final

NUREG-0075

environmental statement

related to construction of

STERLING POWER PROJECT NUCLEAR UNIT 1

ROCHESTER GAS AND ELECTRIC CORPORATION
ORANGE AND ROCKLAND UTILITIES, INC.
CENTRAL HUDSON GAS & ELECTRIC CORPORATION
NIAGARA MOHAWK POWER CORPORATION

JUNE 1976

Docket No. STN 50-485

7908240358

POOR ORIGINAL

715 001

~~720 503~~

U. S. Nuclear Regulatory Commission • Office of Nuclear Reactor Regulation

Available from
National Technical Information Service
Springfield, Virginia 22161
Price: Printed Copy $9.75 ; Microfiche $2.25

715 002

720 304

NUREG-0075
JUNE 1976

FINAL ENVIRONMENTAL STATEMENT

by the

U. S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

FOR

STERLING POWER PROJECT NUCLEAR UNIT NO. 1

proposed by

ROCHESTER GAS AND ELECTRIC CORPORATION
ORANGE AND ROCKLAND UTILITIES, INC.
CENTRAL HUDSON GAS & ELECTRIC CORPORATION
NIAGARA MOHAWK POWER CORPORATION

Docket No. STN 50-485

SUMMARY AND CONCLUSIONS

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

1. This action is administrative.

2. The proposed action is the issuance of a construction permit to the Rochester Gas and Electric Corporation, Central Hudson Gas and Electric Corporation, Orange and Rockland Utilities, Incorporated, and Niagara Mohawk Power Corporation for the construction of the Sterling Power Project (SPP) Nuclear Unit No. 1 located in Cayuga County, New York (Docket No. STN 50-485).

   The plant will employ a pressurized-water reactor to produce a warranted output of 3425 MWt. A steam turbine generator will use this heat to provide 1150 MWe (net) of electrical power capacity. The exhaust steam will be cooled by a once-through flow of water obtained from and discharged to Lake Ontario.

3. Summary of environmental impact and adverse effects:

   a. A total of about 2800 acres will be used for the Sterling Power Project site. Construction-related activities on the primary site will disturb about 255 acres. Approximately 99 acres of land will be required for the offsite transmission line right-of-way, and a railroad spur may affect an additional 36 acres off site, if developed. This constitutes a minor local impact. (Sect. 4.1)

   b. Plant construction will involve some community impacts. Eighty permanent and 70 summer or temporary residents will be displaced from the site property. Traffic on local roads will increase due to construction and commuting activities. The influx of construction worker families (a peak work force of about 1370) is expected to cause no major housing or school problems. (Sects. 4.4.1)

   c. The heat dissipation system will require a maximum circulating flow of 1860 cfs. Any alterations in plankton productivity or shifts in species composition resulting from entrainment or thermal alteration of the discharge area will be highly localized and seasonal; no adverse impacts are expected. The loss of fish due to thermal shock, cold shock, gas supersaturation, and overcrowding resulting from their residence in the discharge plume will be minimal and no impact on the local fish species is expected (Sect. 5.5.2).

   d. Most fish at all stages of development entrained in the circulating water system will be killed as a result of mechanical, chemical, and thermal shocks or impingement on the traveling screens. Some reduction in the local standing crop and recruitment rates of alewives due to impingement may occur, but no regional or lakewide impacts on the alewife populations are expected. The effects of impingement on the local alewife population can be reduced to an acceptable level if low velocities are maintained at the intake ports. Losses of larval fish due to entrainment may result in a loss of approximately 3.2×10^5 two-year-olds; a loss of this magnitude should not result in long-term adverse effects on fish populations in the lake. Operating intake velocities of 1.5 fps for 12 of the first 36 months is not expected to cause any long-term adverse impacts on fish populations.

   e. The risk associated with accidental radiation exposure is very low. (Sect. 7.1)

   f. No significant environmental impacts are anticipated from normal operational releases of radioactive materials. The estimated maximum integrated dose (including occupational exposure) to the population of the United States due to operation of the station is about 470 man-rems/year, less than the normal fluctuations in the 26,000,000 man-rems/year background dose this population would receive. (Sect. 5.4.2)

4. Principal alternatives considered were:

   a. Purchase of power
   b. Alternative energy systems
   c. Alternative sites
   d. Alternative heat dissipation methods

715 004

720 306

5. The following Federal, State, and local agencies were asked to comment on this Environmental Statement:

   - Advisory Council on Historic Preservation
   - Department of Agriculture
   - Department of the Army, Corps of Engineers
   - Department of Commerce
   - Department of Health, Education, and Welfare
   - Department of Housing and Urban Development
   - Department of the Interior
   - Department of Transportation
   - Energy Research and Development Administration
   - Environmental Protection Agency
   - Federal Energy Administration
   - Federal Power Commission
   - New York State Atomic Energy Council
   - Cayuga County Legislature
   - Town Supervisor, Town of Sterling

6. This Environmental Statement was made available to the public, to the Council on Environmental Quality, and to other specified agencies in June 1976.

7. On the basis of the analysis and evaluation set forth in this statement, after weighing the environmental, economic, technical, and other benefits of the Sterling Power Project Unit 1 against environmental and other costs and considering available alternatives, it is concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 is the issuance of a construction permit for the plant subject to the following conditions for the protection of the environment:

   a. The applicant shall take the necessary mitigating actions, including those summarized in Sect. 4.5 of this Environmental Statement, during construction of the plant, associated transmission lines, and the railroad spur to avoid unnecessary adverse environmental impacts from construction activities. Near shore lake dredging operations will be restricted to the period mid-August through mid-June to avoid potential adverse impacts on spawning fish populations.

   b. In addition to the preoperational monitoring programs described in Sect. 6.1 of the ER, with amendments, the staff recommendations included in Sect. 6.1 of this document shall be followed.

   c. The design and construction of the 765-kV transmission line shall include provisions for adequate grounding and surveillance to minimize shock hazards. (Sect. 5.1.2)

   d. To reduce entrainment losses of fish larvae and juveniles, the applicant shall position the intake structure at a minimum bottom depth of 35.5 ft below mean lake elevation, as shown in the ER, Fig. 3.4-3, Rev. 2. Approach velocities at the intake ports shall be limited to 0.8 fps. To study the impact of higher intake velocities the applicant is authorized to operate at an intake velocity not to exceed 1.5 fps for a total of 12 months during the first 36 months of plant operation.

   e. Before engaging in a construction activity not evaluated by the Commission, the applicant will prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this Environmental Statement, the applicant shall provide a written evaluation of such activities and obtain prior approval of the Director of Site Safety and Environmental Analysis for the activities.

   f. The applicant shall establish a control program that shall include written procedures and instructions to control all construction activities as prescribed herein and shall provide for periodic management audits to determine the adequacy of implementation of environmental conditions. The applicant shall maintain sufficient records to furnish evidence of compliance with all the environmental conditions herein.

   g. If unexpected harmful effects or evidence of serious damage are detected during plant construction, the applicant shall provide to the staff an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects or damage.

715 005
~~720 307~~

CONTENTS

715 006
720 308

720 309

715 007

LIST OF FIGURES

LIST OF TABLES

715 013
~~720 315~~

715 014

720 316

715 015

~~720 317~~

FOREWORD

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

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

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

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

(i) the environmental impact of the proposed action,

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

(iii) alternatives to the proposed action,

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

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

Pursuant to 10 CFR Part 51, the NRC Office of Nuclear Reactor Regulation prepares a detailed statement on the foregoing considerations with respect to each application for a construction permit or full-power operating license for a nuclear power reactor.

When application is made for a construction permit or an operating license, the applicant submits an environmental report to the NRC. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the Environmental Report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff exercises its own expertise and seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA and 10 CFR Part 51.

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

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

Single copies may be obtained as indicated on the inside front cover. Mr. D. C. Scaletti is the NRC Environmental Project Manager for this statement. Should there be any questions regarding the contents of this statement, Mr. Scaletti may be contacted at the following address:

Division of Site Safety and
 Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
(301) 443-6990

1. INTRODUCTION

1.1 THE PROPOSED PROJECT

Pursuant to the Atomic Energy Act, as amended, and the Commission's Regulations in Title 10, Code of Federal Regulations, an application, with an accompanying Environmental Report, was filed by Rochester Gas and Electric Corporation (RG & E). A contract for the joint ownership of the proposed plant was signed in September 1975 by RG & E, Central Hudson Gas & Electric Corporation (CH), Orange and Rockland Utilities, Inc. (O & R), and Niagara Mohawk Power Corporation (NM). The shares to be owned by the participating utilities in the Sterling Nuclear Power Plant are RG & E 28%; CH 17%; O & R 33% and NM 22%. RG & E will act as project manager on behalf of itself and the other applicants (hereinafter collectively referred to as the applicant) for a construction permit to build a pressurized-water nuclear reactor designated as the Sterling Power Project (SPP) Nuclear Unit No. 1 (Docket No. STN 50-485), which is designed for initial operation at approximately 3425 megawatts thermal (MWt) with a nominal net electrical output of about 1150 MW. The proposed plant is to be located in Cayuga County, New York, approximately 8 miles SW of Oswego on the south shore of Lake Ontario.

Regulation 10 CFR Part 51 requires that the Director of Nuclear Reactor Regulation, analyze the Environmental Report submitted by the applicant and prepare a detailed statement of environmental considerations. It is within this framework that this Environmental Statement related to the construction of the Sterling Power Project (SPP) has been prepared by the Division of Site Safety and Environmental Analysis (staff) of the U.S. Nuclear Regulatory Commission.

Major documents used in the preparation of this statement were the applicant's Environmental Report (ER),[1] Preliminary Safety Analysis Report (PSAR),[2] and supplements thereto issued for the Sterling Power Project. Independent calculations and sources of information were also used as a basis for the assessment of environmental impact. In addition, some of the information was gained from visits by the staff to the project site and surrounding areas in January 1975. Although data from all of these sources were examined by the staff in making its assessments, only brief summaries of the most pertinent data are given in this statement. To avoid repetition, the staff has provided references to the sources of detailed information, much of which is found in the applicant's Environmental Report.

As a part of its safety evaluation leading to the issuance of construction permits and operating licenses, the Commission makes a detailed evaluation of the applicant's plans and facilities for minimizing and controlling the release of radioactive materials under both normal conditions and potential accident conditions, including the effects of natural phenomena on the facility. Inasmuch as these aspects are considered fully in other documents, only the salient features that bear directly on the anticipated environmental effects are repeated in this environmental statement.

Copies of this Draft Environmental Statement and the applicant's Environmental Report (ER) are available for public inspection at the Commission's Public Document Room, 1717 H Street, N.W., Washington, D.C., and at the Oswego City Library, 120 Second Street, Oswego, New York.

1.2 STATUS OF REVIEWS AND APPROVALS

The applicant has provided a status listing of environmentally related permits, approvals, licenses, etc., required from Federal, State, regional, and local agencies in connection with the proposed project (ER, Sect. 12). A summary of the applications for permits and approvals is listed in Table 1.1. The staff has reviewed that listing and has consulted with some the appropriate agencies in an effort to identify any significant environmental issues of concern to the reviewing agencies. As a result, the following potential licensing (non-NRC) problem has been identified.

On October 8, 1974, the Environmental Protection Agency Effluent Guidelines and Standards (40 CFR 423) became effective. These regulations require, in part, that all large base-load units completed after July 1, 1977, must use a closed-cycle cooling system.

Table 1.1. Federal and State authorizations required for construction and operation of the Sterling Power Project Nuclear Unit No. 1

Agency	Application for permit or approval	Status
	Federal	
Nuclear Regulatory Commission	Construction permit	May 1974
	Operating license	Future
	Materials license	Future
Department of the Army	FWPCA Sect. 404	Future
U.S. Coast Guard	Waterfront structures	Future
	State	
New York Siting Board	Certificate of environmental compatibility and public need	February 1975
	FWPCA Sect. 401	April 1975
	FWPCA Sect. 402	October 1975
	FWPCA Sect. 316a	November 1975
	FWPCA Sect. 316b	November 1975

Since the Sterling Power Project as proposed incorporates a once-through cooling system, the applicant applied to the New York State Siting Board for an exemption from the closed-cycle cooling system requirements, as provided for in Part 316(a) of the Federal Water Pollution Control Act Amendments of 1972. The staff has evaluated the once-through system as planned by the applicant and has also evaluated closed-cycle systems as alternatives (Sect. 9.2.1).

REFERENCES FOR SECTION 1

1. Rochester Gas and Electric Corporation, *Sterling Power Project, Unit 1, Environmental Report*, Docket No. STN 50-485, December 20, 1974, and subsequent amendments.
2. Rochester Gas and Electric Corporation, *Preliminary Safety Analysis Report, Site Addendum for Sterling Power Project, Unit 1*, Docket No. STN 50-485, August 16, 1974, and subsequent amendments.

2. THE SITE

2.1 STATION LOCATION

The proposed site for the Sterling Plant (Fig. 2.1) is on the south shore of Lake Ontario in northern Cayuga County, New York. The center of the proposed site is located at 43°23'12"N latitude and 76°39'02"W longitude, which is approximately 8 miles SW of the City of Oswego and about 30 miles NW of metropolitan Syracuse. Figure 2.2 shows the counties and larger cities and towns within 50 miles of the site.

The land within 5 miles of the site (Fig. 2.3) is predominantly rural, with land being used mainly for agriculture, forest, and wetlands. Almost one-half of the area within a 5-mile radius of the site is Lake Ontario.

The nearest commercial airport with scheduled passenger service is the Syracuse-Hancock International Airport, in Syracuse, New York. Federal Aviation Administration charts[1] show no airports within 10 statute miles of the site, but the applicant does report a private landing facility, Granby Airport, approximately 9 miles ESE of Sterling. The Oswego County Airport, 13 miles E, has a 4000-ft lighted, hard-surface runway, but has no scheduled commercial flights.

The only state highway that passes within 5 miles of the site is State Route 104A, which passes within 1.6 miles of the plant proper and forms part of the Sterling site boundary. The nearest railroad line is the Hojack branch of the Penn Central Transportation Company, which passes about 4 miles S of the site.

2.2 REGIONAL DEMOGRAPHY, LAND USE, AND WATER USE

2.2.1 Regional demography

The Sterling site is located in an area of low population density, with 705 people living within a 3-mile radius. Because the site is located on the southern shore of Lake Ontario, a large segment of the area within a 50-mile radius of the site is uninhabited.

Cities and villages within 50 miles of the Sterling site are shown in Fig. 2.2. There are four towns within 10 miles of the site, the largest being Oswego City, 8 miles NE. Oswego had a 1970 population of 23,844, a 7.6% increase over the 1960 population.

There are three more major cities within a 50-mile radius of the site: Auburn, 33.1 miles; Syracuse, 34.5 miles; and Rochester, 47.5 miles. Table 2.1 lists the population and location of all cities and villages within 50 miles of the site. Table 2.2 shows the present and projected populations within the 5-, 10-, and 50-mile radii. Additional details and sector population projections are presented in the ER, Sect. 2.2.

The area within 5 miles of the site has no schools or hospitals. The closest school is the Fair Haven Elementary School, located 5.4 miles SW, with an enrollment of 150 students. There are a total of 19 public and private schools and one university within 10 miles of the site, with a combined enrollment of 17,078 students. The largest school in the area is the State University College at Oswego, 7.4 miles NE of the site, with 6820 full-time and 2029 part-time students. Additional details concerning schools are presented in the ER, Sect. 2.2.2.

Three small companies are located within 5 miles of the site: Corenco Fertilizer, 5 miles SSE, employing 15 to 18 people seasonally; Polaski Wood Company, Incorporated, 4.5 miles SSE, employing 12; and Sterling Co-Op, 4.8 miles S, employing 70 to 80 people seasonally.

The only hospital in the immediate vicinity of the site is Oswego Hospital, located 8.4 miles E. The hospital has 176 beds at present. There are three nursing homes in Oswego with a total of 320 beds, for which there are currently lengthy waiting lists. Other hospital and health facilities are located in Fulton, 13 miles ESE, and in the metropolitan Syracuse area, 33 miles SE.

ES-1780R1

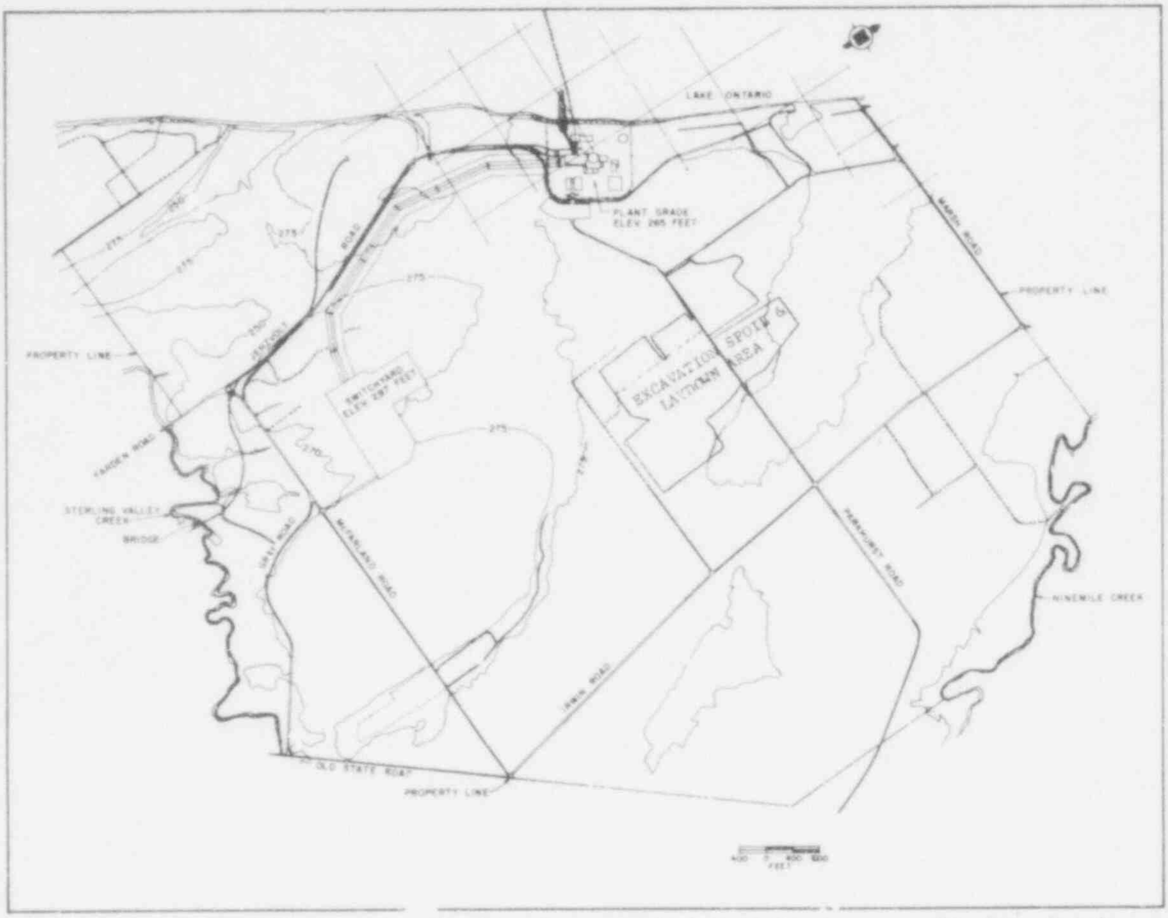


Fig. 2.1. Site layout — Sterling Power Project Unit 1. Source: ER, Fig. 2.5-1, Rev. 2.

There are numerous recreational areas within 10 miles of the site, the closest and most widely used being Fair Haven Beach State Park, located 2.4 miles SW (see Fig. 2.3). The park's activities are water-shoreline oriented, and 1972 summer visitors numbered 192,729. Additional information on recreational facilities within 10 miles of the site are detailed in the ER, Sect. 2.2.2.

The major existing and planned power plants on Lake Ontario are shown in Appendix C, Fig. C.1.

2.2.2 Land use

Agriculture is the most important industry in Cayuga County but has steadily declined since 1880. Approximately 95% of Cayuga County was in farmlands in 1880;[2] in 1925, 83% was in farmlands, dropping to 47% in 1974.[3] The main reason for the decline is due primarily to the natural characteristics of the soil, the changed economic conditions, and the opening of better farmlands inland.[2] About 51% of the land (10,594 acres) within 5 miles of the site is agricultural, with about one-half of the site also being used for farmland (ER, Table 2.2-10 and Fig. 2.2-11). Crop production in the area includes corn, wheat, soybeans, alfalfa and other forage crops, potatoes, sweet potatoes, sweet corn, other vegetables, melons, berries, fruit (including apples), and greenhouse products. Livestock include beef cattle, dairy cows, sheep, horses, and poultry.

The dairy industry is the most important agricultural enterprise in Cayuga County, while corn and hay production is ranked next as an important source of county agricultural income. Urban expansion from the Syracuse area has discouraged new agricultural investments, especially in dairying.

Table 2.2-10 of the ER gives a detailed breakdown of the land use categories within 5 miles of the Sterling site. In addition to agricultural use, 3% of the area is residential, 5% is natural ponds or lakes, 8% is other wetlands, 32% is forested, and less than 1% is recreational.

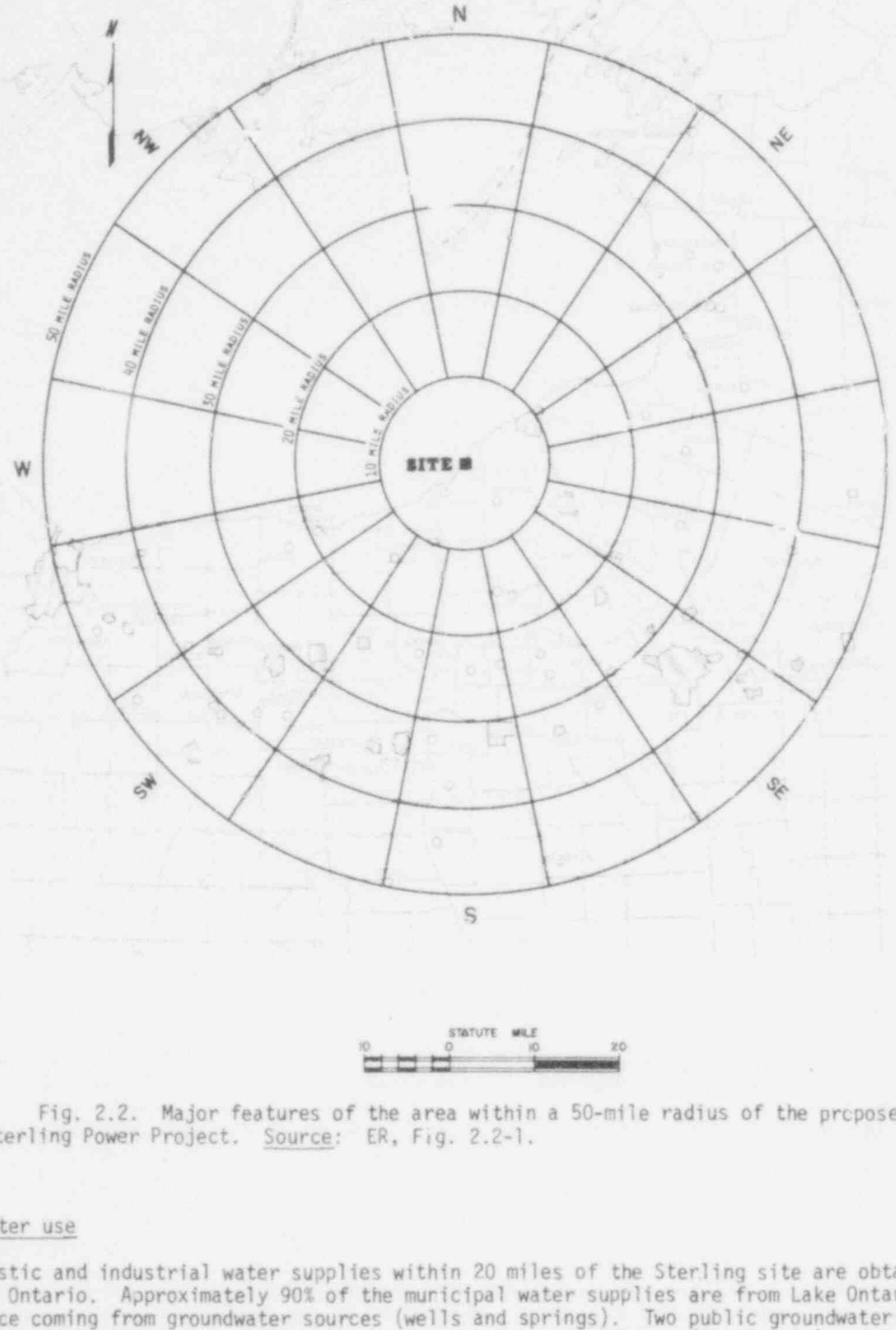


Fig. 2.2. Major features of the area within a 50-mile radius of the proposed Sterling Power Project. Source: ER, Fig. 2.2-1.

2.2.3 Water use

Most domestic and industrial water supplies within 20 miles of the Sterling site are obtained from Lake Ontario. Approximately 90% of the municipal water supplies are from Lake Ontario, with the balance coming from groundwater sources (wells and springs). Two public groundwater supplies are located within 10 miles of the proposed site — Fair Haven Village (5 miles SW) and Red Creek (9.5 miles SW). The closest water intake from Lake Ontario is the City of Oswego's intake, approximately 7 miles from the Sterling Power Project discharge canal. Surface waters from local streams are used for farm irrigation, but they are not used for either domestic or industrial needs.

POOR ORIGINAL

715 022

~~720 324~~

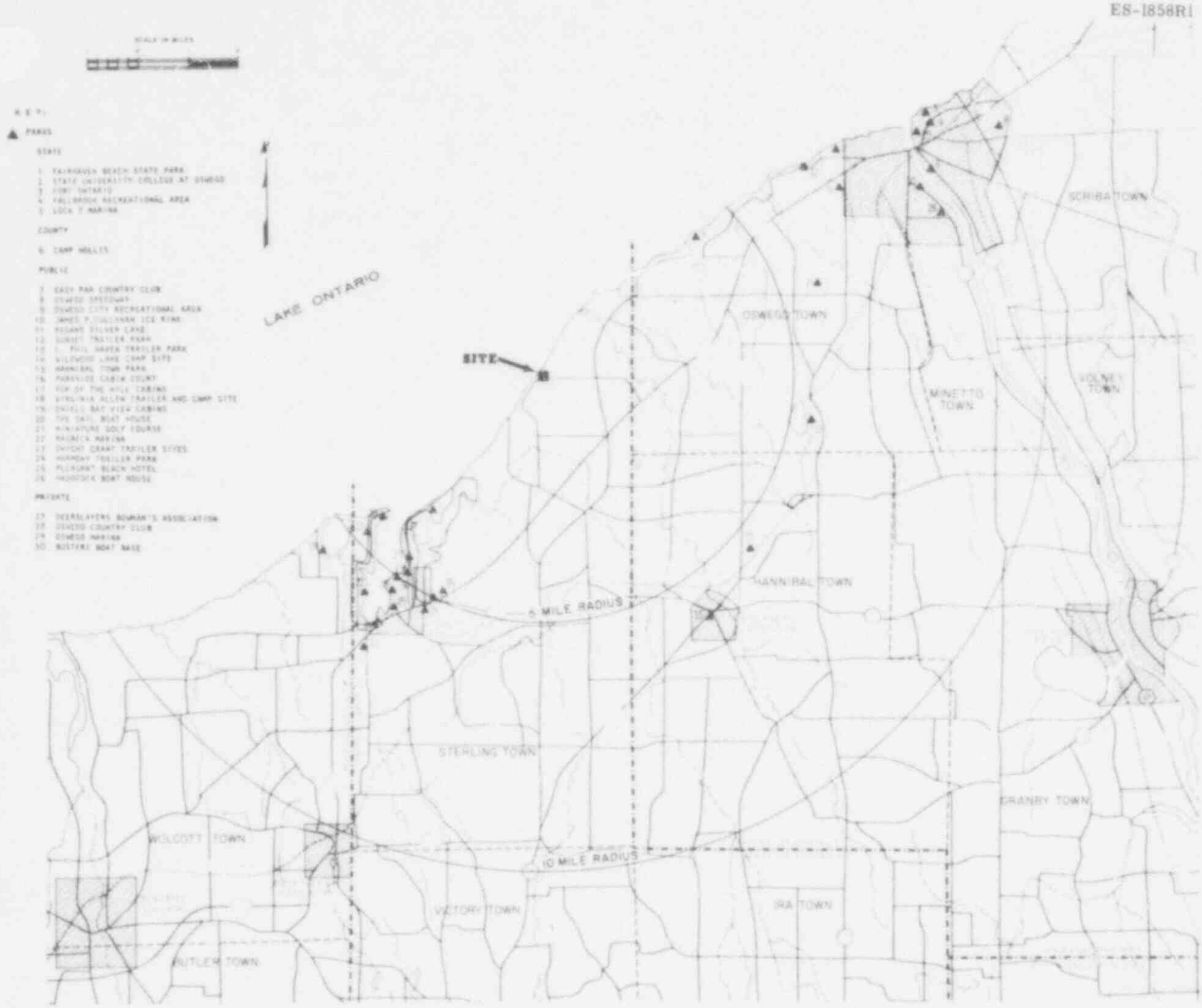


Fig. 2.3. Major features of the area within 5- and 10-mile radii of the proposed Sterling Power Project. Source: ER, Figs. 2.2-2 and 2.2-6.

Fishing, boating, and swimming are the main water-oriented recreational activities in the area. The State of New York stocks six streams for fishing within 10 miles of the site. As noted in Sect. 2.2.1, there are public and private recreational areas along the shore of Lake Ontario. Commerical transportation is supported by Lake Ontario and by the New York State Barge Canal, Oswego Division (9 miles E of the site). Details concerning water usage, fishing, transportation, etc., are available in the ER, Sect. 2.2.5.

2.3 HISTORIC AND ARCHAEOLOGICAL SITES AND NATURAL LANDMARKS

2.3.1 Historic sites

The Sterling site has no known historic places or locations. The transmission line hookup is not a factor since it will connect to the New York State transmission grid that will be located on the site.

The National Register of Historic Places lists the nearest historic sites as being the Oswego City Library, the City Hall, and Fort Ontario. The City Library is located approximately 8 miles NE of the site, Fort Ontario is about 8.2 miles NE, and the Oswego City Hall is 8.6 miles NE.

POOR ORIGINAL

Table 2.1. Population of cities and villages within 50 miles of the Sterling site, 1970

Community	Population	Distance from site (miles)	Direction
Cayuga County			
Auburn City	34,599	33.1	S
Aurora Village	1,072	44.4	S
Cato Village	601	15.5	SSE
Cayuga Village	693	32.6	S
Fair Haven Village	859	3.8	SSW
Meridian Village	[illegible]69	16.4	SSE
Moravia Village	1,642	49.6	SSE
Port Byron Village	1,330	24.0	S
Union Springs Village	1,183	37.9	S
Weedsport Village	1,900	23.8	S
Jefferson County			
Adams Village	1,951	43.8	NE
Ellisburg Village	337	36.0	NE
Mannsville Village	494	37.6	NE
Sacketts Harbor Village	1,202	47.3	NE
Madison County			
Canasto Village	5,033	48.8	ESE
Chittenango Village	3,605	45.5	ESE
Monroe County			
East Rochester Village	8,347	46.3	WSW
Fairport Village	6,474	44.5	WSW
Pittsford Village	1,755	48.2	WSW
Rochester City	296,233	47.5	WSW
Webster Village	5,037	41.0	WSW
Oneida County			
Camden Village	2,936	46.0	E
Onondaga County			
Baldwinsville Village	6,398	22.2	SE
Camillus Village	1,534	29.8	SE
East Syracuse Village	4,333	36.7	SE
Elbridge Village	1,040	26.4	SSE
Fayetteville Village	4,996	41.0	SE
Jordan Village	1,493	23.9	SSE
Liverpool Village	3,307	29.3	SE
Manlius Village	4,295	41.8	SE
Marcellus Village	2,017	32.0	SSE
Minoa Village	2,245	39.4	SE
North Syracuse Village	8,687	31.5	SE
Skaneateles Village	3,055	32.6	SSE
Solvay Village	8,280	31.2	SE
Syracuse City	197,208	34.5	SE
Tully Village	899	49.0	SSE
Onondaga Indian Reservation	785	27.0	SE
Ontario County			
Canadaigua City	10,488	47.0	SW
Clifton Springs Village	2,058	38.4	SW
Geneva City	16,793	38.1	SW
Manchester Village	1,305	41.2	SW
Phelps Village	1,989	36.3	SW
Shortsville Village	1,516	41.3	SW
Victor Village	2,1[illegible]	48.0	SW
Oswego County			
Altmar Village	448	34.1	ENE
Central Square Village	1,298	26.6	ESE
Cleveland Village	821	39.8	ESE
Fulton City	14,003	11.4	ESE
Hannibal Village	686	6.4	SE

715 024

~~720 326~~

Table 2.1 (continued)

Community	Population	Distance from site (miles)	Direction
Lacona Village	556	35.2	ENE
Mexico Village	1,555	21.9	ENE
Oswego City	23,844	8.0	ENE
Parish Village	634	26.2	E
Phoenix Village	2,617	20.3	ESE
Pulaski Village	2,480	29.7	ENE
Sandy Creek Village	731	34.3	ENE
	Seneca County		
Ovid Village	779	49.7	S
Seneca Falls Village	7,794	32.2	SSW
Waterloo Village	5,418	34.5	SSW
	Wayne County		
Clyde Village	2,828	23.6	SSW
Lyons Village	4,496	27.2	SSW
Macedon Village	1,168	39.4	WSW
Newark Village	11,644	31.8	SW
Palmyra Village	3,776	36.4	SW
Red Creek Village	626	9.8	SSW
Savannah Village	636	22.8	SSW
Sodus Point Village	1,172	19.4	WSW
Sodus Village	1,813	23.8	WSW
Wolcott Village	1,617	14.4	SW
	Prince Edward County, Ontario, Canada		
Picton	4,875	50	NNW

Source: ER, Table 2.2-1.

Table 2.2. Present and projected populations in the region surrounding the plant

Year	0–5 miles	0–10 miles	0–50 miles
1970	2778	36,180	1,148,233
1980	3229	41,220	1,290,063
1990	3787	47,153	1,473,865
2000	4356	53,928	1,647,959
2010	4981	64,570	1,878,448
2020	5658	75,676	2,134,227

Source: ER, Table 2.2-2.

The New York State Department of Historic Preservation informed the applicant that, as of September 5, 1974, no additional sites in the Sterling area have been nominated for the National Register of Historic Places.

2.3.2 Archaeological sites

The archaeological potential of the Sterling site was evaluated by Charles F. Hayes III, Director of the Rochester Museum and Science Center and Curator of Anthropology. He found no indication of artifacts on the site and is aware of only one ever found near the location.

Mr. Hayes postulates that Pleistocene mammal remains may be unearthed if the swamp area is excavated, and if so, they should be studied for their value. The applicant has stated that an archaeologically trained person will be present periodically during foundation excavation to further evaluate the site.

2.3.3 Natural landmarks

There are no distinct natural landmarks in the immediate site area. The site's major topographic features are drumlin formations left during the Ice Age.

2.4 GEOLOGY AND SEISMOLOGY

2.4.1 Geology

The proposed site is within the Erie-Ontario Lowlands Physiographic Province. The land surface of the Erie-Ontario Lowlands consists of a relatively flat plain, which rises gradually to the S and SW. The major topographic feature of the Lowlands is the presence of drumlins, elliptically shaped hills of glacial till and outwash oriented in a N-S direction.

The site is typical of the Erie-Ontario Lowlands, with more than two-thirds of the site occupied by drumlins. The lowlands between the drumlins vary in width from several hundred feet to more than one-half mile and are generally poorly drained swamps or wetlands. Elevations at the site vary from about 245 ft mean sea level (MSL) in the lowlands area to 420 ft MSL at the top of the highest drumlins. The normal water level of Lake Ontario is approximately 246 ft MSL.

The wave and current action of Lake Ontario is a dominant feature in the shaping of the topography of the land near its shore. The shoreline at the site intersects several drumlins, and erosion has resulted in bluffs up to 90 ft high with near vertical slopes in the site area (see Fig. 3.1).

The site consists of 30 to 130 ft of Pleistocene deposits covering approximately 2400 ft of Cambrian and Ordovician sedementary rocks. Borings at the site encountered rocks of the Queenston Formation. The rock cores were composed of more than 90% hard, competent, red sandstone with thin beds of siltstone and shale.

2.4.2 Seismology

The general upper New York area has some record of earthquakes but none in the immediate vicinity of the site. Earthquakes have occurred in the Niagara Falls-Buffalo region some 130 miles W; shocks were felt in 1857, 1873, 1879, and 1962 at an intensity of 6 (Rossi-Forel scale).

At Attica, 80 miles from the site, a shock of intensity 8 (Rossi-Forel scale) occurred in 1929 which did no reported damage closer than Batavia, New York, about 73 miles from the site. A structural feature called the Clarendon-Linden structure is located near the site of the 1929 earthquake, and the two may have been related.

The other center of earthquake activity of significance to the Sterling site is the St. Lawrence Valley. The valley has experienced a number of moderately intense earthquakes. One in 1925 was felt in much of eastern Canada, southward to Virginia, and westward to the Mississippi River. The seismic category of the Sterling site is 0.15 g.

Further details on seismology can be found in the NRC Safety Evaluation Report.

2.5 SURFACE WATER AND GROUNDWATER

2.5.1 Surface water

The proposed site is located on the southern shore of Lake Ontario, an international body of water between the United States and Canada. The lake has a maximum width of 53 miles and is approximately 193 miles long with a surface area of 7340 sq miles. The maximum depth is about 800 to 850 ft and the average depth is about 276 ft. The total volume of the lake is approximately 393 cu miles.

The lake has virtually no tide. The Niagara River is the major natural inlet for Lake Ontario and accounts for approximately 200,000 cfs, or about 80% of the total water supplied to the lake. Direct runoff from the lake's 34,800 sq miles of watershed in New York State and the Canadian Province of Ontario (exclusive of lake surface) provides, on the average, an additional 34,000 cfs. The combined outflow from Lake Ontario via the St. Lawrence River averages 239,000 cfs. More detailed discussions of the characteristics of Lake Ontario are given in Appendix C and in the ER, Sects. 2.5 and 2.7. The drainage around the Sterling site is discharged directly into the lake and indirectly via either of the two site-bordering streams, Nine Mile Creek or Sterling Valley Creek. All plant water requirements will be satisfied by the waters of Lake Ontario. Inland streams will not be used, nor will they receive discharges during plant operation. During construction, runoff, after treatment, and when in compliance with effluent limitations, will be discharged into inland streams.

The New York State Public Health Department monitors the water quality of Lake Ontario, with sampling data available for the City of Oswego. Data obtained from the Sterling site are generally of the same magnitude as that recorded by New York State Department of Environmental Conservation. Concentrations of ammonia, phosphates, and sulfates at Oswego are significantly higher than those recorded at the site. This is probably due to the influence of waste discharges to the lake at Oswego.

Lake Ontario is a dimictic lake (with spring and fall turnover) and has a maximum average surface temperature of 75°F in the summer with some unusually high temperatures of up to 77°F at the surface and near the shore. In the winter, the upper water is essentially isothermal (32°F). Ice accumulations are usually limited to the shoreline and to the northeast portion of the lake. In the nearshore regions, dissolved oxygen concentrations are generally at or near saturation.

The circulation of the lake is generally in a counterclockwise direction at very low velocity. Winds are the principal cause of the currents in the lakes, although temperature gradients also produce some currents of smaller magnitude. Measurements at the site indicate generally NE or SW current flow, essentially parallel to the shoreline.

2.5.2 Groundwater

The major source of groundwater supplies in the lowlands area is wells (both dug and drilled) in the alluvial, glacial, and glaciolacustrine deposits. Generally, the upper 20 ft of bedrock in the area contain adequate water for local domestic use.

In the site area, the most widely used groundwater source is the glacial till. Wells in the area generally yield between 2 and 25 gpm. The applicant has listed 72 wells within 2 miles of the proposed plant location in the ER, Sect. 2.2.5.

The major source of recharge to the groundwater aquifers at the site is rainfall. The groundwater flow in the area is toward the lake.

The applicant has a program of groundwater quality testing at the site. Details are available in the ER, Sect. 2.5.4.

2.6 METEOROLOGY

2.6.1 Regional climatology

The climate of northwestern New York, with long, cold winters and short, warm summers, is characteristic of continental climates in northern regions.[4,5] Lake Ontario, however, exerts a modifying influence on the portions of the area near the lake by storing heat in the summer and dissipating it in the autumn and early winter. Alternately, the lake remains colder than the adjacent land in the spring and early summer and tends to cool the land during these periods. The combined effect is a prolongation of warmer weather into the autumn and colder weather into the spring over the land areas adjacent to Lake Ontario.[4] The lake also modifies precipitation patterns over the area. During the autumn and early winter, air flowing southward over the warmer lake surface takes up moisture, which then falls out, often as snow, as the moisture-laden air is cooled upon moving ashore and encountering the colder land surface.[4,5] This phenomenon results in the existence of a "snow belt," an area of heavy snowfall, extending along the eastern shore of Lake Ontario.

Temperatures may be expected to reach 90°F or higher about 5 days each year.[6] Temperatures of 0°F or lower may also be expected 5 days each year, and temperatures of 32°F or lower approximately 130 days.[6] Precipitation is distributed rather uniformly throughout the year, averaging about 35 in. annually and occurring mainly as thundershowers during the warm season and as snow in the cold season.[4-6] Relative humidity, on an annual basis, averages about 75%.[6]

2.6.2 Local meteorology

Long-term weather records from Oswego, New York, 8 miles ENE of the site, show that the extreme maximum and minimum temperatures recorded there are 100 and -23°F respectively.[7] At Syracuse, 30 miles to the SE, extreme maximum and minimum temperatures of 102 and -26°F have been recorded.[5] A maximum 24-hr precipitation total of 3.8 in. has been recorded at Oswego.[7] A 24-hr snowfall total of 40 in. was recorded at the Oswego Teachers' College in December 1958, and an estimated 24-hr snowfall total of 45 in. in December 1966 has been reported in the vicinity of Oswego.[7,8] Data from Rochester and Syracuse indicate that heavy fog (visibility 1/4 mile or less) may occur on 15 to 20 days annually.[4,5] Wind data collected at the 33-ft level on site during the period from May 1973 to May 1974 show that the predominant wind flow over the site is from the S and

WSW, with a frequency of 10.3% for each of these two directions.[7] Winds from the ENE occurred least frequently (2.2%). The mean wind speed over the site at this level during the year of record was 7.4 mph. Additional climatological information is presented in Table 2.3 and Fig. 2.4.

Table 2.3. Wind direction frequency distribution at a 33 ft level, Sterling Power Project, May 13, 1973–May 14, 1974[a]

Direction[b]	Frequency (%)	Direction[b]	Frequency (%)
N	3.45	S	10.27
NNE	5.29	SSW	8.81
NE	2.81	SW	7.73
ENE	2.20	WSW	10.32
E	3.64	W	9.28
ESE	5.24	WNW	5.18
SE	9.28	NW	5.22
SSE	7.44	NNW	3.80
		Calm	0.04

[a] Data recovery rate – 94.3%.

[b] Direction from which wind is blowing.

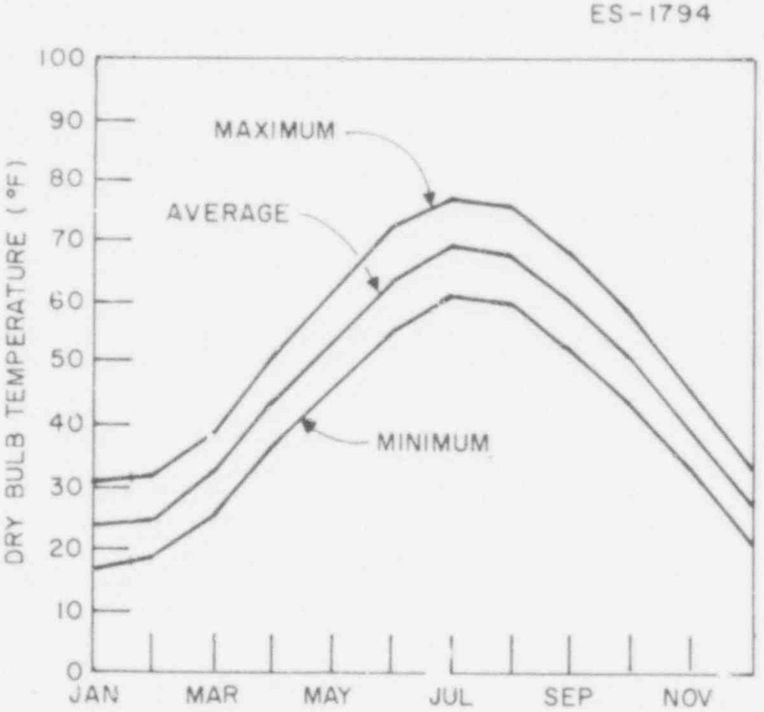


Fig. 2.4. Monthly average and average daily extremes of dry-bulb temperature (Oswego, New York; 43°27'N, 76°32'W; ground level — 350 ft; 1939-1968). Source: ER, Fig. 2.6-2.

2.6.3 Severe weather

Severe weather occurrences in the vicinity of the plant are most commonly associated either with intense winter storms moving along a storm track that runs northeastward across Lake Ontario and through the St. Lawrence River Valley or with severe thunderstorms, primarily in the summer.[4,5] Remnants of hurricanes or tropical storms only rarely affect the area.[9,10]

Six tornadoes were reported within the one-degree latitude-longitude square containing the site during the period 1955-1967, giving a mean annual tornado frequency of 0.5 and a recurrence interval for a tornado at the plant site of 2660 years.[11,12] There were six reports of hail 3/4-in. diam or greater in this one-degree square during the same period, and 15 windstorms with speeds of 50 knots (58 mph) or greater.[11] A 1-min sustained wind of just over 70 mph has been recorded at Oswego which would be equivalent to a "fastest mile" speed of about 82 mph.[7] A severe ice storm may be expected to occur once every 6 years in the region.[13] A high air pollution potential (air stagnation) episode can be expected to exist on no more than 1 day during the year.[14]

2.7 ECOLOGY OF THE SITE AND ENVIRONS

2.7.1 Terrestrial ecology

2.7.1.1 Soils

Soils of the site are described in detail in Sect. 2.5 of the PSAR. These belong to the Ontario-Mohawk Plain group. Upland soils of this group developed in glacial till derived mainly from limestone and shale. Lowland soils developed from lacustrine or glaciofluvial deposits. In general, soils of the site include silt loams, fine sandy loams, gravelly loams, and shallow to deep mucks (ER, Fig. 2.4-7). Muck soils are found in lowland areas, are poorly drained, and normally support an elm-ash forest. The silt loams and fine sandy loams develop on adjacent benches, are moderately drained, and normally support upland forest dominated by hemlocks. Gravelly loams comprise well drained ridge soils that support oak, hickory, beech and sugar maple hardwood forest vegetation.

2.7.1.2 Producers

A summary of land classification units and plant communities of the site is presented in Appendix B, Table B.1, and a vegetation map is given in Fig. 2.5. A large portion of the Ontario-Mohawk Plain was cleared for agriculture and remains intensively cultivated today. On the portion of onsite acreage not under cultivation, there are two distinct natural plant associations leading to different climax vegetation types: beech-maple and elm-ash forests.

A summary of the types and acreage of seral plant communities of beech-maple forest typical for the site is presented in Appendix B, Table B.1. Originally, 92% of the site was covered by beech-maple forest (Table B.1). Characteristic species are beech, sugar maple, and white ash. Common associates are listed in the ER, Appendix C, Tables A2.7-3a, A2.7-3e, A2.7-3h, and A2.7-3i. Hemlock is common along the lakeshore and along ravines and edges of swamps. Much of the original upland forest was cleared for agricultural purposes, and today only 2% of the upland site area is mature hardwood forest (Table B.1).

A summary of the types and acreage of seral plant communities of elm-ash forest (primarily wooded swamps) is presented in Table B.1. Originally, only about 8% of the site was comprised of this particular cover type. Characteristic species are silver maple, black ash, green ash, and American elm (many of which are now dead). Silver maple could be considered a subclimax species, which may disappear as the forest matures. However, since it has high importance values in the middle story in many of the lowland stands, it might more properly be considered an edaphic climax. Common associates are listed in the ER, Appendix C, Tables A2.7-3b and A2.7-3f. About 88% of the lowland area on site is presently forested (Table B.1).

Eight species that occur on site are included on a list of protected native plants for New York State (ER, Table A2.7-10). These are given in Appendix B, Table B.2, which include the respective status, habitat requirements, and distribution of each within site communities.

2.7.1.3 Consumers

The site occurs in the broad transitional area between the Canadian and Carolinian biotic provinces,[15] more specifically, the Erie-Ontario Plain.[16] This area is considered the principal range for so-called farm game — the ring neck pheasant and cottontail rabbit, both of which were observed on the Sterling site. The cottontail first extended its range into this area during the late 1800s and has become numerous enough to be labeled a nuisance. White-tailed deer were introduced during the 1930s. Fertile marshes lining lowland areas have been noted for muskrat and waterfowl production.

The site provides a wide variety of habitats supporting 178 observed species of vertebrates, including 17 reptiles and amphibians, 19 mammals, and 142 birds (Table B.3), and almost 100 species of Arthropods (Article VIII, Sect. 79.2). Only seven of the vertebrate species are restricted to single habitat types (Tables B.3 and B.4), most being capable of inhabiting multiple habitats. The largest group of species is urban-woodland — native forest species that also use urban landscaped environments (18%, Table B.3). About 20% of the observed fauna are restricted to wetland environments of the site that include Lake Ontario, inland deep freshwater marshes, and small streams (Table B.4). A fairly substantial percentage (15%) are wide-ranging terrestrial species that include the important farm game species.

Fig. 2.5. Sterling vegetation & land use types, 1974. Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 74, February 1975, Figs. 79.2-1 and 79.2-2.

The status of the important wildlife species observed on the site is depicted in Table B.4. No rare or endangered species were observed to be nesting on the site; however, bald eagles and ospreys were observed flying over the site area. The bald eagle is officially recognized as an endangered species. The osprey is listed nationally by the Department of Interior as "status undetermined," but within New York State, the osprey is considered endangered (ER, Table A2.7-9). Six species observed on the site are currently showing population declines: marsh hawk, sparrow hawk, sharp-shinned hawk, Bewick's wren, grasshopper sparrow, and Henslow's sparrow.[17]

The pine grosbeak is a peripheral species whose southern range extends into the northeastern United States (the term peripheral indicates that this bird is threatened with extinction within the United States although not in other areas of its range). Important game and fur-bearing species are listed in Table B.4.

2.7.2 Aquatic ecology

The applicant has initiated ecological baseline studies of the Sterling site and environs. Data collected through April 1974 are presented in the ER, Sect. 2.7.1 and Appendices 2E and 2F (Vol. 4), and in Refs. 18 and 19 of this section of this statement. A brief discussion of Lake Ontario as a whole is included in the following descriptions of the ecology of the Sterling site area.

2.7.2.1 Physical and chemical limnology

Lake Ontario is a dimictic lake (one that undergoes turnover in the spring and fall). For practical purposes, the lake can be considered to be essentially isothermal (32°F) in winter, although in the deepest portions the temperatures may approach 38.5 to 39°F (temperatures at which water has its maximum density for the depths considered).[20] The lake does not freeze over, but ice cover does develop in the shallow northeastern portions and along the shoreline in other areas (such as the Sterling site).[21]

In the spring, mixing of the water in the entire lake begins when water, warmed to temperatures above 32°F, begins to sink because of its increased density. During the mixing, which is assisted by wind-driven currents, the shallow inshore waters of the lake warm up more rapidly than do the waters farther out. When the water temperatures inshore exceed 39°F from the surface to the bottom, a thermal bar is formed. The water temperature at the thermal bar is about 39°F, whereas offshore water temperatures are less than 39°F.[22]

As the warming progresses, the thermal bar gradually moves toward the center of the lake until it disappears sometime in June. In the warmer waters inshore, temperature and density gradients (surface to bottom) that restrict the depth of circulation of the surface waters exist. In the colder waters beyond the thermal bar, little stratification occurs; thus, the circulation of the surface waters is deeper.[22] Nutrients carried into the lake by runoff are impounded inshore behind the thermal bar.[22]

As the thermal bar disappears, the thermal stratification, which began inshore behind the thermal bar, spreads over the entire lake. By summer, the lake has become vertically stratified, both thermally and chemically. In autumn, the upper waters cool, and mixing is reinitiated. A thermal bar reforms, although the patterns of temperature are reversed compared with those of the bar that forms in spring.[22] Cooling proceeds until the lake becomes essentially isothermal in winter.

On April 30, 1972, the thermal bar was detected at the Sterling site. The bar was approximately 1.4 km off shore at both the east and west transects. By May 2, 1972, the bar had moved far enough off shore to elude detection at the lake stations. On May 9, 1972, as part of the International Field Year for the Great Lakes (IFYGL) program, water temperatures were taken out to 8 km off shore (measurements taken off Ford shoal approximately 8 km east of the Sterling site). In 1973 the thermal bar was located on April 15. [illegible]osition was approximately 1.5 km off shore at the Sterling site. By May 7, 1973, the bar had [illegible] beyond the sampling transects. On April 12, 1974, the thermal bar was located 0.34 km [illegible]ore at the Sterling site. By April 22, 1974, the thermal bar had moved beyond 1.5 km from shore (past the 11-m stations), and by May 6, 1974, the bar was located approximately 2.5 km off shore. The offshore movement of the thermal bar is quite rapid and the area on the shoreward side of the thermal bar will be one-half of the total lake area within 2 1/2 to 4 weeks after the emergence of the thermal bar in Lake Ontario.[23]

The surface circulation of the lake is generally counterclockwise. The currents are wind-driven; they respond rapidly at the surface to changes in wind speed and direction. Under isothermal conditions, the wind affects currents at a much greater depth than when the lake is stratified.[24] General physical features, temperature cycles, and current regimes of Lake Ontario are addressed in further detail in Appendix C.

On the basis of its morphoedaphic index, that is, total dissolved solids (in parts per million) per mean depth (in meters), Lake Ontario is an oligotrophic (low productivity) lake.[25] Morphometry (physical dimensions), offshore phytoplanktonic[26-28] and benthic compositions, and the relatively low dissolved oxygen depletion (>80 to 90% of saturation) in deep waters[24,30,31] indicate that oligotrophic conditions exist in the lake, at least in offshore waters. However, the relatively low transparency and high turbidity (comparable with those of Lake Erie),[25,32] high conductivity,[25,32] high concentrations of organic matter,[33] high total dissolved solids concentration,[32] and the inshore phytoplanktonic[26-28] and benthic[25,29,34] compositions indicate that eutrophic (highly productive) conditions exist in certain areas of the lake: (1) inshore around the lake (particularly near metropolitan areas) and (2) in the Bay of Quinte, which is near the mouth of the St. Lawrence River (see Fig. 2.2). The Bay of Quinte, in addition to having high phytoplanktonic productivity,[28] is relatively shallow[25] and has significant oxygen depletion in the hypolimnion.[31]

Changes in Lake Ontario closely parallel those in Lake Erie. The greater concentrations of dissolved solids in Lake Ontario (compared with Lake Erie) have been attributed to growth of the Toronto, Hamilton, and Rochester metropolitan areas and to industrial expansion along the upper Niagara River.[32]

Concentrations of important nutrients (soluble phosphate, nitrate plus nitrite, and silica) in surface waters of Lake Ontario exhibit very regular seasonal fluctuations. The concentrations are maximal following the fall turnover (mixing with bottom waters), then begin to decrease in early spring until they reach fairly steady low values from midsummer to early fall.[35] Because spring and early summer phytoplanktonic populations are dominated by diatoms which require all three of these nutrients, the observed declines appear to be related to the magnitude of diatom populations.[26-28]

2.7.2.2 Phytoplankton

Densities of phytoplankton in Lake Ontario have been characterized as low to moderate with highest densities generally occurring in the western end of the lake.[28] Lakewide sampling during 1970 revealed that diatoms, cryptomonads, and green algae, in decreasing order, dominated the phytoplankton community in Lake Ontario.[26] During winter and spring, diatoms comprised approximately 80% of the phytoplankton volume, whereas green algae predominated during the maximum blooms of summer and fall. Densities were generally lower but more evenly distributed in the offshore areas than in the inshore areas.[26] Species of the genera *Rhodomonas*, *Cryptomonas*, *Scenedesmus*, and *Asterionella* were relatively abundant during winter. *Melosira binderana*, *Stephanodiscus tenuis*, and *S. hantzschii* were among the dominant species in the spring. Dominants in the summer included species of *Pediastrum*, *Chlorella*, and *Ankistrodesmus*, whereas representatives of the blue greens *Chroococcus* and *Oscillatoria* and the greens *Chlamydomonas*, and *Pedinomonas* composed much of the fall community.[26] Studies off Gibralter Point revealed *Stephanodiscus tenuis* to dominate the nearshore waters from January to July of 1964, while *Melosira islandica* and *Asterionella formosa* dominated the offshore waters.[27] The latter two species are indicative of oligotrophic conditions.

Preliminary findings of recent IFYGL studies indicating that phytoplankton assemblages of Lake Ontario show unusually high variations in abundance and temporal and spatial distribution suggest a relatively unstable system to some observers.[36] Further, these observers believe most of the abundant species require or are tolerant of eutrophic conditions.[36] These observations, coupled with the fact that phytoplankton densities in Lake Ontario nearshore waters have increased two to four times since 1925,[28,37] suggest that the lake is changing toward mesotrophic, if not eutrophic, conditions.

During the applicant's October 1972 through August 1974 sampling program at the Sterling site, diatoms (mainly *Asterionella sp.*) and green algae (mainly *Spirogyra* and *Microspora spp.*) dominated the phytoplankton community from April through June.[18,19] In July, August, and September, blue-greens, especially *Oscillatoria sp.*, and green algae (*Pandorina*, *Staurastum*, and *Pediastrum spp.*) were most abundant.

2.7.2.3 Zooplankton

The zooplankton communities of Lake Ontario have apparently shifted significantly in species composition since 1939 when calanoid and cyclopoid copepods dominated the crustacean plankton, thus underscoring the profound changes that are apparently taking place.[38] Now cladocerans, particularly *Bosmina longirostris*, may be most numerous.[24,38] Patalas,[39] however, found *Cyclops bicuspidatus*, *Bosmina longirostris*, *Daphnia retrocurva*, *Tropocyclops prasinus*, and *B. coregoni*, in decreasing order, to be most abundant from June to October 1967. Population densities were generally greater in the eastern region of the lake, presumably due to warmer water.[39]

Species of *Asplanchna* and *Keratella* appear to be important representatives of the rotifers in offshore waters,[24] whereas *Synchaeta* and *Polyarthra* constitute the major inhabitants of the inshore surface rotifer community.[40]

The zooplankton community at the Sterling site is similar to those previously described. *Keratella*, *Polyarthra*, and *Asplanchna* were important among the rotifers; *B. longirostris* and *Daphnia spp.* dominated the cladocerans, and *Cyclops bicuspidatus* was the most numerous species of copepods.[18,19] Total zooplankton abundance ranged from a winter minimum of nearly zero to a summer maximum of nearly 5000 plankters/liter.[19]

2.7.2.4 Benthos

In terms of density, four families of oligochaetes (Tubificidae, Lumbriculidae, Naididae, and Enchytraeidae) dominate the macrobenthos of Lake Ontario.[34,41] The amphipod *Pontoporeia affinis* is present (up to nearly 10,000/m^2) over a wide range of depths and, together with *Mysis relicta* and the dominant oligochaetes, indicates generally oligotrophic conditions in the offshore waters.[24] Nearer shore, the lake is harder to position on the oligotrophy-eutrophy spectrum on the sole basis of benthic organisms, because organisms characteristic of either or both ends of the spectrum may be present, depending on proximity to sources of pollution and other factors. Oligochaetes and chironomids are common, and *Gammarus* often achieves densities in excess of 1000/m^2 down to depths of 30 m or more.[34] This amphipod, along with *P. affinis*, constitutes a vital food source for many fish species in the lake. Other components of the macrobenthos include fingernail and seed clams.[34] Presumably as a result of wave action, species diversity in the upper littoral zone is inferior to that of the sublittoral zone down to a depth of about 13 m.[41]

The applicant sampled the benthos at the Sterling site at depths of 2, 5, 8, and 11 m. *Gammarus*, several midge species (*Chironomidae*), and oligochaetes (particularly *Naididae*) predominated, with densities generally decreasing with increasing depth.[18,19] In an earlier study at the site, the total number of organisms per sq meter exceeded 25,000 on occasion.[18] Fish food studies conducted by the applicant show *Gammarus fasciatus* to be one of the most important food items for fishes in the inshore areas from April to October (ER, p. 2.7-8). Crayfish, snails, and larval insects also contributed significantly to the diet of inshore fishes (ER, Table 2.7-2).

The filamentous green alga *Cladophora* (particularly *C. glomerata*) constitutes the dominant floral feature of the benthos, and many of the faunal components, including *Gammarus* and various chironomids, are intimately associated with it (ER, p. 2.7-6). The often rocky bottom at the site provides suitable substrate for fairly dense growths down to a depth of about 15 ft.[19] Temperature and photoperiod elicit maximum growth in June followed by a decline until late August when a secondary bloom develops.[42] *Cladophora* is a serious problem in Lake Ontario due to its fouling of water supplies, interference with fish nets, and assault on the aesthetic and recreational value of the shoreline. This is particularly true in July when massive mats of decomposing *cladophora* build up in the inshore areas.[24]

2.7.2.5 Fishes

One investigator has properly characterized the history of the Great Lakes fisheries as "tumultuous" and the changes in fish stocks as "catastrophic."[43] In Lake Ontario, which has been historically the least productive of the Great Lakes,[31] the major factors that have contributed to these conditions are:

(1) *Intensive selective exploitation by commercial fisheries*, first for Atlantic salmon (*Salmo salar*); then for lake sturgeon (*Acipenser fulvescens*), lake whitefish (*Coregonus clupeaformis*), and lake trout; later for lake herring, ciscoes, and blue pike (*Stizostedion vitreum glaucum*); and finally for walleye, yellow perch, smelt, and warm-water species.[43-45]

(2) *Extreme modification of drainage areas* by construction of dams on tributaries, by flow reductions and increases in water temperature in tributaries accompanying deforestation, and by swamp and marsh drainage.[43]

(3) *Establishment of marine species by both invasion and introduction*, first the alewife, sea lamprey (possibly indigenous to Lake Ontario), and rainbow smelt; then white perch (the most recent invader); and finally the Pacific salmon (the most recent introduction).[43,46-49]

(4) *Cultural eutrophication*, physical-chemical modifications that have resulted from urbanization and from advanced industrial and agricultural technologies.[43]

Authorities may disagree on the exact sequence and on the relative importance of the factors described above; that is, whether commercial fishing or the development of large sea lamprey populations was the dominant factor in the decline of a species such as the lake trout; but the effect of these factors is rather apparent today. The Atlantic salmon and some deepwater ciscoes have become extinct in Lake Ontario. The lake trout, other ciscoes, burbot, blue pike, lake whitefish, deepwater sculpin (*Myoxocephalus thompsonii*), and lake sturgeon have been reduced to levels that approach extinction.

The U.S. portion of the Lake Ontario fishery has of late supported only limited commercial fishing. Chaumont Bay, in the extreme eastern end of Lake Ontario, yields more than half of the very low total U.S. fish catch from the lake.[31] The eastern areas, particularly those in Canadian waters, provide superior spawning habitat for many of the most desirable species remaining.[21]

Evidence is available that the success of introducing the Pacific salmon is being hampered by existing sea lamprey populations: 8 of the 14 salmon captured had lamprey scars or wounds (7 bore multiple marks). Lamprey control efforts by the Ontario Department of Lands and Forests and of the NYSDEC, in cooperation with the Great Lakes Fishery Commission, are encouraging. These organizations have identified 43 streams for tentative lampricide applications, and attempts are being made to accelerate the advance of greatly needed lamprey control to Lake Ontario.[47]

As Fig. 2.6 shows, the community of forage fishes is dominated by the alewife, followed in abundance by the rainbow smelt and shiner minnow, in shallow water areas. The corresponding deepwater community is dominated by the slimy sculpin, smelt, and alewife. The present forage base has replaced the deepwater sculpin and an efficient zooplanktonic-feeding community consisting of diverse species of ciscoes and shiners. The reduced efficiency of zooplanktonic feeding has been given as a reason for the low fishery productivity in the lake. Another factor is the absence of significant deepwater predator populations to use available benthic food sources (invertebrates and slimy sculpins).[43,48] The alewife, which has wreaked so much havoc in the Great Lakes (both by its effects on other fish stocks[43,48] and by its tendency to suffer mass mortalities in midwinter, early spring, and summer[50,51]), is currently the single most abundant fish in Lake Ontario. Mass mortalities of alewives produce undesirable effects comparable to those of rotting masses of *Cladophora*. Large Pacific salmon (coho and chinook) have been introduced into Lake Ontario both to reduce the alewife population and to restore deepwater predator populations; hence, they are included in the trophic diagrams (Figs. 2.6 and 2.7). Their introduction may ultimately be as successful as that in Lake Michigan, which has a lamprey control program; if lamprey control does not become a reality, this hope may be a false one.

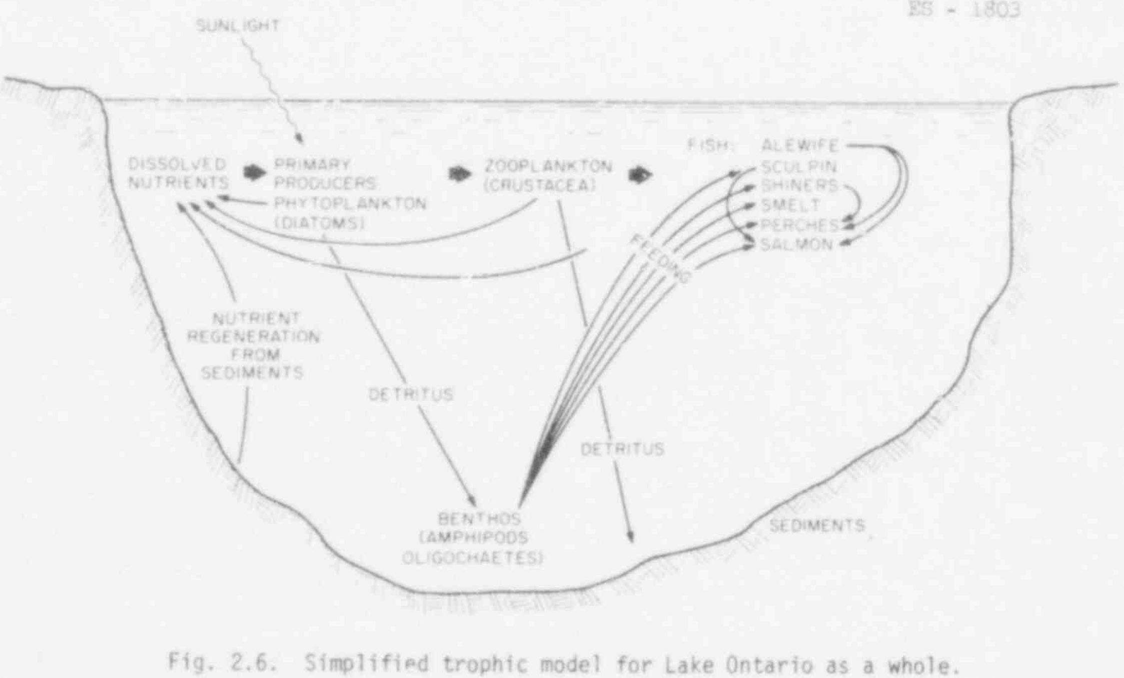


Fig. 2.6. Simplified trophic model for Lake Ontario as a whole.

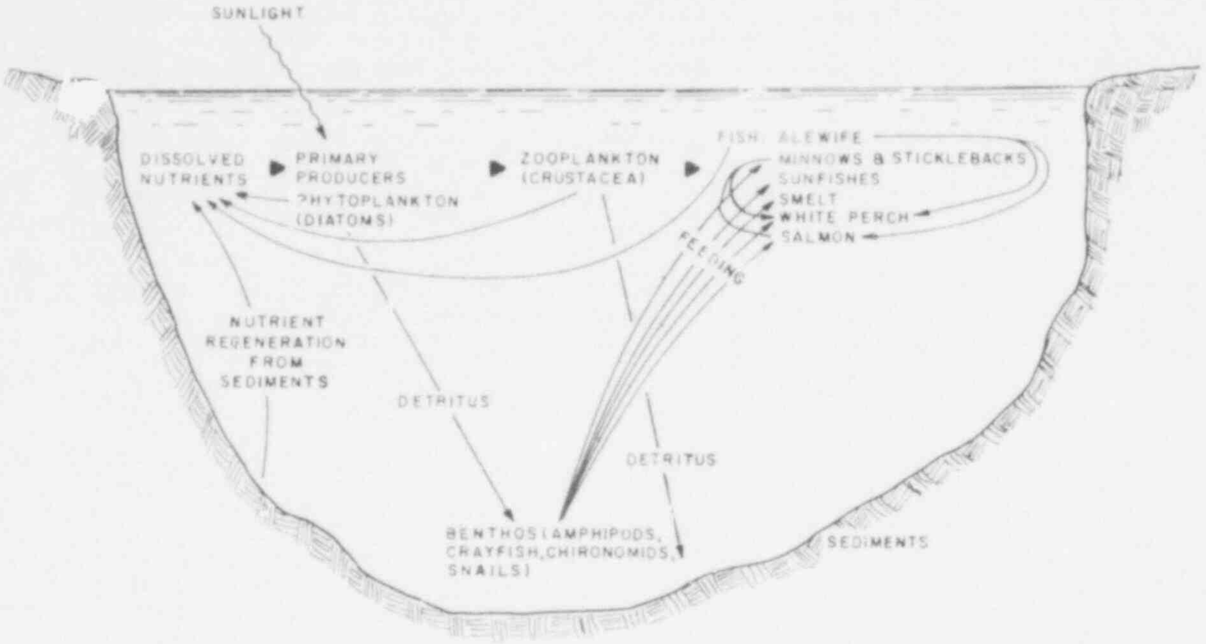


Fig. 2.7. Simplified trophic model for Lake Ontario at the Sterling site.

The research vessel *Kaho* conducted fishery surveys along several transects distributed throughout Lake Ontario from May through October 1972. Alewives, smelt, and slimy sculpins dominated trawl catches, whereas alewives, smelt, white perch, yellow perch, white suckers, and carp (roughly in that order) contributed most to the gillnet catch. A few chinook and coho salmon were also counted. The faunal composition near the Sterling site, as revealed by the applicant's gillnetting studies, was quite similar except for the relative importance of smallmouth bass and other sunfishes at the Sterling site.

Alewife, smelt, white sucker, gizzard shad, and probably minnows appear to be the most abundant forage species at the Sterling site (Table 2.4). The most abundant small predators are white perch and sunfishes (especially rock bass and pumpkinseed). Smallmouth bass and occasionally coho salmon comprise the principal large predators in the area. A generalized trophic model for the Sterling site (Fig. 2.7) differs from that for Lake Ontario as a whole (Fig. 2.6) due to differences in benthic and fish species composition in inshore areas.

Table 2.4 presents, in order of decreasing abundance, the fishes collected during the applicant's sampling program at the Sterling site. Relative species abundance, as determined from earlier studies at the Ginna Nuclear Power Plant approximately 35 miles WSW of Sterling, and at Nine Mile Point approximately 15 miles to the NE, are presented in Appendix B, Tables B.6 and B.7 respectively. Table B.8 presents spawning, food preference, and importance of the more abundant fishes in the Sterling area. Echo sounding studies performed monthly on transects extending 10,000 ft into the lake suggest that total fish densities are much higher within 2000 ft of the shore.[19]

Fish larvae and small juveniles achieved considerable abundance at Sterling. During May and June 1973, fish larval densities at the site ranged as high as 1.76 larvae /m^3 at mid-depth in water 5 m deep. Densities greater than 1.0/m^3 were also obtained in July and early August. However, densities of larvae were substantially lower in 1974 (see discussion in Sect. 5.5.2.3 and Table 5.16). Clupeid larvae, probably alewives, were most abundant, followed by serranid larvae and those of centrarchids, minnows, and perch.[18] In 1973, juveniles, mainly those of alewives, white perch, and minnows, also achieved densities[18] in excess of 1.0/m^3. From these observations and the direct observation by divers of alewife eggs in the *Cladophora* mats, the nearshore waters at the site appear to be used to some extent as a spawning ground and nursery by at least alewives, white perch, centrarchids, and some minnows.[18,19] Yellow perch and carp may also spawn among the *Cladophora* mats. Heavy wave activity probably discourages spawning by nest-builders and others providing parental care of young, such as the sunfish, although otherwise suitable habitat may exist farther offshore on the bottom of glacial cobble, gravel, boulders, and sand.

Table 2.4. Fish species gillnetted from the Sterling site, Lake Ontario, in order of decreasing abundance, September 1971 through September 1974

Common name	Scientific name
September 1971–September 1974[a]	
Alewife	*Alosa pseudoharengus*
White perch	*Morone americana*
Smallmouth bass	*Micropterus dolomieui*
Rock bass	*Ambloplites rupestris*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*
Gizzard shad	*Dorosoma cepedianum*
Lake chub	*Hybopsis plumbea*
Pumpkinseed	*Lepomis gibbosus*
Rainbow smelt	*Osmerus mordax*
Carp	*Cyprinus carpio*
Catfish	*Ictalurus punctatus*
Brown bullhead	*Ictalurus nebulosus*
Walleye	*Stizostedion vitreum*
Johnny darter	*Etheostoma nigrum*
American eel	*Anguilla rostrata*
Burbot	*Lota lota*
White fish	*Coregonus clupeaformis*
Coho salmon	*Oncorhynchus kisutch*
March–August 1974[b]	
Alewife	*Alosa pseudoharengus*
White perch	*Morone americanus*
Gizzard shad	*Dorosoma cepedianum*
Bullhead	*Ictalurus spp.*
Smallmouth bass	*Micropterus dolomieui*
Yellow perch	*Perca flavescens*
White sucker	*Catostomus commersoni*
Rock bass	*Ambloplites rupestris*
Carp	*Cyprinus carpio*
Pumpkinseed	*Lepomis gibbosus*
Lake chub	*Hybopsis plumbea*
Rainbow smelt	*Osmerus mordax*
Bowfin	*Amia calva*
Northern pike	*Esox lucius*
Coho salmon	*Oncorhynchus kisutch*
Bluegill	*Lepomis macrochirus*
Walleye	*Stizostedion vitreum*
Lake rainbow	*Salmo gairdneri*
Freshwater drum	*Aplodinotus grunniens*

[a] Data from the ER, Appendix 2E.

[b] Data from Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 73, February 1975.

Two streams, Sterling Valley Creek and Nine Mile Creek, enter Lake Ontario near the site. In the spring, alewives and white suckers enter these streams to spawn. Other visitors and residents include northern pike, bowfin, yellow bullhead, rock bass, yellow perch, white perch, carp, and creek chubsucker (ER, Table 2.7-19). Limited stocking efforts (brown and brook trout) have been directed at both streams in the past (ER, Table 2.2-19). The large elm-ash swamp described in Sect. 2.7.1 yielded only brook sticklebacks to collectors (ER, p. 2.7-35).

2.7.2.6 Threatened species

No species listed as rare or endangered by the U.S. Department of the Interior[52] or by the Endangered Species Committee of the American Fisheries Society[53] were collected at the Sterling site during the applicant's sampling program. The endangered blue pike, *Stizostedion vitreum glaucum*, however, may still exist in small numbers in the deeper and cooler areas of Lake Ontario.[52]

REFERENCES FOR SECTION 2

1. Federal Aviation Administration, "New York Sectional Aeronautical Chart," 10th ed., National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C., January 2, 1975.

2. L. M. Vaughn, *Abandoned Farm Areas in New York*, Cornell University Agr. Exp. Stat. Bull. No. 490, 1929.

3. New York State Division of the Budget/Office of Statistical Coordination, *New York State Statistical Yearbook*, 1974.

4. U.S. Department of Commerce, Environmental Data Service, *Local Climatological Data, Annual Summary with Comparative Data — Rochester, New York*, published annually.

5. U.S. Department of Commerce, Environmental Data Service; *Local Climatological Data, Annual Summary with Comparative Data — Syracuse, New York*, published annually.

6. U.S. Department of Commerce, Environmental Data Service, *Climatic Atlas of the United States*, Environmental Science Services Administration, Washington, D.C., June 1968.

7. Rochester Gas and Electric Corporation, *Preliminary Safety Analysis Report, Standard Nuclear Power Plant System. Sterling Power Project — Nuclear Unit 1 Addendum*, 1974.

8. P. Riorden, *Extreme 24-Hour Snowfalls in the United States: Accumulation, Distribution, and Frequency*, Special Report ETL-SE-73-4, U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia, 1973.

9. G. W. Cry, *Tropical Cyclones of the North Atlantic Ocean*, Technical Paper No. 55, U.S. Department of Commerce, Weather Bureau, Washington, D.C., 1965.

10. U.S. Department of Commerce, *Tropical Storm and Atlantic Hurricane Articles from the Monthly Weather Review*, published monthly through December 1973.

11. SELS Unit Staff, *National Severe Storms Forecast Center: Severe Local Storm Occurrences, 1955-1967*, ESSA Technical Memorandum WBTM FCST 12, Office of Meteorological Operations, Silver Spring, Maryland, 1969.

12. H. C. S. Thom, "Tornado Probabilities," pp. 730-737 in *Monthly Weather Review*, (October-December 1963).

13. P. Tattleman and I. I. Gringorten, *Estimated Glaze Ice and Wind Loads at the Earth's Surface for the Contiguous United States*, Air Force Cambridge Research Laboratories, Bedford, Massachusetts, 1973.

14. G. S. Holzworth, *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*, AP-101, U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina, 1972.

15. L. R. Dice, *The Biotic Provinces of North America*, University of Michigan Press, Ann Arbor, Michigan, 1943.

16. R. H. Smith, *A History and Definition of State Game Ranges in New York State*, Final Report, Project W-23-R, New York State Conservation Department, Division of Fish and Game, November 1954.

17. National Audubon Society, "The Blue List for 1976," *American Birds* 29(6): 1067-1072 (1975).

18. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Fossil-Fueled)*, Vol. 2, Part 74, January 1974.

19. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 74, February 1975.

20. G. E. Hutchinson, *A Treatise on Limnology*, Vol. 1, Wiley Publishing Company, New York, 1957.

21. D. R. Rondy, *Great Lakes Ice Atlas*, U.S. Lake Survey, Research Report 5-6, Great Lakes Research Center, Detroit, Michigan, April 1969.

~~720 339~~

715 037

G. K. Rodgers, "The Thermal Bar in the Laurentian Great Lakes," pp. 358-363 in *Publication No. 13*, Great Lakes Research Division, University of Michigan, Ann Arbor, 1965.

N. J. Campbell, *Pollution of Lake Ontario and the International Section of the St. Lawrence River, Vol. 3*, International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence River Water Pollution Board, 1969, pp. 27-37.

24. The International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence Water Pollution Board, *Pollution of Lake Ontario and the International Section of the St. Lawrence River*, Vol. 3, 1969.

25. R. A. Ryder, "The Limnology and Fishes of Oligotrophic Glacial Lakes in North America (About 1800 A.D.)," *J. Fish. Res. Bd. Canada* 29(6): 617-628 (1972).

26. M. Munawar and A. Nauwerck, "The Composition and Horizontal Distribution of Phytoplankton in Lake Ontario During the Year 1970," pp. 69-78 in *Proc. 14th Conf. Great Lakes Res.*, 1971.

27. C. Nalewajko, "Composition of Phytoplankton in Surface Waters of Lake Ontario," *J. Fish. Res. Bd. Canada*, 23(11): 1715-1725.

28. M. F. P. Michalski "Phytoplankton Levels in Canadian Near-Shore Waters of the Lower Great Lakes," pp. 85-95 in *Proc. 11th Conf. Great Lakes Res.*, 1968.

29. "Proceedings of the Conference on Changes in the Biota of Lakes Erie and Ontario, April 16-17, 1968," *Bull. Buffalo Soc. Natur. Sci.* 25(1): 1-84 (1969).

30. Great Lakes Fishery Commission, *Limnological Survey of Lake Ontario, 1964*, Technical Report No. 14, Ann Arbor, Michigan, 1969.

31. Fish and Wildlife Service, *Fish and Wildlife as Related to Water Quality of the Lake Ontario Basin*, U.S Department of Interior, 1969.

32. A. M. Beeton, "Eutrophication of the St. Lawrence Great Lakes," *Limnol. Oceanogr.* 10(2): 240-254 (1966).

33. A. Robertson and C. F. Powers, *Comparison of the Distribution of Organic Matter in the Five Great Lakes*, Special Report No. 30, Great Lakes Research Division, University of Michigan, Ann Arbor, 1967.

34. J. K. Hiltunen, *The Benthic Macrofauna of Lake Ontario*, Great Lakes Fish. Comm. Technical Report No. 14, 1969, pp. 39-49.

35. Y. K. Chau, V. K. Chawla, H. F. Nicholson, and R. A. Vollenweider, "Distribution of Trace Elements and Chlorophyll *a* in Lake Ontario," pp. 659-672 in *Proc. 13th Conf. Great Lakes Res.*, 1970.

36. E. F. Stoermer, "Analysis of Phytoplankton Composition and Abundance During IFYGL," pp. 89-110 in *First Annual Reports of the EPA IFYGL Projects*, EPA 660/3-73-021, 1973.

37. C. F. Schenk and R. E. Thompson, "Long-term Changes in Water Chemistry and Abundance of Plankton at a Single Sampling Location in Lake Ontario," pp. 197-208 in Publication No. 13, Great Lakes Research Division, University of Michigan, Ann Arbor, 1965.

38. D. C. McNaught and M. Buzzard, "Changes in Zooplankton Populations in Lake Ontario (1939-1972)," pp. 89-110 in *First Annual Reports of the EPA IFYGL Projects*, EPA 660/3-73-021, 1973.

39. K. Patalas, "Composition and Distribution of Crustacean Plankton in Lake Ontario," *J. Fish. Res. Bd. Canada* 26(8): 2135-2164, 1969.

40. D. C. McNaught, S. J. Markello, and D. Giovannangelo, "Planktonic Rotifers and Crustacea of the Lake Ontario Inshore Region," pp. 191-206 in *First Annual Reports of the EPA IFYGL Projects*, EPA 660/3-73-021, 1973.

41. J. H. Judd and D. T. Gemmel, "Distribution of Benthic Macrofauna in the Littoral Zone of Southeastern Lake Ontario," presented at the Nineteenth Annual Meeting of the Midwest Benthological Society, March 1971, Lake Ontario Environmental Laboratory, State University College, Oswego, New York.

42. J. F. Storr and R. A. Sweeney, "Development of Theoretical Seasonal Growth Response Curve of *Cladophora glomerata* to Temperature and Photoperiod," pp. 119-127 in *Proc. 14th Conf. Great Lakes Res.*, 1971.

43. S. H. Smith, "Factors of Ecologic Succession in Oligotrophic Fish Communities of the Laurentian Great Lakes," *J. Fish. Res. Bd. Canada* 29(6): 717-730 (1972).

44. N. S. Baldwin and R. W. Saalfeld, *Commercial Fish Production in the Great Lakes, 1867-1960*, Technical Report No. 3, Great Lakes Fishery Commission, Ann Arbor, Michigan, 1962.

45. Great Lakes Fishery Commission, *Supplement to Technical Report No. 3 Covering the Years 1961 to 1968*, Ann Arbor, Michigan, 1970.

46. Great Lakes Fishery Commission, *Annual Report*, Ann Arbor, Michigan, 1969.

47. Great Lakes Fishery Commission, *Annual Report*, Ann Arbor, Michigan, 1970.

48. S. H. Smith, "Species Interactions of the Alewife in the Great Lakes," *Trans. Amer. Fish. Soc.* 99(4): 754-765 (1970).

49. W. I. Aron and S. H. Smith, "Ship Canals and Aquatic Eco-systems," *Science* 174(4004): 13-20 (1971).

50. S. H. Smith, "The Alewife," *Limnos* 1(2) (Summer 1968).

51. P. J. Colby, "Alewife Dieoffs: Why Do They Occur?," *Limnos* 4(2): 18-27 (1971).

52. Bureau of Sport Fisheries and Wildlife, *Threatened Wildlife of the United States*, Resource Publication 114, U.S. Government Printing Office, Washington, D.C., 1973.

53. R. R. Miller, "Threatened Freshwater Fishes of the United States," *Trans. Amer. Fish. Soc.* 101(2): 239-252 (1972).

3. THE STATION

3.1 EXTERNAL APPEARANCE

Views of the proposed plant are shown in Figs. 3.1 and 3.2. Prominent features of the proposed plant are the reactor containment, rectilinear turbine, and fuel buildings. The reactor building will have a silo shape 140 ft in diameter and rising to a dome 205 ft above ground level. The radioactive waste building can be seen detached and adjacent to the fuel building.

The exterior will be a neutral organic color to blend with the natural setting and to minimize the scale of the plant. Bright primary colors will be used to define important elements such as fire hydrants and entrances. The area surrounding the complex is wooded hillside.

The buildings mentioned above will all be seen from the lake and will preclude views of the other buildings behind them. The plant will also be visible from the interior of the site (the plant parking areas and the immediately adjacent access roads). Woods will surround the plant on all but the lake side.

3.2 REACTOR, STEAM-ELECTRIC SYSTEM, AND FUEL INVENTORY

The proposed plant will consist of a single Standardized Nuclear Unit Power Plant System (SNUPPS) and auxiliaries. The power source will be a pressurized-light-water reactor supplied by Westinghouse Electric Corporation. The operation of the reactor is shown in Fig. 3.3. In the primary coolant loop, water under high pressure (so it cannot boil) is pumped through the reactor core where it is heated by contact with fuel rods containing uranium. The heated water passes through the steam generators and returns to the core. In the steam generators, water in the secondary coolant loop is boiled. This steam drives a turbine-generator system, is liquefied in the condenser, and returns to the steam generators. The condenser is cooled by water drawn from and returned to Lake Ontario. The reactor has four primary and one secondary cooling loops. The turbine-generator system will be manufactured by General Electric Company. Bechtel Power Corporation is the architect-engineer.

At design conditions, the plant will generate 1206 MWe net electrical power and will reject 2359 MWt waste heat to the environment. More detailed operating parameters are listed in Table 3.1. The initial fuel loading will be 222,600 lb of enriched uranium dioxide pellets contained in 50,942 tubular fuel rods.

3.3 STATION WATER USE

By far the largest use of water in the Sterling plant will be in the plant's once-through cooling system. At design conditions, about 1860 cfs will be withdrawn from Lake Ontario, heated 19.3°F, and returned to the lake. This will include 1773 cfs circulating water (heated about 19.7°F) and 85 cfs service water (heated about 10°F). The flow rates of all other systems are less than 2 cfs. Details of the water budget are presented in Table 3.2 and Fig. 3.4. All water used at Sterling is obtained from and returned to Lake Ontario.

3.4 HEAT DISSIPATION SYSTEM

3.4.1 General description

The applicant has proposed a once-through cooling system for Sterling Nuclear Unit No. 1. Figure 3.5 shows the layout of the system. Water will be withdrawn from Lake Ontario through a submerged intake structure and piped to separate circulating water and service water screenwell-pumphouse structures on shore. The circulating water will flow through the main condenser while the service water will cool various auxiliary heat exchangers. The circulating and service water will be returned to Lake Ontario through a common shoreline surface discharge canal. The estimated total time for a particle to pass from intake to discharge is 12 min. The estimated retention times in various sections of the circulating water system are listed in Table 3.3.

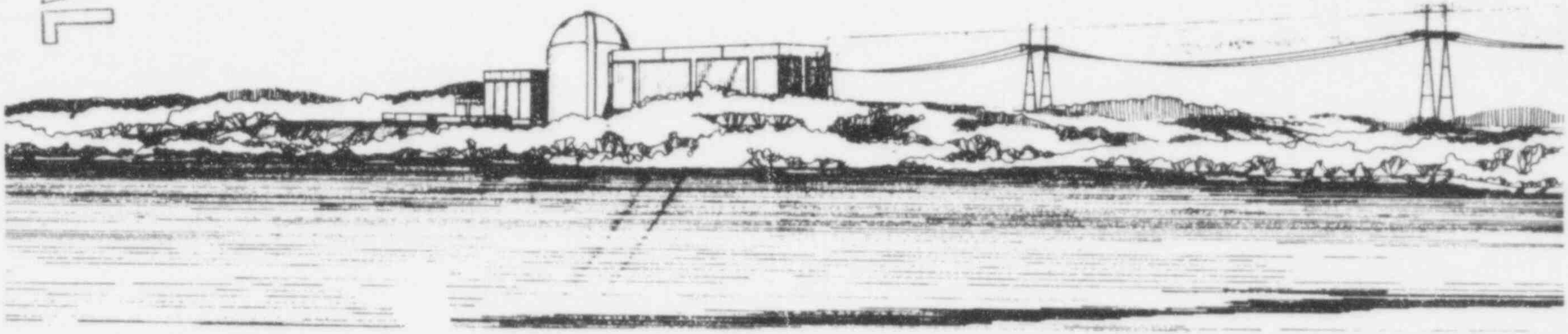


Fig. 3.1. Artist's conception of the proposed Sterling Power Project.

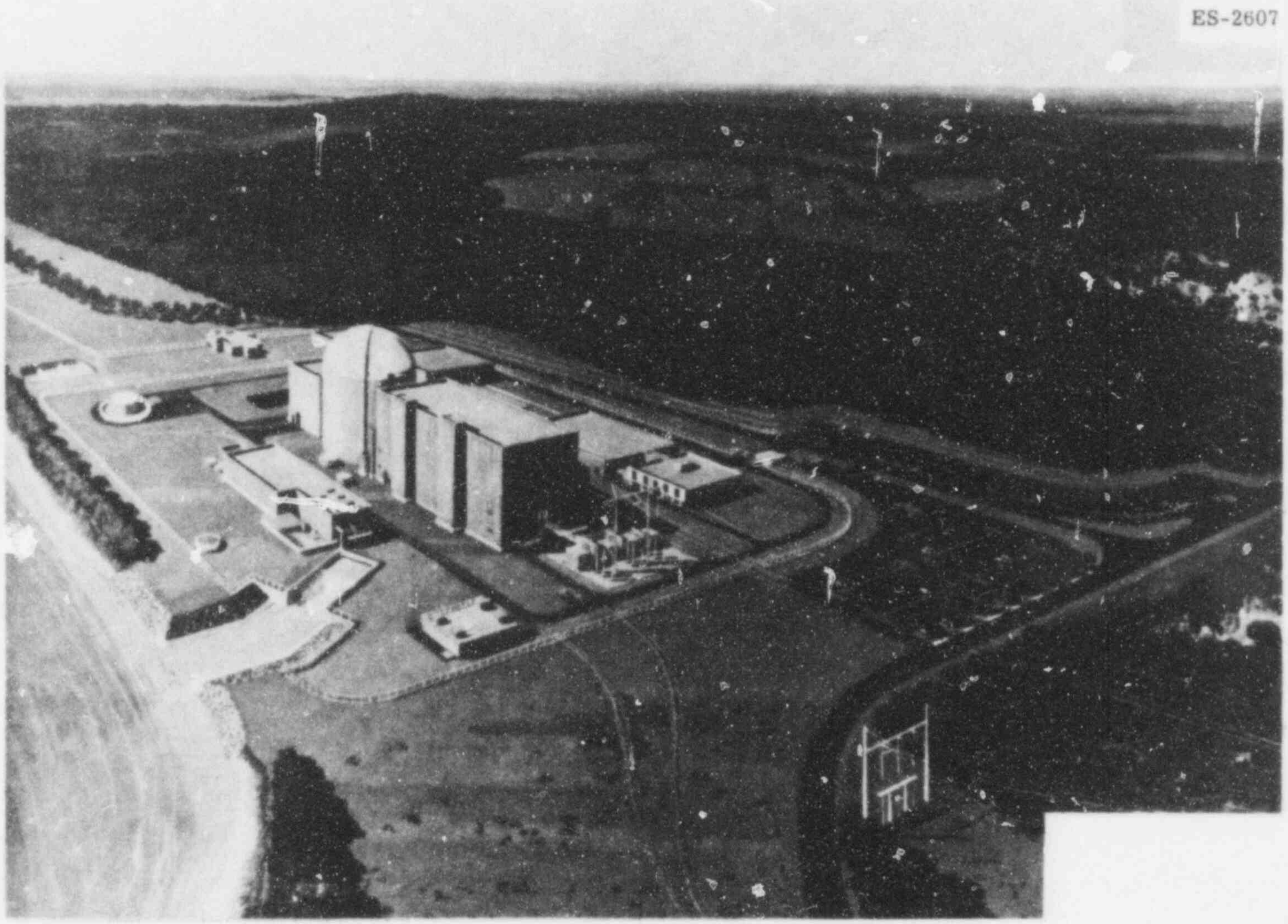


Fig. 3.2. Artist's conception of the proposed Sterling Power Project. Source: ER, Fig. 3.1-2, Rev. 6.

