

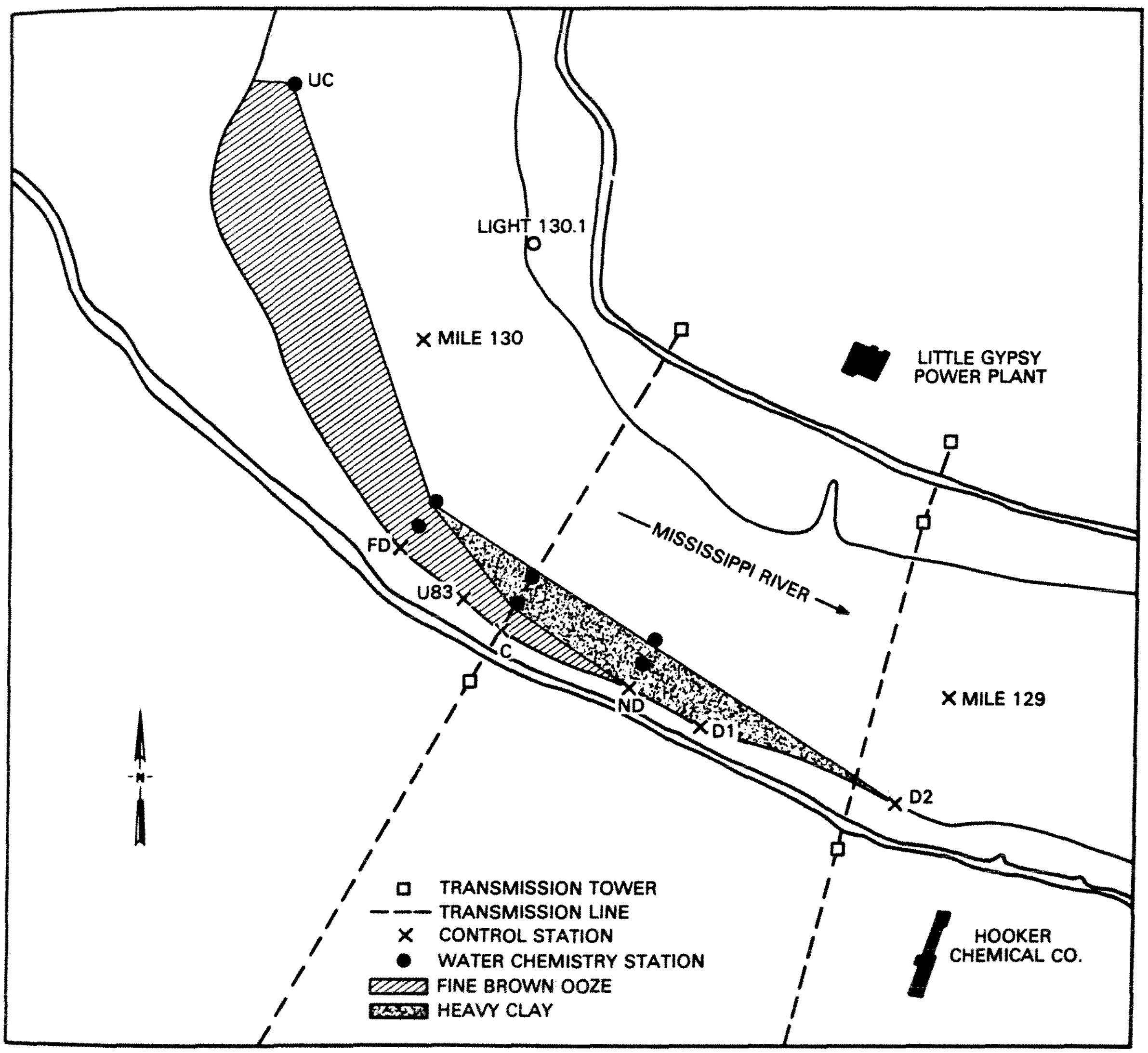

FIGURE II-6. WATER AND SEDIMENT SAMPLING STATIONS

TABLE II-5

CHEMICAL COMPOSITION OF MISSISSIPPI RIVER WATER
OCTOBER 1967 - SEPTEMBER 1968[a]

Analysis	Maximum	Minimum	Ave
Silica (ppm)	7.9	0.8	4.
Iron (ppm)	0.26	0.00	0
Calcium (ppm)	52	29	39
Magnesium (ppm)	14	7.1	10
Sodium (ppm)	40	15	23
Potassium (ppm)	5.4	1.2	3
Bicarbonate (ppm)	179	89	123
Sulfate (ppm)	77	38	56
Chloride (ppm)	43	1.8	27
Fluoride (ppm)	0.5	0.2	0
Nitrate (ppm)	4.2	0.1	2
Dissolved Solids (ppm)[a]	295	175	
Dissolved Solids (ppm)[b]	270	232	--
Hardness (ppm as $CaCO_3$)	188	104	1
Noncarbonate Hardness (ppm as $CaCO_3$)	52	31	41
Specific Conductance (micro ohms at 25°C)	580	261	397
Temperature (°C)	30	11	18
Color	50	4	20
pH[a]	7.9	6.7	7
pH[b]	8.00	7.72	--
Dissolved Oxygen (DO)[b]	6.0	4.9	--
Dissolved Oxygen, Little Gypsy Discharge Canal[b]	6.2	6.1	--

(a) Representative values from the U.S. Geological Survey for samp taken at St. Francesville and at Luling Ferry, Louisiana.[30]

(b) Values determined by the Applicant, 1971.

TABLE II-6

POTABLE WATER INTAKES DOWNSTREAM OF WATERFORD UNIT 3 DISCHARGE (RIVER MILE 129.6)[a]

Intake	River Mile
1. Union Carbide Corporation	128
2. Shell Oil Company	126
3. St. Charles Parish Water Works District No. 1	125.1
4. St. Charles Parish Water Works District No. 2	120.6
5. Jefferson Parish Water Works District No. 1	105.4
6. Sewage & Water Board New Orleans Carrollton Plant	104.7
7. City of Westwego Water District	101.5
8. Jefferson Parish Water Works District No. 2	99.1
9. City of Gretna Water District	96.7
10. Sewage & Water Board New Orleans Algiers Plant	95.8
11. American Sugar Company	90.8
12. Kaiser Aluminum & Chemical Corporation	89.3
13. St. Bernard Parish Water Works District No. 1	87.9
14. Dalcour Water Works District	80.9
15. Belle Chase Water Works District	75.8
16. Gulf Oil Corporation, Alliance Refinery	62.5
17. Pointe-A-La-Hache Water District	49.2
18. Freeport Sulphur Company	39.4
19. Buras Water Works District	29.9
20. Boothville-Venice Water Works	18.6

[a] Compiled by LP&L.

insects. The major portion of the animals, birds and reptiles live within the wooded swamp and along and on the Mississippi River.

Penfound and Hathway have defined plant communities in the marshlands of southeastern Louisiana.[32] They describe the physiographic conditions and edaphic factors that determine the species composition within the different plant communities. The edaphhic factors that are most important in defining the extent or boundaries of the various plant communities are: the water level with reference to soil surface; salinity of free soil water; water content of the soil; and percent of organic matter in the soil. The marsh plant community types in southeastern Louisiana are closely correlated with salt content of the soil water from the freshwater marsh (0.0% salt) to the saline-marsh (2.0 to 5.0% salt). Each plant species has its individual range of salt tolerance and there is a gradual transition from the freshwater to the saline water marsh types with rather broad ecotones. Water level, water content of the soil and organic matter help to determine the species content of an area, such as, free floating plants, roots anchored in soil below or above the water surface.

A study transect defined by Penfound as "Raceland" was established southeast of Des Allemand and this transect has a plant community similar to that of the marshland of the Waterford site. This freshwater transect consisted of oak forest, cypress-gum swamp and a freshwater marsh. Appendix Table A-1 lists the species of plants found in fresh and near-fresh water (0 to 0.6% salt) of swamps of southeastern Louisiana.[32]

Many game birds and animals occur in St. Charles Parish and the Applicant has provided a list of the species and their abundance as reported by R. A. Beter of the Louisiana Wildlife and Fisheries Commission.[33] This list is included as Appendix Table A-2.

The Audubon Society Christmas Day bird count for 1971 was made in the vicinity of La Place across the Mississippi River from the Waterford site.[34] The bird counters observed 19,282 individual birds consisting of 115 species within a 15-mile diameter circle on December 28, 1971. The observations are listed in Appendix Table A-3. Other birds seen in the count area but not on count day were horned grebe, double-crested cormorant, green heron, ringnecked duck, canvasback, least sandpiper, western sandpiper, hummingbird and Baltimore oriole.

Of the birds and animals shown in Appendix Tables A-2 and A-3, only the alligator is on the list of endangered species.[35] However, there is a possibility that the brown pelican, the southern bald eagle and the American peregrine falcon may occur on the Waterford site.[36]

2. Aquatic

In general, the ecology of the lower Mississippi River near Taft-Luling is poorly known, particularly in the occurrence and seasonal distribution of aquatic organisms. Notwithstanding the paucity of information, trophic pathways in the aquatic ecosystem near the Waterford site can be approximated by comparison with those in other systems. Probable trophic pathways in the lower Mississippi River are illustrated in Figure II-7, modified from ecological studies conducted in the middle Mississippi River in Iowa.[37]

a. Finfish Populations

The species composition, relative abundance, distribution and ecology of finfish in the lower Mississippi River near the Site are not well known. This is due primarily to the difficulty of obtaining qualitative and quantitative samples in a large turbid river, seasonal changes in available fish populations and environmental changes that have resulted from aids-to-navigation projects in the lower Mississippi in recent decades.

The Applicant supported a preliminary environmental survey at the Site, conducted from July 12 to July 21, 1971, that provides some fish population data.[38] During this survey, the most common fish collected by trawling were juvenile catfish, family Ictaluridae (79.8%), fresh-water drum (13.5%) and blue catfish (3.7%); the most common fish collected by gill nets were gizzard shad (55.2%), carp (16.4%) and blue catfish (10.4%) (Table II-7). The difference in catches between the two types of gear reflects fishing efficiency as well as the area where the collections were made. The Staff believes, due to the briefness of the survey, that only a limited number of species actually present at the Site were taken.

A fish census taken by the Federal Water Quality Administration during 1964-1968 at seven stations located between Vicksburg, Mississippi, downriver to Luling, Louisiana, directly below the Waterford site, revealed the presence of 63 species.[39] Of these, 25 were predators, 38 were nonpredators, 16 were game fish and 28 were commerical fish.

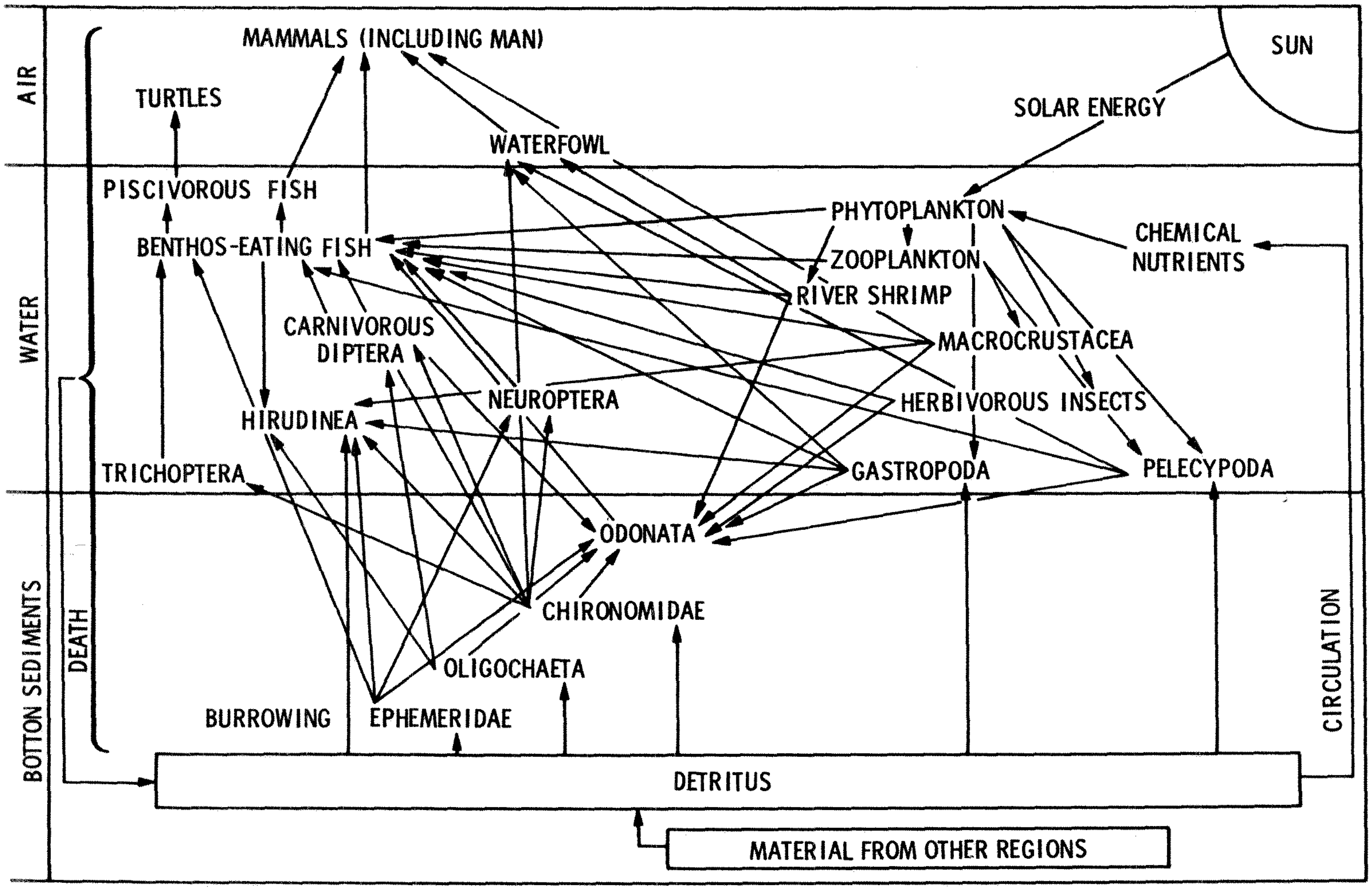

FIGURE II-7. PROBABLE NUTRIENT AND ENERGY FLOW IN THE BIOLOGICAL COMMUNITY WITHIN THE LOWER MISSISSIPPI RIVER

TABLE II-7

FINFISH COLLECTED IN THE LOWER MISSISSIPPI RIVER AT THE WATERFORD SITE BY THE EBASCO SURVEY, JULY 1972[37]

Family	Species	Common Name	Relative Abundance (%)	
			Trawls	Gill Nets
Anguillidae	*Anguilla rostrata*	American eel	0.1	---
Bothidae	*Paralichthys lethostigma*	Southern flounder[(a)]	0.4	3.7
Catostomidae	*Ictiobus bubalis*	Smallmouth buffalo	---	0.7
	Unidentified Catostomids		---	1.5
Clupeidae	*Dorosoma cepedianum*	Gizzard shad	---	55.2
	Alosa chrysochloris	Skipjack herring	---	0.5
	Unidentified Clupeids		---	6.7
Cyprinidae	*Cyprinus carpio*	Carp	0.2	16.4
	Unidentified Cyprinids		0.5	---
Ictaluridae	*Ictalurus furcatus*	Blue catfish	3.7	10.4
	Ictalurus punctatus	Channel catfish	0.7	0.7
	Pylodictis olivaris	Flathead catfish	0.2	---
	Juvenile Ictalurids		79.8	---
Lepisosteidae	*Lepiosteus osseus*	Longnose gar	---	1.5
	Lepiosteus platostomus	Shornose gar	---	0.7
Sciaenidae	*Aplodinotus grunniens*	Freshwater drum	13.5	---
Serranidae	*Morone saxatilis*	Striped bass[(a)]	---	1.5
Soleidae	*Trinectes maculatus*	Hogchoker[(a)]	0.8	---

(a) Marine fish entering fresh water.

Fifty of the 63 species taken in the Federal Water Quality Administration survey were collected in the lower Mississippi River near Luling. These are shown in Appendix Table A-4. Of these, the seven most common were gizzard shad (14.3% of total catch), threadfin shad (11.2%), channel catfish (10.4%), skipjack herring (10.0%), blue catfish (6.6%), carp (6.3%), and menhaden (6.1%). The 13 species found upriver but not in the vicinity of the Waterford site have dominant freshwater preferences. Their absence in the lower river reflects the estuarine influence of the Gulf of Mexico upriver at Luling. Fifteen of the species collected during the survey occur primarily in marine or in brackish marine waters, again reflecting estuarine influence at the Site.

Those fishes occurring near Taft-Luling with a life cycle involving adult growth and reproduction in offshore marine areas and the migration of young into brackish waters (loc. cit.) include the Atlantic croaker, silver seatrout, spot and striped mullet. Species present at Taft-Luling that are primarily freshwater residents but have migratory or spawning runs within the lower Mississippi River (loc. cit.) include the paddlefish (P. spathula), shovelnose sturgeon (S. platorynchus), white bass (M. chrysops), yellow bass (M. mississippiensis), channel catfish (J. punctatus) and sauger (Stizostedion canadense).

Some fishes of the Delta are listed by Rounsefell according to their occurrence in relation to salinities.[22] Most of these fishes are juveniles that utilize the productive brackish water of the Delta for growth and development before dispersing into the Gulf of Mexico. Of the fishes listed (loc. cit.) the blue catfish (I. furcatus), "sunfish" (Lepomis sp.), Gulf killifish (Fundulus grandis) and "pipefish" (probably Syngnathus scorelli, the Gulf pipefish) occurred only in areas of 1.3 to 6.5 ppt salinity, i.e., at the head of seawater influence. Of the remainder, the sheepshead minnow (Cyprinodom variegatus), striped mullet (M. cephalus), hogchoker (Trinectes maculatus), naked gobi (Gobiosoma bosci) and menhaden (Brevoortia sp.) revealed a strong preference (>50% occurrence) for areas of similar low salinity.

In general, fishes in the lower Mississippi River are species ecologically adapted to a wide temperature range and tolerant to seasonally warm temperatures. This is illustrated by their common occurrence in backwater areas and oxbow lakes, where summer temperatures usually exceed those in the main channel of the Mississippi River. Some data on the ecology of various species are given in Appendix Table A-5. Most fishes in the lower Mississippi begin to spawn in the early spring as water temperatures rise to levels stimulating reproduction, and the larvae and juveniles develop under warm summer temperature conditions.

None of the fishes known to occur in the lower Mississippi River are on the endangered species list prepared by the Survival Service Commission.[40] Moreover, none of the 13 rare fish species listed as present in Louisiana waters by Miller are known to occur at the Site.[41]

b. Benthic Invertebrates

Invertebrate species in the lower Mississippi River have received little attention, and apparently the only pertinent study was conducted in the vicinity of Baton Rouge, Louisiana.[42] Since this study was only a preliminary survey, little can be concluded other than that certain species were present; but the species found are wide-ranging forms and they probably occur at the Plant site. The dominant invertebrates encountered (loc. cit.), exclusive of protozoa, were as follows:

Hydra: *Hydra americana*

Nematodes: *Dorylaimus* sp.

Oligochaetes: *Tubifex tubifex*

Gastropoda molluscs: *Physa pomilis*

Decapods: *Macrobranchium ohione*

Amphipods: *Gammarus fasciatus*

Insect Larvae:

Ephemeroptera (mayflies) - *Stenonema frontale*, *Rithogena* sp., *Heptagenia* sp.

Trichoptera (caddisflies) - *Hydropsyche simulans*, *Triaenoides* sp., *Elophilia* sp.

Diptera (true flies) - *Culex quinquefasciatus*, *Mochlony* sp., *Chaoborus* sp., *Pentaneura* sp., *Tendipes* sp., *Tendipes tentans*, *Chrysops* sp., *Tabanus* sp.

The Applicant's preliminary environmental survey conducted by Ebasco Services in July 1971,[38] revealed a few additional species present at the Waterford site. These organisms are listed in Table II-8. The river shrimp (96.4% of catch) was dominant in the trawl catches whereas oligochaete worms (85.4%) prevailed in the benthic section samples. Corbicula leana is a bivalve mollusc introduced into the lower Mississippi River from Asia. The isopod Probopyrus is a parasite of river shrimp. The influence of the estuary is evident in the appearance of small blue crabs; adult crabs mate in the estuary and juvenile crabs migrate into the lower Mississippi River in May.[43]

The Ebasco survey indicated the occurrence of two distinct assemblages of benthic organisms associated with contrasting sediment types. Oligochaete worms and a few molluscs occurred in fine brown ooze in areas of low current velocities. Mayfly nymphs and mollusca dominated in the clay sediments in areas of moderate to high current velocities.

The Mississippi River at the Waterford site is poor frog and crayfish habitat. The frogs Rana catesbiana, R. clamitans and R. pipiens as well as the crayfish Procambarus clarkii may occur there but only low population levels are expected. The red-eared turtle (Pseudemys scripta) and the smooth softshell turtle (Trionix muticus) are probably the most common, but the snapping turtle (Chelydra serpentina), alligator snapping turtle (Macrochlemys temmincki) and Mississippi mud turtle(Kinosternomys sp.) also are likely to occur at the Site. The Ebasco survey revealed only the red-eared turtle.

c. Planktonic Organisms

Since no detailed data are currently available on zooplankton and phytoplankton organisms of the lower Mississippi River, the Applicant conducted a brief preliminary survey in July 1971 to characterize the planktonic life in the river near the Waterford site. The survey, although brief and not inclusive of a total analysis of samples, revealed the limited composition of zooplankton (copepods, brachiopods, the rotifer Branchionus sp., cladocerans and larval river shrimp) and phytoplankton (green algae Pediastrum and Closterium, yellow-green algae Tribonema, diatom Fragilaria, and blue-green algae Gomphosphaeria and Anabaena).[38]

This survey was not sufficiently comprehensive to provide a listing of the complete annual plankton spectrum and accordingly is not considered adequate for that purpose. The staff believes, however, that the conclusions concerning the effect of plant operation on the planktonic organisms would be the same even had the identification of species been more inclusive.

Phytoplankton require sunlight for photosynthesis, which is possible only in the surface layers of highly turbid water. Consequently, the production of phytoplankton in the lower Mississippi River is relatively low.

d. Aquatic Plants

Aquatic and semi-aquatic plants are present in areas bordering the lower Mississippi River but little information is available on most of these species. The heavily turbid condition of the river and low light penetration inhibit the establishment of submerged aquatic plants in depths away from the shoreline. However, it is possible to predict the occurrence of certain species in shallow areas contiguous to the shoreline or in overflow areas. On the basis of limited data from plant communities along the periphery of the Mississippi River, some of the contiguous species are listed in Appendix Table A-6.[44,45] The staff considers this to be an adequate representation of the aquatic plant life to assess the impact of Waterford 3 operation on the species.

e. Commercial and Sport Fishing

There is relatively little commercial fishing in the lower Mississippi River between the towns of La Place and Hahnville, Louisiana, a 50-mile section of the river extending above and below the Site. Based on data compiled by the National Marine Fisheries Service, United States Department of Commerce, it is estimated that approximately 20,000 pounds of fish are taken annually from this area. Of these, about 80% are catfish (Ictalurus spp.) and the remainder are freshwater sheephead.[46]

Commercial catches from the Mississippi River fisheries for the State of Louisiana in 1968 totalled 5,467,000 lb of finfish valued at $754,000 and 4,000,000 lb of shellfish valued at $744,000.[47] The composition of the Louisiana catch from the Mississippi River proper in 1968 (omitting lakes, river and tributary streams within the state) was as follows (loc. cit.):

Species	lb	Value ($)
bowfin	4,100	217
buffalofish	73,500	9,686
carp	12,300	365
catfish & bullheads	67,000	19,192
garfish	23,000	1,763
paddlefish	1,500	85
sheepshead	9,000	962
crawfish	10,200	1,816
shrimp	1,200	540
snapper turtles	500	141
frogs	500	300

In 1968 there were 40 fish wholesaling and processing establishments in Louisiana employing an average of 239 persons per season and 162 persons per year (loc. cit.).

Sport fishing in the Mississippi River proper near the Plant appears to be limited. Catches consist primarily of freshwater bass (*Micropterus* spp.). Apparently, the vast array of lakes, ponds and streams in Louisiana provides fishing of higher quality than the river itself and is utilized to a greater extent by sport fishermen.

The general public has somewhat limited access to the land immediately adjoining the river, as much of it is owned by private individuals or commercial enterprises. This tends to restrict all shore-based recreational activity including fishing. The Applicant states that maximum effort will be made to open river front land to the public consistent with general public safety and considerations of liability.

TABLE II-8

SUMMARY OF INVERTEBRATES COLLECTED IN A PRELIMINARY SURVEY AT THE WATERFORD SITE, JULY 1971[37]

Taxonomic Group	Species	Otter Trawl No.	Otter Trawl (%)	Benthic Suction Sampler No.	Benthic Suction Sampler (%)
Oligochaeta:					
Naididae	Unidentified	148	(2.4)	15,253	(85.4)
Mollusca:					
Corbiculidae	*Corbicula leana*	41	(0.7)	557	(3.1)
Unionidae	Unidentified	0	-	1	-
Amnicolidae	Unidentified	0	-	98	(0.6)
Pleuroceridae	*Goniobasis* sp.	0	1	39	(0.2)
Arthropoda:					
Palaemonidae	*Macrobranchium ohione* (river shrimp)	5,965	(96.4)	31	(0.2)
Portunidae	*Callinectes sapidus*	8	-	0	-
Isopoda:					
Bopyridae	*Probopyrus bithynis*	0	-	1	-
Insecta:					
Ephemeroptera	*Tortopus* sp.	4	-	1,866	(10.5)
Piptera (Chironomidae)	Unidentified	0		5	-
Odonata	Unidentified	19	(0.3)	0	-
Hirudinea	Unidentified	1	-	0	-

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III. THE PLANT

A. EXTERNAL APPEARANCE

The Plant will have five principal structures: the reactor building, the fuel handling building, the reactor auxiliary building, the turbine building and the administration building (see Figure III-1). The reactor building will be the most prominent of these structures and will consist of a cylindrical concrete structure, with a domed roof, that houses the steel containment vessel in which is located the reactor and nuclear steam supply system.

The other buildings, also of structural concrete, will be of more conventional design. It is the Applicant's intent that all will be harmoniously arranged to present a clean architectural ensemble giving little interference with the natural surroundings. An architect's rendering of the Plant is shown in Figure III-2. As of late June 1972 excavation for the fuel handling, reactor and auxiliary buildings was underway and the Site was being laid out and generally prepared for construction of the Plant.

B. TRANSMISSION LINES

The Waterford 230 kV Substation was originally constructed at the Site in 1971 to accommodate three 230 kV lines; one serving the Union Carbide and Hooker Chemical Company industrial complex on the right bank, one to the Little Gypsy Steam Electric Station across the river, and the third as a major transmission tie to the extreme southeast part of the state of Louisiana. Plans are to enlarge this substation for the 230 kV ties to the fossil-fired Waterford Units 1 and 2 and their common start-up transformer. By 1977 the substation will be expanded further to accommodate Waterford Unit 3: its two start-up transformers and three additional on-site 230 kV lines. The only new construction external to the Site will be a 230 kV line to the Churchill Substation located some 5 miles south of Ninemile Point Steam Electric Station in the New Orleans Metropolitan area. This new line will be 23.5 miles in length and will utilize a 100 foot wide right-of-way corridor. Future transmission requirements of Louisiana Power call for a 500 kV circuit circling the entire service area around New Orleans. This line is independent of Waterford 3; however, it is planned to have the right-of-way for this line parallel the 23.5 mile 230 kV Waterford 3 line. Accordingly, the Applicant proposes to initially acquire a full 250 foot right-of-way corridor for both lines. At the time of constructing the 230 kV line for Waterford 3 operation, only the 100 foot corridor will be cleared. This will be equivalent to approximately 280 acres. This new 230 kV line for Waterford 3 is shown in Figure III-3.

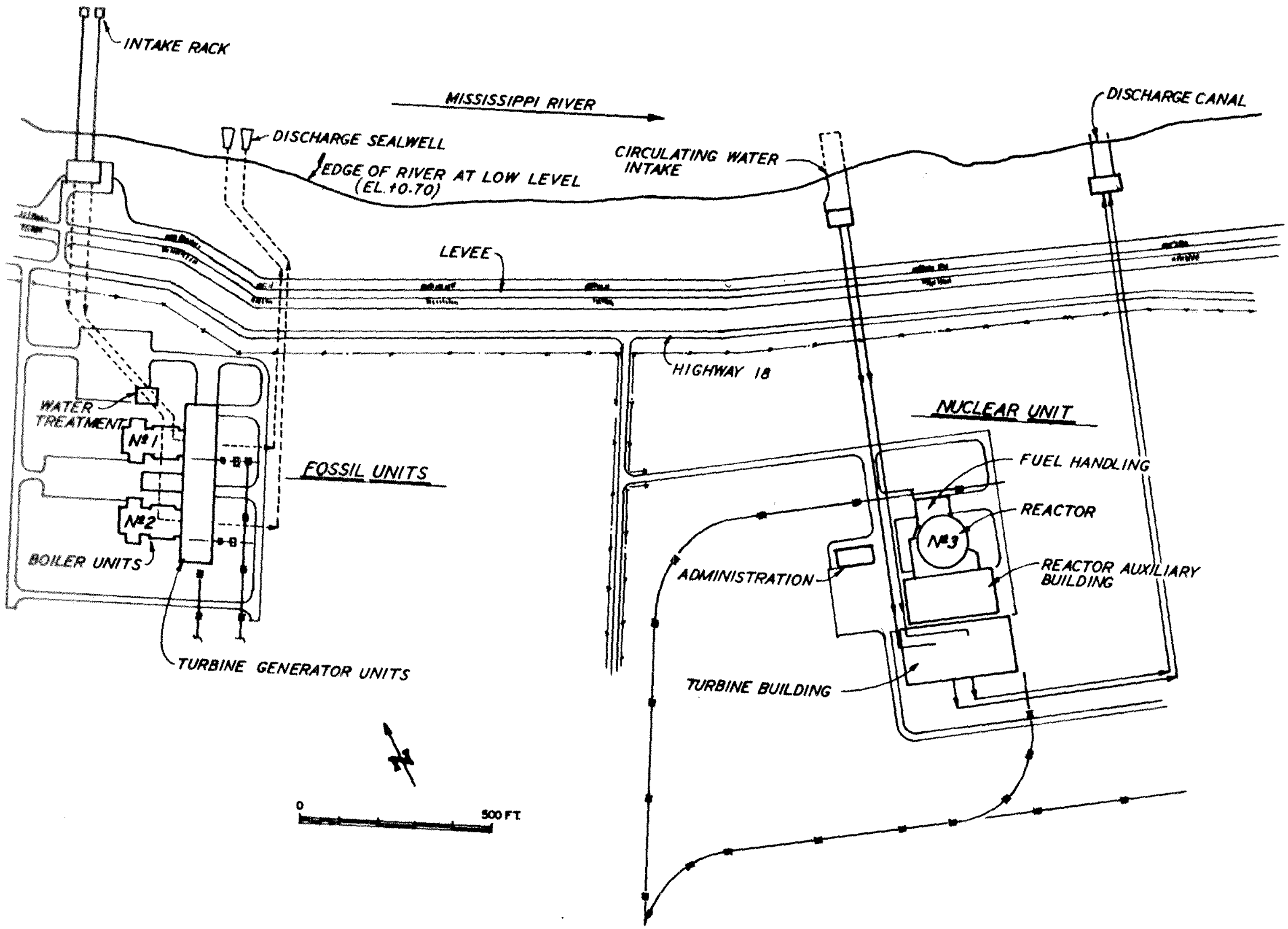

FIGURE III-1. SITE PLAN SHOWING PRINCIPAL BUILDINGS AND FACILITIES

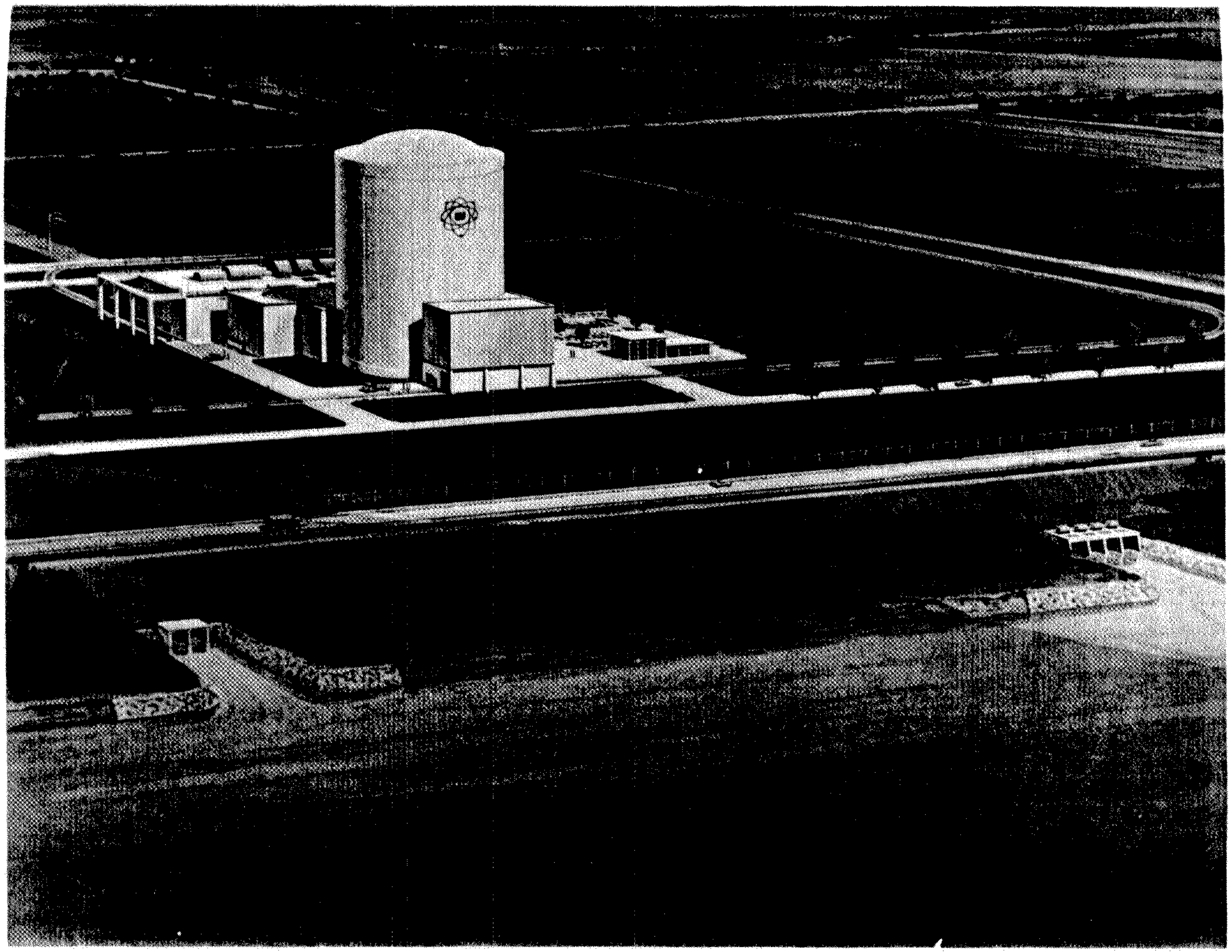

FIGURE III-2. ARCHITECT'S RENDENING OF THE PLANT

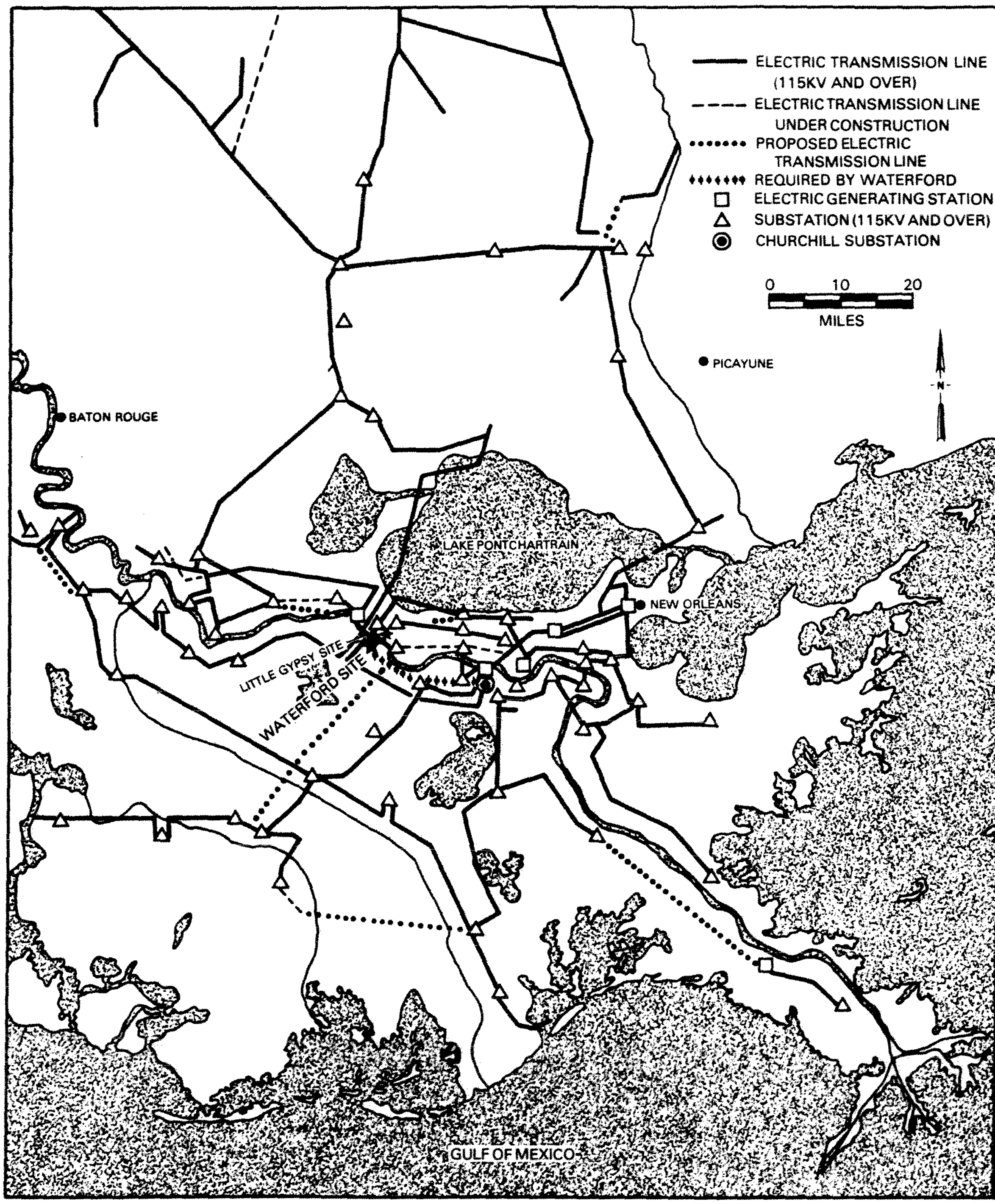

FIGURE III-3. SOUTHERN PART OF THE SERVICE AREA, SHOWING TRANSMISSION LINES

This transmission line will be completely located in St. Charles and Jefferson Parishes and its routing will be selected to traverse only uninhabited marsh and timbered swamp.[1] Marsh buggies and helicopters will be used during the construction of the lines. Approximately 80% of the line will traverse uninhabited marsh and the remaining 20% will cross timbered swamp. The discussion of construction methods to be used and the Staff evaluation of the construction effects on the environment are given in Chapter IV.

C. REACTOR AND STEAM-ELECTRIC SYSTEM

The Waterford Unit 3 is the nuclear unit of a power generating complex located on the Waterford Steam Electric Station. A plan of the Site is shown in Figure III-1. Units 1 and 2 are 430 MWe fossil fuel units presently under construction. Unit 1 is scheduled for commercial operation in late 1973 or early 1974 and Unit 2 about one year later. Unit 3, the plant under consideration in this Statement, is a pressurized water reactor built by Combustion Engineering, Inc. Westinghouse Electric Corporation is the manufacturer of the steam turbine-generator system. The ultimate design thermal power level is 3560 MWt producing 1165 MWe net electrical power. The architect-engineer for the project is Ebasco Services, Inc.

The reactor plant incorporates use of three separate water loops to convert nuclear heat energy to electrical power. Water in the primary loop moderates the nuclear reaction in the core and transfers heat from the nuclear fuel elements. The heated primary loop water is pumped to a heat exchanger where steam is generated in the secondary water loop. The steam generated in the secondary loop passes through turbines where power is extracted and then to a surface condenser where the spent steam is condensed to liquid. The condensed water in the secondary loop is pumped back to the primary heat exchanger to again form steam to drive the turbines. Both the primary and secondary cooling loops are separately sealed water loops, and as such do not release heat or material directly to the environment. In the third loop, water from the Mississippi River is passed through the condenser heat exchanger. Waste heat from the spent steam is transferred to the river water. This third loop is once-through, with warmed effluent being discharged back to the Mississippi River via the discharge canal.

D. EFFLUENT SYSTEMS

1. Heat

For Unit 3, 975,000 gpm (2172 cfs) of Mississippi River water will be used for cooling purposes. Approximately 98% of this intake or 2129 cfs will pass through the condenser where it will be heated 16.0°F (8.9°C) when the Plant is operated at maximum power level. The two fossil units require 214,500 gpm (478 cfs) each, and discharge heated water upstream from the intake of Unit 3. Some of the heated discharge from the upstream units will be drawn into the intake of Unit 3. At river flows of about 200,000 cfs, the Applicant estimates that when the fossil units are operated at full power, the Unit 3 circulating water intake temperature will be raised 2°F above ambient river temperature, resulting in a discharge temperature about 18°F above ambient. The Staff estimates that more of the heated discharge from Units 1 and 2 will enter Unit 3 when river flows are high. (See Section V-B).

In addition to the three units at the Waterford site, the Applicant now has installed 1,229 MWe of fossil-fueled generating capacity at the Little Gypsy Generating Station, located on the north shore of the Mississippi River directly across from the Waterford site. The total heat discharged to the river by all units at the Waterford site and the Little Gypsy Station operating at full capacity will amount to 18 x 10^9 Btu/hr. Discharge of this heat load to the Mississippi River during low flow conditions (200,000 cfs) would produce, theoretically, an average mixed temperature increase of less than 0.6°F (0.3°C) if completely mixed at the point of discharge.

Cooling water is withdrawn from the river at a point 600 ft from the centerline of the levee through a canal with sides made from sheet pile. For the first 210 ft of length the canal is 35 ft wide. In the next 110 ft, its width increases uniformly to 59.5 ft at the intake structure. The water depth in the intake canal at average low water is 35.8 ft. Velocity in the narrow section of the intake canal is 1.8 fps at average low water. The intake canal is shown schematically in Figure III-4.

At the intake structure, cooling water passes under a skimmer wall 15 ft deep to prevent entry of large floating debris. The maximum entrance velocity of water into the intake structure beneath the skimmer wall is estimated to be 1.7 fps, with an approach velocity of 1.33 fps at average low water level and 0.7 fps at average high water level. It then passes through vertical traveling screens (1/4 in. square openings). The approach velocity at the screens is 1.25 fps, average low water. The water then enters four circulating water pumps. Details of the intake structure are shown in Figure III-5.

From the pumps, water is delivered to Unit 3 through four 9-ft diameter steel pipelines which run over the river levee and beneath the state road. Velocity in the 320-ft long steel pipes is 8.8 fps.

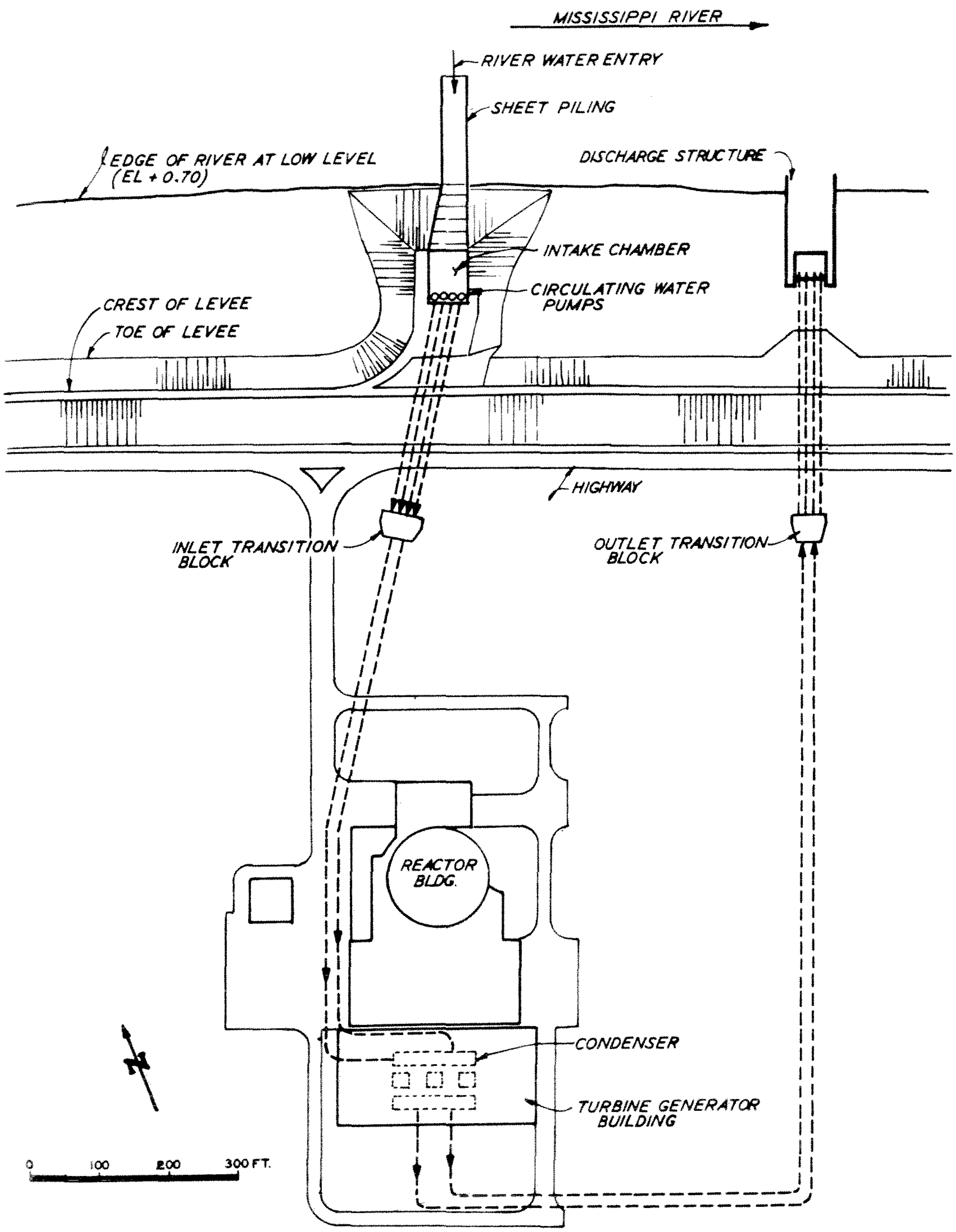

FIGURE III-4. SITE PLAN SHOWING COOLING WATER INTAKE AND DISCHARGE SYSTEMS

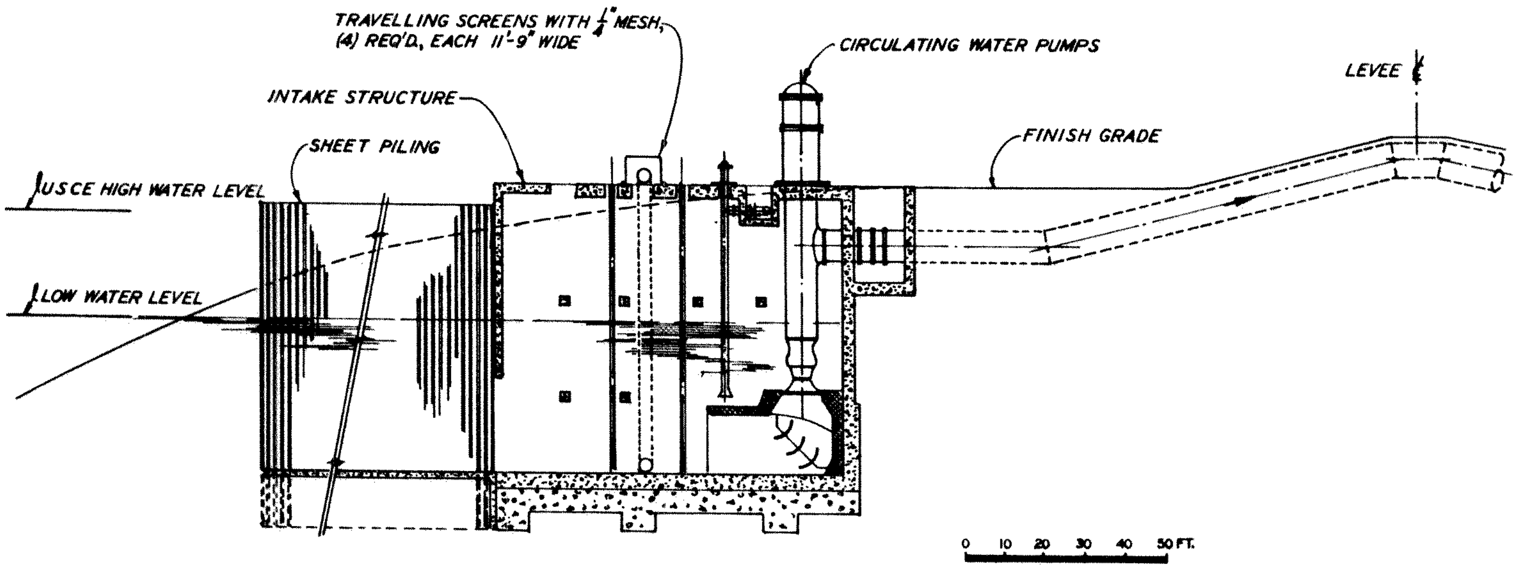

FIGURE III-5. SCHEMATIC VIEW OF THE INTAKE STRUCTURE

These pipes terminate in a concrete transition block from which water is conveyed to the Plant in two 11-ft diameter concrete pipes at a velocity of 11.7 fps. The concrete pipes are 890 ft in length.

