Final

environmental statement

related to operation of

KEWAUNEE NUCLEAR POWER PLANT

WISCONSIN PUBLIC SERVICE CORPORATION

DOCKET NO. 50-305

December 1972

RETURN TO REGULATORY CENTRAL FILES
ROOM 016

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

Docket No. 50-305

ERRATA

Final Environmental Statement

for

Kewaunee Nuclear Power Plant

1. Insert the attached page E-9 into Appendix E.

2. Delete the 5 lines regarding Appendix C that appear on page E-1.

December 21, 1972

Soil Conservation Service
USDA
Comments on Draft Environmental Statement
Prepared by: U. S. Department of Agriculture, Rural Electrification Administration, Washington, D.C.
For: Kewaunee Nuclear Power Plant, Wisconsin Public Service Corporation

1. Section 2.3.8 - Impact of Construction Operations

Reference is made to a soil erosion control plan developed for the area controlled by the Power Company. This plan should be fully implemented as soon as possible to assure the desired erosion protection.

2. Page 2.3-10

The agricultural operations will be discontinued on 790 acres this fall. The plan is to place this land back into agriculture in the near future on a lease arrangement with local farmers. We strongly suggest that soil and water conservation be made a condition of any such leasing arrangements.

FINAL ENVIRONMENTAL STATEMENT

RELATED TO OPERATION OF

THE KEWAUNEE NUCLEAR POWER PLANT

OF

WISCONSIN PUBLIC SERVICE CORPORATION

DOCKET NO. 50-305

DECEMBER 1972

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 actions are the continuation of construction permit CPPR-50 and the issuance of an operating license to the Wisconsin Public Service Corporation for the Kewaunee Nuclear Power Plant located within the Township of Carlton, Kewaunee County, Wisconsin (Docket No. 50-305). The Plant utilizes a Pressurized-Water Reactor (PWR) to produce 1650 megawatts of heat and has a net electrical output of 540 megawatts. The condenser cooling is accomplished by using once-through cooling water from Lake Michigan at the rate of 413,000 gallons per minute.

3. Summary of environmental impacts and resulting beneficial and adverse effects:

   a. Most of the 908-acre site was under cultivation prior to its acquisition, and almost 800 acres continued until 1971 to be used in this manner on a lease-back arrangement during Plant construction. Of the remaining 110 acres reserved for activities associated with the construction and subsequent operations, only about 40 acres were disturbed in the construction and landfill operations, and only about 15 acres are being actually used for construction.

   b. A maximum of 413,000 gallons per minute (gpm) of Lake Michigan water will be circulated through the condenser during the summer months with a 20°F temperature rise; in winter, since the water will be colder, there will be a volume reduction to 287,000 gpm with a temperature increase of 28°F.

   c. The number of fish entrained in the condenser cooling water will be minimized by air bubble screens and intake flow rate of less than one foot per second. Some small organisms will pass through the water intake and condenser and some of these will be killed. However, the total effect of Plant operation on aquatic biota will be very localized and inconsequential in terms of total Lake Michigan ecology. The use of chlorine (hypochlorite) as an antifoulant for the condenser system is not anticipated by the Applicant, but provision is made for its use if required.

d. The Wisconsin Public Service Commission and a commercial forester were consulted regarding the location and coordination of the transmission lines with the terrain traversed. The corridors for the approximately 60 miles of transmission lines involve 1066 acres of land. The Staff finds that since only 7% of this land was woodland, the environmental impact is not significant.

e. The radwaste system has been designed and built to assure that releases of radioactive materials will be as low as practicable as required by Commission regulation. No adverse environmental effects are expected from the release of small quantities of radioactive materials from this Plant.

The Staff has calculated that during normal operations, the Plant will release to the environment liquid effluents with a radioactivity content of less than or equal to 5 curies per year in addition to an estimated 1000 curies of tritium per year. Approximately 2000 curies per year of gaseous wastes will also be released.

The risk associated with accidental radiation exposures is very low.

f. The effect of all chemical releases is expected to be negligible and no long-term buildup is anticipated.

g. The Plant will provide 3.3 billion kilowatt hours per year (at an average capacity factor of 70%) of the additional electrical power forecast to be required due to the continuing increases in population and industrial development in the region. An increase in the local economy will result from Plant operation and the additional taxes should benefit the State and local governments.

h. The meteorological, hydrological, biological and radiological monitoring programs initiated for the Plant's vicinity will provide data on the impact of the Plant and be of interest to the scientific community, particularly in regard to the ecology of Lake Michigan.

4. The following principal alternatives were considered:

a. A total of eleven alternate sites, both on the shore of Lake Michigan and inland.

b. Alternatives to construction of the Plant:

1) Do not produce the power.
2) Purchase the power from other utilities.
3) Install a fossil fuel plant.

c. Alternative cooling methods:

1) Natural-draft cooling towers.
2) Mechanical-draft towers.
3) Spray pond.
4) Cooling pond.
5) Dry towers.

5. The following agencies and organizations have submitted comments on the Draft Environmental Statement (issued July 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 the Interior
   Department of Transportation
   Environmental Protection Agency
   Federal Power Commission
   Department of Natural Resources, State of Wisconsin
   Public Service Commission of Wisconsin
   State Historical Society of Wisconsin
   Wisconsin Public Service Corporation

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 December 1972.

7. On the basis of the evaluation and analysis set forth in this Statement, and after weighing the environmental, economic, technical and other benefits of the Kewaunee Nuclear Power Plant against the environmental and other costs, and considering available alternatives, it is concluded that the actions called for, under NEPA and Appendix D to 10 CFR Part 50, are the continuation of construction permit CPPR-50, and the issuance of an operating license for the facility, subject to the following conditions for the protection of the environment:

   a. The implementation of a comprehensive biological monitoring program which will identify and quantify the major biotic groups present in the nearby lake area and will consider the influence

of the Plant discharge plume on all major biotic groups present. Part of this program will be requirements to monitor:

1) Fish caught on the travelling screens,

2) Fish movement into the cooling water discharge canal,

3) Fish migration before and after startup and during shutdowns,

4) Plankton contained in the intake and effluent waters,

5) Toxicological aspects of uptake by fish of potentially harmful elements or compounds from discharge water.

The monitoring program, similar to the preoperational program, should be continued for at least two years after the Plant begins operation.

The Applicant will be required to evaluate the contribution of the warmed Plant effluents on the biotic stresses already in the lake. The evaluation of the discharges of pollutants, especially dissolved solids and compounds of phosphorous (plant nutrients), should take long-term effects into consideration. This will entail a comparative study before and after startup, and an analysis of the effect of the Plant on the overall stress, and alternative methods of solids disposal.

b. The hydrological monitoring program sampling frequency will be increased during preoperational testing and during at least the first year of Plant operation in order to provide significant information on changes at various locations and depths in the discharge plume area. In addition to chemical and other physical properties, it will be required that the thermal plume be determined for a variety of lake and current conditions.

If chlorination is required, there will be monitoring of the total residual chlorine concentration in the Plant effluent during and immediately following chlorination. If this concentration exceeds 0.1 ppm, the Applicant should take all practical measures to reduce it below this value. Should these efforts fail, the Applicant should determine the extent of the zone in the lake within which the total residual chlorine concentration exceeds the EPA recommendations. The Staff-approved Environmental Technical Specifications for the Plant will further describe the procedures to be followed during chlorination.

c. The radiological monitoring program will be augmented by more frequent sampling and analyses of fish, bottom sediments and bottom organisms and aquatic plants, and by collecting these at additional locations in the near vicinity of the discharge. The program is also to be expanded to include more frequent sampling and analyses of milk and meat produced in the Plant environs, particularly within two miles of the Plant.

d. Shoreline erosion at this Plant site is being monitored by aerial photography. If it becomes evident that the riprap and other shoreline structures added during construction or the thermal discharge during Plant operation have resulted in an increased rate of erosion along the shoreline in the vicinity of these alterations, the Applicant will be required to provide additional shoreline protection.

e. The Applicant will define a comprehensive environmental monitoring program, including as appropriate those topics specified above, for inclusion in the Technical Specifications (for the Plant operation) which are acceptable to the Regulatory Staff for determining environmental effects which may occur as a result of the operation of the Plant.

f. If harmful effects or evidence of irreversible damage are detected by the monitoring programs, the Applicant will provide to the Staff an analysis of the problem and plan of action to be taken to eliminate or significantly reduce the detrimental effects or damage.

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FOREWORD

This Final Environmental Statement considers the environmental effects of the Kewaunee Nuclear Power Plant (Docket No. 50-305). It is a requisite part of the evaluation associated with the proposed issuance of an operating license for that Plant to the Applicant, the Wisconsin Public Service Corporation (WPS), acting in behalf of a pool of three power companies. These are the WPS, Wisconsin Power and Light Company (WPL), and Madison Gas and Electric Company (MGE), known collectively as the Wisconsin Power Pool (WPP). Presently scheduled startup date is March 1973.

Prepared by the U.S. Atomic Energy Commission's (Commission) Regulatory Staff (Staff), this Final Statement is in accordance with the Commission's regulations implementing the National Environmental Policy Act of 1969 (NEPA) as set forth in the revised Appendix D of its 10CFR Part 50 regulations. Revised Appendix D, published in the Federal Register for September 9, 1971, is an interim statement of Commission policy and procedure for implementing NEPA in accordance with the opinion of the U. S. Court of Appeals for the District of Columbia Circuit rendered in its decision in Calvert Cliffs Coordinating Committee Inc., et al. United States Atomic Energy Commission, et al., 449 F.2d 1109 (D.C. Cir. 1971).

Section 102(2)(C) of NEPA calls for a detailed statement on:

(a) The environmental impact of the proposed action,

(b) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(c) alternatives to the proposed action,

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

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

An Environmental Report (ER) for the Plant was submitted by the Applicant in January 1971 and a revised ER was submitted November 1971. This Report by the Applicant is titled "Environmental Report - Operating License Stage." The Applicant's revised Environmental Report includes an Appendix (A) that presents the qualifications of principal investigators, and an Appendix (B) that provides copies of those permits, approvals, and comments obtained from various agencies which are related to environmental aspects. This Final Statement, presented here, takes into consideration the Applicant's

Environmental Reports; April 17, 1972 and May 8, 1972 amendments to the revised ER; the comments received from Federal and State Agencies regarding the Applicant's ER; additional information furnished to the AEC by the Applicant responding to those items in the Federal and State Agency comments requiring further clarification; information contained in the Final Safety Analysis Report (FSAR) as amended, including amendments through No. 21; the literature cited in the revised ER and the Draft Environmental Statement; and an inspection of the Plant site.

Comments received on the Draft Environmental Statement and the Applicant's response to these comments have been considered in the preparation of this Final Environmental Statement. Copies of the comment letters received are included herein as Appendix E and discussed in Section XII.

The Applicant must comply with all requirements of Section 21(b) of the Federal Water Pollution Control Act, as amended by the Water Quality Improvement Act of 1970 (Public Law 91-224) and as amended in October 1972.

Because safety requirements are considered fully in other documents, only salient features that bear directly on the anticipated radiation dose to the public are treated here. Comments received from other Federal and State Agencies relative to radiological aspects are being taken into account by the Staff in respect to overall safety evaluations which are a separate part of the licensing procedure.

The Environmental Project Manager for this Final Environmental Statement is R. G. West (301-973-7731), Directorate of Licensing, U. S. Atomic Energy Commission, Washington, D. C. 20545.

I. INTRODUCTION

On August 18, 1967, the Wisconsin Public Service Corporation (WPS), hereafter referred to as the Applicant, applied to the U.S. Atomic Energy Commission (USAEC) for a construction permit and operating license for a nuclear power plant on a site in the Town of Carlton, Kewaunee County, Wisconsin. This plant is designated as the Kewaunee Nuclear Power Plant (KNPP), hereafter referred to as the Plant.

The Plant is owned jointly by the Applicant, the Wisconsin Power and Light Company (WPL) and the Madison Gas and Electric Company (MGE). These three companies, known collectively as the Wisconsin Power Pool (WPP), entered into a joint power supply agreement on February 2, 1967 for maximizing the efficiency of power production and distribution in their territories. The Applicant acts for all members of the WPP on matters related to the design and construction of the Plant.

The Plant has a pressurized-water reactor which supplies steam to a turbo-generator, and is designed to produce 540 net megawatts of electrical power (MWe). It is located on a 908-acre site on the shore of Lake Michigan. Lake water is used in a once-through, full-return cooling system.

The application was reviewed by the AEC's regulatory staff and by the Advisory Committee on Reactor Safeguards. A public hearing was held before a three-man Atomic Safety and Licensing Board in Kewaunee, Wisconsin on June 27 and 28, 1968. On August 6, 1968 the USAEC issued a provisional construction permit for this Plant. Regulatory material pertinent to this Plant is available for public inspection in Docket No. 50-305 at the AEC's Public Document Room (1717-H Street, N.W., Washington, D.C.) and at the Kewaunee Public Library (314 Milwaukee Street, Kewaunee, Wisconsin).

Construction of the Plant was about 94% complete on September 1, 1972. Fuel loading is scheduled for March 1973 and commercial operation in September 1973.

A. SITE SELECTION

As a part of the company's long-range planning activities, the Applicant undertook, in 1966, a detailed investigation of the feasibility of eleven available sites for future power stations. Concurrently, a comparison of alternate forms of power generation was undertaken, with emphasis on fossil- and nuclear-fueled steam plants. The considerations which led to the selection of a nuclear plant at the Kewaunee site are recounted here. These steps were taken by the Applicant prior to the 1967 addition of WPL and MGE as partners in this undertaking.

Within the Applicant's service area there are numerous sites available for power plants. There are many lakes and streams that could provide cooling water, and the relatively flat, rolling terrain is amenable to formation of cooling ponds.

Selection of a site involves achieving a balance among many physical, economic, social, and environmental factors of which the most important are as follows:

1. Distance from system's load centers and transmission lines, and from cooling water.

2. Costs of land and foundation construction.

3. Elevation of plant with respect to source of cooling water.

4. Disruption of local economy during construction.

5. Destruction of forests, natural areas, historical sites, etc.

6. Adverse effects on aquatic, animal, and bird life.

7. Public opposition.

In addition, the population density near the site is an important consideration for nuclear plants, and the cost of fuel and waste transportation for a fossil-fueled plant.

A total of eleven sites, both on the shore of Lake Michigan and inland, were considered in the mid-1960's when the need for an additional generating plant was recognized but before a decision had been made on the type. An evaluation of the factors mentioned above narrowed the list to three, two on Lake Michigan and one on the Fox River. When the results of a concurrent study of the type of plant indicated a preference for a nuclear plant, the Point Beach site emerged as a first choice. However, by this time the Wisconsin Electric Power Company had obtained an option on that property so a reevaluation of all sites was undertaken with the added consideration that the plant would be nuclear-fueled. With a reduced importance placed on proximity of transportation facilities, the Kewaunee site rose to a favored position among the possible sites. The 908 acres and the twelve residences thereon were acquired without major public opposition or a need to resort to court action.

These alternative site evaluations did not make detailed impact analyses for alternative cooling means or other alternative plant designs, although

the relative merits of the two general types of cooling systems were considered in terms of broad economic, water-use, land-use, and power-generation requirements. Detailed evaluations of environmental impact of alternative cooling systems were made later for the Kewaunee site, as described in Section XI.A.

No other lakeshore sites were judged more favorable from an environmental viewpoint. The low elevation near the center of the site and the lakefront location make coolant water pumping costs reasonable. Detailed studies have demonstrated favorable geological and meteorological conditions for Plant construction and operation. As discussed in the following chapter, the Plant will have essentially no effects on land use and there will be no alteration of natural and historical areas. The location is in a region of very low population. The additional transmission lines required by this location are described in Chapter III, and the effects of construction are considered in Chapter IV.

The geological and hydrological nature of the general region precluded consideration of a hydroelectric plant to supply the projected need for additional system capability. The fuel options for a steam plant were evaluated. Because of supply problems, the choice was essentially limited to either nuclear fuel or coal. The net result of an economic evaluation of these alternatives, performed by an independent power engineering firm, was that a nuclear plant had an economic advantage for the Applicant's territory. A consideration of the environmental impact of each type of plant by the Applicant did not alter his choice.

B. APPLICATIONS AND APPROVALS

Approvals for the construction and operation of the Plant, or parts thereof, are required from numerous Federal and State agencies. Tables I-1 and I-2 summarize the permits required and indicate their status. Correspondence concerning those permits that relate most directly to environmental factors has been appended to the Applicant's Supplemental Environmental Report[4] and are indicated in these tables. The other letters of application and approval are available on request from the Applicant. Other documentation submitted in support of the applications to the USAEC is indicated[1-3, 6-13, 15-21], since it has been the source for some of the information contained in this statement. A related USAEC document has also been used.[14]

Review and approval in regard to waste systems and discharge of wastes in a manner which will not violate water quality standards, as regulated by Sections 144.04 and 144.44 of the State of Wisconsin Statutes, have been given by the Division of Environmental Protection of the State's Department of Natural Resources. These are included in Table I-2, together with information on other approvals within the Department of Natural Resources and by other State Agencies.

TABLE I-1.

Permits and Approvals from Federal Agencies

Subject	Application Date	Approval Date	Reference
Atomic Energy Commission (AEC)			
Construction Permit	August 18, 1967	August 6, 1968	5a
Operating License	January 12, 1971	Pending	3, 6-13
Special Nuclear Material License	August 23, 1971	September 7, 1971	
Corps of Engineers (CE)			
Intake and Discharge Facilities	June 17, 1968	December 12, 1968	5b
Concurrence by Fish and Wildlife Dept.	July 23, 1968	October 23, 1968	
Temporary Breakwater	April 2, 1969	May 5, 1969	
Discharge during Construction	June 16, 1971	Pending	

TABLE I-2.

Permits and Approvals from State of Wisconsin Agencies

Subject	Application Date	Approval Date	Reference
Department of Natural Resources (DNR)			
Construct High Capacity Wells	November 11, 1967	December 26, 1967	
Yard Piping and Plumbing	June 13, 1969	October 21, 1969	
High Capacity Test Well	June 20, 1969	June 25, 1969	
Harbor and Water Supply Structures	PSC (internal)	December 4 & 27, 1967	
Circulating Water Intake and Discharge System	March 19, 1968	May 21, 1968	5f
Sewer Pipe Installation	April 10, 1968	April 15, 1968	
Sewer System and Sewage Plant	April 26, 1968	May 22, 1968 & August 29, 1968	5g,5h
Intended New Wastes	January 24, 1969	June 5, 1969	5i
Discharge during Construction	August 2, 1971	Pending	
State Highway Commission (SHC)			
Access Road to Highway 42	December 8, 1967	December 12.1967	
Department of Industry, Labor and Human Relations (DILHR)			
Grading and Excavation	December 28, 1967	March 25, 1968	
Foundation Substructure	June 12, 1968	January 15, 1969	
Reactor Bldg. Shield	November 14, 1968	December 12, 1968	
Superstructure	December 12, 1968	January 15, 1969	
Fuel Oil Facility	April 22, 1970	May 8, 1970	
Steam Heating	April 22, 1970	May 13, 1970	
Heating, Ventilating and Air Conditioning for Administration Bldg.	August 7, 1970	September 15, 1970	
Turbine Bldg. Ventilation	October 2, 1970	October 15, 1970	
Temporary L. P. Gas Storage	February 3, 1971	February 22, 1971	
Public Service Commission (PSC)			
Construct and Operate Plant	March 17, 1967	October 17, 1967	5c
Transmission Line, Point Beach to North Appleton	December 3, 1967	February 8, 1968	5d
Substation, Transmission Lines	December 17, 1968	February 17, 1969	5e

At various stages of the planning and construction of the Plant, contacts have been made by the Applicant with the Chairman of the Boards for Carlton Township and Kewaunee County and with representatives of the city of Kewaunee, the Kewaunee County Sheriff's Department and the U.S. Coast Guard. Discussions have also been held by the Applicant with a variety of civic, educational, public-interest and social groups, including the Wisconsin Ecological Society, and with representatives of the local press.

In addition to required distribution to and by the USAEC, copies of the application documents have been sent by the Applicant to the Wisconsin Department of Natural Resources, the Public Service Commissions of Wisconsin and Michigan, the Chairman of Carlton Township, and public libraries within the area.

Section I-References

1. WPS, "Environmental Report: Questions and Answers," Amendment 1 to November 1971 Environmental Report-Operating License Stage (Revised), April 17, 1972.

2. WPS, "Amendment 2 to November 1971 Environmental Report-Operating License Stage (Revised)," May 8, 1972.

3. Wisconsin Public Service, "Statement Showing Cause Why the Construction Permit for the Kewaunee Nuclear Power Plant Should Not Be Suspended, in Whole or in Part, Pending Completion of the NEPA Environmental Review," October 11, 1971.

4. Wisconsin Public Service Corp., "Environmental Report - Operating License Stage (Revised)," November 1971.

5. ibid., "Appendix B; Major Permits and Approvals:"

   a. Letter and Provisional Construction Permit, P. A. Morris (AEC-DRL) to G. F. Hrubesky (WPS), August 6, 1968.

   b. Letter and Permit, N. E. Saxton (Operations Div., Chicago Dist., CE) to WPS, December 12, 1968.

   c. Letter and Findings of Fact, Certificate and Order, J. F. Goertz (Public Service Com. of Wisconsin) to Distribution, October 17, 1967.

   d. Letter and Findings of Fact, Certificate and Order, J. F. Goertz (PSC of Wisconsin) to Distribution, February 8, 1968.

   e. Letter and Findings of Fact, Certificate and Order, J. F. Goertz (PSC of Wisconsin) to WPS and WEP, February 17, 1969.

   f. Letter, T. G. Frangos (Bureau of Water Resources, Wisconsin Department of Natural Resources) to N. E. Knutzen (WPS), May 21, 1968.

   g. Letter, T. G. Frangos (BWR, Wisconsin DNR) to N. E. Knutzen (WPS), May 22, 1968.

   h. Letter, C. J. Blabaum (Bureau of Water Supply and Pollution Control, Wisconsin DNR) to N. E. Knutzen (WPS), August 29, 1968.

   i. Letter and Report of Intended (KNPP) Wastes, C. J. Blabaum (Bur. WS & PC, Wisconsin DNR) to N. E. Knutzen (WPS), June 5, 1969.

6. Wisconsin Public Service, "Final Safety Analysis Report - Amendment No. 7 to the Application for Construction Permit and Operating License for Kewaunee Nuclear Power Plant," January 27, 1971.

7. WPS, "Environmental Report - Operating License Stage," January 1971.

8. WPS, "Amendment No. 9: JAB-PS-01 and JAB-PS-03 Regarding Earthquake Analysis," May 20, 1971.

9. WPS, "Amendment No. 10: Questions and Answers," September 15, 1971.

10. WPS, "Amendment No. 11: Design Report for the Containment Fan Coil Units - PEP 253," October 20, 1971.

11. WPS, "Amendment No. 12: Additional Answers to Questions Transmitted July 7, 1971 and October 23, 1971," November 8, 1971.

12. WPS, "Amendment No. 13: Additional Answers to Questions Transmitted July 7, 1971 and October 23, 1971," December 15, 1971.

13. WPS, "Amendment No. 14: KNPP Questions and Answers," January 4, 1972.

14. Division of Reactor Licensing, USAEC, "Discussion and Findings Relating to Consideration of Suspension Pending NEPA Environmental Review of the Provisional Construction Permit for the Kewaunee Nuclear Power Plant," November 23, 1971.

15. WPS, "Amendment No. 15: Rev. and Additional pages to FSAR; Answers to Questions Transmitted December 30, 1971; Report NUS-808, Analysis of Kewaunee Meteorological Data," January 28, 1972.

16. WPS, "Amendment No. 16: Rev. and Additional pages to FSAR; Answers to Questions Transmitted January 22, 1972; Suppl. to Report NUS-808," March 17, 1972.

17. WPS, "Amendment No. 17: Revised pages to FSAR; Answers to Questions Transmitted April 24, 1972; Appendix H," May 12, 1972.

18. WPS, "Amendment No. 18: Revised and Additional pages to FSAR," May 19, 1972.

19. WPS, "Amendment No. 19: Answers to Informal Questions", June 20, 1972.

20. WPS, "Amendment No. 20: Operating and Permanent Shutdown Costs", July 18, 1972.

21. WPS, "Amendment No. 21: "Minor System Modifications", August 31, 1972.

II. THE SITE

The Plant is located in east-central Wisconsin, at the eastern edge of the territory served by the Wisconsin Power Pool, of which the Applicant is one of three member utilities. The site is on the west-central shore of Lake Michigan, in a predominantly rural area between the lakeside towns of Kewaunee, eight miles to the north, and Two Rivers, thirteen miles to the south. Prior to construction of the Plant, the 908 acres acquired by the Applicant were used solely for farming. Subsequent sections of this chapter describe significant features of the site and its vicinity, including demography, land use, history, surface and ground waters, climate, geology and interactions of the indigenous biota with the environment.

A. LOCATION OF PLANT

Figure II-1 is a map of the land area within approximately 75 miles of the site, showing major roads, population centers and adjacent bodies of water. Circles of 10-mile increments in radius, up to 50 miles, are indicated, centered on the site which is in the Carlton Township of Kewaunee County in the state of Wisconsin. The largest population center within a 50-mile radius of the site is the city of Green Bay, located approximately 27 miles west-northwest. The only sizeable community within a 10-mile radius of the site is Kewaunee, which had a population of 2901 in 1970.

Figure II-2 shows the topography within approximately five miles of the Plant site. Except for the crossroads communities of Two Creeks, Tisch Mills and Norman, and the Point Beach Nuclear Power Plant, which is located on a 2065-acre lakefront site 4.5 miles south of the Plant, this region is occupied mainly by farmlands, associated farmsteads and limited regions of forests. Figure II-3 shows the principal physical features of the site and immediate vicinity. Access to the Plant is by way of Wisconsin State Highway 42 which approximately bisects the site in a north-south direction.

The site as shown in Figure II-3 is the property of the WPP except for the highways and a cemetery of 1.13 acres located on State Highway 42 north of the Plant. The cemetery is owned by and will remain in the ownership of the Carlton Township with perpetual care to be provided by it. There are no dwellings or public buildings on the cemetery site.

Total acreage owned as Plant site is 907.57 acres. Overall ground surface at the site is gently rolling to flat with elevations varying from 10 to 100 feet above the level of Lake Michigan. The land surface slopes gradually toward the lake from the higher areas west of the site. The major

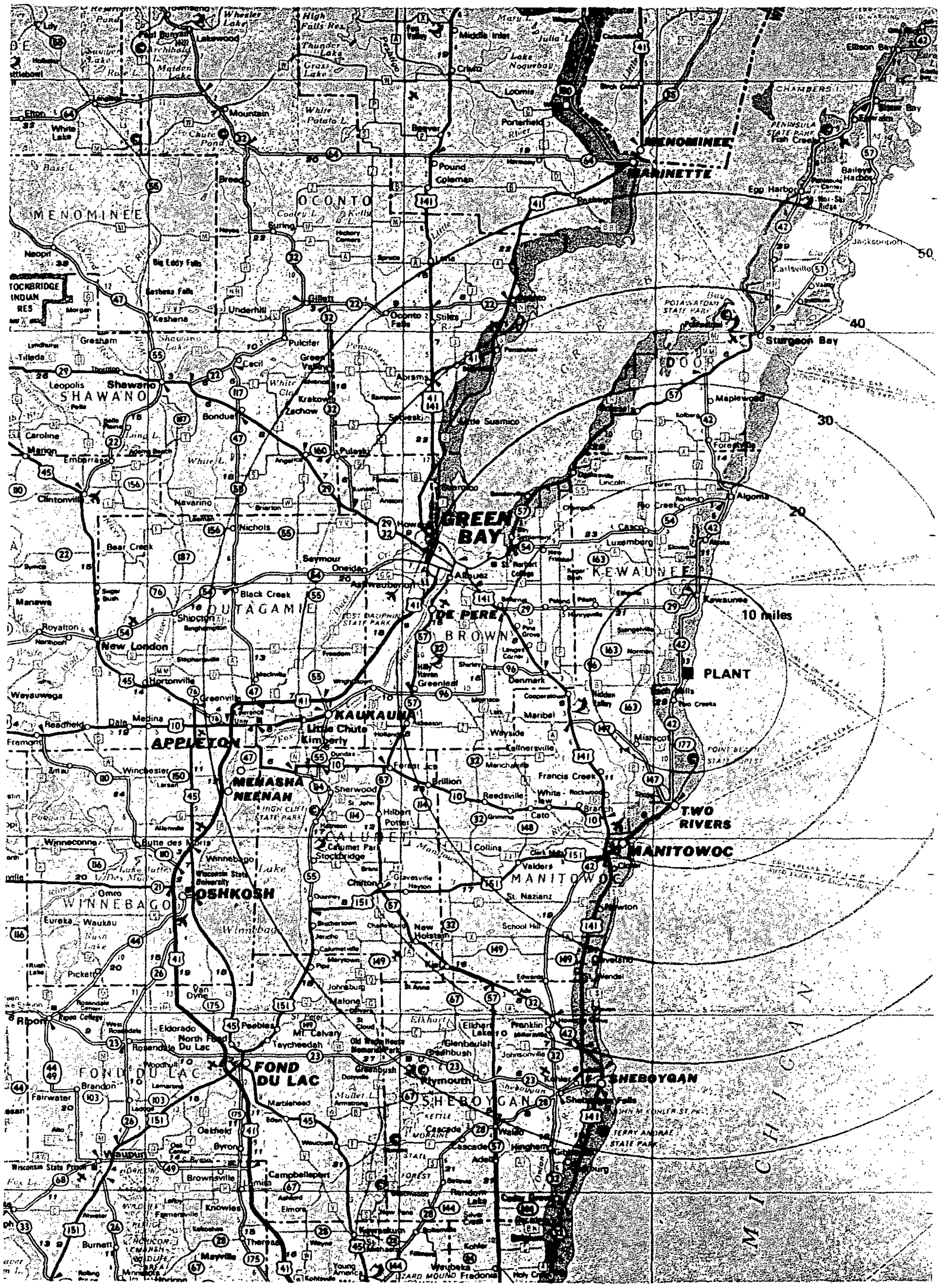


Figure II-1: Land Area of the Region

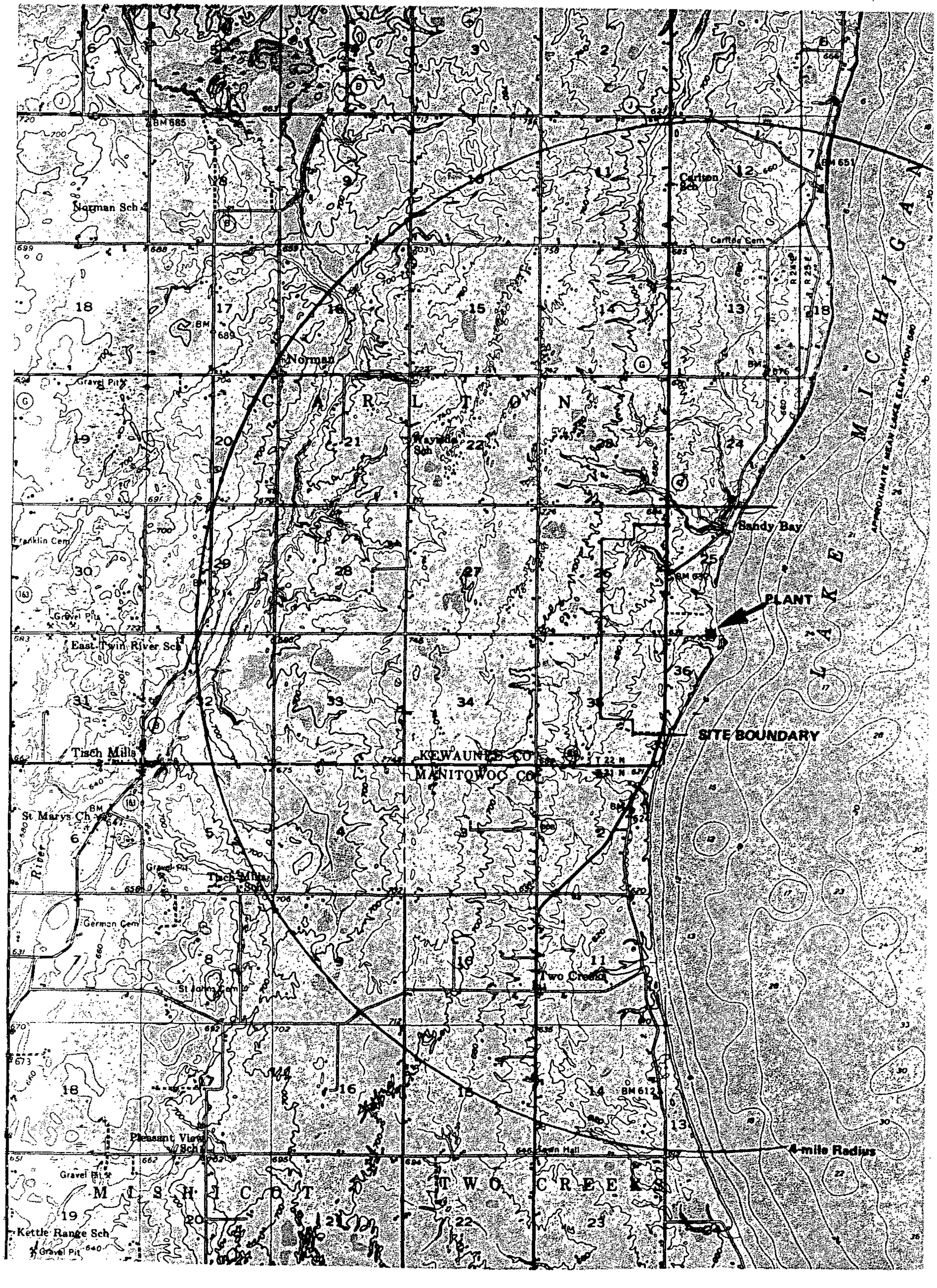


Figure II-2: Topography in the Vicinity of the Plant Site

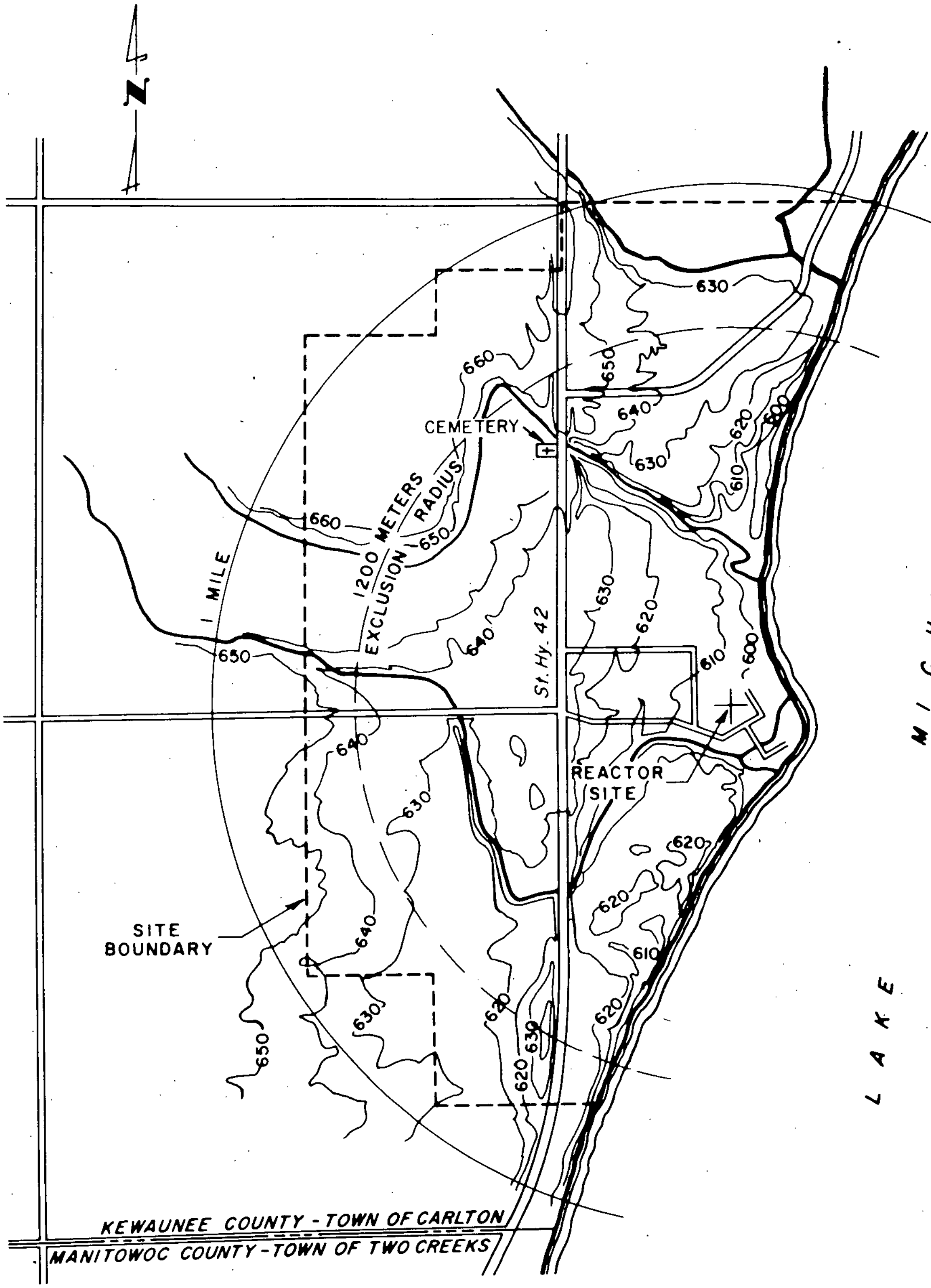


Fig. II-3. Physical Features in the Immediate Vicinity of the Kewaunee Nuclear Power Plant.

surface drainage is from 3 intermittent creeks which pass through the site and discharge into Lake Michigan. At the northern and southern edges of the site, bluffs face the Lake Michigan shore; near the center of the site, the land slopes to a sandy beach.

Most of the site was under cultivation prior to its acquisition, and almost 800 acres were continued in use in this manner on a lease-back arrangement during Plant construction through the summer of 1971. Of the remaining 110 acres reserved for activities associated with the construction and subsequent operations, only about 40 acres were disturbed in the construction and landfill operations. Only about 15 acres are being actually used for construction (see Figure III-3).

B. REGIONAL DEMOGRAPHY AND LAND AND WATER USE

Approximately two-thirds of the area within a 50 mile radius of the Plant is covered by bodies of water. Lake Michigan accounts for the major portion, but Green Bay and Lake Winnebago contribute significant parts to the total area of water. While it is realistic to assume that the population in the area is confined to the land, the use of both water and land for the needs of the population is considered here. Decreasing attention is given to zones at increasing distances from the Plant.

1. Population

a. Distribution.

The permanent population of the region, as determined by the 1970 census and projected to 2010, is given for successive annuli in Table II-1. Also included are the average densities for each of the annuli. The data in Table II-1 demonstrate clearly the increase in population density with increasing distance from the site, up to 30 miles. Since a large fraction of the area is covered by water, the actual average densities are approximately double those indicated for radii up to 20 miles, because of Lake Michigan. Beyond 20 miles, the factor is greater than two because of the area covered by the waters of Green Bay and Lake Winnebago. Some representative values are included in Table II-1.

The projected population in the region represents a growth rate of about 20% per decade. The Bureau of the Census[8] projects an increase in population for the state of Wisconsin ranging from 11.2 to 15.0% for the decade from 1970 to 1980. Values in this range depend upon assumptions made regarding fertility and migration. The corresponding range for 1980 to 1990 is 10.5 to 16.4%. The growth from 1960 to 1970 was 11.8%. However,

TABLE II-1.

Population Distribution in the Region

Annulus (miles)	Number of People		Average 1970 Density	
	1970 Census	2010 Estimate	#/square mile	#/square mile of land
0-1	8	10	2.6	5
1-2	159	191	16.9	-
2-3	320	412	20.4	-
3-4	447	611	20.4	-
4-5	811	1,197	28.6	-
5-10	11,014	21,140	47.1	95
10-20	75,302	104,191	79.8	160
20-30	157,745	405,896	100.2	250
30-40	98,633	225,795	44.8	-
40-50	230,192	443,200	81.4	-
0-5	1,745	2,421	22.3	45
5-50	572,501	1,200,222	73.9	-
0-50	574,246	1,202,643	73.2	220

the Plant is situated in the general area of the fastest growing portion of the state. The assumed 20% growth rate per decade for the region is based on a continuation of the actual rates for 1960 to 1970. These were 26.5% for Brown County, 24% for Calumet County, 3.7% for Kewaunee County, 9.4% for Manitowoc County, and 20.4% for Winnebago County.

Extended areas of high population density in the region exist in the vicinity of the major cities. These are as follows:

City	1970 Population	Location from Plant
Green Bay	87,809	27 miles WNW
Appleton	57,143	43 miles W
Sheboygan	48,484	40 miles SSW
Manitowoc	33,180	18 miles SSW
Two Rivers	13,437	13 miles S

Note that the size of the cities increases with increasing distance from the Plant, except for Green Bay.

The only communities in the vicinity of the Plant are Two Creeks (20 people, 3.0 miles SSW), Norman (25 people, 3.9 miles NW) and Tisch Mills (250 people, 4.5 miles WSW). In the 5 to 10 mile annulus around the Plant, there are only four towns. These are Krok (25 people, 8 miles NW), Kewaunee (2901 people, 8 miles N), Mishicot (938 people, 9 miles SW), and Stangelville (100 people, 9 miles WNW).

Half of the area within one mile of the Plant is occupied by Lake Michigan. Of the remaining 1000 acres, the site accounts for 908 acres. Eight people now reside within one mile, the nearest being 0.8 miles north of the Plant. Transients within the immediate vicinity will include the 60-70 operating personnel at the Plant, visitors at the Plant, agricultural workers on the 800 acres of the site under cultivation, users of the adjacent lake for recreational purposes, motorists using the highways, and maintenance workers on the highways and at the cemetery.

The population of the region is augmented moderately during the summer months by vacationers from major population centers to the south. The most popular recreational areas are in Door County, at distances in excess of 35 miles from the Plant.

b. <u>Employment</u>.

Some perspective regarding the nature of the region is provided by a consideration of the distribution of employment among various activities. Such information is given in Table II-2 for Kewaunee County in which the Plant is located and the nearby counties of Brown and Manitowoc.

TABLE II-2

Distribution of Employment by Type for Three Counties in General Area of the Plant[1,9]

Type	Brown Co. #	Kewaunee Co. #	Manitowoc Co. #	Total #	Total %
Agriculture and Forestry	2,791	2,475	3,754	9,020	11
Mining	16	12	53	81	~0
Construction	2,161	133	1,713	4,007	5
Manufacturing	16,811	2,308	13,222	32,341	39
Trade	13,639	749	5,236	19,624	24
Transportation and Utilities	3,466	180	758	4,404	5
Other Services	9,265	622	3,179	13,066	16
Total	48,149	6,479	27,915	82,543	

While agriculture and forestry provide employment for only 11% of the work force in these three counties, they account for the major portion of land use. Hence major attention is given to these activities in the section which follows. Because of its importance to the economic vitality of the region, some information is given for industrial and transportation-related activities, in spite of their limited demand in term of acreage. Data on the construction workers are of interest here primarily in terms of the impact of Plant construction on the region.

2. Land and Water Use

The land area within a 25-mile radius includes all of Kewaunee County, about one-half of Brown and Manitowoc Counties, and about 5% of Door County. The main counties within 50 miles are Brown (100%), Calumet (100%), Kewaunee (100%), Manitowoc (100%), Door (70%), Outagamie (60%), and Sheboygan (50%). Smaller portions of the counties of Marinette, Oconto, Shawano, Winnebago, and Fond du Lac are located at the periphery of the region.

The region is predominantly rural. Land use is predominantly agricultural, related principally to livestock, poultry, and products derived therefrom. Land within five miles of the Plant is devoted exclusively to agriculture, except for the Point Beach Nuclear Power Station.

a. Agriculture[2]

Table II-3 summarizes the agricultural land use of Kewaunee County, in which the Plant is located, and the adjacent counties of Brown and Manitowoc. Table II-4 demonstrates the dominance of dairy and animal products in the agricultural economy of these counties. The principal field crops, in terms of both acreage and income, are corn, oats, and hay. Pertinent data are given in Table II-5.

Forest products were included in the tabulation of agricultural product sales in Table II-4. About 15% of the land in the counties of Brown, Kewaunee, and Manitowoc is devoted to forestry. This is approximately one-third of the statewide average.

b. Industry.

As mentioned above, the land in the vicinity of the Plant is devoted solely to agricultural use except for the Point Beach Nuclear Power Station which will have a permanent work force of 86 people, a small fraction of the peak of about 1100 people during its construction. However, there are major industrial and commercial centers in the region. These coincide with the areas of high population described in Section II.B.1.

TABLE II-3

Agricultural Land Use Near the Plant in 1969

County	Area (sq. miles)	Number of Farms	Average Acreage	Area of Farms (sq. miles)	Percent of Total
Brown	524	1887	136	400	76.4
Kewaunee	330	1380	139	299	90.7
Manitowoc	590	2274	133	475	80.5

TABLE II-4

Market Value of All Agricultural Products Sold in 1969 ($1000s)

County	Total Value	Crops, including Nursery and Hay	Livestock, Poultry and Products	Forest Products
Brown	26,872	2,447	24,385	40
Kewaunee	17,228	1,057	16,066	105
Manitowoc	29,622	2,982	26,587	54

TABLE II-5

Acres of Principal Field Crops Harvested in 1970

Crop	Brown Co.	Kewaunee Co.	Manitowoc Co.
Corn			
Grain	5,200	3,900	15,000
Silage	30,500	14,300	23,800
Hay			
Alfalfa	75,000	50,700	84,000
Clover and Timothy	8,400	7,200	8,600
Oats	46,200	37,500	54,500
Total	165,300	113,600	185,900
% of Farm Acreage	64.5	61.4	61.4

Table II-6 summarizes the principal employers, as of March 1969[3] within a 20-mile radius of the Plant, other than the Plant itself and the Point Beach Power Station. All except one are manufacturers. The products indicate the diversity of the industrial activities in the general area of the Plant. In addition, there are four dairy plants in Kewaunee County, eleven in Manitowoc County, and 22 processing and bottling plants in Brown County. The nearest town in which there is any significant industrial activity is Mishicot.

Mining activities within the three-county area are limited to quarrying operations for sand, gravel, lime, crushed and cut limestone, portland cement, and clay for construction purposes. There are numerous pits and quarries in this area, but none of significance is located closer than six miles from the Plant.

c. Transportation.

Figure II-1 demonstrates the paucity of major highways in the general area of the Plant. State Highway 42, which bisects the Plant site, is heavily travelled, particularly in the summer months, since it is the most direct route from Milwaukee and Chicago to the popular recreational areas in Door County. Average daily traffic thereon is about 1150 vehicles, but the summer average is about 30% higher. U.S. Highway 141 and State Highway 147 from the Two Rivers-Manitowoc area to Green Bay also have a high volume of traffic, but their closest point to the Plant is over 9 miles away. An Interstate Highway (#57) between Milwaukee and Green Bay has been authorized[4], but its point of closest approach to the Plant is not likely to be closer than 20 miles away. The long range plan of the Wisconsin State Highway Commission[5] provides for upgrading of State Highway 42 and U.S. Highway 141 to expressway status by 1990. This is likely to increase the use of these highways in excess of that expected in connection with normal regional growth.

The railroad right-of-ways which bound the general area of the Plant are a 13-mile roadway from Kewaunee to Casco Junction (Kewaunee, Green Bay, and Western), a 23-mile roadway from Casco Junction to Green Bay (K.G.B. and W.), a 36-mile roadway from Green Bay to Manitowoc (Chicago and Northwestern) and a 6-mile roadway from Manitowoc to Two Rivers (C&NW).[6] Only freight is moved on these roads, and the nearest tracks are 8 miles from the Plant.

The Manitowoc airport, located 15 miles SSW, is the one closest to the Plant. Austin-Straubel Field, serving Green Bay, is 30 miles WNW. These are the only airports having scheduled, commercial flights within the region. The only other airports within 30 miles are near DePere, WNW of the site. These are Nicolet (26 miles) and Grove (30 miles).[7]

TABLE II-6

Principal Employers within Twenty Miles of the Plant in 1969

Name	Products or Business	Employment
Kewaunee (8 miles N)		
Leyse Aluminum Co.	Aluminum utensils	200-300
Frank Hamachek Machine Co.	Special machinery, castings	100-200
Kewaunee Engineering Co.	Steel fabrication, ship repair	300-400
Two Rivers (13 miles S)		
American Hospital Supply Corp.	Laboratory furnishings	1500-1600
Paragon Electric Co., Inc.	Time controls, switches	800-900
Manitowoc (18 miles SSW)		
I-T-E Imperial	Hose assemblies	400-500
Mirro Aluminum Co.	Cooking utensils, rolling mill	2800-3000
Aluminum Specialty Co.	Cooking utensils, aluminum toys	500-600
Manitowoc Engineering Corps.	Power cranes, excavators	1000-1200
Manitowoc Shipbuilding, Inc.	Shipbuilding, machinery	700-800
Kelvinator Commercial Prod., Inc.	Freezers, ice machines	300-400
J. C. Penney	Department store	100-200
Algoma(a) (19 miles NNE)		
U.S. Plywood-Champion Papers, Inc.	Panels, doors	900-1000
Plumbers Woodwork Co.	Toilet seats	100-200
Algoma Wood Industries, Inc.	Veneer and plywood containers	100-200

(a) 1970 Population: 4023.

The principal ports within the region are Kewaunee (8 miles N), Two Rivers (13 miles S), Manitowoc (18 miles SSW), Green Bay (27 miles WNW), Sheboygan (40 miles SSW), and Sturgeon Bay (46 miles NNE). East-west rail traffic flows through Kewaunee because of year-round car ferry service across Lake Michigan, provided to and from Frankfort and Ludington, Michigan. Kewaunee also receives shipments of petroleum products. The port of Two Rivers receives fuel, and harbors a small fishing fleet. Manitowoc receives coal and grain and also is a rail car ferry port for the Ann Arbor railroad to Frankfort and the Chesapeake and Ohio railroad to Ludington. Green Bay is a large industrial harbor and receives raw materials used by the industries located in the Fox River Valley. It is second only to Milwaukee among Wisconsin's seaway general cargo ports. Sheboygan also handles general cargo for overseas. Sturgeon Bay is also a seaway port, principally for the shipment of canned fruit.

Petroleum products, natural gas and water are transported by pipeline in the region.[9] A north-south pipeline for petroleum products and LPG from Milwaukee to Green Bay passes through the area. Its closest point to the Plant is about 25 miles away. Natural gas is distributed by pipeline to Kewaunee and Two Rivers, but these two towns are served by separate lines. The nearest approach to the Plant is in excess of 5 miles. The water supply for Green Bay, averaging in excess of 16 million gallons per day, is drawn from Lake Michigan at Rostok, 11 miles north of the Plant, and piped directly west to Green Bay.

d. Outdoor Recreation.

Table II-7 provides a summary[3] of the current availability of land and water for recreational purposes in the three counties within the general area of the Plant. Developed land refers to areas which have improvements for various types of activities such as camping, skiing, snowmobiling, fishing, canoeing, swimming, hiking, and golfing. While the undeveloped lands are available for some of these activities, and others such as hunting, these areas are essentially in their natural state.

The area is deficient in small lakes, compared with other parts of the state, but, in terms of recreational activities, there are Lake Michigan, Green Bay, and Lake Winnebago nearby. In addition to Lake Michigan, popular fishing spots near the Plant are on 224 acres of state-owned public fishing grounds along the Kewaunee River nine miles to the north, on 411 acres of state-owned grounds along Little Scarboro Creek 13 miles NNW, and at Heidmann's Lake County Park 10 miles to the west.

A major recreational area close to the Plant is the Point Beach State Forest. It is located on the lakeshore, 7 miles to the south, and contains 2397 acres. There are no other state parks or forests closer than 25 miles from the Plant. The 19-acre Fort Dauphin State Historical Memorial Park is located 25 miles to the west, and the Potawatomi State Park is 32 miles north, in Door County near Sturgeon Bay.

e. Commercial and Sport Fishing in Lake Michigan.

The importance of Lake Michigan commercial fishing to the Wisconsin economy is demonstrated by Table II-8.[12] Since the introduction of effective measures to control the sea lamprey, attempts to rebuild populations of steelhead, brook trout, lake trout, and salmon by hatchery propagation have been very successful. Whitefish commercial catches have increased as well. In recent years, the commercial use of salmon for human consumption has declined, not because the fish have been less plentiful, but because their flesh contains levels of DDT which exceed FDA regulations (i.e., more than 5 ppm DDT, which prohibits their sale in interstate commerce). Commercial fishing in Lake Michigan is permitted outside of one-half mile of harbors, piers, or breakwaters or beyond one-quarter mile of the mouths of navigable streams entering the lake. Annual harvest records vary appreciably due to fluctuations in fishing pressure and sizes of the fish populations, but an average of 1,400,000 pounds is harvested by fishermen based in nearby ports. Fishing pressure is largely determined by fishing success, weather conditions, and market values. Variations in year-class abundance determine the availability of the fish populations. No single age group appears to dominate the commercial harvest of most species. To a large extent, the effort expended by commercial fishermen is influenced by the market value of each species. An added factor in recent years has been competition from the invading alewives, which presently dominate pound-net and trawl catches, but have limited commercial value.[40]

Sport fishing opportunities on Lake Michigan provide recreational outlets to residents and nonresidents in the four-state area bordering the lake. The demand for sport fishing is now large, and an extensive program of lamprey control and fishery management of coho, chinook salmon, steelhead, and lake trout is underway.[10,13] Introduction of Pacific Northwest salmonids to the waters of Lake Michigan has provided the Midwest fisherman with a new fishery. At the same time there is evidence that rainbow trout, coho and chinook salmon are taking their toll of the nuisance species, alewife.[29]

Throughout the entire Great Lakes, most of the 1970 catch of coho salmon (80%), chinook salmon (90%), and steelhead trout (70%) came from Lake Michigan and its tributaries.[14] Trout and salmon are the most commonly caught sport species, and the shoreline area for about 50 miles to the north and south is considered to be good fishing waters for salmonids.[30,41] The 1970 creel census for Wisconsin indicated 66,064 trout and salmon

TABLE II-7

Land and Water Use for Recreational Purposes in the General Area of the Plant[3]

	Brown Co.	Kewaunee Co.	Manitowoc Co.
Designated Recreational Land (Acres)			
Developed	2,222	351	1,855
Undeveloped	3,088	1,728	16,560
Total	5,310	2,079	18,415
% of Co. Area	1.6	1.0	4.9
Acres/1000 people	33.6	109.7	223.8
Named Lakes			
Number	1	9	55
Acreage	42	221	1,367
Shoreline (Miles)	28	26	33

TABLE II-8

Comparison of Fish Caught by Wisconsin-Based Fishermen with Total Production of Lake Michigan (thousands of pounds)[12]

Year	Total Production	Wisconsin-Based	% of Total
1960	24,311	14,836	61.0
1962	23,475	15,595	66.4
1964	26,201	17,149	65.5
1966	42,764	28,408	66.5
1968	45,810	27,714	60.5

caught by sport fishermen in Lake Michigan. Sport fishing on Lake Michigan is limited due to lack of suitable fishing grounds off Kewaunee County, and lack of well-spaced access sites. The principal fishery is for yellow perch, however, heavy seas are common and result in very low fishing pressure, except at city breakwaters. A recently established rainbow trout fishery off Algoma has increased fishing pressure somewhat.[40] Anglers in the area are also attracted by the availability of yellow perch, walleye, small-mouth bass, northern pike, and muskellunge in the nearby lakes and streams.

f. Water Supplies.

Within the area, Lake Michigan is used as the source of municipal water supply for the cities of Two Rivers, Manitowoc, Sheboygan, and Green Bay (intake at Rostok, 11 miles north of the site). The nearest surface water bodies that are used for public supply, other than Lake Michigan, are the Fox River (43 miles W) and Lake Winnebago (40 miles W).

Five municipalities located within 20 miles of the site and virtually all of the rural and village residences draw their water supply from ground water aquifers. The former are identified in Table II-9. About half of the domestic water wells located near the site obtain water from the glacial outwash aquifer (see Section II.D.2). The remaining domestic water wells of the area are drilled into the Niagara aquifer.

TABLE II-9. Municipal Ground Water Supplies

Municipality	Location	1970 Population	Well Depth (feet)
Kewaunee	8 miles N	2901	187-700
Mishicot	9 miles SW	938	80
Denmark	15 miles W	1364	309-456
Luxemburg	16 miles NW	853	431-495
Whitelaw	19 miles SW	557	495

C. HISTORICAL SIGNIFICANCE

Little is known of the people inhabiting Wisconsin in prehistoric times, but there is evidence that people were living in the area during an interval of deglaciation 11,000 to 12,500 years ago. Jean Nicolet was commissioned by the French government to explore the area west of the Great Lakes, and he visited the Green Bay region as early as 1634. Green Bay was one of the first French settlements in Wisconsin, and there was a flourishing

fur trade in the area. The region was lost to the English during the French and Indian Wars, and nominally lost by them during the American Revolution although the transfer was consummated only after the War of 1812.

Scattered Indian trading posts were established in the 18th century in the region, including one on the Kewaunee River. By 1800 there were still perhaps only 200 whites in what is now Wisconsin, and less than 15,000 Indians. The region was heavily forested, and significant settlement began in the 1830's, when lumbering was started and the streams were dammed for water power. The vast forests of pine and larchwood led to shipbuilding. Farm settlement in the region followed the lumbermen, toward the end of the 19th century. Agriculture persists today as the principal land use.

This history of the region is reflected in the places included in the National Register of Historic Places.[15] These are listed in Table II-10. None of these are in the vicinity of the Plant site. To date only one, the Oconto site where evidence of copper technology about 6000-7000 BC has been found, has been designated as a National Historic Landmark. The nearest National Landmark is the Ridges Sanctuary in Door County, about 60 miles NNE of the Plant.[16]

There are no documented archeological sites within the site boundaries, but evidence of Indian habitation has been discovered in the town of Kewaunee and the Township of Ahnapee (near Algoma). There is an extensive buried forest in the region. The forest was first filled by rising lake water, then covered by a glacier about 12,000 years ago. It is now 10 to 40 feet below the ground surface. No evidence of it was discovered during excavation for the Plant, although it is known to underlie the Point Beach Nuclear Power Station.

D. ENVIRONMENTAL FEATURES

1. Surface Water

a. Land Area.

The watersheds and drainage pattern in the general area of the Plant are shown in Figure II-4.[17] The general easterly slope of bedrock in the area influences surface drainage considerably. Drainage near the shore of Lake Michigan is provided largely by a number of small creeks. Within the boundaries of the site are three intermittent creeks. A large area to the north of the Plant is drained by the Kewaunee River, and that to the west and south by the East Twin River system. Both flow to Lake Michigan.

TABLE II-10

Locations of Historical Significance in the Plant's Region[15]

Name	Location	Distance (miles)	Description
Baird Law Office	Green Bay, Wisc.	27	Built 1836; office of State's practicing attorney
Cotton House	Green Bay, Wisc.	27	Built early 1840's; example of Jefferson architecture
Fort Howard Hospital	Green Bay, Wisc.	27	Built around 1816
Hazlewood	Green Bay, Wisc.	27	Built around 1835; State's Constitution drafted here
Tank Cottage	Green Bay, Wisc.	27	Built 1776; oldest existing house in the State
Oconto Site	Oconto, Wisc.	43	Site of prehistoric copper culture
Peshtigo Fire Cemetery	Peshtigo, Wisc.	51	Major fire in 1871

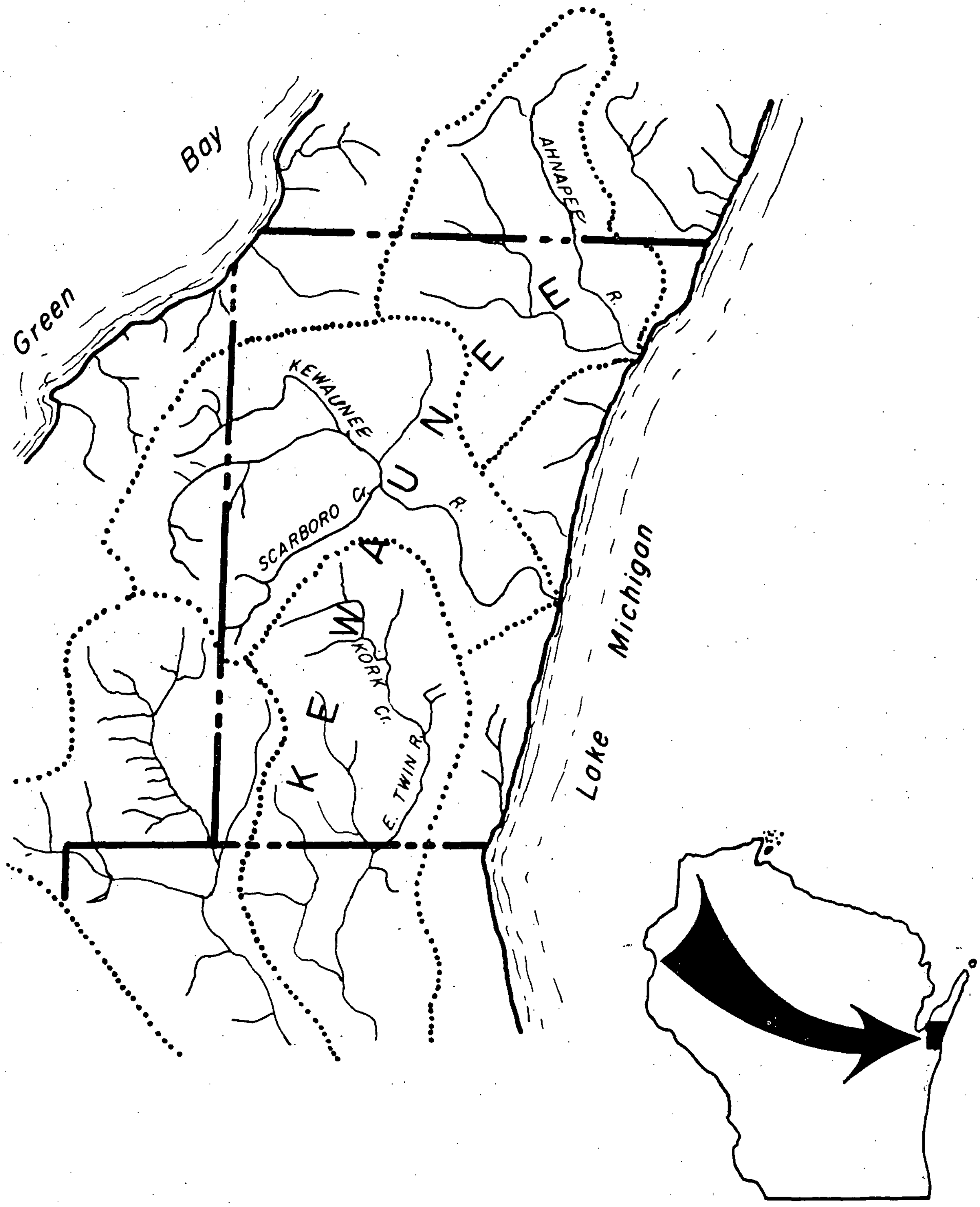


Figure II-4: Major Watersheds and Drainage Paths In the Region near the KNPP Site[17]

The characteristics of the near-surface soils influence the disposition of rainfall in the area. The glacial drift materials which overlie the rock are predominantly compact soils of high density. They are relatively impermeable and have high water holding capacity. Because of their clayey nature, only a small fraction of the average annual precipitation of 28 inches seeps into the ground. A majority is evaporated, and the remainder runs off as surface water.

The topography of the Plant site virtually eliminates the possibility of flooding. The ground surface varies from beach level to a maximum of 100 feet above the surface of Lake Michigan, and is gently rolling to flat. The lakeside boundary varies from steep bluffs at the north and south borders of the site to sandy beaches near the center.

b. Lake Area.

Lake Michigan has a normal water level of 577.0 feet above the International Great Lakes Datum. Its observed maximum range during the past 85 years has been from 581.9 feet in 1886 to 575.4 feet in 1964. Its natural flow is through the Straits of Mackinac into Lake Huron, at a rate from 40,000 to 55,000 cubic feet per second (cfs). At the southern end of the lake, 3200 cfs is diverted into the Chicago Ship and Sanitary Canal. The combined annual flow is equivalent to about 1% of the lake's volume.

Lake currents are quite variable and, in combination with water temperature - density effects, result in rather thorough mixing of the waters in the lake. These currents result from a combination of drainage at the northern and southern ends of the lake, motion due to wind, and water temperature - density effects. Shore currents flow opposite to the directions of the main currents a portion of the time. Figures 2.3-6 and 2.3-7 of the Applicant's revised Environmental Report [30] indicates the variations in the surface currents of the lake with season and wind direction. Figures III-6 to 10 of this Statement provide an indication of large local variations in the vicinity of the Plant.

The phenomenon of thermal stratification is a well-known feature of Lake Michigan [18]. In summer the surface water warms up more rapidly than the deeper water and continues to be less dense until it becomes separated from the deeper water by a transitional horizontal stratum called the thermocline. The upper warm layer of water (the epilimnion)tends to act as a lid on the cooler lower layer (the hypolimnion) and prevents total vertical lake mixing. This separation of the two strata in Lake Michigan starts in late May and persists until November, or occasionally into December, in the southern basin. In the northern basin, summer stratification

may not begin until late June or early July and likewise may persist into December. Winds induce vertical motion of the thermocline. A common occurence during late summer and early fall is cold water up-welling in the lake, caused by off-shore winds near the Plant site. This produces a northward flowing current on the western shore of the lake. Figures III-7 to 10 illustrate how a buoyant thermal plume is transported northward by the flow resulting from cold, up-welling water near shore. The cold water up-wellings and turbulence in the area of the Plant contribute to good mixing of the water and rapid heat exchange and distribution in the near-shore water. Resulting current movements in the lake water near the Plant are such as to promote good general circulation of Plant effluents with little tendency to form pockets of undiluted effluent.

A specific aspect of thermally induced heterogeneity is associated with the maximum density of water which occurs at 39.2°F. As surface waters warm in the spring or cool in the winter, they tend to sink as they approach this temperature. This downward flowing region of 39.2°F water, called the thermal bar, serves to temporarily separate the inshore waters from the mid-lake waters. The inshore waters are warmer in the spring and cooler in the winter. During spring, the shoreward side of the thermal bar develops a thermocline separating the rapidly warming surface water from deeper, cold water. Offshore of the thermal bar, vertical mixing extends from the surface to the bottom due to the absence of a thermocline. The main movement of the thermal bar is away from the shore, until it eventually disappears in mid-lak The thermal bar lasts for 4 to 8 weeks. The thermal plume shown in Figure II is typical of those expected in the spring when the more rapidly warming surfa water near shore is kept near shore in geostrophically balanced flows southward along the west shore of Lake Michigan.

During the summer months, surface water temperatures rise to near equilibrium for the region, near 70°F. At this time, stratification of surface waters also occurs, stabilized by the incoming solar energy, while lower levels in the lake, below 30-50 feet, remain relatively cold, about 50°F. This combination of factors favors the creation of an offshore warm zone with lower currents generally tending south, while the surface winds cause water movements to the north and east on a variable basis. Inshore temperatures are often colder because of up-welling.

The maximum and minimum temperatures, observed [19] in continuous recordings of the water temperature at two levels below the lake surface at a point 2000 feet offshore from the Plant between August 5 and October 14, 1969, were as follows:

	Minimum		Maximum	
	8 ft	16 ft	8 ft	16 ft
August	48°F	47°F	69°F	69°F
September	49	49	66	66
October	44	43	59	59

The data show a 20° temperature difference between maximum and minimum temperatures. Generally, any increase or decrease was gradual over a few days time. However, there were two times at which there were more rapid temperature changes: between August 26 and August 30 the temperature dropped from 69° to 50°F and increased back to 65°F, and a similar pattern of temperature change occurred from September 14 to September 18.

Climatic heating and cooling in the spring and fall are largely responsible for the differences in the maximum and minimum temperatures. Inflow of tributary waters also contributes to this effect. However, the shallow waters near shore are particularly susceptible to a more rapid temperature change. During the summer, the minimum temperatures are largely due to cold water up-wellings. During the winter, the water temperature is near its freezing point, and the lake is nearly isothermal.

As a result of extremes in climate, shoreline water temperature conditions are highly variable and the continuing erosion of the near-shore lake bottom produces a relatively high turbidity up to a half-mile offshore. During the winter, the lake surface is covered with floating block ice which is moved by the wind. Pack ice, in the form of frozen spray and ice blocks, has been reported by local residents to have been as high as 20 feet.

A preoperational sampling program is being conducted by the Applicant to evaluate the quality of the lake water near the Plant. An analyis of recent samples provided the following results, in milligrams per liter (mg/l):

Alkalinity (as $CaCO_3$)	108
Biological Oxygen Demand	1
Chemical Oxygen Demand	<5
Dissolved Oxygen	12
Total Solids	153
Total Dissolved Solids	138
Total Suspended Solids	15
Total Volatile Solids	40
Ammonia (as N)	<0.04
Kjeldahl Nitrogen	0.02
Nitrate (as N)	1.16
Total Phosphorus (as P)	0.71
Hardness (as $CaCO_3$)	135
Sulfate	27.6
Chloride	9
Boron	0.64
Calcium	37.3
Magnesium	12
Potassium	1.25
Sodium	5
Surfactants (MBAS)	0.01
Algicides	Not Present

The samples were obtained at the forebay and consisted of 24 hour composite grab samples taken every hour on December 8 and 9, 1971. During this period, one of the two circulating water pumps was operating at 210,000 gallons per minute (gpm). The average intake temperature for this period was 36.5°F and the average pH was 7.9.