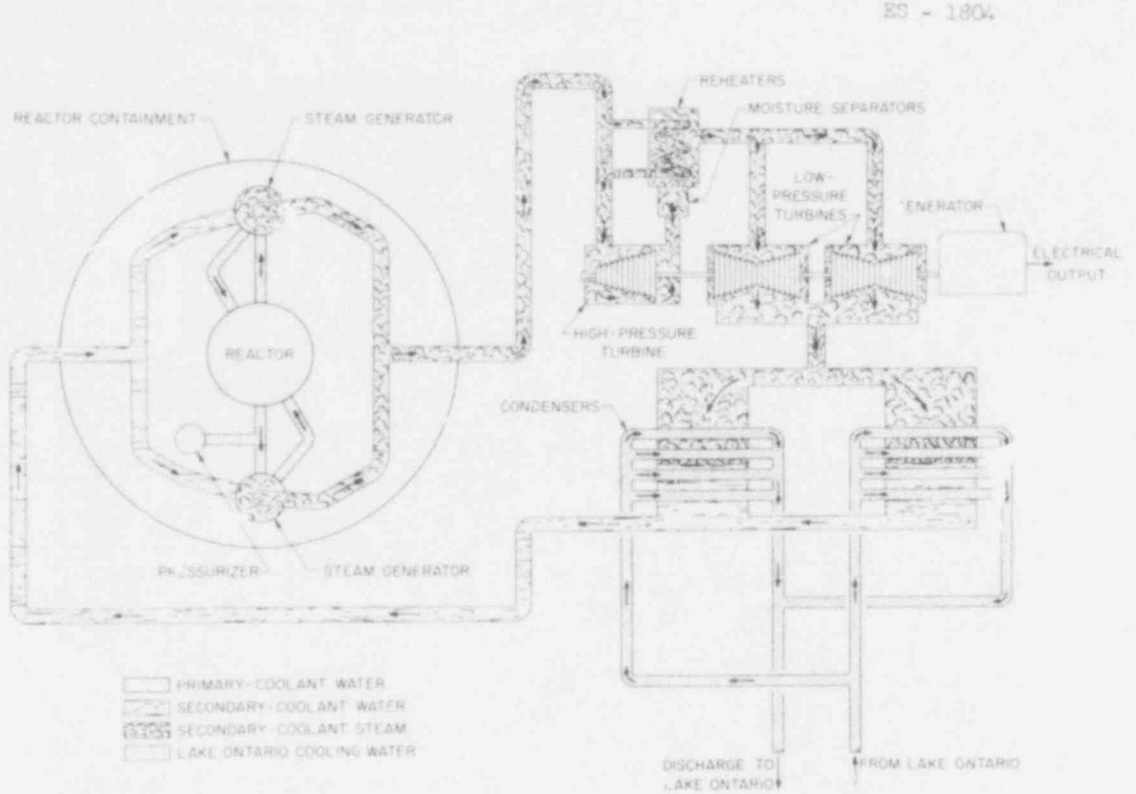


Fig. 3.3. Simplified flow diagram of the steam-electric system.

Table 3.1. Operating parameters of the Sterling Power Project Nuclear Unit No. 1

Rated conditions	
Core thermal power, MWt	3411
Gross electrical generation, MWe	1195
Station service requirement, MWe	49
Net electrical output, MWe	1146
Waste heat rejected, MWt	2265
Efficiency, %	33.6
Design conditions	
Core thermal power, MWt	3565
Gross electrical generation, MWe	1255
Station service requirement, MWe	49
Net electrical output, MWe	1206
Waste heat rejected, MWt	2359
Efficiency, %	33.8
Fuel assemblies, number	193
Fuel rods per assembly, number	264
Initial enriched uranium loading, lb	222,600
Initial enrichment range, %	2.1–3.1

POOR ORIGINAL

715 043
~~720~~ 345

Table 3.2. Estimated water use at full power operation

	GPD	GPM
Untreated		
Condenser cooling water	1,144,800,000	795,000
House service water	54,720,000	38,000
Screen wash water (circulating system)	864,000	600
Screen wash water (house service)	288,000	200
Runoff from oil storage[a]	650	0.5
Subtotal	1,200,672,650	833,800.5
In-plant treated water (via raw water pretreatment system)		
Demineralized water treatment products		
Demineralizer waste[a]	4,800	3.3
Steam generator blowdown[a]	28,800	20.0
Low level rad waste	1,440	1.0
Nonradioactive floor drains[a]	13,460	9.3
Pretreatment waste[a]	3,200	2.2
Sanitary waste	2,500	1.7
Subtotal	54,200	37.5
Total	1,200,726,850	833,838.0

[a] Processed by industrial waste treatment system prior to discharge.

Source: ER, Table 3.3-1, Rev. 8.

3.4.2 Water intake

As shown in Fig. 3.6, the design presented in the ER, Rev. 8, calls for a submerged offshore intake structure. Each of the ten vertical faces measures 23 x 20 ft and contains 176 sq ft of open area protected by 3/4-in. bars every 10 in. These bars will be electrically heated to prevent frazil ice formation.

In the ER, Rev. 8, the applicant proposes closing the three inshore faces by removable panels to reduce fish entrainment. With seven unblocked faces, the velocity through the open areas will be about 1.5 fps at the design flow of 1860 cfs. Design features proposed to reduce entrainment are the placement of the lower edge of the intake port 6 ft above the lake bottom, the provision of a solid vertical face from the bottom of the intake port to the lake bottom, and unspecified artificial roughening of the intake passages to produce vibrational warnings to the fish. The structure will be located 4200 ft offshore. When the lake reaches its minimum still water level of 239.74 ft MSL [U.S. Coast and Geodetic Survey (USC & GS)] the submergence of the intake structure will be about 9 ft. The submergence beneath the average lake level of 246 ft MSL (USC & GS) is 15.5 ft. Since Rev. 8 to the ER was issued, the applicant has committed to a redesign of the intake structure. The velocity through the trash racks of the intake structure will be reduced to 0.8 fps.[1] No details of the new design have been specified as yet.

The water travels to the onshore circulating water screenwell and pump structure through a 15.5-ft-ID concrete-lined tunnel. As shown in Fig. 3.5, this tunnel descends vertically about 130 ft, runs to shore, and rises vertically about 130 ft before discharging into the forebay of the screenwell and pump structure. These three right-angle turns will produce extreme local turbulence. Flow through the pipe will have an average velocity of 9.9 fps and will be highly turbulent. Radial velocity fluctuations of about 0.4 fps will occur throughout the pipe.

The circulating water screenwell and pump structure proposed in Rev. 8 of the ER is shown in Fig. 3.7. Due to head loss in the inlet tunnel, the water level in the forebay at design flow will be about 10 ft less than the lake level. The velocity in the forebay at minimum lake level will be 1.0 fps, and at average lake level this velocity will be 0.7 fps. The circulating water passes through one of eight traveling screens to reach one of four vertical wet pit pumps. All four pumps are necessary to supply the design circulating water flow of 1773 cfs. The pumps discharge into a common plenum from which three 10-ft-ID pipes lead to the condenser.

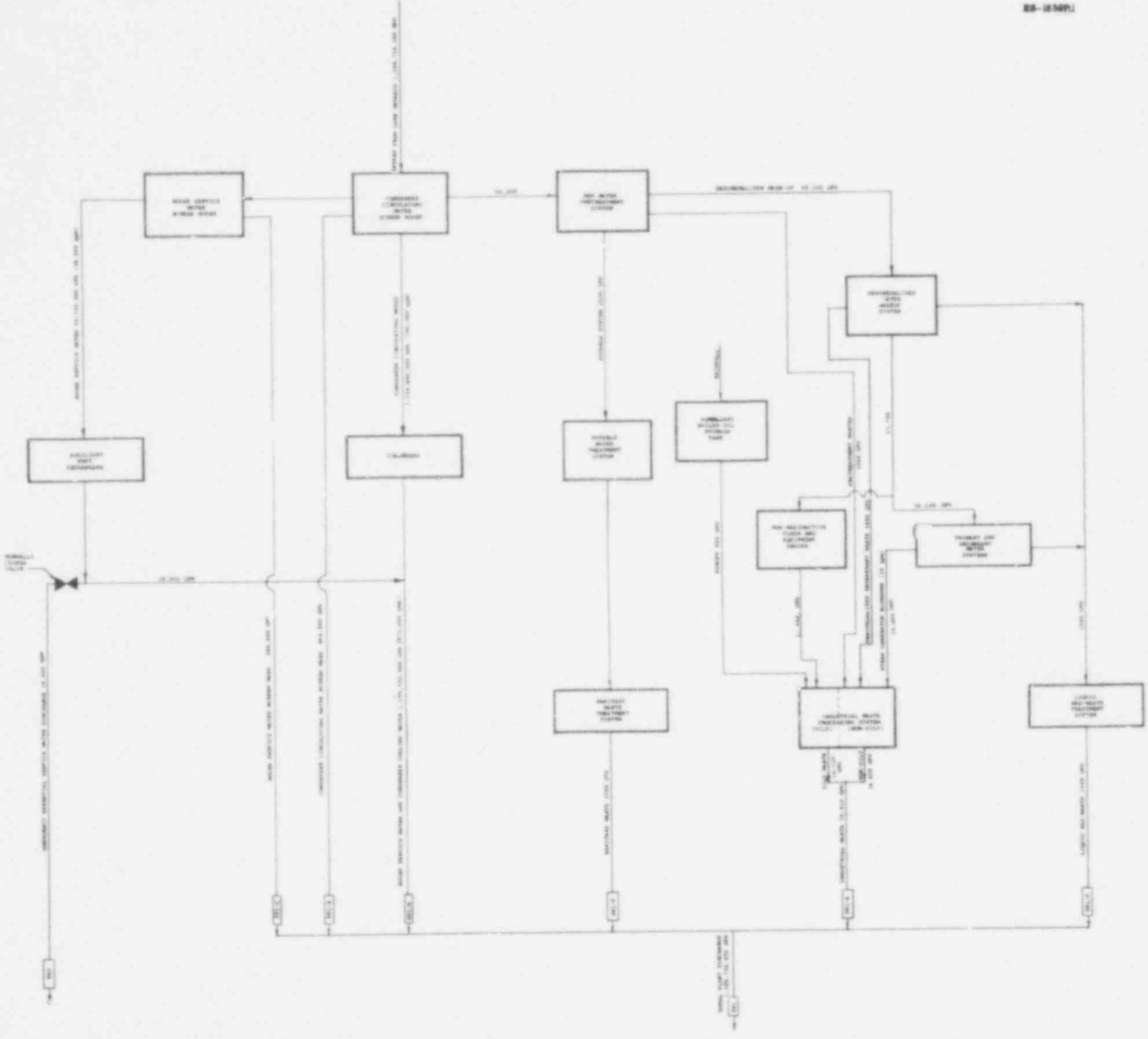


Fig. 3.4. Plant water use at full power. Source: ER, Fig. 3.3-1, Rev. 8.

POOR
ORIGINAL

POOR ORIGINAL

~~720 348~~

715 046

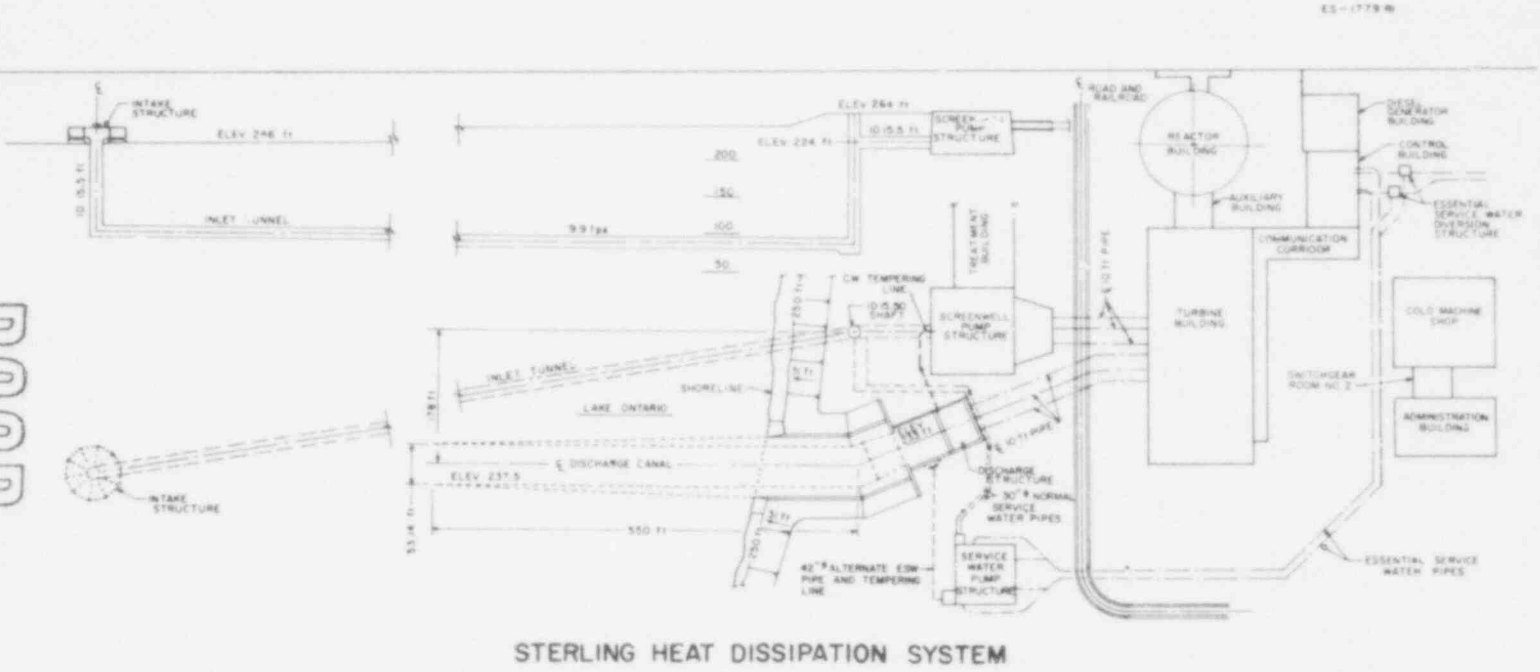


Fig. 3.5. Heat dissipation system. Source: ER, Fig. 3.4-3, Rev. 8.

Table 3.3. Estimated retention times – circulating water system

Location		Retention time[a]	
From	To	Seconds	Minutes
Intake structure	Screenwell pump structure	450	7.5
Screenwell pump structure	Center line circulating water pumps	140	2.3
Center line circulating water pumps	Condenser entrance	30	0.5
Condenser entrance[b]	Condenser exit	40	0.7
Condenser exit	Discharge structure	20	0.3
Discharge structure	Lake Ontario	40	0.7
Total		720	12

[a] Times based on a total flow of 1938 cfs.

[b] This includes 20 sec of residence time in the piping connecting the low-pressure and high-pressure condenser shells. There is a 10°F temperature rise in each shell.

Source: ER, Table 3.4-1.

Each circulating water pump is provided with two traveling screens to prevent entrainment of debris and nekton. The screens will have 3/8-in. openings (56% open area). The velocity through these open areas will be 3.1 fps at minimum lake level and 2.2 fps at average lake level. Screen wash sprays will be provided to remove impinged material. Normally, each screen will be washed for 15 min once an hour; but provision has been made for simultaneous washing of all screens in response to high water level differential across the screens. This wash water is directed to a 20-in.-wide concrete trough. Under maximum wash flow conditions, this trough will contain 8.4 in. of water flowing at a velocity of 4.8 fps. An 18-in. pipe carries the wash water 210 ft, terminating below the water surface of the discharge structure. The maximum velocity in this pipe will be 5 fps. The maximum retention time on the screens will be two hours. Since Rev. 8 to the ER was issued, the applicant has committed to the use of Ristroph-type[1] traveling screens. These screens use fish baskets and gentle screen wash sprays to reduce damage to impinged fish. The applicant will operate these screens so that the maximum retention time on the screens is 2 min and will provide a fish return to the lake.

To maintain optimum condenser efficiency and avoid icing, the applicant plans to maintain a 36°F temperature in the circulating water screenwell and pump structure by recirculation. Whenever the lake temperature drops below 40°F (mid-December to mid-April), the intake flow will be reduced and the deficit made up by recirculating some water from the discharge structure sealwell to the forebay of the circulating water screenwell and pump structure according to the schedule presented in Table 3.4. This will result in a lower discharge volume at higher temperatures. At a lake temperature of 32°F, the intake and discharge flows will be 1539 cfs, and the temperature increase will be 23.3°F.

Under non-accident conditions, 85 cfs service water is withdrawn through two 30-in.-ID pipes from the inlet tunnel riser. This water flows at 6.4 fps for about 500 ft to the service water pump structure. The design of this structure is illustrated in Fig. 3.8. There are four pumps, each with its own traveling screen. Cleaning of the screens by wash jets is initiated automatically whenever a high water level differential occurs across the screens. No regular cleaning schedule has been proposed. Debris and fish will be returned to a discharge canal by an unspecified system. Any two pumps can provide the ordinary service water requirement. After passing through the service heat exchangers, the water is discharged into the sealwell of the discharge structure.

In the event of an accident, an essential service water flow of 33.5 cfs will be needed to cool plant components required for safe shutdown. This water will ordinarily be supplied in the same manner as the normal service water. Any one pump can supply the essential service flow rate. In the event of damage to the primary intake system, provisions will be made to obtain emergency service water from the discharge structure plunge basin via a 42-in.-ID pipe. The plunge basin will connect directly with Lake Ontario, and the intake pipes will be placed to ensure 3.5-ft submergence at minimum still lake level. It will be provided with a cleanable trash rack. This pipe feeds into the service water pump structure forebay. After passing through the essential service heat exchangers, the heated water passes through two flow diversion structures located inland of the power block. These allow the heated water to be directed to the site drainage system which flows into Lake Ontario at a site remote from the discharge structure, thus preventing recirculation. If necessary, all or part of the heated water can be routed to the forebay of the service water pumphouse to prevent frazil ice formation.

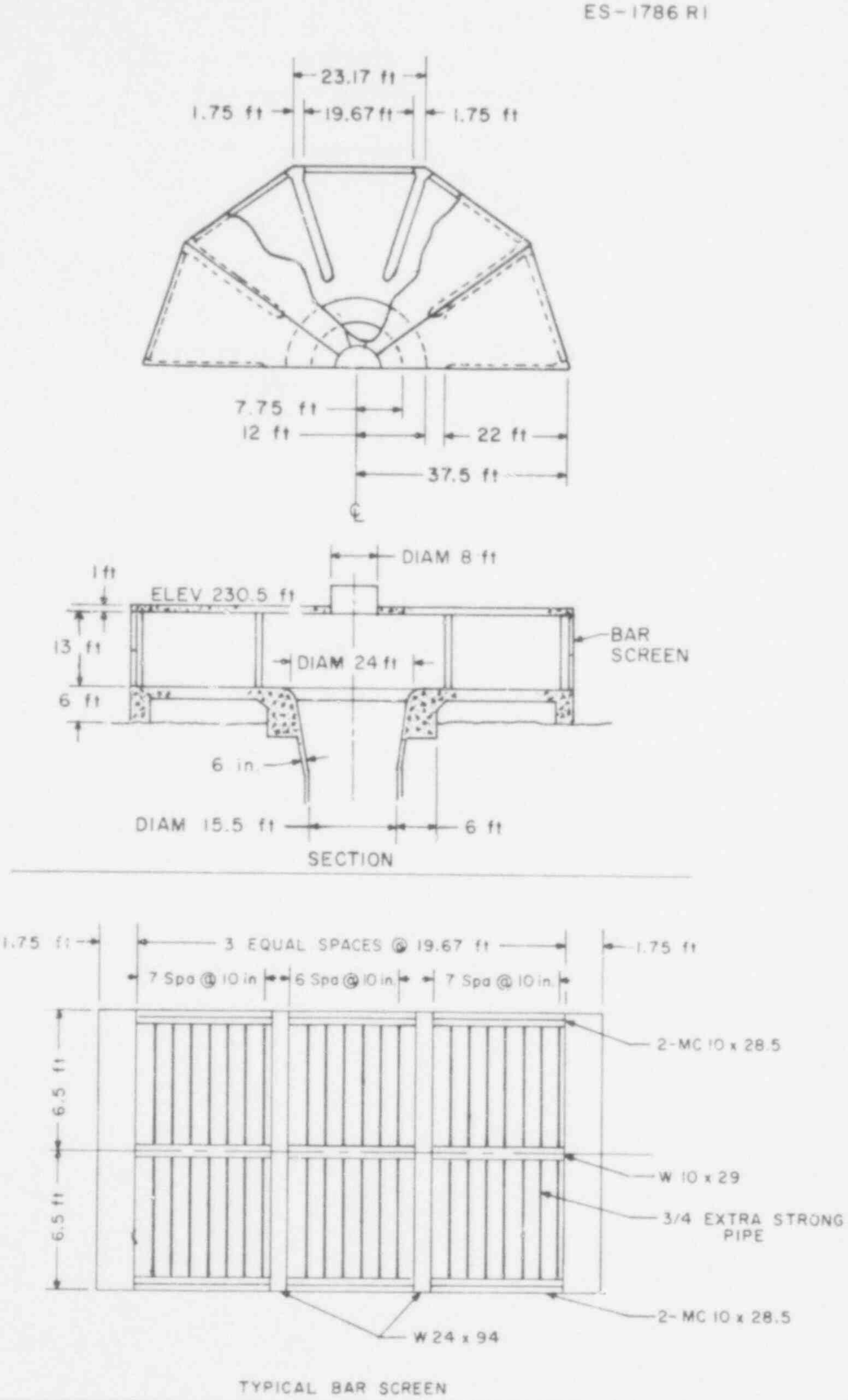


Fig. 3.6. Proposed intake structure. Source: ER, Fig. 3.4-3, Rev. 8.

720 350

715 048

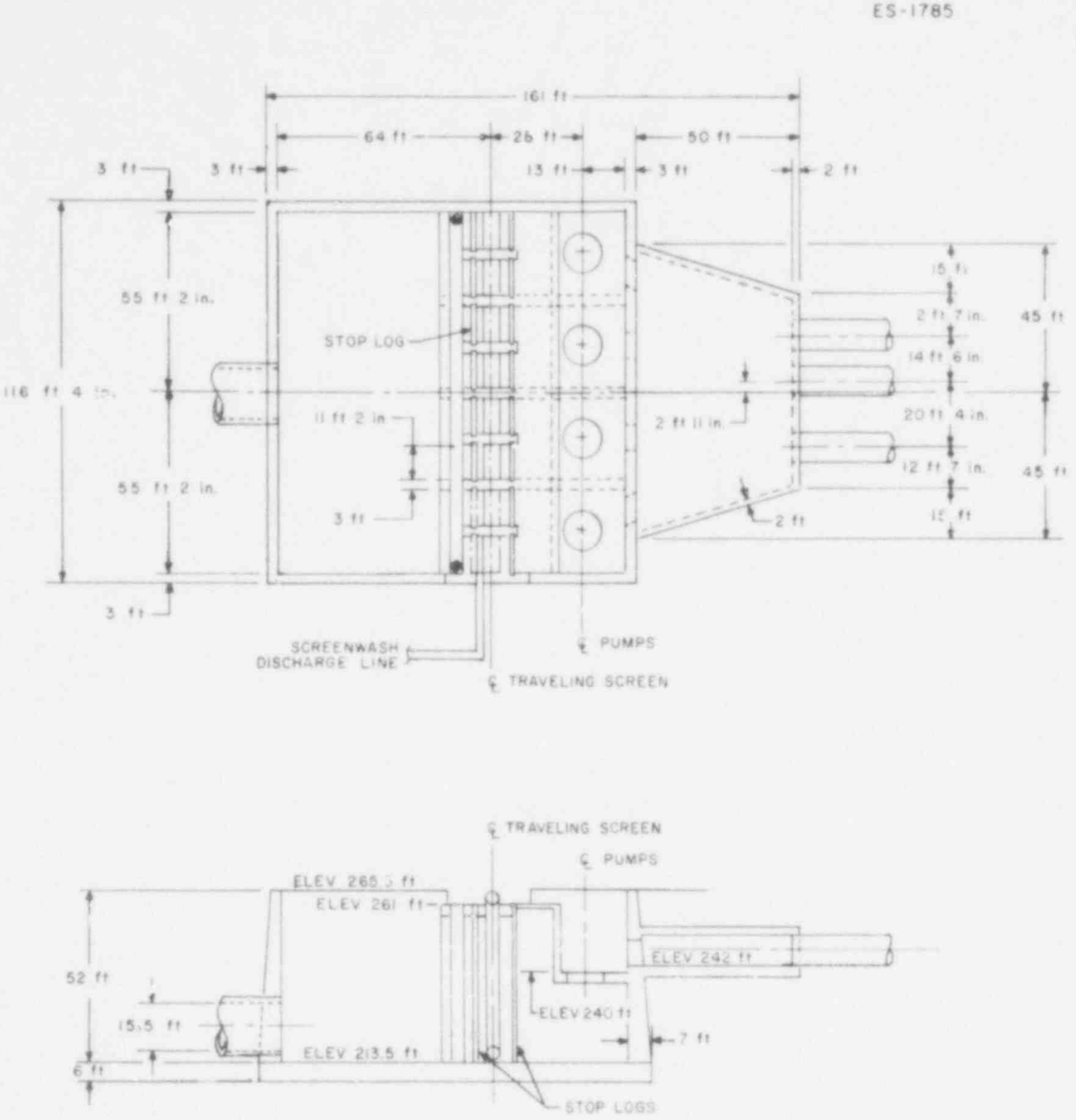


Fig. 3.7. Circulating water screenwell and pump structure. Source: ER, Fig. 3.4-3, Rev. 8.

3.4.3 Water discharge

Details of the discharge structure are shown in Fig. 3.9. Circulating and service water flow into a sealwell, over a weir into the plunge basin, and through a 180-ft straight open channel ending at the shoreline. The open channel has a trapezoidal cross section with a 53.14-ft base and one-to-one sides. Depending on the flow rate and lake level, the velocity in the canal will range from 1.5 to 15 fps. For design flow and the annual average lake level, the discharge velocity will be 3.7 fps. The upper surface of the canal base is at 237.5 ft MSL (USC & GS), and an extension of this depth will be dredged from the shoreline to the point where this depth occurs naturally, about 370 ft offshore.

715 049
720 351

Table 3.4. Proposed Sterling recirculation schedule

Intake temperature (°F)	Forebay temperature (°F)	Discharge temperature (°F)	Temperature rise (°F)	Discharge flow rate (cfs)	Percent recirculation
32	36	55.3	23.3	1539	17.2
33	37	56.3	23.3	1539	17.2
34	38	57.3	23.3	1539	17.2
35	39	58.3	23.3	1539	17.2
36	40	59.3	23.3	1539	17.2
37	40	59.3	22.3	1608	13.4
38	40	59.3	21.3	1683	9.4
39	40	59.3	20.3	1766	4.9
40	40	59.3	19.3	1858	0

Source: ER, Table 3.4-3, Rev. 8.

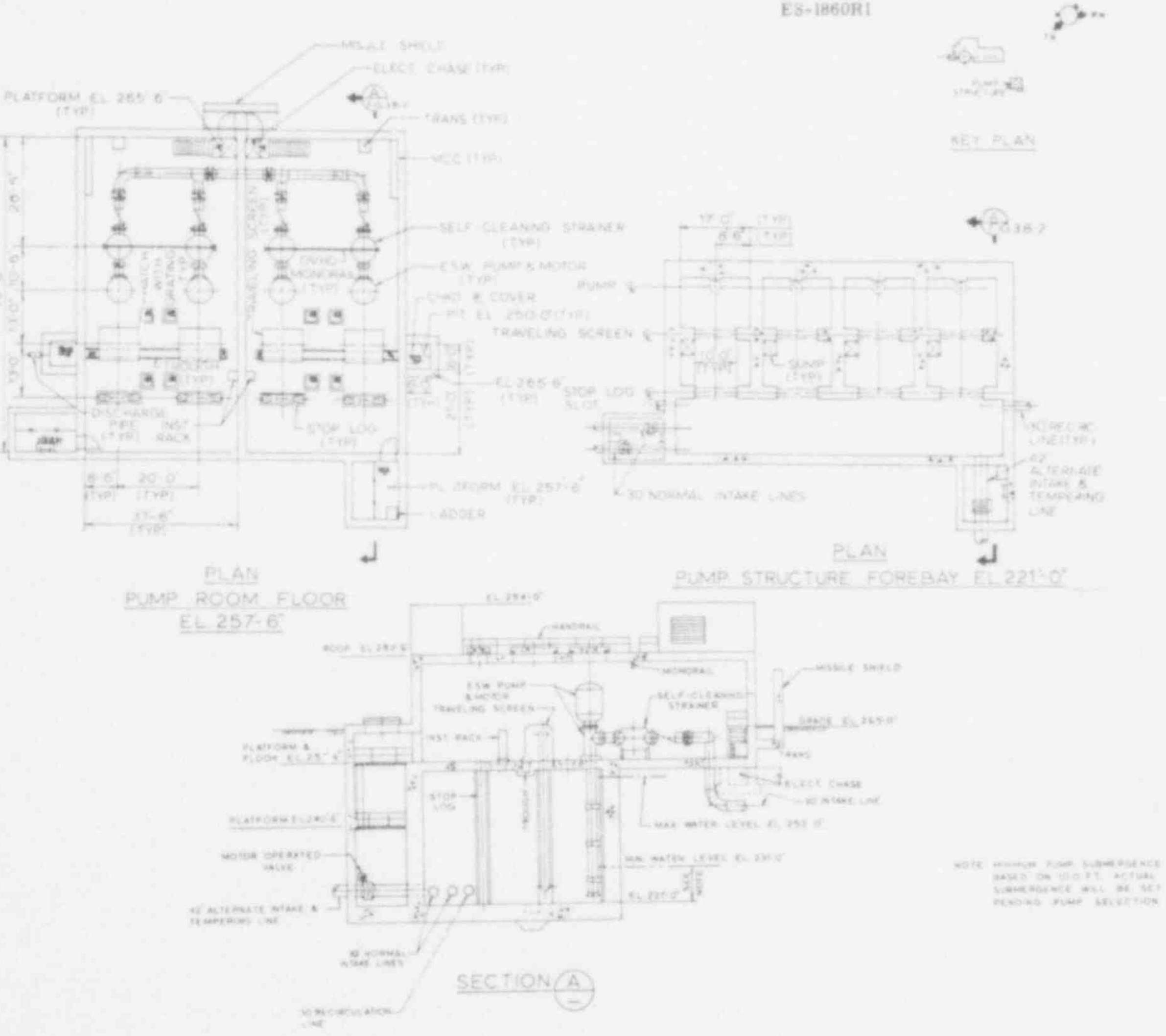


Fig. 3.8. Service water pump structure. Source: ER, Figs. 3.4-5, Rev. 6 and 3.4-6, Rev. 6.

POOR ORIGINAL

715 050

~~720 352~~

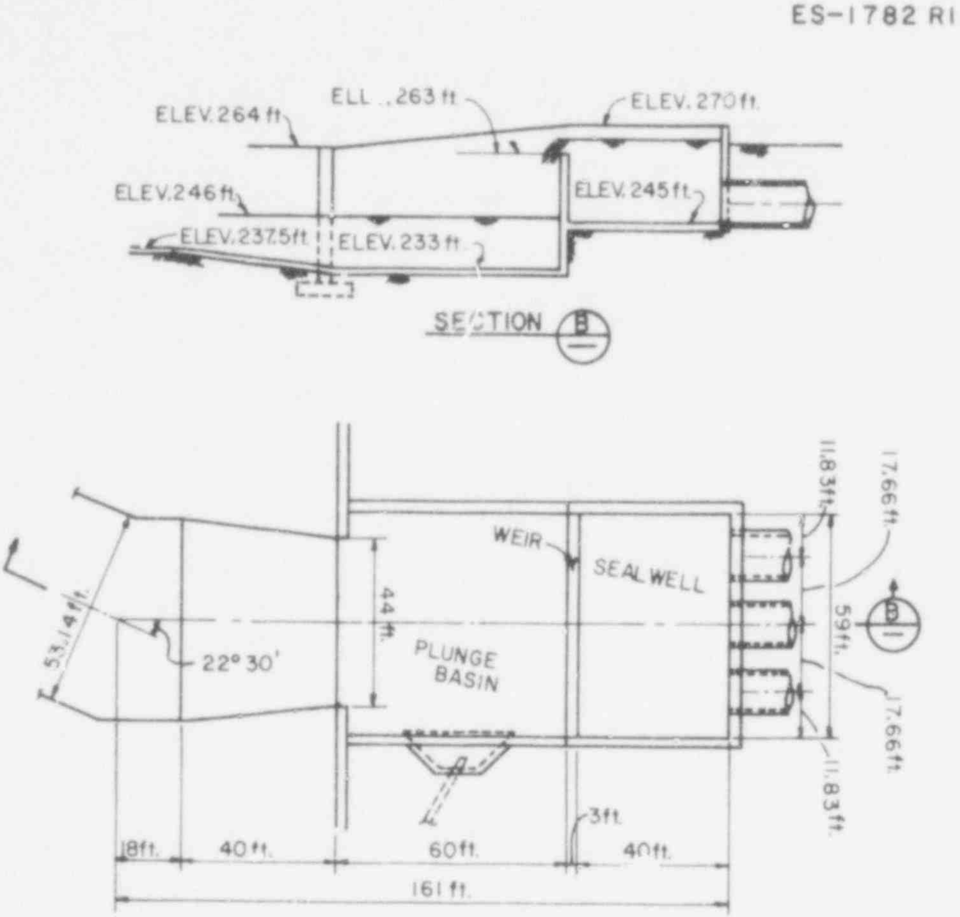


Fig. 3.9. Shoreline discharge structure. Source: ER, Fig. 3.4-3, Rev. 8.

3.5 RADIOACTIVE WASTE SYSTEMS

During the operation of Sterling Power Project Nuclear Unit No. 1, radioactive materials will be produced by fission and by neutron activation of corrosion products in the primary coolant. From the radioactive materials produced, small amounts of gaseous and liquid radioactive wastes will enter the waste streams. These streams will be processed and monitored for radioactivity within the plant to reduce the quantities of radionuclides ultimately released to the atmosphere and to Lake Ontario. The waste handling and treatment systems to be installed at the station are discussed in the SNUPPS Preliminary Safety Analysis Report dated June 21, 1974, and the applicant's Environmental Report dated October 29, 1974. These documents contain an analysis of the treatment systems and an estimate of the expected annual release of radioactive effluents.

In the following paragraphs, the radwaste treatment systems are described and an analysis is given based on the staff's model of the applicant's systems. The staff's model has been developed from a review of available data from operating nuclear power plants, adjusted to apply over a 30-year operating life. The coolant activities and flows used in this evaluation are based on experience and data from operating reactors. As a result, the parameters used and the subsequent calculated releases vary somewhat from those given in the applicant's evaluation. The liquid and gaseous source terms were calculated by means of the GALE Code as outlined in Draft Regulatory Guide 1.BB, *Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWRs)*.[2] The principal parameters used in the source term calculations are given in Table 3.5. The bases for these parameters are given in Draft Regulatory Guide 1.BB. In the Annex to Appendix I to 10 CFR Part 50, dated September 4, 1975, the applicant was provided an alternative to Section II.D of Appendix I. The applicant has chosen this alternative, and therefore, no cost-benefit analysis has been performed. Based on the following evaluation, the staff concludes that the liquid, gaseous, and solid radwaste treatment systems are acceptable and that the effluents meet as low as is reasonably achievable levels in accordance with 10 CFR Part 50.34a, Sections II.A, II.B, and II.C of Appendix I to 10 CFR Part 50, and the alternative to Section II.D of Appendix I as provided in the Annex to Appendix I.

Table 3.5. **Principal parameters and conditions used in calculating releases of radioactive material in liquid and gaseous effluent from Sterling Power Project**

Reactor power level, MWt	3565
Plant capacity factor	0.80
Failed fuel, %[a]	0.12
Primary system	
Mass of coolant, lb	5.17×10^5
Letdown rate to CVCS, gpm	75
Shim bleed rate, gpm	1.3
Leakage rate to secondary system, lb/day	100
Leakage rate to auxiliary building, lb/day	160
Leakage rate to containment building, lb/day	240
Secondary system	
Steam flow rate, lb/hr	1.51×10^7
Mass of steam/steam generator, lb	8.5×10^3
Mass of liquid/steam generator, lb	9.6×10^4
Secondary coolant mass, lb	2.13×10^6
Rate of steam leakage to turbine building, lb/hr	1.7×10^3
Steam generator blowdown rate, gpm	30
Containment building volume, ft^3	2.5×10^6
Frequency of containment purges per year	4
Iodine partition factors, gas/liquid	
Leakage to containment building	1%/day primary coolant noble gas inventory; 0.001%/day primary coolant iodine inventory
Leakage to auxiliary building	0.0075
Steam leakage to turbine building	1
Steam generator, carryover	0.01
Main condenser air ejector	0.0005

Decontamination factors (liquids)

System	I	Cs,Rb	Others
Boron recovery	10^5	2×10^3	10^4
High-conductivity waste treatment	10^3	2×10^4	10^4
Low-conductivity waste treatment	10^3	10^4	10^3
Steam generator blowdown treatment	10^3	10^2	10^3

	All nuclides except iodine	Iodine
Waste evaporator DF	10^4	10^3
BRS evaporator DF	10^3	10^2

	Cation[b]	Anion[b]	Cs,Rb
Mixed-bed demineralizer DF (H^+OH^-)[c,d]	10^2 (10)	10^2 (10)	2(10)
Mixed-bed demineralizer DF ($LiBO_3$)[e]	10	10	2

	Removal factor
Removal by plateout	
Mo, Tc	10^2
Y	10^2

---

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

[b] Does not include Cs, Mo, Y, Rb, Tc.

[c] Applies to all mixed-bed demineralizers except the chemical and volume control system (CVCS) letdown demineralizer.

[d] For two demineralizers in series, or for a polishing demineralizer, the DF for the second demineralizer is given in parentheses.

[e] CVCS letdown demineralizer.

715 052

~~720 354~~

POOR ORIGINAL

3.5.1 Liquid wastes

The liquid radioactive waste will be processed on a batch basis to permit optimum control of releases. Prior to being released, samples will be analyzed to determine the types and amounts of radioactive material present. Based on the results of the analysis, the waste will be released under controlled conditions to Lake Ontario or retained for further processing. Radiation monitors will automatically terminate liquid waste discharges if radiation measurements exceed a predetermined level in the discharge line. Simplified diagrams of the liquid radioactive waste treatment systems are shown in Fig. 3.10.

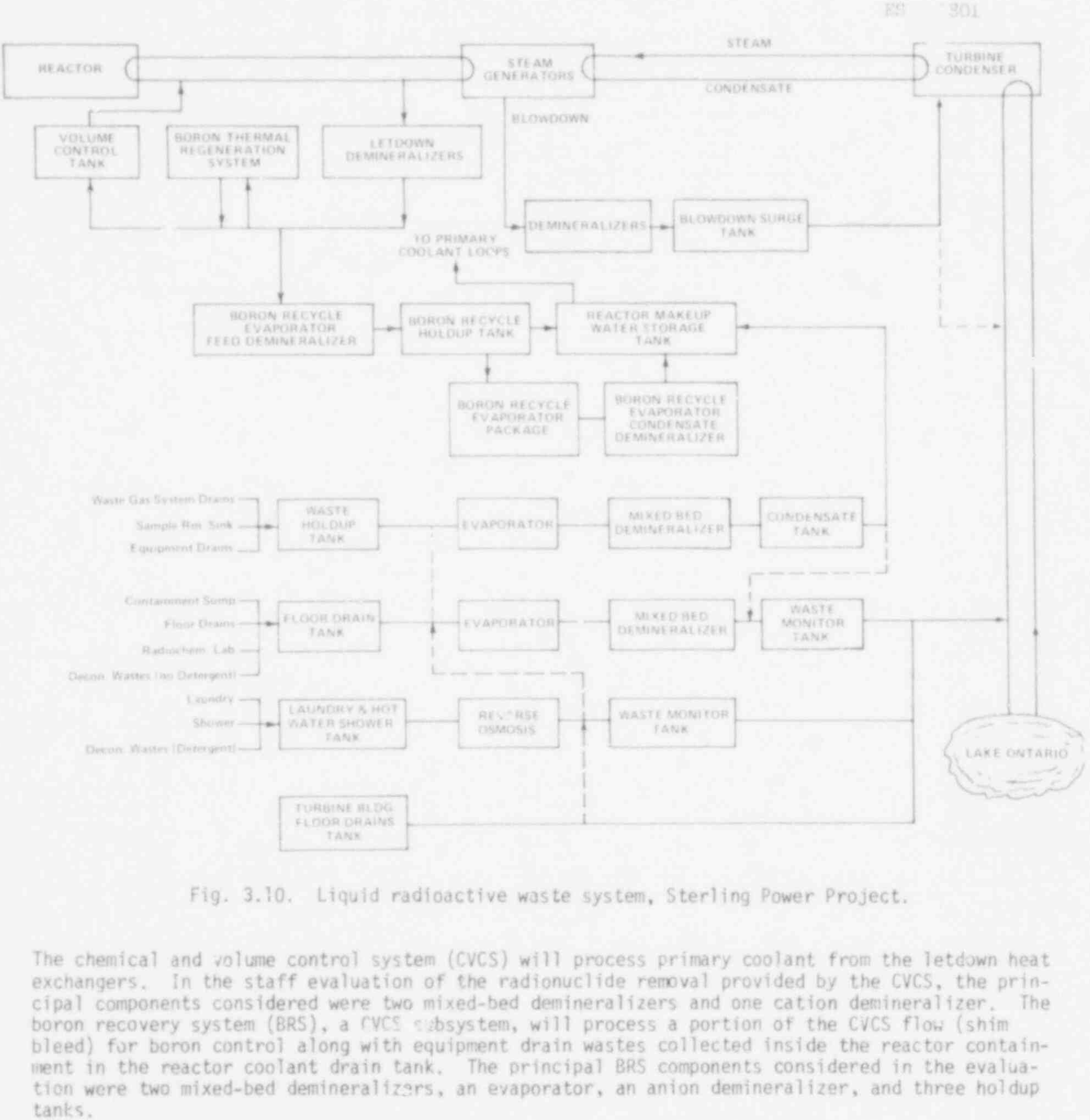


Fig. 3.10. Liquid radioactive waste system, Sterling Power Project.

The chemical and volume control system (CVCS) will process primary coolant from the letdown heat exchangers. In the staff evaluation of the radionuclide removal provided by the CVCS, the principal components considered were two mixed-bed demineralizers and one cation demineralizer. The boron recovery system (BRS), a CVCS subsystem, will process a portion of the CVCS flow (shim bleed) for boron control along with equipment drain wastes collected inside the reactor containment in the reactor coolant drain tank. The principal BRS components considered in the evaluation were two mixed-bed demineralizers, an evaporator, an anion demineralizer, and three holdup tanks.

Miscellaneous radioactive wastes collected outside the reactor containment will be processed through the liquid waste processing system (LWPS). The LWPS will segregate and process wastes according to their chemical makeup. High-conductivity wastes will be processed through a subsystem consisting of a floor drain tank, a charcoal absorber (for removal of organics), a mixed-bed demineralizer, an evaporator, and a waste monitoring tank. Low-conductivity wastes will be processed through a subsystem consisting of a waste holdup tank, an evaporator, a mixed-bed demineralizer, and an evaporator condensate tank. Turbine building floor drain wastes will be monitored and discharged to Lake Ontario without treatment if radioactive effluent content is below a predetermined level. If necessary, the waste will be diverted to the LWPS for processing.

Steam generator blowdown wastes will normally be processed through mixed-bed demineralizers and recycled to the condenser. Detergent (laundry and decontamination) wastes will be processed through a waste treatment system which includes a holdup tank, a reverse osmosis unit, and a waste monitoring tank. The following paragraphs contain the staff's evaluation of the liquid waste system and the calculated liquid source term.

3.5.1.1 Chemical and volume control system (CVCS)

A letdown stream of approximately 75 gpm of primary coolant will be removed from the reactor coolant system for processing through the CVCS. The letdown stream will be cooled through the letdown heat exchangers, reduced in pressure, filtered, and processed through one of two mixed-bed demineralizers in the Li_3BO_3 form. A cation demineralizer will be valved into the process stream when further purification is required. The processed letdown stream will be collected in the volume control tank and reused in the plant. In the staff's evaluation of the purification provided by this portion of the CVCS, an input flow of 75 gpm at primary coolant activity was assumed, and the decontamination factors listed in Table 3.5 for the CVCS mixed-bed demineralizer were applied. The staff also assumed that 10% of the letdown stream will pass through the cation demineralizer.

The CVCS will be used to control the primary coolant boron concentration by passing a portion of the letdown stream through the boron thermal regeneration system and by diverting a portion of the treated letdown system to the BRS as shim bleed. In the boron thermal regeneration system, boron will be either adsorbed from or desorbed into the letdown stream depending upon the stream temperature. Since the thermal regeneration demineralizer resins will desorb as well as adsorb radioactive materials, the thermal regeneration system was not considered for radionuclide removal. However, use of the thermal regeneration system will reduce the quantity of liquid waste generated to maintain boron control. Approximately 1.7% of the purified letdown flow will be processed through the BRS for boron control. The staff estimated the BRS input from the CVCS letdown stream to be 1840 gpd at approximately 1.0 primary coolant activity (PCA). Primary coolant grade water from equipment drains, equipment leakoffs, and from relief valves inside containment will be collected in the 350-gal reactor coolant drain tank. The staff estimated the BRS input from the reactor coolant drain tank to be approximately 300 gpd at PCA. The 1840-gpd shim bleed and 300-gpd reactor and equipment drain tank wastes will be collected in one of two 56,000-gal recycle holdup tanks. The staff applied the decontamination factors listed in Table 3.5 for the preholdup mixed-bed demineralizer to the streams entering the recycle holdup tanks. The decay time provided by the holdup tanks was calculated to be approximately 20 days based on 2140-gpd input flow filling one tank to 80% capacity while the second tank is being processed. Liquid collected in the recycle holdup tanks will be processed batchwise through a 15-gpm evaporator. The concentrated bottoms will be either pumped to the boric acid makeup tank for reuse in the plant or to the solid waste management system (SWMS) for disposal. In its evaluation, the staff considered the concentrated evaporator bottoms to be processed through the solid waste system. The evaporator condensate will be processed through an anion demineralizer to remove radionuclides entrained in moisture carryover; the condensate will then be either collected in the reactor makeup water storage tank for reuse in the plant or diverted to the waste recycle tanks in the LWPS for sampling and discharge. In its evaluation, the staff used the decontamination factors in Table 3.5 for the BRS evaporator and BRS condensate demineralizer. The staff calculated the holdup time due to processing to be .1 days on the basis of processing the contents of one recycle tank filled to 80% capacity through the BRS evaporator at 15 gpm. The staff assumed that 90% of the evaporator condensate will be recycled for reuse in the plant while 10% will be discharged for tritium control and for maintenance of the plant water balance. The applicant assumed total recycle of the BRS stream in his evaluation.

3.5.1.2 Liquid waste processing system (LWPS)

Low-conductivity wastes, primarily from equipment drains outside the reactor containment, will be collected in a 10,000-gal waste holdup tank, processed through a 35-gpm evaporator and mixed-bed demineralizer, and collected and monitored in a 5000-gal evaporator condensate tank. Finally, these wastes will be either pumped to the reactor makeup water storage tank for reuse, recycled to the recycle or waste holdup tanks for reprocessing, or pumped to the waste monitoring tank for monitoring and release to Lake Ontario. On the basis of information submitted by the applicant and the staff's parameters for liquid waste volumes and activities,[3] the total flow in this system was estimated to be 200 gpd at 1 PCA. The staff calculated the collection time in the waste holdup tank to be 20 days on the basis of filling the holdup tank (10,000 gal) to 80% capacity at 200 gpd. Because there is only a single holdup tank and the contents of the tank may be processed while the tank is being filled, only 50% of filling time was used in calculating the holdup time. The staff calculated the system processing time to be 0.08 day on the basis of the evaporator design flow rate of 35 gpm. High-conductivity wastes, primarily from floor drains, nondetergent decontamination operations, and radiochemistry lab drains will be collected in a 10,000-gal floor drain tank, sampled to determine the degree of processing required, processed as necessary through a mixed-bed demineralizer, an evaporator, or both, collected and monitored in a 5000-gal waste monitoring tank and released to Lake Ontario. If the amount of radioactive material is above a predetermined level, the waste will be recycled for additional treatment.

In calculating releases from the LWPS, the staff assumed that all waste is processed once through the evaporator and demineralizer before release. On the basis of information submitted by the applicant and the staff's parameters for liquid waste volumes and activities,[2] the total flow in the system was estimated to be 1340 gpd at 0.051 PCA. The staff calculated the collection time in the floor drain tank to be [illegible] days on the basis of 50% of the time being needed to fill the single floor drain tank to 80% capacity at 1340 gpd. The system processing time was calculated to be 0.08 day on the basis of the evaporator design flow rate of 35 gpm. In both systems the evaporator bottoms and demineralizer resins will be disposed of as solid waste. There will be no regeneration of demineralizer resins.

The applicant proposes to recycle all the clean wastes to the primary system. In the staff's evaluation, 10% of the clean wastes and 100% of the dirty wastes are assumed to be discharged. On the basis of this information and the parameters given in Table 3.5, the calculated releases from the LWPS were approximately 0.19 Ci/year/reactor, excluding tritium and dissolved gases. In the applicant's evaluation, calculated LWPS releases were 0.004 Ci/year/reactor. The difference between the staff's calculated releases and those of the applicant are due primarily to differences in estimates of short-lived fission product release. The applicant estimated, on the basis of lower estimates of input volumes to the LWPS, a holdup time of about 30 days whereas the staff calculated a holdup time of 3 days.

3.5.1.3 Turbine building floor drains and detergent wastes

Wastes collected by the turbine building floor drain system contain radioactive materials resulting from secondary system leakage. The applicant has indicated that these wastes will not be treated prior to discharge. On the basis of the staff assumption of a 5-gpm leak rate at main steam activity (0.001 secondary coolant concentration), a release of approximately 0.002 Ci/year/reactor, excluding tritium, was calculated from this source. Detergent wastes generated from laundry and decontamination operations will normally be released to the circulating water discharge. If the amount of radioactive material is above a predetermined level, the wastes will be processed through a reverse osmosis unit; and if further treatment is required, it will be processed through the LWPS. In the staff's calculations, all waste was assumed to be processed through the reverse osmosis unit only prior to release. On the basis of the assumption of 450 gpd of detergent waste and a decontamination factor of 30 for the reverse osmosis unit, the staff calculated a release of 0.002 Ci/year/reactor, excluding tritium, from this source.

3.5.1.4 Steam generator blowdown

Blowdown from the steam generators will normally be processed through two mixed-bed demineralizers and returned to the condenser. There will be provisions to discharge the blowdown to the environment without processing. However, if the amount of radioactive effluent in the material being released to the environment exceeds a predetermined level, flow will be automatically diverted by one of two radiation monitor controlled valves for processing through the mixed-bed demineralizers prior to release. In the staff evaluation, the blowdown rate was assumed to be approximately [illegible] gpm at secondary coolant activity, and 1% of this flow was assumed to be released to the environment after processing. On the basis of these assumptions, the staff estimates negligible releases, excluding tritium, from this source.

3.5.1.5 Secondary liquid waste system

The secondary liquid waste system (SLWS) is designed to process the regenerant solutions from the condensate cleanup system. The condensate demineralizer regeneration wastes will be processed (whenever the radioactivity is above a predetermined level) by the SLWS. The SLWS will consist of a 30-gpm evaporator, a 100-gpm mixed-bed demineralizer, a charcoal bed, an oil interceptor, a filter, and the necessary tanks and pumps. There will be no releases to the environment from this system since the effluent will be recycled back to the secondary system, and evaporator bottoms will be solidified.

3.5.1.6 Liquid waste summary

Based on the staff evaluation of the liquid waste systems, the releases of radioactive materials in liquid wastes were calculated to be approximately 0.19 Ci/year/reactor, excluding tritium and dissolved gases (see Table 3.6). The tritium release was calculated to be approximately 410 Ci/year. The applicant estimated the liquid releases to be approximately 0.10 Ci/year/reactor. excluding tritium and dissolved gases, and 120 Ci/year/reactor for tritium.

Table 3.6 Sterling Power Project liquid source term (Ci/year/reactor)

Nuclide	Release	Nuclide	Release
Cr-51	0.00012	Te-131m	0.00004
Mn-54	0.00006	I-131	0.11
Fe-55	0.00012	Te-132	0.00093
Fe-59	0.00007	I-132	0.0016
Co-58	0.0012	I-133	0.04
Co-60	0.00043	Cs-134	0.01
Np-239	0.00004	I-135	0.003
Rb-86	0.00002	Cs-136	0.003
Sr-89	0.00002	Cs-137	0.0078
Mo-99	0.0027	Ba-137m	0.0066
Tc-99m	0.0025	Ba-140	0.00001
Te-127m	0.00002	La-140	0.00001
Te-127	0.0000[illegible]	All others	0.00006
Te-129m	0.00008	Total (except H-3)	0.19
Te-129	0.00006		
I-130	0.00001	H-3	410

Based on the staff's evaluation, the radioactivity in liquid effluents from Unit 1 will not result in whole body doses greater than 3 mrem/year or critical organ doses greater than 10 mrem/year in accordance with Section II.A of Appendix I to 10 CFR Part 50. Also, the radioactivity in the liquid effluents, exclusive of tritium and noble gases, will be less than 5 Ci/year, and the whole body and critical organ doses will be less than 5 mrem/year from the site, in accordance with the alternative to Section II.D of Appendix I as provided in the Annex to Appendix I. The staff concludes that the liquid radwaste treatment system will reduce liquid radioactive effluents to as low as practicable levels in accordance with 10 CFR Part 50.34a, Appendix I to 10 CFR Part 50, and the Annex to Appendix I to 10 CFR Part 50.

3.5.2 Gaseous waste

The principal source of gaseous radioactive wastes will be gases stripped from the primary coolant in the BRS. Additional sources of gaseous wastes will be main condenser air removal system off-gases, ventilation exhausts from the auxiliary fuel and radioactive waste buildings, and gases collected in the reactor containment building. The principal system for treating gaseous wastes will be the gaseous waste processing system (GWPS). The GWPS will collect and store gases stripped from the primary coolant and gases vented from tanks and systems containing radioactive fission gases. The GWPS will consist of two compressors, two catalytic recombiners, and eight gas decay tanks. Ventilation air from the fuel, auxiliary, and radioactive waste buildings and offgases from the main condenser air ejectors will be processed through charcoal adsorbers prior to release. The reactor containment atmosphere will be recirculated through HEPA filters and charcoal adsorbers prior to release. Ventilation air from the turbine building will be released without treatment.

715 056

~~720 358~~

Ventilation air from the containment, auxiliary, and fuel buildings and gaseous wastes from the condenser air removal system will be exhausted through the unit vent atop the containment building. Ventilation air from the radioactive waste and turbine buildings will be exhausted through the radioactive waste and turbine building roof vents, respectively. The gaseous waste and ventilation treatment systems are shown schematically in Fig. 3.11.

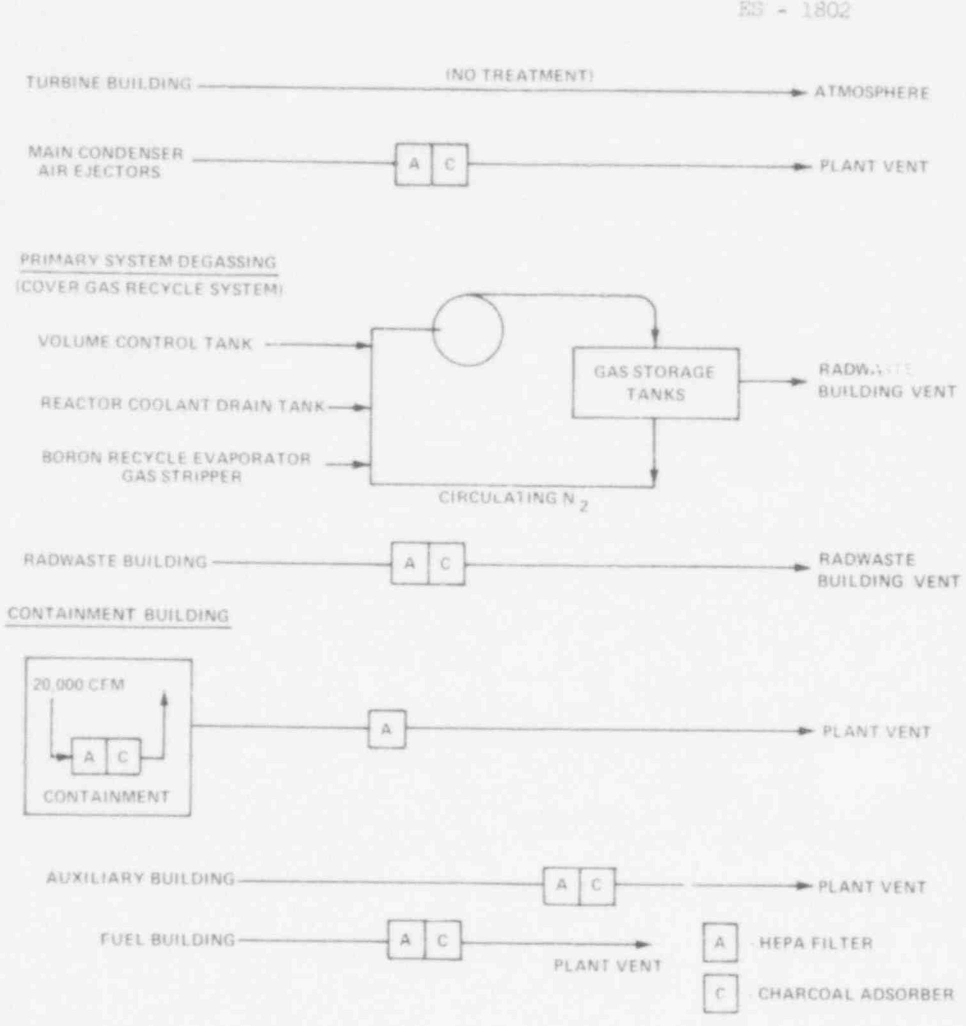


Fig. 3.11. Gaseous radioactive waste system, Sterling Power Project.

3.5.2.1 Gaseous waste processing system (GWPS)

The GWPS will be designed to collect and process gases stripped from the primary coolant along with cover gases from miscellaneous tanks. Gaseous inputs will include a continuous 0.7-scfm hydrogen purge of the CVCS volume control tank and smaller quantities of radioactive gas from the boron recycle evaporator, reactor coolant drain tank, and the recycle holdup tanks. Input gases will be processed in a closed loop containing two waste gas compressors, two catalytic hydrogen recombiners, and eight 600-ft^3 gas decay tanks (six for normal operation and two for startup and shutdown). The system will be designed for continuous release of radioactive gases; however, the staff evaluation assumed that the radioactive gases will be released to the atmosphere after a 90-day holdup in the system. On this basis, the staff calculated the GWPS releases to be approximately 260 Ci/year/reactor for noble gases, less than 10^{-4} Ci/year/reactor for iodine-131, 0.0003 Ci/year/reactor for particulates, and 8 Ci/year/reactor for carbon-14.

3.5.2.2 Containment ventilation system

Radioactive gases will be released inside the reactor containment when primary system components are opened or when leakage occurs from the primary system. The gaseous activity will be sealed within the containment during normal operation but will be released during containment purges. The staff assumed that the containment will be purged 24 times/year. Prior to purging the containment, the containment atmosphere will be recirculated through the containment atmospheric control system (CACS) at about 20,000 cfm. The CACS will consist of two parallel trains, each containing HEPA filters and activated charcoal adsorbers. Purge effluent will be released from the plant vent after passing through HEPA filters and being monitored for radioactivity. The staff calculated the containment airborne activity on the basis of 240 lb of primary coolant leakage per day to the containment and a partition factor for radioiodine as outlined in Table 3.5. On this basis, the staff calculated releases from the containment to be approximately 1800 Ci/year/reactor for noble gases, 0.0032 Ci/year for iodine-131, 1 Ci/year/reactor of carbon-14, 25 Ci/year/reactor of argon-41, and 0.00003 Ci/year/reactor of particulates.

3.5.2.3 Ventilation systems for other buildings

Radioactive material will be introduced into the plant atmosphere due to leakage from equipment processing or holding radioactive materials. Ventilation air from the auxiliary and fuel buildings will be processed through HEPA filters and charcoal adsorbers, monitored for radioactive effluent, and released through the plant vent. Ventilation air from the radioactive waste building will be processed in the same manner and released through the radioactive waste building roof vent. Ventilation air from the turbine building will be monitored for radioactive effluent and released without treatment.

The staff estimated that 160 lb of primary coolant per day will leak to the auxiliary and radioactive waste buildings, with a partition factor of 0.0075 for radioiodine. On this basis, the staff calculated the auxiliary and radioactive waste building releases to be approximately 130 Ci/year/reactor for noble gases and 0.0045 Ci/year/reactor for iodine-131, 0.0016 Ci/year/reactor for particulates, and 1000 Ci/year/reactor for tritium. The applicant calculated the auxiliary and radioactive waste building releases to be approximately 1350 Ci/year/reactor for noble gases and 0.0077 Ci/year/reactor for iodine-131. The difference between the staff's estimate of the release of noble gases and that of the applicant is due principally to the applicant's assumption that the noble gases in the GWPS will be continually recycled and that 100 scf per year will leak from the GWPS into the radioactive waste building.

The staff estimated that 1700 lb of steam per hour will leak to the turbine building atmosphere, and all noble gases and radioiodine released with the steam will remain airborne. On this basis, the turbine building vent release was calculated to be less than 1 Ci/year/reactor for noble gases and 0.00052 Ci/year/reactor for iodine-131. The applicant calculated the turbine building releases to be negligible for noble gases and 0.015 Ci/year for iodine-131.

3.5.2.4 Steam releases to the atmosphere

The turbine bypass capacity to the condenser will be approximately 40%. The staff's analysis indicates that steam releases to the environment due to turbine trips and low-power physics testing will have a negligible effect on our calculated source terms.

3.5.2.5 Main condenser offgas releases

Offgas from the main condenser air ejectors will contain radioactive gases resulting from primary to secondary system leakage. Iodine will be partitioned between the steam and water in the steam generators and between the condensing and noncondensing phases in the main condenser. Main condenser offgas will be processed through a charcoal adsorber prior to release. The staff considered 110 lb of primary to secondary system leakage per day, partition factors for radioiodine of 0.01 and 0.0005 in the steam generator and main condenser, respectively, and an iodine decontamination factor of 10 for the charcoal adsorber on the offgas line. On this basis, the main condenser offgas releases were calculated to be approximately 80 Ci/year/reactor for noble gases and 0.0028 Ci/year/reactor for iodine-131. The applicant calculated the releases from the main condenser to be approximately 155 Ci/year/reactor for noble gases and 0.004 Ci/year/reactor for iodine-131.

3.5.2.6 Gaseous waste summary

Based on the parameters given in Table 3.5, the staff calculates the total radioactive gaseous releases to be approximately 2300 Ci/year/reactor of noble gases, 0.011 Ci/year/reactor of iodine-131, 9 Ci/year/reactor of carbon-14, 1000 Ci/year/reactor of tritium, 25 Ci/year/reactor of argon-41, and 0.002 Ci/year/reactor of particulates. The principal sources and isotopic distributions are given in Table 3.7. The applicant has calculated an overall release of approximately 3000 Ci/year/reactor of noble gases, 0.03 Ci/year/reactor of iodine-131, and negligible amounts of carbon-14, argon-41, particulates, and tritium.

Based on the staff's evaluation, the radioactivity in gaseous effluents from Unit 1 will not result in a whole body dose greater than 10 mrads/year for gamma radiation, 20 mrads/year for beta radiation, or 15 mrem/year for radioiodine and radioactive particulates in accordance with Sections II.B and II.C of Appendix I to 10 CFR Part 50. Also, the effluents from the site wil not result in an annual gamma air dose greater than 1 Ci/reactor, or a dose from radioiodine and radioactive particulates released greater than 15 mrem, in accordance with the alternative to Section II.D of Appendix I as provided in the Annex to Appendix I. The staff concludes that the gaseous radwaste treatment system will reduce gaseous radioactive effluents to as low as practicable levels in accordance with 10 CFR Part 50.34a, Appendix I to 10 CFR Part 50, and the Annex to Appendix I to 10 CFR Part 50.

Table 3.7. Sterling Power Project gaseous source term (Ci/year/reactor)

	Waste gas processing system	Building ventilation		Turbine building	Air ejector	Total
		Containment	Auxiliary			
Kr-83m	[a]	[a]	[a]	[a]	[a]	[a]
Kr-85m	[a]	2	2	[a]	[a]	5
Kr-85	250	5	[a]	[a]	[a]	260
Kr-87	[a]	[a]	1	[a]	[a]	1
Kr-88	[a]	2	4	[a]	3	9
Kr-89	[a]	[a]	[a]	[a]	[a]	[a]
Xe-131m	3	9	[a]	[a]	[a]	12
Xe-133m	[a]	19	2	[a]	1	22
Xe-133	1	1800	110	[a]	69	2000
Xe-135m	[a]	[a]	[a]	[a]	[a]	[a]
Xe-135	[a]	10	7	[a]	4	21
Xe-137	[a]	[a]	[a]	[a]	[a]	[a]
Xe-138	[a]	[a]	1	[a]	[a]	7
I-131	[a]	0.0032		0.00052	0.0028	0.011
I-133	[a]	0.003	0.01	0.00069	0.004	0.014

[a] Less than 1 Ci/year noble gases; less than 10^{-4} Ci/year iodines.

3.5.3 Solid wastes

The solid waste management system (SWMS) will be designed to process two general types of solid wastes — "wet" wastes that require solidification and packaging and "dry" solid wastes that require packaging only. Wet solid wastes will consist mainly of spent filter cartridges, demineralizer resins, and evaporator and reverse osmosis unit concentrates, and they will contain radioactive materials removed from liquid streams during processing. Dry solid wastes will consist mainly of low-activity ventilation air filters, contaminated clothing, paper, and miscellaneous items such as laboratory glassware and tools. Miscellaneous solid wastes, such as irradiated primary system components, will be handled case by case on the basis of their size and activity. The principal sources of spent demineralizer resins will be four 30-ft^3 CVCS evaporator condensate demineralizers, two 30-ft^3 LWPS demineralizers, and four 75-ft^3 steam generator blowdown (SGB) demineralizers. Spent resins from these demineralizers will be collected in the 4000-gal SGB spent resin storage tank and the 2600-gal LWPS spent resin storage tank, sluiced to a solidification holdup tank for dewatering, mixed with a solidification agent and catalyst, and solidified in 55-gal drums.

Concentrated wastes from the two 35-gpm LWPS evaporators, the 15-gpm CVCS boric acid evaporator, and the 30-gpm secondary liquid waste evaporator will be pumped from their respective concentrate holdup tanks to the 500-gal or 2500-gal solidification holdup tank. Concentrates from the solidification holdup tank and solidification agent will be pumped simultaneously to the shipping containers for solidification. Catalysts will be added in the shipping container.

715 059 720 361

On the basis of evaluations of PWRs with similar liquid waste systems, the staff has determined that approximately 15,400 ft^3 of wet solid wastes will be generated annually per reactor; the staff has estimated these to contain approximately 2500 Ci of radioactive elements per reactor, principally Cs-137 and Cs-134. The applicant estimates the wet solid wastes shipped offsite per reactor to be approximately 13,900 ft^3 per year containing 9500 Ci of activity.

Dry solid wastes will be packaged in 55-gal drums. Compressible wastes (e.g., clothing and contaminated rags), will be compressed using a hydraulic baler. The staff estimates the dry solid wastes per reactor to be approximately 450 drums per year containing a total of 5 Ci. The applicant's estimates are essentially the same.

On the basis of the evaluation of the solid waste system, the staff concludes that the system design will accommodate the wastes expected during normal operations, including anticipated operational occurrences in accordance with existing NRC Regulations. The wastes will be packaged and shipped to a licensed burial site in accordance with NRC and Department of Transportation Regulations. On the basis of these findings, the staff concludes that the solid waste system is acceptable.

3.6 CHEMICAL AND BIOCIDAL EFFLUENTS

The operation of the Sterling Power Project will result in some chemical wastes as indicated in Table 3.8. These will be dispersed in the condenser cooling water and will enter Lake Ontario when the cooling water leaves the discharge canal. The information in Table 3.9 is provided to put the relative magnitude of such discharges in perspective by giving the concentration ranges of some chemicals normally present in the water of Lake Ontario, as measured at Oswego, New York, about 8 miles NE of the Sterling site. Similar values were observed at the Sterling site (ER, Table 2.5-11), except that ammonia, phosphates, and sulfates were significantly higher at Oswego, probably due to waste discharges to the lake at this point.

Table 3.8. Chemicals added to discharge during operation

Chemical	Yearly discharge (total lb)	Maximum estimated concentration in effluent (ppm)
Chlorine (Cl_2)	1.6×10^5	
Free residual		0.5
Chlorine reaction products (chloride, chloramines, chloro organics, etc.)		0.5
Copper	1.4×10^3	5×10^{-4}
Nickel	1.4×10^2	5×10^{-5}
Sodium sulfate	4.7×10^4	0.2

3.6.1 Condenser and service water system

To control algal growth, the circulating and service water systems will be treated intermittently with a 10% sodium hypochlorite solution. The expected rate of chlorination will be about 540 lb/day (as sodium hypochlorite). Addition at a level of 1 ppm chlorine will be made at the intake for three 20-min periods per day. During chlorination periods, the free residual chlorine in the discharge will be monitored, and a feedback control system will automatically adjust the sodium hypochlorite injection rate so that average and maximum concentrations in the discharge will not exceed 0.2 and 0.5 ppm respectively.

Corrosion of the main condenser tubes will cause slight increases in copper and nickel concentrations in the discharge of about 5 x 10^{-4} and 5 x 10^{-5} ppm respectively (ER, Rev. 7, p. 3.6-1).

Table 3.9. Lake Ontario water-quality data recorded at Oswego, N.Y.[a,b]

Characteristic	Unit of measurement	Number of samples	Data-record period	Measured values			Maximum permissible concentration[c]
				Min	Mean	Max	
Hardness ($CaCO_3$)	mg/liter	54	6/64–1/71	112	146	240	
Alkalinity ($CaCO_3$)	mg/liter	16	3/65–11/66	85	94	101	
Ammonia, nitrogen (N)	mg/liter	54	6/64–1/71	0.0	0.47	1.31	
Calcium (Ca)	mg/liter	54	6/64–1/71	32.0	44.0	54.0	
Chlorides (Cl^-)	mg/liter	54	6/64–1/71	3.8	30.3	55.5	250
Iron (Fe)	mg/liter	54	6/64–1/71	0.0	0.6	0.9	0.3
Manganese (Mn)	mg/liter	54	6/64–1/71	0.0	.01	0.13	0.3
Magnesium (Mg)	mg/liter	51	9/65–1/71	4.9	8.9	29.0	
Nitrates (N) (sic)	mg/liter	54	6/64–1/71	0.0	0.14	0.51	10
Nitrates (N) (sic)	mg/liter	54	6/64–1/71	0.0	0.005	0.029	
Phosphates (PO_4^{3-})	mg/liter	54	6/64–1/71	0.0	0.19	1.65	
Potassium (K)	mg/liter	54	6/64–1/71	0.5	1.6	11.4	
Sodium (Na)	mg/liter	54	6/64–1/71	1.0	16.6	45.0	
Sulfates (SO_4^{2-})	mg/liter	54	6/64–1/71	13.0	30.1	50.0	250
pH		71	5/64–1/71	7.2	7.9	9.0	
Turbidity	ft	71	5/64–1/71	1.0	8.4	25.0	5
Temperature	°F	70	5/64–1/71	34	49.3	73.4	
Dissolved oxygen	ppm	70	5/64–1/71	6.8	10.9	14.4	
BOD,[d] 5-day	ppm	66	5/64–1/71	0.2	1.25	3.0	
Color		68	6/64–1/71	2	8.5	20	15
Conductivity	millimhos	53	6/64–1/71	131.0	306	437.0	
Coliform bacteria	No./100	70	5/64–1/71	2.2	56	240	1.1
COD,[e] dichromate	ppm	51	6/64–1/71	0.2	7.9	28.1	
Residue on evaporation (total)	ppm	54	6/64–1/71	128	243	533	
Residue on evaporation (fixed)	ppm	51	9/65–1/71	73	135	367	
Suspended solids (total)	ppm	51	9/65–1/71	1	10.5	44	
Suspended solids (fixed)	ppm	26	8/66–1/71	0	5.5	17	

[a] Data recorded by New York State Department of Environmental Conservation.

[b] City-water intake located 6,000 ft from shore at a depth of 40 ft below lake level.

[c] According to U.S. Public Health Service and New York State standards.

[d] BOD = biological oxygen demand.

[e] COD = chemical oxygen demand.

Source: ER, Table 2.5-11.

3.6.2 Demineralizer regeneration system

The makeup water requirements for the plant will be met by using demineralization techniques. Pretreated water from Lake Ontario will be passed through demineralizer trains, which will be regenerated using NaOH and H_2SO_4. The amounts (maximum/average) of sodium hydroxide and sulfuric acid used will be about 2000/300 lb per day and 1440/210 lb per day respectively (ER, Table 3.6-2). The regeneration wastes will be treated in a waste processing system before being released to Lake Ontario via the discharge canal. About 48,000 gpd of makeup water will be processed under normal conditions, producing about 4800 gpd of regeneration wastes. Assuming one regeneration every six days, this will produce a batch flow of about 30,000 gal. Maximum and average release rates from the waste processing system to the discharge canal will be 634,000 and 50,910 gpd respectively. When the plant is operating at 80% capacity factor, this will result in maximum and average sodium sulfate concentrations in the discharge to Lake Ontario of about 0.2 and 0.02 ppm respectively.

3.7 SANITARY WASTES AND OTHER EFFLUENTS

3.7.1 Temporary

During construction, both the permanent and a temporary sanitary waste system will be used. Portable chemical facilities will be used to supplement the permanent system during this period of high load. The portable facilities will be maintained by a commercial service having the equipment and permits for proper disposal.

3.7.2 Permanent

The sewage waste treatment system will consist of two prefabricated units, each with a capacity of 8000 gpd. One unit will normally be in operation with the second unit in standby. The system will use the extended aeration process and will include a comminutor, aeration chamber, clarifier, chlorine contact tank, and a sludge storage tank. During plant operation, the effluent from the system will contain about 30 ppm BOD, 30 ppm suspended solids, and 200 fecal coliform per 100 ml. The applicant states that the effluent will meet the limits of 40 CFR 133 (ER, p. 3.7-1). Sludge produced by the system will be removed by a commercial service having the proper equipment and permits for disposal.

3.7.3 Gaseous wastes

Two emergency diesel generators and an auxiliary steam boiler, all fired with No. 2 (0.35% sulfur) fuel oil, will be operated at various times. Normally, the diesels are operated for only one hour per month (for testing purposes), consuming about 10,800 gal per year. The auxiliary steam generators will be operated for about 1500 hr per year, consuming about 1.1 million gal per year. The effluents are shown in Table 3.10. The applicant states that operating characteristics will be in compliance with State and Federal regulations (ER, p. 3.7-2).

Table 3.10. Effluents from auxiliary steam boiler operation[a]

	Emission factor (lb/1000 gal)	Emissions (lb/10^6 Btu)	Emissions (lb/year)
Particulates	6	0.043	6,570
SO_2	50	0.36	54,750
CO	4	0.029	4,380
Hydrocarbons	3	0.021	3,285
NO_x	42	0.30	45,990

[a] Based on burning Number 2 fuel oil (140,000 Btu/gal) with a sulfur content of 0.35%. Fuel consumption is 730 gal/hr and estimated running time is 1500 hr/year.

Source: ER, Table 3.7-2.

3.8 TRANSMISSION SYSTEM

Only a limited amount of new construction is required to tie Sterling with the applicant's grid distribution system (ER, Sect. 3.9). Approximately 1 mile of 765-kV line requiring a total of ten 150-ft towers (Table 3.11) is necessary to effect connection of Sterling with the proposed 765-kV line extending across the site (Fig. 2.1). Auxiliary power will be supplied by an underground 13.8-kV line and an overhead 115-kV line. The underground 13.8-kV line (1 mile long, Fig. 2.1) will be buried within the onsite 115-kV right-of-way. The offsite 115-kV auxiliary line will be constructed along a route generally depicted in Figs. 3.9-5 and 3.9-6 of the ER. From South Oswego Substation, in the City of Oswego, the 115-kV line will run south for approximately 4.8 miles, using an existing vacant circuit position on towers of a 115-kV line until it meets the proposed Volney-Pannell cross-state 765-kV line. It will then proceed westward for approximately 8.2 miles, parallel and contiguous with the north side of the proposed Volney-Pannell 765-kV transmission line right-of-way, to the Sterling substation.

Table 3.11. Sterling transmission lines

Line	Length (miles)	Voltage (kV)	Width of corridor (ft)	Towers		
				Type[b]	Number	Height (ft)
Nuclear power plant tie line	1	765	300[c]	H' frame tubular steel poles	6	150
Onsite auxiliary and construction power lines						
Overhead	1	115	100	Wooden, H' frame	6	75
Underground	1	13.8	2[a]			
Offsite auxiliary power line	8	115	100	Wooden, H' frame	54	75

[a] Included in 10 ft of overhead 115-kV line.

[b] Other types may be used in certain areas.

[c] Selectively cut in wooded areas.

3.9 TRANSPORTATION

3.9.1 Railroad

The Sterling site may be served by a railroad spur from the Hojak branch of the Penn Central Railroad (see Fig. 2.1). The line runs parallel to Lake Ontario between Oswego and Rochester. In the site vicinity, the line is located about 4 miles S of the site boundary.

3.9.2 Site road

Existing roads on the site will be upgraded as needed, and three new roads will be built to provide access to the nuclear plant site. One of the new access roads will be extended south from Marsh Road via Dogwood Road; a second will be west from Dogwood Road; and the third will be north from Jenzvolt Road (see Fig. 2.1).

3.9.3 Water

Barge docking facilities on Lake Ontario will be required during construction only. There are no plans for water transportation during operation.

REFERENCES FOR SECTION 3

1. Letter, May 24, 1976, R. L. Koprowski to Bernard C. Rusche.

2. *Draft Regulatory Guide 1.BB, Calculation of Releases of Radioactive Material in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWRs)*, Docket No. RM-50-2, February 20, 1974.

3. U. S. Atomic Energy Commission, WASH-1258, Vol. 2, Appendix A.

4. ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND OF STATION AND TRANSMISSION FACILITIES CONSTRUCTION

4.1 IMPACTS ON LAND USE

The site area consists of approximately 2800 acres. The areas that will be affected by construction of the plant and plant-related facilities are indicated in Table 4.1. The single largest commitment of land will be involved with initial site preparation.

Table 4.1. Summary of areas affected by construction activities

Construction	Land area affected by construction (acres)	Completed area (acres)
Plant and plant facilities	82	61
Railroad spur	6	6
Access roads	5	5
Switchyard	37	30
Soil stockpiles	77	0
Onsite transmission tie lines[a]	48	5
Total	255	107

[a] Staff estimate based on Table 3.9.

Source: ER, Tables 4.1-2, 4.4-7, and Sect. 4.1.2.2.

4.1.1 Plant-related facilities

Construction of the plant will require excavating a considerable area below the existing terrain. Excavated material will be hauled to designated stockpiles, which will cover 77 to 90 acres and will be located 2200 ft east of the reactor building. Excess excavated material not used for backfill will be graded and planted with grass. Topsoil removed during excavation will be stockpiled on site and replaced during finish grading. Established engineering measures will be taken to control erosion from stockpiles and other areas (Sect. 4.5). Explosives will be used under controlled conditions and in compliance with all applicable rules and regulations (ER, Sect. 4.1.2.2).

During the initial phases of construction, existing undergrowth and vegetation will be removed from approximately 61 acres. Attempts will be made to market cleared timber, the estimated commercial value of which is $12,000 to $16,000 (ER, Sect. 4.1.3.1). Wood not sold will be used in erecting erosion control structures and/or burned under controlled conditions in accordance with applicable regulations (ER, Sect. 4.1.2.1). Brush and tree limbs will be shredded and used as mulch for erosion control or landscaping.

4.1.2 Transmission lines

A tie line (1 mile long) will be constructed onsite from the Sterling Power Project to the proposed 765-kV cross-state line. In addition, three auxiliary lines (one 8-mile offsite and two 1-mile lines onsite) will be required (Table 3.10). For 4.8 miles between the South Oswego Substation and the Volney-Pannell 765-kV right-of-way, the offsite 115-kV auxiliary line will utilize a vacant circuit position on towers of an existing 115-kV line. From that point to the onsite substation, a new right-of-way, 8 miles in length, will be built paralleling the 765-kV right-of-way. A total of 67 acres of woodlands are involved in both onsite and offsite transmission lines. To limit adverse environmental effects in the SiM-1 wooded wetland, the 765-kV tie line will cross the swamp at its narrowest point (Fig. 2.1). The staff believes that the transmission line construction can be accomplished without substantial adverse effects upon agricultural production along the right-of-way.

The staff believes that, on the whole, construction of the Sterling Power Project and its transmission facilities will demand only a very small fraction of available inventories of land (Sect. 2.2.2 and Table B.5). Provided that controls and measures set forth in Sect. 4.5 are implemented, the staff concludes that the proposed project can go forward with acceptable impacts on local or regional land use.

4.1.3 Railroad

The rail spur line is described in Sect. 3.9.1. The Hojak line runs parallel to the lake shore between Oswego and Rochester. The new spur, if built, will depart from the Hojak line approximately 0.7 mile W of the Hojak crossing of Route 104A. The spur will be 3 miles long and occupy 36 acres of land offsite; it will make one crossing of Nine Mile Creek. The applicant expects that the Hojak line will require extensive upgrading. New track will have to be laid on the existing right-of-way from Newark to Wellington. A decision on building this spur will not be made until it is known whether the existing lines will be included in the State and Federal Government's plans for railroad preservation and subsidies (ER, Sect. 4.1.3.3.3).

4.1.4 Access roads

The access roads are described in Sect. 3.9.2. Existing roads will be upgraded. The first access road, to be extended south from Marsh Road, is 3.3 miles to the plant (2.6 miles existing). The second access road, to be extended north from Jenzvolt Road, is 2.6 miles to the plant (2.1 miles existing). The third access road, to be extended west from Dogwood Road, is 2.2 miles to the plant (1.8 miles existing). Access roads will be 24 ft wide with bituminous paving. No new roads will be required outside the site boundary.

4.1.5 Pipeline relocations

There are no oil or gas pipelines within 5 miles of the site. No pipeline relocations will be required.

4.2 IMPACTS ON WATER USE

Effects of construction on the local waters themselves will be essentially due to clearing portions of the watershed and to limited dewatering due to excavation. Sediment control structures will be used to minimize turbidity problems. Short-term reversible impact on lake water quality and benthos will be caused by the construction of the intake and discharge structures. Construction of the intake will disturb 0.3 acre of benthic habitat, and discharge construction will disturb 1.4 acres. About 0.2 and 1.2 acres of these areas will be permanently destroyed. Shoreline erosion and wave runup will be prevented by a rip-rap dike along the shore after completion of tunneling work. Beach access for recreational uses will be restricted in the immediate plant vicinity.

The low permeability of the soils in the site vicinity will limit the lateral extent of the drawdown cone during construction dewatering. Groundwater affected by dewatering is separate and distinct from other groundwater basins at the site, due to topographic differences and lack of physical connections between basins. In addition, groundwater movement away from the site is toward Lake Ontario. Due to the localized nature of these basins, the hydraulic gradient of the groundwater, and the limited area of influence of the drawdown cone, nearby wells, including their water levels, should not be affected.

4.3 EFFECTS ON ECOLOGICAL SYSTEMS

4.3.1 Terrestrial

4.3.1.1 Onsite construction

The land areas involved in construction are shown in Table 4.1 and are discussed in Sect. 4.1. Only 9% of the 2800-acre site will be affected. Clearing and grading for siting of the plant and associated facilities will eliminate approximately 82 acres of upland terrestrial habitat; 77 acres will be used for a soil stockpile and construction laydown; 59 acres will be cleared for roads, transmission line rights-of-way, and a railroad spur; and another 37 acres will be used in construction of the switchyard. Construction impacts on soils, producers, and consumer organisms are treated below.

Erosion

Construction activities will affect four of the seven onsite drainage basins (Sterling Valley Creek watershed, SiM-1 wooded swamp watershed, SiM-2 wooded swamp watershed, and the A-2 watershed) as shown in Fig. 4.1. The increases in peak flow rate from SiM-1 and SiM-2 basins during the maximum 10-year-frequency 6-hr storm are estimated at 80 and 26 cfs respectively (ER, Table 4.1-5B). The increase in the A-2 and Sterling Valley Creek flow rate is insignificant due to

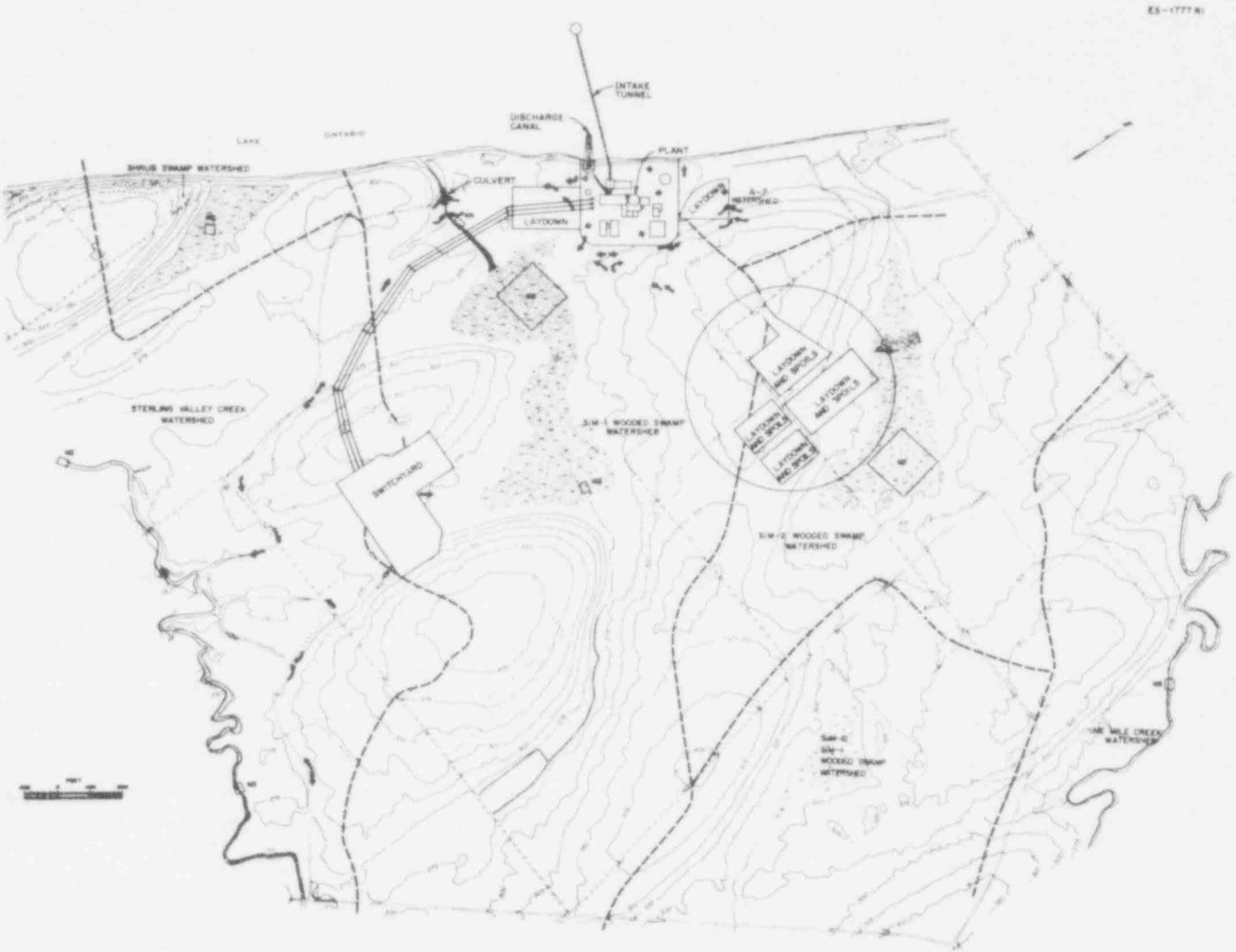


Fig. 4.1. Site map delineating the watershed basins. Source: ER, Fig. 2.7-3, Rev. 1.

minimal clearing within these basins. The applicant's mitigative measures include construction of sedimentation basins large enough to store an expected annual sediment yield from all areas under construction within each watershed basin. The staff believes that, with the implementation of measures as discussed in Sect. 4.5, erosion will be controlled to acceptable limits.

Producers

Native and cropland communities that will be disturbed by onsite construction activities include about 254 acres of uplands (beech-maple association) and about 1 acre of lowlands (elm-ash association). Construction activities in the upland areas will affect approximately 108 acres of man-dominated lands and 99 acres of natural communities, of which 33 acres are mature beech-maple forest (Table 4.2). This reduction amounts to a loss of 64% of the remaining mature beech-maple forest on the site. However, beech-maple forest such as those on the Sterling site are common in upstate New York and are not unique to the site (Table B.5). About 10% of the total upland forested areas at the site, or about 1% of the upland forest within a 5-mile radius, will be removed during construction.

Table 4.2. Changes in acreage of land classification units and plant associations as a result of construction of the Sterling Power Project[a]

Land classification	Preconstruction acreage	Postconstruction acreage	Acres affected	Percent loss
		Upland areas[b]		
Mature hardwood forest	51	18.5	32.5	64
Young to intermediate forest	695	653	42	6
Scrub lands	197	177	20	10
Abandoned fields	147	143	4	3
Cultivated fields	674	599	75	11
Pastures	491	466	25	5
Orchards	71	71	0	0
Pine plantations	14	8.5	5.5	39
Residential	49	47	2	4
Subtotal	2389	2183	206	9
		Lowland areas[c]		
Wooded swamp	179	178	1	1
Shrub swamp	20	20	0	0
Inland deep freshwater marsh	0.7	0.7	0	0
Muck fields	2	2	0	0
Pasture	0.5	0.4	0.1	20
Subtotal	**202**	**201**	**1**	1
Total	**2591**[d]	2384	**207**	8

[a] Includes all areas delineated in Table 4.1 except for the onsite transmission lines.

[b] Potential beech-maple forest association.

[c] Potential elm-ash forest association.

[d] This figure varies from the 2800 acres used elsewhere in the FES because of the technique used for measuring individual areas.

Source: ER, Tables 2.7-33, 4.1-2, and 4.4-7.

About 1 acre of the elm-ash forest (wooded swamp) will be altered due to construction of the plant and associated facilities. Impacts on the wooded swamps of the site could result from increased runoff and sediment loading due to erosion. To reduce these potential impacts, runoff from the major construction areas will be collected in sediment ponds that will remove most of the sediments and attenuate the runoff peaks into the wetlands. The increased peak flows of 80 and 26 cfs to wooded wetlands SiM-1 and SiM-2, respectively, will yield slight, but temporary, increases in swamp water levels. If water levels remain high in the swamps for a prolonged period of time, death of woody species, including silver maple, could occur. The applicant will follow mitigative measures to prevent such prolonged periods of elevated water levels in the swamps, including the surveillance of the discharge area from SiM-1 during site preparation and construction periods to ensure that culverts are not blocked.

715 067

721 008

Other potential impacts could result from the alteration of drainage patterns into the swamps. Preparation of the nuclear plant site will alter the natural flow of water into the SiM-1 swamp. Long-term loss of water would destroy amphibian breeding areas and habitats suitable for hydrophytic flora. However, the applicant plans to allow sediment-free water from the retention basins to reenter natural drainage patterns to lessen the potential loss of water in the swamp. Also, there are several different input areas into SiM-1 swamp. Therefore, a short-term loss of water from one of the input areas combined with the applicant's commitment to return sediment-free water to natural drainage patterns should not result in any unacceptable adverse effects.