At the condenser, water flows inside tubes at a velocity of 10 fps. At full power the cooling water is heated 16°F during the transit time period of 4 seconds.

Cooling water which exits from the condenser is conveyed 1530 ft in two 11-ft diameter concrete pipes to a transition block. Four 9-ft diameter steel pipes carry the water 390 ft to a seal well at the river. Flow velocity is 11.7 fps in the concrete pipes and 8.8 fps in the steel pipes.

a. Outfall Design

As a result of technical exchanges with the staff, the applicant has modified the proposed discharge system to increase the exit velocity of the water to 7 fps by reducing the terminal width of the sheet pile structure.[3] At flows under 500,000 cfs this modification will serve to increase the extent of momentum jet entrainment, thereby reducing the mixing zone size. Also, for these lower flows, this modification essentially eliminates contact of water warmed in excess of 5°F with the right bank of the river. At 200,000 cfs river flow, the revised design discharge plume centerline will arc outward from the bank to about 500 feet and then flow parallel to the bank downstream. At these same river flows, the maximum spread of detectably warm water (1°F) will be about 1,200 feet from the bank at a point 2,000 feet below the outfall, and will then gradually expand to the left bank several miles downsteam. The depth of water in the mixing zone will decrease from about 20 feet in the zone of flow establishment to about 8 - 10 feet in depth as the plume moves downstream. Eventually, the buoyant forces will be overcome by turbulence and the remaining thermal increment (<0.2°F) will occupy the entire river depth, approximately 7 - 8 miles downstream. Some intermingling of the effluent flows from Units #1, #2, and #3 and the Little Gypsy Station will occur; however, the plume will not occupy the full cross section of the river at any point downstream where the total thermal increment is greater than 0.2°F.

At river flows in excess of 500,000 cfs, the discharge will be bent sharply and hug the right bank because the effluent discharge velocity will be reduced due to increased river water elevation and the system will act essentially the same as the low velocity system previously described.

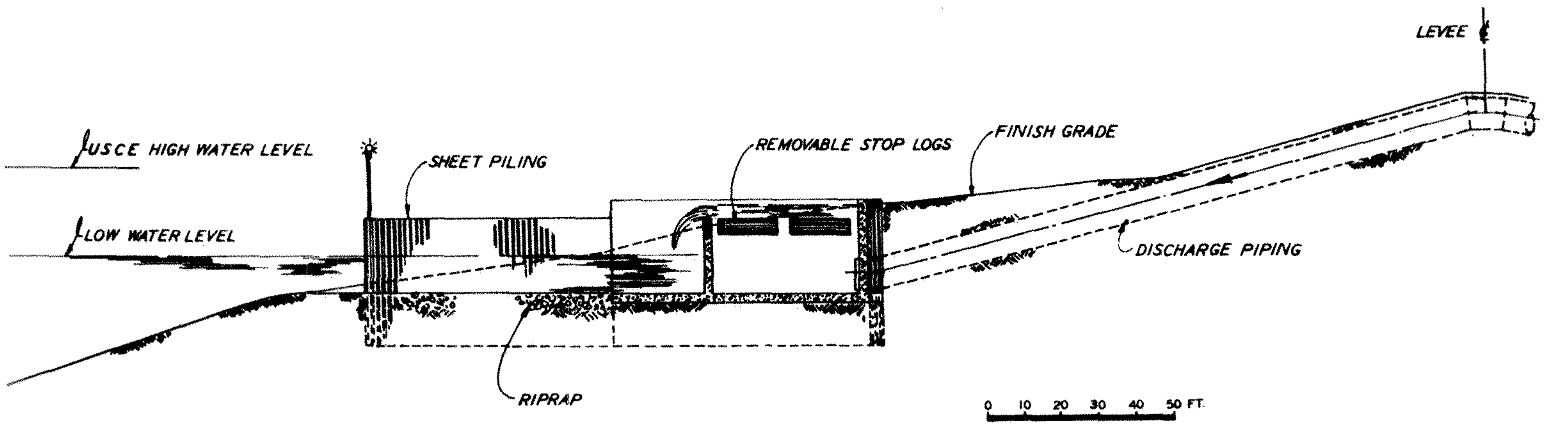

FIGURE III-6. SCHEMATIC VIEW OF THE DISCHARGE SYSTEM OUTFALL STRUCTURE

b. Cooling Towers - Component Cooling Water System

The Applicant, by means of a recent amendment to the Waterford application, has committed to installation of small dry and wet cooling towers within the nuclear plant island structure as a part of the Component Cooling Water System (CCWS) for the purpose of removing heat from the reactor coolant and the reactor auxiliary systems, and for the emergency shutdown following a loss-of-coolant accident (LOCA).

The dry cooling tower system is designed for the removal of approximately 80 x 10^6 BTU/hr following a LOCA. During normal operation, the dry tower system will also be used to remove heat from CCWS. Normal dry tower loads are expected to be reduced from those seen during LOCA. Immediately following LOCA, the wet tower system will come into operation to assist the dry towers in providing the necessary capacity to remove the higher heat loads resulting from the LOCA. Under LOCA conditions, the wet towers may operate for 2-3 days until the post-LOCA heat load has been reduced to levels that can be handled by the dry tower system.

Although the towers are related to emergency shutdown operations and component cooling, the Staff reviewed their operation from an environmental impact viewpoint which is discussed in Chapter V. A detailed description and discussion of the CCWS and related safety considerations is given in the Commission's Safety Evaluation.

2. Radioactive Wastes

In the operation of the Plant, radioactive material will be produced by fission and by neutron activation reactions of metals and other material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes will enter the Plant streams but will be processed within the Plant to minimize the radioactive nuclides that will ultimately be released to the atmosphere and into the Mississippi River. The radioactive material that may be released during operation of the Plant will be in accordance with the Commission's regulations as set forth in 10 CFR Part 20 and 10 CFR Part 50.

The waste treatment systems described in the following paragraphs are designed to collect and process the gaseous, liquid, and solid waste which might contain radioactive materials.

a. Liquid Waste

The liquid radioactive waste treatment system is designed to collect, process, monitor, and dispose of radioactive liquid wastes. The liquid waste treatment system will be divided into three main parts: the boron management system, the liquid waste management system and the laundry waste system. The interrelations of these systems and their interaction with other components of the Plant are shown in Figure III-7.

The boron management system will process excess liquid from the chemical and volume control system (shim bleed) and reactor coolant liquid from controlled leakoffs from equipment inside the containment building collected in the reactor drain tank and equipment drain tank (clean waste). The shim bleed activity will be equivalent to that of the primary coolant after it has passed through a mixed-bed demineralizer. The liquid from the shim bleed, reactor drain tank, and equipment drain tank will first enter a flash tank and will then be sent to one of four hold-up tanks at an estimated rate of 780,000 gal/yr (17 days decay during tank filling). It will then be filtered, passed through a mixed-bed demineralizer, and sent to one of two boric acid evaporators. The condensate from the evaporator will be passed through an anion exchanger and collected in one of two condensate tanks (6 days decay during tank filling). The liquid in these tanks will then be reused as primary makeup water or released into the discharge canal. In the Staff evaluation of the liquid radioactive waste treatment system it was assumed that one primary coolant volume will be discharged annually. The evaporator bottoms (concentrated residue containing boric acid) will be sent to the chemical and volume control system for reuse or disposed of as solid radioactive waste together with spent resins and used filter cartridges.

The discharges from floor, equipment, decontamination, and laboratory drains and sumps (dirty waste) and radioactive steam generator blowdown will be processed in the liquid waste management system. The liquids will be collected in one of two waste tanks and the steam generator blowdown tank at a rate of about 4,400,000 gal/yr. The liquid will then be filtered and processed through the waste evaporator (20 gpm), collected in one of two waste condensate tanks (1 day decay during tank filling), and discharged into the discharge canal. The evaporator bottoms (concentrates) will be disposed of as solid radioactive waste.

The laundry wastes will be collected in one of two laundry waste tanks at an estimated rate of 86,700 gal/yr. These wastes will

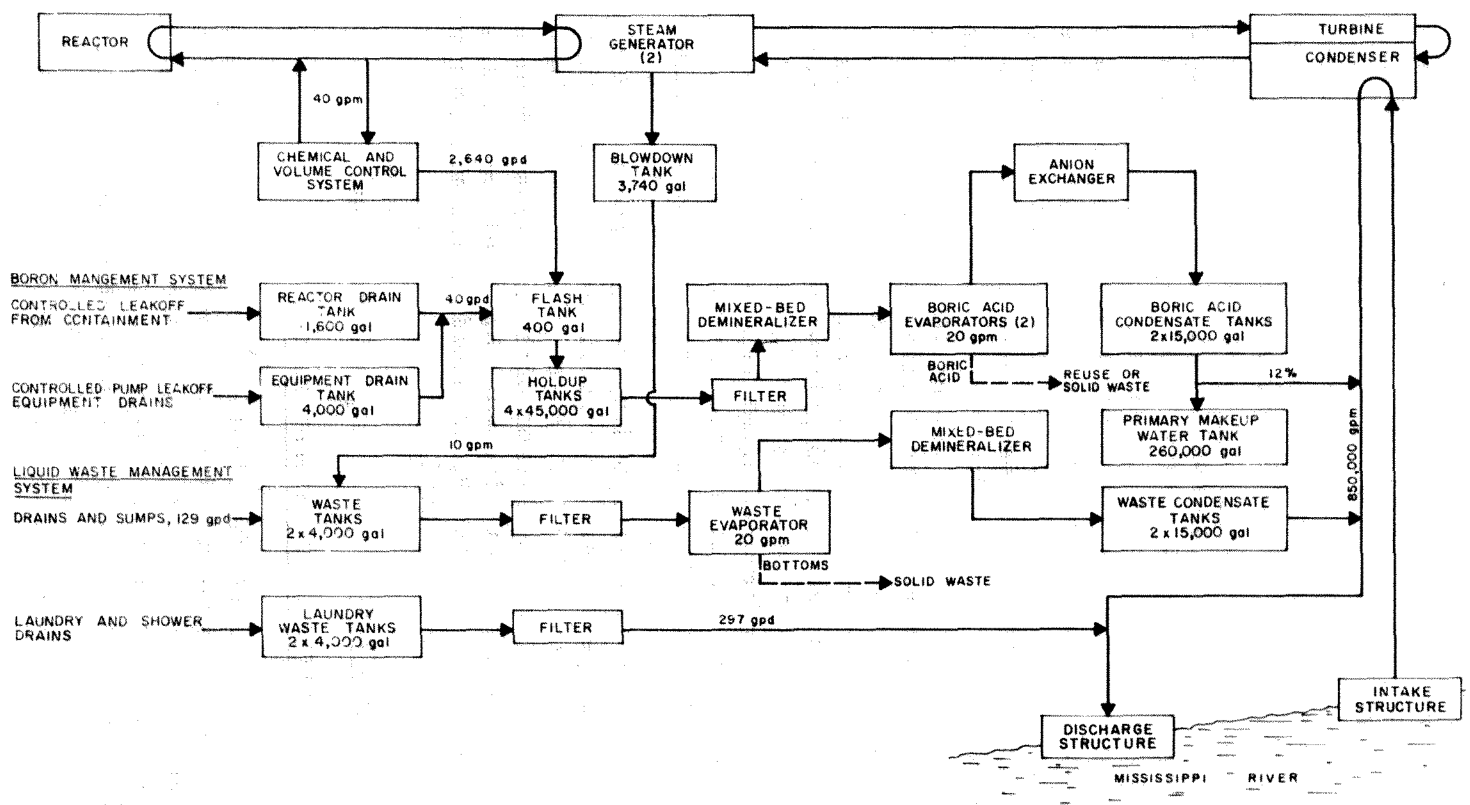

FIGURE III-7. LIQUID RADIOACTIVE WASTE SYSTEMS normally be filtered and discharged to the circulating water canal. However, the capability will be provided to recycle laundry wastes through the liquid waste management system if the activity of the laundry waste tank is above a predetermined level. In the Staff evaluation, it was assumed 100% discharge without treatment. There will be some leakage from the secondary loops to the turbine area which will also be released untreated.

Annual releases of fission product radionuclides from the Plant were calculated based on reactor operation at 3560 MWt (maximum power) for 295 full power days with 0.25% of the operating power fission product source term. Corrosion product activities were based on operating experience with pressurized water reactors. Based on the assumptions shown in Table III-1, the annual releases of radioactive materials in the liquid waste were calculated to be less than 1 Ci/yr (excluding tritium). However, to compensate for treatment equipment downtime and expected operational occurrences, the values shown in Table III-2 have been normalized upward, in direct proportion, to 5 Ci/yr. Based on experience at operating reactors, the Staff estimates that about 1,000 Ci/yr of tritium will be released to the environment. Based on an 850,000 gallon per day discharge of water (Fig. III-7) and an average annual tritium release of 1000 Ci per year, the resulting concentration of tritium in that volume of water is slightly less than 600 picocuries per liter. The numerical limiting condition for average annual tritium concentration prior to dilution in a natural body of water set forth in proposed Appendix I to 10 CFR 50 corresponding to the Waterford 3 conditions is 5000 picocuries per liter. The Applicant estimates that 0.05 Ci/yr of radionuclides and 310 Ci of tritium will be released to the environment in the liquid operation effluent. The radiological evaluation of the plant operation and the resulting effect on the environment, given in Chapter V, is based on the radioactivity releases calculated by the Staff.

b. Gaseous Waste

(1) Effluent Treatment System

During power operation of the Plant, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor, and particulate material including both fission products and activated corrosion products.

TABLE III-1

PRINCIPAL ASSUMPTIONS USED IN EVALUATION OF WATERFORD UNIT 3 (Augmented Radiological Waste System)

1.	Design Thermal Power	3560 MWt
2.	Plant Factor	0.80
3.	Failed Fuel	0.25%[a]
4.	Steam Generator Leak Rate	20 gal/day
5.	Steam Generator Blowdown Rate	4800 lb/hr
6.	Rate of Shim Bleed	1.5 gpm
7.	Containment Purge	4 times/yr
8.	Primary Coolant Degassed	2 times/yr
9.	Gas Decay Time	30 days
10.	Containment Leak Rate	40 gal/day
11.	Auxiliary Building Leak Rate	20 gal/day
12.	Partition Coefficients for Iodine:	
	Steam Generator Internal Partition	0.01
	Steam Generator Blowdown Vent	-0-
	Condenser Air Ejector[b]	0.000005
	Primary Coolant Leakage to Containment	0.01
	Primary Coolant Leakage to Auxiliary Bldg.	0.0005

13. Decontamination Factors:

	Anion	Cs, Rb	Other Cations
Mixed-bed demineralizer (Li_3-BO_3)	10	2	10
Mixed-bed demineralizer (H-OH)	100	2	100
Cation-bed demineralizer			
Anion-bed demineralizer (after evap.)	10	1	1
Horizontal evaporator	10	100	100

14. Removal factors:

Mo & Tc	100
Y	10

(a) This value is constant and corresponds to 0.25% of the operating power fission product source term.

(b) A mechanical water-sealed vacuum pump.

TABLE III-2

CALCULATED ANNUAL RELEASE OF RADIONUCLIDES IN THE LIQUID EFFLUENT FROM WATERFORD UNIT 3

Nuclide	Ci/yr	Nuclide	Ci/yr
Rb-86	0.0031	I-131	0.29
Sr-89	0.00013	I-132	0.0028
Sr-90	0.000005	I-133	0.12
Sr-91	0.000006	I-135	0.0068
Y-90	0.000065	Cs-134	1.6
Y-91m	0.000004	Cs-136	0.39
Y-91	0.017	Cs-137	1.3
Y-93	0.00001	Ba-137m	1.2
Zr-95	0.000022	Ba-140	0.00011
Zr-97	0.000001	La-140	0.0001
Nb-95	0.000024	Ce-141	0.000022
Nb-97m	0.0000009	Ce-143	0.0000023
Nb-97	0.0000009	Ce-144	0.000015
Mo-99	0.054	Pr-143	0.000015
Tc-99m	0.051	Pr-144	0.000015
Ru-103	0.000015	Nd-147	0.0000055
Ru-106	0.0000045	Pm-147	0.0000016
Rh-103m	0.000015	Np-239	0.000044
Rh-105	0.0000016	Cr-51	0.000078
Rh-106	0.0000045	Mn-54	0.000082
Sb-127	0.0000003	Mn-56	0.00000044
Te-125m	0.000012	Fe-55	0.00018
Te-127m	0.00011	Fe-59	0.000092
Te-127	0.00011	Co-58	0.0025
Te-129m	0.00097	Co-60	0.000082
Te-129	0.00062		
Te-131m	0.00011	TOTAL	∿5 (excluding tritium)
Te-131	0.000021		
Te-132	0.0027		
I-130	0.00027		

Tritium ∿1,000 Ci/yr

The systems for the processing of radioactive gaseous waste and ventilation paths are shown schematically in Figure III-8. The primary source of gaseous radioactive waste will be from the degassing of the primary coolant during letdown of the cooling water into the various holding tanks. This is principally from the Boron Management System (BMS) flash tank, the exhaust of cover gas from equipment vents. Additional sources of gaseous waste activity include ventilation air released from the auxiliary building, fuel handling building and the open turbine area, off-gases from the steam generator blowdown tanks, venting of the mechanical air ejectors, and purging of the reactor containment building.

(2) Augmented Effluent Treatment System

Subsequent to the issuance of the Draft Statement, the applicant committed to augment the auxiliary building, the steam generator blowdown tank exhaust, off-gas from the condenser, and the reactor containment purge treatment subsystems in order to reduce the radioiodine releases. The discharge from the auxiliary building will be released to the plant vent through prefilters, HEPA, and charcoal filters in series. The steam generator blowdown tank will be vented to the main condenser. Off-gas from the main condenser is vented through a charcoal filter to the plant vent. The reactor containment atmosphere will be purged through roughing, HEPA, and charcoal filters before discharge to the plant vent. These augmented gaseous treatment systems reduce the iodine releases from the plant to approximately 0.16 Ci/yr. The annual release of radioactive materials in the gaseous effluent, calculated by the Staff, as a result of the Augmented System is shown in Table III-3. Modified assumptions used in evaluating the augmented system are given in Table III-1. The total noble gas release is approximately 4722 Ci per year and the release of the I-131 and I-133 nuclides is about 0.16 Ci per year. The evaluation of the system considered operation of the reactor with 0.25% operating power fission product source term and a 20 gal/day primary-to-secondary system leak rate. Calculated releases from the gas storage tanks were based on a holdup time of 30 days. The Applicant estimates that about 2261 Ci of noble gases and .025 Ci of I-131 and I-133 will be released to the environment annually in the gaseous effluents. The difference in this estimate by the Applicant and the Staff estimate of 0.16 Ci per year is due to the differing assumptions in failed fuel and iodine partitioning factors.

Most of the gaseous radioactivity received by the gaseous waste disposal system will be from the degassing of the primary coolant

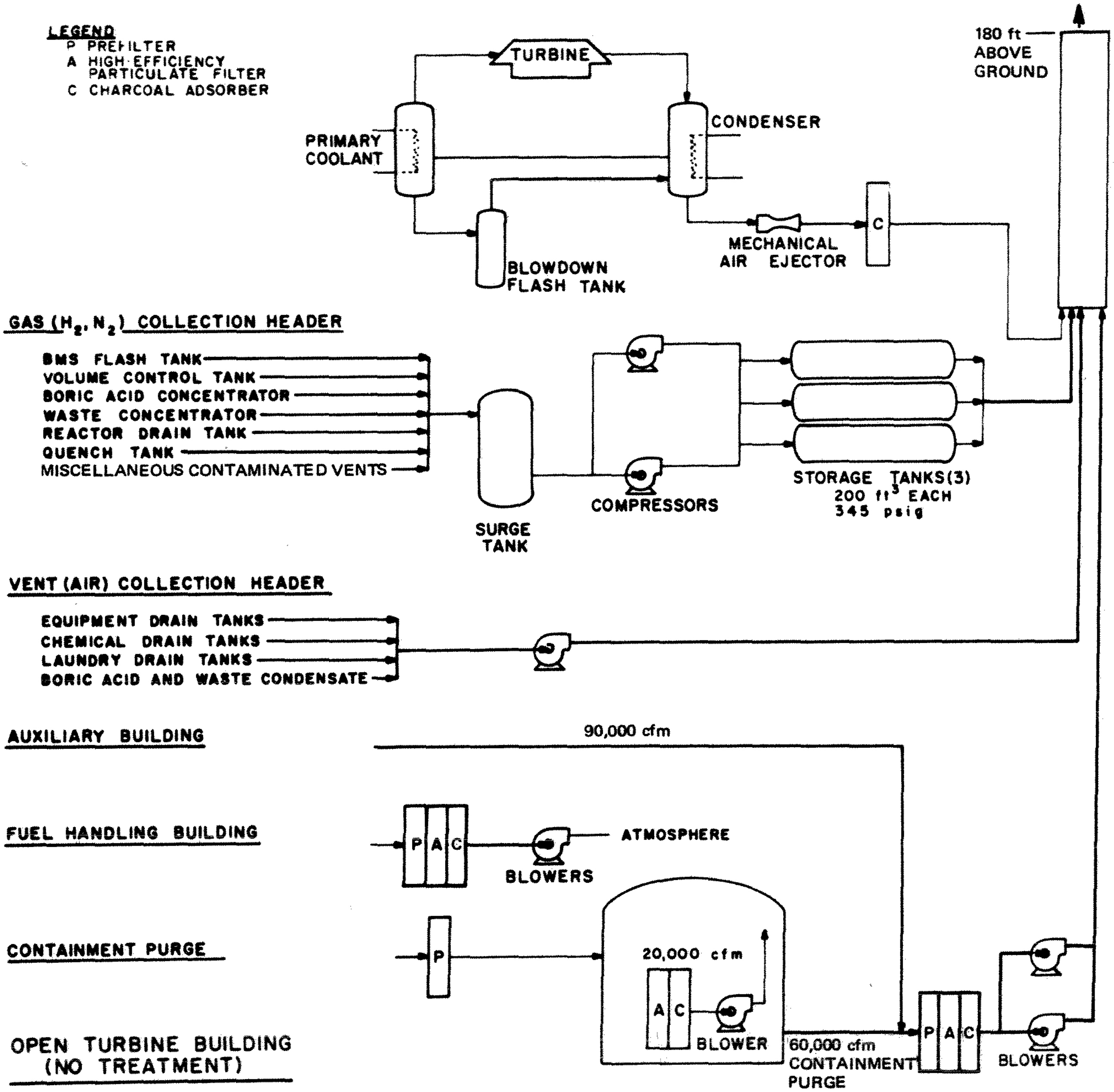

FIGURE III-8. GASEOUS WASTE DISPOSAL AND VENTILATION SYSTEM (AUGMENTED)

TABLE III-3

CALCULATED ANNUAL RELEASE OF RADIOACTIVE GASES FROM WATERFORD UNIT 3
(Augmented Radiological Waste System)
(ci/yr)

Isotope	Auxiliary Bldg.	Containment Purge	Gas Processing System Degassification (30 Days Decay)	Steam Generator Leak: Blowdown Tank	Steam Generator Leak: Air Ejector	Steam Generator Leak: Turbine Area	Total
Kr-83m	1	--	--	--	1	--	2
Kr-85m	7	--	--	--	7	--	14
Kr-85	7	14	960	--	7	--	988
Kr-87	4	--	--	--	4	--	8
Kr-88	13	--	--	--	13	--	26
Kr-89	--	--	--	--	--	--	--
Xe-131m	7	3	85	--	7	--	102
Xe-133m	14	1	--	--	14	--	29
Xe-133	1100	190	1090	--	1120	--	3500
Xe-135m	1	--	--	--	1	--	2
Xe-135	21	--	--	--	22	--	43
Xe-137	1	--	--	--	1	--	2
Xe-138	3	--	--	--	3	--	6
Total: Noble Gases	∿1180	∿208	∿2135	--	∿1200	--	∿4722
I-131	∿0.012	∿0.0042 (a)	--	--	∿0.0031	∿0.09	∿0.11
I-133	∿0.013	∿0.001 (a)	--	--	∿0.0013	∿0.04	∿0.05

(a) With airborne radioactivity removal system operating 10 hours prior to purge.

during letdown of the cooling water into the various holdup tanks and from the BMS flash tank. These gases will be collected in the gas collection header and will flow through one of two waste gas compressors to one of three gas storage tanks where the gas will be held up for radioactive decay. The control arrangement is such that only one tank may be filled at a time. In the Staff evaluation, it is assumed that all gas held in the storage tanks will be discharged to the atmosphere. Based on the Staff's evaluation, it appears that the gaseous waste disposal system has sufficient capacity to permit a holdup time of at least 30 days. The gas released from the storage tanks will be combined with the gases from the aerated vent collection header and ventilation air exhausted from the auxiliary building, all discharging to the atmosphere through the unit vent.

The ventilation systems for the auxiliary building and fuel handling building have been designed to ensure that air flow is from areas of low potential to areas having a greater potential for accidental release of airborne radioactive material. The exhausts of these buildings will be filtered by prefilters and High Efficiency Particulate Air (HEPA) filters and charcoal filters in series, with the discharges from the auxiliary building released to the atmosphere through the plant vent. The discharge from the fuel handling building after passing the HEPA filters will be directly to the atmosphere. During periods when fuel handling operations are underway, the effluent from the fuel handling building will also be passed through charcoal filters.

Off-gas from the condenser air ejectors will be filtered by HEPA and charcoal filters before release through the Plant vent. The steam generator blowdown tank will be diverted to the main condenser and passed through charcoal filters prior to venting to the atmosphere. Because of the open turbine building, steam system leakage which may occur in the turbines and/or ancillary equipment will be released directly to the atmosphere.

Radioactive gases may be released inside the reactor containment building when components of the primary system are opened to the building atmosphere for operational reasons or when minor leaks occur in the primary system. The reactor containment atmosphere can be purged through roughing, HEPA and charcoal filters and discharged to the Plant vent. Prior to purging, the containment airborne radioactivity removal system can reduce the iodine and particulate activity by recirculating the containment atmosphere through HEPA filters and charcoal adsorbers. In the Staff evaluation, it was assumed that the airborne radioactivity removal system would be operated for 10 hours prior to purging the containment.

c. Solid Waste

Four types of solid wastes will be packaged for offsite disposal. Dry wastes will be compacted in 55-gallon drums. Spent filter cartridges will be packaged in shielded drums. Evaporator wastes will be pumped directly from the concentrated waste storage or concentrated boric acid tanks into the solidification mixture contained in drums. Resins from the spent resin tank will be discharged to a shielded shipping container.

All solid waste will be packaged and shipped to a licensed burial site in accordance with AEC and Department of Transportation (DOT) regulations. Based on plants presently in operation, it is expected that approximately 235 drums of spent resin filters, flocculation wastes and evaporator bottoms will be stored per year. The Staff estimates that each drum will contain about 21 Ci after 180 days decay. In addition, it is expected that 600 drums/yr of dry waste containing less than 5 Ci/yr will also be transported offsite.

3. Chemical and Sanitary Wastes

a. Reactor Coolant Chemicals

Small quantities of boron are discharged from the Boron Management System into the circulating water discharge; about 9 lb of boron per year will be released. The concentration of boron in the condensate from the boric acid evaporator will be 0-0.3 ppm before dilution in the circulating water system; the dilution factor there will be a minimum of 20,000 so the boron concentration will be less than 2×10^{-5} ppm at the discharge point. Waste effluent volumes and chemical concentrations are given in Table III-4

Steam generator blowdown will release secondary water which contains a small quantity of hydrazine (used in the Plant for dissolved oxygen removal). The secondary water will be diluted in and discharged with the circulating water and the estimated hydrazine concentration in the circulating water will be 1×10^{-6} ppm. The annual hydrazine release will be about 4 lb.

Other chemicals which the Applicant plans to discharge from the secondary system include ammonia (for pH control) and sodium phosphate (a metal surface conditioner); the former is released from feedwater drains and sodium phosphate is released by leaks in the closed cooling water system and the discharge of cleaning solutions. The estimated concentrations of these chemicals and the volume of wastewater discharged are given in Table III-4.

TABLE III-4

CHEMICAL WASTE DISCHARGE SUMMARY

Water Type	Source	Quantity (gals/yr)	Chemical Content	Estimated Average Concentration Prior To Dilution (ppm or %)	Released To	Estimated Average Concentration After Dilution[b] (ppm)
Reactor Coolant[c]	Boron Management System	780,000[a]	Boron	0.3	Circulating Water	4.0×10^{-7}[k]
Nonrecoverable Water	Waste Management System	200,000	Detergent, Dirt[i]	1	Circulating Water	4.0×10^{-7}[k]
Detergent Waste	Laundry, Showers	86,700	Detergent, Dirt	10	Circulating Water	1.7×10^{-6}[k]
Blowdown[d]	Steam Generator	44,000	Hydrazine	0.05	Circulating Water	4.3×10^{-9}
			Ammonia	0-1		8.6×10^{-8}
			Sodium Phosphate	25		2.2×10^{-6}
Turbine Building Drains	Feedwater Drains	60,000	Hydrazine	0.05	Circulating Water	5.9×10^{-9}
			Ammonia	0-1		1.2×10^{-7}
			Sodium Phosphate	25		2.9×10^{-6}
	Floor Drains[e]	67,000	Detergent, Dirt[i]	0.1	Circulating Water	1.3×10^{-8}
Regenerative Solutions	Makeup Demineralizer	4,000,000	Sodium Hydroxide	0-4%	Waste Collection Basin[h]	0.35[j]
			Sulfuric Acid	0-4%		
Pretreatment Plant Wash Water	Pretreatment System	65,000,000	Polyelectrolyte	0-1	Circulating Water	1.3×10^{-4}
			Residual Chlorine	0-0.1		1.3×10^{-5}
Sanitary	Sewage Treatment System	2,200,000	Residual Chlorine	0-0.5	Waste Collection Basin[h]	2.15×10^{-6}
Chemical Cleaning Solutions[f]	Secondary System[g]	900,000	Phosphate	0-5000	Waste Collection Basin[h]	

(a) Due to fuel burnup and hot and cold shutdowns.
(b) Normal circulating water flow is approximately 970,000 gpm.
(c) Normally condensate from boric acid concentrator will be reused.
(d) Estimated at 5 GPH to maintain water chemistry without leaks in steam generator.
(e) Includes leakage from turbine closed cooling water system.
(f) Chemical cleaning occurs only during initial startup.
(g) Volume of secondary system is approximately 300,000 gallons.
(h) Releases to the waste collection basin eventually go to the circulating water.
(i) Trace quantities of chromates would be present only if there is leakage from closed cooling water systems.
(j) Consists of neutralization products (calcium sulfate, calcium chloride, magnesium sulfate, magnesium chloride, sodium sulfate, sodium chloride).
(k) Average annual basis; the more probable release on a batch basis would result in short duration concentrations about two orders of magnitude greater.

The Applicant will discharge the solutions, in mixture with the circulating water, into the Mississippi River.[3]

b. Water Treatment Wastes

Disposal Procedure

Wastes from the water treatment[2] will consist mainly of spent demineralizer regenerant solution and filter backwashes. The demineralizer regenerants consist of 4% sodium hydroxide solutions and 4% sulfuric acid solutions. Subsequent to issuance of the Draft Environmental Statement, the applicant has modified the water treatment waste system to provide for neutralization of the sulfuric acid and sodium hydroxide solutions in a neutralization facility within the area of the plant structures.[3] From there, the waste could be recycled to the waste collection basin for further treatment, if required or discharged directly to the discharge canal, mixed with the circulating water and discharged to the Mississippi River. This procedure is schematically shown in Figure III-9. Effluent volumes and chemical concentrations are given in Table III-4.

c. Closed Cooling Water Loops

No significant chemical discharges from closed-cooling water loops are anticipated. Any such wastes, as from a leakage, would be evaporated and the concentrates pumped to a drumming station for solidification and subsequent offsite disposal.

d. Condenser Cooling System Output

The Applicant plans to use occasional chlorination to control algae buildup and other fouling in the condenser tubes only if the water conditions and fouling rates require it.

The heavy silt load in the lower Mississippi River is expected aid significantly in the scouring of the condenser tubes and materially reduce fouling by nuisance organisms. Because of this aid, an injection of hypochlorite solution will be made into the circulating water system for short periods of no more than 30 minutes per day. Based on the experience of needed chlorination at the Little Gypsy plant directly across the river

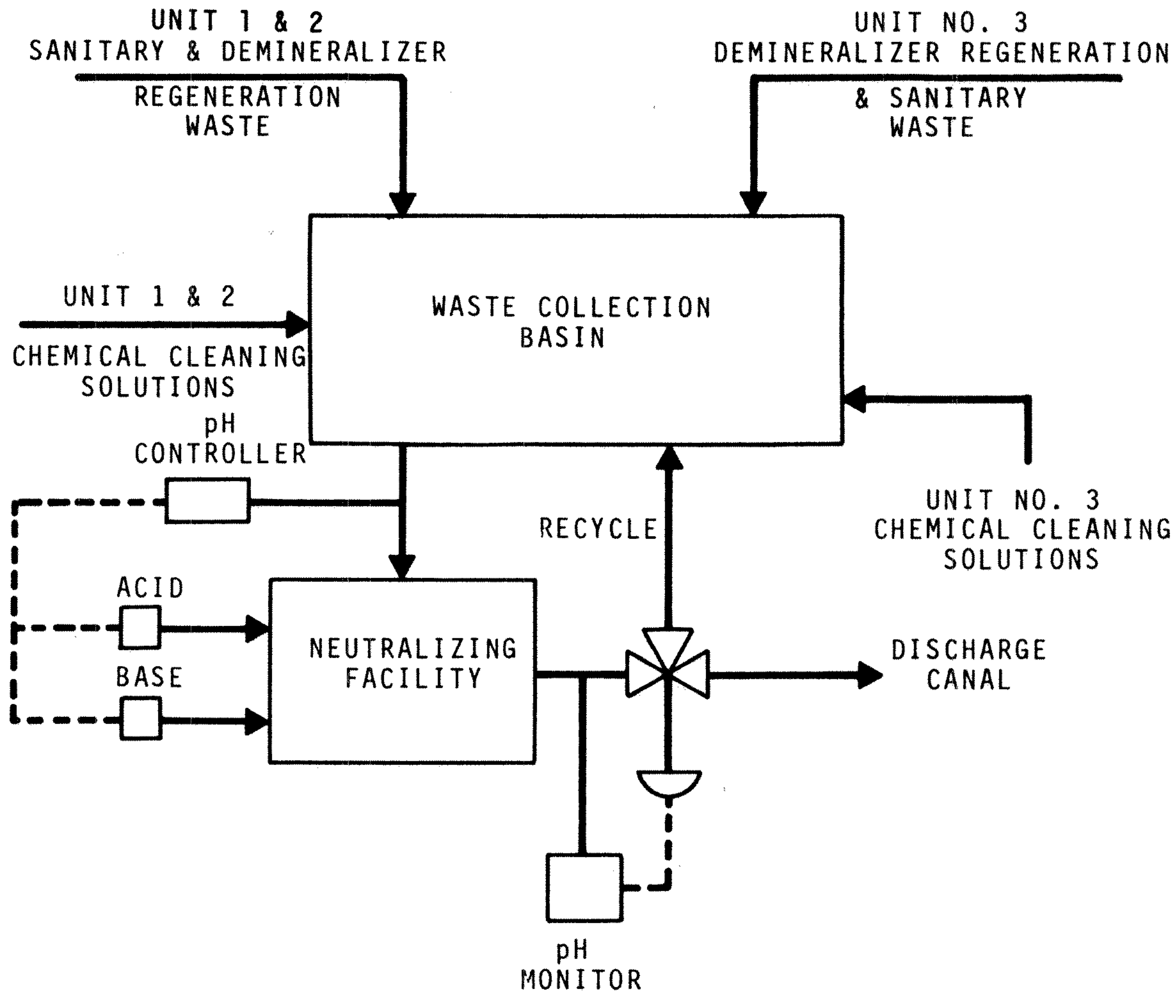

FIGURE III-9 WASTE TREATMENT FACILITY

from the Waterford site (3 to 6 times per year), the Staff believes that the chlorination required for Waterford 3 will be similarly infrequent.

The Applicant has further stated[3] that during the intermittent periods of 30 minutes when chlorine will be injected, the residual chlorine at the condenser outlet will be controlled so that the concentration will be less than 0.1 ppm. The resulting concentration in the Mississippi River will be much less than that value and will persist for a very short time.

e. Laboratory and Decontamination Solutions

Nonrecoverable waste from dirty liquid, auxiliary building sumps, and auxiliary cooling systems will be concentrated and the concentrates from the evaporator will be pumped to a drumming station for solidification and offsite disposal. The condensate will be demineralized and sampled prior to release to the circulating water discharge. The total solids concentration in the condensate before release is expected to be less than 1 ppm.

Laundry wastes will be sampled and filtered before release to the circulating water discharge. The Applicant anticipates that approximately 200 lb of biodegradable detergent will be released annually at a concentration of 10 ppm before dilution in the circulating water.

f. Sanitary Wastes

Sanitary wastes of about 6000 gal/day will be routed by subsurface pipe to a packaged sewage treatment plant. Treatment will consist of biological oxidation by the extended-aeration activated sludge process. This system makes it possible to transform raw sewage into stable, odorless, and relatively clear liquids which will be discharged to the field drains. The normal operational efficiency of such a system is above 80% removal of the biochemical oxygen demand (BOD) and 85% removal of suspended solids. The effluent from the packaged treatment plant will be chlorinated to destroy any harmful bacteria that might be present.

g. Summary of Modified Chemical Waste Disposal System

The Applicant plans to modify the chemical waste disposal system as initially planned to divert all waste water to the circulating water discharge canal and thence to the Mississippi River. As described in the preceding paragraphs, the modifications eliminate the stabilization pond which was to have discharged waste water to the 40-Arpent Canal, the 80-Arpent Canal and Lac des Allemands. Demineralizer regeneration wastes, treated sanitary waste water and cleaning solutions, in the modified procedure, will be collected and neutralized prior to disposal, as illustrated in Figure III-9.

4. Other Wastes

There is expected to be no release of combustion products to the atmosphere in the normal operation of the Plant.

This unit will, however, have two 3,500 kW diesel generating units associated with it as part of an emergency generating system. Each diesel, operating at full capacity, will require approximately 540 lb of low sulfur content diesel fuel per hour. The sulfur content of the diesel fuel oil will be approximately 0.17 percent. Table III-5 indicates the combustion products normally released per pound of fuel consumed.

TABLE III-5

PRINCIPAL COMBUSTION PRODUCTS FROM EMERGENCY SYSTEM DIESEL GENERATING UNITS

Combustion Product	Grams/lb Fuel
Carbon Monoxide, CO	11.42
Nitrogen Oxide, NO_x	17.17
Hydrocarbons	4.13
Particulates	0.60
Aldehydes	0.58

REFERENCES

1. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit No. 3, Environmental Report, Supplement 1, Docket No. 50-382, July 26, 1972.

2. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit No. 3, Environmental Report, Supplement 1, Docket No. 50-382, July 26, 1972.

3. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit No. 3, Environmental Report, Supplement 3, Docket No. 50-382, December 15, 1972.

IV. ENVIRONMENTAL IMPACT OF SITE PREPARATION AND PLANT CONSTRUCTION

A. SUMMARY OF PLANS AND SCHEDULES

Site preparation for the Waterford Station Unit 3 began in the spring of 1972. By summer about 50 acres had been modified and excavation was underway for the major structures.

The Applicant's revised application indicates end of construction by May 1977 with initial fuel loading projected shortly thereafter. Plant operation is scheduled for summer 1977.

B. LAND USE

1. The Site

A temporary road of approximately 1,000 ft will be built from State Road 18 into the construction site. The State Road will be elevated about 12 ft and shifted a few feet south of its present location for a 2,000-ft stretch in front of the Plant to accommodate the Plant's circulating water lines. The State of Louisiana Department of Highways has issued approval for this highway modification.

There will be a railroad spur of approximately 3,300 ft constructed from the Texas and Pacific line crossing the Site to the Plant area. The spur will become two tracks at the Plant area with one track to the fuel handling building and the other to the turbine area.

An excavation approximately 60 ft deep will be necessary to locate Plant foundations on Pleistocene clay and 700,000 cubic yards of earth will be removed for this. Some of the spoil will be used for raising grade for various structures around the nuclear unit (up to 3 1/2 feet) and surplus materials will be trucked offsite for use as land fill at suitable locations.

The Applicant plans to establish slopes related to the excavation at a 1 to 5 grade to eliminate cave-ins and reduce erosion.[1] The roads, parking and laydown areas will be surfaced and maintained to reduce dust. Suitable vegetation will be grown on slopes to reduce erosion and dusting.

Only the acreage affected by construction will be removed from its present use for sugar cane production. After construction is completed, the disturbed construction area will be regraded, seeded and landscaped with vegetation suitable for the Site.

The number of animals and birds that may be permanently displaced from the Waterford site due to the plant facilities, roads and other works of man (approximately 100 acres) can be roughly estimated by using the relative abundance data given in Appendix A, Table A-2. Accordingly, it might be reasonably expected to have about 200 or so dove and quail and a few tens of rabbit, snipe, miscellaneous insects and reptile species removed from their natural habitat. Once construction is complete, disturbed areas are restored by plantings, and the noise and traffic conditions which exist during any large construction effort such as building the Waterford Station are eliminated, it is expected that a reduction of animal life on the overall 3600 acres of the Waterford Steam Electric Station would be very small if any at all. The Staff believes that due to the general industrial characterization of the region around the Waterford site and the extensive portion of the Waterford site itself which will not be disturbed (about 3500 acres), construction activities will not appreciably disturb the local wildlife habitat.

The marshland and swamp on the site will not be disturbed by the construction of the nuclear plant. The Applicant states there are no present development plans for the marshland of the site and the major portion of it should remain largely unaffected by the construction of the Plant.

2. Transmission Lines

As indicated in Section III. B, the Applicant is constructing a new 23.5 mile cross-country transmission line for tie-in with Waterford 3. Modern methods emphasize the use of helicopters and marsh buggies in the transport and setting of towers and the stringing of cables. Such techniques minimize the impact of construction and maintenance of rights-of-way along the lines. The Applicant has further stated that the final routing of the right-of-way corridor for this transmission line will be made so as to maximize the use of natural screening to the greatest extent possible. At road and highway crossings in wooded areas, the transmission line towers will be set well back from roadside and offset from each other to preclude long "tunnel" views of the right-of-way. The selection of routing will be made to avoid interference with agricultural areas of any kind and, therefore, create no interference with farmers.

With respect to the clearing of the corridors for the transmission line (less than 300 acres), selective cutting will be utilized at primary road crossings. To the extent feasible, natural growth will be retained. Trees that are cut will have all limbs removed, the trees and limbs will be windrowed on one side of the corridor with special attention given to keeping the windrow to a reasonably low height (six to ten feet). Since nearly all of the right-of-way will traverse marsh and swamp land, experience has shown that within two or three years the cut trees will decay and deteriorate. Because of this, the Applicant states that no burning of felled trees and cleared brush will take place. The judicious use of basal sprays will be employed to retard regrowth of the trees that have been cut; however, the selection of sprays and herbicides to curtail brush and tree growth will be made to encourage growth of new species of plants which will be beneficial to deer, birds and other wildlife. The Applicant suggests that growth of new plants which attain heights of about two feet would be the most favorable. Due to the climatic conditions in the marsh and swamp lands, regrowth of grasses and other plant life is quite rapid.

Required access roads to the right-of-way corridor will be curvilinear to provide shielding of the lines from the public driving on the nearby highways. Special plantings will be made to further provide a shielding of view. The Applicant has stated that the Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic, and Recreational Values in the Design and Location of Rights-of-Way and Transmission Lines will be utilized.

Based on the Applicant's policy of routing transmission lines, to the extent feasible, in a manner to minimize interference with agricultural areas and populated areas, and to minimize routes along public highways, acceptable alternative routes for the 23.5 mile line from Waterford 3 to the Churchill Substation would also traverse uninhabited swamp and marsh lands. Accordingly, the Staff considers the planned routing of the Waterford 3 line to be the best alternative for an overhead transmission line.

C. WATER USE

During erection of the Plant, the foundation excavation will require extensive pumping to control water levels. In addition, the foundation stabilization work may involve the use of compaction methods using either sand drains or hydraulic placement of selected backfill. This combination of foundation construction activities would be expected to noticeably increase river turbidity in the immediate vicinity of the Site. Ordinary care in the use of stilling basins and related water quality conservation control methods would be expected to minimize all but the visual impact of the construction operation. Site work associated with the intake and discharge facilities will produce some local effects on the immediate areaa of the Mississippi River. A cofferdam approximately 80 by 100 ft will be sunk into the batture of the river a few feet from the bank. The intake and discharge canals will be excavated and lined with sheet pile. During this construction with perhaps excess mud and silt drainage into the river, an increase in the local river turbidity will be noticed, but the Staff believes that this will not affect the water quality of the Mississippi River significantly due to the use of the cofferdam and the large volume of the river.

Due to the long distance to the fresh water canals and to Lac des Allemands, an adequate opportunity will be afforded for the settling of mud from the water used in construction created by rainfall during construction that may have a tendency to drain in that direction from the site.

No effect on the water table is expected since no withdrawal or addition to groundwater is called for or planned.

D. SOCIAL IMPACT

Since the Plant is an addition to a site already set aside for electric power generation, there will be no further relocation of families or redistribution of population other than a few tenants living in houses on the Waterford site at the present time. These few houses will be removed and the tenants relocated when Unit 3 construction commences. The clearing of land for farming was done long ago so the present loss is that due to withdrawal of the sugar cane fields from production.

The closest residence is about 4,000 ft from the Site (across the river); residents there and the general public will be minimally affected by normal activities peculiar to the construction of the Waterford Station.

Sanitary wastes during the construction period will be treated in a Delta-Aer aerobic portable sewage treatment system with a 2000 gal/day capacity. The resulting solids will be trucked away for fertilizer manufacture or disposal and the solutions will be sent to the field drains.

The Applicant anticipated that the work force at the Waterford site will be at the highest levels during a two year period which occurs about 2-3 years following start-up of construction. Late in the second year of construction the manpower level is expected to be about 700 and increasing rapidly during the following year to a peak of approximately 1200 people. A decline in the number of construction workers to 600-700 will occur in subsequent years to a force of about 100 at the time construction is nearing completion.

It is expected that the local area, including the metropolitan New Orleans area, will provide nearly all of the work force. Workers not already residing in nearby communities are expected to be commuters and not create any burden on local housing, schools, or other community facilities. A small number of migrant workers who may reside in trailers are not expected to have any significant effect on the local environs. Vehicular traffic on State Highway 18 and the Luling and Reserve ferries will increase during the construction period; however, a new highway running through the Site, but outside the exclusion area, is scheduled for completion in early 1974 and will help to minimize this traffic increase. On balance, the population increase due to Waterford construction is not expected to result in a significant adverse impact, and will be temporary.

There will be an increased payroll of more than $70 million as a result of this construction activity. Sales tax to St. Charles Parish will be approximately $1,700,000. Various construction materials and services will be obtained locally, thus resulting in additional stimulation to the local economy.