2. Ground Water

The region is entirely within an area having rocks of paleozoic age covered by glacial deposits. The three principal water-bearing formations which underlie the region are a glacial outwash aquifer, a Niagara dolomite aquifer and a deep sandstone aquifer. Figure II-5 illustrates graphically the bedrock and aquifers in eastern Wisconsin [20].

Glacial drift in this area consists of clay soils interbedded with irregular outwash (sand and gravel) aquifers. The most persistent aquifer is located at the base of the glacial drift section and directly overlies the Niagara dolomite. This aquifer is not continuous at the Plant site.

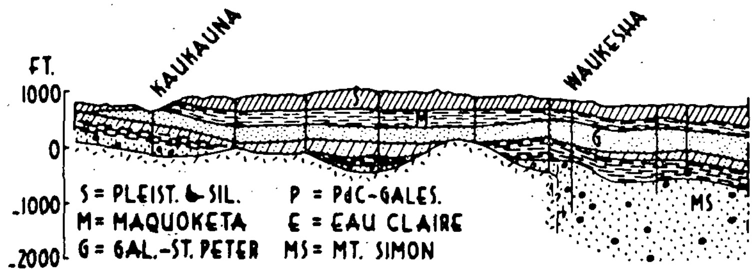
The Niagara dolomite is the upper-most bedrock formation along the Lake Michigan coastline in eastern Wisconsin. The Niagara aquifer is recharged by water percolating through the overlying glacial drift and by more direct infiltration of surface runoff in the areas of higher elevation to the west where the infiltration path is shorter.

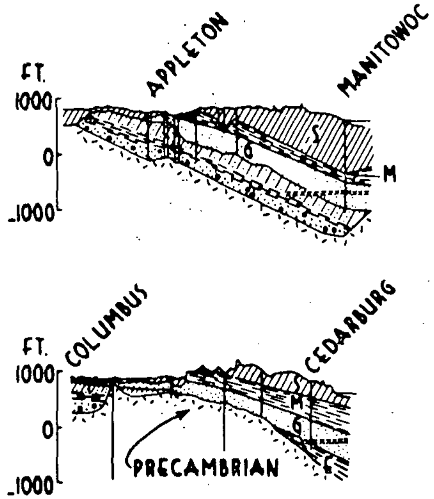
Several formations of a sandstone aquifer, with some interbedded shale and dolomite underlie the entire southeastern portion of the state of Wisconsin. The Cambrian sandstones exist between depths of about 1200 and 1700 feet below the surface of the site. They are separated from the Niagara dolomite by about 800 feet of impermeable shale and dolomite strata. The sandstone aquifer is the most heavily pumped aquifer in the state. However, in some places near Lake Michigan, in counties north of Milwaukee, it provides saline water. This situation exists in the general area of the Plant site.

Observation of water levels in the preliminary borings at the site indicated that the static ground water level inland from the lake is at depths ranging from 10 to 30 feet below the ground surface. The water table at the site slopes in the general direction of Lake Michigan (east), indicating a migration of ground water in that direction.

The water from the aquifers in the area near the Plant is quite hard (several hundred ppm). The mineral content for onsite surface wells is 840 ppm. These exceed appreciably the values for Lake Michigan water which is in a 110-140 ppm range. The use of these aquifers as a source of potable water was discussed in Section II.B.2.f.

AQUIFERS OF EASTERN WISCONSIN





GRAPHIC LOG	ROCK UNIT		WISCONSIN
	PLEISTOCENE		GLACIAL DEPOSITS
	SILURIAN		DOLOMITE AQUIFER
	ORDOVICIAN	MAQUOKETA	AQUICLUDE
		GALENA-PLATTEVILLE	SANDSTONE AQUIFER
		ST. PETER	
		PRAIRIE DU CHIEN	
	CAMBRIAN	TREMPEALEAU	
		FRANCONIA	
		GALESVILLE	
		EAU CLAIRE	
		MT. SIMON	

GEOLOGY OF BEDROCK

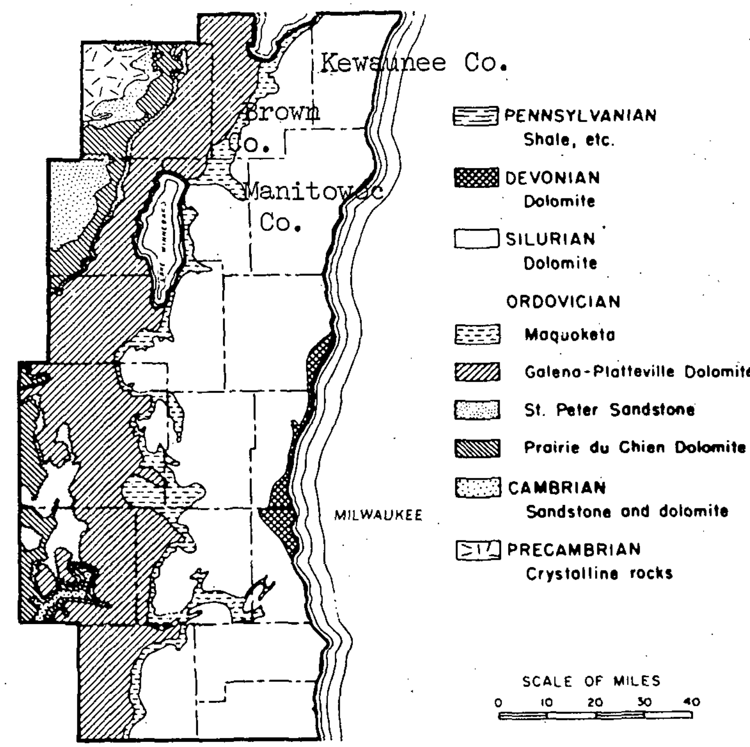


Figure II-5: Aquifiers and Bedrock Geology in Eastern Wisconsin[20]

3. Meteorology

The climate of the region is basically continental and influenced by the general storms which move eastward along the northern tier of the United States and by those which move northeastward from the southwestern part of the country to the Great Lakes. The climate is modified by Lake Michigan, so that the site temperature extremes are less pronounced than inland.

a. Temperature and Precipitation.

From 40 years of U.S. Weather Bureau data (1930-1969) at Kewaunee and Manitowoc, Wisconsin, summer temperatures are expected to exceed 90°F for 6 days each year on the average. Freezing temperatures occur for an average of 147 days per year, with a mean of 14 days below zero each year. Rainfall averages about 28 inches per year, with 55% falling in the months of May through September. Maximum rainfall during 24 hours was about 6 inches in September 1964. The specific data for the nearest weather stations are as follows:

	Kewaunee	Two Rivers	Manitowoc
Average Annual Precipitation (Inches)	26.53	28.65	28.39
Maximum Annual Precipitation (Inches)	34.99	41.17	46.43
Maximum 24-Hour Rainfall (Inches)	4.92	N. A.	6.39

Snowfall averages about 45 inches per year, with a maximum of 15 inches in 24 hours observed in January, 1947. Ice storms are infrequent in this region of Wisconsin. The Applicant has a number of transmission lines in this area, one of which is a line from Green Bay to Kewaunee to Sturgeon Bay. Six outages due to ice storms have occurred on this line between 1940 and 1956, ranging in duration from 22 minutes to 2.5 hours. Since rebuilding the line with improved conductors in 1956, only one outage has occurred due to ice storms.

b. Wind

i. Direction.

A meteorological facility was placed in operation at the Plant site in August 1968. The seasonal and annual distributions of wind direction, measured at the top of a 180-foot tower located 630 feet south of the containment structure, are displayed in Figure II-6.

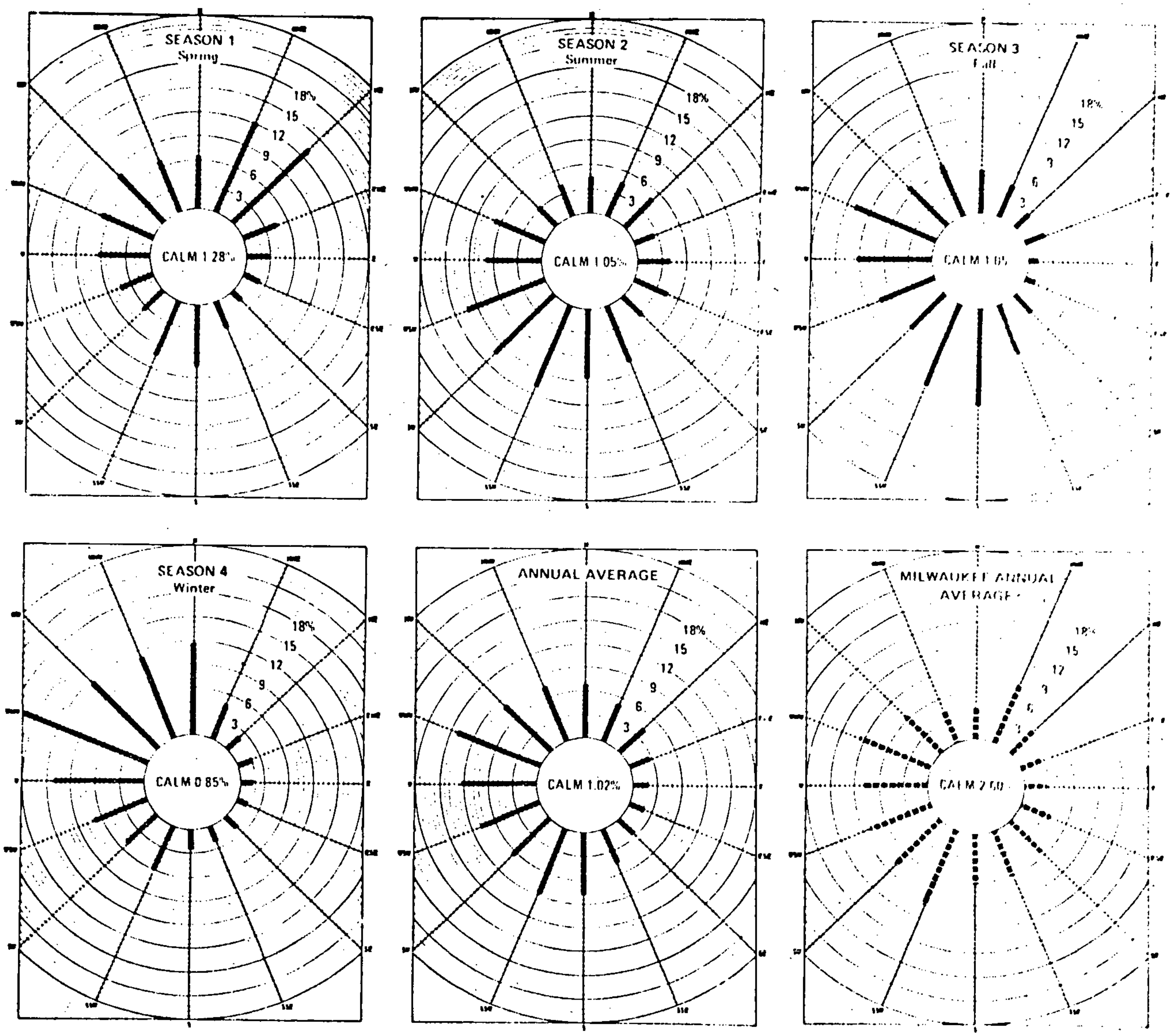


Fig. II-6. Average Wind Roses Observed at the KNPP Site, and Comparison with Annual Rose at Milwaukee.

Local winds occur mainly from the western (180° through 360°) half of the compass (74.26%) annually. The distribution is quite similar to data obtained at the Point Beach Station [21]. There appear to be no significant channeling effects or predominant directions although there is a low frequency of easterly component winds. Easterly winds, usually associated with local onshore winds at this site, flow against the large-scale gradient flow and consequently are diminished in frequency of occurrence and speed.

Seasonally, there are some variations in the distribution of wind directions. Spring is characterized by a maximum occurrence of north-northeast and northeast winds. Winds predominate from the southwest quadrant (48.69%) during the summer season. Autumn reflects a change from a summer southerly flow to a winter northerly one with 57.38% of the winds occurring between south and west-northwest. The majority of winds (60.01%) occurs in the northwest quadrant during the winter.

TABLE II-11.

Wind Distribution Observed at the Kewaunee Site, in %

	Onshore (NNE-S)	Offshore (SSW-N)	Calm
Spring	49.15	49.57	1.28
Summer	40.56	58.39	1.05
Autumn	34.47	64.48	1.05
Winter	20.36	78.79	0.85
Annual	36.14	62.81	1.02

Table II-11 presents the distribution of onshore and offshore winds. It is significant to note that offshore winds (blowing toward Lake Michigan) occur over 60% of the time annually. Onshore winds occur most frequently during the spring and summer. The maximum occurrence of offshore winds is during the autumn and winter. Due to the temperature lag of Lake Michigan land temperatures are warmer than the lake during spring and summer and colder during autumn and winter. During spring and summer, a circulation results when air is heated from below by the land, rises, and is replaced by air over the lake flowing toward the land. A reversal occurs during the autumn and winter; air ascends over the warmer lake surface and is replaced by air flowing from the land. An offshore lake-breeze wind can occur nocturnally during the summer but is usually quite weak. Onshore lake-breezes normally only penetrate a few miles inland.

ii. Persistence.

Wind direction persistence is a measure of the tendency of the winds to blow from a specific direction for a continuing period of time. Figure II-7 shows the probability of occurrence, based on site data, of wind flow persistence in a 22-1/2° direction range, greater than a time period "t". There is only a 5% chance of continuous persistence periods greater than 11 hours and only a 1% chance of periods greater than 18 hours.

The maximum persistence episodes recorded during nineteen months of Kewaunee site data from August 1968 through February 1970 were 25 hours occurring in February and again in October. The variance of the azimuthal wind direction angle was low during the two periods, but was compensated for by high average wind speeds of 16.0 and 19.4 mph, respectively. In general, persistence periods at the site are associated with quite high winds and relatively low lateral wind direction fluctuation.

iii. Speed.

The seasonal and annual wind speed averages, based on data for the Kewaunee Plant site, are:

Average Wind Speed (mph)

Spring	Summer	Autumn	Winter	Annual
9.2	10.9	14.7	15.4	12.6

The 12.6-mph annual average wind speed at the Kewaunee site is significantly greater than the 6.0-mph Milwaukee annual average. This can be attributed to the higher elevation of the site wind instrumentation (180') compared to the low-level sensors at Milwaukee, and also to the more exposed location of the Kewaunee site, being adjacent to Lake Michigan on one side and surrounded on the other sides by relatively smooth, unforested rural terrain. Therefore, low-level wind speed at Kewaunee site would be greater than the low-level Milwaukee value, but somewhat less than the reported 180-ft value.

iv. Extreme Conditions.

Extreme winds at the 30-foot elevation are not expected to exceed 54 mph with a recurrence interval of once in 2 years, and 90 mph with a 100-year recurrence interval [22].

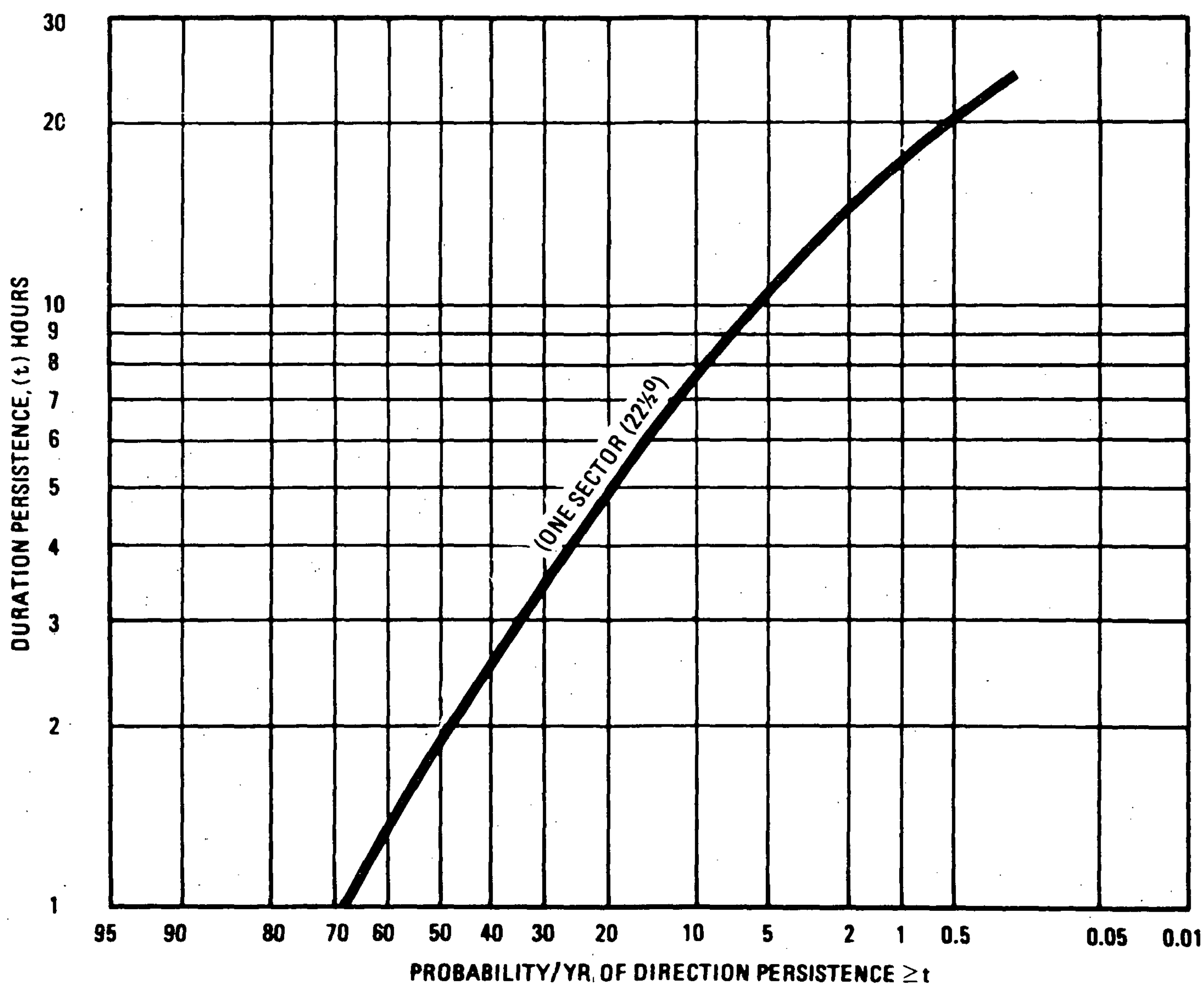


Fig. II-7. Wind Direction Persistence at the KNPP Site.

Wisconsin lies to the northeast of the principal tornado belt in the United States. During the 10-year period, 1960-1969, one hundred sixty-one tornadoes were reported in the State. Only six of these tornadoes occurred in Brown, Door, Kewaunee, or Manitowoc Counties. During the period 1916-1969, only one tornado caused injury to people or major property damage within these four counties. Approximately six tornadoes occurred in the Green Bay-Kewaunee area on April 22, 1970. Damages were estimated at approximately $500,000 and 4 or 5 people were injured.

4. Geology

Geological features related to ground water in the region have already been considered in Section II.D.2. The descriptive material on the general geological characteristics of the region and the Plant site, and the seismic activity of the area is based on investigations [24,25] undertaken for the Applicant to determine the adequacy of the site for location of a nuclear power plant there.

a. Regional Geology.

In the site area and elsewhere in the State, the Precambrian rocks are overlain by Paleozoic sedimentary strata consisting primarily of dolomite, sandstone and shale. Younger formations originally present in the region have been removed by erosion.

The bedrock surface in the eastern Wisconsin region is covered by a thick mantle of glacial overburden, formed when most of Wisconsin and adjacent areas were subjected to repeated glaciation during the Pleistocene epoch. The advancing glaciers scoured major stream valleys, enlarged the large depressions now occupied by the Great Lakes, and deposited a thick mantle of glacial drift over the bedrock surface. Recent sediments deposited by streams and lakes added to the unconsolidated cover in local areas, particularly along the Lake Michigan shore.

b. Local Features.

The site occupies an area of rolling farm land which is bordered on the east by flat beaches adjoining Lake Michigan. Maximum relief between the rolling terrain and the flat beaches is on the order of 100 feet.

Ground surface elevations on the site range from 590 to 700 feet (International Great Lakes Datum). The rolling topography at the site represents

part of a glacial end moraine deposited along the Lake Michigan shoreline during the most recent period of glaciation.

Coastline recession along Lake Michigan is a major environmental characteristic affecting the site. The rate of coastline recession is a function of the water level of the lake, storm conditions, wave action and the amount of ground water seepage along the face of the bluffs. Observations made over a period of time indicate that the rate of recession at various points along the Wisconsin shoreline ranges up to 12 feet per year.

The shoreline along most of the site is characterized by steep, unstable bluffs. A short stretch of coastline with moderately flat, stable slopes near the center of the site is protected from active erosion by a promontory extending into the lake. It is conceivable that the promontory could be removed by erosion within the lifetime of the Plant, thus exposing the low terrain on the north side of the promontory to increased erosion. Measures to protect this area from excessive shoreline erosion are feasible.

Due to currents and wave action, considerable quantities of sediments have accumulated against many of the existing offshore facilities along the Wisconsin coastline, such as wharfs, piers, and breakwaters. This is usually accompanied by increased erosion on the down-current side of such obstructions. Intake and discharge structures for the Plant will require protection from sedimentation.

Test borings to investigate subsurface conditions at the site revealed that the glacial drift overlying the bedrock consists essentially of an upper layer of glacial till underlain by glacial lacustrine deposits. The glacial soils consist essentially of stiff to hard silty clay which contains variable amounts of sand, gravel, and seams of sand and silt. The upper layer of till contains layers and pockets of sandy soil, and also contains traces or pockets of buried forest growth and peat beds. Discontinuous deposits of glacial outwash, sand, and gravel were encountered immediately above the bedrock at several locations within the site. The glacial drift was found to range from approximately 60 to 150 feet in thickness.

The bedrock immediately underlying the site consists of moderately fractured Niagara dolomite. This formation is 350 to 600 feet thick and has a regional dip to the east of about 30 feet per mile. The lower bedrock formations consist predominantly of sandstone and dolomite with subordinate layers of shale. Precambrian basement rock is encountered at a depth of more than 1000 feet below sea level in this part of Wisconsin. The general site geology is further depicted in Figure II-8.

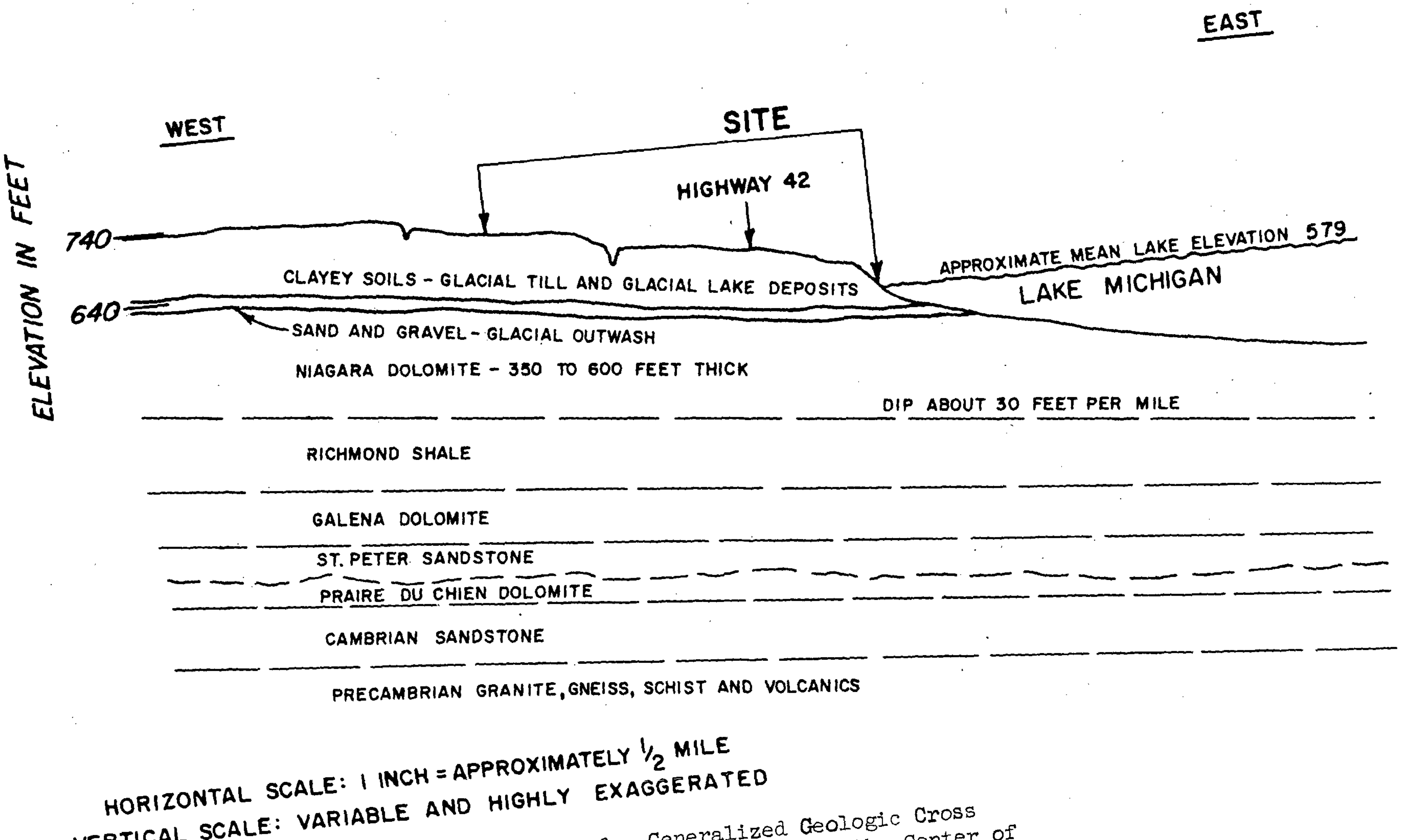


Figure II-8: Generalized Geologic Cross Section through the Center of the KNPP Site

c. Seismic Activity.

The first earthquake with an epicenter known to be in Wisconsin was a mild shock recorded in 1931 near Madison. Since that time, five additional shocks have occurred with known epicenters in Wisconsin. The largest of these shocks, on May 6, 1947, had its origin in southeast Wisconsin near Milwaukee, and was felt from the Illinois border northward to Sheboygan, Wisconsin and approximately 25 miles inland from Lake Michigan. Its maximum intensity was V on the Modified Mercalli Intensity Scale ("felt by nearly everyone; some very slight damage").

No shock is known with an epicenter within a distance of 50 miles of the site and only nine earthquakes have been recorded within 150 miles. Most earthquakes in the general region occur in a limited area between the Wisconsin Arch and Kankakee Arch approximately 100 miles or more south to southwest of the site. There is no evidence to link these earthquakes to geologic structures near the site. No major earthquake has been experienced in the region, and the available history indicates a low regional seismicity [26]. Even these 150-mile events had epicentral intensities of V or less and it is doubtful that they were felt at the site. The one exception to this is the May 26, 1909 earthquake that had an epicentral intensity of VII ("everybody runs outdoors; considerable damage to poorly built structures") south of Beloit, Wisconsin and along the Illinois-Wisconsin border. At Kewaunee, Wisconsin, an intensity of III ("vibration like passing of truck") was reported.

5. Soils

The Kewaunee site is located in the reddish clay loam region, one of nine general soils regions into which Wisconsin has been divided from an agricultural viewpoint [27]. The clays in this system usually have high shrink-swell properties.

The predominant soil types within the site are Kewaunee silt loam and Manawa loam [28]. The Kewaunee loam is generally a light-colored, well-drained, clayey silt topsoil over a reddish brown silt to clay subsoil with an underlying calcareous clayey till at depths of 20 to 40 inches. These relatively impermeable soils have potentially high water-holding capacity. The production use of this type soil is medium to high for woodland, and slight for pasture because of erosion. The Manawa loam is a poorly drained, dark silt loam topsoil over a dark brown to reddish brown silt to clay subsoil underlain with clayey till at depths of 20 to 40 inches. The rating

for cropland of such soils is moderate, slight for pastures, medium to high for hardwoods, and low to medium for pines.

E. ECOLOGY OF SITE AND ENVIRONS

1. Terrestrial

The ecology of the Plant site has been altered by past utilization for agriculture. At present, it represents a mixture of plant and animal communities which can be divided into four major habitats: agricultural fields; tree groves; lake and stream-side vegetation; and ornamental grasses and shrubs.

The terrain of this land is slightly rolling. It has been used in the past for pasturing dairy cattle, and for raising silage and grains. Crops grown in the regions near the site are corn, oats, barley, hay, green peas, potatoes, and wheat. Dairy products still remain by far the largest source of farm income. Within a radius of two miles from the Plant, there are 650 milk cows and a few beef cattle. Woodland areas occur in the form of scattered groves of trees along a creek (about 17 acres) located approximately 3/4 mile north of the Plant location, and in a woodlot of 13 acres about 1/2 mile south of the Plant. On the Point Beach property south of the Kewaunee Site, there are two woodlots of 66 and 23 acres in size [29].

About 15 percent of the land in Kewaunee, Manitowoc, and Brown Counties is forest. The nearest forest, other than the smaller areas mentioned, is Point Beach State Park, located between 8 and 11 miles south of the Plant along the Lake Michigan shore [29]. Plant species found in this forest area are listed in Appendix C, Table C-1 [3, 47]. Wooded areas on and near the Kewaunee Site are typically composed of bushes and trees including oak, birch, poplar, beech, and pine (see Table C-2). These wooded areas and the surrounding mosaic of other habitats, including the grassy edges of fields and roads, have a great variety of fauna, and afford some food and cover for all sizes of mammals. A variety of nesting sites for birds is also provided. The composition of the forest species indicates that the wooded areas are in a relatively static climax and that little succession will take place anywhere other than at the edges. It is the intention of the Applicant to continue to lease the fields outside of the industrial complex for agricultural use. Most of the mammals mentioned, with the exception of those adapted to arboreal living, use the agricultural fields to varying degrees for food and cover. Some ground-nesting birds such as the meadowlark live in the fields, and small mammals occupy those areas which are not regularly plowed. The fields, which occupy the greatest area, probably have the least numbers of species as well as individual animals on the site.

TABLE II-12.

Mammalian Species Known to Occur on the Plant Site and Their Relative Abundance [29-31]

Species	Abundance[a]	Species	Abundance[a]
Shrews	Rare	Deer	Rare
Mice	Present	Raccoon	Present
Wolves	Rare	Fox (red and grey)	Present
Cotton-tail Rabbit	Present	Chipmunks	Present
Squirrel (tree)	Present	Muskrats	Present
Squirrel (ground)	Present		

[a] Abundance increases in the following order: Rare, Present, Common, and Abundant.

The mammalian species listed in Table II-12 are known to occur in the area, and a quantitative estimate of their abundance has been made [29-31]. One public hunting ground in Kewaunee County is in the township of West Kewaunee, about 10 miles north of the site, and a second is in the southwest corner of Casco Township, 13 miles north-northwest of the site [1,17]. The predominant game species are cotton-tail rabbit, Hungarian partridge, and pheasant. The Kewaunee County uplands also provide ruffed grouse and woodcock for hunters. Deer generally confine themselves to the wooded wetlands, such as Black Ash Swamp and Lipsky's Swamp. Bow hunting for deer is popular in these areas. Migratory waterfowl utilize aquatic and terrestrial habitats within the vicinity of the Kewaunee Nuclear Plant, and migratory waterfowl are hunted off the shores of Lake Michigan in the vicinity of the Plant site. When the water level of Lake Michigan is low, exposed sand bars in the vicinity of the site attract several hundred geese (snow, blue, and Canadian). Also, the agricultural lands adjacent to Lake Michigan attract migratory geese for resting and feeding. However, nesting ducks are seldom found on site because of the lack of suitable habitat. Waterfowl hunting is somewhat dependent upon weather conditions. Rough water on Lake Michigan will drive birds inland to the small lakes.

The high shoreline on Lake Michigan (generally 30-50 feet above water level) provides excellent vantage points for observing waterfowl, gulls,

and shorebirds, which are common along the lakeshore. Goldeneye, mergansers, old-squaw, and bufflehead are common winter residents and move up and down the coast [17]. Birds characteristic of the Kewaunee region are listed in Table C-3.

Little information is available for sport value of wildlife in this region. Land fowl and waterfowl (game birds) are known to be seasonably abundant. The 1971 buck deer kill was 186 animals in Kewaunee County. Conversations with the game department indicate that the economic value of deer and other game along the lake is not high compared to other parts of the state.

2. Inland Waters

There are approximately 9000 acres of wetland in Kewaunee County, most of which are in small wooded swamp pockets, or marshy river flood plains. The marshy valley of the Ahnapee River is an example of the latter. There are about 4.3 acres of good waterfowl breeding habitat per square mile of land in Kewaunee County. Constituting this figure are the normally intermittent shallow marshes with less than one foot of water, and the deep marshes with one to three feet of water. Some of the smaller lakes may fall into the latter category in a wetlands classification.

Wetlands totalling 1105 acres adjoin six of the lakes. Largest are the wooded wetland of the Red River Swamp area and the wooded wetlands bordering the northern end of Shea Lake. There are several other major wetland pockets not associated with lakes, notably Black Ash Swamp north of Algoma, and Lipsky's Swamp south of Little Scarboro Creek. Nearly all wetlands have some association with streams, with the exception of a few isolated pockets. In all, about 5600 acres border the streams in this county [17].

The Wisconsin Conservation Department presently owns 334 acres of which most is wetland in a game project near the mouth of the Kewaunee River, and 432 acres with possibly some wetlands in a fish project on Little Scarboro Creek [17].

Some biotic communities are restricted to the small streams and chronically damp areas on the site. The plants present are adapted to wet conditions and few of them grow anywhere else on the site where water is not readily available. Weeds found in these and other areas of the Kewaunee region are listed in Table C-4. Many birds and mammals visit these communities to obtain succulent vegetation when other plants begin to dry up, and many

come to obtain water. Muskrats are restricted to this type of community, although they do wander far from water to obtain food. A number of reptiles and amphibians are also found in the general Kewaunee region (see Table II-13).

A variety of fish (see Table II-14) is caught by sport fishermen along the Kewaunee County shore of Lake Michigan and on several small inland lakes in the site vicinity [17,32]. Largemouth bass and panfish make up the most common fishery; however, there are two lakes which support trout and two lakes with muskellunge (only one of which is considered as a fishery). Noteworthy fishing lakes are Heidmann Lake, with northern pike, largemouth bass, and panfishes; Krohns Lake, with trout, largemouth bass, and panfishes; Shea Lake, with northern pike, largemouth bass, and panfishes; and West Alaska Lake, with trout, largemouth bass, and panfishes. East Alaska Lake has a desirable fishery for muskellunge, walleyes, largemouth bass, and panfishes. Management programs have enhanced some of these fisheries.

The abundance of small, slow growing fish is listed as a major use problem in two of the 15 inland lakes (Engledinger with yellow perch, Shea with bullheads and crappies). This is a common problem for small lakes, which have more than adequate spawning areas, and are able to exceed forage requirements of prey species. The causes of stunting are not fully understood but generally are combinations of lack of sufficient food, and physiological responses induced by crowding [17]. Corrective therapy is generally drastic, involving either partial or total elimination of the fish population and reintroduction of desired species. Attempts to increase fishing pressure and thereby improve the size of the individual fishes have been unsuccessful. Heavy stocking with predators also has had limited success.

There are nine streams which support trout for at least part of the year. These make a total of approximately 23 stream miles. There is some natural reproduction in 4 miles of four streams which have brook trout populations [17].

Recent efforts to establish rainbow trout in streams tributary to Lake Michigan accounts for the classification of Stony Creek and Three Mile Creek as trout water. Public lands associated with one of these streams (Little Scarboro Creek) assures its availability for the future. Seasonal fluctuations in flow threaten the trout fishery in seven streams. Pollution threatens the trout fishery in one stream. An experimental program to establish rainbow trout in streams tributary to Lake Michigan may bring added interest in Stony Creek and Three Mile Creek, and the mouths of the Ahnapee and Kewaunee Rivers.

TABLE II-13.

List of Reptiles and Amphibians in the General Kewaunee Region[a]

Common snapping turtle	Blue-spotted salamander
Western & Midland painted turtle	Jefferson salamander
Blanding's Turtle	Spotted salamander
Five-lined skink	Eastern tiger salamander
Northern red-bellied snake	Red-backed salamander
Northern water snake	Four-toed salamander
Eastern garter snake	American toad
Eastern hognose snake	Northern spring peeper
Northern ringneck snake	Eastern gray tree frog
Eastern smooth green snake	Western chorus frog
Bullsnake	Pickeral frog
Western fox snake	Northern leopard frog
Eastern milk snake	Green frog
Lake Winnebago mudpuppy	Wood frog
Central newt	Bullfrog

[a] Taken from ranges indicated in "A Field Guide to Reptiles and Amphibians of Eastern North America," 1968, by Roger Connant.

- - -

TABLE II-14.

Fishes in Kewaunee County Lakes [17]

Fish Species		
Muskellunge	Black Crappie	Bullhead (spp.)
Northern Pike	White Crappie	Carp
Walleye	Rock Bass	White Sucker
Yellow Perch	Pumpkinseed	Northern Redhorse
Largemouth Bass	Warmouth	Lake Chubsucker
Smallmouth Bass	Green Sunfish	Golden Shiner
Bluegill	Channel Catfish	Trout (spp.)

There are no streams classified as good smallmouth bass waters in Kewaunee County. The intermittent and highly variable flow in nearly all county streams seriously impedes fishery management. Poor land management practices such as cutting forests and wood lots, stream channel straightening, stream bank pasturing, and row crop farming on steep slopes are just a few of the causative agents. As the rate of runoff is accelerated, stream stability diminishes until a situation exists where flood waters scour stream beds at times and at other times dry beds are all that remain. Newer farming practices, such as dry lot feeding, farm woodlot management, and contouring of row crops may stem the runoff rate and have a stabilizing effect on stream flow.

Both the Ahnapee River and the Kewaunee River, near their mouths, have significant runs of northern pike in spring. Smelt and suckers are dipped from these streams during the spring spawning runs. This is also true of the Red River, which for most of the year is intermittent [17].

During construction of the Plant, some parts of the site were altered to make room for the buildings and to provide a spoil bank for excess cut and fill dirt. In the areas adjacent to the Plant, these disturbed sites have been planted with ornamental grasses and shrubs which will help stabilize the spoils and enhance the aesthetics of the Plant surroundings. Native grasses and forbs have also invaded some of the spoil banks. The communities of ornamental plants will provide little, if any, cover for indigenous plants and animals, but they may be a source of food. As long as the grounds crews maintain these areas there will be no natural succession.

The Department of Natural Resources is preparing a report of rare and endangered species in Wisconsin. Based on contacts with regional and state biologists of the Department, there are no known rare or endangered species of birds or mammals on-site, although osprey and the American bald eagle are known to be in the region.

Several species of the endangered ciscoes or chubs potentially could be present at times along the shore of Lake Michigan near the Plant, but these species have not been recovered in samples of 3,000 fish taken from the area in 1971 [46].

3. Lake Michigan

a. General.

Lake Michigan is the second largest of the Great Lakes with an area of about 23,000 square miles and a shoreline exceeding 1600 miles [33,34]. Water levels are highest in summer and lowest in late winter and early

spring. The surface of the lake lies an average 577 feet above mean sea level. Maximum depth is 923 feet; mean depth is 276 feet. The shoreline extends over a four-state area of Wisconsin, Illinois, Indiana, and Michigan.

In the area of the Kewaunee Plant, the lake is characterized by a shallow, gently sloping bottom. Fifteen-hundred feet offshore at the water intake site, water depth is only 15 feet. At a distance of 6000 feet offshore water depth averages about 30 feet. The bottom sediments in the site region primarily consist of hard red clay with an overlay of fine to medium sand. There is heavy erosion of the shoreline in the general area of the site, and as a consequence there is little to no emergent vegetation along the shore and lake bottom [30].

Lake current patterns differ in the near-shore areas from the stronger currents which occur generally beyond the 30 foot depth contour. These near-shore current patterns are variable and, though not well defined, are the subject of continuing studies.

Seasonal water temperatures in the near-shore area range from near freezing in winter to 70°F in late August and September. Although a general warming trend occurs during summer, large fluctuations in water temperature occur within a period of a few days. These fluctuations are due to cold water up-wellings resulting when warmer surface waters are blown offshore. In general, the inshore areas (to a depth of about 30 feet) have greater temperature changes during the summer and early fall than do offshore areas. Good mixing in the near-shore areas is indicated by similar temperatures at different depths [19,30].

b. Plankton.

Planktonic organisms are those small organisms that remain suspended in the water and that move with water currents. These are normally microscopic or quite small and include bacteria, algae, protozoans, rotifers, larvae, and small crustaceans. For the purpose of this analysis, small organisms that represent the early stages of fish life (eggs, sac fry) are also considered as part of the plankton community [34].

(1) Phytoplankton.

The base of the Lake Michigan food chains is almost exclusively composed of phytoplankton (Figure II-9), a characteristic of large and deep lakes. Diatoms predominate, comprising 50 to 80 percent of the total. Taking the

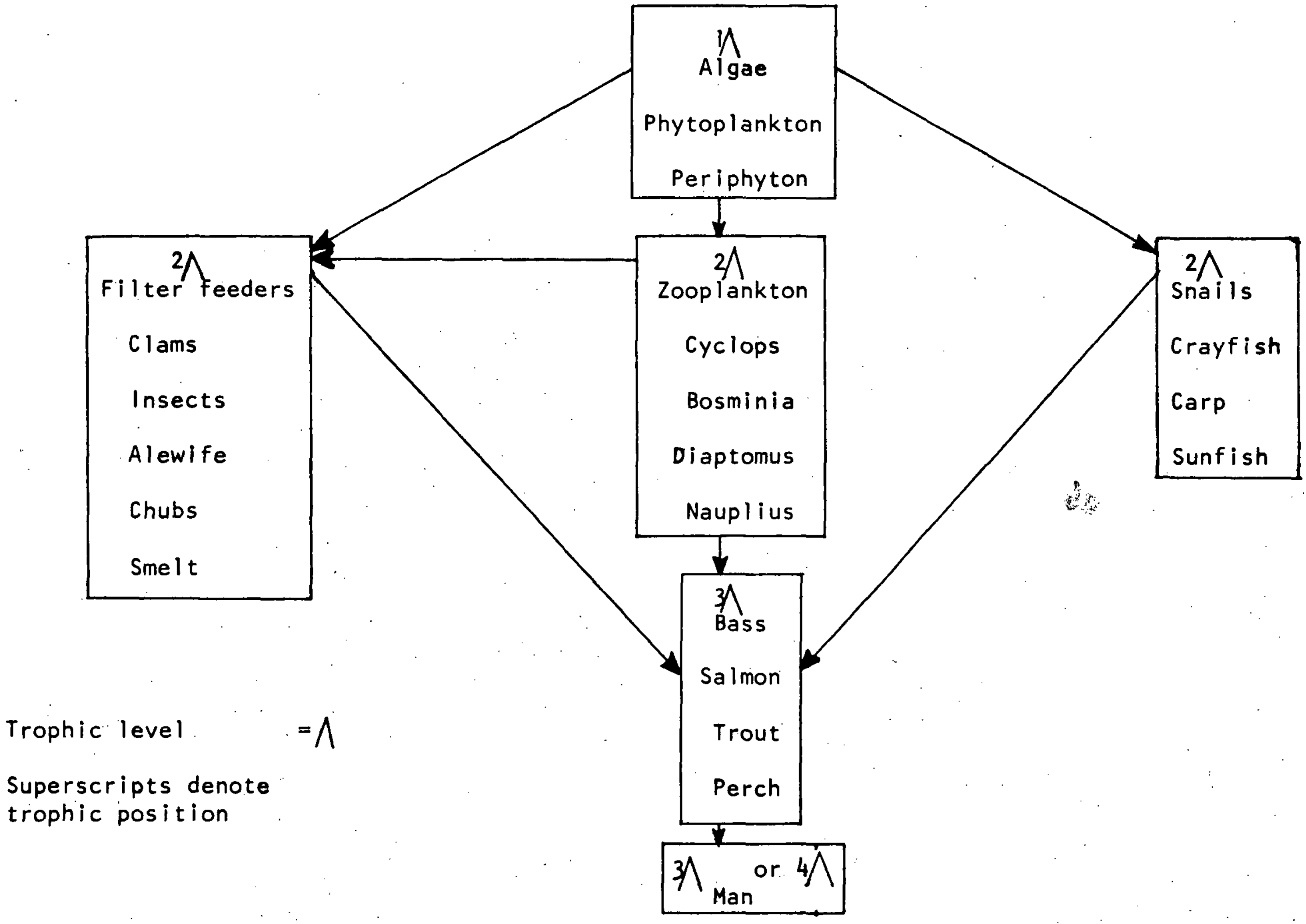


Fig. II-9. Aquatic Food Web [30]

lake in its entirety, the predominate diatom species are Asterionella, Cyclotella, Fragilaria, Melosira, Syndera, and Tabellaria. Comparison of data gathered in various phytoplankton studies dating back to 1872 shows that the diatom species that prevailed years ago are still present and abundant [48, 49, 51]. In the entire lake, with the exception of Green Bay and various localized inshore areas which have become more eutrophic, there apparently have been only slight changes in the quality of the aquatic environment [29, 30, 40].

The inshore waters of Lake Michigan are characterized by greater diatom populations and different species composition in diatom communities than offshore waters. A change in species composition at the primary trophic level serves as an index of altered environmental quality, e.g., eutrophication. Total diatoms were more abundant and variable near shore, reflecting nutrient enrichment from land runoff and waste effluents.[37,40] On the other hand, the average values for diatom numbers and species composition in offshore waters were close and comparable from year to year.[40] Concentrations of diatoms, green algae, and blue-green algae naturally increase seasonally during the spring and summer months as the lake water warms [40, 45]. When they occur, the pattern of algal blooms varies with locations about the lake. Certain portions of the lake experience two blooms, one in the spring and one in the fall, while other sections produce only one bloom [29, 52]. Data gathered at the Chicago water intakes over the past thirty-three years shows an increase of 13 plankton organisms per milliliter per year. This can be interpreted as indicative of eutrophication.

One hundred and four species of phytoplankton including 24 nondiatom species have been identified in the Kewaunee area using the Millipore filter and Lackey scan techniques. These [38,39,46] are listed in Appendix C, Table C-5. Of the species and varieties found at Kewaunee, Fragilaria pinnata was among the most abundant. Other plentiful species in the Kewaunee Plant area are as follows [38]: Fragilaria crotonensis, Stephanodiscus hantzschii-tenuis, Synedra acus, Tabellaria flocculosa, Diatoma tenue var. elongatum, and Coelosphaerium naegelianum. Blue-green algae were the second most abundant group (after the diatoms), representing an average of 2% of the phytoplankton in May, 10% in August and 20% in November 1971.[38] The higher percentages during August and November were due to an increase by a single species at the surface of the offshore station, Coelosphaerium naegelianum.

(2) Bacteria.

Coliform bacteria are organisms present normally in the digestive tract of human and other vertebrates, and may thus be introduced into Lake Michigan via feces and raw sewage. The communities of Algoma, Casco, Kewaunee, and Luxemburg have public sewerage and discharge treated waste waters. Receiving streams are the Ahnapee River, Casco Creek,

Kewaunee River, and Luxemburg Creek. Nearly the entire flow of Luxemburg Creek consists of treated effluent. The smaller villages lack public sewerage and must rely on private single family disposal means.

The principal industrial waste sources of importance to stream pollution are dairy plants. The East Twin River, Kewaunee River, Luxemburg Creek, Rio Creek, Casco Creek, and Ahnapee River receive such effluent. Pollution-caused fish-kills have occurred on Rio Creek, and Casco Creek was dropped from the trout stocking program because of unfavorable water quality [17].

The distribution of coliforms in the receiving lakewaters is dependent upon the action of currents. Coliform counts inshore at the Kewaunee site are well below the maximum level set in the Wisconsin Water Quality Standards for both inshore recreational (1000/100 ml) and open water zones (200/100 ml) for average annual values. Nine sampling sites in Lake Michigan near the Kewaunee Plant were used on May 25, August 31, and November 16, 1971. Replicate samples were taken for coliform and streptococci counts on these dates [2, 38]. The coliform counts were low (median 3/100 ml). The strep counts were similar except on November 16.

The Kewaunee Plant sanitary system is fully adequate for presently planned usage [30,31]. (See Section III.D.3 and V.B.2.)

(3) Zooplankton

Zooplankton organisms are a significant food source for fish. In Lake Michigan they are predominated by copepods, particularly *Cyclops bicuspidatus* and several species of the genus *Diaptomus*. At certain times of the year, notably late summer and early fall, the cladoceran *Bosmina longirostris* may comprise 50 to 80 percent of the zooplankton community [38]. Also important in the zooplankton are two species of the cladoceran genus *Daphnia*. Flagellates, ciliates, and rotifers are also present [17, 29, 30, 41, 51].

Plankton hauls have shown a range of 7 to 268 individuals per liter of the *Bosmina* group during 1969 bi-monthly surveys, the low occurring in December and the high in June [19]. Data for 1970 were similar, but the largest zooplankton population occurred in August and September. The total number of zooplankton per liter varied from 0 to 1800 during this period with the high occurring in August [19, 30, 39].

Data suggest that there is a vertical distribution of the combined zooplankton at some of the stations but not at others. Members of *Bosmina* sp. appear to especially congregate near the bottom. Although there were no statistical differences found in vertical distribution of zooplankton when compared for one collecting date, an independent comparison of surface and bottom samples over the year by non-parametric test shows an apparent difference for Kewaunee North, South, and County Park Stations [39].

Indi...tion of stratification at some locations and at various sampling dates may reflect differences in upwelling or wave mixing at those points. Temperature profiles suggest that there is considerable mixing in the shallow insnore waters and that upwelling is not an uncommon occurrence. The influence of a bouyant discharge plume on the vertical distribution and behavior responses of zooplankters is considered in the design of the environmental sampling program [38]. Recent (Jan.-Dec. 1971) zooplankton data, obtained within 500 feet north and a similar distance south of the Plant intake cones are given in Appendix C, Table C-7.

c. Periphyton

Periphyton are defined as the complex assemblage of aquatic organisms, especially green and blue-green filamentous algae, that grow attached to permanent substrates such as rocks, logs, steel pilings, etc. in shoreline areas. In addition to the larger algae, there are less obvious diatoms, many bacteria, protozoa, and invertebrate animals which constitute the periphyton community. Under normal conditions periphytic growth is considered to be beneficial because it is a food source to many fish or fish food organisms. Some of the bottom-feeding fish, such as carp and suckers, will browse directly on the filamentous algae. Forage fish feed on the protozoa and invetebrates. As the algae die and decompose, the organic material released becomes nutrients for other algae and invertebrates, all of which constitute the aquatic food chain of the littoral area [51].

The common shoreline algae at the Kewaunee Plant and County Park area are Cladophora and Ulothrix [39]. Diatoms were found to be the most abundant form of periphyton that grew on plastic slides placed in the Point Beach area in both 1969 [19] and 1970 [39]. Similar findings were reported at the Kewaunee site from natural substrates [38]. The identifications of Kewaunee periphyton (see Table C-6), [38].showed a consistently high abundance of species of Fragilaria. This genus was represented by nine species [19, 5]. Generic identifications also showed that species of the Gomphonema were very common, and it is known that certain species such as G. parvulum grow very will in organically enriched waters. G. parvulum was very rare in the Kewaunee Plant area, and the dominant species was G. olivaceum, a form common in clean water [38].

d. Benthos

An extensive series of benthic surveys were conducted in 1964-65 by a team from the Great Lakes Research Division of the University of Michigan Institute of Science and Technology[50]. The results of these efforts showed that three taxonomic groups comprised most of the benthos: amphipods, oligochaetes (worms), and tendipedids (midgefly larvae). Occasional additional organisms such as leeches, snails, roundworms, flatworms, mysids, ostracods, and

bryozoan colonies were found. Most of the samples taken in this survey were under deeper offshore waters and direct application of the data to the Kewaunee Plant discharge area is limited. A total of thirty-five sampling stations were visited during the study. The deep water macrobenthos is dominated by oligochaetes and amphipods. These organisms provide forage for such fishes as whitefish, smelt, alewives, and sculpins. These fishes in turn provide the forage for the next trophic level occupied by lake trout, coho salmon and chinook salmon [29,51].

Because of the bottom type in the near-shore areas at the Kewaunee Plant site, thery is little attached vegetation and relatively few benthic organisms. Only 7 of 30 bottom grab samples contained organisms and three of these were replicates from a single station [38]. Many of the benthic organisms collected were characteristic of cold, oligotrophic conditions. There was a maximum of 18 organisms in one sample and a total of 71 for all samples. Table II-15 lists the species found [30, 38, 51]. No leeches have been taken either in benthos samples from near the site or from the stomachs of fish collected from the vicinity. As indicated in the Report of the Committee on Nuclear Power Plant Waste Disposal to the Conferees of the Lake Michigan Enforcement Conference [42], and its confirmation by sampling in the area [38], bottom life is relatively scarce in the Kewaunee area.

Chironomidae (midge larvae) was the predominant group of benthic organisms (Table II-15). Large numbers of chironomids have also been observed in shallow water habitats in Lake Superior [38]. Their abundance is associated with their ability to construct cases and avoid being swept away by wave action. Different chironomid genera, with the exception of Heterotrissocladius, were observed each season. This trend may be related either to their life cycle or sampling difficulty.

Organisms that are intolerant of eutrophication which may be important in future studies are the oligochaete worm Stylodrilus heringianus, the crustacean Pontoporeia affinis, the chironomid Monodiamesa and Heterotrissocladius, and the caddisfly Athripsodes. These five species represented 21% of the total number of organisms collected near the Plant. Organisms near the Plant that may be increased by eutrophication are the oligochaete Limnodrilus hoffmeisteri and the chironomids Chironomus, Glyptotendipes, Paracladopelma, Polypedilum, and Stictochironomus [38].

Preliminary temperature measurements in the mixing zone at Point Beach indicate bottom water may increase 1-3° due to the discharge effluent. The latter is lighter than lake water, and it tends to float. Studies at the Ginna site on Lake Ontario showed that, at mixing zone depths greater than 7 to 9 feet, water temperatures were not different from ambient values [30,42]. Thus, bottom organisms were not warmed below a 9-foot depth.

TABLE II-15
Average number of benthic organisms per square meter
in Lake Michigan near Kewaunee, Wisconsin, 1971 [30, 38]*

	Date of Collection, Station and Sampling Depth								
	25 May 1971			31 August 1971			16 November 1971		
	A	B	C	A	B	C	A	B	C
Organisms	2m	8m	8m	2m	8m	8m	2m	7m	7m
Oligochaeta									
Lumbriculidae (worms)									
Stylodrilus heringianus	0	47.3 1/	0	0	0	0	0	5.8	0
Tubificidae (worms)									
Limnodrilus hoffmeisteri		0	0	0	5.7	13.2	0	0	0
immatures		0	0	0	18.9	321.3	0	5.7	0
Arthropoda									
Crustacca									
Haustoriidae (amphipods)									
Pontoporeia affinis	0	0	28.4	13.2	13.2	18.9	0	0	0
Insecta									
Ephemeroptera (mayflies)									
Heptageniidae	0	0	0	0	0	0	0	0	5.7
Trichoptera (caddis flies)									
Leptoceridae									
Arthripsodes	0	0	0	0	0	0	0	0	18.9
Diptera									
Chironomidae (midges)									
Monodiamesa	0	0	0	5.7	56.7	5.7	0	0	0
Heterotrissocladius	0	0	47.3	0	5.7	0	0	0	0
Cricoptopus	0	0	47.4	0	0	0	0	0	0
Pseudosmittia	0	0	0	0	0	0	0	251.4	126.6
Chironomus	0	0	0	5.7	5.7	5.7	0	0	0
Glyptotendipes	0	0	0	0	0	0	0	62.4	24.6
Paracladopelma	0	0	18.9	0	0	0	0	0	0
Polypedilum	0	0	28.4	0	0	0	0	0	0
Stictochironomus	0	9.5	1.9	0	0	0	0	0	0
Mollusca									
Gastropoda (snails)									
Lymnaea	0	9.5	0	0	0	0	0	0	0
Total Benthos	0	66.2	172.0	24.6	105.8	364.8	0	325.1	175.8

1/ Average of three samples
*Sampling sites are located near the Plant intake: A is 200 feet from shore
B is 500 feet south of intake structure
C is 500 feet north of intake structure

Beeton has reported a shift in the bottom fauna of Lake Erie in the years following the 1918-1928 decade [43]. This was attributed to an average increase in the temperature of lake waters by 2°F plus the addition of chemicals. It is not expected that this will occur in the Kewaunee area because of differences in water quality and quantity, and the extent of area warmed. Within the limited warmed zone, increased biological activity could occur; with a possible increase in nutrients from the mortality of plankton passed through the condenser, a small change in abundance and shift in species composition of the benthic community may occur. However, the maximum size of the area affected by a potential change in temperature of 3°F or greater will be about 250 acres (see Section III.D.1.a.i.).

e. Fish

Because of the major waterway projects of the past and the nature of modern resources management practices, the fish populations of Lake Michigan are in a state of flux. Also, many of the former spawning sites for desirable fish species are not available as a result of stream pollution [32,40].

Spawning areas have not been specifically identified in the vicinity of the Kewaunee site. The determination of possible spawning areas in the immediate vicinity of the Plant has been made by examination of the condition of the gonads of fish in the 1971 survey and will be investigated again in 1972. By this method, some information is obtained relative to whether important species are in this area at a time when they may be in spawning (ripe) condition. Minnow seine hauls were made in 1971 and will be made again in 1972. If the young fish of important species inhabit the shoreline area at some time during the year, some should be collected. No young of the year or yearling yellow perch were found in minnow seine hauls during 1971. This casts some doubt on whether this species is reproducing successfully in this immediate area [46].

Successful lake trout reproduction has not been reported from anywhere in Lake Michigan for many years, although sexually mature lake trout were collected in the vicinity of the Kewaunee site in 1971 [38]. Eggs taken from females in the general area have been successfully hatched. Chubs spawn in deeper water than would be found in the Kewaunee biological sampling area. Alewives and smelt may possibly spawn in this area, but they probably spawn generally throughout the shoreline area of Lake Michigan [35,46].

Other fishes important to Lake Michigan ecology are yellow perch, walleyes, chubs, and suckers [33,44]. Recent collections by state fisheries and game personnel have shown that the following species of fish are present at the Kewaunee site at some time during the year (Table II-16). The most

abundant sport fish found in the area during 1971 was the lake trout [38]. Virtually all had been stocked in Wisconsin waters by Federal or State agencies, as indicated by their clipped fins. The bulk of the fish taken were year-class V (1966) fish. They were predominant in the spring and fall; year-class III and IV fish were more in evidence during the summer months [38, 51].

TABLE II-16

Fish Species in Lake Michigan near the Kewaunee Site [17, 30, 51, 38]

Species	Scientific Name	North of Site	At Site	Total
Alewife	Alosa pseudoharengus	1172	943	2114
Smelt	Osmerus mordax	116	51	167
Lake Trout	Salvelinus namycush	140	214	354
Brook Trout	Salvelinus fontinalis	5	0	5
Rainbow Trout	Salmo trutta	8	5	13
Bloater	Coregonus hoyi	0	2	2
Round Whitefish	Prosopium cylindraceum	8	0	8
Slimy Sculpin	Cottus cognatus	22	5	27
Yellow Perch	Perca flavescens	30	21	51
Longnose Sucker	Catostomus catostomus	5	12	17
White Sucker	Catostomus commersoni	11	28	39
Longnose Dace	Rhinichthys cataractae	31	0	31
Spottail Shiner	Notropis hudsonius	0	1	1
Fathead Minnow	Pimephales promelas	7	1	8
Lake Northern Chub	Hybopsis plumbea	8	50	58
Coho	Oncorhynchus kisutch	1	0	1
Total		1562	1328	2890
Percent of Total		54.0%	46.0%	

The fish species composition of the Great Lakes and of Lake Michigan in particular have been altered by overfishing, agricultural land drainage, and at least three other changes brought about by man:

(1) Penetration of the sea lamprey into the lake had a devastating effect upon the populations of the larger fishes. Once important fisheries of lake herring, lake trout, and whitefish were decimated by lamprey predation. The commercial fishing industry of the lake gradually collapsed within several years following the opening of the Welland Canal.

The U.S. Bureau of Commercial Fisheries, Division of Sea Lamprey Control, operated an electromechanical weir in the Kewaunee River from 1952 to the late 1960's. Moderate sized spawning runs of adult sea lamprey occurred and were collected at the weir during all of its years of operation. As a result of successive surveys for larval sea lamprey (sea lamprey ammocetes), it was found that in spite of the spawning runs of adults, there was very little spawning success. Recent surveys of the watershed have found less than ten sea lamprey ammocetes per survey. Nesting surveys have brought similar results [46].

The closest sea lamprey-producing stream of any significance is Three Mile Creek located to the north, and just south of the town of Algoma, Wisconsin. South of the Kewaunee River, the E. Twin River at Two Rivers, Wisconsin had large spawning runs of adult sea lamprey in the late 1950's; however, no spawning success was apparent. Stream surveys of the watershed have never found sea lamprey ammocetes, although sea lamprey spawning nests have been found in recent years. It has been theorized that high summer stream water temperatures are responsible for ammocete mortality.

(2) The alewife was soon found in all of the Great Lakes and it reached such large numbers that a massive die-off occurred. The beaches of Lake Michigan were cluttered with decaying fish, which greatly reduced the recreational use of the beaches. It is likely that the explosive growth of the alewife population resulted in the further decrease in lake herring numbers, although the exact causal relationship is not clear. The alewife first entered the commercial fishery in the Kewaunee area in 1961, and has since so increased in occurrence that the catch of alewives in trawling operations is now about the same as the catch of small chubs. The lack of marketing stability for this species (alewife) has made it a detriment rather than an asset to

commercial fishing operations. Food and space competition between the alewife and other fish species of greater commercial value, notably yellow perch, young ciscoes, and whitefish, may be their greatest threat to fisheries. However, rainbow, brown and lake trout seem to utilize the alewife as a ready food supply, a circumstance which might counter-balance their otherwise detrimental qualities [38].

(3) Stocking of fishes has had an effect on the species composition. Exotic species which have become locally established include: American smelt, German brown trout, rainbow trout, carp, gambusia or mosquitofish, chinook and coho salmon [29].

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III. THE PLANT

A. EXTERNAL APPEARANCE

The finished appearance of the major Plant buildings is shown in Figure III-1, as visualized from about the ground level at the lakeshore just south of the Plant. Figure III-2 is a photograph taken from about 500 ft. over the lake. It shows the status of construction for the Plant as of October 15, 1971. This view shows the generally flat land inland and the slightly rolling, natural-drainage features near the lake.

Pioneer Service and Engineering Co. is the architect-engineering firm for the Plant. The principal features of the Plant are indicated in Figure III-3. A somewhat more detailed layout is included in Appendix E (see p. E-57). The reactor building is the tallest structure, a domed silo 180 ft. tall and 120 ft. in diameter. On the lakeside of the reactor building is the turbine building of rectilinear dimensions 228 ft. long, 100 ft. high and 130 ft. wide. The auxiliary building adjoins the reactor building and is somewhat smaller than the turbine building. The administration building is smaller and faces the lake in front of the turbine building. The screenhouse, which contains components for supplying lake water for cooling, abuts the lake directly and has its roof at ground level. The switch yard and transmission towers are just west of the major buildings. The transmission lines are described in the following section.

The location for and excavation at the Plant site, and the burial of debris in a landfill just south of the buildings were carried out with regard to stabilizing the shore terrain against natural erosion. Top-soil and planting will be returned to the landfill, and the land near the Plant landscaped to give an appearance natural to the general area.

B. TRANSMISSION LINES

The electricity generated at the Plant results in a net Plant output of about 540 MWe. The generator output of approximately 20 kilovolts (kV) is fed to transformers that raise the voltage to 138 and 345 kV for delivery to the distribution system. The substation, switchyards and transmission towers at the Plant occupy about 10 acres.

The major new transmission lines required for the Kewaunee Plant are 345 kV lines for connection to the North Appleton substation (50.6 miles) and to the Point Beach substation (5.6 miles). Local system inter-connections at 138 kV are provided by two lines of 2-mile length. The corridors for these lines involve 1066 acres of land.