With regard to individual floral components, it is notable that eight plant species listed on a list of protected native plants in New York State occur on the site (Table B.2). All these species are abundant in habitats that are not likely to be significantly altered; thus, only minimal effects on these are anticipated.

None of the common species that occur in the mature beech-maple or elm-ash forest are restricted to a single plant association. All are wide-ranging species occurring in at least nine different plant associations.[1] Thus, impacts of construction on native flora will be minimal.

Consumers

Construction activities will have a direct effect on consumer populations of the site. Clearing, excavating, filling, and grading will result in destruction of less mobile species such as invertebrates, amphibians, reptiles, and small mammals. Most birds and larger mammals will leave the immediate vicinity as construction activities increase, but the more adaptable species are expected to return as construction activities subside. Increased traffic in the area will likely result in some increase in road kills of mammals, amphibians, and reptiles.

An indirect effect of construction activities on consumer populations will occur by way of loss of suitable habitat. Many of the less mobile and/or highly territorial consumer species, such as soil and litter invertebrates, amphibians, breeding birds, and certain small mammals, will be displaced and may not be successful in locating other suitable habitat. Some of the more mobile and/or nonterritorial organisms may re-establish habitation in other areas. The staff implemented a scheme for estimating potential loss of various taxa as a function of numbers and kinds of habitat in which a given species occurs. Appendix B, Table B.3 provides numbers of observed species for each of 17 ecological groups; Table B.4 lists the important species of each group and indicates their status (e.g., endangered, game, etc.).

The impacts from habitat alteration usually result in reductions in numbers of those species that cannot adapt to the altered habitat. These population reductions will not be significant for a species as a whole unless it is endangered, rare, or restricted to a single habitat. Table B.4 lists 15 species meeting one or more of the criteria for protective action that were reported as occurring on the site. The two endangered species, bald eagle and osprey, are wetland species; the eastern gray tree frog is also usually found in wetland areas and breeds in quiet shallow water. Because no reduction of potential habitats for these three taxa will occur due to construction activities on the site, impacts on the species will be minor. Bald eagles currently use the site only for feeding and resting and have not nested there for at least 50 years. The closest historic recorded nest was located about 15 miles to the west at Sodus Point. Since eagles have not nested on the Sterling site in the recent past, the level of disturbance there appears to be already sufficient to preclude its use for that purpose in the near future. For the area to become suitable eagle habitat, major reductions in man-dominated land use would probably be required. This is not likely to occur, whether or not the Sterling plant is constructed. Therefore, since the area appears to have no significant potential for eagle nesting and since the plant will have little effect on the currently used eagle habitat, it should have little impact on the species. Species such as marsh hawks (cropland-wetland), sparrow hawks and Bewick's wrens (terrestrial), pine grosbeaks (urban-woodland), and the grasshopper sparrow (urban-cropland) should be able to adapt to altered habitats. Reduction of forest habitats and abandoned field areas will have minor local impacts on the woodland, restricted forest, and restricted cropland species respectively.

The sharp-shinned hawk is a woodland species that is currently listed on the Audubon Blue List (Table B.4). It commonly inhabits open woodlands, thickets, and lakeshores in the area. One individual was observed in the 6.0 acres of pine plantations that were surveyed on the site (ER, Table 2.7-58). Approximately 39% of these plantations (Table 4.2) on the site will be destroyed during construction with the resulting new habitat unacceptable for sharp-shinned hawks. However, this species is not completely dependent on coniferous habitat and can use other wooded lands in the area. Therefore, since woodland habitats in the region are currently increasing,[2] the staff concludes that the reduction in onsite habitat should have only a minor effect on regional populations of the sharp-shinned hawks.

715 068

~~721 009~~

Species restricted to forests include the wood frog, eastern gray squirrel, goshawk, barred owl, and hairy woodpecker. All these species can inhabit young intermediate hardwood forests, and some can use elm-ash swamp forest. A maximum 10% reduction is predicted for populations of the above species on site; however, as successional processes continue on the abandoned lands, lost forest habitat will be replaced. Thus, population reductions can be considered temporary.

Species restricted to croplands include the Henslow's sparrow, which has been placed on the Audubon Blue List. The loss of cropland habitat within the Ontario-Mohawk Plain due to successional processes is probably the most significant factor in the decline of this species in the area. Construction activities will remove about 1% of the abandoned field cover type on the site. However, because the most significant impact on the Henslow's sparrow will be associated with the conversion of some 145 acres of cropland to brushlands and forest vegetation through succession, the staff recommends measures for halting the advance of forest colonization, thereby ensuring some substantial onsite habitat for this and other cropland species.

4.3.1.2 Offsite construction

The physical details of the offsite transmission system are discussed in Sect. 3.8 and in the ER, Sect. 3.9; the railroad spur and access roads are described in Sect. 3.9 and in the ER, Sect. 3.10. Approximately 8 miles of transmission line will be constructed; in addition, 3 miles of railroad spur may be constructed. The impacts of this construction on soils, producers, and consumers are treated in the following subsections.

Soils

The construction impacts on the soils of the terrestrial ecosystem will be similar to those discussed in Sect. 4.3.1. The staff concludes that, with mitigating measures proposed by the applicant during construction, impacts due to soil erosion should be held to acceptable levels.

Producers

The combined offsite rights-of-way (transmission line and railroad spur) include approximately 59 acres of young hardwoods, 52 acres of tilled fields, and 24 acres of scrubland. The present land use of the transmission line right-of-way will be maintained except where the line transverses some 53 acres of young hardwoods and in the areas occupied by tower bases. The 19 acres of cropland and 17 acres of natural communities found along the railroad right-of-way will be lost. Construction impacts on producers will be similar to those discussed in Sect. 4.3.1.

Consumers

Construction impacts on consumers will be similar to those discussed in Sect. 4.3.1.

The staff believes that the transmission lines and railroad spur can be constructed without substantial adverse effects upon ecological systems along the right-of-way.

4.3.2 Aquatic

Adverse effects of site preparation and construction include (1) increased turbidity and siltation, (2) chemical and waste effluents, and (3) direct destruction of aquatic habitats. The following discussion treats the various perturbations applied to aquatic systems on site and to nearshore areas of Lake Ontario. Sects. 4.1 and 4.3.1 provide further details on actual construction activities.

4.3.2.1 Clearing and inland construction of plant facilities

The clearing of 190 acres of land and subsequent construction will affect inland waters primarily through increases in turbidity (TSS, total suspended solids) and siltation. The large elm-ash swamp and its discharge stream (approximately 90 acres by staff estimates; Fig. 4.1) will receive runoff from activities associated with construction laydown areas. A smaller swamp of about 35 acres will receive runoff from construction laydown areas. Some runoff from switchyard and road construction will enter Sterling Valley Creek (Fig. 4.1).

The effects of increased turbidity and siltation on aquatic systems and biota are well documented and include reduction of light penetration and photosynthesis; impairment of respiratory and feeding functions; obliteration of spawning sites and microhabitats such as the interstitial spaces of bottom substrates; smothering of benthos and demersal fish eggs;[3,4,6] alterations in species composition;[3] and lower fish production.[7] However, all of these impacts can be substantially reduced through proper use of sedimentation control measures. To that end, the applicant will build dikes, berms, and sediment retention basins designed to contain the expected one-year sediment yield from all areas under construction (ER, pp. 4.1-2, 4.1-7). The sediment basins will have outlet pipes for discharging the water onto rip-rap energy dissipators; these pipes will be designed to carry a maximum rainfall of 3.65 in. in 24 hr. When their capacity drops to less than 40% of initial capacity, the basins will be cleaned. This sediment will be removed, drained, or mechanically dewatered, and transported to the fills areas indicated on Fig. 2.1. Revegetation will be applied to sloped areas and areas with easily erodible soils to further control erosion (ER, p. 4.1-4).

Shoreline erosion and wave runup will be prevented by a dike that will be constructed after excavation of the intake tunnel. It will be located along the shoreline on both sides of the discharge canal. The primary cover layer (rip-rap) will probably be rough quarry stone in 4 x 6 x 6 ft blocks which will be embedded almost entirely by land-based equipment along approximately 350 ft of shoreline. Disturbance of the inshore area will be of short duration, and any impacts associated with the construction of this dike will be minimal. Finally, the construction water needs (approximately 1 cfs) can be provided from buried and perforated piping in the near shore area. Although this withdrawal system has not been finalized, any impacts resulting from the construction of such a system will be insignificant.

In addition to implementation of the above measures included in the applicant's commitments, the staff shall require the applicant to (1) monitor total suspended solids (TSS) in all runoff discharged to Sterling Valley Creek and to both swamps, (2) limit TSS levels of all such discharges to applicable EPA standards (40 CFR 423, Sect. 423.45), and (3) dispose of sediments removed from retention basins in a manner precluding contamination of streams or swamps. Fulfillment of applicant commitments and staff requirements will limit adverse effects to relatively insignificant and temporary disturbances.

In addition to the above impacts, construction of a combination road-railroad-pipeline embankment across the discharge stream of the large swamp will directly destroy 0.8 acre of wooded swamp and stream (ER, p. 4.1-22). Approximately 500 ft upstream of the proposed embankment, partial clearing of the streambanks for the transmission line crossing will be required. Turbidity downstream of the embankment and transmission crossing will temporarily increase during actual construction. The stickleback population in the discharge stream may be temporarily reduced as a result. The applicant is committed to designing the embankment so as not to affect flow characteristics (ER, p. 4.1-22). The staff considers these impacts of no permanent consequence.

Construction of intake and discharge structures

Dredging operations for construction of the intake structure, barge docking facilities, and discharge canal will constitute the major impacts of construction on Lake Ontario. Approximately 0.4 acres of benthic habitat will be disturbed, of which 0.3 acres will be permanently lost as a result of the placement of the intake structure.[8] The 4200-ft intake tunnel will be excavated rather than dredged and will be situated approximately 100 ft below the lake bed. Construction of the barge docking facility, which will be used for delivery of the steam generator, reactor, and reactor internals, and the discharge canal will disturb 3.5 acres and eliminate 1.0 acres of lake bottom.[8] The excavated and dredged material (spoil) will be disposed of onshore near the meteorological tower (see ER, Fig. 4.1-1) where sedimentation basins will be provided to control turbidity of runoff from the spoil pile. These offshore dredging operations will require one month to complete.

Dredging activities associated with the construction of the above structures will cause an increase in turbidity and siltation and the release of potentially toxic substances (e.g., pesticides, heavy metals) from the sediments. The area of the lake that will be subjected to changes in turbidity and siltation is dependent upon the composition of the sediments and the local current and wave patterns. The uppermost layer of the substratum is a dense brown, silty-fine sand, underneath which is a very dense grey till. Data on the particle size distribution are given in Fig. S74.3-1-2,[8] but information on the chemical composition of the sediments at the site is incomplete, since no analysis of the concentration of heavy metals or pesticide residues in the sediments was made. Sediments act as sinks for many heavy metals and are also capable of rapidly absorbing large amounts of dissolved pesticides from a water solution.[9] The release of these substances can result in mortality to aquatic organisms by direct exposure or magnification of the concentrations along the food chain after their initial ingestion by filter-feeding organisms. Although research has shown that benthic species can ingest contaminated sediment particles, no model exists to describe the degree to which contaminants are dissociated from the sediment and incorporated into benthic body tissues, thereby gaining entry into the food chain.[10]

The staff expects no long-term adverse impacts resulting from the construction of the intake structure, barge slip facility, and the discharge canal. Further, the dilution of these heavy metals in the water column and the disposal of dredged material on shore represents factors that will reduce the short-term impact; however, 3.5 acres of the highly productive nearshore area will be subjected to increases in turbidity (which may actually affect a larger area than 3.5 acres) and siltation. The most serious impacts will be the exposure of the aquatic biota to potentially high levels of toxic substances, the obliteration of spawning sites, and the smothering of benthos and demersal fish eggs. On the basis of the above analysis, the staff concludes that (1) dredging operations be prohibited during the peak of the spawning season (mid-June to mid-August), and (2) the permanent loss of 1.3 acres due to placement of the intake structure and barge facility is acceptable.

Chemical wastes

Liquid wastes, including chemicals, fuels, and lubricants, will be discharged into containers for salvage or offsite treatment and disposal. Temporary storage of chemicals and wastes will avoid areas near streams or wetlands. Concrete waste washings will be processed. No wastes will enter the streams or wetlands. To provide further protection, the staff shall require the applicant to (1) establish a program for effective emergency handling of any accidental spills and (2) meet all applicable EPA standards for discharge of effluents.

Sanitary wastes

During the initial stages of construction, portable chemical toilets will be used in accordance with New York State standards. No sanitary wastes will enter stream watersheds or Lake Ontario (ER, p. 4.1-5). Upon completion of the permanent sanitary waste treatment plant, wastes will be treated in accordance with EPA standards (40 CFR 133) and released via the cooling system discharge canal to Lake Ontario at a maximum flow rate of 0.025 cfs.

A minimum chlorine residual concentration of 0.5 ppm will be maintained in the effluent, but immediate and effective dilution in the discharge canal will ensure the safety of biota beyond the canal. The staff foresees no adverse environmental impacts from proposed treatment and disposal of sanitary wastes.

Dewatering effluents

Groundwater samples at the site and under the lake exhibited concentrations of total solids ranging from 127 to 17,350 mg/liter. Exposure to the higher concentrations could be injurious to aquatic organisms. The applicant is committed to storage of saline water encountered during intake tunnel excavation in onsite storage tanks for dilution and subsequent discharge to Lake Ontario. On the basis of available information,[11,12] the staff believes restriction of total dissolved solids (TDS) to a maximum of 1000 mg/liter will provide adequate protection for aquatic life. Therefore, the staff shall require the applicant to limit TDS in all groundwater releases to a maximum of 1000 mg/liter and TSS to 50 mg/liter.

Conclusion

The staff concludes that the adverse effects of site preparation and construction on aquatic ecosystems on or near the site area will be minimal and, in most cases, temporary if all staff requirements and applicant commitments are fulfilled.

Impacts of construction of the Sterling Power Project on aquatic ecosystems are summarized in Table 4.3.

4.4 EFFECTS ON THE COMMUNITY

4.4.1 Physical impacts

Twenty-four permanent residences and 21 vacation cottages located on the site property will be acquired by the applicant. Eight of the permanent residences and 19 cottages are located in the exclusion zone or construction area and are to be abandoned, at a cost of approximately $263,100 (ER, Sect. 4.1.3.3). The economic and psychological effects of this relocation are difficult to predict. The applicant states that those not displaced by the exclusion zone or ancillary facilities will be encouraged to maintain their residences. The applicant estimates that approximately 80 permanent residents and 70 summer or temporary residents will have to be relocated (ER, Sect. 4.1.3.3).

715 071

721 012

Table 4.3. Summary of environmental impacts due to construction

Potential impact	Applicant's plans to mitigate	Expected relative significance	Corrective actions available and remarks
Increased turbidity and siltation; release of potentially toxic materials (e.g., heavy metals, pesticides) from sediments			
Intake, discharge, and barge facility construction in Lake Ontario	Deposition of dredged material onshore where sedimentation basins will control turbidity of runoff, or, alternatively, deposition in Lake Ontario in accordance with EPA and Corps of Engineers rules and specified dumping areas.	Temporarily severe in immediate areas of construction; of no consequence on a regional basis.	Dredging operations prohibited during spawning season (mid-June to mid-August)
Discharge of construction runoff into inland watershed	Construction runoff control plan, including dikes, berms, gravel and straw silt traps, and sedimentation basins.	Temporary, but potentially moderate adverse effects on productivity and species composition of local streams and swamps.	Applicant must limit TSS levels of all effluents and runoff to meet EPA standards.
Chemicals and liquid wastes	Storage away from sensitive watersheds; no chemicals or liquid wastes will be allowed to enter stream drainage or wetland.	Insignificant, unless a major spill were to occur.	Applicant must establish procedures for emergency clean-up of spills.
Sanitary wastes	Initially, portable toilets and removal of wastes from site, then treatment in accordance with EPA standards and discharge to Lake Ontario.	Insignificant; some biota in immediate area of discharge may be adversely affected.	Applicant must also meet State standards.
Dewatering effluents (possibly high in TDS and TSS)	Storage in onshore tanks with subsequent dilution before discharge to Lake Ontario.	Slight	Applicant must limit TDS in dewatering effluents to no more than 1000 mg/liter before discharge to Lake Ontario or inland waters; TSS must not exceed EPA standards.
Direct destruction of aquatic habitat	Avoid when possible.	Insignificant	
Loss of approximately 100 acres of cropland, 81 acres of forest, and 24 acres of scrubland and abandoned fields	None	Permanent loss of habitat and its flora; due to land abandonment policy, wildlife habitat is increasing in region, and thus only short-term effect is expected.	Idle parts of site will be kept in agricultural production to ensure that abandoned field habitats exist for Henslow's sparrow.

715 072

~~721 013~~

Construction activities will produce noise and dust that will be discernible to nearby residents. However, considering the period of construction that will produce the highest noise levels and using conservative assumptions, the applicant found that no residents, schools, or hospitals will be impacted beyond what is considered normally acceptable by the U.S. Department of Housing and Urban Development[13] (ER, Sect. 4.1.3.3.5). Thus, although construction noise may be heard routinely by approximately 20 people, it will not be sufficiently loud to interfere with normal outdoor conversation (ER, Sect. 4.1.3.3.5 and 4.4.1.2.3).

Construction activities are anticipated to have minimal impact on water in the region. Runoff from stripped areas will be controlled, and silt and sediment will be trapped or filtered (ER, Sect. 4.1.4). Sewage from the construction site will be handled by licensed contractors in accordance with New York State requirements (ER, Sect. 4.1.4.2). A maximum quantity of sewage sludge of 24 gpd will be produced during the peak construction period. This compares to about 54,000 gpd produced by the Sewage Treatment Plant of the City of Auburn and about 4,700 gpd produced at the Oswego Sewage Treatment Plant. The small amount of sludge from the plant should be easily disposed of by either burning or land filling and should place little strain on existing disposal sites. Because of the localized nature of the groundwater basins and because no use will be made of groundwater during construction (except for dewatering in the immediate construction area), there will be minimum impact upon this system (ER, Sect. 4.1.4.4).

The daily flow of construction-related traffic was estimated on a worst-case basis, assuming each of the 1370 workers in the peak year would drive (ER, Sect. 4.1.3.3.3). The problem of construction worker traffic may be mitigated by carpooling and a limited form of mass transportation (ER, Sect. 4.1.3.3.3). In addition, the applicant states that starting and quitting times are normally off-periods of peak traffic flow. The applicant has also proposed a traffic control plan to local traffic officials covering the main access point to the site (ER, Sect. 4.1.3.3.3). The traffic problems will likely be accentuated during the summer months when traffic is heavier than usual. The staff recommends that the applicant actively encourage employee carpools and further investigate mass transportation alternatives.

4.4.2 Population growth and construction worker income

The work force is estimated to be about 1370 at the time of peak construction activities (ER, Sect. 4.1.3.3). A maximum of about 120 families is expected to relocate in the Sterling area (ER, Sect. 4.1.3.3.4). The population of Cayuga County, in which Sterling is located, was 77,439 in the 1970 census.[2] The neighboring counties of Wayne and Oswego had populations of 79,404 and 100,897 respectively.[2] Based on the proximity of Rochester and Syracuse to the site, the staff concludes that the applicant's estimate of 120 families moving into the Sterling area at peak construction is reasonable.

The construction employment and associated payroll during the period in which the plant is to be built is given in Table 4.4.

Table 4.4. Construction employment and payroll estimates for the Sterling Power Project

Year	Average number employed	Man-hours (X 1000)	Payroll (millions of dollars)
1978	270	420	6.5
1979	960	2000	32.5
1980	1370	2850	49.6
1981	1330	2760	51.4
1982	1050	2170	43.2
1983	490	1020	21.7
1984	60	30	0.7

Source: ER, Table 8.1-2, Rev. 6.

4.4.3 Impact on community services

Housing availability is fairly good with a 9.6% vacancy rate in the Sterling area (ER, Sect. 4.1.3.3.4). The probable number of families that may move into the area would exert a marginal impact on the market. A larger than anticipated influx of workers can be accommodated in mobile homes. Many of the nearby communities have adopted mobile home ordinances to regulate this form of housing (ER, Sect. 4.1.3.3.2). The staff believes that problems associated with proliferation of mobile home parks can be adequately handled. More important is the fact that Rochester and Syracuse are within easy commutation distance and can absorb a significant number of people desiring to purchase or rent homes (ER, Sect. 8.2.2.3).

Because the Sterling site will be self-serviced with respect to water, sewage, and security, it will produce little or no demand on the local communities to provide these services.

One possible impact will be on major roads in the area. The major roads in the area are probably capable of bearing the increased traffic load without undue inconvenience to local traffic. The staff recommends that the applicant work with local authorities planning and coordinating repairs to the major access roads.

4.4.4 Impact on local institutions

The applicant has estimated the maximum increase in the number of school children as a result of an influx of construction workers (ER, Sect. 4.1.3.3.4). The schools most likely to be impacted were surveyed and the capacity and enrollments determined (ER, Tables 2.2-4A and 8.2-1). Except for the middle school in Oswego, all schools have excess capacity, and the systems can each absorb from about 200 to 600 additional pupils. A small number of additional teachers may be required in a given system.

Oswego Hospital (176 beds), the closest hospital to the site, is within about 10 miles (ER, Sect. 2.2.2.3). Recently it has been operating at about a 93% occupancy rate, which the staff considers overcrowded. The hospital is relatively small and has no plans for expansion. Thus, it cannot reasonably be expected to absorb any additional load incurred by an influx of workers beyond what is necessary for emergency treatment. Furthermore, there is a substantially greater patient/physician ratio in the immediate region than for the State as a whole (ER, Sect. 8.2.2.2). The applicant, however, has no plans to attract additional medical personnel into the area (ER, p. R540.17-1). Potential problems may be mitigated to some extent by the proximity of the large metropolitan areas of Syracuse and Rochester.

The staff considers that, because the large majority of workers will probably commute, the area institutions will not be severely impacted.

4.4.5 Impact on recreational capacity of area

There are a substantial number of recreational facilities within 10 miles of the site (ER, Table 2.2-7 and Fig. 2.2-6) that are sufficient to provide for the probable influx of workers and their families. Small boat navigation on the lake will be restricted only in the immediate vicinity of the temporary caisson and drilling platform (ER, Sect. 4.1.4.3).

The staff concludes that there will be minimal impact on the recreational capacity of the area during construction.

4.5 MEASURES AND CONTROLS TO LIMIT ADVERSE EFFECTS DURING CONSTRUCTION

4.5.1 Applicant commitments

The following is a summary of the applicant's plans to limit adverse effects during construction.

(1) The applicant will attempt to sell cleared timber having commercial value. Wood not sold will be used in the construction of erosion control structures or burned under carefully controlled conditions in accordance with applicable regulations. Brush and tree limbs will be shredded and used as mulch for erosion control in landscaping disturbed areas.

(2) Deep excavation for the plant buildings and other structures will be done using maximum slopes of one horizontal to one vertical. Topsoil removed during excavation will be stockpiled, and established engineering measures will be used to prevent erosion.

(3) Vegetative materials will be used to control and to maintain sloped areas and cover on soils known to be easily erodible such as the silty loams. Additionally, windbreaks will be left standing to aid in controlling effects of winds from Lake Ontario.

(4) Sedimentation retention basins will be designed to store an expected one-year sediment load from all areas under construction in accordance with Guidelines for Erosion and Sediment Control in Urban Areas of New York State.[14] The basins will be cleaned when their capacity drops to less than 40% of initial values. Outlet spillways will be

designed to pass peak rates of runoff from the design storm. The design storm for drainage areas of 20 acres or less will be a 10-year-frequency storm, and for drainage areas greater than 20 acres, a 25-year-frequency storm. Pipe spillways will have perforated vertical risers to allow the gradual drawdown of the water level in the basins. The outlet pipes will extend through and discharge beyond the downstream embankments of the basins.

(5) All permanent drainage facilities will be designed to carry a 100-year rainfall intensity for the Oswego area, and temporary drainage facilities will be designed using a 10-year rainfall intensity duration curve for the area.

(6) In areas in the immediate vicinity of excavations, surface runoff from precipitation will be collected in subdrainage trenches and sumps. This water will then be pumped from the trenches and sumps and treated before being discharged into natural drainage channels. Check dams and energy dissipators will be used if necessary to control velocities, potential erosion, and the quality of effluent water.

(7) Liquid wastes, such as chemicals, fuels, lubricants and bitumens, will be deposited or discharged into containers for salvage or subsequent removal to appropriate offsite treatment locations.

(8) Washings from concrete mixing and transporting will be processed in a manner that will provide aggregate recovery and control the quality of the effluent. These wastes will be prevented from entering the stream drainages and wetlands.

(9) Solid waste, such as trash and refuse material, will be promptly collected for offsite disposal in accordance with applicable regulations.

(10) Construction scrap and debris will be collected on a regular basis in designated onsite areas for salvage, incineration, burial, or disposal. Unusable, combustible material will be incinerated in a portable incineration unit located on the site. Emission levels and operation of the incinerator will be in accordance with applicable Air Quality Regulation at the time of construction.

(11) Portable chemical toilets will be utilized during construction in accordance with the applicable New York State standards. These sanitary wastes will not be released into onsite water or the lake.

(12) Dust resulting from vehicular traffic on unpaved haul roads and access roads will be controlled by spraying problem areas with asphalt cutback as necessary. Dust from wind action on off-road and cleared areas will be minimized by applications of mulch and reseeding of bare areas as part of the erosion control effort. Gravel will be used on heavily traveled roads, and early paving of permanent access roads and parking areas is planned.

(13) The applicant contemplates minimal use of herbicides during construction. The use of pesticides will be kept to a minimum and will be monitored by the measurement of pesticide concentrations in samples of the runoff from construction areas. Nutrient leaching will be minimized in restorable areas by the proper applications of fertilizer, mulch, and seed.

(14) During construction, the runoff from the areas stripped of protective vegetative cover will be engineered to flow through silt traps to prevent sediment from being carried out of the construction area. Cut and fill areas with slopes steeper than 1:1 and more than 15 ft high will be benched. All such slopes will be protected from surface runoff from above the slope face. These slope faces will be mulched where applicable.

(15) Major construction areas will be drained into temporary sediment ponds.

(16) The concrete batch plant will be equipped with dust control systems.

(17) The combination road-railroad-pipeline embankment to be constructed across the SiM-1 swamp discharge stream will be designed so as not to affect flow characteristics of the stream during or after construction. Further, surveillance of the discharge area during construction and site preparation will be done to ensure that the culverts are not blocked off.

(18) Any significant quantities of saline water that may be encountered during excavation will be stored in onsite storage tanks and diluted prior to discharge into Lake Ontario.

(19) A nourishment program will be initiated if the shoreline erosion monitoring program indicates accelerated erosion rates resulting from the presence of the flood control dike.

4.5.2 Staff evaluation

Based on a review of the anticipated construction activities and their expected environmental effects, the staff concludes that the measures and controls proposed by the applicant as summarized above are adequate to ensure that adverse environmental effects will be at a minimum practicable level, with the following additional precautions:

(1) At least 150 acres outside the exclusion boundary should be managed for Henslow's sparrow habitat, a resident breeding population included in the Audubon Blue List. This would involve leaving half of the area fallow one year while the other half is farmed, and then alternating farmed and fallow areas the next year.

(2) All construction runoff to natural streams and swamps must be monitored for TSS and must not exceed 50 mg/liter.

(3) Any effluents discharged from the processing of concrete must be routed to the nearest settling pond and treated to meet EPA standards.

(4) The applicant shall establish procedures for effective emergency clean-up of accidental spills of chemicals and wastes. These procedures must be presented to the staff for acceptance prior to commencement of construction.

(5) Dewatering effluents from intake tunnel excavation and from onsite excavations shall be diluted in order that the TDS of effluent discharged to Lake Ontario will not exceed 1000 mg/liter.

(6) The applicant will be required to follow all conditions of the SPDES Construction Runoff Permit, the Section 404 Permit, and the New York State Fresh Water Wetlands Act to reduce erosion due to construction activities.

(7) Near shore lake dredging operations will be prohibited during the spawning season (mid-June to mid-August).

REFERENCES FOR SECTION 4

1. A. W. Kuchler, "Potential Natural Vegetation of the Coterminous United States," *Amer. Geog. Soc. Pub.* 36 (1964).

2. New York State Division of the Budget, Office of Statistical Coordination, *New York State Statistical Yearbook*, 1974.

3. E. H. Hollis, J. G. Boone, C. R. DeRose, and G. J. Murphy, *A Literature Review of the Effects of Turbidity and Siltation on Aquatic Life*, Staff Report, Department of Chesapeake Bay Affairs, Annapolis, Maryland, 1964.

4. A. J. Cordone and D. W. Kelley, "The Influence of Inorganic Sediment on the Aquatic Life of Streams," *Calif. Fish and Game* 47(2): 189-228 (1961).

5. J. Cairns, "Suspended Solids Standards for the Protection of Aquatic Organisms," pp. 16-27 in *Proc. 22nd. Indust. Waste Conf., Part 1*, Purdue Univ. Engr. Ext. Sir. No. 129, May 1967.

6. J. C. Ritchie, "Sediment, Fish and Fish Habitat," *J. Soil Water Conserv.* 27(3): 124-125 (1972).

7. D. H. Buck, "Effects of Turbidity on Fish and Fishing," pp. 249-261 in *Trans. 21st. N.A. Wildl. Conf.*, 1956.

8. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 74, February 1975.

9. J. B. Herbich, *Coastal and Deep Ocean Dredging*, Gulf Publishing Company, Houston, Tex., 1975.

10. D. D. Smith, "New Federal Regulations for Dredged and Fill Material," *Env. Sci. Tech.* 10(4): 328-333 (1976).

11. H. P. Clemens and W. H. Jones, "Toxicity of Brine Water from Oil Wells," *Trans. Amer. Fish Soc.* 84: 97-109 (1954).

12. J. E. McKee and H. W. Wolf, eds., *Water Quality Criteria*, California State Water Quality Control Board, 1963.

13. Department of Housing and Urban Development, *Noise Abatement and Control: Department Policy, Implementation, Responsibilities, and Standards*, Circular 1390.2, August 4, 1971.

14. U.S. Department of Agriculture, Soil Conservation Service, *Guidelines for Erosion and Sediment Control in Urban Areas of New York State*, Syracuse, New York, 1972.

5. ENVIRONMENTAL EFFECTS OF OPERATION OF THE STATION AND TRANSMISSION FACILITIES

5.1 IMPACTS ON LAND USE

5.1.1 Station operation

Of the 2800-acre site, about 91%, or approximately 2545 acres, will not be altered by construction. Approximately 1600 acres outside the exclusion boundary will be kept in present land use. Remaining acreage inside the exclusion boundary will be left in the natural state as much as possible; thus, about 270 acres of agricultural land within the exclusion area will be removed from agricultural productivity.

5.1.2 Transmission lines

For both onsite and offsite transmission lines, a total of 147 acres of right-of-way will be required. Forty-nine acres are agricultural land, the remaining consisting of natural communities. Of the 98 acres of natural communities to be crossed, about 67 acres of wooded land will be cleared and maintained as required.

The electric field associated with an energized 765-kV transmission line will induce voltages in conducting objects within the field. If the object is well grounded, the resulting potential between the object and the ground will be near zero. However, if the object is insulated from the ground, significant voltages may be induced and a potential shock hazard created. The magnitude of the charge, and therefore the severity of the shock, will be related to parameters associated with the transmission line design, line voltage, size and dimensions of the object, proximity of the object to the line, and degree of insulation of the object from the ground. The quality of the insulation between a person coming in contact with such an object and the earth will, of course, also affect the severity of the shock.

Body-passage currents caused by contact with a charged object may range from barely detectable currents to those resulting in lethal effects. Dalziel[1] reports that currents less than about one milliampere (mA) produce little or no measurable physiological response. Therefore, these are not classed as shock currents. Shock currents have been classified into two groups according to the degree of severity of shock they produce.[1] Currents between 1 (the perception level for steady-state current) and 6 mA are considered secondary or "let-go" currents. Let-go current is the maximum current level at which a human holding an energized conductor can control his muscles enough to release the conductor. Secondary currents, although not dangerous in themselves, may cause involuntary movement that could trigger an accident. Currents of 6 mA or larger are considered primary currents. The most dangerous possible consequence of primary shock current is ventricular fibrillation, a condition of incoordinate action of the main pumping chambers of the heart, resulting in immediate arrest of blood circulation. The current at which fibrillation begins varies with the weight of the person shocked and with the shock duration.[2]

According to the IEEE Working Group on Electrostatic Effects of Transmission Lines, "the value of ground gradient at the threshold of sensation (about 1 mA) is equal to or greater than 15 kV/m for the great majority of cases."[3] The applicant states that the maximum electrostatic field gradient resulting from operation of the 765-kV lines is expected to be 9.5 kV/m within the right-of-way at a point of minimum conductor-to-ground clearance. These values are consistent with the design requirements that electrostatically induced voltages from the transmission line do not exceed the perception level. If the magnitude of the field is as intended, a person near or on the transmission line right-of-way should not be subject to a shock hazard.

The IEEE Working Group found that a significant shock hazard can develop if insulated conducting objects are placed in close proximity to high-voltage transmission lines. In particular, they state that "lethal currents can be built up on long insulated fences under such lines."[3] To prevent this occurrence, the applicant plans to ground all metallic fences that enter or cross the transmission line right-of-way.

The IEEE Group also suggested that the "parking of vehicles in transmission line rights-of-way above 230 kV should be reviewed in detail on an individual basis."[3] Care should also be taken to assure that stationary structures, such as barns with metal roofs, are adequately grounded to prevent the build-up of electrostatic charge. As the IEEE Group states, "In all cases, careful grounding of objects or conductors will limit electrostatic hazards."[3] The staff will require the design and construction of the proposed 765-kV transmission lines to include provisions for adequate grounding and surveillance to ensure that shock hazards will be minimized.

5.2 IMPACTS ON WATER USE

5.2.1 Surface water

There will be no direct consumptive use of water by the once-through cooling system proposed by the applicant. The extra evaporation from Lake Ontario caused by the discharge of waste heat will be less than 9×10^8 ft^3/year. This is less than 0.2% of the natural evaporation from the lake. Possible impacts on Lake Ontario include those resulting from thermal and chemical effluents. The staff does not expect the Sterling plant to cause significant effects on navigational or recreational uses of the lake.

5.2.2 Groundwater

The Sterling site will use no groundwater during operation. The natural flow of the groundwater is toward Lake Ontario, and because there are no down-gradient offsite wells, there will be no effect on local groundwater use during plant operation.

5.3 EFFECTS OF OPERATION OF THE HEAT DISSIPATION SYSTEM

As described in Sect. 3.4, the applicant has proposed a once-through cooling system for Sterling Power Project Nuclear Unit No. 1. The primary environmental impacts of this system will be the withdrawal, heating, and discharge of 1860 cfs of Lake Ontario water at design conditions.

5.3.1 Applicant's analysis

5.3.1.1 Water discharge

Heated water will be discharged to Lake Ontario through a surface canal described in Sect. 3.4.3. Many complex fluid dynamic and thermal phenomena near the Sterling site have been reported in the ER and elsewhere. These include wind-driven currents, surface waves, internal waves,[4] Langmuir cells,[5] thermal bars, fine structure layering,[6] and stratification. Because no existing analytical model can reliably predict the behavior of heated water discharged into such a complex ambient, the applicant has presented three separate studies of the Sterling plume. The earliest study was performed for the applicant by Acres American, Incorporated, and is presented in the ER as Appendix 5A. This study forms the basis for the discussion of thermal impacts in the ER. The second and third studies were performed for the applicant by NUS Corporation and do not appear in the ER. They form Appendices 4B and 4C of the Operating Discharge Permit Application — 316(a) and 316(b) Demonstrations.[7] Since NUS I and NUS II were issued subsequent to the preparation of the Sterling DES, they were not discussed in that document. Each of the applicant's studies assumes a flow rate of 1936 cfs, a temperature rise of 19.7°F, and a heat rejection rate of 2510 MWt (6% higher than the present design value). These conservatively high values correspond to an earlier design of the Sterling reactor. None of the applicant's studies takes account of the schedule of deliberate recirculation proposed in Table 3.4, and none accounts for the sinking plume phenomenon which is expected to occur whenever the ambient lake temperature drops below 39°F. In the following sections, special attention is given to the surface area within the 3°F excess temperature isotherm, because this is the New York state criteria governing thermal discharges (Sect. 5.3.3).

5.3.1.1.1 Acres American study

The Acres American study (ER, Appendix 5A) derived a model for the Sterling discharge from observations of the thermal plume at a nearby power station with a similar discharge.

Since 1969, the applicant has operated the Ginna Nuclear Power Plant, a 490-MWe plant on Lake Ontario about 35 miles WSW of Sterling. At design conditions, Ginna heats 892 cfs about 19°F and discharges it into the lake through a surface canal of trapezoidal cross-section. The applicant has mapped the thermal plume once each month since March 1970, except during periods of shutdown or inclement weather. These measurements are obtained by a boat-mounted thermistor array. Data from four depths, ranging from 6 in. to about 8 ft, are recorded and used to produce maps of isotherms at 1°F intervals. Figure 5.1 shows one such map. The Acres American study envisions Ginna as an elaborate physical model of Sterling and extrapolates the results of the Ginna monitoring program to predict the Sterling plume.

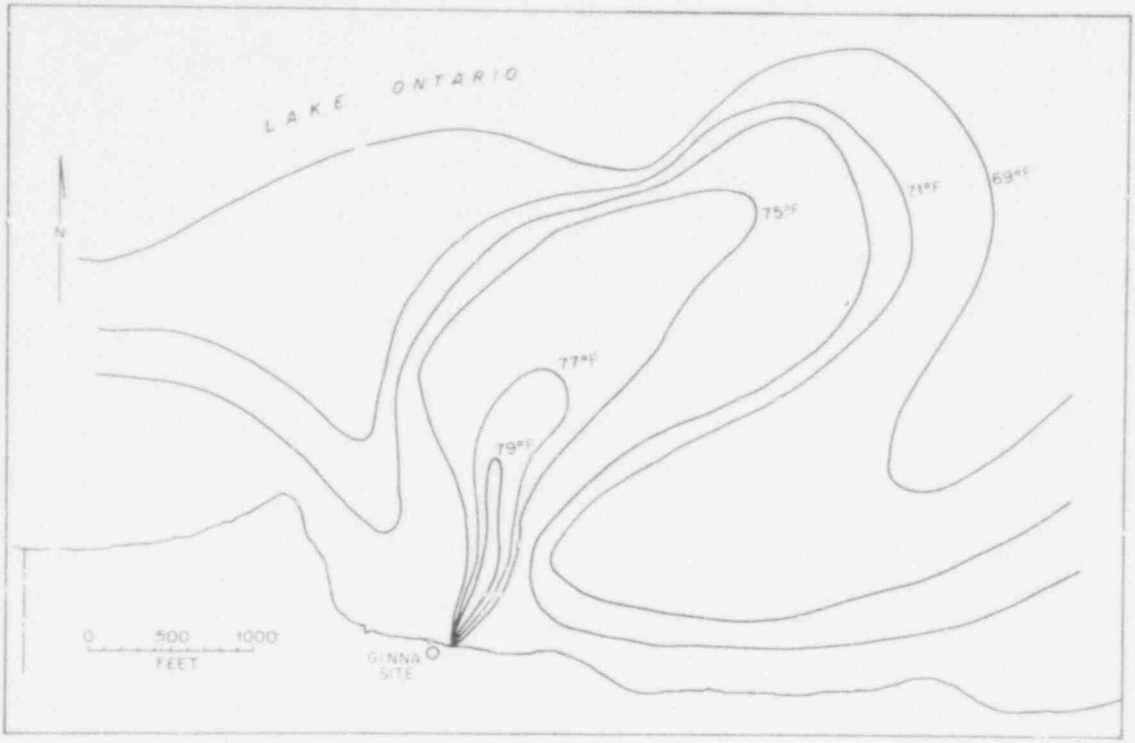


Fig. 5.1. Surface isotherms in Lake Ontario measured at 6-in. depth near the Ginna site on July 15, 1971.

More than 36 individual plumes had been mapped by November 1974, but the Acres American study incorporated into the ER is based on the analysis of only eight plumes. The dates of the chosen plume maps are 6-23-70, 7-14-70, 6-28-71, 7-15-71, 8-31-71, 9-30-71, 7-19-72, and 8-30-72. Although the chosen plumes spanned more than two years, they all occurred during summer or early fall. Consequently, they do not represent the full range of environmental parameters encountered during an annual cycle. Despite the fact that the range of measured operating and ambient parameters associated with these plumes is relatively small, the areas enclosed by the 3°F excess temperature isotherm vary by more than an order of magnitude.

Acres American generalized these eight plumes in the following manner. A curvilinear coordinate system was established by taking as the x-axis the locus of vertices of the isotherms. Horizontal straight lines normal to the x-axis define the r directions. The z coordinate is the depth below the surface. For each plume, the centerline temperature above ambient (excess temperature) at various distances along the center line and the r variation of excess temperature at these locations were recorded. This information was nondimensionalized by appropriate temperature and length scales and then plotted. Because of the large amount of scatter, curves representing average and worst-case conditions were drawn through the data. These curves fix the nondimensional relationship between position and temperature for all dynamically similar plumes, regardless of actual size. The same process was performed on z = 6 ft data from six of the same data sets. By reversing the procedure, idealized predictions of the Sterling plume were obtained. These predictions assume that the plant discharges 1936 cfs of 61.7°F water into a motionless, unstratified 42°F lake. The lake is assumed to be at its annual average level [246 ft (USGS)], resulting in a discharge velocity of 3.71 fps and a Froude number of 6.9. The formulation does not allow an assessment of the effect of varying lake level or ambient temperature, but idealized isotherm plots for average and worst-case plumes are presented for the 6-in. and 6-ft levels. The surface area within the 3°F excess temperature isotherm is predicted to be 174 acres under average conditions and 1160 acres under worst-case conditions.

The validity of this method depends on whether dynamical similarity of the two discharges exists and it also depends on whether all relevant variables have been accounted for. Since these questions also arise in connection with NUS II, they will be addressed in Sect. 5.3.1.1.3. Aside from such considerations, the staff believes that the Acres American study has two serious limitations: the small and unrepresentative data base from which it is derived and the inability to account for plume variations in response to changes in ambient conditions.

Currents near the south shore of Lake Ontario are light and variable. In these eight sets of Ginna data, ambient currents were always less than 7% of the discharge velocities. Such small cross flows will deflect the plume but should have little effect on its dilution; hence, the dynamical effects of ambient currents have been ignored in the Acres American analysis.

Based on the relationships derived in the Acres American study, the applicant has prepared plots showing plumes kinematically deflected by alongshore currents. The staff feels these plots contain so many approximations that they serve little purpose.

The Acres American study has attributed the great scatter in the measured plumes to the variation of surface heat transfer and has provided predictive curves for average and low-heat transfer. In the staff's opinion, the range of heat exchange coefficients in the eight measured cases (3.3 to 4.8 Btu/ft^2 per hr per °F) is insufficient to explain the order of magnitude variation in areas. The staff suggests that variations in ambient turbulence level, perhaps as a cumulative result of several days' weather, are a more probable cause. Unfortunately, sufficiently detailed current records are not available to verify this hypothesis.

5.3.1.1.2 NUS I

NUS I [316(a) Demostration – Appendix 4B][7] is a parametric study that was conducted to indicate how variations in ambient conditions would affect the predictions of the Acres American study (which apply for one particular set of ambient conditions only). The study was conducted using the computer program HOTSUD. This program is based on the three-dimensional, steady, near-field surface discharge model developed by Stolzenbach and Harleman.[8] This approach accounts for buoyancy, turbulent entrainment, and surface heat loss. The approach neglects ambient turbulence, ambient stratification, and the effect of finite water depth.

Solutions were obtained for the nine cases formed by considering lake levels of 244 ft, 246 ft, and 248 ft (U.S. Geological Survey) and lake temperatures of 42°F, 60°F, and 75°F. The 246 ft, 42°F conditions are those for which the predictions of the Acres American study are valid. This is termed the base case. The areas within the 1°F to 15°F excess temperature isotherms at the surface and the 6-ft level were divided by the corresponding areas of the base case. Only the area ratios are presented; the actual areas predicted by HOTSUD are not given. To determine the area within the 5°F excess temperature isotherm when the ambient temperature is 75°F and the lake level is 244 ft, one would multiply the area within the 5°F isotherm predicted in the Acres American study by the appropriate ratio from NUS I.

Increasing the ambient temperature means enhanced buoyancy forces, increased surface isotherm areas, and a lowered Froude number (other things being equal). Increasing the lake level affects both the Froude number and the aspect ratio. Increasing the lake level increases the discharge depth and decreases the discharge velocity, thus reducing the Froude number. This trend tends to increase the surface isotherm areas. On the other hand, increasing the lake level increases the aspect ratio, which tends to increase entrainment, and hence, decrease the surface isotherm areas. The range of aspect ratios considered in these calculations is only 0.22 to 0.34, and the effect is expected to be small. The actual calculations show that increasing the lake level does increase the surface isotherm area ratios, thus verifying the fact that the Froude number effect is dominant for the cases under consideration. The surface isotherm area ratios in this study vary from 0.26 to 6.7, with the greatest effect at excess temperatures of 5°F to 6°F. The average condition area within the 3°F excess temperature isotherm at Sterling is expected to range from 63 acres for the 244-ft (USGS), 42°F case to 450 acres for the 248-ft (USGS), 75°F case. The corresponding worst-case areas are predicted to be 410 acres and 2950 acres.

Increasing ambient temperatures and lake levels increase the 6-ft depth area ratios for high excess temperatures and decrease the 6-ft depth area ratios for small excess temperatures. Increasing ambient temperatures and lake levels decrease the maximum depth of plume penetration. The ratio of plume depth to that of the base case varies from 0.47 to 1.33.

The Stolzenbach-Harleman[8] model assumes an infinitely deep ambient; consequently, the application to the Sterling plume requires that the effect of the lake bottom on the size of the isotherms should in all cases be the same as for the base case. As pointed out in NUS I, this is not true. In fact, an increase in the Froude number implies an increase in severity and area of bottom interference. Furthermore, it should be noted that the Stolzenbach-Harleman[8] model is a near-field model and is, therefore, of questionable validity at the 3°F excess temperature isotherm. Since these uncertainties must be confounded with the uncertainties of the Acres American study, the staff does not place a high degree of confidence in the results of NUS I.

5.3.1.1.3 NUS II

NUS II [316(a) Demonstration — Appendix 4C][7] uses observations of the Ginna plume to construct an empirical model of the Sterling plume. In this respect, it is similar to the Acres American study, but NUS II is a more complete and systematic work. The NUS II data base consists of 43 monthly plume surveys of the type described in Sect. 5.3.1.1.1. They were taken from 1970 through 1975 and include plumes in all months except January, February, and March. The ambient temperature is always greater than 39°F, so no sinking plumes were studied.

Analyses are presented for both surface and subsurface isotherms. The surface analysis makes use of all 43 isotherm maps at the 6-in. depth. A curvilinear coordinate system was constructed for each plume in the manner described in Sect. 5.3.1.1.1. For each plume, the centerline excess temperature and corresponding temperature half widths were measured and nondimensionalized by the square root of half of the discharge area. A mathematical function expressing the dependence of dimensionless centerline excess temperature on dimensionless position, lake level, and Froude number was postulated. A least-squares regression analysis showed that the dependence on lake level and Froude number was negligible and led to a correlation between dimensionless temperatures and position with a correlation coefficient of 0.784. A function expressing the dependence of dimensionless halfwidth on dimensionless position, lake level, and Froude number was also postulated. Least-squares regression revealed that the dependence on lake level was negligible and resulted in an expression for dimensionless halfwidth as a function of dimensionless position and Froude number, with a correlation coefficient of 0.647. Lateral excess temperature distributions from five surveys were found to be adequately represented by a normalized Gaussian function, and this form was adopted. It is not clear whether only 6-in. depth data was used to deduce this relation, but it has apparently been used to characterize the lateral excess temperature distribution at subsurface depths, also.

For a given Froude number, these correlations can be evaluated using the Sterling scale factors to predict the surface isotherms which are expected at Sterling. Figure 5.2 illustrates the expected distribution for the average lake level of 246 ft (USGS) and an ambient temperature of 50°F. The smooth, symmetrical nature of this plot is clearly unrealistic, but it does give some feel for the pattern to be expected. From such figures, the area within given isotherms can be measured. The area enclosed by the 3°F excess temperature isotherm as a function of lake level and ambient temperature is illustrated in Fig. 5.3. The area is seen to increase with increasing lake levels and ambient temperatures in agreement with NUS I. For the same conditions for which the Acres American study predicted 174 acres, NUS II predicts 164 acres.

The least-squares correlations for dimensionless centerline excess temperature and dimensionless halfwidth discussed above are representative of all the measured cases. Consequently, they lead to predictions of average or expected plumes. To account for extreme conditions, 95% upper confidence interval plume areas were determined by combining the 95% upper confidence interval relation for dimensionless centerline excess temperature with the expected (correlation equation) value for dimensionless halfwidth. Comparison of such a combination with the original Ginna measurements supports this assumption. Since the expected values of the dimensionless halfwidth depend on lake level and ambient temperature, the 95% upper confidence interval areas also show this dependence. The 95% upper confidence interval areas are assumed to represent worst-case conditions. The worst-case areas within the 3°F excess temperature isotherms are presented in Fig. 5.4. For the same conditions for which the Acres American study predicted a worst-case area of 1160 acres, NUS II predicts about 470 acres.

To investigate how the worst-case plume might vary from month to month, 95% upper confidence intervals were determined for the daily maximum water levels recorded at the National Oceanic and Atmospheric Administration Rochester gaging station[9] from January 1953 through February 1975 and for the monthly averages of daily maximum Ginna intake temperatures[10] from 1970 through 1974. These values were used to calculate the expected dimensionless halfwidths and resultant monthly worst-case plume configurations. The areas within the 3°F excess temperature isotherms are listed in Table 5.1. No prediction is given for February because the plume is expected to sink due to the low ambient temperature. The predicted trend is for larger plumes to occur during the summer months.

Since the Ginna plume seldom extended below 10 ft, data collected near the 6-ft level was selected to characterize the subsurface plume. During the course of the Ginna monitoring program, the depths of the subsurface probes were frequently changed. Hence, data taken at depths of 6 ft ± 13 in. were used in this analysis. In addition, some subsurface data were rejected because of anomalous features. This left a 32-plume subset for analysis out of the original 43-plume subset.

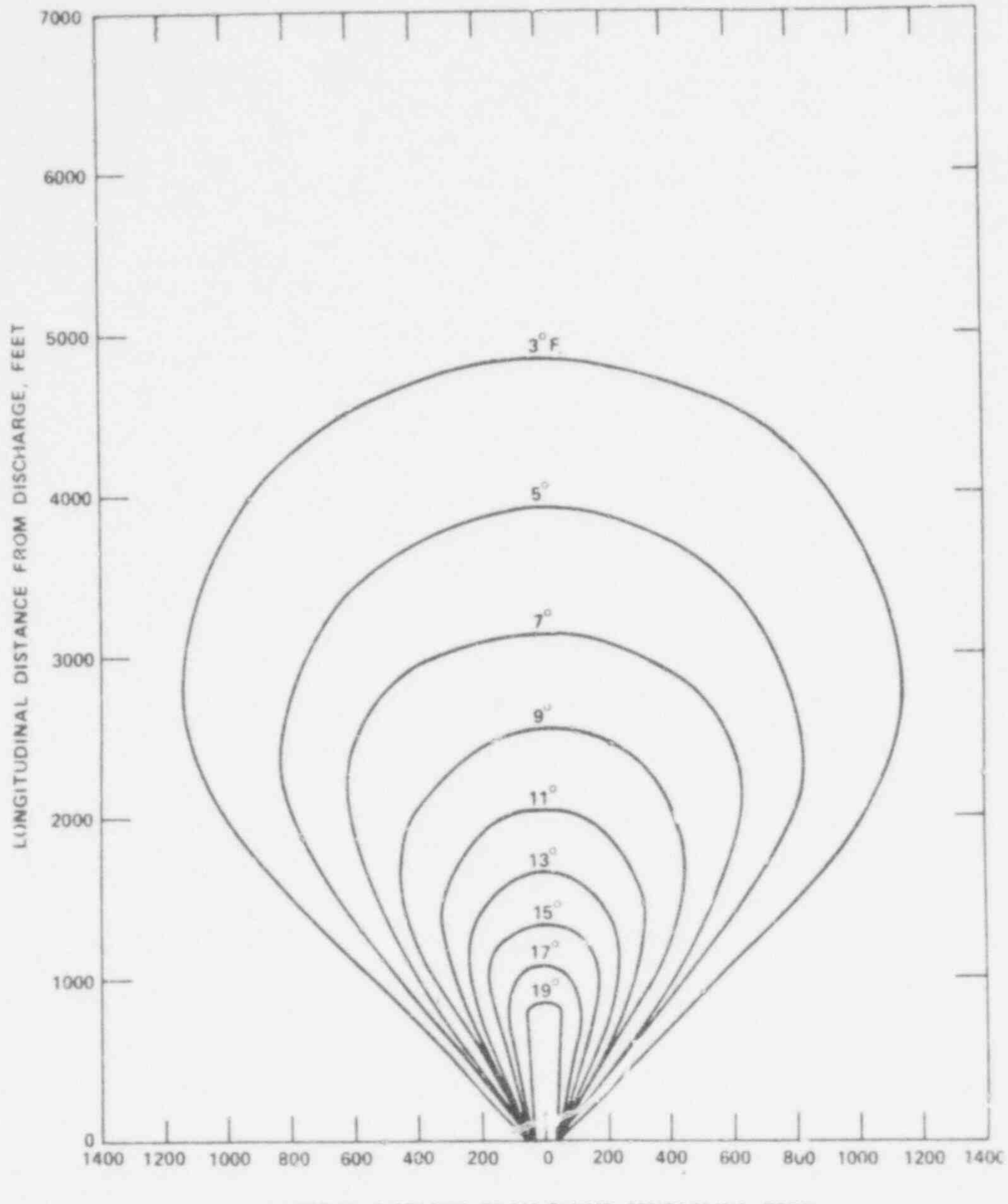


Fig. 5.2. Applicant's prediction (NUS II) for lake surface isotherms at Sterling. Lake level = 246 ft (USGS), ambient temperature = 50°F, Froude number = 5.5. Source: 316(a) Demonstration, Appendix 4C, Fig. 24.

The same technique used in the surface study shows that the subsurface centerline dimensionless excess temperature depends on dimensionless position and Froude number. The correlation coefficient for this relation is 0.746. The subsurface dimensionless halfwidth is determined by dimensionless position and Froude number, with a correlation coefficient of 0.600. These relations are used with the normalized Gaussian lateral temperature function to predict expected subsurface plumes at Sterling. NUS II argues that vertical distances should scale with discharge depth rather than the square root of half of the discharge area. Since the ratio of discharge depths at Sterling and Ginna is about 1, the study concludes that subsurface depth to which these predictions apply at Sterling is 6 ft. The expected subsurface isotherm pattern corresponding to the surface pattern in Fig. 5.2 is presented in Fig. 5.5. As shown in Fig. 5.6, the expected area within the subsurface 3°F excess temperature isotherm increases with increasing lake levels and decreases with increasing ambient temperatures. These trends agree with NUS I. Table 5.1 tabulates the monthly worst-case subsurface areas obtained by the same method as the surface worst-case areas. Larger areas are seen to be predicted during the winter months. This implies a greater interaction with the lake bottom, particularly since the lake level is lowest during that period.

715 083

721 024

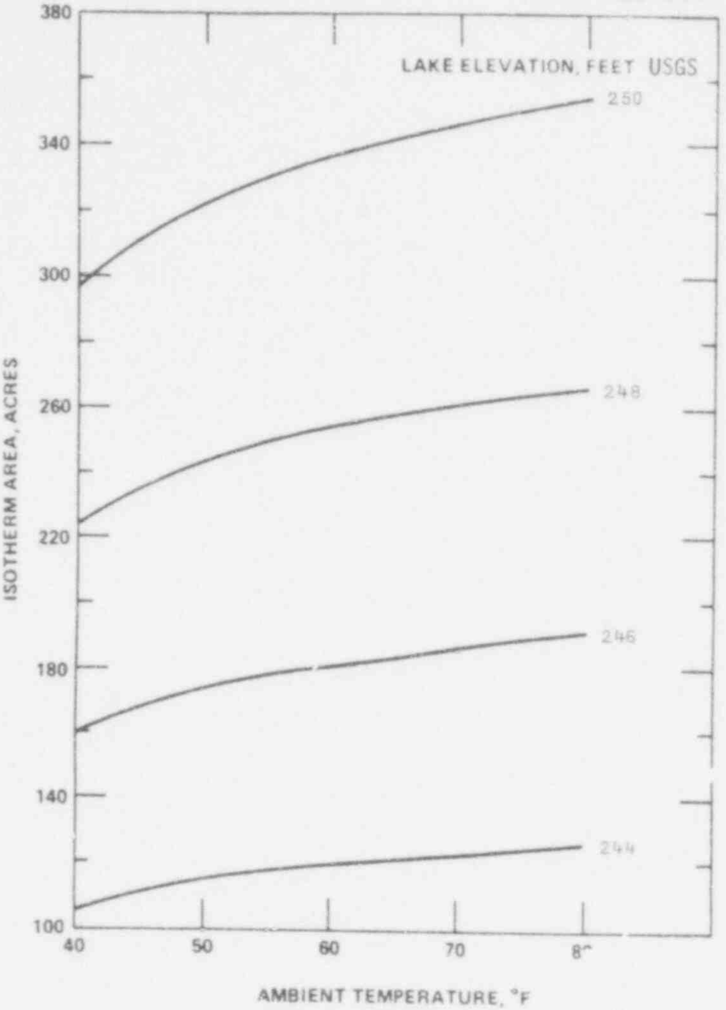


Fig. 5.3. Applicant's prediction (NUS II) of expected areas within 3°F excess temperature surface isotherm at Sterling. Source: 316(a) Demonstration, Appendix 4C, Fig. 19.

The validity of the approach used in NUS II and in the Acres American study depends on the existance of dynamical similarity between the Ginna and Sterling discharges. This requires that all relevant variables scale properly or, alternatively, that all nondimensional variables be identical. Among the factors which might influence the extent of the thermal plume are Reynolds number, Froude number, discharge geometry, lake bottom geometry, shoreline geometry, surface heat transfer, ambient current speed and direction, and ambient turbulence level.

Both the Ginna and Sterling discharges have Reynolds numbers which are far into the turbulent range. Similarity in this parameter is assured. The Sterling discharge canal has been designed so that it will operate in the same Froude number range as Ginna. NUS II explicitly includes the influence of Froude number variation in its analysis.

Similarity of discharge geometry has been considered in terms of channel side slope, aspect ratio, and dimensionless lake level. Both channels have the same side slope. In order to maintain Froude number equality, the velocity and depth of the Sterling discharge were made approximately equal to those at Ginna. Since the Sterling flow rate is double that at Ginna, the channel had to be made wider. The aspect ratio is defined as channel bottom width divided by depth. The staff believes that a more appropriate definition for a trapezoidal channel would involve the average width. Nevertheless, it is true that the aspect ratio of a given discharge depends only on the lake level. In going from Ginna to Sterling, however, the aspect ratio increases by a factor of about 2.7, owing to the greater width of the canal. This is outside the range of aspect ratio variation experienced at Ginna and introduces the uncertainty of extrapolation into the analysis. NUS II and the Acres American study argue that this change in aspect ratio is accounted for by the use of the square root of one-half the discharge area as a horizontal scale factor. The staff acknowledges that this is true for discharges into unbounded ambients, but points out that there may be more important aspect ratio effects in this case

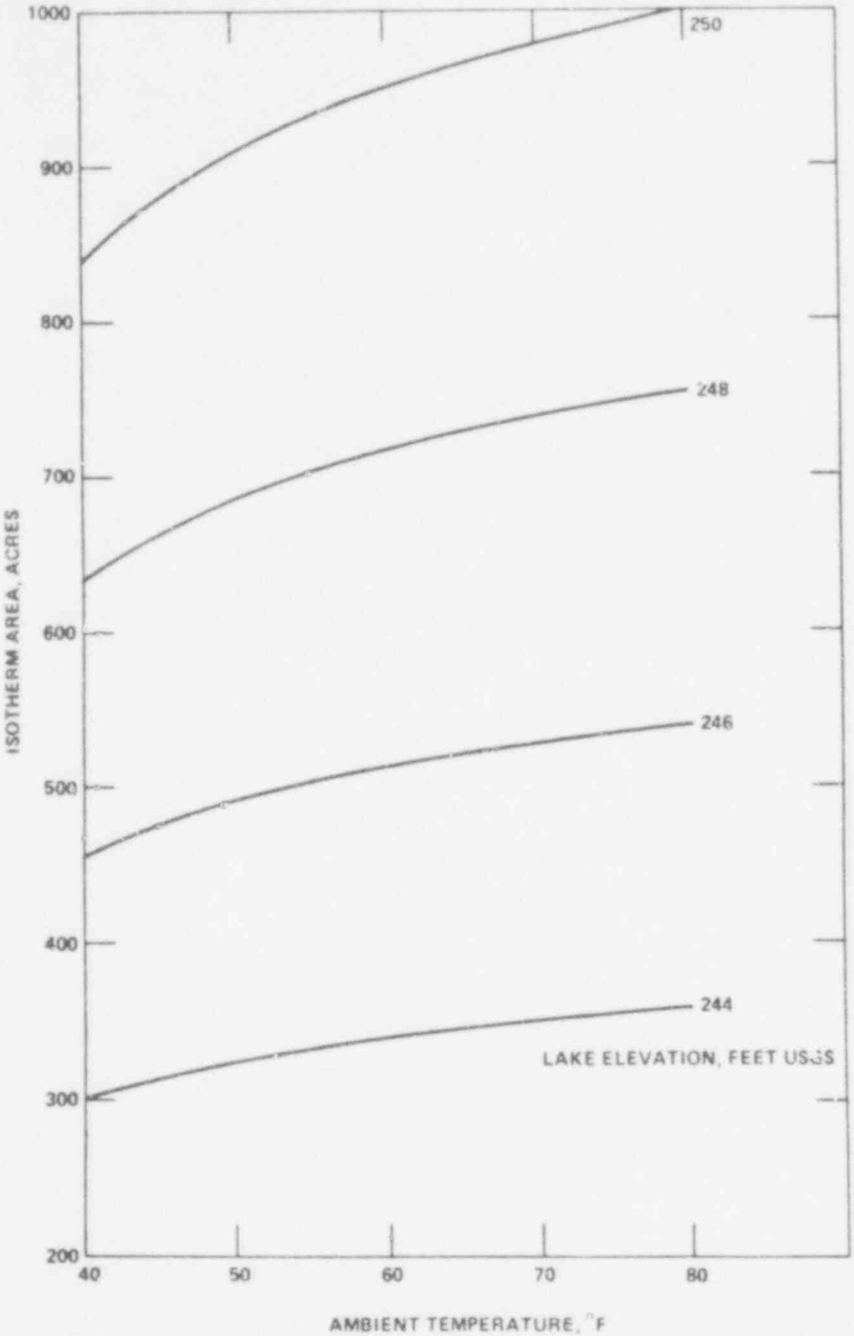


Fig. 5.4. Applicant's prediction (NUS II) of worst-case areas within 3°F excess temperature surface isotherm at Sterling. Source: 316(a) Demonstration, Appendix 4C, Fig. 38.

because of the shallowness of the receiving water. The greater aspect ratio at Sterling means that a greater percentage of the plume surface will suffer reduced entrainment due to the proximity of the bottom. NUS II attempts to quantify the effect of the lake bottom on the Ginna plume by examining the dependence on the lake level and reports no significant correlation. This is probably because of the relatively small range of lake level fluctuations and because the effects of these changes show up in the Froude number. This technique cannot account for the mechanism suggested above, however. There is an additional difference in the geometries of the two discharges that has been overlooked by NUS II and the Acres American study. This difference is a 90° bend in the Ginna canal 30 ft upstream of the discharge. The staff believes that this bend probably creates significant large-scale turbulence and results in higher dilutions than if the canal were straight as at Sterling.

721 026

715 085

Table 5.1. Applicant's prediction of monthly worst-case areas within 3°F excess temperature isotherms

Month	Ambient temperature–95% upper confidence level (°F)	Lake elevation–95% upper confidence level (ft USGS)	Worst case 3°F surface isotherm area (acres)	Worst case 3°F subsurface isotherm area (acres)
January	39.4	247.52	584	290
February	35.2	247.56		
March	40.4	248.27	663	303
April	50.8	248.98	795	287
May	49.8	249.23	819	293
June	62.8	249.23	865	270
July	69.5	249.02	856	260
August	70.0	248.44	805	245
September	71.9	247.64	724	244
October	59.6	247.25	636	248
November	53.4	247.03	599	252
December	45.5	247.12	580	267

Source: Rochester Gas and Electric Corporation, *Application to the New York Board on Electric Generation Siting and the Environment (Nuclear)*, Federal Water Pollution Control Act, 316(a) and 316(b) Demonstration, vol. IV, November 1975.

The effects of differing lake topography are also difficult to judge. The lake bottom slopes nearly twice as fast at Ginna (1:120) as at Sterling (1:200). This difference implies that there will be less dilution from below at Sterling, an effect enhanced by the wider discharge. On the other hand, Smoky Point peninsula tends to shield the Ginna plume from westerly ambient currents, perhaps reducing dilution. On the basis of comparison of the Ginna data with theoretical predictions, laboratory experiments, and other field data, the studies presented by the applicant conclude that the shielding effect of Smoky Point is quite significant and will result in conservative predictions of the Sterling plume. The staff does not feel that this point has been proven.

Because the two sites are relatively close together, the surface heat transfer, which reflects the influence of weather conditions, should be very similar. Moreover, the staff agrees with the conclusion of NUS II that the effect of surface heat transfer is relatively minor, at least within the 1°F isotherm.

The influence of ambient currents is neglected in NUS II because no data were available for analysis and because high currents should tend to enhance dilution. The staff points out that the lack of information on currents at the times of the Ginna surveys implies that some high current cases may have been included in the data base, thus reducing the degree of conservatism in the model. The effect of ambient turbulence level has also been neglected due to a lack of data. This is particularly unfortunate since the staff suspects that this parameter may be one of the most important influences on plume size.

An additional uncertainty arises in connection with the subsurface analysis. NUS II is based on measurements taken at approximately the same physical depth (6 ft ± 13 in.). Actually, the measurements should be taken at the same dimensionless depth (measurement depth divided by discharge depth). The dimensionless depths of the subsurface measurements used in NUS II have a large range: from 0.45 (6-20-73) to 0.87 (12-1-71). A possible symptom of this inconsistency is revealed by a comparison of the surface and subsurface isotherm maps for ambient temperature (40°F) and lake level (244 ft) (NUS II, Figs. 23 and 34). In these maps, the subsurface 9, 7, 5, and 3°F isotherms extend further into the lake than do the corresponding surface isotherms. The staff knows of no physical mechanism that could produce this result, nor is it aware of any experiments in which such a phenomenon has been observed. Consequently, the staff believes that the subsurface analysis of NUS II must be regarded with particular caution.

The accuracy of all the analyses presented by the applicant depends ultimately on the quality of the field data. Few details of the measurement program have been supplied. One source of error which is well known is the difficulty of specifying an ambient temperature. This is commented on in Sect. 6.1.1.

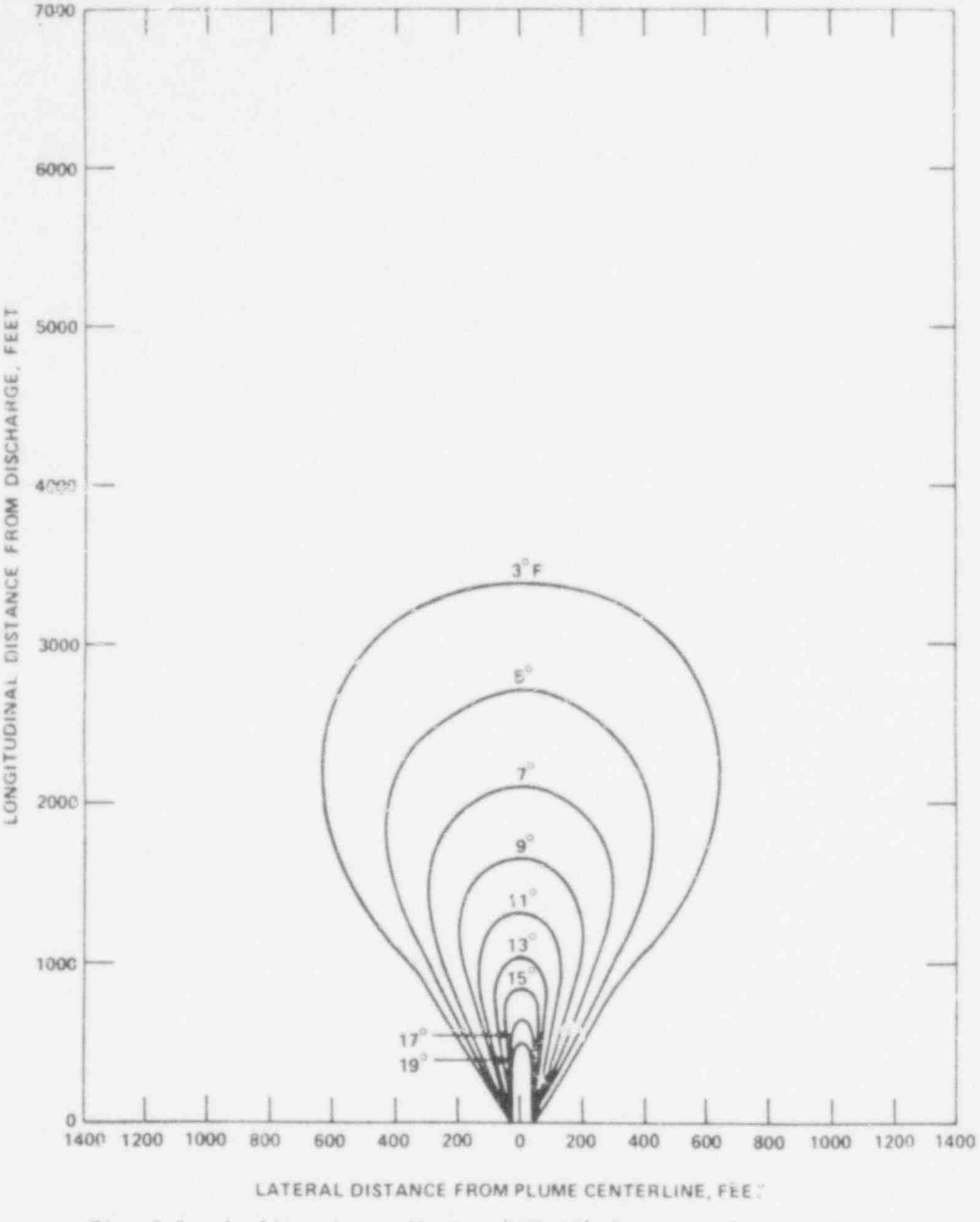


Fig. 5.5. Applicant's prediction (NUS II) for subsurface isotherms at Sterling. Lake level = 246 ft (USGS), ambient temperature = 50°F, Froude number = 5.5. <u>Source</u>: 316(a) Demonstration, Appendix 4C, Fig. 35.

5.3.1.1.4 Dye studies

The applicant has performed a series of dye dispersion studies described in the ER, Appendix 2A. During August 1973, dye was released continuously at a constant rate, and concentrations were measured daily by an instrumented boat. By means of the heat-dye analogy, the isoconcentration lines were related to isotherms. Since the heat-dye analogy neglects near-field dilution, buoyant spreading, and heat transfer to the atmosphere, the results obtained are conservative. This study indicates that the area within the 3°F isotherm will vary from 380 to 2000 acres during August. Because heat transfer to the atmosphere has no effect on dye, the staff attributes this large range to changes in the ambient turbulence.

During the course of the August study, an equipment malfunction resulted in the release of a large slug of dye. Analysis of the dispersion of this slug yielded an eddy dispersion coefficient close to that previously measured at Ginna. This result suggests that ambient turbulence is similar at the two sites and adds confidence to the use of Ginna data to model the Sterling plume.

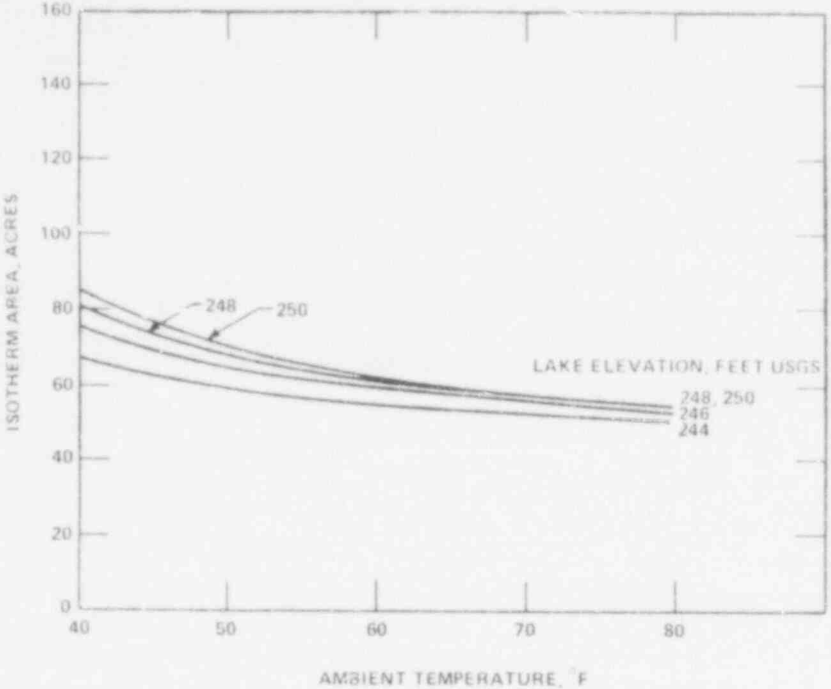


Fig. 5.6. Applicant's prediction (NUS II) of expected areas within 3°F excess temperature subsurface isotherm at Sterling. Source: 316(a) Demonstration, Appendix 4C, Fig. 27.

5.3.1.2 Water intake

Flow velocities through various parts of the intake structure have been discussed in Sect. 3.4.2. The applicant has also presented an approximate analysis of the amount of inadvertent recirculation that could result from heated water being drawn into the intake. This analysis uses the relations developed by Bohan and Grace[11] for withdrawal of fluid from a stratified reservoir. The applicant assumed that the intake structure proposed in the ER, Rev. 8, was 3800 ft offshore rather than the proposed 4200 ft. The center line of the plume was assumed to lie directly over the intake, and the plume was assumed to be 8 ft deep, with a linearly decreasing temperature profile. These assumptions are very conservative. Using the Acres American plume predictions, calculations were carried out for average and low surface cooling conditions, 42 and 70°F ambients, and average [246 ft MSL (USGS)] and low (242 ft MSL) lake levels. The greatest temperature rise at the intake above ambient was 0.35°F in the case of average surface cooling, 42°F ambient, and low lake level. When the lake temperature drops below 39°F, the plume will begin to sink. Under this condition, higher inadvertent recirculation temperatures conceivably might result. Because little is known about the dynamics of the sinking plume, no definite statement can be made. On the other hand, the applicant intends to use deliberate recirculation to maintain the intake water temperature at 36°F. In those instances, entrainment of the plume by the intake will be a favorable occurrence. The reduced intake velocity of 0.8 fps to which the applicant is committed will probably further reduce recirculation. The staff concludes that recirculation will not be a problem at Sterling.

5.3.2 Staff's analysis

As noted in Sect. 5.3.1.1, the fluid dynamics of a surface discharge into Lake Ontario is too complex for treatment by existing analytical models. Hence, the staff has made use of the semi-empirical model of Pritchard.[12,13] This combined near-field/far-field model is based largely on the personal observations of D. W. Pritchard. Although it has little theoretical justification, this model has often been found to yield more accurate predictions than more sophisticated treatments.

The computer program written by the staff follows closely the outline presented in Ref. 12. Initially, the surface areas within specified isotherms are calculated under the assumption that the plume spreads horizontally, but not vertically. These numbers are then corrected for vertical spreading if the critical mixing depth (Z_c) is assigned a different value than the depth of discharge (Z_o). Next, a correction for stratification is applied if the intake temperature is different from the surface ambient temperature. Finally, the surface area within each isotherm is reduced to account for heat transfer to the atmosphere.

Because tnis technique has little foundation in theory, the conditions under which it will yield accurate predictions cannot be known a priori. To see if it would be adequate at Sterling, calculations were made for 19 of the thermal plumes measured by the applicant at Ginna. The details of this comparison are presented in Appendix E. The staff found that the best results were obtained by accounting for lake level variations, taking the discharge width equal to the average width of the trapezoidal cross section and letting Z_σ equal Z_o and 10 ft. For individual plumes, the predictions were usually within a factor of three of the measured area within the 3°F excess temperature isotherm. Because Pritchard's model sometimes underpredicted, it cannot be considered conservative in all cases. On the average, calculations with $Z_\sigma = Z_o$ and 10 ft bracketed the measured area.

Heat transfer to the atmosphere was calculated by using an overall heat transfer coefficient K. This value was calculated by a well-known correlation recommended in Ref. 12 as a function of excess temperature and wind speed. The results were relatively insensitive to the exact value of K, because about 90% of the heat was usually advected beyond the 1°F isotherm. This is in agreement with previous findings.[13]

Satisfied that Pritchard's model is a reasonable approximation for Sterling, the staff calculated plumes for the conditions described in Table 5.2. In each case, the plant was assumed to be rejecting 2359 MWt in accordance with the most recent design conditions. Monthly and annual average lake levels at Oswego, New York, for the period 1960 to 1970[14] were assumed for Cases 1 through 13. Cases 14, 15, and 16 used the absolute minimum, minimum monthly average, and maximum lake levels at Oswego as reported in the ER, Sect. 2.5.1.1.1.2. The parameters of Case 17 were chosen to be identical to those used in the Acres American study. Cases 18, 19, and 20 are the same cases for which isotherm plots are provided in NUS II. Flow rate and condenser temperature rise were chosen to reflect the deliberate recirculation schedule proposed in Table 3.4. The intake temperatures for Cases 1 through 13 were rounded off from the 5-year average intake temperatures measured at Ginna and reported in the ER, Table 520.4-1. Cases 14 and 15 assume 40°F, and Case 16 assumes the maximum observed lake temperature reported in the ER, Sect. 2.5.2.1. The values used for the difference between intake and ambient temperatures were derived from the ER, Tables S80.2-8 and S80.2-9. Temperature differences between the 0.2- and 8-m levels at the 11-m station of the east transect (see Fig. 6.1) were averaged by months and rounded off to produce these numbers. To ensure that heat transfer to the atmosphere was not underestimated, a wind speed of 15 knots was assumed in all cases. This value exceeds all monthly average winds for Rochester, New York, reported in the ER, Table 2.6-4. Typical values of K range from 4 to 8 Btu/ft^2-hr-°F.

Pritchard's model is not intended to apply when the ambient current velocity exceeds 10% of the discharge velocity. According to the ER, Sect. 5.1.1.3.1, currents in the Sterling area have magnitudes below 0.4 fps for at least 80% of the time. Inspection of the discharge velocities in Table 5.2 reveals that Pritchard's model will apply most of the time.

The predicted areas within the 3°F excess temperature isotherm are listed in Table 5.3. The results for Cases 1, 2, and 3 must be regarded with caution because the plume will eventually sink, given the ambient temperatures of these cases. Nevertheless, the trend of larger plume areas during the winter is expected to occur. Evidence of such a trend in the Ginna plume has been reported by Chermack and Galletta.[15] Table 5.4 shows seasonal averages of 60 Ginna plumes measured using airborne infrared radiation thermometry from 1969 to 1972. This trend contradicts the opinion of the applicant, expressed in reply to ER Item 520.8, that predictions based on summer plumes at Ginna are conservative. It is also in contrast to the predictions of NUS II as presented in Table 5.1.

For the conditions of Case 17, the Acres American study predicts a 3°F area of 174 acres in the average cooling case and 1160 acres in the unfavorable case, thus bracketing the staff's predictions. The NUS II report predicts an expected area of 164 acres and a worst-case area of 470 acres. This barely overlaps the staff's predicted range. The NUS II predictions corresponding to Case 18 are 105 acres in the expected case and 300 acres in the worst case, partially overlapping the range of the staff's predictions. The same trend is observed for the conditions of Case 19, for which NUS II predicts 175 acres and 490 acres. Better agreement is exhibited in the predictions for Case 20. Here, NUS II predicts 265 acres and 750 acres. The worst-case prediction exceeds the staff's value. Apparently, better agreement between the staff's predictions and NUS II can be expected for summer plumes.

None of the models which have been applied to predict the Sterling plume is free of objections. At low lake levels and ambient temperatures, the staff's model tends to predict plumes that are larger by a factor of two than those predicted by NUS II. During periods of high lake levels and ambient temperatures, the two models exhibit better agreement. In consideration of the agreement of the seasonal trend of the staff's predictions with plumes measured at Ginna, the staff feels that its model may be more reliable. Comparison with Ginna data has established that it is not always conservative, however.

Table 5.2. Sterling discharge—Pritchard model input conditions

Case number	Description	Lake level[a] (ft)	*Zo* discharge depth (ft)	Flow rate (cfs)	Condenser temperature rise (°F)	Intake temperature (°F)	Stratification[b] (°F)	Discharge velocity (fps)
1	January	244.87	7.37	1539	23.3	34	0	3.45
2	February	244.81	7.31	1539	23.3	33	0	3.48
3	March	244.91	7.41	1539	23.3	34	0	3.43
4	April	245.65	8.15	1860	19.3	40	0	3.72
5	May	246.30	8.80	1860	19.3	44	3	3.41
6	June	246.63	9.13	1860	19.3	52	7	3.33
7	July	246.63	9.13	1860	19.3	64	4	3.33
8	August	246.31	8.81	1860	19.3	67	2	3.41
9	September	245.83	8.33	1860	19.3	64	1	3.63
10	October	245.38	7.89	1860	19.3	54	3	3.86
11	November	245.11	7.61	1860	19.3	47	1	4.02
12	December	245.06	7.56	1766	20.3	39	0	3.85
13	Annual average	245.62	8.12	1860	19.3	48	0	3.74
14	Minimum lake level	239.74	2.24	1860	19.3	40	0	14.99
15	Minimum monthly average lake level	242.67	5.17	1860	19.3	40	0	6.17
16	Maximum lake level	253.00	15.50	1860	19.3	75	0	1.75
17	Acres American	246.00	8.50	1936	19.7	42	0	3.70
18	NUS II A	244.00	6.50	1936	19.7	40	0	4.99
19	NUS II B	246.00	8.5	1936	19.7	50	0	3.70
20	NUS II C	248.00	10.5	1936	19.7	80	0	2.90

[a] U.S. Geological Survey.

[b] Intake temperature—ambient temperature.

Table 5.3. Sterling discharge — staff's prediction of areas within 3°F isotherm

Case number	Description	Froude number	3°F area (acres)	
			Zc = *Zo*	*Zc* = 10 ft
1	January	6.96	910	459
2	February	7.21	909	449
3	March	6.90	911	466
4	April	6.72	653	406
5	May	5.57	447	298
6	June	4.81	188	137
7	July	4.24	370	271
8	August	4.31	507	368
9	September	4.84	572	367
10	October	5.86	430	217
11	November	6.78	573	258
12	December	7.23	706	383
Average of monthly plumes		5.95	598	340
13	Annual average	6.02	648	400
14	Minimum lake level	51.68	539	
15	Minimum monthly average lake level	14.00	594	74
16	Maximum lake level	1.56	763	
17	Acres American	6.30	688	428
18	NUS II A	10.03	647	194
19	NUS II B	5.63	682	426
20	NUS II C	3.00	688	

Table 5.4. Seasonal averages of observed areas within the 3°F excess temperature isotherm at Ginna

Months	Area (acres)
January–March	119
April–June	82
July–September	51
October–December	113
Annual	72

Source: E. F. Chermack and T. A. Galletta, "Power Plant Thermal Effluents in Southeastern Lake Ontario," pp. 663–674 in *Proc. 16th Conference on Great Lakes Research 1973.*

5.3.3 Thermal standards

The State of New York classifies Lake Ontario as a lake. The State has adopted new thermal standards for lakes. The standards (Part 704 — Criteria Governing Thermal Discharges) require that, outside of a mixing zone, the water temperature at the surface of a lake shall not be raised more than 3°F over the temperature that existed before the addition of heat of artificial origin. The mixing zone shall be specified by the New York State Siting Board, but the following requirements must be respected. The conditions in the mixing zone shall not be lethal in contravention of water quality standards to aquatic biota that may enter the zone. Furthermore, the location of the mixing zone shall not interfere with spawning areas, nursery areas, or fish migration routes.

Finally, the regulations provide that the best technology available for minimizing adverse environmental impact be reflected in the location, design, construction, and capacity of cooling water intake structures.

With respect to thermal discharges from power plants, the U.S. EPA has adopted Limitation 423.15 (1) (1). This limitation requires, in part, that all large base-load units completed after July 1, 1977, must use a closed-cycle cooling system to achieve the degree of effluent reduction attainable by the application of the best available technology economically achievable.

Because the Sterling Power Project Unit No. 1, as proposed, incorporates a once-through cooling system, the applicant has applied to the New York State Siting Board for an exemption from the closed-cycle cooling system required as provided for in Part 316(a) of the Federal Water Pollution Control Act Amendments of 1972 (PL92-500).

5.3.4 Summary

The staff judges the applicant's analysis of recirculation to be adequate. Of the thermal plume models presented by the applicant, the staff believes that NUS II is the most correct. Nevertheless, the staff has reservations about it, particularly in regard to the subsurface analysis. The staff analysis should more accurately predict the area contained within the 3°F excess temperature isotherm at the surface under most conditions, although larger areas may occasionally be observed.

5.4 RADIOLOGICAL IMPACT

5.4.1 Radiological impact on man

The models and considerations for environmental pathways leading to estimates of radiation doses to individuals are discussed in detail in Draft Regulatory Guide 1.AA (in preparation). Similarly, use of these models and additional assumptions for population dose estimates are described in Appendix F of this statement.

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

5.4.1.1 Exposure pathways

The environmental pathways which were considered in preparing this section are shown in Fig. 5.7. Estimates were made of radiation doses to man at and beyond the site boundary based on NRC staff estimates of expected effluents as shown in Tables 3.6 and 3.7, site meteorological and hydrological considerations, and exposure pathways at the Sterling Nuclear Power Station.

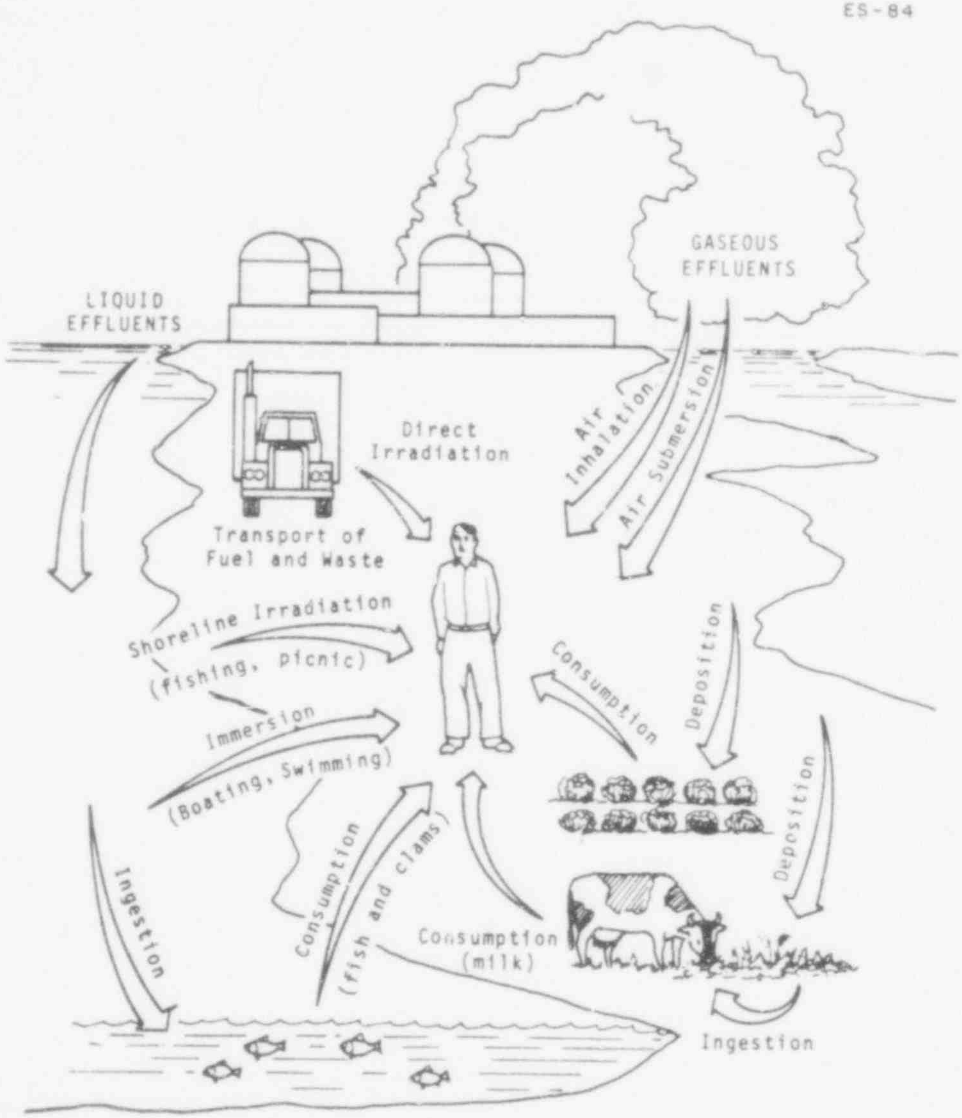


Fig. 5.7. Exposure pathways to man.

Inhalation of air and ingestion of food (and water) containing tritium and radiocarbon are estimated to account for essentially all of the total body radiation dose commitments to individuals and the population.

5.4.1.2 Dose from radioactive releases to the atmosphere

Radioactive effluents released to the atmosphere from the Sterling facility will result in small radiation doses to the public. NRC staff estimates of the expected gaseous and particulate releases listed in Table 3.7, and the site meteorological considerations discussed in Sect. 2.6 of this statement and summarized in Table 5.5 were used to estimate radiation doses to individuals and populations. The results of the calculations are discussed below.

Table 5.5. Summary of atmospheric dispersion factors and deposition values for selected locations near the Sterling Nuclear Power Station[a]

Location	Source	X/Q (sec/m^3)	Relative deposition (m^{-2})
Nearest[b] site water boundary (0.11 mile – NW)	A[c]	1.4×10^{-5}	6.8×10^{-7}
	B[d]	1.7×10^{-5}	3.4×10^{-7}
	C[e]	5.4×10^{-5}	6.8×10^{-7}
Nearest site land boundary (0.74 mile – NNE)	A	5.6×10^{-6}	1.1×10^{-7}
	B	6.6×10^{-6}	5.1×10^{-8}
	C	6.3×10^{-6}	6.8×10^{-8}
Nearest residence/garden (0.62 mile – SSW)	A	4.2×10^{-6}	1.4×10^{-7}
	B	3.5×10^{-6}	4.2×10^{-8}
	C	6.2×10^{-6}	7.5×10^{-8}
Nearest milk animal (1.1 mile – ENE)	A	2.2×10^{-6}	7.5×10^{-8}
	B	1.3×10^{-6}	2.2×10^{-8}
	C	3.4×10^{-6}	4.3×10^{-8}
Nearest meat animal (2.0 mile – ESE)	A	2.5×10^{-7}	4.7×10^{-9}
	B	1.8×10^{-7}	2.4×10^{-9}
	C	8.4×10^{-7}	8.8×10^{-9}

[a] The doses presented in the following tables are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with *Draft Regulatory Guide 1.DD, Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors*, September 1975.

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

[c] Source A is Unit Vent.

[d] Source B is Turbine Exhaust.

[e] Source C is Radwaste Vent.

Radiation dose commitments to individuals

The predicted dose commitments to individuals at selected offsite locations where doses are expected to be largest are listed in Table 5.6. The standard NRC models were used to realistically model features of the Sterling plant design and the site environs. Applicant-proposed values for the individual usage factors for milk, inhalation, vegetables, beef, water, and fish were not utilized in performing the staff analysis. The staff's values are more up-to-date.