The Applicant appears to have anticipated the normal social impacts that are a direct result of construction activities. The effects of excavation, disposal of debris, dust, noise and heavy equipment hazards will be generally confined to the Plant Site. Grading and landscaping will be done as needed for erosion control. Aesthetic quality of the Site will be enhanced by the planting of shrubs and grasses.

In summary, the Staff believes any adverse effect will not exceed that normally associated with construction of such a scope, that it will be temporary and will not remain upon completion of construction.

V. ENVIRONMENTAL IMPACT OF PLANT OPERATION

A. LAND USE

The land used by the Plant has been withdrawn from its recent agricultural use and all not required for buildings and related facilities will be returned thereto after construction has been completed and operation stabilized.

About 10 acres of land is planned for the neutralization and stabilization facility, although the Applicant may elect to neutralize the acid and base solutions concerned within the Plant. In view of the Staff judgment that the nonradiological chemical wastes be discharged into the Mississippi River, the stabilization facility may not be used insofar as Waterford 3 is concerned. In this case, the operation of Waterford 3 would result in no adverse impact on the 10 acres of land.

B. WATER USE

The Applicant has performed field studies in the mixing zone of the Little Gypsy plant and has conducted dye studies of the turbulence and lateral diffusion of conservative tracers on the Waterford Unit 3 bank of the river. The Applicant indicates that he has used the methods outlined by Edinger and Polk.[1] An artist's illustration of the Applicant's predicted steady state isothermal pattern in the two dimensional plan is presented in Figure V-1. The Applicant has supplemented this with a number of vertical two dimensional sections which are summarized in Figure V-2.

The Applicant has summarized his methodology in Appendix B of the Waterford Environmental Report and its supplements.[2] The Edinger and Polk method uses a solution of a three-dimensional diffusion function which requires field measured values or estimates of the vertical, longitudinal and lateral diffusion coefficients. The method assumes a Gaussian distribution in the vertical far field and for this reason adjustments to estimate the depth of the stratified upper layer are necessary in order to maintain continuity in the material and energy balance. The Applicant has illustrated relatively great depths of vertical penetration of the mixed effluent plume from each facility which appears to be at variance with his other statements[2] to the effect that the warmed upper layer would be confined to the upper 10 to 15 ft. In addition, the dye tests used by the Applicant on the Waterford shore are point source releases and have not, to the best knowledge of the Staff, been corrected for buoyancy and the effects of discharge momentum of the large volumetric releases. These in effect create a large virtual image, 100 ft or more in width, before longitudinal dispersion can be effective. As a special case, the releases

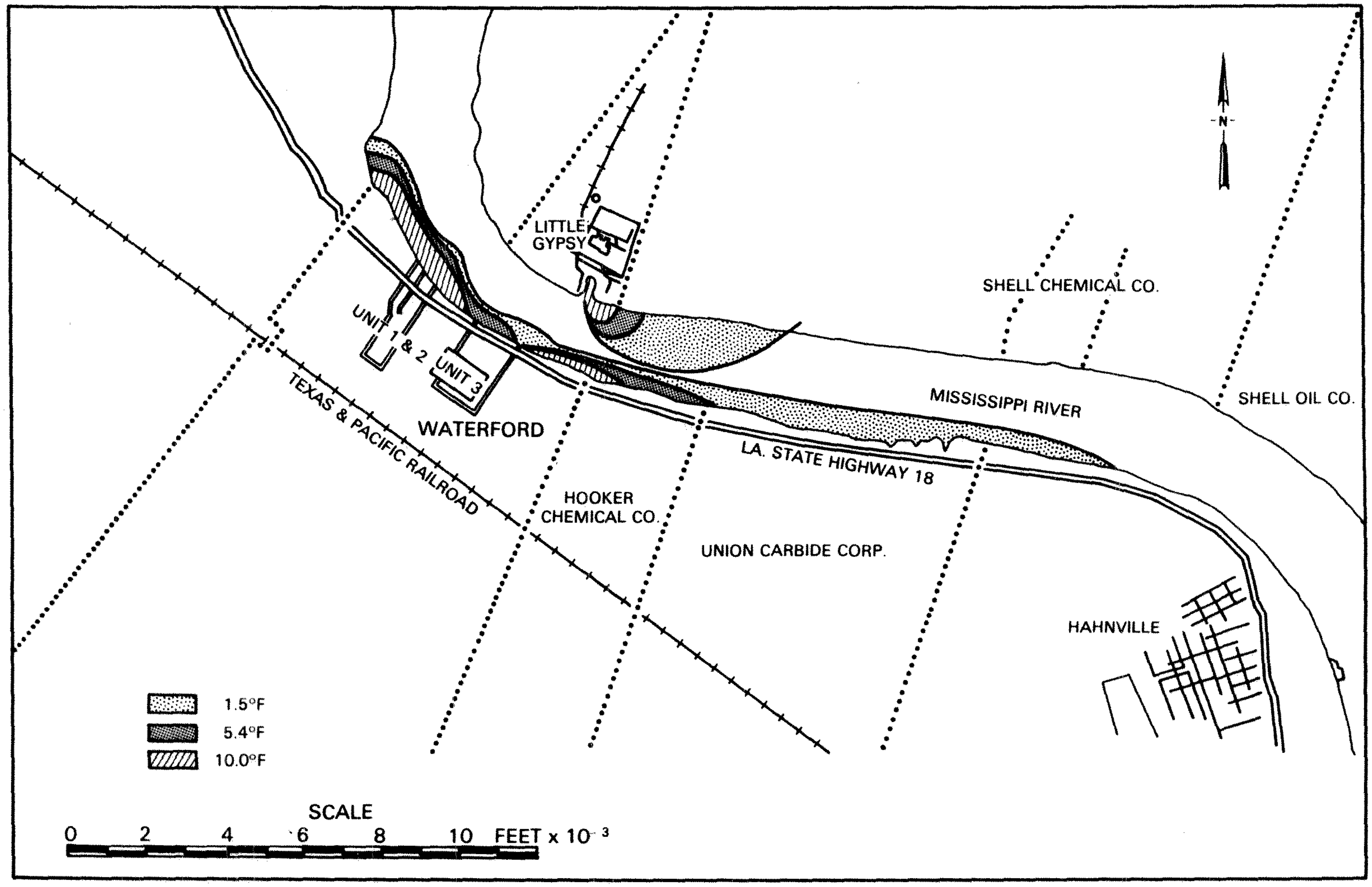

FIGURE V-1. TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE MISSISSIPPI RIVER AT THE WATERFORD SITE, RIVER FLOW 200,000 cfs, APPLICANT'S DATA, ALL PLANTS AT FULL POWER.

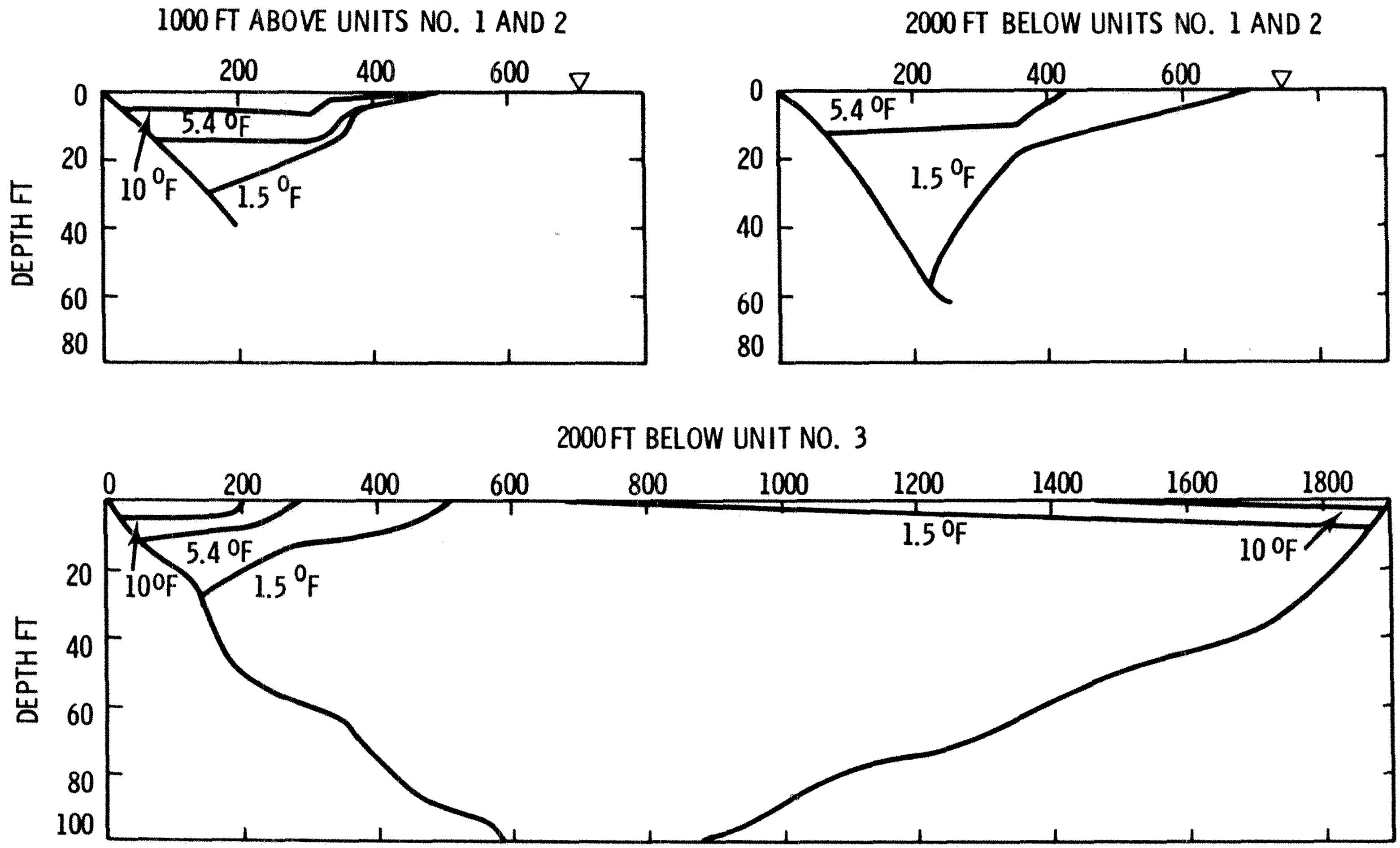

FIGURE V-2. VERTICAL PROFILES, TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE MISSISSIPPI RIVER AT THE WATERFORD SITE, RIVER FLOW 200,000 cfs, APPLICANT'S DATA, ALL PLANTS AT FULL POWER.

from the Little Gypsy plant as projected to the three unit operation at full power for a river flow of 200,000 cfs do not appear to relate the momentum mixing effects of the near field to the far field conditions which might be realistically expected. The effectiveness of surface heat transfer for any of the plume configurations will be dependent upon dilution; and, therefore, the validity of deliberate "floating" of the effluent for the purpose of prompt heat dissipation is questionable in view of the realities of the Waterford thermal dissipation situation.

The discharge structure proposed by the Applicant has a spill-over feature which slows down the velocity of the effluent discharge to accomplish the purpose of "floating" the discharge. The conditions suggest that better use of the hydraulic energy in the effluent would be made by introducing the effluent at relatively high velocity by eliminating the overflow weir and by permitting the effluent to flow directly from the structure using orifices or pipe friction to control vacuum in the inverted siphon.

As a result of the staff review, it was demonstrated that the original proposal had somewhat understated the size of the thermal plume and the surface areas associated within the near and far field. This has led to a modified design by the Applicant (see III-D-1) to reduce the terminal width of the discharge structure to 30 feet, which, at low flows of 200,000 cfs, has the effect of producing a discharge jet of about 7 feet per second using head available from the inverted siphon over the dike. As water levels increase, velocities will decrease, and at mean flows of about 590,000 cfs, the discharge velocity will be about 5 fps.

The effect of this higher discharge velocity is to greatly reduce the area of isotherms significantly above ambient, and essentially eliminate water temperature increments above 10° F in the mixing zone. A comparison of the areas enclosed in the thermal plume is shown in Table V-1.

Another effect of the modified design is to entrain the remaining thermal plume from Units 1 and 2 with the Unit 3 water and direct the mixed mass away from the bank to the more central portion of the river, where higher currents and better mixing occur. This substantially eliminates overlapping effects of the three plants on the right bank shallows below the Unit 3. Since Unit 3 intake pumphouse will have a curtain wall to restrict intake water flow from the deeper water, any tendency for warmed waters from Units 1 and 2 to enter 3 will be minimized.

Some potential navigation hazards introduced by the jetted discharge flow may be visualized. A number of other plants with discharges as high as 10 fps have been proposed for navigable waters of Delaware and Chesapeake Bay and no objection has been raised by transportation interests. Flow velocities in the area enclosed by the 9°F isotherm would be expected to average 4 fps at low water. Such velocities are routinely encountered around islands and water control structures on the navigable portions of the Columbia and Snake Rivers in areas heavily used for recreation purposes without incident. While the staff cannot overlook the potential possibility of upset of small unsafe watercraft with low freeboard, the overall risk is not considered to be greater than the routine hazard of small craft passing large vessels in the Mississippi on a routine basis.

The Applicant's new design model is based on work reported by Pritchard and Carter. One of the weaknesses of this is that it is essentially two-dimensional and requires judgment and the use of auxiliary relationships to estimate the depth of the plume. Other reviews[3] have revealed weaknesses associated with the inability to respond in detail to the densimetric Froude number of the entraining jet. The staff has considered these modeling problems and compared the results with other methods based on the laboratory work of Stolzenbach and Harleman[4] and developed an independent analysis applicable to rivers which is responsive to varying Froude numbers. The staff estimates of the size of the near field are sufficiently close to those of the Applicant to permit adoption of those values. However, in the far field (beyond 5,000 ft), the staff believes that the isotherm map previously presented by the staff in the draft Environmental Statement would be unaffected by the design change proposed by the applicant.

With due consideration of the strengths and weaknesses of the methods used by the Applicant, the Staff has evaluated the operational effects of the prototypical design using severak different models, including those cited above, as well as judgment factors. The Staff is in agreement with the Applicant's contention that the methods used for predicting the characteristics of the plume are only approximate and, because of the rapid change in the river current regime of the river, the adoption of any steady state solution is very transitory in value. The results of the Staff examination indicate isotherm fields which are shallower and more extended in length downstream than those initially predicted by the Applicant. A comparison of the Staff and Applicant calculations appears in Table V-1, and detailed drawings of the combined effects of the three facilities drawn to the same scale as the Applicant's submissions appear in Figures V-3 and V-4.

The differences result from the assumptions used to estimate the width of the plume and the extent of mixing and heat transfer in the effected

TABLE V-1

SURFACE AREAS WITHIN SELECTED ISOTHERMS FOR WATERFORD
Unit #3, RIVER FLOW AT 200,000 cfs

Isotherm of Temperature Rise °F	Maximum Offshore Extent (ft)			Surface Area (Acres)		
	Applicant Original	Staff Original	Revised Design	Applicant Original	Staff Original	Revised Design
10	215	300	620	9	15	5.5
5.4	295	800	1050	22	59	70
1.5	545	1100	1200	148	620	620

Isotherm of Temperature Rise °F	Maximum Distance Downstream (ft)			Stream Cross Section (Ft^2)		
	Applicant Original	Staff Original	Revised Design	Applicant Original	Staff Original	Revised Design
10	2600	1400	650	1200	4500	1500
5.4	4800	4500	3200	2300	7500	3600
1.5	15000	23000	23000	8400	25000	25000

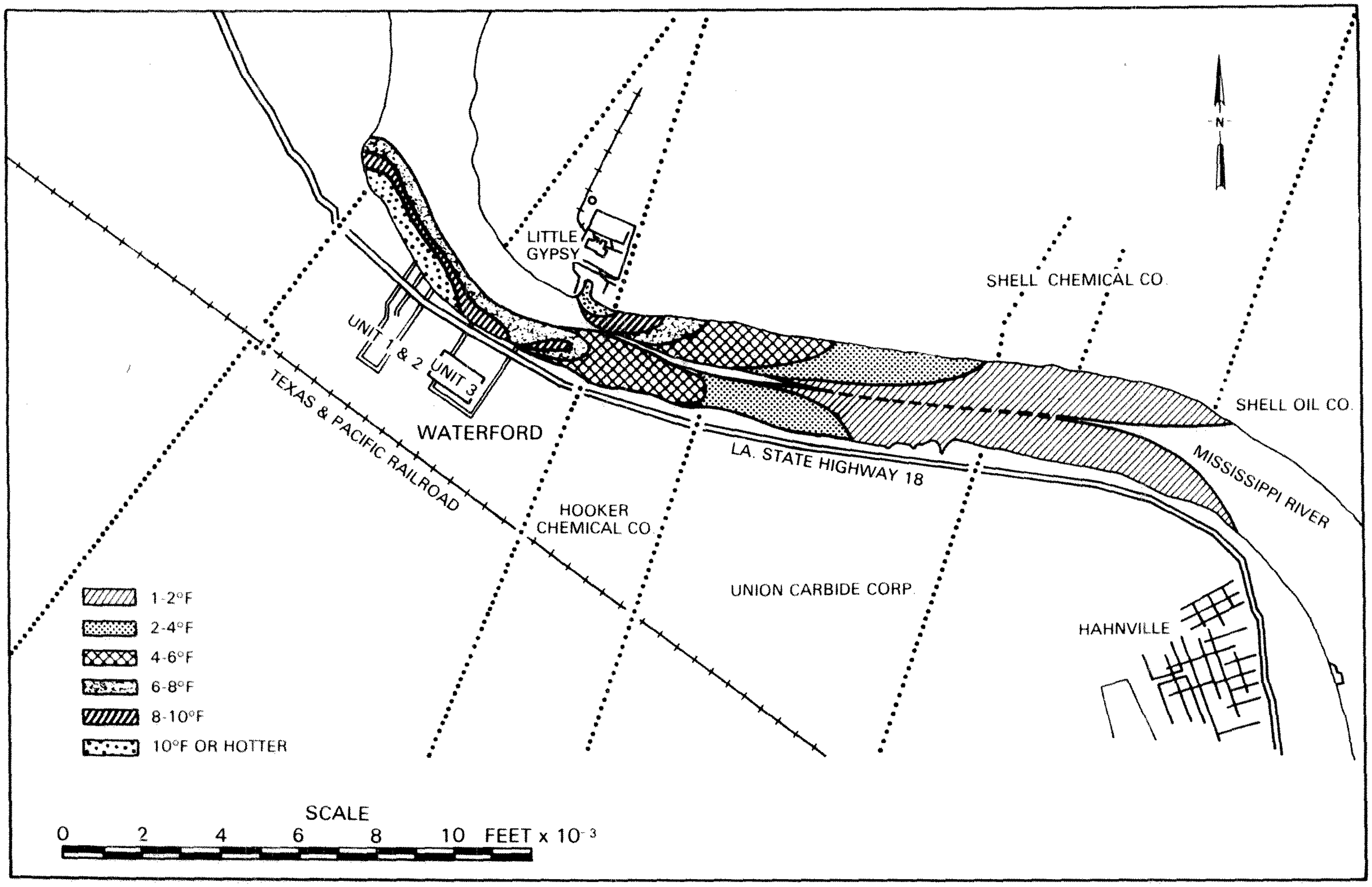

FIGURE V-3. TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE MISSISSIPPI RIVER AT THE WATERFORD SITE, RIVER FLOW 200,000 cfs, REVISED STAFF ESTIMATES, ALL PLANTS FULL POWER.

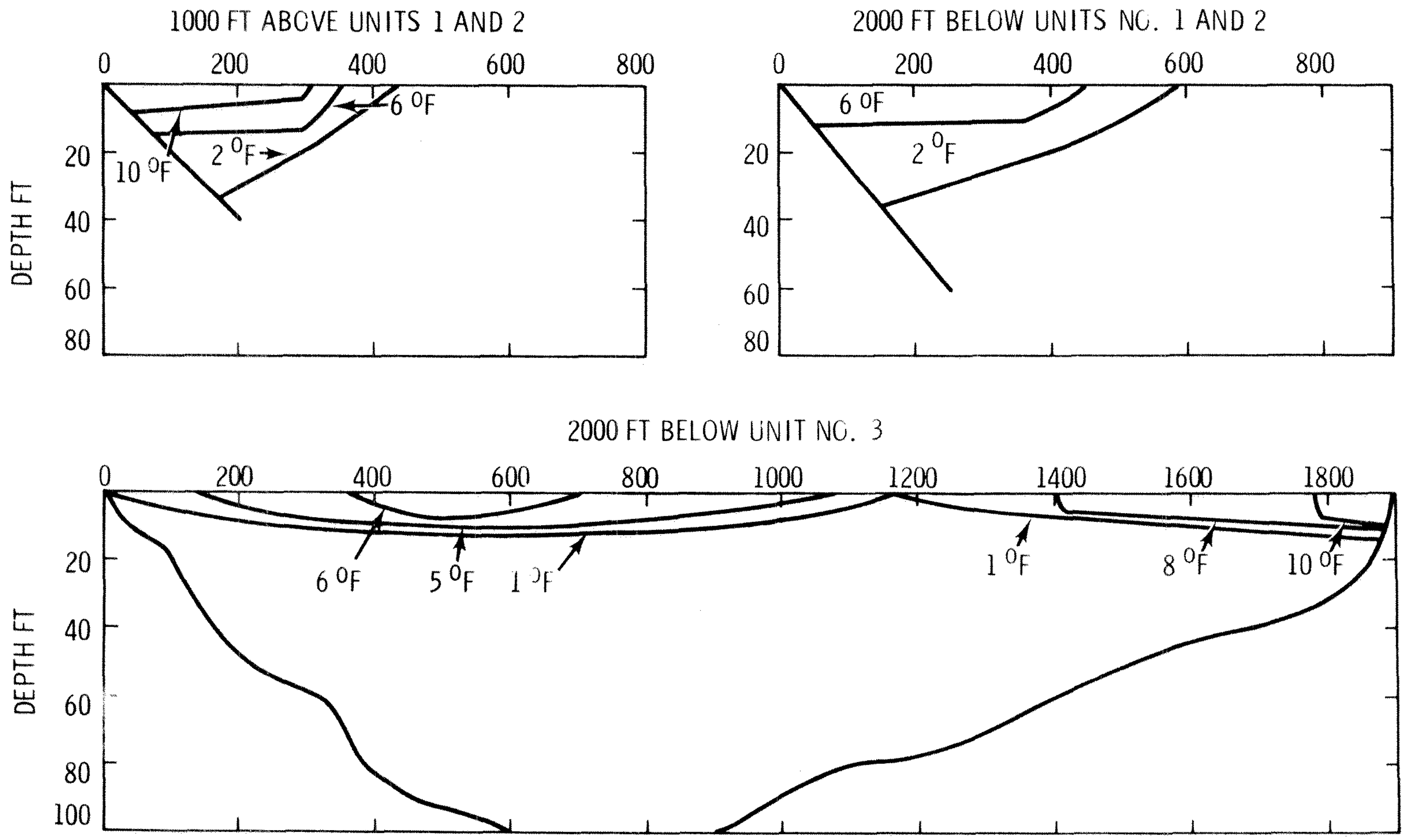

FIGURE V-4. VERTICAL PROFILES, TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE MISSISSIPPI RIVER AT THE WATERFORD SITE, RIVER FLOW 200,000 cfs, REVISED STAFF ESTIMATES, ALL PLANTS AT FULL POWER.

areas. It would not appear that these differences would produce substantive changes in conclusions regarding the effect on contacted organisms, but they could lead to a different interpretation as to the merits of alternative effluent system designs in terms of the areas and volumes of water in the various thermal fields.

A related problem is the question of the proximity of Waterford Units 1 and 2 to the intake of Unit 3. Based on the Applicant's tests in the vicinity of Waterford Units 1 and 2, the Staff predicts that extensive recycling of the warmed water from Units 1 and 2 through Unit 3 could occur. As stream velocities increase, at flows greater than 600,000 cfs, the recirculating tendency of the effluent introduced by Units 1 and 2 that can be expected at lower flows will tend to be reduced and the plume from the upstream units can be expected to hug the downstream shore similar to that for Unit 3. On this basis the staff estimates that water temperatures as high as 4°F above ambient (rather than only 2°F as estimated by the Applicant) might be swept into the Waterford Unit 3 intake. The proposed installation of a curtain[5] to confine intake to the lower depths would serve to minimize this effect; however, insufficient modeling of the effects of Units 1 and 2 under a wide variety of flow conditions has been performed to make an exact analysis. Therefore, the Staff study is based on judgment and points to the continued need for additional examination of the potential recirculation of effluent by the Applicant.

With these considerations as a base, Table V-2, prepared by the Staff, shows resulting river temperatures downstream of the Waterford facility for each month of the year. In each case an allowance for the effect of Waterford Units 1 and 2 is made and identified in the Table. All temperatures are for the upper 10 ft of water and, in the case of the far field of 2 miles or more, for a plume width of approximately 50% of the river. It should be noted in this regard, that the Staff estimate of the combined effects of Waterford Units 1, 2 and 3 and the Little Gypsy indicate that 100% of the stream width is affected to some extent to a depth of 10 ft at a distance of 3 miles below the Waterford Unit 3 site.

The originally proposed use of the 10-acre stabilization pond and neturalization basin with the drainage from them into Lac des Allemands would have a potential impact on water use that is separate from that associated with the Mississippi River. The substantial amounts of sulfate (about 500 lb/day) routed to the basin would remain largely as soluble salts in the water that overflows from it. Eventually this sulfate would have reached Lac Des Allemands. The concentrations of sulfates in the water of the canals leading to Lac Des Allemands would likely be in

TABLE V-2

MONTHLY MAXIMUM RIVER TEMPERATURES 100 ft FROM THE RIGHT BANK BELOW WATERFORD UNIT 3

Month	Anticipated Increment of Units 1 and 2 (°F)	Ambient River Maximums (°F)	Estimated Temperatures Below Unit 3 (°F) 1 Mile	2 Miles	3 Miles
Jan	2	50	57	54	53
Feb	2	50	57	54	53
Mar	2	56	63	60	59
Apr	2	63	72	69	68
May	3	78	87	84	83
Jun	4	83	95	90	89
Jul	2	87	94	91	90
Aug	2	90	98	94	93
Sep	2	87	94	91	90
Oct	2	78	86	83	82
Nov	3	71	79	77	76
Dec.	2	57	64	62	61

the range of 50 to 100 mg/liter (including the natural sulfate content and that added from Waterford Units 1 and 2) which is well within drinking water standards.[6] Nevertheless, the capacity of Lac de Allemands to accommodate these sulfate salts is far less than that of the Mississippi River.

On the basis of the above evaluation and in line with the Staff's recommendation, the Applicant has altered the manner in which the products of neutralization, mainly sodium sulfate, will be handled. Rather than discharge to an open stabilization pond and thence into the 40- and 80- Arpent canals, the discharge of the chemical wastes will be into the Mississippi River. The Staff calculates that the added concentration in the effluent water would be 0.35 ppm of the salt Na_2SO_4 (0.24 ppm of sulfate). The weight of the sulfate added to the Mississippi River would be approximately 22 pounds. The Mississippi River carries about 8 million pounds of sulfate per hour past the Waterford Plant from upstream origins. The existing concentrations of sulfates in the Mississippi River averages about 56 ppm (see Table II-5) which compares with the drinking water standard of 250 ppm.

The environmental impact of the removal of Component Cooling Water System heat by means of continuous operation of a small dry cooling tower system has been evaluated by the Staff.

The flow rate of air through the towers will vary in response to actual capacity needs, but on the basis of an assumed normal system load of from 60 to 80 x 10^6 BTU per hour, the capacity is considered adequate. This discharge of dry heat to the atmosphere is approximately equivalent to the thermal discharge of a 5 MW combustion turbine. With a 40°F leaving difference, tower air flow would be about 2 x 10^6 CFM with a discharge air temperature of 140°F during the hottest recorded weather. This differential and an estimated discharge flow velocity of about 30 ft/sec should give an adequate plume rise to lift the dry heat well clear of the plant environs to the upper atmosphere. On this basis, the Staff concludes that there will be no measurable environmental impact due to the tower operation. The only manifestation will be the tendency for small cumulus clouds to be formed under unusual inversion conditions (< 1% of the time).

A considerable steam plume could occur from the wet towers used during LOCA, but the circumstances of this operation are of low probability and would not contribute to routine environmental impact.

C. BIOLOGICAL IMPACT

1. Terrestrial Ecology

The operation of the Plant will have little effect on the terrestrial components of the environment beyond that associated with the loss of habitat. This loss was described in Section IV.

The use of the stabilization pond for the liquid chemical wastes and the relatively small potential hazard for waterfowl and small mammals that might use it as an occasional or permanent habitat is now eliminated since the disposal of these wastes has been modified by the Applicant (Section III-D-3.g.). The risk would be small if only the water treatment chemicals and filter backwash were sent to the pond or, under normal operating conditions, for the demineralizer regenerant solution. However, the Staff anticipated that there would occasionally have been some loss of control and that the basin will receive un-neutralized acid or caustic that could be hazardous to wildlife that happen to be using the basin at the time. Some of this risk could be minimized by fencing. Frequent monitoring for off-standard conditions in the neutralization basin would be necessary to assure that any hazardous conditions which develop are promptly detected and corrected. The disposal of waste water containing other chemicals, including morpholine to an open stabilization pond would also poses problems of unknown severity.

The potential risk associated with soluble components of the chemical wastes penetrating the soil and affecting the groundwater is low. The soil of the Site is deep and heavy in clay that has a high cation exchange capacity and that is restrictive to underground water movement.[7]

The problems described above arising from the use of morpholine and from the disposition of chemical wastes to the land are obviated by the modified procedure which utilizes small amounts of ammonia rather than morpholine and disposal to the river instead of the land disposal.

2. Aquatic Ecology

a. Effects of the Intake Structure

The effect of impingement on the intake screens will be most severe to juvenile fish. The ability of small fish to swim against currents varies between species, with their relative sizes, and with their physical status and whether or not they are conditioned to living in static or moving water. In order to minimize the loss of juvenile fish on the intake screens, approach velocities of 1 fps or less are usually specified. For protection of white crappie and channel catfish, Moyer and Raney recommend that approach velocities should not exceed 0.75 fps.[8] Kerr found that striped bass larvae had little ability to resist low current velocities, even below 0.5 fps, but bass and chinook salmon in early yearling stages could resist velocities of 1 fps for 10 minute intervals. As the yearling groups developed, 2.75 fps was indicated as their top range for ten minute intervals.[9] Kerr also found that survival of larvae and small yearling bass from impingement on screens, even for a short period of time, was extremely low.

The Applicant believes that mechanical damage to adult fish at the intake screens during normal Plant operation will be minimal because the estimated maximum intake velocity (1.8 fps at low water) will permit them to avoid impingement. The Staff believes that this assumption is reasonable and that most of the fish killed at the intake screens will be small numbers of larvae or juveniles.

The Staff estimates of the effects of impingement at the Plant are based upon the fish kill on the intake screens of the Little Gypsy Power Station located across the river from Waterford,[10] as shown in Table V-3.[11,12]

TABLE V-3

ESTIMATED KILL OF FISH ON INTAKE SCREENS AT THE LITTLE GYPSY PLANT

Type of Fish	Annual kill (lb)	Size Range (in.)	Value/lb ($)	Total Value ($)
Shad	1000	8	0	-
Blue catfish	150	6-8	0.29	43.50
Buffalo fish	400	10-12	0.13	52.00
River shrimp	100	2	0.45	45.00
Eel	"a few"	-	0	-

No commercial value is attributed to gizzard shad and eels. The Staff estimates that the total commercial loss of economically valuable fish is less than $200 annually.

Impingement is highly seasonal. Shad are killed mostly in the spring, primarily February and March; blue catfish throughout the year, but usually during the spring; buffalo fish usually in the spring; river shrimp in late spring and early summer; and eels during the spring.

The trend toward spring screen-kill is correlated with high flows in the lower Mississippi River as well as the seasonal presence of shad and eels.

Intake velocity at Little Gypsy is about 5 fps, considerably higher than that expected at Waterford Unit 3. Because of the lower intake velocity at Unit 3, fish impingement is expected to be less than observed at Little Gypsy. If the volume of coolant water at Unit 3 is 2160 cfs (1445 cfs at Little Gypsy) and the intake velocity is in the range of 1.3-2.0 fps (5 fps at Little Gypsy), the Staff estimates the destruction of fish at Waterford 3 should not exceed 500 lb valued at less than $100 annually. The bulk of this kill will consist of shad, which have no commercial value.

In summary, impingement on the intake screens of Waterford 3 will involve mostly small fish and juveniles. Small fish, including both commercial and forage species, are generally more common in areas where the current velocity is low. Two factors will operate to reduce concentrations of small fish near the intake screens of the Plant: 1) the normally high current velocities of the Mississippi River at the intake, which vary according to season and total river discharge and 2) the location of the intake on an outside bend where current velocities are stronger compared to those at the inside bend intake of Little Gypsy on the opposite side of the river. The Staff believes that it is unlikely significant numbers of small fish (<3 in. long) will congregate near the intake structure and the loss of both small and large fish will be insignificant with respect to ecological considerations such as population dynamics, age composition, and reproductive potential.

The extent of this potential problem should be studied after startup of the Plant to assure that substantial losses do not occur. The Staff recommends that the monitoring and surveillance of fish kill on the intake screen be a part of the overall environmental monitoring problem.

b. Entrainment of Organisms in the Cooling Water

Some aquatic organisms swept downstream in the Mississippi River will be drawn into the Plant with the condenser cooling water. All organisms entrained will experience a maximum temperature rise of about 16°F (8.9°C). Passage through the plant and discharge pipes will take about 5.3 minutes (4 pumps), 6.3 minutes (3 pumps), or 8.5 minutes (2 pumps). About one half of this time will involve in-plant exposure to incremental temperatures. The organisms will consist primarily of small free-floating phytoplankton and zooplankton, drifting insect larvae and similar invertebrate forms, and will include under certain seasonal and flow conditions, fish larvae and eggs. Passage through the condenser system may also cause mechanical injury but this effect cannot generally be distinguished from thermal (or chemical) effects.

For determination of extreme entrainment impact, the Staff assumes that all entrained organisms will be killed. Furthermore, it is assumed the fraction of organisms entrained is in direct proportion to the fraction of the river flow utilized by the Plant. The nominal low flow of the Mississippi River at the Waterford site, between the confining levee walls is assumed to be 100,000 cfs and the maximum flow pumped through the Plant is to be 2,160 cfs (975,100 gpm). Therefore, under extreme low flow conditions, only 2.2% of the river might by used by the Plant. This maximum proportion of in-plant use would be rare, since the lowest river discharge during the past 10 years was 110,000 cfs.

To aid evaluation under average low, mean and high flow conditions, and to consider simultaneous entrainment of river organisms at Waterford Units 1 and 2 (fossil-fueled) and Little Gypsy Station (on the opposite bank), additional calculations are given in Table V-4. Under mean minimum flow conditions occurring in the Mississippi River during midsummer

TABLE V-4

PERCENT OF MISSISSIPPI RIVER WATER USED
AT WATERFORD UNIT 3 AND ASSOCIATED STATIONS
UNDER VARIOUS FLOW CONDITIONS

Station	Maximum Cooling Water Used (cfs)	Percent of River Water Used[(a)]		
		Minimum Flows	Mean Flows	Maximum Flows
Waterford Unit 3	2160	1.4	0.5	0.2
Waterford Units 1 & 2	960	0.6	0.2	0.1
Little Gypsy Station	1445	0.9	0.4	0.1
Combined Stations	4565	2.9	1.1	0.4

(a) Based on 10-yr average flows, measured at Red River Landing (1960-1963) and Tarbert Landing (1964-1969); average flows in the lower Mississippi River were: mean minimum, 157,300 cfs; mean mean, 409,000 cfs; and mean maximum, 971,000 cfs.

and fall, all stations together would use 2.9% of the total river water. That is, assuming total in-plant kill, the highest proportion of river organisms entrained and destroyed is 2.9%.

The percentage of entrained organisms killed by passing through condensers at nuclear power stations tends to be variable. The proportion destroyed depends upon such factors as the organisms involved, the base river temperature, the in-plant thermal increment, the duration of exposure, various water quality parameters, and intermittent chlorination.

Studies made on the Potomac River indicate that most freshwater phytoplankton are relatively resistant to thermal shock from entrainment and suffer little or no harm at temperatures as high as 34°C (93.2°F).[13] The relative resistance of phytoplankton to heat has been confirmed in experimental studies.[14] In the York River, Virginia, an increase of 14°F over the condensers first decreased productivity of phytoplankton when the base river temperature was above 59°F (15°C), and this depression then increased directly as the river temperature increased.[15] Mihursky stated that phytoplankton showed a 68 to 94% reduction in photosynthetic activity after passing through a power plant on the Patuxent River during maximum river temperatures of summer and fall.[16]

Zooplankton and insects occurring in the river drift are major food organisms for the early life stages of many fishes living in the lower Mississippi River. These organisms are also subject to entrainment. Most zooplankton are likely to be more sensitive to heat than phytoplankton, but Markowski has shown that zooplankton, including crustaceans and insect larvae (Diptera), were not killed when exposed to temperatures as high as 88°F (31.1°C).[17] Roessler, et al., found that 80% of the zooplankton collected at the Turkey Point plant (Florida) were dead when the water temperature was 104°F (40°C).[18] Laboratory studies of thermal tolerance with a number of insects common to river ecosystems (stoneflies, caddisflies and mayflies) showed that specimens acclimated to 50°F (10°C) suffered 50% mortality in 96 hours (96-hour Median Lethal Temperature, TLM) when exposed to temperatures ranging from 70 to 87°F (21.1-30.6°C).[19] One can expect that higher TLM values will occur at higher acclimation temperatures. In nature, many populations of aquatic insects survive at higher temperature regimes.

Fish eggs and larvae carried downriver by the current will also be subject to entrainment. The extent of fish spawning above Waterford and the occurrence of eggs and larvae in the river drift have not been described either qualitatively or quantitatively, but eggs and larvae that are present will be at risk because of passage through the Plant. Marcy found that larvae and juveniles of nine species [*Alosa pseudoharengus* (alewives), *A. aestivalis* (blueback herring), *A. sapidissima* (Amer. shad), *Morone americanus* (white perch), *Cyprinus carpio* (carp), *Ictalurus catus* (white catfish), *Anguilla rostrata* (Amer. eel), *Notropis hudsonius* (spottail shines), and *Etheostoma nigrum* (johnny darter)] failed to survive entrainment through a power plant and discharge canal on the lower Connecticut River when intake temperatures were above 30°C (86°F) and the duration of exposure was 50-100 minutes.[20]

The precise level of river temperature where entrainment and the resulting thermal exposure at Waterford Unit 3 becomes critical to the survival of various river organisms cannot be predicted with confidence. On the basis of available Mississippi River temperature data, ambient temperature levels will exceed 25°C (77°F) most of the time from June through September. The temperature of the effluent will exceed 34°C (93°F) from in-plant thermal increment over this period. At least some entrained river organisms will be destroyed by heat and mechanical trauma.

Based on the low proportion of total river flow used by the Plant, the Staff believes that destruction of any or all of the river organisms during the entrainment process will have an insignificant impact on the total river ecology, particularly since no nutrients will be removed from trophic circulation in the ecosystem.

c. Thermal Effects in the Mixing Zone

The present Louisiana State temperature criteria for Zone 1 of the Mississippi River require that the river temperature shall not be raised more than 3°C (5.4°F) above ambient, nor shall it exceed a maximum of 36°C (96.8°F). These criteria apply outside a mixing zone, which has not been defined. In addition, the National Technical Advisory Committee on Water Quality Criteria has recommended that temperature increases be limited to 5°F in freshwater stream environments.[21] These temperature limits are to apply outside of established mixing zones, which were defined as 25% of the cross-sectional area and/or volume of flow of a stream or estuary.

The dispersal of heated water from the Plant appears to meet these criteria under maximum temperature conditions for each month. This is due principally to the vast dilution capacity of the Lower Mississippi River. The design of the three plants, while meeting the criteria, does not take full advantage of this dilution capacity. Temperatures in the warmest zone have been reduced by use of momentum jet mixing and a better integration of the Waterford Units 1 and 2 with Waterford Unit 3. Temperatures in the river now approach 90°F for short periods of time. To assess the thermal impact of the Waterford 3 discharge on the river, the relation of the integrated heat sink capability of the river with the details of plant design and upstream and downstream uses is important and should be considered in a detailed and as precise manner as can be done.

Accordingly, the primary concern of high temperatures in the mixing zone is that aquatic organisms which penetrate the zone will be subjected to thermal shock. The maximum thermal increment at the discharge is ΔT 16°F (8.9°C), or 18°F (10°C) to 20°F (12°C) if the carry-over elevation of ΔT 2°F to 4°F, from Units 1 and 2 (upstream) is included. Below the point of discharge, temperature elevations will be lower as the effluent becomes mixed with the main flow of the river. The effect of thermal shock varies with the species, as shown in Table V-5, and will depend upon ambient river temperature, thermal elevations within the mixing zone, the duration of exposure of a given organism to a potentially lethal temperature, and upon the inherent thermal resistance of that organism.

TABLE V-5

THERMAL TOLERANCE LIMITS FOR SOME AQUATIC ORGANISMS FOUND IN THE LOWER MISSISSIPPI RIVER

Species	Temperature °C(°F)	Effect[(a)]
Callinectes sapidus (Blue crab)		
adults & juveniles[23]	31.4-39.0 (88.5-102)	48 hr TLM; less tolerant at low salinities
juveniles[24]	37.1 (98.7)	1000 min TLM, 20C Accl.
	38.6 (101.4)	25C Accl.
	39.4 (103.0)	30C Accl.
Cyprinus carpio (Carp)		
---[25]	31-34 (87.9-93.2)	24 hr TLM, 20C Accl.
	35.7 (96.3)	25C Accl.
"small"[26]	38-39 (100.4-102.2)	---
"large"	35-36 (95-96.8)	
Dorosoma cepedianum[27] (Gizzard shad)		
---	34.0 (93.2)	lethal, 25C Accl. (OH)
	36.0 (96.8)	lethal, 30C Accl. (OH)
	36.5 (97.7)	lethal, 35C Accl. (OH)
	34.6 (94.2)	lethal, 25C Accl. (TN)
	35.8 (96.4)	lethal, 30C Accl. (TN)
Fundulus grandis (Gulf killifish)		
adults[28]	38.5 (101.3)	lethal, 1360 min, 35C Accl. (TX)
	40.0 (104)	lethal, 97 min, 35C Accl.

TABLE V-5 (Continued)

Species	Temperature °C(°F)	Effect[(a)]
Ictalurus punctatus (lacustris)[27]		
(Channel catfish)	32.7 (90.8)	lethal, 20C Accl. (OH)
	33.5 (92.3)	lethal, 25C Accl. (OH)
	30.3 (86.5)	lethal, 15C Accl. (FL)
	32.8 (91.1)	lethal, 25C Accl. (FL)
	33.5 (92.3)	lethal, 30C Accl. (FL)
juveniles[29]	36.6 (97.9)	7 day TLM, 26C Accl. (AR)
	37.3 (99.2)	7 day TLM, 30C Accl. (AR)
	37.8 (100)	7 day TLM, 34C Accl. (AR)
Lepomis macrochirus[30] (Bluegill)		
	31.7 (89.0)	lethal, 5C Accl. (PA)
	35.0 (95.0)	lethal, 10C Accl.
	36.1-3712 (97.0-99.0)	lethal, 25C Accl.
	39.5 (103.1)	ultimate, Accl.
---[27]	31.5 (88.8)	lethal, 20C Accl. (FL)
	33.8 (92.9)	lethal, 30C Accl. (FL)
Lepomis megalotis (Longear sunfish)		
juveniles[31]	35.5 (95.9)	7+ day TLM, 25C Accl. (TX)
	36.6 (97.9)	7+ day TLM, 30C Accl.
	38.2 (100.8)	7+ day TLM, 35C Accl.
Micropterus salmoides (Largemouth bass)		
---[25]	28.9 (84)	24-hr TLM_{50} 20-21C Accl. (B.C.)
---[27]	31.8 (89.2)	lethal, 20C Accl. (FL)
	32.7 (90.8)	lethal, 25C Accl. (FL)
	33.7 (92.6)	lethal, 30C Accl. (OH)
	32.5 (90.5)	lethal, 20C Accl. (OH)
	36.4 (97.6)	lethal, 30C Accl. (OH)

TABLE V-5 (Continued)

Species	Temperature °C(°F)	Effect[(a)]
Micropterus salmoides (Cont'd)		
---[30]	35.0 (95.0)	lethal, 10C Accl. (PA)
	36.1-36.7 (97-98)	lethal, 25C Accl.
---[32]	32.5 (90.5)	lethal, 20C Accl.
	36.4 (97.5)	lethal, 30C Accl.
---[33]	30.6-32.88 (87-91)	avoidance, 25C Accl. (DE)
Mugil cephalus (Striped mullet)		
prolarvae & postlarvae[34]	32.0 (89.6)	upper thermal limit

(a) C = degrees Centigrade
Accl = acclimation temperature
TLM = Median lethal temperature at which 50% of the test organsims die in the indicated time span.

( ) = State in the U.S. where the study was conducted.

Studies in the Columbia River,[22] a cold water stream, show that thermally sensitive juvenile Chinook salmon were but rarely killed when drifted in cages through hot water plumes. Some mortality resulted under late summer conditions when ambient river temperatures exceeded 16°C (60.8°F) and incremental temperatures exceeded ΔT 10°C (18°F). On other occasions temperatures were well above these levels but exposure durations were too short to be lethal to these fish. Thermal resistance data for a few organisms occurring in the lower Mississippi River are given in Table V-5. There are no experimental data for most of the resident fauna. Upper thermal tolerance limits vary with acclimation temperature and geographical location of different species. However, in general, the organisms occurring in the river near Waterford are warm water forms seasonally adapted to relatively high temperature regimes and with a general high level of thermal tolerance.

Several phenomena at Waterford Unit 3 suggest that effects of the heated discharge on river organisms will be minimal: 1) There will be no long, open discharge canal in which fish and other organisms can congregate. Rather, the discharge will be pumped from the Plant over the levee through pipes into a "sea well" surrounded by a weir from where it disperses. 2) The discharge will be contained in a plume along the south bank of the river due to strong seaward current flow. 3) The 5.4°F (3°C) isotherm of the discharge plume is estimated to cover about 3.5% of the total river cross section when the river is flowing at 200,000 cfs, while the 10°F (5.5°C) isotherm will cover about 1.5%. 4) Only during the summer and early fall months are ambient river temperatures sufficiently high so that thermal increments of 5.4°F (3°C) or above might impose significant stress on river organisms passing through the discharge plume.

These phenomena suggest that fish kills are not likely to occur from sudden temperature decline (cold-shock), should the Plant be shut down during the winter. Furthermore, there should be little effect on the spawning of fish or on reproduction of aquatic invertebrates near the Plant. Most fishes common to the lower Mississippi River spawn in the spring prior to the season of high water temperatures, and, with the exception of a few species (such as gizzard and threadfin shad), fish eggs and larvae are not likely to occur in quantity in the river drift. Nevertheless, since little information is available, qualitatively or quantitatively, concerning fish eggs and larvae drifting past the Plant, the Staff recommends that the environmental monitoring program to be conducted during plant operation include sampling and evaluation to determine if significant quantities are destroyed by passing through the mixing zone.

The dilution capacity and mixing characteristics of the lower Mississipp River will tend to preclude any eutrophication or significant shift in composition of planktonic algae as a result of heated discharges from the Plant. Surface dispersal of the heated effluent, along with the normal depth and current velocity of the river will tend to restrict concentrations of adult fish within, but not necessarily under the discharge plume. The composition of periphyton (attached algae) growing on surfaces within the plume would probably change, but periphyton is not considered to be abundant in the lower Mississippi River due to heavy silt loads.

Since warm water holds less oxygen in solution than cold water, increasing coolant temperatures by 16°F (8.9°C) theoretically might result in lower dissolved oxygen (DO) levels in the discharge. Once the cooling water enters the receiving stream, rates of oxygen demand by organic material (both living and decomposing) will be increased by the higher temperatures. If the receiving stream is heavily loaded with decomposing organic material, the additional demand might exceed the rate of reoxygenation at the water surface and dissolved oxygen (DO) levels could fall below those required by aquatic life. However, the Mississippi River at the Waterford site is not considered to be heavily loaded with decomposing organic material.

In the lower Mississippi, DO values are generally at 90% saturation during April, and August through September. Lowest DO values, about 70% saturation, usually occur during June and July.