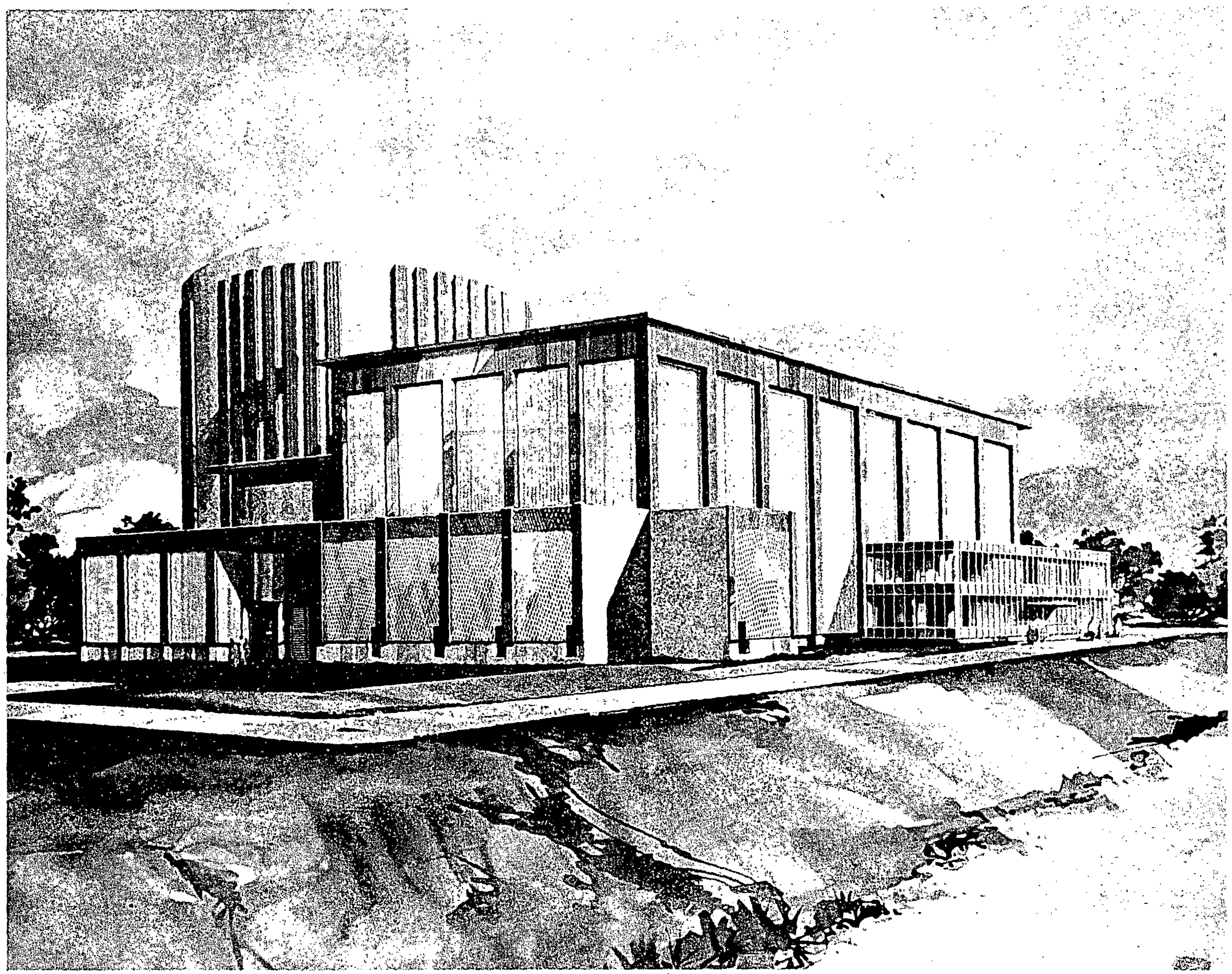


Fig. III-1: Artist's Rendition of the Completed Plant Buildings

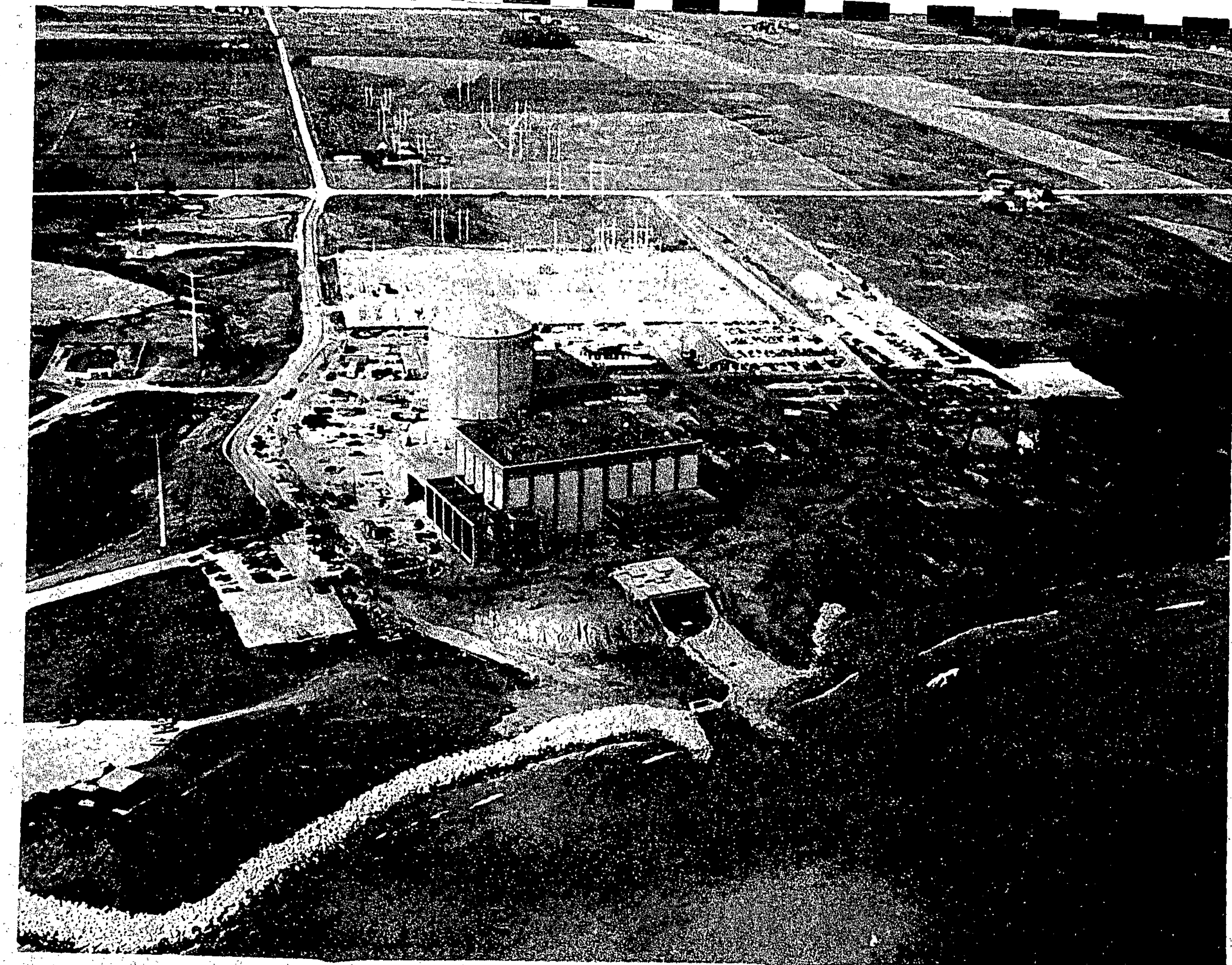


Fig. III-2: Aerial Photo Showing Plant Construction Status as of October 15, 1971

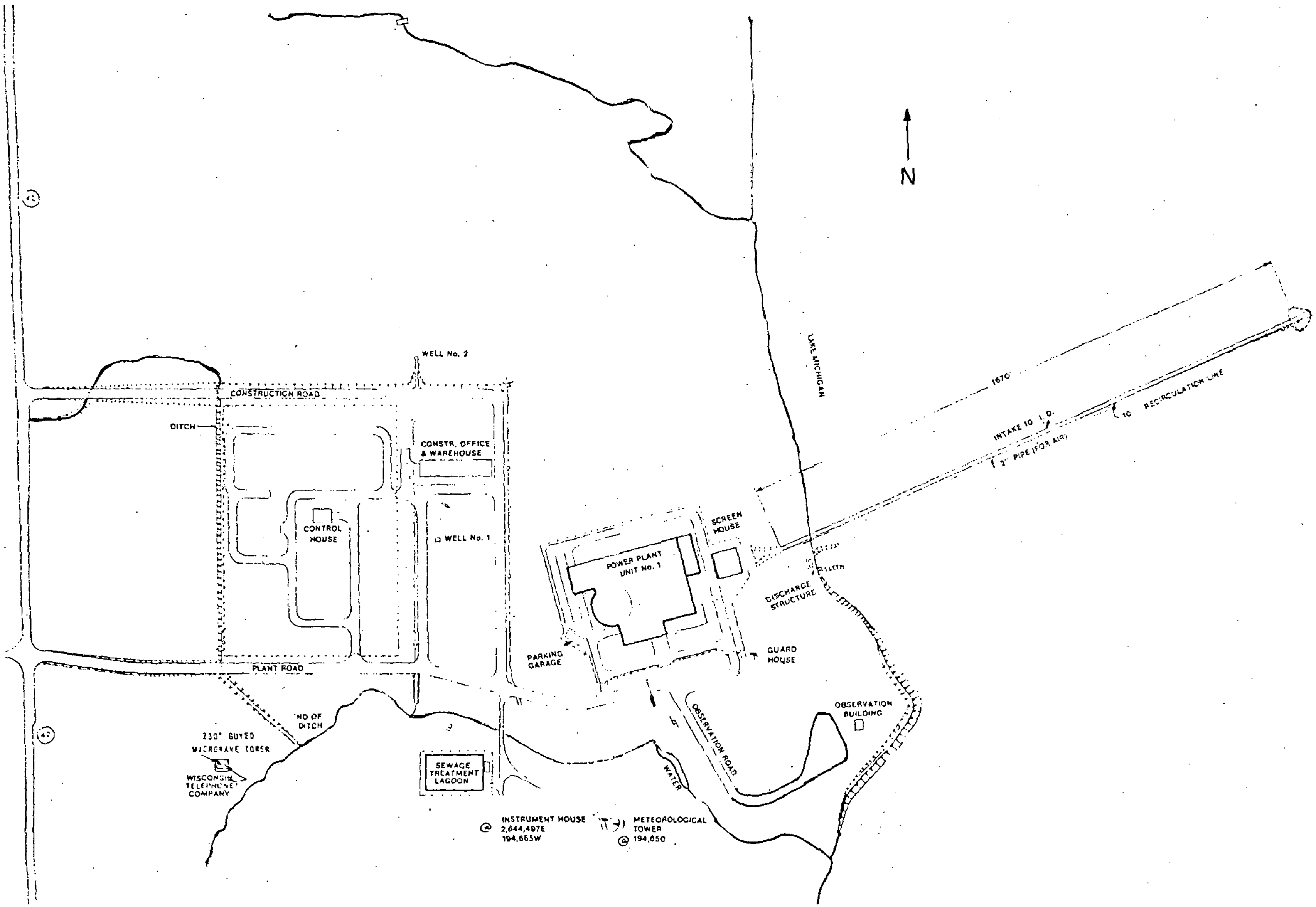


Figure III-3: Layout of the Physical Facilities

Plans for the new transmission lines were made in 1968 and finalized in 1969. Although this predates recently issued federal guidelines, the lines conform to many of those recommendations. The Applicant consulted with the Wisconsin Public Service Commission regarding the detailed plans, and supplemental plantings of trees and shrubs along the right-of-way followed the advice of a commercial forester. Care was taken to blend the lines with the terrain and to avoid interfering with the view of the lake where the lines paralleled lakeshore roads.

These transmission lines conform to the Applicant's policy of minimizing environmental and visual impact, by appropriate design and by maintenance of the right-of-way, including planting. In general, previous agricultural uses are continued for the land involved. No access roads are used. Transmission lines are high enough to avoid a visual impression of being "fenced in." Routing of transmission lines across hilltops was avoided, and the towers, of simple H-frame design, were constructed of wood for a natural appearance. Land along the transmission right-of-way was formerly farmland (84%), woodland (7%), wetlands (2%), and scrubland (7%).

C. REACTOR AND STEAM-ELECTRIC SYSTEMS

The Plant has a single pressurized-water reactor in the nuclear steam supply system, and a turbine-generator system, both supplied by the Westinghouse Electric Corporation. Lake Michigan water is used for once-through cooling of the condenser. The license application power level is 1650 MWt (540 MWe net). The maximum anticipated power capability of the Plant is 1721 MWt and the accident analyses and radiological impact calculations done herein are based on this maximum level.

1. Nuclear Steam Supply System

The nuclear steam supply system consists of a pressurized-water reactor, a reactor coolant system, and associated auxiliary fluid systems. The reactor coolant system is arranged as two closed reactor coolant loops connected in parallel to the reactor vessel, each containing a reactor coolant pump and a steam generator. An electrically heated pressurizer is connected to one of the loops.

The reactor core is composed of uranium dioxide pellets enclosed in Zircaloy tubes with welded end-plugs. The tubes are supported in assemblies by a spring-clip grid structure. The mechanical control rods consist of clusters of stainless-steel-clad absorber rods and

Zircaloy guide tubes located within the fuel assembly. The core fuel is loaded in three regions, with new fuel being introduced into the outer region, then moved inward in a checkerboard pattern at successive refuelings and finally discharged from the inner region to spent fuel storage.

The steam generators are vertical U-tube units utilizing Inconel tubes. Integral separating equipment reduces the moisture content of the steam at the turbine throttle to 1/4 percent or less.

The reactor coolant pumps are vertical, single stage, centrifugal pumps equipped with controlled-leakage shaft seals.

Auxiliary systems are provided to charge the reactor coolant system and to add makeup water, purify reactor coolant water, provide chemicals for corrosion inhibition and reactor control, cool system components, remove residual heat when the reactor is shut down, cool the spent fuel storage pool, sample reactor coolant water, provide for emergency safety injection, and vent and drain the reactor coolant system.

The reactor is controlled by a coordinated combination of chemical shim and mechanical control rods. The control system allows the plant to accept step load changes of 10% and ramp load changes of 5% per min. over the load range of 15 to 95% power under nominal operating conditions. It is also designed to sustain reactor operation following total rejection of the electrical output from 100% power. Complete supervision of both the reactor and turbine-generator is accomplished from the control room.

The reactor fuel-handling system is designed to handle spent fuel under water from the time it leaves the reactor vessel until it is placed in a cask for shipment from the site. Underwater transfer of spent fuel provides an optically transparent radiation shield, as well as a reliable source of coolant for removal of decay heat. This system also provides capability for receiving, handling and storage of new fuel.

2. Turbine-Generator System

The turbine is a tandem-compound, 3-element 1800 rpm unit having 40-in. last row blades in the low-pressure elements. Four combination moisture separator-reheater units are employed to dry and superheat the steam between the high- and low-pressure turbine elements. The turbine is rated at 563 MW when operating with inlet steam conditions of 720 pounds per square inch absolute (psia), 506°F, exhausting at 0.74 psia with zero makeup and five stages of feedwater heating.

For condensing steam leaving the turbine, a single-pass deaerating, double-flow surface condenser, steam-jet air ejector, two 50% capacity condensate pumps, two 50% capacity motor-driven feedwater pumps, and one stage of feedwater heating are provided. One steam-driven and two motor-driven auxiliary feedwater pumps are available to remove heat from the reactor coolant system in case of loss of primary power.

The main generator is an 1800 rpm, 3-phase, 60 Hertz, hydrogen-innercooled unit. Electrical energy generated at 20 kV is transformed to 345 and 138 kV and delivered to the Applicant's 345/138 kV system. The plant auxiliary electrical system consists of auxiliary transformers, 4160-V switchgear, 480-V motor control centers, and 125-V d.c. and 120-V a.c. equipment. Emergency power is supplied by alternate sources including two diesel generators. It is capable of operating post-accident containment cooling equipment as well as both high- and low-head safety injection pumps, to ensure an acceptable transient after a postulated loss of coolant accident.

3. Condenser Cooling System

The circulating water system provides once-through cooling of the main condenser of the steam-electric system. The normal flow rate at the condenser is 413,000 gallons per minute (gpm), or 918 cubic feet per second (cfs), with a rise in water temperature of 20°F. This cooling rate is equal to 4.1 billion British thermal units per hour (4.1×10^9 Btu/hr). In normal operation, the above flows are those withdrawn from the lake at the intake structure, passed through the condenser, and returned to the lake via the discharge structure. In winter, the lower temperature of the lake water allows a reduced-flow operation, such that only about 287,000 gpm passes through the condenser, with a temperature rise of 28°F.

The intake structure is located approximately 1600 ft. from the shore where the lake depth is 15 ft. The inlet structure is three inverted cones with 22-ft.-diameter openings at 1 ft. above the lake bottom. At full flow, the velocity at the intake mouth is about 0.9 feet per second (fps). Entering water moves downward where the taper of the cone is such that within 6 feet the velocity increases to about 11 fps at which point the water enters a 6-ft.-diameter pipe for each cone. These three water inlets are connected to a single 10-ft. pipe conducting the water to the screenhouse. The three cones are 40 feet apart (on centers) so that a single barge could not block all three simultaneously.

The openings of the intake cones are protected with a metal grid with square 12-in. openings, and an air bubble screen around each of the cones. The bubble screen was included because of its effectiveness at the Applicant's Pulliam (fossil-fueled) Power Plant at Green Bay. Prior to the installation of the air screen at Pulliam, units had to be taken off the line due to plugging of the intake screens or condensers by alewives. Effective exclusion of alewives by the bubble screen has been observed. Also, the screen did not lose effectiveness in darkness.

Intake is conducted in the main 10-ft.-diameter pipe to the forebay at the screenhouse on the shore. The 6-ft. and 10-ft.-diameter pipes are buried a minimum of three feet below the lake floor and coated inside and out with asphaltum (noted for its corrosion resistance and low solubility in water). The forebay water passes through four travelling screens (in parallel) with a mesh size of 3/8 in. The screens are provided with automatic water backwashing. Trash collected from the screens is removed by a local waste handling firm.

The discharge of the circulating water is made directly into the lake at the shore, by means of a special outlet basin. The discharged water enters the basin through a submerged 10-ft.-diameter concrete pipe, which connects through a concrete transition piece to an open basin, 40 ft. wide, constructed of sheet-piling sides and riprap bottom. The bottom of this basin slopes upward to meet the natural sand bottom of the lake. At the mouth of the basin, sheet-metal piling fans out to protect the adjacent shoreline. The total length of the transition piece and the basin is about 130 ft. The maximum distance at which the discharge facility has affected the lake bottom configuration in any way is about 500 ft. from the shore.

Provision has been made to add a sodium hypochlorite solution to the circulating water to prevent fouling by biological organisms, especially algae. Additions would be intermittent, and controlled to meet applicable standards. Little, if any, use is expected by the Applicant.

D. EFFLUENT SYSTEMS

1. Heat

a. Thermal Plume Dispersion

The warm water flowing from the Plant condenser is discharged in a direction perpendicular to the shoreline from a discharge structure located at lake level on the shoreline (see Figures III-2 and III-3, and Section III.C.3). The Kewaunee discharge flows from the discharge structure into a channel dredged into the shallow bottom of Lake Michigan. The channel is 40 ft wide at the bottom and has a depth of

5 ft. with the lake at its normal water level of 577 ft., International Great Lakes Datum (IGLD). The channel extends approximately 530 ft. into the lake, where the elevation of the lake bottom becomes 572 ft. (IGLD). The lake bottom in this area has a gradual slope of about 1:100. The average discharge velocity at the mouth of the discharge basin, where the discharge structure pilings diverge from the 40-ft.-wide channel, is 4.7 fps when the lake is at its mean level of 577 ft. (IGLD). At the low water level of 575.4 ft. (IGLD), the discharge velocity would be 6.9 fps, while at the high water level of 581.9 ft. (IGLD) it would be 2.4 fps. These are initial velocities entering the lake. As the discharged water moves into the lake, mixing occurs and the velocity decreases.

An analysis [1] of the Plant discharge performed for the Applicant indicated that, for the assumed conditions, the 3° F isotherm (above ambient) would extend about 7000 ft. from the discharge structure and that the area within the 3°F isotherm would be about 1000 acres. The shape of the predicted isotherms were oval, with their short axis coinciding with the centerline of the discharge. The mathematical model used was highly idealized, assumed no ambient lake current, and had to assume values for a number of important parameters. As with virtually all other mathematical models applicable to thermal discharges into large lakes, this model has not been validated against field data and therefore the results are both tentative and unverified. A better understanding of the physical nature and behavior of the Kewaunee thermal discharge is obtained from the results of pertinent laboratory studies and field studies of plumes with similar discharge configurations.

i. Correlated Observations

Asbury and Frigo [2] correlated data from six power plants having surface discharges into large lakes, as shown in Figure III-4. A total of 23 thermal plumes were included in the correlation and data therefrom are indicated by letters in the figure. The temperature excess (Θ) above ambient, normalized to the maximum temperature excess (Θ_o) at the discharge, is shown as a function of the ratio of the area within a given isotherm divided by the discharge flow rate. The estimated areas within certain isotherms, obtained from Figure III-4 for the Kewaunee flow rate of 918 cfs, are as follows:

Temperature above ambient	Area
15°F	3.2 acres
10	25.3
5	129
3	254

The Applicant's estimate of 1000 acres within the 3°F isotherm is not consistent with the data shown in Figure III-4, but it is very conservative in terms of perturbation of the natural lake conditions.

ii. Physical Modeling

A laboratory study by Wiegel, et al., [3] produced data for conditions similar to the Kewaunee discharge, as shown in Table III-1. Tests were also run for the case where a 1:10 (1.22 in. wide) nozzle discharged into a channel 2 in. wide, grooved into the 1:100 slope beach. This case is geometrically similar to the Kewaunee discharge. The water level was varied from the level of the discharge to below the level of the discharge.

TABLE III-1. Comparison of Flow Parameters in Test Model[3] and KNPP Coolant Discharge

Parameter	Value: Tests	Value: Actual
Discharge aspect ratio	1:10	1:8
Bottom Slope	1:100	∿1:100
Densimetric Froude number, F_R	$5 < F_R < 50$	6.3
Discharge Reynolds number, R_e	$700 < R_e < 9300$	3.6×10^6

The data for the test conditions indicated a flow development region (distance before centerline temperature and velocity are reduced) of approximately 30 equivalent diameters downstream. The distances along the plume centerline to certain excess temperatures are tabulated below.

Centerline Excess Temperature	Distance from Discharge
20°F	264 ft
15	440
10	685
5	1760
3	3600

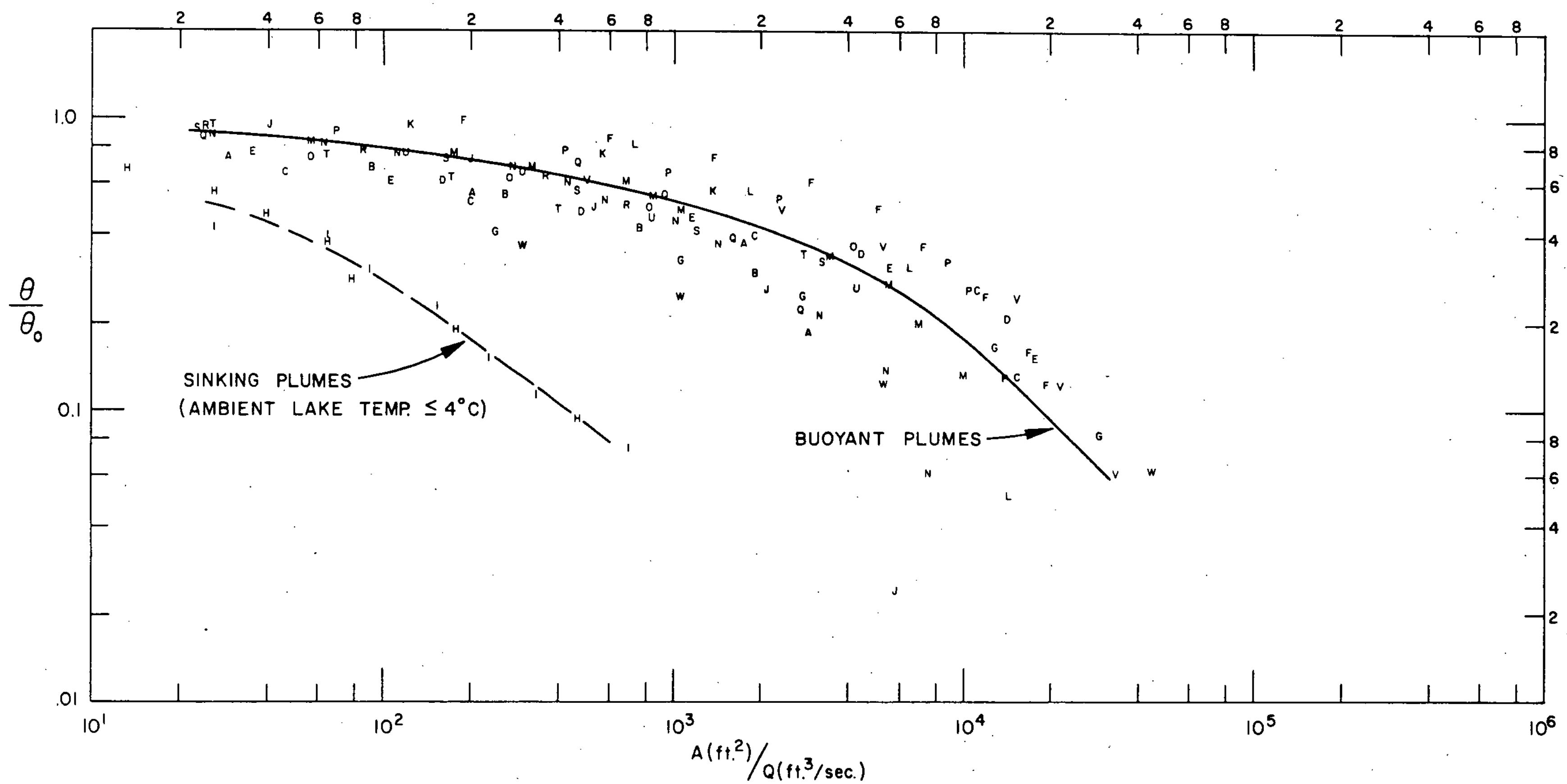


Fig. III-4: Fractional Excess Temperature $\left(\frac{\theta}{\theta_0}\right)$ as a Function of the Ratio of Surface Area (A) to Discharge Flow Rate (Q).

The relative effect of the magnitude of the bottom slope on the isotherms is shown in Figure III-5. [3] In general, it may be seen that mixing increases with increasing slope. The investigators observed for most of their tests that "...a 'high-level' turbulent mixing occurred with relatively large eddies swirling throughout the mixing jet. Large eddies formed at the edges of the mixing jet, entrapping water from the surrounding receiving water."

The results of the tests where the 1:10 nozzle was mounted in a rectangular channel cut into the 1:100 slope "beach" showed that the lower the water level with respect to the elevation of the nozzle, the less effective the mixing. Thus, when the level of Lake Michigan falls below the mean water level, the dispersion of the Kewaunee plume will probably be adversly affected. The degree to which it might be affected cannot be determined at this time.

iii. Measurements at Point Beach

Field data have been obtained [4] for Unit 1 at the Point Beach Plant located approximately 4.5 miles south of the Kewaunee Plant. The plants are similar in many respects:

	Point Beach Unit 1	Kewaunee
Reactor Type	PWR	PWR
Thermal Power, MWt	1518	1650
Net Power, MWe	497	540
Condenser Flow, cfs	783	918
Coolant ΔT, °F	19	20
Discharge Dimensions, ft.	13.3 D x 35 W	5D x 40 W
Discharge Velocity, fps	1.65	4.6
Densimetric Froude No.	3.1	6.3

Because of the proximity of the plants, the lake conditions should be approximately the same so that the thermal discharge patterns observed at Point Beach should be similar to those produced at Kewaunee. Figures III-6 through III-10 are a partial representation of some plume

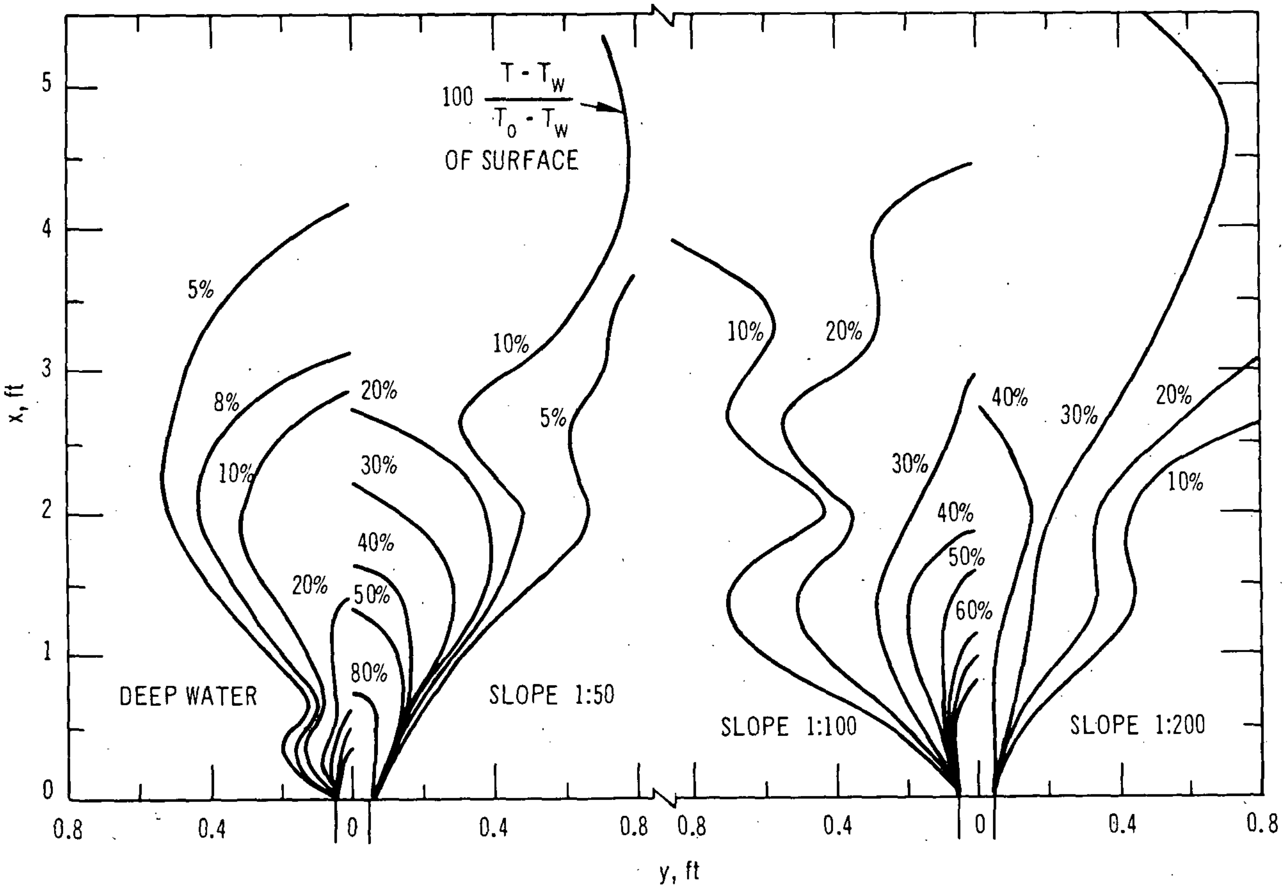


Fig. III-5: Surface Temperature Concentration T(x,y), in Terms of Ambient (T_W) and Inlet (T_O) Temperatures, for a 1:10 Rectangular Orifice Discharging at the Surface of Deep Water and Water with Bottom Slopes of 1:50, 1:100 and 1:200.

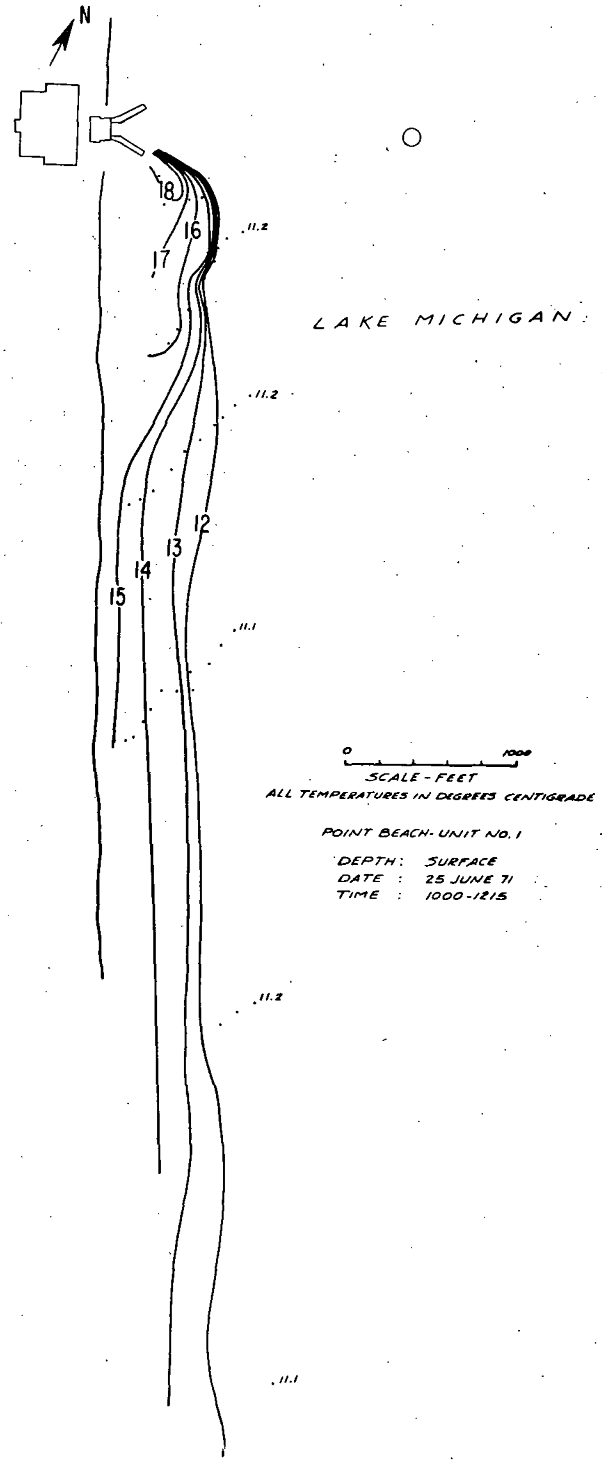


Fig. III-6: Observed Plume Dispersion for Point Beach Unit 1 on June 25, 1971.

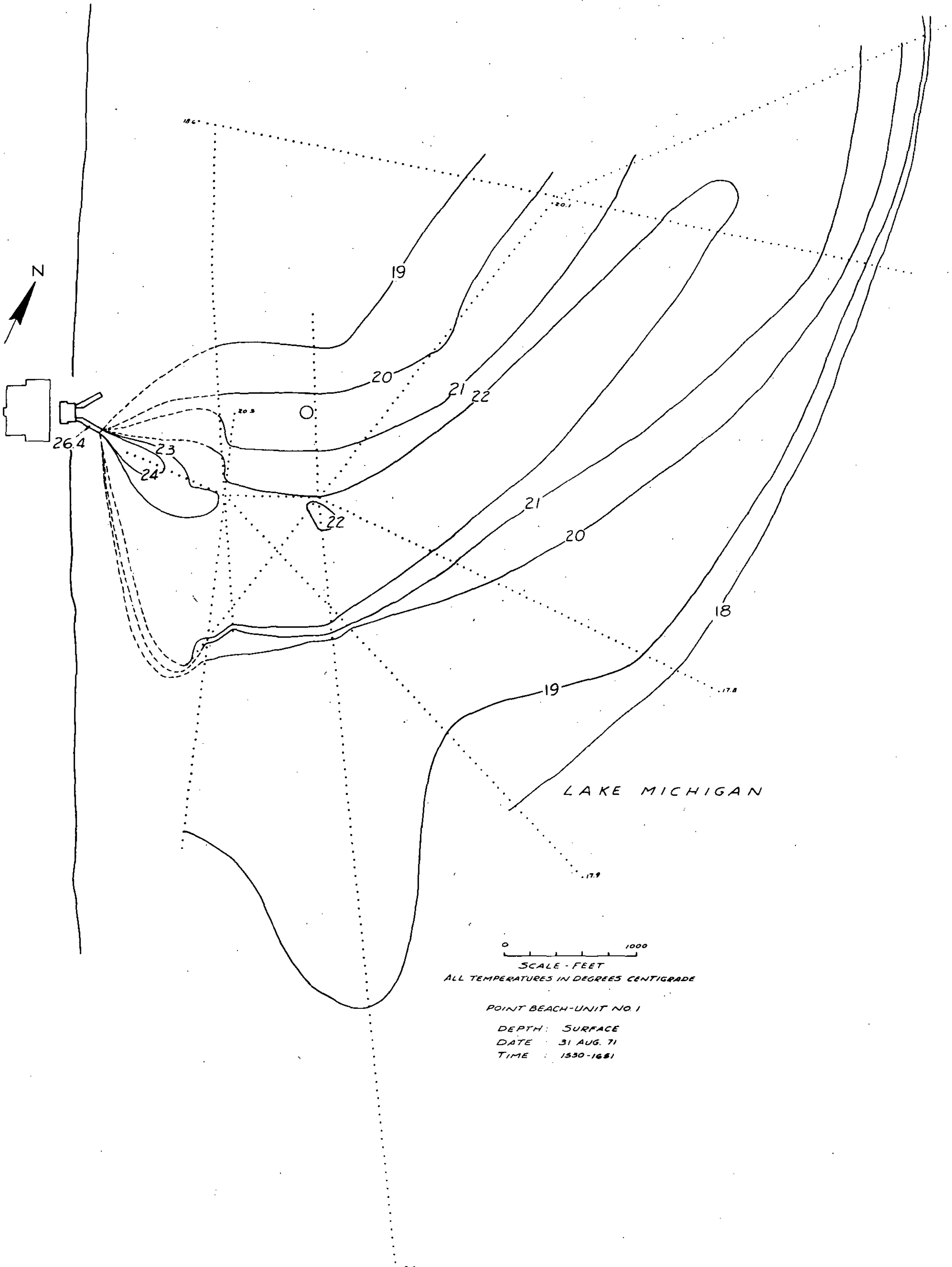


Fig. III-7: Observed Plume Dispersion for Point Beach Unit 1 on August 31, 1971.

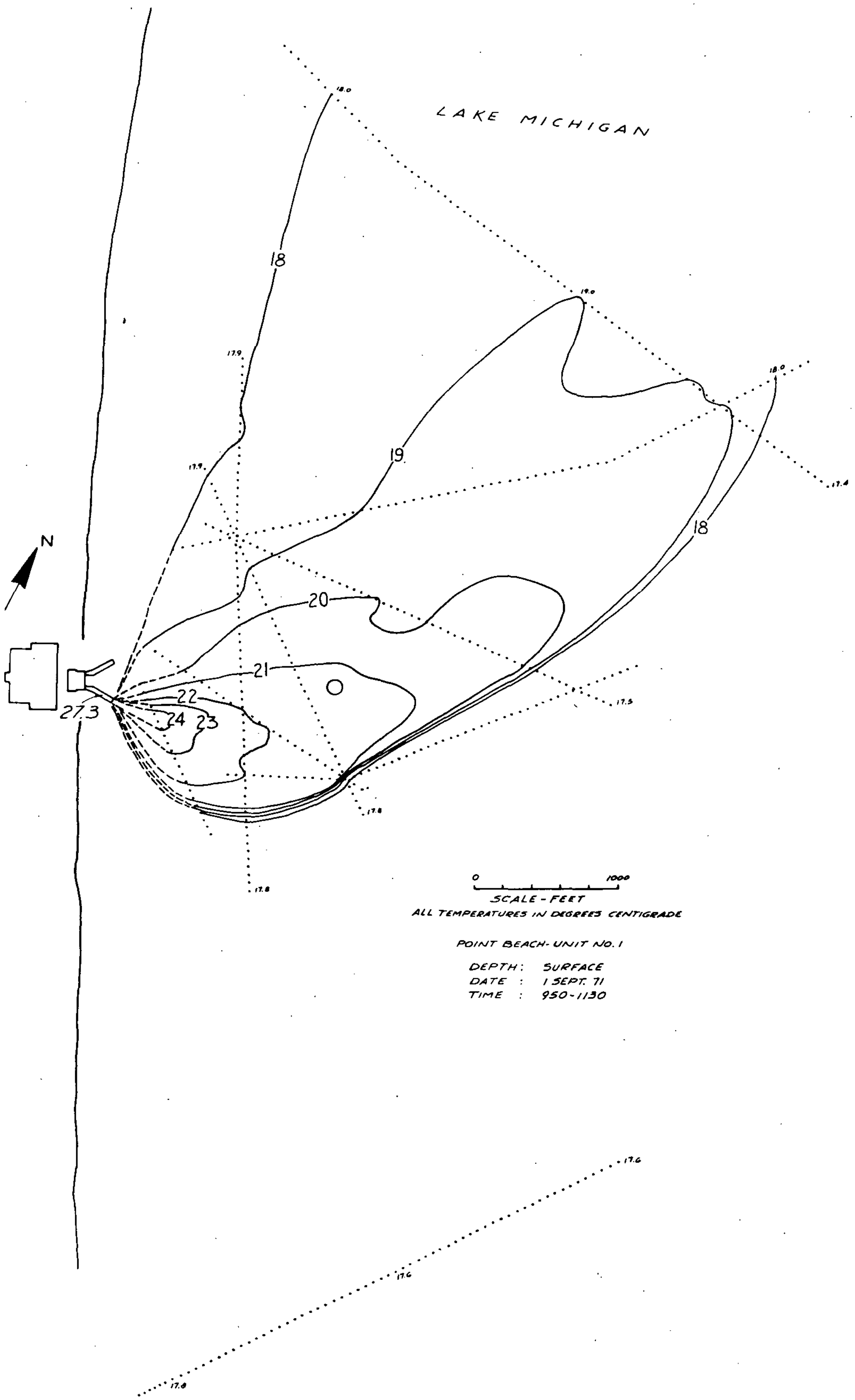


Fig. III-8: Observed Plume Dispersion for Point Beach Unit 1 in the Morning of September 1, 1971.

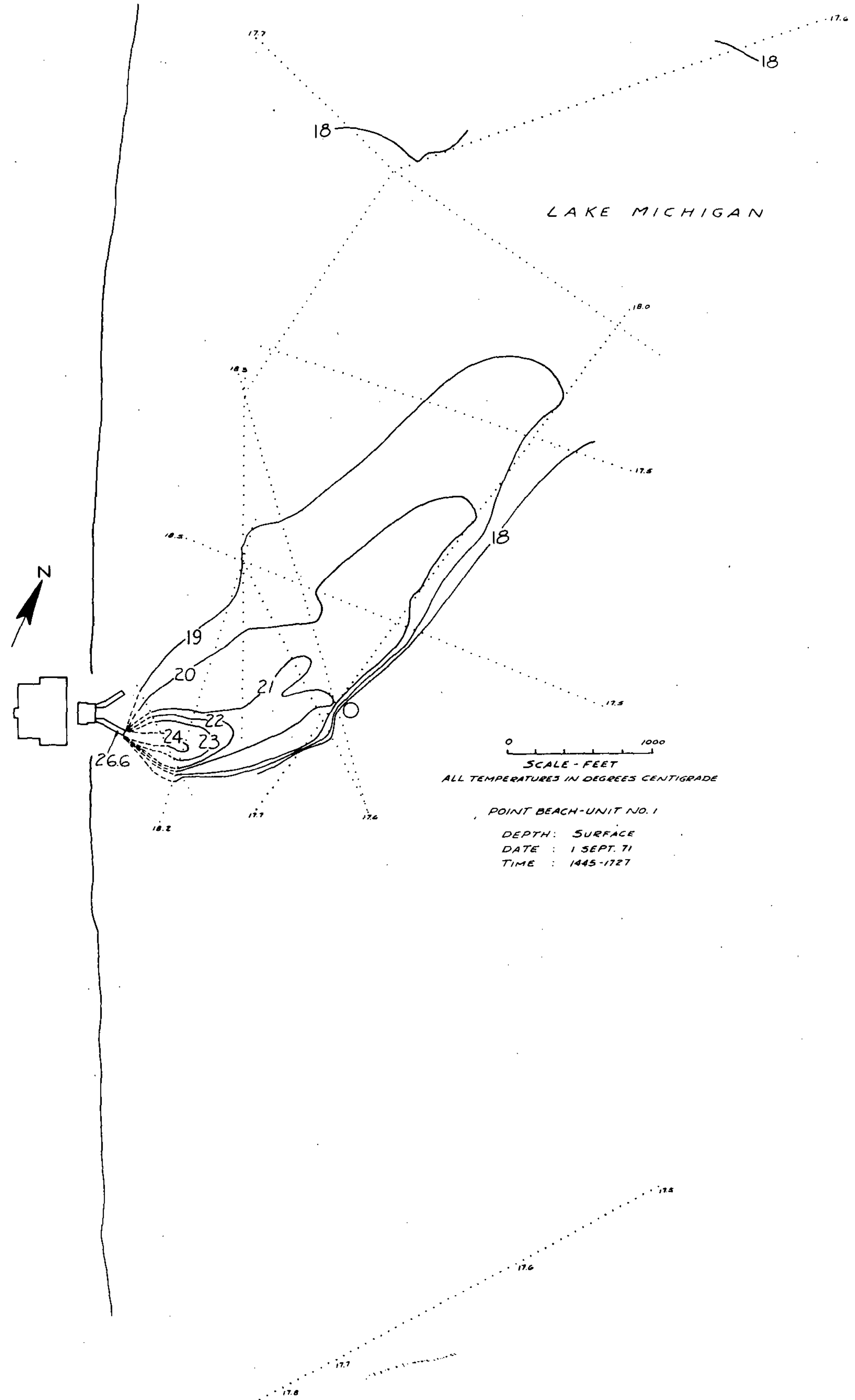


Fig. III-9: Observed Plume Dispersion for Point Beach Unit 1 in the Afternoon of September 1, 1971.

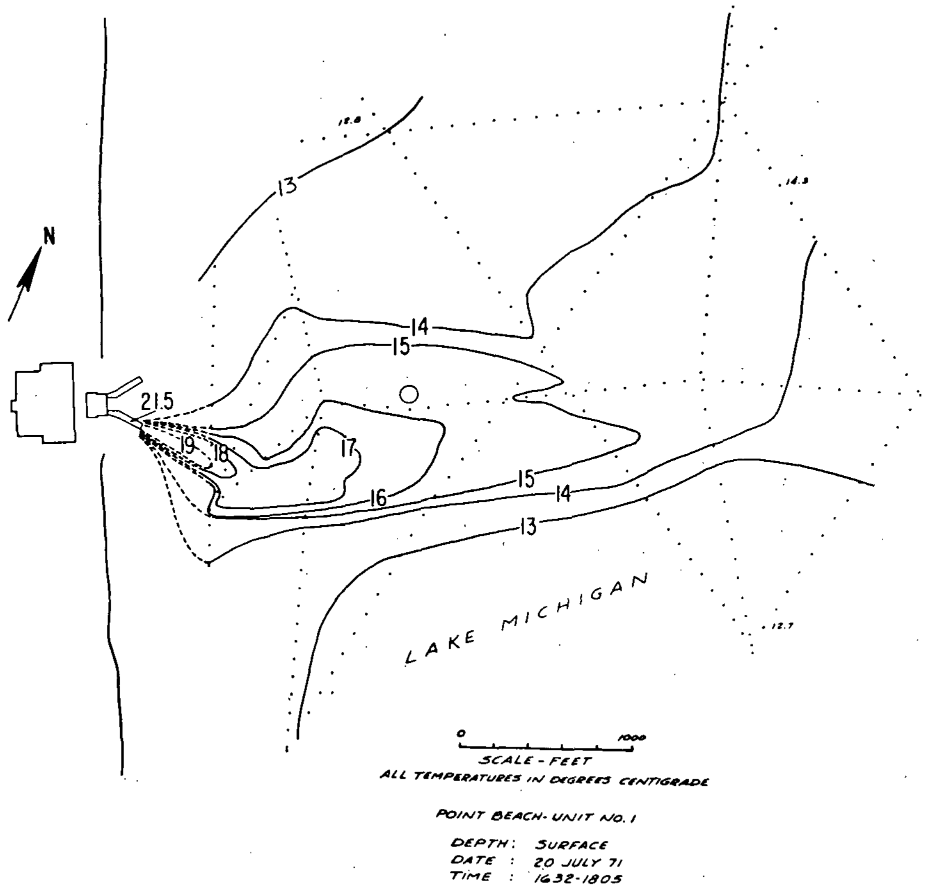


Fig. III-10: Observed Plume Dispersion for Point Beach Unit 1 on July 20, 1971.

configurations observed during 1971. The majority of plumes observed move in a northerly direction toward Kewaunee. The two most spectacular plumes are shown in Figures III-6 and III-7. In Figure III-6, the plume hugged the shoreline. It persisted as shown for at least 3 miles, the limit of the surveillance. Figure III-7 depicts the largest plume observed. Figures III-8 and III-9 show how the size of this plume decreased in one day.

iv. Applicability to the Kewaunee Plant

Factors that would tend to make the Kewaunee plume differ from the Point Beach plume are the somewhat higher power level (1650 MWt compared with 1518 MWt for each Point Beach unit), which would make it larger, and the higher Froude number or discharge velocity which should tend to promote more rapid mixing and thus reduce the temperature more quickly. Counteracting this, however, is the shallower discharge region that would tend to inhibit mixing.

The feature that could possibly be the most significant in distorting the Kewaunee plume relative to the Point Beach plume is the promontory projecting into the lake just south of the cooling water discharge area (see Figures III-2 and III-3). With a north-flowing lake current, this could produce eddying which might promote mixing in the near-field region but which may also hold some of the warm water against the shoreline in the vicinity of the Plant.

The Kewaunee plume will interact with the lake bottom in the region surrounding the dredged discharge canal. Beyond this point, where the lake bottom gradually recedes (beyond 530 ft from the discharge), the plume may follow the bottom contour for a short distance before separating and stratifying at the surface. The Point Beach plume starts somewhat deeper but appears to separate from the bottom within a distance of about 600 ft. from the discharge. Figure III-11 shows typical vertical profiles of the Point Beach plume at distances of 1000 and 2200 ft. from the discharge. The plume depth is about 6 ft. in the far-field region. These data correspond to the July 20, 1971 plume shown in Figure III-10.

The possibility of the Point Beach plume interacting with the Kewaunee plume may be assessed by consideration of the infrared image of the Point Beach plume shown in Figure III-12. This shows the area from the Point Beach intake structure, northward to the Kewaunee site (note the promontory). The infrared data show a slight trace of the plume in the area of the Kewaunee Plant. The data shown in Figures III-8 and III-9

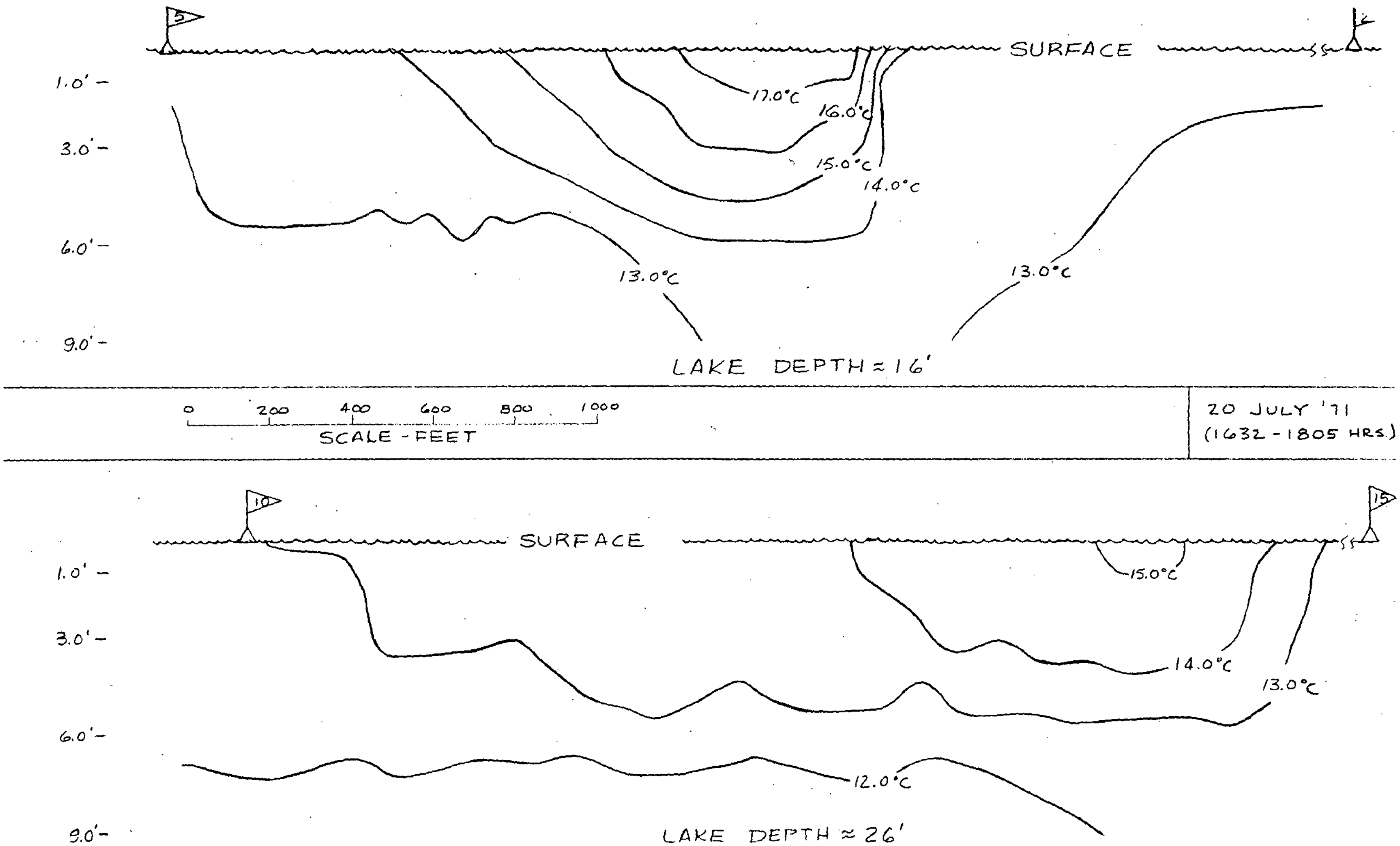


Fig. III-11: Vertical Profiles of the Point Beach Plume of July 20, 1971 at Distances of 1000 and 2200 Feet from the Discharge.

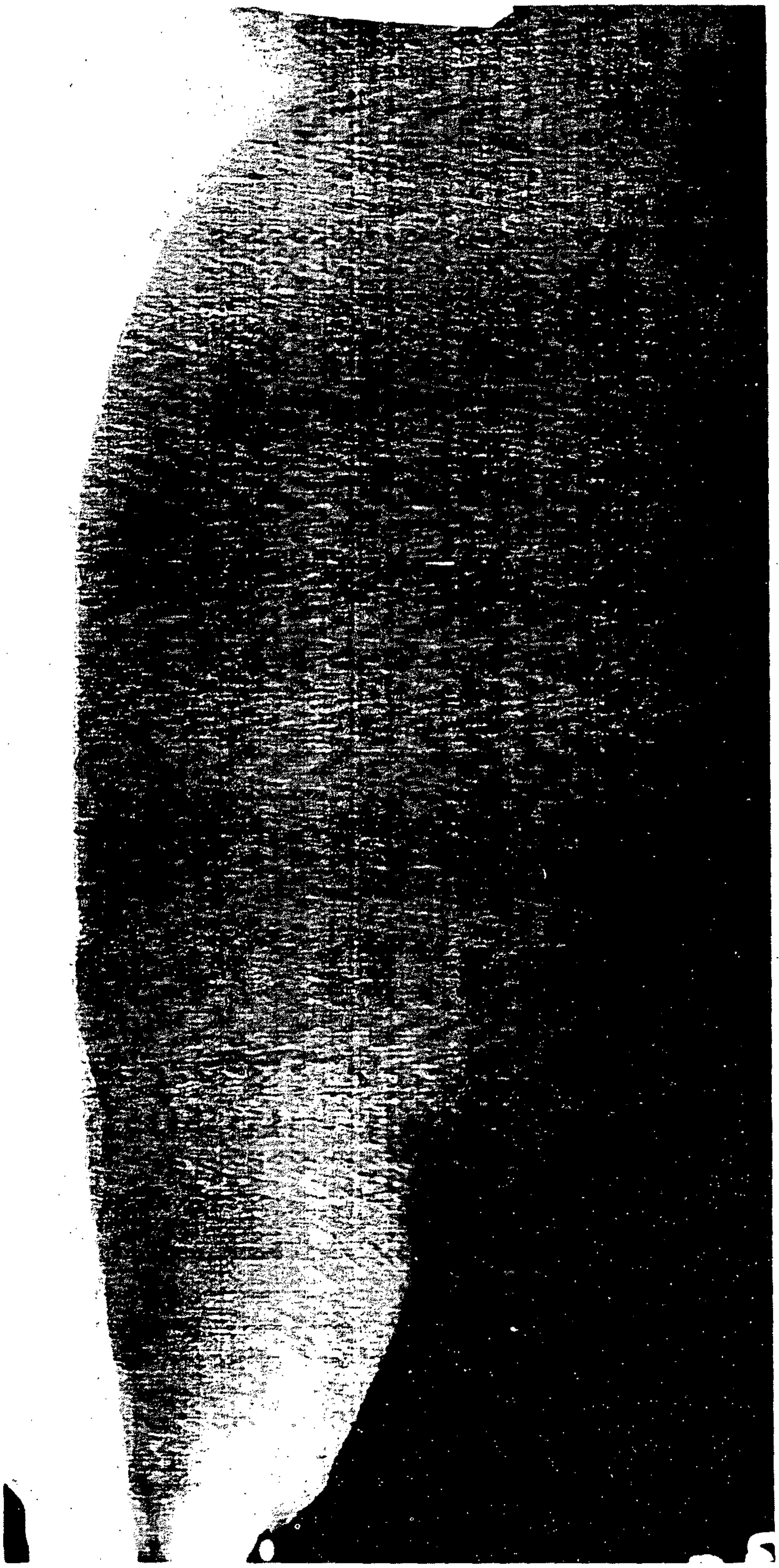


Fig. III-12: Infra-Red Image of Point Beach Plume on September 1, 1971

were obtained just before and just after the infrared data. They indicate that the plume temperature dropped to within 1°F of the ambient lake temperature at a distance of approximately 1 mile north of the discharge. Thus the influence at Kewaunee, at a distance of 4.5 miles, would only be a fraction of a degree. Operation of the second unit at Point Beach will increase the size of the plume, and the effect at Kewaunee should be less than or equal to 1°F. Further discussion of this is found in Section V.B.1.

b. Duration of Maximum Temperature in the Coolant

For organisms entrained in the cooling water, the time of passage from the condenser to the end of the discharge structure is approximately one minute. Assuming that the centerline velocity decays in the same manner as the temperature, an additional 0.6 to 1.8 minutes (depending on the lake level) is required for an organism carried along the plume centerline to reach the point 264 ft. from the discharge where the temperature begins to be attenuated. Therefore, some of the organisms will experience the maximum temperature for as much as 3 min.

2. Radioactive Wastes

During the operation of the Kewaunee Nuclear Power Plant, radioactive material will be produced by fission and by neutron activation reactions of metals and material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes will enter the effluent streams, which will be monitored and processed within the Plant to minimize the radioactive nuclides released to the atmosphere and into Lake Michigan at low concentrations under controlled conditions. The radioactivity 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 Commission regulations require the Applicant to keep releases to the environment as low as practicable. The approved Technical Specifications for this Plant will delineate these criteria.

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

The waste handling and treatment systems for the Plant are discussed in detail in the Final Safety Analysis Report, dated January 27, 1971, and its amendments, and in the Applicant's Supplementary Environmental Report, dated November 1971.

a. Gaseous Waste

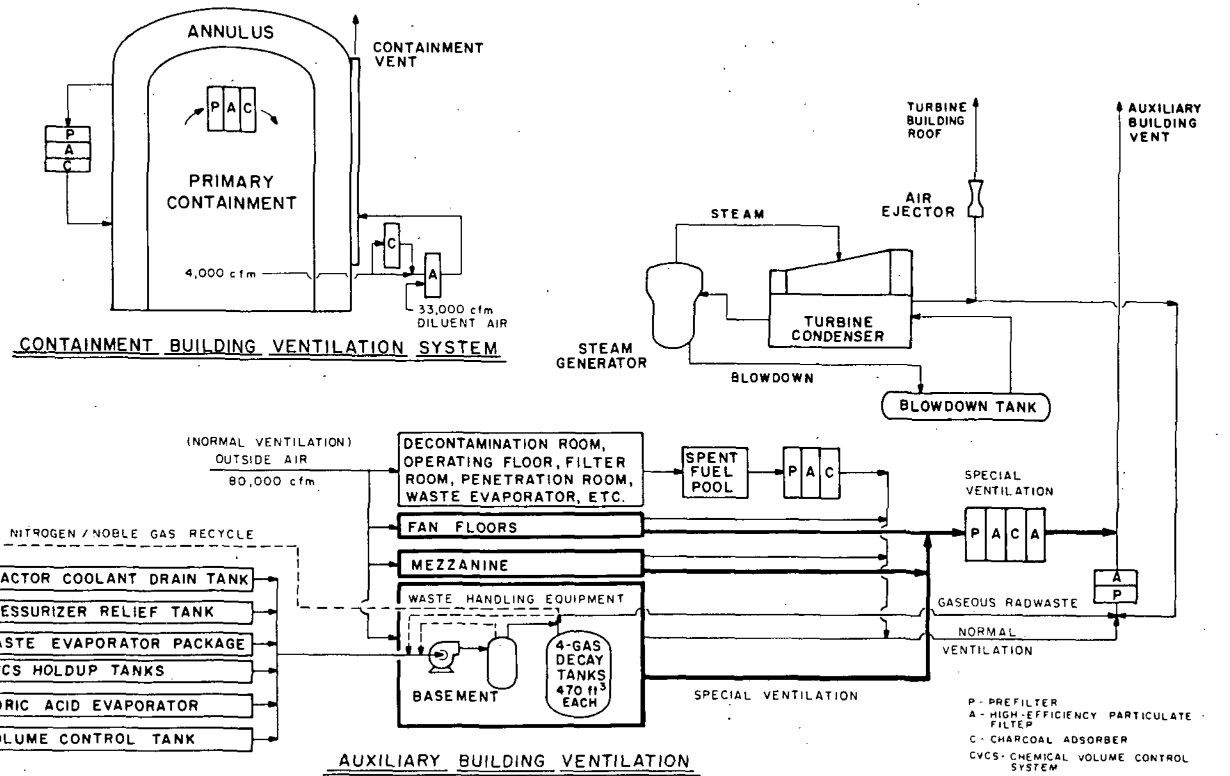
During operation of the Plant, radioactive materials released to the atmosphere in gaseous effluents will include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor, and particulate material, including both fission products and activated corrosion products. The systems currently installed for the processing of radioactive gaseous waste, and ventilation paths, except for the turbine building, are shown schematically in Fig. III-13.

Concentrations of various solutes, such as hydrogen and boron, in the primary coolant will be maintained at specified values, and the buildup of fission and activation products will be limited by withdrawing coolant at a normal rate of 40 gpm (the letdown stream). This coolant will be cooled, depressurized, and diverted to the makeup and purification system and, as necessary, to the boron management system or liquid waste disposal system.

Normally, the vent valves on the makeup and purification system equipment will be closed and the system operated at a positive pressure. By this procedure the inventories of noble gases in the coolant will increase to steady-state values, except in the case of long-lived krypton 85. Only the coolant that is diverted to the boron control system will normally be degassed. Since the Kewaunee Plant will be at least partially a load-following unit, the quantity of coolant degassed will be large (about 60 coolant volumes a year).

Gases stripped from the recycled reactor coolant, together with displaced cover gases, will be collected, compressed and stored in pressurized tanks for radioactive decay. With the exception of krypton 85, the gases will decay to a small fraction of the original activity prior to being released. Gases in the gas decay tanks can be returned to act as cover gases, or released to the atmosphere through the monitored auxiliary building vent, which has a high efficiency particulate filter (HEPA).

Additional sources of radioactive gases, which are not concentrated enough to permit collection and storage, will include the auxiliary building exhaust, the turbine building exhaust, the reactor building containment air, and the main condenser air ejectors (which will remove



KEWAUNEE NUCLEAR POWER PLANT

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radioactive gases which have collected in the condenser as a result of primary to secondary system leakage and from routing of the gases from the steam generator blowdown flash tank to the condenser). The air ejector exhaust is normally routed to the auxiliary building vent where the gases pass through HEPA filters prior to discharge. Besides the normal ventilation system, gases may be diverted to a special ventilation system to allow gases to pass through HEPA and charcoal adsorbers before being discharged to the auxiliary building vent.

Under normal conditions, gases in the turbine condenser, including in-leakage air, will be discharged through the auxiliary building vent. Staff calculations of gaseous discharges, Table III-2, are based on this normal mode of operation. They may be compared with the Applicant's estimates presented in Appendix A, Table A-1.

b. Liquid Waste

The liquid waste system is shown schematically in Figure III-14. The Chemical and Volume Control System (CVCS) forms one part of the radwaste management system. To control primary coolant activity during normal operation, a portion of the reactor primary coolant will be let down continuously, and passed through a mixed-bed demineralizer, a cation demineralizer (intermittently for cesium removal), a deborating demineralizer (used near the end of core life), a filter (for large particle removal), and into the volume control tank, from which it can be fed back to the primary coolant. Deaerated liquid wastes originating in the CVCS charging and letdown paths and from miscellaneous equipment drains will also be processed through this system. To minimize the escape of gaseous radioactivity, coolant water that may leak along stems of valves located in the containment and the auxiliary building will drain through a closed piping system to the deaerated drain tank. The deaerated drain tank will be isolated from the atmosphere by a flexible diaphram type seal and vented to the waste gas processing system.

If the boron concentration must be changed, primary coolant letdown can be directed from the volume control tank to the CVCS holdup tanks, which normally will go to two demineralizers in series (a third is available in parallel with the first or in series), a filter, a gas stripper and a boric acid evaporator. The boric acid evaporator concentrates normally will be sent through a filter to a concentrate holding tank and then to the boric acid storage tank for reuse. Alternatively, the bottoms can be sent directly to waste solidification for processing.

The boric acid evaporator condensate stream can be passed through a demineralizer and filter, and flow into monitor tanks. If the

Table III-2. Calculated Annual Release of Radioactive Nuclides in Gaseous Effluent from the Kewaunee Nuclear Power Station

	Discharge Rate (Ci/year)					
			Gas Processing System (45-Day Decay)		Steam Generator Leak	
Isotope	Containment Purge	Auxiliary Building	Cold Shutdown	Letdown Degassing	Air Ejector	Total
$^{83}Kr^m$	--	1	--	--	1	2
$^{85}Kr^m$	--	6	--	--	6	12
^{85}Kr	2	1	15	455	1	474
^{87}Kr	--	3	--	--	3	6
^{88}Kr	--	11	--	--	11	22
$^{131}Xe^m$	1	2	2	41	2	48
$^{133}Xe^m$	1	8	--	--	9	18
^{133}Xe	86	510	18	239	515	1368
$^{135}Xe^m$	--	1	--	--	1	2
^{135}Xe	--	17	--	--	17	34
^{137}Xe	--	1	--	--	1	2
^{138}Xe	--	3	--	--	3	6
^{131}I	--	0.001	--	--	0.08	0.081
^{133}I	--	0.001	--	--	0.05	0.051

A dash in the table means less than 0.5 Ci of noble gas per year or less than 0.0005 Ci of iodine per year.

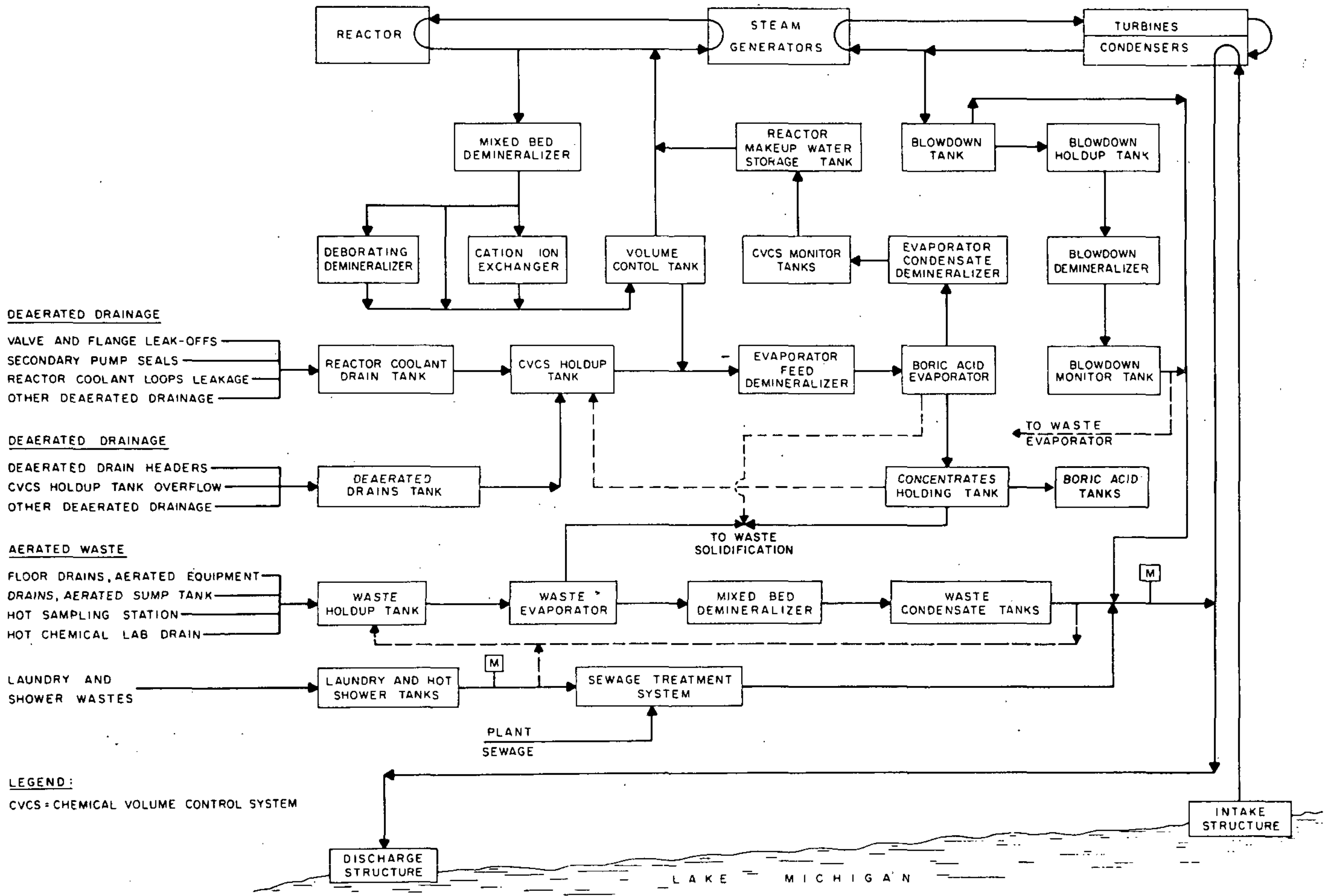

Fig. III-14. LIQUID WASTE DISPOSAL SYSTEM KEWAUNEE NUCLEAR POWER PLANT

radioactive concentration in the CVCS monitor tanks is sufficiently low, it may be discharged through two normally-closed valves, with continuous monitoring and automatic valve closure and alarm. The monitor tank effluent, if sufficiently pure, may also go to the primary water storage tank. If the effluent is not acceptable radiologically or chemically, it may be recycled through the condensate demineralizers or go back to the CVCS holdup tanks for complete reprocessing.

The Waste Disposal System (WDS) will handle the other sources of liquid wastes. Accumulator drains, aerated drains for equipment inside the containment, and leakage from reactor coolant pump seals, reactor flanges and valves, will be fed to the reactor coolant drain tank and then to the waste holdup tank (WHT), or, if reuseable, to the CVCS holdup tank. Liquids from the spent resin storage tank and from floor drain sumps and other equipment drains will be collected in a sump tank and the go to the WHT. All other sources, such as the containment sump, will go directly to the WHT.

If acceptable for release, the WHT liquids will go to the waste condensate tanks; otherwise, they will pass through the waste filter to the 2-gpm waste evaporator. Evaporator bottoms will be drummed. The condensate may be further treated by demineralizer and filter and then go to the waste condensate tanks; it will be sampled prior to discharge, which will be monitored with automatic valve closure and alarm. If the condensate tank liquid is not acceptable for release, it can be returned to the WHT for reprocessing.

The laundry and hot shower waste will be collected in the laundry and hot shower tanks. After monitoring, the waste normally will be sent to the sewage treatment system, or can be discharged directly to the condenser cooling water return. If there is appreciable radioactivity present in the laundry and hot shower wastes, it can be sent to the waste holdup tank for appropriate treatment before discharge to the lake via the condenser cooling water return.

The steam generator blowdown from both steam generators will go to the steam generator blowdown tank. Normally, in continuous blowdown this will be discharged directly to the condenser cooling water return. If radioactivity is detected, however, blowdown can be sent from the blowdown tank to the steam generator blowdown treatment (SGBT) holdup tanks for treatment by the SGBT ion exchangers. The treated blowdown will pass then to the SGBT monitor tanks before being discharged to the condenser cooling water return.