Radiation doses to populations

The estimated radiation dose commitment to the population (within 50 miles) for the Sterling Nuclear Power Plant from gaseous and particulate releases was based on the projected site population distribution for the year 2000 as shown in Table 5.7. Doses beyond the 50-mile radius were based on the average population densities discussed in Appendix F of this statement and the total U.S. population. The population doses are presented in Table 5.8. Background radiation doses are provided for comparison. The doses from atmospheric releases from the Sterling facility during normal operation represent an extremely small increase in the normal population dose from background radiation sources.

5.4.1.3 Dose commitments from radioactive liquid releases to the hydrosphere

Radioactive effluents released to the hydrosphere from the Sterling facility during normal operation will result in small radiation doses to individuals and populations. NRC staff estimates of the expected liquid releases listed in Table 3.6, and the site hydrological considerations discussed in Sect. 2.5 of this statement and summarized in Table 5.9 were used to estimate radiation dose commitments to individuals and populations. The results of the calculations are discussed below.

Table 5.5. Annual individual dose commitments due to gaseous and particulate effluents

Location	Pathway	Dose (mrem/year)						
		Total body	Bone	Liver	Thyroid	Lung	Skin	GI-tract
Nearest[a] residence/garden (0.62 mile – SSW)	Plume	0.11	0.11	0.11	0.11	0.11	0.32	0.11
	Ground deposit	0.020	0.020	0.020	0.020	0.020	0.024	0.020
	Inhalation (adult)	0.13	*b*	0.13	0.15	0.13	0.13	0.13
	Vegetation (child)	1.4	0.8[illegible]	1.4	1.7	1.4	1.4	1.4
Nearest meat animals (2.0 miles – ESE)	Meat (child)	0.024	0.022	0.024	0.094	0.024	0.024	0.024
Nearest milk animals (1.1 miles – ENE)	Milk (infant)	0.80	0.65	0.82	6.9	0.79	0.78	0.78
Nearest water site boundary (0.11 mile – NW)	Plume	0.59	0.59	0.59	0.59	0.61	2.0	0.59
	Ground deposit	0.13	0.13	0.13	0.13	0.13	0.15	0.13
	Inhalation (adult)	0.43	*b*	0.44	0.55	0.44	0.43	0.43
Nearest land site boundary (0.74 mile – NNE)	Plume	0.14	0.14	0.14	0.14	0.15	0.41	0.14
	Ground deposit	0.017	0.017	0.017	0.017	0.017	0.020	0.017
	Inhalation (adult)	0.17	0.10	0.17	0.20	0.17	0.17	0.17

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

[b] Less than 0.01 mrem/year.

Radiation dose commitments to individuals

The estimated dose commitments to individuals at selected offsite locations where exposures are expected to be largest are listed in Table 5.10. With the exception of the following individual usage factors, the standard NRC models were used to realistically model features of the Sterling plant design and the site environs. Based on the study of the recreation on Lake Ontario in the vicinity of the plant, the applicant presented the following individual usage factors: (1) swimming — 200 hr/year; (2) boating — 200 hr/year; and (3) picnicking — 200 hr/year.

Radiation dose commitments to populations

The estimated population radiation dose commitments to 50 miles for the Sterling facility from liquid releases, based on the use of water and biota from Lake Ontario, are shown in Table 5.8. Doses beyond 50 miles were based on the assumptions discussed in Appendix F.

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

5.4.1.4 Direct radiation

Radiation from the facility

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

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

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

~~721 035~~

715 094

Table 5.7. Projected population distribution of resident population for the year 2000 within a 50-mile radius of the Sterling site

Direction	0–1	1–2	2–3	3–4	4–5	5–10	10–20	20–30	30–40	40–50
N	0	0	0	0	0	0	0	0	0	0
NNE	0	0	0	0	0	0	0	0	228	1,761
NE	0	54	152	123	382	27,782	1,865	379	4,736	8,107
ENE	0	8	75	343	706	8,479	8,044	15,552	9,197	1,153
E	0	35	220	27	136	5,080	9,726	14,489	6,401	8,313
ESE	0	34	64	76	254	2,173	25,552	62,096	62,095	37,811
SE	0	24	49	95	109	1,314	12,357	80,463	348,161	49,560
SSE	0	34	161	92	126	1,142	6,802	28,843	26,126	10,698
S	0	21	79	149	256	760	3,100	13,689	47,391	9,273
SSW	0	24	0	37	319	995	3,436	7,974	42,095	19,448
SW	0	0	0	0	92	1,825	8,395	13,765	45,897	50,005
WSW	0	0	0	0	0	22	3,963	20,930	48,810	401,694
W	0	0	0	0	0	0	0	0	217	13,135
WNW	0	0	0	0	0	0	0	0	0	0
NW	0	0	0	0	0	0	0	0	0	1,333
NNW	0	0	0	0	0	0	0	0	0	3,397

Table 5.8. Annual population dose commitments in the year 2000

Category	Population dose commitment (man-rem)	
	50 miles	U.S. population
Natural radiation background[a]	1.7 X 10^{5}[b]	2.6 X 10^{7}[c]
Sterling Nuclear Power Plant operation		
Plant work force	*d*	450
General public		
Inhalation	*e*	*e*
Noble gases	*e*	*e*
Terrestrial foods	*e*	16
Drinking water usage	1,2	1,2
Aquatic foods	*e*	*e*
Recreation	*e*	*e*
Transportation of nuclear fuel and radioactive wastes	*d*	7

[a] *Natural Radiation Exposure in the United States*, U.S. Environmental Protection Agency, Report ORP-SID 72-1, June 1972.

[b] Using the average New York state background dose (106 mrem/year) in Footnote *a* and year 2000 projected population from Table 5.7.

[c] Using the avorage U.S. background dose (102 mrem/year) in Footnote *a* and year 2000 projected U.S. population from *Population Estimates and Projections*, Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 541, February 1975.

[d] Included in the U.S. population.

[e] Less than 1 man-rem/year.

Occupational radiation exposure

Based on a review of the applicant's safety analysis report, the staff has determined that individual occupational doses can be maintained within the limits of 10 CFR Part 20. Radiation dose limits of 10 CFR Part 20 are based on a thorough consideration of the biological risk of exposure to ionizing radiation. Maintaining radiation doses of plant personnel within these limits ensures that the risk associated with radiation exposure is no greater than those risks normally accepted by workers in other present-day industries. Using information compiled by the Commission of past experience from operating nuclear reactor plants, it is estimated that the total dose to all onsite personnel at large operating nuclear plants will be, on the average, approximately 450 man-rem/year/unit. The total dose for this plant will be influenced by several factors for which definitive numerical values are not available. These factors are expected to lead to doses to

Table 5.9. Summary of hydrologic transport and dispersion for liquid releases from the Sterling Nuclear Power Plant[a]

Location	Transit time (hr)	Dilution factor
Nearest drinking water intake (Oswego City, N.Y.) (8.5 miles – NE, Lake Ontario)	72	20
Nearest sport fishing location (Lake Ontario) (outfall area)[b]	24	1.0
Nearest shoreline (land site boundary meets lake)[b]	1.0	1.0

[a] See *Draft Regulatory Guide 1.EE, Analytical Models for Estimating Radioisotopes Concentrations in Different Water Bodies*, September 1975.

[b] Assumed for purposes of an upper limit estimate; detailed information not available.

Table 5.10. Annual individual dose commitments due to liquid effluents

Location	Pathway	Dose (mrem/year)					
		Total body	Bone	Liver	Thyroid	Lung	GI tract
Nearest river water use (Oswego City, N.Y.) (8.5 miles – NE, Lake Ontario)	Drinking water (infant)	*a*	*a*	*a*	0.019	*a*	*a*
Nearest fish production (Lake Ontario – outfall area)[b]	Fish (adult)	0.046	0.032	0.060	0.039	*a*	*a*
Nearest shoreline (land site boundary meets lake)[b]	Sediments (adult)	*a*	*a*	*a*	*a*	*a*	*a*

[a] Less than 0.01 mrem/year.

[b] Assumed for purposes of an upper limit estimate; detailed information on usage and productivity not available.

onsite personnel lower than estimated above. On the other hand, improvements to the radioactive waste effluent treatment system to maintain offsite population doses as low as practicable may cause an increase to onsite personnel doses. If all other factors remain unchanged, however, the applicant's implementation of Regulatory Guide 8.8 and other guidance provided through the staff radiation protection review process is expected to result in an overall reduction of total doses from those currently experienced. Because of the uncertainty in the factors modifying the above estimate, a value of 450 man-rem will be used for the occupational radiation exposure for the single unit station.

Transportation of radioactive material

The transportation of cold fuel to a reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the NRC report entitled *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*. The environmental effects of such transportation are summarized in Table 5.11.

Table 5.11. Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor[a]

Normal conditions of transport			
Heat (per irradiated fuel cask in transit)			250,000 Btu/hr
Weight (governed by Federal or State restrictions)			73,000 lb per truck; 100 tons per cask per rail car
Traffic density			<1/day
Rail			<3/month
Exposed population	Estimated number of persons	Range of doses to exposed individuals[b] (millirems per reactor year)	Cumulative dose to exposed population (man-rems per reactor year)[c]
Transportation worker	200	0.01 to 300	4
General public			
Onlookers	1,100	0.003 to 1.3	
Along route	600,000	0.0001 to 0.06	3
Accidents in transport			
Radiological effects		Small[d]	
Common (nonradiological) causes		1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year	

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

[b] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5000 millirems/year for individuals as a result of occupational exposure and should be limited to 500 millirems/year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirems/year.

[c] Man-rem is an expression for the summation of whole-body doses to individuals in a group. Thus, if each member of a population group of 1000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirems) each, the total man-rem in each case would be 1 man-rem.

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

5.4.1.5 Evaluation of radiological impact

The radiological impact of operating the proposed Sterling Nuclear Power Station is presented in terms of individual doses in Table 5.6 and Table 5.10, and population dose commitments in Table 5.8. The annual individual doses resulting from routine operation of the plant are a small fraction of the dose limits specified in 10 CFR Part 20 and within the design objectives stated in Appendix I to 10 CFR Part 50. The population doses are small fractions of the dose from natural environmental radioactivity. As a result, the staff concluded that there will be no measurable radiological impact on man from routine operation of the Sterling plant.

5.4.1.6 Comparison of calculated doses with NRC design objectives

Tables 5.12 and 5.13 show a comparison of calculated doses from routine releases of liquid and gaseous effluents from the Sterling plant with the design objectives of Appendix I to 10 CFR Part 50 and with the proposed staff design objectives of RM-50-2.

Table 5.12. Comparison of calculated doses from Sterling operation with Guides for Design Objectives proposed by the staff[a]

Criterion	RM-50-2 Design Objective	Calculated Dose
Liquid effluents		
Dose to total body or any organ from all pathways	5 mrem/yr	0.058 mrem/yr
Gaseous effluents		
Gamma dose in air	10 mrad/yr	0.23 mrad/yr
Beta dose in air	20 mrad/yr	0.54 mrad/yr
Dose to total body of an individual	5 mrem/yr	0.14 mrem/yr
Dose to skin of an individual	15 mrem/yr	0.41 mrem/yr
Radioiodine and particulates[b]		
Dose to any organ from all pathways	15 mrem/yr	6.9 mrem/yr

[a] Guides on Design Objectives proposed by the NRC staff on February 20, 1974; considers doses to individuals from all units on site. From U.S. Atomic Energy Commission, *Concluding Statement of Position of the Regulatory Staff*, Docket No. RM-50-2, Washington, D.C., February 20, 1974, pp. 25–30.

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

Table 5.13. Comparison of calculated doses from Sterling operation with Appendix I Design Objectives[a]

Criterion	Appendix I Design Objective	Calculated Doses
Liquid effluents		
Dose to total body from all pathways	3 mrem/year	0.046 mrem/year
Dose to any organ from all pathways	10 mrem/year	0.058 mrem/year
Noble gas effluents		
Gamma dose in air	10 mrad/year	0.23 mrad/year
Beta dose in air	20 mrad/year	0.54 mrad/year
Dose to total body of an individual	5 mrem/year	0.14 mrem/year
Dose to skin of an individual	15 mrem/year	0.41 mrem/year
Radioiodines and particulates[b]		
Dose to any organ from all pathways	15 mrem/year	6.9 mrem/year

[a] Appendix I Design Objectives from Sects. II.A, II.B, and II.C of Appendix I, 10 CFR Part 50; considers doses to maximum individual per reactor unit. From *Fed. Regist.* 40: 19442 (May 5, 1975).

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

715 098 ~~721 039~~

5.4.2 Radiological impact on biota other than man

The models and considerations for environmental pathways leading to estimates of radiation doses to biota are discussed in detail in Vol. 2, *Analytical Models and Calculations* of WASH-1258.[16]

5.4.2.1 Exposure pathways

The environmental pathways which were considered in preparing this section are shown in Fig. 5.8. Dose estimates were made for biota at the nearest land and water boundaries of the site, and in the aquatic environment at the point where plant's liquid effluents mix with Lake Ontario. The estimates were based on estimates of expected effluents as shown in Tables 3.6 and 3.7, site meteorological and hydrological considerations, and the exposure pathways anticipated at the Sterling Nuclear Power Station.

5.4.2.2 Doses to biota from radioactive releases to the biosphere

Depending on the pathway (as discussed in Draft Regulatory Guide 1.AA), terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than man receives. Dose estimates for some typical biota at the Sterling site are shown in Table 5.14. Doses to a greater number of similar biota in the offsite environs will generally be much lower.

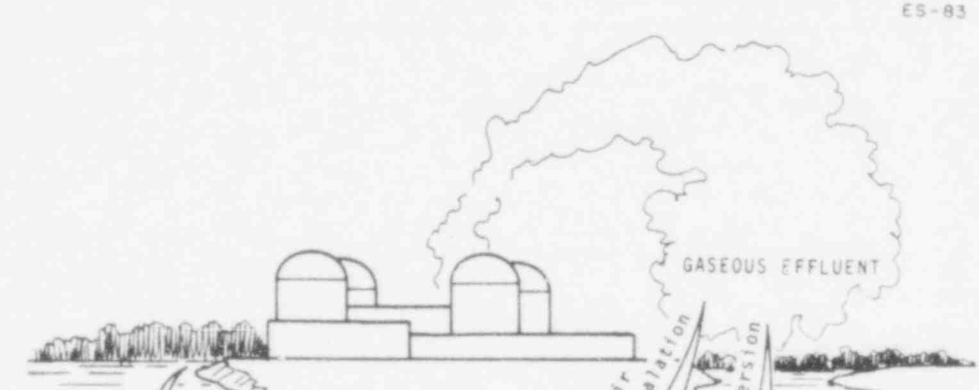


Fig. 5.8. Exposure pathways to biota other than man.

Table 5.14. Dose estimates for typical biota at the Sterling Site

Biota	Location	Pathway	Dose (mrad/year)
Deer	Nearest site land boundary (0.74 mile – NNE)	Atmosphere[a]	0.78
Fox	Nearest site land boundary (0.74 mile – NNE)	Atmosphere	0.31
Terrestrial flora	Nearest site land boundary (0.74 mile – NNE)	Atmosphere	0.14
Raccoon	Nearest site water boundary (0.11 mile – NW)	Atmosphere	0.98
		Hydrosphere	0.34
Muskrat	Nearest site water boundary (0.11 mile – NW)	Atmosphere	0.98
		Hydrosphere	0.79
Heron	Nearest site water boundary (0.11 mile – NW)	Atmosphere	0.98
		Hydrosphere	4.2
Duck	Plant outfall Lake Ontario	Atmosphere	0.98
		Hydrosphere	0.73
Fish	Plant outfall Lake Ontario	Hydrosphere	0.27
Invertebrates	Plant outfall Lake Ontario	Hydrosphere	1.7
Algae	Plant outfall Lake Ontario	Hydrosphere	0.091

[a] Atmospheric doses include estimates of plume dose, ground deposition dose, inhalation dose, and ingestion doses where appropriate. Hydrospheric doses include estimates of immersion dose, dose from consumption, and sediment dose where appropriate.

5.4.2.3 Doses to biota from direct radiation

Although many of the terrestrial species may be continuously exposed and thereby receive higher doses than man, aquatic species and some terrestrial species may receive somewhat lower doses depending on shielding by water or soil (e.g., burrows). As a result of these uncertainties, it was assumed that the direct radiation doses to biota at the site boundary will be about the same as for man. As discussed in Sect. 5.4.1.4, direct radiation doses will generally be less than 5 mrad/year.

5.4.2.4 Evaluation of the radiological impact on biota[17,18]

Although guidelines have not been established for desirable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes. While the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions with other stresses (e.g., heat, biocides, etc.), no biota have yet been discovered that show a sensitivity (in terms of increased disease or death) to radiation exposures as low as those expected in the area surrounding the Sterling Nuclear Power Station. The "BEIR" Report[18] concluded that the evidence to date indicates that no other living organisms are very much more radiosensitive than man; therefore, no measurable radiological impact on populations of biota is expected from the radiation and radioactivity released to the biosphere as a result of the routine operation of the Sterling Nuclear Power Station.

5.4.3 Environmental effects of the uranium fuel cycle

The environmental effects of uranium mining and milling, production of uranium hexafluoride, enrichment of isotopes, fabrication of fuel, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low-level and high-level radioactive wastes are within the scope of the AEC report (WASH-1248) entitled *Environmental Survey of the Uranium Fuel Cycle*. The contribution of such environmental effects is summarized in Table 5.15.

Table 5.15. **Summary of environmental considerations for uranium fuel cycle**

Normalized to model LWR annual fuel requirement

Natural resource use	Total	Maximum effect per annual fuel requirement of model 1,000 MWe LWR
Land (acres)		
Temporarily committed	63	
Undisturbed area	45	
Disturbed area	18	Equivalent to 90 MWe coal fired power plant.
Permanently committed	4.6	
Overburden moved (millions of metric tons)	2.7	Equivalent to 90 MWe coal fired power plant.
Water (millions of gallons)		
Discharged to air	156	≈2% model 1000 MWe LWR with cooling tower.
Discharged to water bodies	11,040	
Discharged to ground	123	
Total	11,319	<4% of model 1000 MWe LWR with once-through cooling.
Fossil fuel		
Electrical energy (thousands of MW-hour)	317	<5% of model 1000 MWe LWR output.
Equivalent coal (thousands of metric tons)	115	Equivalent to the consumption of a 45 MWe coal fired power plant.
Natural gas (millions of scf)	92	<0.2% of model 1000-MWe energy output.
Effluents – chemical (metric tons)		
Gases (including entrainment)[a]		
SO_2	4,400	
NO_x[b]	1,177	Equivalent to emissions from 45 MWe coal fired plant for a year.
Hydrocarbons	13.5	
CO	28.7	
Particulates	1,156	
Other gases		
F^-	0.72	Principally from UF_6 production enrichment and reprocessing. Concentration within range of state standards – below level that has effects on human health.
Liquids		
SO_4^-	10.3	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constitutents that require dilution and the flow of dilution water are: NH_3 – 600 cfs. NO_3 – 20 cfs. Fluoride – 70 cfs.
NO_3^-	26.7	
Fluoride	12.9	
Ca^{2+}	5.4	
Cl^-	8.6	
Na^+	16.9	
NH_3	11.5	
Fe	0.4	
Tailings solutions (thousands of metric tons)	240	From mills only – no significant effluents to environment.
Solids	91,000	Principally from mills – no significant effluents to environment.
Effluents – radiological (curies)		
Gases (including entrainment)		
Rn-222	75	Principally from mills – maximum annual dose rate <4% of average natural background within 5 miles of mill. Results in 0.06 man-rem per annual fuel requirement.
Ra-226	0.02	
Th-230	0.02	
Uranium	0.032	Principally from fuel reprocessing plants – whole body dose is 5 man-rem per annual fuel requirements for population within 50-mile radius. This is <0.007% of average natural background dose to this population. Release from Federal Waste Repository of 0.005 Ci/year has been included in fission products and transuranics total.
Tritium (thousand)	16.7	
Kr-85 (thousands)	350	
I-129	0.0024	
I-131	0.024	
Fission products and transuranics	1.01	
Liquids		
Uranium and daughters	2.1	Principally from milling – included in tailings liquor and returned to ground – no effluents; therefore, no effect on environment.
Ra-226	0.0034	From UF_6 production – concentration 5% of 10 CFR 20 for total processing of 27.5 model LWR annual fuel requirements.
Th-230	0.0015	
Th-234	0.01	From fuel fabrication plants – concentration 10% of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Ru-106	0.15[c]	From reprocessing plants – maximum concentration 4% of 10 CFR 20 for total reprocessing of 26 annual fuel requirements for model LWR.
Tritium (thousands)	2.5	
Solids (buried)		
Other than high level	601	All except 1 Ci comes from mills – included in tailings returned to ground – no significant effluent to the environment, 1 Ci from conversion and fuel fabrication is buried.
Effluents – thermal (billions of Btu's)	3,360	<7% of model 1000-MWe LWR.
Transportation (man-rem): exposure of workers and general public.	0.334	

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

[b] 1.2% from natural gas use and process.

[c] Cs-137 (0.075 Ci/AFR) and Sr-90 (0.004 Ci/AFR) are also emitted.

Source: Paragraph 51.20(e), 10 CFR 51.

POOR ORIGINAL

5.5 NONRADIOLOGICAL EFFECTS ON ECOLOGICAL SYSTEMS

5.5.1 Terrestrial

5.5.1.1 Impacts of plant operation

Because of the nature of the cooling system, the major ecological impacts of plant operation will be on the aquatic environment. The staff concludes that the operation of Sterling will have only minor nonradiological impacts on terrestrial ecosystems of the local area.

The staff estimates that the air pollutants resulting from operation of the emergency diesels and auxiliary steam boilers will have no noticeable effects at the site boundary even under stagnant meteorological conditions (ER, Sect. 3.7.2).

Noise levels associated with the operation of the plant are not expected to constitute a serious disturbance to wildlife. The sound level at 100 ft from the 1150-MWe nuclear plant is estimated to be 48.5 dBA (ER, Sect. 3.10.1). Sources of noise include main power transformers, steam release valves, diesel engines, and ventilation systems. The staff considers it likely that resident wildlife species will become accustomed to routine noises of this level.

Some disturbance and increased mortality of wildlife may occur as a result of motor vehicle movement and other activities around the site. In the judgment of the staff, these disturbances will not be serious.

Because of the size of the buildings and their locations on Lake Ontario, there is a potential for bird mortality due to collisions. Existing large facilities along the lake shore have caused bird deaths from collisions, but no massive kills have been reported. Also, collisions account for less than 1% of the nonhunting waterfowl mortality.[19] Therefore, the buildings at the Sterling site should have only minimal effects on bird populations.

5.5.1.2 Impacts of transmission line operation

Maintenance of lines

Vegetation control in transmission line corridors will be accomplished by the selective basal application of herbicides. The applicant plans to use only those herbicides that are approved by appropriate governmental agencies for brush control along utility rights-of-way, and in situations near water only those herbicides deemed safe will be applied. The proposed herbicides, recommended application rates, and their uses are as follows:

(1) 2,4,5-T, 4 gal in 96 gal of oil as a selective basal spray;

(2) Tordon 155 mixture, 4 gal in 96 gal of oil as a selective basal spray;

(3) 2,4-D and 2,4,5-T mixture, 4 gal of this 50-50 mixture in 96 gal of oil as a selective basal spray.

The quantity of herbicide to be used will depend upon the density of the invading undesired vegetation. Application rates of 1 pint per stem every 3 to 5 years is adequate to maintain vegetation control.

Products containing 2,4,5-T should not be used near lakes, ponds, or ditch banks nor around homes or recreation areas. In these areas Hyvar XL may be used. Hyvar XL was selected over other alternatives because of its relative safety, LD_{50} rating (acute oral LD_{50} — 5200 mg/kg for rats),[20] its biodegradability, and its ability to control fast-growing woody species.

The selective use of herbicides has several advantages over physical removal of obstructing vegetation for transmission line maintenance, particularly where the use of heavy equipment could damage soil and plant cover, or in areas inaccessible to motor vehicles. Also, selective use of herbicides encourages game cover and preserves screening vegetation and is generally less expensive than manual trimming and cutting.

However, there are potential environmental hazards associated with the use of certain herbicides, particularly the phenoxy herbicide 2,4,5-T.[21] This compound has been implicated as a possible teratogen (an agent capable of causing birth defects or abnormalities).[22] Commercial preparations of 2,4,5-T may contain up to 0.5 ppm dioxin, a compound that has been reported to be acutely toxic at 0.0006 mg/kg body weight in tests with guinea pigs.[23]

Inadvertent damage to wildlife, crops, and other nontarget species may result from drift during spray operations or from careless application. Also, the increase in edge along the right-of-way will increase the available habitat for certain species of wildlife, resulting in a greater potential for those organisms to be exposed to herbicides. In view of the above considerations, the staff recommends that the applicant's use of herbicides include the following considerations:

(1) That the use of 2,4,5-T and Hyvar XL be limited to stump and basal application;

(2) That herbicides not be applied immediately before, after, or during a heavy rainstorm or during irrigation of cropland along the right-of-way;

(3) That spraying not be performed when the wind speed is greater than 5 mph, the temperature greater than 80°F, or the relative humidity less than 50%;

(4) That the dioxin content of undiluted phenoxy herbicides be less than 0.1 ppm.

Ozone

Ozone is recognized as a major component of the photochemical air pollution-oxidant complex. Because of the possibility of adverse environmental effects caused by ozone generated by corona discharge in the vicinity of the proposed 765-kV transmission lines, this problem has been reviewed by the staff. The National Primary Air Quality Standard for oxidants, as issued by the Environmental Protection Agency, is 80 ppb by volume maximum arithmetic mean for a one-hour concentration, not to be exceeded more than once per year (Appendix D of 42 CFR 410). However, ozone may be injurious to vegetation, animals, and humans when concentrations exceed 50 ppb for prolonged periods.[24] Sensitive varieties of tobacco can be injured after an 8-hr exposure to 50 ppb ozone.[25] Metabolic effects, not accompanied by visible injury, have been observed in white pine at ozone concentrations of 100 ppb in only 10 min.[26] Most humans experience discomfort when ozone concentrations approach 50 ppb, and laboratory mice show an increase in mortality when exposed to 100 to 200 ppb for a period of three weeks (7 hr/day).[27] To assess the possible effect of a particular concentration of ozone on natural and domesticated biota or humans is difficult because almost every other environmental factor studied appears to interact with the ozone effect.[28] Duration of exposure, age, temperature, relative humidity, vigor, presence of other pollutants, and light intensity, among others, all affect the response of a particular species to ozone.

Ozone is produced naturally in the atmosphere by a variety of reactions. Dissociation of oxygen by ultraviolet radiation in the stratosphere and lightning discharges are probably the major natural sources of ozone. Ground-level ozone concentrations in areas distant from urban pollution sources usually range from 10 to 50 ppb.[28,29] Unusually high ozone concentrations (60 to 100 ppb) in remote areas may be due to mixing from the stratosphere by violent meteorological conditions or to photochemical reactions involving volatile compounds emanating from natural vegetation such as pine trees.[28]

Ozone and small amounts of nitrogen oxides are also produced by corona discharge from energized high-voltage transmission lines. Corona discharge is determined by conductor surface potential gradients, which, in turn, are dependent upon design parameters of the transmission system selected. Such parameters are height of conductors above the ground, spacing of the phases, ground wire configuration, size of conductor, bundle configuration, and transmission line voltage. The latter three are most significant. Corona will increase in any system as a result of abrasions, foreign adhering particles, or sharp points on the conductor as well as by adverse weather conditions. Presence of water droplets on the conductor during foul weather will increase corona discharge greatly. The use of larger and multiple conductors per phase (bundling) is particularly effective in reducing corona discharge. Through the use of such design alternatives, higher voltage systems such as 765-kV may be operated with no greater corona discharge than lower voltage systems, which are currently acceptable. The staff believes that the Sterling transmission system design has utilized these alternatives.

Several field studies[30,31] have attempted to measure increases in ambient ozone levels near energized 765-kV lines. No increase in ambient levels were found even when detectors were placed 6 m downwind from the conductor at the conductor height. Tests were performed under a variety of weather conditions with similar results. However, the staff considers both of the field studies summarized above to be deficient in one or more areas of procedure, analysis, or interpretation. For example, during corona discharge the amount of corona loss (and presumably ozone production) around high-voltage transmission lines increases by a large factor with small increases in voltage — a 5% increase in voltage can almost double the corona.[32] Yet neither of the field studies report the actual line voltage at the time the ozone measurements were made. It should be emphasized, however, that in no case were ozone levels detected that were measurably above ambient levels.

On the basis of the cited references, the staff believes that the proposed transmission lines may be operated with no unacceptable impacts resulting from the generation of ozone. Contributions from the lines are expected to constitute a minor part of ambient ozone levels that are principally generated by natural processes and well below the National Primary Air Quality Standard described above.

Low-level electric fields

The applicant states (ER, Sect. 5.6.2.2), "It is anticipated there will be no harmful effects due to electrostatic fields resulting from the proposed double 765-kV lines on humans or animals."

According to the IEEE Working Group on Electrostatic Effects of Transmission Lines, "the value of ground gradient at the threshold of sensation (about 1 mA) is equal to or greater than 15 kV/m for the great majority of cases."[3] The applicant states that the maximum electrostatic field gradient resulting from operation of the 765-kV lines is expected to be 9.5 kV/m within the right-of-way at a point of minimum conductor-to-ground clearance. These values are consistent with the design requirements that electrostatically induced voltages from the transmission line do not exceed the perception level.

Because the general public is not expected to spend significant time in the transmission line right-of-way corridors, and on the basis of the indicated ground-level electrostatic field values, the staff does not believe that adverse physiological effects on the public will result from this source. Employees such as linemen will be expected to work in fields of higher intensity. However, they will be protected by the provisions of the Occupational Safety and Health Act.

Audible noise

All high-voltage power transmission lines emit audible noise to some extent. The audible noise frequencies are generated by the corona discharge and the majority are in the range of human or wildlife hearing. The applicant estimates that the audible noise level during foggy conditions (the worst case) at 50 ft from the outermost conductor will be about 48 dBA (ER, Sect. 5.6.3.1). Measurements made at the American Electric Power System and Westinghouse Electric Corporation joint research project, Apple Grove, West Virginia, indicate that audible noise levels near a typical 765-kV transmission line will vary from 37 dBA under fair weather to 56 dBA under heavy rain conditions. A level of 51 dBA is expected under fog conditions. The variation from the applicant's value of 61 dBA is not considered significant. Ambient noise levels from 30 to 45 dBA have been reported to exist in rural or semirural areas, such as those areas in which transmission lines might be located.[33] Using this criterion, it is apparent that audible noise under fair weather conditions should not be unduly objectionable. During foul weather, however, noise should be clearly evident within several hundred feet of the line. Resident wildlife, however, will be more distracted by the weather and will become accustomed to slight increases in noise level. Therefore, the staff does not regard audible noise from transmission lines as an unacceptable adverse effect.

Bird collisions

A nationwide study of nonhunting mortality of waterfowl found that 50% of the recorded deaths due to collisions (cars, buildings, etc.) were the result of impacts with telephone and power lines.[19] However, collisions as a whole accounted for only 0.14% of the total nonhunting mortality (3,015 out of 2,133,165 observations), disease being the main cause of death. At the Sterling site, there will be only one mile of transmission lines, all of which will be onsite and will cross primarily low-growing vegetation. Therefore, because of the above factors, the transmission lines associated with the Sterling plant should have only a minimal impact on birds due to collisions.

5.5.2 Aquatic

Entrainment in the cooling system, impingement on the intake screens, and exposure to the thermal and chemical discharges constitute the major sources of operational impacts on the biota of Lake Ontario.

5.5.2.1 Discharge of heated water

Temperature exerts a strong influence on aquatic ecosystems. Physical parameters such as dissolved gases, viscosity, and specific gravity respond to changes in temperature and in turn influence the biota of the ecosystem.[34] The organisms themselves possess upper and lower temperature tolerance limits and optimum growth, reproduction, and migration temperatures.

As discussed in Sect. 3.4, large quantities of heat will be discharged to Lake Ontario during operation of the Sterling Power Project. During the hottest month and period of maximum lake level, the staff's thermal analysis (Case 16, Table 5.3) predicts discharge temperatures as high as 94.3°F compared with an intake temperature of 75°F. Under these conditions, the 15°F isotherm would encompass about 2.3 acres of lake surface; the 10°F isotherm, 11.6 acres; and the 3°F isotherm, 763 acres. The duration of exposure greatly influences the effects of elevated temperatures on organisms. An organism entrained in the plume at the mouth of the discharge structure and unable to swim out of the plume would experience a thermal shock greater than 15°F above ambient (90°F) for about 5.6 min; 10°F above ambient (85°F) for 18.7 min; and 3°F above ambient (78°F) for 7.2 hr. Organisms entrained in the intake structure would experience an additional 1.7 min of elevated temperatures. Normally, residence times within each of the above isotherms will be roughly half those quoted above.

Significantly, the temperature of intake water drawn from the 15- to 28-ft depths will often be lower than the temperature of the surface water, particularly during early thermal stratification in the spring. Thus, during these periods, the effective ΔT between the plume and surface water may be reduced considerably. Withdrawal of cooler subsurface water reduces both the duration of the exposure to higher temperatures and the extent of the effective mixing zone. During winter, partial recirculation of cooling water to prevent ice formation on the intake screens increases the maximum ΔT at the point of discharge to 23.3°F; the cooling water flow is correspondingly reduced.

Tables 5.16 and 5.17 give some published upper critical temperatures for Lake Ontario species. During periods when ambient surface water temperatures approach 80°F (a short period each year), some of these organisms will be living near their upper temperature limits and probably above their thermal range of metabolic insensitivity.[35] Additions of large quantities of heat to Lake Ontario at these times conceivably could result in changes in the biotic community, although on a highly localized scale.

Table 5.16. Upper temperature limits of non-salmonid aquatic species found in Lake Ontario at the Sterling site[a]

Common name	Criterion[b]	Temperature			
		Acclimation		Upper critical	
		°C	°F	°C	°F
Sea lamprey (larvae)	T	20	68	28.5	83.3
Gizzard shad (juvenile)	T	25	77	34.0	93.2
	T	35	95	36.5	97.7
Northern pike (juvenile)	T	25	77	32.3	90.1
	T	30	86	33.2	91.7
Goldfish (juvenile)	14-hr LD_{50}	24	75.2	36.0	96.8
	14-hr LD_{50}	38	100.4	41.0	105.8
Emerald shiner (juvenile)	T	25	77	30.7	87.3
Common shiner	T	25	77	31.0	87.8
	T	30	86	31.0	87.8
White sucker	T	25	77	31.0	87.8
Brown bullhead	T	25	77	33.8	92.8
	T	34	93.2	34.8	94.6
Channel catfish					
Juvenile	T	26	78.8	36.6	97.9
	T	34	93.2	38.0	100.4
Adult	T	25	77	33.5	92.3
Threespine stickleback	T	19	66.2	25.8	78.4
White perch	8-hr LD_{50}	4.4	39.9	27.8	82.0
Bluegill	T	25	77	33.0	91.4
	T	30	86	33.8	92.8
Largemouth bass					
Juvenile	T	30	86	36.4	97.5
	T	35	95	36.4	97.5
Adult	T	25	77	34.5	94.1
	T	30	86	36.4	97.5
Yellow perch					
Juvenile	T	19	66.2	32.0	89.6
Adult	T	25	77	29.7	85.5
Gammarus fasciatus (amphipod)	24-hr LD_{50}	15	59	31.5	88.7

[a] Data based on laboratory studies.

[b] T = maximum tolerated temperature; LD_{50} = the temperature expected to kill 50% of the individuals exposed for the indicated duration.

Source: C. C. Coutant, *Time–Temperature Relationships for Thermal Resistances of Aquatic Organisms, Principally Fish*, ORNL-EIS-27, Oak Ridge National Laboratory, 1974.

POOR ORIGINAL

Table 5.17. Upper and lower temperature limits of certain salmonid species found in Lake Ontario[a]

Common name	Criterion[b]	Temperature			
		Acclimation		Critical	
		°C	°F	°C	°F
Coho salmon (juvenile)	T	5	41	22.9	73.2
		10	50	23.7	74.7
		15	59	24.3	75.7
		20	68	25.0	77.0
		23	73.4	25.0	77.0
	L	5	41	0.2	32.4
		10	50	1.7	35.1
		15	59	3.5	38.3
		20	68	4.5	40.1
		23	73.4	6.4	43.5
Chinook salmon(juvenile)	T	5	41	21.5	70.7
		10	50	24.3	75.7
		15	59	25.0	77.0
		20	68	25.1	77.2
		24	75.2	25.1	77.2
	L	10	50	0.8	33.4
		15	59	2.5	36.5
		20	68	4.5	40.1
		23	73.4	7.4	45.3
Rainbow trout					
Juvenile	T	18	64.4	26.5	79.7
Adult		20	68	27.0	80.6
Adult steelhead		19	66.2	21.0	69.8
Brown trout					
Early fry	T	6	42.8	22.0	71.6
Late fry		5	41	22.2	72.0
		10	50	23.4	74.1
		20	68	23.5	74.3
Lake trout	T	8	46.4	22.7	72.9
		15	59	23.5	74.3
		20	68	23.5	74.3

[a] Data based on laboratory studies.

[b] T = maximum tolerated temperature; L = minimum tolerated temperature.

Source: C. C. Coutant, *Time-Temperature Relationships for Thermal Resistances of Aquatic Organisms, Principally Fish*, ORNL-EIS-27, Oak Ridge National Laboratory, 1974.

POOR ORIGINAL

Fish

Fish species have definite temperature preferences (if dissolved oxygen, chemical concentrations, light, food concentrations, and other variables are optimum) that cause them to seek areas of a water body whose temperature is as close to the preferred temperature as possible. Table 5.18 gives temperature-preference information on Lake Ontario fishes. Those temperature preferences reported in Table 5.18 that are based on field data may be affected by other limnological characteristics as well as by the age of the fish. The alewife's apparent anomalous preference for low temperatures is characteristic of juveniles, which inhabit the colder middepths; adults appear to prefer much higher temperatures.

Most fish will avoid areas of the thermal plume warmer than their preferred range; a few fish may encounter these areas by accident. In addition, survivors of entrainment (plankton and immature fishes) will receive an extended exposure to higher temperatures, particularly (in the case of small fishes) if they have been stunned by the initial shock. Studies at the Ginna plant have shown that white perch, pumpkinseed, and smallmouth bass are attracted to the thermal plume in the warmest period of the year (Table 5.19). Based on studies conducted at the Point Beach Nuclear Plant on Lake Michigan, smelt should be found near the Sterling discharge in early spring and alewives should be abundant in the near-shore area and within the plume during June and July.[36] Various salmonids, including coho and chinook salmon, brown trout, and rainbow trout, might also be present near the discharge due to the change in distribution of their principal prey, the alewife and smelt. An increase in the density of chinook salmon and brown trout in and near the thermal plume will occur again in the fall as these species begin migrating in search of suitable spawning tributaries.[37,38] In short, the seasonal changes in abundance and species composition of fish in the thermal plume exhibit patterns directly related to their reproductive cycles.[36]

Table 5.18. **Temperature ranges preferred by Lake Ontario fishes**

Common name	Preferred temperature range		Data source[a]
	°C	°F	
Alewife	4.4–8.8	39.9–47.8	F
Rainbow smelt	6.6–12.8	43.9–55.0	F
Lake trout	8.0–15.5	46.4–59.9	F
	12.0	53.6	L
Chinook salmon	11.7	53.1	L
Brown trout	12.4–17.6	54.3–63.7	L
Rainbow trout	13.6	56.5	L
White sucker	11.8–20.6	53.2–69.0	F
Rock bass	14.7–21.3	58.5–70.3	F
Yellow perch	19.7–21.2	67.5–70.2	F
	21.0–24.2	69.8–75.6	L
Walleye	20.6–23.2	69.0–73.8	F
Smallmouth bass	20.3–21.4	68.5–70.5	F
	28.0	82.4	L
Freshwater drum	21.6–22.2	70.9–72.0	F
Gizzard shad	22.5–23.0	72.5–73.4	F
Largemouth bass	26.6–27.7	79.9–81.9	F
	30.0–32.0	86.0–89.6	L
Goldfish	28.0	50.4	L
Channel catfish	30.0–31.0	86.0–87.8	L
Pumpkinseed	31.5	88.7	L
Carp	32.0	89.6	L
Bluegill	32.3	90.1	L

[a]F = field, L = laboratory.

Sources:

1. R. G. Ferguson, "The Preferred Temperature of Fish and Their Mid-summer Distribution in Temperate Lakes and Streams," *J. Fish. Res. Bd. Can.* 15(4): 607–624, 1958.

2. K. Strawn, paper presented at the 97th Annual Meeting, American Fisheries Society, Toronto, Canada, 1967.

Table 5.19. **Results of the applicant's gillnet surveys of fish in the plume at the Ginna site**

Common name	Catch (number/net/day)					
	Late spring[a] 1971	Early summer[a] 1971	Late summer		Autumn	
			1970	1971	1970	1971
Longnose gar	0	0.5	0	0	0	0
Alewife	5.0	36	2.0	1.0	2.0	0
Gizzard shad	0	0	4.0	0.60	41	6.0
Rainbow smelt	0	0	0	0	0	2.0
Northern pike	0	0	0	0.20	0	0
Goldfish	0	0.50	0.50	0.20	0	0
Carp	0	0.30	0	4.0	0	6.0
Spottail shiner	4.0	0.50	0	0.40	0	2.0
Emerald shiner	0.30	0	0	0	0	0
White sucker	5.0	0	0	0.20	0.50	0.30
Brown bullhead	0	1.0	1.0	0.40	0	0
White perch	35	13	48	21	0.50	32
White bass	0.30	0	1.0	0	0	0
Rock bass	2.0	3.0	0	0.60	0	0
Pumpkinseed	0	0.80	15	6.0	0	0
Smallmouth bass	1.0	6.0	18	4.0	0	2.0
Yellow perch	0.30	0	0.50	0	0.50	0.30

[a]No surveys were made in late spring and early summer of 1970.

Sources:

1. Rochester Gas and Electric Corporation, *Ecological Studies of Cooling Water Discharge, Ginna Nuclear Power Plant*, Part 1, "Summary of Ecological Effects and Changes Resulting from Introduction of Thermal Discharge," Rochester, N. Y., 1972.

2. *Ibid.*, Part 3, "Fish Net Survey."

Tagging studies with several salmonid species have shown that the maximum residence times within the warmest part of the discharge was less than 10% of the total time between release and recapture.[39] Exposure of yellow perch and white suckers to heated effluents from the Nanticoke Generating Station on Lake Erie was found to be less than 9 hr.[40] Similarly, studies of the brown bullhead have shown that this species rarely entered the region of highest temperature and was only associated with the plume for very short periods of time.[41] The attraction of certain species to thermal discharges during the summer indicates that temperatures in the plume (outside the immediate area of the outfall) seldom exceed the preferred temperatures of the warm water species in the area.[42] As a result, no mortality from thermal shock is expected for those species residing in the Sterling plume during the warmest times of the year.

However, temperatures preferred by a given species are not necessarily the optimum temperatures for growth, reproduction, and resistance to disease. For example, recent investigations have shown that yellow perch require a winter chill period and that the length of time and the degree of chill are important in determining successful reproduction.[43] Normal reproductive success for this species requires residence in waters of 40°F or less for several months, a condition usually satisfied in the Great Lakes where no access to heated effluents is possible.[44] Since the presence of yellow perch in thermal discharges in Lake Michigan indicate the fish will select temperatures known to significantly impair reproduction,[44] the staff has evaluated the potential impact of the Sterling discharge on the yellow perch population in the vicinity of the site.

The major concentrations of this species occur in eastern Lake Ontario from the Oswego-Mexico Bay region to Prince Edward Point.[45] At the Sterling site, yellow perch comprised less than 2% of the 4913 fish collected in gill nets from May to August of 1974 (ER, Table 74.2-23). Further substantiation for the low densities in the region west of Oswego is provided by impingement data. The number of yellow perch impinged at Ginna in 1973 was less than 2% of the number impinged at Nine Mile Point Unit 1 (Appendix B, Tables B.11 and B.12). Finally, in contrast to the conclusion drawn by Edsall and Yocum[37] a study of yellow perch in Lake Ontario has shown that this species seems to exhibit little attraction to the warmer waters in a heated discharge.[46] In addition, they are only periodically observed in the discharge at the Point Beach Nuclear Power Plant in Lake Michigan,[36] and if they do occur in the plume, the actual residence time may be rather brief.[40] Thus the exposure of a relatively small population to the Sterling discharge for brief intermittent periods of time will result in a negligible impact on the population at the site.

Another aspect of exposure to the thermal plume will occur in the winter. As water temperatures drop in the autumn, most fish normally leave the site area to spend the winter in deeper, somewhat warmer (at that season) waters. Many fish may be attracted to the plume and to the discharge canal. Because water velocities at the exit to the discharge canal are fairly high (about 4 fps), only relatively large fishes will be able to enter the canal proper; they include the Lake Ontario game fishes of sizes that sport fishermen consider to be desirable. To discourage entry to the upper portion of the canal, the applicant will install an electric screen, a device that has not proved to be completely effective at the Ginna installation. However, the canal has few acres in which fish can seek shelter from the current so most fish should not remain for sustained periods of time in the canal proper.

If the density of fish populations in the plume and in the discharge canal does not exceed the carrying capacity of the area, a beneficial effect of the plant could be an increase in the growth of the fish during the colder months. However, little evidence is available to support this hypothesis. Instead, a comparison of growth rates and condition factors of rainbow trout, brown trout, and Chinook salmon from the discharge plume at the Point Beach Nuclear Plant and two control areas indicated only that (1) plume "residence" did not cause obvious growth abnormalities during the fall and (2) plume fish did not remain at elevated temperatures for long periods of time.[47] Since the plume will contact the bottom during the winter, the area may attract increased members of benthic organisms such as *Gammarus*[46] and crayfish and this increased food availability as well as the ability of motile fish to regulate their temperature exposures behaviorally may compensate for the accelerated metabolic demands.[47] Overcrowding and subsequent loss of condition is expected to be negligible.

Cold shock. In the event of a rapid reactor shutdown, those fish acclimated to the warmer water of the discharge plume will experience cold shock as temperatures in the plume rapidly approach ambient. This temperature drop will be greatly accelerated if forced circulation of ambient lake water continues after reactor shutdown. When ambient temperatures are close to the freezing point of water, the effects of sudden temperature drops can be lethal.[35] In fact, a recent study indicates that the rate of temperature change during cold shock is 20 times more critical than during heat shock.[48]

The applicant expects one scheduled shutdown of about 6 weeks' duration and an undetermined number of unscheduled shutdowns at Sterling each year (ER, p. 5.1-30). At the applicant's Ginna Nuclear Power Plant, unscheduled shutdowns have averaged 10/year over the last 5 years. Because several shutdowns may reasonably be expected during the winter months of operation and ΔTs may range as high as 23.5°F, the potential for cold shock fish kills will exist. The assumption that fish primarily reside in the warmest portions of the plume, however, is not supported by the available data.[39,41,47] Many species that inhabit the plume during the winter exhibit the ability to traverse large temperature gradients (≤10°C) with no great effect on body temperature.[49] Also, the contact of a fish with a given isotherm may be intermittent. The length of residency may vary greatly but is usually substantially less than maximum.[39] Since the above studies were carried out on salmonid species, which may be more sensitive than warmwater species to the sudden drops in temperature that result from a plant shutdown, the staff concludes that any mortality resulting from cold shock will be minimal and will not result in any regional or lakewide reductions in recruitment rates and standing crops.

Gas supersaturation. Because the solubility of gases in water is inversely proportional to temperature, water already approaching gas saturation and then suddenly heated within the condensers of the proposed plant will likely exhibit temporary supersaturation, particularly for nitrogen. Consequently, a plume of supersaturated water will issue from the discharge canal, its boundaries defined by the rapidity with which equilibration is achieved. Any fish entering the plume or canal, whether through accidental entrainment or volition, runs the risk of gas bubble disease as dissolved gases enter the tissues of the fish through the gills. The direct cause of this disease, physiologically equivalent to the "bends" in man, is the formation of gas emboli in tissues and fluids as the gases are released from solution. The disease manifests itself in various ways, ranging from behavioral disturbances and visible bubbles in the skin to massive lesions and death.[50-52]

Although numerous occurrences of this disease have been associated with hydroelectric plants and even natural developments,[52] few investigations have been directed at steam generating stations. However, studies conducted in the 0.4 mile long discharge canal of the Marshall Steam Station on Lake Norman, North Carolina, have shown that 13 species representing 9.2% of the total 3641 fish collected exhibited external symptoms of gas bubble disease. Some mortality was observed.[51]

On the basis of the available evidence, the staff believes that the proposed cooling system will likely generate a plume of nitrogen-supersaturated water. But, the area of highest initial supersaturation will be reduced in the plume by the cooling of the discharge water due to dilution with ambient lake water.[53] Fish might also be displaced from those areas of the plume containing the highest degree of supersaturation by the 3.7 fps flow velocities at the outfall. Further, certain species may be capable of detecting areas of supersaturation and avoiding them, as was shown in laboratory studies with Chinook salmon.[54] The staff concludes that any mortality resulting from gas supersaturation will be minimal.

Shoreline migrations. The thermal plume from the Sterling Power Plant may parallel the shoreline and, on occasion, impinge upon it. An IR imagery survey conducted by the EPA indicated that the plume at Ginna contacted the shoreline for a distance of approximately 1800 ft with an increase in the inshore temperature of 2 to 4°F above ambient. Similar increases in temperature of the nearshore waters at the Sterling site may prompt a negligible degree of premature spawning and hatching but should not effectively block the offshore migrations of the smelt in mid-summer or the alewife in late summer and early fall. Likewise, the migratory movement of the various salmonid species should not be impeded, although brown trout and chinook salmon may establish a brief residency on the thermal plume during the spawning season in the fall.[36,37] These fish should be able to pass beneath or around the plume. The elevated temperatures in the discharge area may interrupt the normal movement patterns of the brown bullhead, a semi-permanent local resident.[41] However, the blockage will most likely be brief and no permanent behavioral aberrations are expected.

The enhancement of local eutrophication in the onshore area is expected to be minimal. Eutrophication is controlled at any given time by a limiting nutrient,[55] and an increase in temperature with only a minimal increase in nutrient input may not stimulate an increase in primary productivity. Sufficient light is also required. Since the plant will directly provide a negligible amount of additional nutrients to the lake ecosystem apart from what are already present, neither an increase in productivity nor a shift in species composition towards a community dominated by blue-green algal species is expected. Although plankton that have been killed as a result of passing through the condenser cooling system may accumulate in the discharge area and provide a potential source of nutrients, the mortality rate of entrained organisms was only 18.3% for a rise of approximately 18°F across the condensers based on studies conducted at the Ginna site.[56] Finally, the residence times of the algae in the heated effluents may not be long enough to create blooms in response to elevated temperatures. Thus, minimal nutrient input, together with short residence times and frequent periods of high turbidity in the inshore waters, will likely inhibit any potential increase in either the abundance of blue-green algae or their period of occurrence.

Zooplankton and phytoplankton

The relatively few studies extant on zooplankton population responses to artificially increased temperature indicate a general tendency for populations to increase with temperature, short of lethal levels.[57,58] A study at the Paradise Power Plant on the Green River in Kentucky revealed zooplankton to be highly abundant in warm water up to 96.8°F.[58] A sampling station near a thermal discharge in a Texas reservoir reached temperatures as high as 107.6°F in August, yet annual zooplankton yields (particularly copepods and cladocerans) were greater here than at cooler stations.[57] However, lowest yields at this particular station occurred simultaneously with highest summer temperatures. Fifteen miles NE of the Sterling site at Nine Mile Point Nuclear Station, investigators have noted apparent increases in the standing crops of *Bosmina* and *Daphnia retrocurva*, presumably a result of thermal additions.[59]

Except for the immediate area of the discharge outfall, temperatures in the plume are not likely to exceed the lethal levels for most algal species for which temperature information is available.[35] The residence times of phytoplankters entrained in the plume will be too short for temperature to effect any significant shifts in species composition.

The staff concludes that zooplankton productivity in the thermal plume at Sterling will likely experience some depression during the hottest summer months and some enhancement during the rest of the year. This enhanced productivity will compensate for entrainment losses to some degree.

Benthos

Except for the immediate area of the discharge outfall, the staff anticipates no direct thermal effects on benthic invertebrates when ambient temperatures exceed 39°F because the plume will float on the surface of the lake. However, when ambient water temperatures are below 39°F, the plume will sink after cooling sufficiently. For example, given an ambient temperature of 33°F, the staff's analysis indicates that the plume will begin to sink approximately 1000 ft from the discharge outfall (plume temperature at this point equals 45°F). Benthic invertebrates and bottom fish, such as sculpins, in the path of the sunken plume will experience increases in temperatures as high as 12°F. If food is available, a beneficial increase in benthic productivity may well result, thus providing forage for fish attracted to the plume.

5.5.2.2 Discharge of biocidal and other chemical effluents

Section 3.6 describes those chemical effluents subject to release to Lake Ontario. The potential impacts of the more important chemicals are addressed in the following discussion.

Chlorine

Biological fouling of the circulating and service water systems will be controlled by three 20-min injections of 10% sodium hypochlorite solution into the intake water (at the pumps) each day. During chlorination, the concentration of free available chlorine (molecular chlorine, hypochlorous acid, or hypochlorite ion) in the discharge will allow automatic adjustment of chlorine injection rate through a feedback control mechanism (ER, p. 3.6-1).

The applicant provided no estimates of total residual chlorine (free available plus combined) concentrations expected in the discharge stream, but does propose addition of chlorine at a level of 1 ppm with a maximum free available chlorine in the discharge of 0.5 ppm. According to the applicant, the resulting concentrations in the discharge will be in compliance with Environmental Protection Agency Guidelines.[60] However, compliance with EPA Guidelines limits only the concentration of free available chlorine that can be discharged and not the amount of combined residual chlorine (that portion of the chlorine that remains combined with ammonia or nitrogenous compounds after the chlorine demand has been satisfied). Chlorine demand is the amount of chlorine consumed in reaction with the oxidizable elements in water and is a term used when referring to the difference between the amount of chlorine injected into the water and the total residual chlorine remaining at the end of a specified period. Since chlorine demand fluctuates with time, the amount of chlorine that will be discharged cannot be predicted. Further, a measure of only the concentration of free available chlorine does not take into account the presence of combined residual chlorine (e.g., as chloramines), which is also toxic; so, a criterion based exclusively on the concentration of free available chlorine is not a satisfactory safeguard for aquatic organisms.

Figure 5.9 summarizes the toxicity of total residual chlorine to aquatic organisms (primarily fish). The data points are not differentiated according to types of residual chlorine measured. Brungs'[61] review of the evidence, however, suggests that toxicities of the principal species of residual chlorine are of sufficient similarity to justify use of a measure of total residual chlorine to define acute toxicity.

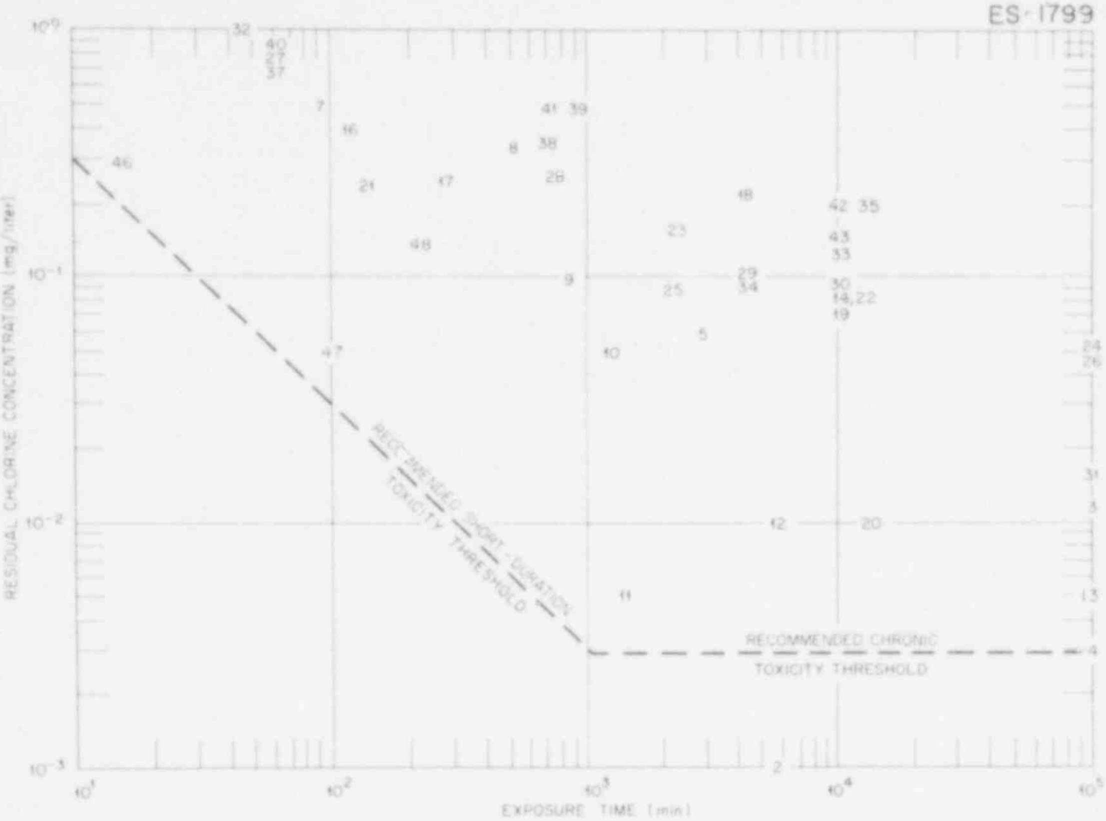


Fig. 5.9. Summary of residual chlorine toxicity data.

Most organisms entrained in the Sterling circulating water system during chlorination will probably die from the high chlorine concentration acting in concert with thermal and mechanical stresses. These losses in themselves would not likely be significant due to brevity of treatment (total of 1 hr/day). However, the loss of fish temporarily entrained or residing in the discharge plumes during chlorination may be high, particularly in winter when fish will tend to congregate in the warm water of the plume.

Based on the applicant's proposed chlorination scheme, the staff estimates that a maximum concentration of 1.0 ppm total residual chlorine could exist in the discharge area (conservatively assuming no chlorine demand in the lake water). Applying dilution factors (Table 5.20) developed in the thermal plume analysis to the total residual chlorine concentrations in the discharge and based on information presented in Fig. 5.9, toxic chlorine levels could exist covering 1400 acres and extending to 16,900 feet from the discharge resulting in exposure to a large number of aquatic organisms. The staff believes that the above estimate is conservative, realizing that chlorine demand and decay of residuals will act to reduce the total residual chlorine below that estimated by the staff. However, to ensure the protection of the aquatic biota in the vicinity of the Sterling Power Plant, the staff believes that the concentration of total residual chlorine at the point of discharge should be limited to a value not to exceed 0.1 ppm.

Copper and nickel

Corrosion of the copper-nickel alloy material in the main condenser tubing will raise the concentrations of copper and nickel in the discharged cooling water by about 5×10^{-4} ppm and 5×10^{-5} ppm respectively (ER, p. 3.6-1). Because these increments represent concentrations approximately one order of magnitude less than those found occurring naturally in most U. S. waters, including Lake Michigan,[62] the staff expects no toxic effects from these slight increases in copper and nickel.

Key to Fig. 5.9. Exposures of aquatic organisms to total residual chlorine

All concentrations were measured

Species	Point No.	Effect end point[a]	Reference
Protozoa	1	Lethal	Hale, 1930
Cladoceran	2	Lethal (4 days)	Biesinger, 1971
Scud	3	Safe concentration	Arthur, 1971
	4	Safe concentration	Arthur and Eaton, 1972
Trout fry	5	Lethal (2 days)	Coventry et al., 1935
	6	Lethal (instantly)	Coventry et al., 1935
Brook trout	7	Median mortality (90 min)	Pyle, 1960
	8	Mean survival time 8.7 hr	Dandy, 1967
	9	Mean survival time 14.1 hr	Dandy, 1967
	10	Mean survival time 20.9 hr	Dandy, 1967
	11	Mean survival time 24 hr	Dandy, 1967
	12	67% lethality (4 days)	Dandy, 1967
	13	Depressed activity	Dandy, 1967
	14	7-day TL50	Arthur, 1971
	44	Not found in streams	Tsai, 1971
Brown trout	45	Not found in streams	Tsai, 1971
Fingerling rainbow trout	17	Lethal (4 to 5 hr)	Taylor and James, 1928
Rainbow trout	15	Slight avoidance (10 min)	Sprague and Drury, 1969
	16	Lethal (2 hr)	Taylor and James 1928
	18	96-hr TL50	Basch, 1971
	19	7-day TL50	Merkens, 1958
	20	Lethal (12 days)	Sprague and Drury, 1969
Chinook salmon	21	First death 2.2 hr	Holland et al., 1960
Coho salmon	22	7-day TL50	Arthur, 1971
	23	100% kill (1–2 days)	Holland et al., 1960
	24	Maximum nonlethal	Holland et al., 1960
Pink salmon	25	100% kill (1–2 days)	Holland et al., 1960
	26	Maximum nonlethal	Holland et al., 1960
Fathead minnow	27	TL50 (1 hr)	Arthur, 1972
	28	TL50 (12 hr)	Arthur, 1972
	29	96-hr TL50	Zillich, 1969
	30	7-day TL50	Arthur, 1971
	31	Safe concentration	Arthur and Eaton, 1972
White sucker	32	Lethal (30–60 min)	Fobes, 1971
	33	7-day TL50	Arthur, 1971
Black bullhead	34	96-hr TL50	Arthur, 1971
Largemouth bass	35	7-day TL50	Arthur, 1971
	37	TL50 (1 hr)	Arthur, 1972
	38	TL50 (12 hr)	Arthur, 1972
Smallmouth bass	36	Not found in streams	Tsai, 1971
	39	Median mortality (15 hr)	Pyle, 1960
Yellow perch	40	TL50 (1 hr)	Arthur, 1972
	41	TL50 (12 hr)	Arthur, 1972
	42	7-day TL50	Arthur, 1971
Walleye	43	7-day TL50	Arthur, 1971
Miscellaneous fish	46	Initial kill 15 min	Truchan, 1971
Rainbow trout	47	100% lethal in plant effluent	Michigan Water Resources Commission, 1971
Daphnia magna	48	0 recovery	National Water Quality Lab. 1971

[a] TL50: median tolerance limit.

POOR ORIGINAL

References for Figure 5.9

Arthur, John W., and John G. Eaton. 1972. Toxicity of chloramines to the amphipod, *Gammarus pseudolimnaeus* Bousfield, and the fathead minnow, *Pimephales promelas* Rafinesque. J. Fisheries Res. Board Can.

Arthur, J. W. 1971. Progress reports. National Water Quality Laboratory, Duluth, Minn.

Arthur, J. W. 1972. Progress reports. National Water Quality Laboratory, Duluth, Minn.

Basch, Robert E. 1971. In-situ investigations of the toxicity of chlorinated municipal wastewater treatment plant effluents to rainbow trout (*Salmo gairdneri*) and fathead minnows (*Pimephales promelas*). Bureau of Water Management, Michigan Department of Natural Resources, Lansing, Mich. 48926. 50 pp.

Biesinger, K. E. 1971. Processed report. National Water Quality Laboratory, Duluth, Minn.

Brungs, W. A. 1972. Literature review of the effects of residual chlorine on aquatic life. Environmental Protection Agency, National Water Quality Laboratory, Duluth, Minn.

Coventry, F. L., V. E. Shelford, and L. F. Miller. 1935. The conditioning of a chloramine treated water supply for biological purposes. Ecology 16: 60–66.

Dandy, J. W. T. 1967. The effects of chemical characteristics of the environment on the activity of an aquatic organism. Thesis. University of Toronto, Ont. Dissertation abstracts 29, B. 3132 (1969), Water Pollution Abs. (Brit.) 42 1708 (1969).

Fobes, Ronald L. 1971. Chlorine toxicity and its effect on gill tissue respiration of the white sucker, *Castostomus commersoni* (Lacepede). MS thesis. Department of Fisheries and Wildlife, Michigan State University, East Lansing, Mich.

Hale, F. E. 1930. Control of microscopic organisms in public water supplies with particular reference to New York City. New Engl. Water Works Assoc. 44: 361–385.

Holland, G. A., J. E. Lasater, E. D. Neumann, and W. E. Eldridge. 1960. Toxic effects of organic and inorganic pollutants on young salmon and trout. State of Washington, Department of Fisheries, Research Bulletin No. 5, September, 1960. Pp. 198–214.

Merkens, J. C. 1958. Studies on the toxicity of chlorine and chloramines to the rainbow trout. Water and Waste Treat. J. 7: 150–151.

Michigan Water Resources Commission. 1971. A survey of chlorine concentrations in the Weadock Power Plant discharge canal. Processed report. 6 pp.

National Water Quality Laboratory. 1971. Processed report. Duluth, Minn.

Pyle, E. A. 1960. Neutralizing chlorine in city water for use in fish-distribution tanks. Prog. Fish-Cult. 22: 30–33.

Sprague, J. B., and D. E. Drury. 1969. Avoidance reactions of salmonid fish to representative pollutants. Advances in Water Pollution Research, Proceedings of the 4th International Conference. Pp. 169–179.

Taylor, R. S., and M. C. James. 1928. Treatment for removal of chlorine from city water for use in aquaria. U.S. Bur. Fish. Doc. 1045. Rept. U.S. Comm. Fish. App. 7: 322–327.

Truchan, J. G. 1971. As reported by Brungs (1972).

Tsai, C. 1971. Water quality and fish life below sewage outfalls. Progress Report. National Resources Institute, University of Maryland, College Park, Md.

Zillich, J. A. 1969a. The toxicity of the Wyoming Wastewater Treatment Plant effluent to the fathead minnow and the white sucker, July 28–August 1, 1969. Michigan Water Resources Commission, Michigan Department of Natural Resources. 7 pp.

Zillich, J. A. 1969b. The toxic effects of the Grandville Wastewater Treatment Plant effluent to the fathead minnow, *Pimephales promelas*, November 17–21, 1969. Michigan Water Resources Commission, Michigan Department of Natural Resources. 9 pp.

Zillich, J. A. 1969c. The toxicity of the Wyoming Wastewater Treatment Plant effluent to the fathead minnow, December 8–12, 1969. Michigan Water Resources Commission, Michigan Department of Natural Resources. 12 pp.

Table 5.20. Dilution of residual chlorine concentration in the discharge plume at the Sterling Power Plant for annual average lake level conditions (staff's Case 13)

Distance from discharge point (ft)	Average travel time (min)	Chlorine concentration (ppm)[a] as a function of distance and time from point of discharge (concentration at point of discharge)		
		0.1 ppm	0.5 ppm	1.0 ppm
1,700	7.8	0.050	0.250	0.50
5,420	61.8	0.025	0.125	0.25
16,900	338.0	0.010	0.050	0.10

[a] Assumed that reduction in concentration is by dilution only.

Sodium hydroxide and sulfuric acid

Section 3.6.2 describes the demineralizer regeneration effluents. The use of sodium hydroxide and sulfuric acid in regeneration will result in the discharge of sodium sulfate to the discharge canal. Dilution here will reduce sodium sulfate concentration to a maximum of 0.2 ppm and an average of 0.02 ppm, concentrations far below those known to adversely affect aquatic organisms.[63]

Sanitary wastes

The sewage treatment facilities will be designed to treat sewage by the extended aeration process and chlorination (ER, p. 3.7-1) to meet the limits established by the EPA in 40 CFR 133, "Secondary Treatment Information" and other Federal and State regulations. Treated effluent, ranging from 0.004 cfs during normal operation to 0.012 cfs during shutdown, will discharge into Lake Ontario via the discharge canal. Dilution of chlorine by a circulating water flow of 1860 cfs should ensure the safety of aquatic organisms. Slight increases in nutrients may stimulate primary productivity in the discharge area, but the increased productivity would probably be undetectable. A commercial service equipped with proper facilities and necessary permits will remove sewage sludge (about 7 gpd during normal operation) offsite for disposal in compliance with existing State and Federal regulations (ER, pp. 3.7-1, 5.5-2).

Scouring

The discharge of cooling water will cause some scouring in and near the discharge canal resulting in sharp declines in densities of benthic organisms in the immediate area. The applicant estimates that 3 to 6 acres of lake bottom will be scoured where the discharge velocity exceeds 1 fps. A localized increase in turbidity will follow initial startup as loose sediments (silt and fine sand with some gravel and traces of clay) are resuspended by the 3.7 fps discharge flow and transported by the littoral currents. No significant or long-term adverse impacts are expected from either the increase in turbidity or the increase in sediments to the littoral drift system. During plant operation, the effect of the surface discharge on the velocity of the currents near the lake bottom and the resuspension and entrainment of sediments will be negligible.

To a certain extent, the discharge flow may also reduce the intensity of wave activity directed toward the shore and thereby reduce shore erosion. This possibility can probably be ignored, since both the shoreline and the facility will be protected by the presence of a rip-rapped flood control dike situated along the shoreline on either side of the discharge canal. This structure will cut off the supply of sediment currently furnished to the lake by natural erosion processes along the length of shoreline to be protected by the dike. The effect of the dike on the sediment budget in the littoral zone will be mitigated by the applicant's plan to initiate a nourishment program if the monitoring of shore line erosion rates indicates that this is necessary.[64] Thus the staff concludes that the impact of the dike on littoral drift should be acceptable, since the supply of sediment contributed to the lake will be maintained.

5.5.2.3 Intake effects

Impingement

The number of fish likely to be impinged during operation of a thermal power plant is a function of both biological and physical parameters. Biological parameters include the species in the area and their abundance, size, swimming speed, and seasonality, while physical parameters include factors such as intake design and location, the volume of water withdrawn, and the velocity of the water approaching the intake ports. The intake structure proposed for the Sterling Power Project is described and illustrated in Sect. 3.4.2.

Estimates of the potential annual impingement at the Sterling site are based on observations of the numbers of impinged fish collected on the intake screens at the Ginna Power Plant in 1973 and 1974 (Table 5.21). The extrapolation of the impingement data at Ginna rather than Nine Mile Point Unit 1 was based on the similarities in the intake design and location between the Ginna and Sterling Plants (Table 5.22). In order to obtain the most reliable estimates of cumulative (regional and lakewide) impacts, however, the data for both operating plants were used. The population of alewives more than any other fish species in Lake Ontario will sustain the greatest impact as a result of impingement. Game fish such as the smallmouth bass and various salmonid species are impinged in relatively low numbers (Appendix B), but in 1973 the alewife constituted 91 and 97% of all the fish impinged at Ginna and Nine Mile Point Unit 1 respectively (Appendix B). Similar values were found in 1974 when alewives comprised 93% of the impingement total at Ginna[65] and 94% at both Nine Mile Point Unit 1[66] and the Pickering Generating Station, a larger power plant (2000 MWe) located near Toronto.[67]

Table 5.21. **Observed and predicted annual impingement of Lake Ontario fish due to power plant operation**

Power plant	Number of fish impinged per year (X 10^6)	Percent of total lake alewife stock[a]	
		10^9	10^{10}
Observed impingement			
Ginna			
1973	2.56	0.23	0.02
1974	2.02	0.19	0.02
Nine Mile Point 1			
1973	4.63	0.45	0.04
1974	2.50	0.24	0.02
Predicted impingement			
Sterling[b]	4.76	0.45	0.04
Sterling[c]	5.37	0.51	0.05
All plants, southeast shore			
1976 (MWe = 3,146)[d,e]	16.54	1.57	0.16
1990 (MWe = 6,246)[d,f]	32.84	3.12	0.31
Lakewide			
1976 (MWe = 9,006)[d,e]	47.35	4.50	0.45
1990 (MWe = 23,506)[d,f]	123.58	11.74	1.17

[a] Assumes 95% of impinged fish to be alewives for calculations of predicted annual impingement; first column assumes a total alewife population of 10^9 fish, and the second column assumes a total alewife population of 10^{10} fish.

[b] Estimate based on: (1) an annual impingement at Ginna of 2.29 X 10^6 fish (mean of the 1973 and 1974 values), and (2) the assumption that impingement is a linear function of the amount of water withdrawn (Sterling withdrawal rate is 2.08 times that of Ginna).

[c] Estimate based on the assumption that impingement is a linear function of the generating capacity of the plant (MWe). An average value of 4673 fish impinged per MWe based on data for 1973 and 1974 at Ginna was used in the calculations.

[d] Estimate based on the assumption in Footnote c and the assumption of exclusive use of once-through cooling. An average value of 5257 fish per MWe was used in the calculation (mean of the 1973 and 1974 impingement numbers at Ginna and Nine Mile Point Unit 1).

[e] Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, vol. 4, November 1975, Table 316-4.1.

[f] Letter from E. R. Effer, Supervisor of Environmental Studies at Ontario Hydro to P. A. Isaacson, New York State Public Service Commission, June 30, 1975.

Table 5.22. **Comparison of the intake design parameters of the Sterling, Ginna, and Nine Mile Point Unit 1 Power Plants**

Parameter	Sterling[a] (1150 MWe)	Ginna[b] (490 MWe)	Nine Mile Point 1[c] (610 MWe)
Volume of water withdrawn (cfs)	1860	892	600
Intake location			
Depth (ft)	35.5	33	18
Distance from shore (ft)	4200	3100	850
Velocity			
At the intake ports (fps)	1.5	0.8	2.0
In the intake tunnel (fps)	10.3	11.0	8.0
At the traveling screens (fps)	2.2	0.8	0.8

[a] ER, Sect. 3.4.2.1.

[b] U.S. Atomic Energy Commission, Directorate of Licensing, *Final Environmental Statement, R. E. Ginna Nuclear Power Plant*, Docket No. 50-244, December 1973.

[c] U.S. Atomic Energy Commission Directorate of Licensing, *Final Environmental Statement, Nine Mile Point Nuclear Station, Unit 1*, Docket No. 50-220, January 1974.

Historically, the alewife appears to have been a grossly underutilized species in Lake Ontario due to a paucity of predators and commercial fishing pressures. Although it can be argued that power plant intakes are simply predators on a fluctuating but generally superabundant alewife population, the fact that the State of New York and the Province of Ontario are attempting to establish a salmonid fishery based on this forage fish should be emphasized. Table 5.22 presents the numbers of salmonids stocked for 1973 and 1974 and estimates for 1975. The competition of salmonids and power plant "predators" for alewives could conceivably provide the incremental increase in alewife mortality leading to the diminishment of alewife stocks followed by a reduction in the salmonid populations. On the other hand, if diminishment of the alewife population allowed a recovery of other forage fish stocks, some of which may be superior to the alewife, the net impact on the total fishery could be beneficial, although some of these species may also prove vulnerable to impingement or entrainment. The staff has provided these widely different scenarios of potential impacts to illustrate the difficulty in evaluating the ultimate impact of power plants on the Lake Ontario fishery. Nevertheless, the staff has assumed that the alewife is important to the development of gamefish populations as a forage fish. Until the dynamics of alewife populations are more fully understood, the stocks must be protected as much as possible.

Table 5.23. **Summary of Lake Ontario salmonid stocking program, 1973–1975**

Species	Development stage[a]	Year		
		1973	1974	1975[b]
Coho	Y	214,900	147,000	>150,000
Coho[c]	Y		438,400	
Coho	F	24,900		
Chinook	f	700,000	975,000	975,000
Chinook[c]	f		224,500	
Steelhead	Y	100	200,000	
Brown trout	Y	60,300	80,000	80,000
Lake trout[d]	Y	66,000	130,000	
Lake trout[e]	F		500,000	
Rainbow trout	Y		15,000	
Rainbow trout[c]	F		90,000	
Splake[c]	Y		16,000	

[a] Y – yearlings; F – fall fingerlings; f – spring fingerlings.

[b] 1975 figures are estimates.

[c] Stocked by Canada.

[d] Stocked by New York State Department of Environmental Conservation.

[e] Stocked by Federal government.

Source: Sea Grant Advisory Service, in cooperation with New York State Department of Environment Conservation, October 1974.

Finally, the addition of Sterling (1150 MWe) alone to the present Lake Ontario power pool (9006 MWe) would result in a 0.06 and a 0.57% increase in the cropping of the alewife populations assuming standing crops of 10^{10} and 10^9 fish respectively. The staff concludes that the regional and lakewide impacts resulting from the impingement of fish at the Sterling Power Project are acceptable but that some reduction in local standing crops and recruitment rates is possible. A discussion of mitigative measures to be taken to minimize the impacts on the local fish populations follows.

A fairly strong case can be made for the possibility that a large majority of the alewives impinged at Ginna in March and April were either dead or dying prior to impingement as a result of thermal shocks and other natural stresses, in which case impingement would be of much less concern. These periods of peak impingement rates have been largely responsible for the magnitude of the annual impingement estimate. For example, more than 90% of the total annual alewife impingement occured during April and May at both Ginna[65] and Nine Mile Point Unit 1 in 1973[68] and also at Ginna in 1974.[65] That massive die-offs occur during these months is well documented. Impingement studies at Ginna suggest that natural cold shock figured importantly during the highest impingement rates because ambient lake temperatures (35°F) were below those known to severely stress alewives[69,70] (ER, Vol. 4, Appendix 2G). A recent study has shown the ultimate lower lethal temperature for this species to be approximately 37°F.[71] Cold-stressed alewives and smelt (the latter of which comprises approximately 2 to 6% of the total impingement numbers) may be unable to respond to the stimulus created by water flowing through the Sterling intake ports at 1.5 fps and, consequently, may not swim upcurrent and away from the intake. Indeed, results from an experimental impingement study conducted at the Ginna Power Plant indicated that larger numbers of both alewives and smelt were impinged at an intake velocity of 1.3 fps than at a velocity of 0.8 fps (Table 5.24).

Table 5.24. **Mean number of fish impinged per hour at different approach velocities from March 12 to May 15, 1975, at the Ginna Power Plant**

Species	Mean number of fish impinged per hour (approach velocity)	
	0.8 fps[a]	1.3 fps[a]
Alewife		
Adult	9.14	34.81
Juvenile	0.07	0.73
Rainbow Smelt		
Adult	8.30	38.40
Juvenile	3.80	4.32
Three-spine stickleback	12.61	26.48
Others	3.65	2.04
Total	37.57	106.77

[a] To obtain approach velocities at the intake ports of 0.8 and 1.3 fps, the pumping rate was varied. At 0.8 fps, one pump was operating at 245,000 gpm; at 1.3 fps, two pumps were operating with a total flow of 395,000 gpm. The tabular values above have been corrected for this difference in flow by multiplying the number of fish impinged per hour at 0.8 fps by 1.6122, the difference between the high- and low-flow rates.

Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, vol. 4, November 1975, Appendix 11A.

Finally, it should be noted that several species, especially the alewife and rainbow smelt, may be susceptible to stresses other than those that are strictly thermal in origin. Stresses resulting from being transported through the intake tunnel, impinged on the traveling screen, carried down the sluiceway, and finally passed into the discharge canal may, in part, account for the low survival of impinged alewives and smelt that was observed in studies conducted at Ginna and Nine Mile Point Unit 1 (Table 5.25). Thus the staff concludes that mitigative measures taken to reduce the impingement of alewives and smelt, which together can constitute as much as 99% of the total impingement, must ultimately be directed at reducing the numbers of fish entering the intake structure itself.

According to the applicant (ER, p. 3.4-2), the proposed intake structure will incorporate the following design features to minimize entrainment of fish:

(1) The lower edge of the intake ports will be placed 6 ft off the lake bottom to avoid entrainment of bottom fish and larger fish that may spend a substantial fraction of the day on the bottom;

(2) Solid, vertical walls will extend from the bottom of the intake ports to the lake bottom, thereby eliminating overhangs attractive to fish as shelter.

(3) Three of the intake ports on the "down-wave" side of the structure will be closed to minimize entrainment of fish seeking shelter from waves;

Table 5.25. **Estimates of percent survival of impinged fish at the Ginna and Nine Mile Point Unit 1 Power Plants**

Species	Ginna				Nine Mile Point Unit 1	
	1973[a]		1974[b]		1974[c]	
	Number of fish tested (n)	Mean annual survival (%)	Number of fish tested (n)	Mean annual survival (%)	Number of fish tested (n)	Mean annual survival (%)
Alewife	339	4	[illegible]1 (11)[d]	3.7 (0.0)	20,870	13.0
Rainbow smelt	649	8	1485 (482)[d]	27.7 (6.0)	5,502	4.2
Gizzard shad	NA[e]	NA	6	33.3	305	24.3
Three-spine stickleback	58	79	42	26.2	73	4.1
White perch	109	29	43	34.9	NA	NA
Smallmouth bass	11	100	16	75.0	NA	NA
Mottled sculpin	62	77	52	96.2	NA	NA
Spottail shiner	116	63	80	28.7	NA	NA
Lake chub	132	49	81	92.6	NA	NA

[a] Fish taken from sluiceway and placed into a holding tank (6 ft in diameter and 1 ft deep) for 24 hr at ambient lake temperature (ER, Table 73.1.7-4).

[b] Fish taken from sluiceway and placed into 4 ft X 2 ft metal tubs or oval tank (4 ft X 8 ft X 3 ft) for varying lengths of time (4 to 96 hr) at ambient lake temperature (Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, vol. 4, November 1975, Tables 1 through 16.

[c] Fish taken from fish basket located at the junction of the screen wash sluiceway and the discharge canal after being washed from traveling screens by water at a pressure ranging from 138 to 155 psi. Fish were exposed to the heated discharged for 1 to 4 min (ΔT = 25°F) and observed after 45 min (Lawler, Matusky, and Skelley Engineers), *1974 Nine Mile Point Aquatic Ecology Studies*, vol. II, Chapters VII through X, December 1975.

[d] Juveniles.

[e] No data available.

(4) Water will pass horizontally through the ports at 1.5 fps to enhance detection and subsequent avoidance by fish near the structure;

(5) The inner walls of the intake ports will be roughened to further warn fish of danger through increased turbulence;

(6) The structure will be located in 35.5 ft of water, 4200 ft offshore.

The staff agrees that items (1), (2), and (6) will help to reduce entrainment of fish. Fathometric studies performed by the applicant at Sterling and Ginna suggest that fish abundance generally declines beyond approximately 2000 to 3000 ft offshore and depths of about 25 ft[42] (ER, Sect. 5.1). Fish larvae tend to concentrate closer inshore as a rule.

Closure of "down-wave" ports might provide some protection against entrainment, but the resulting i[illegible] in intake velocity could more than balance this mitigative measure. Whether roughening o[illegible]r walls of intake ports will measurably diminish entrainment is unknown.

While agreeing that horizontal flow of intake water is superior to vertical flows in warning fish of danger, the staff questions the value of high intake velocities. The applicant argues that high velocities (in this case 1.5 fps or higher) generate turbulence that warns fish of danger. However, the staff is unaware of any demonstration that the turbulence will be sufficient to alert fish to danger or that the fish, once alerted, can overcome the intake current. Swim speed data suggest that many fish, especially small adults and juveniles, fail to overcome intake velocities greater than 0.5 to 1.0 fps.[69,72] Since fish are poikilotherms (body temperature approximates that of the environment), their swim speeds vary inversely with ambient temperature, with the result that fish are particularly susceptible to impingement during the coldest months of winter and spring. Large fish impingement counts have been reported in winter months where intake velocities exceeded 0.5 fps.[44]

The applicant has recently committed[73] to a maximum intake velocity of 0.8 fps and the staff concurs on this decision. Justification for this low velocity has been discussed previously and, in summary, is based on the following evidence: (1) more than 90% of the fish impinged are alewives; (2) the highest impingement rates occur when the fish are cold-stressed and migrating to inshore waters; thus, they may be incapable of responding to stimuli such as increased current flows; (3) survival rates of impinged fish are low, suggesting that the mitigative measures must be applied before the fish are actually impinged; and (4) experimental impingement studies conducted at Ginna resulted in higher impingement rates for alewives at the higher approach velocity. An approach velocity of 0.8 fps will not reduce the impingement rate to zero; however, it should ensure that any reductions in the standing crop and recruitment rates of alewives will be minimal.

Finally, the applicant will install a Ristroph Traveling Screen system at the Sterling facility.[65] This system will include a gentle screen wash. Since the screens will be operated continuously, retention times of fish on the screens will be approximately two min. This system has been installed at the Surry Power Station on the James River in Virginia, where survival rates of impinged fish exceed 90%. The staff agrees that this system should increase the survival rates for most species over those observed at Ginna and Nine Mile Point Unit 1. Specifically, the survival of impinged gamefish such as the smallmouth bass and the various salmonid species may approach 100%. However, the staff concludes that the increase in the survival of alewives and rainbow smelt will not approach 100%, but will be substantially less due to the condition of the individuals of these species at the time of impingement.

If the fish are returned to the upper portion of the 180-ft discharge canal, thermal and chemical stress may ensue and the value of the Ristroph traveling screen system may be lost. Since the survival studies at Ginna did not include exposure of the fish to the discharge and because the studies at Nine Mile Point included only very brief exposures (1 to 4 min), the staff recommends that the fish be returned to the discharge canal at a point close to the lake. With the application of these mitigative measures, the staff concludes that the impact of the Sterling facility on the resident fish populations near the site will be acceptable.

Entrainment

The intake structure for the circulating water system will lie on the 35.5-ft depth contour (mean lake elevation) 4200 ft offshore (ER, Fig. 3.4-3). The upper and lower edges of the 10 intake ports will lie 16.5 ft and 29.5 ft below mean lake elevation respectively. The lower edges will be 6 ft above the bottom. For a more detailed discussion of the circulating water system, see Sect. 3.4.2.

Maximum temperature increase across the condenser (ΔT) will be 23.3°F during January, February, and March of an average year. Thus, organisms entrained at an ambient lake temperature of 33°F would be exposed to a maximum temperature of 56°F. Within 14.6 min of discharge, the temperature in the plume would drop to 43°F. From April through November during an average year, the ΔT is expected to be 19.3°F, resulting in a temperature of 86.3°F in the condensers in August. Under worst-case conditions (ambient lake temperature of 75°F), the maximum temperature in the condensers will reach 94.3°F.

Water entering the intake structure at 1860 cfs will inevitably bring aquatic organisms along. Large numbers of phytoplankton, zooplankton, immature fish, and, on occasion, smaller numbers of benthic organisms such as *Gammarus* will pass through the 3/8-in. mesh traveling screens and on to the condensers, where they will experience thermal, mechanical, and chemical shocks. Table 3.3 presents expected retention times in each section of the circulating water system.

Effects on plankton. Several phytoplankton entrainment studies indicate that increases in productivity of entrained plankton often follow during the colder months, followed by a decrease when ambient temperatures exceed 60 to 70°F.[35,44,74] Phytoplankton and zooplankton surviving entrainment may exhibit sublethal effects such as reduced photosynthesis or reproductive potential. However, investigations at Indian Point revealed no observable damage or change in growth rates of entrained phytoplankton.[75] Significantly, Sterling will withdraw cooling water from the 15- to 29-ft-depth range under normal lake elevation. At these depths, phytoplankton densities should be less than those near the surface.

Zooplankton mortalities, as reported in various entrainment studies, range from around 3 to 100%.[35,44,74,76] At the Millstone Point plant on Long Island Sound (ΔT = 23.4°F), 70% of the entrained copepods were lost, apparently as a result of mechanical or hydraulic stresses.[74] On the other hand, differences in zooplankton mortality between intake and discharge at four California coastal plants (ΔT range of 16 to 27°F) averaged less than 6%.[76] An 18% mortality rate was observed for all plankters (ΔT=18°F) at Ginna.[56] Davies and Jensen[77] noted decreases in zooplankton abundance in water discharged from the condensers (ΔT = 11 to 36°F) of three mid-Atlantic power plants during summer but observed no decreases of populations in the receiving waters.[77]

Given sublethal temperature increases, the available evidence suggests that entrainment mortality varies directly with increasing size of entrained organisms.[35,44] Generally, phytoplankton appear least harmed by entrainment, small zooplankton sustain somewhat greater mortality, and larger zooplankton experience the greatest mortality.[35,44,74] Ichthyoplankton and early juvenile fish entrainment mortality probably approaches 100% at many plants, much of the mortality being a result of mechanical damage.[78]

Mortality and other adverse effects of entrainment, as suggested by numerous studies at power plants and laboratories throughout the nation,[78] vary tremendously according to species, season, ambient temperature, ΔT, water chemistry, and many other parameters. Thus, accurate predictions of mortality and sublethal effects at a proposed plant are difficult.

Although no quantitative assessment of entrainment mortality at Sterling can be made on the basis of data from other plants, the staff believes a large fraction of phytoplankton and zooplankton will survive passage through the circulating water system during the cooler months. During the hotter summer months and during chlorination, mortality may approach 100% for some species. However, the dead plankton will still be available as food for predators and scavengers, and the rapid population turnover of these species should ensure re-establishment of pre-entrainment densities and species composition a few hundred yards beyond the discharge canal. The staff concludes that any decreases in plankton abundance or shifts in species composition as a result of entrainment will be seasonal, highly localized, and of no consequence to Lake Ontario as a whole.

Effects on fish eggs and larvae. Immature fish have neither the rapid population turnover nor the capacity for survival of entrainment displayed by other elements of the plankton. Young fish will encounter all the hazards described for entrapped adult fish as far as the traveling screens, particularly since many young fish will have already developed swim bladders and will risk damage in the pumps before injection into the condensers and subsequent mechanical, thermal, and chemical shocks. Upon discharge, those still alive may suffer heightened predation due to their disorientation and weakened condition, and they will face further thermal exposure and possible gas bubble disease.[35,50] At most operating plants for which data are available, ichthyoplankton entrainment mortality has generally ranged from 90 to 100%.[79] For these reasons, the staff has assumed 100% mortality for ichthyoplankton entrained at Sterling.

Fish egg densities exceeding 20,000 eggs/m^2 of lake bottom were occasionally observed at the Sterling site. However, densities were greatest by far at the 2- and 5-m contours and decreased dramatically beyond 5 m (ER, Appendix A74.1-2). Due to the demersal and adhesive nature of fish eggs likely to occur in the area, the staff foresees no adverse effects on area fish populations resulting from entrainment of eggs.

Fish larvae were relatively abundant at Sterling. During May and June 1973, larval densities at the site ranged as high as 1.76 larvae/m^3 at mid-depth in water 5 m deep. Densities greater than 1.0/m^3 also occurred in July and early August. The mean density for all sampling efforts was 0.66/m^3. Clupeid larvae (probably alewives) were most abundant, followed by serranid larvae and larvae of centrarchids, cyprinids, and perch.[80] From May 9 through August 16, 1974, the mean larval density was 0.023 larvae/m^3, only 2.3% of the mean density obtained in 1973 for the same period and stations (1.014 larvae/m^3); see Table 5.26.

Table 5.26. **Fish larvae abundance – Lake Ontario at the Sterling site, May–August**

Tow samples								Bottom samples (pump) 1974			
1973				1974							
Contour and depth (m)[a]	Number of samples taken[c]	Mean number (m^3)	Range	Contour and depth (m)[a]	Number of samples taken[c]	Mean number (m^3)	Range	Contour and depth (m)	Number of samples taken[c]	Mean number (m^2)	Range
2 S	4 (4)	1.060	0.963–1.135	2 S	31 (8)	0.034	0–0.265	2	22 (6)	85.4	0–1408
5 S	4 (4)	0.662	0.243–0.968	5 S	28 (7)	0.022	0–0.392	5	23 (6)	29.2	0–416
5 M	4 (4)	1.321	0.717–1.762	5 M	24 (6)	0.018	0–0.145				
8		*b*		8 S	27 (7)	0.004	0–0.024	8	23 (6)	17.4	0–128
				8 M	20 (6)	0.013	0–0.068				
11		*b*		11 S	24 (6)	0.002	0–0.022	11	20 (6)	7.2	0–64
				11 M	9 (3)	0.017	0–0.051				
18		*b*		18 S	8 (2)	0.001	0–0.009	18	12 (4)	0	
				18 M	4 (1)	0.011	0–0.019				

[a] S – surface; M – mid-depth.

[b] Not sampled.

[c] Number of sampling periods in parentheses.

Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Generation Siting and the Environment (Nuclear)*, Part 74, February 1975, Rev. 2.

715 120

721 061

Alewives and shiners comprised 82.4 and 11.2% of the larvae collected in 1974 respectively. Sunfish (2.9%), rainbow smelt (1.7%), darters and yellow perch (0.6% each), and sculpins and white perch (0.3% each) comprised the remainder of the larvae found at the Sterling site.