Measurements of DO in the Mississippi River near the Waterford site by Ebasco Services in July 1971 revealed values ranging from 4.9 to 6.0, with most values in the 5.3 to 5.6 range. The DO values measured in this brief survey decreased with depth, a natural phenomena due to oxygenation of the river surface from the atmosphere and photosynthesis production of oxygen by phytoplankton in the illuminated surface layer. Records of the U.S. Geological Survey did not reveal DO data for this reach of the Mississippi River. The staff concludes however, that the DO values, measured by Ebasco, passing through the Waterford 3 plant are not likely to be reduced to harmful levels to aquatic life, and in fact, may be increased by turbulence and entrapment of air.

The Applicant's re-design of the discharge structure, directing circulating water into the river at a velocity of about 7 fps (at low water), will facilitate rapid mixing and dissipation of waste heat. This modification should produce no substantial change in the staff's conclusions regarding the impact of heated effluent on aquatic life at Waterford Unit 3.

Drift organisms exposed to the discharge plume will experience temperature changes varying in duration and extent depending on how long they remain in the plume influence. The potential impact will be somewhat reduced because of greater efficiency of the mixing process. The jet forces also tend to displace the warmest portion of the discharge away from the shoreline, so that fish and benthic invertebrates inhabiting the shoreline zone will be less exposed to extreme thermal increments and abrupt temperature changes. The main axis of the jet will occur about 500 ft offshore and near the surface of the river. Fish and invertebrates residing on or near the river substrate will be below the main influence of the plume.

In summary, the Staff believes that the physical features of the lower Mississippi River in relation to the anticipated dispersal of heated discharges from the Waterford Unit 3 will minimize potential environmental impact. Observable effects, if any, would be restricted to the limited confines of the mixing zone near the discharge and would not significantly affect river biota as a whole.

d. Effects of Chemical Discharges

Under most conditions, the heavy silt load in the lower Mississippi River is expected to aid in the scouring of the condenser tubes of the Plant and prevent fouling by nuisance organisms. However, intermittent chlorination during periods of low water is planned by the Applicant to control fouling in the condenser tubes. The method will involve injection of controlled amounts of a hypochlorite solution into the circulating water inlet so that only trace quantities of chlorine will be detectible in the discharge. Controlled chlorination is planned to take place once a day for no more than a 30 minute period and occurring only at intermittent times when water conditions and fouling rates indicate a need for treatment. As discussed in Chapter III, the experience of needed chlorination at the Little Gypsy Plant, directly across the river from Waterford, leads the Staff to believe that chlorination will be conducted at relatively infrequent times during the year. Further, the Applicant has committed to rigorously control the chlorination procedure so that concentrations at the condenser outlet will be less than 0.1 ppm. Dilution with river water in the mixing zone will further reduce chlorine levels so that the effect on aquatic river life is expected to be insignificant.

As described in Section III,[35] chemicals released to the circulating cooling water will be: boric acid (estimated release concentration 0.0001 ppm), detergents or phosphate (0.0005 ppm) and hydrazine (1×10^{-8} ppm).

Boric acid is generally non-toxic to aquatic organisms at concentrations even well in excess of 100 ppm. Wallen, et al., found that 18,000 ppm was needed to kill 50% of test mosquito fish in 24 hours and that 5,600 ppm caused 50% mortality in 96 hours.[32]

Disposal of steam generator blowdown and turbine building drainage to the circulating water will release very small quantities of ammonia to the river in lieu of morpholine as originally planned. The total concentration of ammonia added to the circulating water from the two sources is 2×10^{-7} ppm.

The toxicity of phosphates, a main ingredient of detergents, is reviewed by McKee and Wolf.[37] Daphnia magna was the most sensitive organism discussed, being affected by levels above 50 ppm. Most other organisms were much less sensitiive. Only about 200 lb of biodegradable detergents will likely be released from Waterford Unit 3 annually.

Although the discharge of cleaning solutions containing relatively high concentrations of phosphate could cause excessive fertilization of the receiving waters and a resultant undesirable algae growth, it is the Staff's opinion that the quantities of phosphates to be discharged into the river due to Waterford 3 operation and considering the transit time of the water to the ocean, no serious algae buildup will occur. Nevertheless, to preclude any adverse effect on the aquatic biota and eliminate algae buildup, the Staff recommends that a relatively simple treatment of these wastes in the plant be made to remove the phosphates.

Hydrazine hydrate at 0.7 ppm causes fingerling trout to lose equilibrium in less than 24 hours, but 5 ppm does not affect sea lampreys over the same exposure time.[37] Corti reports that rainbow trout exposed to 146 ppm of hydrazine at pH 8.35 and 56.3°F (13.5°C) show an adverse reaction after 14-18 minutes and succumb in 22-35 minutes.[37]

The Staff believes that the estimated concentrations of the chemicals occurring in the Plant discharge to the Mississippi River provide a safe margin for the survival of aquatic organisms. Particularly, in the discharge to the river, dilution in the discharge and mixing zone will widen this margin by reducing concentrations well below those kno to produce toxic effects.

Disposal of sodium sulfate from the neutralizing facility into the Mississippi River, as now committed to by the Applicant, eliminates the potential of contamination problems in receiving canals and in Lac des Allemands. This is an improved method of disposal since the river will dilute and disperse low levels of sulfates as they are discharged. Sodium sulfate is readily soluble in water and, as shown by data compiled by McKee and Wolf,[38] is normally toxic to aquatic life only at prolonged exposures to concentrations above 1,000 ppm, which are substantially above the concentrations in the Waterford circulating water.

The Staff concludes that although a serious and irreversible impact on the terrestrial and aquatic life in the vicinity of the stabilization pond, in and near the 40- and 80-arpent canals and eventually Lac des Allemands itself would not be likely due to the discharge of chemical wastes from Waterford 3, it is not a desirable method of disposal. Further, with the character of water movement in and out of Lac des Allemands not well known, the Staff concludes that the discharge of the chemical wastes to the Mississippi River with the resulting marked dilution will have an insignificant effect on aquatic life with river and will not adversely affect downstream water uses.

e. Radiation Damage to Aquatic Organisms

Radiation dose rates that may be received by aquatic organisms in the Mississippi River near the Plant can be predicted on the basis of estimated release rates of radionuclides into the circulating coolant (see Table III-3), their subsequent dilution in the receiving water, and the bioaccummulation factors listed in Table V-6 for freshwater organisms. At the postulated concentrations in the discharged coolant, entrained planktonic forms would receive doses of the order of 10^{-6} mrad/hr. Doses to plankton in the river drift passing through the mixing zone would diminish rapidly as the effluent is diluted in the river and passes downstream from the discharge focus.

Organisms likely to receive the highest radiation dose from the Plant are aquatic species living in or near (moving in and out) the effluent plume such as sessile invertebrates and fish. A clam living on the bottom at the exit of the discharge canal would receive an estimated total dose of about 80 mrem/yr. Most of this dose would come from Cs-137 deposited in the bottom silt. The dose to a fish living continuously in the undiluted effluent was calculated to be 10 mrem/yr, almost entirely from radionuclides accumulated from the effluent.

TABLE V-6

FRESHWATER BIOACCUMULATION FACTORS[39,40]
(pCi/kg Organism per pCi/liter Water)

ELEMENT[(a)]	FISH	CRUSTACEA	MOLLUSCS	ALGAE
H	1	1	1	1
Cr	1	10	10	20
Mn	1,000	40,000	40,000	10,000
Fe	5,000	10,000	10,000	5,000
Co	50	200	200	1,000
Rb	2,000	2,000	2,000	1,000
Sr	1	20	20	500
Y	100	1,000	1,000	10,000
Zr	10	100	100	1,000
Nb	30,000	100	100	1,000
Mo	100	100	100	100
Tc	1	25	25	100
Ru	5	100	100	2,000
Rh	100	100	100	2,000
Sb	40	16,000	16,000	10,000
Te	400	75	75	100
I	1	25	25	100
Cs	1,000	1,000	1,000	200
Ba	10	200	200	500
La	50	500	500	10,000
Ce	50	500	500	10,000
Pr	50	500	500	10,000
Nd	100	1,000	1,000	10,000
Pm	100	1,000	1,000	10,000
Np	10	300	300	1,000

(a) All isotopes of an element have the same chemical behavior.

A small mammal such as a muskrat, which makes its den near the shore and occasionally enters the discharge canal, would receive a dose of about 60 mrem/yr from the Plant-related sources. This same animal receives about 100 mrem annually from naturally occurring radionuclides.

Annual doses predicted for aquatic organisms below the outfall of the Plant (80 mrem/yr) are 1/1000 of the chronic dose levels that might produce demonstrable radiation damage to aquatic organisms.[41] For example, chironomid larvae (Insecta) living in bottom sediments near the Oak Ridge facility in Tennessee receiving radiation at the rate of about 230-240 rem/yr for more than 130 generations have not decreased in abundance even though slightly greater than normal number of chromosome aberrations are displayed.[42] The brood size of a fresh-water fish (Gambusia) increased when exposed to chronic radiation of 10.9 rads/day, although somewhat more dead embryos and abnormalities were observed in irradiated populations than in controls; increased fecundity is the means by which animals having a short life cycle and producing large numbers of progeny can adjust to radiation stress.[43] The irradiation of salmon eggs and larvae at a rate of 500 mrem/day did not affect either the number of adult fish subsequently returning from the ocean or the ability of the adults to spawn.[44] The number of salmon spawning in the vicinity of the Hanford reactors on the Columbia River have not been affected by dose rates in the range of 100 to 200 mrads/week.[45]

Populations of aquatic organisms residing near the outfall of Waterford Unit 3 are not expected to be affected by radionuclides in the discharge effluent. The reasons are threefold: 1) the planned release of radionuclides will be a small fraction of releases that have occurred in the past at major nuclear facilities and that caused no detectible adverse effects, 2) the estimated dose rates will be 1/1000 of the level expected to cause radiation damage, and 3) the lower Mississippi River rapidly dilutes and disperses the discharged effluent by a factor of about 100 during most of the year. The levels of activities discharged and their dilution are judged by the Staff to represent no threat to aquatic organisms based on the evidence from past reactor operations and experimental studies.

f. Effect of Plant Operation on Endangered Species

The American alligator is the only endangered species known to be indigenous to the area of the Waterford site, although there exists the possibility of the presence, at times, of the brown pelican, the southern bald eagle and the American peregrine falcon.

Since these species are likely to be present in the wooded swampland and the large marshlands rather than in or on the banks of the Mississippi river, the discharge of chemical wastes into the river will result in no effect on the alligator or birds. There is also no adverse impact expected on any of the endangered species, particularly the American alligator, from routine releases of radionuclides. The only exposure of the alligator and other animals and birds is the slight exposure due to the gaseous effluent release. Radiation exposure at the distances where the alligator is likely to be found near the site is expected to be a few tens of millirem per year, substantially below the normal annual background level of about 100 mrem, and not different from that likely to be received by man. The Staff does not identify any other effects of plant construction or operation which could have any adverse impact on the alligator or transient birds such as the pelican, eagle or falcon.

D. RADIOLOGICAL IMPACT ON MAN

In the design and operation of any facility utilizing or generating radioactive materials, the consideration of primary importance is the radiation dose which people in the Plant environs might receive. The release rates of radionuclides to the environment must be in conformance with Federal regulations set forth in 10 CFR Part 20. In addition, the releases must meet the requirements specified in Appendix I, 10 CFR 50 when it becomes finalized.

The Staff has estimated the radiation doses that may be received by people from the concentrations of radionuclides that are anticipated in the air, the water, and on the ground as a result of radionuclides released during the normal operation of the Waterford Steam Electric Station Unit 3. These release rates listed previously in Tables III-2 and III-3 for the Applicant's augmented radiological waste system are based upon operating experience with power reactors of similar design and having similar radwaste systems as that proposed by the Applicant for Waterford Unit 3. The dose estimates from the liquid pathways were calculated using the bioaccumulation factors listed in Tables V-6 and V-7.

1. Impact of Gaseous Releases

The gaseous effluents from the Waterford Plant are released from roof vents but, to be conservative, dose rates were calculated assuming a ground-level release without a building wake factor. Meteorological frequency tables used were those derived from five year's Moisant Airport data, 20 foot levels.[47]

TABLE V-7

SALTWATER BIOACCUMULATION FACTORS[46]
(pCi/kg Organism per pCi/liter Water)

ELEMENT	FISH	CRUSTACEA	MOLLUSCS	ALGAE
H	1	1	1	1
Cr	100	1,000	1,000	1,000
Mn	3,000	10,000	50,000	10,000
Fe	1,000	4,000	20,000	6,000
Co	100	10,000	300	100
Rb	30	50	10	10
Sr	1	1	1	20
Y	30	100	100	300
Zr	30	100	100	1,000
Nb	100	200	200	100
Mo	10	100	100	100
Tc	10	100	100	1,000
Ru	3	100	100	1,000
Rh	10	100	100	100
Sb	1,000	1,000	1,000	10,000
Te	10	10	100	1,000
I	20	100	100	10,000
Cs	30	50	10	10
Ba	3	3	3	100
La	30	100	100	300
Ce	30	100	100	300
Pr	100	1,000	1,000	1,000
Nd	100	1,000	1,000	1,000
Pm	100	1,000	1,000	1,000
Np	10	300	300	1,000

The maximum exposure rate at the Site exclusion boundary occurs 0.2 mile NNE of the reactor at the edge of the river where the annual average atmospheric dilution factor was calculated to be 2.2×10^{-5} sec/m^3. The total-body dose to an individual remaining at this location all year is estimated to be 0.9 mrem/yr, principally from Kr-88 and Xe-133. The estimated skin dose is somewhat higher (3 mrem/yr) because of the beta contribution from the radionuclides released with the gaseous effluents.

Individuals estimated to receive the greatest exposure to the gaseous effluents released by the Plant are those residing at the house just outside the Applicant's property line, 0.9 mile to the northwest of the Plant. A family cow is pastured at this location where the average annual atmospheric dilution factor is 1.3×10^{-6} sec/m^3. The external air submersion total-body dose to an individual residing all year at this location would be 0.05 mrem/yr; his skin dose would be 0.2 mrem/yr. These doses are summarized in Tables V-8.

Since radioiodines in the gaseous effluents will be deposited on food crops (leafy vegetables) as well as on animal forage and therefore be directly ingested by an individual, an estimate was made of the dose to an individual consuming fresh green leafy vegetables obtained from gardens of the residents living in the dwellings along the site boundary (approximately 0.9 mile NW of the plant). The estimate is based on the conservative assumptions that (1) the individual adult eats 72 kg (a 2 year old child eats 18 kg) of the leafy vegetables throughout the 12 months of the year; (2) .25% of the radioiodine deposited on the garden surface is deposited on the vegetables; (3) the environmental half-life of the radioiodines on the vegetables is 14 days; (4) the leaves are exposed above ground for three months before being harvested; and (5) there is no loss of radioiodine through decay or preparation of the vegetables before eating.

The additional thyroid dose to the adult and child from eating the leafy vegetables is estimated to be 3 mrem/yr and approximately 5 mrem/yr, respectively.

In addition to the above, doses from gaseous effluents were also estimated for other locations of interest. An air submersion dose was calculated for an individual residing throughout the year at the closest house located across the river near the town of Montz, 0.75 mile NNE of the Plant. At this location the annual average atmospheric dilution factor was estimated to be 1.88×10^{-6} sec/m^3.

TABLE V-8

ESTIMATED RADIATION DOSES RECEIVED BY AN INDIVIDUAL FROM THE EFFLUENTS RELEASED AT THE WATERFORD PLANT[(a)]--AUGMENTED SYSTEM (mrem/yr)

Pathway	Annual Exposure	Skin	Total-Body	GI Tract	Thyroid	Bone
Air Submersion						
At home[(b)]	8766 hr	0.18	0.052	(0.052)[(c)]	(0.052)	(0.052)
Fishing[(e)]	500 hr	0.17	0.051	(0.051)	(0.051)	(0.051)
Inhalation						
At home[(b)]	7300 m^3	--	--	--	0.052	--
Fishing	420 m^3	--	--	--	0.049	--
Milk Consumption[(b)]	365 liter	--	--	--	2.0	--
Vegetable Consumption[(b)]	72 kg	--	--	--	2.6	--
Fish Consumption	18 kg	--	2.0	0.074	8×10^{-3}	1.6
Drinking Water[(d)]	250 liter	--	0.005	1×10^{-3}	.009	2×10^{-3}
Swimming	100 hr	4×10^{-4}	3×10^{-4}	(3×10^{-4})	(3×10^{-4})	(3×10^{-4})
Shoreline Silt	500 hr	2.3	1.9	(1.9)	(1.9)	(1.9)
Total Dose (Adult)		3	4	2	~4.7	4
Milk Consumption[(b)] (Child)	365 liter				16	
Vegetable Consumption[(b)]	18 kg				5.3	

(a) Based on release rates listed in Tables III-2 and III-3.
(b) At house 0.9 mile NW of the Plant.
(c) ( ) indicates internal dose from external exposure.
(d) At Union Carbide, 1.5 miles ESE of Plant.
(e) At Plant outfall.

The total-body dose for such a resident would be 0.08 mrem/yr and his corresponding skin dose would be 0.3 mrem/yr. An estimate was also made for the dose to the thyroid from radioiodines released in gaseous effluents from the Plant. Iodine inhalation would result in a dose of 7×10^{-2} mrem/yr to a child and 5×10^{-2} mrem/yr to an adult residing there.

The dose calculations based on estimated releases from the Plant with the augmented gaseous effluent treatment system (Table III-3) are shown in Table V-8. In summary, air concentrations of I-131 and I-133 are estimated to be 4.4×10^{-3} and 2.1×10^{-3} pCi/m^3, respectively, at the house where the family cow is pastured. The child thyroid dose from drinking one liter of milk per day from the cow pastured all year at this location is calculated to be 16 mrem/yr; the corresponding adult dose is about 2 mrem/yr.

The thyroid dose due to iodine inhalation to an adult resident in the town of Montz, across the river, is estimated at 0.08 mrem/yr and 0.1 mrem/yr to a child.

A calculation was made of the air submersion dose to pupils or teachers at the school located on the property line 0.95 mile west of the Plant. At this school the average atmospheric dilution factor is 1.42×10^{-6} sec/m^3. Assuming attendance for six hours each school day during 9 months of the year, an individual would receive a total-body dose of only 0.008 mrem/yr and a skin dose of 0.03 mrem/yr.

A dose rate was calculated for a fisherman located at the Plant discharge canal 0.25 mile NE of the reactor. An individual at this location where the average atmospheric dilution factor is 2.05×10^{-5} sec/m^3 would receive a total-body dose of 1×10^{-4} mrem/hr and a skin dose of 3×10^{-4} mrem/hr.

2. Impact of Liquid Releases

The Staff has estimated the radiation doses from radionuclides released into the liquid effluents from the Plant. Radionuclides listed in Table III-2 are diluted with the Plant condenser water flow of 2160 cfs and released through a 400-ft discharge canal to the River. It was assumed that the individual most likely to receive the highest radiation dose via the liquid pathway would be a fisherman who spends 500 hours fishing from the bank in the area of the Plant outfall. Further, it was assumed that this same individual swims 100 hr/yr in the river in the same area, and that he is exposed for 500 hr/yr to the radionuclides accumulated in the sediment along the shoreline. In addition, the Staff assumed this individual to eat 18 kg/yr[48] of fish 24 hours after harvest from the outfall area where no river dilution was assumed to take place.

The total-body dose from fish consumption is estimated to be 2 mrem/yr; an additional 2 mrem/yr is estimated to be received from exposure to shoreline and while swimming (about 80% of the latter dose results from Cs-137 accumulated in the silt). Since most direct exposure to the water and shoreline would actually be at concentrations much below the Plant discharge concentration, an added degree of conservatism is reflected in the dose estimates.

According to the Applicant, the nearest withdrawal of river water for drinking purposes downstream from the Plant occurs at the Union Carbide Corporation whose intake is located approximately 1.6 miles east of the Waterford Unit 3 discharge canal. For the purpose of estimating an internal dose to an individual who drinks this water during an 8-hour working day it was assumed that he consumes 1 liter/day for 250 days/yr and that 24 hours elapsed between radionuclide release from the Waterford Plant and uptake by the individual. Further, from information received from the Applicant, it was estimated that the Plant effluent would be diluted 9:1 by the River before reaching the intake of the Union Carbide water supply system.[49] No credit was taken for removal of radionuclides in the water treatment system of the Union Carbide Plant. Based on these assumptions it was estimated that this individual would receive a total-body dose of 0.005 mrem/yr and a thyroid dose of 0.009 mrem/yr from drinking water at this chemical plant. These doses are also summarized in Table V-8.

3. Population Doses from All Sources

In addition to the doses to the individual, the Staff has estimated the integrated annual dose (man-rem) for all persons living within a 50-mile radius of the Waterford Plant. An integrated gaseous submersion dose was calculated for the 1.7 million people (1980 estimate) living within a 50-mile radius of the Plant. Table V-9 lists the cumulative population, cumulative dose, and the average annual dose to the total body from gaseous effluents (primarily noble gases) at various radial distances from the Plant. This population dose is estimated to be 1.1 man-rem/yr.

The dose derived from pathways associated with the liquid effluent released into the river has also been estimated. The total seafood catch in the river downstream from the Plant and the catch in the gulf around the delta of the river was used to estimate the dose from fish consumption. Based on data compiled by the National Marine Fisheries Service, Department of Commerce, the applicant estimates that 20,000 pounds of fish are taken commercially from the river between LaPlace (5 miles upstream) and Hahnville (5 miles downstream of the Plant).[50] Undoubtedly some of this harvest is used for bait and non-human consumption. In the absence of definite data on the harvest of edible fish from the River below the Plant, it was assumed that 20,000 lbs of fish were caught below the Plant in waters containing reactor effluent at 230:1 dilution.[a] The total landings of seafood in the eastern district around the delta region in the Gulf was used to estimate the population dose from seafood consumption.[51,52] These landing statistics indicate that approximately 8 x 10^6 lbs of fish (mostly menhaden), 4 x 10^7 lbs of shrimp and blue crabs, and 5 x 10^6 lbs of oysters are taken from these waters. It was assumed that 50% of this Gulf catch was taken in waters containing Plant effluent at a concentration 1/10 of that in the river (230:1 dilution). For both the river and Gulf catches it was assumed that 24 hours elapsed between the release of the effluents into the river and the consumption of the seafood. In addition, the ratio of edible weight to live weight was assumed to be 50% for both river fish and seafood. Bioaccumulation factors used in the calculations are listed in Tablves V-6 and V-7 for fresh and saltwater organisms. Based on the dose assumptions, the resultant total-body dose to the population from the total aquatic food pathway would be 0.02 man-rem/yr.

Since the river water downstream of the Plant is used for supplying public water supplies of New Orleans and other river towns, an estimate was made of the annual dose received by the population obtaining potable water from these sources. It was estimated that approximately 10^6 persons would obtain water from public water supply systems downstream from the Plant, and that they each consumed on the average 438 liter/yr of water containing radionuclides released 24 hours previously from the Waterford Plant. A total River dilution of 230:1 was used in the calculation. From these assumptions it was estimated that these 10^6 people would receive a total-body dose from drinking water of 0.34 man-rem/yr. Total-body doses of this magnitude are nearly undetectable and essentially non-measureable except by very sophisticated laboratory instrumentation.

External exposure to the population from recreational activities associated with the liquid effluents was also estimated by the Staff. It was assumed that the average person spends 10 hr/yr on the shoreline (fishing, hiking or picnicking) of the river containing Plant effluent at a dilution of 230:1. The total-body dose from shoreline activities is estimated to be only 0.29 man-rem/yr. Boating and swimming were assumed to be negligible activities on the lower Mississippi.

4. Evaluation of Radiological Impact

The total population dose received from all effluent pathways from routine operation of the Waterford Plant is estimated to be 2 man-rem/yr. By comparison, in Louisiana the natural background radiation as reported

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(a) 493,000 cfs river flow ÷ 2160 cfs plant flow = 230.

TABLE V-9

CUMULATIVE POPULATION, ANNUAL MAN-REM DOSE, AND AVERAGE ANNUAL DOSE IN SELECTED CIRCULAR AREAS AROUND THE WATERFORD PLANT

Cumulative Radius (miles)	Cumulative Population (1980)	Cumulative Dose (man-rem)	Average Dose (mrem)
1	460	0.080	0.17
2	1,900	0.11	0.058
3	3,700	0.14	0.038
4	13,000	0.23	0.018
5	18,000	0.26	0.014
10	41,000	0.30	0.007
20	310,000	0.59	0.002
30	1,100,000	1.0	0.0009
40	1,400,000	1.1	0.0007
50	1,700,000	1.1	0.0006

by the EPA is 0.10 rem/yr, which results in an integrated dose of about 170,000 man-rem/yr to the population of 1.7 x 10^6 persons (1980). Thus, routine operation of the Waterford Plant is expected to contribute a negligibly small incremental total-body dose to that which the population already receive as a result of natural background. From Table V-8, the total-body dose to an individual is conservatively calculated to be about 4 mrem/yr. This compares with the dose standard of 170 mrem/yr to an individual of the population as given in 10 CFR 20.

In the draft statement, the staff concluded the potential organ dose (thyroid) to individuals living on the site boundary due to I-131 through the food-milk pathway to be excessive. The Staff believed that technically feasible plant design modifications could be made to the gaseous radiological waste treatment system which would substantially reduce the radioiodine releases to the environment and result in lower calculated doses to the thyroid of individuals living at the site boundary. To insure that no individual receives a thyroid dose in excess of 5 mrem/yr, the Staff further concluded that the Applicant would be required to carry out a substantive and comprehensive sampling and monitoring program of the milk and leafy vegetables and calculate doses on the basis of the analysis of the milk and vegetables. Both of these Staff positions were cited in the draft statement as conditions for issuance of a construction permit for Waterford 3.

By means of Supplement 3 to the Applicant's Environmental Report dated December 15, 1972, and discussed in Chapter III, the Applicant has committed to a substantial augmentation of the gaseous radioactive waste treatment system to reduce iodine releases to acceptable levels. The Staff, in evaluating the augmented system, has concluded that the steps taken by the Applicant are acceptable and considered to be practicable and represent the state-of-the-art. The model used by the Staff to calculate the estimated iodine releases is based on the best available, but very limited amount of operating data and a number of assumptions. Because of the lack of sufficient operating data, the Staff's assumptions on nuclide deposition, plate-out, the partitioning factors for radioiodines released, and species composition have been established on a conservative basis. Therefore, the actual dose may be much less than the calculated value. Although the potential thyroid dose to a child from drinking milk from a cow pastured at the site boundary is presently estimated to be in excess of the 5 mrem/yr "low-as-practicable" values, in consideration of the uncertainties and built-in conservatism in the Staff's calculations, we consider the augmented gaseous radioactive waste treatment system to be acceptable. Nevertheless, the Staff will require the Applicant to undertake a sampling and monitoring program of the cow's milk and the vegetables growing in gardens at the site boundary to confirm the predictions of dose at the boundary and to insure that the actual dose to any individual does not exceed 5 mrem/yr.

The dose calculations made in this statement were made primarily on the basis of weather data from the Moisant airport.[47] Calculations were also made using partial weather data from the Waterford site meteorological station. The dose calculations were essentially the same. Nevertheless, the Staff does not consider the weather data from the airport to be adequate to characterize the Waterford site weather, and concludes that complete weather data be obtained at the site so that confirming dose prediction calculations due to the release of gaseous effluents can be made for normal operating conditions and for plant accident situations

E. ENVIRONMENTAL MONITORING

The brief bioenvironmental monitoring and sampling program conducted by Ebasco Services, Inc. for Louisiana Power and Light Company was conducted to provide a basis for the development of a more comprehensive environmental monitoring and surveillance program to be carried out prior to operation of Waterford 3 and to be continued for a period of at least one year of plant operation.

The Applicant has committed to an ecological studies program which will focus on two areas of investigation, monitoring and sampling -- (1) Aquatic Studies and (2) Radiological Studies.[5] The specifics of the program are as follows:

1. Aquatic Studies

The objectives set forth by the Applicant[5] include collecting, analyzing and interpreting sufficient data to establish a baseline which characterizes the aquatic ecology of the Mississippi River; to establish a monitoring and surveillance network to allow assessment of the effect of the operation of Waterford 3 on the river biota; to confirm the calculations and estimates of the thermal effects of the Waterford Units 1 and 2 discharges in the vicinity of Unit 3 intake; and to determine the existence and location of river back eddy at varying flow conditions of the river. The studies, discussed below, will be carried out for a period of two years before the startup of operation of Waterford 3 and are planned to continue for at least the first two years of Waterford 3 operation.

Primary emphasis will be given to the determination of the distributions and abundances of fish, benthic organisms and planktonic organisms. Emphasis on the fish surveys and monitoring will be directed to determining the more prevalent species and those more sensitive to higher temperature regimes. River shrimp, the clam and the mayfly (Tortopus sp.) will be the principal invertebrate indicators. Since phytoplankton form the base of all aquatic food chains and zooplankton are immediate food chain components and may be affected minimally by the operation of Waterford 3, the Applicant has stated an intent to monitor and document the population of these organisms. The Applicant further states that the monitoring program should include estimates of select physical, chemical and biological parameters, with the biological populations monitored at several trophic levels. The Applicant cites the following parameters which might be monitored:

temperature	dissolved oxygen
salinity	river current
detritus	productivity of species
planktonic life	benthic organisms
fish eggs and larvae	fish inventory

The Applicant further states that the planned aquatic surveillance program will include: (1) continuous water quality monitoring at the Unit 3 intake structure and at a control station yet to be selected; (2) river current and dye diffusion measurements during low and high flow conditions; (3) biological and water quality sampling during each of the four yearly seasons at selected stations around the Waterford site; and (4) periodic water quality sampling for detailed chemical analysis.

With respect to the water quality monitors, the Applicant will install continuous water quality monitors at a location near the Unit 3 intake and at a control station, probably in the vicinity of the Little Gypsy intake structure. These monitors will record the temperature increase and change in water quality at the Unit 3 intake as a result of the cooling water discharge from Units 1 and 2. Prior to operation of Unit 1, the relationship between water temperature and quality measured at the control station and at the Unit 3 intake will be established.

These monitoring stations will also continuously measure temperature, dissolved oxygen concentrations, pH, and conductivity at one depth in the water column. At the Waterford 3 intake, however, water temperature will be measured at four depths in order to verify predictions of intake water temperature.

The current and dye measurement program will include the release of dye at the location of the Units 1 and 2 intake and dye concentration measurement survey conducted in the river. Concurrent with this survey, river currents, direction and velocities will be measured in the vicinity of the Waterford Plant. In addition to the above, the dye surveys, conducted at a time of low flow (200,000 cfs or less) and of high flow (750,000 cfs or greater), will also substantiate the existence, location and extent of the river back eddy that was observed and measured during the preoperational survey. So that effects of power plant operation on the back eddy can be fully established, the dye studies will be repeated when Unit 1 becomes operational and again after both Units 1 and 2 are on line.

The Applicant proposes the ecological sampling program to be conducted four times each year, and is directed toward providing: (1) the status of river organisms, including plankton, benthos and fish, prior to the operation of any generating units at Waterford; (2) the effects, if any, of Units 1 and 2 on the relatively productive area upstream of Units 1 and 2 discharge; (3) a determination of the effects of Units 1 and 2 discharge, if any, on the Unit 3 intake and discharge areas and; (4) the response of organisms downstream of Unit 3 to the discharge from that unit.

In addition, a control station, unaffected by any heated effluent, will provide a measure of changes which occur naturally in the Mississippi River ecosystem. Natural changes in the river's biota, if observed only at stations affected by thermal discharges, may well be attributed to plant operation rather than to natural environmental variables.

Three sampling stations will be established in the vicinity of the Waterford site for the spring and fall ecology surveillance programs and the more frequent water quality monitoring program.

At each station, water samples will be analyzed for more than 40 chemical and physical parameters including inorganic plant nutrients, heavy metals and organic wastes. Water samples will also be taken for phytoplankton analysis. Each sample will be analyzed for dry weight, chlorophyll, carbon, phosphorus, nitrogen and ATP content. The water will also be used to estimate primary productivity and aliquots will be preserved for taxonomic identification of phytoplankton.

A series of net tows will be made to collect zooplankton. Samples will be preserved for identification and taxonomy as well as for quantitative analysis.

The benthic fauna and fish population will be sampled in a manner similar to that described in the preoperational ecological survey. In addition to taxonomic identification, these data will be quantified.

A water chemistry program will detect changes in such parameters as plant nutrients, heavy metals, pesticides, organic materials and other constituents of Mississippi River water. Samples will be taken at monthly intervals until river flow and water temperatures reach their winter minima. With rising water level and increasing temperature, samples will be taken at weekly intervals to detect changes in chemical parameters, particularly the nitrogen and phosphorus compounds which are essential plant nutrients. When concentrations of these compounds increase, or if a spring phytoplankton bloom is observed, the springtime ecological field program will be initiated. When this program has been completed, monthly sampling will continue until the following spring.

In addition to providing information essential for the spring sampling schedule, the water chemistry program will provide additional data necessary to assess the Mississippi River environment.

The Staff concurs in the general scope and extent of the Aquatic Studies program set forth by the Applicant, however, it is the Staff's judgment that the following changes and additions be included in the program definition:

(1) Although the Staff considers the proposed number and location of sampling stations to be adequate for assessment of aquatic populations and the subsequent assessment of operational impact, we consider the frequency of sampling on an annual basis to be inadequate to detect seasonal changes in abundance of many of the aquatic organisms. The Staff recommends that the minimum frequency of sampling for fish and benthos be bimonthly (six times annually) and that the planktonic organisms be sampled on a monthly basis (12 times annually).

(2) A surveillance of the Waterford 3 intake screens should be undertaken to record the fish kill due to impingement. A sampling program should be formulated which would indicate the number of organisms entrained and the condition of the organisms after passage through the condensers.

(3) The inventories and measurements of the various species in the terrestrial and aquatic sectors should be made so that observed changes during plant operation can be related to the baseline population data, population dynamics and to the regeneration times of the organisms concerned and therefore allow substantiation of the ecological significance of any changes.

2. Radiological Studies and Monitoring

The Applicant's program consists of two parts.[5] One involves continuous monitoring of discharges to the environment for gross and specific radioactivity analysis. The second part involves analyses of a variety of environmental samples for radioactivity analysis.

The preoperational radioactivity monitoring program will be conducted determine the magnitude and nature of the radioactivity in the environ ment surrounding the site prior to the startup of the Waterford 3 unit This program is outlined in Table V-10 and is taken from the Applicant Environmental Report (Supplement 3). Proposed sampling stations on th Mississippi River and on the site are shown in Figures II-6 and V-5. In addition, the Applicant states that two radiological monitoring stations at least 10 miles from the site will also be established to document airborne radioactivity in those locations. It is also planne that the overall environmental monitoring program will be closely coor nated with any existing State of Louisiana programs for monitoring air water and agricultural products throughout the State of Louisiana.

TABLE V-10

PROPOSED ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

No.	Location	Type Analysis	Type Sample	Frequency Sampled	No. Samples & Volume	Minimum Sensitivity
1	W-1	Gross B - γ	River Water	Weekly	1 - 100 ml ea	2×10^{-10} μCi/cc
2	W-2	"	"	"	"	"
3	W-3	"	"	"	"	"
4	W-4	"	"	"	"	"
5	W-1	γ - Scan	"	Quarterly	1 - 1,000 ml ea	1.5×10^{-8} μCi/cc
6	W-2	"	"	"	"	"
7	W-3	"	"	"	"	"
8	W-4	"	"	"	"	"
9	W-1	Tritium B - γ	"	"	1 - 1,000 ml ea	4×10^{-8} μCi/cc
10	W-2	"	"	"	"	"
11	W-3	"	"	"	"	"
12	W-4	"	"	"	"	"
13	W-1	Gross B - γ	River Sediment	Monthly	1 - 2 kg ea	2×10^{-7} μCi/gm
14	W-2	"	"	"	"	"
15	W-3	"	"	"	"	"
16	W-4	"	"	"	"	"

TABLE V-10 (Cont'd)

PROPOSED ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

No.	Location	Type Analysis	Type Sample	Frequency Sampled	No. Samples & Volume	Minimum Sensitivity
17	W-3	Gross B - γ	Fish	Quarterly	1 - 2 kg	2 x 10^{-7}μCi/gm
18	W-4	"	"	"	"	"
19	W-1	γ - Scan	River Sediment	"	1 - 2 kg	1 x 5^{-8} x 10 μCi/cc
20	W-2	"	"	"	"	"
21	W-3	"	"	"	"	"
22	W-4	"	"	"	"	"
23	W-3	γ - Scan	Fish	Quarterly	4 - .5 kg	1.5 x 10^{-8}μCi/cc
24	W-4	"	"	"	"	"
25	W-3	Gross B - γ	Plankton	"	4 - 100 kg	2 x 10^{-10}μCi/cc
26	W-4	"	"	"	"	"
27	W-3	"	Benthic Organisms	"	"	"
28	W-4	"	"	"	"	"
29	W-3	"	Silt	"	"	"
30	W-4	"	"	"	"	"

TABLE V-10 (Cont'd)

PROPOSED ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

No.	Location	Type Analysis	Type Sample	Frequency Sampled	No. Samples & Volume	Minimum Sensitivity
31	A-1	Gross B - γ	Hi-Vol. Air Sampler Filter	Monthly	1 - 20 min	$1 \times 10^{-12} \mu Ci/cc$
32	A-5	"	"	"	"	"
33	A-8	"	"	"	"	"
34	A-12	"	"	"	"	"
35	A-1	I^{131}	Charcoal Filter	Quarterly	1 - 30 min	-
36	A-5	"	"	"	"	"
37	A-8	"	"	"	"	"
38	A-12	"	"	"	"	"
39	A-1	Air Total B - γ	TLD	Quarterly Integrated	1 - N.A.	5 mr
40	A-2	"	"	"	"	"
41	A-3	"	"	"	"	"
42	A-4	"	"	"	"	"
43	A-5	"	"	"	"	"
44	A-6	"	"	"	"	"
45	A-7	"	"	"	"	"
46	A-8	"	"	"	"	"

TABLE V-10 (Cont'd)

PROPOSED ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

No.	Location	Type Analysis	Type Sample	Frequency Sampled	No. Samples & Volume	Minimum Sensitivity
47	A-9	Air Total B - γ	TLD	Quarterly Integrated	1 - N.A.	5 mr
48	A-10	"	"	"	"	"
49	A-11	"	"	"	"	"
50	A-12	"	"	"	"	"
51	A-13	"	"	"	"	"
52	A-14	"	"	"	"	"
53	A-15	"	"	"	"	"
54	A-16	"	"	"	"	"
55	A-17	"	"	"	"	"
56	A-18	"	"	"	"	"
57	S-1	Gross B - γ	Gross	Quarterly	1 - 2 kg	2×10^{-10} μCi/cc
58	S-2	"	"	"	"	"
59	S-3	"	"	"	"	"
60	S-4	"	"	"	"	"
61	S-1	Gross B - γ	Sugar Cane	"	"	"
62	S-3	"	"	"	"	"

TABLE V-10 (Cont'd)

PROPOSED ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

No.	Location	Type Analysis	Type Sample	Frequency Sampled	No. Samples & Volume	Minimum Sensitivity
63	S-1	Gross B - γ	Soil	Quarterly	1 - 2 kg	2×10^{-10} μCi/cc
64	S-2	"	"	"	"	"
65	S-3	"	"	"	"	"
66	S-4	"	"	"	"	"
67	W-1	B - γ	River Water	Continuous	N.A.	1×10^{-9} μCi/cc
68	W-2	"	"	"	"	"
69	A-1	"	Air	"	"	1×10^{-7} μCi/cc
70	A-19	I-131	milk	Monthly	1-500 ml	1×10^{-8} μCi/cc
71	A-19	I-131	grass	Quarterly	1-2 kg	2×10^{-6} μCi/gm
72	A-19	I-131	leafy garden vegetables	Seasonally (at harvest)	1-2 kg	2×10^{-6} μCi/gm

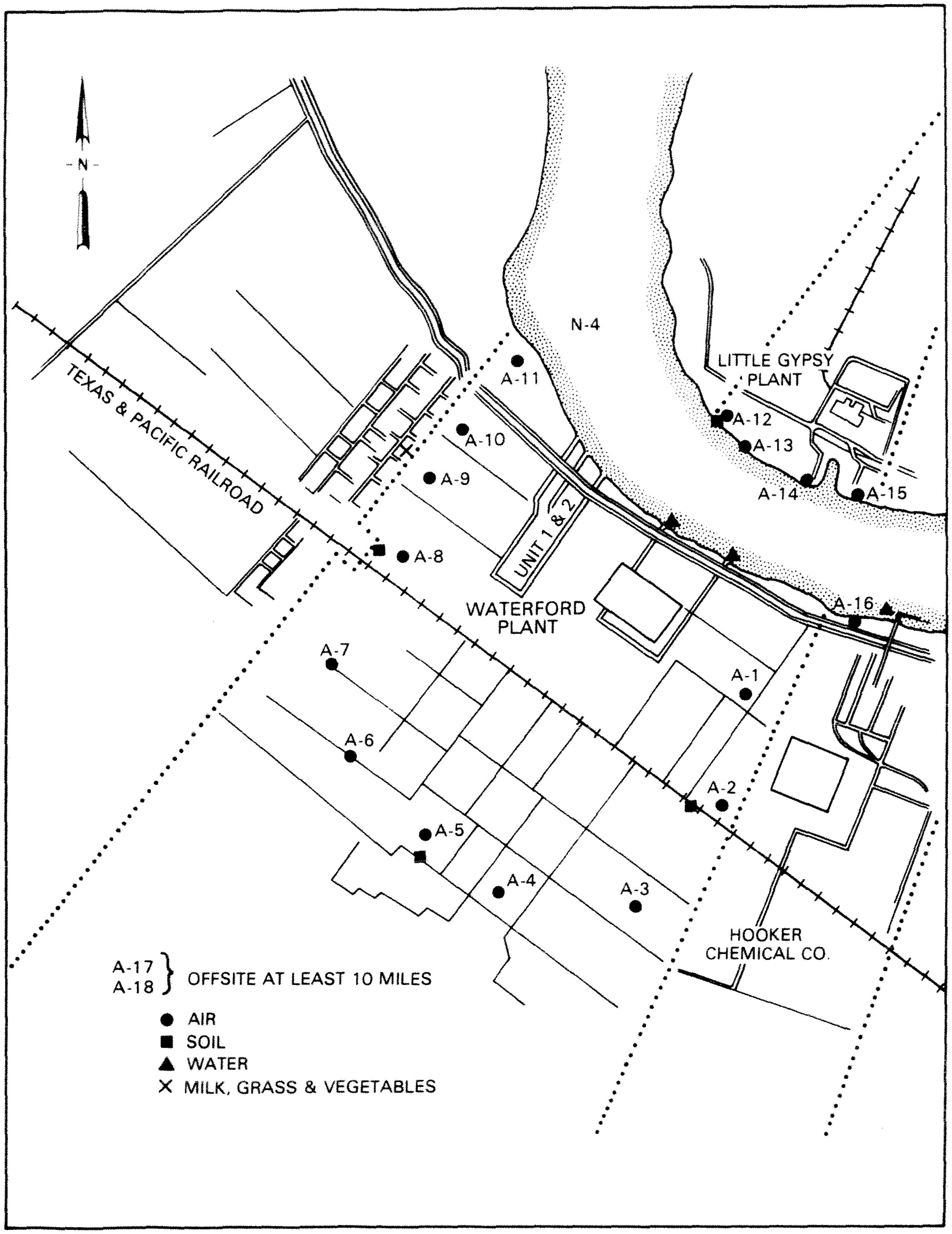

FIGURE V-5. RADIOLOGICAL SAMPLING STATIONS

The Applicant has proposed that the scope and extent of the post-operational program will be modified if any sample analysis or monitoring indicate that the average quarterly plant discharge of radioactivity is in excess of values specified in AEC regulations, including those in proposed Appendix I, 10 CFR 50.

Further, in the development of the environmental radiation monitoring program as it concerns the marine environment, special emphasis will be given to determining if reconcentration of specific nuclides occurs. Included in this part of the program are sampling of river water, bottom sediments, fish and other organisms living in the river.

The Staff considers the Applicant's proposed pre-operational and post-startup radiological monitoring program to be adequate, except for the following:

(1) In order to more readily follow short term variations of radioiodine levels in milk from family cows close to the site boundary, the sampling frequency for this critical food should be increased to weekly during the period in which fresh forage is used for grazing. Also, the sample volumes should be large enough to enable the decrease in the detection limit so as to insure that annual dose to the thyroid of any individual dose not exceed 5 mrem.

(2) The applicant will expand the radiological monitoring program shown in Table V-11 to include a representation of terrestrial species and aquatic vegetation for analysis and considered to be adequate by the Staff.

The detailed procedures, numerical limits, if any, and specific criteria for the postoperational radiological monitoring program will be precisely defined and included in the Technical Specifications for the operation of the Waterford Unit 3 to be developed during the operating license stage.

F. TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for the Plant is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in Zircaloy-clad fuel rods. Each year in normal operation, about 73 fuel elements are replaced. The Applicant has indicated that new fuel for the reactor will be supplied by Combustion Engineering, Inc., and will be transported by truck. The Applicant has not indicated where the irradiated fuel or solid radioactive wastes will be shipped. He did indicate transportation by road, rail or water is available. The Staff assumed a distance of 700 miles (Barnwell, South Carolina) for shipping the irradiated fuel and 900 miles (Morehead, Kentucky) for the solid radioactive wastes.

1. Transport of New Fuel

The Applicant has indicated that new fuel will be shipped in AEC-DOT approved containers which hold two fuel elements per container. About 5 truckloads of 6 containers each will be required each year for replacement fuel and about 15 truckloads for the initial loading.

2. Transport of Irradiated Fuel

Fuel elements removed from the reactor will be unchanged in appearance and will contain some of the original uranium-235 (which is recoverable). As a result of the irradiation and fissioning of the uranium, the fuel element will contain large amounts of fission products and some plutonium. As the radioactivity decays, it produces radiation and "decay heat." The amount of radioactivity remaining in the fuel varies according to the length of time after discharge from the reactor. After discharge from a reactor, the fuel elements are placed under water in a storage pool for cooling prior to being loaded into a cask for transport.

Although the specific cask design has not been identified, the Applicant states that the irradiated fuel elements will be shipped in approved casks after at least 120 days cooling period. The cask will weigh perhaps 30 tons for truck shipment to 100 tons for shipment by rail or water. To transport the irradiated fuel, the Applicant estimates 50 to 75 truck shipments, 5 to 7 rail shipments, or 2 boat shipments/yr. An equal number of shipments will be required to return the empty casks.

3. Transport of Solid Radioactive Wastes

The Applicant estimates that about 10,000 gallons/yr of evaporator bottoms, 288 cubic feet of demineralizer resins, 12 filter baskets and 300 cubic feet of miscellaneous solid radioactive wastes will be generated by the operation of Unit 3. Spent resins and waste evaporator bottoms will be solidified and soft, solid wastes compacted in drums for shipment and disposal. The Staff estimates about 15 truckloads of waste each year.

4. Principles of Safety in Transport

The transportation of radioactive material is regulated by the Department of Transportation (DOT) and the Atomic Energy Commission. The regulations provide protection of the public and transport workers from radiation.

This protection is achieved by a combination of standards and requirements applicable to packaging, limitations on the contents of packages and radiation levels from packages, and procedures to limit the exposure of persons under normal and accident conditions.

Primary reliance for safety in transport of radioactive material is placed on the packaging. The packaging must meet regulatory standards established according to the type and form of material for containment, shielding, nuclear criticality safety, and heat dissipation.[53] The standards provide that the packaging shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety, and provide adequate heat dissipation under normal conditions of transport and under specified accident damage test conditions. The contents of packages not designed to withstand accidents are limited, thereby limiting the risk from releases which could occur in an accident. The contents of the package also must be limited so that the standards for external radiation levels, temperature, pressure, and containment are met.

Procedures applicable to the shipment of packages of radioactive material require that the package be labelled with a unique radioactive materials label. In transport the carrier is required to exercise control over radioactive material packages including loading and storage in areas separated from persons and limitations on aggregations of packages to limit the exposure of persons under normal conditions. The procedures carriers must follow in case of accident include segregation of damaged and leaking packages from people and notification of the shipper and DOT.

Through the provisions of a government inter-agency agreement, radiological emergency assistance teams are available, upon request, to bring into action essentially every kind of currently available trained manpower, equipment, facilities and service capability applicable to radiological emergencies. The activities of inter-agency radiological assistance teams are coordinated with state, county and local government organizations and their emergency capabilities.

Within the regulatory standards, radioactive materials are required to be safely transported in routine commerce using conventional transportation equipment with no special restrictions on speed of vehicle, routing, or ambient transport conditions. According to DOT, the record of safety in the transportation of radioactive materials exceeds that for any other type of hazardous commodity. DOT estimates approximately 800,000 packages of radioactive materials are currently being shipped in the United States each year. Thus far, based on the best available information, there have been no known deaths or serious injuries to the public or to transport workers due to radiation from a radioactive material shipment.