Based on the assumptions noted above and shown in Table III-3, the releases from the primary sources for normal operation were calculated

TABLE III-3

Principal Assumptions Used In Calculating Releases of Radioactive Effluents at Kewaunee

Reactor Power, MWt	1721
Plant Capacity Factor	0.8
Failed Fuel, %	0.25*
Leak of Primary Coolant into Steam Generators, gpd	20
Leak of Primary Coolant to the Containment, gpd	40
Leak of Primary Coolant to the Auxiliary Building, gpd	20
Frequency of Containment Purge, times/yr	4
Waste Gas Holdup for Decay, days	45
Cold Shutdowns, times/yr	2
Coolant Volumes Degassed and Processed during Cold Shutdowns and Normal Operations (including load-follow)	62
Deaerated Liquid Waste Processed and Discharged, gallons/yr	20,000
Aerated Liquid Waste Processed and Discharged, gallons/yr	140,000
Steam Generator Blowdown Processed and Discharged, gallons/yr	5,000,000

*This value is constant and corresponds to 0.25% of the operating power equilibrium fission product source term.

TABLE III-4

Calculated Annual Release of Radioactive Material in Liquid Effluents from Kewaunee Nuclear Power Plant

FISSION

Nuclide	Curies	Nuclide	Curies	Nuclide	Curies	Nuclide	Curies
Br-82	0.000035	Tc-102	0.000014	Cs-134	0.031	La-142	0.0000068
Br-83	0.002	Tc-104	0.0000039	Cs-135m	0.0000083	Ce-141	0.00014
Br-84	0.00027	Ru-103	0.000093	Cs-136	0.46	Ce-143	0.000063
Rb-86	0.00068	Ru-105	0.000015	Cs-137	0.27	Ce-144	0.000081
Rb-88	0.49	Ru-106	0.000023	Cs-138	0.32	Pr-143	0.00012
Rb-89	0.026	Rh-103m	0.000093	Cs-139	0.011	Pr-144	0.000081
Rb-90	0.001	Rh-105m	0.000015	Cs-140	0.0002	Pr-145	0.0000086
Rb-91	0.00014	Rh-105	0.000038	Cs-141	0.000012	Nd-147	0.000049
Sr-89	0.00081	Rh-106	0.000023	Ba-137m	0.0051	Pm-147	0.0000088
Sr-90	0.000026	Te-125m	0.000065	Ba-139	0.0018	Pm-148	0.000019
Sr-91	0.00053	Te-127m	0.0005	Ba-140	0.00091	Pm-149	0.000024
Sr-92	0.000044	Te-127	0.00091	Ba-141	0.000011	Pm-151	0.0000061
Y-90	0.000032	Te-129m	0.0057	La-140	0.00051	Sm-153	0.000012
Y-91m	0.00034	Te-129	0.0037	La-141	0.000094	Eu-156	0.0000063
Y-91	0.0082	Te-131m	0.0032				
Y-92	0.0001	Te-131	0.00063				
Y-93	0.00013	Te-132	0.047				
Zr-95	0.00013	Te-133m	0.00026				
Zr-97	0.00004	Te-133	0.000049				
Nb-95	0.00013	Te-134	0.00025				
Nb-97m	0.000038	Sb-127	0.0000039				
Nb-97	0.000043	I-130	0.00021				
Mo-99	1.1	I-131	0.51				
Mo-101	0.000054	I-132	0.081				
Mo-102	0.000028	I-133	0.53				
Tc-99m	0.91	I-134	0.0077				
Tc-101	0.0001	I-135	0.15				
Tc-102m	0.00002	Cs-134m	0.00017				

ACTIVATION

Nuclide	Curies	Nuclide	Curies
Cr-51	0.0026	Co-58	0.026
Mn-54	0.00087	Co-60	0.0026
Mn-56	0.0000087	U-237	0.000036
Fe-55	0.0043	Np-238	0.0000066
Fe-59	0.00087	Np-239	0.0009

Total (Non-tritium)	5.0
Tritium	1000

to be less than 5 curies per year (Ci/yr). To compensate for treatment equipment downtime and expected operational occurrences, the values shown in Table III-4 have been normalized to 5 Ci/yr. They may be compared with the Applicant's estimates, based on 1% fuel leaks, given in Appendix A, Table A-2.

c. Solid Waste

Radioactive solid wastes will consist mainly of spent ion-exchange resins, evaporator bottoms, and spent filters. In addition, there will be miscellaneous solid wastes such as paper, rags, glass, plastic bags, and protective clothing.

The spent resins from the CVCS and other system demineralizers will be flushed to a spent resin storage tank. Periodically, batches will be transferred to the drumming station where the material is mixed with cement and drummed for offsite disposal. Concentrates from the waste evaporator also will be sent to the container station where the material is mixed with cement and drummed for offsite disposal. Miscellaneous materials, such as paper, plastic bags, glass, and protective clothing, can be compressed with a hydraulic press and containerized for offsite burial.

All solid waste will be packaged and shipped to a licensed burial site in accordance with AEC and DOT regulations. Based on plants presently in operation, it is expected that approximately 300 to 600 drums of solid waste will be transported offsite each year.

3. Chemical and Sanitary Wastes

The wastes considered here are the liquid wastes from systems that do not contain radioactivity (in excess of naturally occurring amounts). These systems, their wastes, and the effluent waste streams are as follows:

System	Waste	Effluent to Environment
1. Makeup coolant water	Settled solids from clarifier and solution from regeneration of demineralizer	Solids to land fill and solution to circulating-water discharge to lake via waste-neutralizing tank
2. Secondary coolant	Boiler blowdown of coolant containing chemicals	To lake via circulating water discharges

3.	Sanitary water supply	Regeneration of water softener resins	To lake via circulating water discharge
4.	Sewage treatment plant (aerobic digestion and settling followed by chlorination and polishing pond)	Sanitary sewage	To lake via creek discharge from polishing pond
5.	Condenser circulating-water system, intermittent addition of hypochlorite solution to eliminate the buildup of fouling slimes	Circulating-water effluent	Circulating-water discharge to lake

A schematic of the Plant's water flows is given in Figure III-15. Dashed lines in the figure indicate connections of inlet and exit from the Plant via indirect means.

Plant makeup water will be produced by clarifying and demineralizing lake water. The chemicals added to the clarifier-flocculator are alum (to coagulate the turbidity), lime ("softening" by combining with calcium and magnesium ions), polyelectrolyte (as needed to improve settling), hypochlorite (to kill bacteria and sterilize), and sodium sulfite (to reduce hypochlorite to chloride before entering the demineralizers). The addition of the clarifier to the original demineralizer reduces the amount of sodium hydroxide and sulfuric acid needed for regeneration of the demineralizer by about a factor of four. The overall discharge of chemicals is also reduced, because of the very small amount of chemicals added in the clarification step. Based on a capacity of the system of 108,000 gallons before periodic regeneration, the total amounts of chemicals added to the circulating water discharge are 4.6 lb/day for the clarifier and 268 lb/day for the demineralizer regeneration (including neutralizing). These daily quantities, if discharged into the 413,000 gpm circulating-water system over a period of 2 hours, are calculated to increase the dissolved solids content (normally 135 ppm) by 0.7 ppm. In the clarifier, after addition of the coagulating chemicals, the water passes through a paddle mixer into a settling area where most of the solids are removed from the water. The solids are gathered into a sludge hopper and removed to one of two sludge ponds located adjacent to the sewage treatment plant. The clarified water is sent to a holdup tank, from which it is pumped to five pressure filters and thence to the demineralizer. Solid from the sludge ponds is periodically removed to a land fill area. Any excess liquid from the ponds is discharged to the lake via an overflow weir into the circulating-water discharge.

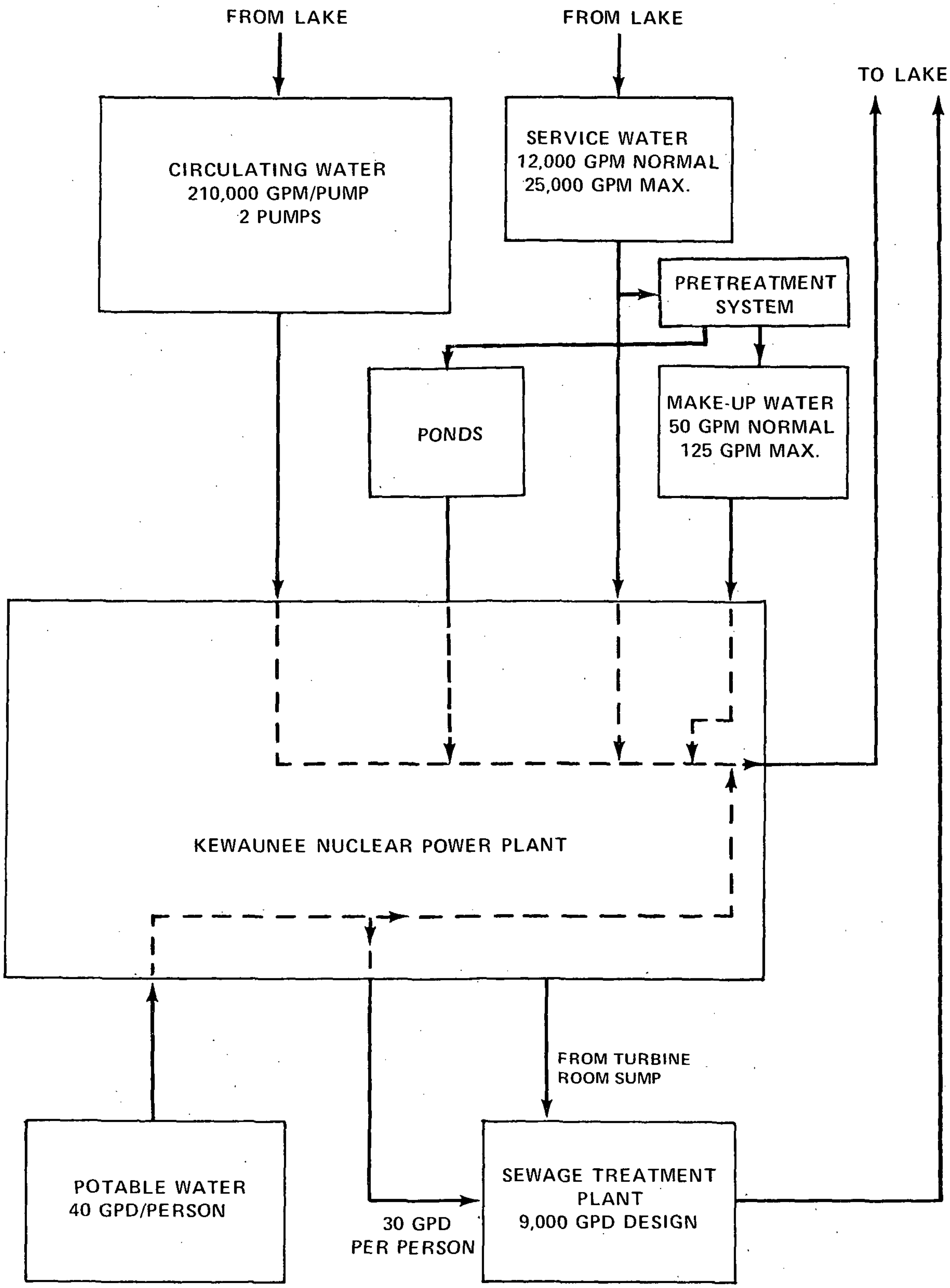

Figure. III-15. WATER USAGE BY THE KNPP.

The boiler blowdown (item 2 above) contains the three chemicals added as conditioners in the secondary-coolant system: hydrazine, N_2H_4; morpholine, $C_4H_{10}NO$; and phosphate. Of these, hydrazine decomposes into gas at elevated temperature and morpholine is present at a lower concentration than the phosphate, which is present at a normal maximum of 5 ppm in the coolant. The normal blowdown, based on an estimated average primary to secondary leak rate of 20 gal/day, will be two 5-min. periods at a rate of 50 gpm. At this flow rate, dilution of the phosphate waste by the 413,000 gpm (summer) circulating water coolant discharge will give an incremental increase in phosphate concentration of 6×10^{-4} ppm in the effluent at the time of blowdown. This increase will be above that (0.0-0.2 ppm) normally in the lake. It can be expected that there will be infrequent periods of leakage of circulating water into the condenser. During such periods, phosphates will be added to the secondary water, to control hardness, at levels up to perhaps 60 ppm. At this concentration, and at the expected increased blowdown rate of 125 ppm, the circulating water effluent phosphate content would be increased by about 0.02 ppm.

Regeneration of the zeolite resin for softening the sanitary water supply (item 3 above) will release some salts, largely a mixture of sulfates and bicarbonates of calcium and magnesium. These will be added to the circulating water discharge. Assuming that the maximum of 9000 gallons per day of raw water for the sanitary supply will be well water with a hardness of 840 ppm (calculated as $CaCO_3$, see Section II.D.2.), the hardness of the circulating water discharge will be increased by about 2 ppm (as $CaCO_3$) during a one hour regeneration period once a week.

The operation of the sewage-treatment plant (item 4) is expected to add chemical and biological wastes to the lake at concentrations within accepted standards. (The design and performance of this plant are described in Section V.B.2.) The polishing-pond effluent is expected to contain a maximum of 0.8 ppm residual chlorine and a minimum of 4.0 ppm dissolved oxygen. The discharge of the sanitary waste system is variable but it is to be operated below its design capacity of 9000 gal/day. Since the permanent work force will be less than 100, the total effluent to the lake will be quite small compared to municipal discharges into the lake.

The need for addition of hypochlorite to the circulating water (item 5) has not been established. It is anticipated that it will be used infrequently, if at all, based on experience at the Point Beach Station where it has not been necessary to inject the chemical during the first

year of operation. Assuming that the hypochlorite would be injected only to one-half of the condenser water system at one time, to a free chlorine level of 0.5 ppm (i.e., the sum of the chlorine contents of HOCl and OCl^- is 0.25 ppm, equal in oxidizing capacity to 0.5 ppm Cl_2), this would be diluted to 0.25 ppm upon mixing with the untreated stream.

In the near absence of dissolved ammonia in the lake water (see analysis in Section II.D.1.b), no chloramines would be expected to form, and the unstable hypochlorite would decay rapidly to the comparatively innocuous chloride ion. This decay rate cannot be stated accurately. In the light-catalyzed reaction

$$HOCl \rightarrow 1/2O_2 + H^+ + Cl^-,$$

the in-laboratory experimental results of Hancil and Smith [5] indicate that, under their conditions of illumination, about 25 seconds would be required for reduction of the free chlorine from 0.25 to 0.01 ppm, a level probably not harmful to fish in intermittent doses. On this basis, treated effluent from the end of the discharge basin would not be expected to harm fish in the daytime, since the time for the outlet coolant to traverse the basin is of the order of four minutes. At night, the reaction is approximately 100 times slower [6]; consequently, the Applicant will be required to chlorinate (if neces ary) only during daylight hours.

4. Other Wastes

Miscellaneous nonradioactive solid waste, such as paper and glass, will be removed by a local waste handling firm to a certified landfill area offsite. Debris collected from circulating lake water on the traveling screens (3/8-in. mesh) will also be handled in the same manner.

Emergency electric power generation for the Plant is provided by two diesel generator sets. The diesel engines, rated at 2600 kW at 0.8 power factor for continuous operation and 3050 kW overload for 30 minutes, have normal exhaust effluent but are only operated very briefly for testing, and, of course, for unscheduled emergency use. Safety and support functions are powered electrically.

Combustion-gas emissions also occur from the occasional use of a standby heating boiler in addition to those from the emergency diesel-electric generators. Heating for normal plant operation comes from steam bled from the secondary steam system; however, during plant shutdown for refueling, the oil-fired heating boiler will be activated. The boiler supplies 30,000 lb/hr of steam at 150 psig ($\sim$30 x 10^6 Btu/hr) and uses No. 2 fuel oil. Typical analysis of No. 2 fuel oil shows sulfur content is 0.3 wt%. [7]

Section III References

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3. R. L. Wiegel, I. Mobarek, and Y. Jen, "Discharge of Warm Jet Over Sloping Bottom," Hydraulic Engineering Laboratory, U. of California, Berkeley, 1964.

4. A. A. Frigo and G. P. Romberg, "Thermal Plume Dispersion Studies," in Reactor Development Program Progress Report, ANL-7861, Argonne National Laboratory, Argonne, Illinois, pp. 9.1 to 9.7, September 1971.

5. Vladislav Hancil and J. M. Smith, "Chlorine-Sensitized Photochemical Oxidation of Soluble Organics in Municipal Waste Water," Ind. Eng. Chem. Process Des. Develop. 10, 515 (1971).

6. J. E. Draley, "The Treatment of Cooling Waters With Chlorine," ANL/ES-12, Argonne National Laboratory, February 1972.

7. WPS, "Comments on Federal, State and Local Agencies' Comments on the AEC DES," October 9, 1972.

IV. ENVIRONMENTAL IMPACTS OF SITE PREPARATION AND PLANT CONSTRUCTION

A. SUMMARY OF PLANS AND SCHEDULES

The Plant site was purchased in 1966 and site grading and clearing began in November of 1967. Other key dates in the construction program are indicated in Table IV-1. A pictorial indication of the status of the construction as of October 15, 1971 is provided by Figure III-2.

The peak work force for the Plant construction was 750 persons. This peak occurred after that for the Point Beach Station. When the force for the latter peaked at 900 men during the summer of 1969, the work force at the KNPP was still at a low level, averaging only about 150 persons.

B. IMPACTS ON LAND, WATER, AND HUMAN RESOURCES

1. Land

There were originally twelve residences on the 908-acre site. These were purchased by the Applicant and all except one have been removed from the site. That one, a log cabin, will be retained as a classroom for instruction for high school classes, in conjunction with about five acres being reserved for future conservation activities by high school groups.

Plant construction activities are limited to 110 acres adjoining the lake. Approximately 790 acres continued to be used for agricultural operations, on a leasing arrangement, until the fall of 1971. This arrangement may be resumed.

The only significant alterations in land use have occurred within the 110 acres where the Plant is being constructed. These have resulted from excavation and grading, construction of buildings and related facilities, placement of sanitary landfill, and the movement and storage of construction materials and equipment. The Plant buildings, substation and transportation facilities (roads and parking) will occupy about 15 acres.

About 17 acres have been used as landfill for the disposal of construction waste, and it is estimated that less than three more acres will be required for this. Topographically suitable acreage southwest of the Plant has been used. In addition to construction debris,

TABLE IV-1

Key Dates in the KNPP Schedule

Activity	Date
Excavation started	November 1967
AEC construction permit received	August 1968
Offshore work completed	October 1969
Reactor vessel arrived on site	January 1971
Electrical substation and incoming transmission lines completed	May 1971
Construction testing started	June 1971
Reactor coolant cold hydro	November 1972
Hot functional test start	January 1973
Fuel loading	March 1973
Commercial operation	September 1973

which is buried approximately six feet below the surface, surplus soil from excavations for the buildings and dredging of the trench for the lake water intake have been spread in this area. A portion of this land fill area will be used for service water pretreatment settling basins.

Riprap protection has been provided along the shoreline to reduce the high rate of natural erosion. Limestone rock was moved by truck from a quarry about 10 miles away to achieve this protection. A temporary onsite plant was used to provide concrete required for construction. The constituent materials were hauled by truck from nearby quarries.

As described in Section III.B, about 60 miles of new transmission lines were required to tie the Plant into the existing regional transmission grid. Fifty-six miles of these were for 345 kv lines, requiring a 150-foot right-of-way, and four miles were for 138 kv lines with a 100-foot right-of-way. The dominant prior use of the 1066 acres of land in these corridors was for farming (84%) and it will continue as such. Extensive use of wooden H-frame structures for line support allowed considerable freedom in selecting structure sites at road and stream crossings and minimizes the loss of use of farmland since farm machinery can be operated in close proximity to the poles.

2. Water

Excavation and construction activities have unavoidably caused some minor changes in the surface water run-off from the site. The most significant change was to the southernmost of the three intermittent creeks which flow through the site to the lake. As indicated in Figure III-3, its flow was diverted around the substation by a ditch. In addition, landfill operations southwest of the Plant resulted in some minor alterations in that creek's course and flow.

Ground water aquifers have been tapped by two wells to provide water for drinking, sanitary and construction purposes. There was a gradual increase in the mineral content of this water, to a level above 800 ppm. For that reason, future water requirements, except for sanitary and drinking water, will be supplied by Lake Michigan.

During the initial construction activities, temporary trailer facilities were used for sanitary wastes, but a permanent 9000 gallon per day sewage treatment system was soon installed. This system treats all in-plant wastes and has been operating for three years. (See Section V.B.2.) The intake water supply is from an on-site well. After hold-up of the treated sewage effluent in a polishing pond, it is

discharged to the lake. Monitoring by state authorities has indicated that no detectable amounts of chemicals or nutrients have been added to Lake Michigan as a result of the operation of the sanitary waste treatment system.

The cooling water intake is located about 1600 feet from the lake shore. Three 22-foot-diameter inverted cones connect to 6-foot-diameter pipes which in turn join a 10-foot-diameter pipe. The cones extend one foot above the lake bottom and the remainder of the intake system is buried a minimum of three feet. Dredging of a 1600-foot-long channel was required for installation of this intake and additional movement of the dredged material was required, both to bury the structure and to restore the lake bottom to its original level. Obviously, the ambient benthic organisms were displaced in this operation. To provide protection for the inlet construction, two barges were sunk temporarily in the lake as a breakwater and removed after completion of the construction work.

The circulating cooling water is discharged into an outlet basin at the shoreline. The outlet basin is forty feet wide and slopes upward to the lake. Earth dredged in forming the outlet basin, as well as surplus material from the installation of the intake structure, was disposed of in the on-site landfill area.

3. Roads

A permanent Plant road and a temporary construction road connect with State Highway 42. The state highway has proven adequate to handle all traffic generated by Plant construction. Large Plant components such as the steam generators and pressure vessel were moved by barge from the suppliers' plants to the harbor at Kewaunee and then by trailer truck to the site. Other than a brief disruption of normal road traffic and the reinforcement of a culvert along the route used, no problems were encountered in these shipments.

4. Human Resources

Except for key specialists, most of the construction force are residents of the region. One survey indicated that 89% of the employees (544 of 612 persons) were local residents of the lakeshore-Fox River Valley area. Thus the impact of the work force is largely economic, rather than social. The creation of additional jobs, although mostly temporary, is a positive contribution to the commercial activities in the region. A sizeable fraction of the work force is drawn from

the cities of Green Bay and Manitowoc. This serves both to diffuse the impact on the economy of the region and to avoid localized area of high unemployment upon completion of the construction phase.

No public transportation facilities serve the Plant site, so the construction did serve to increase traffic on the local roads, decreasing with increasing distance from the site. Accommodations for mobile homes were provided at a former U.S. Army missile site about three miles southwest of the Plant. This was limited to space for 30 units and proved to be adequate for the demand. No supplemental funds were sought by the local schools for children of families drawn temporarily into the area by construction activities.

C. CONTROLS TO REDUCE OR LIMIT IMPACTS

The construction area was defined and limited to 110 acres. On the remainder of the site, the original land character was maintained except for normal modifications of the vegetation associated with farming operations.

Soil erosion is an ever-present problem in farming areas, so expert advice was readily available to the Applicant from a local soil conservation group and from state agencies such as the Soil Conservation Service and the Department of Natural Resources. From cooperation among these groups evolved plans and procedures for reducing erosion as a consequence of Plant construction. The plans have been followed since the start of construction[1]. These measures included the planting of grasses, e.g., vetch, to stabilize cuts, underground drainage to reduce sliding of wet soil, gravel risers to ground surface as a means to accelerate drainage in parking lots, and stabilization dams in gulleys, to control water flow.

The various roads and parking lots will be paved before Plant operation begins, but during the construction phase they were subjected to water sprinkling and periodic oil treatment to control dust. Noise abatement procedures were not considered necessary during the construction activities because of the isolation of the Plant. The nearest residence is 0.8 miles away, and nearby areas were considered adequate retreats for any native wildlife perturbed by noise and activity in the construction area.

Sanitary landfill methods were used for disposal of solid waste from construction activities, in preference over on-site burning or hauling to off-site dumping areas. The debris is buried, using excavation material from the Plant building area and dredging material

from the lake. This material was placed in a manner to improve land contour and drainage and appropriately graded to blend in with the natural landscape. As each section of the landfill area was completed, it was stabilized by seeding with grass for both erosion control and aesthetic improvement.

Standard industrial safety procedures are being followed to protect the construction workers and operating personnel from excessive noise. Off-site noise level measurements have demonstrated that normal highway noise levels are considerably higher at nearby residences than Plant construction noises[1].

Coastline recession is a major problem along Lake Michigan, proceeding at a rate as high as 12 feet per year. The stable slopes near the center of the site, where the Plant is located, are somewhat protected from active erosion by a promontory extending into the lake just south of the Plant. Additional stabilization is provided by the riprap placed in the vicinity of the discharge area and around the promontory. Aerial photographs are being taken on a regular basis, to monitor the rate of recession of the local shoreline under the influence of high water, currents, turbulence, and thermal discharge[1].

Early construction and operation of the permanent sewage treatment facility was another measure which served to reduce the impact of construction. As mentioned above, the impact on the lake due to facility effluent has been so low as to be undetected.

The external appearance of the Plant, and the clustering of component structures in coordinated arrangement will serve to reduce the visual impact of a massive, man-made facility situated in rural surroundings. In addition, the lines of, and contrast presented by, the Plant will be softened by judicious landscaping and maintenance of the plantings and natural vegetation.

Section IV Reference

1. Wisconsin Public Service Corporation, "Comments on Federal, State, and Local Agencies' Comments on the AEC Draft Environmental Statement", October 19, 1972, USAEC Docket #50-305.

V. ENVIRONMENTAL IMPACTS OF PLANT OPERATION

The overall environmental impact associated with the operation of the Plant is a composite of many factors, some favorable and others potentially detrimental. Included in the former are the provision of power required in the territory served by the Owners, the remote location of the Plant, the release of few noxious by-products, and the educational uses of the site. Among the latter are the release of low levels of radioactivity to the environment, the discharge of small quantities of chemicals, and consequences to aquatic biota of the heated water discharged to the lake.

A. LAND USE

The Applicant has chosen to confine the Plant and related activities to a small portion of the total acreage owned, and hopes that the remainder will serve both as a buffer zone and as productive farmland. This is also true for the 56 mile corridor used for the new transmission lines.

1. Site Modifications

The Owners of the Plant have acquired 908 acres. The actual Plant site occupies approximately 110 acres. Of this, the Plant buildings, substation, and transportation facilities cover approximately 15 acres, and about 17 acres southwest of the Plant proper were used as land-fill for the disposal of construction refuse. Four to five acres are being reserved for proposed high school conservation classes. Approximately 790 acres have been under cultivation. Agricultural operations were discontinued in the fall of 1971, but the land will be leased back for local farm operations if approval is granted. Any such leasing agreement would require the practice of appropriate soil and water conservation measures and would exclude livestock grazing [56].

Twelve families have been displaced from on-site residences acquired along with the land. Use of a schoolhouse had been terminated prior to the purchase of the site.

The only other significant alterations in land use occurred within the 110 acres where the plant is being constructed and along the shoreline. These alterations have been the result of grading activities, the construction of structures and facilities, placement

of sanitary land-fill, the transportation and storage of construction materials and equipment, and the placement of protective riprap along a portion of the shoreline. All disturbed areas not otherwise developed will be graded, landscaped, and seeded to grass as soon as the construction schedule permits [2]. This will provide an aesthetically pleasing grass and tree environment around the Plant. The protection of a portion of the shoreline by riprap may be in part offset by accelerated erosion of adjacent areas. Furthermore, the thermal discharge will reduce ice formation in the vicinity of the discharge structure. This may eliminate, beyond the extent of the riprap, a naturally occurring protection present prior to Plant operation. However, available evidence [57], based on aerial photographic ice-reconnaisance surveys of the entire shoreline of Lake Michigan during the winter of 1969-70 and 1970-71, indicates that discharges of waste heat from nuclear and fossil-fueled power plants do not cause extensive melting of shore ice. As mentioned previously in Section IV. C, shoreline erosion at this Plant site is being monitored by aerial photography. If it becomes evident that the riprap and other shoreline structures added during construction or the thermal discharge during Plant operation have resulted in an increased rate of erosion along the shoreline in the vicinity of these alterations, the Applicant will be required to provide additional shoreline protection.

As noted in Section II.D.5., the soil on the site is relatively impermeable. Paving of roads and parking lots will increase water runoff, but not significantly. This slight increase in runoff will increase sedimentation in the streams near the Plant and some of this sediment will be carried into the lake. The amount will be small in comparison with that already being deposited by normal runoff. Another possible source of increased sedimentation in the vicinity of the discharge structure is sediment that enters the intake and passes through the circulating water system. This quantity should be small, since the intake velocity is low and the inlets are one foot above the lake bottom at a depth of 14 feet. The velocity of the water at the mouth of the discharge basin has a maximum range of from 2.4 to 6.9 fps (see Section III. D. 1. a). Any sediment carried by the circulating water will be deposited over a large area in shallow water near the shore. Because of the high onshore turbulence at the Kewaunee site, wave action should distribute such sediment widely.

The primary effect of the Plant on previous plans for the land use was to convert about 110 acres of land from agricultural to industrial use. No other plans for the land are known. No historical or archeological values are significantly affected. Hunting restrictions will be applied to the land in the immediate area of the Plant, to reduce the chance of damage to it. Fires on the beach within the site will be prohibited, to reduce the possibility of grass fires on the site.

A major north-south highway, State Route No. 42, bisects the Plant site. No interference with traffic flow will result from normal Plant operation. In the event of improbable accident conditions which would make rerouting of traffic advisable, this could be accomplished with a minimum of inconvenience to motorists. The alternate routes are apparent in Figures II-1 and II-2.

Much of the site will retain the appearance of the countryside characteristic of the agricultural activities in the region. Reaction to the addition of a cluster of buildings and transmission facilities to this rural scene is highly subjective. Care has been taken to design the structures and ancillary facilities to conform with contemporary architectural practices, and the clean lines, color scheme (turquoise and silver) and landscaping will be as pleasing as possible. Passersby cannot help but notice the Plant because of its proximity to the highway. Roadside signs will invite motorists for a closer inspection from the observation pavillion near the Plant, and some descriptive displays are mounted there. The facilities provided for visitors are minimal, but this is understandable in view of the large information center already in operation at the Point Beach Plant just 4.5 miles to the south and the latter's access from the same highway which passes the Kewaunee Plant. Provision of picnicking facilities at the observation pavillion would add to the attractiveness of the observation area at a low cost.

A limited amount of data is available concerning uses of the land by wildlife. The regional character is such that it provides some refuge for inland fowl and small ground animals. This subject is discussed more fully in Sections II.E and V.C.

Operation of the Plant is not expected to have any detrimental effects, such as fogging, icing, etc., on the use of the land. Fresh and spent fuel will be moved by truck, but this will not affect

land use. Those shipments must comply with all requirements for such shipments on public highways, and no special relaxation of the rules will be applied for the Plant property.

2. Offsite Impacts

There will be no new impact on land areas contiguous with the site, since the site's peripheral areas will continue to be used for agricultural activities, subject to Commission approval, just as they were before. If continuing use for crops and pasture is considered inappropriate, forestry is a possible alternate. The principal offsite impacts will be those resulting from the permanent employees at the Plant, the new transmission lines, and the provision of additional electrical energy in the territory served by the Pool.

Permanent employees at the Plant who have moved into the area from more distant points have not experienced difficulty in locating suitable accommodations. Most have settled in nearby towns of moderate size, such as Kewaunee and Two Rivers, and their assimilation into these communities has been readily accomplished. The total permanent Plant staff will be less than 100 persons, which represents a minor perturbation to the population of over 85,000 within a reasonable commuting distance (20 miles).

Prior land uses along the new 56-mile transmission right-of-way included farm land (84%), woodland (7%), wetlands (2%) and scrubland (7%), and this will remain virtually unaffected by the installation of the supporting structures for the lines. The Applicant's decisions regarding structures and locations have been guided by a desire to minimize the environmental and visual impact of the installations. This effort has extended from design procedures to planting and maintenance of the right-of-way. No access roads are used. The transmission lines are high enough to avoid a psychological visual partition, or "fencing-in" effect. Routing of transmission lines across hilltops was avoided and the towers were constructed of wood to harmonize with the environs.

The expansion of the Pool's capability is in anticipation of a continuing growth in power requirements for the region, and in turn the availability of adequate electrical power will foster a continuation of the region's development. Because of the resources of the region, including raw materials, labor force and water shipment routes, it is likely that industrial activities will grow more rapidly than

agricultural ones, particularly since the latter is land-intensive and such capabilities are now essentially utilized to the maximum extent. However, such further industrialization is to be expected more in existing centers of population than in the vicinity of the Plant.

Probable future uses of land in the vicinity can be inferred from a review of published economic statistics pertaining to labor, recreation, industry, transportation, and agriculture [31-35]. The results of the available studies [36] indicate that land use within the vicinity of the Plant site for the forseeable future will continue to be devoted primarily to agriculture. Income will be derived largely from dairy and livestock products. The small amount of acreage removed from the regional economy by the Plant will be more than balanced by the corresponding positive economic effects of the Plant operation. Thus the construction and operation of the Kewaunee Plant will not significantly alter land use in the vicinity, and the overall regional economy will not be negatively affected.

B. WATER AND AIR USE

As indicated in Figure III-15, up to a maximum of 420,000 gpm will be withdrawn from the lake for heat dissipation and other purposes and up to 25,000 gpm will be withdrawn for in-plant uses. Lake Michigan will be the source for all of this water and it will be returned thereto. Ground water from an on-site well will be used as the potable and sanitary water supply.

The effects of this water usage will be limited to surface waters, particularly Lake Michigan, and the chemicals and aquatic life therein. No additional discharge of water from the Plant is intended, other than the indirect flow from the polishing pond of the sewage treatment plant to the lake by way of an on-site creek. Local bedrock aquifers containing potable water in the site area are of a relatively low permeability. The water table is relatively flat, and the direction of the ground water movement is toward Lake Michigan at a slow rate. The surficial soils in the area are relatively impervious. Bedrock in the vicinity is below the elevation of Lake Michigan (see Figure II-8), and therefore the vertical component of the ground water movement is upward, which precludes the possible contamination of the bedrock aquifers from accidental discharge of fluids on or below the ground surface. Fluids would run off or percolate slowly in the direction of Lake Michigan.

There are numerous effects on Lake Michigan, both in terms of alterations in the temperature, chemical content, and radioactivity and in terms of the use of the lake and its water for other purposes. The existence of such effects is not significant in all cases, as the discussion below and in Sections V.C. and V.D. will show.

1. Thermal Discharge

During full power operation, the temperature rise through the circulating water system will be about 20°F during the summer and about 28°F in winter. The temperature of the water discharged into the lake will decrease rapidly by mixing and spreading beyond the discharge point. Because of lake bottom conditions, the biological environment in the vicinity of the discharge point is relatively barren and not representative of the lake as a whole (see Sections II.E.3.d and V.C.3.d.). Estimates of the extent of the dispersion of the heated discharge water were given in Section III.D.1. For example, the isotherm for 3°F above ambient temperature was estimated to enclose 254 acres of lake surface area. The distribution of the heated water will be influenced strongly by wind and current conditions, as illustrated by Figures III-6 through III-11. Possible effects of this heat on aquatic species in the lake are considered in Section V.C. below.

The hydrological characteristics of this portion of Lake Michigan appears to be such that the near-shore circulation pattern in the vicinity of Kewaunee does not significantly interact with the circulation pattern in the vicinity of the Point Beach Plant to the south. Evidence that the discharged heat from the Point Beach Unit No. 1, located 4.5 miles south of the Plant, is dissipated before reaching the water near the Plant was presented in Section III.D.1.

The observations reported in Figures III-6 through III-12 apply to the Point Beach Plant with only Unit 1 operating. At maximum flow through the condensers and full power operation, each unit will discharge 3.9×10^9 Btu/hr to the lake. The outfall structures are located 200 feet from the shoreline and the direction of flow from each is at an angle of 60° relative to the shoreline and to each other. However, from the Kewaunee Plant at a distance of 4.5 miles away, the discharges may be treated as coincident with negligible error and so the effect of the Point Beach units on the water temperature near the Plant would be double that observed in the 1971 measurements.

The extreme effect of the Point Beach discharges on the water temperature near the Kewaunee Plant would be expected for a northward current near the lakeshore, such as that which existed (but in the opposite direction) during the observations reported in Figure III-6. The Staff has estimated that, for both Point Beach units operating at full power and producing a 19.3°F rise in the circulating water temperature, the maximum distance of the isotherm for 1°F above ambient is 28,000 feet (5.3 miles) and 11,000 feet (2.1 miles) for 2°F [8]. These are overestimates, since they assume that the temperature of the intake water is identical with that at the surface. The intake water is taken from seventeen feet below the lake surface and one feet above the bottom at a point 1600 feet offshore. The temperature of the intake water is often around 15°F cooler than the ambient surface water temperature of the lake and the actual differential between effluent water temperature and ambient surface water temperature is often of the order of 5° to 10°F. Thus it is expected that the incremental water temperature near the Kewaunee Plant due to operation of the Point Beach Plant will seldom, if ever, exceed 1°F and will average appreciably lower. Conversely, the effect of the Kewaunee Plant on the water temperature near the Point Beach Plant will be even lower, since the thermal discharge from the former is about half that of the latter.

Additive thermal effects are expected to be negligible. Although a temperature rise of about 1°F above ambient might occur occasionally near the Kewaunee Plant because of the Point Beach Plant, the same northward lake current which carried heated water there from the Point Beach Plant would deflect the thermal discharge from the Kewaunee Plant northward. Thus the thermal plumes would not overlap to any significant extent.

As mentioned in Section III.D.1, the promontory just south of the Kewaunee Plant may restrict dilution of heat in the nearshore water when a northbound lakeshore current exists. Figures II-3 and III-3 show that the acreage of water protected by the promontory under such circumstances is small. Furthermore, the outfall structure for the Plant guides the cooling water away from the shore in a perpendicular direction with a velocity of 4.7 ft/sec at the mouth of the discharge basin. In the absence of any modeling studies of the perturbation to flow as a result of this promontory, it will be required that the water temperature be monitored at locations in this region to determine whether any unusual temperature effects occur when both the Plant and the Point Beach Plant are operating at full power.

The heated water from the condenser cooling system will result in increased evaporation from Lake Michigan near the Plant. The amount of this increase will be negligible in comparison with the total evaporation from the lake and with the lake's volume. Localized meteorological effects are expected to be insignificant. Increased steam fog is expected. Such fog forms over water when the air temperature is less than the surface-water temperature. The increase in the frequency and density of this type of fog, due to the heated water discharge, will be very localized and will not be a significant environmental impact. Likewise, the alterations in current flow near the Plant, due to the velocity of the discharged cooling water, will be a very minor and highly localized phenomenon.

The condenser cooling system was designed to limit discharge temperature in compliance with applicable Federal - State water quality standards. These standards, approved by the Federal Government in 1967, allow cooling water discharge temperatures as high as 89°F, without mixing zone specifications. The Applicant's permit authorizes the Plant to discharge water at a temperature of up to 86°F.

The normal summertime intake rate will be 413,000 gallons per minute (gpm) with a rise in water temperature through the condensers of about 20°F. During the winter, it is planned that circulating water flow will be reduced to 287,000 gpm, with a corresponding maximum rise in temperature of the cooling water of about 28°F. Average summertime intake temperatures recorded at the Point Beach Unit 1 intake crib (4.5 miles south) range from 50° to 60°F. On this basis, it is expected that the normal summertime discharge temperature will be approximately 70° to 80°F. During late summer, higher intake temperatures can be expected for short periods. Data for 1969 and 1970 showed intake temperatures at 66°F or above for 6 and 7 days and temperatures at 70°F or above for 0 and 5 days, respectively [3,5]. The records also correlate well with the Rostok intake for the City of Green Bay municipal water supply system 12 miles to the north of the Kewaunee Plant site. Thus it is unlikely that compliance with the temperature limit established by the State will result in operation at reduced power for more than a few days each year.

Recently the Lake Michigan Enforcement Conference (LMEC) has recommended different thermal standards for the protection of the lake biota. These recommendations are reproduced in Appendix E (Pages E-40 to 42). Representatives of the State of Wisconsin

participated in the formulation of these controls recommended for waste heat discharges to the lake. Subsequently, the Wisconsin Department of Natural Resources held public hearings and issued thermal standards for Lake Michigan based on the LMEC recommendations, as described in Appendix B. The Environmental Quality Committee of the Wisconsin Natural Resources Board is studying and reviewing the situation. A recent statement by the latter is also included in Appendix B. These requirements and the steps being taken by the Applicant as a consequence thereof are discussed in Section XII. A.

2. Chemical Discharges

The sources and quantities of chemicals used in Plant operation which are released to Lake Michigan have been described in Section III.D.3. Most of the chemicals released from the plant are sulfates and bicarbonates of sodium, calcium and magnesium. These are innocuous since they are released at a sufficiently low rate that they add at most a few percent to the amounts already present in the lake water. Phosphates are released in much smaller quantities, but, because of the very low level of phosphates present in the lake water, they too can cause increases of the order of a few percent under some circumstances. For example, if circulating water leaks into the condenser, phosphates will be added to the secondary water to control hardness. These would be released later in the boiler blowdown. The maximum release rates will add no more than a very few parts per million (ppm) to the natural content of about 150 ppm of solids in the circulating lake water, and dilution and dispersion of the cooling water will soon make these additions imperceptible.

The sewage treatment plant has been in operation for about three years, under the supervision of state-licensed personnel and with monitoring by the State. The system employs three basic methods of treatment. These are screening, aeration and settling. In addition, the Applicant has added a chlorination system and a polishing pond to further treat the effluent prior to discharge to the lake.

As the sewage passes from the screening device it enters into the aeration tank. In this tank, the sewage is oxidized,aerobically in an activated sludge system supplied with compressed air,into carbon dioxide, water, and inoffensive organic constituents. The

bacteria form an activated sludge, some of which is returned to mix with the incoming sewage. The treated sewage will have 85% to 95% of its organic, or pollutional, material removed before it is discharged.

The effluent from the settling tank is passed through a chlorination contact chamber to kill any pathogenic organisms which might remain in the effluent. The Plant effluent is held in the chlorine contact tank for thirty minutes at average design flow. This is twice the contact time recommended by the Wisconsin Department of Natural Resources. Upon discharge from the chlorine contact tank, the effluent is discharged to a polishing pond which provides additional hold-up time for the treated sewage effluent prior to discharge to the lake by way of an on-site creek. The current intake water supply for the sewage treatment system is from a well on site.

The concentrations of chemical and biological wastes released to the lake are within the State's standards. Current measurements show a concentration of chlorine of 0.4 to 0.6 mg/liter and a pH of 7.6 for the effluent at the discharge point. The rapid reduction of free chlorine to a level believed not harmful to fish has been explained in Section III.D.3. Dilution of the effluent will reduce the concentrations to even lower levels.

Sludge buildup in the final retention pond has been very small during the years of treatment plant operation and to date there has been no need for sludge disposal. Should this become a problem in the future, a state-approved sanitary land fill procedure would be followed [56].

3. Recreational and Other Uses

The beach and offshore areas near the Plant have not been popular for recreational uses such as swimming and fishing, for a variety of reasons. These include the low population level in the vicinity, the poor quality of the beach, the temperature of the water, and the availability of public beaches and docking facilities at locations not too distant to the north and south. The addition of riprap to the shoreline near the Plant will make this portion of the beach even less attractive for swimming. On the other hand, based on the experience at the Point Beach Plant, fish will be attracted at certain seasons by the heated effluent and this in turn is expected to attract sports fishermen. Commercial fishing is excluded by a

State regulation which prohibits such activities in Lake Michigan waters closer than one-half mile from the shore. The water velocity at the intake cones is sufficiently low (less than 1 fps) and their depth sufficiently great (14 ft.) that there will be no interference with possible swimmers or small boats.

The nearest intake of Lake Michigan water for use as a municipal supply is at Rostok, 12 miles north of the site. Under the most adverse conditions, a dilution factor of approximately 80 would be expected for Plant effluent. Thus the chemical and radioactive (see Section V.D. below) discharges from the Plant will have a negligible effect on water drawn from the lake for municipal use.

4. Hydrological Monitoring Program

Monitoring of the physical and chemical properties of Lake Michigan water is being performed for the Applicant by an industrial laboratory in order to:

a. Evaluate the baseline physical and chemical characteristics of Lake Michigan water before and after plant operation commences;

b. Compare the quality of the water in the lake with applicable standards to assure compliance with regulations; and

c. Provide data for evaluating the impact of the Plant on the aquatic biota.

The Applicant has recently expanded the hydrological monitoring program to provide more frequent measurements of selected physical and chemical properties at a larger number of locations [55]. Temperature profiles at 17 locations and water quality at 7 locations will be determined twice every three months, and lake currents will be monitored continuously in the immediate vicinity of the intake and discharge structures and at a second, variable location. The sampling locations and types of measurements to be made for samples taken from these locations are identified in Figure V-1. The monitoring program for biological species is also indicated.

Temperature and dissolved oxygen will be measured twice each calendar quarter immediately below the lake surface and at each meter of depth near the mouth of the discharge (#10 in Figure V-1), two miles offshore where the depth is 40 feet (#14), and at five locations along

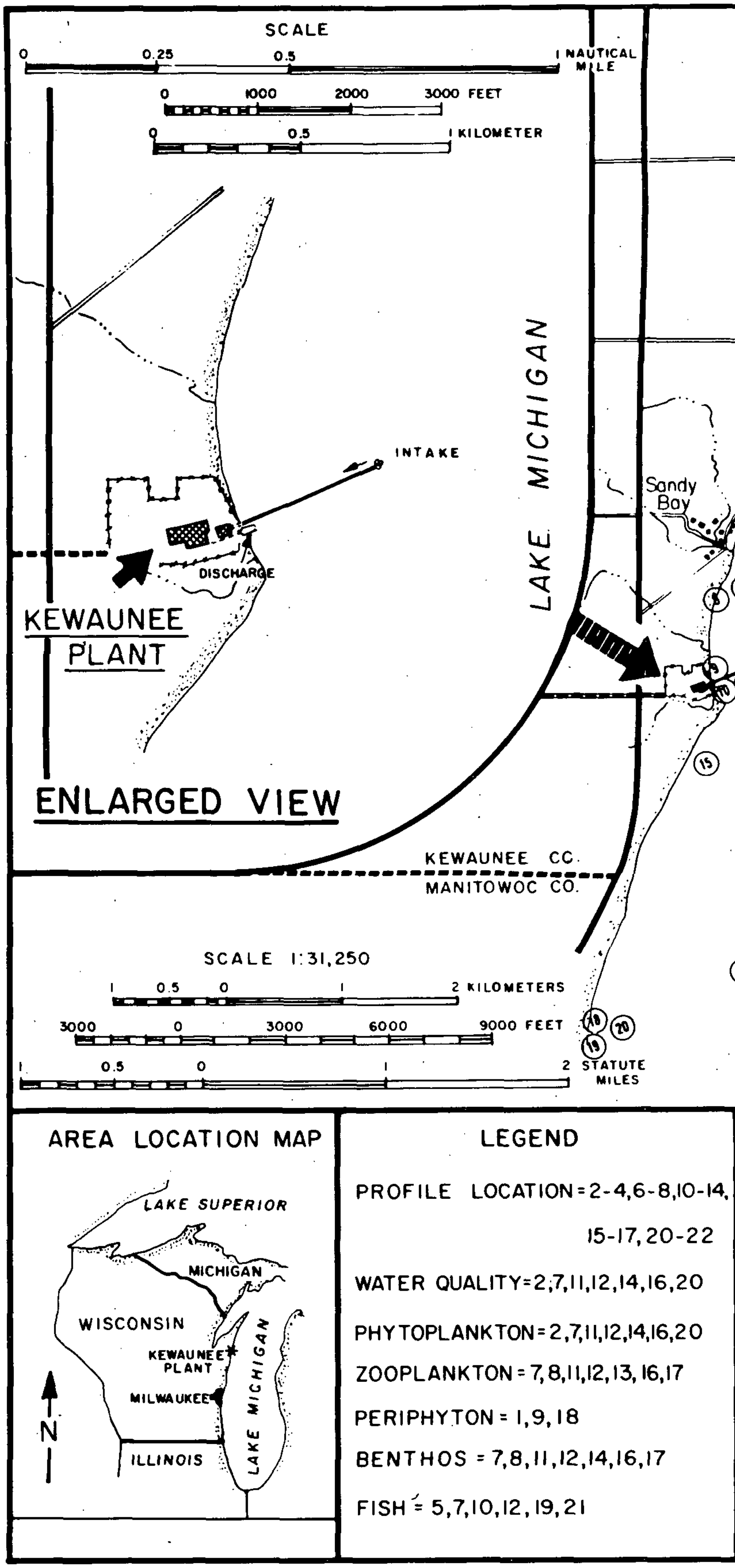

FIG. V-1.

FIELD SAMPLING MAP
KEWAUNEE NUCLEAR
POWER PLANT
THERMAL EFFECTS STUDY
1972

each of the 10-, 20- and 30-foot depth contours (#2, 6, 11, 15 and 20; #3, 7, 12, 16 and 21; and #4, 8, 13, 17 and 22). Duplicate samples for water quality analyses will be collected from seven of these locations at the same frequency. For the three locations at 10-foot depth, mid-depth samples will be taken; for the three locations at 20-foot depth, samples will be taken one meter below the surface and one meter above the bottom; samples will be taken at the top, mid-point and bottom of the water column at the single 40-foot deep location. Thirty-three chemical and physical characteristics of these samples will be determined, including ammonia, nitrate, nitride and total organic nitrogen; soluble orthophosphate and total phosphorus; chloride; alkalinity, pH, total hardness and total dissolved solids; and chemical oxygen demand.

The monitoring program is now in effect and will continue after the Plant is operating. Details of the sampling program will be modified if the results acquired indicate that it is appropriate to do so. The Applicant has agreed to make any modifications considered necessary by appropriate regulatory agencies to assure that the environmental impact of the Plant's operation on the aquatic system will be fully evaluated.

It will be required that the hydrological monitoring program sampling frequency be increased during preoperational testing and during at least the first year of plant operation in order to provide significant information on changes at various locations and depths in the discharge plume area.

C. BIOLOGICAL IMPACT

1. Terrestrial Ecosystems

The biological impact of the Kewaunee facility on the terrestrial environment includes the use of about 110 acres of the 908 acre property for the actual Plant site. Approximately 32 acres of the site are occupied by buildings, substation, transportation facilities, and landfill area. This disturbance has already taken place. The damage included loss of substrate for plants and the loss of some food and cover for birds and mammals. Secondly, there is a visual impact of the Plant and associated power lines, as well as a possible hazard of the cables to migratory waterfowl in flyways and to small aircraft.

The site ecology will now remain essentially as it is with regard to planned disturbances [2,6]. Approximately 790 acres of the site property will be leased back to farming if approval is granted. Four to five acres of the forest area will be reserved for local school conservation classes. Woodlots will not be cut down. This will have a positive impact on the remaining flora and fauna since it will provide an extensive habitat, free from further major disturbances, except for farming activities if some of the land is again leased for agricultural purposes.

There are no uncontrolled ways by which airborne, solid or liquid contaminated wastes could interact with the terrestrial plants and animals; consequently, the total impact of Plant operation on wildlife of the area appears to be slight. The migratory waterfowl habitat in Lake Michigan will be enhanced during the winter since the heated effluent will maintain an ice-free channel [28,29].

2. Aquatic Intake and Entrainment Effects

a. Plankton

Damage to plankton occurs as a result of stresses they encounter in passing through the Plant. These stresses are caused by chemical additives (if present), turbulence, elevated temperatures, and pressure as the plankton go through the pumps, condenser, various pipes, and the thermal plume. The plant forms (phytoplankton) as well as the animal forms (zooplankton) are affected.

Damage to the phytoplankton is not considered as critical as damage to other forms for two reasons: (1) regeneration of the population lost in the Plant occurs rapidly in the plume and surrounding waters because of the short life cycles; and (2) phytoplankton damaged in the Plant are still available as food to other organisms after being discharged [60]. Damage to some of these other organisms is a more serious consideration. Fish eggs and sac fry are the important forms considered here since their development is slower and they produce the standing fish crop for the area [27].

In Plant operation, mechanical and pressure damage to organisms cannot generally be distinguished from thermal or chemical effects, and are evaluated as part of the sum stress in studies of plankton populations. Several studies have indicated mortality or decreased

motility of zooplankters. A report from the Ginna Nuclear Station on Lake Ontario [12] estimates mortality of plankton (primarily zooplankton) at 2-3% of those passing through the pump and condenser system and maximum values of 11% mortality under conditions when organisms are exposed to some natural environmental stress (such as storms) before entering the cooling system. Most of the mortality was attributed to mechanical action, but thermal effects cannot be ruled out. The ΔT at the Ginna Plant was 17°F, and at the Kewaunee Plant, it will be about 20°F during a similar time of year. Wright [2,10] found that a zooplankton motility loss of 10-20% occurred as a result of passage of organisms through the pump and condenser system, apparently in the absence of chlorination. If the water is not chlorinated, the organisms that enter the intake and pass through the condenser at the Kewaunee facility should also have a rather low percentage mortality. They will experience maximum temperature changes of approximately 20°F in the summer and 28°F in the winter. These organisms will consist primarily of free floating phyto- and zooplankton and may possibly include small fish and fish eggs [2,4,6].

Environmental studies, conducted at the Point Beach Plant by the Department of Botany of the University of Wisconsin-Milwaukee, indicated that the diatoms, cladocerons, and copepods predominate among the lake plankton, but they are sparsely distributed. This condition appears to be similar at the Kewaunee site and probably exists due to the relative oligotrophy of the lake. In terms of the operational impact of the Plant, this means that relatively low numbers of these organisms will be entrained. Assuming that all of the organisms entrained are killed, the impact is expected to be minimal and of little, if any, significance to the planktonic population in the region or to the food web. The reasons are: (1) only a small fraction of the inshore lake water (less than 0.4%) passes through the Plant per year; (2) many of the species, including phytoplankton and some zooplankton, have short generation times (a few hours to weeks) [58,60]; and (3) the area in the lake near the Kewaunee Plant is known not to be a productive fish spawning area and thus the eggs of animals with larger generation times (fish) will probably not be involved [4]. A detailed biotic monitoring plan has been developed [2,55] and thorough monitoring of all major biotic groups by the Applicant will be required.

b. Fish Eggs and Larvae

At the Point Beach site an evaluation [11] of the numbers and species of fish that pass through the pump-condenser system was made by the Wisconsin Department of Natural Resources [11,45]. In 14 samples taken at the discharge area during March and May of 1971, the total catch was eight sculpin and two samples with a few smelt. The total volume filtered was 3-4 million gallons. It was concluded that there was little direct physical damage to salmonids or whitefish of the area, and it is apparent that few other species were involved during this period. Calculations made for the Kewaunee site [27] estimated a total loss of 20 pounds of potential adult fish per day due to passage of eggs or young into the system. Recent observations based upon the collection of a three-week sample from the trash rack, with one of the two pumps operating, indicated that about 20 pounds of fish were caught, [6]. However, this did not include a study of the eggs and larval fish. Some increase in the mortality rate of fish eggs and larvae due to entrainment is expected at Kewaunee after startup. For example, some eggs and larvae of alewife, whitefish, or perch, which are shallow, warm water spawners [56], will be drawn into the Plant intake. Information gained from the biological monitoring program at Kewaunee will help evaluate the abundance of young fish and eggs in the area that may potentially enter the water intake [2,4,55]. More information will be available when all of the 1972 sampling data are analyzed for the monitoring program. Some limited mortality is expected of alewife, smelt, sculpin, and the larvae of shiners (Cyprinidae) as a result of their entrainment in the intake water. However, no reduction in the local fish populations in the lake is anticipated. It is not known whether or not perch will spawn in the area of the effluent plume [4]. It is too shallow for bloater chubs and probably also for lake trout to spawn. There are no adequate streams nearby for brown and rainbow trout runs or for coho or chinook salmon to spawn.

c. Impact of Entrainment on Young and Adult Fish

The prime concern here is for fish that may enter the intake system and be unable to swim back to the lake. Fish may enter the system through one of three intake cones. At this point, the velocity is approximately 1 fps and most fish could escape the pull with a short burst of speed. If they do not, they will soon experience a velocity of approximately 11 fps (see Section III.C.3). It is unlikely they

will then be able to swim out of the intake flow and they will eventually die and be swept out with trash accumulated by the rotating screens. For this reason, emphasis has been placed on discouraging fish from entering the intake system by providing a screen of bubbles surrounding the three intake cones. Experience with an air bubble screen at the Applicant's Pulliam Plant indicates that such a screen is successful in minimizing fish entrapment [2,6]. At the Kewaunee Plant, a value of 50% effectiveness for the air screen was assumed [27,45]. That is, of the standing fish population around the inlet, one-half would avoid capture as a result of the air screen's effectiveness. In addition to the bubble curtain which is incorporated in the plant design, fish entrainment at the cooling water intake may possibly be further reduced by adding an electric probe system if necessary. However, little is known about the electric probe system. It may work if fish are lead away from the intake. On the other hand, if shock immobilizes the fish, it would make them more prone to impingement.

In the absence of other data, a standing fish crop of 45 pounds per surface acre in the area of the plant was taken as a representative (a high value) of cold water fisheries. Based on this population and the fractional captures and mortalities indicated above, a maximum fish damage of 7650 pounds per year (or about 20 pounds per day on the average) can be expected with the once-through cooling at the Kewaunee Plant [27,45]. The Applicant will be required to monitor the fish caught on the travelling screens and this will provide a measure of the effectiveness of methods used to prevent fish from entering the intake system.

3. Effects of Thermal Discharge

a. Area Affected

A model study [13] indicates that a surface area of approximately 1000 acres will be exposed to a 3°F or greater rise, based on a discharge of 413,000 gpm with a 20°F rise over ambient water temperature in the summer, and up to 28°F in the winter [2]. Under conditions of no wind or current dispersal, the plume will extend no more than 7000 ft. The 10°F isotherm will extend out about 1000 ft, and the 6°F isotherm about 1600 ft. Data presented (see Section III.D.1.a.i.) indicate that these values are overly conservative. The temperature

of the water discharged into the lake will at no time be allowed to exceed 86°F, and will decrease rapidly by mixing and spreading beyond the discharge point. It is expected that the normal summertime discharge temperature will be about 70° to 80°F [2].

Based on information from the nearby Point Beach Plant, Unit 1, [44] which has operated since January 1971, and has a similar discharge and temperature rise (350,000 gpm, 19.3°F rise), it appears that under various wind directions the plume will not extend more than 1 to 1.5 miles along the shoreline with an isotherm of $\Delta T = 3°F$ or more. However, the Point Beach discharge is located 150 ft. offshore and the Kewaunee outfall is on shore, so the Kewaunee shore area will be warmed a greater portion of the year.

Because of lake bottom conditions, the biological environment in the vicinity of the discharge point of the lake is relatively barren and not representative of the lake as a whole (See Sections II.E.3.d and V.C.3.d.). Specific measurements will be made during Plant operation to evaluate the extent of the plume under varying weather conditions, at various depths and along the bottom. The Applicant has also initiated a measurement program to document any changes in bottom contour [55].

b. General Effects of the Effluent

In evaluating the effects of the thermal plume, consideration of two points is essential: (1) the temperature rise above the temperature to which the organisms have been previously exposed, and (2) the duration of exposure to the elevated temperature [14-16]. Organisms of all types exposed to the warm discharge plume will experience temperature changes, varying in duration and magnitude depending upon where they are in the plume and how long they remain within the plume's influence. These organisms include any non-motile forms within the plume area, phyto- and zooplankton, and motile vertebrates and invertebrates [2,12]. In addition to a study of the organisms already present, a complete evaluation of the biological impact of the thermal plume will include an assessment of the thermal effects on the types and quantities of organisms that will be attracted to the area as a result of plant operation [55].

Effects on phytoplankton and zooplankton, on benthos, and on fish are considered in detail in the following subsections.

c. <u>Phytoplankton and Zooplankton</u>

The discharge of heated water from the Plant into the lake will have some additional local effects on the viability, reproduction, food-web relationships, and growth of aquatic animals as well as the photosynthetic capacity of algae [19-25]. The plankton, periphyton, and benthos communities of inshore waters were sampled near the Point Beach Nuclear Plant by Argonne National Laboratory, during 1971, to determine the biological effects of the thermal discharge [60]. With respect to phytoplankton, it was concluded from vertical tows for plankton that no significant differences existed between plume and nonplume water in terms of plankton biomass. However, fluorometric analysis of phytoplankton samples showed considerable variation in chlorophyl a concentration (proportional to phytoplankton productivity) at the sampling stations [60]. With respect to periphyton, its growth was significantly greater at the three stations nearest the discharge. Growth at all other stations was similar to that at the control areas. This localized increase in periphyton growth may not be in any way detrimental. It is only when the periphyton growth exceeds the rate at which fish and invertebrates can assimilate it into the normal food chain that the growth becomes excessive and a nuisance. Excessive growth can create problems, both aesthetically and practically, when the filamentous algae break away and float onto beaches to decay [60].

It is unlikely that any unusual algal blooms will occur as a result of the Kewaunee plume because of the relatively low nutrient and temperature enrichments. The nutrients released by the Plant (Section III.D.3) will be well controlled, limited, and comparable to those of Point Beach Unit 1 where no unusual algal blooms have occurred. At Point Beach, two years of preoperational data have been compared with the one year of postoperational data and no plant-related difference has been shown in the plankton species composition or in the timing of seasonal population pulses. No abnormalities in the dynamics of biological rhythms of phytoplankton have been found [29].

During the warmer, summer months, nearshore temperatures in the Kewaunee area have ranged from a low of 49°F to a high of 70°F based on data from 1969 and 1970. These are extreme values. More typical temperatures are in the order of 50° to 60°F. Summer temperatures would usually be in the 70° to 80°F range at the point of discharge and lower in the surrounding area. These temperatures should not unduly stimulate growth of blue-green algae. A temperature range of about 95°F to 104°F is best for the growth of blue-green algae, in non-eutrophic water [14].

The more desirable diatoms generally grow best at temperatures of 64° to 86°F [14]. The expected temperatures within the Kewaunee plume area are well within this range for the optimum growth for diatoms. Monitoring for changes in baseline populations of phyto- and zooplankton will continue at Kewaunee after operations begin. An advantage to the interpretation of data from the Kewaunee site will be the availability of information from the Point Beach site, which will have been in operation over two years before Kewaunee begins operation [2,29].

d. Effects of the Thermal Effluent on the Benthos

The factors of current and heat will be partially intertwined in the Kewaunee site discharge area and interpretation of effects specific to current will be based on other studies and prior knowledge of species' preference or avoidance of current conditions. Data from ecological studies at the Ginna site [12], where non-heated discharges occurred for a period, suggest that changes in bottom fauna and fish can occur from current alone. Although strictly local effects of the establishment of a current by the Kewaunee effluent may be anticipated, the overall impact is not expected to be great. Within the limited area of bottom and water mass where a current significantly greater than prevailing water currents occurs (up to 1 fps), the attraction of some species of fish and invertebrates can be expected. In a small area where current velocity is high, scouring and loss of habitat for organisms that do not favor current will occur. This should not influence a large area. Any changes that do occur should be detected by the sampling program [2,55].

The population of benthic organisms in the Kewaunee area is sparse, due to the nature of the bottom [4]. It is assumed that the elevated temperature of the effluent water will cause minimum damage. This appraisal is also supported by the fact that the discharged water will be more buoyant than the receiving waters, due to its elevated temperature, so that under most conditions the plume will not come into contact with the benthos. A possible exception exists in the winter when a sinking plume may occur.

e. Effluent Effects on Fish

(1) Effects of Temperature Increases

Thermal additions may affect fish in several ways [16]: (1) by thermal shock due to relatively sudden increases or decreases in temperature; (2) by influencing species composition in the area through differences in thermal preference and the possibility of increased or decreased food supply; (3) by influencing spawning times of fish; (4) by influencing the survival of eggs and young spawned in the area due to direct thermal effects or changes in predation rates: and (5) by influencing migration routes. These effects at the Kewaunee Plant are expected to be minimal, for the various reasons given in the following paragraph [2].

Information from the nearby Point Beach Plant is most pertinent to potential effects of the Kewaunee discharge. No fish kills or other adverse effects have been observed by plant personnel or fish and game representatives of the State Department of Natural Resources [2]. During March and April in 1971, the cooling water effluent from the Point Beach Plant was monitored. Fourteen different samples were taken in the outlet flume with a Clarke-Bumpus plankton sampler. The median volume per sample was 580 gallons [45]. Plankton, sculpins, and smelt eggs were caught. Only one salmonid egg was found. However, only a very small part of the total effluent was sampled, and large numbers of eggs and fry of various species could have passed through the plant undetected. A somewhat similar intake system has been designed and built at the Kewaunee Plant, and considering the entire volume of water required in a year for cooling, relatively heavy entrainment of eggs and larvae, if present, can be anticipated. The percent survival of these organisms as a result of condenser passage is unknown. However, very little spawning activity in the Plant area is anticipated [4]. The monitoring programs will yield needed information [2,55].

At the present time there is no evidence of a deleterious effect on sport or commercial fishing from operation of the nearby Point Beach Plant. Based on catch statistics supplied to the Bureau of Sport Fish and Wildlife, Ann Arbor, Michigan, commercial fishing in the Kewaunee area is primarily limited to alewife and smelt. These species are not presently being harvested to any great extent because of market conditions. However, they have value as the base of the food chain for salmonids and trout in Lake Michigan. Their importance should also be recognized from this basis.

Fish of primarily sport interest are the salmon and trout species and these have been found to be attracted at certain seasons to the Point Beach discharge zone, based on observations of fishermen, regional biologists, and limited sampling. Fishermen congregate in the plume areas and good catches are reported by the regional biologist and wildlife protection agent. Alewives, smelt, and several minnow species probably spawn in this area since they spawn along much of the beach in the region. Biologists consider it desirable to harvest the adult fish before large natural mortality occurs.

Very few yellow perch have been observed or collected near the Point Beach plume. Wisconsin DNR personnel state that few yellow perch frequent the area at any time, and neither spawning nor distinctive accumulation of perch have occurred [2].

Investigations will be continued in the Kewaunee fish sampling program for evidence of spawning in the Plant area, but no spawning is now known and little is anticipated after startup. Available information indicates that the portion of the Lake Michigan shore under consideration at the Kewaunee site is neither a spawning nor a nursery ground [4]. Surveys conducted in the area have failed to collect more than occasional fish larvae. Studies by the Wisconsin Department of Natural Resources in the early summer of 1970 indicated very few eggs or larvae of fish going through the condenser system at Point Beach [11]. These studies were repeated in the fall of 1970 with similar results. Thus, no significant impact is anticipated on the spawning or larvae activities of native fish at the Kewaunee site. Reproduction of the salmonids introduced into the lake, i.e., coho and chinook salmon, and brown, rainbow, and brook trout, is almost wholly artifical and therefore, will not be influenced by the Kewaunee thermal discharges [1]. There is the possibility that the discharge plume will interfere with nearshore movements of juvenile salmonids [2,18]. An increased concentration of predator fish in the plume area could result in an increased predation rate on juveniles forced into the plume as they move along the shoreline. Sampling of fish in the plume area after startup should reveal if this is a major concern.

It is unlikely that juvenile or adult fish will voluntarily enter the warmer parts of the thermal plume abruptly as fish are known to have definite temperature preferences and tend to stay in or move to waters of these preferred temperatures, if available. However, it is possible that fish coming from the side of the plume could experience temperature

changes up to 20°F in summer and 28°F in winter. Increased predation during these times may take place [2]. In addition, there are no strong currents or physical obstructions in the Plant area to force the fish to swim through heated water and remain there for a period which would be damaging to the fish. Therefore, it is unlikely that juvenile or adult fish life will be killed due to high temperature shock [18, 27], and it is not expected that the heated discharge will have a significant effect on the commercially important fish species. The adult whitefish are deep water fish which migrate from deeper to shallower waters for spawning in the fall. Other lake fish such as bloater and chub are deep water fish most of the year.

Studies have indicated that for most fish an exposure to a temperature shock of 9° to 12°F above previous thermal exposure for a long period, more than several minutes, is sufficient to cause death due to thermal considerations alone, i.e., when temperature is the only stress factor [18]. However, mature and most juvenile fish will not be confined by the thermal plume at the Kewaunee Plant and will be able to avoid it. The thermal plume might exert a slight effect on smelt since they move inshore during the spring when the water temperature is 39° to 42°F, and smelt spawn in beach areas in 50°F waters. Active sport fishing occurs during these spawning runs in April through May [24-26].

Experience has shown that the existing warm water discharge sites on Lake Michigan serve to attract many lake species at certain times of the year. As long as the ambient water temperatures remain low, the added heatload of the release water represents no threat. Often cold water species such as the salmonids are observed directly in the discharges. When the ambient water temperatures increase and the effluent temperature exceeds the tolerance of the fishes, they move out from the source and seek cooler water although they remain in the fringe area of the plume. At present it is not known how long individual fish remain in the area of the warm plume or if the feeding habits of fish are modified. Studies are in progress by Drs. John Magnuson and Ross Horrall, University of Wisconsin, Madison, to determine seasonal abundance of species and movements of fish in a plume area. Industrial Bio-Test Laboratories data for 1971 contain information on feeding habits of some species of sport fishes in the Kewaunee sampling zone [4].