The applicant directed somewhat sporadic sampling efforts at the surface and mid-depths of the 11 and 18 m contours during 1974 (Table 5.27) and did not sample at night in either year. Several conservative approaches were taken to obtain estimates of potential annual losses of larval fish due to entrainment (Table 5.26). First, losses were estimated using mean density at mid-depth at the 5 m contour where the sampling effort was substantially greater than at the 11 m mid-depth station. Estimates were also made on the basis of larval densities at the surface of the 11 m contour. Ichthyoplankton studies at Nine Mile Point Unit 1 were conducted in 1974 and approximately 2000 tow samples were taken.[81] Densities during the day were, on the average, 1.59 times higher at the surface then at mid-depth and were 1.64 times lower in deeper water (40 ft), as compared with the more shallow areas near shore (20 ft). Thus the use of data collected from 11 m station (at the surface) and the 5 m station (at mid-depth) yields conservative estimates of entrainment potential. Finally, the staff used densities observed in 1973 by extrapolating to the 11 m contour using the density gradient (decline in numbers from inshore to offshore areas) found in 1974. Since the applicant included all immature fish that were less than 50 mm in his definition of 'larvae,' many of the ichthyoplankton taken in 1973 may have been too large to pass through the 3/8-in. mesh of the vertical traveling screens. No estimates were made of entrainment based on the densities of juveniles obtained in 1973, since fish that are larger than 40 mm are probably impinged rather than entrained. Rainbow smelt as small as 25 mm were, in fact, impinged at Nine Mile Point Unit 1.[82]

The number of larvae entrained based on these different density values was used to calculate the potential number of two-year-olds that would be lost if the larvae were subject only to natural mortalities. The assumption that the natural annual survival of larvae is 0.08% is based on fecundities of fish found in the Great Lakes as reported in the literature.[83-85]

Table 5.27. **Potential annual entrainment of fish larvae at the Sterling Power Project, May through August**[a]

Densities assumed (larvae/m^3)[b]	Number of larvae entrained per year	Potential number of two-year-olds represented[c]	Potential pounds of two-year-olds lost per year[d]
0.017[e] (0.153)	2.38×10^7	19,040	1,904
0.018[f] (0.162)	2.52×10^7	20,160	2,016
0.002[g] (0.004)	8.40×10^5	672	67
0.290[h] (2.610)	4.06×10^8	324,800	32,480

[a] All estimates based on continuous withdrawal of 1860 cfs for 123 days (May 1 to August 31). Estimates were calculated using the daytime densities for 61.5 days and the densities at night for 61.5 days.

[b] Densities assumed during the night are in parentheses. Since the applicant did not sample at night, the staff assumed that densities at night were approximately 9 times higher than densities during the day. This assumption is based on results obtained from day and night sampling at Nine Mile Point Unit 1 in 1974 (Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, vol. 4, November 1975).

[c] Assuming 0.08% natural survival of larvae.

[d] Assuming average weight per fish of 0.1 lb.

[e] Mean larval density for May through August 1974 at mid-depth at the 11 m contour (intake location).

[f] Mean larval density for May through August 1974 at the 5 m contour (mid-depth).

[g] Mean larval density for May through August 1974 at the 11 m contour (surface).

[h] Mean larval density for May through August 1973 extrapolated to the 11 m contour. Since densities at 11 m, surface (s) + mid-depth (m), were 0.286 times the inshore densities (2s + 5s + 5m) in 1974, the mean density of 1.014 larvae/m^3 (2s + 5s + 5m/3) in 1973 was multipled by 0.286 to obtain the value shown in the table.

715 121 721 062

The staff concludes that a potential loss of 3.2×10^5 two-year-olds per year as a result of the entrainment of larvae will not significantly affect the standing crops or recruitment rates of the resident fish populations at the site. Since these estimates are conservative and because there is little evidence that the inshore waters of the Sterling site are superior as a nursery to most other relatively undisturbed inshore area of Lake Ontario, losses of this magnitude will not result in a substantial impact on the fisheries in Lake Ontario.

5.6 EFFECTS ON THE COMMUNITY

5.6.1 Physical impacts

Air pollution from occasional operation of diesel engines on emergency equipment will not be significant. Such operation will occur infrequently and be of short duration, and the emission involved will meet applicable standards (ER, Sect. 10.10.3.2.1).

No pollution of groundwater resources by chemicals is expected (ER, Sect. 10.10.2.2.1). During permanent operation of the plant, sanitary wastes will be given secondary treatment and chlorination prior to discharge. An extended aeration unit will also be involved in treating the wastes (ER, Sect. 10.6). The treated wastes, ranging in volume from 2500 to 7500 gpd, will be diluted in the discharge canal by about 834,000 gal of circulation and service water per minute so that the resulting concentrations will be too low to affect the lake in a measurable manner (ER, Sect. 5.5.1). A maximum quantity of 21 gpd of sewage sludge will be produced during shutdown periods, once plant operation has started. Since this is less than the maximum produced during the period of peak construction activity, it should have a correspondingly lesser impact and should place little strain on existing disposal sites. No groundwater will be used during plant operation. All water needs will be met from Lake Ontario; thus, there will be no effect on nearby wells (ER, Sect. 10.10.2.1.1).

Transportation of the operating personnel is expected to have only a minor impact on traffic. The roads that were upgraded or were already capable of carrying the loads during construction will be more than adequate for continued use during plant operation.

The terrain in the general vicinity of the site consists primarily of rolling hills; thus, the view of the plant from the landward direction will be blocked to a large extent by the hills and by vegetation. It will, however, be visible from the lake (Fig. 3.1) and nearby shoreline, but the staff believes this will represent a minor visual impact.

5.6.2 Population growth and operating personnel income

About 156 persons are estimated to be employed in the operation of the plant. Salaries and wages are expected to be in excess of $3.6 million/year beginning in 1984 (ER, Sect. 8.1.3.2.4).

The applicant estimates that perhaps 120 employees would represent newcomers to the area. If the average household size for New York (3.01 persons/household)[86] is assumed, approximately 360 individuals would move into the area (0.5% increase in the area population).

5.6.3 Impact on community services

The availability of housing in the general area is discussed in Sects. 4.1.3.3 and 8.2.2.3. Sufficient housing is expected to be available for the operating forces as the construction phase ends. In the staff's judgement, the impact of the new residents on the communities in which they reside will be minor because their numbers are expected to be small in relation to the existing population. The taxes the new residents will pay will compensate their local communities for any additional required services.

5.6.4 Impact on local institutions

The principal institutions that might be affected by the permanent work force are the local school systems. However, since the total influx of operating personnel will be relatively small in relation to existing populations, the staff does not expect significant effects on any of the local school systems. The staff expects no other local institutions to be significantly affected.

Taxes paid by the utility will offset any costs incurred by the operation of the plant. The applicant estimates that the total full value of the plant will exceed $1 billion, which will result in about $10 million in annual real property taxes (ER, Sect. 8.1.3.1). The recipients of the local property taxes are expected to be Cayuga County, Hannibal Central School District, and the town of Sterling. Taxes also will be paid in the form of gross income, gross earnings, excess dividends, unemployment, highway use of New York State, Federal income and unemployment, and Cayuga County sales and use (ER, Sect. 8.1.3.1).

5.6.5 Impact on recreational capacity of the area

The extensive local recreational capacity of the immediate region was discussed in Sect. 4.4.5 above. Because a relatively small number of operating personnel will move into the area and because the recreational opportunities currently available are expected to continue through the life of the plant, the staff expects only minor impacts on recreational facilities. Operation of the plant itself will affect the recreational capacity of the area because no access will be permitted within the fenced area. However, this loss is judged to be of only minor significance.

5.6.6 Conclusions

The staff concludes that the impacts on the community as a result of operation of the Sterling plant are acceptable.

REFERENCES FOR SECTION 5

1. C. F. Dalziel, "The Threshold of Perception Currents," *Electrical Eng.* 73: 625-630 (1954).

2. C. F. Dalziel and W. R. Lee, "Lethal Electrical Currents," *IEEE Spectrum* 6(2) 1969.

3. L. O. Barthold et al., *Electrostatic Effects of Overhead Transmission Lines*, IEEE Transaction Paper, No. TP 644-PWR, August 1971.

4. G. T. Csanady, "Hydrodynamics of Large Lakes," *Annual Review of Fluid Mechanics* 7: 357-386 (1975).

5. G. P. Harris and J. N. A. Lott, "Observations of Langmuir Circulations in Lake Ontario," *Limnology and Oceanography* 18: 584-589 (1973).

6. A. H. Lee and G. K. Rodgers, "Temperature Fine Structure in Lake Ontario," *Limnology and Oceanography* 17: 672-677 (1972).

7. Rochester Gas and Electric Corporation, *Application to the New York Board on Electric Generation Siting and the Environment (Nuclear)*, Federal Water Pollution Control Act, 316(a) and 316(b) Demonstration, vol. IV, November 1975.

8. K. D. Stolzenbach and D. R. F. Harleman, *An Analytical and Experimental Investigation of Surface Discharges of Heated Water*, Report No. 135, Department of Civil Engineering, Massachusetts Institute of Technology, 1971.

9. National Oceanic and Atmospheric Administration, *National Ocean Survey*, Lake Survey Center, Detroit, Mich.

10. "Site Specific Information on Hydrology, Meteorology, Economic, and Recreation Uses — Lake Ontario Hydrology," Sect. 3.1 of *The Sterling Power Project Water Permits Nuclear Unit No. 1*, vol. 4, 1975.

11. J. P. Bohan and J. L. Grace, *Mechanics of Flow from Stratified Reservoirs in the Interest of Water Quality*, Technical Report H-69-10, U.S. Army Corps of Engineers, July 1969.

12. B. A. Benedict, J. L. Anderson, and E. L. Yandell, Jr., *Analytical Modeling of Thermal Discharges, A Review of the State of the Art*, ANL/ES-18, Argonne National Laboratory, April 1974, pp. 128-149.

13. A. J. Policastro and J. V. Tokar, *Heated Effluent Dispersion in Large Lakes: State-of-the-Art of Analytical Modeling. Part I. Critique of Model Formulations*, ANL/ES-11, January 1972, pp. 254-278.

14. U.S. Department of Commerce, *Great Lakes Water Levels 1860-1970*, National Oceanic and Atmospheric Administration, National Ocean Survey.

15. E. F. Chermack and T. A. Galletta, "Power Plant Thermal Effluents in Southeastern Lake Ontario," pp. 663-674 in *Proc. 16th Conference on Great Lakes Research 1973.*

16. U.S. Atomic Energy Commission, *Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents*, Report WASH-1258, July 1973.

17. S. J. Auerbach, "Ecological Considerations in Siting Nuclear Power Plants. The Long Term Biota Effects Problem," *Nucl. Safety* 12: 25 (1971).

18. *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation*, report of the Advisory Committee on Biological Effects of Ionizing Radiations, NAS-NRC, 1972.

19. I. J. Stout, *The Nature and Pattern of Nonhunting Mortality in Fledged North American Waterfowl*, MS. thesis, Virginia Polytechnic Institute, Blacksburg, Virginia, 1967.

20. *1973 Farm Chemicals Handbook*, Meister Publishing Company, Willoughby, Ohio, 1973, p. D-28.

21. J. D. Buffington, *Assessment of the Ecological Consequences of Herbicides Use Along Transmission Line Right-of-Way and Recommendation for such Use*, Argonne National Laboratory Publication, 1974.

22. K. S. Khera et al., "Pre- and Post-Natal Studies on 2,4,5-T and 2,4-D and Derivatives in Wistar Rats," *Toxicology and Applied Pharmacology Abstracts, 10th Annual Meeting* 19: 369-370 (1971).

23. J. E. Johnson "The Public Health Implications of Widespread Use of the Phenoxy Herbicides and Picloram," *Bioscience* 21: 599-905 (1971).

24. American Industrial Hygiene Association, "Community Air Quality Guides. Ozone," *American Indust. Hygiene Assoc. J.* 29: 299-303 (1968).

25. H. E. Heggestad, "Consideration of Air Quality Standards for Vegetation with Respect to Ozone," *J. Air Poll. Cont. Assoc.* 19: 424-426 (1969).

26. T. G. Wilkinson and R. L. Barnes, "Effects of Ozone on $C^{14}O_2$ Fixation Patterns in Pine," *Can. J. Bot.* 51: 1573-1578 (1973).

27. L. S. Jaffe, "Photochemical Air Pollutants and Their Effects on Men and Animals," *Arch. Environ. Health* 16: 241-255 (1968).

28. E. F. Darley and J. T. Middleton, "Problems of Air Pollution in Plant Pathology," *Ann. Rev. Plant Pathology* 4: 103-118 (1966).

29. M. Treshaw, *Environment and Plant Response*, McGraw-Hill, 1970, pp. 322-353.

30. M. Frydman et al., "Oxidant Measurements in the Vicinity of Energized 765-kV Lines," *IEEE Transactions on Power Apparatus and Systems* PAS-92(3): 1141-1148 (1973).

31. W. J. Fern and R. I. Brabets, "Field Investigation of Ozone Adjacent to High Voltage Transmission Lines," presented at IEEE PES Winter Meeting, New York, January 27-February 1, 1974.

32. N. Kolcio et al., "Radio-Influence and Corona-Loss Aspects of AEP 765-kV Lines," *IEEE Transaction on Power Apparatus and Systems* PAS-88(9): 1343-1355 (1969).

33. R. A. Byron, "Design EHV Lines to Reduce Impact," *Electrical World*, pp. 74-77 (Jan. 15, 1974).

34. M. Munawar and A. Nauwerck "The Composition and Horizontal Distribution of Phytoplankton in Lake Ontario During the Year 1970," pp. 69-78 in *Proc. 14th Conf. Great Lakes Res.*, 1971.

35. C. P. Goodyear, C. C. Coutant, and J. R. Trabalka, "Sources of Potential Biological Damage from Once-Through Cooling Systems of Nuclear Power Plants," ORNL-TM-4180, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1974.

36. G. P. Romberg and S. A. Spigarelli, "Seasonal Variation in Species Composition and Abundance of Fish at the Point Beach Nuclear Plant Between March and November," *Radiological and Environmental Research Division Annual Report, January-December, 1973*, Report ANL-8060, Part III.

37. G. P. Romberg and M. M. Thommes, "Comparison of the Movement and Recapture of Salmonid Fishes Tagged at Two Power Plants," *Radiological and Environmental Research Division Annual Report, January-December, 1974*, Report ANL-75-3, Part III.

38. S. A. Spigarelli, "Fish Tagging Studies at the Point Beach Nuclear Power Plant: Part II. The Movements of Tagged Fish," *Radiological and Environmental Research Division Annual Report, January-December, 1972*, Report ANL-7960, Part III.

39. G. P. Romberg and W. Prepejchal, "Plume Residence of TLD Tagged Fish," *Radiological and Environmental Research Division Annual Report, January-December, 1973*, Report ANL-8060, Part III.

40. J. R. M. Kelso, "Movement of Yellow Perch (*Perca flavescens*) and White Sucker (*Catostomus commersoni*) in a Nearshore Great Lakes Habitat Subject to a Thermal Discharge," *J. Fis. Res. Board Can.* 33(1): 42-53 (1976).

41. J. R. M. Kelso, "Influence of a Thermal Effluent on Movement of Brown Bullhead (*Ictalurus nebulosus*) as Determined by Ultrasonic Tracking," *J. Fish. Res. Board Can.* 31(9): 1507-1513 (1974).

42. Directorate of Licensing, USAEC, *Final Environmental Statement, R. E. Ginna Nuclear Power Plant*, Docket No. 50-244, December 1973.

43. D. Mount, "Environmental Effects of Thermal Discharges — Ecological Elements," *Environmental Effects of Thermal Discharges: The Elements in Formulating Rational Public Policy, Annual Meeting American Society of Mechanical Engineers*, New York, 1970.

44. T. A. Edsall and T. G. Yocum, "Review of Recent Technical Information Concerning the Adverse Effects of Once-Through Cooling on Lake Michigan," U.S. Fish and Wildlife Service, paper prepared for Lake Michigan Enforcement Conference, 1972.

45. Quirk, Hawler, and Matusky Engineers. "Fish Impingement Studies, Nine Mile Point Unit 2," *Niagara Mohawk Power Corporation Water Quality Certification Report*, No. 1, vol. II, December 1973.

46. J. F. Storr and G. Schlenker, "Response to Perch and Their Forage to Thermal Discharges in Lake Ontario," *Thermal Ecology Symposium*, USAEC, Report CONF 730505, 1974.

47. S. A. Spigarelli and D. W. Smith, "Growth of Plume 'Resident' Fishes in Lake Michigan," *Radiological and Environmental Research Division Annual Report, January–December, 1974*, Report ANL-75-3, Part III.

48. J. N. Speakman and P. A. Krenkel, *Quantification of the Effects of Rate of Temperature Change on Aquatic Biota*, Report No. 6, National Center for Research and Training in the Hydrologic and Hydraulic Aspects of Water Pollution Control, Vanderbilt University, Nashville, Tennessee, May 1971.

49. W. Prepejchal, J. Haumann, and S. A. Spigarelli, "Developments in Underwater Radiotelemetry and Preliminary Fish Tracking in Thermal Plumes," *Radiological and Environmental Research Division Annual Report, January-December, 1974*, Report ANL-75-3, Part III.

50. R. W. Miller, "Incidence and Cause of Gas-Bubble Disease in a Heated Effluent," pp. 79-93 in *Thermal Ecology*, J. W. Gibbons and R. R. Sharitz, eds., AEC Symposium Series (CONF730505), 1975.

51. D. J. Demont and R. W. Miller, "First Reported Incidence of Gas-Bubble Disease in the Heated Effluent of a Steam Generating Station," *Proc. 25th Annu. Conf. Southeastern Assoc. Game Fish Commissioners*, 1971.

52. R. E. Wolke, G. R. Bouch, and R. K. Stroud, "Gas Bubble Disease: A Review in Relation to Modern Energy Production," *Fisheries and Energy Production: A Symposium*, S. B. Saila, ed., Lexington Books, Massachusetts, 1975.

53. G. F. Lee and P. H. Martin "Dissolved Gas Supersaturation and Dilution in Thermal Plumes from Steam Electric Generating Stations," *Water Research* 9: 643-648 (1975).

54. T. H. Blahm, B. McConnell and G. R. Synder, "Gas Supersaturation Research National Marine Fisheries Service Prescott Facility-1971 to 1974," *Gas Bubble Disease: Proceedings of a Workshop at Batelle, Pacific Northwest*, ERDA, CONF-741033 (1976).

55. C. L. Schelske and E. F. Stoerner, "Phosphorus, Silica, and Eutrophication of Lake Michigan," *Proceedings of the Symposium on Nutrients and Eutrophication: The Limiting-Nutrient Controversy*, Amer. Soc. Limnol. Oceanog., Vol. I: 157-171 (1972).

56. J. F. Storr, "Plankton Entrainment by the Condenser Systems of Nuclear Power Stations on Lake Ontario," *Thermal Ecology Symposium*, USAEC, CONF-730505 (1974).

57. S. F. Smith, "Effects of a Thermal Effluent on Aquatic Life in an East Texas Reservoir," pp. 374-384 in *Proc. 25th Annu. Conf. Southeastern Assoc. Game Fish Commissioners*, 1972.

58. M. A. Churchill and T. A. Wojtalik, "Effects of Heated Discharges: The TVA Experience," *Nucl. News*, September 1969.

59. Directorate of Licensing, USAEC, *Final Environmental Statement, Nine Mile Point Nuclear Station, Unit 2*, Docket No. 50-410, June 1973.

60. *Fed. Regist.* 39(196) Part III, October 8, 1974.

61. W. A. Brungs, "Effects of Residual Chlorine on Aquatic Life," *J. Water Poll. Contr. Fed.* 45(10): 2180-2193 (1973).

62. G. E. Hutchinson, *A Treatise on Limnology, Vol. 1*, Wiley Publishing Company, New York, 1957.

63. C. D. Becker and T. O. Thatcher, *Toxicity of Power Plant Chemicals to Aquatic Life*, USAEC WASH-1249, 1973.

64. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, vol. 1, Written Testimony, February 1975.

65. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, vol. 4, November 1975.

66. Lawler, Matusky, and Skelly Engineers, *1974 Nine Mile Point Aquatic Ecology Studies*, Vol. II: Chapters VII through X, December 1975.

67. Letter from E. R. Effer, Supervisor of Environmental Studies of Ontario Hydro, to W. E. Knapp, Power Plant Specialist for the U.S. Fish and Wildlife Service, September 15, 1975.

68. Quirk, Lawler, and Matusky Engineers, *Fish Impingement Studies Unit 2*, Niagara Mohawk Power Corporation Water Quality Certification Report No. 2, Vol. II, February 1974.

69. P. J. Colby, "Response of the Alewives, *Alosa pseudoharengus*, to Environmental Change," pp. 163-196 in *Responses of Fish to Environmental Changes*, W. Chavin, ed., C. C. Thomas Company, Springfield, Illinois, 1973.

70. P. J. Colby, "Alewife Dieoffs: Why Do They Occur?" *Limnos*. 4(2): 18-27 (1971).

71. R. G. Otto, M. A. Kitchel, and J. O. Rice, "Lethal and Preferred Temperatures of the Alewife (*Alosa pseudoharengus*) in Lake Michigan," *Trans. Amer. Fish. Soc.* 105(1): 96-106 (1976).

72. L. R. King, *Supplementary Results of Swimming Speed and Endurance Studies on White Perch as Determined by the Beamish Respirometer*, Ichthyological Associates, Ithaca, New York, December 1970.

73. Letter, May 24, 1976, R. L. Koprowski to Bernard C. Rusche.

74. E. J. Carpenter, B. B. Peck, and S. J. Anderson, "Summary of Entrainment Research at the Millstone Point Nuclear Power Station, 1970 to 1972," *Entrainment and Intake Screening*, Report No. 15, The Johns Hopkins University, Departments of Geography and Environmental Engineering, 1974.

75. G. J. Lauer et al., "Entrainment Studies on Hudson River Organisms," *Entrainment and Intake Screening*, Report No. 15, The Johns Hopkins University, Departments of Geography and Environmental Engineering, 1974.

76. J. W. Icanberry and J. R. Adams, "Zooplankton Survival in Cooling Water Systems of Four Thermal Power Plants on the California Coast – Interim Report," *Entrainment and Intake Screening*, Report No. 15, The John Hopkins University, Departments of Geography and Environmental Engineering, 1974.

77. R. M. Davies and L. D. Jensen, "Entrainment of Zooplankton at Three Mid-Atlantic Power Plants," *Entrainment and Intake Screening*, Report No. 15, The John Hopkins University, Departments of Geography and Environmental Engineering, 1974.

78. B. C. Marcy, Jr., "Vulnerability and Survival of Young Connecticut River Fish Entrained at a Nuclear Power Plant," *J. Fish. Res. Board Can.* 30(8): 1195-1203 (1973).

79. B. C. Marcy, "Entrainment of Organisms at Power Plants, with Emphasis on Fishes – An Overview," *Fisheries and Energy Production, A Symposium*, S. B. Saila, ed., Lexington Books, Massachusetts, 1975.

80. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Fossil Fuel)*, Vol. 2, Part 74, January 1974.

81. Lawler, Matusky, and Shelly Engineers, *Nine Mile Point Aquatic Ecology Studies Data Report, January–December, 1974, Niagara Mohawk Power Corporation and the Power Authority of the State of New York*, vol. I, chapters III through V, November 1975.

82. Lawler, Matusky, and Shelly Engineers, *Nine Mile Point Aquatic Ecology Studies Data Report, January-December, 1974, Niagara Power Corporation and the Power Authority of the State of New York*, vol. IV, chapters VIII through IX, November 1975.

83. C. R. Norden, "Age, Growth and Fecundity of the Alewife, *Alosa pseudoharengus* (Wilson), in Lake Michigan," *Trans. Amer. Fish. Soc.* 96(4): 387-383 (1967).

84. K. D. Carlander, *Handbook of Freshwater Fishery Biology*, vol. 1. The Iowa State University Press, Ames, Iowa, 1969.

85. C. M. Breder, Jr., and D. E. Rosen, *Modes of Reproduction in Fishes: How Fishes Breed*, TFH Publication, Jersey City, New Jersey, 1966.

86. Publications Office, New York State Division of the Budget, *New York State Statistical Yearbook*, Albany, July 1974.

6. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAM

6.1 PREOPERATIONAL

6.1.1 Hydrological

The applicant has undertaken various studies of the hydrothermal conditions at the Sterling site. From August 1971 to April 1974, temperatures were recorded on a biweekly or monthly basis, weather permitting. These measurements were made at 1-m depth increments at four or more offshore sampling stations near the site. Additional vertical temperature profiles at four stations were measured by the New York State Atomic and Space Development Authority in August and September 1971. The results of these programs are contained in the ER, Appendix 2F.

From July to November 1973 and during part of July 1974, current speed and direction were monitored by continuously recording meters mounted at about 8- and 17-ft depths on a tower in 25 ft of water. The tower was located about 2600 ft offshore, as shown in Fig. 6.1. This data was used to produce a series of current roses, which are presented in the ER, Appendix 2F and Sect. 2.5. Current measurements were also made in 50 ft of water, but these have not been reported.

From August 8 through August 29, a dye dispersion study was performed by the applicant. Fluorescent dye was released at a continuous rate of 0.598 lb/hr, corresponding to a heat rejection rate of 2520 MWt. Dye concentrations were tracked daily by an instrumented boat for as long as they were detectable, and isoconcentration maps were prepared. Dye measurements were corrected for background fluorescence. The injection point was located about 1 mile W of the proposed discharge and 492 ft from shore (Fig. 6.1) to partially simulate the offshore momentum of the thermal discharge. On August 14, a large slug of dye was released due to an equipment malfunction. This slug was tracked, and its dispersion was used to estimate eddy diffusion at the site. On November 20 and 21, dye streaks were used to study patterns of horizontal velocity shear. The results of these dye studies are presented in the ER, Appendix 2A.

The pattern of naturally occurring surface temperatures at Sterling has been studied by researchers from the Lake Ontario Environmental Laboratory of the State University College at Oswego, New York.[1] Twenty-three isotherm maps have been prepared from airborne infrared radiation thermometry data collected from April 1973 to May 1974. A typical map is presented in Fig. 6.2. The use of a single temperature to characterize the thermal state of the ambient water obviously yields a gross approximation.

6.1.2 Meteorological

The applicant has installed a 340-ft-high meteorological tower 3000 ft E of the reactor complex. Wind speed, wind direction, and air temperatures are measured at the 33-, 150-, and 340-ft levels on the tower (ER, Sect. 6.1.3). Dewpoint temperature is measured at the 33- and 340-ft levels, and wind fluctuation angles (vertical and horizontal) are measured at the 150-ft level. Vertical temperature differences are measured between the 33- and 150-ft levels and between the 33- and 340-ft levels. Precipitation is measured at ground level (ER, Sect. 6.1.3). This onsite meteorological program, which became operational in December 1972, conforms to the recommendations of Regulatory Guide 1.23, *Onsite Meteorological Programs*.[2]

The applicant has provided a full year of meteorological data collected during the period from May 13, 1973, to May 13, 1974, using the onsite system (ER, Sect. 6.1.3). The staff's dispersion estimates, based on these data, were made using the joint frequency distributions of wind speed and direction at the 33-ft level and atmospheric stability based on the vertical temperature difference between the 33- and 150-ft levels. The joint recovery rate for these data was 94%. A Gaussian diffusion model, assuming a ground-level release with adjustments for building wake effects, was used to make estimates of relative atmospheric dispersion (χ/Q) values at the various distances and directions from the site, as specified in Sect. 5.[3,4]

721 070

715 129

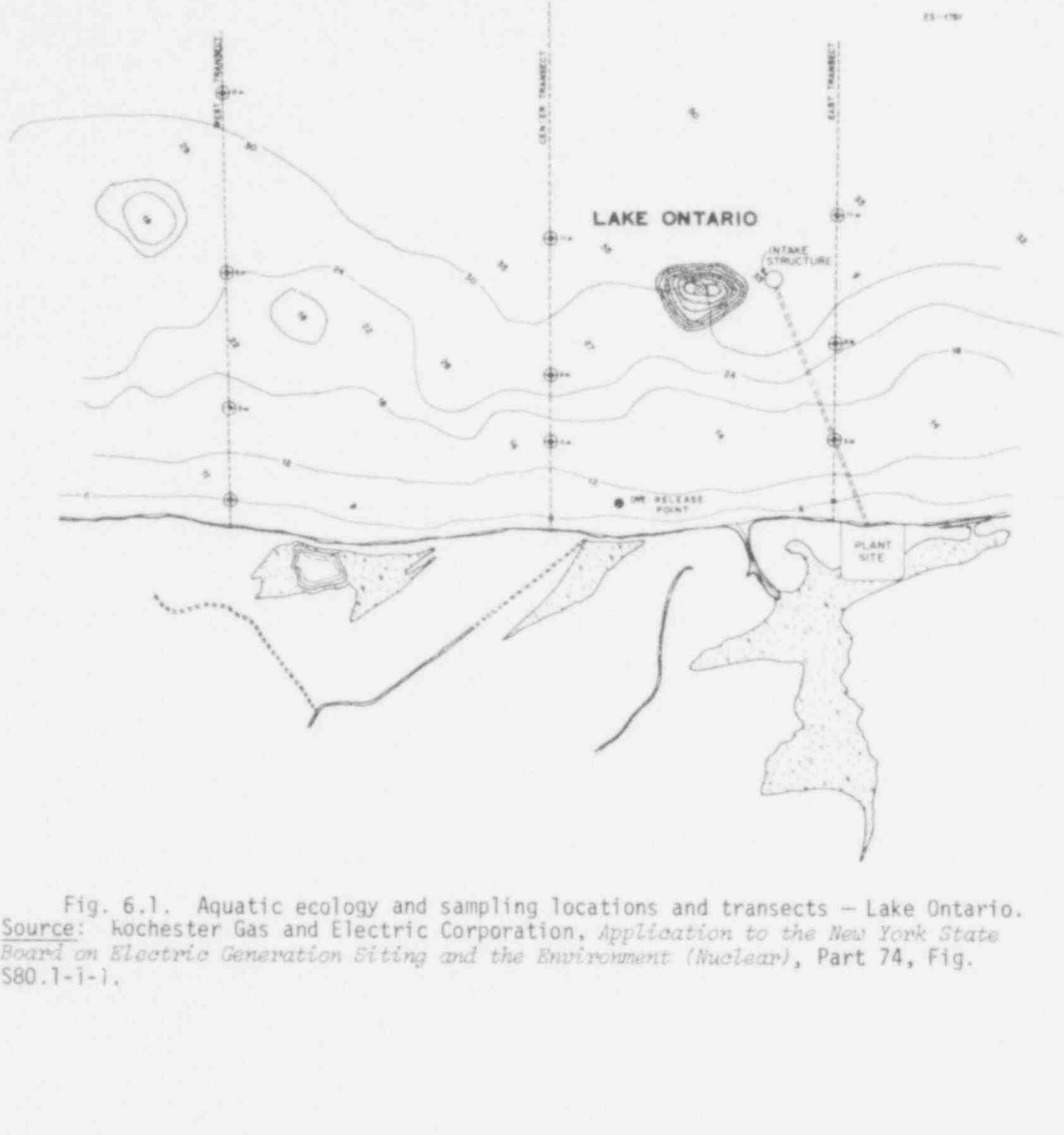


Fig. 6.1. Aquatic ecology and sampling locations and transects — Lake Ontario. Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 74, Fig. S80.1-i-i.

POOR ORIGINAL

~~721 071~~

715 130

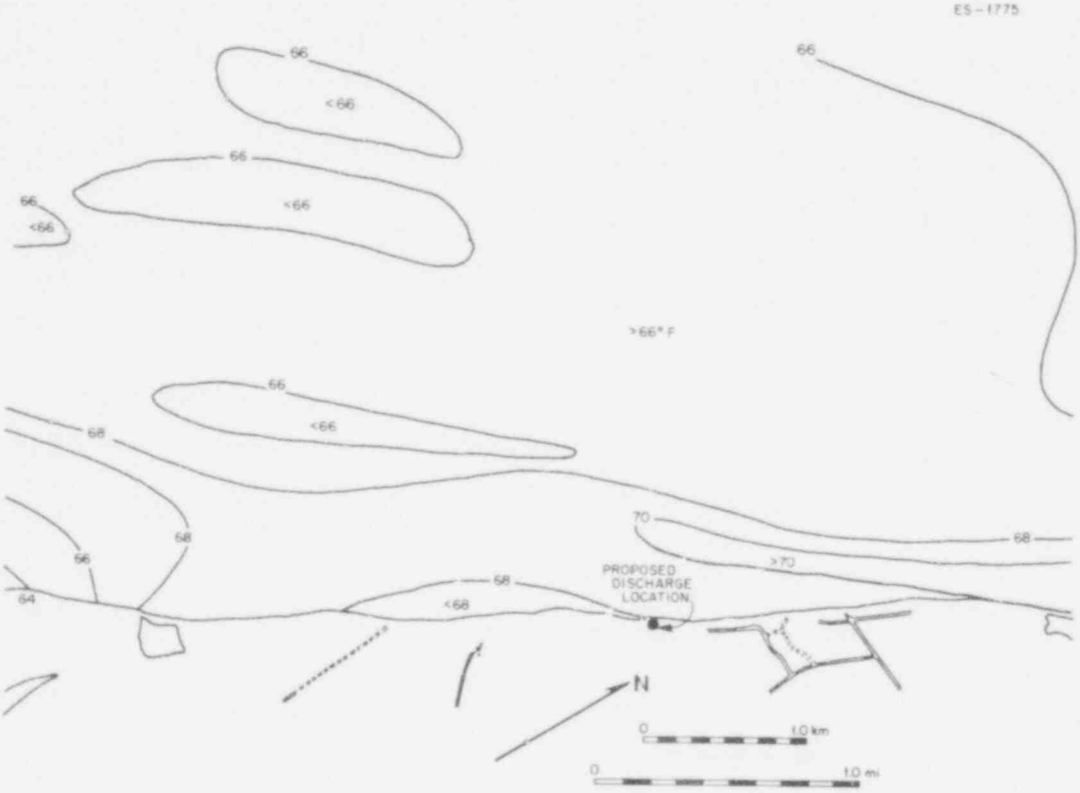


Fig. 6.2. Surface water temperatures at the Sterling site obtained by infrared thermometry at 5:15 PM, June 7, 1973. Air temperature 70°F, wind from WSW at 9 mph. Source: E. E. Chermack and T. A. Galletta, *Study of Near Shore Surface Temperatures at Sterling, New York (1973-1974)*, Report No. 190, Lake Ontario Environmental Laboratory, State University College, Oswego, New York, 1974.

6.1.3 Ecological

6.1.3.1 Terrestrial

The applicant has obtained baseline data on terrestrial biota. These studies and subsequent preconstruction studies will be used in assessing the ultimate effects of site preparation and construction. The baseline study was designed to establish quantitative and qualitative data on terrestrial ecosystems of the site. Chapter 6 of the Environmental Report contains a summary of the preconstruction and the preoperational terrestrial monitoring program. The staff has reviewed these programs and finds them quite adequate.

6.1.3.2 Aquatic

Baseline studies

The Lake Ontario Environmental Laboratory (LOTEL), State University College at Oswego, conducted baseline ecological sampling of Lake Ontario and inland streams and wetlands at the Sterling site from October 1972 through August 1974 for the applicant. From September 1971 through August 1972, preliminary and less intensive site surveys were preformed by LOTEL for the New York State Atomic and Space Development Authority. The applicant reported the results in the ER, Sect. 2.7 and Appendix 2F, and in other documents.[5,6] The various communities sampled, methods used, and schedules followed are described in some detail in Sect. 6.1 of the ER and are summarized in Table 6.1 of this statement. Fig. 6.1 shows transects and stations sampled in Lake Ontario.

Table 6.1. Summary of the applicant's baseline sampling of area aquatic ecology

Biological community	Sampling frequency	Methods
Phytoplankton	Biweekly	Vertical tows using a No. 20 Wisconsin net (helicopter grab samples with 8-liter Nisken bottles during winter) at 2-, 5-, 8-, 11-, and 18-m stations along east and west transects. Vertical distribution of plankton using 3-liter Nisken bottles at surface, mid-depth, and bottom at the above stations. Productivity measurements by suspension of light and dark bottles innoculated with C^{14}-labeled bicarbonate at test depths.
Zooplankton	Biweekly	As above with addition of Van Dorn sampler and Clarke-Bumpus net.
Periphyton	Monthly	Artificial substrates suspended at different depths at the 5-, 8-, and 11-m stations of center transect. Later, 2-, 5-, and 8-m stations; also hand collections by SCUBA.
Benthos	Biweekly	Scuba divers using plexiglas boxes at 2-, 5-, 8-, and 11-m stations stations of three transects; also artificial substrate cages.
Fish adults	Monthly[a]	Experimental gill nets 6 X 175 ft (7 panels: $\frac{3}{4}$-, 1-, $1\frac{1}{4}$-, $1\frac{1}{2}$-, 2-, $2\frac{1}{2}$-, and 3-in square mesh) set perpendicular to shore along east and west transects for 24 hr. Recording Fathometer for gross distribution studies (6 transects out to 15-m depth contour).
Fish eggs and larvae	Monthly[a]	1973: Twin 0-mesh $\frac{1}{2}$-m plankton nets towed horizontally at surface of 2-m contour; surface and mid-depth of 5-m contour. 1974: Surface and mid-depth of 8-m, and occasionally 11- and 18-m contours added for net samples. Benthic pump samples at 2-, 5-, 8-, 11-, and 18-m contours.
Bacteria	Monthly	Plate counts.

[a] Biweekly since Spring 1974.

POOR ORIGINAL

715 132

721 073

Although the applicant's ichthyoplankton sampling program failed to adequately census temporal changes in the density of the larval fish populations at the mid-depth station of the 11 m contour, the staff concludes that further sampling is not needed to adequately assess the impact of entrainment during operation of the Sterling Power Project. The staff's estimate of a potential loss of $3.2 \times 10^{\text{[illegible]}}$ two-year-old fish is highly conservative and represents the maximum loss to be expected. Since a loss of this magnitude will not result in any long-term adverse impacts on the populations in the lake, further baseline sampling would only serve to refine and possibly reduce this estimate.

The inland streams and wetlands baseline studies should also be adequate to enable assessment of impacts of construction and potential impacts of operation of the Sterling Power Project on streams and wetlands. However, upon commencement of construction, the staff will require the applicant to monitor TSS and TDS of runoff discharged from construction areas on a weekly basis.

Interim lake monitoring

Following completion of the baseline studies and prior to commencement of operational studies, the applicant will conduct a less intensive monitoring program keyed on a few important organisms such as *Gammarus*, *Cladophora*, and fish. Fathometer runs and a series of trap nets will be used during June, July, and August to determine numbers, diversity, mobility, and residence time. The staff will require the applicant to add another sampling period in May and to initiate these studies no later than May of 1976. Water temperature should be measured concurrently with each sampling effort.

6.1.4 Radiological

The applicant has proposed an offsite preoperational radiological monitoring program to provide for measurement of background radiation levels and radioactivity in the plant environs. The preoperational program, which provides a necessary basis for the operational radiological monitoring program, will also permit the applicant to train personnel and evaluate procedures, equipment, and techniques, as indicated in Regulatory Guide 4.1.

A description of the applicant's proposed program is summarized in Table 6.2. More detailed information on the applicant's radiological monitoring program is presented in Sect. 6.1 of the applicant's Environmental Report. The applicant proposes to initiate the program two years prior to operation of the plant.

The staff concludes that the preoperational monitoring program proposed by the applicant is generally acceptable; however, the following changes are recommended to improve the effectiveness of the program:

1. For analysis of airborne iodine, weekly samples should be taken.
2. Milk should be sampled and analyzed semi-monthly when dairy animals are on pasture.
3. Water from the two nearest lake intakes for human use should be sampled semi-monthly.
4. Both benthos and bottom sediments should be sampled semi-annually. Gamma isotopic analysis and Sr-89, Sr-90 analysis should be performed on these samples.
5. Soil should be sampled every three years at the air sampling locations. Gamma isotopic analysis and Sr-89, Sr-90 analysis should be performed on these samples.

6.2 OPERATIONAL PROGRAMS

6.2.1 Hydrological, meteorological, ecological

The applicant discussed these operational monitoring programs in the ER, Sect. 6.2, and these have been reviewed by the staff. Since the proposed action pertains to issuance of construction permits, detailed staff evaluation of this program will be done at the time of application for an operating license. A more definitive program can subsequently be developed on the basis of the preoperational monitoring results.

Table 6.2. Radiological environmental monitoring program, preoperational phase

Type of sample	Analyses[a]
Airborne particulates	B, G
Airborne iodine	I
Precipitation	B, G
Direct radiation	T
Vegetation	G, I
Milk	G, S, I
Meat	G
Lake water	B, H, G
Drinking water	B, H, G
Fish	G
Sediment	G
Well water	B, H, G

[a] B = beta analysis;
G = gamma isotopic analysis;
I = iodine analysis;
T = TLD dose readings;
H = tritium analysis; and
S = strontium analysis.

6.2.2 Radiological

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

The applicant plans essentially to continue the proposed preoperational program during the operating period. However, refinements will be made in the program to reflect changes in land use or preoperational monitoring experience.

An evaluation of the applicant's proposed operational monitoring program will be performed during the operating license review, and the details of the required monitoring program will be incorporated into the Environmental Technical Specifications for the operating license. NRC Regulatory Guide 4.8 also provides detailed information on operational programs for nuclear power plants.

REFERENCES FOR SECTION 6

1. E. E. Chermack and T. A. Galletta, *Study of Near Shore Surface Temperatures at Sterling, New York (1973-1974)*, Report No. 190, Lake Ontario Environmental Laboratory, State University College, Oswego, New York, 1974.

2. U.S. Atomic Energy Commission, *Onsite Meteorological Programs*, Regulatory Guide 1.23 (Safety Guide 23), USAEC Directorate of Regulatory Standards, Washington, D.C., 1972.

3. J. F. Sagendorf, *A Program for Evaluating Atmospheric Dispersion from a Nuclear Power Station*, NOAA Technical Memorandum ERL ARL-42, Air Resources Laboratory, NOAA, Idaho Falls, Idaho, 1974.

4. U.S. Atomic Energy Commission, *Interim Licensing Policy On As Low As Practicable for Gaseous Radioiodine Released from Light-Water-Cooled Nuclear Power Reactors*, Regulatory Guide 1.42, Rev. 1, Appendix B, "Procedure for Calculation of Annual Average Relative Concentrations in Air," USAEC Directorate of Regulatory Standards, Washington, D.C., 1974.

5. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Fossil-Fueled)*, Vol. 2, Part 74, January 1974.

6. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 74, February 1975.

7. ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

7.1 PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Sterling Power Project Nuclear Unit No. 1 is provided through correct design, manufacture, and operation and through 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 designed to place and maintain the plant in a safe condition. Notwithstanding this requirement, the conservative postulate is made that serious accidents might occur, even though they may be extremely unlikely; engineered safety features will be installed to mitigate the consequences of those postulated events judged credible.

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

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

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

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences that are anticipated during plant operations, and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; however, events of this type could occur sometime during the 40-year plant lifetime. Although 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, they are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighted by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain a high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

Table 7.1. Classification of postulated accidents and occurrences

Class	NRC description	Applicant's examples
1	Trivial incidents	Evaluated under routine releases
2	Small releases outside containment	Evaluated under routine releases
3	Radioactive waste system failure	Radioactive waste system leakage or malfunction; releases from gas/liquid waste storage tanks
4	Fission products to primary system (BWR)	Not applicable
5	Fission products to primary and secondary systems (PWR)	Fuel cladding defects and steam generator tube leaks; steam generator tube rupture
6	Refueling accident	Fuel bundle drop; heavy objects dropped onto fuel in core
7	Spent fuel handling accident	Fuel cladding defects and steam generator tube leaks; steam generator tube rupture
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Pipe breaks; rod ejection accidents
9	Hypothetical sequence of failures more severe than Class 8	Not considered

The NRC has performed a study to assess these risks more quantitatively. The results of these efforts were made available in October 1975.[1] This study, called the *Reactor Safety Study*, represents an effort to develop realistic data on the probabilities and sequences of accidents in water-cooled power reactors to improve the quantification of available knowledge related to nuclear reactor accident probabilities. The Commission organized a special group of about 50 specialists under the direction of Professor Norman Rasmussen of MIT to conduct the study. The scope of the study, which has been discussed with EPA and described in correspondence with EPA, has been placed in the NRC Public Document Room.[2]

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

7.2 TRANSPORTATION ACCIDENTS

As discussed in Sect. 5.4.2.5, the staff has completed an analysis of the potential impact on the environment of transporting fuel and solid radioactive wastes for nuclear power plants under existing regulations. The results of this analysis were published in a report entitled *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*.[3] The report contains an analysis of the probabilities of occurrences of accidents and the expected consequences of such accidents, as well as the potential exposures to transport workers and the general public under normal conditions of transport.

Table 7.2. Summary of radiological consequences of postulated accidents[a]

Class	Event	Estimated fraction of 10 CFR Part 20 limit at site boundary[b]	Estimated dose to population in 50-mile radius (man-rem)
1.0	Trivial incidents	c	c
2.0	Small releases outside containment	c	c
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.023	3.9
3.2	Release of waste gas storage tank contents	0.091	16
3.3	Release of liquid waste storage contents	0.003	0.43
4.0	Fission products to primary system (BWR)	NA	NA
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	c	c
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	<0.001	<0.1
5.3	Steam generator tube rupture	0.030	5.2
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.005	0.82
6.2	Heavy object drop onto fuel in core	0.083	14
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel rack	0.003	0.52
7.2	Heavy object drop onto fuel rack	0.012	2.1
7.3	Fuel cask drop	0.073	13
8.0	Accident initiation events considered in design basis evaluation in the Safety Analysis Report		
8.1	Loss-of-coolant accidents		
	Small break	0.053	16
	Large break	0.51	520
8.1(a)	Break in instrument line from primary system that penetrates the containment	NA	NA
8.2(a)	Rod ejection accident (PWR)	0.051	52
8.2(b)	Rod drop accident (BWR)	NA	NA
8.3(a)	Steamline breaks (PWRs outside containment)		
	Small break	<0.001	<0.1
	Large break	<0.001	<0.1
8.3(b)	Steamline break (BWR)	NA	NA

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

[b] Represents the calculated fraction of a whole-body dose of 500 millirems, or the equivalent dose to an organ.

[c] These releases are expected to be in accord with proposed Appendix I for routine effluents (i.e., 5 millirems/year to the whole body from either gaseous or liquid effluents).

The transportation of cold fuel to the plant, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the AEC report mentioned above.[3] The environmental risks of accidents in transportation are summarized in Table 7.3.[3] (Normal conditions of transport were summarized in Table 5.9.)

Table 7.3. Environmental risks of accidents in transport of fuel and waste to and from a typical light-water-cooled nuclear power reactor[a]

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

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

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

REFERENCES FOR SECTION 7

1. U.S. Nuclear Regulatory Commission, *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants*, Report WASH-1400, October 1975.
2. Letter from W. D. Doub, U.S. Atomic Energy Commission, to D. D. Dominick, Environmental Protection Agency, June 5, 1973.
3. U.S. Atomic Energy Commission, *Environmental Survey of Transportation of Radioactive Material to and from Nuclear Power Plants*, WASH-1238, December 1972.

8. NEED FOR POWER GENERATING CAPACITY

8.1 DESCRIPTION OF THE SYSTEM

The staff's assessment of the applicants' need for additional power generating capacity in the early 1980s is presented in this section. The evaluation includes discussions of the applicants' power system, power requirements, power supply, and reserve requirements. The Sterling Power Project Unit 1 is assumed to come on line in 1984.

8.1.1 Applicants' system and service area

The participants in the Sterling Power Project — Rochester Gas and Electric Corporation (RGE), Orange and Rockland Utilities, Incorporated (OR), Central Hudson Gas and Electric Corporation (CH), and Niagara Mohawk Power Corporation (NM) — serve a combined area that is approximately 60% of the total area of New York State (i.e., 29,900 sq miles out of 49,460 sq miles). Figure 8.1 shows the service area, which encompasses most of the State except for New York City, Long Island, and the south central portion of the State. The total population currently served is about 5.4 million, which is approximately 29% of the total population of New York State.

The major load centers are the City of Rochester (RGE), the northern metropolitan New York City area, and southern Catskill area west of the Hudson River (OR), the cities of Poughkeepsie, Newburgh, and Kingston (CH), and the metropolitan areas of Buffalo-Niagara Falls, Syracuse, Albany-Schenectady-Troy, and Utica (NM).

8.1.2 Regional relationships

The Sterling Power Project participants are members of the New York Power Pool (NYPP) whose membership comprises seven large investor-owned systems and the Power Authority of the State of New York.[1] The seven investor-owned systems are the Central Hudson Gas and Electric Corporation; Consolidated Edison Company of New York, Incorporated; Long Island Lighting Company; New York State Electric and Gas Corporation; Niagara Mohawk Power Corporation; Orange and Rockland Utilities, Incorporated; and Rochester Gas and Electric Corporation.[2] The NYPP service area (the State of New York) makes up the Federal Power Commission (FPC) study Area B in Region I, which is the geographical area of concern to the Northeast Regional Advisory Committee. The NYPP is one of three pools in the FPC Region I; the other two are the New England Power Pool (NEPOOL) and the Pennsylvania-New Jersey-Maryland Interconnection (PJM). Regional operations of the NYPP and NEPOOL are coordinated by the Northeast Power Coordinating Council (NPCC) (see Fig. 8.2). The applicants' service areas generally fall within FPC power supply area 3 in the above mentioned study Area B.

The purpose of the NYPP is to coordinate the development and operation of the production and transmission facilities of its members to obtain optimum reliability and efficiency of operation of their interconnected systems. Although each member continues to be responsible for maintaining adequate electrical capacity and transmission facilities within its own service area, pool operation enables the members mutually to determine the best location, size, timing, and required transmission for new generating units.[1]

8.2 POWER REQUIREMENTS

Planning for electric utility needs is based on both a forecast of anticipated energy consumption in kilowatt-hours over a given period of years and a forecast of the peak demand or load in kilowatts that must be met each year. The applicants' historical and projected energy consumption and peak load demands and the effects of energy conservation on those factors are discussed in the following sections.

ES-1863

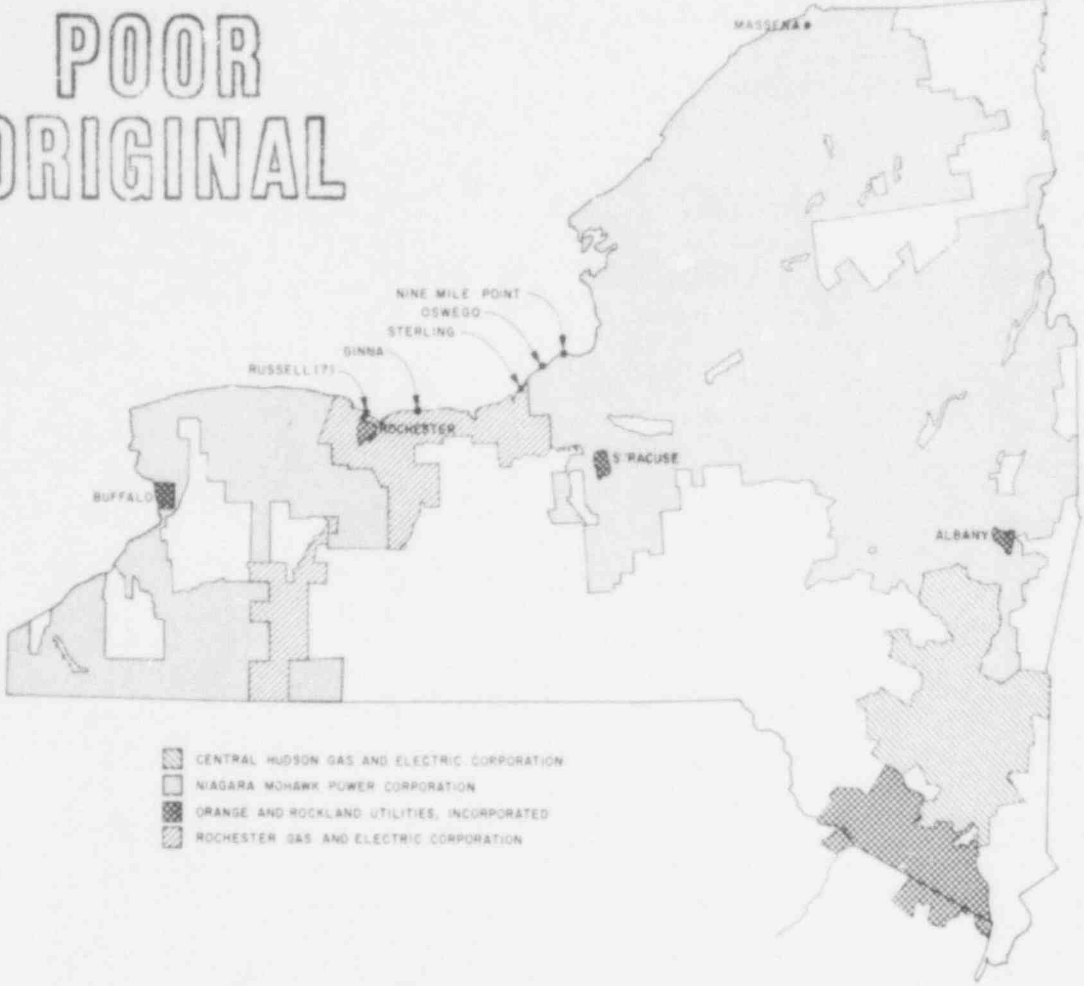


Fig. 8.1. Service areas of the Sterling Power Project participants for New York State.

8.2.1 Energy consumption

The Sterling Power Project participants serve a fairly large and varied load: residential customers represent the largest part of the load of OR and CH, whereas NM has a greater portion of its output going to industrial customers. Sales by class of customer for 1974 and projections for the year 1983 are shown in Table 8.1. The most significant trends are OR's relative growth in residential customers, which becomes its dominant customer class (undoubtedly due to the expanding suburbs surrounding New York City) and the substantial reduction in the percentage of load to NM's industrial customer class.

Growth in electrical energy usage in the Sterling Power Project service area has increased at an average compound growth rate of 4.8% between 1964 and 1974 (ER, Table 1.1-4). Among the applicants, this growth rate varied from a low of 4% for NM to a high of 9% for OR. Historic growth to 1973 was somewhat higher since all of the applicants experienced absolute declines in energy consumption in 1974. Excluding 1974, the composite historic growth rate for 1964 to 1973 averages approximately 5.4%, with the rate of growth ranging from 4.5% for NM to 10.4% for OR. In the aggregate, the average compound growth rate for annual energy requirements is projected to be 4.6% between 1975 and 1987. Table 8.2 shows the total annual energy requirements for the individual utilities and the aggregate as a whole, the year-to-year percentage change for the preceding ten years and the applicants' projections for the next thirteen years.

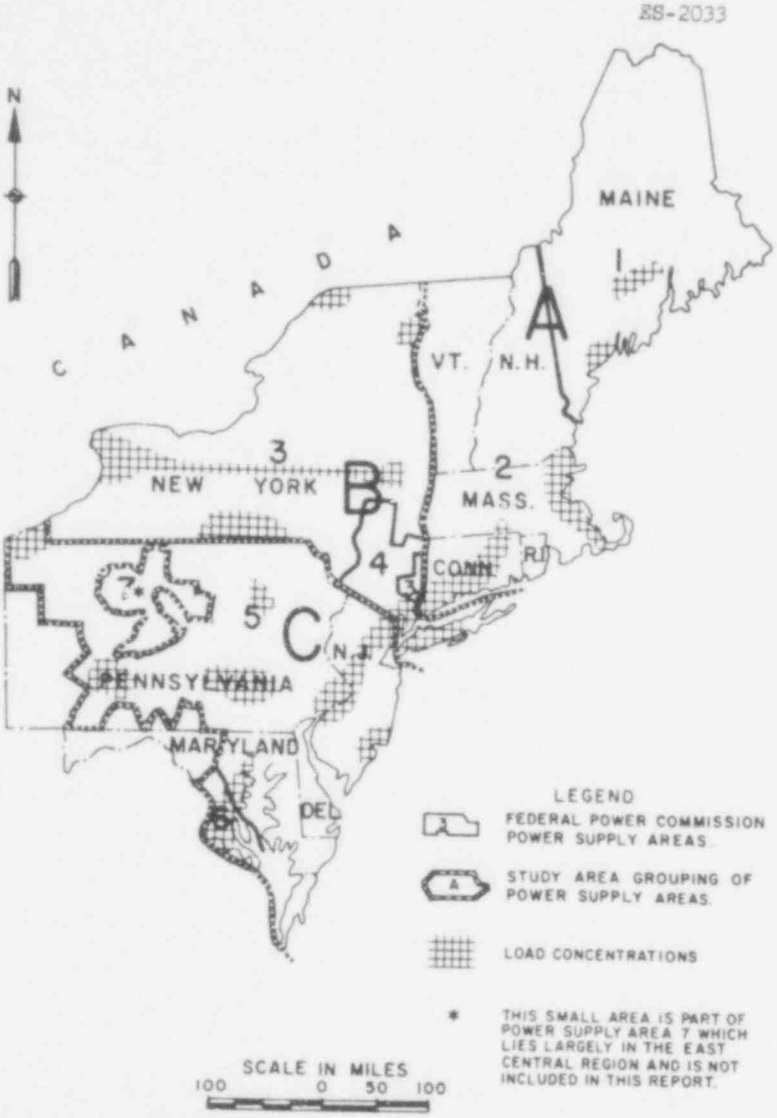


Fig. 8.2. Federal Power Commission, Region I: areas of load concentration. Source: Federal Power Commission, *The 1970 National Power Survey, Part II, Electric Power in the Northeast*, U.S. Government Printing Office, Washington, D.C., p. II-1-9.

POOR ORIGINAL

Table 8.1. Sales by class of customers (GWhr)

	RGE	%	OR[a]	%	CH	%	NM	%	Total	%
Residential										
1974	1455	33.0	1045	39.7	1159.8	37.4	7,060	25.9	10,720	28.6
1983	2373	30.7	2168	42.3	2375.0	38.0	10,307	26.7	17,223	29.8
Commercial										
1974	1222	27.7	667	25.3	820.1	26.4	7,777	28.5	10,486	28.0
1983	2216	28.6	1339	25.2	1770.0	28.3	12,760	33.0	18,075	31.3
Industrial										
1974	1345	30.5	812	30.8	1089.2	35.1	12,119	44.4	15,365	41.0
1983	2441	31.6	1426	27.8	2062.0	33.0	15,179	39.3	21,108	36.6
Other[b]										
1974	385	8.8	109	4.1	35.5	1.1	322	1.2	851	2.3
1983	686	8.9	187	3.6	46.0	0.7	395	1.0	1314	2.3
Total										
1974	4407		2633		3104.6		27,278		37,423	
1983	7716		5120		6253.0		38,631		57,720	

Source: ER, Tables 540.11-1 to 540.11-4.

[a] For OR, *Commercial* is small commercial and industrial; *Industrial* is large commercial and industrial.

[b] Losses and company use not included, except for O&R Company use.

Table 8.2. Annual energy requirements (GWhr)

Year	RGE	Change (%)	OR	Change (%)	CH	Change (%)	NM	Change (%)	Total	Change (%)
1964	2,534		1,219		1,745		20,570		26,068	
1965	2,797	10.4	1,351	10.8	1,950	11.7	22,068	7.3	28,166	8.0
1966	3,027	8.2	1,511	11.8	2,232	14.5	23,486	6.4	30,256	7.4
1967	3,329	10.0	1,652	9.3	2,325	4.2	24,028	2.3	31,334	3.6
1968	3,626	9.0	1,869	13.1	2,507	7.8	25,402	5.7	33,404	6.6
1969	3,966	9.4	2,083	11.5	2,750	9.7	26,712	5.2	35,511	6.3
1970	4,134	4.2	2,348	12.7	2,959	7.6	27,150	1.6	36,591	3.0
1971	4,382	6.0	2,553	8.8	3,127	5.7	27,543	1.4	37,605	2.8
1972	4,693	7.1	2,804	9.8	3,378	8.0	28,836	4.7	39,711	5.6
1973	4,928	5.0	2,971	6.0	3,530	4.5	30,457	5.6	41,886	5.5
1974	4,881	(1.0)	2,883	(3.0)	3,358	(4.9)	30,426	(0.1)	41,548	(0.1)
Forecast										
1975	5,058	3.6	3,094	7.3	3,685	9.7	31,674	4.1	43,511	4.7
1976	5,411	7.0	3,281	6.0	3,971	7.8	32,911	3.9	45,574	4.7
1977	5,789	7.0	3,594	9.5	4,281	7.8	34,175	3.8	47,839	5.0
1978	6,194	7.0	3,922	9.1	4,619	7.9	35,471	3.8	50,206	4.9
1979	6,626	7.0	4,258	8.6	4,982	7.8	36,796	3.7	52,662	4.9
1980	7,090	7.0	4,604	8.1	5,375	7.9	38,152	3.7	55,221	4.8
1981	7,498	5.8	4,952	7.6	5,806	8.0	39,528	3.6	57,784	4.6
1982	7,961	6.2	5,308	7.2	6,264	7.9	40,934	3.6	60,467	4.6
1983	8,435	6.0	5,675	6.9	6,752	7.8	42,370	3.5	63,232	4.7
1984	8,915	5.7	6,051	6.6	7,269	7.6	43,834	3.4	66,069	4.5
1985	9,413	5.6	6,435	6.3	7,823	7.6	45,329	3.4	69,000	4.4
1986	9,933	5.5	6,830	6.1	8,379	7.1	46,838	3.3	71,980	4.3
1987	10,480	5.5	7,233	5.9	8,943	6.7	48,375	3.3	75,031	4.2

Source: ER, Tables 1.1-4 and 1.1-5.

It is of interest to note that the number of customers is increasing in each of the utility's service areas. More significant, however, is the fact that the customers in each category for each utility are using more energy (Table 8.3). For example, Table 8.3 shows that the weighted average residential use increased from 4730 kWhr in 1967 to 6345 kWhr in 1973, about a 34% increase. Very likely a good portion of this increase may be attributed to the increased use of residential air conditioning.

Table 8.3. Residential and commercial and industrial consumption per customer

	CH		OR[a]		RGE		NM	
	1967	1973	1967	1973	1967	1973	1967	1973
Residential sales (millions of kWhr)	679	1,176	389	752	988	1,468	5,010	7,158
Number of residential customers	141,269	163,181	94,774	116,633	212,146	238,917	1,046,072	1,144,511
Kilowatt-hours per customer	4,805	7,206	4,110	6,447	4,657	6,146	4,790	6,254
Commercial and industrial sales (millions of kWhr)	1,413	1,871	596	1,071	1,747	2,686	15,725	20,604
Number of commercial and industrial customers	20,953	22,545	12,844	14,922	22,290	24,662	120,856	132,233
Kilowatt-hours per customer	67,461	83,005	46,434	71,816	78,359	108,962	130,114	155,816

[a] Pike County Electric and Rockland Electric Companies are not considered to be part of O&R Utilities, Inc., in this analysis.

Source: Moody's Investor Service, Inc., *Moody's Public Utility Manual*, New York, N.Y., 1974.

In the commercial and industrial sectors, the average consumption per customer increased from 110,091 kWhr in 1967 to 134,952 kWhr in 1973, an increase of approximately 23%. Although the residential customer consumptions are rather similar for all of the utilities, NM and RGE both have commercial and industrial customers whose consumption is considerably higher than commercial-industrial consumption of the other two utilities. Such differences might arise because the individual customers have expanded the size of their operations, because there has been a more intensive use of electricity in production, or because both reasons are operative. Unfortunately, data are not readily available to distinguish among the three possibilities.

It is imperative to note that the applicant has a legal obligation to provide the power that may be demanded by the service area.[3]

8.2.2 Peak load

Two of the applicants, RG&E and OR, are currently summer peaking utilities, whereas NM is winter peaking. CH appears to be experiencing a new peak each season (ER, p. 1.1-5). In the aggregate, the four applicants are winter peaking because NM's winter peak demand overshadows in absolute size the other applicant's peak loads. Furthermore, by 1982, RG&E's peak load forecast shows a shift from a summer to winter peak. On the other hand, the New York Power Pool has been a summer peaking system since 1968 (ER, Table 1.1-9). The historical and forecast peak load demands for the applicants' systems and for the NYPP are discussed in the following paragraphs.

8.2.2.1 Applicants' peak loads

The applicants' load experience (1964 to 1974) and projected loads through 1987 are shown in Table 8.4 for the largest peak in the year, regardless of the season. In the aggregate the four utilities experienced a combined average annual compound growth rate of 5.0% from 1964 to 1973. In the year 1974 each of the utilities experienced a drop in load demand averaging approximately 3.2%.

Table 8.5 recapitulates the load experience of each utility and differentiates between winter and summer peaks. Also included are purchases and sales of power. Taken together, the four utilities have been and are forecast to continue to be net purchasers of power. Historically, small quantities of power have been sold by three of the utilities; CH discontinued these sales in 1970, RG&E in 1973, and OR in 1975. Since 1964, NM has not sold any power, and no sales are forecast by any of the applicants through 1987.

None of the applicants has any interruptible loads.

721 085

715 144

Table 8.4. Annual peak load demand (MW)[a]

Year	RGE	Change (%)	OR	Change (%)	CH	Change (%)	NM	Change (%)	Total	Change (%)
1964	504		233		324		3497		4,558	
1965	542	7.5	255	9.4	363	12.0	3701	5.8	4,861	6.6
1966	592	9.2	293	14.9	393	8.3	3987	7.7	5,265	8.3
1967	620	4.6	313	6.8	409	4.1	4050	1.6	5,392	2.4
1968	686	10.8	381	21.7	458	12.0	4335	7.0	5,860	8.7
1969	712	3.8	434	13.9	494	7.9	4442	2.5	6,082	3.8
1970	762	7.0	476	9.7	522	5.7	4614	3.9	6,374	4.8
1971	790	3.7	524	10.1	550	5.4	4551	(1.4)	6,415	0.6
1972	855	8.2	579	10.5	588	6.9	4827	6.1	6,849	6.8
1973	922	7.8	640	10.5	633	7.7	4896	1.4	7,091	3.5
1974	880	(4.6)	610	(4.7)	585	(7.6)	4787	(2.2)	6862	(3.2)
Forecast										
1975	932	5.9	658	7.9	650	11.1	5220	9.0	7,460	8.7
1976	997	7.0	692	5.2	700	7.7	5407	3.6	7,796	4.5
1977	1066	6.9	757	9.4	755	7.5	5596	3.5	8,174	4.8
1978	1141	7.0	824	8.8	815	7.9	5790	3.5	8,570	4.8
1979	1220	6.9	894	8.5	880	8.0	5988	3.4	8,982	4.8
1980	1305	7.0	966	8.0	950	8.0	6189	3.4	9,410	4.8
1981	1387	6.3	1038	7.4	1025	7.9	6393	3.3	9,843	4.6
1982	1466	5.7	1112	7.1	1110	8.3	6601	3.2	10,289	4.5
1983	1545	5.4	1189	6.9	1195	7.6	6813	3.2	10,742	4.4
1984	1626	5.2	1267	6.6	1285	7.5	7029	3.2	11,207	4.3
1985	1709	5.1	1347	6.3	1385	7.8	7249	3.1	11,690	4.3
1986	1799	5.3	1429	6.1	1485	7.2	7470	3.0	12,183	4.2
1987	1893	5.2	1512	5.8	1585	6.7	7695	3.0	12,685	4.1

[a] Based on calendar year.

Source: ER, Tables 1.1-4 and 1.1-5.

8.2.2.2 NYPP peak loads

The New York Power Pool (NYPP) winter peak load demand increased at an average compound rate of 3.0%, from 13,937 MWe at the time of the 1966-1967 winter peak to 18,181 MWe at the 1975-1976 winter peak.[4] The 1975-1976 winter peak demand was 4.3% greater than that of the previous year, but was about 12% below the peak demand that previously had been forecast for that period.[5]

The NYPP summer peak demand increased at a compound annual rate of 4.4%, from 13,609 MWe in 1966 to 20,001 MWe in 1975.[4] The 1975 summer peak represented an increase of 2.1% in terms of peak hourly demand from 1974, but a 10.6% decrease from that forecast for 1975.[5]

The NYPP statewide peak load forecast is prepared from individual company projections adjusted to reflect anticipated diversity factors.[4] The diversity factor is divided into the sum of the forecast independent company peak loads to determine the annual coincident peak loads. Diversities are reviewed periodically, and the factors used are revised in light of the most recent historical trends or anticipated future changes. For the period 1976 to 1996, summer period diversity factors of 1.03 to 1.06 and a winter period diversity factor of 1.01 are anticipated (see Sect. 8.3.2).[4] The NYPP has no interruptible loads, and none are used in future studies to reduce the forecast annual peak demands (ER, p. 1.1-18).

The 1976 pool forecast of peak demand shows an approximate rate of growth of 4%/year during the late 1970s, declining to an annual rate of 3.5% by 1990.[4] However, because this forecast relies heavily on factors present in 1974 and 1975 which limited growth and because these factors constitute a relatively limited experience, the pool views this forecast as containing an element of uncertainty not present when previous forecasts were prepared. Therefore, the possibility of more accelerated growth is addressed as well.

8.2.2.3 Load characteristics

The projected load duration curves for 1985 for each utility are shown in Fig. 8.3. These curves give some insight into how a given electric utility expects to meet the electrical demands of its customers. Basically, the load duration curve is nothing more than a rearrangement of all the hourly load elements of a chronological curve in order of decreasing magnitude. The ordinate measures peak load demand (MW) and the abscissa is in total hours. Presented in this fashion,

Table 8.5. Applicant's load and capacity data excluding Sterling Power Project Nuclear Unit 1[a]

	1[illegible]		1965		1966		1967		1968		1969	
	Summer	Winter	Summer		Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
						Installed capability						
CH	342	342	342	342	342	341	346	576	581	579	579	599
OR	173	173	171	168	359	369	368	360	359	360	561	562
RGE	516	511	516	511	516	511	516	503	525	520	564	636
NM	2,792	2,858	2,793	2,856	2,801	3,032	3,002	3,046	3,061	3,055	3,172	3,690
Total	3,823	3,884	3,822	3,877	4,018	4,253	4,232	4,485	4,526	4,514	4,876	5,487
						Purchases or (sales)						
CH	36	40	32	53	89	103	106	0	(99)	(33)	(55)	(40)
OR	104	100	108	127	5	(50)	(26)	0	26	33	(66)	(120)
RGE	210	130	228	228	235	235	174	248	248	248	248	223
NM	987	1,209	958	1,280	1,119	1,376	986	1,458	1,259	1,459	1,466	1,467
Total	1,337	1,479	1,326	1,688	1,448	1,664	1,240	1,706	1,434	1,707	1,593	1,530
						Total capability						
CH	378	382	374	395	431	444	452	576	482	546	524	559
OR	277	273	279	295	364	319	342	360	385	393	495	442
RGE	726	641	744	739	751	746	690	751	773	768	812	859
NM	3,779	4,067	3,751	4,136	3,920	4,408	3,988	4,504	4,320	4,514	4,638	5,157
Total	5,160	5,363	5,148	5,565	5,466	5,917	5,472	6,141	5,969	6,221	6,469	7,017
						Peak load						
CH	301	324	340	363	382	393	385	432	441	458	479	494
OR	224	233	251	255	293	291	308	313	381	350	434	390
RGE	447	504	506	542	529	592	585	620	648	686	708	712
NM	3,[illegible]97	3,497	3,357	3,701	3,463	3,987	3,670	4,050	3,855	4,335	4,030	4,442
Total	4,[illegible]	4,558	4,454	4,861	4,667	5,263	4,948	5,415	5,325	5,829	5,651	6,038
						Reserve requirement						
CH	42	45	48	51	53	55	54	60	62	64	67	69
OR	31	32	35	37	41	40	43	43	53	49	61	54
RGE	42	60	61	65	63	71	70	74	78	82	85	85
NM	372	420	403	444	415	478	440	486	463	520	484	533
Total	499	557	547	597	572	644	607	663	656	715	697	741
						Total required capability						
CH	343	369	388	414	435	448	439	492	503	522	546	563
OR	255	265	286	292	334	331	351	356	434	399	495	444
RGE	501	564	567	607	592	663	655	694	726	768	793	797
NM	3,469	3,917	3,760	4,145	3,878	4,465	4,110	4,536	4,318	4,855	4,514	4,975
Total	4,568	5,115	5,001	5,458	5,239	5,907	5,555	6,078	5,981	6,544	6,348	6,779
						Excess or (deficiency)						
CH	35	13	(14)	(19)	(4)	(4)	13	84	(21)	24	(22)	(4)
OR	22	8	(7)	3	30	(12)	(9)	4	(49)	(6)	0	(2)
RGE	225	77	177	132	159	83	35	57	47	0	19	62
NM	310	150	(9)	(9)	42	(57)	(122)	(32)	2	(341)	124	182
Total	592	248	147	147	227	10	(83)	113	(21)	(323)	121	238

Table 8.5 (continued)

	1970		1971		1972		1973		1974		1975	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Installed capability												
CH	611	623	611	592	580	591	577	591	580	804	800	811
OR	561	562	635	650	622	835	814	827	1,014	1,027	1,022	1,035
RGE	989	981	989	978	1,002	999	998	995	998	995	998	995
NM	3,707	3,825	3,832	4,030	3,929	3,899	3,768	3,851	3,772	4,314	4,889	4,979
Total	5,868	5,991	6,060	6,250	6,133	6,324	6,157	6,264	6,364	7,140	7,709	7,820
Purchases or (sales)												
CH	(12)	0	45	58	104	93	85	150	161	100	100	188
OR	0	0	(10)	(58)	63	(200)	(62)	(200)	(200)	(200)	(65)	9
RGE	(22)	(2)	(27)	(7)	(33)	(33)	15	87	147	197	252	384
NM	1,464	1,593	1,483	1,730	1,748	1,735	1,771	2,301	2,302	1,887	2,246	2,435
Total	1,430	1,591	1,491	1,723	1,882	1,595	2,339	2,338	2,410	1,984	2,533	3,016
Total capability												
CH	599	623	656	650	684	684	662	741	741	904	900	1,099
OR	561	562	625	592	685	635	752	627	814	827	957	1,044
RGE	967	979	962	971	969	966	1,013	1,082	1,145	1,192	1,250	1,379
NM	5,171	5,418	5,315	5,760	5,677	5,634	5,539	6,152	6,074	6,201	7,135	7,414
Total	7,298	7,582	7,558	7,973	8,015	7,919	7,966	8,602	8,774	9,124	10,242	10,936
Peak load												
CH	512	522	540	554	566	603	633	586	585	585	650	675
OR	476	420	524	448	579	481	640	463	610	466	658	522
RGE	762	744	790	783	855	827	922	799	880	823	932	903
NM	4,169	4,614	4,300	4,551	4,392	4,827	4,724	4,896	4,561	4,870	4,830	5,220
Total	5,919	6,300	6,154	6,326	6,392	6,738	6,919	6,744	6,656	6,744	7,070	7,320
Reserve requirement												
CH	72	73	76	78	79	84	89	82	82	82	117	122
OR	66	58	73	62	81	67	89	65	85	65	118	215
RGE	91	89	95	94	103	99	111	96	106	163	168	147
NM	500	553	516	546	527	579	499	588	503	877	877	940
Total	729	773	760	780	790	829	788	831	776	1,187	1,280	1,424
Total required capability												
CH	584	595	616	632	645	687	722	668	667	667	767	797
OR	542	478	597	510	660	546	729	528	695	531	776	737
RGE	853	833	885	877	958	926	1,033	895	986	986	1,100	1,050
NM	4,669	5,167	4,816	5,097	4,919	5,406	5,223	5,484	5,084	5,747	5,707	6,160
Total	6,648	7,073	6,914	7,116	7,182	7,567	7,707	7,575	7,432	7,931	8,350	8,744
Excess or (deficiency)												
CH	15	28	40	18	39	(3)	(60)	73	74	237	133	302
OR	19	84	28	82	25	87	23	99	119	296	181	307
RGE	114	146	77	94	11	40	(20)	187	159	206	150	329
NM	502	251	499	663	758	228	316	668	990	454	1,428	1,254
Total	650	509	644	857	833	352	259	1,027	1,342	1,193	1,892	2,192

Table 8.5 (continued)

	1976		1977		1978		1979		1980		1981	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Installed capability												
CH	800	811	800	811	800	1,051	1,040	1,051	1,040	1,051	1,040	1,051
OR	1,022	1,035	1,022	1,035	1,022	1,035	1,022	1,035	1,152	1,181	1,152	1,181
RGE	998	995	998	995	998	995	1,202	1,199	1,202	1,199	1,202	1,199
NM	5,104	5,179	5,104	5,179	5,104	5,059	5,630	5,705	5,630	5,705	5,630	5,705
Total	7,924	8,020	7,924	8,020	6,924	8,140	8,894	8,990	9,024	9,136	9,024	9,136
Purchases or (sales)												
CH	163	353	373	434	452	187	263	180	399	179	394	473
OR	16	7	16	7	16	7	33	0	0	0	73	0
RGE	382	263	398	354	396	354	394	351	391	392	425	387
NM	2,042	2,218	1,776	2,132	1,739	1,892	1,782	1,774	1,609	1,765	1,742	2,134
Total	2,603	2,841	2,563	2,927	2,603	2,440	2,472	2,305	2,399	2,336	2,634	2,994
Total capability												
CH	963	1,164	1,173	1,245	1,252	1,238	1,303	1,231	1,439	1,230	1,434	1,524
OR	1,038	1,042	1,038	1,042	1,038	1,042	1,055	1,035	1,152	1,181	1,225	1,181
RGE	1,380	1,258	1,396	1,349	1,394	1,349	1,596	1,550	1,593	1,591	1,627	1,586
NM	7,146	7,397	6,880	7,311	6,843	6,951	7,412	7,479	7,239	7,470	7,372	7,839
Total	10,527	10,861	10,487	10,947	10,527	10,580	11,366	11,295	11,423	11,472	11,658	12,130
Peak load												
CH	700	725	755	785	815	845	880	915	950	985	1,025	1,065
OR	692	562	757	612	824	666	894	721	966	779	1,038	837
RGE	997	970	1,066	1,043	1,141	1,121	1,220	1,204	1,305	1,294	1,387	1,381
NM	5,019	5,407	5,214	5,596	5,413	5,790	5,615	5,988	5,823	6,189	6,034	6,393
Total	7,664	7,792	7,792	8,036	8,193	8,422	8,609	8,828	9,044	9,247	9,487	9,676
Reserve requirement												
CH	126	131	136	141	147	152	158	165	171	177	185	192
OR	125	214	136	236	148	257	161	281	174	304	187	327
RGE	179	150	192	165	205	175	220	176	235	186	250	196
NM	940	973	973	1,007	1,007	1,042	1,042	1,077	1,077	1,114	1,114	1,150
Total	1,370	1,468	1,437	1,549	1,507	1,626	1,581	1,699	1,657	1,781	1,736	1,865
Total required capability												
CH	826	856	891	926	962	997	1,038	1,080	1,121	1,162	1,210	1,257
OR	817	776	893	848	972	923	1,055	1,002	1,140	1,083	1,225	1,164
RGE	1,176	1,120	1,258	1,208	1,346	1,296	1,440	1,380	1,150	1,480	1,637	1,577
NM	5,959	6,380	6,187	6,603	6,420	6,832	6,657	7,065	6,900	7,303	7,148	7,543
Total	8,778	9,132	9,229	9,585	9,700	10,048	10,190	10,527	10,311	11,028	11,220	11,541
Excess or (deficiency)												
CH	137	308	282	319	290	241	265	151	318	68	224	267
OR	221	266	145	[illegible]	66	119	0	33	12	98	0	17
RGE	204	138	138	141	48	53	156	170	53	111	(10)	9
NM	1,187	1,017	693	708	423	119	755	414	339	167	224	296
Total	1,749	1,729	1,258	1,362	827	532	1,176	768	722	444	438	589

~~721 089~~

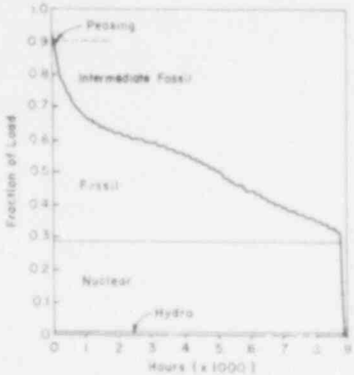
715 148

Table 8.5 (continued)

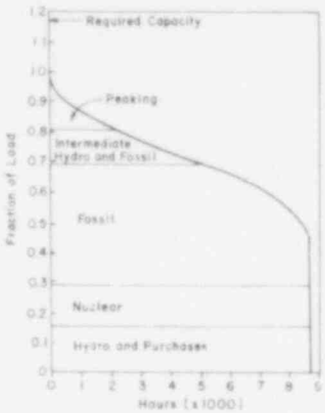
	1982		1983		1984		1985		1986		1987	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
						Installed capability						
CH	1,040	1,390	1,379	1,390	1,317	1,328	1,317	1,328	1,317	1,328	1,257	1,268
OR	1,152	1,181	1,152	1,181	1,152	1,181	1,152	1,181	1,152	1,181	1,152	1,181
RGE	1,202	1,353	1,356	1,353	1,356	1,353	1,330	1,346	1,330	1,346	1,330	1,346
NM	5,630	6,036	5,961	6,036	5,961	6,036	5,961	6,886	6,811	6,886	6,811	7,736
Total	9,024	9,960	9,848	9,960	9,786	9,898	9,760	10,741	10,610	10,741	10,550	11,531
						Purchases or (sales)						
CH	304	127	122	123	119	118	117	116	115	115	114	114
OR	160	64	251	152	0	0	0	0	0	0	0	0
RGE	421	383	415	380	412	378	407	376	405	375	403	373
NM	1,727	2,097	2,052	2,068	2,041	2,036	2,027	2,022	2,019	2,019	2,016	2,016
Total	2,612	2,672	2,840	2,723	2,572	2,532	2,551	2,514	2,539	2,509	2,533	2,503
						Total capability						
CH	1,344	1,517	1,501	1,513	1,436	1,446	1,434	1,444	1,432	1,443	1,371	1,382
OR	1,312	1,246	1,403	1,333	1,152	1,181	1,152	1,181	1,152	1,181	1,152	1,181
RGE	1,623	1,736	1,771	1,733	1,768	1,731	1,737	1,722	1,735	1,721	1,733	1,719
NM	7,357	8,133	8,013	8,104	8,002	8,072	7,988	8,908	8,830	8,905	8,827	9,750
Total	11,636	12,632	12,688	12,683	12,358	12,430	12,311	13,255	13,149	13,250	13,083	14,032
						Peak load						
CH	1,110	1,150	1,195	1,235	1,285	1,330	1,385	1,435	1,485	1,535	1,585	1,640
OR	1,112	897	1,189	959	1,267	1,024	1,347	1,090	1,429	1,158	1,512	1,229
RGE	1,466	1,467	1,545	1,553	1,626	1,641	1,709	1,733	1,799	1,829	1,893	1,930
NM	6,249	6,601	6,470	6,813	6,695	7,029	6,924	7,249	7,155	7,470	7,391	7,695
Total	9,937	10,115	10,399	10,560	10,873	11,024	11,365	11,507	11,868	11,992	12,381	12,494
						Reserve requirement						
CH	200	207	215	222	231	239	249	258	267	276	285	295
OR	200	349	214	374	228	396	242	420	257	444	272	466
RGE	264	264	278	280	293	295	308	312	324	329	341	347
NM	1,150	1,188	1,188	1,226	1,226	1,265	1,265	1,305	1,305	1,345	1,345	1,385
Total	1,814	2,008	1,895	2,102	1,978	2,195	2,064	2,295	2,153	2,394	2,243	2,493
						Total required capability						
CH	1,310	1,357	1,410	1,457	1,516	1,569	1,634	1,693	1,752	1,811	1,870	1,935
OR	1,312	1,246	1,403	1,333	1,495	1,410	1,589	1,510	1,686	1,602	1,784	1,695
RGE	1,730	1,731	1,823	1,833	1,919	1,936	2,017	2,045	2,123	2,158	2,234	2,277
NM	7,399	7,789	7,658	8,039	7,921	8,294	8,189	8,554	8,460	8,815	8,736	9,080
Total	11,751	12,123	12,294	12,662	12,851	13,219	13,429	13,802	14,021	14,386	14,624	14,987
						Excess or (deficiency)						
CH	34	160	91	56	(80)	(123)	(200)	(249)	(320)	(368)	(499)	(553)
OR	0	0	0	0	(343)	(239)	(437)	(329)	(534)	(421)	(632)	(514)
RGE	(107)	5	(52)	(100)	(151)	(205)	(280)	(323)	(388)	(437)	(501)	(558)
NM	(42)	344	355	65	81	(222)	(201)	354	370	90	91	670
Total	(114)	509	394	21	(493)	(789)	(1,118)	(547)	(806)	(1,136)	(1,362)	(955)

[a] Based on forecasting year (May 1 to April 30).

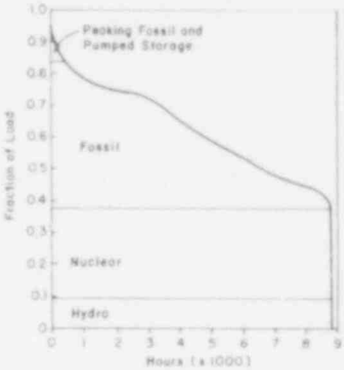
Source: ER, Table 1.1-3.



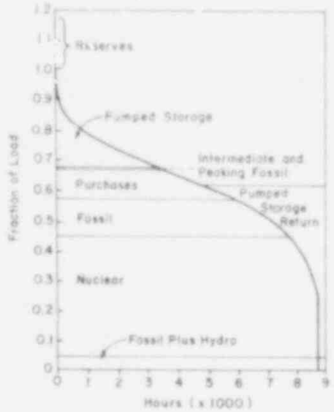
ORANGE AND ROCKLAND 1985 LOAD DURATION CURVES WITH STERLING.



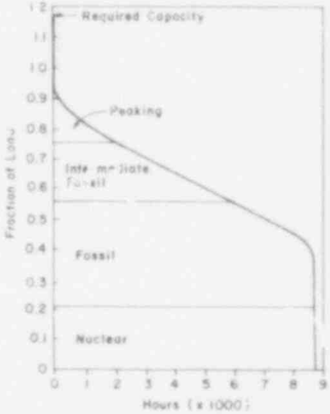
NIAGARA MOHAWK 1985 LOAD DURATION CURVE WITH STERLING.



NEW YORK POWER POOL 1985 LOAD DURATION CURVES WITH STERLING.



ROCHESTER GAS AND ELECTRIC 1985 LOAD DURATION CURVE WITH STERLING.



CENTRAL HUDSON 1985 LOAD DURATION CURVE WITH STERLING.

Fig. 8.3. Projected load duration curves for 1985 for the Sterling Power Project participants. Source: ER, Figs. 1.1-5 through 1.1-8, 1.1-10.

the curve enables one to depict pictorially the baseload demand on each of the applicants' systems. For example, the curves show that throughout the year the minimum load maintained by the applicants' customers varies from between 30 and 50% of peak demand and that load required at least 50% of the time corresponds to between roughly 50 and 70% of peak demand. The curves clearly suggest that a large share of the load should be supplied by baseload capacity. A useful approach that can be used to determine the need for a baseload facility is one that assumes that the baseload portion of an electric system's total demand is equal to the average load. Having determined the baseload portion of the applicant's electrical demand, this value should then be multiplied by 1.25 to arrive at the amount of baseload capacity required to serve the baseload demand. Increasing the baseload demand by a factor of 1.25 accounts for baseload plants operating at a 75% capacity factor rather than 100%. In 1984, the applicants' forecast electricity sales of 66,069 GWhr, which translates to an average load of 7,542 MW. Adjusting for a 75% capacity factor produces a required baseload capacity of 9428 MW. In 1984, the applicants' projected baseload capacity is 8809 MW with Sterling and 7659 MW without Sterling. Clearly, applying this measure, there exists a need for baseload capacity.

Figure 8.3 also displays the anticipated load duration curve of the entire New York Power Pool for the year 1985. The baseloads are projected to be carried by nuclear and hydro generation. The shape of the load duration curve is such that approximately 38% of the peak load is required 100% of the time. Thus the Sterling Power Project fits in well with New York requirements for baseload generation.

721 091

8.2.3 The impact of energy conservation and substitution on need for power

Recent energy shortages have focused the nation's attention on the importance of energy conservation as well as on measures by which to increase the domestic supply of alternative energy sources. The need to conserve energy and to promote substitution of other energy sources for oil and gas have been recommended by the *Report to the President on the Nation's Energy Future* as major efforts in regaining national energy self-sufficiency by 1980.[6] In the following sections, the staff considers conservation of energy as related to the need for the electricity to be produced by the Sterling Power Project.

8.2.3.1 Recent experience

Implementation of energy conservation measures by households, business, and government has already contributed to a substantial reduction of growth in the consumption of electricity nationally since the third quarter of 1973. Consumption of electricity was below forecasts for each of the utilities (ER, p. R540.18-1, 2) ranging from 0.7% to a maximum of 21.6% below forecast for the period October 1973 to December 1974. The utilities, except for NM, show a consistent reduction in usage during the period October to December 1973 when compared with the figures for the same period for the year before. The same appears to be true for all the utilities' peak demands for the approximate period of March through April 1974. Thereafter, all utilities show no consistent reduction compared with the year before, some month's demands being higher and others lower (ER, Table 1.1-4). Milder-than-anticipated weather in the participants' service areas, energy conservation, and the general economic climate probably all contributed to the reduction in growth of peak demand, but the magnitude of each factor is unknown. Due to limited trend data and other data deficiencies, the interpretation of the significance of energy conservation impacts on the forecast need for power in the general service areas over the next six to ten years is highly uncertain. Also, data are not available on the effects of energy conservation during the summer months, which is the peak load period for RG&E, OR, and CH and for the NYPP as a whole.

Much will depend, of course, on the future decisions of consumers and governmental agencies in responding to the energy crisis and potential developments in energy supply and demand factors that might ease the energy crisis or cause it to worsen. However, as time progresses, historical information of these kinds and the actual data on power demand impacts in the general service areas will provide a more significant basis for demand projections.

8.2.3.2 Promotional advertisement and conservation information services

In the past, the participants in the Sterling Power Project have attempted, through advertising, to accelerate the demand for electricity in their service areas. Generally, the major thrust of advertising was to promote demand during off-peak periods, thereby replacing expensive peaking capacity with expanded, lower cost, baseload capacity. Notably, electric space heating (for summer peaking systems), lighting, and water heating have been promoted to offset the higher seasonal peaking demands and thus to levelize loads.

The participants have terminated or curtailed promotional advertising to selective applications and now have a program which, by direct mail and mass media advertising, disseminates information designed to promote efficient residential usage of electricity (ER, p. 9.1-2*ff*). Accordingly, elimination of promotional advertising is no longer an available measure with which the participants can dampen demand. On the other hand, promotional advertising by manufacturers of electrical appliances and equipment has not been eliminated. Nationwide, these manufacturers spent an estimated $450 million in promotional advertising in 1972.[7]

The participants have developed a program to promote conservation of electricity. This program has two thrusts, varying somewhat among individual participants. One aim is to achieve short-term improvements in energy consumption and peak demand by disseminating information on how best to use and buy appliances and other electricity-consuming devices.[8] Also, the advantage of home improvements to reduce thermal exchange is stressed. Efforts to reduce electricity use in the long term are directed toward programs with builders to improve construction and install energy-efficient systems in buildings. Methods of communication include:

- Booklets, pamphlets, and brochures.
- Personal contact (visits or telephone calls to the Consumer Information Center; demonstrations and speakers programs).
- Public releases.
- Bill inserts.
- Advertising (special print publications; television, radio, newspaper).

Considering the combined impact of the programs discussed above, the staff feels that there is no conclusive measure of the degree to which these programs will impact projected demand.

8.2.3.3 Change in utility rates and structures

The Federal Power Commission regulates the transmission and sale of energy in interstate commerce. The New York State Public Service Commission regulates the intrastate rates that utilities charge in the participants' service areas.[9]

Economic theory indicates that implementation of substantial revisions in rate levels and rate structure, such as inversion of rates, time-of-day metering, or peak-load pricing, will change the pattern and growth of electricity demand. Table 8.6 shows a decline, then an increase, in prices across rate classes over the 1963-1974 period. Insufficient knowledge is available on the separate impact of price on sales and whether increasing prices would have the reverse impact of decreasing price in order to formulate a judgment on the degree to which increasing rates would dampen sales. Neither adequate data nor studies exist that would support a conclusion that such price and rate structure changes would so reduce the projected need for power in the applicant's service area in the next several years as to make unnecessary the construction and operation of the Sterling Power Project. The body of literature on quantitative demand analysis does not address the effects of rate structure changes per se. Some authors have discussed the potential consequences in theoretical terms of rate structure changes upon demand for electricity. However, a review of the literature on this subject does not reveal a forecasting methodology commonly agreed upon as having acceptable accuracy that indicates how a given change in rate structure would affect the date at which the generating capacity represented by the Sterling Power Project will be required.