Safety in transportation is provided by the package design and limitations on the contents and external radiation levels and does not depend on controls over routing. Although the regulations require all carriers of hazardous materials to avoid congested areas[54] wherever practical to do so, in general, carriers choose the most direct and fastest route. Routing restrictions which require use of secondary highways, or other than the most direct route, may increase the overall environmental impact of transportation as a result of increased accident frequency or severity. Any attempt to specify routing would involve continued analysis of routes in view of the changing local conditions as well as changing of sources of material and delivery points.

5. Exposures During Normal (No Accident) Conditions

a. New Fuel

Since the nuclear radiations and heat emitted by new fuel are small, there will be essentially no effect on the environment during transport under normal conditions. Exposure of individual transport workers is estimated to be less than 1 millirem (mrem)/shipment. For the 5 shipments, with two drivers for each vehicle, the total dose would be about 0.01 man-rem/yr. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 6 ft from the truck. A member of the general public who spends 3 minutes at an average distance of 3 ft from the truck might receive a dose of about 0.005 mrem/shipment. The dose to other persons along the shipping route would be extremely small.

b. Irradiated Fuel

Based on actual radiation levels associated with shipments of irradiated fuel elements, the Staff estimates the radiation level at 3 ft from the truck or the rail car will be about 25 mrem/hr.

The average dose to the individual truck driver during a 700-mile shipment of irradiated fuel is estimated to be about 15 mrem. With two drivers on each vehicle, the annual cumulative dose for 75 shipments would be about 2.25 man-rem.

Train brakemen might spend a few minutes in the vicinity of the car at an average distance of 3 ft, for an average exposure of about 0.5 mrem/shipment. With 10 different brakemen involved along the route, the annual cumulative dose for 10 shipments during the year is estimated to be about 0.05 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 ft from the truck or rail car, might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose would be about 1 man-rem for truck shipments and 0.1 man-rem for rail shipments. Water shipments would be unlikely to involve any such exposures. Approximately 210,000 persons who reside along the 700-mile route over which the irradiated fuel is transported might receive an annual cumulative dose of about 0.9 man-rem for truck shipments and 0.09 man-rem for rail shipments. For water shipments, the number of persons would be about 70,000 and the annual cumulative dose, about 0.008 man-rem. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 ft from the vehicle was used to calculate the integrated dose to persons in an area between 100 ft and 1/2 mile on both sides of the shipping route. It was assumed the shipment would travel 200 miles/day and the population density would average 330 persons/square mile along the route except that for water shipment it was estimated that persons were within 1/2 mile of the shipment only 1/3 of the time.

The amount of heat released to the air from each cask will vary from about 10 kW for a truck cask to 70 kW for a cask shipped by rail or water. This might be compared to about 50 kW of waste heat which is released from a 100 horsepower truck engine. Although the temperature of the air which contacts the loaded cask may be increased a few degress, because the amount of heat is small and is being released over the entire transportation route, no appreciable thermal effects on the environment will result.

c. Solid Radioactive Wastes

Under normal conditions, the individual truck driver might receive as much as 15 mrem/shipment. If the same driver were to drive 15 truckloads in a year, he could receive an estimated dose of about 225 mrem during the year. The cumulative dose to all drivers for the year, assuming 2 drivers/vehicle, might be about 0.5 man-rem. A member of the general public who spends 3 minutes at an average distance of 3 ft from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed/shipment, the annual cumulative dose would be about 0.2 man-rem. Approximately 270,000 persons who reside along the 900-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.2 man-rem. These doses were calculated for persons in an area between 100 ft and 1/2 mile on either side of the shipping route, assuming 330 persons/square mile, 10 mrem/hr at 6 ft from the vehicle, and the shipment traveling 200 miles/day.

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VI. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

A. PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Waterford Steam Electric Station Unit No. 3 is provided by conservative design, manufacture, and operation, and by the quality assurance program used to assure the necessary high integrity of the reactor system, as will be considered in the Commission's Safety Evaluation. Off-normal conditions that might occur are handled by protective systems designed to place and hold the nuclear plant in a safe condition. Notwithstanding this, the conservative postulation is made that serious accidents might occur, even though they are extremely unlikely; and engineered safety features are installed to mitigate the consequences of these postulated events.

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

The Commission issued guidance to applicants on September 1, 1971 requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicant's response was contained in the revised "Environmental Report - Construction Permit Stage", dated February 24, 1972.

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

TABLE VI-1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

No. of Class	AEC Description	Applicant's Examples
1	Trivial incidents	Not considered
2	Misc. small releases outside containment	(a) 10 gpd continuous leakage (b) 1000 gallons from pipe crack
3	Radwaste System failures	(a) Gas: 5-second erroneous release (b) Liquid & Gas: 5-second erroneous release
4	Events that release radioactivity into the primary system (BWR)	Considered only as related to other classes (0.1% failed fuel).
5	Events that release radioactivity into the primary and secondary systems (PWR)	Loss of load with 5 gph leakage into secondary system
6	Refueling accidents	Dropped fuel assembly; 14 fuel rods fail
7	Spent Fuel Handling Accident	Dropped fuel assembly: 14 fuel rods fail
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	(a) Loss of coolant: all fuel cladding fails (b) Control rod ejection: no fuel cladding failure (c) Double-ended steam generator tube rupture (d) Main steam line rupture
9	Hypothetical sequences of failures more severe than Class 8	Not considered

examples are reasonably homogeneous in terms of probability within each class, although the Staff considers the steam generator tube rupture as more appropriately in Class 5 (the Applicant uses Class 8). Certain assumptions made by the Applicant to evaluate the consequences of postulated accidents do not exactly agree with those in the proposed Annex to Appendix D, but the use of alternative assumptions does not significantly affect the overall environmental risk.

Commission estimates of the dose that might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table VI-2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table VI-2. The man-rem estimate is based on the projected population around the site for the year 2010.

To rigorously establish a realistic annual risk, the calculated doses in Table VI-2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operation; and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; but events of this type could occur sometime during the 40 year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but still are possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table VI-2 are weighted by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design basis of protective systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently low in probability that the environmental risk is extremely low.

Table VI-2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of

TABLE VI-2

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary 1/	Estimated Dose to population in 50 mile radius, man-rem
1.0	Trivial incidents	2/	2/
2.0	Small releases outside containment	2/	2/
3.0	Radwaste System failures		
3.1	Equipment leakage or malfunction	0.039	7.0
3.2	Release of waste gas storage tank contents	0.16	28
3.3	Release of liquid waste storage contents	0.004	0.77
4.0	Fission products to primary system (BWR)	N.A.	N.A.
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	2/	2/
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	<0.001	0.16
5.3	Steam generator tube rupture	0.052	9.2
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.008	1.4
6.2	Heavy object drop onto fuel in core	0.14	25

TABLE VI-2 (Cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[1/]	Estimated Dose to population in 50-mile radius, man-rem
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop on fuel rack	0.005	0.92
7.2	Heavy object drop onto fuel rack	0.021	3.7
7.3	Fuel cask drop	N. A.	N. A.
8.0	Accident initiation events considered in design basis evaluation in the Safety Analysis Report		
8.1	Loss-of-Coolant Accidents		
	Small Break	0.086	28
	Large Break	0.093	53
8.1(a)	Break in instrument line from primary steam that penetrates the containment	N. A.	N. A.
8.2(a)	Rod ejection accident (PWR)	0.009	5.3
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small Break	<0.001	<0.1
	Large Break	<0.001	<0.1
8.3(b)	Steamline Break (BWR)	N. A.	N. A.

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

2/ These releases are expected to be in accord with proposed Appendix I for routine effluents (i.e., 5 mrem per year to an individual from either gaseous or liquid effluents).

radioactive materials within the Maximum Permissible Concentrations (MPC) of Table II of 10 CFR Part 20. The tabulated information also shows that the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident would be orders of magnitude smaller than that from naturally occurring radioactivity. The exposure from naturally occurring radioactivity corresponds to approximately 2500 man-rem per year within a 5 mile radius and 240,000 man-rem/yr within a 50 mile radius of the site. This is based on a natural background level of 100 mrem/year. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation, and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small.

B. TRANSPORTATION ACCIDENTS

Exposures Resulting From Postulated Accidents

Based on recent accident statistics,[1] a shipment of fuel or waste may be expected to be involved in an accident about once in a total of 750,000 shipment-miles. The Staff has estimated that only about 1 in 10 of those accidents which involve Type A packages or 1 in 100 of those involving Type B packages might result in any leakage of radioactive material. In case of an accident, procedures which carriers are required[2] to follow will reduce the consequences of an accident in many cases. The procedures include segregation of damaged and leaking packages from people, and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-governmental program to provide equipped and trained personnel. These teams, dispatched in response to calls for emergency assistance, can mitigate the consequences of an accident.

1. New Fuel

Under accident conditions other than accidental criticality, the pelletized form of the nuclear fuel, its encapsulation, and the low specific activity of the fuel limit the radiological impact on the environment to negligible levels.

The packaging is designed to prevent criticality under normal and severe accident conditions. To release a number of fuel assemblies under conditions that could lead to accidental criticality would require severe damage or destruction of more than one package, which is unlikely to happen in other than an extremely severe accident.

The probability that an accident could occur under conditions that could result in accidental criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 ft from the accident might receive a serious exposure; but beyond that distance, no detectable radiation effects would be likely. Persons within a few feet of the accident could receive fatal or near-fatal exposures unless shielded by intervening material. Although there would be no nuclear explosion, heat generated in the reaction would probably separate the fuel elements so that the reaction would stop. The reaction would not be expected to continue for more than a few seconds and normally would not recur. Residual radiation levels due to induced radioactivity in the fuel elements might reach a few roentgens per hour at 3 ft. There would be very little dispersion of radioactive material.

2. Irradiated Fuel

Effects on the environment from accidental releases of radioactive materials during shipment of irradiated fuel have been estimated for the situation where contaminated coolant is released and the situation where gases and coolant are released.

a. Leakage of contaminated coolant

Leakage of contaminated coolant resulting from improper closing of the cask is possible as a result of human error, even though the shipper is required to follow specific procedures which include tests and examination of the closed container prior to each shipment. Such an accident is highly unlikely during the 40-year life of the Plant.

Leakage of liquid at a rate of 0.001 cc/second or about 80 drops/hour is about the smallest amount of leakage that can be detected by visual observation of a large container. If undetected leakage of contaminated liquid coolant were to occur, the amount would be so small that the individual exposure would not exceed a few mrem and only a very few people would receive such exposures.

b. Release of gases and coolant

Release of gases and coolant is a very remote possibility. In the improbable event that a cask is involved in an extremely severe accident such that the cask containment is breached and the cladding of the fuel assemblies penetrated, some of the coolant and some of the noble gases might be released from the cask.

In such an accident, the amount of radioactive material released would be limited to the available fraction of the noble gases in the void spaces in the fuel pins and some fraction of the low level contamination in the coolant. Persons would not be expected to remain near the accident due to the severe conditions which would be involved, including a major fire. If releases occurred, they would be expected to take place in a short period of time. Only a limited area would be affected. Persons in the downwind region and within 100 ft or so of the accident might receive doses as high as a few hundred mrem. Under average weather conditions, a few hundred square feet might be contaminated to the extent that it would require decontamination (that is, Range I contamination levels) according to the standards[3] of the Environmental Protection Agency.

3. Solid Radioactive Wastes

It is highly unlikely that a shipment of solid radioactive waste will be involved in a severe accident during the 40-year life of the Plant. If a shipment of low-level waste (in drums) becomes involved in a severe accident, some release of waste might occur but the specific activity of the waste will be so low that the exposure of personnel would not be expected to be significant. Other solid radioactive wastes will be shipped in Type B packages. The probability of release from a Type B package, in even a very severe accident, is sufficiently small that, considering the solid form of the waste and the very remote probability that a shipment of such waste would be involved in a very severe accident, the likelihood of significant exposure would be extremely small.

In either case, spread of the contamination beyond the immediate area is unlikely and, although local clean-up might be required, no significant exposure to the general public would be expected to result.

4. Severity of Postulated Transportation Accidents

The events postulated in this analysis are unlikely but possible. More severe accidents than those analyzed can be postulated and their consequences could be severe. Quality assurance for design, manufacture, and use of the packages, continued surveillance and testing of packages and transport conditions, and conservative design of packages insure that the probability of accidents of this latter potential is sufficiently small that the environmental risk is extremely low. For those reasons, more severe accidents have not been included in the analysis.

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VII. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

Waterford Unit 3 occupies about 100 acres of the 3,600-acre site. This area, the corresponding area occupied by the fossil-fueled plants, the switchyard areas and other smaller areas are already cleared and are no longer in the natural state. The impact of altering the shoreland has already been made.

The Plant will require about 3.5×10^5 gal/day of fresh water; this will be obtained from the Mississippi River. The temperature increase in the discharge canal and in the mixing zone due to the spent cooling water will increase the evaporative losses both in the canal and in the river. This will amount to less than 25 acre-ft/day; this is a small loss and should not contribute to changes in climate nor influence fogging conditions.

Water temperatures of 5.4°F above ambient in the discharge zone are expected to occur in about 70 acres; if sessile flora and fauna are contacted by such waters, there is a potential for damage. Mobile forms in the proximity of such a zone are expected to avoid exposures of duration sufficient to harm them.

Chemicals and radioactive materials added to the effluent water should be of such small concentrations and activities that no toxic or long-term accumulative effects in the river are to be expected. Adverse effects due to chemical releases combined with the increased temperature are not expected.

Impingement of small and juvenile aquatic organisms on the intake screens will cause a measurable but insignificant loss to the ecosystem. Phytoplankton, zooplankton and larval fish forms drawn into the intakes may be killed in passing through the condensers and canal. Even if the kill is 100%, this loss will have negligible effect on the overall productivity of the river ecosystem.

The Applicant's commitment to the alternative of discharge of chemicals to the Mississippi River will substantially reduce potential adverse effects and the staff believes the effect of the chemicals on aquatic life in the river will be negligible.

Releases of radioactive materials in the gaseous effluents will conform to requirements that they be as low-as-practicable so that the resulting dose to people in the environs will be within an acceptable range and the overall effect on the environment will be insignificant.

There will be some visual impact of the Plant but the high point, the top of the reactor containment building, is lower than the boiler houses of the fossil plants and particularly their chimneys. The transmission corridors and steel towers were planned, by choice of route and materials, to be unobtrusive. The former avoided poir of interest and scenic locations.

VIII. SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

A. SHORT-TERM USES

Waterford Unit 3 has been designed to maintain at a very low level the impact on resources. The Plant itself will use a portion of the Waterford site that has been cleared of its native vegetation for many years. During construction only about 100 acres of the 3600-acre site will be taken out of agricultural production and used for spoil deposition, storage yard, parking lots, warehouse and construction sheds, switchyard and the permanent facilities associated with the nuclear plant. The Applicant states that after construction that portion of the modified lands not needed for Plant operation will be regraded and landscaped.

The Mississippi River will be used to supply water for cooling and to receive it again as heated condenser water. The atmosphere will be used to receive and disperse small quantities of radioactive gaseous wastes. The Plant will use various materials of construction such as steel and concrete and approximately 42,570 kg of uranium-235 will be expended during a 30 year operating period.[1]

B. LONG-TERM PRODUCTIVITY

Sport fishing in the Mississippi River near the Plant is limited and commercial fishing between the towns of La Place and Hahnville, Louisiana (a 50-mile section of the river in which the Site falls) yields about 20,000 lb of fish annually. About 80% of the commercial catch is catfish and the remainder is sheepshead. In 1968, the State of Louisiana had 40 fish wholesaling and processing establishments employing an average of 162 persons per year, only a small portion of which utilized fish taken near the Site.

The Plant will have little short or long-term effect on either sport or commercial fishing. Some river fish may gather below the discharge plume along the right bank of the river when water temperatures are cold during winter months, as has been observed at other plant sites. Thus, recreational fishing during the winter could improve near the Plant.

Features that limit fish populations, in the lower Mississippi River, are not expected to change significantly over the next 50 years. These features include channelization for flood control, heavy silt loads, industrialization and river traffic, the annual temperature and discharge cycles, and water quality characteristics.

Operation of the Plant is scheduled for the summer of 1977. The Applicant estimates that about 45 employees will be needed to operate the Plant. Over the long-term, the annual payroll of these employees will average about $950,000.

C. DECOMMISSIONING STATION AFTER OPERATING LIFE

No specific plan for the decommissioning of Waterford Unit No. 3 has been developed. This is consistent with the Commission's current regulations which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a proposed decommissioning plan which is submitted to the AEC for review. The licensee will be required to comply with Commission regulations then in effect and decommissioning of the facility may not commence without authorization from the AEC.

To date, experience with decommissioning of civilian nuclear power reactors is limited to six facilities which have been shut down or dismantled: Hallam Nuclear Power Facility, Carolina Virginia Tube Reactor (CVTR), Boiling Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor, and the Elk River Reactor.

There are several alternatives which can be and have been used in the decommissioning of reactors: (1) Remove the fuel (possibly followed by decontamination procedures); seal and cap the pipes; and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. (2) In addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. (3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill all cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor. Alternative decommissioning procedures (1) and (2) would require long-term surveillance of the reactor site. After a final check to assure that all reactor-produced radioactivity has been removed, alternative (3) would not require any subsequent surveillance. Possible effects of erosion or flooding will be included in these considerations.

At the Waterford site, the land adjacent to the river currently contains a considerable amount of industrial development from New Orleans to Baton Rouge. This trend may be further influenced by the construction of a new state highway which passes through the middle of the 3600 acre site. Although there is no formal commitment to industrialize this area, the present indications appear to point in this direction. Accordingly, it is quite unlikely that the Waterford site will be returned to its original state as a plantation. It is expected that the site will continue to be used for power production even after the operating life of Waterford Unit 3.

The Applicant has estimated the cost of permanently shutting down the facility, including reactor core removal, decontamination of remaining components, and building isolation, at approximately $1,900,000 on a present cost basis. In addition, the cost of maintaining the shutdown facility in a safe condition is estimated to be $40,000 annually.

In cost-benefit considerations, future decommissioning costs should be discounted to obtain their present worth. At a current discount rate of 6% per year for a 30-year operating period, costs incurred at the end of that operating period would be divided by 5.7 to determine their present worth. The present worth of future costs involved would be about $446,000. Thus, the decommissioning costs would not appreciably alter any of the conclusions of the cost-benefit analysis in this statement.

REFERENCES

1. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit No. 3, Environmental Report, Supplement No. 1, Docket No. 50-382, Question E 11-1, July 26, 1972.

IX. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The materials and the land used by the Plant, together with the uranium-235 used as fuel are the only resources irreversibly and irretrievably committed by the construction and operation of Waterford Station Unit 3.

The materials committed in construction of the Plant are those common to any large industrial plant: e.g., wood, iron and steel, aluminum and concrete. One and one-half million board feet of lumber, about 200,000 cubic yards of concrete, about 2500 tons of iron and steel, and about 100 tons of aluminum will be used in the construction of the reactor. While these are not strictly irretrievable, it is hardly conceivable that any one of them would be completely recovered except under conditions of dire stress.

The construction of the Plant has removed approximately 100 acres of sugar cane land from production. Upon completion of the useful life of the generating unit, the land conceivably could be converted back to sugar cane land or to other productive purposes. However, it is the Applicant's judgment, and the Staff concurs, that the Waterford site will remain committed to power generation and not be restored to its original agricultural use.

Uranium in the form of nuclear fuel, consumed by the fission process and converted into waste radioactive materials, is committed irreversibly and irretrievably. At Waterford 3, the initial core will contain 95,027 kg of uranium with three region enrichments of 1.9%, 2.3%, and 2.9% respectively. Equilibrium reloads will consist of approximately 31,000 kg uranium at an enrichment of 3.33%.

X. THE NEED FOR POWER

The Louisiana Power and Light Company is one of five operating companies of Middle South Utilities, Inc., whose systems serve portions of Louisiana, Mississippi, Arkansas and Missouri. Louisiana Power and Light provides electrical service to 358,033[1] customers over an area of about 19,500 square miles of northern and southeastern Louisiana (see Figure I-1). The service area includes parts or all of 46 of Louisiana's 64 parishes. The major load of the service area is located in the New Orleans portion of the state. In total, the Louisiana Power and Light service area has an estimated 1971 resident population of approximately 1,130,000.[1] Between 1960 and 1970, the service area population increased 38.5%. The Applicant expects the service area population to increase at a slightly lower rate during the 70's and projects the service area population to reach 1,400,000 by 1980.

Population growth of the service area, coupled with increased unit consumption of electricity (kilowatt sales per resident customer increased from 3411 in 1960 to 9239 in 1970-a 170% increase)[2] has caused a rapid increase in system electrical energy. During the same 10-year period, energy sales increased 328% producing an annual growth rate of 15.6%.[2] Louisiana Power and Light system peak load during the same period grew at an annual rate of 13.2%.[2] For the total Middle South Utilities, Inc., the 10-year system peak load grew at an annual rate of 10.2%.

Louisiana Power and Light shares reserves through contractual arrangement with the other utilities of the Middle South Utilities, Inc. system. In general, the system calls for the construction of new large base generating facilities to be located in the service area having the greatest deficit in its load, within certain transmission and fuel economic constraints. Because of long times necessary in planning and construction of major power facilities, Middle South Utilities' generation expansion program must be based on long-range electrical load demand forecasts. System forecasts indicate that system peak load will increase by about 1100 MWe between 1976 and 1977 and that the utility having the largest deficit is Louisiana Power and Light. The peak load for the Middle South Utilities system is projected to increase at a rate of 10.2% annually during the 1970's. The continuation of this growth rate takes into account the increasing use of electricity in environmental control such as air and water pollution control systems. In addition, as the Middle South Utilities system is required to convert operating gas-fired plants to other fossil fuels, some existing generation capacity is expected to be lost, requiring compensating capacity to be factored into the plans for new facilities. The planned generating capability additions for the Middle South Utilities System through 1980 are shown in Table X-1.

TABLE X-1

MIDDLE SOUTH UTILITIES SYSTEM PLANNED GENERATING CAPABILITY ADDITIONS THROUGH 1980

Year	Unit	Month	Unit Rating
1973	Ninemile 5	Mar	750 MW (LP&
1973	Arkansas Nuclear One, Unit 1	Sept	830 MW (AP&
1973	Sterlington 7A & B	May	100 MW (LP&
1974	Sterlington 7C	May	100 MW (LP&
1974	Waterford 1	Mar	430 MW (LP&
1975	Waterford 2	Jan	430 MW (LP&
1975	Andrus 1	Jan	750 MW (MP&
1976	Arkansas Nuclear One, Unit 2	Jan	950 MW (AP&
1977	Waterford 3	Summer	1165 MW (LP&
1978	Unassigned Capacity	Jan	1474 MW
1979	Unassigned Capacity	Jan	1595 MW
1980	Other MSU Utility	Jan	1290 MW
1980	Unassigned Capacity	Jan	465 MW

Summarized electrical forecasts for the Applicant and for the Middl South Utilities system for the year 1972 through 1980, are presented in Table X-2. Without Waterford Unit 3, the forecast indica that the Middle South Utilities, Inc. system and thus the Applicant

TABLE X-2

FORECASTED ELECTRICAL STATISTICS FOR LOUISIANA POWER AND LIGHT AND THE MIDDLE SOUTH UTILITIES SYSTEM (MW)

LOUISIANA POWER AND LIGHT

YEAR	SYSTEM CAPABILITY	PURCHASES WITHOUT RESERVES	TOTAL CAPABILITY	PEAK LOAD	PURCHASES WITH RESERVES	LOAD RESPONSIBILITY	DESIRED 16% RESERVES	ACTUAL RESERVE, % WITH NO. 3	ACTUAL RESERVE, % WITHOUT NO. 3
1972	2618	112	2730	2500	16	2484	397	---	10
1973	3363	112	3475	2770	-262	3032	485	---	15
1974	3893	112	4005	3098	-223	3321	531	---	21
1975	4275	112	4387	3459	-182	3641	583	---	20
1976	4275	112	4387	3863	120	3743	599	---	17
1977	5440	112	5552	4310	-484	4794	767	16	6

MIDDLE SOUTH UTILITIES SYSTEM

YEAR	SYSTEM CAPABILITY	PURCHASES WITHOUT RESERVES	TOTAL CAPABILITY	PEAK LOAD	SALES WITH RESERVES	PURCHASES WITH RESERVES	LOAD RESPONSIBILITY	DESIRED 16% RESERVES	ACTUAL RESERVE, % WITH NO. 3	ACTUAL RESERVE, % WITHOUT NO. 3
1972	7779	706	8485	7696	738	713	7721	1235	---	10
1973	8526	271	8797	8362	42	726	7678	1228	---	15
1974	9886	387	10273	9202	49	735	8516	1363	---	21
1975	10995	387	11382	10137	54	743	9448	1512	---	20
1976	11945	387	12332	11166	60	702	10524	1684	---	17
1977	13110	387	13497	12300	68	710	11658	1865	16	6
1978	14584	387	14971	13549	77	720	12906	2065	16	7
1979	16179	387	16566	14925	86	730	14281	2285	16	8
1980	17934	387	18321	16440	95	741	15794	2527	16	9

system will fall short of the system capability required to maintain a peak load reserve of 16%.

Louisiana Power and Light Company and Middle South Utilities are members of the National Electrical Reliability Council. To provide for the contingency of loss of MSU's two largest units and to provide a margin of protection against forecast load error, the National Electrical Reliability Council has indicated a desired system reserve base of 16%.

As noted in Table X-1, not all capacity additions to the Middle South Utilities system have been assigned; thus load and capacity forecasts for Louisiana Power and Light in Table X-2 cannot be provided for years beyond 1977.

REFERENCES - CHAPTER X

1. Louisiana Power and Light Company 1971 Annual Report.

2. Louisiana Power and Light Company 1970 Annual Report.

XI. ALTERNATIVES TO THE PROPOSED ACTION AND BENEFIT-COST ANALYSIS OF THEIR ENVIRONMENTAL EFFECTS

There are several alternatives to the selection and design of the Waterford Unit 3 Station. These include:

- Not providing the power
- Purchase of power
- Alternative power sources
- Selection of a site other than Waterford
- Alternative land uses of the chosen site
- Alternative heat disposal systems
- Alternative demineralizer waste disposal.

A. SUMMARY OF ALTERNATIVES

1. Not Providing Power

Based on forecasts of future power requirements, the alternative of not providing northern and southeastern Louisiana with an additional block of power represented by Waterford Unit 3 could allow a power shortage in the service area to occur and would have the following principal impacts: (1) reduction in system reserves with attendant risks of power outages; and (2) economic and societal impacts associated with a power shortage in the region. The need for power was demonstrated in Section X. Not providing the additional power represented by Waterford Unit 3 is, therefore, an untenable alternative.

2. Purchase of Power

The six companies forming the Middle South Utilities System (MSU) have agreed to share reserves and have agreed that new large generating units should be planned and sized to meet requirements of MSU as well as individual utility requirements. This arrangement allows efficient planning of regional transmission facilities and the construction of large efficient generating units.

The MSU and seven neighboring utilities who generally have peak loads during the summer months have arranged a diversity energy exchange with the Tennessee Valley Authority who has a winter peak load and thus generally has available excess capacity for export during summer months. The Applicant indicates that the total diversity capacity available for exchange is approximately 1,500,000 kilowatts and that the Applicant's (LP&L) share is only 159,000 kilowatts.

Waterford Unit 3 will provide 1165 MWe of baseload power for a 30 year period. The purchase of this large block of power from outside the MSU system would require a neighboring utility system to be willing to commit and build a large facility for the purpose of supplying MSU's power needs. Such a facility would have an environmental impact comparable to Waterford 3. The transmission of this large block of power to LP&L and other MSU utilities would have a greater environmental impact than that of the planned Waterford 3 transmission of power. The purchase of a large block of power equivalent to Waterford 3 is not considered a feasible long-term alternative.

3. Alternative Power Sources

Generation of power by means of fossil-fired plants is the only alternative means for generating power available to the Applicant, as there are no adequate hydroelectric or pumped storage sites available in the service area capable of providing a large block of firm power. Four types of fossil facilities have been considered by the Applicant: (1) diesel generators, (2) gas turbine generators, (3) a combined cycle plant, and (4) a steam electric plant fired by either natural gas, residual fuel oil or coal.

Typically diesel generators are small and range in capacity up to 15 MW. The large number required (80 to 120) and their high operation and maintenance cost make diesel generators an impractical substitute for Waterford Unit 3.

Use of gas turbine-peaking units, regardless of the type of fuel, as a substitute for a base loaded unit such as Waterford Unit 3 requires up to 60% more fuel than a comparable fossil-fired base loaded plant, and at the same time does not entirely eliminate environmental considerations. In addition, operating and maintenance costs are as much as eight times higher than other fossil-fired plants. Although the gas turbine units would not use Mississippi River water for cooling, their exhaust gas would contain significant amounts of nitrogen oxides and small quantities of sulfur oxides and particulates.

Fossil-fired steam electric plants can be designed to burn gas, oil or coal. Currently the Applicant's generating capacity is based on natural gas as the primary fuel. The Applicant, however, indicates that it has not been able to negotiate a satisfactory long-term contract for either natural gas or residual fuel oil. Since the Applicant could not negotiate a contract, only a coal-fired plant has been evaluated as an alternative to the Waterford Unit No. 3 nuclear generating facility.

The greatest environmental advantage of coal over nuclear fuels is the higher efficiency of converting thermal energy into electricity. In addition, about 10% of the discharge heat is discharged directly to the atmosphere. Thus, a coal-fired steam electric plant would discharge about 1500 MW to the Mississippi River; this is 67% of that discharged to the river by Waterford Unit 3.

Although a fossil-fired plant has a thermal efficiency advantage over a nuclear plant, this advantage must be balanced against the disadvantages of fuel transportation, fuel storage, atmospheric pollution, ash disposal, aesthetics and economics. A nuclear station the size of Waterford Unit 3 operates on about 40 metric tons of fresh nuclear fuel per year, and the same amount of spent fuel is transported offsite each year for reprocessing; a coal-fired plant of the same size consumes on the average about 2,700,000 metric tons of fuel per year. The impact of delivering this amount of coal annually to the Plant would be significant. It would require a train 100 cars long to make approximately 300 deliveries to the Plant or, if barged, it would require approximately 2000 river barges carrying about 1500 tons each. Typically, desired coal stockpiles of utilities range from 60 to 90 days. A coal-fired plant the size of Waterford Unit 3 would need a storage area of about 19 acres.

The quantities of gaseous and particulate material that may be released to the atmosphere from the burning of about 2,700,000 metric tons per year as estimated by the Applicant[1] is shown in Table XI-1. In addition, it is estimated that about 310,000 metric tons of ash would need to be disposed of annually. Ash disposal could require up to 24 acres annually.

TABLE XI-1

GASEOUS PRODUCTS FROM A
1150 MWe COAL-FIRED PLANT

Product	Metric Tons/yr
SO_2	40,400
NO_x	23,600
Particulates	3,400

The Applicant found that the economics of substituting coal is unfavorable. Total production costs over a 30 year operating period, which include capital costs plus fuel and operating expenses, when present worthed are estimated to be about $684 million for a coal-fired plant and about $579 million for the nuclear plant. The present worth differential is $105 million.

4. Selection of a Site Other Than Waterford

A discussion of the alternate sites for the Waterford Unit 3 was presented in Section II-B.

Although it appears that the present Waterford Site is at least as acceptable as the two identified alternates, the Staff concludes that, on balance, the Waterford Site is the best alternative. The area surrounding the Waterford Site is already quite heavily industrialized relative to the alternate sites. Both alternate sites would require the construction of new transmission substations and one of the two sites would require an additional transmission line across the Mississippi River. The differential in land costs, transmission facilities, and transmission losses are 9 to 12 million dollars in the case of the two alternate sites. The Staff considers that the Waterford site is more centrally located with respect to LPL's power load. Another factor, although not too significant, is that the Waterford site is 25-30 miles further from the Baton Rouge fault than are the two alternate locations. Considering additional costs, and the fact that the Waterford Site is central to an ever-growing industrial area, the balancing of factors favors the chosen site as the best alternative.

5. Alternative Land Uses of the Chosen Site

Currently the Waterford site consists of about 1200 acres of cultivated sugar cane, 2200 acres of timbered swamp and 200 acres of land modified in support of construction of Waterford Units 1 and 2 (fossil-fired) and Waterford Unit 3. The modified lands have reduced the cultivated sugar cane acreage from 1400 to 1200 acres. Therefore, an immediate alternative land use consideration would be the retention of the modified land in agricultural production. On the basis of past production (23 tons/acre with a market value of $10/ton) it is estimated that the 100 acres of modified land associated with Waterford Unit 3 can support up to 2 jobs. The loss of sugar cane production is about $23,000 annually. Other than the area modified for construction and operation of the electrical generation and support facilities, the Applicant indicates a preference for retaining the nondiverted site lands in timbered swamp and agriculture.

Site visits by Staff personnel, review of local industry and zoning, and discussions with parish officials support the Applicant's contention that land adjacent to the Mississippi River in this region is being converted to industrial uses. The construction of a new state highway through the Waterford site will tend to separate the industrializing river front lands from other land uses in the parish and thus restrict potential residential and commercial use of this land. In the long run, if the Waterford site were not used for electrical power generation, it is expected that the Waterford site would be developed for some other type of heavy industrial use.

6. Alternate Heat Disposal Systems

Despite what appears to be a relatively large thermal capacity of the Mississippi, the Staff has considered the use of a number of heat dissipation alternatives. The rationale used attempts to quantify the cost of options which might, for reasons of policy, be considered superior in the public interest. Three groupings of options were considered:

a. Alternatives involving full heat release to the river
b. Alternatives involving reduction of heat release (68% less) to the river and a 5°F differential
c. Alternatives involving complete off-stream cooling with minimal thermal release to the river

Options studied in b. relate to supplemental or helper systems not including dilution. A number of dilution alternatives were considered, but those involving additional pumping were rejected because the depth and volumetric flow of the river indicated very high performance of in situ methods of dilution induction. In the case of Waterford Unit 3, the alternatives are especially difficult to evaluate because of the influences of the Waterford Units 1 and 2 upstream. The Staff estimates these units will add a 2 to 4°F increment to the water temperature at the Unit 3 intake. When Waterford Units 1 and 2 begin operation, detailed data should be collected and the relationships between Units 1 and 2 outfall with Unit 3 intake studied to further understand and quantify the interactions.

a. Alternatives Involving Full Thermal Release to the River (8.1×10^9 Btu/hr)

(1) High Velocity Momentum Mixing

On the basis of operating experience with a number of large plants with once-through cooling on relatively rapidly flowing rivers (2 to 6 fps) it can be demonstrated that entrance velocities on the order of 8 to 10 fps normal to the current provide a very prompt shearing and mixing action resulting in immediate dilutions on the order of 2 to 1 to as much as 4 to 1 in the zone of flow establishment. In the Waterford Unit 3 case, the Applicant has made a special effort to reduce the entrance velocities to the extent practicable in order to take advantage of the small increment of higher heat transfer to the air in mixing zone. Because of the relatively small area that will have incremental surface temperatures in excess of 4°F, this effect is essentially insignificant and can be neglected.

The Staff believes the outfall structure could be redesigned so there would be but a minimal head loss in the seal well and so the size and shape of the flume would tend to maximize the velocity of the effluent as it enters the river. Such an arrangement would minimize the volume of the mixing zone where incremental temperatures are more than 5°F above ambient. The Staff's estimates of the areas affected by the reference design proposed by the Applicant and by the high velocity discharge alternative are shown in Table XI-2. Costs of such an alternative outfall structure have not been estimated by the Applicant but the Staff believes that the cost would not be substantially different than for the Applicant's proposed design. Since issuance of the Staff's draft statement, the Applicant has committed to this alternative of outfall redesign.

TABLE XI-2

COMPARISON OF AFFECTED AREAS BETWEEN REFERENCE AND PROPOSED ALTERNATIVE
(200,000 cfs Flow Waterford Unit 3)

Isotherm of Temperature Rise °F	Surface Area (Acres) Reference	Surface Area (Acres) Alternative
10	15	5.5
5.4	59	70
1.5	620	620

There would probably be a small benefit to fish and other aquatic life if the size of the 10°F increment zone were smaller because there would be less surface area and benthic area with above optimum temperature conditions. However, no adverse effect of significance to either migratory or resident fish is predicted for the outfall design as proposed by the Applicant.

Similar high velocity discharges for the Waterford Units 1 and 2 upstream would also improve the mixing zone pattern. Discharges of this type would reduce the quantity of warm water from the upstream units taken in by the Waterford Unit 3 and make the over-all temperature regimen in this segment of the river less variable. With high discharge velocities from Waterford Units 1 and 2, temperature increments of 2°F or less at the Unit 3 intake would probably prevail on a year-round basis.

(2) Multiport Diffuser

At the request of the Staff, the Applicant prepared a reference design for two versions of a multiport diffuser located alternatively in 40 and 80 ft of water off-shore from Waterford Unit 3. The computations reveal a very significant reduction in the surface area of the high temperature zone. The maximum surface temperature increase would be only about 1°F. The Applicant's design uses a limited number of ports, and the resulting temperature distribution was computed using the accepted methods of Koh and Fan.[2] These methods were then superimposed on a velocity vector gradient and the thermal field developed for the two alternatives at a flow of 200,000 cfs (river velocity about 1.2 fps). Construction of the multiport diffuser would require a cofferdam extending out to as far as 500 ft into the river and could interfere with river navigation. The Applicant's estimated additional capital cost of $2,500,000 for a diffuser does not appear to reflect all of the construction and maintenance costs anticipated over an extended number of years. However, in the case of the Waterford 1 and 2 Units, added study may reveal that such a design could be economically justified in relation to the reduction of long-term operating losses at Waterford Unit 3. A 1°F increment in intake temperature of Unit 3 is worth approximately 10 MWe, or a present worth of about $2 million for a 30-year period of plant operation. This assumes that the capital losses would be made up by the addition of a gas turbine to the system.

b. Alternatives Involving Partial Reduction of Thermal Release to the River (3.3×10^9 Btu/hr)

A number of supplementary cooling systems could be considered. The Staff believes three representative systems each sized on the assumption that no mixing zone would exist (no release of water in excess of 5° above ambient river temperature) would clearly illustrate the relative benefit cost advantages. The three selected were ponding, cooling towers and spray ponds. All three require additional pumping facilities to return cooling water over the levee to the river. These facilities are estimated to add $5 million in capital costs to each alternative (included in the costs listed below).

(1) Open Cycle Pond

The Staff evaluation of this alternative is based on the information presented by the Applicant. The advantages of the system are primarily reduction of the thermal load on the Mississippi River. Disadvantages include increased retention time for passed plankton and potential groundwater involvement as well as the utilization of lands for a low value use. The estimate of the Applicant of 1950 acres is considerably higher than would be necessary to reduce the temperature of the effluent to 5°F above ambient. The Staff estimates that on the order of 800 acres would be adequate. On this basis the Applicant's cost estimate might be reduced by the incremental value of 1150 acres, estimated by the Staff as a $2 million reduction. The additional capital cost of the open-cycle cooling pond is estimated to be about $12 million.

(2) Cooling Towers (Open-Cycle)

The choice between a natural draft and mechanical draft system for "helper" or supplementary duty has not been analyzed in detail by the Applicant. Estimates by the Staff are drawn from experience and standard references.[3] Added capital costs for natural draft and forced draft "helper" systems, 25°F range and 10°F approach are estimated to be about $18 million and $12 million, respectively. Annual operating and maintenance differential costs including capability penalty costs are estimated to be about $1.15 million for the natural draft system and about $1.53 million for the forced draft system.

(3) Open-Cycle Spray Pond

Application of open-cycle spray ponds to Waterford Unit 3 was considered by the Staff on the same basis as the other open-cycle concepts, namely to reduce the thermal increment to 5°F by reducing heat rejection to the river by about 60%. The design of such a system is considered in the Applicant's Environmental Report.[4] The system would incorporate the use of 276 modules in a pond 14,500 ft long, and 140 acres in area. The Applicant's statements as to the infeasibility of the system do not appear to be consistent with the Applicant's data on wet bulb temperatures given in Table X-D-3 of the Applicant's Environmental Report. A 15°F approach in August is not unusual and does not appear to be a disabling factor. The evaluation of the alternative is complicated by the Applicant's high cost estimate which is almost twice that proposed by other applicants for similar systems, including the necessary pumping facilities. The Staff estimates differential capital costs to be about $12 million and the annual differential operating and maintenance cost to be about $0.3 million.

This adjustment does not, however, change the Staff's evaluation of the merit of spray type systems for supplementary cooling. The advantage of reduced thermal loading to the Mississippi River is more than offset by increased plankton losses from extended holding at higher temperatures, fogging and drift of condensate, and high operating penalties from power module requirements and back pressure losses.

c. Alternatives Involving Elimination of Thermal Releases to the River (less than 1.6×10^8 Btu/hr)

(1) Closed-Cycle Cooling Pond

A closed-cycle cooling pond of 1500 acres has been studied by the Applicant. The differential capital cost of the cooling pond has been estimated by the Applicant as $8 million in excess of the reference design. Typical annual operating and maintenance costs for 30 years of operation are about $0.3 million. The disadvantages of the concept involve questions of whether the 1500 acres could be more beneficially used as agriculture or industrial lands, and what impact the pond would have on local groundwater conditions. The investment required for a closed cycle pond would be relatively high.

The principal advantage of a closed-cycle pond would be the nearly complete elimination of heat to the river. All of the plankton drawn into the cooling water system with the river water supplied to make up evaporative loss and for pond blowdown would be destroyed. However, this loss would likely be less than that associated with the proposed once-through system with its much greater volume of water.

(2) Closed-Cycle Cooling Towers

The Applicant has provided a detailed evaluation of the use of natural draft and mechanical draft, closed-cycle cooling systems as an alternative.[5] While construction details are not given for the actual structures, the Applicant's costs appear to be low. Typically, a natural draft tower of the Waterford Unit 3 size would have a differential capital cost of about $16 million while the forced draft tower would be expected to have a differential capital cost of about $9 million. The Staff estimates that the natural draft tower would be of hyperbolic, cross or counter-flow design. With a 30°F range indicated in the Applicant's statement the tower would use 542,000 gpm of circulating water. Based on a heat release of 8.1×10^9 Btu/hr, the summer water consumption would be 34 cfs at a concentration factor of 4. The tower would be about 550 ft tall with an equivalent dimension at the base. The Applicant has estimated the visible plume from the tower as extensive. At times it would extend to distances of 100 miles under extreme stability conditions. The total evaporation of 28 cfs from the tower is insignificant for the Waterford site. Drift from the tower would be expected to be as low as 0.003% and consequently would not create a salt deposition problem.

Mechanical draft towers are also technically feasible. Using the same range criteria as the Applicant (25°F and a flow of 645,000 gpm) the Staff estimates that four or five elongated cell assemblies covering an area of some five acres would be employed. Drift losses for mechanical draft towers would be on the order of 0.1% and could create a salt deposition problem in the immediate area of the towers in dry seasons. Water losses would be somewhat higher than that for natural draft towers, about 36 cfs. The extent of fogging for mechanical draft towers would be expected to be more severe for higher stability conditions because of the greater relative humidity of the released vapors. Placement of the towers, while not suggested in the Applicant's Environmental Report, could be made to minimize persistent low level fogging by reducing the tendency of the plumes to assume a line source rather than a series of point sources. Plankton losses for this system would be total in the intake water, but relatively low in comparison to the reference design.

(3) Dry Cooling Towers

In a dry cooling system, heat is rejected directly to the atmosphere without using water as the intermediate heat receiver. One of the obvious advantages of this system is the elimination of the need for a water makeup supply. Further, dry towers appear to be attractive from an environmental standpoint in that they produce neither vapor plumes or potential fogging or icing at low altitudes, nor chemical fallout from liquid entrainment. Disadvantages which counterbalance these advantages include serious losses in plant efficiency due to increased turbine back pressures, condenser replacement costs, large capital requirements, and increased plant power requirements for cooling tower fans.

Because of these disadvantages, and also because dry cooling tower reliability and performance has not been demonstrated for heat loads as large as that for Waterford 3, the Staff considers the dry cooling tower to be an unacceptable alternative to the proposed design.

7. Other Alternatives

a. Chemical Waste Disposal System

The Applicant originally planned to neutralize dilute caustic solutions with dilute sulfuric acid solutions (both arising from the regeneration of spent ion exchange materials). The resulting sodium sulfate solutions would be discharged to the neutralizing basin, the stabilization pond and then to field drains and drainage canals toward Lac des Allemands

An alternative disposal method would reject the sodium sulfate solution through the condenser coolant discharge to the river. The added concentration in the effluent water would be 0.35 mg of the salt Na_2SO_4 (0.24 mg of sulfate) per liter and the weight of sulfate added to the river per hour would be 22 lb. The Mississippi River carries about

8 million lb of sulfate past the Plant from upstream origins per hour. The existing concentration of sulfate in the river averages about 56 mg/liter (see Table II-5)[5] which may be compared with the drinking water standard of 250 mg/liter.[6] The small increment added by the Waterford Unit 3 would have no appreciable effect on the downstream uses of the river. The costs of this system are about the same as the reference case. The Applicant has now committed to this chemical waste disposal alternative.

The adoption of this alternative by the Applicant eliminates any unknown deleterious effect of the disposal of dilute sodium sulfate toward Lac des Allemands. Such an adoption, in combination with the non-disposal of morpholine to the stabilization pond and the in-plant treatment of phosphate solutions, now avoids the discharge to the environment (other than the river) of all wastes including those from the sewage treatment system and the floor drains.

b. Purified Water Production Process

Another alternative would be the use of reverse osmosis pretreatment on the feed water to the ion exchange demineralization process to reduce the production of regenerant waste (i.e., sodium sulfate). In this alternative reverse osmosis would remove 90% or more of the dissolved salts thereby reducing the chemical regenerant requirement of the ion exchange demineralizers by an equivalent amount. The incremental additional costs of this process are estimated by the Staff to be about $1 million.

c. Transportation Procedures

Alternatives, such as special routing of shipments, providing escorts in separate vehicles, adding shielding to the containers, and constructing a fuel recovery and fabrication plant on the Site rather than shipping fuel to and from the station, have been examined by the Staff for the general case. The impact on the environment of transportation under normal or postulated accident conditions is not considered to be sufficient to justify the additional effort required to implement any of the alternatives.

B. BENEFITS AND COSTS OF THE PROPOSED ACTION

Previous sections described characteristics of Waterford Unit 3 and various alternatives. This section reviews beneficial and detrimental effects of the Applicant's reference design as a basis for benefit-cost comparison with alternatives.

1. Plant and Environmental Benefits

a. Power Generation

Waterford Unit 3 is expected to have a net electrical output of 1165 MWe. Assuming that the Plant will operate at 80% over a period of 30 years, the average annual generation is 8.2×10^9 kW-hr. In addition to the direct benefit from the kilowatt hours generated, there is a benefit from the plant as it contributes to the reliability of power supply in the Applicant's system and in the system of interconnected utilities.

b. Employment

The permanent work force for the Plant is expected to be about 45 persons, with an annual payroll of approximately $700,000. Construction and operation of Waterford Unit 3 eliminates about 100 acres of cultivated sugar cane, with the ability of supporting up to 2 jobs. The net result is an increase in long-term employment of about 43 jobs. Construction of the Plant will require approximately 2900 man-years of construction employment over a 5-year period. The work force is expected to reach about 1100 in 1975. The Applicant estimates the construction payroll to be more than $70 million.

c. Tax Generation

Based upon the Applicant's calculations of the direct taxes to be paid during construction and use of Waterford Unit 3 and from the sale of electric power it appears that local and state governments will receive several million dollars annually in taxes -- perhaps as much as $4 million per year. In addition, 45 direct jobs will be supported requiring up to $750,000 in new residences in the surrounding communities.

d. Educational Benefits

Waterford Unit 3 is the first nuclear generating plant scheduled for operation in the Louisiana Power and Light service area. It is anticipated that construction and operation of the Plant will be watched closely by many local residents and will be of general interest to many Louisiana Power and Light customers. Presently, the Applicant is considering several methods of keeping the public informed concerning Waterford Unit 3; e.g. mobile information displays and visitor center. In this way Waterford Unit 3 will contribute to general education through increased public knowledge of nuclear power plants and their effects.

2. Plant and Environmental Costs

a. Capital Cost and Related Resource Commitments

Construction of the Plant is estimated to cost approximately $350 million. Assuming the normal distribution between labor and materials for nuclear plants, about $85 million will be spent for labor, $128 million for site materials, and $66 million for factory equipment.