Fish in the Point Beach area were routinely collected by Argonne National Laboratory from several locations, including the discharge canal, and the beach zone near the Point Beach plant. Hand seining was used in the

shallow beach zones, and scuba divers speared large fish in the discharge canal. This sampling disclosed that during the summer months of May through July, alewives were the most abundant fish in the discharge canal and the beach zone. Dense schools were observed in the discharge canal and often out into the lake as far as 150 yards from the discharge. Carp were also a commonly observed fish, both in the discharge and beach zones. Schools of 10-30 fish swam in and out of the discharge canal along the sides and bottom through temperature gradients of up to 18°F. Suckers were observed each time divers entered the discharge (June-September). Smallmouth bass of various sizes were observed only in the discharge. Trout and salmon were not observed in the discharge channel during the higher-temperature periods (>72°F). Trout and salmon frequented the near-field plume region as evidenced by good catches made by boat fishermen [60].

The spatial distribution of fish in and around a thermal plume was observed by Argonne National Laboratory during tests to examine the feasibility of acoustic fish-locating equipment. On October 28, 1971, simultaneous echo-sounding and temperature measurements were made as a boat traversed through the Point Beach Nuclear Plant thermal plume. Observations were made in daylight and after dark. The major difference observed between the day and night runs was the presence of a large number of schools of fish during the day and the complete absence of schools during the night. The number of individual fish observed at night is almost seven times greater than during the day. In general, during both the day and night series, the majority of fish (species unknown) were in water less than 55°F, and at no time were fish detected in plume water warmer than 59°F [60].

A study of the effect of thermal discharges on the swimming patterns of coho salmon past the Point Beach Nuclear Plant has been released by the University of Wisconsin - Madison. The fish were tracked by underwater telemetry equipment and a special temperature-sensitive ultrasonic transmitter attached externally to the fish. All fish tracked in 1971 were adult coho salmon captured at Algoma, Wisconsin. The fish were displaced 23 miles southward and released for tracking at a point approximately 0.9 mile southeast of the Point Beach water-intake structure. Preliminary analysis of the 1971 tracking data indicates that three general patterns of movement were followed by the fish tracked in the Point Beach area: 1) five fish closely followed the shoreline and definitely did encounter the plume; 2) two fish swam approximately 0.3-0.6 mile offshore and may or may not have come into contact with the plume; and 3) four fish definitely did not encounter the plume [60].

Of the fish that definitely contacted the thermal plume, two made a course change of about 90° at a point considered to be the location

of the plume interface and subsequently swam approximately parallel to the interface. At the location of course change of these fish, the temperature increase across the plume interface was from 52° to 59°F in the first case, and from 55° to 61°F in the second. A third fish twice encountered the plume edge very near the hot-water-discharge structure, and upon each contact changed swimming direction by 180°. The temperature rise across the plume interface in this area was from 59° to 70°F. The fish was swimming northward at 1.6 ft. per second and immediately before first contacting the plume, his speed increased to 2.5 fps. After first contact with the plume, the fish changed direction and swam south, approximately 0.1 mile, at 0.8 fps. After turning northward again, he was swimming at 0.7 fps while approaching the plume for a second time. After the second contact, the fish swam 0.75 mile southward at 2 fps before turning north and approaching the discharge area a third time. The transmitter signal was then lost after the fish had been tracked to within 0.2 mile of the discharge structure. The tracking signal was also lost from two other fish which had entered the plume area before sufficient data on their behavior at the plume interface could be obtained.

Of the other fish that encountered the plume, all four exhibited a marked increase in swimming speed during the track segment immediately preceding contact with the plume. Three of these fish were lost in the plume due to transmitter failure, but the fourth was tracked through the plume. While passing through or under the plume, this fish decreased its swimming speed slightly from 2.3 to 2 fps. Two of the fish that were among those lost in the plume due to transmitter failure were later captured in their home stream area (Algoma, Wis.) by sport fishermen [60].

(2) Effects of Temperature Decreases

Fish that become adjusted to plume temperatures may experience a shock when there is a Plant shutdown or an emergency stoppage. During these times, temperatures may drop to near ambient conditions within a few hours. Temperature increases due to Plant start-up are less sudden [2].

Wurtz and Renn [15] reported that many aquatic organisms are able to acclimate to higher temperatures in relatively short times, a day or less, and that they lose this acclimation slowly. They point out that the effects of sharp rises in temperatures are especially difficult to assess, as sudden change is common in many aquatic environments.

In the Plant area, inshore water temperatures in the summer have varied due to natural causes by as much as 20°F within 3 days (see Section II.D.1.b). It is not known whether fish exposed to this change stay within the area or move to minimize the extent of change. During winter, ambient water temperature is near freezing and there are no natural sudden changes

in water temperature. Sudden chilling from the shutdown of the Plant, if it occurs, may have adverse effects. These will depend upon the rate of the shutdown, and the temperature differential. A rapid shutdown is unlikely. However, during the colder months when fish may concentrate in large numbers in the warmer water, they conceivably could be subjected to a 28°F decrease in temperature within a short period [2]. This extreme shock would probably be fatal to most Great Lakes fishes and benthic organisms. However, juvenile and adult fish are capable of moving rapidly with a shift in direction of a thermal plume or a reduction in its size. Because of this, they can usually avoid damage due to shifts in the thermal plume or non-scram shutdowns. Because of the thermal sensitivity of fish and some other organisms, sudden Plant shutdowns should be avoided when possible, especially during the colder months. Benthic organisms would ordinarily be below the plume, or the warmest part of it, and not be adversely affected by a sudden shutdown.

It is significant to note that operating experience for the first six months at the Point Beach Plant showed that with 20 shutdowns, occurring primarily in the winter months, no fish are known to have been killed, and no other adverse effects were observed in spite of concerted efforts on the part of the operators to detect them [8]. If numbers of fish are killed around the discharge of a plant, like Point Beach, it is likely that some of these would appear on the intake screens or due to ice free water they would be washed up on shore. This is the method of observation used. Winter is a very difficult time of year to make other types of observation. The period, manner and number of observations made is being documented in present Point Beach reporting. It is likely that relatively few fish are occupying the shallow water area in the winter; most species move out to deeper waters. This would need to be documented. Similarly, the hypothesis of debilitation due to low temperature shock causing fish to sink to the bottom of the lake needs documentation. Only one shutdown is planned for the first commercial operating year at Kewaunee, although additional shutdowns may occur [2]. Independent studies by the University of Wisconsin Center for Oceanographic Study will provide additional information on thermal effects from heated water effluents.

(3) Effluent Impact on Species Composition

The species composition in the vicinity of the Kewaunee thermal plume may be altered. Observations at the Point Beach Plant and other facilities have shown that alewife, trout (brook, rainbow, lake, and brown), salmon, carp, and other fish are attracted to the discharge at various times of the year. At Point Beach this has had a positive effect on sport fishing by providing a zone of concentration of fish. Resultant fish catches, primarily salmonids, have been good. This is another

indication that heated effluents are good for fishing in certain areas. However, heated effluents may not be good for the fish or the people who consume the fish. It is possible that the rate of uptake of potentially harmful elements or compounds from water by fish increases with water temperature. Thus, fish attracted to and residing in heated effluents could be expected to have higher concentrations than fish in cooler waters. Monitoring of this toxicological aspect will be required.

According to state fisheries' biologists and other data [2, 4, 29] there is little natural spawning success of salmonids in the general area of the Plant, and mortality is associated with the unavailability of spawning area for sexually mature fish. The net impact thus appears to be beneficial for sport fishing based on the opinion of the state game protector and the popularity of the Point Beach discharge area as a fishing spot. A similar response is expected at the Kewaunee site [2]. At this location there is a high degree of erosion, a lack of emerging vegetation, and a bottom primarily of hard clay and shifting sand [4]. There are no known spawning grounds for fish in the area. However, conversations with state fisheries' biologists indicate that alewife, smelt, yellow perch (seasonally abundant on occasion), and some cyprinids may spawn along this type of shoreline. Consequently, investigators in the Kewaunee fish sampling (monitoring) program will specifically look for evidence of spawning. The three small creeks within the site are intermittent and support no spawning of valuable fishes. On the basis of the above, no deleterious impact on spawning of important fishes is envisaged. Although there is no evidence of salmon spawning, maturing coho are known to occur near the Kewaunee Plant [2, 4].

(4) Possible Migration of Fish into the Plant by Way of the Condenser Effluent

The average discharge velocity of the condenser effluent as it enters the lake is 4.7 fps with a range of 2.4 to 6.9 fps (Sec. III.D.1.a.). It is thus possible for fish to swim into this effluent and congregate within the plant structure. No mechanical barrier is present between the open lake and the condensers to prevent the inward migration of fish. Consequently, the Applicant will be required to monitor for fish movements into the Plant by way of the cooling water discharge, and if they occur, to apply effective preventive measures. Monitoring of fish migrations in the lake before and after startup and during shutdowns will be required, if not done by others through the Sea Grant Program [54] or other arrangements. Special attention is being given in the Sea Grant Program to the effects of large electric power plants sited on Lake Michigan on the behavior of the migratory as well as the local resident fishes.

(5) Cumulative Overall Biotic Stresses in the Lake

The Applicant will be required to evaluate the contribution of the warmed Plant effluents on the biotic stresses already in the lake. The evaluation of the discharges of pollutants, especially dissolved solids and compounds of phosphorous (plant nutrients), should take long-term effects into consideration. This will entail a comparative study before and after startup, and an analysis of the effect of the Plant on the overall stress, and alternative methods of solids disposal. Other biotic stresses may include: (1) Municipal sewage treatment plants which discharge treated wastewater into the lake from the communities of Algoma, Casco, Kewaunee, and Luxemburg; (2) Small villages in the vicinity which rely on private, single family sewage disposal means; and (3) Dairy plants, which are the principal sources of industrial wastewater. These sources bring varying amounts of organic material into the lake. This trend toward eutrophication might be further assisted by the warm water of the Kewaunee Plant's thermal plume.

4. Consequences of Chemical and Radioactive Releases to the Lake Biota

The use of anti-foulants for the elimination of growths in the cooling system and for various water processing needs was anticipated, and the existing design has these provisions. Hypochlorite can be introduced into the screen forebays to control growths on the condenser tubes, and chlorine will be used for sanitary waste treatment. However, the oligotrophic nature of the lake has obviated the requirement for the use of either hypochlorite or chlorine in the condenser coolant water for Unit No. 1 of the Point Beach Power Plant during its first year of operating history. Operation of the anti-foulant systems at Point Beach is under continuous review by the Wisconsin Department of Natural Resources and any future use will be based on controlled applications under the supervision of that body [18]. There is no reason to believe that conditions will be any different at Kewaunee.

Data concerning the effects of total residual chlorine on fish and other organisms in natural systems are not well documented because of its transient and unstable nature. In waters with relatively high BOD content, ammonia is present and forms chloramines which are toxic to fish and other aquatic organisms. Data reported by the State of Michigan's Bureau of Water Management [18] indicate that rainbow trout died in four days from chloramine concentrations on the order of 0.014 mg/liter at distances of up to 0.8 miles below monitored waste discharge points. Additional chlorine data, reported by the State of California's Water Control Board, summarize the results of a number of investigators who report that 0.05 mg/liter is a critical level for young salmon and that 0.03 to 0.08 mg/liter killed 50% of rainbow trout in seven days [18,40]. The crustacean Daphnia Magna is sensitive to 0.001 mg/l chlorine and below [59].

Since fish are attracted to the warmer waters of the mixing zone, the addition of toxic substances such as chlorine to the discharge water must be very carefully controlled. The warmed effluent tends to lower the pH, which increases the toxicity of chlorine. Thus, the use of chlorine as a biocide could entail considerable risk to fish attracted to the thermal mixing zone [18]. The potential impact of free and combined chlorine (total residual) could conceivably be much greater than that of the thermal plume. This complicates the regulatory problem involving thermal discharges by introducing a second, less well-defined parameter as a potential undesirable impact.

In the absence of precise data on the effects of total residual chlorine discharges, and if chlorination becomes necessary, it is recommended that the Applicant monitor the concentration of total residual chlorine in the Plant effluent during and following chlorination. If the concentration in the effluent is greater than 0.1 ppm, the Applicant should use all practicable means to reduce the concentrations of total residual chlorine so that it will always be less than 0.1 ppm. Should efforts to reduce to 0.1 ppm fail, the Applicant should determine the extent of the zone in the lake within which total residual chlorine exceeds the EPA recommendations (see Appendix E, p. E-35).

Low concentrations of other chemicals are released, but none is known to accumulate in a toxic form [2]. Before regeneration products from the ion exchange columns are returned to the lake, they are neutralized, with the net result that the sulfuric acid and sodium hydroxide are converted to sodium sulfate, which is then slowly released to the lake. Since sodium sulfate is a "soft" chemical found in all natural waters, the net effect on the water quality is negligible [18]. Hydrazine breaks down within the system to NH_3, H_2O, and NO_2. Concentrations of morpholine are less than 1 part per billion (ppb) and much of this is expected to break down. Boron is released at intervals but at very low concentrations, averaging 0.01 ppm. The release of phosphate, which might serve to enrich the water in the area, will only increase the background phosphate level a very small amount (see Sections III.D.3 and V.B.2). The effect of all chemical releases is expected to be negligible and no long-term buildup is anticipated [2].

According to the Applicant [2,28], the standards set by Federal and State agencies for concentration of pollutants in air and water effluents will be fully met at Kewaunee, and an effort will be made to minimize these concentrations to less than the maximum levels set by the regulatory agencies. It has been shown elsewhere in this Statement that the concentrations of pollutants which will result from normal Plant operation will

not directly or indirectly be a significant hazard to human health. The direct effects on the aquatic biota are minimized by the particular ecological situation at this location but would be small in any event.

Radiation doses to biota were estimated by: 1) assuming continuous immersion in plant liquid effluents (i.e., immediately prior to mixing with lake water), 2) using radionuclide release rates given in Table III-4 and a coolant flow rate of 210,000 gpm, and 3) using the bioaccumulation factors given in Table V-1. Doses calculated by using the above assumptions were 45 millirads per year (mrad/yr) to a 4000-gram fish, 45 mrad/yr to a 300-gram invertebrate, and 3 mrad/yr to a 6-gram aquatic plant. These doses are below those at which demonstrable radiation effects to aquatic organisms have been observed [50-53]. In a recent review [51], the problem of detecting low level radiation effects is summarized:

> "...with dose rates to aquatic biota at or around the maximum permissible concentrations of radionuclides in 10 CFR 20, our best technologies and methods cannot demonstrate that there is any effect on these systems (aquatic biota)."

Although relatively near (4.5 miles), the Point Beach Plant should contribute no more than 10% of the dose to the biota at Kewaunee. Circulation patterns in the lake are such that waste discharges do not mix except in a very complex fashion involving a large portion of the lake through which dilution processes are highly effective and favorable [2].

5. Interaction of Point Beach and Kewaunee Cooling Water Effluents

The Kewaunee and Point Beach discharge areas are 4.5 shoreline miles apart. Thermal changes and water quantities at the plants are similar, except that discharges would be nearly double at Point Beach with two units operating [2].

Current flow studies at Kewaunee and thermal plume studies at Point Beach, although not complete, indicate that there will be no significant interaction of the two facilities [4]. At a distance of 1.25 to 1.5 miles from Point Beach, the temperature rise will be 2°F or less when northward currents move the plume along the shore toward Kewaunee [2].

Considering thermal interaction under the worst possible conditions, i.e., the plume from each plant going directly towards the other, there would be less than a one degree temperature increment in the plumes' overlap. This is a highly unlikely condition, since it would involve currents moving in opposite directions. Under other conditions, the

TABLE V-1

Bioaccumulation Factors for Radionuclides in Fresh Water Species [46]

Radionuclide	Fish	Invertebrates	Plants
Cr-51	200	2000	4000
Mn-54	25	40000	10000
Fe-55	300	3200	5000
Co-58	500	1500	1000
Co-60	500	1500	1000
Sr-89	40	700	500
Sr-90	40	700	500
Nb-95	30000	100	1000
Mo-99	100	100	100
Tc-99m	1	25	100
Ru-103	100	2000	2000
Ru-106	100	2000	2000
I-129	1	25	100
I-131	1	25	100
I-133	1	25	100
I-135	1	25	100
Te-132	1000	10	1000
Cs-134	1000	1000	200
Cs-136	1000	1000	200
Cs-137	1000	1000	200
Ba-140	10	200	500
Ce-141	100	1000	10000
Ce-144	100	1000	10000
Heavy elements	100	100	100
All other	100	100	100
H-3	1	1	1

difference will be virtually undetectable. In either case, it is highly improbable that any biological effect would be deleterious or even detectable [2].

The worst conditions for the interaction of chemical and radioactive effluents are an additive effect on concentrations. Neglecting the dilution which will occur in the intervening distance of the two facilities, there would be an approximate doubling of concentrations of these substances. The concentrations of these substances are already quite low, and even under the worst conditions it is not anticipated that a significant adverse impact would result. The biological impact of the interaction of effluents between the two plants is expected to be negligible. In any event, the biological monitoring program at both stations should detect any adverse impact and allow corrective measures to be taken [2].

6. Biological Monitoring Programs

The purpose of the aquatic studies is to provide a basis for detecting and evaluating the effects of Plant operation on aquatic life. Baseline biological studies by the Department of Botany, University of Wisconsin-Milwaukee began in the summer of 1969 [3] to document the species and abundance of periphyton and zooplankton. In 1971, a more extensive sampling program was done to evaluate water quality and give additional information on phytoplankton, periphyton, zooplankton, benthos, and fish [4,5]. Bacteriological samples were also collected for the determination of total coliform, fecal coliform, and fecal streptococci from the same sites as those for phytoplankton samples. In addition, at each benthic sample location, determinations for dissolved oxygen and pH were made on water near the bottom, and pH and organic content (volatile solids) were determined in the bottom sediments. These studies will continue during the operating phase [2,4,55].

Organisms are identified as to species whenever possible. Triplicate samples are taken at each location for plankton, benthos, and water analysis. Triplicate samples of bottom organisms, plankton, and water for chemical analyses are collected in May, August, and November. Sampling for fish is done seven times a year. Four of these are in spring, one in summer and two in fall. The fish sampling dates and duration for 1971 were April 16-17, April 28-29, May 27-28, June 15-16, July 8-9, October 6-7, and October 21-22 [56].

Fish seining is done in selected habitats in the vicinity of the Kewaunee site. Overnight gill nets are set for a 20 hour interval and at least 10 minnow seine hauls are made at each sampling period. The studies are designed to assess the age, species composition, and abundance of fish, as well as thei distribution and food habits. Particular emphasis is placed on spawning that might occur in the area [2]. A program for monitoring fish migration

before and after startup, and during shutdown should be included. A comprehensive biological monitoring program which will identify and quantify the major biotic groups present in the nearby lake area, that also considers the influence of the Plant discharge plume on all major biotic groups present, should be continued before and after startup. Part of this program will also be the requirement to monitor fish caught on the travelling screens in order to provide a measure of the effectiveness of methods used to prevent fish from entering the intake system. This must include the development of a program to periodically monitor the numbers, size, and species of fishes trapped on the traveling screens. Plankton contained in the intake and effluent waters should also be monitored and the effects reported.

An operational study, similar to the preoperational study, should be continued for at least two years after the Plant begins operation. Based on the preoperational and operational studies, a monitoring program should be developed which would involve sampling of those parameters which show the most promise of being indicators of Plant effects. Statistical analyses of variance could conceivably justify reducing frequency and numbers of samples. Recent updating of the Plant aquatic monitoring program has been made [55].

In addition to the foregoing, the Applicant is aware of and will take account of other on-going studies which pertain to the Kewaunee site or more generally to thermal effects from power plants on the Great Lakes. These include studies made for the nearby Point Beach Plant and studies by independent research groups from the Argonne National Laboratory, the Center for the Great Lakes Oceanographic Study, the University of Wisconsin-Madison, and the University of Michigan [2].

D. RADIOLOGICAL IMPACT ON MAN

1. Introduction

During routine operation of the Kewaunee Plant, small quantities of radioactive materials will be released to the environment. The releases will be as low as practicable in accordance with 10 CFR 50 and within the limits of 10 CFR 20.

The expected releases of radioactivity to the environment from this Plant are listed in Tables III-2 and III-4, and form the basis for the estimated dose to humans presented in this section.

Possible significant pathways for radiation exposures to man are depicted in Figure V-2. The specific pathways considered for Kewaunee are:

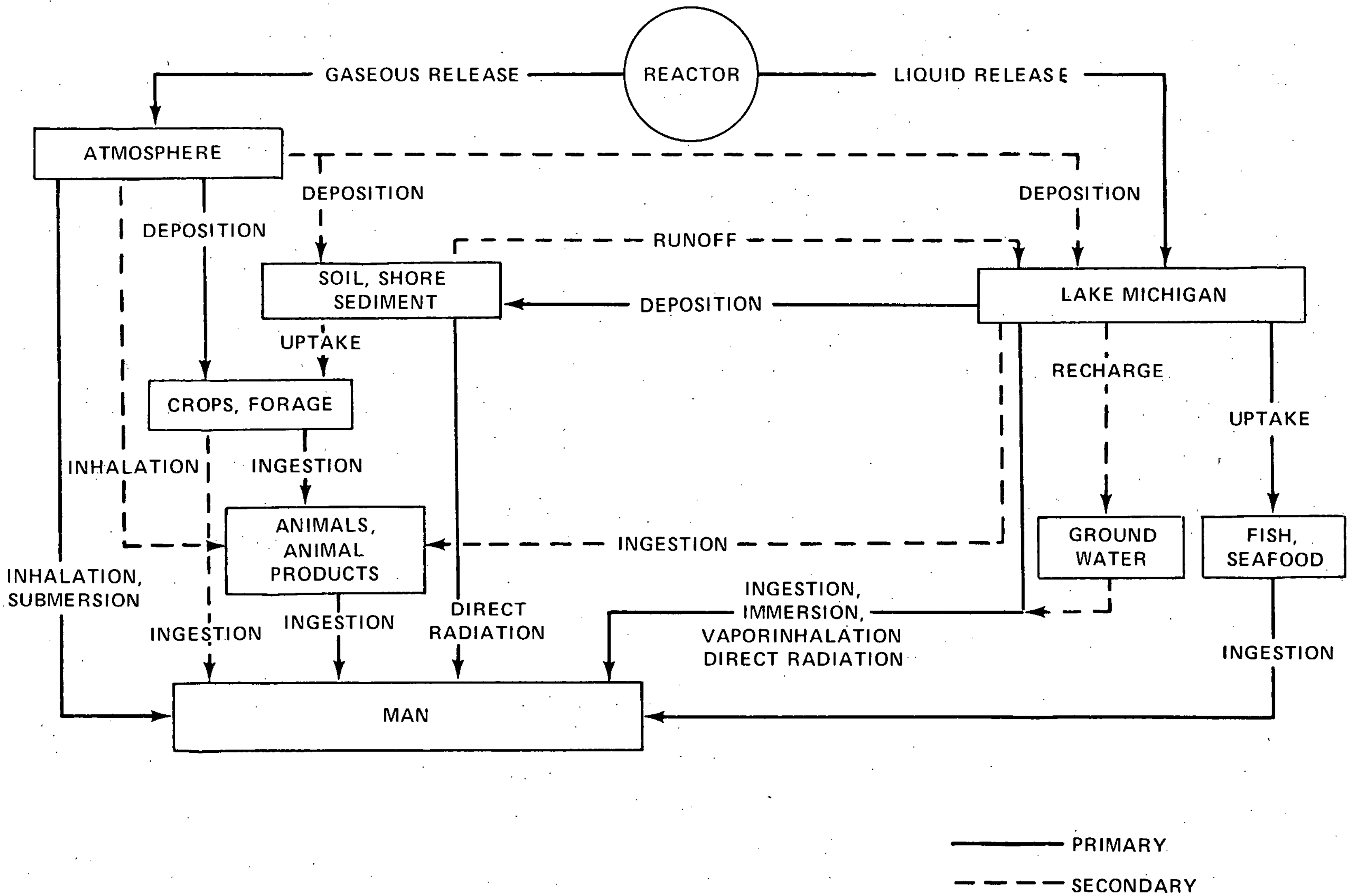

Figure V-2. PATHWAYS TO MAN

a) direct exposure to the off-gas plume;
b) consumption of milk from cows fed on local pastures;
c) use of Lake Michigan water for drinking and other domestic purposes;
d) consumption of fish from Lake Michigan;
e) recreational use of Lake Michigan for boating, swimming, and shoreline recreation.

These pathways will be considered in terms of estimated yearly average releases from the Plant. Two cases will be considered:

1. Dose to individuals living, working and using recreational facilities in the vicinity of the Plant, and
2. Dose to a suitably large population.

The second case considers the total dose to a large population expressed in man-rem. This gives a reasonable basis for comparison of the possible effects of radiation on a population. It carries the assumption that such effects are dependent on total dose to the population without regard to the details of its allocation. The evaluation of population dose for this Plant was based on the 1970 population of 575,000 residing within 50 miles of the Plant.

The dose calculations were based on the models of the International Commission on Radiological Protection (ICRP) [47]. The doses were calculated for the whole body and various organs of adult individuals except where noted.

2. Radioactive Material Released to the Atmosphere

Gaseous effluents from this Plant will consist mainly of isotopes of the noble gas fission products krypton and xenon, together with a small quantity of radioiodine. Doses therefrom to individuals off-site were calculated assuming a single release point 24 meters above grade, using annual averaged meteorological data for the Kewaunee site [41].

Ground level concentrations in a given direction will peak between 400 and 500 meters from the reactor. The maximum total body dose from submersion exposure to noble gases will be about 0.37 mrem/year to the east southeast in the lake, where the X/Q is about 2.4×10^{-6} sec/m^3. The highest dose at an occupied residence (about 1300 meters north where the X/Q is about 5.5×10^{-7} sec/m^3) will be about 0.09 mrem/year.

This was also considered to be the nearest off-site location at which fodder for a dairy cow could be grown and is, in fact, the approximate

location of the nearest dairy herd which consists of approximately 25 cows. The dose to a child's thyroid from direct inhalation will be about 0.007 mrem/year while the dose to the thyroid (2 gram) of a child drinking 1 liter of milk each day will be about 4 mrem/year, assuming that fresh fodder is available six months of the year. If the same child drank milk from a sample pooled from the entire region (50 miles), its thyroid dose would be about 0.03 mrem/year.

Doses calculated for an individual living in the nearest dwelling are summarized in Table V-2. Doses for this location, as well as others, are presented in detail in Table D-1 of Appendix D.

3. Radioactive Material Released to Receiving Waters

Radioactive effluent will be diluted in the cooling water discharged at a minimum rate of 210,000 gpm from the Plant. At that flow rate, the expected annual average concentration of radionuclides in the discharge canal will be about 8.4×10^{-9} microcuries per cubic centimeter (μCi/cc), excluding tritium. The tritium concentration will be about 1.7×10^{-6} μCi/cc at that point.

Exposure of humans to radiation from this effluent will occur with the use of Lake Michigan water for domestic purposes and during lakeside and on-lake activities such as swimming, boating, fishing and sunbathing. Concentration of radionuclides at various locations away from the Plant discharge were calculated using a steady state diffusion model of Okubo [42]. A diffusion velocity of 0.5 cm/sec and an effective mixing depth of 1,000 cm was assumed.

Within 50 miles of the site, the cities of Green Bay (inlet at Rostok), Two Rivers, Manitowoc and Sheboygan take municipal water from the lake. The water is used for a full range of domestic purposes including drinking, cooking, bathing, and humidification.

Doses to the total body and to selected organs have been calculated for individuals using water from these intakes, based on the assumption that 1.2 liters of lake water is consumed daily. For Green Bay, doses so calculated were 0.004 mrem/yr to the total body and 0.13 mrem/yr to a child's thyroid (2 grams). The total body dose includes the contribution from breathing air containing tritiated water vapor throughout the year. It was assumed that on a year-around basis, a humidity of 10% is attributable to the municipal water supply. These doses are summarized in Table V-2 and are presented in more detail in Table V-3 for those individuals using water from several water supplies.

TABLE V-2

Summary of Annual Radiation Doses to Individuals from Kewaunee Effluents

Pathway	Locations	Dose (mrem/yr) Adult Total Body	Dose (mrem/yr) Child's Thyroid
A. Gaseous Effluents			
1. Air Immersion	Nearest Dwelling (0.8 mi N)	0.086	---
2. Iodine Inhalation	"	---	0.007
3. Milk Consumption	"	---	4
B. Liquid Effluents			
1. Drinking Water	Rostok (Green Bay) (11.5 mi)	0.004	0.13
2. Fish Consumption (50 g/day)	Lake Michigan (adjacent to site)	1	---
3. Swimming + Other Water Contact Activities	"	.006	---
4. Shoreline Use	"	0.18	---

TABLE V-3

Total Body Dose to Individuals from Public Water Supplies On Lake Michigan

Location	Distance from Discharge (miles)	Dilution Factor	Population Served	Total Body Dose (mrem
Rostok (Green Bay)	11.5	1:84	87,400	0.00[illegible]
Two Rivers	16	1:120	13,600	0.00[illegible]
Manitowoc	20	1:150	34,400	0.002
Sheboygan	44	1:330	51,800	0.00[illegible]

The dose to the total body of an adult individual eating fish from Lake Michigan adjacent to the site is shown in Table V-2. The fish and their supporting food web are assumed to be in equilibrium with the water in the discharge basin and the individuals considered are assumed to consume 50 grams of fish flesh per day. Concentrations of the various radioelements in fish flesh were calculated using the bio-accumulation factors presented in Table V-1.

Estimates were also made of total body doses resulting from activities on the lake and along its shore such as swimming, fishing, boating, and sunbathing. The external dose from radioactivity deposited on the sediment along the shoreline ranged from 0.0006 mrem/yr at Sheboygan to 0.18 mrem/yr at the Plant discharge, based on 100 hours of exposure time per year. This dose is estimated from an infinite plane calculation and ignores the fact that the area of deposition along Lake Michigan would be narrow and covered with water of varying depths.

Dose from immersion in Lake Michigan water and from boating on the lake will be about two orders of magnitude lower for equivalent exposure time, ranging from 0.00002 mrem/yr at Sheboygan to 0.005 mrem/yr at the Plant discharge for swimming. Doses from all of the above activities are summarized in Table V-2 and are presented in detail in Tables D-2, 3 and 4 of Appendix D.

These representative dose estimates may be concatenated to obtain a dose estimate for a particular individual. For example, an adult, who lives in Two Rivers, eats 50 grams of the fish per day, and spends 500 hours per year fishing near the Plant discharge, will receive an annual total body dose via liquid pathways of about 2 mrem/yr.

4. Population Dose from All Sources

For the purpose of assessing the radiological impact of this Plant, the total population dose, based on 1970 population data, has been calculated and expressed in units of man-rem. A summary of the various components of the total body dose received by the population in the Kewaunee environs is presented in Table V-4.

The population dose from direct exposure to the off-gas plume was based on averaged annual meteorological data furnished by the Applicant and was estimated to be 0.13 man-rem/yr. The average dose to an individual in each of 160 annular sectors around the Plant was calculated according to the submersion model of the International Commission on Radiological Protection (ICRP) [47]. These doses were multiplied by the population in the corresponding sector and these products were then summed to obtain the population dose. The cumulative population dose as a function of distance from the Plant is shown in Table V-5.

TABLE V-4

Summary of Population Dose

	Dose to Population (man-rem/year)
KEWAUNEE SOURCES	
Gaseous Effluents	
Direct dose via off-gas plume	0.13
Dose via cows milk (total body dose to 7 kg/child)	0.03
Liquid Effluents	
Domestic water use (drinking, bathing, humidification)	0.52
Lake Michigan recreation (swimming, boating, sunbathing, fishing, etc)	1.1
Fish consumption	3.7
Other	
Transportation of radioactive materials*	3.4
TOTAL	∿ 9
OTHER RADIATION SOURCES	
Natural background	75,000
Medical diagnostic radiation	42,000
TOTAL	117,000

*The major portion of this dose (2.4 man-rem) is estimated to be received by the transportation workers (see Sec. V.E.5.b.).

TABLE V-5

Cumulative Population and Average Annual Dose from Exposure to Gaseous Effluents from Kewaunee Plant

Radius (miles)	Cumulative Population	Cumulative Dose (man-rem/yr)	Cumulative Average Dose (millirem/year)
1	8	.00045	.056
2	167	.0032	.019
3	487	.0057	.012
4	934	.0073	.0084
5	1,765	.010	.0057
10	12,780	.031	.0024
20	88,080	.081	.00092
30	245,800	.11	.00043
40	344,500	.12	.00034
50	574,700	.13	.00024

Dose from direct radiation from the Plant will be less than 1 mrem/year at the site boundary. The population dose from the source will therefore be less than 0.7 man-rem/year.

Population dose through iodine-milk-human pathway was calculated using the following assumptions:

a) The total grade-A milk production within the 50-mile region was 1.27 x 10^8 gallons per year [37];

b) This production was distributed uniformly throughout the land area of the region;

c) The cows were fed on fresh fodder 6 months of the year; and

d) The total dose commitment from consumption of this milk was attributed to the Kewaunee Plant regardless of where it will be consumed.

This pathway adds 0.03 man-rem to the population dose.

The population dose from fish consumption (3.7 man-rem/yr) was based on a consumption rate of 3 grams per day per individual of Lake Michigan fish. The consumption rate is compatible with 1971 estimates [45] of 11.3 million pounds of commercial fish and 132,000 lbs. of sport fish caught in the lake between Two Rivers and Kewaunee. For this calculation, all of the sports fish (mostly salmonids) and 10% of the commercial catch were assumed to be consumed by humans. The latter percentage is undoubted high because alewives are currently the predominant species (greater than 90% by weight). The fish and their supporting food web were assumed to be in equilibrium with water having a radionuclide concentration one-tenth of that in the discharge basin. This condition will occur at about 1.5 miles from the discharge.

The dose to the population segment using domestic water from the previousl mentioned water intakes was estimated to be 0.52 man-rem/yr. It includes contributions from drinking water, exposure to tritium water vapor (10% relative humidity), and bathing (immersion).

The estimate of the population dose (1.1 man-rem/yr) from recreational activities on or beside the lake was based on a continuous Lake Michigan shoreline population of 25,000 persons, 8 hours per day for five months. The exposures were estimated for a location where the radionuclide concentration is a factor of 50 below that in the Plant discharge. This will occur at a distance of about 7 miles (the location of the nearest

state park). The radiation dose from activity deposited in sediments is the dominant contribution, exceeding that from swimming by a factor of about 20.

The annual dose to the population (approximately 210,000, including transportation workers) from the transportation of radioactive materials was estimated to be 3.4 man-rem. This estimate was based on the direct gamma radiation exposure the population would receive from shipment of reactor fuel and solid radioactive wastes to West Valley, New York.

5. Evaluation of Radiological Impact

Some perspective may be gained by comparing the doses attributable to this Plant with those from the natural background and from medical diagnostic radiation. The natural-radiation background includes contributions from cosmic rays, cosmic-ray-produced tritium and carbon-14 in air and water, uranium- and thorium-bearing soils, and radioactive potassium within the human body. These sources contribute about 130 millirem/year per individual in Wisconsin. However, it is quite variable from place to place depending mainly on altitude above sea level and the nature of the local soil. In the U.S., it ranges from about 60 to about 250 millirem/year. For the 575,000 people living within 50 miles of the Kewaunee Plant (1970), this amounts to a total population dose of about 75,000 man-rem/yr. The results of a recent study [43] indicated that the somatic (abdominal) dose to the population averaged about 73 millirem per year per individual from diagnostic radiation. This would contribute about 42,000 man-rem/yr to the population considered here. The total population dose attributed to the routine operation of this Plant (9 man-rem/yr) is very small compared with the doses from natural background and medical diagnostic radiation.

6. Radiological Monitoring of the Environment

The radiological monitoring program for the Kewaunee site began in September 1969. About four years of pre-operational survey data will be available for comparison with the effect of the operating Plant. The program uses 8 sampling locations on the site itself and an additional 17 locations off-site at distances up to 27 miles. These locations are shown in Figure V-3 and are further described in Table V-6. Sample types by location are given in Table V-7. The analyses performed on these various sample types are indicated in Table V-8.

The current program is an amended version of the program reported in the Applicant's Environmental Report. Sampling frequencies for bottom sediments, bottom organisms, soil, and fish have been doubled. An increased number of

TABLE V-7

Types of Samples Taken, Location and Frequency

Location	Weekly	Monthly	Quarterly	Semi-annually	Annually
	Frequency				
K-1					
1a		SW		SL	
1b		SW		SL	
1c			BS,BO		
1d		SW		SL,FI	
1e		SW		SL,VE,SO	
1f	AI,IO	FB,RC,PR		TLD	TLD
1g		WW			
1h		WW			
K-2	AI,IO	FB,RC		TLD	TLD
K-3		FB,RC,MI		TLD,VE,SO	TLD
K-4		FB,RC,MI		TLD,VE,SO	TLD
K-5		FB,RC,MI		TLD,VE,SO	TLD
K-6		RB,RC,MI		TLD,VE,SO	TLD
K-7	AI,IO	FB,RC		TLD	TLD
K-8	AI,IO	FB,RC		TLD	TLD
K-9		SW	BS,BO	SL	
K-10			WW		
K-11			WW		
K-12			WW		
K-13			WW		
K-14		SW	BS,BO	SL	
K-15	AI,IO	FB,RC		TLD	TLD
K-16	AI,IO	FB,RC		TLD	TLD
K-17			EG		VEG
K-18					VEG

Note: See Table V-8 for sampling codes

TABLE V-8. Types and Frequencies of Sampling and Analysis

Samples	No. of Stations	Frequencies	Types of Analyses
Ambient Gamma			
Film Badge (FB)	10	Monthly	Gamma
Stray Radiation Chamber (RC)	10	Monthly	Gamma
Thermoluminescent Dosimeter (TLD)	10	Quarterly	Gamma
Thermoluminescent	10	Semi-Annually	Gamma
Dosimeter	10	Annually	Gamma
Airborne Activity (AI)			
Particulates	6	Weekly	Gross α,β,γ scan
Iodine (IO)	6		Iodine
Surface Water (SW)	6	Monthly	Gross α,β activity dissolved, suspended and in residue; Tritium, K-40
Well Water (WW)	2	Monthly	K-40, Tritium, Gross α,β
Well Water (WW)	4	Quarterly	K-40, Tritium, Gross α,β
Milk (MI)	4	Monthly	Sr-89, -90, I-131, K-40 Cs-137, Ba-140, Total potassium and calcium
Fish (FI)	1	Semi-Annually	γ scan, gross α,β Cs-137 in flesh, Sr-89, -90 in bone
Bottom Sediments (BS)	3	Quarterly	γ scan, gross α,β Sr-89, -90
Bottom Organisms (BO)	3	Quarterly	γ scan, gross α,β Sr-89, -90
Slime Samples (SL)	6	Semi-Annually	γ scan, gross α,β Sr-89, -90
Soil Samples (SO)	5	Semi-Annually	γ scan, gross α,β Sr-89, -90
Vegetation (VE)	5	Semi-Annually	γ scan, gross α,β Sr-89, -90

TABLE V-8 (Continued)

Precipitation (PR) (on-site)	1	Monthly (cumulative)	Tritium
Vegetables (VEG)	2	Annually	Gross α,β; γ scan; Sr-89, -90
Eggs (EG)	1	Quarterly	Gross α,β; γ scan; Sr-89, -90

locations are sampled for airborne radioiodine, soil and vegetation. Eggs and vegetables have been added to the list of media sampled. It will be required that the program be further augmented in the following respects:

(1) Sampling of bottom sediments and organisms within 500 feet of the discharge,

(2) Sampling of aquatic plants including filamentous green algae at the same location,

(3) More frequent sampling of locally produced milk, particularly within two miles of the Plant, and

(4) Sampling of flesh of locally butchered meat animals.

In describing his radiological monitoring program, the Applicant has included aquatic plants under the general category of bottom organisms. In addition, slime samples are taken. These include aquatic plants (diatoms, blue-green algae, etc.). However, radiological monitoring reports examined to date have not given results for aquatic plants except to the extent that they may be reflected in the slime samples. Therefore, the Staff has specifically recommended that aquatic plants, including filamentous green algae, be sampled.

Sample collection and analysis are done by Industrial Bio-Test Laboratories of Northbrook, Illinois. Review of the data reported so far [61,62,63], indicates that environmental radioactivity levels are typical of the background range for this region.

It is recommended that future reports compare these data with those reported (e.g., in the EPA publication "Radiation Data and Reports") by others for the same region. It is further suggested that the reports include a description of the Bio-Test analytical quality control procedures.

E. TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTES

The nuclear fuel for the Kewaunee reactor is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy fuel rods. A fuel element consists of a 14 x 14 array of fuel rods.

1. Transport of New Fuel

The fuel elements will be transported by conventional trucks of the tractor-trailer type. The first fuel load, composed of 121 fuel elements, will be transported from the Westinghouse Nuclear Fuel Division Plant at

Columbia, South Carolina, to the Kewaunee Plant. This shipment is expected to be made over a six-week period. The fuel will be shipped on a 24-hr. basis with two elements per container, in fuel-shipping containers designed to protect the fuel element from damage. The fuel elements will be enclosed in a polyethylene wrapper and covered with reusable steel-foil reinforced corrugated paper board protective jackets. Each fuel element weighs approximately 1260 pounds. Of the 1260 pounds, approximately 945 pounds are UO_2.

The shipping container is a reusable metal container and is designed for leak tightness, humidity control, and shock and vibration isolation of fuel elements to protect them against damage during normal handling and shipping for a temperature range from -40° to +150°F. The fuel elements are supported in a rigid frame which is shock-mounted to the container. All surfaces contacting the fuel elements are lined with a protective material. The dimensions of the container are about 4 ft. high by 4 ft. wide by 16 ft. long. The loaded container will weigh approximately 6400 pounds. Each container has enough structural strength to support as much as twice its own loaded weight. It is expected that about six containers will constitute a truckload of about 20 tons.

The new fuel for subsequent annual loadings of 40 (or less) elements will be shipped from either the Westinghouse Nuclear Fuel Plant in Columbia, South Carolina, or another qualified fuel fabricator's plant over an approximate three-week period to the Kewaunee Nuclear Plant. The shipping will be done similarly.

2. Transport of Irradiated Fuel

The movement of spent nuclear fuel elements, between the Kewaunee Nuclear Plant and the Nuclear Fuel Services Reprocessing Plant (NFSRP) at West Valley, New York, will be carried out under carefully controlled and regulated conditions. The fuel elements will be carried in spent fuel shipping casks which are designed and licensed specifically for this purpose. Spent fuel casks will be transported by truck or rail. Shipment by truck is presently considered to be more probable. Shipment by barge is not being considered [56].

All the applicable State and/or Federal regulations will be met. Specifically, the spent fuel casks and selected mode must meet all appropriate Federal, State, and local regulations with the major controlling criteria being provided by Title 10, Code of Federal Regulations, Chapter 1, Part 70 - Special Nuclear Material and Part 71 - Packaging of Radioactive Material for Transport, and Title 49, Code of Federal Regulations, Parts 1-199 of the Department of Transportation (DOT), Hazardous Material Regulations. These regulations define the overall design and operational

criteria, both normal and accident, that must be met by any type of spent fuel shipping cask.

a. Shipping Casks

The shipping casks to be used for shipping spent fuel from the Kewaunee Nuclear Plant to the NFSRP are designed to comply with these regulations. These are designed to accommodate from one to four PWR fuel elements. The cask is a circular cylinder approximately 17 ft. in length and about 6 ft. in diameter. Lead or depleted uranium gamma-ray shielding is used in conjunction with an hydrogeneous neutron shield to provide radiation protection. Normal shipment of the spent fuel element from the reactor to the reprocessing plant will be accomplished without any detectable release of radioactive material. The radiation intensity emerging from the cask will be well below the limit established by the Federal standards. In the unlikely event of a severe shipping accident, in which the maximum hypothetical accident conditions are assumed to exist, the environmental release of radioactivity would be at most limited to inert gas and low activity coolant which would not pose a severe radiation hazard. The allowable increase in external radiation levels, because of possible shielding reduction, would similarly not allow an unreasonable hazard to exist. Therefore, the resulting environmental impact of transporting spent fuel elements to the reprocessing site is considered insignificant.

b. Timing

The shipment of spent fuel from the reactor site would normally be initiated 100-200 days after it is discharged from the reactor installation subject to both the reprocessing plants' detailed schedule and possible local weather or driving restrictions. The number of annual trips required for each reactor refueling would vary from 10 to 40 for a discharge of 40 elements and for casks with a capacity of from 4 to 1 PWR assemblies, respectively. It is anticipated that the casks would be loaded and shipped when convenient on a 24 hr/day, 7 day/week basis.

c. Drivers

High standards are used in selecting drivers for transporting spent nuclear fuel to achieve the desired benefits of a safe, overall transport. Additionally, these high standards are used because of the inherent value of a shipping cask ($100,000-$750,000) and its contents ($50,000-$200,000). All drivers must meet the normal ICC requirements (medical, sight, etc.) plus specific demands of individual companies, such as reasonably accident free records, no felony charges, etc. The drivers are provided instructions as to the normal operating condition of the shipping cask and the type of periodic inspections to make while in transit. Included is a simple radiation monitoring instrument which is normally supplied to the

driver so that he can monitor radiation levels. Training and instructions are also provided to each driver to assure familiarity with emergencies or accident procedures to be followed. A detailed listing of appropriate emergency contacts, i.e., USAEC Radiological Emergency Teams, local and state police, etc., is also provided for each planned routing.

d. Route

Routing from the Kewaunee Nuclear Plant to the NFSRP at West Valley, New York, will be as follows:

1. Local roads from the Plant to State Route 42.
2. Route 42 to U.S. Route 141 at Manitowoc, Wisconsin.
3. Route 141 to Interstate Route 94 at Milwaukee, Wisconsin.
4. I-94 to I-294 around Chicago to I-80.
5. I-80 across Indiana and around Cleveland to I-271.
6. I-271 to I-90 across Pennsylvania to U. S. Route 20.
7. Route 20 into New York to State Route 39 to U.S. Route 219.
8. Route 219 to the county access road for the West Valley reprocessing plant site.

Many alternate routes appear feasible, with all being subject to change due to bridge restrictions, weather conditions, etc.

e. Loads

If the spent fuel is shipped three elements or more at a time, the shipping will be by overweight shipping. Permits for such overweight shipping are routinely issued for the weight ranges contemplated. The shipping of spent nuclear fuel by overweight trucks is expected to contribute to less than 2% of all overweight shipping.

3. Transport of Solid Radioactive Wastes

Spent resins, waste evaporator bottoms and some process liquids will be dewatered, concentrated, and solidified. These are combined with other solid wastes and loaded into containers for shipment and disposal. The

staff estimates 8 truckloads of wastes each year. This also may be shipped to West Valley, New York, for disposal, a shipping distance of about 700 miles.

4. Principles of Safety in Transport

The transportation of radioactive material is regulated by the Department of Transportation 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 [48] established according to the type and form of material for containment, shielding, nuclear criticality safety, and heat dissipation. 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 the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipment and trained personnel, if necessary, in such emergencies.

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 the Department of Transportation (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.

Controls over routing in transport have not been considered a factor in establishing safety standards. Emphasis was placed on package standards and quality assurance procedures apart from any routing restrictions. Although the regulations require all carriers of hazardous materials to avoid congested areas [49] 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 cold 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) per shipment. For 4 shipments, with two drivers for each vehicle, the total dose would be about 0.01 man-rem per year. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 6 feet from the truck. A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of about 0.005 mrem per 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, we estimate that the radiation level at 3 feet from the truck or rail car will be about 25 mrem/hr. The individual truck driver would be unlikely to receive more than about 30 millirem in the 700-mile shipment. For 40 shipments by truck during the year with 2 drivers on each vehicle, the annual cumulative dose would be about 2.4 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the total annual dose would be about 0.5 man-rem. Approximately 210,000 persons who reside along the 700-mile route over which the irradiated fuel is transported might receive

an annual dose of about 0.7 man-rem. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 feet from the vehicle was used to calculate the integrated dose to persons in an area between 100 feet and 1/2 mile on both sides of the shipping route. It was assumed that the shipment would travel 200 miles per day and the population density would average 330 persons per square mile along the route.

The rate of release of heat to the air from each cask will be about 30,000 Btu/hr. For comparison, 35,000 Btu/hr is about equal to the heat released from an air conditioner in an average sized home. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, 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

The staff estimates that about 8 truckloads of solid radioactive wastes will be shipped to a disposal site. Under normal conditions, the individual truck driver might receive as much as 15 mrem per shipment. If the same driver were used for all 8 truckloads in a year, he could receive an estimated dose of about 120 mrem during the year. The cumulative dose to all drivers for the year, assuming 2 drivers per vehicle, might be about 0.2 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the cumulative annual dose would be about 0.1 man-rem. Approximately 210,000 persons who reside along the 700-mile route over which the solid radioactive waste is transported might receive a cumulative annual dose of about 0.1 man-rem. These doses were calculated for persons in an area between 100 feet and 1/2 mile on either side of the shipping route, assuming 330 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

Section V References

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VI. ENVIRONMENTAL IMPACT OF ACCIDENTS

A. PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Kewaunee Nuclear Power Plant is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as will be considered in the Commission's Safety Evaluation. Deviations that may occur are handled by protective systems to place and hold the Plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, in spite of the fact that 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 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 - Operating License Stage," dated November 8, 1971.

The Applicant's report has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. These are described in Table VI-1. 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

TABLE VI-1

Classification of Postulated Accidents and Occurrences

No. of Class	AEC Description	Applicant's Example(s)
1	Trivial Incidents	Small spills Small leaks inside containment
2	Misc. small releases outside containment	Spills Leaks and pipe breaks
3	Radwaste System failures	Equipment failure Serious malfunction or human error
4	Events that release radioactivity into the primary system (BWR)	Fuel failure during normal operation Transients outside expected range of variables
5	Events that release radioactivity into primary and secondary systems (PWR)	Class 4 and heat exchanger leak
6	Refueling accidents inside containment	Drop fuel element Drop heavy object onto fuel Mechanical malfunction or loss of cooling in transfer tube
7	Accidents to spent fuel outside containment	Drop fuel element Drop heavy object onto fuel Drop shielding cask -- loss of cooling to cask Transporation incident on site

TABLE VI-1 (continued)

8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Reactivity transient Rupture of primary piping Flow decrease - steamline break
9	Hypothetical sequences of failures more severe than Class 8	Successive failures of multiple barriers normally provided and maintained

have a higher occurrence rate. The examples selected by the Applicant are also included in Table VI-1. They are reasonably homogeneous in terms of probability within each class, although we consider 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 are reasonable in terms of experience with operating plants even though they do not exactly agree with those in the proposed Annex to Appendix D. However, the use of alternative assumptions does not significantly affect the overall environmental risks.

Commission estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table VI-2. The meteorological conditions indicated in the annex to Appendix D of 10 CFR Part 50 approximate the dispersion conditions which would prevail at least 50% of the time. 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 was 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 are still 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 protection 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 small in probability that the environmental risk is extremely low.

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	0.023	2.4
3.2	Release of waste gas storage tank contents	0.089	9.3
3.3	Release of liquid waste storage tank contents	0.002	0.26
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 failures above those expected, and steam generator leak	<0.001	<0.1
5.3	Steam generator tube rupture	0.030	3.1
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.005	0.49
6.2	Heavy object drop onto fuel in core	0.082	8.6
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	0.003	0.31
7.2	Heavy object drop onto fuel rack	0.012	1.2
7.3	Fuel cask drop	N.A.	N.A.

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
8.0	Accident initiation events considered in design basis evaluation in the Safety Analysis Report		
8.1	Loss-of-coolant accidents		
	Small break	0.05	9.8
	Large break	0.027	10
8.1(a)	Break in instrument line from primary system that penetrates containment	N.A.	N.A.
8.2(a)	Rod ejection accident (PWR)	0.003	1.0
8.2(b)	Rod drop accident (BWR)	N.A.	N.A.
8.3(a)	Steamline break (PWR-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 will be comparable to the design objectives indicated in the proposed Appendix I to 10 CFR Part 50 for routine effluent releases, i.e., 5 mrem/yr to an individual from liquid or gaseous effluents.

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 radioactive materials within the Maximum Permissible Concentrations (MPC) of Table II of 10 CFR Part 20. The table 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, which corresponds to approximately 156,000 man-rem/yr based on a natural background level of 130 mrem/yr. 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

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 feet 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 feet. 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 per 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 millirem and only a very few people would receive such exposures.

b. Release of Gases and Coolant

Release of gases and coolant is an extremely 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 possible 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 feet or so of the accident might receive doses as high as a few hundred millirem. 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 ensure 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.

5. Alternatives to Normal Transportation Procedures

Alternatives, such as special routing of shipments, providing escorts in separate vehicles, and adding shielding to the containers have been examined. 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.

Section VI References

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2. 49 CFR §§ 171.15, 174.566, 177.861.

3. Federal Radiation Council Report No. 7, "Background Material for the Development of Radiation Protection Standards; Protective Action Guides for Strontium 89, Strontium 90, and Cesium 137," May 1965.

VII. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

The Applicant has demonstrated considerable sensitivity to environmental effects associated with the construction and operation of the Plant and has sought to reduce the impacts of the Plant on the region. Design changes intended to reduce environmental effects have been made, such as relocation of the coolant water outfall and improvements in the radwaste systems. Thus the remaining adverse environmental effects are generally inconsequential ones for which a significant further reduction was considered impractical or ones that are subjective in nature.

Adverse effects on land, water, and air are considered first. Biological effects resulting therefrom are discussed next. Finally, some subjective views regarding aesthetic aspects are presented. Throughout the discussion an attempt is made to categorize these in terms of their importance, but this is not always feasible because of limited knowledge now available. Also, some indication is given regarding the temporal nature of certain effects. The classification of some effects as adverse may be debatable, but the underlying assumption is that existing natural processes have evolved over millions of years and that man-made perturbations are more likely to be disruptive to the natural system than not.

A. LAND USE

Acquisition of the site and dedication of a portion of it to industrial activity obviously are disruptive influences on the prior land use. However, it is not likely that there will be a shortage of land in the region for those agricultural uses eliminated by the construction of this Plant. Abundant farmland exists in Kewaunee and adjacent counties, and recreational use of the lakeshore in the vicinity has been minimal. Only hunters are likely to be affected adversely on a long-term basis, and this only locally.

The industrial plant buildings and grounds will occupy about 110 acres of the 908-acre site. A sizeable fraction of the 110 acres has been altered during the construction, but much of this will be restored to a state similar to its original, natural character. Twelve families were displaced from their homes on the land acquired for the site, forcing them to locate housing elsewhere. Most of the approximately 70 permanent Plant employees have moved

or will move to a location near the Plant. These two groups have placed a small, added demand on the services provided in the communities and rural areas where they have settled.

Shoreline protection afforded by the riprap placed along the beach at the center of the lake boundary of the site is a favorable development in that it will slow appreciably the erosion of the land by wave action, but this is slightly countered by the reduced attractiveness of that portion of the shoreline for swimming and related recreational activities. Disruption of the land during construction and the attendant noise displaced wildlife in the immediate proximity of the Plant, at least temporarily. However, because of the use of the site for agricultural activities prior to its acquisition by the Applicant, and the continued use of much of it in this way during construction, disruption of the wildlife population was small.

Along the 56 miles of new transmission lines, some vegetation was and will continue to be disturbed because of the need for avoiding interference with the lines, and this too will interfere with some wildlife. This will be slight, because 84% of the land through which this narrow corridor passes is used for farming, and even where trees must be cut or trimmed to keep the lines clear, the narrow width of the channel will displace wildlife, e.g., birds, only a small distance.

B. <u>WATER</u>

Construction, dredging and sanitary landfill operations have resulted in localized changes in the course of an on-site creek and in the adjacent lake basin, and some silting and erosion have been unavoidable. Eventually equilibrium will be restored, but under somewhat modified conditions.

Localized water loss in excess of natural amounts will occur on a continuing basis, through increased evaporation in the thermal plume from the outfall, due to higher than ambient temperatures.

This redistribution of water is not significant in view of the large volume of Lake Michigan.

There will be a variety of chemical additions and increases in concentrations of dissolved solids in the waters immediately adjacent to the Plant. These additions, including the possibility of chlorine treatment of the cooling water to keep the condenser clean, were described in Section III.D.3. Some of the radioactive materials processed by the radwaste system will be diluted with Plant water and released into the lake, as explained in Section III.D.2. Thus there will be a continuing addition of chemicals to the nearby waters. Admittedly these chemicals will be diluted by currents in the lake, but nonetheless they constitute a sustained net increase in the dissolved solids in the nearby water.

C. AIR

The principal materials released to the air by Plant operation are water vapor from the thermal plume, and small amounts of gaseous radionuclides from the radwaste system. Under certain conditions, localized steam-fog will be caused or enhanced by the thermal plume. Eventually, the moisture released by evaporation from the thermal plume will return to the earth's surface as precipitation, but this should be widely distributed. The quantity of water that becomes airborne in this way is a minute fraction of the normal evaporation from Lake Michigan. The consequences of the release of of the radionuclides are considered in the following section.

D. BIOLOGICAL EFFECTS

Here attention is directed to the possible consequences to living matter as a result of changes in land, water, and air with the construction and operation of the Plant. The impact of the water-intake structure on fish and other aquatic life is also considered.

Revegetation of disturbed land areas, and the intention to continue with agricultural use of other parts of the site, so that they are not industrialized or urbanized, will compensate for the loss in certain of the wildlife habitats due to land being committed to the Plant. New grass and other vegetation planted by the Applicant may improve the food supply for endemic wildlife.

The temporary dredging operations for the coolant intake structure and discharge basin caused damage to only an insignificant part of the benthic populations in the lake near the Plant. The risk of

widespread adverse effects on the biota of Lake Michigan from the operation of the Plant is remote and very unlikely, because the waters and lake bottom nearby are relatively barren.

The heated water effluent from the condenser into the lake will be essentially dissipated within a few thousand feet of the outlet. Free-swimming organisms are not expected to remain in the plume unless they are gradually adapted. Especially during the winter months, some fish will be attracted by the thermal plume in the lake, but no significant adverse effect is anticipated because of it, unless it ceases abruptly due to sudden shutdown of the Plant.

The ice-free water in the area of the effluent will provide a safe open space for waterfowl in winter.

Organisms of less than 3/8 inch may be killed during passage through the condenser cooling systems but there will be no significant impact on the population level in Lake Michigan because of it. Fish will be discouraged from swimming into the coolant water intake cones by air bubble screens, and the water velocity at the entrance to the cones will be sufficiently low that fish will be able to escape. Thus, any losses will be very small when compared with the total production of fish and plankton in Lake Michigan.

The releases of radioactive materials from the Kewaunee Plant will conform to the USAEC requirements that they be "as low as practicable," that the resulting concentrations in air and water meet or, if possible, be lower than specified limits, and that the resulting dose to people in the environs be well within an acceptable range.

E. AESTHETIC ASPECTS

The Plant's design reflects good architectural use of construction materials, although the functional nature of some of the components cannot be camouflaged conveniently. The structures which constitute the Plant contrast strongly with the typical construction on the surrounding agricultural land. The low density of population in the area surrounding the site means that comparatively few people, other than motorists passing along State Highway 42, will experience this change in the countryside's appearance caused by the Plant. Its location at the lakeshore puts it in a peripheral location for most people in the area. While the Plant is visible from a distance of a few miles in some directions, the gently rolling terrain serves somewhat to hide the Plant or reduce its prominence on the horizon.

Even fewer people will view the Plant from the lake. The riprap placed along the shore near the Plant serves to draw attention to the Plant. The Plant, in this setting, will be a prominent feature in the appearance of an otherwise uniform shoreline in that area.

In summary, it is unlikely that the Plant, with the appearance of a unified cluster of buildings with attractive lines from distances in excess of a mile or so, will foster an adverse reaction by many people. In a similar way, the additional transmission lines are likely to be virtually unnoticed by all except those few persons whose homes happen to be in close proximity to some of the wooden H-shaped supports for the power lines.

VIII. THE RELATIONSHIP BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The relationship between local short-term uses of man's environment and enhancement of long-term productivity is discussed relative to the Plant. To provide power, it has been necessary to invest some land and to anticipate the heating of a small portion of Lake Michigan. By the discharge of heat and small amounts of other wastes, principally into the lake, some of the biota are affected. This aspect has been considered in Section V.C. of this Statement. The local short-term uses of the environment include those required to construct and operate the facility (during which it will therefore "use" the local environment), and some period beyond, during which time certain of the Plant's environmental effects may continue. Radioactive effluents discharged to the environment will be as low as practicable, in accordance with the guidance of 10 CFR Part 50, and will be small fractions of the 10 CFR Part 20 limits.

A variety of environmental monitoring methods will be utilized to detect and evaluate any radiological impact which might lead to long-term effects in order that timely corrective action can be taken, if required. The effects of chemical and thermal discharges are also expected to be negligible, but monitoring programs applied to these aspects will include the sampling and analysis of the water, aquatic life, and the food web near the facility, and the site land and air, including resident biota. Both thermal and chemical discharges will meet applicable standards. These monitoring programs ensure that the local short-term uses of the environment involved in the construction and operation of the Plant will not jeopardize the long-term productivity of the environment. During the 40-year design lifetime of the Plant, the site could be used for several environmentally related activities in addition to power generation including recreation, forestry development, and research.

It is instructive to consider productive uses of the site land and adjacent waters before the advent of the Kewaunee electric-power-production facilities. The entire site was in large part used for agriculture. Except for the Plant buildings and grounds, most of this land will be returned to agriculture almost immediately after startup, according to present plans. The beneficial occupancy by

native wildlife should not be impaired once the site development is completed. Before construction began, the physical characteristics of the beach were poor in terms of recreational use; these aspects have not been changed, although the water will be warmed after startup, making it more comfortable for swimmers and it will tend to attract fish.

At some future date, the Kewaunee Plant will become obsolete and be retired. Many of the disturbances of the environment will cease when the Plant is shut down, and a rebalancing of the biota will occur. Thus, the "trade-off" between production of electricity and small changes in the local environment is reversible. Recent experience with other experimental and developmental nuclear plants has demonstrated the feasibility of decommissioning and dismantling such a plant sufficiently to restore its site to its former use. The degree of dismantlement, as with most abandoned industrial plants, will be contingent on a balance among health and safety considerations, salvage values, and environmental impact. The fuel could be removed and reclaimed, residual radioactivity removed or shielded, components salvaged, structures dismantled, and the reactor vessel sealed. The extent to which the land in the industrial zone is restored to its former state will be influenced strongly by desired uses for the land beyond the life of the Plant and the relationship between benefits achieved thereby and the cost of restoration.

IX. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

Numerous resources are involved in construction and operation of a major facility such as the Plant. These resources include the land upon which the facility is located, the materials and chemicals used to construct and maintain the Plant, fuel used to operate the Plant, and human talent, skill and labor.

Major resources to be committed irreversibly and irretrievably due to the operation of the Plant are essentially the land (during the life of the Plant) and the uranium consumed by the reactor.

The land removed from agriculture by the Plant buildings and grounds represents less than 0.05 percent of the productive cropland in Kewaunee County and is an extremely small part of the productive cropland in the areas served by the Owners. It is possible that the land used for the reactor building may be irretrievably committed. The loss of this resource is negligible.

In the process of consuming the uranium-235 portion of fuel, the Plant draws on a natural resource. The amount of this uranium is extremely small in comparison to the amount of fossil fuels that would be consumed by the production of a similar amount of power from other types of thermal generating stations. Actually, plutonium production in the Kewaunee Plant will offset the loss of U-235 to a moderate extent. Even though known nuclear fuel reserves are not significantly different (in terms of the number of years to depletion) from fossil fuel reserves, it is apparent that as nuclear technology develops in the area of breeder reactors, real reserves will expand. There is no such prospect for fossil fuels. On this basis, and under the premise that power must be produced, the commitment of nuclear fuel resources to the production of power at Kewaunee or any other power plant is considered to be a positive commitment and one which is favorable in the long term. Suitable hydroelectric power sites are not available to the area served by Kewaunee. The use of solar energy for reliable electric power production has not yet proved feasible.

Human resources involve the time and effort required to design and build the Plant as well as to operate it. This kind of resource is almost totally irretrievable, and were the Plant never to operate

at all, much of that already expended would be lost. None of this resource is really salvageable, except for the degree of experience gained in design and construction of the Plant. It would be difficult to demonstrate that any alternative method of producing power would directly involve significantly less human resource than a nuclear generating station. To evolve even more efficient methods of nuclear power generation will involve substantial time and effort but will eventually lead to even lower rates of resource use per unit of power produced. The least further consumption of human resources would be to proceed with the proposed action; any alternative would involve further -- even duplicative -- commitments of time and effort.

The commitment of construction materials has already been made for Kewaunee. Only if the Kewaunee Plant were to be abandoned at this time and completely different alternatives adopted would additional resources of this kind be required.

The use of the environment (air, water, land) by the Plant does not represent significant irreversible or irretrievable resource commitments, but rather a relatively short-term investment. The biota of the region have been studied, and the probable impact of the Plant on this complex resource is considered elsewhere in this statement (Section V.C.). In essence, no significant short- or long-term damage or loss to the biota of the region has occurred or is anticipated. Should a significant detrimental effect to any of the biotic communities appear, the monitoring programs at Kewaunee are designed to detect it, and corrective measures would then be taken by the Applicant.

X. THE NEED FOR POWER

The Applicant, Wisconsin Public Service (WPS), provides electrical power for a region of 10,000 square miles in northeastern Wisconsin and Menominee County, Michigan. Its 1970 population was 699,000. Wisconsin Power and Light (WPL) services a territory of 16,000 square miles in the southern and central one-third of Wisconsin, which had 846,000 inhabitants in 1970. 244,000 people in and near Madison, Wisconsin are provided with electricity by Madison Gas & Electric (MGE). A cooperative arrangement was initiated by WPS and WPL in December 1960, and they have jointly developed two power units, one at Green Bay and one at Sheboygan. They were joined in this cooperative arrangement by MGE in February 1967, to form the Wisconsin Power Pool (WPP). The WPP, as a member of the Wisconsin-Upper Michigan System, is a part of a large, interconnected grid of transmission and production capability which extends over a large portion of the Midwest. The latter system is known as the Mid-America Interpool Network (MAIN).

The members of the WPP supply electricity to a large fraction of Wisconsin's residential, commercial, and industrial population, including its second and fourth largest cities. For example, the Applicant's 1971 energy production has the following distribution in terms of use: Industrial, 49%; Commercial, 13%; Residential, 30%; and Other, 8%. Corresponding values for the Pool were 34%, 17%, 32%, and 17%, respectively. The U.S. Department of Labor projects increases in Wisconsin's population and labor force of 16 and 19%, respectively, for the decade from 1970 to 1980. Because of the long lead times involved in the planning and construction of major power facilities, electric utilities must base their expansion programs on demand forecasts.

The average annual rate of increase experienced by the members of the WPP, in combination, during the last 10 years has been 8.0% in summer demand and 6.9% in winter demand. Estimates of the combined demands for the recent past and the next several years are given in Table X-1. The latest actual experience has been maximum demands of 1670 MW in the 1970-71 winter, 1850 MW in the 1971 summer, 1971 MW in the 1971-72 winter, and 2010 MW in the 1972 summer. Emergency load reduction measures had to be initiated during the 1972 summer by the Wisconsin-Upper Michigan System, an informal coordinating organization of which the Applicant and the co-owners of the plant are members. This involved both voltage reduction and appeals for voluntary conservation of power use by customers. The forecasted rate of increase is conservative in comparison with the average rates of increase during the last decade, and in recent years the actual demand growth in Wisconsin has exceeded forecast figures.

TABLE X-1
WPP Capacity-Demand-Reserve Data for 1971-1977 (in MWe) [4]

	Owned Capability	Native Demand	Purchases (Sales)	Adjusted Demand	Margin	Reserve With Kewaunee (%)	Reserve Without Kewaunee (%)
1971							
W	1993	1825(l)	155(a)	1670	323		19.3
1972							
S	1930	2002(m)	265(b)	1737	193		11.1
W	1993	1946	195(d)	1751	242		13.8
1973							
S	2707(c)	2154	225(e)	1929	778	40.3	13.0
W	2770	2069	75(i)	1994	776	38.9	12.5
1974							
S	2707	2312	175(f)	2137	570	26.6	2.0
W	2770	2205	175	2030	740	36.4	10.5
1975							
S	3207(g)	2479	(225)(j)	2704	503	18.6	-0.9
W	3270	2334	(225)	2559	711	27.7	7.2
1976							
S	3207	2641	(170)(k)	2811	396	14.0	-4.7
W	3270	2473	(170)	2643	627	23.7	3.8
1977							
S	3257(h)	2826	-	2826	431	15.2	-3.4
W	3517	2622	-	2622	698	26.6	6.5

(a) 75 MW by MGE and 80 MW by pool, both from Wisconsin Electric (WE), for 12 months beginning June 1971.

(b) 75 MW by MGE and 190 MW by pool, both from WE, beginning June 1972 for 3 months, then reduced by 40 MW.

(c) Install Kewaunee #1, 527 MW, and five 50-MW gas turbines.

(d) 75 MW by MGE and 120 MW by pool, both from WE, for 6 months beginning December 1972.

(e) 75 MW by MGE and 150 MW by pool, both from WE, for 3 months beginning June 1973.