8.2.3.4 Load shedding, load staggering, and interruptible load contracts to reduce peak demand

In determining the possibility of using load shedding as a technique that might eliminate the need for additional electricity from the station, it is first important to distinguish between load curtailment and load relief measures and load shedding.

Load curtailment measures include all methods of reducing demands on electric utility systems during periods when capacity is inadequate, for whatever reason, to serve load. A list of load curtailment measures follows:

- Curtailment of all nonessential electric power usage at all utility-owned power plants and office facilities.
- Discontinuing service to contractually interruptible loads, the attractiveness of which depends upon the rate incentive offered and the specification of the number and duration of the interruptions that may also be specified in the contract.
- Voltage reduction. (Generally, voltage levels may be reduced 3 to 5% but in exceptional situations an 8% reduction may be affected.)
- Voluntary curtailment of nonessential loads of large commercial and industrial customers.

These methods of decreasing demand during emergency periods have been used successfully by many utilities. The participants do not have and do not anticipate having interruptible load contracts. Those utilities that do have interruptible load do not use it to reduce the annual peak demands of energy requirements in power planning studies.

For interruptible load contracts to be effective in system planning, the load reduction must be large enough to be effective in system stability planning. Thus, this type of contract is primarily related to industrial customers. The acceptability of interruptible load contracts to industrial customers depends upon balancing the potential economic loss resulting from unannounced interruptions against the saving resulting from the reduced price of electricity. If the frequency or duration of interruptions increases as a result of insufficient installed capacity, the customer becomes more inclined to convert to a normal industrial load contract. In any case, interruptible load contracts are more likely to obviate the need for peaking units rather than base units such as are planned for Sterling.

Load shedding is an emergency measure to prevent system collapse when peak demand placed upon the system is greater than the system is capable of providing. This measure is usually not taken until all other measures are exhausted. The Federal Power Commission's report on the major load shedding that occurred during the Northeast power failure of November 9 and 10, 1965, indicates that reliability of service of the electrical distribution systems should be given more emphasis, even with the additional costs.[10] This report identified several areas that are seriously affected by loss of power, such as elevators, traffic lights, subway lighting, and prison and communication facilities. It is the serious impact on areas such as these that results in load shedding as only a temporary method to overcome a shortage of generating capacity during an emergency.

Load staggering has also been considered by the staff as a possible conservation measure. Basically, this alternative involves shifting the work hours of industrial or commercial firms to avoid diurnal or weekday peaks. However, it appears unlikely that rates could be adjusted to the degree necessary to cause substantial changes in work patterns. Thus, this practice could not be relied upon to obviate the need for the Sterling Power Project.

Table 8.6. Average price of electricity in cents per kilowatt-hour by utility[a] and customer class compared to average USA prices[b]

Year	CH		OR		RGE			NM			USA		
	Residential	Commercial and industrial	Residential	Commercial and industrial	Residential	Commercial	Industrial	Residential	Commercial	Industrial	Residential	Commercial	Industrial
1974[c]	NA	NA	5.32	4.46	3.11	3.09	2.29	2.87	2.56	1.34			
1973	2.64	1.91	3.55	2.80	2.87	2.72	1.94	2.57	1.99	0.96			
1972	2.61	1.86	3.07	2.34	2.62	2.53	1.82	2.59	2.18	0.96			
1971	2.59	1.82	2.81	2.16	2.55	2.47	1.79	2.38	2.19	0.89	2.32	2.20	1.10
1970	2.45	1.68	2.60	2.02	2.38	2.29	1.66	2.31	1.96	0.82	2.22	2.08	1.02
1969	2.51	1.68	2.67	2.03	2.46	2.21	1.57	2.18	1.77	0.75	2.21	2.06	0.98
1968	2.57	1.73	2.72	2.08	2.55	2.23	1.55	2.20	1.78	0.74	2.25	2.07	0.97
1967	2.63	1.75	2.84	2.14	2.68	2.25	1.54	2.27	1.82	0.74	2.31	2.11	0.98
1966	2.71	1.71	3.06	2.14	2.75	2.26	1.54	2.31	1.87	0.73	2.34	2.13	0.98
1965	2.79	1.80	3.18	2.21	2.78	2.30	1.57	2.34	1.91	0.73	2.39	2.18	1.00
1964	3.00	1.85	3.24	2.25	2.90	2.33	1.62	2.38	1.94	0.75	2.45	2.26	1.02
1963	3.12	1.90	3.37	2.26	2.94	2.42	1.68	2.39	1.97	0.76			

[a] Moody's Investors Service, Inc., *Moody's Public Utility Manual*, New York, N.Y., 1969 and 1974.

[b] Federal Power Commission, *Statistics of Privately Owned Electric Utilities in the United States, 1971*, FPC 226, U.S. Government Printing Office, Washington, D.C., October, 1972.

[c] *Annual Reports, 1974*, Orange and Rockland Utilities, Inc., Rochester Gas & Electric Corportation, Niagara Mohawk Power Corporation; comparable data is not available in the Central Hudson annual report.

8.2.3.5 Factors affecting the efficient utilization of electrical energy

During the past two years, much of industry, the Federal government, and many state and local governments have made the promotion of energy conservation a priority program. The U.S. Department of Commerce has developed a department-wide effort to (1) encourage business firms to conserve energy in the operation of their own processes and building; (2) encourage the manufacture and marketing of more energy-efficient products; and (3) encourage businessmen to disseminate information on energy conservation. The National Bureau of Standards has been given a leading role in promoting the development and implementation of energy-saving standards. Programs include voluntary labeling of household appliances; research, development and education with respect to energy conservation in building; efficient use of energy in industrial processes; and improved energy efficiency in environmental control processes. Although considerable efficiencies in electricity usage have already been gained and although further efficiencies will be realized, any present estimates of the magnitude of electricity savings to be realized over time must be treated as tentative and subject to continual reassessment.

The need for generating capacity is based on annual peak load demand rather than the volume of consumption over the year. Any conservation measures that reduce consumption but not peak demand will have little or no impact on the need for capacity. The growth in peak demand will continue to be strongly influenced by installation of air conditioning in an increasing percentage of residences and commercial and industrial buildings.

Considerable efficiency can be achieved in space conditioning by improved insulation and the use of building materials with better insulation properties, as well as by using equipment that transfers or stores excess heat or cold. For example, the seven-story Federal Office Building to be built in Manchester, New Hampshire, illustrates the potential for energy conservation in future commercial buildings using existing technology. For this particular building, energy savings are anticipated to be a minimum of 20 to 25% over a conventionally designed building in the same location. Heat savings alone are expected to be 44% because of better insulated walls, less window areas, use of efficient heating and heat storage equipment, and the use of solar collectors on the roof.

In 1971, FHA established new insulation standards that would reduce average residential heating losses by one-third. Studies have shown that it is possible to gain even greater reductions in heat loss through improved insulation at costs that are economical over a period of years.[11] Improved insulation conserves energy not only in winter but also reduces the air-conditioning burden in the summer.

Lighting, which has accounted for about 24% of all electricity sold nationally, is another area where savings are being realized. Many experts believe recommended lighting levels in typical commercial buildings have been excessive.[12] It has been calculated that adequate illumination in commercial buildings can be achieved at 50% of current levels through various design and operational changes. Another study indicated that if all households in 1970 had changed to fluorescent from incandescent lighting, the residential use of electricity for lighting would have been reduced approximately 2.5%.[13] However, because the majority of residential lighting occurs in off-peak hours, the reduction of peak demand would be less than 1%.

The potential for greater efficiency in household appliances is well recognized. The National Bureau of Standards is working with an industrial task force from the Association of Home Appliance Manufacturers in a voluntary labeling program that would provide consumers with energy consumption and efficiency values for each appliance and educate them as to how to use this information. Room air conditioners are the first to be labeled. The next two categories of house appliances that are to be labeled are refrigerators and refrigerator/freezers and hot water heaters.

The importance of energy-efficiency labeling of appliances is that it will allow the consumer to select the most energy-efficient appliance. A recent study entitled *The Room Air Conditioner as an Energy Consumer* has estimated that an improvement in average efficiency from six to ten Btu/watt-hr could hypothetically save electric utilities almost 58,000 MW in 1980.[14] Air conditioners that are more energy-efficient require a combination of increased heat-exchanger size and higher-efficiency compressors resulting in higher initial cost. The consumer must be convinced that it is profitable for him in the long term to purchase the more expensive machine. Today, however, there is a high degree of uncertainty in predicting to what extent consumers will actually purchase these more expensive appliances. In addition, selection of central air conditioning by developers and many homeowners has historically been based on minimizing front-end costs subject to meeting local building codes.

Considerable opportunity for electricity conservation exists in industry in addition to lighting and air conditioning efficiency already mentioned. Electric motors should be turned off when not in use and motors should be carefully sized according to the work they are to perform. Small savings can be realized by de-energizing transformers whenever possible. Fuel requirements from vacuum furnaces can be reduced by 75% if local direct combustion low-quality heat rather than high-quality electrical resistance heating is employed.[15]

As experience is accumulated, a better forecast can be made of the extent to which savings from these kinds of conservation measures will be implemented. In addition, the staff is aware that the National Institute of Occupational Safety and Health has recommended heat-stress standards to the Occupational Safety and Health Administration which, if adopted, would require a significant number of employers to air condition their plants.[16] This possible requirement, coupled with the above, makes any significant reduction in the future peak demand for electricity due to this conservation of energy measure highly uncertain at this time.

8.2.3.6 Consumer substitution of electricity for scarce fuels

Although conservation measures are rather quickly adopted in a "crisis" situation, the consumer's substitution of electrical energy for fuels such as oil or gas takes several years or more to result in a substantial upward demand for power because of its reaction to capital investments that use electricity. Substitution of electricity for scarce energy sources will likely accelerate in the applicant's service area because of the uncertainty of oil and gas supplies and the outlook for higher prices for these fuels with respect to the price of electricity produced from nuclear plants.

For instance, in the Sterling Power Project participants' service areas between 1.5 and 6.7% of residences were electrically heated. This is projected to rise to 7.7 and 16.2% by 1984 (ER, p. R540.21-1). Similarly, with respect to air conditioners, substantial growth is anticipated with OR already showing 51% of its customers having air conditioners in 1975 (ER, p. R540.20-1). The advent of electric automobiles and other new uses of electricity cannot be discounted and are not now quantified in projecting need for power because of their high degree of uncertainty. The staff's evaluation is that substitution effects will be, to some substantial degree, offset by savings from conservation of energy techniques.

A second kind of substitution that is relatively important in considering the need to add the proposed nuclear plant to this system is the desirability of adding nuclear capacity to reduce fuel consumed by gas- and oil-fired units now forming a large part of the system. This, in turn, will increase the availability of these more versatile fuel resources for other uses for which there is no available substitute.

8.3 POWER SUPPLY

8.3.1 System capability

Each participant has independently-owned generating capacity. Table 8.7 shows the current capacity with respect to class of service and type of fuel as well as the capacity projected for 1983 and 1984 when the Sterling Power Project is expected to be on line. Individual listings of the units are found in the ER, Appendix 1D, which also contains information on each unit of the entire NYPP.

The combined capacity of the Sterling Power Project participants was 6906 MWe in 1974. These utilities rely quite heavily on fossil-fueled plants with some capacity in hydro and combustion turbines. Nuclear power is also making a substantial contribution at the present time.

8.3.2 Regional capability

The NYPP generation was provided by approximately 269 units (including those of the applicant) with a total summer rated capacity of 28,099 MWe (ER, Table 1.1-18). Currently, only 9.8% of the NYPP installed generating capacity is nuclear; the remainder consists of oil-fired (46.9%), coal-fired (11.6%), kerosene-fired (5.1%), gas-fired (0.5%), and hydro (17.8%) units.

Oil has replaced coal as the fuel for many of New York's generating units in recent years because of strict environmental standards, but because of the recent oil shortages and rapid increase in oil prices, the NYPP has placed greater emphasis on nuclear and coal-fired plants in its long-range expansion program.[17] Additions to the NYPP generating capacity (including upratings, deratings, and retirements) planned from 1974 through 1985 total 16,792 MWe.[18] The major generating additions include oil-fired units with a total summer-rated capacity of 2563 MWe, coal-fired units with a total capacity of 1842 MWe, and nuclear units with a total capacity of 10,041 MWe.[19] The nuclear unit additions planned from 1975 through 1985 are given in Table 8.8.

Table 8.7. Applicants' combined system capability including Sterling (MW)

	1974					1983					1984				
	CH	RGE	OR	NM	Total	CH	RGE	OR	NM	Total	CH	RGE	OR	NM	Total
							Peaking								
Coal															
Oil	10	112	39		161		112	39		151		112	39		151
Diesel	5			9	14	5			9	14	5			9	14
Gas turbine	38	29	74	346	487	48	29	204	346	627	48	29	204	346	627
Hydro	45		44	240	329	46		44	240	330	46		44	240	330
Nuclear															
							Intermediate								
Coal				91	91				91	91				91	91
Oil			68	375	443	122		68	375	565	60		68	375	503
Diesel															
Gas turbine															
Hydro				300	300				300	300				300	300
Nuclear															
							Base								
Coal		340		1379	1719		340		1379	1719		340		1379	1719
Oil	482		789	865	2136	1070	204	797	2136	4207	1070	204	797	2136	4006
Diesel															
Gas turbine												3			3
Hydro		47		99	146		47		99	146		47		99	146
Nuclear		470		610	1080	99	624		1061	1784	295	946	380	1314	2935
Total	580	998	1014	4314	6906	1390	1356	1152	6036	9934	1524	1678	1532	6289	10,825

Source: Er, Appendix 1D.

Table 8.8. Additions to the New York Power Pool nuclear base load generating capacity planned for 1975 through 1985

Plant	Capacity (MWe)	On-line date	Responsible member[a]
Fitzpatrick	821	April 1975	PASNY
Indian Point Unit 3[b]	1033	January 1976	CE
Shoreham Unit 1	820	September 1978	LILCO
Nine Mile Point Unit 2	1100	August 1981	NMPC
Jamesport Unit 1	1150	May 1982	LILCO
Sterling Unit 1	1150	April 1984	RG&E
Somerset Unit 1	1200	April 1984	NYSE&G
Jamesport Unit 2	1150	May 1984	LILCO
Greene County	1200	May 1983	PASNY

[a] PASNY, Power Authority of the State of New York; CE, Consolidated Edison Company of New York; NMPC, Niagara Mohawk Power Corporation; RG&E, Rochester Gas and Electric Corporation; NYSE&G, New York State Electric & Gas Corporation; LILCO, Long Island Lighting Company.

[b] Con Edison assumes that Indian Point Unit 3 will begin operation at 873 MWe in 1976 and uprate by 92 MWe in 1978 and by 68 MWe in 1980.

Source: *1974 Report of Member Electric Corporation of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149-b of the Public Service Law, Volume 2, Long Range Generation and Transmission Expansion Plan*, April 1, 1975, Exhibit 1.

Current information indicates that the New Hampton coal-fired unit (400 MWe) planned by the Orange and Rockland Utilities for operation in May 1980 and a Central Hudson Gas and Electric Corporation coal-fired unit (400 MWe) planned for operation in May 1983 have been cancelled. Current deferrals include two oil-fired units (Astoria 6 from May 1975 to May 1977 and Oswego 6 from November 1975 to 1979), three nuclear units (Nine Mile Point 2 from April 1979 to 1982, Somerset 1 from November 1982 to 1984, and Somerset 2 from November 1984 to 1986), and the Consolidated Edison Cornwall hydroelectric pumped storage units (Cornwall Units 1-4 from May 1979 to 1985 and Cornwall Units 5-8 from November 1979 to 1986).[17] The NYPP planned generating capability at the time of the summer peak load (July) and the forecast summer peak loads and reserves are given in Table 8.9.

Table 8.9 New York Power Pool planned generating capacity (MWe) at time of summer peak (July) and forecast summer peak loads and reserves, 1976 through 1991

Maximum installed net capability	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Thermal (oil fired)	13,360	14,147	14,468	15,249	15,249	15,112	15,062	15,029	14,987	14,378	14,178	13,978	13,778	13,578	13,378	13,178
Thermal (coal fired)	3,263	3,263	3,570	3,570	3,570	3,561	3,556	5,103	5,098	4,988	5,738	5,638	6,388	6,288	6,188	6,088
Thermal (other)	0	0	0	32	32	32	32	32	32	32	32	32	32	32	32	32
Thermal (gas turbines)	3,777	3,836	3,846	3,867	3,867	3,867	3,867	3,867	3,867	3,867	3,867	3,867	3,867	3,867	3,867	3,867
Thermal (diesel)	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74
Thermal (nuclear)	2,774	3,647	3,739	4,719	4,787	4,756	4,736	6,920	8,037	10,354	10,354	10,354	10,354	12,836	15,318	17,842
Hydro (conventional)	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025	4,025
Hydro (pumped storage)	1,000	1,000	1,000	1,000	1,000	1,000	2,000	2,000	2,000	2,000	2,000	3,000	4,000	4,000	4,000	4,000
Undetermined intermediate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total controlled sources	28,273	29,992	30,722	32,536	32,604	32,426	33,352	37,050	38,090	39,718	40,268	40,968	42,518	44,700	46,882	49,106
Capacity purchases	83	11	807	803	800	800	800	800	800	800	800	800	800	800	800	800
Capacity sales	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Total capacity for load of area	28,206	29,853	31,379	33,189	33,254	33,076	34,002	37,700	38,740	40,368	40,918	41,618	43,168	45,350	47,532	49,756
Coincident peak load	21,000	21,920	22,770	23,650	24,610	25,600	26,600	27,600	28,640	29,760	30,890	32,060	33,280	34,450	35,700	36,950
Gross margin	7,206	7,933	8,609	9,539	8,644	7,476	7,402	10,100	10,100	10,608	10,028	9,558	9,888	10,900	11,832	12,806
Gross margin, % of load	34.3	36.2	37.8	40.3	35.1	29.2	27.8	36.6	35.3	35.6	32.5	29.8	29.7	31.6	33.1	34.7

Source: 1976 Report of Member Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149.b of the Public Service Law Volume 2, Long Range Generation and Transmission Plan, April 1, 1976, Appendix C.

POOR ORIGINAL

8.4 RESERVE REQUIREMENTS

8.4.1 General considerations

All electric power systems need a reserve capacity to ensure a reliable supply of electricity to their customers. This reserve capacity is generally measured by the excess of generating capacity over the annual peak load. The reserve margin is determined by several factors.[20] Generating capacity for forced outages usually makes up the largest required block of reserves. This capacity is generally related to the reliability standards of the region (see below), the type of generating capacity (fossil fuel, hydroelectric, or nuclear), and the size of the individual units. Reserves are also required for off-peak maintenance and provision of uncertainties in estimated local growth.

Reserve requirements generally decrease as the number of units in the system increases (or as the size of the system increases). Thus, some of the primary benefits of power pooling are lower installed reserve requirements and lower spinning requirements.[21] Other benefits of power pooling include the ability to install larger generating units (resulting in economy of scale) and the ability to exchange economy energy. Economy of scale is a consequence of the general proposition that the larger the plant, the lower are construction and operating costs per unit of production.[22]

Three basic methods have been used to calculate reserve requirements: (1) standard percent reserve, (2) loss of largest generator, and (3) probability methods.[23] In the standard percent reserve method, some fixed percentage (determined by utility experience) of the forecast system peak load is used as the required reserve. This method is considered inefficient for larger utilities. The loss of largest generator method equates required reserves with the size of the largest generator plus additional reserves required by other factors. A disadvantage of this method is that the system is being designed to an unknown variable reliability. However, this is generally the most practical method for some utilities, particularly the smaller ones. The advent of the electronic computer has made practical the use of the probability method, and this method has found widespread use among many power pools and the larger utilities.

Of the potential methods available for determining reserve requirements by probability, the one most widely used is the loss-of-load method. This method estimates the required reserves as a function of the probability of the loss of capacity required to meet the expected load. Probabilities of being unavailable for operation due to forced outages are assigned to each generator in the system. Maintenance schedules, system load models, weather and business cycle variations, variation of generator forced outage rates as the units mature, transmission interconnections and reliability, and interaction with other systems are all considered in the calculations. Usually the utilities' reserve levels are based on regional reliability requirements as determined by the regional reliability council or the power pool to which the utility belongs. The reliability standard in widespread use is that the utility's generating supply will equal or exceed system load at least 99.9615% of the time, which is equivalent to a loss-of-load probability of one day in ten years based on a 250-day year. (The load model excludes weekends and holidays because the load is usually depressed on these days; therefore, their inclusion does not contribute measurably to the annual risk of load loss.)[24] When a utility becomes part of a power pool in which the different members have peak loads that are generally noncoincident, the same reliability standard can be maintained with lower reserve requirements for the individual utility than would be the case when the utility's system is considered as an isolated entity. This is another significant benefit of power pool membership. Further benefits of power pool membership have been described by the Federal Power Commission.[25]

8.4.2 Applicants' and NYPP reserve responsibility

The NYPP determination of an adequate reserve is based on the reliability standards of the Northeast Power Coordinating Council (NPCC), which specify: "Generating capacity will be installed and located in such a manner that after due allowance for required maintenance and expected forced outages, each area's generating supply will equal or exceed area load at least 99.9615% of the time. This is equivalent to a loss of load probability of one day in ten years." To meet this NPCC criterion, the NYPP has determined that the reserve margin responsibility of each member after 1975 will be 18% of peak load (ER, p. 1.1-19). Due to diversity, this results in reserves of approximately 20% over peak load for the State (ER, p. 1.1-19).

8.5 STAFF FORECAST AND ANALYSIS OF RESERVES

The results of an independent analysis of staff demand forecasts and reserve margins are presented in this section. The analysis synthesizes the results of two recent Federal studies, one concerned with future energy supply and demand and the other concerned with forecasting regional economic activity. The staff's methodology for analyzing the need for the generating capacity which the Sterling Power Project Unit 1 would provide is to compare the total projected peak load demand plus reserves with projected capacity without the plant for all of the four applicants combined. Section 8.5.1 describes the staff's methodology and the combined projections for the four utilities. Tables 11.5 and 11.6 contain projections for the individual utilities using the same methodology but aggregating data at a different level.

8.5.1 Peak load forecast

The *1976 National Energy Outlook*,[26] released by the Federal Energy Administration in February 1976, represents the first of an annual series of energy forecasts developed to evaluate alternative energy policies. The forecasts are based on improved versions of national energy supply and demand models FEA has developed during the last two years, and uses the most up-to-date data that are collected.

The *National Energy Outlook*[26] provides three projections of future electrical demand: (1) the business-as-usual (BAU) case, which does not assume passage of any energy conservation actions but does include the conservation effect of higher energy prices; (2) the conservation case, which represents the BAU case as modified by conservation actions, industrial coal conversion, and dispersed solar heating and cooling actions; and (3) the electrification case, which incorporates into the BAU case certain measures aimed at substituting coal and electricity in place of oil and gas in the residential, commercial, and industrial sectors. Under the BAU case, with oil at $13/bbl, electric peak demand is projected to grow at 5.9% per year between 1974 and 1985. Under the conservation and electrification cases, peak load growth is projected to be 3.9 and 6.9% respectively.

The FEA model uses calculations of price elasticities which are different from the usual long-run elasticities presented in the literature. Thus, meaningful comparisons cannot be made. It also forecasts an average electricity price, in constant dollars, of 29.73 mills/kWhr in 1985 compared with 18 mills/kWhr in 1972.[27] In addition, the FEA forecasts are based on projected annual growth rates in GNP of 5.5 and 3.6% for the periods 1975 to 1980 and 1980 to 1985 respectively. These rates can be compared to historical growth rates of 4.1 and -2.1% for the periods 1960 to 1972 and 1973 to 1974 respectively.

Identifying differences in projected growth of major economic variables such as population and income allows one to draw conclusions about the expected rate of growth in demand for electricity within a service area relative to the national rate of growth. The most widely used set of long-term regional economic projections, *OBERS Projections, Regional Economic Activity in the United States*, is prepared by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) and the U.S. Department of Agriculture, Economic Research Service for the U.S. Water Resources Council.[28] The complex projection procedure used is based on the empirical and theoretically supported observation that economic growth over time is related to the size and productivity of the labor force. Quite reliable projections of population and the labor force are published by the U.S. Bureau of the Census. Estimates of future output per man-hour are based on detailed analyses of trends in productivity in each sector of the economy and judgmental forecasts of significant future developments that might affect productivity. Although no projections coincide exactly with the applicant's service area, a reasonably representative forecast can be spliced together for the service area by totaling water subareas 0202, 412, 413, 414, and 415.

The relevant comparison between the Sterling Power Project service areas and the nation as a whole are presented in Tables 8.10 through 8.14. The latter table summarizes the comparison. Note that population is projected in the Sterling Power Project service area to grow at a rate which is approximately 74% that of the national rate during the decade 1970 to 1980. From 1980 to 1985 the population is predicted to grow at about 78% of the national rate and will be maintained at about the same rate for the years 1985 to 1990. Total personal income is anticipated to grow at a rate only slightly less than the national rate, that is, about 97% of the U.S. rate. The per capita income rate of growth will be slightly greater overall than the U.S. growth rate, being about 9% higher for most years and about 4% lower for about five years. Overall, the Sterling Power Project service area will probably experience somewhat lower growth rates than the nation as a whole.

Table 8.10. United States population, employment, personal income, and earnings, actual and projected, selected years 1962–1990

Item	1962[a]	1970	1980	1985	1990
Population, mid-year, millions	185.7	203.9	223.5	234.5	246.0
Per capita income, 1967 $	2,585	3,476	4,700	5,400	6,100
Total employment, millions	66.4	79.3	96.1	101.1	106.4
Total personal income, billion $	480	709	1,068	1,273	1,517

[a] Employment for 1960.

Source: *1972-E OBERS Projections*, Vol. 1, Table 1, p. 38.

Table 8.11. Average annual percentage rates of change, United States population, employment, personal income, and earnings, actual and projected, selected periods 1962–1990

Item	1962–1970[a]	1970–1980	1980–1985	1985–1990
Population	1.17	0.92	0.96	0.96
Per capita income	3.97	3.06	2.82	2.47
Total employment	1.80	1.34	1.02	1.02
Total personal income	5.00	4.19	3.57	3.57

[a] Employment for the period 1960–1970.

Source: Estimated from Table 8.10.

715 159

~~721 100~~

Table 8.12. Population, employment, and personal income of water subareas 0202, 412, 413, 414, and 415, historical and projected, selected years 1962–1990

Item	1962[a]	1970	1980	1985	1990
Population, mid-year, millions	5.79	6.14	6.57	6.82	7.08
Per capita income, 1967 $	2,605	3,457	4,808	5,492	6,273
Total employment thousands	2,058	2,363	2,828	2,955	3,090
Total personal income, million 1967 $	15,082	21,227	31,591	37,453	44,414

[a] Employment for 1960.

Table 8.13. Average annual percentage rate of change, population, employment, and personal income, historic and projected, water subareas 0202, 412, 413, 414, and 415, selected periods 1962–1990

Item	1962–1970[a]	1970–1980	1980–1985	1985–1990
Population	0.74	0.68	0.75	0.75
Per capita income	3.60	3.35	2.70	2.69
Total employment	1.39	1.82	0.88	0.90
Total personal income	4.36	4.06	3.46	3.47

[a] Employment for 1960–1970.

Table 8.14. Water subareas 0202, 412, 413, 414, and 415 as a ratio of United States average annual rate of population, employment, and income, historical and projected, selected periods 1962–1990

Item	1962–1970[a]	1970–1980	1980–1985	1985–1990
Population	0.63	0.74	0.78	0.78
Per capita income	0.91	1.09	0.96	1.09
Total employment	0.77	0.94	0.86	0.88
Total personal income	0.87	0.97	0.97	0.97

[a] Employment 1960–1970.

An estimate of the likely growth rate of the peak load in the Sterling Power Project service area may be derived by ratioing the national projections in the same proportion as ratios of the rates of growth in population and economic activity indicators. At this point, it is necessary to establish which national projections are to be used as a basis. The staff elected to consider the three FFA projections that cover a reasonable range of national demand estimates, that is, 3.9%, 5.9%, and 6.9%.

Weighted average multiplying factors were derived by the staff from the ratios of the parametric rates of change by assuming the total personal income factor to be equivalent to all the others. The factor was calculated to be approximately 0.94 for the two decades from 1970 to 1990. For each of the three projected national growth rates listed above, this factor yielded projected growth rates in demand for the Sterling Power Project service areas of approximately 3.7, 5.5, and 6.5% per year respectively. The results are plotted in Fig. 8.4 and are represented by the upper wide band. The applicants' projection is also plotted, and although it agrees quite well with the staff projection in the near term, it begins to deviate in about 1980 and becomes progressively lower with time.

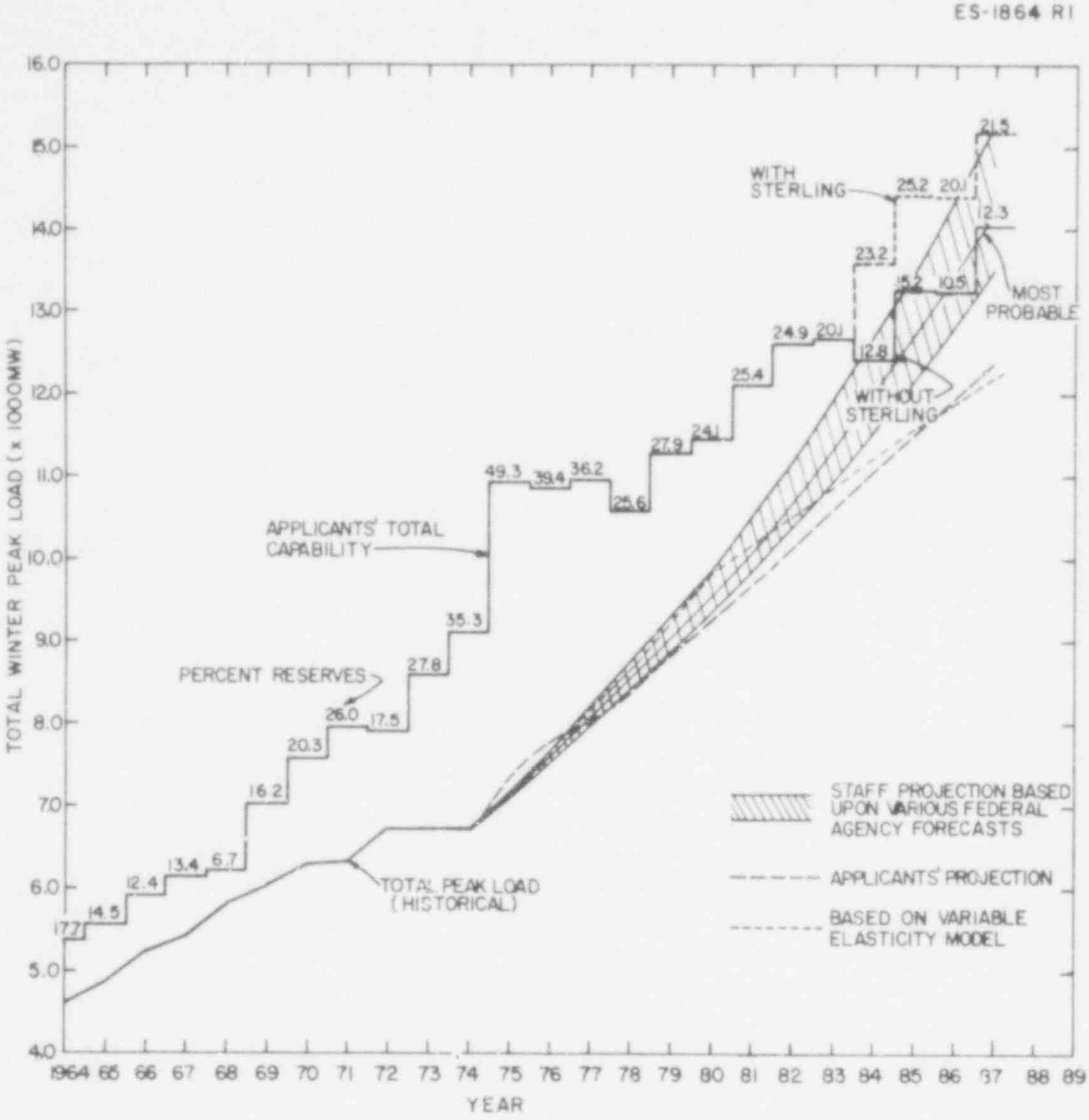


Fig. 8.4. Historic and projected total winter peak load for the Sterling Power Project participants' service area.

Another projection was made with the basis, in this case, resting upon an econometric analysis using variable elasticities.[29] Inasmuch as these projections were made on a statewide basis and in terms of energy consumption, they also were adjusted for the Sterling Power Project participants' service areas by ratioing the parameters applicable to the service areas to those applicable to the state in a similar manner as before. Finally, the energy consumption forecast was related to load growth by assuming that the past decade's ratio of average compound growth rate of peak load to energy consumption growth rate would apply to the next decade as well. This gave rise to calculated growth rates of 6.7% per year until 1980 and 3.7% per year until 1985. This too is plotted on Fig. 8.4 and agrees quite well with the applicant's projection until it begins to deviate after 1981.

As shown in Fig. 8.4, the applicant predicts a 12.8% reserve margin without the Sterling Power Project in 1984 and 23.2% with the plant. Considering the 5.9% per year projection to be the most likely rate of growth, it is seen that without Sterling there may be only about a 7.5% reserve in 1984. Should the highest growth rate pertain, then, without Sterling in 1984, there would be a deficit expected and no reserves. On the other hand, if the lowest growth rate is applicable, the reserves may be 40.5% and 28.6% with and without the Sterling Power Project respectively.

8.5.2 NYPP

With respect to the power pool, projected gross margins are shown in Table 8.9. As indicated, the projections give the impression that reserve margins will be 35.3 and 35.6% in 1984 and 1985 respectively. These projections were derived under the assumptions that there will be no contingencies and that the base-load plan for additions will proceed according to schedule. Hence, this is a most optimistic and perhaps unrealistic view point. It is already evident, at the time this is being written, that the projections of capacity that are part of the basis for the margin projections will not be fulfilled. For example, there are problems with certification of the Jamesport unit and other facilities (Breakabeen, Cayuga, Cornwall) such that there may be much less capacity than had been hoped for. Finally, the requirement by EPA that cooling towers be used in new units will decrease the available capacity even further. Three scenarios are examined in the 149-b report[30] which show that when deratings, postponements, and accelerated load forecasts are taken into account, it is entirely possible that NYPP will experience a potential reserve margin of 17.8% in 1985. Hence, the Sterling Power Project participants cannot rely upon the NYPP to supply their needs in 1984 and 1985.

8.6 CONCLUSIONS

The staff concludes that the growth rate forecasts of the applicant represent an intermediate estimate that is a reasonable forecast for planning purposes. The consequences of building a plant earlier than needed are not equivalent to those of building it too late. Forecasts that are too low could result in the use of higher-cost generating equipment, purchases of high-cost replacement energy (if it is available), increase in air pollution through use of old and inefficient fossil units, greater consumption of scarce fuels such as gas and oil (contributing to shortages and U.S. balance of payment deficits), increased inflation in the price of fossil fuels, and a reduction in systems reliability involving greater risks of brownouts and blackouts. Forecasts that are too high can lead to construction of underutilized generating and transmission capacity, thus leading to higher costs of electricity and inflationary pressures on the cost of capital financing as well as higher interest charges if construction is stretched out over a large period to avoid underutilization of capacity. However, building nuclear capacity earlier than needed could also have some favorable impacts such as earlier retirement of inefficient high-cost generating units, reduction in air pollution, savings of scarce fuels (thus advancing the goals to Project Independence), an increased outlook for electricity sales to neighboring utilities with a mutual advantage to both service areas, or, failing this, an increase in reserve margins with a reduced probability of brownouts and blackouts.

Thus, there is a decided advantage in guarding against the risk of building the units later than demand growth and other considerations would justify. Construction delay schedules for large-scale projects are quite frequent, and planning on the basis of a lower growth rate would not provide a cushion for delays if the forecasts were in error. Also, the construction schedule can be stretched out as the time approaches for on-line use and a better forecast of the need is available. This can be advantageous under conditions of capital shortages. The staff therefore finds that the construction schedule planned by the applicant is reasonable.

REFERENCES FOR SECTION 8

1. Federal Power Commission, *The 1970 National Power Survey, Part II, Electric Power in the Northeast*, U.S. Government Printing Office, Washington, D.C., pp. II-1-73 through II-1-85.

2. Northeast Power Coordinating Council, *Data on Coordinated Regional Bulk Power Supply Programs*, FPC Order 383-3, Docket R-362, Appendix A-1, New York State Interconnected System Load and Capacity Report New York, April 1, 1974.

3. New York Public Service Law § 65 (McKinney, 1955).

4. *1976 Report to Member Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149-b of the Public Service Law of New York State*, April 1, 1976.

5. *1974 Report to Member Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149-b of the Public Service Law of New York State, Volume 1, Electric Power Requirements*, April 1, 1974, pp. 12-15.

6. U.S. Atomic Energy Commission, *The Nation's Energy Future*, WASH-1281, U.S. Government Printing Office, Washington, D.C., December 1973.

7. Crain Communications, Inc., "Leading National Advertisers", in *National Advertising Service Book 1972, Advertising Age*, Norwalk, Conn., Sept. 10, 1973.

8. U.S. Department of Commerce, Bureau of the Census, *Annual Survey of Manufactures: 1971 Fuels and Electric Energy Used, By Major Industry Groups*, M71 (AS-4), U.S. Government Printing Office, Washington, D.C., 1973.

9. Federal Power Commission, *Federal and State Jurisdiction of Electric and Telephone Utilities*, FPC 5-231, Washington, D.C., 1973.

10. Federal Power Commission, *Northeast Power Failure*, U.S. Government Printing Office, Washington, D.C., December 1965.

11. J. Moyers, *The Value of Thermal Insulation in Residential Construction: Economics and Conservation of Energy*, ORNL-NSF-EP-9, Oak Ridge National Laboratory, Oak Ridge, Tenn., December 1971.

12. R. Stein, "A Matter of Design," *Environment* (October 1972).

13. J. Tansil, *Residential Consumption of Electricity 1950-1970*, ORNL-NSF-EP-51, Oak Ridge National Laboratory, Oak Ridge, Tenn., July 1973.

14. J. Moyers, *The Room Air Conditioner as an Energy Consumer*, ORNL-NSF-EP-59, Oak Ridge National Laboratory, Oak Ridge, Tenn., October 1973.

15. Federal Power Commission, Office of the Chief Engineer, *Staff Report, A Technical Basis for Energy Conservation*, U.S. Government Printing Office, Washington, D.C., April 1974.

16. U.S. Department of Health, Education and Welfare, *Occupational Exposure to Hot Environments*, HSM 72-10269, U.S. Government Printing Office, Washington, D.C., 1972.

17. *1975 Report to Members Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149-b of the Public Service Law of New York State, Volume 1, Electric Power Requirements*, April 1, 1975, p. 4.

18. Ref. 17, p. 7-2.

19. Ref. 17, p. F-1.

20. Ref. 1, Chap V.

21. Ref. 1, p. II-1-70.

22. Federal Power Commission, *The 1970 National Power Survey, Part IV, Fossil-Fired Steam Electric Generating*, U.S. Government Printing Office, Washington, D.C., Chap. I.

23. Ref. 1, p. II-1-52.

24. Ref. 1, p. II-1-55.

25. Federal Power Commission, *The 1970 National Power Survey, Part I*, U.S. Government Printing Office, Washington, D.C., Chap. 17.

26. Federal Energy Administration, *1976 National Energy Outlook*, February 1976.

27. Ref. 11, Appendix A II, p. 60.

28. U.S. Water Resources Council, *1972 OBERS Projections, Regional Economic Activity in the U.S., Series E Population, by Economic Area, Water Resources Region and Subarea, State, and SMSA and Non-SMSA Portions of the Areas, Historical and Projected, 1929-2020*, 7 vols., Washington, D.C., April 1974.

29. T. V. Tyrrell, *Projections of Electricity Demand*, ORNL-NSF-EP-50, Oak Ridge National Laboratory, Oak Ridge, Tenn., November 1973.

30. Ref. 17, Exhibits 7B-7E.

9. COST-BENEFIT ANALYSIS OF ALTERNATIVES

9.1 ALTERNATIVE BASE-LOAD ENERGY SOURCES AND SITES

9.1.1 Alternatives not requiring creation of new generating capacity

9.1.1.1 Purchased power

The Sterling Power Project participants have indicated (ER, Sect. 9.1.2) that purchase of base-load power is not a viable alternative in amounts in excess of those already scheduled (between 565 and 967 MWe during summer peaks, 1981-1985). (Because firm contracts have not yet been completed, an estimation of energy is not yet possible.) Purchased energy is generally only a viable alternative when excess capacity exists in another region or system during the time period when the energy is needed. Constructing new capacity in a different region or system would merely shift the energy-producing burdens to another region without any significant overall advantages.

In its report to the Federal Power Commission for the 1970 National Power Survey, the Northeast Regional Advisory Committee discussed seasonal diversities within the Northeast as capacity sources. The Committee concluded that opportunities for seasonal exchange not already implemented were relatively small and uncertain so that little, if any, transmission for seasonal exchange purposes could be justified.[1]

The staff concludes that purchasing base-load power for a period of time corresponding to the expected lifetime of the Sterling Power Project is not a practicable alternative.

9.1.1.2 Postponed retirement or reclassification of existing units

The Sterling Power Project participants have indicated an intent to retire some existing generating capacity (approximately 160 MWe) between 1983 and 1989.[2] By 1983 all of the existing non-supercritical base-load coal-fired stations will probably largely be used for intermediate-type operation. Because of the discrepancy between the planned retirement capacity and the capacity of the proposed station, postponed retirement cannot be considered a viable alternative to the proposed action.

9.1.1.3 Base-load operation of intermediate or peaking facilities

Extended operation of units designed for intermediate or peaking operation would result in extensive maintenance problems and reduced availability of the peaking capacity and reduced system reliability when it is needed because these units are not designed for continuous baseload operation. This case is particularly true for the peaking units and, to a lesser extent, for intermediate-type units. Moreover, fuel costs for these units are generally higher than those designed for base-load duty (ER, p. 9.1-9); also, fuel for some of these units (oil and gas-fired) is expected to be in relatively short supply and may not be available for their continuous operation. Because a portion of the peaking capacity is hydroelectric or pumped-storage hydroelectric capacity, the extent to which these facilities can be operated is dependent upon the water supply. Both types of hydroelectric facilities are limited to use for peaking purposes only (ER, Sect. 9.1.3). The system also needs a major block of generation to operate in the load-following portion of the curve. Upgrading these units to base-load operation would deprive the system of an important part of the generation mix needed for efficient operation. Another aspect to be considered is that without the addition of new generating capacity, peak demand will eventually outgrow the system's total generating capacity and will result in the absence of any reserve capacity. Thus, the staff concludes that base-load operation of existing intermediate or peaking facilities is not a feasible alternative for the long term.

9.1.1.4 Reactivating or upgrading older plants

Because the Sterling Power Project participants plan to retire only small existing units between 1983 and 1989 and because those scheduled to be retired in 1975 are also relatively small and are used only for peaking purposes, reactivating older plants is not a viable alternative to building new base-load capacity in the amount to be supplied by the Sterling Power Project.

Upgrading existing facilities by a significant extent is generally not economically feasible, because most boiler and turbine-generator facilities are closely matched. Thus, upgrading would require replacement of boilers, turbines, and condensers with a resulting probable cost approaching that of new capacity. An associated additional disadvantage is that all output from these units would be lost during the rebuilding period. Furthermore, installation of higher capacity at a particular location would require additional capability to dissipate waste heat and probably additional transmission lines. The staff does not consider upgrading to be a viable alternative to replace the power expected to be supplied by the Sterling Power Project.

9.1.1.5 Conservation of energy

See Section 8.2.3 for a discussion of energy conservation.

9.1.1.6 Conclusions

The staff concludes that there are no feasible alternatives not requiring creation of new generating capacity to meet the projected energy requirements.

9.1.2 Alternatives requiring the creation of new generating capacity

9.1.2.1 Energy type and source consideration

Coal

Coal supplied the energy for about 26% of the power generated by the Sterling Power Project participants in 1974 (ER, Sect. 1).[3]

In the staff's opinion, a conventional coal-fired power plant is the only serious alternative to the Sterling Power Project since all of the criteria for selection are fulfilled in a broad sense. To determine which of the two is more socially desirable, each criterion must be examined and compared. The staff's view is that the only differences arise from two criteria: expected price (cost of production) and environmental acceptability. Before considering these two points specifically, the coal option shall be considered more generally. At the beginning of the 20th century, coal accounted for 90% of the energy in the United States. However, in recent decades, coal has lost some of its important markets and is now used mainly in generating electricity and in making steel and other manufactured goods. It is the most abundant fossil fuel, accounting for 73% of the total recoverable fuels in the nation. By contrast, oil and natural gas account for 9% and oil shale about 17%.[4] A supply of economically recoverable coal is expected to be available beyond the year 2000 to meet future domestic power demand.

Logistics and transportation of coal are much more costly than for gas, oil, or nuclear fuel regardless of the geographic supply area. An 1150-MWe station operating at 70% capacity with a heat rate of 9700 Btu/kWhr would consume annually about 2,700,000 tons of 12,670 Btu/lb coal. If 100-car unit trains were used and each car had a capacity of 100 tons, about 270 train deliveries would be required annually.

Coal-fired stations require about 60 acres for each 1000 MWe of capacity, including coal storage areas. Additionally, an estimated 35 acres would be required for ash storage and coal handling equipment. A smokestack several hundred feet tall would be required. These facilities make coal-fired stations aesthetically less desirable than nuclear stations. The necessary fuel handling and pollution abatement equipment for high-sulfur coal adds to the capital investment of the station. As an example, the additional investment cost for an SO_2-removal system for a 1000-MW station burning 3.0% sulfur coal, including initial investment and capitalized operating cost and capacity penalty, is approximately $ 79/kWe in 1975 dollars, depending upon the type of process used.[5]

To meet Federal new source performance standards, the emission from a power plant would be limited to 1.2 lb of SO_2 per million BTU.[6] This would mean, for example, that coal with a heat content of 10,000 BTU/lb would be limited to a 0.6% sulfur content or the plant would be required to be equipped with flue gas desulfurization facilities.

Coal having a low sulfur content (approximately 0.6% or less) and other characteristics required to satisfy current environmental emission standards is available in the western portion of the United States (primarily in Montana and Wyoming) in the quantities necessary to meet the requirements of an 1150-MWe station. The use of eastern low-sulfur coal (1% or less) for power generation will be limited in the future because it is in high demand by the metallurgical industry. The mere existence of a coal reserve, however, is not sufficient basis for its consideration as an economic fuel alternative.[7] It is doubtful that eastern coal having characteristics required to satisfy current environmental standards would be available in the necessary quantities without SO_2-removal equipment as part of the plant.

Present coal-fired stations convert thermal energy into electricity more efficiently than do nuclear stations, and the capital cost of a coal-fired plant is about 70% that of a comparably sized nuclear station. However, the long-term costs of energy from a nuclear station are less because of the lower fuel and operating costs. The staff has estimated the generating cost for a coal-fired power plant using eastern high-sulfur coal (2.5% sulphur) and has compared it with the Sterling Power Project. The results are tabulated as a function of capacity factor in Table 9.1. The staff concludes that, for capacity factors within the expected range of station operation, a nuclear-powered plant is more economical than a conventional coal-fired plant. (Note that both plants would be expected to operate in the range of 60 to 80% capacity factor.) The staff has examined the overall environmental impact of a coal-fired plant compared with a nuclear plant sited at Sterling as described in a number of reviews[7-9]and concludes that, although a coal-fired plant is a resonable alternative to the proposed Sterling Power Project, it is a less favorable alternative because of higher fuel and pollution abatement costs and greater adverse impacts, environmentally.

Table 9.1. Comparison of costs of Sterling Power Project and equivalent coal-fired station for 1984 operation
(10% discount rate)

Capacity factor	Nuclear			Coal[a]		
	60	70	80	60	70	80
Capital cost,[b] million $	1015	1015	1015	804	804	804
Decommission cost, million $	26.9	26.9	26.9	-	-	-
Annual cost, million $						
Operation and maintenance	11.7	11.8	11.8	22.5	24.0	25.5
Fuel	49.6	57.8	66.1	113.6	132.6	151.5
Total annual cost, million $	61.3	69.6	77.9	136.1	156.6	177.0
Total cost (present worth of capital), million $	2010.4	2141.6	2272.7	2954.4	3278.3	3600.6
Annualized total cost, million $	213.3	227.2	241.1	313.4	347.8	382.0
Generation, 10^9 kWhr/year	6.04	7.05	8.06	6.04	7.05	8.06
30-year-levelized energy cost, mills/kWhr	35.3	32.2	29.9	51.9	49.3	47.4

[a] High sulphur (2.5%) eastern coal with SO_x removal.
[b] All cost in millions of 1984 dollars.

The staff has considered the alternative of two 600 megawatt coal fired plants to replace the capacity of the Sterling unit. The alternative considered was one 600 megawatt plant in the service areas of N.M. and RG&E and one 600 megawatt plant in the service areas of O&R and CH. Capital costs of two 600-MWe units (not at the same site) are about 18% greater than for one 1150-MWe unit (see Appendix D). Operating and maintenance costs would also be greater for two 600-MWe units at different locations as compared to one 1150-MWe unit. The additional costs of shipping coal a longer distance to the O&R and CH service areas would be offset to some extent by reduction in electrical transmission costs expected when one of the units is located closer to the area which it serves; the staff has assumed that the additional coal shipping costs would equal the reduced transmission costs. Consequently, the staff concludes that two 600-MWe units at different locations would be less economical than one 1150-MWe unit. Since a uranium-fueled station was more economical when 1150-MWe sizes were compared and in view of the increased capital and operating and maintenance costs when 600-MWe units are constructed and operated at separate sites, the staff concludes that the nuclear plant is more economical than either coal-fired alternative.

721 108

715 167

Oil

Oil was used to generate about 45% of the Sterling Power Project participants' power in 1974 (Sect. 1);[3] its use was mainly for intermediate-type and peaking units. Oil at a price of $11/bbl (about $1.90/10^6 Btu) is about equivalent in electrical energy generation capability to coal at a price of $50/ton. Thus the applicant does not consider oil to be a feasible alternative fuel source (ER, Sect. 9.2.1). The staff concurs in this evaluation.

In addition to the economic aspects that preclude the further consideration of oil as a fuel for a large base-load power station, other reasons also discourage its use. An important factor is the future availability of oil in the United States as a fuel for base-load power stations. As events since late 1973 have shown, oil supplies from foreign countries (which make up a significant part of our total annual consumption) are subject to availability and costs as dictated to a large extent by political considerations. The cost factor is important not only in relation to predicting the economics of station operation but also with regard to national policies related to the U.S. balance-of-payments problems. The latter could lead to restrictions on the large-scale use of oil for power stations to conserve it for other purposes for which there are no readily available substitutes (such as fuel for internal combustion engines, raw materials for synthetic organic chemicals, etc.). Therefore, even disregarding the economics of station operation, the unreliability of foreign supplies of oil and the potential effects on the allocation of available supplies make it desirable for a utility not to increase its dependence on oil as a fuel source. The staff concludes that it is not reasonable at this time for the Sterling Power Project participants to plan a base-load electrical generating station that would consume large quantities of oil.

Natural gas

Only about 2% of the Sterling Power Project participants' 1974 power was generated by the use of natural gas (ER, Sect. 1),[3] and this use was mainly for intermediate-type and peaking units. For the future, domestic supplies of natural gas are not expected to be available in the quantities required for long-term (30 to 40 years) operation of a natural gas-fueled power station to replace the applicant's proposed uranium-fueled station.[10]

Therefore, the staff does not consider natural gas as a viable alternative fuel for the proposed base-load Sterling unit.

Hydroelectric

Because of the characteristics of stream flows in the applicant's service area, hydroelectric power generation is limited in usefulness to peaking service. In 1974, hydroelectric facilities generated about 12% of the Sterling Power Project participants' total power generation (ER, Sect. 1).[3] There are only a few hydroelectric sites remaining that are suitable for development for peaking service (ER, Sect. 9.2.1.4).[11] The staff concludes that it is not practicable to utilize hydroelectric power in the applicant's service area to supply base-load power in the amount expected to be generated by the Sterling Power Project.

Geothermal

Geothermal electric power generation, at favorable geologic sites, has been found to be feasible and competitive with other commercial sources of energy. However, the kinds of geological formations that produce steam suitable for use in geothermal plants appear to be nonexistent in New York State (ER, Sect. 9.2.1.6).

The staff concludes that geothermal power cannot reasonably be considered as an alternative energy source for the proposed base-load uranium-fueled power station.

Solar power

Although solar generation of electricity may be a future supplier of electrical energy in the United States, a pilot plant has not yet been put into operation. To succeed as a base-load plant, low-cost methods of power storage (to supply power when the sun is obscured by clouds or at night) would have to be developed and coupled with the solar energy conversion units. Even if a considerable number of technological problems are solved, commercial operation of a solar power station would not be expected until about 1990.[12] If solar energy is used for a peaking power station (in localities where the peak occurs during hot, sunny days when air conditioning is a major load), even this energy source is not likely to be competitive before about 1990.[13]

Although in certain locations the use of solar energy for heating and cooling of individual buildings may be economically feasible, the staff does not consider widespread generation of electrical energy at individual homes from solar energy to be, now or in the foreseeable future, economically feasible. Thus, the staff does not consider solar power a viable alternative to the proposed base-load uranium-fueled power station.

Wind power

Power from the wind has been obtained on a 1.25-MW unit in Vermont and a 0.1-MW wind machine has been constructed in Ohio.[14] There are plans to build two 0.2-MW units in 1976 and 1977 and two 1.5-MW units in 1978.[15] Because the wind is intermittent and changing, wind-powered turbines must be designed to operate over a wide range of conditions. Furthermore, they will be subjected to various types of extraneous loadings, which can cause cyclic motions and vibrations in the wind machine components and thus limit reliability, lifetime, and performance.[14] At the present time, there is insufficient experience regarding the operation of these machines to predict their reliability and lifetimes.[16]

Because wind power is intermittent, it is unsuitable as a source of base-load power unless coupled with energy storage facilities, which would add to the cost of the electrical energy produced. There are questions regarding aesthetics since these machines could have about 200 ft diameter rotors mounted on 150-ft high towers. Precautions must be taken with these units to prevent radio or television interference and injury or mishaps due to the breaking of rotors or shedding of ice. As a consequence of the considerations mentioned above, the staff does not consider power from the wind a viable alternative to the proposed base-load plant at this time.

Fusion power

The present status of nuclear fusion as a source of energy is such that a demonstration plant is not expected to be built before about 1990 and a commercial power station is not expected to be available before the year 2000.[17] Therefore, the staff does not consider fusion power to be a viable alternative to the proposed nuclear power plant at this time.

Municipal solid wastes

Substantial sources of energy exist in the large quantities of refuse generated in this nation each year. Wheelabrator-Frye is erecting a refuse-to-energy plant near Boston and will reportedly burn the garbage generated by half a million people (1200 tons/day) and generate steam to run turbines at an adjacent facility of the General Electric Company.[18] Connecticut, the first state in the nation to adopt a statewide garbage disposal plan, will recycle 85% of its residential and commercial solid wastes by 1985. The Connecticut Resources Recovery Authority estimates that the resultant fuel will meet 10% of the State's power needs.[19] The Union Electric Company and the City of St. Louis are engaged in a cooperative program in which the city collects, prepares, and delivers waste to Union Electric where it is burned with pulverized coal. A number of utilities are involved in similar projects.

It is estimated, however, that the total animal and urban solid wastes available under conditions not involving potentially prohibitive collection costs may amount to from 4 to 6 x 10^7 tons of dry organic material per year.[20] Urban waste generation is assumed to approximate 5 lb per person per day. Of this, approximately one-half is dry organic material obtained from waste paper, kitchen wastes, and garden or lawn wastes. The average heat content of the dry organic material may amount to 16 x 10^6 Btu/ton, providing an annual energy supply of from 0.6 to 1.0 x 10^{15} Btu. This represents only about 6% of the present energy requirements of electric generating plants.[20] The burning of refuse in the Sterling Power Project participants' service area would produce only relatively small amounts of heat for the generation of electric power. Until demonstrated on a large scale, refuse combustion cannot be considered an alternative source of energy for the proposed 1150 MWe of generating capacity.

Coal gasification

Pilot plants for coal gasification have been constructed. This method appears to be a promising alternative for fueling large central power stations, but it has not been developed to the extent that it can be considered as an alternative to the Sterling Power Project. A commercial process might be available by the late 1980s.

Coal liquefaction

Development of coal liquefaction processes have not progressed to the same extent as for coal gasification processes. Although one or more processes might be commercially available by the late 1980s, this will not be in time to be considered as an alternative to the proposed plant.

Magnetohydrodynamics

Construction of a large-scale magnetohydrodynamic electrical generating plant depends upon the solution of a number of technological problems. Therefore, such a station is not expected to be available until even later than coal gasification or liquefaction technology and, consequently, will not be available in the time frame required.

Other

There are a number of other alternative energy sources that might be mentioned, such as conversion of foreign natural gas to methanol and its transportation to the United States as a liquid; extraction of fuel oil from oil shale or from tar sands; or the use of fuel cells. However, these energy sources cannot be considered as viable alternatives to meet the requirements for power in the time frame that this power is needed because they are either not technically feasible at this time or not available in the quantities needed.

Summary and conclusions

Of the various types of energy sources that were considered, the staff found that only coal was a viable alternative to nuclear power as fuel for a large base-load power station. The staff's cost comparison of these two types of power stations is given in Table 9.1. The following is a brief discussion of the staff's method of comparison.

A recently developed computer program has been used by the staff to estimate capital costs for the nuclear and coal stations. This computer program, CONCEPT,[21-24] was designed primarily for use in examining average trends in costs, identifying important elements in the cost structure, determining sensitivity to technical and economic factors, and providing reasonable long-range projections of costs. The main factor in this computerized approach is the technique of separating the plant cost into individual components, applying appropriate scaling functions (to account for the difference in size from a reference design) and location-dependent cost adjustments (to account for costs of materials and labor at particular regions of the country), and escalating these costs to different construction and startup dates. These capital cost estimates are given in Table 9.1 for both the coal-fired and nuclear-fueled plants.

From an economic standpoint, the values presented in Table 9.1 indicate that a nuclear power station is preferred. From an environmental viewpoint, the major effects of the alternative generating system result from the condenser cooling water requirements and the radioactive and nonradioactive particulate and gaseous effluents. The coal-fired station would have essentially the same type of condenser cooling water system as the nuclear station, but, because of its higher efficiency and the transfer of some heat to the atmosphere through stack gases, the intake water requirement would be less (by about 30%) than for a nuclear station. The particulate and gaseous emissions from a coal-fueled station would be significantly higher than those from a nuclear station, but they would meet the applicable standards and thus should be acceptable. Although the radioactive effluents from a nuclear station are potentially higher than those from a coal-fired station, the controls imposed on the nuclear station would result in such effluents being equivalent to only a fraction of the natural background radioactivity.

On balancing expected costs of production and environmental acceptability, the staff concludes that SPP is the more favorable alternative from both economic and environmental considerations.

9.1.2.2 Alternative sites

Background

Each of the participants in the Sterling Nuclear Power Project were involved in individual siting efforts for possible power plants prior to joining the Sterling Project. Both Central Hudson Gas and Electric Corporation (CH) and Orange and Rockland Utilities Incorporated (O&R) had evaluated and selected sites for possible coal- and oil-fueled power plants prior to their participation in Sterling. Niagara Mohawk was involved in siting studies for a large nuclear or fossil plant relating to the construction permit application for Nine Mile Point Nuclear Station Unit 2. Each utility had the following basic criteria for candidate areas: (1) water availability, (2) land availability, (3) transportation facilities, and (4) transmission facilities. CH studied three sites in the Hudson River Valley and chose one on the Hudson River for further environmental evaluation. In May 1972, the Terry Brickyard Site was purchased by CH for possible use as an oil-fired 800-MW power plant. During 1973, due to uncertain energy resources and economics, CH joined with O&R in joint planning of a dual-fuel (coal and oil) power plant.

O&R began site selection in 1971. Five areas were chosen — the Hudson River Valley, Neversink River, Lower Mongaup River, Upper Mongaup Region, and Central Division. Both surface water and groundwater source sites were initially considered, but groundwater sources were later eliminated as not being adequate. Fourteen sites were studied by O&R, with final analysis reduced to two sites by 1974. (For additional details, see ER, Sect. 9.2.2.1 and 2.2.2.2.)

In considering whether sites identified by these two utilities within their service areas might be better than the Sterling site for large nuclear power stations, the staff examined Phase I of the Nuclear Power Siting Program of the New York State Atomic & Space Development Authority. This was a state-wide survey whose purpose was to identify regions in which large (1,000 MWe or greater) nuclear power stations could be located. This report identified seven areas within which the most suitable sites existed for nuclear power stations. These seven areas included the shore of Lake Ontario within New York State and the Hudson River south of Poughkeepsie and north of Tarrytown (except for the vicinity of Newburgh, Beacon, and Peekskill). Both of these areas are also within the western and southeastern portions of New York State which the Phase I report identified as areas in which sites were to be sought, where practicable, in view of projected load growth and facility retirement objectives of the New York Power Pool. Except for the above-mentioned section of the Hudson River, the report did not identify any other water sources within the Orange and Rockland Utilities, Inc. or Central Hudson Gas and Electric Corporation service areas as possibilities for preferred site locations for a 1,000 MWe nuclear power station. It should be noted that the report's restriction with regard to the Hudson River south of Poughkeepsie eliminates the three prime sites identified by the Central Hudson Gas and Electric Corporation during its site surveys; these were all north of Poughkeepsie. The two preferred candidate sites identified by Orange and Rockland Utilities, Inc. in their site-selection studies, Lovett and Bowline Point, are on the Hudson River below Poughkeepsie and thus are in a suitable areas as defined by the New York State Nuclear Power Siting Program. The April 1, 1976, "Long Range Generation and Transmission Plan" by member electric systems of the New York Power Pool and the Empire State Electric Energy Research Corporation indicated (at page 73) that only two estuarine reaches of the Hudson River were considered potentially suitable for power plants with once-through cooling systems; these were between milepoints 125 and 70, and between milepoints 30 and 0. Since Bowline and Lovett are a milepoints 37.5 and 41.5, respectively, it would appear that these locations are not recommended for power stations with once-through cooling.

Niagara Mohawk became an owner in the Sterling Project after the site had been selected and did not conduct a search for an alternate site specifically for this application. However, as a result of an agreement among six New York State Utilities to share ownership in three generating units (Oswego Unit 6, Nine Mile Point Unit 2, and Sterling Nuclear Unit No. 1), Niagara Mohawk has been able to reduce 500-MW from its exclusive needs in the 1978-1984 time period (ER, p. 9.2-23). Niagara Mohawk's site survey for the Nine Mile Point Station included 12 sites: four on Lake Erie, three on Lake Ontario, three on the Saint Lawrence River, and two in the Hudson Valley.

Of the sites studied by Niagara Mohawk in the Nine Mile Point review, the four Lake Erie sites (Ripley, Dunkirk, Huntley and Tonawanda) and the Hudson Valley sites (Easton and Albany) would not support once-through cooling. These sites along with the three Saint Lawrence River sites (Morristown, Waddington and Rooseveltown) and the Stony Point site on the eastern shore of Lake Ontario would require extensive transmission distances to the load centers of the member utilities. In addition, it is questionable whether the Stony Point site could support open cycle cooling due to the shallower water along the eastern shore of the lake. The two remaining sites, Olcott and Nine Mile Point, are not considered by the staff to be preferable alternatives because of the uncertainty of the SNUPPS design being able to accommodate a higher g value that probably would be associated with the Olcott site, and because of uncertainties regarding the ability of the Nine Mile 2 site to accommodate a fourth large plant using once through cooling without adversely affecting the aquatic biota in the area.

The staff has reviewed the alternate sites for NM (Nine Mile Point Unit 2), CH, and O&R and concludes that none of them represent a more desirable alternative than the Sterling Site. Most of the sites would either require extensive transmission systems for offsite distribution of power or cooling towers for heat dissipation; both would add significantly to the cost of the project.

RG&E started an area survey in 1968-1969 for potential plant sites. The basic criteria was that the eventual site could support a 1000-MW power plant with the preferred plant being (1) nuclear, (2) coal-fueled, (3) oil-fueled.

Twenty-seven sites in five general regional areas were chosen for evaluation. With cooperation of the New York State planning groups, the site selection process was finally reduced to two sites, Sterling and Ginna, both of which are on the south shore of Lake Ontario. (For detail , see ER, Sect. 9.2.2.3.)

Sites

In the initial evaluation of sites, RG&E chose 27 preliminary sites for study on the basis of a broad evaluation of water sources, land area, and availability of transportation facilities. The 27 sites were grouped in five distinct geographic areas:

(1) Lake Ontario (6 sites),

(2) Lower Genesee River (7 sites),

(3) Finger Lakes Area (2 sites),

(4) Central Genesee River (7 sites),

(5) Upper Genesee River (5 sites).

The applicant conducted a four-phase study of the sites. The results of the studies are shown in Table 9.2. After each phase of the study, the number of sites for evaluation was reduced, with only three sites remaining at the end of the study. The sites chosen were Site 22 (Boller Point), Site 26 (Sterling), and Site 27 (Ginna). Because the Boller Point site area is principally

715 172

~~721 113~~

Table 9.2. Alternative site evaluation[a]

Siting factor	Site number																												Remarks
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26A	26B	27	
Phase I (27 sites)																													
Water availability (1000-MW fossil or nuclear)	0	3	3	3	3	3	0	0	0	3	3	3	3	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	Sites 26A and 26B counted as one; 16 of 27 sites eliminated from study.
Other hydrologic factors (flood plain, topography, etc.)	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	
Population distribution within 10 miles	All are favorable																												
Land use (extensive relocation of facilities)	All are favorable except site 15																												
Regional geologic, seismic, and groundwater conditions	All are favorable																												
Phase II (11 viable sites)																													
Special land uses within 2000 ft								0	0							0		0		0		0	0	0	0	0	0	0	Sites 26A and 26B counted as one; no sites eliminated.
Land uses within 5 miles (parks, schools, airfields, etc.)								0	0							0		0		0		0	0	0	0	0	0	0	
Historic or archaeological sites (10 miles, preliminary evaluation)								0	0							0		0		0		0	0	0	0	0	0	0	
Population characteristics (10 miles, rural vs incorporated)								0	0							0		0		0		0	0	0	0	0	0	0	
Phase III (7 most viable sites)																													
Geology, seismology								0	0							2		2		0		0	0	0	0	0	0	0	Sites 26A and 26B counted as one; sites 20, 22, 23, 24, 25, 26A, 26B, and 27 remain.
Groundwater characteristics								2	2							0		0		0		0	0	0	0	0	0	0	
Phase IV (3 most viable sites)																													
Terrestrial biology																													
Rare or endangered species																				0		0	0	0	0	0	0	0	Sites 22, 26A, and 27 the most suitable sites.
Habitat diversity and managed areas																				3		0	2	2	2	1	2	0	
Aquatic biology																				3		0	0	0	0	0	0	0	
Diffusion characteristics																				3		0	0	0	0	0	0	0	
Present and future land uses (within 5 miles)																				0		0	0	0	0	0	0	0	
Historical/archaeological significance of site																				1		1	1	0	1	0	0	0	
Meteorology																				1		0	0	0	0	0	0	0	
																						x				x		x	Suitable sites.

[a] Key to ranking: 0 – favorable; 1 – unfavorable; 2 – unacceptable; 3 – prohibitive.

Source: ER, Appendix 9A, Table A.5.

715 173

721 114

owned by an upstate university and is being used for agricultural experimentation, that site was eliminated, leaving the Sterling and Ginna sites for final consideration. The following is a summary of the major considerations in the Sterling-Ginna site selection.

General setting and land use. Both sites are mainly rural, low population density areas located on the south shore of Lake Ontario. The major local land use is agricultural, and forest is present at both sites. The Ginna site is smaller and currently has a 490-MWe nuclear unit.

Demography. Both sites are in low population density areas; however, the current and projected populations are greater for the Ginna site than for the Sterling site.

Water. Both sites are served by Lake Ontario, and due to the relative proximity of the two sites, they are essentially equivalent in terms of water supply.

Geology and seismology. Both sites are suitable for a nuclear power plant with no distinct seismological differences between sites.

Meteorology. Both sites have very similar meteorological conditions with some differences due to local topographical and shoreline orientation differences. Either location is acceptable from a meteorological standpoint.

Terrestrial considerations. Both sites are acceptable, although Sterling does have areas of wetland habitat that will be minimally affected by the power plant construction and operation.

Aquatic habitats. Both sites appear similar in aquatic ecology, and the impact at either site would probably be acceptable.

Transportation. Ginna has adequate transportation facilities due to the existing power plant. The Sterling site would need to establish rail and highway facilities, but both are available within a reasonable distance of the site. Both sites will require onsite transportation construction.

Aesthetics. The Ginna site is smaller and flatter, with less natural cover. The Sterling site would offer greater natural reduction in the visual impact of a plant from the landward direction owing to the rolling hills and vegetation. The two sites would be equivalent from a lake-oriented visual standpoint.

Transmission facilities. Transmission system requirements are the most significant difference between the two sites. The Sterling site will require 8 miles of offsite transmission facilities. The Ginna site would require approximately 35 miles of new transmission corridor construction at a cost of approximately $21,000,000 Additional impacts would affect approximately 1100 acres needed for the transmission corridor at the Ginna site.

Atomic and Space Development Authority (ASDA). The State of New York has conducted a statewide assessment of potential nuclear power plant sites. The ASDA concluded that the Lake Ontario region was a prime area for siting of nuclear power plants. Further specific site-oriented studies by ASDA have concluded that the Sterling site is a prime site for nuclear power generating facilities.

Table 9.3 summarizes the important characteristics of the Ginna and Sterling sites.

Conclusions

The applicant had evaluated several regions and sites prior to choosing the Sterling site. The study considered surface water hydrology, population, land use, regional geology, groundwater, seismic characteristics, terrestrial and aquatic biology, and meteorology. The staff believes that the methods and procedures used by the applicant for site selection are reasonable.

Table 9.3. Comparison of Ginna and Sterling sites

Feature	Ginna	Sterling
Population (1980, 5-mile radius)	7513	2778
Geology	Fault on site	Nearest fault 18 miles NE
	(Both faults are considered to be minor)	
Water source	Lake Ontario	Lake Ontario
	(Neither location would effect groundwater supply)	
Aquatic ecology	Similar impacts for both sites	
Terrestrial	Early stage habitats and orchards	Some wetlands and wooded swamp minimally affected by plant construction and operation
Additional costs	21 M for transmission lines	765-kV transmission line will pass through site; rail spur may be needed

The applicant has submitted an application to the New York State Board on Electrical Generation Siting and the Environment for a Certificate of Environmental Compatibility and Public Need for the Sterling site. The application was submitted, with detailed descriptions, in February 1975, and the New York State Siting Board is conducting hearings on the site selection.

The staff has studied RG&E's site selection process and the sites and concludes that either the Sterling or Ginna site is suitable for construction. The costs associated with locating the plant at the Ginna site would be higher because of additional transmission line costs. Additionally, the staff has considered the possibility of locating the proposed station within the service areas of the other participating utilities and concludes these alternative sites do not offer a more desirable alternative from an environmental viewpoint. The sites reviewed would either require extensive transmission systems or cooling towers, both adding to the development cost over that required for the Sterling site. Therefore, the staff concurs in the applicant's selection of the Sterling site.

9.2 ALTERNATIVE PLANT DESIGNS

9.2.1 Alternative cooling systems

The applicant has discussed wet natural-draft cooling towers, wet-dry mechanical-draft cooling towers, wet mechanical-draft cooling towers, dry cooling towers, spray canals, and a cooling pond as alternative cooling systems (ER, Sects. 10.1 and 10.10).

9.2.1.1 Wet natural-draft cooling towers

Although the applicant believes that a single wet natural-draft tower is the most desirable alternative, no detailed design has been proposed. Instead, the applicant has mentioned two similar preliminary designs, here designated A and B, whose parameters are tabulated in Table 9.4. Tower A is described partially in the ER, Sect. 10.1.3.2, and partially in Part 73 of the nuclear unit *Application to the New York State Board on Electric Generation Siting and the Environment.*[25] This document is not referenced in the ER, Sects. 10.1 or 10.10. Tower B, the most recent design, is described in the applicant's response to Item 520.16. At some places in Sect. 10.10 of the ER, the applicant uses predictions made for yet another system — a two-tower system for a 1200-MWe coal-fired plant described in the Sterling Power Project Cooling Tower Report.[26] Because none of these systems has been discussed in a complete manner, the staff has attempted to draw upon each treatment to consider the entire range of impacts.

According to the applicant, Tower A will require the clearing of more land (16 acres) and cost more ($33,293,000, present worth) than the proposed system.

The aesthetic impact of natural-draft towers will be considerable. The structures will be visible for many miles in all directions. They will be visible from the lake and from Fair Haven Beach State Park. During many hours, a visible plume will result in even larger impacts. In Ref. 25, the applicant has used a modified Gaussian plume dispersion model to calculate the increase in relative humidity due to the plume. This calculation was performed every hour for one year using weather data recorded at the Sterling meteorological tower from May 13, 1973 to May 13, 1974. Whenever the relative humidity at some point reached 100%, a visible plume was assumed to exist at that location. Figure 9.1 shows the expected number of hours during which the plume will be visible overhead at locations within a 5-mile radius of Tower A. The calculation reveals that a visible plume would have extended 5 miles to the east for about 110 hr in 1973-1974. To predict the number of additional hours of ground fog due to tower operation, the applicant has counted

Table 9.4. Natural-draft cooling tower design parameters

	Tower A[a]	Tower B[b]
Wet-bulb temperature, °F	68	75
Range, °F	30	27.7
Approach, °F	18	15
Heat rejection rate, MWt	2417	2303
Water flow rate, cfs	1227	1267
Water/air mass flow ratio		1.807
Evaporation rate, cfs	29.6	29.4
Drift rate, %	0.003	0.002
Exit air temperature, °F		109.9
Exit air velocity, fps	12.5	18
Height, ft	492	500
Exit diameter, ft	276	220
Basin water TDS, ppm	800	570[c]
Cycles of concentration	2	3[d]
Makeup rate, cfs	42.9	44.1[c]
Blowdown rate, cfs	13.4	14.7[c]

[a] ER, Sect. 10.1.3.2; Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 73, February 1975.

[b] ER, Response to Item 520.16.

[c] Staff calculated values.

[d] Assumed.

the number of hours when the visible plume extended to ground level. Realistic topography was used in this calculation, but no hours of ground fog were predicted. Because the visible plume is never expected to reach the ground, icing of ground level structures due to fog is not expected.

To estimate the impacts due to drift from Tower A, the applicant used a model that approximately follows the trajectory of different-sized particles from the drift eliminators until they impact the ground. These trajectories were calculated hourly, using the one-year onsite weather record mentioned earlier. The effects of varying ground elevation were considered. The drift particle spectrum assumed by the applicant is listed in Table 9.5. Figure 9.2 shows the predicted annual average salt deposition out to 2 miles, and Fig. 9.3 shows the same quantity within a 10-mile radius. A maximum salt deposition of about 8.6 lb/acre-year is expected 0.5 mile ESE of the tower. The staff has checked these results by means of the Oak Ridge Fog and Drift code (ORFAD),[27] which uses a similar analytical description of particle trajectories but does not account for topography. This code calculated the drift occurring every hour on the basis of weather data recorded from 1959 to 1969 at Rochester, New York. The results exhibited order of magnitude agreement with the applicant's numbers. The staff then calculated the expected annual average drift resulting from Tower B, using ORFAD with Rochester weather and the drift particle spectrum presented in Table 9.6. As anticipated, the amount of salt deposited by Tower B was somewhat lower than for Tower A. Figure 9.4 shows the calculated distribution. The maximum deposition was 2.4 lb/acre-year 0.5 mile NE of the tower. The staff concurs with the applicant that drift rates of this magnitude should cause no measurable harm to the vegetation or the groundwater.

Using the same model described in the preceding paragraph, the applicant has prepared Figs. 9.5 and 9.6, showing the expected annual average airborne salt concentration at ground level from Tower A. The maximum annual average salt concentration is predicted to be 0.02 $\mu g/m^3$ about 0.5 mile E of the tower. The staff's annual average airborne salt concentration predictions for Tower B, obtained using ORFAD, are shown in Fig. 9.7. Again, the numbers are lower than the applicant's. The maximum predicted value is 0.01 $\mu g/m^3$ 0.5 mile NE of the tower. Either prediction is considerably below the annual average New York State and Federal Secondary Ambient Air Quality Standards of 55 and 60 $\mu g/m^3$ respectively.

The applicant's drift model also predicts icing due to drift. According to this model, ice accumulation due to drift will never exceed 0.025 cm at any ground level location.

Unacceptable noise due to the cooling towers is estimated to extend 2500 ft from the source. No unacceptable noise will occur beyond the applicant's property, and no residents will be affected.

On the basis of Ginna experience, the applicant estimates that the reduced makeup requirements of Tower A will result in the impingement of about 21,000 lb of fish and the fatal entrainment of 10^5 lb of plankton annually.

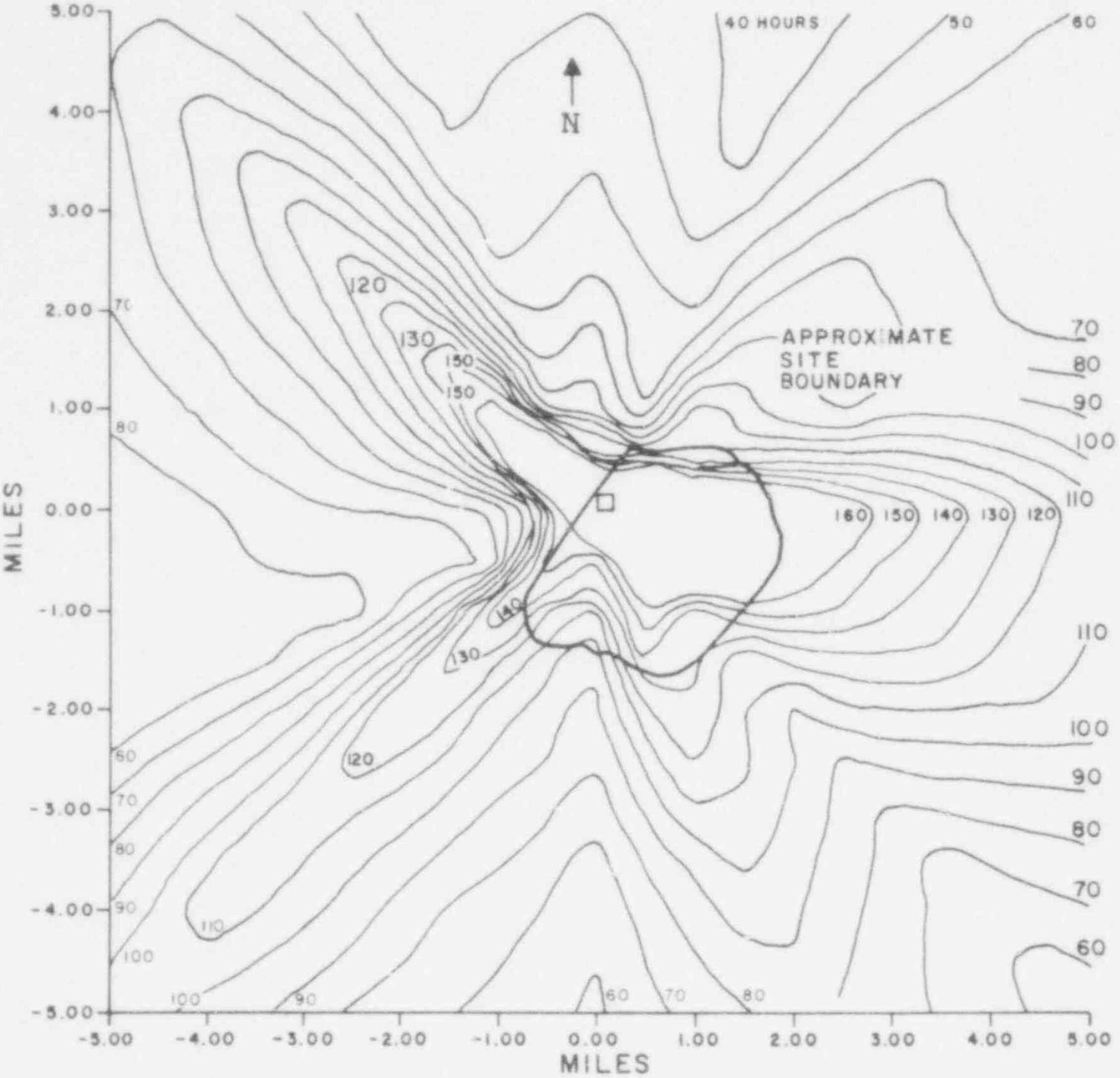


Fig. 9.1. Applicant's prediction of number of hours visible plume extends downwind (0 to 5 miles) in each direction for natural-draft Tower A. Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment*, Part 73, February 1975, Fig. 73.4-1-1.

Table 9.5. Natural-draft tower drift particle size distribution used by applicant

Nominal diameter (μm)	Weight fraction
50	0.50
100	0.06
150	0.02
200	0.03
280	0.10
450	0.29

Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 73, February 1975, Table 73.4-13.

~~721 118~~

715 177

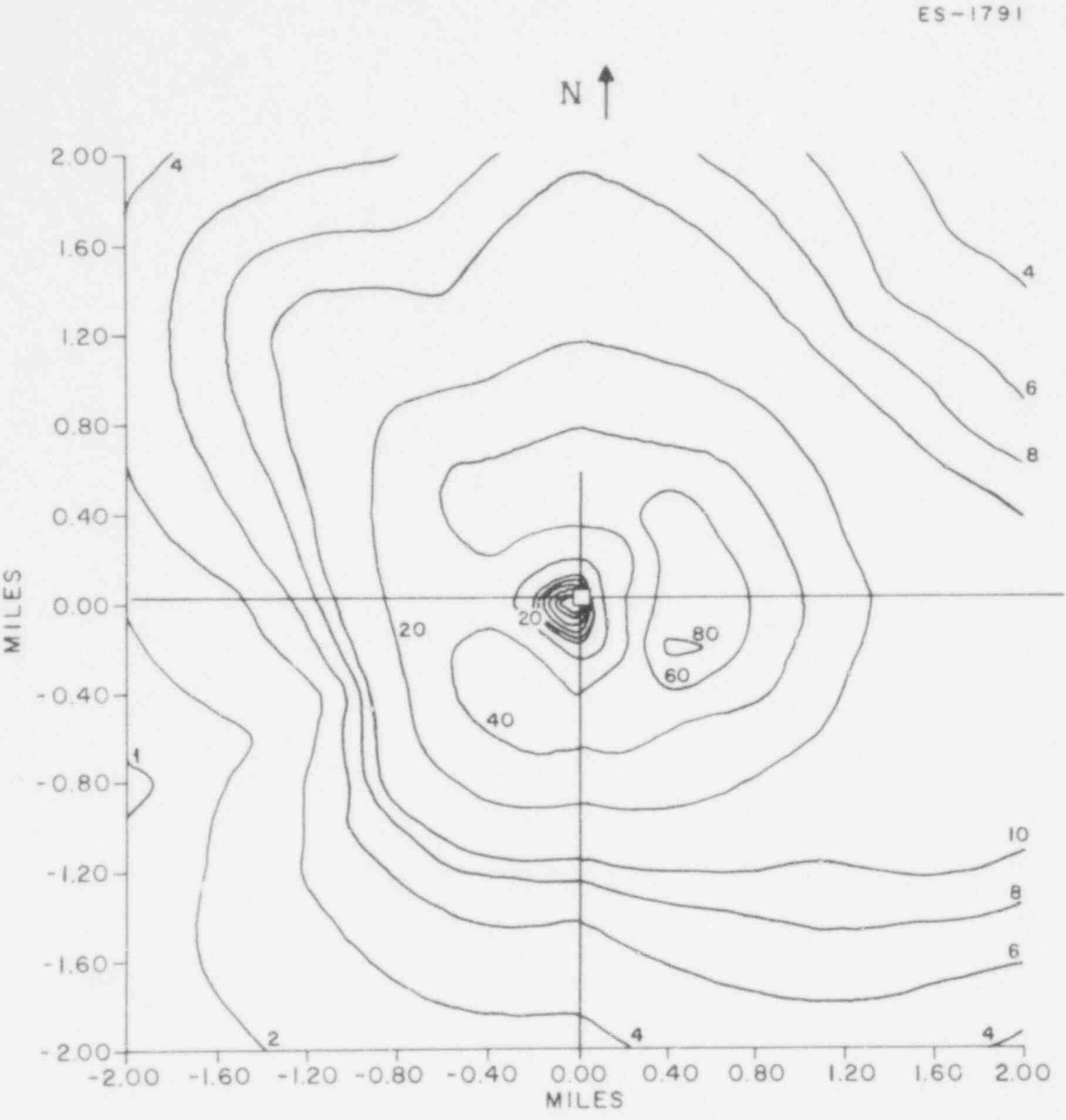


Fig. 9.2. Applicant's prediction of annual average ground-level dry deposition rates (kg/km^2/month) of salt for natural-draft Tower A, 0 to 2 miles. Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment*, Part 73, February 1975, Fig. 73.4-1-5.

Using the method described in Sect. 5.3.1, the applicant estimates that the surface area of water in the blowdown plume having an excess temperature of 3°F will range from 7.2 to 48 acres. As discussed in Sect. 5.3.4, the staff believes that this method adequately predicts the range of areas to be expected. The chemical composition of the blowdown will meet applicable State and Federal standards.

9.2.1.2 Wet-dry mechanical-draft cooling towers

In the response to Item 520.16, the applicant states that wet-dry mechanical-draft towers are not a viable alternative. The applicant has not presented a conceptual design for this system, although a few parameters have been given. Most of the limited numerical predictions are based on a preliminary design for a 1200-MWe coal plant presented in Ref. 26.

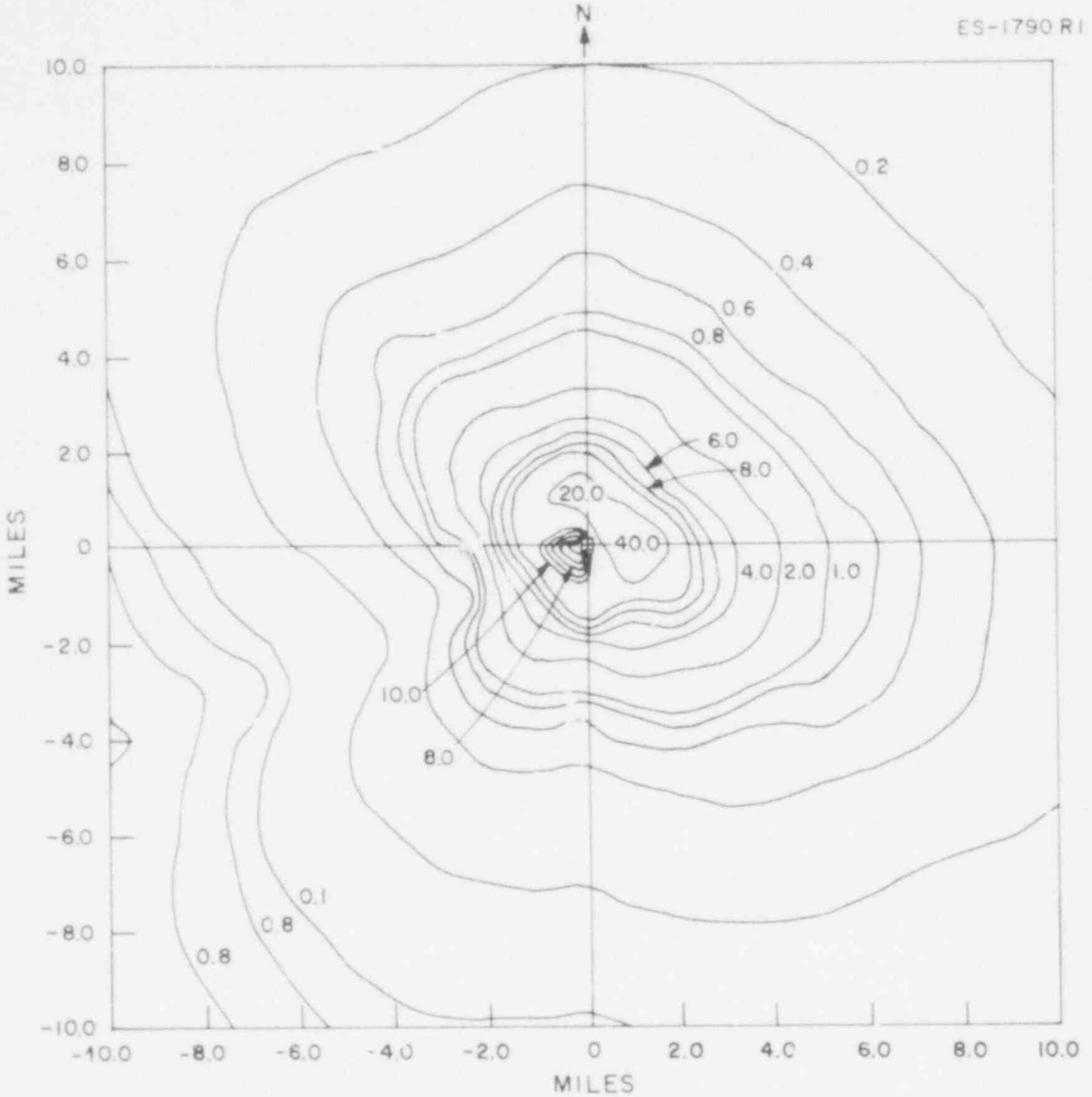


Fig. 9.3. Applicant's prediction of annual average ground-level dry deposition rates (kg/km^2/month) of salt for natural-draft Tower A, 0 to 10 miles. <u>Source</u>: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment*, Part 73, February 1975, Fig. 73.4-1-6.

The applicant estimates that 13 acres of additional land would need to be cleared, compared with the once-through design. The present worth of wet-dry towers in excess of the proposed system is $55,038,000.

The aesthetic impact of these towers would be less than for natural-draft towers. The structures would be less than 100 ft in height and would probably not be visible from land areas off site. Ground fog and consequent icing could be eliminated by operation of the dry section of the tower. The occurrence of visible plumes aloft could be restricted in a similar manner.

Drift deposition from the wet-dry towers will exceed that from natural-draft towers because of a higher anticipated drift rate (0.004%) and because of the lower tower elevation. The applicant expects a maximum deposition of about 98 lb/acre-year 1600 ft from the towers. The staff concurs with the applicant that drifts of this magnitude will not adversely affect either vegetation or groundwater. The maximum annual average airborne salt concentration at ground level is estimated to be 0.15 $\mu g/m^3$, which is far below applicable standards. Icing due to drift of ground level objects should never exceed 0.025 cm at any location.

715 179 ~~721 120~~

Table 9.6. Natural-draft tower drift particle size distribution used by staff[a]

Mean diameter (μm)	Weight fraction
20	0.04
60	0.29
100	0.21
140	0.13
180	0.11
250	0.15
350	0.05
450	0.02

[a] F. M. Shofner *et al.*, "Measurement and interpretation of drift particle characteristics," presented at Conference on Cooling Tower Environment – 1974, University of Maryland, March 4–6 1974.

The applicant predicts unacceptable noise 5000 ft from the towers. This noise would affect about 40 residents along the northern property line.

The thermal and chemical effects of the blowdown plume are expected to be somewhat smaller than those from the natural-draft alternative.

9.2.1.3 Wet mechanical-draft cooling towers

No conceptual design for a wet mechanical-draft cooling system has been given. The applicant does not believe these are a viable alternative because of the potential for 100 to 200 hr of additional ground fog per month.[28] Except for the consequences of the vapor plume, the other impacts of wet mechanical-draft towers will be similar to the wet-dry alternative.