Typically the resources committed to a plant the size of Waterford Unit 3 include about 1.5 million board feet of lumber, 200,000 yd^3 of concrete, 2500 tons of iron, 100 tons of aluminum, and a very large amount of electrical power. In addition Waterford Unit 3 will require the use of about 100 acres of land. Permanent resource commitments include all the energy and much of the materials mentioned above, especially materials in the reactor, plus adjacent shields and equipment. These materials probably will be committed for decades because of activation of long half-life isotopes by reactor neutrons. The few acres occupied by the reactor building and allied facilities probably also will be committed to long-term industrial use.

b. Operation Cost and Related Resource Commitments

The Applicant estimates annual operation and maintenance costs to be $5.2 million/yr. About $0.7 million is labor costs and the remaining $4.5 million is mostly for materials and maintenance. In addition, nuclear insurance is estimated to cost over $1 million annually and nuclear fuel expenses are estimated at $15.5 million annually.

The primary resource irreversibly committed in the operation of Waterford Unit 3 is the nuclear fuel consumed. The Applicant estimates that about 1400 kg of uranium-235 will be consumed annually. The operating materials consumed include such operative materials as office supplies, protective clothing, water treatment chemicals, and such maintenance materials as oils, paints and repair parts. As discussed previously in Section V.C, small fishes will be exposed to the thermal discharge and some will pass through pumps and condensers and be killed.

c. Aesthetics

Waterford Unit 3 facilities provide a functional architectural design and do not require a tall stack such as with coal-fired plants. And, because a nuclear plant does not need the extensive fuel storage and handling facilities of a coal-fired plant, it provides for a clean architectural design and an operation of very low noise level.

Because of the flat topography of the area, the containment vessel (which will be more than 100 ft tall) and most of the support facilities will be clearly visible for some distance. The new state highway passing through the Waterford site about 1 mile southwest of the Plant will provide a view of the Plant across sugar cane fields. The modified area around the Plant will be landscaped by the Applicant. The selection of materials for outside building surfaces and the choice of colors, as was done in the case of the Little Gypsy Power Generating Station across the river from Waterford, indicates to the Staff that it will be more aesthetically pleasing than the other industrial facilities in the area.

d. Water Quality

The thermal discharges from Waterford Unit 3 to the Mississippi River of up to 2400 MW are expected to have an insignificant environmental impact on the aquatic resources. Therefore, reductions in thermal release through use of cooling ponds, spray modules or cooling towers would provide little environmental benefit.

The discharge of demineralizer regenerant wastes into the neutralization and settling basin will create a minor hazard to wildlife and a potential added burden of sulfate salts to Lac des Allemands. Discharge of phosphate solutions, particularly during startup, could cause excessive fertilization in the receiving waters and undesirable algae growth.

The alternative of discharging the chemical wastes into the river rather than toward the fresh water canals and Lac des Allemands, now committed to by the Applicant, would eliminate these potential adverse conditions.

e. Air Quality

There is no significant release of particulates or noxious chemical compounds to the atmosphere from normal reactor operations. However, two 3500 kW diesel generating units will release small amounts of diesel engine exhaust fumes during periodic testing of the emergency electrical equipment.

f. Radiation Dose

Radioactive materials released to the Mississippi River and to the atmosphere are not expected to result in an annual radiation dose of more than about 4 mrem to the total body. The annual dose to the thyroid of a child who consumes milk from a cow located about a mile from the Plant and eats the leafy vegetables grown in the gardens could be as much as 20 mrem. The total dose to the population of about 1,700,000 people expected to be living within 50 miles of the Plant in 1980 is estimated at about 2 man-rem/yr. This dose is negligible in comparison with the natural background dose of about 170,000 man-rem/yr to this same population.

C. SUMMARIZED COMPARISON OF PLANT AND ALTERNATIVES

Table XI-3 summarizes the primary factors that must be evaluated when balancing the economic costs of the Plant and alternatives against the environmental impact of constructing and operating Waterford Unit 3. Items receiving consideration are listed in the first column. The second column identifies the cost or impact of the Plant as it is presently designed. The remaining columns provide comparative information for an alternate power source, nine heat disposal systems and two alternatives to the present chemical waste system.

It is estimated by the Applicant that the total finished cost of Waterford Unit 3 will be $350 million. The total finished "capital cost" of the Plant and each of the 12 alternatives is shown in the first row. Annual expenses of operation for Waterford Unit 3 include operating payroll costs, maintenance and operation costs, nuclear insurance, and fuel costs. Present worth calculations have been used to translate ("capitalize") these future annual costs into present capital equivalence. At a discount rate of 8.75% and a period of 30 years, the present worth of Waterford Unit 3 annual costs is $229 million.

The incremental environmental impacts of constructing and operating a coal-fired plant are varied. The advantages of a coal-fired plant are that the thermal discharge to the Mississippi River will be reduced by 2.7×10^9 Btu per full power operation hour, and there is no necessity for transporting radioactive materials. Adverse effects to be expected are the impact from transporting coal to the Plant, the large amount of gaseous combustion products released to the

TABLE XI-3

COMPARISON OF ALTERNATIVES FOR THE WATERFORD STEAM ELECTRIC STATION UNIT 3

MONETARY COSTS (MILLIONS OF DOLLARS)	REFERENCE CASE (APPLICANTS DESIGN)	FOSSIL (COAL) PLANT (AT WATERFORD SITE)	FULL THERMAL RELEASE TO RIVER: HIGH VELOCITY MOMENTUM MIXING	FULL THERMAL RELEASE TO RIVER: MULTIPORT MIXER
CAPITAL COSTS				
CAPITAL COST	350	269	350	353
ANNUAL COSTS CAPITALIZED				
FUEL AND OPERATION EXPENSES	229	415	229	229
TOTAL PRESENT WORTH	—	—	—	—
CAPITAL AND ANNUAL EXPENSES	579	684	579	582
INCREMENTAL COST FROM REFERENCE CASE	...	105	-0-	3

ENVIRONMENTAL IMPACTS	REFERENCE CASE (APPLICANTS DESIGN)	INCREMENTAL ENVIRONMENTAL IMPACTS FROM REFERENCE CASE: FOSSIL (COAL) PLANT	HIGH VELOCITY MOMENTUM MIXING	MULTIPORT MIXER
LAND USE				
AGRICULTURAL	ABOUT 100 ACRES CONVERTED TO OTHER USE	NONE	NONE	NONE
RECREATION	NO ADVERSE EFFECT	NONE	NONE	NONE
HISTORIC-SITES	NONE IN AREA	NONE	NONE	NONE
WATER USE				
UTILIZATION	2150 CFS (975, 100 GPM)		NONE	NONE
HEAT RELEASE TO RIVER	8.1×10^9 BTU/HR	REDUCES HEAT RELEASED TO RIVER BY 2.7×10^9 BTU/HR	NONE	NONE
CONSUMPTIVE USE	9 CFS	REDUCES WATER CONSUMPTION BY 3 CFS	NONE	REDUCES WATER CONSUMPTION BY 4 CFS
AREA EXPOSED TO TEMPERATURES IN EXCESS OF 5.4°F	70 ACRES	REDUCES EXPOSED AREA BY 20 ACRES	REDUCES EXPOSED AREA BY 20 ACRES	REDUCES EXPOSED SURFACE AREA BY 70 ACRES
BIOLOGICAL IMPACT				
TERRESTRIAL ECOSYSTEMS	SUGAR CANE HABITAT REDUCED BY 100 ACRES	NONE	NONE	NONE
AQUATIC ECOSYSTEM	A SMALL AMOUNT OF BIOTA WILL BE KILLED IN COOLING WATER CIRCUIT	NONE	NONE	NONE
ATMOSPHERIC IMPACT	NEGLIGIBLE	40,000 TONNES SO_2/YR 24,000 TONNES NO_X/YR 3400 TONNES PARTICULATES/YR	NONE	NONE
AESTHETICS	MINOR INTRUSION	TALL CHIMNEYS	NONE	NONE
FUEL TRANSPORTATION	25-30 TONNES/YR NEW FUEL (5 TRUCK LOADS/YR)	2.7 MILLION TONNES/YR OF COAL (300 TRAINS OF 100 CARS EACH) ELIMINATES TRANSPORTATION OF NUCLEAR FUEL	NONE	NONE
SOLID WASTE PRODUCTS	25-30 TONNES/YR SPENT FUEL (5-7 RAIL CASKS/YR)	390,000 TONNES ASH/YR ELIMINATES NUCLEAR SPENT FUEL AND RADIOACTIVE WASTE	NONE	NONE
	10,000 GAL AND 600 FT^3 OF RADIOACTIVE WASTE TO LICIENSED BURIAL FACILITIES		NONE	NONE

TABLE XI-3 (Continued)

MONETARY COSTS (MILLIONS OF DOLLARS)	REFERENCE CASE (APPLICANTS DESIGN)	PARTIAL REDUCTION OF THERMAL RELEASE TO RIVER: OPEN CYCLE COOLING POND	NATURAL DRAFT COOLING TOWER	MECHANICAL DRAFT COOLING TOWER	OPEN CYCLE SPRAY CANAL
CAPITAL COSTS					
CAPITAL COST	350	362	368	362	360
ANNUAL COSTS CAPITALIZED					
FUEL AND OPERATION EXPENSES	229	232	241	245	239
TOTAL PRESENT WORTH	—	—	—	—	—
CAPITAL AND ANNUAL EXPENSES	579	594	609	602	599
INCREMENTAL COST FROM REFERENCE CASE	---	15	30	28	20
ENVIRONMENTAL IMPACTS		INCREMENTAL ENVIRONMENTAL IMPACTS FROM REFERENCE CASE			
LAND USE					
AGRICULTURAL	ABOUT 100 ACRES CONVERTED TO OTHER USE	ABOUT 800 ACRES	ABOUT 5 ACRES	ABOUT 5 ACRES	ABOUT 140 ACRES
RECREATION	NO ADVERSE EFFECT	NONE	NONE	NONE	NONE
HISTORIC-SITES	NONE IN AREA	NONE	NONE	NONE	NONE
WATER USE					
UTILIZATION	2150 CFS (975, 100 GPM)	NONE	NONE	NONE	NONE
HEAT RELEASE TO RIVER	$8.1x10^9$ BTU/HR	REDUCES HEAT RELEASED TO RIVER BY $4.8x10^9$ BTU/HR	REDUCES HEAT RELEASED TO RIVER BY $4.8x10^9$ BTU/HR	REDUCES HEAT RELEASED TO RIVER BY $4.8x10^9$ BTU/HR	REDUCES HEAT RELEASED TO RIVER BY $4.8x10^9$ BTU/HR
CONSUMPTIVE USE	9 CFS	INCREASES WATER CONSUMPTION BY 19 CFS	INCREASES WATER CONSUMPTION BY 13 CFS	INCREASES WATER CONSUMPTION BY 14 CFS	INCREASES WATER CONSUMPTION BY 14 CFS
AREA EXPOSED TO TEMPERATURES IN EXCESS OF 5.4°F	70 ACRES	REDUCES EXPOSED AREA BY 69 ACRES	REDUCES EXPOSED AREA BY 69 ACRES	REDUCES EXPOSED AREA BY 69 ACRES	REDUCES EXPOSED AREA BY 69 ACRES
BIOLOGICAL IMPACT					
TERRESTRIAL ECOSYSTEMS	SUGAR CANE HABITAT REDUCED BY 100 ACRES	SOME 800 ACRES WOULD BE SUBMERGED	SUGAR CANE HABITAT REDUCED BY 5 ADDNL. ACRES	SUGAR CANE HABITAT REDUCED BY 5 ADDNL. ACRES	SUGAR CANE HABITAT REDUCED BY 140 ACRES
AQUATIC ECOSYSTEM	A SMALL AMOUNT OF BIOTA WILL BE KILLED IN COOLING WATER CIRCUIT	NONE	NONE	NONE	NONE
ATMOSPHERIC IMPACT AESTHETICS	NEGLIGIBLE	LOW FOG RIME DURING COLD WEATHER	HIGH LEVEL FOGGING	SOME POTENTIAL FOR GROUND FOGS	SOME POTENTIAL FOR GROUND FOGS
AESTHETICS	MINOR INTRUSION	NONE	VERY LARGE STRUCTURE HIGHLY VISIBLE	RELATIVELY LARGE STRUCTURES	NONE
FUEL TRANSPORTATION	25-30 TONNES/YR NEW FUEL (5 TRUCK LOADS/YR)	NONE	NONE	NONE	NONE
SOLID WASTE PRODUCTS	25-30 TONNES/YR SPENT FUEL (5-7 RAIL CASKS/YR)	NONE	NONE	NONE	NONE
	10,000 GAL AND 600 FT^3 OF RADIOACTIVE WASTE TO LICIENSED BURIAL FACILITIES	NONE	NONE	NONE	NONE

TABLE XI-3 (Continued)

MONETARY COSTS (MILLIONS OF DOLLARS)	REFERENCE CASE (APPLICANTS DESIGN)	CLOSED CYCLE COOLING				
		CLOSED CYCLE COOLING POND	NATURAL DRAFT COOLING TOWER	MECHANICAL DRAFT COOLING TOWER	DEMINERALIZER WASTE TO MISS. R	DEMINERALIZER PRE-TREATMENT PROCESS
CAPITAL COSTS						
CAPITAL COST	350	358	366	359	350	351
ANNUAL COSTS CAPITALIZED						
FUEL AND OPERATION EXPENSES	229	232	245	251	229	229
TOTAL PRESENT WORTH	—	—	—	—	—	—
CAPITAL AND ANNUAL EXPENSES	579	590	611	610	579	580
INCREMENTAL COST FROM REFERENCE CASE	---	11	32	31	-0-	1
ENVIRONMENTAL IMPACTS		INCREMENTAL ENVIRONMENTAL IMPACTS FROM REFERENCE CASE				
LAND USE						
AGRICULTURAL	ABOUT 100 ACRES CONVERTED TO OTHER USE	ABOUT 1500 ACRES	ABOUT 5 ACRES	ABOUT 5 ACRES	NONE	NONE
RECREATION	NO ADVERSE EFFECT	NONE	NONE	NONE	NONE	NONE
HISTORIC-SITES	NONE IN AREA	NONE	NONE	NONE	NONE	NONE
WATER USE						
HEAT RELEASE TO RIVER	8.1×10^9 BTU/HR	REDUCES HEAT RELEASED TO RIVER BY 7.9×10^9 BTU/HR	REDUCES HEAT RELEASED TO RIVER BY 7.9×10^9 BTU/HR	REDUCES HEAT RELEASED TO RIVER BY 7.9×10^9 BTU/HR	NONE	NONE
CONSUMPTIVE USE	9 CFS	INCREASES WATER CONSUMPTION BY 29 CFS	INCREASES WATER CONSUMPTION BY 19 CFS	INCREASES WATER CONSUMPTION BY 21 CFS	NONE	NONE
AREA EXPOSED TO TEMPERATURES IN EXCESS OF 5.4°F	70 ACRES	REDUCES EXPOSED AREA BY 69 ACRES	REDUCES EXPOSED AREA BY 69 ACRES	REDUCES EXPOSED AREA BY 69 ACRES	NONE	NONE
BIOLOGICAL IMPACT						
TERRESTRIAL ECOSYSTEMS	SUGAR CANE HABITAT REDUCED BY 100 ACRES	SUGAR CANE HABITAT REDUCED BY 1500 ACRES	SUGAR CANE HABITAT REDUCED BY 5 ACRES	SUGAR CANE HABITAT REDUCED BY 5 ACRES	NONE	NONE
AQUATIC ECOSYSTEM	A SMALL AMOUNT OF BIOTA WILL BE KILLED IN COOLING WATER CIRCUIT	NOT SIGNIFICANT	NOT SIGNIFICANT	NOT SIGNIFICANT	REDUCES CHEMICALS TO LAC DES ALLEMANDS	MAJOR REDUCTION IN CHEMICAL WASTE
ATMOSPHERIC IMPACT	NEGLIGIBLE	LOW FOG RIME DURING COLD WEATHER	HIGH LEVEL FOGGING	SOME POTENTIAL FOR GROUND FOGS	NONE	NONE
AESTHETICS	MINOR INTRUSION	NONE	VERY LARGE STRUCTURE HIGHLY VISIBLE	RELATIVELY LARGE STRUCTURES	NONE	NONE
FUEL TRANSPORTATION	25-30 TONNES/YR NEW FUEL (5 TRUCK LOADS/YR)	NONE	NONE	NONE	NONE	NONE
SOLID WASTE PRODUCTS	25-30 TONNES/YR SPENT FUEL (5-7 RAIL CASKS/YR)	NONE	NONE	NONE	NONE	NONE
	10,000 GAL AND 600 FT^3 OF RADIOACTIVE WASTE TO LICIENSED BURIAL FACILITIES	NONE	NONE	NONE	NONE	NONE

atmosphere, large amounts of ash to be disposed of and an increased negative aesthetic impact. Since the environmental impact of the coal plant will probably be greater than a nuclear plant, the increased expense of $105 million is not justified.

Only small modifications appear necessary to the discharge structure as presently planned for Waterford Unit 3 to achieve high velocity momentum mixing. Advantage of this alternative is a reduction in the volume within the isotherms above 5°F. The cost of this system appears to be no higher than the reference case.

The cost of the multiport diffuser system and its potential interference with navigation during construction (the cofferdam would extend out as far as 500 ft into the river) are judged to be too high in relationship to the benefit of lower temperatures in the mixing zone for adoption of this alternative. However, the Applicant should consider a multiport diffuser system or other high velocity momentum system for Waterford Units 1 and 2 to take advantage of the economies from a reduced temperature at the intake to Unit 3.

The Staff evaluated three representative open-cycle cooling systems: ponding, cooling towers and spray ponds. There are no significant advantages to the open-cycle pond, and the disadvantages would include submerging about 800 acres of agricultural land. On balance the Staff judges that the use of the agricultural land for an open-cycle cooling pond would not be preferable to the direct discharge of the cooling water to the river.

The Staff evaluation of the open-cycle cooling tower alternative indicates that the advantage of reduced heat loading to the Mississippi River is more than balanced by higher costs, aesthetic problems involving tower appearance and plume spread, and a higher expected effect on passed plankton due to higher water temperatures encountered in the system for longer time periods. A higher loading of dissolved solids would also result because of the necessity to add acid for pH control to minimize scaling and solids buildup in the towers. On balance, the Staff sees no merit to the use of open-cycle towers in any form for the Waterford Unit 3.

The advantage of reduced thermal loading on the Mississippi River as provided by the open-cycle spray pond is more than offset by the $20 million in capital and operating expenses, increased plankton losses and fogging. On balance, the Staff sees no environmental advantage to the use of open-cycle spray module cooling at the Waterford Unit 3 site.

The Staff evaluated both the cooling pond and cooling tower closed-cycle cooling systems. The closed-cycle cooling pond would require the submersion of about 1500 acres of agricultural land. On balance, the Staff does not believe the reduction of thermal load in the river and the savings of plankton to be worth the $11 million additional cost involved in constructing and operating a closed-cycle cooling pond at the Waterford Unit 3 site. Evaluation of the closed-cycle cooling towers indicates that these systems do not decrease the overall environmental impact of Waterford Unit 3 as presently planned and, in fact, would add other impacts to the area. The high expense of these alternatives make them unsound alternatives to once-through cooling.

Two alternatives to the discharge of sodium sulfate to the neutralization basin have been evaluated. The alternatives would eliminate the possibility of plant discharges of sodium sulfate draining into Lac des Allemands by either releasing these chemical wastes to the Mississippi River, where no appreciable impact would be expected, or by using reverse osmosis ahead of the ion exchange process to purify the water, thus largely eliminating sodium sulfate discharges. The cost of the river release of sodium sulfate is about the same as the planned system and the added cost of the reverse osmosis purified water production process is estimated to be less than $1 million.

By means of Supplement 3 to the Environmental Report, the Applicant has committed to the first of these alternatives and is considered acceptable by the Staff with a Staff judgement that the environmental impact on the Mississippi River will not be appreciable.

The Staff concludes that the Waterford nuclear unit will provide the needed increased production of electricity. With the adoption, by the Applicant, alternatives to plant design and method of operation (thermal discharge, chemical discharge, and reduction of radioiodine release), it is concluded that the benefits of the proposed plant will outweigh the costs incurred.

REFERENCES

1. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit no. 3, Environmental Report, Docket no. 50-382, Construction Permit Stage p. X-6-11.

2. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit no. 3, Environmental Report, Docket no. 50-382, Question A. 13-2.

3. Thermal Pollution and its Treatment, The Implication of Unrestricted Energy Usage with Suggestions For Moderation of the Impact, R. T. Jaske, Oct. 7, 1970, Battelle Memorial Institute, PNW Laboratory, Richland, Washington.

4. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit no. 3, Environmental Report, Docket no. 50-382, p. X-D-9.

5. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit no. 3, Environmental Report, Docket no. 50-382, p. X-D-6.

6. D. K. Todd, The Water Encyclopedia, The Maple Press Company, p. 119, 1970.

7. Public Health Service, "Drinking Water Standards," U.S. Department Health Education and Welfare, 1962.

XII. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to paragraph A.6 of Appendix D to 10 CFR Part 50, the Draft Environmental Statement of October 1972 was transmitted, with a request for comment, to:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
The State of Louisiana
The Police Jury of St. Charles Parish, Louisiana

In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on October 31, 1972 (37 FR 23198).

Comments in response to the requests were received from all of the organizations listed above except The Police Jury of St. Charles Parish, Louisiana. In addition, a comment was received from Environmental and Energy Systems, Inc. in response to the Federal Register notice.

Our consideration of comments received and the disposition of the issues involved are reflected in part by revised text in other sections of this Final Environmental Statement and in part by the following discussion. The comments are included in this statement as Appendix B.

A. NON-RADIOLOGICAL COMMENTS

1. Open-cycle Cooling Towers as "helpers" (EPA, pg. B-32 and Commerce, pg. B-10)

These comments suggested that the alternative of the use of open-cycle cooling towers as "helpers" be given further discussion and, should the additional hydrologic analysis of the combined Waterford-Little Gypsy discharges indicate significant temperature increases in the Mississippi River, the Applicant give consideration to an alternate cooling mode.

In the Draft Statement, the Staff considered open-cycle "helper" systems employing both forced and induced draft cooling towers. No data were available from the Applicant for that analysis, and the Staff depended on internal sources of information for the appraisal. One large system of this type is currently operating at the Monticello Station of the Northern States Power Company. Upon review of the associated capital costs and the expected operating costs and penalties the Staff determined that this alternative, while technically feasible, did not represent an attractive basis for solution of thermal discharge problems for Waterford 3 for the following reasons:

(1) the capital costs for achieving an effluent temperature reducti to a level only 5°F above river ambient were relatively high in comparison to the resulting benefits. An economical tower selection would entail relatively high condensing temperatures which would impose the same losses as for full closed cycle recirculation using cooling towers;

(2) the system would introduce additional water treatment needs adding to the chemical burden on the Mississippi River. In open cycle systems, the pH shifts upward and use of acid additions is required to control scale. Further, the tower would require periodic treatment with biocides to control slime growths, thus adding to the problems of biocide management. Chlorine would probably be the biocide of choice; and

(3) any problems associated with fogging and plume appearance would be essentially the same as for full closed cycle use of towers.

However, for purposes of illustration, the Staff has prepared an isotherm map showing the expected patterns from the release of 2,200 cfs of effluent 5°F above river ambient. As indicated in Fig. XII-1, the resulting plume would be relatively small in comparison to the full thermal release from Waterford 3. No changes in the expected patterns from either Unit 1 and 2 or the Little Gypsy plant would be anticipated. Fig. XII-1 is also applicable to the case of the supplementary cooling lake or the supplementary spray pond system, as all were designed to the same purpose.

Revisions to the Applicant's Aquatic Studies program (Chapter V-E) reflect a commitment to undertake detailed studies and river measurements which will allow a comparison with estimates of the thermal effects of the Waterford 1 and 2 discharges in the vicinity of the Waterford 3 intake; a river current and dye measurement program will also be undertaken to aid in understanding the interaction of the overall Waterford 1, 2 and 3 discharges in the river; and a sampling and measurements program to document the effects of Unit 1 and 2 discharge on the Unit 3 intake and discharge as well as the response of aquatic organisms downstream of Unit 3 to the heated effluent from that unit.

2. High Velocity Momentum Mixing (Interior, pg. B-19)

Chapters III and V of this statement discuss the modifications of the Waterford 3 outfall to provide for more rapid and complete mixing of the heated discharge with the receiving waters and thus reduce the extent of the high temperature isotherms (8-10°F) and the volume of water within the 5.4°F isotherm. The modification consists simply of reducing the terminal width of the sheet pile structure with a resulting increase in velocity of the discharge water.

3. Thermal Blockage of Mississippi River (EPA, pg. B-24)

This comment expresses concern that the high velocity momentum discharge will result in an increased plume penetration which would create a thermal blockage of aquatic organisms due to Little Gypsy and Waterford 1 and 2 interactions.

The potential for thermal blockage to aquatic organisms from Waterford Unit 3, combined with Little Gypsy and Units 1 and 2, would be modified only slightly by using a jet momentum discharge for Unit 3. Supplement No. 3 to the Applicant's Environmental Report indicated that the jet axis of the plume as it extends downriver will occur about 600 ft offshore with the warmest portion of the discharge plume occurring near the surface. Since the Mississippi River is about 100 ft deep at a distance 600 ft offshore, a layer of cooler water will underlie the plume and no complete thermal block will exist at the site. If the situation is considered only on a horizontal plane and at flows under 300,000 cfs, the jetted plume from the Waterford Unit 3 will approach the discharge plume from Little Gypsy Station, on the opposite side of the river. Microscopic organisms occurring in the river drift at or just below the surface of the river will probably enter the influence of the combined plumes under most conditions of river flow. The extent of this impact is related to the actual thermal increment and duration of exposure experienced by drift organisms, and is modified by the more rapid and efficient mixing of the discharge jet from Waterford Unit 3. With the substantial volume of the Mississpppi River on a vertical plane underlying the discharge plume, there should be no detrimental impact on the upriver and downriver movement of migratory fish.

4. Geothermal Energy as an Alternate Energy Source (E and ES, Inc., pg. B-49)

The utilization of the geothermal energy stored in a geopressured belt 750 miles long in the Northern Gulf of Mexico basin which underlies the Coastal Plain inland for 60 to 100 miles was not considered by the Staff as a reasonable alternative to the proposed Waterford Plant. Those alternatives which have significant research and development associated with their availability so that their practical application is many years in the future have not been included in our evaluation. Although the Staff appreciates the potential of geothermal energy to meet some of the nation's energy requirements, it is our opinion that the geological, engineering and environmental studies that would be required to produce a reliable geothermal steam plant of the size of the Waterford unit and the necessary construction and testing could not be completed on a schedule compatible with the energy needs of the Applicant's service area and regional power pool (see Section X).

5. Effects of Residual Chlorine (Commerce, pg. B-9)

The Staff recognizes that bioassay data indicates that free chlorine may be lethal to aquatic organisms in the range of 0.01 to 1.0 ppm for periods of continuous exposure of 24 hours or more. Further, the Staff supports the validity of the lethality data resulting from various studies cited in the comment and its relationship to the exposure of the aquatic species to the chlorine.

However, in the specific case of the Waterford 3 Unit, the Staff conclusion that the residual chlorine levels in the Mississippi River will have an insignificant effect on the aquatic river life is substantiated principally by the fact that the use of chlorine in the circulating water system will be intermittent and rigorously controlled. The Applicant has stated in Supplement No. 3 to the Environmental Report that chlorination will be used for short periods of up to 30 minutes per day. Based on the experience of needed chlorination at the Little Gypsy station directly across the river from the Waterford Site (3-6 times per year), the Staff believes that the chlorination required at Waterford will be relatively infrequent. In any event, the Applicant has stated that during the intermittent periods of 30 minutes when chlorine will be injected, the residual chlorine at the condenser outlet will be controlled so that the concentration will be less than 0.1 ppm. The resulting concentration in the Mississippi River will be much less than that value and persist for a very short time rather than the 24 hours or more of the standard bioassay.

6. Retention Time of Wastes in Stabilization Pond (EPA, pg. B-34)

When the Applicant committed to dispose of chemical wastes to the Mississippi River (described in Chapters III and V), the need for the stabilization pond was eliminated. Wastes will now be discharged from the neutralization facility to the spent condenser coolant and thence to the river.

7. Use of the Stabilization Pond (EPA, pg. B-34)

The acid and base solutions will react in the neutralization facility and be controlled to produce a neutral solution of sodium sulfate. To insure that applicable standards are met, the Staff will specify appropriate numerical limits governing the release of chemicals to the river in the Technical Specifications prepared during the operating license stage of review.

8. Diesel Engine Emissions (EPA, pg. B-37)

Estimated fuel consumption for the two 3,500 KW diesel generating units has been revised upward to 1,900 lbs of fuel per engine per hour. The following Table, based on EPA emission factors, lists the amount of combustion products released per 1,000 gal of fuel consumed. It is expected that the diesel fuel will contain approximately 0.2 percent sulfur.

EMISSIONS FROM EMERGENCY
GENERATING UNITS

Combustion Product	Applicant's Estimate lb/1000 gal fuel	EPA Estimate lb/1000 gal fuel
Carbon Monoxide, CO	177	225
Nitrogen Oxide, NO	266	370
Hydrocarbons	64	37
Particulates	9.3	13
Aldehydes	9.0	3
Oxides of Sulfur (SO_x or SO_2)	-	27

9. Care, Storage and Handling of Diesel Fuel (EPA, pg. B-39)

The Applicant has described the diesel fuel storage system which he plans to use. The system consists of two tanks, each with capacity of 42,500 gallons. The level in the tanks is monitored continuously, and alarms are provided. The tanks will be surrounded by retaining walls of 4.8 and 7.35 ft. A drain will pipe any spilled oil to a 7'9" high, 40' diameter sump from where it will be drummed for off-site disposal.

10. Use of Soil Taxonomic Units (Interior, pg. B-16)

The Waterford Site, consisting of approximately 3,600 acres, is composed of a section of nearly 1,400 acres of land which for many years has been in sugar cane production and essentially void of timber. It is on this land that the nuclear station will be constructed with a small portion of the sugar cane production disturbed. The remaining 2,200 acres is wooded swamp and contains various timber species. This area is far removed from the construction site and the Staff, therefore, cannot identify any effect from construction activities on Plant operation on the timber. Similarly, the 23.5 mile transmission corridor to be constructed traverses uninhabited swampland and some agricultural land. Timber is mainly located in the swampland. Except for removal of trees for the right-of-way corridor (discussed in Chapter IV), the Staff concludes that there will be no adverse effect on any of the timber remaining in the areas traversed by the high voltage transmission lines.

Notwithstanding this conclusion, the Staff has obtained from the Soil Conservation Service's Official Soil Services Description the sugges soil units and site indices for a sample of timber species found in the typical oak forests, cyprus-gum swamps and freshwater marshland of Southeastern Louisiana.

Tree	Soil Unit:Commerce Growth(yrs)	Soil Unit:Commerce Site Index	Soil Unit:Sharkey Growth(yrs)	Soil Unit:Sharkey Site Index
Green Ash	50	80	50	85
Nuttal Oak	50	90	-	-
Water Oak	50	110	-	-
Cottonwood	30	120	30	100
Sweet Gum	-	-	50	90

11. Noise Levels at the Site Boundaries (EPA, pg. B-40)

It is likely that noise from the construction operations at the Waterford Site will be perceptible in the Killona residential area some 4,000 feet away. The background noise level in the Killona area now varies from 57-58 db according to the Applicant. The Staff has estimated, based on experience at other sites with equivalent types of equipment, that the earth moving and construction activities will produce a noise level of 62-64 db at the Site boundary -- a small increase. The Applicant is preparing a noise control report for the operational phase and will consider both in-plant noise and the noise levels at the boundaries of the Plant.

12. Inconsistencies in Meteorological Data (EPA, pg. B-37 and Commerce, pg. B-11)

Apparent discrepancies that exist between the Draft Environmental Statement and the Applicant's Environmental Report are mainly due to different sources of information used for respective reports and terminology.

In reference to prevailing winds at the Site, values in the Draft Statement were based on 10 years (1951-1960) of local climatological data for the Moisant International Airport. These data were obtained from the National Climatic Center, Ashville, North Carolina. It was considered that the data supplied in Table 24 of Appendix B of the Applicant's Environmental Report were less desirable, as they were based on only 2 years of airport data.

The question concerning frequency of occurrence of inversions or isothermal lapse rates is due to a misunderstanding of terms involved. An inversion occurs when the temperature increases with height while an isothermal lapse rate occurs when there is no change of temperature with height. However, a stable atmosphere is one in which the temperature increases with height or decreases with height at a rate less than the dry adiabatic lapse rate (10° C/Km) or moist adiabatic lapse rate (5° C/Km), depending on the state of atmosphere. Therefore the atmosphere could be in a stable state but not have an inversion or isothermal lapse rate. The value for frequency of occurrence of isothermal lapse rates or inversions used in the Draft Statement is based on a similar statement on page II-F-1 of the Applicant's Environ mental Report. From Table 24 of Appendix B, cited above, stable Pasquell categories (sum of stability class values 5, 6 and 7) can be expected to occur 31.43% of the time. Therefore, it would be expected that the frequency of occurrence of inversions or isothermal lapse rates would be less than 31.43% of the time.

The statement that the frequency of occurrence of stable Pasquill atmospheric categories at the Site is 31.43% of the time is sufficiently representative until improved onsite stability measurements become available.

13. Effect of Transmission Line Construction and Operation on Endangered Species (Interior, pg. B-18)

The alligator, being the only endangered species known to the area, should quickly adapt to the areas beneath transmission lines after installation. Lines are patrolled by airplane and the only non-routine disturbances by maintenance crews could occur during line repair. The Staff does not consider the transmission lines to be intolerable to the habitat of the transient birds such as the pelican, eagle, or falcon, and the minor disturbance to other terrestrial species is expected to be minimal, particularly in consideration of the small acreage traversed by the lines relative to the total swampland area in the region of the Plant and transmission line routing.

14. Transmission Line Interference - Railroad Signals (Transportation pg. B-20)

The Applicant has committed to cooperate with the Southern Pacific Railroad, whose line is crossed by the proposed new transmission line. The Applicant states that the transmission line was designed in accord with U. S. Department of Transportation safety rules, one of which requires spacing of electric line and railroad circuits sufficient to make flashover between them improbable. The Applicant further points to his experience in the location of transmission lines in the proximity of railroads and that coordinating such facilities has been routinely accomplished.

15. Transmission Line Interference - Aeronautical (Transportation, pg. B-20)

The Applicant has indicated no expected conflict of the new transmission line with existing airport facilities, and will give adequate and proper notice where construction notice is required by the Federal Air Regulations. Cooperation with State agencies concerned with such matters is a standing practice of the Applicant.

16. Air Transportation Accidents (Transportation, pg. B-21)

The comment suggests that Part 103, Federal Air Regulations be included in the reference of Chapter VI (49 CFR 171.15, 174.566, 177.861) relating to the procedures to be followed by carriers involved in accidents while transporting nuclear materials.

The Staff is aware of this regulation; however, it was not cited in this statement since the Applicant plans no shipment of radioactive materials by air. All new fuel, spent fuel, and other radioactive wastes and sources are to be transported by truck, rail or perhaps by barge on the river.

17. Warning Systems for Accidental Releases of Hazardous Emissions (HUD, pg. B-15)

This comment stresses the need for a virtually instantaneous warning system for communities and industries downstream and downwind of the Plant at any time there is leakage of radioactivity or other hazardous emission.

The Staff's evaluation of the operation of the Waterford 3 Unit carefully considered the impact of the normally occurring releases of radioactivity (both liquid and gases) to the river and to the atmosphere, chemical discharges, and thermal releases to the river. Our conclusion is that the Plant can operate safely with no adverse impact on the environment and no deleterious effect on the health and safety of the public.

Nevertheless, in order to assure that all elements of the environment are adequately protected, the Staff will require the Applicant to maintain a rigorous radiological monitoring program throughout the operating lifetime of the Plant to insure that safety limits are not exceeded. Also, the Applicant will conduct a non-radiological environmental monitoring and sampling program to confirm the predictions of chemical and thermal releases to the river and will be required to set forth corrective actions to be taken should any limits be exceeded. These limits and protective actions are given in the Technical Specifications of the Operating License for the Plant.

The Commission's Safety Evaluation discusses and evaluates in detail the conditions governing Plant accidents and related public health and safety.

18. Compatibility of the Waterford Plant with Future Area Planning (HUD, pg. B-15)

As described in Chapter II of this Statement, the Waterford Station is located in a region of relatively high industrialization. Growth of new industry in this area has been rapid. The St. Charles Parish zoning laws and master planning reflect this growth, and the issuance of pertinent licenses by the various State and Parish governments indicate a compatibility of the Plant with the already heavily industrialized character of the river from Baton Rouge to below New Orleans

19. Dewatering of Shallow Domestic Wells (Interior, pg. B-17)

This comment suggests that the Applicant be particularly careful not to dewater any shallow domestic water wells in use due to the extensiv pumping of water from the Waterford 3 excavation. Although the Applicant's inventory of nearby wells, obtained from the Water Resources Division of the USGS, does not identify any shallow wells within a 2 mile radius of the Site, the Staff concurs with the concern of the Department of the Interior in this regard and the Applicant has stated that he will be aware of the possibility of the dewatering of nearby domestic wells in use and take remedial action should any such wells be affected.

20. Historical Significance and Archeological Surveys (Interior, pg. B-17)

The Staff has contacted the State of Louisiana's Liaison Officer for Historic Preservation concerning the location of historic landmarks and any new nominations to the National Register of Historic Places. Their response is placed in this Statement as Appendix C.

With respect to the suggestion that a professional archeological field survey be made at the Waterford Site and that a study report be prepared and cited in the Final Statement, the Staff believes such action to be unwarranted. Except for the marsh and swampland (2,200 acres), the remaining 1,400 acres of the Waterford Site has been continually in sugar cane production for many years -- originall as the old Killona Plantation and continued by the Applicant. During recent years, the tilling of the cane fields has resulted in disturbance of the area as far as shallow artifacts are concerned. Further, extensive disturbance of the Site was made several years ago due to the excavation of and start of construction of the Applicant's Waterford 1 and 2 fossil-fired plants. Additional disturbance, negating the validity of carrying out a survey now, is the excavation and other activity associated with the construction of the Interstate Highway and the Texas and Pacific Railroad line, both of which traverse the Waterford Site. There has been substantial disturbance of the Site due to the above actions and it is the Staff's opinion that the action taken by the Applicant in contacting the Office of the Archeological Institute of America in New Orleans to learn of any potential archeological significance at the Site was a proper course of action.

21. Rate of Residential and Industrial Energy Consumption (Agriculture, pg. B-3)

The comment states that the rate of residential and industrial electrical energy consumption for the period 1972-1977 is not stated in the Draft Statement.

Despite the rapid acceleration in residential growth during the 1960-1970 period with its increasing demands for energy (air conditioning, etc.), the Applicant does not predict a saturation situation in this area of energy use. Growth, both residential and industrial, in the Applicant's service area is still on the rise. Although a specific prediction of residential and industrial electrical energy consumption is not available for inclusion in this Statement, the projection of approximately 10.2% per year increase in load remains unchanged. This rate of increase reflects the total projected demands for electrical energy including residential and industrial usage, make-up of losses in capacity due to conversion of gas-fired plants to other fossil fuels, and the added energy requirements for environmental control purposes.

22. Management of Undisturbed Acreage at the Waterford Site (Agriculture, pg. B-4)

Of the total 3,600 acres comprising the Waterford Site, approximately 200 acres are disturbed due to Plant construction, and other small acreages are removed from their natural state due to the Interstate Highway and Texas and Pacific Railroad crossing the Site. The balance of land will remain as marshland and swamp (2,200 acres) and in managed sugarcane production. The swamp and bottomland areas will remain in their natural state. The Staff has not been able to iden- tify any effect on these areas from the operation of the Plant excej for a minor termporary disturbance due to construction of the trans- mission line and its corridor.

23. Erosion Control (Agriculture, pg. B-5)

It has been suggested that the statement contain additional discuss: on the control of erosion on slopes.

Essentially, the only permanent slope on the Waterford Site is that created by the Mississippi River levee. Should the levee be disturt due to plant-related construction, the Applicant will take remedial action to prevent erosion. This will be primarily done by planting fast growing, deep-rooted grasses.

During construction, the large excavation for the reactor facilitie: will require erosion control measures. Although the slopes are to be maintained at a 5:1 grade, the Applicant will seed the overall slopes to retard any erosion. The general climate at the Waterford Site is such that growth is extremely rapid. By proper choice of grasses, it is considered doubtful if any temporary mulching will be necessary.

The Applicant states that the existing slopes on the Site preparatic excavation are now growing grasses solely due to airborne seeds, et(In the bottom of the excavation at this time, small willow tree shoc are growing. The Staff believes that during the four years of con- struction erosion will not be a problem and that the Applicant's pl: for planting grasses on the slopes is adequate.

23. Using Herbicides on Transmission Line Corridors (HEW, pg. B-13)

Two classes of herbicidal sprays are used by the Applicant on trans- mission line rights-of-way. They are 2,4-D and 2,4,5-T. The Appli- cant's contractor carrying out the spray program is required to be registered with the State of Louisiana and the chemicals to be used must be certified by the Louisiana Department of Agriculture. Furtt the Applicant states that the type, method and time of application of herbicides is consistent with the guidelines set forth by the Federal Power Commission.

24. Disposal of Solid Debris and Fish Accumulating on the Intake Structure (EPA, pg. B-39 and Interior, pg. B-17)

The Staff estimates of annual fish kill due to impingement on the intake screens is around 500 pounds -- a quite small quantity. The

Applicant indicates that those fish impinging on the circulating water intake traveling screens will be removed by screen wash water and returned to the river. Small debris which impinges on the screens will be disposed of in the same manner.

Large debris will be prevented from entering the intake screen chamber by the skimmer wall at the entrance to the structure. Although unlikely, should large debris become trapped in the intake canal, it will be removed and returned to the river.

B. RADIOLOGICAL COMMENTS

1. Period of Gaseous Effluent Releases (Commerce, pg. B-10)

This comment asks for information concerning the period of time that releases of waste gas follow hold-up. In the Staff's evaluation, it has been estimated that the releases from each gaseous waste decay tank will take place over several days, rather than short sporadic releases of an hour or two. The Staff further considers the several day release period to be sufficient to support the annual average concentration levels cited in the statement. As the FSAR develops, the actual release rate will be established, incorporated into the Technical Specifications and thus become operating limits for the facility.

2. Turbine Building Steam Leaks (EPA, pg. B-27)

EPA indicates that the Final Statement should include an estimate of the contribution to the radioactive gaseous releases resulting from steam leaks in the turbine area. The Staff has estimated that 0.09 Ci/yr of I-131 will be released from the turbine area as a result of a steam leak of 5 gpm of hot condensate.

3. Leakage from Secondary Loops (EPA, pg. B-27)

The Staff has evaluated the contributions of 5 gpm turbine area liquid leak to the estimated total plant releases and has concluded that the contribution will be less than 0.5 Ci/yr. The radiological consequences of this incremental release are considered to be negligible and do not significantly change the doses calculated from liquid wastes. The Commission's Safety Evaluation Report concludes that the Waterford Plant will be suitably equipped to measure the radiation levels in the effluents.

4. Discharge of Xe-133 (EPA, pg. B-39)

The Staff's calculated annual release of Xe-133 from the gaseous waste system is 1090 Ci. This includes an assumed degassing of 2 coolant volumes from the primary coolant system and approximately 9 volumes degassed on the basis of an assumed 1.5 gpm shim bleed. Further, the calculated Xe-133 release reflects a 30-day holdup for decay before release.

5. Plant Accidents (Interior, pg. B-19)

This comment suggests that the statement describe and evaluate the radioactive release to the Mississippi River as a result of postulated accidents.

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

6. Impact of Postulated Accidents (Commerce, pg. B-11)

A comment was made concerning the guidance as to the acceptable frequency of occurrence of meterological conditions and the use of the Annex meteorological assumptions rather than the relative concentration based on a frequency of occurrence approach using measured onsite meteorological data. The guidance in the Annex to Appendix D, 10 CFR Part 50, is intended to approximate the 50 percentile χ/Q values. This is considered adequate since even a factor of ten on the doses does not alter our conclusions as to environmental risk due to these accidents.

The minimum exclusion boundary considered was that described in the Applicant's Preliminary Safety Analysis Report, 914 meters. The relative concentration value used at this boundary was 8×10^{-5} sec/m^3. This is one-tenth the relative concentration given in the safety guide with no building wake effect considered.

7. Reduction of Exposure from Radioactive Releases (State of Louisiana, pg. B-47)

The State of Louisiana expressed concern over the excessive thyroid dose from radioiodine releases which was calculated by the Staff and shown in the Draft Statement.

The Applicant has augmented the gaseous treatment system for the auxiliary building, the steam generator blowdown tank exhaust, off-gas from the condenser, and reactor containment purge to include charcoal filters. These modifications to the gaseous treatment system utilize equipment which represents state-of-the-art, and is considered by the Staff to be a practicable and acceptable modification. As a result of this augmentation, the child's thyroid dose has been substantially reduced from approximately 280 mrem/yr to about 20 mrem/yr. Since this dose still exceeds the 5 mrem/yr "low-as-practicable" guidelines, the Applicant will be required to undertake a rigorous monitoring program and take necessary action, acceptable to the Staff, to insure that the actual dose to any individual does not exceed 5 mrem/yr.

8. Radiological Assessment of Direct Radiation (EPA, pg. B-27)

The annual dose to an individual, at a distance of approximately 4,000 feet from the Waterford Plant, has been estimated to be 2×10^{-5} mrem arising from the three gas decay tanks. The locations of the waste holdup tanks and other sources of radiation are inside the auxiliary building or containment building, behind several feet of concrete, and mostly under grade level. The above dose does not consider alternatives due to other ground shielding (trees, buildings, etc.) or shielding by an individual's house.

9. Transportation of Waste and Irradiated Fuels (HEW, pg. B-13)

Although the Applicant has not at this time contracted for fuel reprocessing or solid waste disposition, Section V-F of this statement discusses the transportation of fuel and wastes to the closest facilities to the Plant (Barnwell, S.C. and Morehead, Ky.). The radiological assessment of such transportation is also given in that Section. Should the actual contractors, selected at a later date, be at locations further distant than those assumed, the Staff dose calculations would be very slightly modified, but would not be significant to the extent that the conclusions concerning transportation would be changed.

C. MONITORING, SAMPLING AND SURVEILLANCE

1. Duration of the Post-operational Sampling Program (EPA, pg. B-35)

The Staff concurs in the comment that the sampling program should extend for a period beyond one year following Plant operation. The

Applicant has now committed to a program extending for two years after the start-up of Waterford 3 (see Section V-E).

2. Duration of Aquatic Studies Program (Commerce, pg. B-8)

The suggestion was made that the Applicant's Aquatic Studies program commence at least one year prior to operation of the Waterford Unit 1 Plant in order to establish base line data in the river before any Waterford 1 effluent is discharged.

The Applicant's commitment to commence the program two years before operation of Waterford 3 is considered adequate by the Staff to establish ecological base line data upon which to measure the effects of the operation of the nuclear unit on the Mississippi River. Our reasons are as follows: (1) preliminary base line studies have been conducted by the Applicant in 1971; (2) studies planned to be conducted two years prior to Unit 3 operation will provide immediate data at about the time Unit 1 commences operation; (3) control stations in other areas of the river, outside the thermal discharge of Unit 1, will provide base line data; and (4) the relationship between water temperature and quality measured at control stations and the Unit 3 intake will be established before Unit 1 becomes operational.