(f) 75 MW by MGE and 100 MW by pool, both from WE, for 12 months beginning June 1974.

(g) Install Columbia #1, 500 MW, April 1975.

(h) Install one 50-MW gas turbine.

(i) 75 MW by MGE from WE.

(j) 225 MW sale to WE pool for 12 months beginning June 1975.

(k) 170 MW sale to WE pool for 12 months beginning June 1976.

(l) Actual peak demand was 1791 MW.

(m) Actual peak demand was 2010 MW.

Table X-1 includes information on the WPP's current capability and capacity additions. The basis for this is given in part in Tables X-2 and X-3. Table X-2 identifies and describes the existing power plants in each of the WPP members' systems.[1] Except as noted, all of the steam plants are coal-fired units. A time range for initial operation indicates the existence of more than two units at that station.

Table X-3 indicates the plants under construction within the Pool and one proposed to satisfy anticipated demands. Planned plant retirements are tentative, since many factors are involved. These include achievement of construction schedules for new facilities, obsolescence of the older units, maintenance requirements, economic considerations including the supply picture for various types of fuel, and accuracy of forecasts of demand.

A breakdown of the total demand into that for each of the members of the WPP is useful in considering the effects of maintenance on possible power shortages. For the period in which the availability of the Plant is expected, the individual demands are as follows:

	Demand (in MWe)	
Company	Winter, 1972-73	Summer, 1973
WPS	762	803
WPL	900	970
MGE	282	374
Total	1944	2147

Each of the systems is summer critical, but by a wide margin only for MGE. The indicated total increase of 10% from winter to summer reflects in part anticipated annual growth in demand, so it is apparent that there is no seasonal period in which maintenance is decidedly advantageous. The WPP has been operating with minimum reserves for several years. The attendant postponement of equipment maintenance has resulted in an increased probability of forced outages. Hence it is important that a higher reserve margin, such as would be provided by early availability of the Plant, be achieved as soon as possible.

TABLE X-2. Operating Power Plants in the Wisconsin Power Pool

Name	Initial Operation	Station(a) MW(e)	Total MW(e)	Remarks
Wisconsin Public Service (WPS)			799.1	
Steam			661.9	
Pulliam	1926-64	406.5		Units 1 and 2 (16.4 MW) converted to gas and oil, 1971
Weston	1954 & 1960	152.8		
Edgewater #4	1969	102.6		31.8% of output; jointly owned with WPL
Hydro			65.2	
High Falls	1910	6.9		
Wausau	1921-24	3.6		
Grand Rapids	1921-24	3.9		
Caldron Falls	1924	6.6		
Grandfather Falls	1938	17.0		
Others	1905-	16.1		15 hydro plants, 54.1 MW total
Pettenwell	1949	6.7		1/3 interest in Wisconsin River Power Company
Castle Rock	1951	5.0		1/3 interest in Wisconsin River Power Company
Diesel	1949 & 1964	6.9	6.9	2 units
Gas Turbine			64.5	
Weston	1968	21.0		
Marinette	1971	43.5		
Wisconsin Power and Light (WPL)			931.9	
Steam			779.9	
Blackhawk	1917-69	58.2		Last unit 25 MW
Edgewater	1931-69	344.3		#3: 72.8 MW; #4: 322.6 MW (102.6 MW to WPS)
Rock River	1954-55	161.2		Last unit 75 MW
Nelson Dewey	1959 & 1962	216.2		

TABLE X-2. (Cont'd)

Name	Initial Operation	Station(a) MW(e)	Total MW(e)	Remarks
Wisconsin Power & Light (WPL)(cont'd)				
Hydro			52.9	
Prairie du Sac	1914-40	29.9		
Kilbourn	1907-39	9.5		
Pettenwell	1949	6.7		1/3 interest in Wisconsin River Power Company
Castle Rock	1951	5.0		1/3 interest in Wisconsin River Power Company
Others	1925-	1.8		
Gas Turbine			99.1	
Rock River	1967 & 1968	54.3		2 units
Sheepskin	1971	44.8		
Madison Gas and Electric (MGE)			258.6	
Steam			198.4	
Blount Street	1923-61	198.4		7 units, from 5 to 44 MW
Gas Turbine			60.2	
Sycamore	1967 & 1971	41.4		
Nine Springs	1964	18.8		

(a) Tested capabilities.

TABLE X-3

Anticipated Additions of Plants in the Wisconsin Power Pool

Name	Type	Startup	MW(e)	Participants
Under Construction				
Kewaunee	Nuclear	1973	540	WPS (41.2%), WPL (41.0%) and MGE (17.8%)
Columbia #1 (Portage)	Fossil	1975	500	WPS (38.9%), WPL (39.3%) and MGE (21.8%)
Proposed				
	5 Gas Turbines[a]	1973	250	
	1 Gas Turbine	1977	50	

[a]Authorized by the Wisc. Public Service Commission, Aug. 22, 1972 (see p. E-5).

TABLE X-4

Wisconsin Power Pool
Precipitator Installation and Upgrading Schedule [3]

Generating Unit	Capacity MW	Planned Installation	Present Schedule
Wisconsin Public Service Corporation			
Pulliam Unit #3	27.3	Precipitator Upgrading	9/73
Pulliam Unit #4	27.2	Precipitator Upgrading	3/73
Pulliam Unit #5	46.9	Precipitator Upgrading	4/74
Pulliam Unit #6	64.8	Precipitator Upgrading	4/75
Pulliam Unit #8	130.3	Precipitator Upgrading	11/74
Wisconsin Power & Light Company			
Edgewater Unit #3	72.7	New Precipitator	10/72
Nelson Dewey Unit #1	109.3	New Precipitator	11/73
Nelson Dewey Unit #2	104.6	New Precipitator	5/74
Madison Gas and Electric Company			
Blount St. Boiler #5	15.0	Oil/Gas Conversion	3/73
Blount St. Boiler #6	15.0	Oil/Gas Conversion	3/73
Blount St. Boiler #8	47.2	New Precipitator	4/73
Blount St. Boiler #9	48.0	New Precipitator	4/73

In addition to normal maintenance, the Wisconsin Department of Natural Resources has directed[3] that changes be made on existing plants to reduce stack emission. The planned changes, shown in Table X-4, are intended to achieve compliance with air quality requirements of Section NR-154.05 of the Wisconsin Administrative Code. The plants involved amount to 38% of the Pool's present capacity, so there is an additional requirement for increasing the reserve margin in the period from 1973 to 1975 over and above that required for routine maintenance and margin for unscheduled outages.

A minimum reserve margin of 15% has been shown by experience to be necessary to allow for required maintenance of the power plants in a system and provide a reasonable contingency for nonscheduled outages of generating facilities. The WPP has not managed in the recent past to maintain such a reserve and on numerous occasions has been forced to depend on other companies in MAIN for supplemental power. There was a reserve of only 10.3% in 1970, and in 1969 it was only 9.0%. As shown in Table X-1, the achievement of the scheduled date for commercial operation of the Plant will provide a margin in excess of the minimum requirement through 1974. A moderately increasing trend in reserve requirements is desirable, since new generating capacity will be in relatively large units whose scheduled completion and availability can be highly uncertain. Thus the anticipated margins beyond 1973, as shown in Table X-1, are not considered excessive.

The size of the Kewaunee Plant conforms with the general trend in the electric utility industry to construct and operate larger capacity units. The Plant's capability exceeds that of the two largest existing units in the WPP, Edgewater #4 (330 MWe) and Pulliam #8 (130 MWe). If available as scheduled, it will account for 19% of Pool's late 1973 capability and, functioning as a baseload supply, will generate a larger percentage of the total Pool's kilowatt-hour requirements. Because the plant is not now scheduled for commercial operation until September 1973, the pool will be slightly deficient in reserve margin for most of that summer. Since the Plant will be undergoing operational testing at that time, some help in alleviating this deficiency in reserve margin is anticipated.[7]

The MAIN reserve will be sufficient to supply any reasonable Pool needs in the 1972-73 winter. By the summer of 1973, the MAIN reserve will be only 22.4% with all MAIN units except the Kewaunee Plant operating.[2] However, all of these reserves are vested in 13 new large generating units scheduled for initial operation during the period from January 1972 through June 1973 (see Appendix E, page E-16). Current information indicates that delays are being experienced in bringing most new large generating

units into commercial operation, and this trend may continue for some time in the future. The Federal Power Commission has concluded that "the electric power output represented by the Kewaunee unit is needed to implement the Applicant's and MAIN's generation expansion programs for meeting projected loads and to provide a reasonable measure of reserve margin capacity for the 1973 summer peak period, particularly in view of the very large amount of other new capacity which must be in operation in MAIN's system on schedule if the forecast capacity margin is to be met" (see Appendix E, page E-18).

MAIN reserves for the summer peaks through 1981 are given below,[5] on the assumption that all new plants go into operation as scheduled. Included are allowances for firm purchases of 620 to 850 megawatts during 1974-77 and of 100 to 130 megawatts during 1978-81. Also shown are the reserves without the Kewaunee Plant.

Year	1973	1974	1975	1976	1977	1978	1979	1980	1981
Reserves (%)									
With Kewaunee	24.2	18.8	16.1	16.8	16.9	15.0	14.3	17.5	13.7
Without Kewaunee	22.4	17.2	14.6	15.4	15.5	13.8	13.2	16.5	12.7

In view of the fact that MAIN itself is expected to be a net purchaser of power and is estimated to have marginal summer reserves during 1974-81, it does not appear that the Wisconsin Power Pool can rely on firm purchases from MAIN during this period as a substitute for operating the Kewaunee Plant. Even if power were available, a utility suffers an economic penalty by purchasing it, paying a price that includes amortization of another utility's plant, instead of operating an existing plant of its own, expecially a nuclear plant with its relatively low operating costs.

The Public Service Commission of Wisconsin has jurisdiction over production of power by all companies in Wisconsin and controls facility expansions of all utilities in the state. The Commission has evaluated the need for expansion of the systems within the WPP and gave approval [6] for the construction and operation of the Plant on October 17, 1967. In anticipation of a delay in start-up of the Kewaunee Plant, the Commission has recently authorized the construction of 250 MW of combustion turbine generating capacity to be completed and available before the summer peak period of 1973. The Commission's Chairman has stated that "the capacity represented by the Kewaunee Nuclear Power Plant is critically needed at the earliest date possible" (see Appendix E, page E-5).

Section X References

1. R. H. Krause, ed., "Moody's Public Utility Manual," Moody's Investors Service, Inc., New York, N.Y., 1971, pp. 201-209, 886-890 and 1403-1410.

2. J. B. Prince and K. E. Wolters, "Analysis of Demand and Capacity Considering Possible Curtailment of Output from Nuclear Plants, 1971-1975," Wisconsin Electric Power Company (for the Mid-America Interpool Network), Milwaukee, Wisconsin, October 1971.

3. Wisconsin Public Service Corp., "Statement Showing Cause Why the Construction Permit for the Kewaunee Nuclear Power Plant Should Not be Suspended, in Whole or in Part, Pending Completion of the NEPA Environmental Review," October 11, 1971.

4. WPS, "Environmental Report: Questions and Answers," Amendment 1 to November 1971 Environmental Report - Operating License Stage (Revised), April 17, 1972.

5. MAIN's 1972 Reply to Appendix A of the Federal Power Commission's Order No. 383 on "Reliability and Adequacy of Electric Service," April 1, 1972.

6. J. F. Goertz, "Letter and Findings of Fact, Certificate and Order," Public Service Commission of Wisconsin, October 17, 1967, Appendix B of "Environmental Report - Operating License Stage (Revised)," Wisconsin Public Service Corporation, Green Bay, Wisconsin, November 1971.

7. Wisconsin Public Service Corporation, "Comments on Federal, State and Local Agencies' Comments on the AEC Draft Environmental Statement," October 19, 1972, USAEC Docket #50-305.

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

A. ALTERNATIVES

The need for additional capability in the Owners' systems was discussed in Chapter X. In view of the history of a continuing demand for additional electrical power, and the utilities' legal responsibility to meet that demand, the alternative of not providing the power is not pertinent here. Obtaining a firm commitment for purchase of large amounts of power for a long period from adjacent electric utilities is improbable, as demonstrated by Federal Power Commission surveys and projections by the Mid-America Interpool Network (MAIN), of which the Owners are members. Those utilities are hard-pressed to keep up with the expanding demands within their own territories. Furthermore, such power would be more costly, because of the greater transmission distances, and its generation elsewhere would merely transfer the environmental impacts to another location. Hence, the discussion which follows starts with the assumption that the Owners must expand their own capability.

1. Past Alternatives

The chronology of past decisions made among major alternatives (capacity, site, and fuel), starting with the forecast in 1966 of additional power needed to meet demand several years later are summarized in Table XI-1, which was included in subsection 2.5.3 of the Applicant's Supplementary Environmental Report. A recent review by the Applicant of these past decisions indicated that no change was desirable. No other lake site appeared more favorable, and no inland site appeared to offer advantages over Kewaunee with respect to closed-cooling systems. The Applicant believes that the general location and meteorological characteristics of the Kewaunee Plant site are exceptionally favorable.

The alternative of hydroelectric power was eliminated because of inappropriate land and water characteristics in the Owners' territories. Gas turbines were considered as an alternative, but eliminated because of disadvantages such as fuel supply problems, maintenance requirements, and the gaseous exhaust. Other methods for producing the required power were rejected because of either cost or unproven technology. Thus, the decision that the capability would be supplied by a steam plant was reached at an early stage.

The fuel options for a steam plant were reduced to two serious contenders - coal and uranium - because of the limited supply of gas and the cost and

TABLE XI-1

Pertinent Project Chronology [1]

Date	Subject	Analysis	Decision
1966	Capacity Requirement	Typical demand forecasts	Major unit required by about 1971
1966	Site Selection	Detailed feasibility studies of 11 available sites	Selection narrowed to group of 3
1966	Generation Method	Comparison of alternate forms of power generation, primarily fossil steam and nuclear plants	Build nuclear facility
1966	Site Re-evaluation	Prime site not available; comparable site sought	Purchase Kewaunee site
1967	Joint Ownership	Combined demand forecasts relative to nuclear plant capability	Agreement between WPS, WPL, MGE
1967-71	Cooling Alternatives	Detailed comparison of economic and environmental aspects of cooling methods	Full return system, recognizing option to change
1967-71	Waste Disposal	Continuous detailed consideration of numerous waste systems alternatives	Present systems

uncertain availability of oil from foreign sources. A comparison of the environmental impact of these two fuel options is given in the following section (XI.A.2).

As indicated in Table XI-1, extended consideration has been given to alternative cooling methods. Factors pertinent to a choice among these alternatives are described in Section XI.A.3.

Alternative routings for the new transmission lines were also considered. The Applicant's criteria for location of the corridor are mentioned in Section III.B. A selection was made from an extremely large number of specific paths by which the Plant could be connected to the existing power distribution network of the Owners. The choice of wooden H-frame towers to blend with the rural area through which the lines were routed was mentioned previously. Overhead lines were chosen in preference to buried ones for their lower cost and lesser environmental impact.

2. Comparison of Coal and Uranium as Fuel

The initial selection of uranium in preference to coal as the fuel for the additional power plant was made largely on economic grounds when the need became apparent in the mid-1960's. The comparison between nuclear and coal plants in terms of environmental impact considers these categories: atmospheric degradation, effects on water bodies, uses of land, consumption of irreplaceable resources, and effects on biota.

a. Atmospheric Degradation

When fossil fuels are burned, chemical oxidation occurs as combustible elements of the fuel are converted to gaseous products and the noncombustible elements to ash. Although the bulk of the gaseous combustion products (oxygen, nitrogen, water vapor and carbon dioxide) are not presently known to be harmful, certain gases (oxides of sulfur, the oxides of nitrogen and organic compounds including polynuclear hydrocarbons) are produced which are harmful to humans, plants, animals, and certain materials, either directly or indirectly.

The sulfur dioxide production from combustion of coal containing 2-1/2 percent sulfur would be about 110 pounds of SO_2 per ton of coal burned, or about 200 tons of sulfur dioxide per day for a 500-megawatt plant. Available systems for sulfur dioxide removal could remove about 60 percent of the SO_2 from the effluent, leaving an emission of 80 tons per day. The Applicant estimates that the additional costs of this reduction of SO_2 emission would be $14,000,000 for equipment, with an annual operating cost

of about \$1,800,000. The ground concentrations of SO_2 can be further reduced by careful plant siting and selection of stack height, effluent temperatures and exit velocities.

About 20 pounds of NO_x is produced per ton of coal. For a 500-megawatt plant, the daily NO_x release to the atmosphere is about 40 tons per day. Nitrogen oxides are by themselves relatively unimportant pollutants. However, in an atmosphere containing unsaturated hydrocarbons (which come from combustion of and evaporation of gasoline, kerosenes and oils), the nitrogen oxides react with the unsaturated hydrocarbons to produce odorous and visibility-restricting smogs.

Visible smoke emissions and soot from stacks can be greatly reduced, by as much as 99.5%, with modern electrostatic precipitators. The visible emissions from the best and newest power plant stacks are almost exclusively condensed water vapor, rather than smoke.

The nuclear plant emits no chemically significant effluents to the atmosphere. It does emit radioactive effluents, but in amounts so small they cannot be distinguished from the natural background radiation at very modest distances from the reactor building.

b. Effects on Water Body Quality

The coal-fired steam generator and the nuclear-fueled steam plant both require waste heat disposal systems. The requirement for heat dissipation is about fifty percent greater for the nuclear plant. The atmosphere can provide a heat sink by means of stacks and cooling towers; rivers and lakes can be sinks by once-through cooling; or cooling ponds can be used which are closed systems needing only makeup water. Combinations of these systems are possible.

In addition to heat discharged to the air and bodies of water, depending upon the system selected, the nuclear plant will add very small amounts of radioactive material to the water returned to heat sinks. These will be in the cooling water return for once-through cooling, or in the blowdown water from towers. Small amounts of chemical pollutants are associated with cooling water return for either a fossil or a nuclear plant.

c. Uses of Land

The land required for a nuclear plant is less than half that for a coal plant, assuming once-through cooling systems in each case. There are exclusion zones associated with a nuclear site; however, the restricted land

can be used for activities such as agriculture or recreation, whereas the land requirements of coal-fired plants for coal storage, transportation facilities such as rail and switchyard, and ash storage preclude the simultaneous use of this land for other purposes.

The land requirements for cooling systems other than once-through ones are greater for nuclear plants because of less efficient use of the heat produced in the plant. This becomes significant in the case of a cooling pond. In the Applicant's comparison of coal and nuclear plants, however, once-through systems were assumed.

Coal-fired plants have historically had a low aesthetic rating. Even with attention to their design, the tall stacks, and coal and ash storage requirements mitigate against their achieving an aesthetic appeal comparable to nuclear plants.

d. Uses of Irretrievable Resources

The reserves of fossil and fissile materials are limited. Each production method expends irretrievable resources. The reserves of uranium fuel, however, will become much less critical with the development of the breeder reactor. Coal has uses as a chemical raw material that will compete with its long-term use as fuel.

A coal plant would require 1,600,000 tons of coal per year, which is available although there are problems in obtaining low-sulfur coal suitable for burning in a power plant. The Kewaunee nuclear plant will require about 350 tons of U_3O_8 (yellow cake) as the raw material for the initial core and about 90 tons of U_3O_8 per year thereafter for replacement loadings. The AEC Report to Congress for 1971 gives on page 136, a preliminary figure of 275,000 tons as of the end of 1971 for U. S. reserves of U_3O_8 recoverable at costs of $8 per pound, representing a 10-year forward supply. Potential resources at costs of $10 per pound or less were estimated at 650,000 tons, but this additional supply will require a major exploration effort to discover, develop, and bring it into production.

e. Effects on Biota

Thermal effects result in some fish damage which, it is assumed, is in direct proportion to the quantity of waste heat. Other water quality effects are in about the same proportion. The actual biological effects of air-borne pollutants from a coal plant have never been adequately assessed, particularly for new plants with efficient particulate control. It is clear, however, that overall air quality effects for a coal plant are significantly greater than for a nuclear plant and the resulting indirect effects on the biota are correspondingly greater.

3. Alternative Methods for Waste Heat Disposal

a. General Comments

There are several practical methods for the disposal of the waste heat developed by a nuclear power plant. These methods include both natural draft and mechanical draft cooling towers, closed cycle cooling ponds, once-through cooling, and spray canals. These five alternative methods are described here in terms of the Kewaunee Plant and compared in the cost-benefit analysis in Section XI.B.2. Figures XI-1 and XI-2 illustrate the relationship between each system and the Plant site.

Another cooling method, dry cooling towers, has the advantage of not adding moisture to the atmosphere. This method is quite inefficient and adds significantly to power costs. Thus, dry towers are not treated as a realistic alternative in this evaluation of possible cooling methods.

The design requirements for each of the alternatives evaluated include the following:

1. Dispose of 4×10^9 Btu per hour;

2. Circulate 413,000 gpm through the steam condensers; and

3. Utilize those portions of the existing KNPP once-through system which are applicable.

b. Natural Draft Cooling Towers

The natural draft cooling tower considered is 450 feet high, circular in all horizontal cross-sections and hyperbolic in vertical cross-section. Diameter of the tower is 480 feet at the base, narrowing to 200 feet at about 300 feet above grade and broadening slightly at the top of the tower. The tower would be about 1,000 feet from the existing Plant, at the location shown in Figure XI-2.

The environmental impact of natural draft towers is due to the moisture added to the air. Up to 7650 gpm of water would be evaporated, and 1350 gpm of wind-drifted water droplets dispersed, from the top of the tower at 450 feet above the ground. As a fraction of total cooling tower water flow, this is about 0.3% drift. On most days of low wind speed, the warm moist plume will continue to rise above the tower top. Occasionally, the plume will react as a down wash on the leeward side of the tower. As the

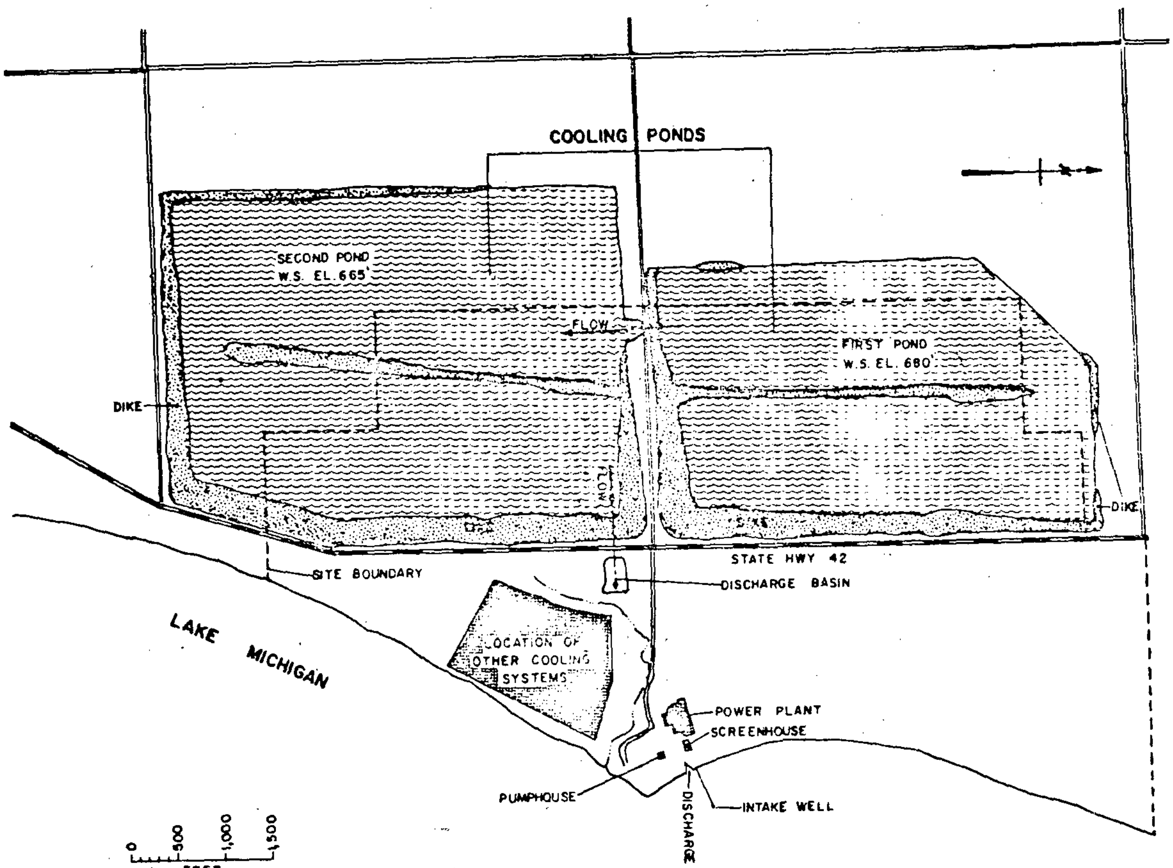


Figure XI-1. 650-acre Cooling Pond Layout [1]

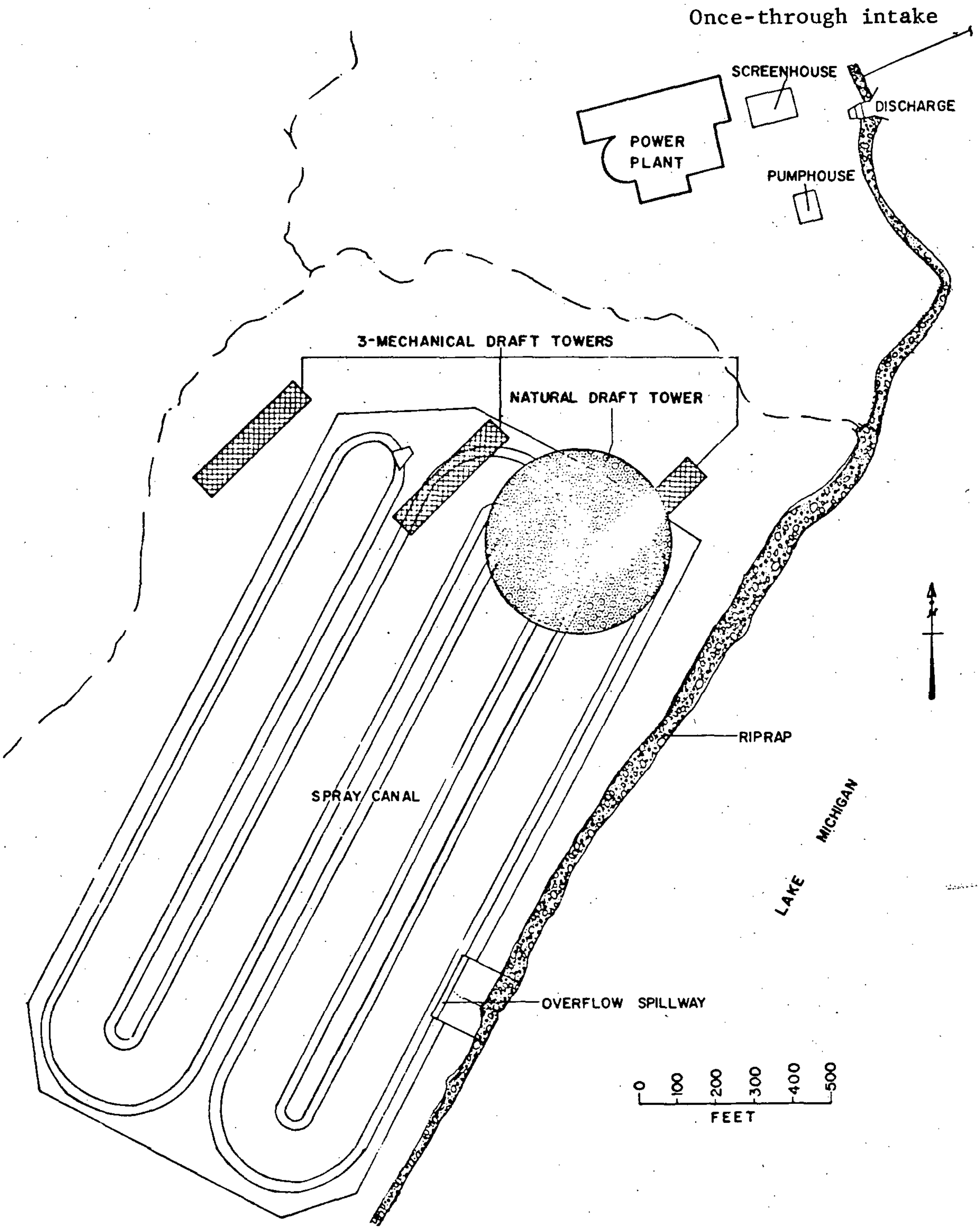


Fig. XI-2. Other Alternative Cooling Systems [1]

plume entrains ambient cold air, condensation may add to the airborne mists so that the visible plume of water droplets extend some distance from the tower. In below-freezing temperature, suspended water droplets would remain unfrozen until they evaporate or until they strike an object and immediately freeze. With the natural draft tower, however, this visible plume with its potential for visibility restriction and icing will rarely return to the ground.

The wind-drift particles carry with them dissolved chemicals, which, when the droplets evaporate, may deposit on the ground. In large quantities, the drift could be detrimental to biota and agriculture, an effect which is periodically mitigated by rainfall and run-off. The drift is spread thin, but over a wide area, because of the high elevation of release. The blow-down water returned to the lake influences drift by reducing the buildup of concentration of chemicals in the tower water from which the droplets are created. The known methods for calculating the deposition and effects of drift are quite inadequate. For fresh water drift in regions of frequent and adequate rain-fall like Wisconsin, the effect is expected to be minimal.

Biological effects accrue primarily from blow-down discharge into the lake. An evaluation of the environmental aspects of cooling towers [3] indicated that total losses in terms of ultimate fish damage would range between about 2 and 20 percent of that attributable to corresponding once-through cooling systems. For a natural draft tower, the small land area occupied by the structure would result in an insignificant loss of wildlife habitat.

The size of the natural draft tower would provide a severe contrast to a landscape characterized by low rolling terrain and primarily small structures. The Kewaunee Plant itself, of course, is not small but it would be dwarfed by a natural draft cooling tower rising to a height of 450 feet. The highest point of the Kewaunee Plant is the top of the reactor silo, approximately 200 feet above ground level. Though the hyperbolic shape of a natural draft tower eases the feeling of massiveness to some degree, the proportions remain substantial and aesthetically unfavorable. Thus, a natural draft cooling tower would dominate the scene for miles around and would detract considerably from the good visual relationship currently established between the Kewaunee Plant and the surrounding farmsteads.

c. Mechanical Draft Cooling Towers

A typical mechanical cooling tower scheme would have three towers of nine cells each, parallel to each other and essentially parallel to the shoreline in a field about 700 feet southwest of the generating Plant, as shown

in Figure XI-2. They would average about 53 feet above ground level. The relatively wide spacing of the towers and the elongated effect of the banks of nine units would produce a horizontal linearity, having a low profile and controlled visual impact. Concrete bases with metal clad upper sections would allow visual integration with the existing Plant and surroundings.

Hot water from the condenser cascades down over baffles from the top of the towers and air is blown up through the water by electrically powered fans. The cooled water is then recirculated to the condensers. The water budget of the towers is similar, but not identical, to that of a natural draft tower, and about the same chemical treatments of water would be necessary.

The towers would evaporate up to 7650 gallons of water per minute and disperse up to 350 gpm of wind drift. As a fraction of total cooling-tower water flow, this is about 0.08% drift. Upon mixing with ambient air, much of the water lost by evaporation condenses into a visible plume, which has little tendency to rise and will move near the ground with the wind. By contrast, the natural draft tower's fog would be high enough to be less perceptible. The low level fog from the mechanical draft units can be objectionable from an aesthetic standpoint as well as occasionally from a safety standpoint, considering the proximity of State Highway 42. Restrictions of visibility could be quite serious in this plume.

At temperatures below freezing, icing is likely through a large section of the visible plume. The extent of this plume would depend on humidity, wind speed, and air stability. Any effects on the ground will be mitigated by the 60% offshore wind condition at the site.

It is possible to decrease plume effects by reducing fan speed during conditions causing severe fogging and icing, since these occur mainly in winter when the cooling towers have a lower cooling requirement. It may also be possible to entrain additional ambient air within the towers, reducing the output air to below 100% relative humidity, thus decreasing the fog and ice impact.

The total drift is less from the mechanical draft than natural draft towers because the droplet formation rate does not exceed 350 gpm. The spread of the drift, coming from three towers, starts from a fairly broad and low source. Much of it may be deposited on the ground within the site area before evaporation of the droplets. A good quantitative estimate of the amount of drift deposited on land surfaces outside the site area is impossible. A qualitative judgment is that the deposition from mechanical

draft towers must be less, and local concentrations probably no higher, than those from natural draft towers. The chemical content of the drift from mechanical towers is, of course, sensitive to the volume of blow-down water returned to Lake Michigan.

Blow-down water will result in some heat and mineral return to the lake. The effects on aquatic life are roughly the same as for the natural draft tower. The land area required for the mechanical-draft towers and the resulting removal of wildlife habitat are insignificant.

d. Cooling Ponds

To achieve the necessary cooling capacity, a lake area between 650 and 1500 acres is needed. The amount of land required for most efficient cooling is not now available at the Kewaunee site. Thus, Figure XI-1 shows a layout for the minimum area of 650 acres.

A multi-pond system is required. The ponds are designed with internal dikes so that the warm water from the Plant condensers would enter a corner of one pond and make a full circuit of its periphery before entering the second pond. Dike-induced circuitous routing in each pond precedes final return of the water to the Plant. During those circuitous routes, the water would have a long time to cool by natural evaporation and contact with the cooler air above it. As with all other systems, evaporative losses of water, makeup water, and blow-down are involved.

Evaporation losses from the ponds after water use for Plant cooling would be about 7650 gpm, the same as for cooling towers, plus an approximately equal amount resulting from solar radiation on the surface of the pond. There is no wind drift, so this is the total consumptive use of water. The frequency of fogging due to the cooling pond would be much less than for any other alternative except once-through cooling. There may be occasions, during very low wind circulation at night, when the ponds would contribute to ground fog in the immediate vicinity including State Highway 42. Actually, for this condition, the fog might have developed in the absence of the ponds. The ponds are not expected to create an icing condition. Natural icing occurs when rain or drizzle falls into below-freezing layers of air near the ground. The ponds would mitigate the below-freezing temperatures of these layers.

Probably the greatest impact upon the terrestrial ecosystem would be the elimination of field crop and pasture lands by the ponds. Installation of cooling ponds of optimum size would require more than the 908 acres presently owned. Hungarian partridge, rabbit, and ring-necked pheasant would be eliminated from the area inundated. Deer would not be adversely affected by the formation of the ponds because their presence near the Plant is

rare. The pond probably would be attractive to migratory waterfowl and shore birds for resting, feeding, and possible nesting. Following excavation, the soil forming the pond bottom may provide substrate for aquatic vegetation and, in turn, invertebrates.

The cooling pond method would have relatively little visual impact on the area. Surface water would be considered an aesthetic gain in most circumstances, but this is probably insignificant when near a large natural lake.

e. Spray Canal

The required spray canal would be 6500 feet long, trapezoidal in cross section, with a bottom width of 140 feet. Floating, self-contained spray modules would be distributed along its length. Water enters the canal from the condensers and moves slowly down the canal with cooling by natural evaporation. At intervals, water is sprayed into the air and it falls back into the canal. The spray modules increase significantly the cooling efficiency of the canal. At the end of the canal, the water is returned to the condensers. The system is quite simple and easily maintained because the individual spray modules may be serviced without interference with others. This concept is quite new and needs additional study to determine the effects of ice on canal operation in winter.

The canal consumes up to 7650 gpm of water by evaporation and up to 1350 gpm by wind drift. The fog impact of the canal would be of the same nature as that of the cooling ponds, but a little more severe because of the more intensive evaporation per unit area.

The wind drift from the canal spray heads is about the same as from the natural draft tower. This spray is very low and much of the contained chemicals will fall in or very close to the canal. To the extent that drift is adverse, the maximum intensity of drift fallout will be greatest from this canal system, but the area covered will be much smaller than that associated with either type of tower.

The biological impact of the canal alternative would be proportional to the land area used so far as wildlife habitat is concerned. The advantages of the waterfowl attraction of the cooling pond will not apply to the canal because of the spray effects. Effects on aquatic life similar to that of cooling towers can be expected for the canal as a result of discharge to the lake.

The spray canal scheme would require much less land than cooling ponds, but would introduce a heightened level of visual activity. At 40-foot intervals in the canal, spray modules would broadcast water in plumes

about 40 feet in diameter and 25 feet in height. The sprays would be coarse enough to hold their form in most wind conditions.

A pumphouse similar to that required for the cooling pond scheme would have to be added to the building complex, and a spillway would be added between the canal and Lake Michigan. Neither would have much visual impact in comparison with the existing structures on the site.

f. Once-Through Cooling System

In the once-through cooling system, up to 413,000 gpm of Lake Michigan water are withdrawn from the lake, pumped through the condensers, warmed 20°F, and returned to the lake. In the winter, at lower flow rates, the temperature will be increased 28°F. The heat discharged to Lake Michigan by this system is as high as 4×10^9 Btu/hr.

This is the cooling system which has been provided for the Plant. Construction has been completed. From an economic viewpoint, it is the least-cost system. Its capital investment has been relatively small, and its operating costs are low.

The primary environmental impacts of the once-through system are its effect on Lake Michigan due to warming caused by its return flow, the impact on the organisms entrained in the cooling water which are passed through the Plant, and the effect on aquatic biota in the lake which never enter the Plant, but are bathed in the effluent plume. These effects and other pertinent aspects of the existing once-through system are described in preceding chapters of this Statement.

g. Effect on Liquid Radwaste System

In the plant as built, the 413,000 gpm water flow through the condenser provides dilution for the radioactivity that would be released to the lake. Switching to a closed-cycle alternative would result in a higher concentration of radioactivity in the release to the lake since the concentration varies inversely with the dilution flow. For example, a closed-cycle alternative involving a 10,000 gpm blowdown to the lake would carry a concentration increased by a factor of 40. This increase could be partially offset by the addition of a polishing demineralizer. Another possible alternative would be the use of a circulating water pump operating at 260,000 gpm to provide dilution for the liquid radwaste. The effect of various dilution alternatives is shown in Table XI-2 [1].

TABLE XI-2

Effect Of Reduced Water Discharge On Release of Radioactivity [1]

Blowdown and Dilution Discharge Rate, gpm	Radioactivity Release, as % of 10 CFR 20 Limit		Reason for Water Discharge
	Various Isotopes	Tritium	
7,000 to 15,000	12% to 5.6%	1% to 0.45%	Minimum Blowdown
20,000	4.2%	0.34%	Reduce Chemical Treatment
40,000	2.1%	0.17%	Eliminate Chemical Treatment
260,000	0.4%	0.032%	Radwaste Dilution

4. Alternatives for Providing Service Water [4]

The present system of providing service water utilizes lake water as makeup, treats it to remove suspended solids, and discharges the chemicals used to the lake. Alternatives involving the use of different chemicals or the use of well water as makeup do not have significant advantages. The least environmental impact would result from utilizing well water and treating it by reverse osmosis, but the present stage of development of that process does not permit an accurate assessment of system reliability. In any case, as indicated in Section V.B.2., the present system meets the State standards for chemical wastes released to the lake.

B. COST-BENEFIT ANALYSIS

1. Economic Comparison of Nuclear and Coal-Burning Plants

The original projection of energy costs, prepared just before the Kewaunee project was initiated, estimated an average cost of electricity for the period from 1972 to 1980 including operating costs and annual carrying charge on investment, of 5.25 mills/kW.hr. for a coal plant and 5.12 mills/kW.hr. for a nuclear plant. The Applicant's most recent projection of these costs [5] indicates 9.47 mills/kW.hr. for a coal plant and 9.37 mills/kW.hr. for a nuclear plant. If the committed costs of the Kewaunee project, $146,000,000 through September 1972, were to be added to the total cost of a replacement coal plant, the resulting cost of electricity would be increased to about 14 mills/kW.hr. The FPC confirms that such costs are within the range of similar costs reported by the electric utility industry (see Appendix E, page E-18).

2. Economic Comparison of Cooling Alternatives

The dollar cost increments for the alternative cooling systems, relative to the once-through cooling system, are summarized in Table XI-3. Included are the added construction costs and the present worth of the added costs of operation and loss of capacity. The capacity loss for the Kewaunee Plant would be about 38 megawatts for a mechanical-draft cooling tower, 37 megawatts for a natural-draft cooling tower, 40 megawatts for a spray canal, and 50 megawatts for a cooling pond.

Also considered was a variation in the location of the intake point for the once-through cooling system [4]. This would consist of a change from the present intake point at 1,570 feet from shore where the water depth is 15 feet to a point at 6,000 feet from shore where the water depth is 30 feet. This would increase the separation between the intake point and the discharge point, which is located at the shore. One effect would be to

TABLE XI-3

Cost Increments of Alternative Cooling Systems, Relative to the Existing Once-Through System, in $1,000,000

	Natural-Draft Cooling Tower	Mechanical-Draft Tower	Cooling Pond[(a)]	Spray Canal
Added construction cost	16.9	10.1	18.1	11.4
Present worth of added cost of operation and loss of capacity[(b)]	21.4	22.1	28.1	23.2
Total	38.3	32.2	46.2	34.6

[(a)] Costs based on an optimum area of 1500 acres rather than the minimum area of 650 acres shown in Figure XI-1.

[(b)] Computed for 30 years of operation with a discount rate of 8.75% per year.

reduce the chances that fish attracted by the warm water being discharged would subsequently be entrained in the intake flow. However, there is no indication that this will be a major problem. Therefore, the incremental cost of approximately $10 million for such a change does not appear to be justified at the present time.

3. Environmental Comparison of Alternatives

The significant features of several alternatives, in regard to environmental aspects, are compared in Table XI-4. The categories of comparison in the table and the bases for the indicated judgments have been discussed elsewhere in this Statement. Additional data for the impact of a coal-fired alternative have been included here to indicate, in an approximate way for typical coal plants, the effects of atmospheric release, the use of land for storage of coal and ash, and the transportation of the coal to the plant.

An analysis has been made for the Applicant of the comparative effects of once-through cooling and cooling towers on the operation of the Kewaunee Plant [3]. The analysis provides a detailed quantitative estimate of the impact upon aquatic biota. However, the estimate admittedly is rather crude and is based on speculative data as to population densities and intake-capture fractions. The estimates were intended to include the maximum conceivable damage to biota. The results of the overall fish damage attributable to direct fish mortality and to loss of plankton for all aquatic effects were 1680 to 10,550 lb/yr for once-through cooling, and 120 to 270 lb/yr for closed-cycle cooling towers. The maximum values correspond to about 29 lb/day and 0.74 lb/day, respectively. Perspective on the estimated maximum fish loss of about 29 lb/day is provided by (a) the known high natural mortality of plankton and pre-adult fish, (b) the fact that the commercial catch in Lake Michigan is of the order of 30,000 lb/day on the average, and (c) the 1970 daily averages of coho salmon (alone) introduced into the lake by hatcheries is 660 lb/day at about $1.50/lb.

4. Benefits

The primary benefits of the Kewaunee Nuclear Power Plant are: (a) to provide an electrical generating capacity of 540 megawatts which will significantly enhance the reliability of meeting the power load of the Wisconsin Power Pool and will contribute to reserves available to other utilities through interconnections in the Wisconsin - Upper Michigan System and the Mid-America Interpool Network (MAIN), and (b) to supply 3.3 billion kilowatt hours of electrical energy per year (at an average capacity factor of 70%) to industrial, commercial and residential users.

TABLE XI-4. Comparison of Environmental Impacts of Existing Kewaunee Plant and Alternatives

Environmental Impact	Existing Kewaunee Plant	Coal Fired Power Plant with Once-Through Cooling	Kewaunee Plant With Cooling Towers		Kewaunee Plant with Cooling Pond	Kewaunee Plant with Spray Canal
			Mechanical Draft	Natural Draft		
Land Purchase	907.6 Acres	∿200 Acres	907.6 Acres	907.6 Acres	1600 Acres	907.6 Acres
Reduction of Agriculture Land	110 Acres	∿200 Acres	130 Acres	130 Acres	1600 Acres	170 Acres
Effect on Aquatic Life	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Effect on Bird Life	Negligible	Minor	Negligible	Negligible	Water fowl favored	Negligible
Heat Addition to Lake Michigan	1100 MW 4.1×10^9 Btu/hr	640 MW 2.2×10^9 Btu/hr	6 MW 1.8×10^7 Btu/hr	6 MW 1.8×10^7 Btu/hr	4 MW 1.2×10^7 Btu/hr	6 MW 1.8×10^7 Btu/hr
Artificial Radioactivity Releases to the Lake (man-rem/yr)	5	0	5	5	5	5
Artificial Radioactivity Releases to the Air (man-rem/yr)	0.2	0	0.2	0.2	0.2	0.2
Particulate Releases	0	∿2300 Tons/yr	0	0	0	0
Chemical Releases to the Lake	93 Tons Na_2SO_4/yr	74 Tons Na_2SO_4/yr	93 Tons Na_2SO_4/yr	93 Tons Na_2SO_4/yr	93 Tons Na_2SO_4/yr	93 Tons Na_2SO_4/yr

TABLE XI-4 (continued)

Environmental Impact	Existing Kewaunee Plant (Once-Through Cooling)	Coal Fired Power Plant with Once-Through Cooling	Kewaunee Plant With Cooling Towers: Mechanical Draft	Kewaunee Plant With Cooling Towers: Natural Draft	Kewaunee Plant with Cooling Pond	Kewaunee Plant with Spray Canal
Chemical Releases to the Air	Negligible	64,000 Tons SO_2/yr 12,800 Tons NO_x/yr	Negligible	Negligible	Negligible	Negligible
Fogging	Negligible	Negligible	Minor low-level fogging (approx. 10 days/year)	Persistent high-level plume	Minor low-level fogging (approx. 10 days/year)	Greater than for cooling pond
Icing	None	None	Negligible	Negligible	Negligible	Rare
Aesthetics	Minor impact	Major impact (stack and coal; ash piles)	Minor impact	Minor impact	Minor impact	Minor impact
Recreational Impact	Improved local fishing	Improved local fishing	None	None	None	None
Noise	Very quiet	Noisy	Moderate noise	Very quiet	Very quiet	Quiet
Transmission Lines	60 miles	60 Miles	60 miles	60 miles	60 miles	60 miles
Fresh Fuel Transport	About 4 truck-loads per year	Numerous long trains, ∿20,000 cars/yr	About 4 truck loads per year	About 4 truck-loads per year	About 4 truck-loads per year	About 4 truck-loads per year
Shoreline Erosion	Elimination near plant	Elimination near plant	Elimination near plant	Elimination near plant	Elimination near plant	Elimination near plant
Accidents	Exceedingly small risk of any significant release of radioactivity	Small risk of accidents associated with massive transport of coal	Same as existing Kewaunee Plant	Same as existing Kewaunee Plant	Same as existing Kewaunee Plant	Same as existing Kewaunee Plant

Availability of reliable power in the general vicinity of the Kewaunee Plant will encourage the expansion of industrial activities there, which presently include shipbuilding and manufacture of heavy equipment, aluminum products, and wood products.

At the peak of construction, the Kewaunee Plant has provided employment for 760 men and an annual payroll of about $12,000,000. The operating force will consist of about 70 men with an annual payroll of approximately $900,000. These are substantial benefits to the local economy.

Ad valorem taxes at the rate of 3.5% of the estimated valuation of the Kewaunee Plant will amount to $6,100,000 in 1973. Of this amount, about $4,900,000 will go to the State of Wisconsin, $800,000 to Kewaunee County, and $400,000 to the town of Carlton [4].

5. Balancing of Costs and Benefits

The main environmental considerations for the Kewaunee Nuclear Power Plant are the change from agricultural to industrial use of the site, negligible impact on aquatic and terrestrial life, radiological doses that are within the proposed AEC criteria of being "as low as practicable" and are a very small fraction of natural background, and an exceedingly small environmental risk of accidents involving radioactive materials. These effects are greatly outweighed by the benefits of supplying needed electricity without the air pollution associated with fossil-fuel plants.

The Staff believes that the choice of site, the selection of nuclear fuel, and once-through cooling for disposal of the discharge heat are realistic in terms of the available alternatives and represent choices which lead to a small environmental impact. As discussed in the preceeding sections, the environmental costs are small in comparison with the benefits resulting from the proposed Plant.

Section XI References

1. Wisconsin Public Service Corp., "Environmental Report - Operating License Stage," Kewaunee Nuclear Power Plant, Docket 50-305 (Nov. 1971).

2. Hubert E. Rissei, "Gasification and Liquefaction - Their Potential Impact on Various Aspects of the Coal Industry," Illinois State Geological Survey, Circular 430 (1968).

3. Environmental Systems Dept., Westinghouse Electric Corp., "Performance and Environmental Aspects of Cooling Towers," Report to Wisconsin Public Service Co., ESD-71-104, August 9, 1971.

4. Wisconsin Public Service Corp., "Environmental Report - Cost Benefit Analysis," for the Kewaunee Nuclear Power Plant, June 23, 1972.

5. Wisconsin Public Service Corp., "Comments on Federal, State and Local Agencies' Comments on the AEC Draft Environmental Statement," October 19, 1972.

XII. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to paragraphs A.6 and D.1 of Appendix D to 10 CFR Part 50, the Draft Environmental Statement (DES) was transmitted to and comments received from the Federal, State and local agencies listed on page iii. In addition, the AEC requested comments on the Statement from interested persons by a notice published in the Federal Register on July 21, 1972 (37 F. R. 14635). All of these comments are reproduced in Appendix E, in the order of receipt. Our consideration of the comments received is reflected principally by revised text in other sections of this Statement and also by the following discussion.

A. TEMPERATURE LIMITS ON THERMAL DISCHARGE (EPA, pp. E-19, 22, 30 and 31; Interior, page E-70)

As mentioned in Section V.B.1, the Plant's Condenser Cooling System was designed to limit the temperature of the water discharged to the lake to that allowed by applicable Federal-State water quality standards. The Staff concluded that compliance with the temperature limit established by the State might require Plant operation at reduced power for a few days during the summer. Recently the State of Wisconsin has adopted new thermal standards for Lake Michigan (see pp. B-1 and 2), derived from recommendations of the Lake Michigan Enforcement Conference (LMEC)(see pp. E-40 to 42).

The State's requirements are less restrictive than the LMEC recommendations, and are concerned only with temperature criteria. The maximum allowed temperatures on a monthly basis are identical with those recommended by the LMEC, but the locations where they are applicable differ. The LMEC recommended that the $\Delta T = 3°F$ isotherm be no more than 1,000 feet from a fixed point adjacent to the discharge. If this point were at the discharge mouth, the area enclosed by the 3°F isotherm would have to be less than 40 acres. Under some lake-current conditions, such as those prevailing during the measurements presented in Figure III-6, operation at only a minute fraction of the design power would be possible if the 1,000 foot limit were to be met. In contrast, the Wisconsin standards apply the 3°F increment to the boundary of a mixing zone which will be established by the State's Department of Natural Resources after completion of an investigation, study, and review of the ecological and environmental impacts of the thermal discharge.

The State code regarding thermal standards for Lake Michigan allows the Department of Natural Resources to order reduction of the thermal discharges to the lake if environmental damage appears imminent or existent.

This is in contrast with the LMEC recommendation that plants placed in operation after March 1,1971 be committed to a closed-cycle cooling system.

The Staff believes that at full power operation the Plant's discharge will exceed the thermal criterion recommended by the LMEC for extent of the 3°F isotherm. The Applicant will be required to conduct a detailed monitoring program to determine the extent of the thermal plume and any associated biological effects. The State's Department of Natural Resources has already reviewed the Applicant's plans for an augmented monitoring program and has found them acceptable in terms of the requirements of the State's thermal standards for Lake Michigan (see pp. E-43 and B-2).

The Staff believes that its primary charge is the assessment of actual environmental impact (encompassing the total environment, not only the aquatic portion), and not just the compliance with existing standards. If unacceptable biological damage is found to be due to the thermal discharge (whether or not the discharge meets LMEC criteria), the Staff recommends modification of the existing discharge system (including going to a closed cycle-system if it is the only alternative) or reducing power at such times as unacceptable biological effects are known to occur.

The Staff is of the opinion that any significant detrimental effects of the thermal discharge will be detected by the Plant's monitoring programs and will be reversible upon removal of the discharge. It is also our opinion that restriction of the proposed thermal discharges on the basis that such discharges <u>may</u> cause environmental damage would prove to be an unnecessary hardship upon the Applicant and would result in the severe disruption of the Applicant's program to provide reliable electric service to the general public in the area.

The Staff endorses the procedure specified in the State's standards that any further restrictions regarding thermal discharge to the lake be established on the basis of results from a localized monitoring program. The Environmental Protection Agency actually has recommended a less precipitous approach than that indicated by the LMEC recommendations. The Assistant Administrator for Enforcement and General Counsel has stated [1] that the EPA's policy on thermal effluent for the permit program is "...that all discharges to the aquatic environment involving waste heat be <u>evaluated on a case-by-case basis</u>.... Where <u>the evidence indicates</u> that once-through cooling will damage the aquatic environment, plants currently operating or under construction should be permitted to

operate, but with a commitment to off-stream cooling..." (emphasis added).

A number of other LMEC recommendations are concerned with water intake and discharge. Two situations related to temperature increments in the lake water which may be at variance with those recommendations have been identified (Page E-31). These are that the plumes from the Kewaunee and Point Beach plants may overlap and that the Plant's intake structure is located within an area that may be affected by its own thermal discharge. On the basis of measurements of the Point Beach plume, presented in part in Section III.D.1.a. iii., the Staff has concluded that the overlap will be insignificant and its consequences unimportant in terms of the effect on the lake's biota. We agree that the Plant's intake structure is located within the area that will, under certain conditions of lake currents, be affected by its thermal discharge. The intake is approximately 1700 feet from the discharge and 14 feet below the lake's surface. The Staff believes that, even for the worst conditions for the lake current, the buoyancy of the heated water discharged from the Plant and its dilution will result in an inconsequential temperature increment for the intake water.

B. CHEMICAL AND THERMAL IMPACT ON BIOTA (EPA, pp. E-32 to 35)

In assessing the significance of chemical and thermal impact on biota, it is appropriate to consider the lake as a natural system. As a whole, the lake has 1400 miles of mainland shoreline, 22,300 sq miles of water surface and a water volume of 1180 cubic miles. Although receipt of water and heat varies daily, seasonally, and randomly, the annual rainfall and evaporation rates both average 40,000 to 50,000 cfs, with a net addition of water. A fraction of the 48,000 cfs rainfall on the land portion draining to the lake serves to augment the lake and supply the 40,000 to 55,000 cfs outflow at the Mackinac Straits and the 3200 cfs diversion at Chicago [2,3].

Present analysis of the lake (see II.D.1.b.) shows 138 ppm of total dissolved solids (TDS), (including 1.2 ppm nitrate, 0.71 phosphorus, 28 sulfate, 9 chloride, 37 calcium, and 108 carbonate). The annual rate of addition of chemicals to the lake in natural drainage and in industrial, agricultural, and municipal wastes is about 97×10^8 kg/yr of TDS, including 8.2×10^8 kg/yr of chloride, 0.11 of phosphate, 0.28 of nitrate, 17 of calcium, and 2.1 of silica [4]. This rate is equivalent to an increase in TDS of 2 ppm per year, neglecting removal processes.

The Plant is located near the south end of the 26.9 miles of Lake Michigan shoreline within Kewaunee County. The County has an area of 330 sq miles of which 17.5 percent is forested, with nearly all the rest under agriculture. The population is about 20,000 with a small amount of manufacturing, but a major (approximately 700 tons/yr) fishing industry. Over 99 percent of the shore is privately owned, and there is limited recreational use of the lake. (See Section II.B). Drainage of the annual 26.5 inches (average) of rain is to the lake, the only rivers being the Kewaunee and the Ahnapee. The lake shore at Kewaunee has a comparatively low density of population and manufacturing. Kewaunee County makes up 0.72% of the total land drainage area of Lake Michigan, and this is equivalent to about 70 x 10^6 kg/yr of total chemical addition to the lake (see above), on a proportional basis. The expected Plant addition to the lake is 46 tons/yr (42,000 kg/yr), or about 0.06% of the estimated chemical addition from Kewaunee County. Thus the Plant's chemical addition to the lake is a small fraction of that naturally occurring for the county and for the lake as a whole.

In the natural warming of the lake (from April through August), the average absorbed heat of 1100 BTU/(sq ft)(day) is equivalent to the once-through discharge of heat from more than 4200 1000-MW(E) nuclear reactors. (Of course, the cooling period of winter results in the loss of an equal amount of heat). Average effects of a 1000-MW(E) nuclear reactor would be to raise the temperature of the lake surface by about 0.003°F per year, and to increase the evaporation rate by about 18 cfs [5]. These temperature effects are small compared to natural variations and are undetectable, except in a very small area near the point of Plant discharge.

In view of the very small quantities of chemical and thermal discharges from the Plant, relative to the total input to the lake, the additional impact is judged to be negligible.

C. POTENTIAL HAZARDS FROM NON-RADIOACTIVE CHEMICALS (EPA, pp. E-37 and 38)

The major types of hazardous liquids at the Kewaunee Nuclear Plant include sulphuric acid and caustic soda (used in the demineralizer regeneration) and sodium hypochlorite (which may be used intermittently as a biocide in the cooling system). Hydrazine, morpholine and phosphates are used in the secondary system for steam and condensate quality control, and small amounts of reagent chemicals are used in both the hot and cold chemistry laboratories. These would be considered common types of chemicals.

There are emergency procedures for both non-radioactive chemical spills and radioactive spills that may occur. (See Section VI.A). Should any of these spills enter either the deaerated or the aerated drain systems within the Plant, the material would be processed through the waste evaporator and demineralizer systems. Since process effluents are monitored before discharge to the circulating water, these hazardous liquids will not directly enter the lake without treatment.

Apart from radioactive materials and from certain materials common in electrical generation, such as hydrogen for generator cooling and transformer oil, there are no special volatile materials. Common aqueous solutions of acids, bases, and salts are not special hazards. Elemental chlorine, often used for chlorination, will not be used at Kewaunee; an aqueous solution of sodium hypochlorite will be used instead, if needed. There are no toxic or hazardous uses of volatile materials in the Kewaunee Plant. Some cleaning solvents, primarily acetone, are used. However, except for extensive cleaning during construction, the quantities on site are too small to constitute a hazard.

D. RELEASE OF RADIOACTIVE MATERIALS TO THE LAKE UNDER ACCIDENT CONDITIONS (Interior, page E-69)

A comment was made that releases to water should be considered. The doses calculated as consequences of the postulated accidents are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. Our evaluation of the accident doses assumes that the Applicant's environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to 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.

Radioactive liquid wastes in the Kewaunee Plant are contained within Class 1 structures. Failure of equipment within these structures would not lead to a release of radioactive liquid to the environment.

E. CONDENSER CLEANING ALTERNATIVES (Commerce, page E-12)

The Applicant is committed to comply with applicable EPA standards for residual chlorine effluent from the circulating water system and to further consider mechanical cleaning methods in the event of any future indicated deleterious effects of chlorine released from the Plant [6].

Chlorine is almost universally used to prevent growth of bacterial slimes in cooling systems, although in some cases mechanical cleaning methods are used to reduce substantially the amount of chlorine required. The Applicant's method of achieving compliance with the EPA's proposed standards of low free chlorine concentration involves close control of the maximum concentration in the effluent and low frequency of use. These controls are detailed in the Technical Specifications. The mechanical systems are appreciably more costly. Backfitting of a mechanical system would impose an additional cost penalty which, when combined with the high installation cost, would exceed the anticipated benefits.

The Staff believes that compliance with the Plant's Technical Specifications will result in an average residual chlorine effluent within the EPA proposed limits, and that, at this low release, any detectible effect beyond an immediate local area of a few acres is highly improbable. The risk of damage is believed acceptable in this specific case, considering the Technical Specifications, the Applicant's monitoring program and commitment to redress damage, the present state of construction of the Plant, and the state-of-the-art of cooling systems.

F. QUANTITATIVE ESTIMATES OF FISH DAMAGE BY ALTERNATIVE COOLING MEANS (Interior, pp. E-69-70)

The results of an estimate by the Applicant of the possible reduction in fish population by the impact of alternative cooling means was cited in Section XI.B.3. The U. S. Department of the Interior has suggested that the estimates may be low because of 1) additional factors in the food chain of fish, and 2) fishing as a recreational asset. The Staff did not intend to imply an endorsement of the Applicant's methodology or the results, but only to call attention to the attempt to make a quantitative balance between a large natural resource and the specific operation of a single plant. In that estimate, a 40-fold higher fish mortality was attributed to once-through cooling as compared with closed-cycle cooling. On the other hand, the highest estimate of fish "lost" per year was about 1/1000th of the average commercial catch, and had an estimated dollar cost of the order of 1/200th of the cost penalty for power generation with closed-cycle cooling. In other words, it was determined that any reasonable value, for fish which would be saved by having a closed-cycle cooling system, is much less than the cost of installing and operating such a system.

The balancing of these costs requires criteria for their acceptable distribution among the several interests involved. The Staff believes that criteria can emerge in the coming period of closely supervised operation of nuclear power plants, as a clearer understanding of actual and potential effects develops.

G. MONITORING PROGRAMS (EPA, pp. E-36 and 37; WPS, pp. E-46 and 51)

In the Draft Environmental Statement the Staff indicated a number of areas in which the proposed monitoring programs did not seem adequate to determine the thermal, chemical and radioactive discharges from the Plant, and to determine the biological and other consequences. Since the time that the DES was prepared, the monitoring programs have been augmented and we have been made aware of additional related studies. The Applicant has provided the following list of current and completed studies [8]:

The list of studies presently underway is as follows:

1. University of Wisconsin - Milwaukee
   - Temperature
   - Radioactivity
   - Sediment
   - Phytoplankton
   - Zooplankton
   - Current Studies
   - Effect of Plankton as they pass through the cooling system

2. University of Wisconsin - Madison & Green Bay
   - Infrared Flyovers
   - Littoral Drift and Sediment Characteristics

3. State of Wisconsin Department of Health & Social Services
   - Radioactivity of Water, Algae, Fish, Milk and Vegetation

4. Great Lakes Research Division - University of Michigan - Dr. John C. Ayers
   - Biological Sampling
   - Dissolved Oxygen Sampling

Studies that have been completed are:

1. Lake Michigan Utility Study Group
   Chemical Composition of Lake Michigan
   Trace Element Analysis of Aquatic Biota

2. Helgeson Nuclear Services, Inc.
   Underwater Gamma Probe

3. Industrial Bio-Test, Inc.
   First Year - Thermal Monitoring Program

A comprehensive program to determine the evaluation of the major components in the food chain to man has been undertaken by the Lake Michigan Utility Study Group of which the licensee is a member.

This study represents an ongoing evaluation of the entire Lake Michigan aquatic ecosystem.

Environmental Research Group - Ann Arbor, Michigan
Analysis of the Food Chain Concentration Factors to Man.

This Final Environmental Statement reflects the additions to the monitoring programs and the consequent reduction in the number of points for which we feel that further clarification and additions will be required. Various aspects of the monitoring program are described in this Statement. Where the information available was not adequate to determine whether the sampling would be sufficient in terms of frequency or number of locations, an appropriate comment was made. In addition, some deficiencies in the program were noted. These are summarized below, with references to the text for related information:

	Item	Reference
1.	Shoreline erosion	V.A.1, IV.C
2.	Temperatures near promontory	V.B.1
3.	Fish movement into the Plant by way of the cooling water discharge	V.C.3.e

Item	Reference
4. Fish migration before and after start-up and during shutdowns	V.C.3.e, V.C.6
5. Control and monitoring of any use of chlorine	V.C.4
6. Radioactivity of bottom sediments, organisms and aquatic plants near discharge	V.D.6
7. Radioactivity of local milk and meat	V.D.6

H. SECONDARY COOLANT SYSTEM LEAKAGE (EPA, pp. E-22 and 25)

Our evaluation assumed a primary-to-secondary leak rate of 20 gallons per day, a continuous blowdown rate of 10 gpm and a leak to the auxiliary building of 20 gallons per day. Section III.D.2.b discusses some of these leaks and indicates that in order to reduce the escape of gaseous radioactivity, coolant water that may leak along valve stems located in the containment and the auxiliary building will drain through a closed piping system to the deaerated drain tank. Deaerated waste is treated and returned to the Plant for reuse. Sources and treatment of aerated waste (floor drains and equipment) are discussed in the aforementioned section. As noted above, we considered a 10 gpm steam generator blowdown and that this waste would be treated by the blowdown demineralizers.

Although not specifically mentioned in the DES, our evaluation did consider leaks to the turbine building, but based on available operating data, we expect these to be a negligible source of activity. As indicated in Section III.D.2.b, our releases for normal operation were calculated to be a fraction of those shown in Table III-4; however, the values have been normalized upward to 5 curies/year to compensate for expected operational occurrences. We do not expect that releases will exceed this value. The approved Technical Specifications for the Plant will delineate the limiting conditions for operation, including effluent releases.

I. COMBINED ENVIRONMENTAL EFFECTS FROM KEWAUNEE AND POINT BEACH (EPA, pp. E-20 and E-26)

The Staff agrees that there are no regional siting criteria which relate to operation of multiple reactors in a region. Multiple plants are now considered, from the standpoint of radiological impact, only in the following instances:

1. If there are multiple units on the same site (e.g., North Anna, Peach Bottom).

2. If two or more plants share a common discharge canal.

3. If two or more plants have a common boundary or boundaries (e.g., FitzPatrick and Nine Mile Point).

This does not mean to imply that the AEC is not cognizant of, or unwilling to examine, the potential impact of multiple plants in the same region, even if the above criteria are not met. This is evidenced by considerations upon which 10 CFR 50 proposed Appendix I is based. The proposed site boundary dose of 5 mrem per year was developed on the basis that, from the standpoint of radiation exposure to humans and projected U. S. power needs to the year 2000, regional effects would be minimal.

J. THERMAL PLUME DISPERSION AND APPLICABILITY TO THE KEWAUNEE PLANT (Interior, pp. E-63 and 64)

The comments assume that the discharge velocity is maintained to the end of the 530 foot long channel cut into the lake bottom. This is not expected to happen since there are no confining boundaries to prevent entrainment of ambient lake water once the cooling water leaves the discharge basin at the shoreline. Data from hydraulic model tests, described in Section III.D.1.a.ii, were used to substantiate that mixing would occur and to estimate the distance that the plume would travel before the centerline temperature started to attenuate. This is believed to be the best data available for this situation. The estimate of an average exposure of two minutes to the maximum temperature is believed to be reasonable.

The effect of strong shore-parallel currents would be to cause the plume of warm water to flow near the shore, as shown in Figure III.6 (for the Point Beach Plant). However, the conditions that promote these strong near-shore currents, i.e., strong winds from the north, northeast, and southeast, also create rough lake conditions, a great deal of turbulence (as indicated by turbidity levels) and waves breaking in the vicinity of

the beach and outfall. These conditions promote mixing and partially, if not completely, compensate for the plume being bounded on one side by the shoreline. Figure III-6 illustrates that the initial temperature has been attenuated within a few hundred feet as a result of the ambient turbulence. Thus, strong shore-parallel currents are not expected to subject entrained organisms to maximum temperatures for a greater time than that estimated in Section III.D.1.b.

While the configuration of the plume, when influenced by strong near-shore currents, leads to long, narrow areas within isotherms, the time that entrained organisms would be subjected to any given temperature will not be significantly greater (in fact,it may be less) than in a plume that does not hug the shore. This is a result of the relatively high velocities (near-shore velocities of 2-2.5 fps have been measured) in the near-shore waters.

It is not clear that the large Point Beach plume shown in Figure III-7 proves or disproves the Applicant's analysis, as stated in the comment. It is a large plume and was included with Figure III-6 to illustrate the variability of plumes observed in an area very near the Kewaunee site. An analysis of ambient lake current data at the Point Beach site indicated that the current shifted from a southerly to a northerly flowing current during the morning of August 31. Thus, for a period of time the plume was mixing, not with ambient lake water, but with water previously associated with the plume. The Applicant's model did not represent this situation. Figures III-8 and 9 represent the plume on the following morning and afternoon (Sept. 1) and show a considerable reduction in size.

Concerning the effects of sinking thermal plumes, little can be said except that they will occur when the ambient lake temperature is less than 4°C. Observations of this phenomenon at the Point Beach site during the winter of 1971-72 [7] showed influences of the plume on the bottom as long as the lake temperature was below 4°C. The maximum temperature observed on the lake bottom was 5.2°C at a point 335 meters from the discharge; at 1525 meters the maximum observed bottom temperature was 2.6°C. Since the cooling water discharge temperature during the deicing mode of operation is about 14°C, this means that the chemical concentrations at a point 335 meters from the discharge would have been a maximum of 37 percent of the discharge concentration and a maximum of 18 percent of the discharge concentration at the point 525 meters from the discharge. Similar conditions should prevail at the Kewaunee site. No data are available to estimate the areas affected by sinking plumes.

Concerning applicability to the Kewaunee Plant, Figure III-11 does not indicate that the plume extends to the bottom. It shows the maximum depth of the 13°C isotherm to be about 10 feet at 1000 feet from the discharge. The lake depth was 16 feet at this point. This is not inconsistent with the statement that the plume separates from the bottom within about 600 feet from the discharge. While the "ambient" temperature is often difficult to define, the great majority of Point Beach data show that the plumes, or what can be readily identified as plumes, are about 6 to 8 feet deep near the Point Beach intake (1750 feet from shore). In the far-field, the measured depths are 6 feet or less. We have no reason to believe that it will be significantly different at the Kewaunee site.