9.2.1.4 Dry mechanical-draft towers

Dry cooling towers remove heat from a circulating fluid through radiation and convection to air being circulated past the heat exchanger tubes. Because of the poor heat transfer properties of air, tubes are generally finned to increase the heat transfer area. The theoretical lowest temperature that a dry cooling system can achieve is the dry-bulb temperature of the air. The dry-bulb temperature is always higher than the wet-bulb temperature, which is the theoretical lowest temperature that a wet cooling tower can achieve. Turbine back-pressures will be increased, as will the range of back-pressures over which the turbines must operate. This will result in a reduced station capability for a reactor of a given size.

Dry tower systems are of three different types:

(1) Smaller units (up to 300 MW) in which steam is ducted from the turbine to the heat exchanger for direct steam condensing can be built. Very large ducts, operating under substantial vacuum and distributing steam over a large heat exchanger area, make this system impractical for large nuclear facilities.[29]

(2) Direct-contact systems in which the cooling water and steam mix in a direct-contact condenser can be built. This system requires a significant increase in water treatment and storage costs, since the entire cooling system uses steam-generator-quality water.[29]

(3) Depending on turbine design, conventional surface condensers (but larger) or multipressure (zoned) surface condensers can also be used, with the dry tower replacing the wet tower in a system similar to existing wet tower systems. These systems do not require steam-generator-quality water. At this time, this is probably the most practical system to consider for large power plants.[30]

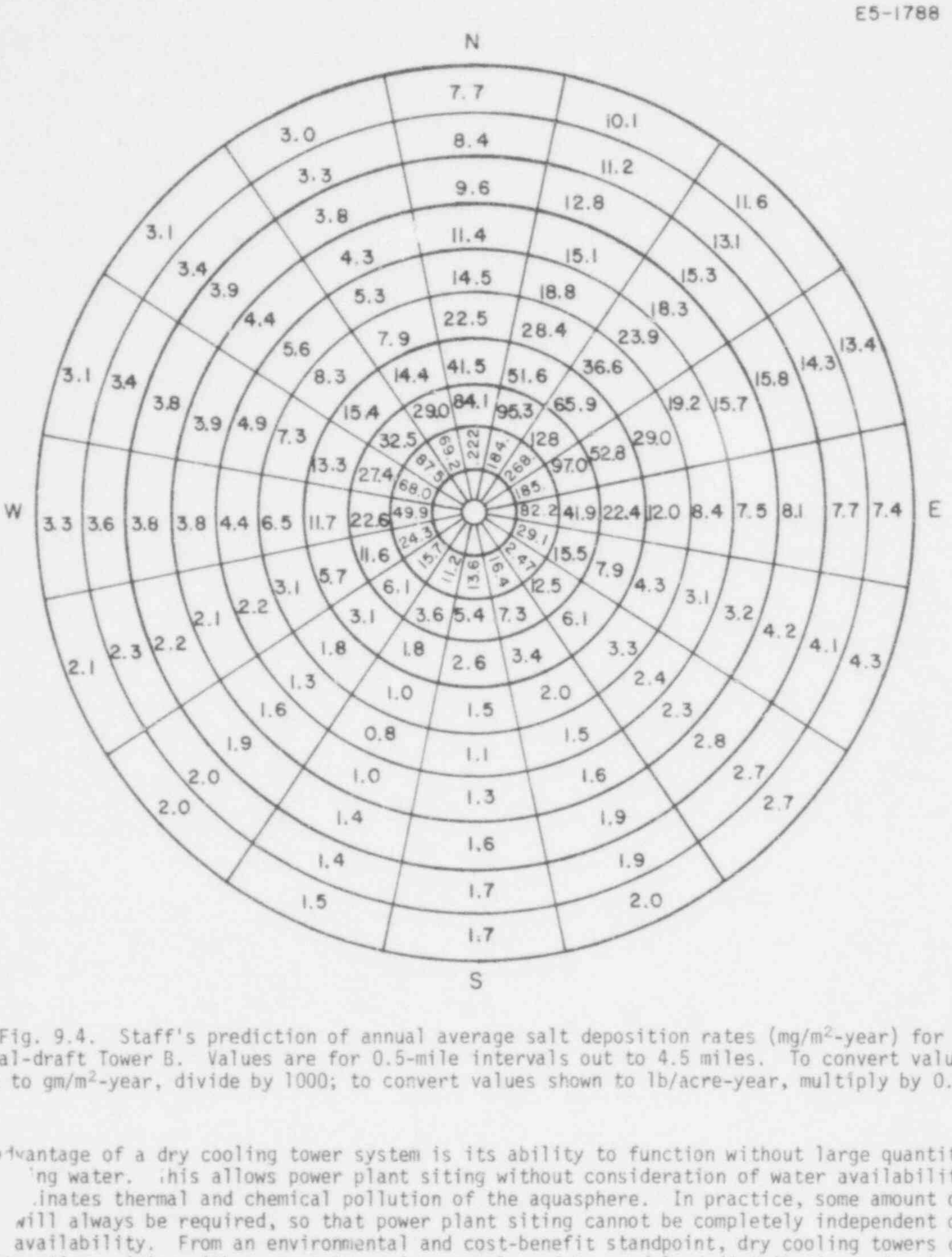


Fig. 9.4. Staff's prediction of annual average salt deposition rates (mg/m^2-year) for natural-draft Tower B. Values are for 0.5-mile intervals out to 4.5 miles. To convert values shown to gm/m^2-year, divide by 1000; to convert values shown to lb/acre-year, multiply by 0.00893.

The advantage of a dry cooling tower system is its ability to function without large quantities of cooling water. This allows power plant siting without consideration of water availability and eliminates thermal and chemical pollution of the aquasphere. In practice, some amount of water will always be required, so that power plant siting cannot be completely independent of water availability. From an environmental and cost-benefit standpoint, dry cooling towers can permit optimum siting with respect to environmental, safety, and load distribution criteria without primary dependence on a supply of cooling water. When considered as a direct alternative to wet cooling towers, the advantages of dry cooling towers include elimination of drift problems, fogging and icing, and blowdown disposal.

The principal disadvantage of dry cooling towers is economic: for a given reactor size, plant capacity can be expected to decrease by about 5 to 15% depending on ambient temperatures and assuming an optimized turbine design.[30] Bus-bar energy costs are expected to be on the order of 20% more than a once-through system and 15% more than a wet cooling tower system, assuming 1980 operation.[30] Environmentally, the effects of heat releases from dry cooling towers have not yet been quantified; some air pollution problems may be encountered; noise generation problems for mechanical-draft towers will be equivalent or more severe than those of wet cooling towers; and the aesthetic impact of natural-draft towers, despite the probable absence of a visible plume,

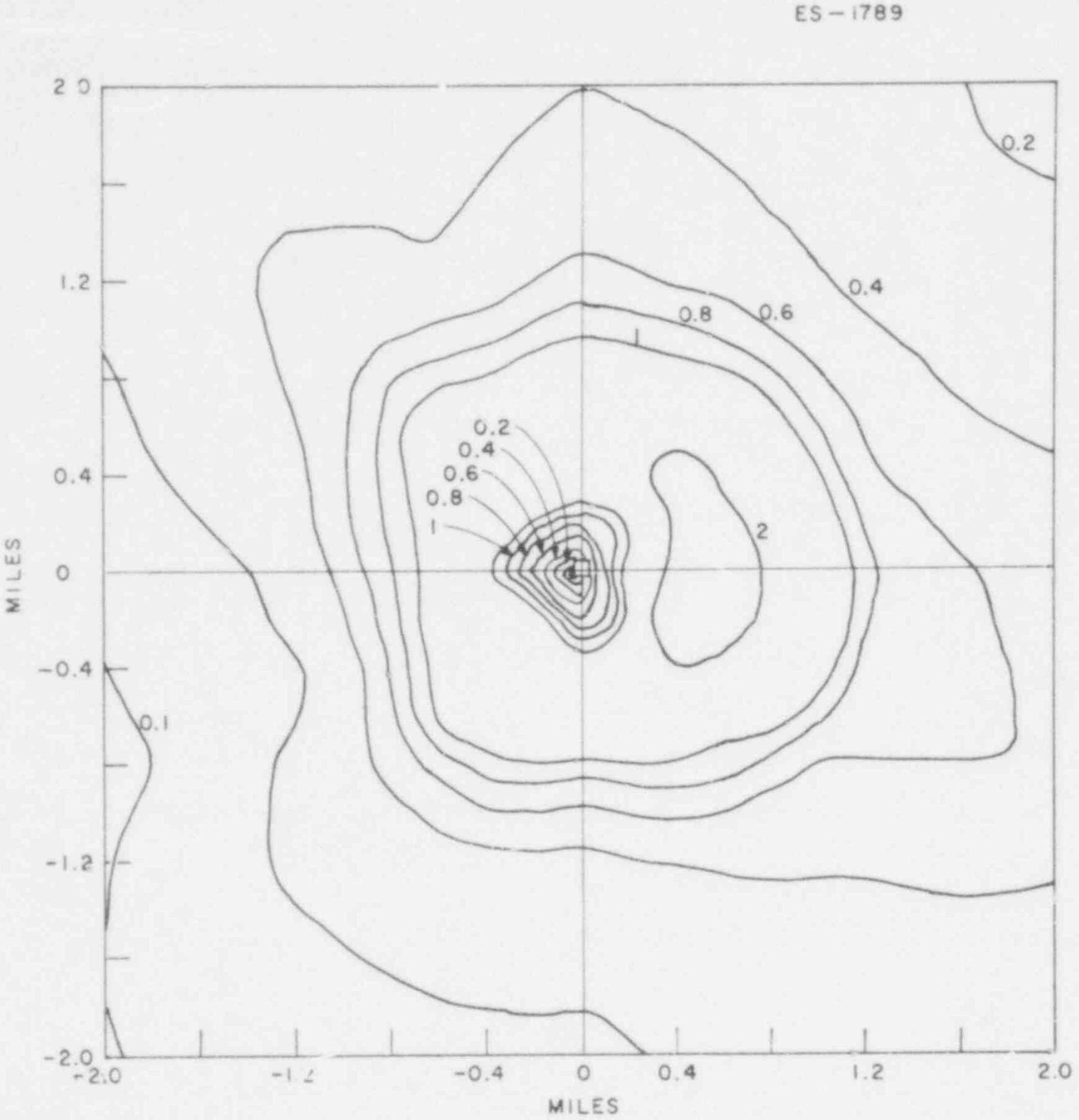


Fig. 9.5. Applicant's prediction of annual average near-ground airborne concentration of salt for Tower A, 0 to 2 miles. Divide numbers by 100 to obtain micrograms per cubic meter. Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment*, Part 73, February 1975, Fig. 73.4-1-7.

will remain. Dry cooling towers now being used for European and African fossil plants are limited to plants in the 200-MW or smaller category; the use of dry towers to meet the much larger cooling requirements of 1000-MW nuclear stations requires new turbine designs to achieve optimum efficiencies at the higher back-pressure and range required of this system.[31]

Mechanical-draft dry cooling towers can be constructed as a series of interconnected modules. Selection of tower layout will be controlled by plant layout, terrain, piping requirements, etc. The total land area required will be larger than that required by equivalent wet cooling towers; however, there should be no recirculation problem with dry cooling towers, so that total plant areas required for cooling towers may not be too dissimilar for wet and dry towers.[29] Total area and numbers of modules will also be influenced by the type of module selected. For a single-fan design, assuming a 60-ft-diam fan and a module area of about 9200 ft^2, the staff estimates that about 40 to 50 modules would be required for a 1000-MWe unit. Thus, a total area of about 10 acres per unit would be used, which probably represents a minimum area design. Additional area will be required for maintenance access, piping runs, clearance, condensate storage tanks, etc.

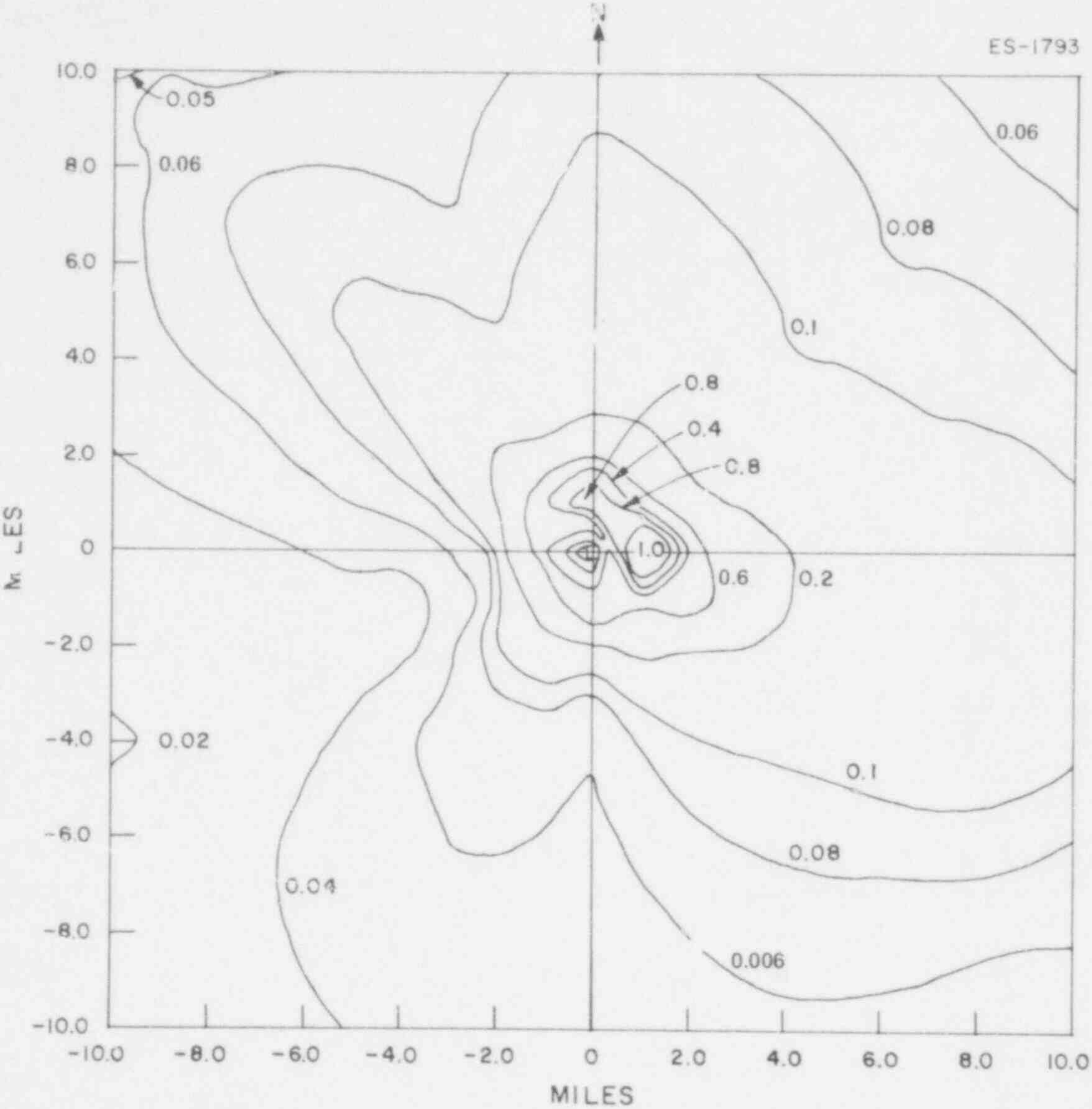


Fig. 9.6. Applicant's prediction of annual average near-ground airborne concentration of salt for Tower A, 0 to 10 miles. Divide numbers by 100 to obtain micrograms per cubic meter. Source: Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment*, Part 73, February 1975, Fig. 73.4-1-8.

After weighing the overall advantages and disadvantages of dry cooling towers, and particularly after comparing the economic penalty associated with their use with the environmental impact of the proposed once-through cooling system, the staff has concluded that dry cooling towers are not a practical alternative cooling method for the Sterling Power Project. The applicant has rejected dry towers for much the same reasons.

9.2.1.5 Spray canals

A spray canal for the Sterling plant would be at least 7500 ft long, 250 ft wide, and 8 ft deep. About 65 acres would have to be cleared and leveled for this system. Fogging, drift, and icing rates near such an installation would be high, although noise and visibility would be minimal. A spray canal system is unsuited to the site because of the severe local environmental impacts, questionable reliability, and increased costs.

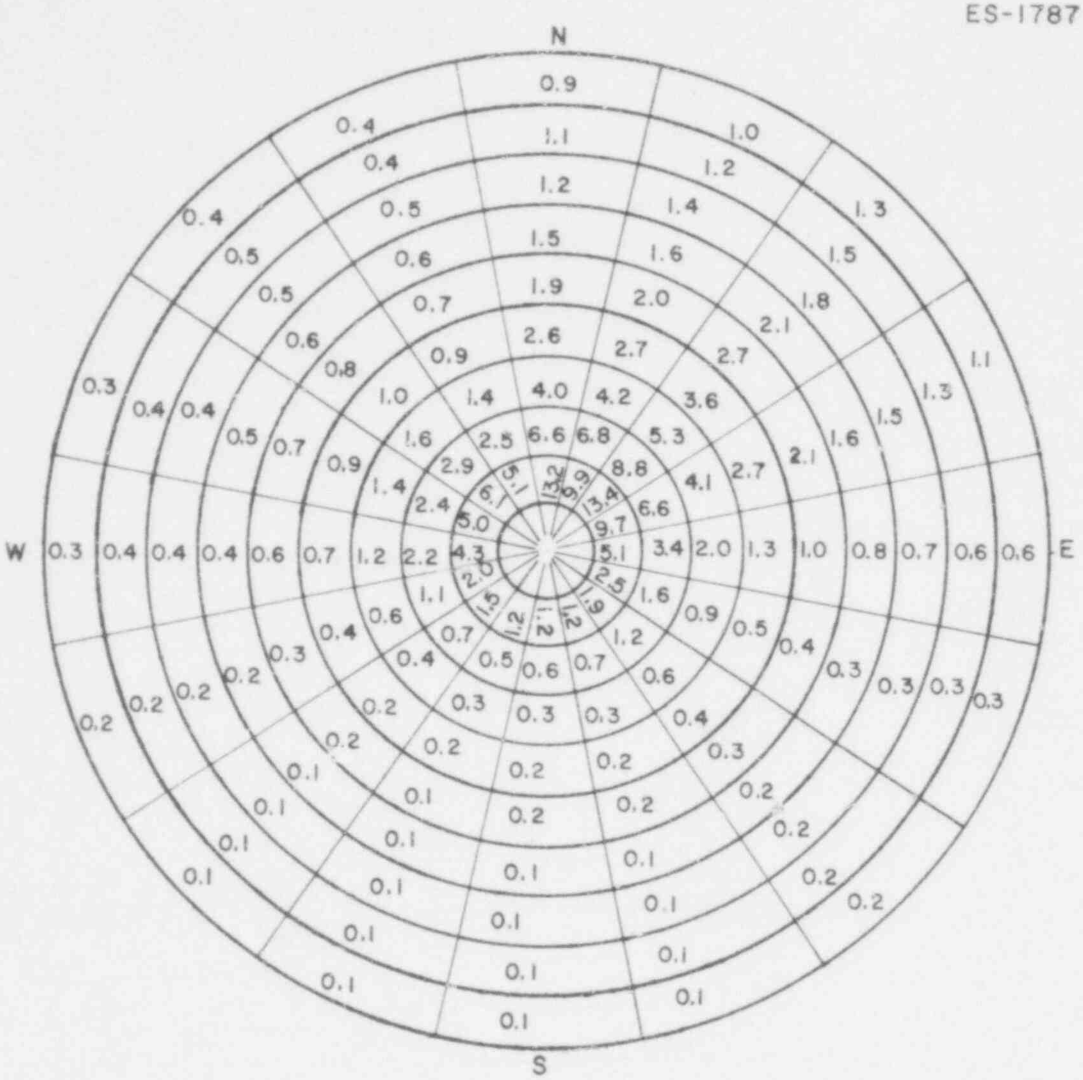


Fig. 9.7. Staff's prediction of annual average airborne salt concentrations (ng/m^3) at tower base elevation for natural-draft Tower B. Values are for 0.5-mile intervals out to 4.5 miles. To convert values shown to μg/m^3, divide by 1000.

9.2.1.6 Cooling pond

A cooling pond would require about 1800 acres or about 64% of the Sterling site. The logic of constructing such an artificial lake adjacent to a large natural lake would be questionable, and the cost would be excessive. This alternative is not viable.

9.2.2 Intake system

The applicant's discussion of alternative once-through intakes is based on a 1965 report[32] that considered possible intake systems for the Ginna Nuclear Power Plant. Ginna is located about 35 miles WSW of Sterling in a similar hydrological setting. The report considered three possible systems:

System A — submerged intake with tunnel under lake bottom;
System B — submerged intake with buried pipe; and
System C — surface intake protected by jetties.

System A was predicted to have excellent properties of economy and reliability and was recommended for plants of less than 1400 MWe. This type of system has operated satisfactorily for more than 5 years at Ginna and is the type proposed for Sterling. Similar designs are in use at other plants along the southeastern shore of Lake Ontario. The staff considers the basic design acceptable, but some modifications may be required if the staff finds that the proposed intake velocities are too high.

System B was found to be prohibitively expensive and was rejected by the applicant. The staff finds no advantage in the use of System B.

System C was recommended for plants larger than 1400 MWe because of economic reasons. This design would call for the construction of an intake pool, protected by jetties, in which the water temperature could be controlled by recirculation of the discharge. The effects of silting, ice accumulation, and wave damage would require an ongoing maintenance program. Scale model tests were deemed necessary to assure optimum design and reliability of the system. System C would result in a larger modification of the shoreline than would the proposed system and would probably entrain more plankton, which concentrate near the surface. The staff finds no reason to favor System C over the proposed system (System A).

9.2.3 Discharge system

The applicant presents a general, largely qualitative comparison of the proposed surface discharge with a submerged multiport diffuser in the ER, Sect. 10.3, Appendix 5A, and Appendix 10A. The submerged multiport diffuser would run 1000 ft parallel to the shoreline. It would be located 3000 to 4000 ft offshore and would have 10 to 12 risers carrying double nozzles 2 ft in diameter. The temperature rise would be about 30°F, and the flow rate would be on the order of 1300 cfs. The proposed system heats 1860 cfs by 19.3°F. Discharge velocity for the diffuser would be about 20 to 25 fps, compared with 3 to 4 fps for the surface discharge. Table 9.7 compares various aspects of the two systems. The applicant believes that the surface discharge would result in smaller environmental impacts, due to the smaller temperature rise, shorter residence times, and reduced velocities. The surface discharge would be simpler to build and operate and would provide more reliability than the submerged diffuser. The present worth of the diffuser is $37,542,000 more than the surface discharge. The power penalty associated with the diffuser would reduce plant output about 1 MWe, or 0.09% of the plant's output. The staff notes that both types of discharge have been used successfully in other plants along the southeastern shore of Lake Ontario — the surface discharge at Ginna and the diffuser at James A. Fitzpatrick Nuclear Power Plant. Either type would probably be acceptable at Sterling, but the staff cannot accurately assess their relative desirability from an environmental standpoint on the basis of available information. From an economic standpoint, the proposed discharge system is superior to the submerged diffuser.

9.2.4 Transmission line

The applicant did not consider alternative routes for the 8-mile 115-kV line that parallels the proposed 765-kV cross-state power line. In the staff's judgment, no other route would offer any significant advantages over the selected route.

Table 9.7. General comparison of surface and submerged discharge

	Surface shoreline	Submerged diffuser
Physical features	53-ft-wide X 200-ft-long discharge canal	10 to 12-ft-diam tunnel beneath lake bed for a distance of 3000 to 4000 ft; 1000 ft along header tunnel with 10 to 12 risers
ΔT	20°F	30°F
Water volume affected	4 times the discharge volume will be entrained	10 to 12 times the discharge volume will be entrained
System residence time	1 to 2 min between condenser and discharge point	10 to 15 min between condenser and discharge point
Water quality	No measurable effect	Same
Mechanical effects on entrained organisms	Small	Large due to pumping head required to overcome friction along tunnel length and to produce requisite discharge velocity
Construction disturbance	Minimum disturbance along small area of shoreline	Major disturbance along lake bed where many organisms reside
Capital cost	Base	$37.5 million more than base for surface discharge
Operating cost	~6800 HP required for pumping	~10,800 HP required for pumping; represents an increase of $360,000 per year over the surface discharge

Source: ER, Table 10.3-1.

REFERENCES FOR SECTION 9

1. Federal Power Commission, "Electric Power in the Southeast, 1970-1980-1990," Part II, *1970 National Power Survey*, April 1969, p. II-1-3.
2. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 72, Table 72.1-6, February 1975.
3. Niagara Mohawk Power Corporation, *Annual Report — Year Ended December 31, 1974.*
4. W. N. Peach, "The Energy Outlook for the 1980's," p. 9 in *A Study Prepared for the Use of the Subcommittee on Economic Progress of the Joint Committee of the Congress of the United States*, U.S. Government Printing Office, Washington, D.C., December 17, 1973.
5. G. G. McGlamery and R. L. Torstricky, "Cost Comparison of Flue Gas Desulphurization Systems," TVA Muscle Shoals, Alabama, Flue Gas Desulphurization Symposium sponsored by EPA Atlanta, Georgia, November 4-7, 1974.
6. Promulgated under Section III of the 1970 Amendment to the Clean Air Act.
7. Federal Power Commission, *The 1970 National Survey — Part II*, U.S. Government Printing Office, Washington, D.C., 1971, p. II-2-21.
8. Advisory Committee on Power Plant Siting, *Electric Power in Texas*, Office of the Governor, Division of Planning Coordination, Austin, Texas, November 1972.
9. U.S. Council of Environmental Quality, *Energy and the Environment, Electric Power*, U.S. Government Printing Office, Washington, D.C., August 1973.
10. National Petroleum Council, *U.S. Energy Outlook — Fuels for Electricity*, 1973, p. 17.
11. Federal Power Commission, *Hydroelectric Power Resources of the United States, Developed and Undeveloped*, January 1, 1972.
12. NSF/NASA Solar Energy Panel, *An Assessment of Geothermal Energy Resource*, December 1972.
13. E. R. G. Eckert and R. N. Schmidt, "Solar Energy — Thermal Conversion," pp. 42-45 in *Energy, Environment, Productivity, Proceedings of the First Symposium on RANN: Research Applied to National Needs, Washington, D.C., November 18-20, 1973*, National Science Foundation.
14. F. R. Eldridge, *Wind Machines*, Report NSF-RA-N-75-051, October 1975.
15. D. D. Teague, Energy Research and Development Administration, personal communication, March 23, 1976.
16. Energy Research and Development Administration, *A National Plan for Energy Research, Development, and Demonstration*, Report ERDA-48, June 28, 1975, vol. 2, p. 34.
17. "Energy Research and Development — An Overview of our National Effort," *Hearing before the Subcommittee on Energy of the Committee on Science and Astronautics*, U.S. House of Representatives, 93rd Congress 1st Session, Statement of H. G. Stever, Director, National Science Foundation, May 15, 1973, p. 4.
18. "Environment," *Electrical World*, p. 108, October 15, 1974.
19. "State to Recycle 85% of Cities' Solid Wastes," *Engineering News-Record*, pp. 39-40, Oct. 17, 1974.
20. National Science Foundation/National Aeronautic and Space Administration Solar Energy Panel, *An Assessment of Solar Energy as a National Energy Resource*, Report No. NSF/RANN-73-001, U.S. Government Printing Office, Washington, D.C. 20402, December 1972, p. 26.
21. *CONCEPT: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Status Report*, USAEC Report WASH-1180, April 1971.
22. R. C. DeLozier, L. D. Reynolds, and H. I. Bowers, *CONCEPT: Computerized Conceptual Cost Estimates for Steam-Electric Power Plants — Phase I User's Manual*, USAEC Report ORNL-TM-3276, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 1971.

23. H. I. Bowers, R. C. DeLozier, L. D. Reynolds, and B. E. Srite, *CONCEPT II: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Phase II User's Manual*, USAEC Report ORNL-4809, Oak Ridge National Laboratory, Oak Ridge, Tennessee, April 1973.

24. Environmental Protection Agency, *Development Document for Proposed Best Technology Available for Minimizing Adverse Environmental Impact of Cooling Water Intake Structures*, December 1973.

25. Rochester Gas and Electric Corporation, *Application to the New York State Board on Electric Generation Siting and the Environment (Nuclear)*, Part 73, February 1975.

26. Rochester Gas and Electric Corporation, *The Sterling Power Project Cooling Tower Report*, Rochester, New York, August 1974.

27. J. V. Wilson, *ORFAD, A Computer Program to Estimate Fog and Drift from Wet Cooling Towers*, ORNL-TM-4568, Oak Ridge National Laboratory, Oak Ridge, Tennessee, January 1975.

28. C. L. Hosler, "Fogging Potential Study for Rochester Gas and Electric Plant Near Oswego," Letter Report from Gilbert Associates, Inc., to Rochester Gas and Electric Corporation, Rochester, New York, February 12, 1972.

29. R. W. Beck and Associates, *Cost Comparison of Dry-Type and Conventional Cooling Systems for Representative Nuclear Generating Plants*, TID 26007, March 1972.

30. K. A. Oleson et al., *Dry Cooling for Large Nuclear Power Plants*, Westinghouse Electric Corporation Power Generation Systems Report, Gen-72-004, February 1972.

31. G. J. Silvestri and J. Davids, "Effects of High Condenser Pressure on Steam Turbine Design," presented at the American Power Conference, Chicago, Illinois, April 1971.

32. Bechtel Corporation, *Circulating Water Inlet and Discharge Study, Brookwood Plant*, Job No. 5421, August 31, 1965.

10. EVALUATION OF PROPOSED ACTION

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

10.1.1 Abiotic

10.1.1.1 On land

The Sterling participants plan to own about 2800 acres at the primary site of the Sterling Power Project. About 44% of the site (about 1200 acres) is currently used for agriculture, principally orchards, pastures, and cropland. Approximately 207 acres will be affected by construction, excluding transmission lines: about 38% (75 acres) is forested, 12% (24 acres) is scrub or abandoned fields, and the remainder is occupied by pastures, cropland, or residences. Excavated material will be hauled to designated stockpiles. Excess excavated material not used for backfill will be used for area fill elsewhere on site. About 270 acres of agricultural land within the exclusion area will revert to native vegetation.

Transmission lines associated directly with the Sterling Power Project will require about 147 acres. The principal impact of the transmission lines will be the conversion of about 67 acres of forest land to low-growing grass and herbaceous cover. The impact on the remaining acreage will be limited to that from grading and other actions associated with construction. These lands will be allowed to revert to their former uses (active and inactive croplands and pastures) following construction.

Construction of the railroad spur may permanently remove about 36 acres of land from other uses, including 19 acres of agricultural lands and 17 acres of natural communities.

The approximately 142 acres of forested land that will be cleared for construction of the plant, transmission line, access roads, and railroad spur will reduce the 1974 inventoried forest acreage of Cayuga County by about 0.1% (0.008% statewide). The conversion of about 340 acres of cropland, pasture, and orchards to other uses will reduce the 1974 inventoried agricultural lands in Cayuga County by about 0.2% (0.005% statewide). Removal of the aforementioned acreages from their current land uses is not expected to have a significant effect on area land use patterns.

10.1.1.2 On surface water

Construction associated with the Sterling Power Project is not expected to affect significantly surface water usage for recreational or other activities. Operation of the plant will result in a maximum consumptive use of about 9×10^8 ft^3/year through evaporation. Loss of this amount of water will not significantly affect other uses of Lake Ontario.

10.1.1.3 On groundwater

No groundwater will be used during construction and operation of the plant. Wells outside the plant site limits should not be affected by construction dewatering or plant operation because glacial deposits in the area are relatively impermeable and the plant is down-gradient from offsite wells.

10.1.1.4 On air

The staff does not expect discharges to the air as a result of Sterling construction and operation (including effects of dust and radioactive and nonradioactive gaseous effluents) to significantly affect air quality or use.

10.1.2 Biotic

10.1.2.1 Terrestrial

The major adverse environmental impacts on terrestrial ecosystems during construction will result from land clearing and erosion. Impacts to terrestrial wildlife as a consequence of these activities will range from temporary disturbances to complete loss of some individuals due to direct destruction (the less mobile forms) or to habitat destruction and subsequent relocation of some species. The clearing of approximately 0.1% of Cayuga County's forested land for this construction will probably reduce the county's population of wildlife inhabiting this type of habitat by about the same percentage. However, successional stages of vegetation are important to some species (e.g., white-tailed deer, cotton tail rabbit, etc.), and the subsequent revegetation of some of the cleared areas will tend to temporarily increase the population of these species; but their numbers should decrease again as succession continues and forests replace the old field stage vegetation. Area waterfowl populations are not expected to be significantly affected by Sterling construction or operation.

10.1.2.2 Aquatic

Thermal

Plankton productivity will probably experience slight stimulation in the cooler months and depression in the hotter months in the immediate area of the thermal plume. Through accident or volition, fish will enter the plume where some may experience heat shock and, on occasion, cold shock following unscheduled reactor shutdowns. No impact on the local fish populations is expected as a result of these thermal stresses. Incidences of gas bubble disease and overcrowding will be infrequent with negligible effects locally.

Chemical

Most organisms entrained in the condensers during the three daily 20-min periods of chlorination will die. The proposed limits on free residual chlorine in the discharge are sufficiently high to adversely affect most aquatic organisms exposed to such concentrations. If the staff requirements regarding total residual chlorine are observed, no measurable losses beyond the discharge canal should occur.

Mechanical

The staff expects a large fraction of phytoplankton and zooplankton to survive entrainment in the circulating water system. Most fish entrained, including adults, juveniles, and larvae, will be killed. Adults entrained in the circulating water system will be impinged on the traveling screens in numbers estimated to be 4 to 5 million per year. Losses of larvae due to entrainment range from 8.4×10^5 to 8.4×10^8, the upper estimate being very conservative. The staff recognizes this conservatism and concludes that the entrainment of larvae at Sterling will not result in any long-term adverse impacts on the fish populations in the lake.

10.1.2.3 Radiological

The staff finds that impacts resulting from radioactive effluents produced during normal operation of Sterling are acceptable.

10.2 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

10.2.1 Scope

The purpose of this section is to set forth the relationship between the proposed use of man's environment implicit in the proposed construction and operation of the Sterling Power Project (as permitted under the terms of the proposed construction permit) and the actions that could be taken to maintain and enhance the long-term productivity.

10.2.2 Enhancement of productivity

The construction of the Sterling Power Project will have potentially beneficial effects on the economy of New York State. The capacity of Sterling represents about 10% of the Sterling participants' total projected system dependable capacity at the time the plant is to be in operation. A present, the service area of the combined participating utilities includes about 29,900 sq miles in New York State.

10.2.3 Uses adverse to productivity

10.2.3.1 Land use

Approximately 2800 acres will be required for the Sterling primary site. Of this acreage, about 107 acres will be occupied by permanent facilities. Approximately 80 permanent residents and 70 summer or temporary residents will have to be relocated. Since about 45% of the site is cleared land suitable for pasture or farming, some impact on agricultural products is expected to result from the construction of the Sterling Power Project. The State and local taxes on the property (estimated to be $10 million annually) greatly outweigh any loss from agricultural production.

10.2.3.2 Water use

Operation of the Sterling Power Project will introduce about 54 trillion Btu/year into Lake Ontario. The increase in evaporation is expected to be less than 9×10^8 ft^3/year, which is less than 0.2% of natural evaporation. No detectable change in lake level is expected to occur.

Chemical discharges from Sterling will increase the dissolved salt content of Lake Ontario by about 130 lb/day of materials already present in substantial concentrations in the lake water. Because the present level of total dissolved solids is about 250 ppm (Table 3.9), the increase due to these discharges would be undetectable.

10.2.4 Decommissioning

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

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

The following alternatives can be and have been used in the decommissioning of reactors.

(1) Remove the fuel (possibly followed by decontamination procedures), seal and cap the pipes, and establish an exclusion area around the plant. The Piqua decommissioning operation was typical of this approach.

(2) In addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions that remain above ground. The Hallam decommissioning operation was of this type.

(3) Remove the fuel, all superstructure, the reactor vessel, and all contaminated equipment and facilities and fill all cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor.

Alternative decommissioning procedures (1) and (2) would require long-term surveillance of the reactor site. After a final check to assure that all reactor-produced radioactive material has been removed, alternative (3) would not require any subsequent surveillance. Possible effects of erosion or flooding will be included in these considerations.

Estimated costs of decommissioning at the lowest level are about $1 million plus an annual maintenance charge on the order of $100,000.[1] Estimates vary from case to case with a large variation arising from differing assumptions as to level of restoration. For example, complete restoration, including regrading, has been estimated to cost $70 million. At present land values, consideration of an economic balance alone likely would not justify a high level of restoration. However, planning required of the applicant at this stage will ensure that variety of choice for restoration is maintained until the end of useful plant life.

The degree of dismantlement would be determined by an economic and environmental study involving the land and scrap value versus the complete demolition and removal of the complex. In any event, the operation will be controlled by the rules and regulations to protect the health and safety of the public that are in effect at the time.

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.3.1 Scope

Irreversible commitments generally concern changes set in motion by the proposed action that, at some later time, could not be altered to restore the present order of environmental resources. Irretrievable commitments are generally the use or consumption of resources that are neither renewable nor recoverable for subsequent utilization.

Commitments inherent in environmental impacts are identified in this section, while the main discussions of the impacts are in Sects. 4 and 5. Also, commitments that involve local long-term effects on productivity are discussed in Sect. 10.2.

10.3.2 Commitments considered

The types of resources of concern in this case can be identified as (1) material resources, such as materials of construction, renewable resource material consumed in operation, and depletable resources consumed, and (2) nonmaterial resources, including a range of beneficial uses of the environment.

Resources that, generally, may be irreversibly committed by the operation are (1) biological species destroyed in the vicinity, (2) construction materials that cannot be recovered and recycled with present technology, (3) materials that are rendered radioactive but cannot be decontaminated and materials consumed or reduced to unrecoverable waste including the U-235 and U-238 consumed, (4) the atmosphere and water bodies used for disposal of heat and certain waste effluents to the extent that other beneficial uses are curtailed, and (5) land areas rendered unfit for other uses.

10.3.3 Biotic resources

10.3.3.1 Terrestrial

Approximately 107 acres will be occupied by permanent structures, roads, railroad spur, and transmission lines. The most significant loss is some 33 acres of mature beech-maple forest, which constitutes about 64% of the old-growth beech-maple forest within a 5-mile radius of the site. Reduction of wildlife habitat will have only a temporary impact in the general area because much of the abandoned agricultural land is reverting to forest.

10.3.3.2 Aquatic

Construction of plant-related facilities will permanently destroy less than 1.0 acres of benthic habitat in Lake Ontario. Cooling water withdrawal will result in the irretrievable loss of some fish and plankton.

10.3.4 Material resources

10.3.4.1 Materials of construction

Materials of construction are almost entirely of the depletable category of resources. Concrete and steel constitute the bulk of these materials; numerous other mineral resources are incorporated in the physical plant. No commitments have been made on whether these materials will be recycled when their present use terminates.

Some materials are of such value that economics clearly promote recycling. Plant operation will contaminate only a portion of the plant to such a degree that radioactive decontamination would be needed to reclaim and recycle the constituents. Some parts of the plant will become radioactive by neutron activation. Radiation shielding around each reactor and around other components inside the primary neutron shield constitutes the major materials in this category, for which it is not feasible to separate the activation products from the base materials. Components that come in contact with reactor coolant or with radioactive wastes will sustain variable degrees of surface contamination, some of which would be removed if recycling is desired. The quantities of materials that could not be decontaminated for unlimited recycling probably represent very small fractions of the resources available in kind and in broad use in industry.

Many materials on the "List of Strategic and Critical Materials"[2] (e.g., Aluminum, Asbestos, Beryllium, Cadmium, Lead, Nickel, Platinum, Silver, Tin, Tungstun, and Zinc) are used in nuclear plants. Construction materials are generally expected to remain in use for the full life of the plant, in contrast to fuel and other replaceable components discussed later. There will be a long period of time before terminal disposition must be decided. At that time, quantities of materials in the categories of precious metals, strategic and critical materials, or resources having small natural reserves must be considered individually, and plans to recover and recycle as much of these valuable depletable resources as is practicable will depend on need.

10.3.4.2 Replaceable components and consumable materials

Uranium is the principal natural resource irretrievably consumed in plant operation. Other materials consumed, for practical purposes, are fuel-cladding materials, reactor-control elements, other replaceable reactor core components, chemicals used in processes such as water treatment and ion-exchanger regeneration, ion-exchange resins, and minor quantities of materials used in maintenance and operation. Except for the uranium isotopes U-235 and U-238, the consumed resource materials have widespread usage; therefore, their use in the proposed operation must be reasonable with respect to needs in other industries. The major use of the natural isotopes of uranium is for production of useful energy.[3]

The Sterling Power Project reactor will be fueled with uranium enriched in the isotope U-235. After use in the plant, the fuel elements will still contain U-235 slightly above the natural fraction. This slightly enriched uranium, upon separation from plutonium and other radioactive materials (separation takes place in a chemical reprocessing plant), is available for recycling through the gaseous diffusion plant. Scrap material containing valuable quantities of uranium is also recycled through appropriate steps in the fuel production process. Fissionable plutonium recovered in the chemical reprocessing of spent fuel is potentially valuable for fuel in power reactors.

Between 5000 and 7000 metric tons of contained natural uranium in the form of U_3O_8 must be produced to feed the unit for 30 years (operating at a 75% plant factor). The assured U.S. reserves of natural uranium, recoverable at a cost of $10 or less per pound of U_3O_8, are 270,000 metric tons of uranium.[4] A greater reserve exists if more expensively mined ore is considered.

In view of the quantities of materials in natural reserves, resources, and stockpile and the quantities produced yearly, the expenditure of such material for the power plant is justified by the benefits from the electrical energy produced.

10.3.5 Water and air resources

A maximum of about 9×10^8 ft^3 of water will be consumptively used by the Sterling Power Project each year. However, the use of the water can be viewed as an irreversible loss only in the same sense that natural evaporation from water bodies is an irreversible loss. The staff does not believe that such usage will have a long-term effect.

The effect of construction and operation of the proposed Sterling Power Project will have little effect on air resources beyond the minimal damage caused by the various equipment emissions.

10.3.6 Land resources

About 2800 acres of land would be committed to the construction and operation of the Sterling Power Project for the years the plant would be licensed to operate. The staff does not expect this land to be returned to present use after decommissioning of the plant. The applicant will probably continue to use the land for some form of power production.

10.4 BENEFIT-COST BALANCE

The benefits and costs are summarized in Tables 10.1 and 10.2 and are discussed below.

10.4.1 Benefits

The major direct and indirect benefits are discussed below and tabulated in Table 10.1.

Table 10.1. Benefits from the proposed Sterling Power Project

Direct benefits	
Capacity, MWe	1150
Electrical energy generation	
Average annual electrical energy generation, GWhr (60 and 80%, plant factor)[a]	6044 (8059)
Proportional distribution of electrical energy, %[b]	
Residential	26
Industrial	26
Commercial	38
Other	10
Other products	None
Indirect benefits	
Employment	
Construction payroll (total), million $	206
Operation, number of permanent employees	156
Operation, annual payroll, million $	3.6
Taxes	
Cayuga County, annual, million $	5.88
Hannibal Central School District, annual, million $	3.14
Town of Sterling, annual, million $	0.57

[a] The first number shown indicates 60% plant factor while the second number in parentheses indicates 80% plant factor.

[b] Overall, for all Sterling Power Project participants.

10.4.1.1 Expected average annual electrical energy generation

The principal benefit of the proposed plant will be the availability to the applicant's service area of 1150 MWe of base-load capacity and of an annual expected generation of electrical energy of 6044 to 8058 GWhr (assuming plant factors of 0.6 to 0.8).

10.4.1.2 Expected proportional distribution of generated electrical energy

The electrical energy generated by this plant will go directly into the applicants' transmission grid to supply the electrical power needs within the service areas. This electrical energy is expected to be distributed to the several categories of the applicants' customers as shown in Table 10.1. These estimates are based on the applicants' observed 1974 distribution of sales in these categories (ER, Table 8.1-1).

10.4.1.3 Other products from the plant

The applicant does not plan to sell steam or other beneficial products from this plant.

10.4.1.4 Taxes

Taxes are expected by the applicant to be about $10 million annually (ER, Sect. 8.1.3.1).

10.4.1.5 Research

Other than the required monitoring programs associated with Sterling operation, the applicant does not plan any specific research program in conjunction with the operation of the plant. The staff considers that the ecological research conducted as necessitated by the pre- and post-operational monitoring programs will be of some benefit. The total cost of preoperational studies through September 1975 was about $5 million (ER, Sect. 8.1.3.4.1).

10.4.1.6 Employment

A peak of about 1370 employees will occur during the projected 6-year construction period, resulting in a total construction payroll of about $206 million (ER, Sect. 8.1.3.2). Permanent plant operation will require an estimated 156 full-time employees, with an expected annual payroll of about $3.6 million during the first year of operation (ER, Sect. 8.1.3.2).

10.4.1.7 Regional development

Operation of the Sterling Power Project will increase the reliability of the applicant's and the region's power supply and will help satisfy the area's electrical energy requirements, thereby making possible some of the commercial and economic activities and residential amenities that the people of this area demand. The availability of the added electrical energy will permit the regional development to occur, but it will not necessarily cause it to occur.

10.4.2 Costs

The major direct and indirect costs are discussed below and tabulated in Tables 9.1 and 10.2.

10.4.2.1 Energy generation costs

The staff estimated the cost of the completed generating plant in 1984 to be $1015 million. The annual operating, maintenance, and fuel costs in 1984, the projected first year of operation, are estimated by the staff to total about $72.4 million assuming a plant factor of 70%. Fuel costs of $8.20/MWhr and operating and maintenance costs of $1.67/MWhr were assumed. With a 10% discount rate, the annualized cost of the capital investment would be $111 million. Total cost of electrical energy generation from the Sterling Power Project during its first full year of operation would therefore be $172.3 million for a plant factor of 70%. At the same plant factor, the bus-bar cost of electrical energy would be 32.2 mills/KWhr.

10.4.2.2 Community service and social costs

Social impacts and impacts on community services were discussed in Sects. 4.4 and 5.8. Cayuga County will probably experience the greatest impacts associated with the construction and operation of the Sterling Power Project and will probably have to provide some increased public services. In most instances, such as in education, housing, water and sewage facilities, police and fire protection, and medical facilities, the existing services and planned improvements can accommodate the impacts of the construction and operating phases. In general, the costs associated with the additional required facilities and services will be compensated for by the additional revenues arising from the construction and operation labor forces.

10.4.2.3 Environmental costs

The major environmental impacts expected to be incurred by construction and operation of the proposed Sterling Power Project are summarized in Table 10.2.

10.4.2.4 Decommissioning costs

No specific plan has been developed for decommissioning the Sterling Power Project, but estimated decommissioning costs range from $1 million plus an annual maintenance charge of about $100,000 to a cost of about $70 million for complete restoration of the site (Sect. 10.2.4).

10.4.2.5 Other costs

The environmental costs associated with the nuclear fuel cycle have been treated generically.[5] The contribution to environmental effects associated with the uranium fuel cycle are sufficiently small as not to significantly affect the conclusion of the benefit-cost balance.

10.4.3 Summary

In 10 CFR Part 51, the NRC has required that a benefit-cost analysis be prepared for each nuclear station considered for licensing. This analysis has attempted to identify and describe all the potentially significant benefits and costs (or risks) expected to accrue if the proposed

Table 10.2. Environmental costs of Sterling Power Project

Effect	Reference section	Summary description
	Land use	
Land required for plant	4.1.1	66 acres; 82 acres affected by construction
Land required for transmission lines (on site)	4.1.1	48 acres
Railroad spur	4.1.1	6 acres
Access roads	4.1.4	5 acres
Switchyard	4.1	30 acres; 37 acres affected by construction
Soils spoil pile and laydown area	4.1	77 acres during construction
Forest land disturbed	4.1.7	142 acres (total)
Loss of agricultural production	5.1.1, 10.1.1.1	340 acres (total)
Erosion	4.3.1.1	Can be minimized by good construction practices
Visual	3.1, 5.6.1	Minimal impact owing to topography inland but visible from lake
	Water use	
Evaporative consumption	5.2.1	$<9 \times 10^8$ ft^3/year evaporative loss
Chemical discharges to Lake Ontario	3.6, 5.5.2.2	Negligible
Thermal discharges to Lake Ontario	5.3.1, 5.5 2.1	Area within 3°F isotherm will be less than 2000 acres and generally between 370 and 510 acres during August
	Social and economic effects	
During construction	4.4	Potential effects on local communities probably can be accommodated by them without significant inconvenience
During operation	5.6	Minor adverse effects on local communities
	Radiological impact	
Cumulative U.S. population dose	5.4.2.5	24.2 man-rems per year
Occupational	5.4.2.4	450 man-rems per year
	Ecological impacts on aquatic life	
Construction	4.3.2	Potential problems from erosion impacts; minor loss of aquatic habitat
Entrainment	5.5.2.3	Potential loss of 3.2×10^6 two-year-olds which should produce no long term adverse effects on fish populations in the lake
Impingement	5.5.2.3	No regional or lakewide impacts are expected and local impacts on alewife population will be acceptable if staff recommended intake velocities are maintained
Chemical discharges	5.5.2.2	Minimal effects if total residual chlorine in the discharge is limited to 0.1 mg/liter
	Ecological impacts on terrestrial life	
Construction of plant	4.3.1	Potential erosion problems; minor lasting impact otherwise
Construction of transmission lines	4.3.1.2	Potential erosion problems; minor lasting impact otherwise
Operation of plant	5.5.1	Minimal impact if vegetative cover is re-established after construction
Operation of transmission lines	5.5.1.2	No significant impact if proper maintenance procedures are followed

715 196

721 137

Sterling Power Project is constructed and operated according to the applicant's proposal (on which is superimposed the conditions to be required by the staff). 10 CFR Part 51 (and the spirit and language of the National Environmental Protection Act which it implements) requires consideration of all potentially adverse effects on the broadly defined environment. No method for assigning dollar values to many of the diverse considerations now commands general acceptance or has even been developed; therefore, to rest the required cost-benefit balance on a simple monetary balance is not possible. However, in this Environmental Statement the staff has attempted to describe, to the extent practicable, the environmental costs and benefits in quantitative terms by indicating, for example, expected ranges of percentage losses of affected biota, specifically affected land uses in relation to the total land in the area currently so used, and the effects of the plant's thermal and chemical discharges on Lake Ontario. Those costs and benefits that the staff has identified and considers to be of the most importance in reaching a conclusion with respect to the proposed action have been summarized in the earlier portions of Sect. 10.

Overall, the major benefit is the electric power to be generated by the Sterling Power Project which will allow economic growth (assuming that this base-load power is necessary in the time frame projected) in the applicant's service area during the period of operation. Most of the costs are more diffuse; they will be borne unequally by people according to when, where, and how they live. Construction activities will cause some inconvenience and costs to local communities. Plant operation should cause only minor inconvenience to local residents. The increased tax base as a consequence of the large capital investment in Sterling will benefit Cayuga County.

Construction of the plant will cause some damage to aquatic and terrestrial biota; however, this should not result in the long-term disturbance of any major ecosystem. Plant operation will be in accordance with staff requirements so that no significant adverse effect is expected on aquatic or terrestrial biota.

As indicated in Sect. 9, the staff believes that there would be no reduction in overall costs of base-load power by the use of an alternative site, the use of alternative fuels, or any combination of these.

The staff concludes, on the basis of the assessments summarized in this Environmental Statement, that the construction and operation of the Sterling Power Project, with modifications as recommended by the staff, is needed by the applicant's service area in the time frame projected and will have accrued benefits that outweigh the economic and social costs. The staff concludes that the distribution of costs and benefits does not place unreasonable costs on any segment of the population.

REFERENCES FOR SECTION 10

1. *Atomic Energy Clearing House*, 17(6): 42 (1971); 17(18): 7 (1971); and 16(35): 12 (1970).
2. G. A. Lincoln, "List of Strategic and Critical Materials," *Fed. Regist.* 37(39): 4123 (1972).
3. U.S. Department of the Interior, Bureau of Mines, *Mineral Facts and Problems*, 1970, p. 230.
4. Energy Research and Development Administration Weekly Announcement No. T5-35 for week ending March 26, 1975.
5. U.S. Atomic Energy Commission, *Environmental Survey of Nuclear Fuel Cycle*, November 1972.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR Part 51, the Draft Environmental Statement for the Sterling Power Project was transmitted, with a request for comments, to:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Energy Research and Development Administration
Environmental Protection Agency
Federal Energy Administration
Federal Power Commission
New York State Atomic Energy Council
Cayuga County Legislature
Town Supervisor, Town of Sterling

In addition, the NRC requested comments on the Draft Environmental Statement from interested persons by a notice published in the *Federal Register* on January 16, 1976. In response to the requests referred to above, comments were received from:

Advisory Council on Historic Preservation (ACHP)
Department of Agriculture (AGR)
Department of the Army, Corps of Engineers (ARM)
Department of Commerce (COM)
Department of Health, Education, and Welfare (HEW)
Department of Housing and Urban Development (HUD)
Department of the Interior (INT)
Energy Research and Development Administration (ERDA)
Environmental Protection Agency (EPA)
Federal Power Commission (FPC)
State of New York, Department of Environmental Conservation (NYS)
State University of New York, Oswego (SUNY)
Ecology Action (EA)
Rochester Gas and Electric Company (RG&E)
Mrs. Robert J. Wernick (MSW)
Dr. R. F. Caldwell (MRC)

The comments were reproduced in this Statement as Appendix A, which is reserved solely for them. The staff's consideration of the comments received and its disposition of the issues involved are reflected in part by revised text in the pertinent sections of this Final Environmental Statement and in part by the following discussion. The comments are referenced by use of the abbreviations indicated above; also, the pages in Appendix A on which copies of the comments appear are indicated.

11.1 NEED FOR POWER GENERATING CAPACITY

11.1.1 Energy conservation effects

(EA A-9)

The uncertainties and data limitations referred to are those related to the significance of energy conservation impacts on the forecast need for power. While both electricity consumption and peak demand have been below earlier forecasts since the implementation of energy conservation programs following the oil embargo of late 1973, other events affecting consumption — milder weather and an economic recession — occured over the same period. Thus, historical evidence to date does not permit an identification of the impact of energy conservation alone, and thus, some uncertainty necessarily remains. Nevertheless, even if the historical evidence were clear, it would still be necessary to forecast the likely impact of conservation efforts in the future which, no less than forecasting the future values of the other determinants of electricity demand, is an activity that cannot be performed with perfect certainty. It does not logically follow, however, that need has not or cannot be demonstrated and that the construction permit should be withheld. Rather, given the lengthy (8 to 10 years) lead time necessary to design and construct a modern power station and given that need can be demonstrated with certainty only as it occurs, simple prudence suggests that the need for power must be anticipated as closely as possible. The staff attempts to employ the best available information regarding the structure of electricity demand and to project values of the determinants of that demand. In addition, and in recognition of the uncertainty necessarily present, the staff prepares a range of forecasts which are taken to encompass the sequence of events considered most likely to occur and which, therefore, can be used as reasonable evidence to demonstrate the need for power.

(EA A9)

The use of shades may be sufficient in some occupational environments to meet heat stress standards, thereby avoiding the need for air conditioning. The use of vacations, however, necessarily would be limited if production is not to be interrupted. The staff's insertion of these comments regarding the heat stress standards and electric automobile use was simply to point out that certain events may occur that could have an impact on energy demand opposite to that of energy conservation, all of which further contributes to the general uncertainty associated with need projections.

11.1.2 Base, peak, and interruptible loads

(EA A-8)

The discrepancy between the statement on page 8-6 and the information in Table 8.7 regarding base load generating mix is principally a matter of definition. The statement on page 8-6 considers base load as that load encountered 100% of the time, in which case, as Fig. 8.3 indicates, for the NYPP in 1985 the projected base load will be carried primarily by nuclear and hydro generation. On the other hand, the base load generation mix reported in Table 8.7 reflects the individual applicant's varying definitions of base load. A review of the load duration curves presented in Figs. 1.1-5 through 1.1-8 of the ER suggest that, for most of the applicants, base load is defined as that level of demand which exists for more than 5000 to 6000 hr/year. It is true that the staff's analysis of the need for power is based on projections of peak load. But analyses of load are also performed to obtain indications of what fractions base, intermediate, and peak generation capacities should be of total generation capacity. On these two bases, the staff has concluded that the Sterling Power Project is needed to meet projected requirements for base-load generation. The use of interruptible load contracts can reduce the need for peaking units but cannot be considered as a viable alternative to a base-load plant. In any event, the total absence of interruptible load contracts by the applicants simply reflects their legal obligation to provide the power that may be demanded by the service area. Any change in this situation would require a new legal and regulatory philosophy encompassing some scheme for rationing power among the various service classes.

11.1.3 Applicant's promotion of energy conservation

(EA A-9)

The applicants' efforts as regards conservation, including the dissemination of booklets and pamphlets, are described in the *1975 Report to Member Electric Corporation of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149-b of the Public Service Law of New York State, April 1, 1975.* While the staff does not have access to each of the booklets and pamphlets, it is clear from the detailed information presented in the 149-b Report that this material addresses both energy conservation in general as well as electricity conservation in particular. This is appropriate, however, considering the fact that several of the applicants are suppliers of gas as well as of electricity. It is not possible, however, to calculate what percentage of this conservation information effort is specifically devoted to electricity conservation, nor is it possible to estimate the extent to which such effort might ultimately affect projected electricity demand.

11.1.4 Power needs for each utility

(EA-8)

Tables 11.1 to 11.4 present the applicant's historical and projected summer and winter peak loads, capabilities, and reserves (with and without the Sterling plant) separately for each participating utility. For each utility for the period in which the Sterling plant is planned to begin operation (1984), without the plant, reserves as a percent of peak load fall below the 18% reserve margin responsibility that is the reliability standard of NYPP individual members. On this evidence, each utility had demonstrated need. The staff has reviewed the applicant's projections presented in Tables 11.1 through 11.4 and considers them reasonable. Staff projections of summer and winter peak loads for each participating utility based on the FEA ranges of 3.9% to 6.9% and and econometric model are presented in Table 11.5. The sum of the staff forecasts of winter peak load for each utility are directly comparable with the total (all participants combined) winter peak load forecasts presented in Figure 8.4. The two forecasts deviate slightly for projections into later years; for example, based on the FEA 5.9% growth rate for 1985, the sum of the individual forecasts is 288 MW less than the total forecast. The staff considers the sum of the individual forecasts to be more accurate than the total forecast since, under the methodology employed, the total forecast does not give proper weight to the lower adjusted rate of load growth for Niagara Mohawk, the utility with the largest load, compared to the other participants.

Finally, Table 11.6 presents the staff's analysis of 1984 summer and winter peak loads, capabilities, and reserves for each participating utility with and without the Sterling plant. The variations in assumed growth rates and projected peak and reserve margins provide a range of possible results in addition to those shown by the applicants.

Table 11.1. Historical and projected summer and winter peak load, capability, and reserves, Central Hudson Gas and Electric Corporation, with and without the Sterling plant (based on applicant's projections)

Year	Summer				Winter			
	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve
1964	378	301	77	25.6	382	324	58	17.9
1965	374	340	34	10.0	395	363	32	8.8
1966	431	382	49	12.8	444	393	51	13.0
1967	452	385	67	17.4	576	432	144	33.3
1968	482	441	41	9.3	546	458	88	19.2
1969	524	479	45	9.4	559	494	65	13.2
1970	599	512	87	17.0	623	522	101	19.3
1971	656	540	116	21.5	650	554	96	17.3
1972	684	566	118	20.8	684	603	81	13.4
1973	662	633	29	4.6	741	586	155	26.5
1974	741	585	156	26.7	904	585	319	54.5
Projected (without Sterling)								
1975	900	650	250	38.5	1099	675	424	62.8
1976	963	700	263	37.6	1164	725	439	60.6
1977	1173	755	418	55.4	1245	785	460	58.6
1978	1252	815	437	53.6	1238	845	393	46.5
1979	1303	880	423	48.1	1231	915	316	34.5
1980	1439	950	489	51.5	1230	985	245	24.9
1981	1434	1025	409	39.9	1524	1065	459	43.1
1982	1344	1110	234	21.1	1517	1150	367	31.9
1983	1501	1195	306	25.6	1513	1235	278	22.5
1984	1436	1285	151	11.8	1446	1330	116	8.7
1985	1434	1385	49	3.5	1444	1435	9	0.6
1986	1432	1485	−53	−3.6	1443	1535	−92	−6.0
1987	1371	1585	−214	−13.5	1382	1640	−258	−15.7
Projected (with Sterling)								
1984	1631	1285	346	26.9	1641	1330	311	23.4
1985	1629	1385	244	17.6	1639	1435	204	14.2
1986	1627	1485	142	9.6	1638	1535	103	6.7
1987	1566	1585	−19	−1.2	1577	1640	−63	−3.8

Table 11.2. Historical and projected summer and winter peak loads, capability, and reserves, Orange and Rockland Utilities, Inc., with and without the Sterling plant (based on applicant's projections)

Year	Summer				Winter			
	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve
1964	277	224	53	23.7	273	233	40	17.2
1965	279	251	28	11.2	295	255	40	15.7
1966	364	293	71	24.2	319	291	28	9.6
1967	342	308	34	11.0	360	313	47	15.0
1968	385	381	4	1.0	393	350	43	12.3
1969	495	434	61	14.1	442	390	52	13.3
1970	561	476	85	17.9	562	420	142	33.8
1971	625	524	101	19.3	592	448	144	32.1
1972	685	579	106	18.3	635	481	154	32.0
1973	752	640	112	17.5	627	463	164	35.4
1974	814	610	204	33.4	827	466	361	77.5
				Projected (without Sterling)				
1975	957	658	299	45.4	1044	522	522	100.0
1976	1038	692	346	50.0	1042	562	480	85.4
1977	1038	757	281	37.1	1042	612	430	70.3
1978	1038	824	214	26.0	1042	666	376	56.5
1979	1055	894	161	18.0	1035	721	314	43.6
1980	1152	966	186	19.3	1181	779	402	51.6
1981	1225	1038	187	18.0	1181	837	344	41.1
1982	1312	1112	200	18.0	1246	897	349	38.9
1983	1403	1189	214	18.0	1333	959	374	39.0
1984	1152	1267	−115	−9.1	1181	1024	157	15.3
1985	1152	1347	−195	−14.5	1181	1090	91	8.3
1986	1152	1429	−277	−19.4	1181	[illegible]	23	2.0
1987	1152	1512	−360	−23.8	1181	1229	−48	−3.9
				Projected (with Sterling)				
1984	1532	1267	265	20.9	1561	1024	537	52.4
1985	1532	1347	185	13.7	1561	1090	471	43.2
1986	1532	1429	103	7.2	1561	1158	403	34.8
1987	1532	1512	20	1.3	1561	1229	332	27.0

715 201

721 142

Table 11.3. Historical and projected summer and winter peak loads, capability, and reserves, Rochester Gas and Electric Corporation, with and without the Sterling plant (based on applicant's projections)

Year	Summer				Winter			
	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve
1964	726	447	279	62.4	641	504	137	27.2
1965	744	506	238	47.0	739	542	197	36.3
1966	751	529	220	42.0	746	592	154	26.0
1967	690	585	105	17.9	751	620	131	21.1
1968	773	648	125	19.3	768	686	82	12.0
1969	812	708	104	14.7	859	712	147	20.6
1970	967	762	205	26.9	979	744	235	31.6
1971	962	790	172	21.8	971	783	188	24.0
1972	969	855	114	13.3	966	827	139	16.8
1973	1013	922	92	9.9	1082	799	283	35.4
1974	1145	880	265	30.1	1192	823	369	44.8
Projected (without sterling)								
1975	1250	932	318	34.1	1379	903	476	52.7
1976	1380	997	383	38.4	1258	970	288	29.7
1977	1396	1066	330	31.0	1349	1043	306	29.3
1978	1394	1141	253	22.2	1349	1121	228	20.3
1979	1596	1220	376	30.8	1550	1204	346	28.7
1980	1593	1305	288	22.1	1591	1294	297	23.0
1981	1627	1387	240	17.3	1586	1381	205	14.8
1982	1623	1466	157	10.7	1736	1467	269	18.3
1983	1771	1545	226	14.6	1733	1553	180	11.6
1984	1768	1626	142	8.7	1731	1641	90	5.5
1985	1737	1709	28	1.6	1722	1733	−11	−0.6
1986	1735	1799	−64	−3.6	1721	1829	−108	−5.9
1987	1733	1893	−160	−8.5	1719	1930	−211	−10.9
Projected (with Sterling)								
1984	2090	1626	464	28.5	2053	1641	412	25.1
1985	2059	1709	350	20.5	2044	1733	311	17.9
1986	2057	1799	258	14.3	2043	1829	214	11.7
1987	2055	1893	162	8.6	2041	1930	111	5.8

Table 11.4. Historical and projected summer and winter peak loads, capability, and reserves Niagara Mohawk Power Corporation, with and without the Sterling plant (based on applicant's projections)

Year	Summer				Winter			
	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve	Total capability (MW)	Peak load (MW)	Reserve (MW)	Percent reserve
1964	3779	3097	682	22.0	4067	3497	570	16.3
1965	3751	3357	394	11.7	4136	3701	435	11.8
1966	3920	3463	457	13.2	4408	3987	421	10.6
1967	3988	3670	318	8.7	4504	4050	454	11.2
1968	4320	3855	456	12.1	4514	4335	179	4.1
1969	4638	4030	608	15.1	5157	4442	715	16.1
1970	5171	4169	1002	24.0	5418	4614	804	17.4
1971	5315	4300	1015	23.6	5760	4551	1209	26.6
1972	5677	4392	1285	29.3	5634	4827	807	16.7
1973	5539	4724	815	17.3	6152	4896	1256	25.7
1974	6074	4581	1493	32.6	6201	4870	1331	21.5
				Projected (without Sterling)				
1975	7135	4830	2305	47.7	7414	5220	2194	42.0
1976	7146	5019	2127	42.4	7397	5407	1990	36.8
1977	6880	5214	1666	32.0	7311	5596	1715	30.6
1978	6843	5413	1430	26.4	6951	5790	1161	20.1
1979	7412	5615	1797	32.0	7479	5988	1491	24.9
1980	7239	5823	1416	24.3	7470	6189	1281	20.7
1981	7372	6034	1338	22.2	7339	6393	1416	22.6
1982	7357	6249	1108	17.7	8133	6601	1532	23.2
1983	8013	6470	1543	23.8	8104	6813	1291	18.9
1984	8002	6695	1307	19.5	8072	7029	1043	14.8
1985	7988	6924	1064	15.4	8908	7249	1659	23.2
1986	8830	7155	1675	23.4	8905	7470	1435	19.2
1987	8827	7391	1436	19.4	9750	7695	2055	26.7
				Projected (with Sterling)				
1984	8255	6695	1560	23.3	8325	7029	1296	18.4
1985	8241	6924	1317	19.0	9161	7249	1912	26.4
1986	9083	7155	1928	26.9	9158	7470	1688	22.6
1987	9080	7391	1689	22.9	10003	7695	2308	30.0

Table 11.5. Projected summer and winter peak loads (staff's analysis)

Year	Summer				Winter			
	Based on FEA forecast			Based on econometric model	Based on FEA forecast			Based on econometric model
	3.9%	5.9%	6.9%		3.9%	5.9%	6.9%	
Central Hudson Gas and Electric Corp.								
1974*	585	585	585	585	585	585	585	585
1976	634	660	672	695	634	660	672	682
1978	687	744	773	826	687	744	773	796
1980	744	839	888	981	744	839	888	928
1982	802	939	1011	1065	802	939	1011	998
1984	864	1051	1151	1156	864	1051	1151	1073
1985	897	1112	1228	1205	897	1112	1228	1113
1987	966	1245	1398	1286	966	1245	1398	1178
Orange and Rockland Utilities, Inc.								
1974*	610	610	610	610	466	466	466	466
1976	661	688	701	742	505	526	536	535
1978	716	776	806	903	547	593	615	613
1980	776	875	926	1098	593	669	707	703
1982	836	979	1054	1206	639	749	805	750
1984	901	1096	1200	1324	688	838	916	800
1985	935	1160	1281	1388	715	887	978	827
1987	1007	1298	1458	1495	770	993	1113	871
Rochester Gas and Electric Corp.								
1974*	880	880	880	880	823	823	823	823
1976	972	1023	1047	1112	909	956	980	967
1978	1074	1188	1247	1405	1004	1111	1166	1136
1980	1186	1381	1484	1775	1109	1292	1388	1335
1982	1303	1590	1750	1991	1218	1488	1637	1444
1984	1431	1831	2064	2232	1338	1713	1931	1562
1985	1499	1964	2242	2364	1402	1838	2097	1624
1987	1650	2265	2649	2586	1543	2120	2478	1726
Niagara Mohawk Power Corp.								
1974*	4581	4581	4581	4581	4870	4870	4870	4870
1976	4879	5031	5108	5118	5187	5349	5431	5349
1978	5196	5526	5697	5718	5524	5875	6056	5875
1980	5534	6069	6352	6389	[illegible]	6452	6753	6452
1982	5871	6628	7043	6765	[illegible]	7046	7488	6779
1984	6229	7237	7810	7163	6621	7694	8303	7122
1985	6415	7563	8223	7371	6820	8040	8743	7300
1987	6832	8306	9187	7722	7263	8830	9768	7595

*Actual.

Table 11.6. 1984 peak loads, capability, and reserves with and without the Sterling Plant (staff's analysis)

Forecast base (Adjusted)	Capability		Projected peak load	Reserves		Percent reserves	
	Without Sterling	With Sterling		Without Sterling	With Sterling	Without Sterling	With Sterling
Central Hudson Gas and Electric Corp. – Summer							
FEA 3.9 (3.9)	1436	1631	864	572	767	66.2	88.8
FEA 5.9 (6.0)	1436	1631	1051	385	580	36.6	55.2
FEA 6.9 (6.9)	1436	1631	1151	285	480	24.8	41.7
Econometric model	1436	1631	1156	280	475	24.2	41.1
Central Hudson Gas and Electric Corp. – Winter							
FEA 3.9	1446	1641	864	572	767	66.2	88.8
FEA 5.9	1446	1641	1051	395	580	36.6	55.2
FEA 6.9	1446	1641	1151	285	480	24.8	41.7
Econometric model	1446	1641	1073	373	568	34.8	52.9
Orange and Rockland Utilities, Inc. – Summer							
FEA 3.9 (3.9)	1152	1532	901	251	631	27.9	70.0
FEA 5.9 (6.0)	1152	1532	1096	56	436	5.1	39.8
FEA 6.9 (6.9)	1152	1532	1200	–48	332	–4.0	27.7
Econometric model	1152	1532	1324	–172	208	–13.0	15.7
Orange and Rockland Utilities, Inc. – Winter							
FEA 3.9	1181	1561	688	493	873	71.7	126.9
FEA 5.9	1181	1561	838	343	723	40.9	86.3
FEA 6.9	1181	1561	916	265	645	28.9	70.4
Econometric model	1181	1561	800	381	761	47.6	95.1
Rochester Gas and Electric Corp. – Summer							
FEA 3.9 (5.0)	1768	2090	1431	337	659	23.5	46.1
FEA 5.9 (7.5)	1768	2090	1831	–63	259	–3.4	14.1
FEA 6.9 (8.8)	1768	2090	2064	–296	26	–14.3	1.3
Econometric model (8.6)	1768	2090	2232	–464	–142	–20.8	–6.4
Rochester Gas and Electric Corp. – Winter							
FEA 3.9	1731	2053	1338	393	715	29.4	53.4
FEA 5.9	1731	2053	1713	18	340	1.1	19.8
FEA 6.9	1731	2053	1931	-200	122	-10.4	6.3
Econometric model	1731	2053	1562	169	491	10.8	31.4
Niagara Mohawk Power Corp. – Summer							
FEA 3.9	8002	8255	6229	1773	2026	28.5	32.5
FEA 5.9	8002	8255	7237	765	1018	10.6	14.1
FEA 6.9	8002	8255	7810	192	445	2.5	5.7
Econometric model	8002	8255	7163	839	1092	11.7	15.2
Niagara Mohawk P[illegible] Corp. – Winter							
FEA 3.9 (3.1)	8072	8325	6621	1451	1704	21.9	25.7
FEA 5.9 (4.7)	8072	8325	7694	378	631	4.9	8.2
FEA 6.9 (5.5)	8072	8325	8303	–231	22	–2.8	0.3
Econometric model (3.5)	8072	8325	7122	950	1203	13.3	16.9

11.1.5 Cost of replacement power

(EA A-8)

The staff's estimates of the 1984 costs of replacement power (not including costs of capacity purchases) are as follows:

Rochester Gas and Electric	41.3 mills/kWhr
Orange and Rockland	41.7 mills/kWhr
Central Hudson Gas and Electric	32.9 mills/kWhr
Niagara Mohawk	44.4 mills/kWhr

These estimates are based on: (1) the use of the applicant's computer model to identify the source and amounts of replacement energy, (2) fuel and operation and maintenance costs for nuclear and coal plants as presented in the Sterling DES (Table 9.1), and (3) fuel and operation and maintenance costs for oil steam plants and gas turbines as estimated by the applicant in the ER. In the latter case, fuel costs were examined by the staff, compared with other sources, and were found to be reasonable. Compared to 1984 fuel and operation and maintenance costs for the Sterling plant (Table 9.1) of approximately 9 mills/kWhr, the staff's assumption that purchases of replacement energy would be high costs compared to that produced by the Sterling plant is clearly reasonable.

11.1.6 Generation mix

(EA A-8)

While Fig. 8.3 in the DES does group oil and coal into a general fossil category, Table 8.7 presents the disaggregated data, thereby adequately showing the planned generation mix in 1983 and 1984.

11.2 WATER QUALITY

11.2.1 Chlorine

(EPA A-40)

Chlorination of condenser cooling water may not be necessary since biofouling will be reduced by scouring action of the normal silt in the lake. However, the applicant would prefer to have the option of chlorinating if necessary. (See Sect. 5.5.2.2 for the staff's discussion of chlorination levels.)

11.2.2 Chemical and biocidal effluents

(EA A-8)

The applicant is required to meet Federal, State, and local water quality criteria. The staff believes these requirements are sufficient to assure adequate protection to the City of Oswego water supply. The Oswego water supply is approximately 8 miles from the Sterling discharge. A dilution ratio of about 7:1 of an already acceptable concentration of effluents should result in an insignificant effect at the Oswego intake.

11.3 RADIOLOGICAL IMPACTS AND ASSESSMENTS

11.3.1 Radiological effluents

(NYS A-53)

The FES indicates that the staff has calculated a release of 9 Ci/year/reactor of carbon-14 from Sterling Power Project in gaseous effluents and that this nuclide is considered in the dose analysis. A discussion of the formation and release of carbon-14 is contained in Draft Regulatory Guide 1.BB, *Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWR's)*, September 9, 1975.

(RGE A-23)

The FES has corrected this discrepancy in the staff's calculated noble gas release from the auxiliary and radwaste building. The FES contains the correct numbers for the ER calculated releases from the auxiliary and radwaste building for noble gases (1350 Ci/year) and iodine-131 (0.0077 Ci/year). The FES also contains the correct number for the ER calculated release from the turbine building for iodine-131 (0.015 Ci/year).

(RGE A-24)

Table 3.5-8 of the ER does not yield 1348 Ci/year, but yields 1525 Ci/year, which was rounded off to 1500 Ci/year, as indicated in the DES. For the total iodine releases, the FES contains the correct number (0.031 Ci/year).

11.3.2 Radioactive waste

(EPA A-42)

The staff has reassessed the solid radwaste to be shipped to licensed land burial sites based on more recent operating data applicable to the Sterling Power Project. Based on this reassessment, the staff has updated the annual quantity and radioactive content of solid wastes in the FES.

(EPA A-44)

On May 7, 1976, ERDA announced that it was issuing a Technical Alternatives Document (TAD) which presents a comprehensive survey of the current status of technologies for handling and storing commercial radioactive waste. The TAD was prepared by approximately 200 waste management experts at laboratories and universities around the country. It is a complete reference work on the status of technology as of September 1, 1975 for waste generated from the production of electricity in nuclear power reactors. ERDA Administrator, Robert C. Seamans, Jr., said, on the basis of the document, that "ERDA is confident that the technology base does exist to arrive at waste management solutions, and its radioactive waste program is directed to develop this capability to an operating level on a timely and acceptable basis."

The TAD document will provide one basis for a generic environmental statement which ERDA will prepare, with assistance from NRC, on the treatment and storage of the radioactive waste generated by nuclear power reactors. This statement will address in a generic way the particular environmental impacts mentioned in the EPA comments. The information in the TAD was presented in summarized form in testimony before the Joint Committee on Atomic Energy (JCAE) on May 10-12, 1976 by a number of ERDA officials.

Parallel developments have been taking place in the NRC. Responding to a Commission request, the ACRS reviewed the NRC program for regulating fuel cycle activities and suggested in a letter dated April 15, 1976 that the regulatory program in the fuel cycle area be accelerated and expanded, enumerating a number of recommendations for NRC action. The NRC responded in a letter dated May 12, 1976 agreeing in general with the recommendations, and expressing a firm commitment to the establishment of an active and effective regulatory program for the management of nuclear wastes.

This commitment was reaffirmed in NRC testimony before the JCAE on May 12, 1976. It was mentioned that the regulatory framework would have to be supported by a comprehensive environmental impact statement. The NRC testimony agreed with the ERDA conclusion that the basic technology for waste management is available and that implementation of that technology on a schedule that will meet national needs should be the main direction of future effort. The NRC has firmly established waste management as a high priority effort and has made the commitment to act rapidly and methodically to establish a sound regulatory base for licensing waste management activities.

11.3.3 Dose assessment

(EPA A-42)

The staff has completed their reassessment of releases of radioactive materials in effluents and the resulting doses to show conformance with the dose design objectives of Appendix I to 10 CFR Part 50. The results of this analysis are presented in the FES.

(EA A-8)

The levels of radioactivity in the environment within a few miles of a nuclear power plant are very small and difficult, if not impossible, to measure. The Sterling plant is far enough from other plants that levels of radioactivity in the vicinity of Sterling due to other plants in the region are insignificant. Individuals living between Sterling and another plant in the region and more than a few miles from Sterling will experience negligible doses from either plant.

11.3.4 Low population zone

(HUD A-5)

The applicant has specified a low population zone with an outer boundary of 2.5 miles. The 1970 resident population within this zone was determined by the applicant to be 399 people, based on a detailed field survey. There is some seasonal transient population in the low population zone, located primarily in approximately 60 summer cottages and mobile homes on the lakeshore just northeast of the site. Fair Haven Beach State Park is located southwest of the site on Lake Ontario. The nearest boundary of the park is 2.4 miles from the center of the reactor building. Our review of the preliminary emergency planning for the site has confirmed the practicability of taking protective measures, including evacuation, within and beyond the low population zone.

The nearest population center, as defined by 10 CFR Part 100, is Oswego, which had a 1970 population of 23,844. The nearest city boundary of Oswego is 6.8 miles northeast of the site, which is well in excess of the minimum population center distance of one and one-third times the low population zone distance, as required by 10 CFR Part 100.

11.3.5 Fuel cycle and waste management impacts

(NYS A-55)

The environmental effects of the uranium fuel cycle were the subject of recent rulemaking (39 FR 14888). 10 CFR Part 51 reads in part:

> " 20.(e) In the Environmental Report required by paragraph (a) for light-water-cooled nuclear power reactors, the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride isotopic enrichment, fuel fabrication reprocessing of irradiated fuel, transportation of radioactive materials, and management of low level wastes and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power reactor shall be as set forth in the following table [S-3 of the Commission's *Environmental Survey of the Uranium Fuel Cycle*]. No further discussion of such environmental effects shall be required."

A similar requirement extends to the Commission's draft and final environmental statement (10 CFR Parts 51.23 and 51.26).

11.4 THERMAL IMPACTS

11.4.1 Micrometeorological impacts

(COM A-6)

The staff knows of only one micrometeorological impact that has ever been observed as a result of once-through cooling. This is the occurrence of steam fog. The applicant reports that in six years of experience at Ginna, such fog has never been observed to drift inland or to interfere with any activities. The presence of the bluffs at Sterling make it even more unlikely that fog induced by the plume could drift inland.

11.4.2 Lake Ontario water levels

(COM A-7)

The staff has attempted to specify all water levels relative to mean sea level (USGS) in the FES. The designation (USGS) stands for U.S. Geological Survey and is used interchangeably with the designation (USC & GS) in this document.

(COM A-7)

The minimum potential still water level for low water design considerations was chosen using the assumptions described in ER, Sect. 2.5.1.5. The station has been designed so that the Emergency Service Water requirement can be fulfilled at this lake level.

11.4.3 Effect of bend in the discharge channel

(RGE A-25)

The staff disagrees with these comments. First, the staff does not believe that the effects of the bend in the discharge channel can be damped out in only five hydraulic diameters. Second, the mean velocity (and, hence, momentum) of the discharge is fixed by the flow rate and water level. The turbulent energy introduced by the bend must be supplied by additional pumping power above that needed to maintain the same flow rate in a straight channel of the same length. Third, the staff believes that the dilutions measured at Ginna might be even lower, were the bend not present.

11.4.4 Use of Ginna information

(RGE A-26)

In going from Ginna to Sterling, variables representing the discharge width, discharge depth, temperature rise, and discharge velocity were all changed. The staff has assumed that a model yielding acceptable predictions at Ginna will also yield acceptable predictions at Sterling. This is equivalent to assuming that both situations lie within the range of validity of the model. This is less restrictive than the applicant's assumption that the experience at Ginna can be transferred to the Sterling site, but neither approach is fully satisfactory.

11.4.5 Thermal plume studies

(EPA A-39)

The staff concurs that the data base used in the applicant's Acres American study was too small. This limitation has been overcome in a later study performed for the applicant by NUS Corporation. For the staff evaluation of this study, see Sect. 5.3.1.1.3.

(EPA A-39)

The report cited by EPA[1] contains infrared images of the thermal plumes from Ginna Nuclear Power Station, Oswego Steam Power Station, and Nine Mile Point Nuclear Station on July 30, 1974, and August 1, 1974. As noted by EPA, the thermal plume from Ginna tends to exhibit a jet-like structure which carries it away from the shore. This is in contrast to the shore-hugging characteristics of the Oswego and Nine Mile Point plumes. The jet-like configuration observed in this report confirms the findings of the applicant's program of triaxial measurements and of the airborne infrared thermometry flights of Lake Ontario Environmental Laboratory (LOTEL) group.[2-6]

The staff believes that the difference in plume structures can be explained by the type of discharge. The Oswego Steam Power Station discharges into the Oswego harbor, and the heated water escapes into the lake through the harbor entrance at a very low velocity. At Nine Mile Point, a submerged diffuser whose momentum is rapidly dissipated is used. The Ginna surface discharge canal, on the other hand, allows the momentum of the discharged water to carry it directly out into the lake. The staff believes that it is the discharge design rather than the shielding effect of Smoky Point that is primarily responsible for the jet-like structure of the Ginna plume. Consequently, the staff expects that shore-hugging will not be a problem at the Sterling site. The staff agrees that the inability to account for ambient currents is a deficiency of its model and of those presented by the applicant.

(EPA A-41)

The sterling site is about 35 miles ENE of Ginna and about 9 miles SW of Oswego. Interaction with the Ginna plume is considered unlikely. The possibility of interaction with the combined Oswego-Nine Mile Point-Fitzpatrick plume is a definite possibility which the staff is unable to assess, given the current state of the art of hydrothermal modeling. Heated water from the combined Oswego-Nine Mile Point-Fitzpatrick plume is expected to be confined to the upper 10 ft of the water column except when the lake temperature is below 39°F. When the lake temperature is above 39°F, no influence on the Sterling intake temperature is expected.

(INT A-48)

Because of their empirical nature, both the staff's model and those of the applicant implicitly account for the reentrainment of heated water into the plume. The ambiguity inherent in the concept of ambient temperature is pointed out in Sect. 6.1.1.

11.5 ALTERNATIVES

11.5.1 Fuels

(EA A-8)

In Sect. 9.1.2.1 of the FES, the staff discusses the use of municipal solid wastes as a source of energy to generate electricity. The staff therein mentioned the Union Electric Company's facility in St. Louis, Missouri, in which a combination of 10% processed municipal solid wastes and 90% coal is used to fuel an electrical generating station. Operating experience at this facility indicates problems due to the presence of: (1) significant levels of bacteria and viruses at the site of the station and in its emissions, which might require additional filters in the plant; (2) unacceptable levels of trace metals and hazardous chemicals in emissions, possibly requiring stricter limits than are currently enforced at the station, resulting in higher capital and operating costs; (3) higher-than-expected particulate emissions because of performance losses of the electrostatic precipitators when refuse and coal are burned together; and (4) problems related to contaminants in the aqueous effluents from the ash pond.[7] Further, operating and maintenance costs for this facility have been running higher than expected.[8] The Tennessee Valley Authority has carried out a feasibility study on the conversion of municipal refuse into a fuel for electrical generating plants and concluded that such a process is not yet economically feasible.[9] Another factor to consider is that coal costs are relatively high in this region (see Table 9.1 of the FES Even if 10% of the coal required for a power station could be replaced with prepared municipal refuse at a slightly lower cost, the saving in fuel cost would not be great enough to offset the economic advantage of uranium fuel (see Table 9.1 of the FES). In addition to technical problems that have not yet been solved, the operation of a refuse-to-fuel facility requires the solution of legal and institutional (political) problems that may be more difficult than the technical problems.[10] The staff concludes that many of the technological and environmental problems have not been solved to date and that it would not be desirable for the applicants to forego planning of Sterling Unit 1 because of the possibility of replacing it with a station burning solid waste as a supplemental fuel.

Costs of replacement power if Sterling is not built are discussed in Sect. 11.5.5. Costs of replacement power would be the same if a coal-fueled power station were not built as compared to a nuclear power station not being built. Table 9.1 assumes construction of these two alternative electrical generating stations. Therefore, consideration of the cost of replacement power is not appropriate in this comparison.

11.5.2 Sites

(EA A-9)

The staff considers that the data concerning site selection was sufficiently accurate and complete to carry out a meaningful selection of a suitable site. Although there are advantages to locating another nuclear power unit at the Ginna site, as compared with locating that unit at the Sterling site (including possibilities of reducing emergency plan costs, decommissioning costs, land acquisition costs, etc.), the staff has considered these in its analysis and has concluded that the Ginna site on the whole is not a more desirable alternative location. Considering the expected impacts of constructing and operating a nuclear power station, the Sterling site is acceptable. The distance from load centers, with its associated loss of electricity during transmission, was considered by the applicants (ER, Sects. 9.2.2.1.2, 9.2.2.2.3, and 9.2.2.3.3) and factored into the final decision on plant location.

(ARM A-15)

Greater detail in the comparison of the Ginna and Sterling sites can be found in the applicants' ER, Sect. 9.3 and Table 9.3-1. For the sake of brevity, the Environmental Statement summarized the more significant aspects of the comparison of the two sites.

(SUNY A-20)

Table 9.4 only summarized some of the important characteristics of the Ginna and Sterling sites. Additional information can be found in Sect. 9.1.2.2 and in the applicants' ER, Sect. 9.3 and Table 9.3-1. It should also be noted that aesthetic impacts favor the Sterling site, that Sterling has a larger exclusion area than Ginna, and that an independent New York State agency concluded also that Sterling was a prime site.

11.5.3 Cooling systems

11.5.3.1 Use of waste heat

(EA A-8)

The staff is of the opinion that in general there has been to date no demonstration of the economic feasibility of utilizing the waste heat from a nuclear power station, or from any alternate steam-electric power station, in a location such as the proposed site for the Sterling Power Project.

11.5.3.2 Cooling towers

(EPA A-34)

The staff did not determine costs of alternate wet natural-draft cooling towers in terms of mills/kWhr over the life of the station but noted that this alternative would be more expensive than the proposed once-through system. Therefore, the staff concludes that it would cost the consumer more than the proposed plant design.

(ERDA A-46)

It should be noted that Table 2, p. D-5, of the DES indicated that on a dollars per kilowatt basis, the cooling tower alternative is more expensive than once-through cooling ($892/kWe for cooling towers compared to $883/kWe for once-through cooling). The total cost of once through cooling is higher on this table because the net capability for the two systems that were compared was different (1150 MWe for the once-through system compared to 1127 MWe for the natural draft system). On a dollars per kilowatt comparison, this would indicate a $10.0 million penalty for the system using natural-draft cooling towers (as compared to the applicant's estimate of a $33 million penalty, as pointed out by ERDA). As noted on pages D-1 and D-2 of the DES, the cost estimates from the CONCEPT code are not intended as substitutes for detailed engineering cost estimates. In particular, the estimates of cooling alternatives from the CONCEPT code should only be used as a rough estimate of cost. Therefore, the staff does not consider that the difference between the capital cost penalties estimated by the staff and the applicant (with regard to cooling alternatives) are of major significance. The staff has revised its capital cost estimates for Sterling as shown in Appendix D. Although no new estimates of the cooling tower alternative were made, the staff expects that the relative difference between the once-through system and the cooling tower alternative would remain approximately the same as calculated earlier.

(NYS A-55)

This comment is addressed in Sect. 9.2.1.1 for natural-draft towers and in Sect. 9.2.1.2 for wet-dry mechanical-draft towers. The applicant predicts a maximum annual average airborne salt concentration of 0.02 $\mu g/m^3$ for natural-draft Tower A. The staff predicts a maximum annual average airborne salt concentration for natural-draft Tower B of 0.01 $\mu g/m^3$. The applicant predicts a maximum annual average airborne salt concentration of 0.15 $\mu g/m^3$ for the wet-dry mechanical-draft towers. All of these predictions are far lower than the annual average New York State and Federal Secondary Ambient Air Quality Standards of 55 and 60 $\mu g/m^3$ respectively.

11.6 AQUATIC ECOLOGY

11.6.1 Aquatic ecological impacts

(COM A-7)

Placement of the intake structure in 80 ft of water approximately 9300 ft from shore may not result in fewer impacts. For example, fish will be exposed for a longer period of time to the stress of passing through the tunnel, and survival rates following impingement may be lowered. Also, alewives and smelt move to the deeper, offshore regions of the lake in the fall. Their residence in deep waters may increase the potential of impingement during the winter. Some impingement of salmonids may also occur. Finally, the additional cost of locating the intake at the 80 ft contour is estimated to be $18,600,000. The staff concludes that the potential impacts described above outweigh any advantages that this alternative may have.

11.7 MISCELLANEOUS

11.7.1 Transmission lines

(INT A-56)

Neither the scrub nor the wooded swamp will be affected by construction of the switchyard. Table 4.1-2 of the ER states that 18 acres of scrub lands, 17 acres of tilled lands, and 2 acres of intermediate hardwoods will be eliminated by construction of the switchyard. No other habitats will be affected by the switchyard.

(INT A-56)

As noted in Sect. 5.5.1.2, "in situations near water, only those herbicides deemed safe will be applied." With this restriction and the recommendation that 2,4,5-T use be limited to stump and basal application, the staff feels that it is unnecessary to prohibit the use of 2,4,5-T onsite.

11.7.2 Uranium availability

(FPC A-4)

The Energy Research and Development Administration estimates the United States uranium reserves recoverable at a cost of $30 or less per pound of U_3O_8 are 640,000 tons, some 40,000 tons more than the estimate as of January 1, 1975.

The ERDA estimate of the reserve at a cost of $15 per pound U_3O_8 or less is 430,000 tons, 10,000 tons greater than last year's estimate.

The reserve at $10 or less per pound is estimated as 270,000 tons U_3O_8, compared with 315,000 tons reported last year. The reduction in this category does not indicate a decrease in the amount of uranium ore present in the ground, but does indicate that less uranium is available at a cost of $10 per pound or less.

An estimated 23,000 tons of U_3O_8 were added to the $10 reserve in 1975. However, during the year about 12,000 tons of U_3O_8 were mined and shipped to mills, and 56,000 tons were subtracted from the $10 reserve category, primarily due to cost escalation.

Estimates are made by evaluating drilling and other data furnished by the uranium mining companies to ERDA's Grand Junction, Colorado, Office.

Estimated operating costs and those capital costs not yet incurred are used by ERDA in calculating reserves. Profit and costs already incurred, such as expenditures for property acquisition, exploration and mine development, are not included. Therefore, \$10, \$15 and \$30 per pound do not represent the prices at which the estimated reserves would be sold.

ERDA's estimates of reserves are considered to have a high reliability for those deposits for which specific information is available. However, there is always some lag in collecting and evaluating data from new discoveries and development activity. During 1975, the rapid and substantial increase in uranium prices resulted in a significant expansion in exploration and development activity and, therefore, a somewhat larger "carry-over" of unavailable and/or unevaluated data than is normally the case, particularly with respect to further development of lower grade deposits which have become economic at the higher prices. As a result, these estimates do not include some material which will probably qualify as reserves when all of the data are in and evaluated.