D. LOCATION OF CHANGES IN THIS STATEMENT WHICH RESPOND TO OTHER COMMENTS

Topic Commented Upon	Section Where Topic Is Addressed
1. Creation of Hazards due to Modification of the Outfall Structure (Dept. of Army, pg. B-6)	V-B
2. Scope of Radiological Monitoring Program (Commerce, pg. B-9)	V-E-2
3. Disposal of Chemical Wastes (Commerce, pg. B-10, Interior, pg. B-18, and HEW, pg. B-14)	III-D-3

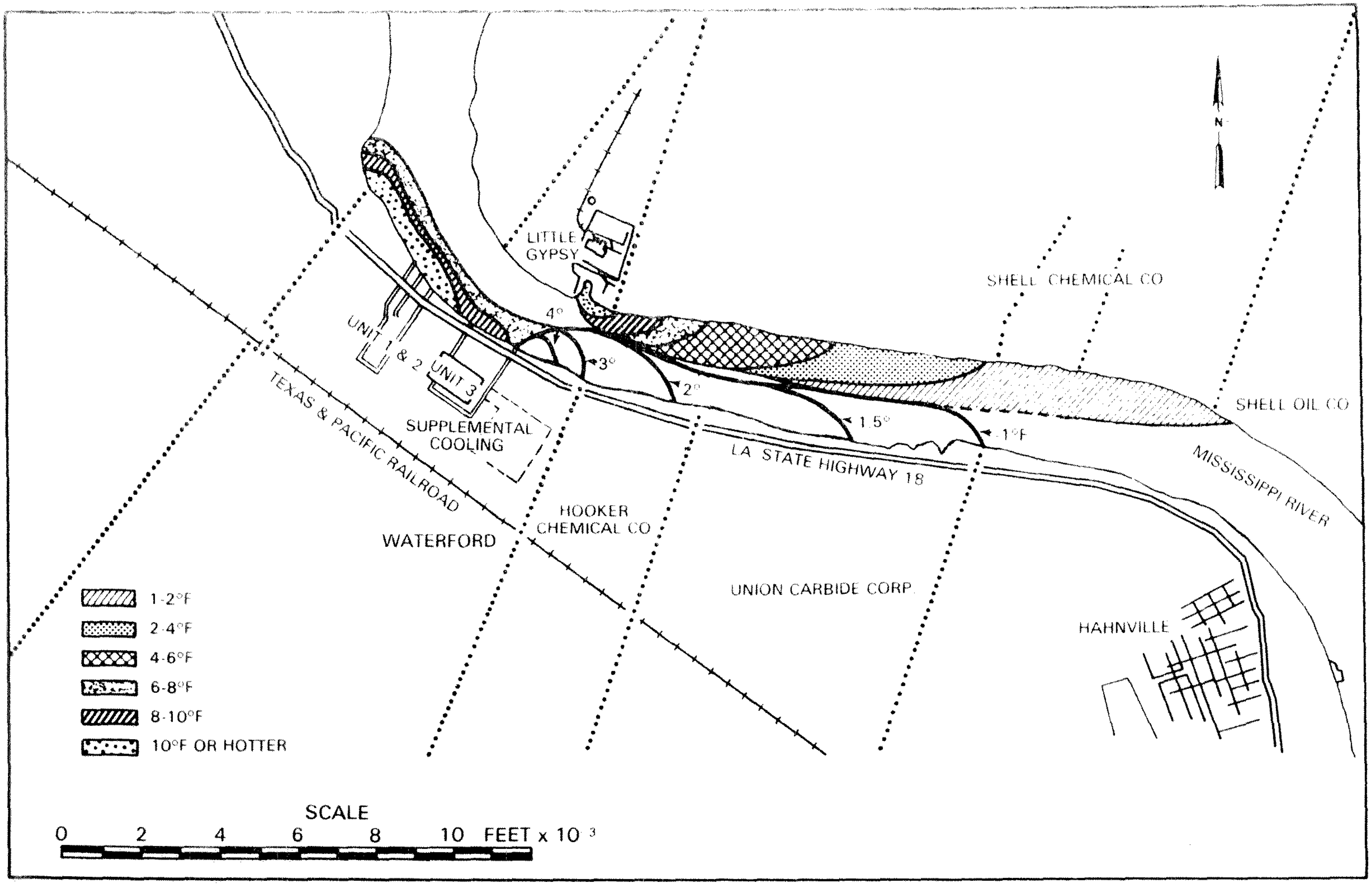

FIGURE XII-1. TEMPERATURE INCREMENTS ABOVE AMBIENT IN THE MISSISSIPPI RIVER AT THE WATERFORD SITE, RIVER FLOW 200,000 cfs, STAFF ESTIMATES, ALL PLANTS FULL POWER. (Waterford #3 Unit Limited to 5°F ΔT at 2160 cfs)

APPENDIX A

FLORA AND FAUNA IN THE REGION OF THE WATERFORD SITE

TABLE A-1

PRESENCE OF PLANT SPECIES IN CYPRESS-GUM SWAMPS OF SOUTHEASTERN LOUISIANA[1]

SPECIES	COMMON NAME
TREES	
Fraxinus profunda	Water Ash
Liquidambar styraciflua	Red Gum
Nyssa aquatica	Tupelogum
Nyssa biflora	Sour Gum
Rufacer drummondii	Swamp Maple
Salix nigra	Black Willow
Tamala pubescens	Red Bay
Taxodium distichum	Bald Cypress
SHRUBS AND VINES	
Amorpha fruiticosa	False Indigo
Ampelopsis arborea	Pepper-Vine
Baccharis halimifolia	Buckbrush
Berchemia scandens	Supplejack
Brunnichia cirrhosa	Florida-Vine
Cephalanthus occidentalis	Buttonbrush
Cerothamnus ceriferus	Wax Myrtle
Convolvulus repens	Marsh Bindweed
Ipomoea sagittata	Marsh Morning Glory
Iva frutescens	Marsh Elder
Mikania scandens	Hemp-Vine
Rubus louisianicus	Swamp Blackberry
Sabal minor	Dwarf Palmetto
Sambucus canadensis	Elderberry
Styrax grandifolia	Storax
HERBS	
Achyranthes philoxeroides	Marsh-Button
Acnida cuspidata	Southern Water-Hemp
Ageratum conyzoides	Ageratum
Asplenium ebenoides	Scott's Spleenwort
Aster exilis	Slim Aster
Blechnum serrulatum	Swamp Fern
Bramia monnieri	Hedge-Hyssap

TABLE A-1 (Continued)

SPECIES	COMMON NAME
HERBS	
Carex comosa	Bristly Sedge
Carex crus-corvi	Crawfoot Sedge
Carex lupulina	Hop Sedge
Chaetochloa geniculata	Marsh Fox Tail
Chaetochloa magna	Giant Fox Tail
Crinum americanum	String-lily
Cyperus virens	Swamp Sedge
Dryopteris patens	Shield Fern
Dryopteris thelypteris	Marsh Shield Fern
Echinochloa Walteri	Duck Millet
Echinodorus radicans	Creeping Bur-Head
Eleocharis albida	White Spike-Rush
Eleocharis olivacea	Green Spike Rush
Erianthus saccharoides	Plume Grass
Globifera umbrosa	Dwarf Moneywort
Gratiola virginiana	Clammy Hedge-Hyssop
Hibiscus lasiocarpus	Rose-Mallow
Hygrophila lacustris	Water Willow
Hymenocallis rotatum	Spider Lily
Ibidium cernuum	Ladies-Tresses
Iris virginica	Coastal Plain Iris
Inardia palustris	Marsh Purslane
Juncus effusus	Common Rush
Justicia lanceolata	Water Willow
Kosteletzkya virginica	Salt Marsh Mallow
Liedwigia elandulata	Ludwigit
Myriophyllum pinnatum	Water Milfoil
Onoclea sensibilis	Sensitive Fern
Osmunda regalis	Royal Fern
Panicum anceps	Beaked Panic-Grass
Panicum agrostoides	Red-Top Panic-Grass
Panicum gymnocarpon	Swamp Panic-Grass
Panicum virgatum	Feather Grass
Persicaria opelousana	Smartweed
Persicaria portoricensis	Giant Knotweed
Persicaria tunctata	Dotted Smartweed
Pluchea camphorcia	Spicy Marsh Fleabane
Pluchea fortida	Viscid Marsh fleabane
Pontederia cordata	Pickerel Weed
Proserpinaca pectinata	Mermaid-Weed

TABLE A-1 (Continued)

SPECIES	COMMON NAME
HERBS	
Rumex verticillatus	Swamp Dock
Rynchospora corniculata	Horned Ruch
Sabbatia campanulata	Slender Marsh Pink
Sacciolepis striata	Gibbous Panic-Grass
Sagittaria lancifolia	Delta Potato
Samolus floribundus	Brookweed
Saururus cernuus	Lizard's Tail
Scirpus californicus	Giant Bulrush
Sesban emerus	Coffee Bean
Solidago mexicana	Seaside Goldenrod
Spartina patens	Couch Grass
Tradescantia reflexa	Spiderwort
Typha angustifolia	Narrowleaf Cattail
Typha latifolia	Broadleaf Cattail
Zitaniopsis miliacea	Cut Grass
HERBS (on logs or stumps)	
Boehmeria cylindrica	False Nettle
Hydrocotyle verticillata	Marsh Pennywort
Lycopus rubellus	Water Hoarhound
Mosses (several species)	
Triadenum petiolatum	St. John's-wort
Trisetum pennsylvanicum	False Oat
AQUATICS	
Azolla caroliniana	Floating Fern
Ceratophyllum submersum	Coontail
Lemna minor	Lesser Duckweed
Piaropus crassipes	Water Hyacinth
Riccia fruitans	Dissected Liverwort
Ricciocarpus natans	Heart-shaped Liverwort
Spirodela polyrhiza	Greater Duckweed
Utricularia gibba	Humped Bladderwort
Utricularia macrorhiza	Commom Bladderwort
Vesiculina purpurea	Purple Bladderwort

TABLE A-2

RELATIVE ABUNDANCE OF MAMMALS, BIRDS AND REPTILES FOUND IN ST. CHARLES PARISH[2]

SPECIES	ABUNDANCE
Deer	Approximately 1 per 30 acres of woodland.
Doves	.32/acre of pasture and 1.93/acre of crop land.
Quail	.06/acre of pasture and .32/acre of crop land.
Rabbit	.39/acre of woodland; .08/acre of fresh marsh; .06/acre of pasture; .39/acre of crop land.
Rail	1/acre of fresh marsh.
Snipe	1/5 acres of marsh; 1/5 acres of pasture; 1/10 acres of crop land.
Squirrel	2.39/acre of woodland.
Turkey	None in parish at present time. Area has a potential for restocking.
Resident Waterfowl	1/100 acres of woodland.
Migratory Waterfowl	1/10 acres of woodland; 1.5/acre of marsh
Woodcock	1/5 acres of woods.
Raccoon	1/2.4 acres of woods; 1/8 acres of marsh.
Fox	1/100 acres of woods.
Bobcat	1/160 acres of woods.
Nutria	1/3 acres of woods; 2/acre of fresh marsh.
Muskrat	1/2.4 acres of woods; 1.2/acre of fresh marsh.
Otter	1/600 acres of woods; 1/300 acres of fresh marsh.
Mink	1/150 acres of woods; 1/100 acres of fresh marsh.
Alligator	1/9 acres of swamp; 1/5 acres of fresh marsh.

TABLE A-2 (Continued)

SPECIES	ABUNDANCE
Opossum	1/2.4 acres of woods.
Snakes	Highland-canebrake rattler, hognose, Holbrook's king snake, Emory's rat snake, garter snake, racer, etc. Aquatic-Natrix-spp., cottonmouth: All above snakes are quite common.
Lizards	Anole, skinks, leilopisma - abundant
Frogs	Bufo spp., Hyla spp., Rana spp., - abundant
Spiders	Abundant.
Ticks	Common.
Ants	Abundant.
Flies	Abundant.
Mosquitoes	Abundant.
Gnats	Abundant.
Moths and Butterflies	Abundant.
Grasshoppers	Abundant.
Many other species of insects are fairly abundant.	
Birds	Many species of passerine birds abundant year around.
Hawks	Several species.
Gulls and Terns	Fairly common.
Herons, Egrets, etc.	Louisiana blue heron, great blue heron, American egret, snowy egret, cattle egret, yellow-crown night heron, black crown night heron, least bittern, American bittern, white ibis, wood ibis. All fairly abundant at various times of the year.
Woodpeckers	Downy woodpecker, redheaded, yellow-bellied sapsucker, pileated - fairly common.

TABLE A-3

AUDUBON SOCIETY BIRD COUNT AT La PLACE, LOUISIANA, DECEMBER 28, 1971[3]

Common Name	No. Birds In 15-Mile Circle	Common Name	No. Birds In 15-Mile Circle
Pied-billed Grebe	7	Pileated Woodpecker	28
Anhinga	1	Red-bellied Woodpecker	40
Great Blue Heron	5	Yellow-bellied Sapsucker	48
Little Blue Heron	103	Hairy Woodpecker	22
Cattle Egret	28	Downy Woodpecker	39
Common Egret	79	Eastern Phoebe	38
Snowy Egret	56	Tree Swallow	2270
Louisiana Heron	23	Rough-winged Swallow	20
Plegadis Ibis (sp.)	18	Blue Jay	67
White Ibis	580	Common Crow	308
Snow Goose	25	Fish Crow	75
Blue Goose	25	Carolina Chickadee	119
Mallard	253	Tufted Titmouse	32
Pintail	4	Brown Creeper	1
Green-winged Teal	2	House Wren	17
Blue-winged Teal	7	Winter Wren	2
Am. Widgeon	4	Carolina Wren	120
Shoveler	3	Long-billed marsh Wren	16
Wood Duck	72	Short-billed marsh Wren	17
Redhead	1	Mockingbird	37
Scaup (sp.)	60	Catbird	21
Lesser Scaup	143	Brown Thrasher	30
Common Goldeneye	1	Robin	2170
Red-breasted Merganser	1	Hermit Thrush	27
Duck (sp.)	55	Eastern Bluebird	32
Turkey Vulture	1	Blue-gray Gnatcatcher	53
Black Vulture	5	Golden-crowned Kinglet	9
Sharp-shinned Hawk	1	Ruby-crowned Kinglet	151
Cooper's Hawk	1	Water Pipit	18
Red-tailed Hawk	3	Cedar Waxwing	159
Red-shouldered Hawk	47	Loggerhead Shrike	13
Marsh Hawk	2	Starling	180
Sparrow Hawk	6	White-eyed Vireo	28
Bobwhite	11	Solitary Vireo	2
King Rail	16	Orange-crowned Warbler	43

TABLE A-3 (Continued)

Common Name	No. Birds In 15-Mile Circle	Common Name	No. Birds In 15-Mile Circle
Virginia Rail	2	Myrtle Warbler	621
Sora	23	Palm Warbler	2
American Coot	225	Ovenbird	1
Killdeer	365	Yellowthroat	128
American Woodcock	3	House Sparrow	41
Common Snipe	27	Eastern Meadowlark	60
Spotted Sandpiper	1	Red-winged Blackbird	3770
Greater Yellowlegs	4	Rusty Blackbird	120
Lesser Yellowlegs	1	Boat-tailed Grackle	40
Dunlin	4	Common Grackle	4491
Herring Gull	12	Brown-headed Cowbird	45
Ringbilled Gull	76	Cardinal	157
Laughing Gull	1	Purple Finch	23
Forster's Tern	38	American Goldfinch	132
Common Tern	2	Rufous-sided Towhee	40
Caspian Tern	1	Savannah Sparrow	15
Mourning Dove	51	Vesper Sparrow	1
Ground Dove	6	Slate-colored Junco	2
Screech Owl	15	Chipping Sparrow	6
Great Horned Owl	2	Field Sparrow	2
Barred Owl	43	White-throated Sparrow	308
Belted Kingfisher	12	Fox Sparrow	1
Yellow-shafted Flicker	53	Swamp Sparrow	390
Song Sparrow	18		

TABLE A-4

SPECIES OF FISH OCCURRING IN THE LOWER MISSISSIPPI RIVER, LOUISIANA[4,5,]

Family	Species	Common Name Game (G) or Commercial (C)	Relative Abundance (%)[(a)]
Acipenseridae	Scaphirhynchus platorynchus	Shovelnose sturgeon(C)	-
Amiidae	Amia calva	Bowfin	0.3
Anguillidae	Anguilla rostrata	American eel	-
Aphredoderidae	Aphredoderus sayanus	Pirate perch	0.1
Ariidae	Bagre marinus	Gafftopsail catfish[(b)] (G)	-
	Arius felis	Sea catfish[(b)] (G)	0.3
Belonidae	Strongylura marina	Atlantic needlefish[(b)]	-
Bothidae	Paralichthys sp.	Flounders[(b)] (C)	0.9
Carangidae	Caranx hippos	Crevalle jack[(b)] (G)	-
	C. latus	Horse-eye jack[(b)]	-
Catostomidae	Ictiobus cyprinellus	Bigmouth buffalo(C)	2.9
	I. niger	Black buffalo(C)	1.0
	I. bubalis	Smallmouth buffalo(C)	5.7
	Carpiodes carpio	River carpsucker(C)	0.4
	Minytrema melanops	Spotted sucker(C)	-
	Erimyzon sucetta	Lake chubsucker(C)	-
Centrarchidae	Lepomus macrochirus	Bluegill sunfish(G)	0.1
	L. megalotus	Longear sunfish(G)	-
	L. microlophus	Redear sunfish(G)	-
	L. gulosus	Warmouth(G)	-
	L. punctatus	Spotted sunfish(G)	-
	L. humilis	Orangespotted sunfish(G)	-
	L. cyanellus	Green sunfish(G)	-

TABLE A-4 (Continued)

Family	Species	Common Name Game (G) or Commercial (C)	Relative Abundance (%)[a]
	Micropterus salmoides	Largemouth bass(C)	0.2
	M. punctatus	Spotted bass(G)	-
	Pomoxis annularis	White crappie(G)	0.8
	P. nigromaculatus	Black crappie(G)	0.8
Clupeidae	*Dorosoma cepedianum*	Gizzard shad[b]	14.3
	D. petenense	Threadfin shad[b]	11.2
	Alosa chrysochloris	Skipjack herring[b]	10.0
	Brevortia patronis	Menhaden[b] (C)	6.1
Cyprinidae	*Cyprinus carpio*	Carp(C)	6.3
Dasyatidae	*Dasyatis sayi*	Bluntnose stingray[b]	-
Elopidae	*Elops saurus*	Ladyfish[b]	0.3
Esocidae	*Esox niger*	Chain pickeral(G)	-
Hiodontidae	*Hiodon alosoides*	Goldeneye	-
	H. tergisus	Mooneye	-
Ictaluridae	*Ictalurus natalis*	Yellow bullhead(G)(C)	-
	I. melas	Black bullhead(G)(C)	0.1
	I. punctatus	Channel catfish(G)(C)	10.4
	I. furcatus	Blue catfish(G)(C)	6.6
	I. nebulosus	Brown bullhead(G)(C)	-
	Pylodictis olivaris	Flathead catfish(G)(C)	-
	Noturus gyrinus	Tadpole madtom	-
Lepisosteidae	*Lepisosteus osseus*	Longnose gar(C)	0.1
	L. platostomus	Shortnosed gar(C)	0.4
	L. oculatus	Spotted gar(C)	0.3
	L. spatula	Alligator gar(C)	0.1
Mugilidae	*Mugil cephalus*	Striped mullet[b] (C)	4.1
	Mugil curema	Silver mullet[b] (C)	-

TABLE A-4 (Continued)

Family	Species	Common Name Game (G) or Commercial (C)	Relative Abundance (%)[a]
Percichthyidae	Morone chrysops	White bass (G)	0.6
	M. mississippiensis	Yellow bass (G)	0.9
Percidae	Stizostedion canadense	Sauger (G)	-
Polydontidae	Polyodon spathula	Paddlefish (C)	-
Sciaenidae	Aplodinotus grunniens	Freshwater drum (G) (C)	4.7
	Cynoscion nothus	Silver seatrout[b] (G) (C)	-
	Micropogon undulatus	Croaker[b] (G) (C)	-
	Leiostomus xanthurus	Spot[b] (C)	-

(a) Relative abundance based on Federal Water Quality Administration survey, 1966-1968.

(b) Also occurs in the Mississippi River estuary and Gulf of Mexico - marine and/or brackish water tolerant forms.

TABLE A-5

FOOD HABITS AND SPAWNING FEATURES OF SOME FRESHWATER FISHES COMMON TO THE LOWER MISSISSIPPI RIVER[7,8]

Species	Food Habits[(a)]	Spawning	Egg Location
American eel (*A. rostrata*)	insects, crayfish, fish	winter (-)	Spawn in sea (catadromus)
Bowfin (*A. calva*)	fish, crayfish, insects, molluscs, etc.	April-July (-)	In guarded nests
Paddlefish (*P. spathula*)	plankton and insects	March-June (14-21°C)	Adhere to gravel
Shovelnose sturgeon (*S. platorynchus*)	insect larvae	April-July (-)	
Longnose gar (*L. osseus*)	Juveniles (≤50 mm)-insect larvae and entomostracea; Adults-other fish	March-August (-)	
Shortnose gar (*L. platostomus*)	Juveniles (≤50 mm)-insect larvae and entomostracea; Adults, other fish	May-July (19-23°C)	Adhesive, in masses
Spotted gar (*L. oculatus*)	fish, insects, blue crab, amphipods	-	
Carp (*C. carpio*)	plankton, insect larvae, algae, plants, molluscs	March-August (14.5-20°C)	Scattered
Buffalofish (*I. bubalis*)	plankton, algae, insects	March-June (≈17°C)	Adhere to vegetation

TABLE A-5 (Continued)

Species	Food Habits[a]	Spawning	Egg Location
Buffalofish (I. cyprinellus)	plankton, insect larvae, copepods, cladocerans	April-June (14.4-18.3°C)	Adhere to vegetation
Blue catfish (I. furcatus)	Juveniles (<127 mm)-zooplankton; Adults-insect larvae, fish, cray-fish, etc.		
Channel catfish (I. punctatus)	Juveniles - insects, arthro-pods; Adults - omnivorous and piscivorous	March-July (21-29°C)	In guarded nests
Black bullhead (I. melas)	Juveniles - insect larvae, fish eggs, amphipods, entomostracea; Adults - insects, fish, entomostracea, frogs, molluscs	April-July	Eggs in nests
Yellow bullhead (I. natalus)	crustacea, insects, fish, molluscs	May-June	Eggs in nests
Flathead catfish (P. olivaris)	Juveniles (<100 mm)-insect larvae; Adults - fish, cray-fish	May-July	In guarded nests
Gizzard shad (D. cepedianum)	Juveniles - protozoa, roti-fers, entomostraca; Adults - plankton, insect larvae, algae	April-June (March-August) (10-21°C) (to 29°C)	Scattered, sticky, adhesive
Threadfin shad (D. petenense)	plankton, insect larvae	April-early July	Adhesive

TABLE A-5 (Continued)

Species	Food Habits[a]	Spawning	Egg Location
Chain pickerel (E. niger)	Juveniles - insect larvae, amphipods, etc. Adults - fish, crayfish, frogs	March-May (6.0-16.0°C)	Adhere to vegetation
Bluegill sunfish (L. macrochirus)	Zooplankton, insects, amphipods, molluscs, etc.	April-June (19.4-26.7°C)	Eggs in nests
Redear sunfish (L. microlophus)	algae, plankton, snails, insects, small fish	May-Sept. (≈23.9°C)	Eggs in nests
Warmouth (L. gulosus)	insects, plankton, snails, crustacea	Spring (21.1°C) (21.1-26.7°C)	Eggs in nests
Black crappie (P. nigromaculatus)	crustacea, insects, fishes	March-July (14.4-17.8°C)	Guarded nests among plants
Largemouth bass (M. salmoides)	Juveniles - copepods, insects; Adults - fish, crayfish, molluscs, etc.	Spring (15.6°C) (15.6-23.9°C)	Eggs on substrate, guarded nests
White bass (R. chrysops)	Juveniles - crustacea, insects; Adults - fish, insects, crustacea	April-June (14.4-23.9°C)	Scatters adhesive eggs

(a) Specific food habits as well as times and temperatures of spawning vary throughout range.

TABLE A-6

AQUATIC PLANTS ASSUMED CONTIGUOUS TO THE LOWER MISSISSIPPI RIVER NEAR THE WATERFORD SITE[9,10]

Macrohabitat (Seral Stage)	Scientific Name	Common Name
Mud deposit (recent) (freshwater)	No plants - first succesion stage	
	Eleocharis spp.	Spikerush
	Brammia monnieri	Water hyssop
Mud flats	Scripus americana	Three-cornered rus
	Sagittaria lancifolia	Arrowhead
	S. platyphylla	Delta duck potatoe
	Cyperus ochraceus	Galingale
Mud flats (brackish)	Typha domingensis	Cattail
	Phragmites commonis	Roseau cane (reeds
	Spartina alternifolia	Oyster grass
	Spartina cynosuroides	Cord grass
	Spartina patens	Cord grass
	Zizaniopsis miliacea	Yellow cutgrass
	Ruppia maritima	
	Vallisneria spiralis	
	Jussiaea sp.	
Ridges	Panicum repens	Dogtooth grass
	Phragmites commonis	Roseau cane (reeds
Deep marsh	Typha domingensis	Cattail
	Alternanthera philoxeriodes	Alligator weed

TABLE A-6 (Continued)

Macrohabitat (Seral Stage)	Scientific Name	Common Name
	Eichornia crassipes	Water hyacinth
	Polygonium spp.	Smartweed
	Cladophora sp.	Filamentous algae
	Oedogonium sp.	Filamentous algae
	Rhizoclonium sp.	Filamentous algae
	Spirogyra sp.	Filamentous algae

REFERENCES

1. W. T. Penfound and E. S. Hathway, "Ecological Plant Communities in Marshlands of Southeastern Louisiana," Ecological Monographs vol. 8, no. 1, pp. 1-55, 1938.

2. Louisiana Power and Light Company, Waterford Steam Electric Station, Unit no. 3, Environmental Report, Docket no. 50-382, p. II-G-4, February 24, 1972.

3. "American Birds," Audubon Field Notes, Nat. Audubon Soc. in cooperation with the U. S. Fish and Wildlife Serv., vol. 26, no. 2, pp. 413-414, April 1972.

4. Federal Water Quality Administration, 1969, "Endrin Pollution i the Lower Mississippi River," FWQA, Department of the Interior, South Central Region, Dallas, Texas.

5. V. W. Lambou, "Fish Populations of Backwater Lakes in Louisiana Trans. Amer. Fish. Soc. vol. 88, pp. 7-15, 1959.

6. V. W. Lambou, "Fish Populations of Mississippi River Oxbow Lake in Louisiana," Proc. Louisiana Acad. Sci., vol. 23. pp. 52-64, 1960.

7. K. D. Carlander, "Life History Data on Freshwater Fishes of the United States and Canada, Exclusive of the Perciformes," Handbook of Freshwater Biology, Iowa State Univ. Press, Ames, Iowa, vol. 1, p. 752, 1969.

8. Department of Fish and Game, "Inland Fisheries Management," State of California, A. Calhoun, p. 546, 1966.

9. T. O'Neil, "The Muskrat in the Louisiana Coastal Marshes," Louisiana Dept. Wildlife Fish., New Orleans, 1949.

10. R. M. Darnell, "Trophic Spectrum of an Estuarine Community, Based on Studies of Lake Pontchartrain, Louisiana, Ecology, vol. 42, no. 3, pp. 553-568, 1961.

APPENDIX B

COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

**ADVISORY COUNCIL
ON
HISTORIC PRESERVATION**

WASHINGTON, D.C. 20240

50-382

December 7, 1972

RECEIVED DEC 12 1972

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muller:

In response to your request of October 30, 1972, for comments on the environmental statement for proposed construction of the Waterford Steam Electric Station Unit 3 by the Louisana Power and Light Company, and pursuant to its responsibilities under Section 102(2) (C) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that your draft environmental statement appears adequate regarding our area of expertise and we have no further comment to make.

Thank you.

Sincerely yours,

John D. McDermott
Acting Executive Secretary

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

50-382

RECEIVED
JAN 17 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

January 12, 1973

Mr. Daniel R. Muller
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

We have had the draft environmental statement for the Waterford Unit No. 3, Louisiana Power and Light Co., reviewed in the relevant agencies of the Department of Agriculture and comments from the Economic Research Service, Soil Conservation Service, and Forest Service, all agencies of the Department, are enclosed.

These comments may have been sent to you two weeks or more ago, but a file has been misplaced and we are not sure. If this duplicates earlier comments, please ignore it.

Sincerely,

T C Byerly

T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosures

ECONOMIC RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE

Comments on the Draft Environmental Statement, Waterford Station Unit 3, Louisiana Power and Light Company

The draft statement is generally complete with regard to NEP Act and CEQ Guideline requirements. However, the discussion of the need for additional generating capacity should be strengthened. Under existing law, the applicant must plan to satisfy the anticipated demand for its services. An important question is whether or not the applicant has projected that demand in a convincing manner. Our review of Chapter X, "The Need for Power," leads us to make the following observations about this projection:

(1) The statement notes a large increase in average residential energy purchases during the period 1960 to 1970. The magnitude of the increase and the level of current consumption indicates the possibility of some market saturation, particularly with respect to energy needed for residential air conditioning. The statement does not indicate what rate of residential electrical energy consumption is predicted for the period 1972-77.

(2) Clearly, some increase in required capacity stems from increased consumption by industry. One question that should be considered is what proportion of such increases stem from the introduction of new industries. Since major new industries will not locate in a region without the required supply of electrical energy, some portion of the deficit attributed to the alternative of not building this facility may not in fact materialize. The statement should consider this component of the predicted generating capacity requirements.

U.S. Department of Agriculture
Forest Service

re: Waterford Steam Electric Station Unit 3
Louisiana Power and Light Company
Draft Environmental Statement

Four documents were examined to uncover description and treatment of forest resources found within the bounds of this Louisiana Power and Light Company property. Information is sparse.

Only two of the four documents mention forested acreage. The site consists of 3,600 acres of which 2,200 acres are in bottomland hardwoods. Species given in report are: Water ash, red gum, tupelo-gum, sour gum, swamp maple, black willow, red bay and bald cypress.

Although only 200 acres of the 3,600-acre site are involved in the plant construction and operation, the remaining acreage is significant enough in size and composition to justify some attention to its present management and future treatment. No further comments can be offered without this information.

Soil Conservation Service, USDA, Comments on Draft Environmental Statement prepared by Directorate of Licensing, U. S. Atomic Energy Commission for Waterford Steam Electric Unit No. 3, Louisiana Power and Light Company

1. The document states that vegetation will be grown on slopes to reduce erosion. This is a very loose statement and does not indicate if temporary vegetation will be used during the construction period. This project will be under construction for a five-year period and some erosion could result if measures are not taken during the entire period. The applicant should have included provisions for using mulch as temporary protection if slopes are to be exposed for periods longer than 30 days, and to use temporary vegetation if exposed slopes are to be left for more than 120 days. Offsite damage caused by erosion and sedimentation will be minimal because of the type soils and topography.

2. Table A-1 of Appendix A is full of archaic taxons and should be revised to present taxonomic standards. Table A-6, page A-14, has archaic taxons which need revision.

3. This company has done a very thorough job of researching the biological impact this plant would have on the ecosystem and the consequences look to be extremely minor.

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT, CORPS OF ENGINEERS
P. O. BOX 60267
NEW ORLEANS, LOUISIANA 70160

50-382

LMNOD-K

4 January 197

RECEIVED
JAN 9 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Mr. Daniel R. Muller
United States Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muller:

Review of the draft environmental statement transmitted under Docket Number 50-382 (for the proposed construction of the Waterford Steam Electric Station Unit No. 3 addition to the Louisiana Power and Light Company (LP&L) system) discloses possible indecision in the ultimate selection of a heat disposal system installation. The surface discharge system described in th LP&L report initially appeared to be the clear selection among available alternatives, but other factors examined in the draft statement seem to hav qualified this choice. I feel that it is necessary to advise you that the favorable permit actions heretofore taken by the New Orleans District on application for a permit for installation and maintenance of heat disposal intake and discharge structures in the Mississippi River and on the levees at the proposed location did not consider any installation other than the surface discharge system selected and described in the LP&L report for Unit No. 3.

Comments on the draft environmental statement are confined to concern for any potentially adverse effects on the safety of navigation that could be created by installation and maintenance of a heat disposal system and appurtenances, other than the original selection. Specific references to selection of such a system were made on pages X-D-2 and -3 and X-D-11 of the applicant's report; on pages XI-2 and -3 and QA. 13-1 of Supplement No. 1 to the report; on page QA. 13-1 of Supplement No. 2 to the report; as well as on pages i, ii, iii, iv, I-6, XI-5, XI-6, XI-7, and XI-19 of the draft environmental statement. Specific areas of consideration are mentioned in the third sentence of paragraph 2) on page XD-2 and the third sentence on page XD-3 of the report, but they are not examined in greater detail in the report or in the draft statement. Another area of consideration is mentioned in the fifth sentence of paragraph (2), Multiport Diffuse on page XI-7 of the environmental statement. The alternatives that appear

LMNOD-K 4 January 1973
Mr. Daniel R. Muller

to be the more preferred are the high velocity mixing and multiport diffuser modes of heat disposal; either of these modes is considered to be sufficiently objectionable to preclude favorable permit action, based on the descriptions set forth in the report and supplements thereto and in the draft statement.

The proposed multiport diffuser installation would be objectionable for the same reasons at the sites shown for Waterford Units No. 1, 2, and 3. Anchorage hazards and plausible obstructions created by failure of anchorage efforts would constitute a primary objection. Such an installation would necessitate elimination of normal anchorage in that reach of the river to protect the installation from damage and preclude hazard-free emergency anchorage because of possible damage to the installation and vessels attempting emergency anchorage. Damage to the installation could create a hazardous obstruction to other watercraft if it were snagged and torn free from the riverbed. An obstruction of this nature could impede traffic for an extended period to permit clearing of the obstruction and repair of the installation. Impediments to navigation during installation, inspection, and maintenance and repair of the installation would include both primary and secondary objections. A cofferdam installation could constitute an extended period hazardous obstruction, particularly if it failed or was damaged prior to completion of protected works and/or removal of the cofferdam.

The proposed velocity momentum mixing system may be objectionable because of changes required in the outlet works or possible turbulence that may be produced in the affected navigable waters. The potential effect on small watercraft normally operating safely in this reach of the river would be of primary concern.

A change in the mode of heat disposal that affects navigability in this reach of the river may, as you can perceive, necessitate revocation of existing favorable permit actions and development of new acceptable criteria and applications prerequisite to issuance of a valid permit.

Sincerely yours,

Richard L. Hunt

RICHARD L. HUNT
Colonel, CE
District Engineer

THE ASSISTANT SECRETARY OF COMME
Washington, D.C. 20230

B-8

December 5, 1972

50-382

Mr. Daniel R. Muller
Assistant Director for Environmental
Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The draft environmental impact statement for "Waterford Steam Electric Generating Station" which accompanied your letter of October 30, 1972, has been received by the Department of Commerce for review and comment.

The Department of Commerce has reviewed the draft environmental statement and has the following comments to offer for your consideration.

Section V, Environmental Impact of Plant Operation, illustrates dramatic differences in the thermal plumes predicted for the Mississippi River by the Applicant (Fig. V-1) and the AEC Staff (Fig. V-3). The plumes predicted by the AEC Staff indicate that parts of the river could be affected by the discharges of all three Waterford units and the Little Gypsy units.

Due to these cumulative or combined effects, we recommend that consideration be given to activating the Aquatic Studies, described in section E, Environmental Monitoring, at least one year prior to operation of the first Unit at Waterford and to carrying out these studies for a minimum of one full year following startup and operation of Waterford Unit 3. The monitoring program should be conducted near all Waterford and Little Gypsy units and downstream at least to Hahnville.

Although a summary of the pre-operational radiological monitoring program is included, it is stated that a sampling program has not been developed for the post-operational period. We note that the pre-operational radiological monitoring program does not include analysis of aquatic vegetation, nor does it specify what animals other than fish will be analyzed. The final statement should include specific information on those plants and animals to be analyzed. In addition, the location of sampling stations, the frequency of sampling, and the types of analyses to be performed should be specified, as suggested by the AEC Staff on Page V-39.

In the section on Effects of Chemical Discharges, Page V-20, it is stated that "...the residual chlorine will have a concentration of (less than) $<$ 1ppm in the effluent. Dilution with river water in the mixing zone will further reduce residual chlorine levels so that the effect on aquatic river life is expected to be insignificant." We suggest that this conclusion be substantiated by data or references which indicate that the expected concentration of residual chlorine will not harm aquatic life, especially since chlorine is an extremely toxic material to aquatic organisms at concentrations of less than 0.1 ppm. Merkens (1)found that, at a pH of 7.0, 0.08 pm of residual chlorine killed half of his test fish in seven days. Zillich (2) found chlorinated sewage effluent to be toxic to fathead minnows at residual chlorine concentrations of 0.04 to 0.05 ppm. and Basch (3) found that 50% of a population of rainbow trout could tolerate 0.23 ppm for only 96 hours. Arthur and

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1. Merkens, J. C. 1958. Studies on the Toxicity of Chlorine and Chloramines to the Rainbow Trout. J. Water Waste Treat, 7: 150-151.
2. Zillich, A. 1972. Toxicity of Combined Chlorine residuals to Fresh-water Fish. J. Wat. Poll. Contr. Fed., 44(2): 212-220
3. Basch, R.E. 1971. In-situ Investigations of Toxicity of Chlorinated Municipal Waste Water Treatment Plant Effluents to Rainbow Trout (Salmo Gairdneri) and Fathead Minnows (Pimephales promelas), Complt. Rept. Grant 38050G22, EPA Water Quality Office.

Eaton (4) found that half of a population of the invertebrate, Gammarus pseudolimnaeus, survived 96 hours at a concentration of 0.22 ppm and that reproduction was reduced when chronic concentrations (for 15 weeks) were maintained at 0.0034 ppm. They also found that the highest concentration that produced no effect on the life cycle of the fathead minnow was 0.016 ppm. Sprague and Drury (5) showed an avoidance response by rainbow trout to free chlorine levels of 0.001 ppm.

In Section XI, Alternatives to the Proposed Action and Benefit-Cost Analysis of Their Environmental Effects, the alternative of open cycle cooling towers as "helpers" should be discussed in greater detail. Comparative information regarding predicted thermal plumes and flow-through times should be presented.

In addition, another alternative chemical waste disposal system should be discussed in which the wastes would be discharged into the Mississippi River rather than to Lac des Allemands, but which would also utilize a neutralization basin. Thorough environmental comparisons should be made of this alternative with those proposed by the Applicant and the AEC Staff.

The AEC Staff's evaluation concludes (page III-17) that most of the routine radioactive waste gas will be discharged to the atmosphere after at least 30 days hold-up in storage tanks. No information is given with regard to the period of release; that is, whether the gases are released to the atmosphere over periods of an hour, day, or months. An annual average concentration is inappropriate in

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4. Arthur, J.W. and J. G. Eaton. 1972 Chlorine Toxicity to the Amphipod, Gammarus pseudolimnaeus, and the Fathead Minnow, Pimpephales promelas. J. Fisheries Research Board of Canada, 28 (12): 1841-1845.
5. Sprague, J. B. and D. E. Drury, 1969. Avoidance Reactions of Salmonid Fish to Representative Pollutants, pp. 169-170 in Advances in Water Pollution Research, Proc. 4th Int. Conf., Prague, 1969.

computing radioactive doses from sporadic releases occurring an hour or two once a month.

No information is given with regard to the meteorological data base upon which the staff's annual relative concentration of 2.2×10^{-5} sec/m^3 is based. Presumably it is based on the Moisant Airport data presented in the applicant's Environmental Report. From one year of onsite data presented in the applicant's Preliminary Safety Analysis Report, we estimate a value of 3.2×10^{-6} sec m^{-3} at the exclusion distance of 914 m.

The staff's analysis of the environmental impact of postulated accidents does not specify the relative concentration value used at the minimum exclusion distance of 914 m or the frequency of occurrence of such a concentration. Our interpretation of the guidance given in the proposed Annex to Appendix D 10 CFR Part 50 results in a concentration value of 4×10^{-5} sec m^{-3} assuming a building wake factor of cA=1220 m^2 and one-tenth the concentration given by Pasquill Type F and a wind speed of 1 m/sec. Our estimate of average hourly concentration (the 50 percentile value) using the one year of onsite date is 1×10^{-4} sec m^{-3}. Although the proposed Annex specifically states that each class of accidents shall be evaluated as to probability or frequency of occurrence to permit estimates of environmental risks, no such guidance is given as to the acceptable frequency of occurrence of the meteorological conditions. In the first estimate above, we used the standard suggested meteorological condition which remains the same regardless of site except for a difference in exclusion distance, while the second estimate is based on a frequency of occurrence approach using measured onsite meteorological data taken hourly for a period of one year.

We agree with the AEC Staff that the projected dose to man from this plant due to I-131 release is substantially higher than acceptable, and is quite correctable, as demonstrated on several other similar plants. We strongly endorse the AEC Staff position that issuance of this construction permit carry the condition that this situation be corrected.

We hope these comments will be of assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

50-382

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

JAN 18 1973

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of October 30, 1972, wherein you requested comments on the draft environmental impact statement for the Waterford Unit No. 3, Louisiana Power and Light Company, Docket Number 50-382.

This Department has reviewed the health aspects of the above project as presented in the documents submitted. The following comments are offered:

1. In the draft environmental impact statement the potential organ dose to the thyroid from I-131 to individuals living on the site boundary is excessive and higher than the criteria set forth in proposed Appendix I, 10 CFR 50. Further, we have noted that the Atomic Energy Commission considers it necessary for the applicant to expand his monitoring program to include a substantive and comprehensive sampling of milk, vegetables, and the iodine deposition thereon in the areas of the site boundaries.

2. The applicant has not yet contracted for any fuel reprocessing services and, until a reprocessor is selected, no shipping route or type of shipping cask will be specified. There also is no mention of the licensed burial facility to be used for solid radioactive wastes.

3. It is stated on page IV-3 that "The judicious use of basal sprays will be used to retard regrowth of the trees that have been cut. . . ." However, no mention of the use of herbicides can be found in the statement. If such use of herbicides is intended, they should be specified.

Page 2 -- Mr. Daniel R. Muller

4. It is noted that the 10-acre stabilization pond and the neutralization basin will eventually drain into Lac des Allemands via unlined drainage canals. Although substantial amounts of chemicals, particularly sulfate, may possibly have an impact upon the water of the canals and eventually Lac des Allemands, nearly all of the aquatic ecology data in the draft environmental impact statement is concerned only with the Mississippi River.

The opportunity to review the draft environmental impact statement is appreciated.

Sincerely yours,

Richard L. Seggel
Acting Assistant Secretary
for Health

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
819 TAYLOR STREET, FORT WORTH, TEXAS 76102

REGION VI

December 15, 1972

IN REPLY REFER TO:
6ME

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
Director of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Re: Docket No. 50-382

Dear Mr. Muller:

The Department of Housing and Urban Development has reviewed the draft environmental impact statement for the Waterford Steam Electric Station Unit 3 near Taft, Louisiana, and has the following comments regarding the said statement and the proposed project for which it was prepared:

1. We wish to stress what we see as a vital need for a virtually instantaneous warning system for communities and industries in the vicinity of and downstream and/or downwind from the plant at any time there is any leakage into the river or into the atmosphere of any radioactive or other hazardous emissions. This is seen as especially critical for those industries and public agencies that have water intakes downstream from the plant.

2. We feel that Louisiana Power and Light Company should be strongly urged to work quite closely with the appropriate public bodies and agencies which have planning and land-use control powers for the area toward the end of assuring, to the maximum extent possible, that all future development in the vicinity is compatible with the plant and its operations.

Sincerely,

Wm R. Yerkes

For David W. Baker
Environmental Clearance Officer

United States Department of the Interior

50-382

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

RECEIVED
JAN 12 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

ER-72/1257

JAN 11 1973

Dear Mr. Muller:

This is in response to your letter of October 30, 1972, requesting our comments on the Atomic Energy Commission's draft statement, dated October 1972, on environmental considerations for Waterford Steam Electric Station, Unit 3, St. Charles Parish, Louisiana.

Our comments are presented according to the format of the statement or according to specific subjects.

Condition of Construction Permit

We believe that the conditions to the issuance of a construction permit given on page iv will provide needed additional protection for the natural environment.

Regional Demography and Land Use

The recreational and associated scenic-aesthetic cultural resources in the area will not be significantly affected by the project.

We suggest that the statement describe the soil-vegetation resources by using soil taxonomic units for the soils and quality ratings (site indices) for the major timber species expected to be affected by the construction and operation of the project, including transmission lines. This would permit correlation between radiation and soil taxonomic units. This information could also serve as basic data for planning future generating stations with similar soil taxonomic landscape units. Information on the soil taxonomic units occurring in the project area can be obtained from the Soil Conservation Service of the U. S. Department of Agriculture.

Historical Significance

The statement should reflect the results of consultation with the State Liaison Officer for Historic Preservation concerning the effects of the proposed action on any places under consideration for nomination to the National Register of Historic Places. The address is Louisiana Historical Preservation and Cultural Commission, Old State Capitol, North Boulevard, Baton Rouge, Louisiana 70802.

The impacts of the project on archeological resources are not adequately described. We think that a professional archeologist should examine the areas to be disturbed and assess the impacts on archeological resources. The statement should reflect the results of this survey and indicate measures which will be taken to mitigate adverse effects. It is not sufficient to indicate that a specific institution believes that there are no known or suspected archeological values available. Scientific documentation such as a field survey and study report should be cited and available for review.

Hydrology

Excavation for plant foundations will be approximately 60 feet deep and will require extensive pumping for dewatering purposes. The applicant should be particularly careful not to dewater any shallow domestic wells and should monitor both water quality and stage in any wells affected before, during, and after construction.

The principal ground-water supplies come from sand aquifers at the 400 and 700 foot depths. Piezometric water levels in the 700 feet deep aquifer is at about -24.5 to -28.0 feet msl. Based on an inventory of well locations and depths, it appears that the applicant is correct in this opinion that it is improbable that the principal deeper aquifers could be contaminated by leakage of radioactive waste.

Effluent Systems

The final environmental statement should describe the manner for disposal of dead fish which are expected to accumulate at the water intake structure.

Water Use

Under certain river flow conditions the temperature of the cooling water at the intake could be much higher than 2°F above ambient conditions as projected by the applicant. The AEC staff has recognized this possibility on page V-5. According to page B-5 of the applicant's environmental report further studies of thermal plumes are planned. These studies would serve to more accurately determine the temperature increases above ambient caused by the two existing plants in the area.

The water temperature of the river downstream of Waterford will be increased by 1° to more than 10°F. The heated water will extend across the entire river. It is not possible to accurately estimate the impacts on aquatic life at this time. However, the proposed biological monitoring and surveillance program should provide this very important data.

The statement indicates that diversion of liquid chemical wastes to the Lac des Allemands drainage could adversely affect aquatic ecology and recreational aspects of that area and indicates on page V-9 that the Mississippi River is better able to accommodate these wastes. We also believe that harmful effluents could adversely affect Lac des Allemands and Lake Salvador and other highly significant water areas and marshes in that drainage. The Lac des Allemands drainage is reputed to be the best catfish fishing in Louisiana; fur animal and waterfowl resources of the drainage area are of particularly high value, and the endangered southern bald eagle and American alligator also are present. The State owns and operates a management area on the shore of Lake Salvador to provide public hunting and fishing opportunities.

Effect of Plant Operation on Endangered Species

In discussing the effects of plant operation on endangered species, it should be mentioned that installation of the transmission line will not only result in a direct loss of wildlife habitat, but will be a disturbance that some specie may not tolerate.

Plant Accidents

This section contains an adequate evaluation of impacts resulting from plant accidents through Class 8 for airborne emissions. However, the environmental effects of releases to water is lacking. Many of these postulated accidents listed in Tables VI-1 and VI-2 could result in releases to the Mississippi River and should be evaluated in detail.

We also think that Class 9 accidents resulting in both air and water releases should be described and the impacts on human life and the remaining environment discussed as long as there is any possibility of occurrence. The consequences of an accident of this severity could have far-reaching effects on land and in the Mississippi River which could persist for centuries affecting millions of people.

High Velocity Momentum Mixing

The proposed mode of returning the heated water from Unit 3 is premised on a low-velocity surface entry so as to encourage heat transfer to the air rather than dilution. As stated on page XI-4, since only a relatively small area of the water surface will have a temperature rise greater than 4°F, it appears that a high velocity jet would reduce the thermal impacts by increasing the dilution factor. It appears that with suitable design the heated water from all five plants could be sufficiently diluted to meet temperature standards. It does not appear that the applicant has made a comprehensive study to determine the best means of disposing of the heat from all five plants.

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

Sincerely yours,

[signature]

Deputy Assistant Secretary of the Interior

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

50-382

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS: (GWS)
U.S. COAST GUARD
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: 202-426-2262

8 DEC 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of October 30, 1972 addressed to Mr. John E. Hirten, Assistant Secretary for Environment and Urban Systems, concerning the draft impact statement, environmental report with supplements 1 and 2 on Waterford Steam Electric Station Unit 3, St. Charles Parish, Louisiana.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material presented.

Noted in the review by the Federal Railroad Administration is the following:

"The draft environmental impact statement makes no mention of the 23.5 mile proposed transmission line crossing any railroad facility. However, the environmental report does indicate a crossing with the Southern Pacific Railroad. The problem of inductive coupling, direct faulting or flashover with railroad signal and communication circuits is one which should be addressed. Destruction of the integrity of railroad signal and communication facilities is more than an inconvenience as the potential for serious accidents exists."

The Federal Aviation Administration commented as follows:

"The proposed location of the Waterford Steam Electric Station Unit 3 and the proposed routing of the transmission line as indicated on Figure III-3 of the subject statement have been considered by this agency. The plant site does not appear to conflict with any existing aeronautical facilities. The proposed route of the transmission line appears to place it in the proximity of the existing general aviation airport, Green and Gold Plantation Airport, Luling, Louisiana. The scale of the map, Figure III-3, is such that accurate computations cannot be made. When the final engineering routing of the transmission line is firm, a determination should be made by Louisiana Power and Light

Company as to the necessity for filing notice of construction in the vicinity of this airport in accordance with the requirements of Part 77, Federal Air Regulations. It is recommended that the section on "Transmission Lines" in the statement include a paragraph stating that all construction notices required by Part 77 of the Federal Air Regulations will be submitted to the Federal Aviation Administration for study and determination as to acceptability of the proposal.