K. LOCATION OF PRINCIPAL CHANGES IN THIS STATEMENT IN RESPONSE TO COMMENTS

Topic Commented Upon	Section Where Topic is Addressed
Consideration of alternative cooling methods during site selection (Commerce, page E-11)	I.A
Year-class abundance of fish (Commerce, pp. E-11 and 12)	II.B.2.e
Lake currents (Commerce, pp. E-6, 12, 58)	II.D.1.b
Thermal bar (Commerce, pp. E-12, 58 to 59)	II.D.1.b
Mineral content of ground water (WPS, page E-45)	II.D.2
Wind conditions (Commerce, page E-6)	II.D.3.b.i and ii
Comparison of inshore and offshore algae (EPA p. E-32, Interior pp. E-62 and 63; WPS, p. E-47)	II.E.3.b.1
Bacterial counts near Plant (WPS, page E-47)	II.E.3.b.2
Revised discussion of zooplankton (WPS, page E-47)	II.E.3.b.3
Augmented discussion of periphyton (WPS, page E-47)	II.E.3.c

Topic Commented Upon	Section Where Topic Is Addressed
Revised discussion of benthos (Interior, page E-63; WPS, page E-47)	II.E.3.d
Lake trout and commercial fishing (WPS, page E-48)	II.E.3.e
Radwaste management (EPA, pp. E-22 and 23)	III.D.2
Iodine control by available Plant systems (EPA, pp. E-19, 22, 23, and 24)	III.D.2.a
Modified steam generator blowdown treatment (WPS, page E-45)	III.D.2.a
Handling of boric acid evaporator bottoms (WPS, page E-45)	III.D.2.b
Modified liquid radwaste disposal system (WPS, page E-45)	III.D.2.b
Discharge of secondary coolant (WPS, page E-45)	III.D.3
Modified make-up water system (WPS, pp. E-45, 52-54, 56)	III.D.3
Disposal of solid refuse (EPA, pp. E-38 to 39; WPS, page E-45)	III.D.4
Emergency heaters and generators (EPA, page E-38)	III.D.4
Revised Plant schedule (WPS, page E-46)	IV.A
Onsite land use (WPS, page E-46)	IV.B.1
Modified water use (WPS, page E-45)	IV.B.2, V.B
Noise abatement measures (EPA, page E-39)	IV.C
Shoreline erosion (EPA, page E-37; Interior, page E-61)	IV.C, V.A.1

Topic Commented Upon	Section Where Topic is Addressed
Soil erosion (Commerce, page E-9; Interior, page E-61)	IV.C, V.A.1
Sedimentation in discharge canal (EPA, page E-37)	V.A.1
Use of property for grazing (EPA, pp. 20, 22, 26)	V.A.1
Deviation from LMEC discharge temperature recommendations (EPA, pp. E-19, 22, 30, 31; Interior, page E-70)	V.B.1
Thermal discharge bottom conditions (Interior, page E-65)	V.B.1
Operation and performance of the sewage treatment system (EPA, pp. E-37 and 38)	V.B.2
Fish attraction and monitoring (WPS, page E-49)	V.B.3, V.B.4.c
Expanded hydrological monitoring program (WPS, page E-46; EPA, page E-36)	V.B.4
Aquatic intake data (Commerce, page E-12; WPS, page E-49)	V.C.2.a
Modified discussion of plankton (Interior, pp. E-65 and 66)	V.C.2.a
Entrainment of fish eggs and larvae (Interior, page E-66)	V.C.2.b
Bubble screen and electric probe (EPA, page E-33)	V.C.2.c
Effects of thermal discharge (Interior, page E-65)	V.C.3.a
Effect on organisms attracted to plume (Interior, pp. E-65 and 66)	V.C.3.b-d
Effects of temperature increases on fish (EPA, page E-32; Interior, pp. E-67 and 68; WPS, pp. E-49 and 50)	V.C.3.e.1

Topic Commented Upon	Section Where Topic is Addressed
Effects of temperature decreases on fish (Commerce, page E-13; Interior, page E-68)	V.C.3.e.2
Impact of effluent on species composition (Interior, page E-68; WPS, pp. E-50 and 51)	V.C.3.e.3
Consequences of chlorine release (EPA, pp. E-34 and 35)	V.C.4
Revised biological monitoring program (EPA, page E-36; Commerce, page E-13)	V.C.6
Duration of fish sampling periods, (Commerce, p. E-13)	V.C.6
Specification of χ/Q values (Commerce, pp. E-6 and 7)	V.D.2
Potential thyroid dose to child (EPA, pp. E-19, 22, and 26)	V.D.2
Whole Body dose on lake (EPA, p. E-26)	V.D.2
Direct radiation dose (EPA, page E-27)	V.D.4
Modified radiological monitoring program (WPS, pp. E-46 and 51; Commerce; page E-13)	V.D.6
Aquatic plant sampling (Commerce, pp. E-13)	V.D.6
Fuel movement by barge (Transportation, page E-10)	V.E.2
Processing of radioactive liquids (WPS, page E-46)	V.E.3
Meterological assumptions for accident analyses (Commerce, page E-7; EPA, page E-38)	VI.A
Need for power (Wisconsin PSC, pp. E-4 to 5; FPC, pp. E-14 to 17)	X

Topic Commented Upon	Section Where Topic is Addressed
Impact of once-through cooling (Interior, page E-69)	XI.A.3.f
Cost of alternate power (Interior, page E-69)	XI.B.1
Applicant's estimate of gaseous radioactivity release (WPS, page E-46)	Appendix A
Effects on historic and archeological resources (ACHP, page E-2; Interior, page E-61)	Appendix E, p. E-60

Section XII References

1. John R. Quarles, Jr., "Policy on Thermal Effluents," Memo to Regional Administrators, Environmental Protection Agency, May 12, 1972.

2. J. V. Tokar, "Thermal Plume in Lakes: Compilations of Field Experience," USAEC Report ANL/ES-3, Argonne, Illinois, August 1971.

3. U. S. Department of Commerce, "Climatic Atlas of the United States" Washington, D. C., June 1968.

4. Sam B. Upchurch, "Natural Weathering and Chemical Loads in the Great Lakes," in Abstracts of the Fifteenth Conference on Great Lakes Research, University of Wisconsin (Madison) 1972, p. 63.

5. J. G. Asbury, "Effects of Thermal Discharges on the Mass/Energy Balance of Lake Michigan," USAEC Report ANL/ES-1, Argonne, Illinois, July 1970.

6. Wisconsin Public Service Corporation, "Comments on Federal, State and Local Agencies' Comments on the AEC Draft Environmental Statement," October 19, 1972, USAEC Docket No. 50-305.

7. Hoglund, B. and Spigarelli, S., "Studies of the Sinking Plume Phenomenon," Proc. of Fifteenth Conf. on Great Lakes Research, Int'l. Assoc. of Great Lakes, (in press).

8. Wisconsin Public Service Corp., "Submission of Environmental (Non-Radiological) Technical Specifications for the KNPP," October 13, 1972.

Appendix A

Table A-1. Applicant's Estimated Annual Gaseous Radioactivity Release, by Isotope[b]

Activity Release, Ci/Yr

Isotope	Decay Tanks	Steam Generator & Air Ejector	Steam Dump (Pressure Relief)	Containment Purge	Auxiliary Building & Misc.	Total
Kr-85	2871	-	-	-	1.0	2872
Kr-85m, 87,88	-[a]	75	-	-	-	75
Xe-133	2429	5000	-	370	87	7886
Xe-133m, 135, 135m, 138	-	200	-	-	5	205
I-131, 133, 135	-	-	0.173	.9	-	1.1
Total	5300	5275	0.173	371	93	11039
Quantities		$1.56 \times 10^9 ft^3$	$6.6 \times 10^5 lb$	$2.7 \times 10^8 ft^3$	$.25 \times 10^{10} ft^3$	

[a]Negligible

[b]Amendment 18 to FSAR, Table 11.1-6, 5/19/72.

Appendix A

Table A-2. Applicant's Estimated Annual Liquid Release,[a] by Isotope

Isotope	Annual Release,[b] Micro-Curies	Average Annual Fraction of MPC
Sr-89	1.79×10^{2}	1.3×10^{-7}
Sr-90	3.15×10^{0}	2.4×10^{-8}
Y-90	3.33×10^{0}	4.03×10^{-10}
Sr-91	4.73×10^{1}	1.66×10^{-9}
Y-91	3.22×10^{2}	2.61×10^{-8}
Y-92	7.60×10^{1}	2.85×10^{-9}
Zr-95	3.41×10^{1}	1.42×10^{-9}
Nb-95	3.18×10^{1}	7.59×10^{-10}
Mo-99	1.32×10^{6}	7.82×10^{-5}
I-131	1.02×10^{5}	8.17×10^{-4}
I-132	2.88×10^{3}	8.6×10^{-7}
I-133	1.32×10^{5}	3.2×10^{-4}
I-134	3.13×10^{1}	4.39×10^{-9}
I-135	4.01×10^{4}	2.37×10^{-5}
Cs-134	4.75×10^{4}	1.3×10^{-5}
Cs-136	2.20×10^{5}	8.77×10^{-6}
Cs-137	2.92×10^{5}	3.44×10^{-5}
Te-132	1.07×10^{4}	8.54×10^{-7}
Ba-140	1.75×10^{2}	2.13×10^{-8}
La-140	5.87×10^{1}	6.99×10^{-9}
Mn-54	2.85×10^{2}	6.76×10^{-9}
Mn-56	1.59×10^{2}	3.79×10^{-9}
Co-58	5.48×10^{2}	1.42×10^{-8}
Co-60	9.51×10^{1}	7.59×10^{-9}
Total	2.17×10^{6}	1.38×10^{-3}

[a]Radioactivity contained in 357,340 gallons of discharged water.

[b]After 3×10^{4} seconds decay.

Appendix B

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
Box 450, Madison, Wisconsin 53701

LAKE MICHIGAN THERMAL STANDARDS
(Adopted by the Natural Resources Board December 8, 1971;
effective February 1, 1972)

NR 102.04 of the Administrative Code is created to read:

102.04 LAKE MICHIGAN THERMAL STANDARDS. For Lake Michigan the following thermal standards are established so as to minimize effects on the aquatic biota in the receiving waters.

(1)(a) Thermal discharges shall not raise the receiving water temperature more than 3°F at the boundary of mixing zones established by the Department.

(b) In addition to the limitation set forth in subsection (1)(a), but excepting the Milwaukee Harbor, Port Washington Harbor and the mouth of the Fox River, thermal discharges shall not raise the temperature of the receiving waters at the boundary of the established mixing zones above the following limits:

January	45°F
February	45°
March	45°
April	55°
May	60°
June	70°
July	80°
August	80°
September	80°
October	65°
November	60°
December	50°

(2) All owners utilizing, maintaining or presently constructing sources of thermal discharges exceeding a daily average of 500 million Btu per hour shall:

(a) Submit monthly reports of temperature and flow data on forms prescribed by the Department commencing 60 days after the effective date of this rule.

(b) Within 24 months of the effective date of this rule, complete an investigation and study of the environmental and ecological impact of such discharge in a manner approved by the Department. After a review of the ecological and environmental impact of the discharge, mixing zones shall be established by the Department.

(c) Submit to the Department within 6 months of the effective date of this rule a preliminary engineering report for the installation of alternative cooling systems.

(d) Submit within 6 months of the effective date of this rule a detailed chemical analysis of blowdown waters discharged to Lake Michigan and its tributaries.

(3) Any plant or facility, the construction of which is commenced after the effective date of this rule, shall be so designed as to avoid significant thermal discharge to Lake Michigan.

(4) The Department may order the reduction of thermal discharges to Lake Michigan regardless of interim measures undertaken by the source owners in compliance with this rule if environmental damage appears imminent or existent.

(5) The provisions of this rule are not applicable to municipal waste and water treatment plants and vessels.

Statement on Thermal Standards for Lake Michigan
by
Environmental Quality Committee
Wisconsin Natural Resources Board

The problem of heat discharges is complex involving not only the scientific data required to establish criteria, but also the social and economic considerations that must be evaluated in establishing standards and providing preventive and corrective measures. Based on our review of the information presented, we are of the opinion that much is unknown about the effects of thermal discharges and about the environmental impact of corrective works or methods that may be employed to reduce the quantity of heat discharged. However, because of the increased possibility of damage to Lake Michigan from proliferation of power plants, the Committee believes that it is sound public policy to prohibit thermal discharge from plants not now operating, operable, or under construction until questions we and others have raised have been answered. The Committee holds that the financial burden to establish the impact of heated discharges rests on the industry.

A two-year study conducted at the various power plant sites on Lake Michigan, together with data now being obtained from several other studies, should provide data on which rational decisions as to proper corrective measures to be taken can be based. These studies will be conducted by the industry and will be designed and supervised by the Department (of Natural Resources).

In the meantime, the Department will be conducting its own investigations, including further evaluation of the environmental problems associated with cooling towers or cooling ponds.

Further, we would reserve to the Board and the Department the right to take immediate remedial action should it be determined at any time during the two-year study period that environmental damage appears imminent or existent.

This provision, coupled with a moratorium on the siting of additional plants on Lake Michigan, satisfies the Committee that the quality of the Lake can and will be maintained to best serve the public interest.

Appendix C

TABLE C-1. PLANT SPECIES FOUND AT POINT BEACH STATE FOREST, TWO RIVERS, WISCONSIN

Trees and Other Woody Plants

Arctostaphylos uvaursi
Betula papyrifera
Ceanothus ovalus
Chaemaedaphne calyculata
Cornus stolonifera
Ilex verticillata
Juniperus communis var. depressa
J. harizontalis
Larix laricina
Populus balsamifera var. subcordata
P. deltoides
P. nigra
Prunus pumila
P. Serotina
P. virginiana
Quercus borealis
Rosa acicularis x R. blanda
R. blanda
R. fendleri
Rubus strigosus
Salix amygdaloides
S. glaucophylloides var. glaucophylla
S. interior
S. lucida
S. petiolaris
S. syrticloa
Shepherdia canadensis
Speraea alba
Thuja occidentalis
Tilia americana
Vitis riparia

Forbs

Anaphalis margaritacea
Anemone cylindrica
Arabis lyrata
Artemisia campestris
A. caudata
Asclepia incarnata
A. syriaca
Aster novae-angliae
A. puniceus
A. simplex
Barbarea vulgaris
Bidens cernua
B. frondosa
Brassica kaber
Cakile edentula
Campanula apariniodes
C. rotundifolia
Chelone glabra
Cirsium pitcheri
Daucus carota
Dryopteris cristata
Epilobium adenocaulon
Equisetum arvense
E. hyemale var. affine
Erigeron pulchellus
Eupatroium maculatum
E. perfoliatum
Liatris aspera
L. cylindracea
Lithospermum canescens
Lobelia siphilitica
Lycopodium clavatum
Lycopus virginicus
Mentha arvensis
Mimulus ringens
Monotropa uniflora
Naumburgia thyrsiflora
Nuphar variegatum
Oenothera biennis
O. humifusa
Orobanche fasciculata
Osmunda claytoniana
O. regalis
Pedicularis lanceolata
Penthorum sedoides
Polygonum lapathifolium
P. natans
P. punctatum
Potentilla anserina
P. palustris
Ranunculus sceleratus
R. septentrionalis
Rorippa islandica
Rumex crispus

TABLE C-1. (Contd.)

Forbs (continued)

Euphorbia polygonifolia
Fragaria chiloensis
F. virginiana
Gentiana clausa
Gerardia purpurea
Gnaphthalium obtusifolium
Habenaria hyperborea
H. viridis var. bracteata
Hieracium canadense
H. paniculatum
Hypericum mutilum
Impatiens biflora
Iris versicolor
Lathyrus maritimus
Lepidium densiflorum
R. martimus
Salsola kali var. tenuifoli
Saponaria officinalis
Scutellaria galericulata
S. laterifolio
Sium suave
Smilacina stellata
Solanum dulcamara
Solidago juncea
Spiranthes cernua
Stellaria longifolia
Thelypteris palustris
Triglochin palustris
Typha latifolia
Viola adunes
Xanthium strumarium

Grasses and Grass-like Plants

Agropyron dasystachium
A. repens
A. smithii
Agrostis hyemalis
Ammophila breiligulata
Andropogon gaardi
A. scoparius
Calamagrostis canadensis
Calamovilfa longifalia var. magna
Carex aurea
C. goberi
C. hystericina
C. pseudo-cyperus
C. retrorsa
C. sparganoides
C. viridula
Cyperus schweinitzii
Dulichium arundinaceum
Eleocharis compressa
Glyceria striata
Juncus balticus
J. scirpoides
Koeleria cristata
Lolium multiflorum
Scirpus cyperinus
S. validus

Non-vascular Plants

Cladonia pysidata
Sphagnum palustre
Riccia fluitans
Tortula ruralis

TABLE C-2. TREES AND SHRUBS WHICH MAY BE FOUND IN THE GENERAL KEWAUNEE REGION[a]

Common Name	Scientific Name
American Basswood	Tilia americana
Hard Maple Sugar	Acer saccharum
White Birch	Betula pendula
White Pine	Pinus strobus
Red Oak	Quercus rubra
American Elm	Ulmus americana
Red Maple	Acer rubrum
Silver Maple	Acer sacharinum
Black Ash	Fraxinus nigra
White Ash	Fraxinus americana
Eastern White Cedar	Thuja occidentalis
Quaking Aspen	Populus tremuliodes
Eastern Hemlock	Tsuga canadensis
Tamarack	Larix laricina
Yellow Birch	Betula allegheniensi
Chokecherry	Prunus virginiana
Pin Cherry	Prunus pensylvanica
Mountain Ash	Sorbus americana
Ironwood	Ostrya virginiana
American Beech	Fagus grandifola
Tag Alder	Alnus sp.
Silky Dogwood	Cornus sp.
Red-oshier Dogwood	Cornus stolonifera
White Oak	Quercus alba
Ninebark	Physocarpus sp.
Bittersweet	Celastrus scandens

[a]Provided by the Regional Forester, State of Wisconsin's Department of Natural Resources.

TABLE C-3. List of Birds from the General Kewaunee Region[a]

Year-round Resident	Summer Resident	Winter Resident	Transient
Canada Goose	Double-crested Cormorant - rare	Old Squaw	Whistling Swan
Black Duck	White Pelican - rare	Rough-legged Hawk	Snow Goose
Mallard	Black-crowned Night Heron	Goshawk - uncommon	Blue Goose
Red-tailed Hawk	Common Egret	Glaucous Gull - rare	Widgeon
Red-shouldered Hawk	Yellow-crowned Night Heron - rare	Ring-billed Gull	Green-winged Teal
Ring-necked Pheasant	Blue-winged Teal	Snowy Owl	Gadwall
Bobwhite Quail	Green Heron	Red-bellied Woodpecker	Pintail
Ruffed Grouse		Black-backed Three-toed Woodpecker - rare	Wood Duck
Hungarian Partridge			Shoveler
Short-eared Owl - rare			Greater Scaup
Screech Owl	Little Blue Heron - rare	Tufted Titmouse	Redhead
Saw-whet Owl - rare	Least Bittern	Boreal Chickadee - rare	Canvasback
Barred Owl	American Bittern	Brown Creeper	Ring-necked Duck
Great Horned Owl	Turkey Vulture - uncommon	Winter Wren - rare	Lesser Scaup
Red-headed Woodpecker	Marsh Hawk	Mockingbird	Ruddy Duck
Yellow-shafted Flicker	Sharp-shinned Hawk - uncommon	Bohemian Waxwing	Hooded Merganser
Downy Woodpecker	Cooper's Hawk - uncommon	Northern Shrike	Bald Eagle - uncommon
Hairy Woodpecker		Evening Grosbeak	Osprey - uncommon
Horned Lark		Pine Grosbeak	Golden Eagle - uncommon
Blue Jay			Peregrin Falcon - rare
			Sparrow Hawk
Crow	Broad-winged Hawk	Pine Siskin	Pigeon Hawk
Black-capped Chickadee	King Rail	Common Redpoll	Sandhill Crane
Red-breasted Nuthatch	Common Gallinule	Hoary Redpoll	Sora Rail
Cedar Waxwing	Killdeer	White-winged Crossbill	Virginia Rail
House Sparrow	Herring Gull	Red Crossbill	Semipalmated Plover
Starling	Common Tern	Tree Sparrow	Black-bellied Plover
Common Grackle	Black Tern	Oregon Junco	Whimbrel - rare
Cardinal	Long-eared Owl - rare	Slate-colored Junco	Hudsonian Godwit - rare
[redacted]ica[redacted]ldf[redacted]	Yellow-bellied [redacted]aps[redacted]r	[redacted]den[redacted]	Marbled Godwit - rare
			Willet - rare
			[redacted]itar[redacted]andp[redacted]r

TABLE C-3. (Contd.)

Year-round Resident	Summer Resident	Winter Resident	Transient
Purple Finch	Scarlet Tanager	Red-breasted Merganser	Greater Yellowlegs
White-throated Sparrow	Brown Thrasher	Common Merganser	Lesser Yellowlegs
Song Sparrow	Great Blue Heron	Snow Bunting	Spotted Sandpiper
Mourning Dove	Chimney Swift		Stilt Sandpiper
White-breasted Nuthatch	Whip-poor-will		Knot - rare
	Common Nighthawk		Western Sandpiper - rare
	Ruby-throated Hummingbird		White-rumped Sandpiper
	Purple Martin		Least Sandpiper
	House Wren		Semipalmated Sandpiper
	Catbird		Baird's Sandpiper
	Eastern Bluebird		Sanderling
	Robin		Dunlin
	Wood Thrush		Pectoral Sandpiper
	Red-eyed Vireo		Northern Phalarope - rare
			Wilson's Phalarope - rare
	Warbling Vireo		Parasitic Jaeger - rare
	Yellow-throated Vireo		Franklin Gull
	Black-and-White Warbler		Caspian Tern
	Golden-winged Warbler		Forster's Tern
	Nashville Warbler		Yellow-billed Cuckoo
	Yellow Warbler		Black-billed Cuckoo
	Chestnut-sided Warbler		Great-crested Flycatcher
			Least Flycatcher
			Eastern Phoebe
			Eastern Wood Pewee
			Traill's Flycatcher
	Dickcissel		Water Pipit
	Bobolink		Fox Sparrow
	Western Meadowlark		Lincoln Sparrow

TABLE C-3. (Contd.)

Year-round Resident	Summer Resident	Winter Resident	Transient
	Eastern Meadowlark		Lapland Longspur
	Brewer's Blackbird		Cattle Egret - very rare
	Yellow-headed Blackbird		Short-billed Marsh Wren
	Red-winged Blackbird		Long-billed Marsh Wren
	Baltimore Oriole		Gray-cheeked Thrush
	American Coot		Hermit Thrush
	Upland Plover		Veery
	American Woodcock		Golden-crowned Kinglet
	Common Snipe		Philadelphia Vireo
	Brown-headed Cowbird		Tennessee Warbler
	Rose-breasted Grosbeak		Orange-crowned Warbler
	Indigo Bunting		Cape May Warbler
	Vesper Sparrow		Bay-breasted Warbler
	Lark Sparrow		Northern Water Thrush
	Henslow's Sparrow		Ovenbird
	Grasshopper Sparrow		Mourning Warbler
	Chipping Sparrow		Yellowthroat
	Clay-colored Sparrow		American Redstart
	Field Sparrow		Wilson's Warbler
	Swamp Sparrow		Canada Warbler
	Bank Swallow		Rusty Blackbird
	Tree Swallow		Rufous-sided Towhee
	Cliff Swallow		Sharp-tailed Sparrow
	Barn Swallow		Le Conte's Sparrow
	Bonaparte's Gull		Harris' Sparrow
	Belted Kingfisher		Golden-crowned Sparrow
			White-crowned Sparrow

[a] Taken from Fish and Wildlife Resources Inventory, Kewaunee River Watershed, January 1972; U.S. Dept. of Agriculture, Soil Conservation Service, Wisc., Dept. of Natural Resources; and The University of Wisc., Cooperative Extension Service.

TABLE C-4. Forbs (Weeds) Which May Be Found in the General Kewaunee Region[a]

Common Name	Scientific Name	Abundance
Horsetail	Equisetum arvense	2
Bracken	Pteridium aquilinum	3
Quackgrass	Agropyron repens	3
Downey Bromegrass	Bromus tectorum	2
Sandbur	Cenchrus pauciflorus	2
Large Crabgrass	Digitaria sanguinalis	2
Barnyard Grass	Echirochloa crusgalli	3
Stinkgrass	Eragrostis cilianensis	2
Wild Barley	Hordeum jubatum	2
Nimblewill	Muhlenbergia schreberi	2
Witchgrass	Panicum capillare	3
Fall Panicum	Panicum dichotiflorum	2
Annual Bluegrass	Poa annua	2
Green Foxtail	Seteria veridis	3
Yellow Foxtail	Seteria lutescens	3
Yellow Nutgrass	Cyperus esculentus	2
Slender Rush	Juncus tenuis	2
Hemp	Cannibis sativa	2
Stinging Nettle	Urtica procera	3
Knotwood	Polygonum aviculare	3
Swamp Smartweed	Polygonum coccineum	2
Wild Buckwheat	Polygonum convolvulus	3
Pennsylvania Smartweed	Polygonum pennsylvanicum	2
Red Sorrel	Rumex acetosella	3
Curled Dock	Rumex crispus	3
Mexican Tea	Chenopodium ambrosioides	3
Maple-leaved Goosefoot	Chenopodium hybridum	2
Tumbleweed	Amarantus albus	2
Prostrate Pigweed	Amarantus graecizans	2
Rough Pigweed	Amarantus retroflexus	3
Wild Four-o'clock	Miribilis nyctaginea	2
Carpetweed	Mollugo verticillata	2
Purslane	Portulaca oleracea	2
Mouse-ear Chickweed	Cerastium vulgatum	2
White Cockle	Lynchnis alba	3
Bouncing Bet	Saponaria officinalis	2
Sleepy Catchfly	Silene antirrhina	2
Night-flowering Catchfly	Silene noctiflora	2
Spurrey	Spergula arvensis	2
Common Chickweed	Stellaria media	2
Small-flowered Buttercup	Ranunculus abortivus	3
Tall Buttercup	Ranunculus acris	3
Yellow Rocket	Varvarea vulgaris	2

TABLE C-4. (Contd.)

Common Name	Scientific Name	Abundance
Hoary Alyssum	Berterio incana	3
Indian mustard	Brassica juncea	2
Black mustard	Brassica nigra	2
Wild mustard	Brassica kaber	2
Shepherd's Purse	Capsella bursa-pastoris	2
Field Peppergrass	Lepidium campestre	2
Peppergrass	Lepidium virginicum	3
Wild Radish	Raphanus raphanistrum	2
Tumbling Mustard	Sisymbrium altissimum	2
Hedge mustard	Sisymbrium officinale	3
Pennycress	Thlaspi arvense	2
Silvery Cinquefoil	Potentilla argontea	2
Rough Cinquefoil	Potentilla norvegical	2
Upright Cinquefoil	Potentilla recta	2
Black Medic	Medicago lupulina	2
Yellow Wood Sorrel	Oxalis europaea	2
Cranesbill	Geranium carolinianum	2
Flowering Spurge	Euphorbia corollata	2
Cyprus Spurge	Euphorbia cyparissias	2
Poison Ivy	Rhus radicans	3
Velvet Leaf	Abutilon theophrasti	2
Venice Mallow	Hibiscus trionum	2
Roundleaf Mallow	Malva neglecta	3
St. John's Wort	Hypericum perforatum	2
Evening Primrose	Oenotheris biennis	2
Water Hemlock	Cicuta maculata	2
Wild Carrot	Daucus carota	2
Wild Parsnip	Pastinaca sativa	3
Indian Hemp	Apocynum cannabinum	3
Common Milkweed	Asclepias syriaca	3
Whorled Milkweed	Asclepias vesticillata	2
Field Bindweed	Convolvulus arvensis	2
Hedge Bindweed	Convolvulus sepium	2
Field Dodder	Cuscuta pentagona	2
Sticktight	Lapula echinata	2
Blue Vervain	Verbena hastata	2
Hoary Vervain	Verbena stricta	2
White Vervain	Verbena urticaefolia	2
Ground Ivy	Glechoma hederacea	2
Henbit	Lamium amplexicaule	3
Motherwort	Leonurus casdiaca	3
Catnip	Nepeta cataria	2
Heal-all	Prunella vulgaris	2

TABLE C-4. (Contd.)

Common Name	Scientific Name	Abundance
Ground Cherry	Physalis heterophylla	2
Horse Nettle	Solanum carolinense	2
Bitter Nightshade	Solanum dulcamara	2
Black Nightshade	Solanum nigrum	2
Yellow Toadflax	Linaria vulgaris	2
Common Mullen	Verbascum thapsus	3
Purslane Speedwell	Veronica peregrina	2
Buckhorn Plantain	Plantago lanceolata	2
Rugels' Plantain	Plantago rugelii	3
Common Plantain	Plantago major	3
Bedstraw	Gallium aparine	2
Bellflower	Campanula raponculiodes	2
Yarrow	Achillen millifolium	2
Lance-leaved Ragweed	Ambrosia bidnetata	2
Perennial Ragweed	Ambrosia psilostachya	2
Giant Ragweed	Ambrosia trifida	2
Plantain-leaved Everlasting	Antennaria plantaginifolia	2
Mayweed	Anthemis cotula	2
Burdock	Arctium minus	2
Many-flowered Aster	Aster ericoides	2
White Heath Aster	Aster pilosus	3
Spanish Needles	Bideus bipinnata	2
Spotted Knapweed	Centaurea maculosa	3
Oxeye Daisy	Chrysanthemum leucanthemum	3
Chicory	Chichorium intybus	2
Bull thistle	Cirsium vulgare	3
Canada thistle	Cirsium arvense	3
Hawksbeard	Crepis capillaris	2
Horseweed	Erigeron canadensis	3
Daisy fleabane	Erigeron strigosus	3
White snakeroot	Erigeron rugosum	2
Cudweed	Gnaphalium obtusifolium	2
Sunflower	Helianthus annuus	2
Jerusalem artichoke	Heliathus tuberosus	2
Orange Hawkweed	Hieracium auran	3
Prickly lettuce	Lactuca scariola	2
Tall lettuce	Lactuca canadensis	2
Pineapple weed	Matricaria matricaroides	2
Gray goldenrod	Solidago nemoralis	2
Stiff-leaved goldenrod	Solidago rigida	2
Perrenial Sowthistle	Sonchus arvensis	2
Common Sowthistle	Sonchus oleraceus	2
Dandelion	Taraxacum officinale	3

TABLE C-4. (Contd.)

Common Name	Scientific Name	Abundance
Yellow goatsbeard	Tragopogon major	2
Cocklebur	Xanthium pennsylvanicum	2

a. No listing of weeds peculiar to the Kewaunee site is available. The preceding list gives species that are considered: (2) occasional to frequent or, (3) general and common in a broad area including the Kewaunee site. Species considered rare (1) are not included. Source of information on distribution is ''Weeds of the North Central States,'' 1960, University of Illinois, Agricultural Experiment Station, Circular 718.

TABLE C-5. List of Phytoplankton Species
Kewaunee Nuclear Power Station, May to November 1971 [Sec. II Ref's 38,39,46]

Achnanthes sp. Bory; *A. hungarica*; *A. minutissima* Kutzing
Actinastrum hantzschii var. *fluviatile* Schroeder
Amphora ovalis Kutz.
Amphora ovalis var. *pediculus* Kutz.
Amphora sp. Ehrenberg
Anabaena circinalis Rabenhorst
Anabaena flos-aquae (Lyngb.) DeBrebisson *in* DeBrebisson and Godey
Anabaena spiroides Klebahn
Ankistrodesmus falcatus (Corda) Ralfs
Ankistrodesmus falcatus var. *mirabilis* West & West
Ankistrodesmus fractus (West & West) Brunnthaler
Ankistrodesmus spiralis (Turner) Lemmermann
Aphanocapsa elachista West and West
Aphanothece castagnei (deBreb.) Rabenhorst
Aphanothece nidulans P. Richter
Arthrodesmus convergens Ehr.
Asterionella formosa Hassall
Asterionella gracillima (Hantzsch) Heiberg
Asterococcus limneticus G. M. Smith
Caloneis sp. Cleve
Centritractus dubius Printz
Ceratium hirundinella (O. F. Muell.) Dujardin
Chlamydomonas sp. Ehrenberg
Chroococcus limneticus Lemmermann
Chroococcus minutus (Kuetz.) Naegeli
Chroococcus pallidus Naegeli
Chroococcus prescottii Drouet and Daily
Chroococcus turgidus (Kuetz.) Naegeli
Chrysophaerella longispina Lauterborn
Closteriopsis longissima Lemmermann
Closteriopsis longissima var. *tropica* West and West
Cocconeis pediculus Ehr.
Cocconeis sp. Ehrenberg
Coelastrum cambricum Archer
Coelastrum sphaericum Naegeli
Coelosphaerium kuetzingianum Naegeli
Coelosphaerium naegelianum Unger
Cosmarium depressum (Naegeli) Lundell.
Cosmarium sp. Corda
Crucigenia quadrata Morren
Crucigenia rectangularis (A. Braun) Gay
Cyclotella atomus Hust.
Cyclotella bodanica Eulenst
Cyclotella comta (Ehr.) Kutz.
Cyclotella glomerata Bachmann
Cyclotella kutzingiana Thwaites
Cyclotella meneghiniana Kutz.
Cyclotella michiganiana Skvortzow
Cyclotella ocellata Pant.
Cyclotella sp. Kutz.

TABLE C-5. (Contd.)

Cyclotella stelligera Cl. v. Grun.
Cymatopleura solea (Breb.) W. Smith
Cymbella cymbiformis
Cymbella microcephala
Cymbella pusilla Grun.
Cymbella prostrata (Berkeley) Cleve
Cymbella turgida (Gregory) Cleve
Cymbella sp. Agardh
Cymbella ventricosa Kutz.
Diatoma sp. DeCandolle; D. minor
Diatoma tenue Agardh
Diatoma tenue var. elongatum Lyngb.
Diatoma vulgare Bory
Dictyosphaerium pulchellum Wood
Dinobryon bavaricum Imhof
Dinobryon cylindricum Imhof
Dinobryon divergens Imhof
Dinobryon pediforme (Lemm.) Steinecke
Dinobryon sertularia Ehrenberg
Dinobryon sociale Ehrenberg
Elakatothrix viridis (Snow) Printz
Euglena minuta Prescott
Euglena sp. Ehrenberg
Fragilaria brevistriata Grun.
Fragilaria capucina Desmazieres
Fragilaria construens (Ehr.) Grunow
Fragilaria construens var. ventor Grunow
Fragilaria crotonensis Kitton
Fragilaria crotonensis var. oregona Sov.
Fragilaria intermedia Grunow
Fragilaria leptostauron (Ehr.) Hust.
Fragilaria pinnata Ehrenberg
Fragilaria sp. Lyngb.
Fragilaria vaucheriae Kutz.
Franceia droescheri (Lemm.) G. M. Smith
Franceia ovalis (France) Lemmermann
Geminella spiralis (Chod.) G. M. Smith
Glenodinium quadridens (Stein) Schiller
Gloeothece sp. Naegeli
Golenkinia radiata (Chod.) Wille
Gomphonema angustatum (Kutz.) Rabh.
Gomphonema divaceum
Gomphonema olivaceum (Lyngb.) Kutz.
Gomphonema sp. Agardh
Gomphosphaeria lacustris var. compacta Lemmermann
Gyrosigma kutzingii (Grun.) Cleve
Hantzschia amphioxys (Ehr.) Grun.
Kirchneriella elongata G. M. Smith
Kirchneriella lunaris (Kirch.) Moebius
Lagerheimia ciliata (Lag.) Chodat
Lyngbya sp. Agardh

TABLE C-5. (Contd.)

Mallomonas acaroides Perty
Mallomonas caudata Iwanoff
Mallomonas producta (Zacharias) Iwanoff
Mallomonas pseudocoronata Prescott
Mallomonas tonsurata Teiling
Melosira ambigua (Grun.) O. Muller
Melosira distans (Ehr.) Kutz.
Melosira granulata (Ehr.) Ralfs
Melosira granulata var. anguistissima Mull.
Melosira islandica O. Mull.
Melosira italica (Ehr.) Kutz.
Melosira sp. Agardh
Meridion circulare Agardh
Merismopedia convoluta deBrebisson in Kuetzing
Micractinium pusilla Fressenius
Microcystis incerta Lemmermann
Monosiga sp. S. Kent
Mougeotia sp. (C. A. Agardh) Wittrock
Navicula sp. Bory; N. cryptocephala; N. odiosa; N. tripunctata
Nephrocytium agardhianum Naegeli
Nephrocytium limneticum (G. M. Smith) G. M. Smith
Nephrocytium sp. Naegeli
Nitzschia acicularis W. Smith
Nitzschia angustata (W. Smith) Grun.
Nitzschia apiculata (Gregory) Grun.
Nitzschia dissipata Grunow
Nitzschia palea (Kutz.) W. Smith
Nitzschia sp. Hassall; N. fonticola
Oocystis borgei Snow
Oocystis lacustris Chodat
Oocystis parva West & West
Oocystis pusilla Hansgirg
Oscillatoria agardhii Gomont
Oscillatoria amoena (Kuetz.) Gomont
Oscillatoria geminata Meneghini
Oscillatoria limnetica Lemmermann
Oscillatoria sp. Vaucher
Oscillatoria tenuis C. A. Agardh
Pandorina morum (Muell.) Bory
Pediastrum boryanum (Turp.) Meneghini
Pediastrum duplex Meyen
Pediastrum integrum Naegeli
Pediastrum tetras (Ehrenb.) Ralfs
Peridinium cinctum (Muell.) Ehrenberg
Peridinium sp. Ehrenberg
Peroniella planctonica G. M. Smith
Radiofilum irregulare (Wille) Brunnthaler
Rhizochrysis limnetica G. M. Smith
Rhizosolenia eriensis H. L. Smith
Rhodomonas lacustris Pascher and Ruttner
Rhodomonas sp. Karsten

TABLE C-5. (Contd.)

Rhoicosphenia curvata (Kutz.) Grun.
Scenedesmus abundans (Kirch.) Chodat
Scenedesmus acuminatus (Lag.) Chodat
Scenedesmus arcuatus Lemmermann
Scenedesmus arcuatus var. platydisca G. M. Smith
Scenedesmus armatus (Chod.) G. M. Smith
Scenedesmus bernardii G. M. Smith
Scenedesmus bijuga (Turp.) Lagerheim
Scenedesmus carinatus (Lemmermann) Chodat
Scenedesmus dimorphus (Turp.) Kuetzing
Scenedesmus intermedius Chodat
Scenedesmus longus Meyen
Scenedesmus longus var. naegelii (deBreb.) G. M. Smith
Scenedesmus obliquus (Turp.) Kuetzing
Scenedesmus opoliensis P. Richter
Scenedesmus quadricauda (Turp.) deBrebisson
Scenedesmus quadricauda var. maximus (Turp.) deBrebisson
Scenedesmus quadricauda var. westii G. M. Smith
Schizochlamys compacta Prescott
Schizochlamys gelatinosa A. Braun in Kuetzing
Selenastrum gracile Reinsch
Selenastrum westii G. M. Smith
Sphaerocystis schroeteri Chodat
Spirogyra sp. Link
Spondylosium planum (Wolle) W. and G. S. West
Spondylosium sp. deBrebisson
Staurastrum sp. Meyen
Stauroneis sp. Ehrenberg
Stephanodiscus astrea (Ehr.) Grun.
Stephanodiscus astrea var. minutula (Kutz.) Grun.
Stephanodiscus binderanus (Kutz.) Krieger
Stephanodiscus hantzschii-tenuis Grun-Schabitkowski
Stephanodiscus niagarae Ehr.
Stephanodiscus sp. Ehr.
Stephanodiscus transilvanicus Pant.
Stichosiphon sp. Geitler
Surirella angustata Kuetzing
Surirella ovata Kuetzing
Synedra acus Kuetzing; S. radians
Synedra sp. Ehrenberg
Synedra ulna (Nitzsch.) Ehr.
Synedra vaucheriae Kutz.
Tabellaria flocculosa (Roth) Ktz.; T. fenestrata
Tetraedron minimum (A. Braun) Hansgirg
Tetraedron regulare Kuetzing
Tetraspora gelatinosa (Vauch.) Desv.
Tetraspora lacustris Lemm.
Tetraspora lamellosa Prescott
Tetrastrum staurogeniaeforme (Schroeder) Lemmermann
Ulothrix sp. Kuetzing
Ulothrix tenuissima Kuetzing

TABLE C-5. (Contd.)

Unidentified centrics
Unidentified pennates
Uroglenopsis americana (Calkins) Lemmermann

TABLE C-6 (Part 1)

Identification and Mean Relative Abundance[a] of Periphyton Species Found on Natural Substrates Near Kewaunee Nuclear Power Plant on May 25, 1971 [Sec. II, Ref. 38]

Taxon	Stations[b] D	E	F
CHLOROPHYTA			
Ulothrix cylindricum	3.3		13.0
Ulothrix sp.	6.7	2.0	9.7
U. tenuissima	7.3		
U. zonata	6.0	9.0	28.7
CHRYSOPHYTA			
Diatoms:			
Achnanthes lanceolata	0.3		
A. minutissima	0.3		
Amphora commutata			0.3
Cocconeis pediculus			0.6
C. placentula			0.6
Cymbella prostrata	1.6		
C. sp.	0.3		
C. turgida	2.7		
C. ventricosa	9.7	5.7	
Diatoma anceps v. *anceps*	7.7	3.0	0.3
D. tenue v. *elongatum*	4.0		
D. vulgare v. *breve*		0.3	
D. vulgare v. *vulgare*			0.3
D. sp.	4.3	0.3	
Eunotia tenella			0.3
Fragilaria capucina	10.3	2.3	1.7
F. construens	7.7	2.0	0.3
F. crotonensis	3.0	1.0	
F. intermedia	17.3	6.7	4.0
F. pinnata	14.0	4.0	1.7
F. spp.	15.3	11.0	4.3
F. undata	0.3		
F. virescens	1.7	0.7	1.0
F. vaucheriae v. *vaucheriae*		0.3	0.3

TABLE C-6 (Part 1) (Cont'd)

Taxon	Stations[b] D	E	F
Gomphonema olivaceum	24.3	12.0	7.0
G. olivaceum v. calearea	6.0		1.3
G. parvulum	0.3		
G. sp.	9.7	4.0	0.7
Melosira sp.	7.3	4.3	8.0
Navicula accomoda	0.3		
N. radiosa	1.3	0.7	
N. sp.	2.7	1.7	0.3
N. tripunctata	2.3	1.3	2.7
N. viridula	1.0		
Nitzschia acicularis	5.7		0.7
N. dissipata	5.3		
N. filiformis	0.7		0.3
N. fonticola	0.7		
N. palea	1.7	0.3	
N. sigmoidea	0.3		
N. sp.	1.7	0.3	
Opephora martyi	2.3	0.3	
Rhoicosphenia curvata	16.0	4.0	1.3
Synedra rumpens	0.7		
S. sp.	1.7		
S. ulna	0.7	0.3	
S. vaucheriae	20.3	5.7	3.3
S. vaucheriae v. capitellata	6.3	5.0	0.7
Surirella angustata	1.0		
Tabellaria flocculosa	1.3		0.7
CYANOPHYTA			
Lyngbya sp.	0.3	14.0	0.3
Oscillatoria sp.			9.0
Phormidium sp.			2.3
Schizothrix muelleri		1.3	

[a]Relative abundance is recorded as the occurrence of a particular organism in 30 sweeps (scans under microscope) widthwise of a 22 x 50 cm slide and interpreted as follows: Occurrence in 1-4 sweeps out of 30 = rare;
Occurrences in 5-14 sweeps out of 30 = common; and
Occurrences in 15-30 sweeps out of 30 = abundant.

[b]D - Shoreline 2000 feet north of intake.
E - Shoreline at site just south of discharge.
F - 500 feet south of discharge at shoreline.

TABLE C-6 (Part 2)

Identification and Mean Relative Abundance of Periphyton Species Found on Natural Substrates Near Kewaunee Nuclear Power Plant on August 31, 1971

Taxon	Stations D	E	F
CHLOROPHYTA			
Ulothrix cylindricum			1.0
U. zonata			5.7
CHRYSOPHYTA			
Diatoms:			
Achnanthes grimmei	0.7		
A. lanceolata	0.3		
A. minutissima v. *cryptocephala*	0.3		
Achnanthes sp.	1.3		
Amphipleura sp.	0.3		
Asterionella sp.	0.3		
Caloneis sp.	0.3		
Cocconeis pediculus	2.3		
C. microcephala	8.3		
Cymbella prostrata	22.0	6.3	12.3
C. spp.	10.3	1.7	4.3
C. tumida			0.3
C. turgida			0.3
C. ventricosa	6.7		0.3
Diatoma anceps	2.7		
D. cf. *anceps* v. *anceps*	1.3		
D. tenue v. *elongatum*	1.0		
Eunotia sp.	0.7		
Eunotia cf. *veneris*	0.3		
Fragilaria capucina	11.3		3.0
F. construens	15.3	1.3	3.3
F. crotonensis	8.7		0.3
F. intermedia	8.0	0.7	5.0
F. pinnata	10.7	0.3	1.3
F. sp.	7.3	2.3	5.3
F. vaucheriae v. *vaucheriae*	1.0		
Gomphonema sp.	0.7	0.3	0.3
Gyrosigma attenuatum	0.3		
Melosira sp.	2.0		0.3
Navicula cryptocephala	5.7		0.7
Navicula spp.	4.3		1.7

TABLE C-6 (Part 2) (Cont'd)

Taxon	Stations D	E	F
N. tripunctata	5.3	0.7	0.3
N. acicularis	0.3		
N. viridula	0.3	1.3	
Nitzschia dissipata	2.3		
N. fonticola	1.3		
N. cf. *fonticola*	2.7	0.3	1.3
N. cf. *elliptica*			0.3
N. halsotica			1.0
N. linearis	0.3		
N. palea	1.0		
N. paradoxa	0.3		
Nitzschia spp.	2.3	0.3	0.3
Pinnularia sp.	1.3		
Rhoicosphenia curvata	1.3		0.7
Sunedra acus	0.7		
S. amphicephala v. *austriaca*	1.7		
S. rumpens	9.0		0.3
S. rumpens v. *familiaris*	0.7		
S. tabulata	0.3		
S. ulna	1.0		0.7
S. vaucheriae	8.7	0.7	6.3
S. vaucheriae v. *capitellata*	1.3		
Tabellaria flocculosa	1.3	0.3	0.3
CYANOPHYTA			
Calothrix sp.			2.3
Lyngbya sp.			0.3
Oscillatoria sp.	0.3		1.0

TABLE C-6 (Part 3)

Identification and Mean Relative Abundance of Periphyton Species Found on Natural Substrates Near Kewaunee Nuclear Power Plant on November 16, 1971

Taxon	Stations D	E	F
CHLOROPHYTA			
Cladophora glomerata			17.3[1/]
Stigeoclonium tenue		1.3	1.3
Ulothrix zonata	0.7	12.7	9.3
CHRYSOPHYTA			
Diatoms:			
Achnanthes minutissima	9.0	16.0	3.3
A. lanceolata	4.0	15.3	17.3
Amphora ovalis	2.7	2.0	
A. ovalis v. pediculus		0.7	2.0
A. perpusilla		0.7	
Asterionella formosa	2.7		2.0
Cocconeis diminuta		0.7	
C. pediculus	3.3	3.3	11.3
C. placentula			0.7
Cymbella prostrata	12.7	14.0	7.3
C. tumida		1.3	
C. turgida	0.7	3.3	1.3
Denticula elegans			0.7
Diatoma anceps v. anceps	1.3	6.0	2.0
D. hiemale			0.7
D. tenue v. elongatum		5.3	
D. spp.		2.7	1.3
Epithemia sp.		0.7	
Fragilaria capucina	4.0	6.0	1.3
F. construens	14.0	22.0	
F. crotonensis	6.7		0.7
F. intermedia	19.3	5.3	8.0
F. lapponica	8.0	11.3	8.7
F. pinnata	10.7	14.0	18.7
F. pinnata v. lanzettula	0.7		
F. spp.	2.7	1.3	2.7

TABLE C-6 (Part 3) (Cont'd)

Taxon	Stations D	E	F
Gomphonema olivaceum	2.7	18.7	16.0
G. olivaceum v. *calcerea*		2.7	2.7
G. spp.		3.3	
Melosira binderana	0.7	0.7	
M. granulata	2.0	2.7	1.3
M. italica			2.0
Navicula anglica			0.7
N. atomus		2.7	1.3
N. confervacea	0.7		0.7
N. cryptocephala	10.7	2.0	2.0
N. exigua		0.7	
N. longirostris	1.3		
N. tripunctata v. *schizonemoides*	8.0	5.3	
N. sp. #3		0.7	1.3
N. spp.	8.0	4.0	4.0
N. subtilissima	0.7		
N. zononi	4.0		0.7
Nitzschia acuta		0.7	
N. dissipata	5.3	6.7	5.3
N. fonticola		1.3	
N. hungarica		1.3	2.0
N. kutzingiana			0.7
N. spp.	3.3	1.3	2.0
N. tryblionella	0.7		
Pinnularia sp.			0.7
Rhoicosphenia curvata	5.3	13.3	16.7
Synedra rumpens	8.7	18.0	16.0
S. rumpens v. *familiaris*		1.3	
S. tabulata			0.7
S. ulna	0.7	2.0	4.0
S. ulna v. *oxyrhynchus*			0.7
S. vaucheriae	10.0	12.0	14.0
Tabellaria flocculosa	2.0	2.7	3.3
CYANOPHYTA			
Lyngbya sp.		1.3	
Mougeotia sp.	0.7		

TABLE C-7

Zooplankton crustacea collected from Lake Michigan near Kewaunee, Wisconsin, 1971 [Sec. II, ref. 38]

	Month of Collection and Station					
	May		August		November	
Organisms	B	C	B	C	B	C
Copepoda						
nauplii	2[1/]	102	32,448	25,093	1,285	900
copedids						
calanoid	4	26	2,026	2.795	495	381
cyclopoid	1	52	8,115	11,251	1,034	832
Diaptomus spp. (female)	7	183	26	78	30	55
D. ashlandi (male)	1	6	10	99	4	13
D. minutus (male)	3	78	0	0	2	2
D. sicilis (male)	0	0	0	0	2	0
D. oregonensis (male)	1	51	0	0	6	30
Epischura lacustris	0	1	0	0	2	9
Eurytemora affinis	0	14	0	0	39	36
Cyclops bicuspidatus thomasi	2	54	300	743	93	57
C. vernalis	0	0	28	0	85	57
Mesocyclops edax	0	0	0	13	0	0
Tropocyclops prasinus	0	5	887	676	11	19
Canthocamptus robertcokeri	1	5	0	0	0	0
Cladocera						
Bosmina longirostris	6	26	58,002	43,234	2,035	1,673
B. coregoni coregoni	0	0	47.2	780	47	36
Alona affinis	0	0	33	0	0	0
Ceriodaphnia lacustris	0	0	86	68	0	0
C. quadrangula	0	0	71	32	0	0
Chydorus sphaericus	0	1	2,266	611	15	15
Daphnia galeata mendotae	0	1	0	0	7	2
D. longiremis	0	2	338	761	9	2
D. retrocurva	0	0	75	168	374	316
Macrothrix hirsuticornis	0	0	0	0	2	0
Holopedium gibberum	1	0	181	566	0	0
Leptodora kindtii	0	0	10	0	0	0
Polyphemus pediculus	0	0	10	49	0	0

1/ No. of organisms/m^3. Based on the mean of six replicates.

Appendix D

TABLE D-1. Dose to Individuals from Gaseous Effluents

Location	Adult Total Body (mrem/yr)	Child Thyroid Inhalation (mrem/yr)	Child Thyroid via Milk (mrem/yr)
Nearest Dwelling (0.8 mi N)	0.09	0.007	4
Two Creeks (3 mi SSW)	0.007	0.0006	0.6
Two Rivers (13 mi S)	0.0007	<0.0001	0.06
Pooled Milk Sample	-	-	0.03

TABLE D-2. Dose to Individuals from Public Water Supplies on Lake Michigan

Location	Distance from Discharge (miles)	Dilution Factor	Population Served	Dose (mrem/yr) Total Body	Child Thyroid	Bone	GI Tract
Discharge Pipe*	0	none	0	0.3	10	0.02	0.02
Rostok (Green Bay)	11.5	1:84	87,400	0.004	0.13	0.0002	0.0003
Two Rivers	16	1:120	13,600	0.003	0.09	0.0002	0.0002
Manitowoc	20	1:150	34,400	0.002	0.07	0.0001	0.0002
Sheboygan	44	1:330	51,800	0.001	0.03	<0.0001	<0.0001

*Assumes 1.2 liter per day of water intake from the circulating water discharge.

TABLE D-3. Annual Dose from Eating Fish (50 gram/day)

Location	Dose (mrem/yr) Total Body	Thyroid	Bone	GI Tract
Plant Discharge	1.	.043	.75	.22
Rostok (Green Bay)	.013	.0005	.009	.003
Two Rivers	.009	.0004	.006	.002
Manitowoc	.007	.0003	.005	.001
Sheboygan	.003	.0001	.002	.0007

TABLE D-4. Total Body Dose from Recreational Activities on Lake Michigan

(Based on 100 hours of exposure time per year for each activity)

	Dose (mrem/yr)		
Location	Shoreline Sediment	Swimming	Boating, Fishing, Water Skiing
Plant Discharge	.18	.006	.003
Rostok	.002	.00007	.00003
Two Rivers	.002	.00005	.00002
Manitowoc	.001	.00004	.00002
Sheboygan	.0006	.00002	.00001

APPENDIX E

COMMENTS BY FEDERAL, STATE AND LOCAL AGENCIES

TABLE C-5. (Contd.)

Unidentified centrics
Unidentified pennates
Uroglenopsis americana (Calkins) Lemmermann

ADVISORY COUNCIL
ON
HISTORIC PRESERVATION

WASHINGTON, D.C. 20240

RECEIVED
AUG 14 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

50-305

AUG 1 1 1972

Dear Mr. Muller:

This is in response to your request for comments on the environmental impact statement identified by a copy of your cover letter attached to this document. The staff of the Advisory Council has reviewed the submitted impact statement and suggests the following, identified by checkmark on this form:

_____The final statement should contain (1) a sentence indicating that the National Register of Historic Places has been consulted and that no National Register properties will be affected by the project, or (2) a listing of the National Register properties to be affected, an analysis of the nature of the effects, a discussion of the ways in which the effects were taken into account, and an account of steps taken to assure compliance with Section 106 of the National Historic Preservation Act of 1966 (80 Stat. 915) in accordance with procedures of the Advisory Council on Historic Preservation as they appear in the Federal Register, March 15, 1972.

_____In the case of properties under the control or jurisdiction of the United States Government, the statement should show evidence of contact with the official appointed by your agency to act as liaison for purposes of Executive Order 11593 of May 13, 1971, and include a discussion of steps taken to comply with Section 2(b) of the Executive Order.

__✓__The final statement should contain evidence of contact with the Historic Preservation Officer for the State involved and a copy of his comments concerning the effect of the undertaking upon historical and archeological resources.

_____Specific comments attached.

Comments on environmental impact statements are not to be considered as comments of the Advisory Council in Section 106 matters.

Sincerely yours,

Robert R. Garvey, Jr.

Robert R. Garvey, Jr.
Executive Secretary

cc: Mr. James Morton Smith, Director, State Historical Society of Wisconsin
816 State Street, Madison, Wisconsin 53706 w/inc.

THE COUNCIL is charged by the Act of October 15, 1966, with advising the President and Congress in the field of Historic Preservation, recommending measures to coordinate governmental with private activities, advising on the dissemination of information, encouraging public interest and participation, recommending the conduct of special studies, advising in the preparation of legislation, and encouraging special training and education. The Council also has the responsibility to comment on Federal or Federally-assisted undertakings that have an effect on cultural property listed in the National Register.

DEPARTMENT OF THE ARMY
CHICAGO DISTRICT. CORPS OF ENGINEERS
219 SOUTH DEARBORN STREET
CHICAGO. ILLINOIS 60604

50-305

14 August 1972

NCCPD-ER

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

Dear Mr. Muller:

Appropriate review of the Draft Environmental Statement for the Kewaunee Nuclear Power Plant, Docket No. 50-305 has been completed by this office. The statement is considered satisfactory.

The opportunity to review this statement is appreciated.

Sincerely yours,

LEROY R. HAYDEN, JR.
Major, Corps of Engineers
Deputy District Engineer

State of Wisconsin \ PUBLIC SERVICE COMMISSION

WILLIAM F. EICH, CHAIRMAN
ARTHUR L. PADRUTT, COMMISSIONER
MICHAEL P. KOMAR, COMMISSIONER
JOHN F. GOETZ, SECRETARY
HILL FARMS STATE OFFICE BUILDING
MADISON, WISCONSIN 53702

August 28, 1972

FILE NO. CA-4759 LL
AEC Docket 50-305

RECEIVED SEP 1 1972

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

Gentlemen:

This is in response to your letter of July 20, 1972 requesting comments on the Draft Environmental Statement dated July, 1972 for the Kewaunee Nuclear Power Plant. Our comments will be directed primarily to Section X - Need for Power. This Commission authorized construction of the Kewaunee Nuclear Power Plant in its joint order in dockets CA-4759 and 2-WP-2570 issued on October 17, 1967. A copy of this order was included in the applicant's revised environmental report. The Wisconsin Public Service Corporation, the Wisconsin Power and Light Company, and the Madison Gas and Electric Company, who will own the Kewaunee Plant as tenants in common are members of the Wisconsin Power Pool and have entered into this formal pooling agreement for the purpose of maintaining an adequate supply of electric energy to meet their combined system requirements. The companies are also members of the Wisconsin Upper Michigan System (WUMS) which is an informal coordinating organization and the MAIN Regional Reliability Council.

Construction delays have already resulted in a significant postponement of the completion of the Kewaunee Plant and the availability of this generation to the pool. The adverse effects of this delay on power supply in Wisconsin have also been compounded by the long and unusual delay in the licensing of the Point Beach Nuclear Plant, Unit No. 2. At this time we are advised that the Kewaunee Plant is not scheduled for operation until approximately the middle of 1973 at the earliest. Future construction and licensing delays could further postpone the availability of this plant.

Because of the delays in the availability of the Kewaunee Nuclear Plant, the three member utilities of the Wisconsin Power Pool have made joint application for authority to construct approximately 250 MW of combustion turbine generating capacity to be completed and available before the summer peak load period of 1973. Without the Kewaunee Power Plant, this new generating capacity will be required to meet the estimated summer peak load of the pool in 1973. Without either, the pool reserve is estimated to be only 0.4%. Even with this new capacity and additional purchases from neighboring utilities, the pool will have an estimated 1973 reserve margin of only about 13.8% which is still somewhat below the desired level in the range of 15-20% reserve. The applications for combustion turbine generating units with a total capacity of approximately 250 MW were authorized by this Commission on August 22, 1972.

The power supply situation for the summer of 1972 is already critical with most of the major Wisconsin generating utilities and pools having a deficient or only marginally adequate reserve margin. The capacity and reserve of some utilities relies on purchases of power from outside the area. Emergency load reduction measures have already been initiated once on July 21, 1972 by the WUMS utilities including voltage reduction and appeals for voluntary conservation of power use by customers. Some utilities also report that generating equipment maintenance is being deferred due to the current power shortage. These problems have been due primarily to the before-mentioned delays in the availability of the Point Beach Unit No. 2. We understand that other utilities in the MAIN region and elsewhere in the country are also experiencing similar construction and licensing delays. For Wisconsin, the capacity represented by the Kewaunee Nuclear Power Plant is critically needed at the earliest date possible. Without this capacity we can only expect that the current power supply shortage will continue and that the reliability of electric service will continue to deteriorate.

In conclusion, we are basically in agreement with and endorse the findings on the need for power in Section X of the AEC staff's Draft Environmental Statement.

Very truly yours,

William F. Eich
Chairman

LLS:kjn

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

E-6

50-305

August 29, 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The draft environmental impact statement for the "Kewaunee Nuclear Power Plant, Docket No. 50-305," which accompanied your letter of July 20, 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.

On page II-28, the conditions described in the last paragraph are more characteristic of a modified monsoonal effect than lake breeze. The lake breeze is as described in the very last sentence on the page (i.e., a diurnal change in wind).

On page II-29, the conclusion shown in the last sentence of paragraph 2 is hardly valid when based on two situations. Normally turbulence would be expected to be greater with higher wind speeds.

It is suggested the draft statement be sent to the Lake Survey Center for comment on Lake Michigan currents.

In previous comments to the AEC Division of Reactor Licensening, dated May 17, 1972, we have computed a maximum average annual concentration of 9×10^{-7} sec m^{-3} at a distance of 1200 m

with winds from the north northeast. This is in close agreement with the applicant's value as shown in fugure 2.7-6 of the Final Safety Analysis Report dated January 27, 1971. The AEC staff analysis of the radiological impact of routine releases (see page V-28) does not specify their resulting average annual concentration and we can only assume it is in general agreement with the applicant's value.

We have not been able to evaluate the AEC staff's analysis of the radiological consequences of postualted accidents since the specific meteorological conditions assumed the resulting relative concentration in sec m^{-3} and the expected frequency of occurrence of such concentrations was not listed in their discussion on page VI-4.

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

50-305

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

September 8, 1972

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

Dear Mr. Muller:

We have had the draft environmental impact statement for the Kewaunee Nuclear Power Plant, Wisconsin Public Service Corporation, reviewed in the relevant agencies of the Department of Agriculture. Comments from the Soil Conservation Service, an agency of the Department, are enclosed.

Sincerely,

T. C. Byerly

T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosure

units into commercial operation, and this trend may continue for some time in the future. The Federal Power Commission has concluded that "the electric power output represented by the Kewaunee unit is needed to implement the Applicant's and MAIN's generation expansion programs for meeting projected loads and to provide a reasonable measure of reserve margin capacity for the 1973 summer peak period, particularly in view of the very large amount of other new capacity which must be in operation in MAIN's system on schedule if the forecast capacity margin is to be met" (see Appendix E, page E-18).

MAIN reserves for the summer peaks through 1981 are given below,[5] on the assumption that all new plants go into operation as scheduled. Included are allowances for firm purchases of 620 to 850 megawatts during 1974-77 and of 100 to 130 megawatts during 1978-81. Also shown are the reserves without the Kewaunee Plant.

Year	1973	1974	1975	1976	1977	1978	1979	1980	1981
Reserves (%)									
With Kewaunee	24.2	18.8	16.1	16.8	16.9	15.0	14.3	17.5	13.7
Without Kewaunee	22.4	17.2	14.6	15.4	15.5	13.8	13.2	16.5	12.7

In view of the fact that MAIN itself is expected to be a net purchaser of power and is estimated to have marginal summer reserves during 1974-81, it does not appear that the Wisconsin Power Pool can rely on firm purchases from MAIN during this period as a substitute for operating the Kewaunee Plant. Even if power were available, a utility suffers an economic penalty by purchasing it, paying a price that includes amortization of another utility's plant, instead of operating an existing plant of its own, expecially a nuclear plant with its relatively low operating costs.

The Public Service Commission of Wisconsin has jurisdiction over production of power by all companies in Wisconsin and controls facility expansions of all utilities in the state. The Commission has evaluated the need for expansion of the systems within the WPP and gave approval [6] for the construction and operation of the Plant on October 17, 1967. In anticipation of a delay in start-up of the Kewaunee Plant, the Commission has recently authorized the construction of 250 MW of combustion turbine generating capacity to be completed and available before the summer peak period of 1973. The Commission's Chairman has stated that "the capacity represented by the Kewaunee Nuclear Power Plant is critically needed at the earliest date possible" (see Appendix E, page E-5).

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (GWS)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20591
PHONE: 202-426-2262

11 SEP 1972

RECEIVED
SEP 13 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

50-305

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of 20 July 1972 addressed to Mr. Herbert F. DeSimone, Assistant Secretary for Environment and Urban Systems, concerning the draft environmental impact statement and report on the Kewaunee Nuclear Power Plant located in Kewaunee County, Wisconsin.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted and the U. S. Coast Guard noted the following:

> "It is felt that the statement should cover more adequately the movement of irradiated fuel by barge. Current AEC and DOT standards only ensure cask integrity in water up to 50 feet deep. Public safety should be protected even if the cask is involved in a transportation accident in waters which exceed that depth. Therefore, the environmental impact statement should demonstrate that either the cask is of sufficient quality that it can withstand the depth of water over which it will travel or that there would be minimal consequences to the environment if the cask is breeched or left for a duration of time in water of that depth."

The Department of Transportation has no further comments to offer nor do we have any objections to the project. It is recommended that the concern of the U. S. Coast Guard be addressed in the final environmental impact statement.

The opportunity to review and comment on the Kewaunee Nuclear Power Plant project is appreciated.

Sincerely,

J. D. McCANN
Captain, U. S. Coast Guard
Acting Chief, Office of Marine
Environment and Systems

5067

E-11

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

September 14, 1972

RECEIVED
SEP 15 1972
U.S. ATOMIC ENERGY

50-305

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The Department of Commerce reviewed the draft environmental statement by the Atomic Energy Commission for the Kewaunee Nuclear Power Plant and forwarded comments to you in our letter of August 29, 1972.

Since that time, additional information has developed which is pertinent to the project. This additional information is offered for your consideration.

Page ii, item f. The discussion here seems to deal solely with economic effects rather than environmental impacts, the avowed topic of this section. It would seem appropriate for the draft statement to discuss both the beneficial and the adverse environmental impacts of these economic effects.

Page iv, item c. Aquatic plants should be included in the discussion of the augmented radiological monitoring program.

1. Introduction

Page 2, Site Selection. Specify the degree to which alternative cooling methods were considered when alternative sites were evaluated in the mid-1960's.

II. The Site

Page 15, item e. It is stated that "Variations in year-class abundance determine the desirability of the fish populations,

however, it appears that no single age group dominates the commercial harvest of most species." The term "desirability" is confusing, and suggest that it be replaced by the term "availability," if the intent of the statement is to refer to the fish populations themselves rather than the economic feasibility of fishing for certain species. With reference to the portion of the above-cited statement referring to age-group dominance, we suggest that the statement may be erroneous and that the draft statement should explore the possibility that a single year-class may support a commercial fishery for several years.

Page 21, item b. In our opinion, the discussion of lake currents in the second paragraph would benefit by inclusion of charts or diagrams depicting the lake current situation in the vicinity of the Kewaunee and Point Beach facilities. The third paragraph, which discusses thermal stratification, should be expanded to include a description of the "thermal bar" mentioned on page II-43.

III. <u>The Plant</u>

Page 8, Section c.3, last paragraph. It is stated that "Provision has been made to add sodium hypochlorite solution to the circulating water to prevent fouling by biological organisms, especially algae." It would be desirable for the draft statement to discuss the use of the various mechanical slime control methods and the reasons for selecting a chemical, rather than a mechanical, method for controlling slime buildup in the condenser circulating water system.

V. <u>Environmental Impacts of Plant Operation</u>

Page 10, first paragraph. Reference is made to a report from the Ginna Nuclear Station on Lake Ontario that refers to estimated mortality of plankton passing through the pump and condenser system. It would be helpful, for comparative purposes, if data on the Ginna plant similar to that provided for the Point Beach and Kewaunee plants on page III-12 were presented in the final EIS.

Page 20, section e (2), last paragraph. It is stated that during the first six months of operation of the Point Beach Plant, a total of 20 shut downs occurred, primarily in the winter months. It is further stated that "...no fish are known to have been killed, and no other adverse effects were observed" (emphasis added). It would seem pertinent to critically examine the possibility that although mortalities have not been observed, some fish may have been so severely debilitated by low temperature shock that they sank to the bottom, perhaps under the ice, where their fate was not observed. Perhaps the final EIS could refer to results of studies that confirm or refute the hypothesis that plant shutdown in winter (or spring) produces adverse effects, such as fish mortalities, which may not be observed at that time or in that place, but which nevertheless occur.

Page 26, second paragraph. It would be helpful if the draft statement mentioned the duration of the seven fish sampling periods.

Page 36, last paragraph. It is stated that AEC will require the Applicant to more frequently sample fish, sediments, and bottom organisms at additional locations near the effluent discharge. The final EIS should include some mention of aquatic plants in the expanded radiological monitoring program. If no plants are available, this fact should be noted.

We hope these comments will be of further assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

50-305
IN REPLY REFER TO:

September 14, 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 July 20, 1972, requesting comments on the AEC Draft Environmental Statement related to the proposed continuation of Construction Permit CPPR-50 and the issuance of an operating license to the Wisconsin Public Service Corporation for the Kewaunee Nuclear Power Plant (Docket No. 50-305).

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 AEC Draft Environmental Statement; the Applicant's Environmental Report 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 analysis of these documents together with related information from other FPC reports. The staff of the Bureau of Power generally 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 peak load period immediately following the availability of the facility.

Need for the Facility

The Kewaunee Nuclear Generating Station is owned jointly by three companies which comprise the Wisconsin Power Pool (WPP), the Wisconsin Public Service Corporation (WPS), the Wisconsin Power and Light Company (WPL), and the Madison Gas and Electric Company (MGE). The pool was established in 1967 to maximize efficiency of power production and distribution for the participants. The Wisconsin Public Service Corporation is acting on behalf of the three companies in all matters pertaining to the design, construction, and licensing of this facility.

The following tabulation shows the electric system loads to be served by the Wisconsin Power Pool and the Mid-America Interpool Network (MAIN) of which the pool is a member, and the relationship of the

Mr. Daniel R. Muller

electrical output of the Kewaunee unit to the available reserve capacities on the summer-peaking pool's and summer peaking MAIN's systems at the time of the 1973 summer peak load. This is the anticipated initial service period of the new unit, but the life of this unit is expected to be some 30 years or more, and it is expected to constitute a significant part of the pool's 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.

Forecast 1973 Summer Peak Load-Supply Situation

	Wisconsin Power Pool	MAIN
Conditions With Kewaunee Unit No. 1 (527 Megawatts)		
Net Total Capability - Megawatts	2,707	36,696
Net Peak Load - Megawatts	1,929 1/	29,543 2/
Reserve Margin - Megawatts	778	7,153
Reserve Margin - Percent of Peak Load	40.3	24.2
Conditions Without Kewaunee Unit No. 1 (527 Megawatts)		
Net Total Capability - Megawatts	2,180	36,169
Net Peak Load - Megawatts	1,929 1/	29,543 2/
Reserve Margin - Megawatts	251	6,626
Reserve Margin - Percent of Peak Load	13.0	22.4
Applicant's Stated Reserve Margin Needs Based on 15 Percent Criterion - Megawatts	289	
Reserve Margin Deficiency - Based on Applicant's Stated 15 Percent Criterion - Megawatts	38	

1/ Reduced by net firm purchases of 225 megawatts.
2/ Reduced by net firm purchases of 476 megawatts.

Mr. Daniel R. Muller

The Kewaunee unit is presently scheduled for commercial operation in March 1973. The availability of the unit for the 1973 summer peak load period would provide the pool an expected system reserve margin of 778 megawatts or 40.3 percent of peak load. Without the Kewaunee unit, the pool forecasts a system reserve margin of 251 megawatts or 13.0 percent of peak load. This represents a deficiency of 38 megawatts based on the pool's stated minimum reserve capacity considered necessary to insure system reliability. The MAIN organization has not yet adopted a region-wide minimum reserve policy for itself or for its members; however, the Applicant states the Wisconsin Power Pool has found through experience, a minimum reserve criterion of 15 percent of its maximum demand must be maintained to allow for scheduled as well as unscheduled outages and othe contingencies. The 15 percent reserve margin also satisfies the share of responsibility for reserves tentatively assigned to WPP to cover the possible loss of the largest generating unit in the MAIN organization. The WPP's tabulated reserve margin for the 1973 summer peak period also includes the scheduled installation of five 50 MW gas turbine units and net firm purchases of 225 megawatts of capacity. The pool has no additiona base-load units scheduled for commercial operation until the 500 megawatt fossil-fired Columbia Unit No. 1 in April 1975.

With the availability of the Kewaunee unit, the MAIN region forecast a reserve margin of 7,153 megawatts or 24.2 percent of peak load for the 1973 summer period. Without the Kewaunee unit, MAIN's reserves are reduced to 6,626 megawatts or 22.4 percent of peak load. All of these reserves are vested in 13 large new generating units scheduled during the period January 1972 through June 1973. The units include seven fossil-fired units totaling 4,155 megawatts and six nuclear units totaling 4,546 megawatts, which are tabulated below:

Station	Capability	Type
Dresden #3	789	Nuclear
Coffeen #2	600	Fossil
Powerton #5	840	Fossil
Quad Cities #1	395	Nuclear
Quad Cities #2	1,039	Nuclear
Labadie #3	580	Fossil
New Madrid #1	600	Fossil
E. D. Edwards #3	350	Fossil
Zion #1	1,039	Nuclear
Point Beach #2	495	Nuclear
Baldwin #2	605	Fossil
Zion #2	1,039	Nuclear
Labadie #4	580	Fossil

The adequacy and reliability of the MAIN regional systems in meeting future loads is dependent upon the timely commercial operation of all the units scheduled in its current construction program. Current information indicates that delays are being experienced in bringing most large new generating units into commercial operation and this trend may continue for some time in the future.

In view of possible construction and licensing delays, as well as the brief time for maturation of these units between their scheduled commercial service dates and the summer peak of 1973, the MAIN resources appear none too large.

MAIN's primary function is to augment reliability of the member's bulk power systems through coordination of the member's expansion plans and coordinated operation of their generation and transmission facilities to provide short term emergency relief in the event of contingencies normally experienced on interconnected power systems. Regional reserves, however, are 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 must be maintained by each system, based on its own load.

Transmission Facilities

The Applicant states the necessary transmission line additions required for the Kewaunee nuclear plant include a 56.2-mile long, 345-kilovolt transmission line which will deliver the output of the Kewaunee plant into the existing 345-kilovolt regional transmission grid and two 138-kilovolt, 2.0-mile, transmission lines to tie into the local distribution system. The 345-kilovolt line will extend 5.6 miles from the Point Beach nuclear plant substation to the Kewaunee plant, where it will turn west for 50.6 miles and tie in with Wisconsin Electric Power Company's substation at North Appleton.

The transmission lines predate recently issued federal guidelines; however, the Applicant states every effort has been made to lessen the environmental and visual impact of the transmission tower structures in accordance with existing company policies. No detailed information was reported, therefore the staff of the Bureau of Power cannot comment on the design adequacy of the Applicant's transmission systems, or the resulting impact on the environment.

Mr. Daniel R. Muller

Alternatives and Costs

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. In making the economic comparison, the Applicant originally estimated 1972-80 total annual costs, including operating costs and annual carrying charges on investment, of 5.25 mills per kilowatt-hour for a nuclear plant. Current projections of similar costs show estimates of 8.12 mills per kilowatt hour for a coal plant and 8.15 mills per kilowatt hour for a nuclear plant. However, if the committed costs of the Kewaunee project, of $132,000,000, were to be added to a replacement coal plant, the resulting cost of energy would be increased to 13.46 mills per kilowatt hour.

The staff of the Bureau of Power finds these costs within the range of similar costs reported by the industry.

Conclusions

The staff of the Bureau of Power concludes that the electric power output represented by the Kewaunee unit is needed to implement the Applicant's and MAIN's generation expansion programs for meeting projected loads and to provide a reasonable measure of reserve margin capacity for the 1973 summer peak period, particularly in view of the very large amount of other new capacity which must be in operation in MAIN's system on schedule if the forecast capacity margin is to be met.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

50-305

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SEP 22 1972

OFFICE OF THE ADMINISTRATOR

RECEIVED SEP 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 the Kewaunee Nuclear Power Plant, and we are pleased to provide our comments.

In our opinion, it may not be possible to operate the Kewaunee plant at full power using the once-through cooling system and avoid significant damage to aquatic biota. We recommend, therefore, that the applicant initiate steps appropriate to assure that the plant facilities and operation will be in accordance with the Lake Michigan Enforcement Conference recommendations and that no significant adverse effect on water quality or aquatic biota will occur.

According to our review of the gaseous effluent control systems provided in the Kewaunee plant, all significant normal gaseous effluent release points are provided with iodine treatment systems. Thus, the iodine releases from Kewaunee should be "as low as practicable." However, the draft statement includes an estimate of 45 millirem/year as a potential thyroid dose to a child. This estimate appears to be excessive and is high because credit was not taken for the capability to treat the condenser steam jet air ejector and blowdown tank vent exhausts. The final statement should provide the criteria for utilizing these effluent treatment systems. Because of the nearby dairies, we encourage the applicant to utilize the available iodine control systems in a manner to minimize releases of radioiodines to the environment.

The draft statement does not include an assessment of: (1) potential thyroid doses resulting from possible future use of part of the plant property as pasture, (2) potential thyroid dose consequences of atmospheric steam dumping, or (3) the combined environmental impact of radioiodine discharges from the Kewaunee and Point Beach nuclear plants. We believe that these points should be addressed in the final statement, and an evaluation of potential dose consequences to the population should be presented.

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

EPA#D-AEC-00063-26

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20460

September 1972

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Kewaunee Nuclear Power Plant

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental statement for the Kewaunee Nuclear Power Plant prepared by the U.S. Atomic Energy Commission (AEC) and issued on July 21, 1972. Following are our major conclusions:

1. In order to provide protection for the aquatic environment of Lake Michigan, we suggest that the applicant initiate steps appropriate to assure that the Kewaunee plant facilities and operation will be in accordance with the Lake Michigan Enforcement Conference recommendations and that no significant adverse effect on water quality or aquatic biota will occur.

2. Analysis of available information indicates that it may not be possible for the Kewaunee plant using the once-through cooling system to operate at full power and, at all times, comply with the thermal criteria of 1000 ft - 3°F as specified in the conference report. The final statement should indicate how compliance is to be accomplished.

3. The most significant radiological consequence from normal operation of the Kewaunee Nuclear Power Plant is expected to be the potential thyroid doses from ingestion of ^{131}I via milk. The final statement should provide clarification of: (1) the criteria for use of the iodine control systems, (2) the potential ^{131}I discharges during transients which result in steam dumps to the atmosphere, and (3) the applicant's plans for returning the site property to agricultural use.

4. Liquid radioactive waste management systems may be capable of treating effluents to levels that can be considered "as low as practicable." However, final determination is not possible since the turbine building sources have not been addressed in either the draft statement or the FSAR.

RADIOLOGICAL ASPECTS

Radioactive Waste Management Systems

The radioactive waste management systems provided for the Kewaunee Nuclear Power Plant appear to be representative of present waste treatment technology and industry practices, except for the liquid waste system evaporator, which has a smaller capacity than evaporators at many other pressurized water reactors (PWR's). Nevertheless, it is expected that the Kewaunee effluents can be adequately treated to meet proposed guidelines of Appendix I to 10 CFR Part 50. Furthermore, the releases may be consistent with the philosophy of "as low as practicable" if the waste treatment equipment provided is used in a manner which is consistent with the commitment given in the draft statement: "The releases...will conform to the U.S.A.E.C. requirements that they be 'as low as practicable,' that...if possible, be lower than specified limits, and that the resulting doses to people...will be well within an acceptable range." The final statement should provide the applicant's criteria to implement this commitment.

The Kewaunee ventilation control systems appear capable of maintaining the discharge of ^{131}I to levels consistent with the philosophy of "as low as practicable." Nevertheless, the AEC estimated that 0.59 curies of ^{131}I would be discharged annually - mainly from the condenser steam jet air ejector and the blowdown tank vent. The draft statement also indicates that this discharge of ^{131}I could reslut in thyroid doses which exceed the guidelines of Appendix I. However, in the draft statement the AEC did not give consideration to the extent of iodine control provided by

available plant systems i.e., (1) routing of the blowdown tank vent discharge to the condenser, (2) routing of the condenser air ejector discharge through the Auxiliary Building Special Ventilation System (ABSVS), and (3) treatment of the auxiliary building exhaust by the ABSVS.

The ability to minimize the iodine discharges from Kewaunee is imperative since there are dairy herds very near the plant, and some herds possibly may be allowed on the site property. Therefore, the final statement should: (1) present clarification of the applicant's commitments to use the various means available to minimize discharge of radioiodine, (2) present the applicant's criteria for using the available systems, and (3) provide a discussion of criteria the AEC will use for gaseous effluent limits to assure that "as low as practicable" levels result.

In their evaluation of the expected plant effluents, the AEC did not comment on the applicant's estimate of an annual discharge of 52 curies of ^{131}I from atmospheric steam dumps (Appendix A to the draft statement). Since this estimated source of ^{131}I discharge is two orders of magnitude greater that the ^{131}I release estimated by the AEC in the draft statement and could result in thyroid doses that may exceed Appendix I guidelines, the AEC should discuss the reasons why they did not address steam dumping in the draft statement. We note that the proposed Appendix I to 10 CFR Part 50 and the present regulations (10 CFR Part 50.36a) indicate that "...discharges...during normal reactor operations, including expected operational occurrences..." apply to discharge and dose limits established for the station. The final statement should include: (1) a detailed discussion and evaluation

of this source of iodine discharge, (2) its environmental impact, and (3) a discussion of the relationship of radionuclide discharges from anticipated operational occurrences to "as low as practicable" concepts.

As we noted previously, the evaporator in the liquid waste treatment system has a smaller capacity than do evaporators in many other nuclear plants. However, because plant wastes are segregated and the steam generator blowdown treatment system can be used for treating liquid wastes, the liquid waste systems may be sufficient to control liquid radioactive effluents to levels which can be considered "as low as practicable." However, the draft statement and FSAR have not evaluated the potential leakage of radioactive liquids from the secondary coolant system. Based on limited data from operating PWR's, this leakage may be of a volume comparable to that discharged via steam generator blowdown. Since this leakage is not addressed in the draft statement or in the FSAR, it is not clear if it is to be monitored or if it can be treated. Thus, firm conclusions cannot be reached as to the adequacy of the liquid waste management system to provide "as low as practicable" discharges. Therefore, the final statement should include: (1) an evaluation of the volume of anticipated secondary system leakage, (2) an estimate of the concentrations of radionuclides in the leakage, and (3) an evaluation of the waste treatment system capability to process this waste. Furthermore, it should include a summary of the technical specifications covering the liquid waste discharges.

Dose Assessment

The most significant dose consequences that are expected to occur as a result of the operation of the Kewaunee Nuclear Power Plant are the potential thyroid doses. The draft statement estimated that daily consumption of milk from the nearest dairy (1,300 meters north) could result in a 45 millirem/year (mrem/yr) thyroid dose to a child. According to the draft statement, the applicant plans to return much of the on-site plant property to agricultural use after the plant commences operation. If this property is used for pasture, the potential thyroid doses may be even greater than those estimated in the draft statement. Furthermore, the estimated doses apparently do not include the dose from the 52 curies of ^{131}I discharged annually as estimated by the applicant from steam dumps to the atmosphere.

According to the draft statement, if a child drank milk from a "pooled" source made up of all the milk produced within 50 miles, the thyroid doses could be 0.19 mrem/yr. While we realize that there are no regional siting or dose criteria which might relate to operation of multiple reactors in a region, we believe that the final statement should include an evaluation of the environmental effects from both the Kewaunee and Point Beach nuclear power plant effluents.

Since a large part of the plant exlusion area extends into Lake Michigan, the potential whole body dose consequences from discharges of radioactive gaseous wastes will be higher within the exclusion area that those calculated at the periphery of the exclusion area where "as low as practicable" criteria are applicable. Since access to this area of the lake is uncontrolled, the final

statement should describe how compliance with Appendix I guidelines in the area will be demonstrated.

Although the proposed guidelines of Appendix I to 10 CFR Part 50 and the release limits of 10 CFR Part 20 do not apply to radiation doses from direct shine from facility components, we believe that these potential radiation doses should be evaluated in assessing the environmental impact of nuclear plant operation. The final statement should evaluate potential direct shine doses to persons at the nearest residence, at the critical boundary "fence post", and at the nearest shore of Lake Michigan. Details of the analysis, such as location of sources, source geometry, source strength and mechanisms to control source strength, should be presented in the final 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 Kewaunee plant employs a once-through cooling system with a submerged intake structure and a shoreline discharge structure. Its expected thermal discharge characteristics appear to meet applicable Federal-State water quality standards. These standards, approved by the Federal Government in 1967, allow cooling water discharge temperatures as high as 89° F without mixing zone specifications. While temperature over 68° F is considered detrimental to the growth and migration routes of certain of the area's salmonids such as coho salmon and trout, the Applicant's permit authorizes the plant to discharge heated water up to 86° F.

Different thermal standards for the protection of biota of Lake Michigan were recommended at the Lake Michigan Enforcement Conference (LMEC) which convened on several occasions between March 31, 1970 and March 25, 1971 (recommendations are attached in Appendix A). The design and operation of this facility was reviewed and evaluated in conjunction with these recommendations.

It appears that the LMEC requirements will not be met by Kewaunee for the following reasons:

1) The 3°F isotherm may extend approximately 7000 feet from the discharge structure and may, therefore, exceed the "1,000 feet from a fixed point adjacent to the discharge" recommendation of the Conference.

2) The plumes from the Kewaunee and Point Beach plants may overlap.

3) The intake structure is located within an area that may be affected by the thermal discharge. In our opinion, closed-cycle cooling would eliminate these problems.

Thus, we recommend that the final statement indicate the means by which these potential problems will be resolved and describe the steps that will be taken to assure that the Kewaunee plant facilities and operation will be in accordance with the recommendations of the Lake Michigan Enforcement Conference.

Biological Effects

Since yellow perch have been identified in the area of the plant site and are important in the Lake Michigan ecology, the final statement should discuss the potential effects of the thermal plume on the spawning success of yellow perch attracted to it during the winter. These fish require a winter chill period to initiate gonadal development. This chill period may not be met if they remain in the plume area for extended periods. To date, investigations by the Applicant show no evidence of any nursery areas in the vicinity of the plant. There is, however, the possibility that the investigations are not complete or that the spawning area and thermal plume area may overlap at some later date.

The statement indicates that the spring thermal barrier tends to inhibit mixing between the open lake and the nutrient-rich, inshore waters. The effect of this spring thermal barrier on the thermal plume heating of the trapped inshore water with possible increase in green and bluegreen algae growth should be addressed in the final statement.

The overall stress on the aquatic environment in the region of the Kewaunee plant should be evaluated in the light of the plant's contribution to the cumulative

biotic stresses from all sources in this part of the lake. Other biotic stress may include: (1) Municipal sewage treatment plants which discharge treated wastewater into the lake from the communities of Algona, Casco, Kewaunee, and Luxemburg, (2) Small villages in the vicinity which rely on private, single-family sewage disposal means, (3) Dairy plants, which furnish the principal industrial wastewater sources. These sources contribute varying amounts of organic material to the Lake. This encouragement to eutrophication could be further assisted by the warm water of the thermal plume.

In addition to the bubble curtain which is incorporated in the plant design, fish entrainment at the cooling water intake may be further reduced by adding an electric probe system. This is suggested because the effectiveness of a bubble curtain as a deterrent is limited by many variables such as currents, fish variety, turbidity, etc.

Chemical Impact on Biota

Sanitary wastes will be given secondary treatment (9000 gal/day capacity) and discharged in small quantity; chemicals in service water will be discharged in very dilute concentrations. Therefore, applicable chemical water quality standards will probably be met.

The evaluation of the discharges of pollutants, especially dissolved solids and compounds of phosphorus (plant nutrients) should take long-term effects into consideration. During periods of peak demand, approximately 25,100 gallons of spent regenerating solution will be neutralized and discharged (100 gal/min) to the lake every other day via the cooling system. This solution will contain an estimated 8800 mg/liter of total dissolved solids per discharge. One of the most important effects of these waste discharges will be their contribution to buildup of dissolved solid concentrations in Lake Michigan over a long period of time. This effect is caused by the very large volume of the lake in relation to the total inflow to the lake. It takes about 100 years to exchange the water in Lake Michigan, and each increment of pollution therefore adds to that already present. Historically, the concentrations of dissolved solids in Lake Michigan have increased continuously. The final

statement should consider such long-term effects of dissolved solids on the environment as well as alternative means of disposal.

The applicant does not yet know if chlorine will be added to the circulating water to prevent fouling. If it is found necessary to use chlorine, it will be in the form of sodium hypochlorite. In order to insure that the residual chlorine level of the receiving water be kept below that which EPA believes would be detrimental to the aquatic life of the plant area, the following is recommended: for intermittent discharges, the residual chlorine in the receiving water should not exceed 0.1 mg/liter for 30 minutes per day or should not exceed 0.05 mg/liter for 2 hours per day. The residual chlorine level of the receiving water may be monitored by the amperometric titration method. This is one of the most accurate methods for determining the quantity of free or combined, available chlorine. The applicant should consider the use of mechanical cleaning devices to eliminate the need for chlorine with its possibly long term toxic effect.

Monitoring and Surveillance

A monitoring program should be developed to measure the effect of the plant's waste discharge on the long-term increase of pollutant in the lake, especially dissolved solids.

A program for monitoring fish migration before and after startup and during shutdown should be conducted. According to the statement maturing coho salmon are known to migrate near the plant site.

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 Kewaunee Nuclear Power Plant. 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 shoreline of the plant site is subject to erosion, but the statement makes no mention of any efforts to control erosion. A properly monitored erosion control program should be instituted, and discussed in the final statement.

2. A discussion of (1) the types of hazardous liquids which are used at the site, (2) the control measures included for the protection of Lake Michigan from these liquids, and (3) the consequences to Lake Michigan of accidents involving these materials, should be included in the final statement.

3. The draft statement indicates that the plant's discharge structures are subject to sedimentation. Plans for offsetting such sedimentation should be discussed in the final statement.

4. Sanitary waste treatment is stated to include aerobic digestion with settling followed by chlorination and a polishing pond. This is not a clear discription. The term "aerobic digestion" probably refers to a tank aeration unit but does not eliminate the possibility of a lagoon with no sludge return. This sewage treatment facility was designed for 9,000 gallons

per day. This should be adequate for a work force of approximately 100, along with visitors to the site. The type of sanitary wastewater treatment should be clarified and assurance should be given that the plant is approved by the state.

5. Although the sewage treatment plant treats a very small amount of waste, the discussion should include the method of sludge disposal and the plant efficiency. Since the plant has been in operation for some time, such information should be available.

6. The annual average atmospheric dilution factors as a function of direction should be given.

7. An analysis of the potential effects of accidents which will release non-radioactive volatile materials should be presented, including: (1) types and quantities of materials, (2) the probabilities of accidents, and (3) the environmental impact.

8. A description should be given of the numbers and kinds of emergency boilers, space heating equipment, and diesel generators, including the capacity, fuel type, fuel sulfur content, and annual use rate. (All such equipment should conform to local and state requirements for fuel use, storage, and emission controls.)

9. It is not clear why some solid refuse is to be buried on-site, while other refuse is transported off-site for burial. This should be clarified in the final statement. (Any landfill operation employed should meet state and Federal regulations and should be state licensed.) Also, it is not clear whether the landfills mentioned on page III-33 and page IV-1 of the

draft statement are the same; this should be clarified in the final statement.

10. The final statement should include a discussion of noise abatement measures to be used during the remaining construction activities and plant operation.

Appendix A

Lake Michigan Enforcement Conference Recommendations

The approved recommendations of the Conference are as follows:

In order to protect Lake Michigan, the following controls for waste heat discharges are concurred in by the Conferees representing Indiana, Michigan, Wisconsin, and the U.S. Environmental Protection Agency. Municipal waste and water treatment plants, and vessels are exempted from the recommendations.

I. Applicable to all waste heat discharges except as noted above:

1. At any time, and at a maximum distance of 1,000 feet from a fixed point adjacent to the discharge, (agreed upon by the state and Federal regulatory agencies), the receiving water temperature shall not be more than 3°F above the existing natural temperature nor shall the maximum temperature exceed those listed below, whichever is lower:

	Surface 3 feet
January	45
February	45
March	45
April	55
May	60
June	70
July	80
August	80
September	80
October	65
November	60
December	50

2. Water intake shall be designed and located to minimize entrainment and damage to desirable aquatic organisms. Requirements may vary depending upon local situations but, in general, intakes

are to have minimum water velocity, shall not be influenced by warmer discharge waters, and shall not be in spawning or nursery areas of important fishes. Water velocity at screens and other exclusion devices shall also be at a minimum.

3. Discharge shall be such that geographic areas affected by thermal plumes do not overlap or intersect. Plumes shall not affect fish spawning and nursery areas nor touch the lake bottom.

4. Each discharger shall complete preliminary plans for appropriate facilities by December 31, 1971, final plans by June 30, 1972, and place such facilities in operation by December 31, 1973. However, in cases where natural draft towers are needed, this date shall be December 31, 1974.

5. All facilities discharging more than a daily average of 0.5 billion BTU/hour of waste heat shall continuously record intake and discharge temperature and flow, and make those records available to regulatory agencies upon request.

II. Applicable to all new waste heat discharges exceeding a daily average of 1/2 billion BTU/hour, except as noted above, which have not begun operation as of March 1, 1971, and which plan to use Lake Michigan waters for cooling:

1. Cooling water discharges shall be limited to that amount essential for blowdown in the operation of a closed-cycle cooling facility.

2. Plants not in operation as of March 1, 1971, will be allowed to go into operation provided they are committed to a closed-cycle cooling system construction schedule approved by the state regulatory agency and EPA.

In all cases, construction of closed-cycle systems and associated intake and discharge facilities shall be completed by December 31, 1974, for facilities utilizing natural draft towers and December 31, 1973, for all other types of closed-cycle systems.

III. The states agree to file with EPA within six months a plant-by-plant program identifying corrective actions for the modificatio of intake facilities, including power plants, municipal, and industrial users, to minimize the entrainment and damage to desirable aquatic organisms.

IV. The Conferees agree that there should not be a proliferation of new power plants on Lake Michigan, and that in addition to the above controls, limitations should be placed on large-volume heated water discharges by requiring closed-cycle cooling systems, using cooling towers or alternative cooling systems on all new power plants.

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

L. P. Voigt
Secretary

BOX 450
MADISON, WISCONSIN 53701

September 25, 1972

IN REPLY REFER TO: 1600

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

RECEIVED
SEP 29 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Dear Mr. Muller:

Re: Docket 50-305

We have reviewed the draft Environmental Statement for the Kewaunee Nuclear Power Plant of the Wisconsin Public Service Corporation - Docket No. 50-305. This statement appears to contain a reasonable and accurate appraisal of the actual and potential effects of this facility on the environment.

We support the recommendations in the Environmental Statement that the issuance of an operating license for the facility be subject to: (a) the development of a more comprehensive biological monitoring program; (b) an increased hydrological monitoring program; and (c) an increased and augmented radiological monitoring program. Our Department has reviewed the specific environmental study proposal with members of the Wisconsin Public Service Corporation and Bio-Test Laboratories and found it to be acceptable.

Thank you for the opportunity to review and comment on this Environmental Statement.

Very truly yours,
Bureau of Environmental Impact

C D Besadny

C. D. Besadny
Director

CDB:ml

WISCONSIN PUBLIC SERVICE CORPORATION

P.O. Box 1200, Green Bay, Wisconsin 54305

October 3, 1972

Mr. R. C. DeYoung, Assistant Director
for Pressurized Water Reactors
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

RECEIVED
OCT 11 1972
U.S. ATOMIC ENERGY COMMISSION

Dear Mr. DeYoung:

Subject: Submittal of Comments to the Draft Environmental Statement for the Kewaunee Nuclear Power Plant

AEC Docket 50-305

Pursuant to your letter of July 20, 1972, which transmitted the Draft Environmental Statement related to the Kewaunee Nuclear Power Plant, we submit herewith, three copies of our comments to the Draft Environmental Statement.

Very truly yours,

E. W. James, Senior Vice President
Power Generation and Engineering

EWJ:mem

WPS COMMENTS TO DRAFT ENVIRONMENTAL STATEMENT ISSUED JULY, 1972 BY THE U S ATOMIC ENERGY COMMISSION DIRECTORATE OF LICENSING

Comment No.	Ref. Page, Figure, Table	Remarks
1	Page II-24	Last paragraph - Analysis of surface wells mineral content have shown values of 840 ppm rather than 330 ppm.
2	Page III-23 Figure III-13	WPS has agreed to modify the steam generator blowdown treatment vent to vent to the condenser instead of venting to atmosphere.
3	Figure III-14	See attached Figure III-14 indicating flow paths.
4	Page III-26	Top of page - Last sentence change to: "Alternatively, the bottoms can be sent directly to waste solidification for processing."
5	Page III-30	Item 2, secondary coolant, boiler blowdown of coolant containing chemicals are discharged directly to the lake by way of the circulating water and are not routed to the neutralizing tank.
6	Page III-30	WPS has modified the make-up water system. (See attached - Service Water Pretreatment System.)
7	Figure III-15	See attached Figure III-15 indicating changes.
8	Page III-32	First paragraph - Change volume of neutralizing tank from 25,100 gallons to 19,000 gallons. Last paragraph - Change last sentence to read: "Assuming that the 9000 gpm of raw water for the sanitary supply will be <u>well</u> water with a hardness of <u>840</u> ppm, the hardness of the circulating water discharge will be increased by 0.3 ppm (as $CaCO_3$) during the addition of the softener regeneration waste."
9	Page III-33	Miscellaneous non-radioactive solid waste will not be put into a hydraulic baler but removed by a local waste handling firm to a certified land fill area off-site.

Comment No.	Ref. Page, Figure, Table	Remarks
10	Page III-34	Diesel generator rating is 2600 KW at 0.8 pf for continuous operation and 3050 Kw overload rating for 30 minutes.
11	Page IV-1	First paragraph - All residences have been removed, the log cabin will be retained, a new building will be erected to serve as the Emergency Control Center. Third paragraph - A minor alteration in land use is being made. This consists of taking land fill area and using a portion of this area for the service water pre-treatment settling basins. Refer to Figure II.1-2 attached.
12	Table IV-1	Change the following dates on the table: Reactor Coolant Cold Hydro - November, 1972 Hot Functional Test Start - January, 1973 Fuel Loading - March 1973 Commercial Operation - September, 1973
13	Page IV-3	Second paragraph under 2. Water: The mineral content of the well water increased in hardness to a level above 800 ppm (See comment 1). For that reason, future water requirements will be from Lake Michigan, except that sanitary and drinking water will be supplied from the wells.
14	Page V-4	B. Water and Air Use - Last sentence, first paragraph - Comment 13 applies.
15	Page V-9	4. Hydrological Monitoring Program - This program has been greatly expanded and approved by the Wisconsin Department of Natural Resources.
16	Page V-38, Table V-6	Sampling station K-8 has been changed to St. Mary's Church, Tisch Mills.
17	Page V-44	3. Transport of Solid Radioactive Wastes First sentence should read as follows: "Spent resins, waste evaporator bottoms and some process liquids will be dewatered, concentrated, and solidified, with other radioactive solid wastes, loaded into containers for shipment and disposed." WPS does not intend to ship liquids.
18	Appendix A Table A-1	The Draft Environmental Statement was based on the FSAR through Amendment 18. (See Page xvii.) Amendment 18 revised this table which appears in Section 11

Comment No.	Ref. Page, Figure Table	Remarks
19	Page II-43	Last sentence, first paragraph - "The fact that the phytoplankton... ...quality in the lake (29,30)." It is recommended this statement be deleted without a definite source of study to show proof.
20	Page II-43	Third paragraph, third sentence - The statement as written is a misinterpretation of Stoermer's work. Reference (27) should be (37). Fourth sentence - The statement as noted is questionable and a source should be given to verify the statement.
21	Page II-43	Fourth paragraph - Delete 59 species; a larger number of species has been found. Delete species *Asterionella formosa*, *Melosira* sp., and *Fragilaria* sp. since these were not determined by the millipore filter and Lackey scan technique.
22	Page II-44	Statement at top of page should be in periphyton section.
23	Page II-44	(2) Bacteria - 3rd paragraph - Reference (45) appears to be incorrect. 4th paragraph - Reference should be given as to where further discussion of Kewaunee plant sanitary system can be found. (3) Periphyton - This is not plankton and should not be in this section. Suggest this section be grouped as follows: a. General b. Plankton c. Periphyton d. Benthos e. Fish
24	Page II-45	First line - End sentence after "...nine species." Delete "F. vaucheriae was the most abundant, followed by F. pinnata (19)." This appears completely out of context and serves no purpose. c. Benthos - A specific reference should be given for the survey done in 1964-1965.
25	Page II-46 Table II-15	The data in the table is not complete; therefore, very misleading. The table should be completed or deleted. Suggest that reference (38) be added to (4) Zooplankton, Page II-45 and delete this table.

Comment No.	Ref. Page, Figure, Table	Remarks
26	Table II-16	Change Lumbricidae to Lumbriculidae. Change (flies) to (midges). Delete Amicolidae (gastropods). Add oligochaeta to worms.
27	Page II-47	First paragraph - The sentence beginning with "Most of the samples taken in this survey were under deeper offshore waters... ..etc." is not consistent with the last sentence which states one sampling station was in the deeper water off Kewaunee. Second paragraph - We suggest deletion of "any heavy erosion" in the first sentence. We question reference cited (31) in line 4. We suggest rewording of third sentence from "The majority of all" to "Many of the"
28	Page II-47	Last paragraph, last sentence - This sentence is inconsistent with statement in second paragraph, Page III-9.
29	Page II-48	First paragraph - Coregonids, smelt and alewives are mostly plankton feeders. The last sentence is not true for rainbow trout and brown trout. d. Fish - The data here is good but appears to be contradictory with data under Fish in Section V.
30	Page II-49	Second paragraph - Under (1), the statement "The commercial fishing industry of the lake collapsed following the opening of the Welland Canal." This is misleading and appears as if the collapse was immediate, where as in fact the collapse took place many years after the canal was opened.
31	Page II-50	We suggest Item (3) be deleted since there is no documentation cited. The same species in other river systems draining into Lake Michigan as in the Mississippi River. Item (4) Sunfish is not considered an exotic fish.
32	Page II-53	Reference 31 should be deleted or expanded to indicate whose. When were observations made? cf II-47.
33	Page III-9	Second paragraph - The 1000 acres is not consistent with Page II-47, (250acres) and the 254 acres listed in (i) below on Page III-9.

Comment No.	Ref. Page, Figure, Table	Remarks
34	Page V-9	First line - We suggest adding "at certain seasons" after "attracted".
35	Page V-13	First paragraph, last three sentences - Small fish are lumped in with "low mortality". Mechanical damage to small fish is likely; the character of pressure change in the plant system will determine much about survival. Few fish eggs (free floating) are expected in area. We suggest deletion of last half of last sentence. End sentence after "zooplankton". Second paragraph - (2) "many of the species have short generation times... .etc." This is true of phytoplankton but not true of zooplankton or fish larvae. b. Fish Eggs and Larvae - A reference should be given for second sentence; conclusion may be in error. Species that might spawn in this area would be smelt and alewives. Whether perch use the area to spawn is questionable and unconfirmed at present. It is probably too shallow for lake trout, although gravid adults appear in collection at 15 feet made by our consultant; it is much too shallow for bloater chubs, which ordinarily spawn deeper than 100 feet. No streams of consequence are nearby for brown and rainbow trout runs or that have been used for coho or chinook imprinting. We will have better information when all of the pumping information is in for this year from the monitoring program. There probably would be some mortality of alewife, smelt, sculpin, and notropis spp. larvae due to entrainment in the intake water, but nothing of significance to the local populations.
36	V-14	First paragraph - A reference should be given for the Wisconsin DNR study.
37	V-18	First paragraph, second line - We suggest adding "at certain seasons" after "attracted". Last sentence - "little natural spawning" is a blanket statement. Alewives, smelt, and several minnow species undoubtedly do spawn in this area, as they spawn along much of the beach area in this area.

Comment No.	Ref. Page, Figure, Table	Remarks
37 (Cont'd)	V-18 (Cont'd)	Second paragraph - Wisconsin DNR reports should be referenced.
		Third paragraph, last sentence - Our consultant's observations have been that lake trout are found in 15 feet of water throughout the sampling periods. Cisco should probably be changed to bloater chub.
38	V-19	First paragraph, seventh line - We suggest deletion of "bloater". They spawn in much deeper water.
		Second paragraph, first line - "Most" should be changed to "Many" and add "at certain times of the year" to end of sentence.
		Eighth Line - Suggest changing "still remain" to "may remain".
		Fourteenth line - Industrial Bio-Test Laboratories data for 1971 contains information on feeding habits of some species of sport fishes in the Kewaunee sampling area.
		Last part of paragraph - The discussion relating to feeding temperatures and food conversion is too generalized and from the low temperatures listed it appears to be referring to cold water fish only. This paragraph we believe is open to questioning and should be deleted or rewritten.
39	V-19	Third paragraph - Reference to fish diseases in plumes as it refers to Lake Michigan is undocumented to our knowledge.
40	V-20	Top of page - We believe the connection with brown trout fungus and thermal discharges is unwarranted in light of the lack of knowledge of this disease.
		Fourth paragraph under (2) - Motile, sessile and non-motile forms are not fish. Fish are capable of moving rather rapidly with a shift in direction of a thermal plume.

Comment No.	Ref. Page, Figure, Table	Remarks
41	V-21	First paragraph, fourth line - Reference should be cited. Second paragraph - First sentence appears to be contradictory with third sentence. Yellow perch are occasionally abundant - a seasonal occurrence. Third paragraph - Alewives are not considered migratory. Salmon have not been taken in any numbers during the WPS sampling, which would indicate that significant "migration" is lacking in this area.
42	V-22	Second paragraph, last sentence - Duluth EPA has reported a 0.001 mg/l a critical level to certain invertebrate organisms.
43	V-23	First paragraph, next to last sentence - This statement appears inconsistent with statement on pages V-7 and V-8. Is 0.02 ppm a critical value?
44	V-26	Second paragraph - The sampling schedule listed was for 1971 and does not necessarily apply to current schedule.
45	Figure V-3 Table V-6 Table V-7 Table V-8	The sampling program has been improved to the extent that two sampling stations have been added; types of samples taken by frequency and location has been expanded; All types and frequency of sampling and analysis have been increased.

Service Water Pre-Treatment System

A threefold increase in mineral content in the two wells supplying water to the makeup system resulted in a reduction in efficiency of the demineralizer units and an increase in the amount of chemical regenerants discharged to the circulating water. This increase in mineral content resulted in modifying the makeup water system by the addition of a pre-treatment system using lake water instead of well water.

The wells will no longer be used for makeup water; instead lake water will be used. A pre-treatment system is being installed.

The lake water will enter a flocculator/clarifier, at this point coagulating chemicals are added. The water then passes through a paddle flocculator into a settling area where most of the solids are removed from the water by tube settlers. The solids are gathered into a sludge hopper and removed to one of two sludge ponds located adjacent to the sewage treatment plant. The clarified water travels to a holdup tank, from which the water is pumped to five (5) pressure filters. The effluent from the filters is directed to the demineralizer system.

This system is capable of supplying from 50 to 350 GPM depending upon system requirements.

The sludge ponds are designed such that while one pond is being used, the other is being emptied to a solid land fill area. Liquid effluent from the ponds is directed to the circulating water discharge piping by means of a weir.

The chemicals added to the flocculator are alum (aluminum sulfate) to coagulate the turbidity in the water; lime to soften the water by combining with the calcium and magnesium ions in the lake water; polyelectrolyte will be used if necessary to aid in the development of the floc and to reduce the time required for the floc to settle; hypochlorite solution to kill the bacteria and sterilize the water; and sodium sulfite to reduce any free chlorine to chloride before entering the demineralizers.

Reference Table I. It can be seen that the amount of chemicals required for each 1,000 gallons of reactor make-up water is reduced with the pre-treatment system and hence results in less chemical discharges to the lake via the circulating water discharge.

Minor variations can be expected in the surface water such that the loadings to the demineralizer will vary somewhat; therefore the data developed from the evaluation is subject to fluctuation based on influent treatment capabilities.

The amounts of chemical compounds added to the circulating water from the pre-treatment system and from the waste neutralizing tank are shown on Table 2.

TABLE I

	Capacity (gallons/regeneration)			Regenerant Used (lbs/regeneration)		Lbs. Chemicals 1,000 Gal. of Makeup Water
	Cation	Anion	Mixed Bed	H_2SO_4	NaOH	
1) Well Water 400 ppm Hardness (Original design)	108,000	108,000	350,000	1058	555	13.8
2) Well Water >1000 ppm Hardness a)	345,000	345,000	345,000	4982	636	16.3
3) Pre-treatment System using Lake Water	313,000	313,000	1,900,000	621	591	3.2

a) Because of the extreme water hardness partial water softening was accomplished using the potable water softening units thereby lowering the Ca & Mg concentration but increasing the Na content, hence the longer Cation and Anion runs than original design.

TABLE 2

Component as $CaCO_3$	lb/day Pre-treatment system	lb/day Discharge from waste neutralizi tank
Calcium Carbonate	1.99	- -
Calcium Sulfate	- -	36.10
Magnesium Chloride	0.04	- -
Magnesium sulfate	1.99	36.82
Potassium chloride	0.05	- -
Potassium sulfate	- -	0.90
Sodium carbonate	- -	0.90
Sodium chloride	0.50	13.34
Sodium fluoride	- -	0.32
Sodium nitrate	- -	0.14
Sodium silicate	- -	1.78
Sodium sulfate	- -	177.73

Total amounts of chemicals added to the circulating water discharge are based on a capacity of 108,000 gallons per regeneration.

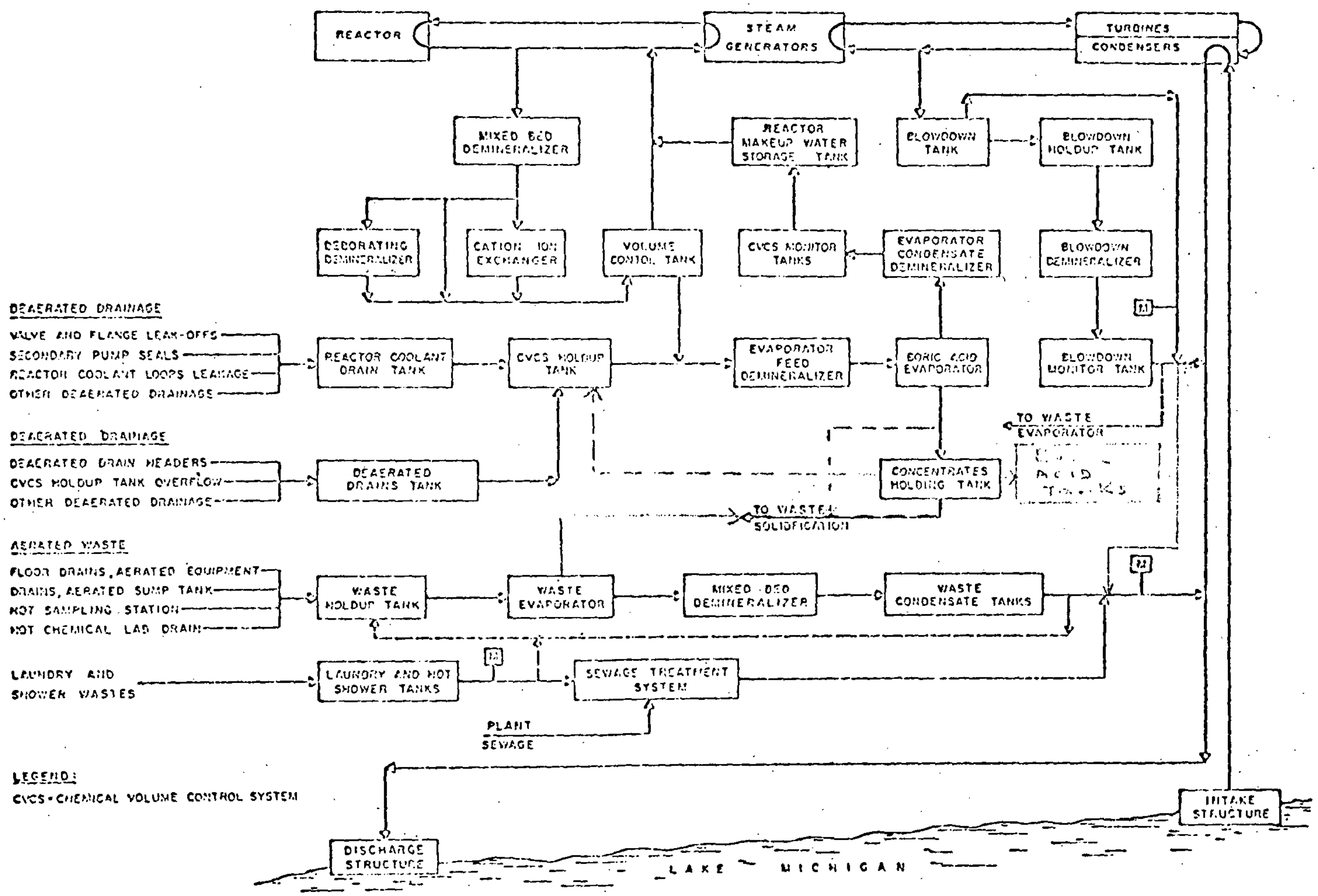


Fig. III-14. LIQUID WASTE DISPOSAL SYSTEM KEWAUNEE NUCLEAR POWER PLANT

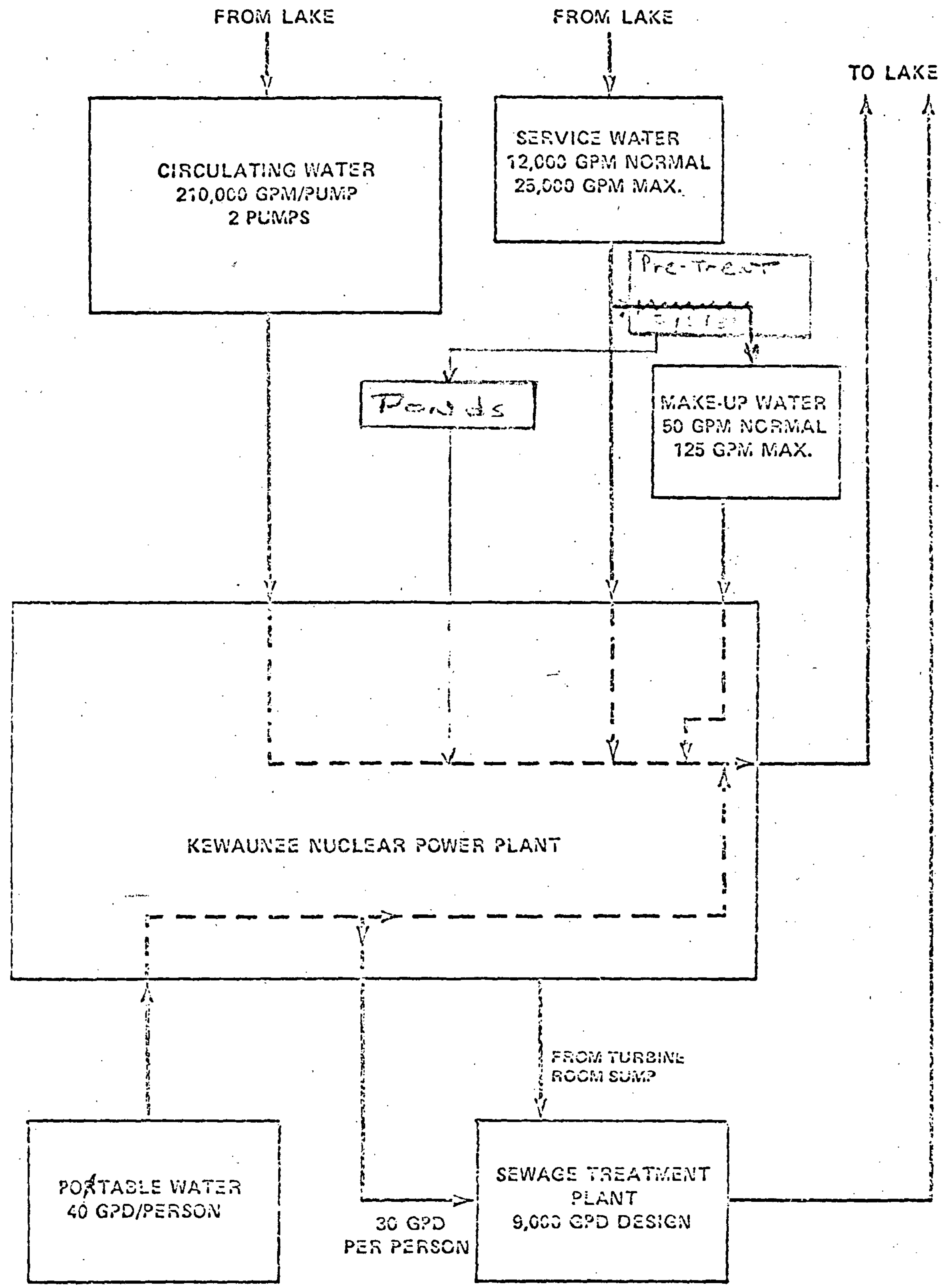
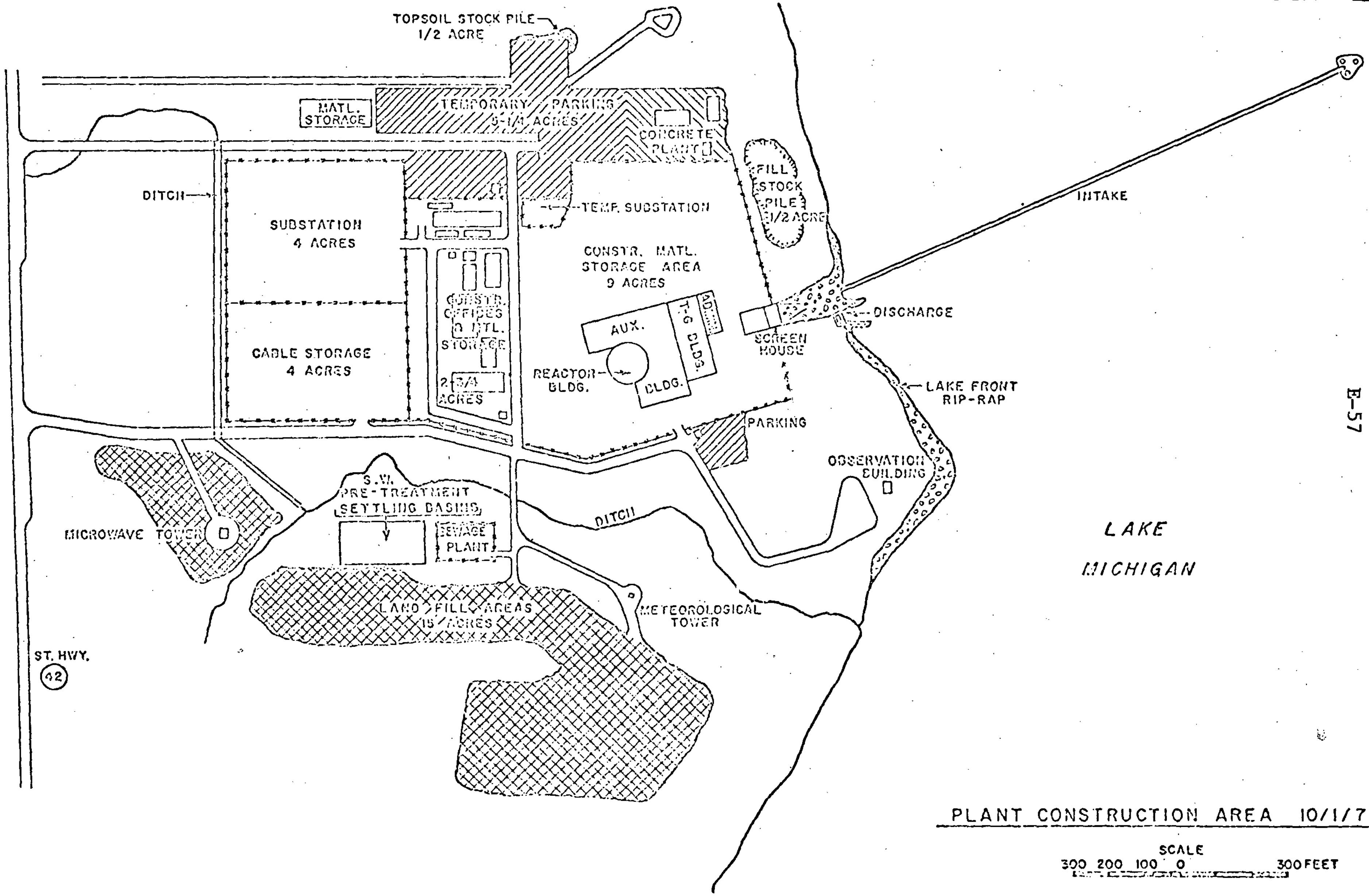


Figure. III-15. WATER USAGE BY THE KNPP.



PLANT CONSTRUCTION AREA 10/1/71

E-57

FIGURE 2.1-2
REV. 10-2-72

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

50-305

RECEIVED
OCT 20 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

October 19, 1972

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

Dear Mr. Muller:

The Department of Commerce reviewed the draft environmental statement by the Atomic Energy Commission for the Kewaunee Nuclear Power Plant and forwarded comments to you in our letter of September 14, 1972.

Since that time, additional information has developed which is pertinent to the project. This additional information is offered as requested by your office.

Page II-21. It is stated that shore currents flow opposite to main lake currents an appreciable portion of the time. It has been Lake Survey Center Experience that nearshore and lake currents of opposite direction do not exist for an appreciable time.

Page II-22. The combination of cold, up-welling water near-shore with an offshore warm zone would produce northward flowing currents in the surface waters due to geostrophy. A buoyant plume would be transported northward in this flow. Figures III-7 through III-10 are illustrative of plume dispersion at Point Beach during such conditions.

Page III-13. The observed plume dispersion at Point Beach on June 25, 1971 (Fig. III-6) is typical of dispersion patterns to be expected during "thermal bar" existence mentioned on page II-43. Surface water which warms most rapidly in the Spring, in the shallow water near the coast is kept near the shore in geostrophically balanced flows. Southward flowing currents along the west shore of Lake Michigan persist until the "thermal bar" terminates in Summer. The description of current patterns in Lake Michigan

would benefit by discussion of this seasonal event. The discussion should include the expected annual duration of the "thermal bar", density structure, and its effect on plume dispersion.

We hope these comments will be of further assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

THE STATE HISTORICAL
SOCIETY OF WISCONSIN

816 STATE STREET / MADISON, WISCONSIN 53706 / JAMES MORTON SMITH, DIRECTOR

Office of the Director

October 18, 1972

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

Dear Mr. Muller:

Attn: Mr. Ben Harless
Re: Docket No. 50-305

We have checked the draft environmental statement for the Kewaunee Nuclear Power Plant and find that no structures or sites listed on the National Register of Historic Places will be affected by the project.

Mr. John Halsey of our archeological division previously was contacted by telephone and reported that no archeological sites of record were located in the area.

Sincerely,

J. M. Smith

James Morton Smith

JMS:rd

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

50-305

RECEIVED
OCT 26 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

ER-72/888

OCT 26 1972

Dear Mr. Muller:

This is in response to your letter of July 20, 1972, requesting our comments on the Atomic Energy Commission's draft statement, dated July 1972, on environmental considerations for Kewaunee Nuclear Power Plant, Kewaunee County, Wisconsin.

Historical Significance

The fourth paragraph on page II-18 infers that there were no impacts on archeological resources resulting from the construction of the plant since there are no documented archeological sites within the site boundaries. The statement does not refer to an archeological survey of the site as the basis for this conclusion. Archeological surveys of the project site and transmission line rights-of-way should have been conducted prior to construction and described in the environmental statement.

Geology

The Geological Survey, as a consultant to the Atomic Energy Commission, has previously reviewed the geology of the proposed site with respect to safety aspects of the operation. The statement adequately displays the expected geological effects of the plant operation.

Environmental Features

The effects of sedimentation and erosion on the plant and the measures to protect this area from these acts of nature are not discussed adequately. Pages II-32 and IV-6 refer to protection by a promontory extending into the lake and additional stabilization being provided by riprap. Figures III-1 and III-2 also give data as to the location of these

features in respect to the plant. These small scattered portions of information should be pulled together and expanded in Chapter IV in order to present adequate coverage of this important feature.

Plankton

The second paragraph on page II-43 should be expanded to include the findings of other ecological studies of Lake Michigan. A report entitled "Physical and Ecological Effects of Waste Heat on Lake Michigan," published in September 1970 by this Department's Bureau of Sport Fisheries and Wildlife, indicated that nutrients in the inshore waters are approaching levels commonly found in the central basin of Lake Erie. Since Lake Michigan receives a substantial and increasing load of nutrients in the form of nitrogen, phosphorous, and other fertilizing agents from domestic effluents and agricultural runoff, it can be expected that the inshore waters of Lake Michigan, if nutrients are not controlled, will attain conditions of algae production similar to those in Lake Erie. If these conditions are reached, temperature will become a very important factor in determining the type of algae.

Stoermer and Yang (1969) reported that although the dominant phytoplankters in Lake Michigan are still diatoms, the numbers of taxa that are associated with degradation of water quality have increased and that a number of species which were able to thrive only in the naturally enriched areas near shore and in estuaries are now found in some areas of the open lake. The authors stated that "consideration of distribution and relative abundance of the major components of the plankton flora leads one to the conclusion that Lake Michigan is probably at the present time about at the breaking point between rather moderate and transient algae nuisances, largely confined to the inshore waters, and drastic and most likely irreversible changes in the entire ecosystem."

C. L. Schelshe and Stoermer, in a paper entitled "Depletion of Silicon and Accelerated Eutrophication in Lake Michigan," which was presented at the meetings of the American Society of Limnology and Oceanography in August 1970, stated that during the past 30 years the relative abundance of diatom species commonly associated with degradation of water quality

has increased. In the summer of 1969, the plankton diatoms comprised less than 10 percent of the phytoplankton in samples from the southern part of the lake, which was a significant deviation from previous years when the diatoms comprised at least 65 percent of the phytoplankton. The evidence, compared with data from Lake Erie and Lake Superior, suggests that accelerated eutrophication in Lake Michigan is rapidly approaching the point of a severe environmental change in which the diatom flora will be reduced or replaced by green and blue-green algae. The overall effect of heated discharges will be to reinforce and increase warmwater species to the detriment of more desirable coldwater species.

Benthos

This section, beginning on page II-45, describes extensive benthic surveys in the deeper offshore waters; however, data on benthos of the Kewaunee site in the nearshore waters where plant operations would have their greatest impact is not given. This data should be obtained and included in the final environmental statement.

Thermal Plume Dispersion

According to the cooling water effluent velocities given on page III-9, the travel time for the effluent to reach the end of the 530-foot discharge channel would vary from 3.7 to 1.3 minutes with 1.9 minutes required when the lake is at its normal water level of 577 feet (IGLD). These time periods appear to be in conflict with the second paragraph on page III-21 which states that the time involved would be approximately one minute. Therefore, organisms entrained in the cooling water would be exposed to maximum temperatures for approximately two minutes plus an additional minute in the effluent plume or a total of about three minutes at mean lake level.

We suggest that the apparent discrepancy between data on pages III-9 and III-21 be reconciled and the second paragraph on page III-21 be expanded to consider the time involved when strong lake currents will cause the plume to run along the shoreline and reduce the opportunity for the effluent to mix with the cooler receiving water. This will cause the duration of exposure of entrained organisms to

maximum temperatures in the effluent plume to be considerably longer than one minute.

We agree with AEC in the conclusion in the second paragraph on page III-9 that the mathematical model may not present an accurate indication of plume size. However, Figure III-7, showing the Point Beach plume on August 31, 1971, would appear to indicate that the applicant's data are reasonable. The Point Beach Unit 1, August 31, 1971, plume indicated distances in excess of a mile. The area enclosed by the 3°F isotherm is a significant area even though it may be less than 1,000 acres, as estimated by the applicant, or more than 254 acres, as estimated by AEC.

Of particular concern is that the statement does not adequately discuss the effects of sinking thermal plumes. It appears probable that the plumes of Kewaunee will sink below the surface at temperatures between 46°F and 32°F when the ambient temperature of the beach water is near freezing. The statement should evaluate this effect and the impact it may have on benthic organisms and on other aquatic life. We have special concern for the effects of biocides which may be carried to the bottom by sinking plumes.

Applicability to the Kewaunee Plant

This section, beginning on page III-13, contains a good discussion of the effluent plumes. We think that the intake temperatures and the plant load factors should also be included for the comparison with the Point Beach plant. Also, Figure III-11 indicates that the Point Beach plume has not completely separated from the lake bottom at about 1,000 feet from shore where the depth is 16 feet, while it is stated on page III-13 that the plume appears to separate from the bottom within a distance of 600 feet from the discharge. If both of these data are correct, there appears to be significant recirculation at Point Beach which could indicate that there will be significant, occasional recirculation of cooling water effluent at Kewaunee where the depth at the intake located 1,600 feet from shore is only 15 feet.

Water and Air Use

The first sentence, third paragraph of page V-4 should be corrected to recognize that the water usage will affect lower

levels of the lake in addition to surface waters. Chemicals will be distributed throughout the lake by vertical and horizontal mixing forces and heated water will sink to the bottom when lake waters are cooler than about 4°C.

Thermal Discharge

It does not appear that sufficient evidence has been presented to show that the biological environment in the vicinity of the discharge is relatively barren as stated on pages V-5 and V-15. Conversely, other sections of the statement indicate that an attractive sports fishery will result from the discharge of the heated effluent and that the area will become biologically bountiful in the future. We think that the effects on the aquatic life in Lake Michigan would be more adequately determined by assessing the impacts on the types and quantities of organisms that will be attracted to the area as a result of the plants' operation.

Recreational and Other Uses

Since the warmed effluent discharge from the plant is expected to attract fish to the area, we suggest that the applicant provide a public fishing pier with attendant sanitary facilities along the lake front. This feature and the applicant's plan to set aside four or five acres for proposed high school conservation classes should be included in an overall land use plan for the 908-acre site. The overall land use plan should be described in the final environmental statement.

Plankton

The rate of eutrophication is controlled primarily by nutrient supply and water temperature. Either can be a limiting factor to productivity. Nutrient control measures are being undertaken at municipal and industrial effluent outfalls on a lake-wide basis; however, many diffuse sources of nutrients such as agricultural and urban runoff and sediment erosion are not amenable to control. Conversely, waste heat inputs are essentially point sources and can be controlled much more efficiently than nutrients. Therefore, based on the importance of thermal effects, we think that the final environmental statement should show quantitatively

the net gain or loss of phytoplankton respiration at various times of the year resulting from the use of lake water to receive the cooling water effluent.

It should be recognized that although plant passage and entrainment of algae at the discharge point may cause a reduction in biomass, there is evidence that this may be followed by a compensatory overshoot in the plume when the temperature rise drops within a few degrees of ambient lake temperature. The area of heated effluent at 1 to 3°F rise is quite large and accelerated production in this area could result in a significant increase in biomass of thermophilic phytoplankters.

The classification of eggs and fry of Lake Michigan fishes, on page V-12, as meroplankton is not correct. The larvae of all Great Lakes fishes are relatively weak swimmers immediately after hatching but only one species, the drum, has a pelagic egg and a pelagic sac fry that is not free-swimming at the time of hatching.

The plant's estimated impact on the planktonic population is based on a ratio of the plant's cooling water intake and the entire volume of Lake Michigan. We suggest that a more accurate comparison would be with the shallow inshore waters of the lake where the water intakes and discharges of the generating plants are located.

Fish Eggs and Larvae

The last sentence on page V-13 states that no increase in mortality rate among the fish eggs and meroplankton is anticipated. This appears to be in error and also in conflict with page II-48 which states that alewives and smelt may spawn in the area.

The recent Point Beach Environmental Impact Statement stated that young fish generally frequent the close inshore areas and species such as smelt, alewives, and minnows may spawn in situations similar to Point Beach. The memorandum from J. R. Bell to F. H. Schranfnagel in Appendix C of the Point Beach statement showed that smelt eggs and fry passed through the cooling systems of the Point Beach and Oak Creek plants. These studies were terminated in late April and early May before the bulk of the eggs would have hatched.

Based on the environmental statements for Point Beach and Kewaunee and our understanding of the aquatic life in Lake Michigan, we suggest that this sentence be modified to indicate that some increase in mortality rate of fish eggs and larvae is anticipated.

Effects of Temperature Increases

We draw different conclusions than those presented in the second paragraph of page V-17 and the first paragraph of page V-18. A memorandum concerning the Point Beach studies and others at Oak Creek was presented at the 1971 Wisconsin hearings on thermal standards, which is apparently the same series of studies discussed in this section.

Plankton nets were used on 14 days during the period from March 3 to May 27, 1971, in the Point Beach cooling water effluent. Plankton, smelt eggs, and sculpins were caught. However, according to calculations based on data in the Wisconsin Department of Natural Resources report, about 31.3 billion gallons of water were passed through the plant cooling water system during the 86-day period covered by the sampling while only 0.001 percent of this flow was strained through the sampling net. Therefore, we must conclude that since the volume of water passed through the sampling net was relatively small, large numbers of eggs or fry of other species could have passed undetected through the plant.

The July 9, 1971, memorandum from Bell to Schranfnagel indicated that one sculpin was taken in each of the samples collected on eight successive sampling days from March 3 to April 29. The expansion of these sculpin catches proportionately on the basis of the total volume of water sampled and the total volume of water passed through the cooling system between the first and last of the eight samples yields an estimate of more than 4 million sculpins that theoretically passed through the Point Beach plant cooling system during the 42 days of operation from March 3 to April 29. The value of 4 million sculpins is difficult to assess; however, sculpins are generally recognized as an important item in the diet of lake trout and some other fishes. The heavy intake entrainment of sculpins during late winter and early spring is consistent with the data of Wells (1968), which shows that late winter and early spring is the time of greatest abundance of this species at the water depth at which the Point Beach plant water intake is located. While the Kewaunee intake velocity is reported as less than the Point Beach velocity, the opportunity for heavy entrainment at Kewaunee appears to be excellent in view of the intake design.

The number of smelt eggs entrained at the Point Beach plant between April 29 and May 19 can also be estimated on the basis of the amount of water filtered and the water passed through the plant. About 52 million gallons of water passed through the plant in the 150-minute sampling period on May 4, of which 0.023 percent or about 12,000 gallons were strained by the collecting net. If the "few" smelt eggs reported captured were actually 10 eggs, an expansion of the catch on the basis of the volume of water sampled yields about 4,000 smelt eggs that passed through the plant in 150 minutes and over 400,000 eggs in the 24 hours of the sampling period. On the same basis, the count would be more than 1 million smelt eggs for the 24 hours of the May 5 sampling.

We do not think that the data presented in the statement are a sufficient basis to conclude that the effects of the Kewaunee plant on fish are expected to be minimal.

Also, even if alewives and smelt are not being harvested because of market conditions they have value as the base of the food chain for salmonids in Lake Michigan. Their importance should also be recognized from this basis.

Effects of Temperature Decreases

This section recognizes the possible impacts on aquatic life due to temperature decreases. We suggest that the fourth paragraph on page V-20 be expanded to recognize that a sudden 28°F temperature drop to about 32°F would be fatal to most Great Lake fishes and benthic organisms. Consequently, sudden plant shutdowns should be avoided when possible, especially during the colder months.

Effluent Impact on Species Composition

The statement does not deal with probable increased uptake of toxic substances by fish in warmed waters. Available information suggests that the rate of uptake of certain harmful compounds (including mercury) from water by fish increases with water temperature. Thus, fish attracted to and residing in heated effluents could be expected to have higher concentrations of these compounds than fish in cooler waters. Therefore, even though the heated effluents may be good for fishing, it may not be good for the fish or for the consumers of the catch.

Environmental Impact of Accidents

This section contains an adequate evaluation of impacts resulting from plant accidents through Class 8 for airbourne emissions. However, the environmental effects of releases to water is lacking. Many of these postulated accidents listed in table VI-1 could result in releases to Lake Michigan 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 lake which could persist for centuries affecting millions of people.

Once-Through Cooling System

The fifth paragraph on page XI-13 concludes that the primary impact of the once-through cooling system is its effect on Lake Michigan due to warming caused by return flow. The impact of organisms being entrained in the cooling water and passed through the plant may be equally important and very little research has been conducted to reliably establish the true importance of this aspect of the problem.

Cost-Benefit Analysis

Detailed data which would permit the reviewer to make an independent confirmation of the reported cost estimate for an alternative coal-fired plant are not presented on page XI-15. We agree that completion of the nuclear plant would probably have an economical advantage since a substantial amount of funds have already been committed; however, we recommend that the final environmental impact statement include data which will permit substantiation of the 13.46 mills per kilowatt hour as the cost of the coal-fired alternative.

Environmental Comparison of Alternatives

We agree that the analysis dealing with damage to biota is somewhat crude. They apparently do not take into account

the role of preadult fish in the food web economy of the lake and merely treat the preadult mortality as loss of pounds of adult fish. Also, the replacement value of $1.50 per pound is valid only for fish that can be reared in hatcheries and apparently does not include the cost of constructing the hatchery. If the value of adult sport fish to the sportsman is used in the analysis, we suggest a value of about $15.00 per pound.

Conclusions and Recommendations

Based on the physical and biological information presented, the apparent conclusion that the Kewaunee plant will not have significant impact on the biota of the lake appears to be somewhat unfounded. Most of the data used were taken from sites other than the Kewaunee site with much of it taken from Point Beach 4.5 miles away.

We believe that the thermal standards set by the Lake Michigan Enforcement in March 1971 and later approved by the Administrator of the Environmental Protection Agency are the minimum requirements which should be met in order to provide adequate protection for the aquatic environment of Lake Michigan. It does not appear that the Kewaunee plant, using the once-through cooling system, can operate at full load and comply with the thermal standards of the conference that there be no significant adverse effects on the aquatic biota.

Therefore, we recommend that the operating license for the Kewaunee Nuclear Power Station contain stipulations that the plant will operate within the limitations of the Lake Michigan Enforcement Conference Standards.

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

Sincerely yours,

Deputy Assistant Secretary of the Interior

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

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DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

OCT 27 1972

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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 July 20, 1972, wherein you requested comments on the draft environmental impact statement for the Kewaunee Nuclear Power Plant, Wisconsin Public Service Corporation, Docket Number 50-305.

The Department of Health, Education, and Welfare has reviewed the health aspects of the above project as presented in the documents submitted. This project does not appear to represent a hazard to public health and safety.

The opportunity to review the draft environmental impact statement is appreciated.

Sincerely yours,

Merlin K. DuVal, M.D.
Assistant Secretary for
Health and Scientific Affairs