The State of Louisiana has an airport system study currently underway to identify airport requirements in the state. It is recommended that coordination with the State Director of Aviation, Louisiana Department of Public Works, be accomplished and indicated in the statement.

The section on "Transportation Accidents" refers to 49 CFR 171.15, 174.566, 177.861 as setting forth procedures to be followed by carriers involved in an accident while transporting nuclear materials. The CFR covers transportation by water, rail, and truck but not by air. It is recommended that reference 2, page VI-9 of the statement, be expanded to include Part 103, Federal Air Regulations, which covers air transportation of dangerous materials."

The Department of Transportation has no further comments to offer. We have no objection to this project. We do feel, however, that the concern of the Federal Railroad Administration and Federal Aviation Administration should be addressed in the final statement.

The opportunity for the Department of Transportation to review and comment on the Waterford Station is appreciated.

Sincerely,

J. D. McCANN
Captain, U. S. Coast Guard
Acting Chief, Office of Marine
Environment and Systems

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

50-382

DEC 22 1972

OFFICE OF THE ADMINISTRATOR

RECEIVED
DEC 22 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Mr. L. Manning Muntzing
Director of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muntzing:

The Environmental Protection Agency has reviewed the draft environmental statement for Waterford Steam Electric Station, Unit 3, and our detailed comments are enclosed.

We agree with the conclusion of the AEC staff that the potential thyroid dose due to release of radioactive iodines is excessive. Therefore, we endorse the recommendations of the AEC for iodine effluent control measures on plant discharge systems.

We anticipate that the station, as proposed, may not be able to operate in compliance with the federally approved water quality standards for Louisiana. It may be necessary to choose one of the alternative cooling systems considered in order to assure compliance with these standards.

We will be pleased to discuss our comments with you or members of your staff.

Sincerely,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

Enclosure

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20450

December 1972

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Waterford Steam Electric Station, Unit 3

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental impact statement for the Waterford Steam Electric Station Unit - 3, prepared by the U.S. Atomic Energy Commission (AEC) and issued October 30, 1972. Following are our major conclusions.

1. We agree with the staff's conclusion that the potential thyroi dose due to the release of radioactive iodine from the Waterford station is excessive and measures should be taken to ensure that t criteria set forth in the proposed Appendix I to 10 CFR Part 50 are met.

2. We anticipate that the Waterford Steam Electric Station, Unit No. 3, as proposed, may not be able to operate in compliance with Federally approved state water quality standards for Louisiana. Information in the draft statement indicates that as far as one mile below the station discharge, Mississippi River water temperature will be above the 96.8°F maximum specified in these standards for receiving waters. The AEC has conditioned the construction permit with the requirement that the applicant "modify the outfall for Waterford 3 to provide for high velocity momentum discharge . . ." In our opinion, this modification would cause further plume penetration into the river and could result in thermal blockage of aquatic organisms due to plume interaction with the Little Gypsy Plant across the river and Units 1 and 2 upstream.

3. In our opinion the applicant should define a comprehensive environmental sampling, monitoring and surveillance program (as required by the AEC) as soon as possible. Further, we believe that this program should be initiated at the earliest possible date for the collection of baseline data. In any event, the program should be in operation prior to 1974 when the Waterford, Unit No. 1 is scheduled to go on-line.

RADIOLOGICAL ASPECTS

Radioactive Waste Treatment

With the exception of the potential release of radioiodine, the solid, liquid, and noble gas radioactive waste treatment systems for the Waterford station appear adequate to allow operation within the current "as low as practicable" criteria as specified in the proposed Appendix I to 10 CFR Part 50. Since the capability to allow operation within this criteria has been provided, we encourage the applicant to develop operating procedures which will insure that discharges are, in fact, "as low as practicable."

We agree with the conclusion of the AEC that the lack of iodine control systems at the Waterford station, along with the proximity of the nearest milk cow and sources of consumable leafy vegetables, produces a situation where thyroid doses could be potentially excessive. [Therefore we concur in the recommendations of the AEC for iodine control systems on plant ventilation systems and for the condenser air ejector.] We note that in Amendment 25 to the Preliminary Safety Analysis Report (PSAR), the applicant has already proposed design modifications to eliminate the venting of steam generator blowdown flash to the atmosphere. While this measure does reduce the potential child's thyroid dose rate below that estimated in the draft statement, from 280 mrem/yr to about 100 mrem/yr, w believe that the additional design modifications suggested by the AEC in the draft statement, i.e., charcoal filters on the turbine and reactor auxiliary buildings, and the air ejectors, are still warranted. We take this position in light of the potential thyroid dose and the criteria of "as low as practicable" effluent release, since current technology is available to bring the iodine discharges to a level which will provide significant further dose reductions to levels comparable with the guidelines in Appendix I to 10 CFR Part 50.

Steam leaks in the turbine building will contribute to the total gaseous radioactivity released from the station. While this source is recognized in the statement (page III-17, paragraph 1), no gaseous discharge estimates have been listed in Table III-3 of the draft statement for this source. Such an estimate should include the contribution to radioactive gaseous discharges resulting from steam leaks in the open turbine area and should be included in the final statement.

In an EPA field study at an operating PWR, it was noted that leakage from the secondary system actually contributed more to the loss of secondary system coolant than routine blowdown of steam generators. In the draft statement the observation is made that "There will be some leakage from the secondary loops to the turbine area which will also be released untreated." It does not seem, from the information provided in the PSAR, that the applicant intends to collect, treat, or monitor such leakage for radioactivity prior to discharge to the environment. We believe that the capability for radiological monitoring (including sampling) of such leakage should be provided. Also, considering that operating experience has demonstrated such leakage to be a major component of released secondary system coolant, we believe that a thorough analysis of this source and its potential radiological consequences should be made.

The radiological consequences of direct radiation (shine) from the plant have not been evaluated in the draft statement. Although at a PWR such direct shine does not usually contribute a significant dose, at the Waterford station there appear to be several residences which are very close to the site boundary, and the direct radiation they could receive from condensate storage tanks or other sources may be potentially significant. We suggest that a complete evaluation of the potential radiological impact of direct radiation from the Waterford station be included in the final environmental statement.

Transportation and Reactor Accidents

In its review of nuclear power plants, EPA has identified a need for additional information on two types of accidents which could result in radiation exposure to the public: (1) those involving transportation of spent fuel and radioactive wastes and (2) in-plant accidents. Since these accidents are common to all nuclear power plants, the environmental risk for each type of accident is amenable to a general analysis. Although the AEC has done considerable work for a number of years on the safety aspects of such accidents, we believe that a thorough analysis of the probabilities of occurrence and the expected consequences of such accidents would result in a better understanding of the environmental risks than a less-detailed examination of the questions on a case-by-case basis. For this reason we have reached an understanding with the AEC that they will conduct such analyses with EPA participation concurrent with review of impact statements for individual facilities and will make the results available in the near future. We are taking this approach primarily because we believe that any changes in equipment or operating procedures for individual plants required as a result of the investigations could be included without appreciable change in the overall plant design. If major redesign of the plants to include engineering changes were expected or if an immediate public or environmental risk were being taken while these two issues were being resolved, we would, of course, make our concerns known.

The statement concludes "... that the environmental risks due to postulated radiological accidents are exceedingly small." This conclusion is based on the standard accident assumptions and guidance issued by the AEC for light-water-cooled reactors as a proposed amendment to Appendix D of 10 CFR Part 50 on December 1, 1971. EPA commented on this proposed amendment in a letter to the Commission on January 13, 1972. These comments essentially raised the necessity for a detailed discussion of the technical bases of the assumptions involved in determining the various classes of accidents and expected consequences. We believe that the general analysis mentioned above will be adequate to resolve these points and that the AEC will apply the results to all licensed facilities.

NON-RADIOLOGICAL ASPECTS

Thermal Effects

The Waterford Steam Electric Station, Unit No. 3 (1165 MWe) will be located on the Mississippi River, 25 miles Northwest of New Orleans. Two oil-fired electrical generating plants (Waterford, Units 1 and 2; 430 MWe each) are presently under construction about 2000 feet upstream from Unit No. 3. The AEC has recognized in their evaluation of Unit No. 3, the influence on water quality of Units 1 and 2 which are expected to go on-line 3 and 2 years, respectively, prior to Unit 3 startup. The Waterford site lies across the river from the Little Gypsy Steam Electric Plant.

Condenser cooling for Unit 3 will be accomplished using a once-through water flow with intake from and discharge to the Mississippi River. In our opinion, the station, as proposed, may not have the capability to operate in compliance with Federally approved state water quality standards (approved 12 February 1968) which specify that Mississippi River water temperature shall "not be raised more than 3°C [5.4°F] above ambient water temperature, nor to exceed a maximum of 36°C [96.8°F]". There is no provision in the standards for an allowable mixing zone.

It is indicated in the draft statement (p V-8) that in the month of August the temperature in the receiving water, after the addition of the Waterford Unit 3 discharge, may be as high as 98°F one mile below the discharge and as high as 93-94°F for as far as two to three miles downstream from the station. The National Technical Advisory Committee has recommended in "Water Quality Criteria", dated April 1, 1968, that temperature rises be restricted to 5°F above ambient and that maximum temperature in receiving waters be restricted to 90°F for the protection of largemouth bass.

One of the conditions set by the AEC in calling for the licensing of the plant is that "The Applicant will modify the outfall of Waterford Unit 3 to provide for high velocity momentum discharge, so as to improve the mixing of effluent at the point of discharge thus decreasing the size of the mixing zone and minimizing the extent of interaction between the Waterford 1, 2 and 3 Units". We agree that higher velocity surface discharge will promote better mixing than the applicant's proposed system. However, high velocity discharge would cause further plume penetration into the river. With the Little Gypsy plant across the river and Units 1 and 2 immediately upstream, thermal blockage of fish movement is a distinct possibility.

In light of the potential thermal effects of the proposed discharge system, in combination with other thermal discharges in the immediate vicinity of the station, we concur with the AEC recommendation that studies of high velocity momentum mixing at Units 1, 2 and 3 be conducted. Should additional hydrologic analysis indicate that a large portion of the river surface may experience significant temperature increases from the combined Waterford-Little Gypsy Steam Electric Station discharges, we recommend further consideration of alternative cooling modes (e.g. the installation of high velocity discharges at Units 1 and 2, and a multi-point diffuser for Unit 3). We recommend, also, that the applicant consider installing, in the effluent lines of the once-through cooling system for Unit 3, capability to permit the rapid installation of a "helper" or supplementary cooling system, if needed, to remove a portion of the heat before discharge.

The applicant has reviewed a number of potential cooling systems ranging from more sophisticated once-through systems (altered discharges, diffusers, and helper devices) to completely closed-cycle cooling ponds and cooling towers. We feel the alternatives have been discussed sufficiently to provide a basis for choosing an environmentally acceptable cooling system for this site.

The 1972 Amendments to the Federal Water Pollution Control Act (Public Law 92-500) require EPA to set effluent guidelines for pollutants discharged from steam electric power plants. Effluent discharges from the Waterford Steam Electric Station, Unit No. 3 will have to be in accordance with the requirements of this law.

Biological and Chemical Effects

Intake velocity at the Waterford Station Unit 3 will be approximately 1.8 feet per second. However, the AEC (page V-11) has concluded that impingement and entrainment losses should not be significant due to the physical location of the intake and the normal high current velocities of the Mississippi River at the site. However, the AEC recommends that the discharges from Units 1 and 2, which now may raise the intake temperature at Unit 3 by as much as 6°F, should be mixed as rapidly as possible in order to reduce the attraction of aquatic life to the Unit 3 intake. We concur with this recommendation as aquatic life attracted to the Unit 3 intake would be susceptable to impingement and/or entrainment in the cooling water system.

Boric acid, chromate, phosphates and hydrazine will be released to the circulating cooling water system and subsequently discharged to the Mississippi River. Other chemicals (morpholene, mono-, di- and tri- sodium phosphate and chlorine residuals) will be discharged to a stabilization pond, and from there to fields draining toward the 40-and 80-arpent Canals and Lac des Allemands. Additional information should be included in the final statement on the location of the stabilization ponds, and the retention time required to stabilize these chemical wastes.

The AEC concludes that the stabilization pond "is not a desirable method of disposal" and comments that, even without stabilization, these wastes would have an insignificant effect on the aquatic life in the river if discharged in the cooling water effluent. We concur with this recommendation, provided standards can be met. If the stabilization pond is required to equalize concentrations of chemicals to be released, the pond should be retained (or some other treatment provided), with the effluent directed to the River. This alternative would prevent discharge of treated chemical wastes to the fresh waters of the canals and lake, and further provide a margin of safety by stabilization of wastes prior to discharge to the Mississippi River.

Little is known about the effect and biological metabolism of morpholene in water environments. However, studies have shown that this chemical is a moderate irritant to the skin, eyes and mucous membranes and has produced kidney damage in experimental animals. Therefore, we concur with the AEC recommendation that use of another, acceptable chemical should be considered by the applicant.

Monitoring and Surveillance

We thoroughly agree with AEC conditions that a more comprehensive monitoring and surveillance program be developed for the environment affected by the power plant. EPA will be pleased to work with Federal and state agencies in developing general guidelines which can be used by the applicant.

The proposed one year post-operational sampling program may not be sufficient for adequate analysis of the station's impact upon the ecology and water quality of the Mississippi

River. In addition, many parameters that are to be measured (i.e. salinity, pH, dissolved solids, turbidity, BOD, TOC, heavy metals, chromates, residual chlorine and sulfates) should be measured at the point of discharge as well as farther out in the River as proposed.

Air Quality

We believe that, with respect to the effects of non-radiological discharges on air quality, the Waterford station will have minimal impact. However, some information presented in the statement is either inconsistent with data given in the applicant's Environmental Report (ER) or needs further clarification or updating.

In the description of the meteorology of the Waterford site it is stated that "... inversions and isothermal lapse rates can be expected 21.99% of the time." However, Table 24 of the applicant's ER indicates these conditions exist 75.6% of the time. The statement also indicates prevailing winds are from the south direction. Table 24 of the ER indicates a maximum frequency of 9.92% for the south-south-east direction and a high total percentage of winds from the easterly directions NNE to SSE (51.9%). These inconsistencies should be clarified in the final statement.

Air pollutant emissions from the diesel engine generating units are listed in Table III-5 of the draft statement. No reference is given for these estimates. We would recommend use of the following emission factors published in AP-24, February 1972, by EPA's Office of Air Programs:

EMISSIONS FROM DIESEL ENGINES
USING 0.3% SULFUR FUEL OIL

Pollutant	Emission Factor* $lb/10^3$ gal.	Emissions Per Engine[1] lb/hr
Particulate	15.0	1.15
Sulfur Dioxide	142 (.3)	3.25
Sulfur Trioxide	2 (.3)	0.05
Carbon Monoxide	0.2	0.02
Hydrocarbons	3.0	0.23
Nitrogen Oxides (NO_2)	(40-80)	6.13
Aldehydes (HCHO)	2.0	0.02

* "Compilation of Air Pollutant Emission Factors," Office of Air Programs Publication No. AP-42, February 1972.

[1] Engine using 0.0766×10^3 gal/hr.

ADDITIONAL COMMENTS

During the review we noted in certain instances that the draft statement does not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Waterford Steam Electric Station. The cumulative effects, however, could be significant. It would, therefore, be helpful in determining the impact of the plant if the following information were included in the final statement:

1. The basis for the assumption that 2 coolant volumes would be degassed per year, with a resultant Xe-133 discharge from the gaseous waste system of 1090 Ci. We calculated (from the assumed rate of shim bleed) that 9 coolant volumes would be degassed per year and that 3700 Ci of Xe-133 would be discharged from the gaseous waste processing system per year.

2. A discussion of methods of disposal for debris trapped by the intake system. (A skimmer wall is incorporated at the intake for prevention of the entry into the condenser cooling system of large floating debris.)

3. Details on the storage of diesel fuel for the two 3,500 diesel generating units in the emergency generating system for the station (i.e., type of storage tank, capacity, fluid level monitoring, spill prevention, and containment and removal procedures.)

4. A discussion of the ambient noise levels and projected noise levels due to construction and operation of the facility. This is important due to the number of people exposed within a one-mile radius of the facility and the proximity of noise sensitive areas, such as schools.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:
50-382

December 6, 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter dated October 30, 1972, requesting comments on the AEC Draft Environmental Statement related to the proposed issuance of a construction permit to the Louisiana Power & Light Company for the Waterford Steam Electric Station Nuclear Unit No. 3, Docket No. 50-382.

The Federal Power Commission's Bureau of Power staff has already commented in detail on the need for the facilities as concerns the adequacy and reliability of the affected bulk power systems and matters related thereto. The comments were contained in a letter to Mr. R. C. DeYoung, Assistant Director for Pressurized Water Reactors, dated August 9, 1972, copy enclosed, discussing the Louisiana Power & Light Company's application for construction exemption for the Waterford Steam Electric Station Nuclear Unit No. 3.

At that time, the staff of the Bureau of Power concluded that the electric power output represented by the Waterford Unit No. 3 will be needed to implement the generation expansion program of Louisiana Power & Light Company and Middle South Utilities Company for meeting projected loads and to provide some measure of reserve margin capacity on their respective systems for the 1977 summer peak period. The Commission has not received any additional information that would alter the comments regarding the need for the Waterford Unit No. 3 as submitted in the letter of August 9, 1972.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

Enclosure

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

AUG 9 1972

Mr. R. C. DeYoung
Assistant Director for
Pressurized Water Reactors
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. DeYoung:

This is in response to your letter dated July 24, 1972, requesting comments on Louisiana Power and Light Company's (LP&L) projections concerning the need for power in 1977 and the potential curtailment of natural gas supplies for fossil-fueled generating units, all related to the LP&L Application for Construction Exemption for the Waterford Steam Electric Station Nuclear Unit No. 3.

Pursuant to the National Environmental Policy Act of 1969, and the Guidelines of the President's Council on Environmental Quality dated April 23, 1971, these comments are directed to a review of the need for the facilities as concerns the adequacy and reliability of the affected bulk power systems and matters related thereto.

In preparing these comments, the Federal Power Commission's Bureau of Power staff has considered the Applicant's Environmental Report, Application for Construction Exemption and supplement thereto; related reports made in response to the Commission's Statement of Policy on Reliability and Adequacy of Electric Service (Order No. 383-2); and the FPC staff's independent analysis of these documents together with related information from other FPC reports. The staff of the Bureau of Power bases its evaluation of the need for a specific bulk power facility upon long term considerations as well as the load supply situation for the critical load period immediately following the availability of the facility.

Need for the Facility

It is considered probable that Waterford Unit No. 3 cannot meet its initially scheduled commercial operating date of January 1977, but its 1,165 megawatts of base-load capacity could still be expected to be available for the 1977 summer peak load period provided the requested construction exemption is granted.

The Louisiana Power and Light Company is one of five operating companies of Middle South Utilities, Inc. (MSU) which plan and size their generating units to meet the requirements of the MSU System to realize economies of scale that would not be feasible if each company operated independently. Through contractual arrangements, reserves are shared by the five companies to achieve "equalized reserves" though each company is obligated to keep its average generating capacity equal to its load plus reserve requirements. When the installation of a large unit gives one company a temporary excess of reserves, the cost of this excess is shared by all other MSU companies.

The generation expansion program through 1977 of the MSU companies is outlined below:

Estimated Commercial In-Service Date	Station	Company	Type	Capab (M
March 1973	Nine Mile Pt. No. 5	Louisiana Pwr. & Lt. Co.	F	7
Sept. 1973	Arkansas Nuclear One No. 1	Arkansas Pwr. & Lt. Co.	N	8
March 1974	Waterford No. 1	Louisiana Pwr. & Lt. Co.	F	4
May 1974	Sterlington No. 7	Louisiana Pwr. & Lt. Co.	F1/	2
Jan. 1975	Waterford No. 2	Louisiana Pwr. & Lt. Co.	F	4
Jan. 1975	Andrus No. 1	Mississippi Pwr. & Lt. Co.	F	7
Jan. 1976	Arkansas Nuclear One No. 2	Arkansas Pwr. & Lt. Co.	N	9
Summer 1977	Waterford No. 3	Louisiana Pwr. & Lt. Co.	N	1,1

1/ Combined Cycle.

The Louisiana Power & Light Company plans the retirement of Sterlington Units Nos. 3 and 4 (total of 64 MW) in December 1972.

The following tabulation shows the electric system loads to be served by the Applicant and MSU and the relationship of the electric output of the Waterford Unit No. 3 unit to the available reserve capacities on the summer-peaking Applicant's and summer-peaking MSU systems at the time of the 1977 summer peak load. The 1977 peak load period is the anticipated initial service period of the new unit, but the life of the unit is expected to be some 30 years or more, and it is expected to constitute a significant part of the Applicants' total generating capacity throughout that period. Therefore, the unit will be depended upon to supply power to meet future demands over a period of many years beyond the initial service needs discussed in this report.

Mr. R. C. DeYoung

Forecast 1977 Summer Peak Load-Supply Situation

	LP&L	MSU
Conditions with Waterford Unit No. 3 (1,165 Megawatts)		
Net Total Capability - Megawatts	5,516 1/	13,284 2/
Net Peak Load - Megawatts	4,853 3/	11,686 4/
Reserve Margin - Megawatts	663	1,598
Reserve Margin - Percent of Peak Load	13.67	13.67
Conditions without Waterford Unit No. 3 (1,165 Megawatts)		
Net Total Capability - Megawatts	4,351 1/	12,119 2/
Net Peak Load - Megawatts	4,195 5/	11,686 4/
Reserve Margin - Megawatts	156	433
Reserve Margin - Percent of Peak Load	3.71	3.71
Applicants stated Reserve Margin Needs Based on 16 Percent Criterion - Megawatts	671	1,870
Reserve Margin Deficiency - Based on Applicants Stated 16 Percent Criterion - Megawatts	515	1,437

1/ Reduced by 79 megawatts due to oil conversion degradation. Includes net firm purchases of 30 megawatts.

2/ Reduced by 757 megawatts due to oil conversion degradation. Includes net firm purchases of 292 megawatts.

3/ Includes increase in system's net peak load of 168 megawatts resulting from a revised estimated annual load growth to 10.15 percent from 8.26 percent. Reduced by TVA diversity of 159 megawatts. Includes Middle South System exchange capacity of 664 megawatts.

4/ Includes increase in system's net peak load of 474 megawatts resulting from a revised estimated annual load growth to 10.15 percent from 8.26 percent. Includes firm sales of 48 megawatts. Reduced by firm purchases of 662 megawatts: SPA 207 megawatts, TVA diversity 445 megawatts.

5/ Includes increase in system's net peak load of 168 megawatts resulting from a revised estimated annual load growth to 10.15 percent from 8.26 percent. Reduced by TVA diversity of 159 megawatts. Includes Middle South System exchange capacity of 6 megawatts.

The availability of Waterford Unit No. 3 for the 1977 summer peak load period would provide the Applicant and the MSU system a reserve margin of 13.67 percent of peak load at that time. Should delays make the unit unavailable for the 1977 summer peak load period, the Applicant's and MSU's systems forecast a reserve margin of 3.71 percent of peak load, a reserve deficiency of 515 megawatts and 1,437 megawatts respectively, based on the Applicant's stated minimum reserve criterion of 16 percent of peak load.

The adequacy and reliability of the Applicant's and MSU's systems in 1977 is not only dependent upon the timely commercial operation of Waterford Unit No. 3 but also on the timely operation of all the units in MSU's current construction program. Current information indicates that delays are being experienced in bringing large units into commercial operation and this trend may continue for some time. The simultaneous loss of any of these units with the unavailability of Waterford Unit No. 3 would project an expected negative reserve margin on the Applicant's system.

As footnoted in the tabulation above, the Applicant's and MSU's net total generating capability was reduced by 79 megawatts and 757 megawatts, respectively, due to oil conversion degradation because of unavailability of natural gas as reported by the Applicant.

The net peak load of the Applicant's and the MSU's systems show an increase of 168 megawatts and 474 megawatts, respectively, from previous estimates, resulting from a revised estimated annual load growth of 10.15 percent from 8.26 percent.

The Southwest Power Pool (SPP) of which the Applicant and MSU are members, reports reserve margins of 21.9 percent of peak load for the 1977 summer period, however, a large portion of these reserves are vested in large new generating units not yet in operation. The Pool's main function is the furthering of bulk power system reliability in the SPP area through coordination of the members' plans for expansion and subsequent operation of their generation and transmission facilities, and the provision of mechanisms for short term emergency relief in the event of contingencies normally experienced on interconnected power systems. However, this short term emergency relief is not a substitute for the firm power, base load requirements of the members. In order to provide adequate reserves for the region, a proportionate reserve should be maintained by each system, based on its own load.

Alternates to the Proposed Facilities

The Applicant, in determining the need for additional generation to meet its projected demands, considered a number of alternatives including location, type (base-load and peaking), fuel (nuclear, coal, oil, or gas), purchase of power, environmental effects and economics. The final decision rested between a base-load nuclear-fueled plant and a base-load coal-fired plant. Economics and environmental considerations led to the selection of the nuclear-fueled plant over the coal-fired plant.

The Applicant reports the cost of a one-year delay in Waterford Unit No. 3 due to failure to proceed with work at the site would result in an additional capital cost of $27,845,000.

Conclusions

The staff of the Bureau of Power concludes that the electric power output represented by Waterford Unit No. 3 is needed to implement the Applicant's and MSU's generation expansion program for meeting projected loads and to provide some measure of reserve margin capacity for the 1977 summer peak period.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

OUISIANA BOARD OF NUCLEAR ENERGY P.O.BOX 44033·CAPITOL STATION·BATON ROUGE, LOUISIANA 70

B-47

December 8, 1972

50-382

Deputy Director for Reactor Projects
Director of Licensing
U. S. Atomic Energy Commission
Washington, D.C. 20545

Gentlemen:

The Louisiana Division of Radiation Control under the authority of the Louisiana Nuclear Energy Act, has the responsibility for the protection of the occupational and public health and safety from sources of ionizing radiation. With regard to the Louisiana Power and Light Company's proposed Waterford Stream Electric Station Unit 3 located near the town of Taft, St. Charles Parish, Louisiana, we are limiting our comments to those areas dealing specifically with radiation and the effects that radiation may have on the health and well-being of the citizens of the State of Louisiana who reside near the area of the nuclear power plant site.

Information contained within the Draft Environmental Statement indicates that an adult in the near-vicinity of the power plant could receive approximately 60 mR per year to the thyroid glands with a majority of the dose coming from milk-food pathways; whereas, a child would receive approximately 280 mR per year from the same chains. This level of dose committment is definitely not in the best interest of these citizens since it subjects them to radiation levels approximately 60% of the natural background radiation for the adult, and 280% in the case of a child. We realize that the basis for determining these levels of exposure are very conservative, and due to the fact that there are no dairy herds in the near vicinity of this plant, the total thyroid dose to the adult would be approximately 30 mR per year and that to a child, would be approximately 70 mR per year.

The release of radioiodines in gaseous effluents appear to be the primary cause of the potential exposure. Therefore, the Division insists that measures be instituted to reduce the exposures sufficiently to insure that no person will receive a total body or organ dose of more than 5 mR per year.

It is also felt that the conservative estimate of two man-rem which the affected population is to receive from Waterford Unit 3 is negligible when compared to the 170,000 man-rem to which the same population is exposed annually from natural background radiation.

It is generally accepted that this additional whole body dose will not significantly increase the radiation-induced health hazard to the general public involved.

Sincerely,

B. Jim Porter
Director
Division of Radiation Control

BJP:dbz

ENVIRONMENTAL & ENERGY SYSTEMS, INC.

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RECEIVED
DEC 14 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

December 1, 1972

U. S. Atomic Energy Commission
Washington, D.C. 20545

Re: AEC Docket No. 50-382 (1972)
Waterford Nuclear Power Generating Station,
St. Charles Parish, Louisiana

Gentlemen:

We submit the following comment in response to the Staff's draft environmental statement issued October 1972:

The staff contends that "Generation of power by mean of fossil-fired plants is the only alternative means for generating power avaailable to the Applicant"(i.e., the Louisiana Power & Light Company).

As seems to be the case with the staff's overall viewpoint towards alternative sources of power which are competitive with nuclear energy, we view this evalaution as inadequate and superficial.

An alternative power source ignored in the staff's evaluation is the geothermal energy stored in a geopressured belt 750 miles long in the Northern Gulf of Mexico basin which underlies the Coastal Plain inland for a distance of 60 to 100 miles. W. J. Hickel, Geothermal Energy, p. 16 (University of Alaska, 1972).

It has been estimated that this belt contains 10^{11} tons of oil worth of geothermal power - in equivalent terms. H. T. Meidav and J. Banwell, Geothermal Energy for the Future, (United Nations, 1972).

This belt has been studied and reported upon by a distinquished scientist employed by the United States Geological Survey, Dr. Paul H. Jones. We suggest you contact him. Cf. P. H. Jones, Geothermal Resources of the Northern Gulf of Mexico Basin, (United Nations, Pisa, Italy, 1970); P. H. Jones, Hydrodynamics of Geopressure in the Northern Gulf of Mexico Basin, (1969).

A recent session of the Republican Task Force on Energy also considered this source and we suggest you obtain the transcript of that testimony.

Very truly yours,

Donald F.X. Finn

Donald F.X. Finn, as Executive Director, Geothermal Energy Institute.

Rec'd Off. Dir. of Reg.
Date 12/13/72
Time 11:30

SOCIETY OF PETROLEUM ENGINEERS OF AIME
6200 North Central Expressway
Dallas, Texas 75206

PAPER
NUMBER SPE 41

B-50

THIS IS A PREPRINT --- SUBJECT TO CORRECTION

Introduction to Geothermal Energy

By

B. P. Bayliss, Member AIME, Lloyd Corp., Ltd.

ABSTRACT

Briefly touches on the present status of development and future potential of geothermal energy. Compares production and reserve estimates including the units and terminology employed in energy calculations of the infant geothermal energy industry with those of the petroleum industry. Discusses the importance of basic thermodynamics to obtain an understanding of the part that steam and hot water play in geothermal energy.

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Energy is the capacity for doing work. Heat is energy. Geothermal heat is a common source of extractive energy quite widely distributed like oil, gas and coal. The heat is largely stored in rock, sometimes referred to as magma or magmatic rock. Water and steam provide the means of transferring the heat at depth to shallower measures. Both conduction and convection of heat are evidenced in the transfer process. Water and steam are also the agents through which geothermal heat escapes to the surface in hot springs and fumaroles.

References at end of paper.

The geothermal energy industry is just now in its infancy. Some liken it to the state of the oil industry just after the turn of this century - about the time of the Lucas gusher at Spindletop.

Geothermal electric power is now being produced in 6 countries - the United States, Italy, New Zealand, Japan, Russia and Iceland - and generating plants are under construction in Mexico and El Salvador. A half dozen other countries are rapidly developing their steam and hot water resources. (1)

The Geysers Area, in Sonomo Co., California, about 80 miles north of San Francisco, is the only geothermal field presently supplying commercial electric power in North America. Three companies, Magma and Thermal Power and Union Oil of California, act together to sell steam to the Pacific Gas and Electric company. At the present time, about 192 megawatts of electricity are being generated and plans are to provide an additional 110 MW per year to the system. 192 megawatts is 192,000 kilowatts. This amount would supply the electrical power requirements of a city of 200,000 population, about the size of Sacramento.

The next areas likely to be producing electric power from a geothermal energy source are Cerro Prieto, Mexico and Imperial County, California just south of the southern tip of the Salton Sea.

There are those who project a bright and promising future for this burgeoning industry, others are more conservative as to the magnitude of the economically developable potential.

There is however, one point on which all those who have looked into the future of geothermal energy agree; the raw energy potential - that is, the quantity of earth heat available, is of enormous magnitude and virtually inexhaustible. It has been stated that the heat stored to a depth of 6 miles under the surface of just the United States is equivalent to the energy derived from burning 900 trillion barrels of oil. Again theoretically, if the Earth's center could be cooled only one degree Fahrenheit it would release enough heat energy to run existing power plants for 20 million years.(2)

Of course, we recognize that figures of this type, while interesting to calculate are not realistic in the sense that our ability to harness or utilize that quantity of heat if limited. Primarily this is because it is too diffuse and remote in occurrence. Nevertheless, the heat, and therefore the energy, is actually there in place. The relevant and significant figure is that which would represent how much of this vast energy potential could be economically converted to man's use.

[As a short aside, let's expand on that last statement for a moment. This business of economically converting natural resources to man's use - that's really the practical benefit of most scientific breakthroughs - and that's exactly the purview of the trained, experienced engineer. Therein lies the engineer's major contribution to society. It's easy to observe, catalogue and analyse a phenomenon but it requires imagination, ingenuity and painstakingly hard work to transform the phenomenon into something useful - and yield a profit in the bargain. The engineer is a fundamental contributor to the progress of our society and I suggest we should take renewed pride in this profession and each do our own public relations work - for, sure as hell, no one else is doing it for us.]

Back to the subject.

The Geothermal Steam Act, signed by President Nixon on December 24, 1970, gave the Secretary of the Interior responsibility for leasing Federal geothermal lands. Within the Department, the U.S.G.S. is responsible for locating and supervising development of geothermal resources, while the BLM is in charge of preparing and issuing Federal leases. The Bureau of Reclamation and the Office of Saline Water are also involved. A federal survey has recently been completed which identifies and locates existing KGRA's (Known Geothermal Resource Areas), the majority of which occur in the 11 western states.

On the State level, primary responsibilities lie with the California State Lands Commission, the Geothermal Resources Board, the Division of Mines and Geology and the State Division of Oil and Gas. The State Geothermal Resources Act of 1967 defines geothermal resources to mean "the natural heat of the earth, the energy, in whatever form, below the surface of the earth present in, resulting from, or created by, or which may be extracted from, such natural heat, and all minerals in solution or other products obtained from naturally heated fluids, brines, associated gases, and steam, in whatever form, found below the surface of the earth, but excluding oil, hydrocarbon gas or other hydrocarbon substances."

The responsibility for supervising exploration, well operations, environmental and subsidence control, and development of geothermal acquifers in California rests with our old friend, the D.O.G.

Oil companies and oil operators, both large and small are becoming more interested and more involved in geothermal operations because of the obvious analogies between the two extractive industries. Both involve well drilling and completion, structural geology and reservoir analysis, production and reserve calculations and many other related problems. Since the first of the year, California operators have filed notice with the D.O.G. for 18 geothermal wells, compared to 9 for the same period last year and new well completions amounted to roughly the equivalent of 2000 B/D oil production.(3

From a loftier viewpoint, another compelling reason for the Petroleum Industry to look at Geothermal is the alarming and increasingly critical shortage of usable energy in this country and indeed world wide

Energy is absolutely essential to our welfare. In the U.S. we use some 15 trillion H.P. hours of energy per year. It's not that we're running out of energy, but our energy exploration and energy conversion systems are falling woefully behind projected demand. Right now we need every BTU we can obtain from petroleum, coal, wood, water, fuel cells, nuclear reactors and geothermal sources. Ponder on this between now and the year 2000, just 28 years away, it's estimated the United States will consume more energy than it has in its entire past history. (4)

This new industry is now impelling us to take a look at the units and terminology it employs. It would be prudent for us, as engineers, to gain some familiarity with them.

Geothermal reservoirs may be divided into two general types. One, the dry steam type, produces mainly dry or slightly superheated steam and is referred to as a vapor-dominated hydrothermal system. Fields of this type are comparatively rare. Examples of vapor-dominated systems are the Geysers, California and Larderello, Italy. The other, much more common type is the hot water reservoir, or water-dominated system containing hi-temperature water under pressure, a portion of which (generally 10 to 20 percent) flashes to steam as it reaches the surface. Examples of hot water reservoirs in California are the Mono-Long Valley-Mammoth Complex and the Imperial Valley-Salton Sea Trough Area.

Production from geothermal wells is normally expressed in terms of pounds of steam per hour. A typically good flowing well at the Geysers, for example will produce 200,000 pounds of steam per hour. That's a sizeable volume of flow. At its existing temperature and pressure one pound of steam occupies 4.1 cu. ft.. So the 200,000 pound per hour well is flowing at the rate of almost 20,000 MCF/D. Now, how can we state this production rate so that it has meaning to us as petroleum engineers?

At the Geysers 18 to 20 pounds of steam is required to produce one kilowatt hour of electrical energy discharge at the power plant.

That is to say, 20 pounds, or a little less, of dry, low pressure steam (the steam inlet pressure of the turbines at the Geysers varies from about 65 to 100 PSIG) will have 3413 useful BTU extracted from it. So, we may rate a 200,000 lb. per hour well as capable of supplying 10,000 KW of continuous electrical power.

Let's compare this with the fuel oil requirement for a 10,000 KW oil fired power plant which requires about 390 barrels per day; call it 400.

Then from an electrical power generating standpoint, a 200,000 lb. steam well is roughly the equivalent of a 400 B/D oil well. An easier ratio to remember would be: a 50,000 lb. steam well is about the equivalent of a 100 B/D oil well as to energy.

I wish to emphasize here that I'm comparing actual plant energy requirement not the total energy in these fuels. For example, I've used a plant heat rate of 9745 BTU/KWH for the oil fired plant which means simply that the plant must gulp in 9745 BTU of fuel energy to discharge 3413 in the form of electrical energy.

In the same way, although we've been saying that it requires 20 pounds of ± 100 PSI steam to produce 1 KWH, checking the steam tables reveals that at 114 PSIA the total heat (or enthalpy) of steam in BTU per pound is 1200 (at about 355°F), which is 24,000 BTU per 20 pounds. It could therefore be stated that the heat rate of the geothermal plant in question was approximately 24,000 BTU per KWH. As a result, the 55 megawatt plant at the Geysers requires an input of about $1\frac{1}{4}$ billion BTU per hour, contained in about 1 million pounds of steam per hour supplied to the turbine inlet, but the generator discharges only about 188 million BTU per hour.

Just a word here about economics. Assume that a contract with a public utility company to deliver steam to its plant calls for a consideration of 3 mills per KW. That would be 3 mills per 20 pounds of steam. Then, a 200,000 pound per hour steam well would be the income equivalent of a 240 B/D well. And if we equate it to natural gas at, say, fifty cents per MCF, it would match the income of a 1440 MCF/D gas well. These figures suggest that steam energy appears underpriced in relation to oil and gas energy. Of course, there are other methods of "merchandizing" or utilizing the steam and hot water such as direct space heating water desalinization, dehydration processing and recovery of entrained chemicals and minerals. These could result in entirely different economics than its use for electrical power generation alone. There have been only limited applications to date for these other uses, but increasing study is being made which will certainly result in additional applications in the future.

Maybe we should back up a minute and review some basic power and energy equivalents. One KWH, we all know, equals 3413 BTU, or to restate it, one KW of electrical energy requires 3413 BTU per hour at 100% efficiency. If this rate of power consumption were maintained for 24 hours, we have 24 KW hours, or one KW "Day" and have consumed 81,192 BTU. Of course, a 24 KW plant would consume the 81,912 BTU every hour. One KW "year" is the same as a steady one KW output for 365 days (8760 hours), and requires about 30½ million BTU. In the same manner, a 365 KW plant would discharge this amount, 30½ million BTU, per day.

The new Japanese turbine generators at the Geysers are rated at 55,000 KW (or 55 megawatts) each and they deliver (or discharge) power, as I mentioned a moment ago, at the rate of about 188 million BTU per hour.

The available (theoretical) energy of residual fuel oil ("resid"), per 42 gallon barrel is (average) 6,000,000 BTU. A typical California crude (.96 spec. grav.) is rated at 18,670 BTU per pound, or 6,276,000 BTU per barrel.

As to petroleum gases, Methane, when burned, releases 1013 BTU per cu. ft.. Ethane averages 1773 BTU per cu. ft.. A common figure per cu. ft. of an average natural gas mixture is 1120 BTU, while manufactured gas releases only about 500 BTU per cu. ft. (5)

Coal develops 24 million BTU per ton. The fuel value of a ton of coal is approximately equivalent to 4 barrels of crude oil and 16 times an MCF of natural gas. These are "rule of thumb" figures.

As soon as we start considering steam and hot water we have to dust off our thermodynamics textbooks. We look at a Mollier diagram and wonder how it's possible to have so many curved lines on a piece of paper that has nothing to do with either a seismic or gravity survey. The twin bugaboos of enthalpy and entropy hit us again. There are few words in the English language as difficult of definition as entropy.

Enthalpy is best thought of as the total heat of the saturated or superheated steam at a given temperature and pressure. Entropy is a concept which gives the measure of the thermodynamic degeneration produced by every actual irreversible physical process and is always accompanied by a decrease in the quantity of energy available for transformation into work. Since entropy is a measure of the amount of energy that is unavailable for work during a natural process, such process always results in an increase in entropy. I hope this is perfectly clear.

There are not less than six separately recognizable types of stored energy - potential, kinetic, chemical, nuclear, energy of flow and internal energy. Internal energy is defined as "energy possessed by matter due to the activity and configuration of its molecules." Gentlemen, remember that definition because dry steam has molecules as active as a month old puppy and this makes for pretty special handling. (6)

As a practical matter, the illustration that might serve here is the contrast of pressure versus energy in a steam well compared to pressure versus energy in a gas or oil well. When steam wells were first being drilled and the comparatively low flowing pressures were encountered - - 75 to 150 PSI - and shut in pressures around 500 PSI, oil men naturally figured they would be easy to control - - no particular BOP problems would be encountered. What they forgot was that the total heat, or enthalpy - the total energy if you will - is the sum of the internal energy plus the product of the pressure times volume and is much higher in the hot steam than in natural gas or crude oil. The steam emerges at a high energy level ready to perform its work. The gas and oil have to be burned to release theirs.

Gas and oil normally transfer their energy by combustion in a furnace or an internal combustion engine. At that time, their energy is released or transferred. Geothermal steam does its transferring as an external combustion device, with "fuel ignition" taking place below the earth. The geothermal reservoir in which the waters are heated by magmatic rock may be considered the "external combustion engine." This steam can release its energy by being turned directly to a turbine blade as it comes out of the bore hole.

Geothermal reservoirs usually have an exaggerated although irregular temperature gradient with depth. Keeping in mind that a normal gradient is of the order of 1°F per 100 feet of depth, a geothermal field may have a temperature increase of 1°F per 10 feet, up to as high as 1° per foot through limited vertical intervals.

Notwithstanding the statement just made, it is still possible to say that the two presently known major vapor - dominated hydrothermal systems, the Geysers and Larderello, have rather uniform reservoir temperatures and pressures of just under 500°F and 500 psia respectively. (7)

Now, here's where I must point out the understanding that the Mollier diagram affords in the steam energy relationship under different pressure and temperature conditions. Checking the total heat (or enthalpy) of steam at 450°F and 450 psia, you'll find it's 1200 BTU and, if you remember, that was also the figure for total heat at the steam inlet conditions of 114 psia and 355°F for the 55 megawatt turbine generator at the Geysers. To answer the seeming paradox of how they can have the same heat content, we must remember that heat content is expressed in BTU per pound. Let's look at the specific volumes under the two conditions. At the 450-450 condition, one pound of steam occupies 1.1 cu. ft. of space, whereas at 114# and 355°, one pound occupies 4.1 cu. ft.. So, on an equal volume basis, the steam under reservoir conditions contains almost exactly 4 times the heat of the steam entering the turbine, i.e. the reservoir energy is compressed into one-fourth the space that it occupies at the turbine inlet.

As to reserves, we have pretty much a "whole new ball game" when comparing geothermal versus oil and gas reserves. We all know how recoverable reserves and tank-oil-in-place are calculated in the case of oil and gas. At present there are at least two tentatively acceptable means of calculating ultimate steam recovery.

One method consists of plotting static reservoir pressure divided by the steam compressibility factor as a function of cumulative steam production. These figures are extrapolated to an arbitrarily determined abandonment or uneconomic pressure value to yield ultimate steam reserves of the productive area under consideration.

This value is converted to a unit basis of steam per acre and applied to the area considered proven by exploration, to give the total reserve.

Plugging in some numbers to give an example: assume actual productive acreage of 500 and an areally weighted subsurface static pressure of 500 psi decreasing to 450 psi while producing 37.5 billion pounds of steam. At an abandonment pressure of 100 psi an ultimate recovery of 310 billion pounds could be anticipated from the 500 acres, or 620 million pounds per acre. Now, assuming an estimated 5000 acres considered proven: ultimate steam recovery would be 3100 billion pounds of steam, which would provide generating capacity of 490 megawatts assuming 20# per hour per KW steam, a 90% load factor and a 40-year generating plant life.

A second method, really nothing more than an educated guess, consists of simply approximating by use of the best data available to you, what the maximum continuously sustainable energy withdrawal rate not harmful to the geothermal reservoir will be. Consider that this rate can be maintained for 25 to 40 years. Equate this to power plant life and obtain a reserve figure, more accurately a capacity figure, by simple multiplication. A key consideration here (and one that does not have much analogy to an oil reservoir) is the replenishment rate of the fluid, in this case water, into the reservoir either by natural means or by man made injection wells.

This, then is a brief introduction to geothermal energy. There's plenty of room for engineers and consultants to get in the swim. If you're interested - plunge in - you'll find the water's warm!

REFERENCES

1. California Geothermal Resources Board: Economic Potential of Geothermal Resources in California, (January, 1971
2. Fortune: (June, 1969) Pg. 138.
3. Pacific Oil World: (August, 1972) Pg.
4. Chase Manhattan Bank: Outlook for Energy in the U. S. to 1985, (June, 197
5. National Tank Co: Handbook, (1959).
6. Warner: Thermodynmic Fundamentals for Engineers, (1964) Pg. 2.
7. White, Muffler and Trousdale: Vapor-Dominated Hydro-thermal Systems compared with Hot Water Systems, Economic Geolog (January, 1971) Vol. 66 No. 1.

APPENDIX C

LETTER FROM STATE OF LOUISIANA
LIAISON OFFICER FOR HISTORIC PRESERVATION

50-382
50-383

STATE OF LOUISIANA

Department of Art, Historical and Cultural Preservation

OLD STATE CAPITOL, BATON ROUGE, LOUISIANA 70801
(504) 389-5086

EDWIN EDWARDS
GOVERNOR
JAY R. BROUSSARD
DIRECTOR
MRS. PEGGY RICHARDS
ASSISTANT DIRECTOR

January 24, 1973

RECEIVED JAN 30 1973

Mr. Fred J. Clark, Jr.
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Clark:

The National Historic Landmark, Homeplace Plantation House or the Old Keller Place, near Hahnville is located some four miles south of the proposed Waterford Nuclear Plant to be constructed by the Louisiana Power Company.

Destrehan Plantation House, some three miles southeast of Hahnville, is at this time in the process of being nominated to the National Register of Historic Places. Because of its increased distance from the proposed Plant site, any effect on Destrehan Plantation would be even less than that on Homeplace Plantation.

We know of no other sites in this area actively being nominated to the National Register of Historic Places at this time.

Sincerely,

Jay R. Broussard

Jay R. Broussard
State Liaison Officer for
Historic Preservation
Department of Art, Historical
and Cultural Preservation

JRB/bc

APPENDIX D

STATE OF LOUISIANA STREAM CONTROL COMMISSION
CERTIFICATION OF COMPLIANCE WITH THE FEDERAL
WATER QUALITY IMPROVEMENT ACT OF 1970

D-1

STATE OF LOUISIANA
STREAM CONTROL COMMISSION
P. O. DRAWER FC
UNIVERSITY STATION
BATON ROUGE, LOUISIANA 70803

APPENDIX B

June 21, 1972

Louisiana Power and Light Company
142 Delaronde Street
New Orleans, Louisiana 70114

Attention: Mr. Donald L. Aswell, Production Manager

Gentlemen:

This is to officially inform you that the discharge permit applications for Units 1, 2, and 3, Taft, Louisiana, to discharge condenser cooling water to the Mississippi River and demineralizer waste to the Forty Arpent Canal were approved by the Louisiana Stream Control Commission at its meeting on May 31, 1972. Any change in either the quality or quantity of the discharges will require submission of new proposals.

The Commission, in approving the discharges, is of the opinion that water quality standards of the State of Louisiana will not be violated. Therefore, in accordance with provisions of Louisiana Revised Statutes of 1950, Title 56, Section 1439(5) - Act 628 of the 1970 Louisiana Legislature - this is your letter of certification from the commission that the installations comply with Section 21(b) of the Federal Water Quality Improvement Act of 1970.

Enclosed is copy of a public notice to be run by you, one (1) time, in the official state journal, the BATON ROUGE STATE TIMES, at your expense.

Very truly yours,

Robert A. Lafleur
Executive Secretary

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Enclosure