In addition to reserves, which are in known deposits and are estimated from detailed drilling and sampling, ERDA has, as part of its National Uranium Resource Evaluation (NURE) program estimated potential resources of 2.9 million tons at a cost of \$30 or less per pound of U_3O_8 on the basis of geologic evidence and limited sampling. (ERDA News Release No. 76-18, March 11, 1976). ERDA has also revised upward its estimate of uranium expected to be produced as a byproduct of phosphate and copper mining during the next 25 years from 90,000 tons U_3O_8 to 140,000 tons.

The following table summarizes the January 1, 1976, U. S. uranium resources position:

U. S. Uranium Resources

January 1, 1976

Tons U_3O_8

\$/lb. U_3O_8 Cutoff Cost	Reserves	Potential		
		Probable	Possible	Speculative
\$10	270,000	440,000	420,000	145,000
\$10-15 Increment	160,000	215,000	255,000	145,000
\$15	430,000	655,000	675,000	290,000
\$15-30 Increment	210,000	405,000	595,000	300,000
\$30	640,000	1,060,000	1,270,000	590,000
Byproduct 1975-2000 1/	140,000			
	780,000	1,060,000	1,270,000	590,000

1/ Byproduct of phosphate and copper production.

Estimates of production, drilling and January 1, 1976 potential resources of uranium were reported in ERDA news release No. 76-18, March 11, 1976, "ERDA Announces Figures for 1975 Uranium Production and Drilling and Estimates for Potential Resources."

The three classes of potential resources are arranged in order of decreasing reliability from probable to speculative. "Probable" potential is in mineralized trends within existing mining districts and productive formations; "possible" potential is in productive provinces and productive formations; "speculative" is in new provinces or new formations.

11.7.3 Land use and recreation

(EA A-8)

Land use within 5 miles of the site is shown in Table 11.7. Figure 2.3 has been modified to show recreational areas. Projections of fishing activity for Cayuga and Oswego counties are shown in Table 11.8.

Table 11.7. Land use categories within 5 miles of the site

Category	Percent	Acres
Active agriculture	33	8,293
Inactive agriculture	18	4,523
Residence	3	753
Water	5	1,256
Wetlands	8	2,010
Forest	32	8,042
Recreation	[a]	
	100	25,132[b]

[a] Recreation accounts for less than 1% of land use within 5 miles of the site.

[b] The total land area within 5 miles is estimated to be approximately 25,000 acres (about half of the 5-mile radius). About 250 acres (1%) are devoted to recreation use, at maximum.

Source: ER, Table 2.2-10

Table 11.8. Fishing activities in Cayuga and Oswego counties

	Cayuga		Oswego	
	1970	1990	1970	1990
Fishermen	16,301	19,391	20,736	30,867
Percent of population	21.1	20.7	20.6	20.7
Average number of fishermen per weekend day	815	969	1,037	1,543
Percent of change in population		23.3		48.9
Percent of change in number of fishermen		18.9		32.8

Source: ER, Table 2.2-9 and staff calculations.

715 214

POOR ORIGINAL

~~721~~ 155

(EA A-8)

The staff understands that there will be a break in the Lake Ontario shoreline due to the plant discharge canal. This will present a barrier to beachcombers, but use of beach areas for other purposes should not be seriously affected.

(ARM A-16)

The applicant plans no high-velocity discharges during the construction phases of the plant.

(INT A-47)

Although previously proposed (ER, Sect. 2.2.3, Rev. 8), the applicant now has no plans for recreational use of the Sterling site.

11.7.4 Roads

(EA A-8, NYS A-53)

The applicant has committed to upgrading of site access roads to acceptable levels (AASHO H20-526-44 loadings, ER, Sect. 4.1.3.3.2). As for U.S. Highway 104, the applicant states as follows (ER, Sect. 4.1.3.3.3): "The main highways are judged to be adequate to handle the increased traffic flow to and from the site, particularly since the starting and quitting times of construction projects are normally off the peak traffic flow times." It seems likely that the increase in local government revenues from the plant could handle the costs of improvement, but the logistics of such improvements need local/applicant coordination in planning and timing. The staff recommends that the applicant work with local authorities in planning and coordinating, upgrading, and repairing access roads.

11.7.5 Health facilities

(EA A-8)

The staff discusses the impact on health care systems in Sect. 4.4.4, and concludes that due to the small number of movers and the proximity of two large metropolitan areas — Syracuse and Rochester — local institutions will not be severely impacted.

11.7.6 Emergency plan

(EA A-9)

The applicant has performed analyses to confirm the practicability of taking protective measures, including evacuation of resident and transient population, within and beyond the site boundary. To assure readiness to cope with major emergencies involving offsite individuals, initial contacts and arrangements have been made with the following agencies: New York State Department of Health, Cayuga County Consolidated Office of Disaster Preparedness, Energy Research and Development Administration Brookhaven Office, Cayuga County Sheriff Department, Fairhaven Fire Department, Rochester General Hospital, and Auburn Memorial Hospital. The New York State Department of Health has been identified as having primary responsibility for radiological emergency planning in the environs of the proposed facility. The staff believes that the cost of emergency preparedness to State and local agencies would not significantly offset the benefits listed in Table 10.1.

11.7.7 Private water intakes

(ARM A-16)

There are private water intakes in the site area that provide domestic water (non-drinking) to cottages. These cottages are located within the exclusion boundary and either are now or will be owned and dismantled by the applicant.

11.7.8 Herbicides

(RGE A-27)

EPA does not set maximum permissible limits for dioxin in 2,4,5-T. However, they are following the recommendations of the President's Advisory Committee of 1971 that the dioxin level in technical grade material of 2,4,5-T be less than 0.1 ppm. The level of dioxin in currently available manufacturers' supplies meets this recommendation. Section 5.5.1.2 has been changed to reflect this new value.

11.7.9 Noise

(NYS A-55)

Environmental ambient sound levels during construction will be such that in the area outside the plant boundary (but less than 5 miles from the power block) about 2800 residents, no school population, and no hospital beds are in the "normally acceptable" category as defined in the Department of Housing and Urban Development criteria. No residents, school population, or hospital beds are within areas designated "normally unacceptable" or "clearly unacceptable" (ER, Sect. 4.1.3.3.5). Operational noise level contribution to the offsite ambient sound will be more than 10 decibels below the L_{90}, or residual, sound levels measured prior to plant construction (ER, Sect. 5.7.1). The applicant estimates that the sound level at 100 ft from an operating 1150-MWe nuclear facility will be 48.5 dBA (ER, Sect. 3.10.1). The staff finds the applicant's assessment of noise levels to be reasonable and expects construction and operational noise levels to be at acceptable levels in offsite areas.

11.7.10 Additional units

(EPA A-45)

The proposed action covered by this Final Environmental Statement is the issuance of a construction permit to the Rochester Gas and Electric Company, Central Hudson Gas and Electric Corporation, Orange and Rockland Utility, Incorporated, and Niagara Mohawk Power Corporation for the construction of the Sterling Power Project Nuclear Unit No. 1. The staff does not know of any future plans by the applicant for additional nuclear units at the Sterling site.

11.7.11 Near-shore currents and shoreline erosion

(ARM A-16, NYS A-56)

Near-shore currents at the Sterling site usually flow parallel to the shoreline. Measurements taken from late June through early October at a point 2300 ft from shore indicate that the predominant flow is in a northeastward direction with an average velocity of 0.14 fps (ER, Table 2.5-1). Southwestwardly currents with an average velocity of 0.10 fps occur infrequently. This latter flow pattern may be evidence of the westward countercurrent which results from the return of water that has "piled up" at the eastern end of the lake by the prevailing westerly wind.

From 1963 to 1973, the average shoreline erosion rate at the site, including the area of McIntyre's Bluffs, was estimated from aerial photographs to be 3.57 ft/year. The eroded material contributes to the littoral drift system in the lake, since these particles can be transported along the beach by the direct action of waves or can be placed in suspension by the turbulence of breaking waves and longshore currents and transported parallel to the shore by these longshore currents.[11]

11.7.12 Reduced Circulating Water Flow During Outages

(INT A-56)

As stated in the reply to ER Item 350.46, the applicant proposes to maintain the full 1860 cfs flow rate even during shutdown. The reasons given by the applicant to justify this procedure include the facilitation of liquid radwaste releases, the control of biofouling, the prevention of ice blockage, and the lessened danger of damage to the circulating water pumps. The applicant has not considered the possibility of adopting the maximum recirculation made during shutdown, but the staff sees no reason why this should not be done. Connection of individual pumps to separate sections of the condenser would require revision of the present design.

11.8 LOCATION OF PRINCIPAL CHANGES IN THE STATEMENT

Topic commented upon	Agency commenting	Section where topic is addressed
Land use	ARM A-16	2.2.2
Station water use	(ER, Revision)	3.3
Transmission lines	INT A-47	4.1.2
Effects on the community	(ER, Revision); EA A-8	4.4
Impacts on water use	INT A-48	4.2
Construction impacts	SUNY A-18; SUNY A-20; SUNY A-51; MSW A-19	4.3.1.1
Heat dissipation system	(ER, Revision); RGE A-25; RGE A-26	3.4, 5.3
Radiological assessment	(ER, Revision); EPA A-42; NYS A-53	3.5, 5.4
Avian impacts	ARM A-19; SUNY A-18; SUNY A-51; MSW A-19	5.5.1.2
Aquatic impacts	COM A-7; EA A-8; RGE A-13; RGE A-14; RGE A-22; RGE A-27; RGE A-33; ARM A-15; ARM A-17; EPA A-35; EPA A-39; EPA A-41; EPA A-45; INT A-48; MRC A-49; NYS A-55	4.3.2, 5.5.2
Energy consumption	EA A-9	8.2.1
Peak load forecasts	EA A-8	8.5.1
Alternate fuels	EA A-9	9.1.2

REFERENCES FOR SECTION 11

1. U.S. Environmental Protection Agency, *Remote Sensing Report, Lake Ontario: A Study of Thermal Discharges from Ginna Nuclear Power Station, Oswego Steam Power Station, and Nine Mile Point Nuclear Power Station*, EPA-330/3-75-002, National Field Investigation Center, Denver, Colorado, April 1975.

2. E. Chermack, T. Galletta, and R. Kathman, *Study of Thermal Effluents at Ginna Power Station by Airborne Radiation Thermometry (1970-1971)*, Lake Ontario Environmental Laboratory, No. 131, January 1972.

3. E. E. Chermack and T. A. Galletta, *Study of Thermal Effluents at Ginna Power Station by Airborne Radiation Thermometry — II (1971-1972)*, Lake Ontario Environmental Laboratory, No. 156, May 1973.

4. E. E. Chermack and T. A. Galletta, *Study of Thermal Effluents at Ginna Power Station by Airborne Radiation Thermometry — III (1973-1974)*, Lake Ontario Environmental Laboratory, No. 191, December 1974.

5. E. E. Chermack and T. A. Galletta, "Power Plant Thermal Effluents in Southeastern Lake Ontario," *Proceedings of the 16th Conference on Great Lakes Research*, 1973, pp. 663-674.

6. E. E. Chermack and T. A. Galletta, "A Four-Year Study of Near-Shore Temperatures Along Southeastern Lake Ontario," preprint presented at *17th Conference on Great Lakes Research*, 1974.

7. "EPA Finds High Bacteria, Virus Count at UE's Trash-Burning Power Plant," *Electr. Week*, Nov. 10, 1975, p. 5.

8. Ref. 7, pp. 5-6.

9. "TVA Tentatively Finds Garbage-Into-Fuel Processing is Poor Economics," *Electr. Week*, October 20, 1975, p. 1.

10. "Fuels From Municipal Refuse for Utilities," Bechtel Corporation Report prepared for Electric Power Research Institute, Report EPRI 261-1, March 1975, p. viii.

11. J. B. Herbich, *Coastal and Deep Ocean Dredging*, Gulf Publishing Company, Houston, Texas, 1975.

APPENDIX A

COMMENTS ON
DRAFT ENVIRONMENTAL STATEMENT

715 218

721 159

Table of Contents

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

RECEIVED
FEB 23 1976

STN 50-485

Mr. William H. Regan, Jr.
Chief, Environmental Projects Branch 3
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

FEB 23 1976

Dear Mr. Regan:

This is in response to your letter dated January 6, 1976, requesting comments on the Nuclear Regulatory Commission's (NRC) Draft Environmental Statement related to the proposed issuance of a construction permit to the Rochester Gas and Electric Corporation (Project Manager), Central Hudson Gas and Electric Corporation, Orange and Rockland Utilities, Inc., and Niagara Mohawk Power Corporation (hereinafter referred to as the Applicants) for the construction of the Sterling Power Project, Unit 1 (Docket No. STN 50-485). The proposed 1,150 megawatt Unit 1 is scheduled to begin commercial operation in April 1984, and is expected to be in service for 30 years or more.

These comments by the Federal Power Commission's Bureau of Power staff, made in compliance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality, are directed to the need for the capacity represented by the Sterling Project and to related bulk electric power supply matters.

The Applicants are members of the New York Power Pool (NYPP), the state-wide electric power pool in New York. In addition, the Applicants are members of the Northeast Power Coordinating Council (NPCC), which includes the major systems in New York State, the major systems in the New England states and those in the Canadian Provinces of New Brunswick and Ontario. The operation of the bulk power transmission and generating facilities of each member in NYPP is coordinated from a single control center, for reliability and economic reasons, but actual control of each of the members' facilities is handled by each of the members themselves. Coordination of the long-range planning of the NYPP and New England systems bulk electric power generation and transmission facilities is accomplished through the several committees of NPCC.

POOR
ORIGINAL

The NPCC has established as a reliability standard for each area, such as NYPP, that the probability of load exceeding generating capacity should not be more than one day in ten years.[1] Based on this criterion, according to the Applicants, the minimum reserve margin for NYPP should be 20 percent of the summer peak load (NYPP is a summer-peaking system).[2] The Federal Power Commission (FPC) has found that many power systems plan for reserve margins between 15 and 25 percent of annual peak load. Moreover, in arriving at estimates of future reserve requirements, the FPC 1970 National Power Survey concluded that with varying regional patterns electric utility planning should overall be based on maintaining an average nation-wide reserve margin of approximately 20 percent. The actual reserve margin in each area will depend on such factors as the shape of the load duration curve (e.g., see Figure 8.3 in the Draft Environmental Statement), the number, size and type of generating units, and the relative strength of interconnections with other areas.

The following tabulation shows the NYPP's projected capability, peak load, and reserve margin for the 1984 summer peak load period, and the effect of the capacity of the Sterling Unit 1 on the reserve margin.

---

[1] Northeast Power Coordinating Council (NPCC) Response dated April 1, 1975, to FPC Order No. 383-3 (Docket R-362).

[2] Applicants' Environmental Report, P. 1.1-9.

1840

1984 SUMMER PEAK LOAD-SUPPLY SITUATION[1]

With Sterling Unit 1 (1,150 Megawatts)	NYPP System
Total Capability - Megawatts	42,121[2]
Peak Load - Megawatts	31,160
Reserve Margin - Megawatts	10,961
Reserve Margin - Percent of Peak Load	35.2
Minimum Reserve Margin (Based on 20 Percent of Peak Load) - Megawatts	6,232
Reserve Deficiency - Megawatts	None
Without Sterling Unit 1	
Reserve Margin - Megawatts	9,811
Reserve Margin - Percent of Peak Load	31.5
Minimum Reserve Margin (Based on 20 Percent of Peak Load) - Megawatts	6,232
Reserve Deficiency - Megawatts	None

POOR ORIGINAL

If the Sterling Unit 1 is available as planned (for April 1984, in time for the 1984 summer peak load), the NYPP's projected reserve margin for the 1984 summer peak will be 35.2 percent of the peak load. Without the Sterling Unit, NYPP's projected reserve margin for that time would be reduced to 31.5 percent of peak load; the NYPP reserve margin would still exceed the stated criterion (i.e., 20 percent of peak load). It appears that the need for the capacity of the Sterling Unit in summer 1984 is not urgent, if the minimum reserve margin is the only criterion. However, it should be understood that the reserve margins calculated in the preceding table are predicated on the projected loads and total capability for the NYPP systems shown in Table 8.9 of the Draft Environmental Statement (DES).

For the period 1975 through 1985, the average annual peak load growth rate is forecast by NYPP to be 4.2 percent. The summer peak load projections by each of the nine Regional Reliability Councils[3]

---

[1] Northeast Power Coordinating Council (NPCC) Response dated April 1, 1975, to FPC Order No. 383-3 (Docket E-362).

[2] Total Capability is adjusted for scheduled maintenance (720 megawatts).

[3] See Attachment A for Council boundaries and explanation of acronyms.

715 220 721 161

received by this Commission in April 1975, for the period 1975 through 1984, show average annual load growth rates of 6.6 percent for ECAR, 7.9 percent for ERCOT, 5.3 percent for MAAC, 6.7 percent for MAIN, 6.7 percent for MARCA, 5.2 percent for NPCC, 8.0 percent for SERC, 8.4 percent for SWPP and 6.0 percent for WSCC. For all nine Councils, the average annual load growth is 6.8 percent.[1] Thus, the NYPP growth rate projected is below the range of growth rates projected by the nine Councils (a range of 5.2 percent to 8.4 percent), and is considerably less than the average rate. With a slightly larger NYPP growth rate, say 5.5 percent, the 1984 summer peak load would be 34,163 megawatts. This would result in reserve margins of 23.3 percent and 19.9 percent with and without Sterling Unit 1. Therefore, an increase of the growth rate of 1.3 percent (4.2 percent + 1.3 percent = 5.5 percent) would result in the need for the capacity of the Sterling Unit for the 1984 peak period.

Consideration must also be given to the failure of many power systems to meet generating plant construction schedules. For example, of nine units that were scheduled for completion by NPCC systems in the first half of 1975, only one was actually completed. For the country as a whole, only 37.5 percent of generating capacity scheduled for completion between January 1, 1975, and June 30, 1975, was actually completed in that time.[2] There is a very real possibility that the total capability shown in the preceding table, on which the reserve margins are based, will not in fact be available. Even if load growth should be held to the 4.2 percent postulated, reduced capacity would reduce the reserve margin.

The above paragraphs point out that determination of the need for additional capacity on the basis of a minimum reserve margin depends, to a large extent, on forecasting the NYPP load and generating capability accurately. If the load growth is less than expected, the scheduled operation of a unit could be delayed; if the load growth is more than expected, the unit would be needed sooner. The following should be kept in mind: it is easier to delay the operation of a generating unit beyond its scheduled commercial operating date than to bring it on-line sooner. Also, a reserve margin greater than 20 percent would allow sale of some capacity for a short period of time to neighboring utilities. On the other hand, failure to maintain the minimum reserve margin would jeopardize system adequacy and reliability.

---

[1] Federal Power Commission News Release No. 21520, dated June 30, 1975.

[2] Federal Power Commission News Release No. 21817, dated October 20, 1975.

The NYPP, up to the present time, has depended heavily on oil for its electric energy requirements. In 1975, it was projected by the NYPP, 44 percent of the electric energy was to have been produced from oil, 19 percent from coal, 17 percent from nuclear fuel and 20 percent from hydro power.1/ For the United States in January 1975, 19 percent of the electric energy was produced from oil, 45 percent from coal, 8 percent from nuclear, 15 percent from hydro, and 13 percent from natural gas.2/ The NYPP projects a shift by 1990 toward more use of nuclear fuel for the production of electric energy: it is expected that 25 percent of the energy will be produced from oil, 18 percent from coal, 47 percent from nuclear fuel, and 10 percent from hydro power.1/ It seems prudent to make use of nuclear fuel to the extent possible and lessen our dependence on foreign oil.

Because nuclear power is expected to play an increasingly important role in the future, the availability of nuclear fuel for electric generation should be discussed in the Final Environmental Statement to a greater extent than discussed in the Draft Environmental Statement. Securing a long-term supply of fuel (in this case, nuclear fuel) is vital to the reliability of an electric system.

The Bureau of Power staff concludes that additional capacity equivalent to that represented by the Sterling Unit 1 is needed to maintain the adequacy and reliability of the NYPP bulk power system.

Very truly yours,

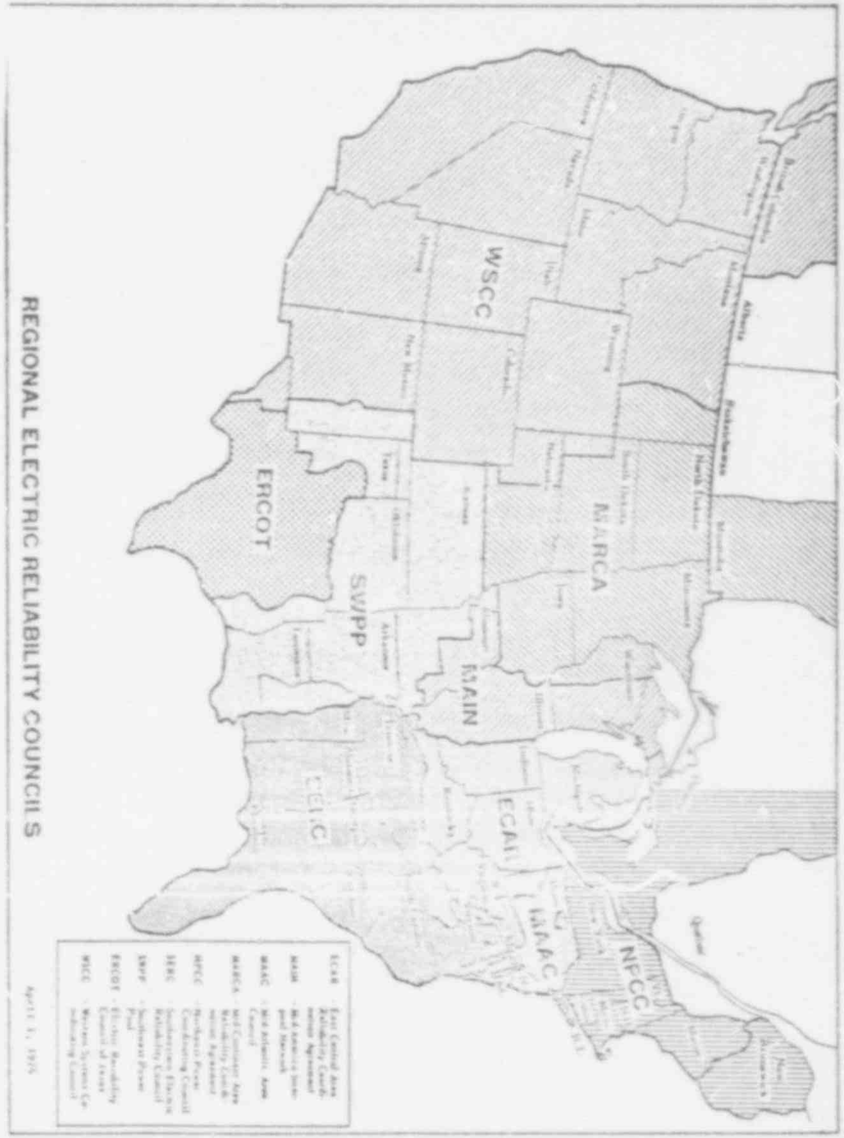
Alton P. Donnell

Alton P. Donnell
Acting Chief, Bureau of Power

Attachment

1/ "1975 Report of Member Electric Corporation of the New York Power Pool and the Empire State Electric Energy Research Corporation Pursuant to Article VIII, Section 149-b of the Public Service Law" Volume 1, April 1, 1975, Page 4.

2/ Federal Power Commission News Release No. 21259 dated March 27, 1975.



REGIONAL ELECTRIC RELIABILITY COUNCILS

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA. 19082
(215) 596-1671

8400
February 24, 1976

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 3
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Refer to: 50-485; Draft Environmental Statement, Sterling Power Project Unit 1, Cayuga County, NY

Dear Mr. Regan:

We have reviewed the above statement on power plant and transmission line construction and maintenance, and in our view the impact of these activities on terrestrial vegetation is satisfactorily described and considered.

The applicant appears to have taken all reasonable measures for mitigation of erosion and other adverse effects.

Thank you for the opportunity to review this Draft Statement.

Sincerely,

DALE O. VANDENBURG
Staff Director
Environmental Quality Evaluation

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
NEW YORK AREA OFFICE
666 FIFTH AVENUE
NEW YORK, NEW YORK 10019

REGION II
26 Federal Plaza
New York, New York 10007

FEB 27 1976

IN REPLY REFER TO:
2.1SS

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 3
Division of Site Safety and
Environmental Analysis
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

Subject: Draft Environmental Statement
Sterling Power Project Unit 1

A copy of the draft environmental statement for Sterling Power Project Unit 1, Cayuga County, New York, has been received by the New York office of the Department of Housing and Urban Development for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

As set forth in 10 CFR Part 100, a nuclear power plant must have a low population zone (LPZ) immediately surrounding its site. Since no technology is without risk, the intent of the LPZ is to provide some assurance that effective action can be taken to minimize exposure of individuals outside the station to any radioactive materials which may be released in the event of a serious accident at the nuclear facility.

We recommend, therefore, that the applicant take the lead to maintain low intensity uses within the LPZ and to deny land uses that may jeopardize the safe operation of the nuclear plant.

In addition, we recommend that the applicant take the lead in establishing such systems as an emergency warning system and a disaster plan for the LPZ so that appropriate measures can be quickly taken in the event of a serious accident.

The comprehensive plans of both Cayuga County and the Central New York Regional Plan and Review Board recommend low density uses, open space, recreation and conservation in this part of the County. Appropriate emergency measures, therefore, should also be devised in the event of a serious accident jeopardizing short-term concentrations of large numbers of people attending a recreation center located within the LPZ area.

The opportunity for this office to review the draft environmental statement is appreciated.

Sincerely,

for Joseph Monticciolo
Director
New York Area Office

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

February 27, 1976

RECEIVED
MAR 3 1976
U.S. NUCLEAR REGULATORY COMMISSION
Mail Section

Mr. Wm. H. Regan, Jr.
Chief
Environmental Projects Branch 3
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

STN 50-485

Dear Mr. Regan:

This is in reference to your draft environmental impact statement entitled, "Sterling Power Project Unit 1." The enclosed comments from the National Oceanic and Atmospheric Administration - Environmental Data Service, and the Great Lakes Environmental Research Laboratory are forwarded for your consideration.

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

Sincerely,

Sidney R. Galler
Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosures - Memo from: NOAA, Environmental Data Service (1-15-76)
NOAA, Environmental Research Laboratories (2-17-76)

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA SERVICE
Washington, D.C. 20235

JAN 19 1976

January 15, 1976

Dx61/DLEC

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

FROM: Douglas LeComte
Special Projects

SUBJECT: EDS Review of DEIS 7601.09 (Sterling Power Project Unit 1)

The EDS has reviewed the subject DEIS and offers the following comments:

> The draft environmental statement would be more complete if the micrometeorological impact of the thermal plume in Lake Ontario were discussed. Increased water temperatures might contribute to increased occurrences of fog, as well as increased convection. Warmer temperatures would conceivably even enhance lake-effect snowfalls over local areas by helping to destabilize lower layers of the atmosphere and by augmenting evaporation of lake water.

715 223

721 164

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Great Lakes Environmental Research Laboratory
2300 Washtenaw Avenue
Ann Arbor, Michigan 48104

February 17, 1976

TO : Director
Office of Ecology and Environmental Conservation, EE

FROM : Eugene J. Aubert
Director, GLERL, RF24

SUBJECT: DEIS 7601.09 - Sterling Power Project Unit 1

The subject DEIS prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, on environmental impacts of construction of a nuclear power plant on Lake Ontario shoreline has been reviewed and comments herewith submitted.

Most serious effects on Lake Ontario ecology will be caused by the use of lake water for once-through cooling. Environmental Impact Statement estimated that at the intake structure, impingement of 5 to 15 million fish per year and entrainment of up to 22 million larvae and 2 million juveniles per day are reasonable possibilities. Losses of these magnitudes could substantially reduce recruitment and standing crops on the local level (Paragraph 5.5.2.3). To minimize fish and larvae losses, the U.S. Nuclear Regulatory Commission specified that the [illegible] structure shall be positioned at a minimum bottom depth of 35.5 feet [illegible] mean lake elevation. The alternatives for the intake structures discussed [illegible] the Statement are limited only to the construction methods: either tunnel, buried pipe, or surface intake. It is suggested that alternatives concerning intake depth be investigated and evaluated. Definite advantage to the lake environment would be gained by placing the intake structure in the hypolimnion, say 80 foot depth. This depth can be reached by extending the present 4200 foot long tunnel to approximately 9300 feet length. Some of the advantages of deeper intake would be:

(1) Impingement and entrainment losses would be greatly reduced due to smaller population of fish larvae and juveniles at greater depths. A large fraction of phytoplankton and zooplankton will survive cooler water temperatures, while in water taken from the surface during hotter summer months mortality may approach 100%.

(2) Water discharges during summer months could be kept at the temperature level of lake surface, eliminating thermal plume during these months. For the proposed system, the discharge temperature [illegible] reach 94.7°F during the month of August and the area within 3°F [illegible] temperature above the ambient was estimated to be 380 - 2000 acre

(3) Nutrient-rich cooling water from hypolimnion would support production of food for the dense fish populations near the discharge plume. Oxygen enrichment should be considered.

(4) Low intake water temperatures would require less cooling water and at least partially compensate the higher construction and operation costs. During winter months, the higher temperatures in deep water as compared with surface water would eliminate need to recirculate cooling water.

Environment Report prepared by Rochester Gas and Electric Company states that although no hunting will be allowed on the site, fishing and hiking will be encouraged to the extent consistent with the considerations of public health and safety (Page 2.2 - 7). Further, it states that it is known that power plant thermal discharge will attract the fish during early spring through the late fall and for this reason, power plants are expected to provide excellent fishing locations. It can be assured that the proposed Sterling Plant will therefore provide incentive for sport fishing in the area (Page 2.2 - 14). However, besides these statements of general nature, the Report provides no specific plans for envouragement of recreational activities. It is suggested that the Report include plans for construction of access roads, parking areas, boat launching ramps, fishing piers, and artificial swimming beaches. Acquisition of additional shoreline and land for a public park would serve to improve public image and acceptance of the proposed power plant.

The Statement lists minimum still water level of Lake Ontario as 239.74 feet MSL (U.S. Coast and Geodetic Survey). Derivation of this level assumes a complete failure of two dams on the St. Lawrence River, Iroquois Control Dam and one of the two - either Long Sault or Moses-Saunders. Further, it assumes that for one year no action will be taken to correct that situation. On top of this, a storm is added with 100 mph winds from the southeast. This minimum water level is based on unrealistic assumptions, does not represent still water level in a lake, and ignores wave action. Still water level at any time, even during storms, is determined by averaging instantaneous water level readings from several water level gages around the lake. Note also that water level gages do not record water level fluctuations due to surface waves. From power plant operation standpoint, submergence of intake should be such that would expose the intake to air and ice entrainment. This design water level usually is determined from the lowest recorded instantaneous water level at the site reduced by about half of the critical wave height.

Both the Impact Statement and Environment Report use two water level datums: MSL (USC & GS) and IGLD (1955). The Report also lists msl (USGS). Use of only one datum would reduce chances of errors. For an area of limited extent, such as power plant construction, any one datum would serve the purpose; however, for problems concerning entire Great Lakes System, the IGLD (1955) is more correct. It reflects true water level relationships which are slowly changing due to crustal movement.

In the test of the Statement, some errors were noted. Captions of the Figures 3.6 and 3.7 should be reversed. In the Figure 3.5, the intake structure is shown above the water level, elevation 2'6 feet. In the Table C.1, mean depth of Lake Ontario, which is usually defined as volume divided by surface area, should be 283 feet instead of 276 feet. Since volume and depths of a lake depend on the lake level, the table would be improved by adding "below LWD" in the Volume and Depth lines. Low Water Datum for Lake Ontario is 242.8 feet.

cc: Kent Groninger, Rx3

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT
STERLING POWER PROJECT UNIT 1
DOCKET NUMBER STN 50-485
BY
ECOLOGY ACTION, BOX 94
OSWEGO, N.Y.

The Draft Environmental Statement is not only inaccurate and incomplete, but also makes illogical conclusions on what little evidence it presents to attempt to prove need and environmental compatibility. It is therefore recommended by intervenors, Ecology Action, that large portions of the document be redrafted.

Many of the problems can be uncovered by the NRC Staff if they make a careful reading of the testimony and cross-examination in Case PSC 80005 (New York State). The following points highlight the grossest errors and omissions:

1. The site: To allow a reader of this section to understand the location of the proposed plant and the impact it would have because of the location (without referring to other parts of the DES, the following points should be included:

a. The population which could be affected by an accident at the plant include those visiting Fair Haven State Park, boating in Fair Haven Bay, attending the State University of New York College at Oswego.

b. Land use within five miles should include recreation, in addition to agriculture, forest and wetlands. A mention of the potential number of fisherman per day in the area when salmon fishing industry is fully developed should be included.

c. Agricultural products should include onions, lettuce and apples, and indicate the amount of each. Special farming land such as muck farms should be mentioned.

d. The seismological category assigned to this area should be mentioned.

e. A mention should be made of the uniqueness of the hardwood stand along the southern shore of Lake Ontario, which the Applicant would destroy.

2. The station:

a. The NRC Staff states that the Applicant "believes that this unusually high intake velocity will alert fish to the danger of entrainment" (pg 3-7). The Staff should report the results of their own analysis to see if the Applicant's statement is correct.

b. The NRC Staff should describe the analysis done on material supplied by the Applicant which allows them to conclude that the Department of Transportation regulations will be followed.

c. The Staff should analyze whether the chemical and biocidal effluents would effect the water supply at Oswego.

d. The Staff should investigate what commercial service will dispose of the sludge from the sewage waste treatment system, where this service will dispose of it, how fast this disposal site will fill up, and the strain placed on those sites.

e. The Staff should keep itself informed on changes in the railroad spur plans and the site of the access roads.

3. Impacts on Land Use

a. The Staff should give the size of area impacted by the stockpile of excavated material.

b. The Staff should clarify the statement "Beach access for recreational uses will be restricted in the immediate plant vicinity" (pg. 4-2). Does this mean that hikers and beach combers will be prevented from walking along the shoreline? If so, the impact on present and future recreation must be assessed.

c. The impact of the rip-rap dike on aesthetics should be assessed.

d. The stockpile or spoil pile area should be included in the percentage of land impacted during construction.

e. The Staff should recommend that the Applicant be required to have its workers form car pools to decrease inconvenience and hardship to the residents and users of 104A. The Staff should describe the study done to come to its conclusions that roads "are probably capable" and "will probably not cause undue inconvenience" (pg. 4-9). They should define the word undue.

f. On what basis does the Staff arrive at a figure of 155 families expected to relocate in the Sterling area. What is their margin of error in this estimate?

g. The Staff should explain what it means by the statement that the Applicant should "join with local authorities to repair access roads"

h. The Staff contradicts Applicants testimony (PSC 80005) on pg 4-11, item 12. Oil not water will be used as a spray.

i. It is incredible that the Staff's evaluation on pg 4-12 does not include the great strain on doctors that the additional residents and workers will have (there are currently no doctors in the Sterling-Fair Haven area).

4. Environmental Effects

a. Table 5.5 should include a breakdown of fish.

b. Radiation dose estimates for air and water pathways should be combined with those the population receives from Nine Mile Point nuclear plants (3 plants).

c. The Staff should be advised to watch developments in the PSC 80005 hearings carefully with respect to water quality, and modify Section 5 accordingly.

d. The Staff should evaluate the feasibility of use of waste heat at Sterling, or the use of waste heat from plants which are alternates.

e. The Staff should clarify its position that Sterling nuclear plant will not "significantly stress an important component of Lake Ontario ecosystem" yet say "acting in concert with other power plants the cumulative impact could result in significant ecological change" (pg. 5-37).

5. Need

a. The Staff frequently state that need projections are highly uncertain (pg. 8-12) adequate data are not available (pg. 8-12, 8-15). Thus, the logical conclusion is that need has not been demonstrated, and that final approval of the construction license should be withheld until need can be shown.

b. The Statement on pg. 8-6 that "baseloads are projected to be carried by nuclear and hydro" is not born out by Table 8.7 which includes coal and oil in baseload. In fact, the Staff's discussion on peak vs. base unit needs is contradictory. On pg. 8-15 they state that need is based on annual peak load yet on pg 8-14 they dismiss interruptible load contracts as an alternative to building the plant because this technique is effective in reducing peaks not the need for baseload units such as Sterling. The Staff should pursue interruptible loads as a viable alternative to the proposed nuclear plant.

c. The Staff should study carefully the utility's booklets and pamphlets etc. for conservation, and should see what percentage is geared towards energy conservation as opposed to electricity conservation.

d. The impact of new heat stress standards would not necessarily require air conditioning. Shades and vacations are other alternatives which employers could use. Also, the "advent of electric automobiles" should not be presented as a possible source of increased need, since the need the Applicant is attempting to prove is peak load, and electric automobiles would use night electricity (off peak).

e. Since each of the four utilities will own a percentage of the plant, each utility needs to prove need. The Staff should supply estimates of need for each utility for summer and winter separately.

f. The Staff should determine the cost of replacement power before it assumes it is high cost compared to the price of electricity produced by the proposed Sterling plant.

g. Since the Staff clearly feels that generation mix is important (pg. 9.1) it should not lump oil and coal into a fossil category thereby not showing generation mix adequately (Fig. 8.3).

6. Alternatives

a. The Staff has not evaluated a plan to float windmills on Lake Ontario. Such a plan was developed by Professor Heronemus (see testimony in Nine Mile Point Unit # 2, construction license hearing before the AEC).

b. The Staff has not evaluated the alternative of coal-garbage combination plants.

c. The Staff should be sure to include replacement power costs in coal vs. nuclear cost comparisons (Table 9.1).

d. The reason the Staff has not found that the Ginna site is a more suitable site than Sterling is because of incorrect and incomplete data. The Applicant's own witness (PSC 80005) says the terrestrial impact would be greater at Sterling than at Ginna. Transmission line cost assumptions are just assumptions (see later point). Factors omitted are : Advantages of second nuclear plant at Ginna (same emergency plan can be used: reduced decommissioning costs because one site not two would have to be guarded, land acquisition costs at Sterling were greater than land at Ginna, less aesthetic impact at Ginna because of the spoiled site vs. virgin site concept, access roads already upgraded at Ginna, etc.). Table 9.4 should be redone and appropriate conclusions drawn.

e. Distance of load centers and cost of transmission and loss of electricity should be analyzed in site comparisons.

7. Additional points

a. Transmission requirements - The Staff has incorrectly assumed that the transmission grid will go through Sterling (pgs. 2-7, 3-22, 4-1, 5-1, 9-8). Although the Applicant believes its transmission proposal will be approved, an equally viable conclusion is Ecology Action's position (intervenors in the transmission line hearing) that it will not be approved - it will not be a 765KV line, and will not go through Sterling. If the Staff insists on agreeing with the Applicant's assumption it must state why. Another alternative is to assume that a new line will need to be constructed to the Volney substation. Thus

comparisons with the Ginna site would include this comparison with a new line constructed to the Pannell substation. Factors such as new vs. the use of an existing right of way etc. become important factors. Another alternative is to wait for the outcome of the transmission line hearings before approving a plant at either the Sterling or Ginna sites.

b. The Staff should discuss the feasibility of an adequate emergency plan. Due to the fact that Sterling is in the snowbelt (pg. 2-9) may make it impossible to evacuate citizens during such a storm. The Staff should look into the cost and feasibility of the local police, fire, health, coast guard and transportation facilities carrying out an emergency plan. The financial impacts may severely effect the indirect benefits listed on Table 10.1.

c. We are pleased with the Staff's recommendation for a review of construction activities, monitoring programs, and ecological baseline studies.

Respectfully,

Helen Daly

Helen Daly, for Ecology Action
Feb. 27, 1976

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649

R. R. KOPROWSKI
VICE PRESIDENT

TELEPHONE
AREA CODE 716 546-2700

March 1, 1976

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

RECEIVED
MAR 2 1976
U. S. NUCLEAR REGULATORY COMMISSION
Mail Section

Subject: Rochester Gas and Electric Corporation
Sterling Power Project Nuclear Unit No. 1
Docket No. STN-50-485
File: 0278

Dear Sir:

Rochester Gas and Electric Corporation has reviewed the Draft Environmental Statement (DES) published December 1975 related to the construction permit stage of Sterling Power Project Nuclear Unit No. 1 and transmits its general comments herewith.

These comments include the identification of recent design progress since the publication of the DES which will be included in Revision 8 3/76 to the Environmental Report. A change in the steam generator blowdown system and the addition of full flow condensate demineralizers will increase effectiveness of steam generator water chemistry control. An approximate 5% reduction in design condenser heat rejection and circulating water system flow will reduce estimated water use and waste heat discharge to the receiving water body. The net effects of these design changes upon environmental assessments are also discussed in the comments.

Please be advised that we will submit, as a supplement, detailed comments relating to technical, editorial and typographical matters on or about March 12, 1976.

Very truly yours,

Robert R. Koprowski

Robert R. Koprowski
Vice President
Engineering and Construction

xc: see page 2

715 228

721 168

2069

DATE March 1, 1976
TO Director, Division of Site Safety and
Environmental Analysis
Office of Nuclear Reactor Regulation

xc: Dr. George C. Anderson
Oceanography Department, WB-10
University of Washington
Seattle, Washington 98195

Edward Luten, Esq.
Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Lester Kornblith, Jr.
Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Auburn L. Mitchell, Esq.
Office of the Executive Legal Director
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Alan S. Rosenthal, Chairman
Atomic Safety and Licensing Appeal Panel
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Joseph Marshall, Chairman
Cayuga County Legislature
Cayuga County Office Building
Auburn, New York 13021

Mr. Albert E. Curtis
Town Supervisor
Sterling Town
P. O. Box 11
Fair Haven, New York 13064

Ms. Sharon Morey
California Road, RD #3
Oswego, New York 13126

J. Bruce MacDonald, Esq.
Counsel
New York State Atomic
Energy Council
99 Washington Avenue
Albany, New York 12210

Lex K. Larson, Esq.
LeBoeuf, Lamb, Leiby &
MacRae
1757 N Street, N.W.
Washington, D.C. 20036

March 1, 1976

Rochester Gas and Electric Corporation
Comments on the
NRC Draft Environmental Statement for
Sterling Power Project Nuclear Unit No. 1

DES Pg iii, Item 3a STERLING POWER PROJECT SITE Acreage

The applicant presently owns or has under option 99% of the Sterling Power Project site which comprises a total area of about 2800 acres. This survey area differs from the 2600 value in ER Table 2.7-33 representing the total general habitat acreages for reasons given in the footnote. The proper identification of the total acreage for the Sterling Power Project site is about 2800 acres.

DES Pg iv, Item 7b DETAILED EROSION CONTROL PLAN

The applicant submits that it has complied with the regulatory guide in establishing measures to mitigate undesirable effects due to erosion during clearing and construction. The implementation of the erosion control measures presented in Chapter 4 of the Environmental Report in conjunction with the applicant's SPDES Construction Runoff Permit Application (dated October 15, 1975) comprise the elements of a detailed erosion control plan. The SPDES application identifies discharge points, numbers of retention ponds, contributing acreages of construction areas, design storm flow, treatment and effluent limitations, etc. The subject plan encompasses the Sterling Power Project construction site in its entirety. It is submitted that the requirement for a detailed erosion control plan will be satisfied through the issuance of the SPDES construction runoff permit. We recommend that this requirement be made a part of control plan for construction activities.

DES Pg iv, Item 7f CONTROL PROGRAM FOR CONSTRUCTION ACTIVITIES

A comprehensive program for environmental management during construction of the plant will be required in connection with the proceeding before the New York State Board on Electric Generation Siting and the Environment, pursuant to Article VIII of the New York State Public Service Law. Applicant believes that this program will satisfy in all respects the conditions on this subject proposed by the NRC Staff.

DES Section 3.5 POWER BLOCK SYSTEM CHANGES

Revision 14 dated January 14, 1976 to the SNUPPS (Standard Plant) Preliminary Safety Analysis Report (PSAR) included design changes which reflects addition of a condensate polishing system, systems associated with the condensate polishing system and modifications to the steam generator blowdown system. Changes in the steam generator blowdown system will increase effectiveness of steam generator water chemistry control. Revisions to this system result in reductions in the equilibrium secondary system activities (PSAR Table 10.4-7) and changes in expected annual liquid discharge activities via turbine building drains (ER Table 3.5-2). REVISION 8 3/76 to the Environmental Report provides appropriate revisions to the sections affected by the above design changes. In summary, specific radionuclides given in ER Table 3.5-2 have revised annual release values equal to or less than those given in REVISION 7 12/75 of the ER.

DES Section 3.4 CHANGE IN CIRCULATING WATER SYSTEM FLOW

Design flow data for circulating cooling water systems formally revised during January 1976 follow:

Water System	Flow (GPM)	Delta T (F)	Heat Rejection (BTU/hr)
Condenser	795,000	19.7	7.86×10^9
Service	38,000	10	0.19×10^9
Total	833,000	19.3	8.05×10^9

At full power, the combined condenser cooling and normal service water system will operate at a total flow of 833,000 GPM with a 19.3°F temperature difference. This results in a combined heat discharge of 8.05×10^9 BTU/hour. This revision represents reductions of approximately 4% in water use and 6% in heat rejection when compared to the initial system design values. REVISION 8 3/76 to the Environmental Report provides appropriate revisions to sections of Chapter 3 affected by the above design changes.

It is noted that environmental impact analyses attributed to the operations of Sterling Power Project Nuclear Unit No. 1 were performed using a condenser cooling water flow of 834,000 GPM with a temperature rise of 20°F above intake ambient temperature. In addition, a plant service water flow of 35,000 GPM with an estimated temperature rise of 12°F above ambient, and an average industrial waste and radwaste water flow of 32.3 GPM,

were included in the discharge with the condenser cooling water, thus providing a total average continuous flow from the discharge canal of about 869,032 GPM (1936 cfs) at a temperature rise of 19.7°F above lake ambient temperature. The environmental assessments based upon the original flows are in most instances, slightly increased in conservatism and adjustments in impact are not warranted with the exception of liquid effluent dose calculations.

The combined effect of design changes to the steam generator blowdown system and reduced circulating cooling water flow upon discharge canal concentrations were evaluated to assess effects upon radiation dose calculations. Changes in circulating cooling water design data were incorporated resulting in a reduced total available annual dilution flow (1.33×10^{15} cc/yr). Adjustments in liquid effluent dose calculations were made in view of the combined effect of the aforementioned modifications. Revised dose estimates indicate values slightly higher for humans and other organisms than were given in ER REVISION 7. Adjusted doses resulting from liquid effluent releases (revised ER Table 5.3-4) show that the "as low as practicable" criteria of 10CFR50, Appendix I, are met. REVISION 8 3/76 provides appropriate revisions to sections of the ER affected by this reassessment of radiation dose calculations.

DES Section 3.7.3 GASEOUS WASTES

The estimated emissions of pollutants from the two emergency diesel generators and auxiliary steam boiler are being revised based upon:

(1) the use of No. 2 (.35%sulfur) fuel oil
(2) 450 GAL per hour (per diesel) rate of fuel consumption, and
(3) revised emission factors

The emissions from these sources are below the "new source" performance standards for such devices, irrespective of requirement applicability. REVISION 8 3/76 to the Environmental Report provides appropriate revisions to the sections affected by above changes in system characteristics.

DES Section 5.5.2.2 CHLORINE

Section 5.5.2.2 addresses the applicant' planned procedure for controlling biological fouling of the circulating and service water systems.

The DES states:

> According to the applicant, the resulting concentrations in the discharge will be in compliance with Environmental Protection Agency Guidelines. However, compliance with EPA Guidelines limits only the free available chlorine that can be discharged, not the combined residual chlorine (e.g., chloramines and chloro-organics), which is also extremely toxic to aquatic life and may be discharged in amounts exceeding free available chlorine. Therefore, a criterion based solely on concentrations of free available chlorine fails to provide satisfactory safeguards for aquatic organisms. (Page 5-25, emphasis supplied.)

As stated by the applicant, the Environmental Protection Agency "new source" standard of performances for the steam electric generating point source category limits the discharge of free available chlorine in once through cooling water to 0.5 mg/l maximum concentration and 0.2 mg/l average concentration for not more than two hours in any day. This is the standard of performance (or effluent limitation) established by EPA for new source power plants (see 40 CFR Part 423.) In effect the Commission Staff is reviewing a standard of performance (effluent limitation) established by EPA under the Federal Water Pollution Control Act Amendments of 1972 (FWPCA) and recommending that, instead of the EPA established limitation, that total residual chlorine concentration be maintained at 0.1 ppm (mg/l) at the point of discharge.

The implication in the Commission Staff's review and recommendation with respect to chlorine is that more stringent limitations can be imposed by the Nuclear Regulatory Commission (NRC) pursuant to its responsibilities under the National Environmental Policy Act of 1969 (NEPA). Such a conclusion, if intended, is contrary to section 511(c)(2) of the FWPCA.

The section is quite clear that the NRC isn't authorized to review or revise limitations established under the FWPCA. The NRC has specifically recognized this limitation on its NEPA authority in a recent memorandum between the NRC and EPA (Second Memorandum of Understanding and Policy Statement Regarding Implementation of Certain NRC and EPA Responsibilities, 40 Fed, Reg. 60115, December 31, 1975). Paragraph 4 of the NRC Policy Statement on Implementation of Section 511 of the Federal Water Pollution Control Act (FWPCA), which accompanies the Memorandum of Understanding indicates that the NRC will not require adoption of an alternative because it would produce less water pollution than allowed by the FWPCA limitations or requirements (40 Fed. Reg. 60120).

The applicant has already indicated to the Staff that it intends to adopt procedures which limit chlorination to a one-hour period (in three 20 minute segments) rather than the two hour period allowed by 40 CFR Part 423. In addition, the applicant has expressed its intent to keep chlorine discharges as low as practicable (consistent with the chlorination equipment and techniques proposed for Sterling Power Project Nuclear Unit No. 1) based on operating experience at the facility. The applicant's proposed procedure for control of biological fouling is not only in conformity with FWPCA limitations, but also representative of a reasonable effort to further reduce such discharges below "new source" levels in Part 423.

DES Pg 6-5 CONTINUATION OF 1974 ICHTHYOPLANKTON SAMPLING PROGRAM FOR AT LEAST ONE YEAR

Section 6.1.3.2 of the DES states "The staff believes further studies are required to adequately characterize ichthyoplankton and juvenile fish populations in the Sterling site area of Lake Ontario." The staff establishes the requirement that " . . . the applicant must continue the 1974 ichthyoplankton sampling program for at least one year . . . " with a listing of modifications.

The applicant believes a further fish egg and larvae study is not required at the Sterling site for the following reasons:

1) 1974 study results showed that there was relatively homogoneous spawning activity across the site.
2) identification of larvae sampled showed that the alewife predominated, and that the site was not a unique spawning area for any species of game or forage fish.
3) since the Sterling area appears to be typical, in terms of spawning activity of the open shoreline of Lake Ontario, the impact of the Sterling Plant upon this site should be viewed in light of the entire lake shoreline.
4) the applicant does not believe that the impacts expressed by the 1974 fish egg and larvae study warrant further investigation to the extent of conducting a more intense biological survey nor would the costs of such a study be justifiable based on the expected result (i.e., a more refined impact assessment).

The applicant's detailed comments on the allegations presented in the DES concerning the 1973 and 1974 ichthyoplankton studies will be included in the March 12, 1976 submittal.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
700 East Water Street, Syracuse, New York 13210

March 1, 1976

Mr. William H. Regan, Jr.
Chief, Environmental Projects
Branch 3
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

STN 50-485

Dear Mr. Regan:

We have reviewed the Draft Environmental Statement related to construction of Sterling Power Project Unit 1, Cayuga County, New York, dated December 1975.

We have no comments to make regarding items of concern or interest to the Soil Conservation Service.

We appreciate the opportunity to review and comment on this proposals.

Sincerely yours,

Robert L. Hilliard

Robert L. Hilliard
State Conservationist

cc: R. M. Davis, Administrator, SCS, Washington, D.C.
Dr. Fowden G. Maxwell, Coordinator, Office of Environmental Quality Activities, USDA, Office of the Sec'y, Washington, D.C.
Council on Environmental Quality, Washington, D.C. (5 copies)

2179

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, BUFFALO
1776 NIAGARA STREET
BUFFALO, NEW YORK 14207

NCBCO-S

1 March 1976

STN 50-485

Mr. D.C. Scaletti
NRC Environmental Project Manager
Division of Reactor Licensing
Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Scaletti:

The draft environmental impact statement for the Sterling Power Project Unit 1, issued by the U.S. Nuclear Regulatory Commission, has been reviewed by my staff. The following comments are submitted as being pertinent:

General Comments

1. A major concern of the U.S. Corps of Engineers is the placement of fill or dredged material in the freshwater wetlands or creeks and streams within the project site. Fill material includes, but is not limited to, such items as culverts, railroad spurs, access roads, energy dissipaters, berms, riprap, and transmission line towers. The placement of fill or dredged material within freshwater wetlands will require a Department of the Army permit. Regulatory authority is established over these areas under the auspices of Section 404 of the Federal Water Pollution Control Act of 1972 (PL 92-500). Construction cannot be initiated in these areas until the proper permits are secured. The potential impacts on freshwater wetlands must be more thoroughly analyzed. The Sterling site wetlands are part of a system of freshwater wetlands that extend along the shoreline of Lake Ontario. The cumulative loss of individual wetlands contained within this system must be investigated.

2. The high intake velocity of 1.5 fps could result in the unnecessary loss of alewives through impingement of adults and entrainment of larvae and juveniles. As indicated in the draft EIS, when the impact of impingement at Sterling is added to that of all power plants

2210

715 234

721 173

on Lake Ontario, the yearly loss could be as high as 11 percent of the lakewide alewife population with Sterling's contribution amounting to 1.4 percent. Further, the alewife population is affected by the cumulative loss of eggs, larvae and juveniles through entrainment at all power plants along Lake Ontario. The impact of impingement and entrainment at Sterling could be significant with respect to the lakewide population of alewives. Therefore, a more thorough evaluation of the impacts associated with the operation of the cooling system is indicated.

Specific Comments

Section 2.2.2 - The land use section accounts only for the agricultural use. The acreage of land utilized by residential, commercial, and public interests is not mentioned. In addition, wetland acreage should be accounted for. Land use within a five-mile radius of the site would be adequate.

Section 2.2.3 - Indicate whether or not any private water intakes are located along the shoreline under consideration.

Section 2.4.1 - Mention should be made of the present shoreline erosion rate and the contribution of this erosion to the littoral drift system.

Figure 2.5 - The data used to characterize vegetation communities is misleading. For example, Figure 2.2 indicates that a wetland is adjacent to Ninemile Creek, whereas Figure 2.5 indicates that this area consists of intermediate hardwood, tilled land, orchard, scrubland, and pasture. Comparing Figure 2.2 to Figure 2.5, one is unable to determine the location of existing freshwater wetlands. These wetlands must be accurately identified since they are sensitive and valuable environmental resources.

Section 2.5.1 - "Measurements at the site indicate generally NE or SW current flow, essentially parallel to the shoreline." Does this statement pertain to the littoral currents? If so, indicate the direction of the predominant current and its velocity. This information along with a discussion of available littoral drift is necessary to evaluate the impacts of the discharge structure on the natural shoreline erosion rate.

Section 2.7.2.2 - It is not possible to accurately assess the impacts of the cooling system on the aquatic food chain when nannoplankton, at the very base of the food chain, have not been studied. The applicant should provide a thorough appraisal of the project area to determine the abundance and diversity of nannoplankton.

Section 3.4.2 - The applicant's statement that unusually high intake velocities will alert fish to the danger of entrainment was based on a study using salmonids, specifically coho and chinook salmon. Swimming against high velocity currents is directly related to their spawning behavior. Most fish species will not exhibit this type of behavior and, in fact, many fish will swim with a current in order to expend less energy. Furthermore, the vibrations which are proposed as a warning system may tend to attract fish toward the intake structure rather than to warn them of danger. More detailed data concerning the behavior of various fish species toward vibrations and high velocity currents is needed to substantiate the applicant's conclusions. In addition, the design of the intake structure should include provisions for returning impinged fish to Lake Ontario.

Section 4.3.1.1 producers - "However, a short-term loss of water should not result in any unacceptable adverse effects." It should be noted that a short-term drawdown of water levels in wetlands will have serious impacts during the winter periods since the insulating water/ice barrier will be absent. Further, it is likely that the filling and manipulation of water levels in the Sterling wetlands will have a serious impact on rare and endangered species which exist only because of specific habitat conditions.

consumers - The general increase in regional woodlands cannot be construed to mean that pine plantations are also increasing. High quality interspersed coniferous habitat is limited in this part of New York State, and many wildlife species are restricted to these habitats. Additional information should be provided to clarify the statement.

Section 4.3.2.1 clearing and inland construction of plant facilities - Indicate the location where accumulated sediment in the discharge-settling basins is going to be deposited once it is removed from the basin.

construction of intake and discharge structures - Include a table or chart indicating the major constituents of the sediments found within the area to be dredged. The fact that thousands of acres of benthic habitat exists in Lake Ontario does not lessen the impact associated with the destruction of this habitat. Figures should be presented which illustrate the cumulative impacts of all dredging and filling operations in Lake Ontario. Even then, only superficial comparisons could be made. It is suggested that this statement be modified.

Section 4.4.5 - What will be the impact of the high velocity discharge on small craft navigating close to shore?

Section 5.4.1.3 - Do the bioaccumulation factors take into account the fact that certain radionuclides will be ingested by lower organisms and then passed up through the food chain resulting in biomagnification of the effects? More specifically, radionuclides of carbon, phosphorous, and iron when ingested will be cumulatively incorporated into the body tissues of higher aquatic organisms.

Section 5.5.1.2 - Maintenance Lines - The EIS should indicate that systematic control of invading vegetation will increase the edge effect (ecotone) and attract certain species of wildlife. This will increase the incidence of exposure to potentially harmful herbicides.

Bird Collisions - The potential impact of bird mortality should not be minimized. Sound data has not been provided to indicate that the impact will not be severe, especially during migration periods. It is recommended that some relationship be drawn between known mortality data and the proposed facility. In addition, a discussion of bird populations and migratory pathways along the transmission line right-of-way would be applicable.

Section 5.5.2.1 - Fish - Have studies on gas supersaturation and its effects on fish been conducted at the Ginna site? If not, such studies should be conducted to clarify the issue.

Section 5.5.2.2 - Scouring - What measures will be taken to minimize shore erosion caused by the operation of the discharge canal? How will the high velocity discharge effect the littoral drift?

Section 5.5.2.3 - Intake Effects - The elevation of the intake structure may act as an attractant for certain fish species which exhibit homing behavior. Fishes exhibiting homing behavior tend to utilize elevated structures as landmarks. Should fish be attracted to this structure, additional impingement losses could occur.

The applicant should investigate the possibility of using a porous limestone dike or screen around the intake structure to reduce entrainment. Further, the use of a multiport intake structure could effectively reduce the intake velocity to 0.5 fps or less, subsequently decreasing mortality due to entrainment.

Impingement - The statement that power plants act as competitors, impinging a fish at one location and not at another, is an oversimplification of the impingement problem. The statement tends to insinuate that this competition negates the cumulative effects of power plants. The design, location, and operating procedures of the plant also determine the degree of impingement. It is, therefore, suggested that the statement be modified.

Entrainment - The warm water in the vicinity of the discharge structure will draw mature fish to this area to spawn. Not only could adults be lost through impingement, but a whole year class of viable eggs could also be lost if drawn into the cooling system. This should be indicated in the impact statement.

Section 9.1.2.2 - Alternative Sites - The discussion of alternative sites does not provide sufficient data to enable a thorough comparison of the beneficial and detrimental aspects of each site. However, the information which is included would tend to indicate that use of the Ginna site would not result in the loss of valuable wetland habitat. The alternative section should be expanded to give a better analysis of the impacts that can be expected if the Ginna site is used.

Additional Comments - A section should be included to indicate the impacts associated with riprap shore protection and its construction. In addition, the applicant proposes to construct a water intake in Lake Ontario to supply water for use during construction. The impacts associated with this intake should be addressed. The applicant also intends to place certain energy dissipaters along Lake Ontario and possibly along the perimeter of freshwater wetlands. These structures should also be addressed. The applicant should investigate various means of preventing large game fish from entering the discharge canal.

We appreciate having had the opportunity to review and comment on the draft environmental statement and hope these comments will be helpful to you in the preparation of the final environmental statement.

Sincerely yours,

BERNARD C. HUGHES
Colonel, Corps of Engineers
District Engineer

Advisory Council
On Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

March 3, 1976

S+N-50-48[illegible]

Mr. William H. Regan, Jr.
Chief, Environmental Projects Branch 3
Division of Site Safety and
  Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Regan:

Thank you for your request of January 6, 1976, for comments on the environmental statement for Sterling Power Project Nuclear Unit 1.

Pursuant to our responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969 and the Advisory Council's "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800), we have determined that your draft environmental statement appears adequate concerning our area of interest, and we have no further comments to make.

Sincerely yours,

John D. McDermott
Director, Office of Review
  and Compliance

715 235
~~721 176~~

2379

The Council is an independent unit of the Executive Branch of the Federal Government [illegible]
October 15, 1966 to advise the President [illegible]

S+N-50-485

OSWEGO

March 16, 1976

Mrs. Martha S. Salk
Environmental Statement Projects
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, Tenn. 37830

Dear Mrs. Salk:

The following comments are directed toward the Draft Environmental Statement related to construction of Sterling Power Project Unit 1, by Rochester Gas and Electric Corp., published December, 1975.

I am a vertebrate zoologist/ecologist and will address concerns in this area. On page 4-5- Consumers - I take exception to the statement that "Because no reduction of potential habitat for these three taxa (bald eagle, osprey and eastern gray tree frog) will occur due to construction activities on the site, impacts on the species will be minor." The osprey and eagle require large areas of undisturbed marsh land and lake shore for successful nesting and feeding requirements to be met. Any disturbance in the whole "Sterling area" will be detrimental to possible future nesting by these two species.

I am concerned with the projected destruction of the sharp-shinned hawk habitat. This species has declined in recent years and any alternation of proven habitat should be seriously considered. The loss of only one pair of a species in decline should be avoided, if possible.

On page 5-20 - Bird Collisions - is treated too lightly. Any obstacles constructed along the south shore of Lake Ontario are likely to prove lethal to the large numbers of migratory birds which utilize the lake shore during migration. On several occasions I have noted that the birds fly low along the shore and maintain a flight path similar to the land contour. Any unnatural, abrupt obstruction is a hazard which many birds cannot avoid. The Oswego College buildings along the shore of the lake have proven to be death traps for migrant species each year. If obstructions need to be built, it would be logical to place them next to existing structures such as might be possible at the Ginna site.

The possible loss of this undisturbed area at the Sterling Site, one of the largest, most beautiful wild areas along the south shore of Lake Ontario, is my greatest concern because of its potential for a Bald Eagle nesting area. The State of New York, through its Department of Environmental Conservation is planning a Bald Eagle Bicentennial Project in cooperation with Cornell University for New York State this year. Funding has been granted for this year for site selection and a literature research. I believe the Sterling Site

3397

would be an ideal location for an attempt at a reintroduction of the Bald Eagle in upstate New York. The incidence of visiting eagles to the Sterling Site lends support to the hypothesis that the area would be ideal for nesting and feeding by the eagles. It seems imperative to retain some wild areas for an endangered species as they attempt to make a comeback as our environment is cleaned up.

I would recommend that the site be preserved as a National Wild life Refuge or Scenic Wild Area and the Rochester Gas and Electric application for a plant site at Sterling be denied.

Sincerely,

George R. Maxwell
Professor of Zoology
Director
Rice Creek Biological Field Station

GRM:cw

R.D. #3
Edwards Circle
Oswego, New York 13126

March 16, 1976

Mrs. Martha S. Salk
Environmental Statement Projects
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, Tenn. 37830

Dear Mrs. Salk:

As a resident of Oswego County and as a person who enjoys walking and birding, I am distressed that arguments of esthetic value, beauty of nature, the immorality of irrevocable destruction of natural resources, etc., have little place in preserving our country. I inquired, therefore, at the college here in Oswego and learned the following facts:

1. Any alteration of the proven habitat of the Sharp-shinned Hawk, which has declined in recent years and is almost an endangered species, should be avoided.

2. Birds fly over bodies of water at low levels and higher as they approach land and cannot avoid constructions, buildings, towers, etc. on land. Our own home windows kill two birds a year; I can imagine the enormous loss when there is that much more obstruction.

3. I believe that NYS and Cornell University are conducting a project that hopes to reintroduce the nesting of Bald Eagles to our area. This has already been funded for 1976. What a beautiful and fitting idea for the Bicentennial! And what an ironic tragedy if the loss of the Sterling Site, proposed for this project, should come to pass.

I strongly urge that Rochester Gas and Electric Corporation's application for a plant at the magnificent Sterling Site be denied.

Yours truly,

Carol Wernick

Mrs. Robert J. Wernick

STATE UNIVERSITY OF NEW YORK
COLLEGE OF ARTS AND SCIENCE AT OSWEGO NEW YORK 13126

STN 50-485

March 17, 1976

Director of Reactor Licensing Division
Office of Nuclear Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Re: DEIS related to construction of Sterling Power Project Unit 1
Rochester Gas and Electric Corporation

Dear Sir:

In general, the DEIS' comments on the adverse environmental impacts are inadequate, in that these effects are significantly greater than are alluded to in this report. I am most concerned with the soil erosion as it effects the adjacent wetlands.

The initial site preparation will have severe effects on the adjacent wetlands, which you have already mentioned. I feel the impact of such sedimentation on wetlands and streams was not completely considered. Historically, man had not been able to construct such facilities and implement "adequate measures" to prevent erosion. The wetlands within this 2,600 acre area will definitely be altered and it will have serious consequences upon the wildlife in the area.

As noted in your report, the Osprey and Bald Eagle have been observed on the Sterling site. In that these birds are greatly endangered by feeding upon fishes containing high concentrations of PCBs, every available wetland which is relatively free from introduction of PCBs and provides a possible feeding ground is vital to their survival. The Sterling site provides an ideal nesting site for both these species. Areas such as this are becoming exceedingly more difficult to find. Coupled with the program proposed by the Department of Environmental Conservation, of reintroducing the Bald Eagle in New York State, it is imperative that these areas and the adjoining areas be left untouched!

The comment in paragraph 10.1.2.1, stating that the population of Cayuga County's wildlife which will be reduced is equal to the percentage of Cayuga County forested land (.1%) to be cleared is absolutely absurd. After a 2 hour walk on the proposed site (May 14, 1974) I and a very competent ornithologist compiled a list of 58 species of birds present in that area. I openly challenge anyone to randomly select an equivalent area elsewhere in Cayuga County and match that count. This type of reasoning is an example of the oversimplification of wildlife habitats when considering construction of this facility.

In looking at Table 9.4 Comparison of Ginna and Sterling sites, it is very much evident that the deciding factor in selecting the Sterling site is the saving of $18,950,000 for construction of transmission lines. Realizing the exceptional wildlife habitat which the Sterling site affords, and which would certainly be severly limited with construction of a nuclear plant, this amount is a good investment for the survival of mankind and the preservation of our environment. Certainly such an area could not be constructed on the Ginna site for 18 million dollars!

Sincerely,

Robert I. Shearer

Robert I. Shearer
Assistant Director
Rice Creek Biological Field Station

RIS:cw

2911

POOR ORIGINAL

~~721 178~~
715 237

ROCHESTER GAS AND ELECTRIC CORPORATION • 89 EAST AVENUE, ROCHESTER, N.Y. 14649

March 19, 1976

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

Subject: Rochester Gas and Electric Corporation
Sterling Power Project Nuclear Unit No. 1
Docket No. STN-50-485
File: 0278

Dear Sir:

Rochester Gas and Electric Corporation has reviewed the Draft Environmental Statement (DES) published December 1975 related to the construction permit stage of Sterling Power Project Nuclear Unit No. 1 and transmits its detailed comments herewith. This submittal supplements general comments dated March 1, 1976 as made by the applicant. Revision 8 to the Environmental Report filed on March 12, 1976 provides support information on detailed comments regarding design changes made since the publication of the DES.

Very truly yours,

Robert R. Koprowski

Robert R. Koprowski
Vice President
Engineering and Construction

RRK:cem

xc: see page 2

721 179

715 238

2850

---

xc: Dr. George C. Anderson
Oceanography Department, WB-10
University of Washington
Seattle, Washington 98195

Edward Luton, Esq.
Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Lester Kornblith, Jr.
Atomic Safety and Licensing Board Panel
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Auburn L. Mitchell, Esq.
Office of the Executive Legal Director
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Alan S. Rosenthal, Chairman
Atomic Safety and Licensing Appeal Panel
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Joseph Marshall, Chairman
Cayuga County Legislature
Cayuga County Office Building
Auburn, New York 13021

Mr. Albert E. Curtis
Town Supervisor
Sterling Town
P. O. Box 11
Fair Haven, New York 13064

Ms. Sharon Morey
California Road, RD #3
Oswego, New York 13126

J. Bruce MacDonald, Esq.
Counsel
New York State Atomic Energy Council
99 Washington Avenue
Albany, New York 12210

Lex K. Larson, Esq.
LeBoeuf, Lamb, Leiby & MacRae
1757 N Street, N.W.
Washington, D.C. 20036

March 19, 1976
Docket No. STN 50-485

Rochester Gas and Electric Corporation
Detailed Comments on the
NRC Draft Environmental Statement for
Sterling Power Project Nuclear Unit No. 1

Page iii, Item 3c

Based upon six years of operational experience and extensive ecological studies of the cooling water discharge at the Ginna Nuclear Power Plant, the applicant has observed no occurrences of fish kill events attributed to thermal shock, cold shock, gas bubble disease, or stresses of crowding. The proposed heat dissipation system for the Sterling Power Project Nuclear Unit No. 1 is similar to the Ginna system.

Page iii, Item 3d, Sentence 1

The applicant recommends the word "most" be deleted and "will" be changed to "may". Applicant's entrainment and impingement studies verify this amended statement.

Page 1-1, Section 1.2, Paragraph 2

Responsibility for NPDES Permit Issuance (including 316(a) and 316(b) authority) was transferred to the State of New York by EPA on October 28, 1975 pursuant to Section 402 of FWPCA. New York State NPDES Permit Authority for electric generating facilities subject to Article VIII (which include Sterling Power Project Nuclear Unit No. 1) will be implemented by the New York State Siting Board. Table 1.1 correctly indicates that these applications have been made to the Siting Board.

Page 2-2, Figure 2.1

Figure 2.1 adequately describes the proposed plot plan site boundary and roadways. The figure, as drawn, misrepresents the topographic and vegetative features of the site (particularly swamp and wetland boundaries) which are accurately presented in figures 2.7-3 (Inland Aquatic Habitats) and 2.7-15 (General Habitats) of the ER.

Page 2-7, Section 2.4.1, Last Paragraph

The last sentence implies that drilling occurred through the entire Paleozoic sequence (2400') and encountered "90% hard... sandstone..." Delete last sentence and add: Borings at the site encountered rocks of the Queenston Formation. The rock cores were composed of more than 90% hard, competent, red sandstone with thin beds of siltstone and shale.

Page 2-8, Section 2.4.2, Paragraph 2 and 3

We would differ with the use of a Rossi-Forel (RF) 9 scale to categorize the 1929 Attica earthquake. While there are references to RF 9 in some publications, it appears to be a typographical error, since the shock is categorized as an RF 8 in an earlier government document (on the basis of actual damage reports) and a Dames & Moore review of the available data would tend to support the original publication.

The "1926" St. Lawrence earthquake occurred on February 28, 1925.

Page 2-8, Section 2.5.1, Paragraph 2

With regard to the use of inland streams (last sentence), the applicant notes that during the construction period, construction runoff, after treatment and when in compliance with effluent limitations, will be discharged into the inland streams. (Reference: Construction Runoff Permit Application).

Page 2-8, Section 2.5.1, Paragraph 3

The New York State Department of Environmental Conservation (NYSDEC) monitors the water quality of Lake Ontario and publishes a summary of such data every three years. The most recent available data, 1974, was not published in time for the 1974 printing of the applicants ER. Therefore 1971 data from the sampling station at the City of Oswego is presented in the E.R. Note that the NYSDEC has discontinued sampling at the City of Oswego water intake as of July 1974. The New York State Public Health Department will continue their sampling, however.

Page 2-12, Section 2.7.1.2, Paragraph 2

Second paragraph should clarify that many elm trees are dead and have been for some time. Also in same paragraph, the silver maple can be considered an edaphic climax species in the long terms of succession and not a subclimax species as stated.

Page 2-12, Section 2.7.1.3, Paragraph 1 and 3

Emphasis on cottontail and ring-necked pheasants should be reduced since the site lacked game. Only the Southern Bald is officially recognized as "endangered". Furthermore,

715 239

721 180

it is uncertain whether the Eagle(s) seen at Sterling were this subspecies.

Page 2-15, Section 2.7.2.5, Paragraph 2

(Add to end of paragraph) Recent increases in gizzard shad abundance indicate continuing changes in the fish community of the lake.

Page 2-15, Section 2.7.2.5, Paragraph 2

Atlantic Salmon, blue pike and deepwater ciscoes are considered endangered not extinct.

Page 3-1, Section 3.3

Section requires incorporation of ER REVISION 8 design changes, including revised table 3.2 and figure 3.4.

Page 3-3, Figure 3.2

Figure should be updated to ER Figure 3.1-2 (REVISION 6).

Page 3-5, Figure 3.5

Figure should be updated to ER Figure 3.4-3 (REVISION 8).

Page 3-7, Section 3.4.2, Paragraph 2, Line 3

It is recommended that the word "unusually" be deleted, and "high" should be "higher".

Paragraph 2, Last sentence

The applicant calculates the submergence beneath average lake level of 246 ft. MSL (USC & GS) as 16 ft.

Paragraph 4, Line 2

The applicant estimates a 10 ft. difference in lake level due to head loss.

Page 3-8, Paragraph 2

Text on ESW system should reflect ER REVISION 6 information.

Figures 3.6 and 3.7

Titles and drawings on these figures interchanged. ER Figure 3.4-3 (REVISION 8) should be referred to.

Page 3-10, Table 3.4

Table should be changed to include ER REVISION 8 data (ER Figure 3.4-3).

Page 3-10 and 3-11, Figures 3.8 and 3.9

Figures persented in DES should be verified for agreement with ER REVISION 8 drawings.

Page 3-11, Section 3.4.3, Line 6

The applicant's design discharge velocity at 246 ft. USGS is about 3.7 fps.

Page 3-16, Section 3.5.1.5, Paragraph 1

Staff quotes RG&E liquid releases to be 0.08 Ci/yr. excluding tritium and 100 Ci/yr. tritium. ER Table 3.5-2 (12/75) has the totals as 0.12 Ci/yr. and 121 Ci/yr., respectively. REVISION 8 totals are 0.10 Ci/yr. (excl ^3H) and 121 Ci/yr. (^3H).

Page 3-18, Section 3.5.2.2

The Staff report that the ER results for release from the containment are "essentially the same" as the NRC's. Our releases, as given in ER Table 3.5-8(11/75) yield noble gas releases a factor of 50 below the Staff's and I-131 releases a factor of approximately 38 below the Staff's.

Page 3-18, Section 3.5.2.3, Paragraph 2

The Staff states that the calculated noble gas release from the auxiliary and radwaste building is 47 Ci/yr. Table 3.7 on page 3-19 gives a total of 83 Ci/yr.

The Staff states that the ER calculated releases from the auxiliary and radwaste buildings are 1270 Ci/yr. for noble gases and 0.002 Ci/yr. of I-131. From ER Figure 3.5-8 (11/75) one obtains 1348 Ci and 0.00773 Ci, respectively.

The Staff states that the ER calculations show a negligible release of I-131 from the turbine building. The value given in ER Table 3.5-8 (11/75) is 0.0145 Ci/yr.

Page 3-18, Section 3.5.2.5

The Staff reports a total release of noble gas from the condenser offgas of 28 Ci/yr. The total from Table 3.7 on page 3-19 for the air ejector is 82 Ci/yr.

Page 3-19, Section 3.5.2.6, Paragraph 1

The Staff's quotes the ER as presenting the total noble gas release as 1500 Ci/yr. and the total iodine release as 0.05 Ci/yr. Table 3.5-8 (11/75) yields 1348 Ci/yr. and 0.0309 Ci/yr., respectively.

Page 3-19, Table 3.7

The "total" column in Table 3.7 is wrong. For example, for Kr-83m, the total should be 18, not 9.

Based on reviews of air ejector releases from similar plants, it would appear that the values given in Table 3.7 are not correct and should be much lower than those listed.

Page 3-20, Section 3.6.1, Last paragraph

Copper and nickel concentrations due to corrosion of the main condenser tubes are calculated to be 0.0005 and 0.00005 ppm respectively. These changes should be included in Table 3.8.

Page 4-4, Table 4.2

The present ER Table 4.1-2 (REVISION 7) lists habitat acreage affected on Sterling site, with the exception of transmission lines and the railroad. It includes, but does not break out separately, onsite roads. It also rounds acreage to the nearest acre. For purposes of maintaining accuracy, it is suggested that numbers on DES Table 4.2 be rounded to the nearest acre.

Page 4-5, Paragraphs 4 and 5

Fourth paragraph, the Bald Eagle and Osprey are open water species not wetland species. Also, the eastern gray tree frog is not restricted to swamp areas, as indicated, since the one gray tree frog caught was in a young hardwoods area. In the fifth paragraph, clarify that very few sharp-shinned hawks were seen and that the pine habitat on the Sterling site is much too small to accommodate all the needs of this raptor.

Page 4-7, Chemical Wastes

The applicant's proposed plans no longer require need of a concrete waste separator. It is recommended that sentence 3 and NRC requirement (2) be deleted in this section.

Page 4-10, Section 4.5.1, Item (4)

The NRC is referred to the applicant's comments on the DETAILED EROSION CONTROL PLAN (Page iv, Item 7b) to limit adverse effects due to erosion during clearing and construction. It is noted that all drainage areas are designed to one-in-ten year storm in accordance with 40 CFR 423. The item (4) commitment is satisfied through the issuance of the SPDES construction runoff permit.

Page 4-11, Item (8)

The applicant recommends deletion of this item since waste concrete separators are not proposed at this time.

Page 4-11, Item (17)

The NRC is referred to ER Section 4.1.2.9 for the use of biocides and nutrients during construction.

Page 4-12, Section 4.5.2, Item (1)

The NRC staff's first evaluation that 150 acres of fallow portions of the site be in agricultural production is considered excessive acreage. The Henslow's sparrow was breeding on about 70 acres, which seems a more reasonable acreage to keep in agricultural production.

Page 4-12, Section 4.5.2, Item (3)

It is recommended that the words "concrete waste separator" be deleted and replaced by "processing of concrete".

Page 5-1, Section 5.1.1

Some information in DES Section 5.1.1 does not accurately reflect information in the applicants ER. Specifically, the Staff is apparently reporting acres of land which will be removed from agricultural productivity and using the numbers interchangeably with numbers of site acres affected. As stated in RG&E ER page 4.1-1 and on page 4.3-2 a total of 201 acres of land including agricultural and woodland classifications will be cleared for plant, ancilliary, and switchyard facility construction inside and outside of the exclusion boundary. If this 201 acres, 105 will be left to natural succession and the balance will be occupied by plant structures, parking areas, roads, and plantings. All agricultural land (about 270 acres) within the exclusion boundary, though not entirely affected by plant construction, will be removed from agricultural productivity.

Dames & Moore has computed agricultural land removed from productivity outside the exclusion boundary as the area occupied by the switchyard and railroad. Agricultural lands removed from productivity within the transmission corridor have not been computed. The computation was made in response to PSC interrogatory 77-13. Total agricultural acres to be removed from the entire site, at that time, was estimated to be 320 acres which is in reasonable agreement with the staff figure of 340 acres (10.1.1.1), though we cannot be certain that the acreage breakdowns for railroad, plant, ancilliary facilities, etc. are similar.

Page 5-1, Section 5.1.2, Paragraph 1

First paragraph, it should be clarified that the 67 acres of woodland to be cleared also includes the tie line from the power block to the substation.

Page 5-2, Section 5.3

It is recommended that the circulating water flow data used for environmental impact analyses be identified at the end of this section. Reference comments entered under section 3.4; 2nd paragraph ltr 3-1-76.

Section 5.3.1.1, Paragraph 3

The applicant refers staff to the following study: "An Empirical Analysis of a Heated Surface Jet Discharged into Shallow Water: Analysis of the R.E. Ginna Discharge with Application to the Sterling Site" prepared by NUS Corporation, February 1976. Study included as APPENDIX 4C to 316(a)(b) Demonstration, REVISION 4 2/76.

The next to last sentence in paragraph 3 is an incomplete statement of the thermal criteria. It should state:

> Because State standards restrict the surface area being heated in excess of 3°F to an area within a designated mixing zone (which will be established by the Siting Board in State proceedings), the area within the 3°F isotherm is presented as a frame of reference.

The last sentence is also not clear.

Page 5-4, Paragraph 1, Lines 7-11

It is true that effect of the bend is an increase in turbulence of the discharge stream. However, it is felt that this effect is neglibible for a number of reasons. First, the 30 ft. of straight channel from the bend to the discharge will allow the flow to re-establish. Second, the turbulence caused by the bend is formed at the expense of discharge momentum. Therefore any turbulence introduced may actually decrease dilution due to the dissipation of discharge momentum prior to the introduction of the stream into the ambient water. Third, the comparison of the Ginna data with other data contained in Appendix 5A of the Environmental Report shows that the Ginna dilutions are lower than the others, thereby assuring that the effects of the 90° bend do not greatly increase the mixing capability of the discharge.

Page 5-4, Paragraph 2, Lines 5-8

Since the ER was filed, two additional studies of the Ginna and Sterling discharges have been completed.(1,2) Both of these significantly expand the discussion of the effects of Smoky Point on the Ginna discharge. Additional analysis(2) has also confirmed the hypothesis that the shielding effect of Smoky Point will result in conservative predictions of the Sterling plume. Pages 46 and 47 of Reference 2 contain a complete discussion of this effect.

Reference 1 - Toblin, A.L. and H.K. Trivedi, The Effects of Varying Lake Elevation and Lake Temperature on the Induced Thermal Distribution from the Sterling Power Project Nuclear Unit Number 1, Appendix 4B of the Sterling Power Project Water Permits Nuclear Unit No. 1, Volume 4, 1975.

Reference 2 - Toblin, A.L., An Empirical Analysis of A Heated Surface Jet Discharged Into Shallow Water: Analysis of the R.E. Ginna Discharge With Application To The Sterling Site, Prepared for Rochester Gas and Electric Corporation, NUS-1637, February, 1976.

Paragraph 5, Lines 7-8

The staff's comment in the DES is misleading without further clarification. The plots are idealized in that they are symmetric, whereas a small current will cause plume assymetry. Also, the worst case conditions (low surface heat transfer) are a combination of worst case centerline temperature excesses and worst case plume half widths. These conditions are not expected to occur simultaneously.

The average surface heat transfer isotherm drawings show the expected behavior of the discharge plume. The isotherms may not be exactly as they appear in the drawings but their characteristics are well represented. The worst case isotherm drawings are highly idealized in that the plume will never be as large as indicated. They are, therefore, an upper limit representation. The statement that the plots are highly idealized without a statement as to the effects of the idealizations may be misleading.

The applicant recommends that the terms "average surface heat transfer" and "low surface heat transfer" be changed respectively to "average case cooling" and "worst case cooling".

Page 5-8, Paragraph 2

The last two sentences of the paragraph would be more accurate if reworded:

> "This study indicates that the plume with relative concentrations of 0.16 is expected to range from 380 to 2,000 acres. In the total absence of atmospheric heat transfer the 3°F isotherm would have the same range of plume size. The large range in predicted plume size results from the variable currents, wind stress and wave size in the area. The range is comparable to that observed for the Ginna plume."

Page 5-8, Section 5.3.2, Last paragraph, and Page 5-9, Paragraph 2, Line 1

The technique discribed above assumes that a model which accurately predicts Ginna site isotherms will accurately predict Sterling site isotherms. The model chosen by the NRC does not account for shoreline and bottom geometry. The only model variable changed in going from one site to the other was the size of the discharge. Therefore, the NRC has assumed that the two sites are similar. In fact, the NRC has done exactly the same thing that RG&E has. Both chose a model which estimates Ginna isotherms, assumed similarity between Sterling and Ginna, and predicted Sterling isotherms based upon the increase in discharge size from Ginna to Sterling.

The NRC has undertaken their analysis because they felt the Ginna data may not be applicable to the Sterling site. In essence, they have assumed that Ginna data is appropriate for use at Sterling.

Page 5-9, Paragraph 4, Lines 6-9

Using the analysis contained in Reference 2 of item 2, calculations were performed for sinking plume conditions with deliberate recirculation. It was found that 3°F surface areas were on the high side, but generally comparable with the maximum monthly areas. Subsurface areas were found to be about 20% larger than the largest of the monthly maximums observed during rising plume conditions.

The model implicitly assumes that buoyant plume rise occurs. For the mid-winter period, a reverse phenomena occurs and the plume will sink. Therefore, the 3°F excess temperature surface isotherm area will be less and the subsurface area will be greater than that described in the previous paragraph.

Page 5-10, Section 5.3.3, Paragraph 1

This paragraph requires correction. First, the State is no longer awaiting EPA approval of the thermal standards. They were approved in February of 1975, although certain portions of the promulgated criteria were "exempted from consideration". Second, the mixing zone (at least for Sterling Nuclear) will not be specified by the NYDEC, but rather by the NYS Siting Board.

Paragraph 2

It is recommended that this paragraph be deleted since the procedure for modification was not approved by EPA. Modification of the thermal criteria may be approved by means of the 316(a) Demonstration procedure.

Page 5-11, Paragraph 2

Reference should be section 423.15 "new source standards of performance".

Paragraph 3, Line 2

Delete "will apply to the Environmental Protection Agency" and add "has applied to the NYS Siting Board".

Page 5-14, Section 5.4.2.1, Paragraph 2

Section 5.4.2.1 states that the NRC assumed that 100% of the population within 50 miles of the plant eat 5 grams of fish per day that were caught in cooling water diluted by a factor of 60. Which population was used? This volume of fish is a gross over conservation. For example, if one uses the 1980 population projection of 1,295,109 people within 50 miles, one finds that 2,600 tons of fish must be caught within the immediate vicinity of the plant each year. Table 5.3-2 of the ER shows that less than 150 tons of fish were recorded as caught in all of Lake Ontario in 1972. Even accounting for sport fishing, it is inconceivable that 2,600 tons could be caught in the immediate plant vicinity each year.

Page 5-14, Table 5.6

The totals given in Table 5.6 are incorrect. The should be 23.4 Man-rem whole body and 71.68 man-rem thyroid. The title for the table should indicate that it includes both gaseous and liquid releases.

The source term for C-14 should appear in Section 3.5 in order to provide a basis for the dose in the table.

Page 5-16, Table 5.8

In Table 5.8, an estimate of 500 man-rem for the plant work force is presented, yet a value of 450 man-rem is given in Section 5.4.2.4.

In Table 5.8, the Staff has incorrectly given the man-rem dose to the general public as 120 man-rem; it should be 23.4 man-rem. A clear distinction must be made between man-rem and man-thyroid-rem, two different factors.

Section 5.4.3 and Table 5.9

The values in Table 5.9 must be increased by a factor of 1.15 to account for the fact the Sterling is an 1150 MWe plant.

Page 5-19, Item (4)

The applicant believes this restriction is not currently technologically feasible or necessary. Current EPA standards dictate 0.5 ppm of dioxin as the maximum permissible limit.

Page 5-20, Audible Noise

The 61dBA at 50 feet for a 765 KV transmission line noise in fog appears conservative. The Commonwealth Associate's plot of audible noise in fog indicates 48dBA at 50 feet. The NRC staff considered the transmission line a point source when extrapolating the value of 41dBA at 500 feet back to 50 feet. In fact, it is a complex line source.

Page 5-21, Paragraph 1

The applicant has determined an estimated temperature-time decay profile for the discharge plume which indicates a time period of less than 80 minutes to achieve the 3°F isotherm above ambient temperature. (Reference ER Appendix 2I and 316(a)(b) Demonstration Chapter 2).

Page 5-24, Paragraph 1

Although fish can enter the canal they may not remain there. Large fish could stay within the canal longer than smaller fish; however, they also will try to go out to the lake proper. The canal has been designed with a minimum of areas in which fish may seek shelter from the flow velocity.

Page 5-24, Paragraph 2

Overcrowding does not seem realistic: the fish have the capability of moving as they please. If sufficient food is not available, it would seem that the fish would not remain in the canal just for the heat's sake.

Page 5-30, Item (5)

Roughened inner walls should also lessen the velocity along walls and provide an escape route for fish as they seek lower velocities. This should be indicated.

Paragraph 3

Velocities of 0.5 fps have not been shown to be superior to 1.5 fps .
Last line - Large impingement may be due to temperature alone and not velocity, that is, velocities of 0.5 fps or less may not have prevented these impingement situations.

Paragraph 4

This data is for 1973; in 1974 Ginna estimates were about 2 x 10^6, while Nine Mile was about 2.34 x 10^6. These more recent data should be considered.

Paragraph 6

Recent pressure studies done by Stone and Webster engineers for Niagara Mohawk Power Corporation showed no mortality due to simulated pressure changes. The change in density should not be sufficient to cause this situation. The flow of water will not allow fish to be bounced along the tunnel bottom.

RG&E does not agree that the majority of fish will be killed (excepting alewives). Survival studies at Ginna Station have shown good percentages of survival.

Paragraph 7

The applicant recommends use of 1974 data for these calculations.

Page 5-31, Paragraph 3

Another estimate of alewife populations based on impingement studies also suggested 20-30 billion alewives (1974 impingement data).

Page 5-33, Paragraph 2 Line 1

Maximum ΔT across condenser will remain 19.7°F at all times under full load. Intake-discharge ΔT may be higher based upon recirculation.

Paragraph 4 Line 1

Change to "Effects of Plankton"

Paragraph 5 Line 6

The applicant believes 3-5% is more accurate.

Pages 5-33 through 5-37, Entrainment

A review of the 1973 and 1974 fish egg, larvae and juvenile studies has provided the applicant with a more realistic impact assessment of the potential entrainment effects of the Sterling plant. The following discussion presents findings as well as the applicant's views concerning the NRC evaluation of potential entrainment at Sterling.

1. Effects on fish eggs. RG&E agrees with the NRC in that . . "densities were greatest by far at the 2- and 5-m contours. Due to the demersal and adhesive nature of fish eggs likely to occur in the area, the staff foresees no adverse effects on area fish populations resulting from entrainment of eggs". Based upon these conclusions, RG&E questions the necessity of conducting further sampling for fish eggs as detailed in DES Section 6.1.3.2.

2. A review of 1973 and 1974 studies. Initial fish larvae and juvenile studies were conducted at Sterling in the fall of 1972 and continued through 1973. During review of this material by both New York State and Federal agencies it became clear that these studies were insufficient to characterize the ichthyoplankton at the Sterling site. Therefore, RG&E agreed to conduct a more intense survey of this biotic component during the 1974 sampling season. This comprehensive survey was utilized by RG&E to make impact assessments of entrainment at Sterling. Since the 1973 sampling was conducted monthly at only the 2 and 5m stations while the 1974 sampling was attempted at the 2,5,8,11 and 18m stations on a twice per month basis, RG&E feels that any analysis using 1973 data is inferior to analyses based on the 1974 study.

   RG&E investigated the cause of the wide difference in ichthyoplankton densities between 1973 and 1974 and the unusually high ratio of juveniles to larvae as requested by the NRC in the DES section 6.1.3.2. The studies in 1973 utilized 1/2M 0-mesh plankton nets, while in 1974 a 1/2M 0-mesh Henson style larvae net. This was the only sampling difference determined between the two studies. This difference in nets does not seem sufficient to account for the wide variability described by the NRC. Aside from this, natural variability is the only other factor which could make the difference.

3. Effects on Larvae

   Page 5-34 Paragraph 2 As stated in 2 above, less intense sampling in 1973 versus 1974 may be primarily responsible for the large reductions in larval densities at the Sterling site between 1973 and 1974.

   Table 5.16 Two sampling periods for tows at the 11M station mid-depth are indicated. An additional sample was taken on May 4, 1974. This would change the Mean number (M^3) to 0.015.

   The June 28, 1974 data table which was referred to is in error, the number of larvae present at the 11M bottom station fourth transect was 0 not 400. This would change the range on Table 5.16 at the 11M bottom station from 0-400 to 0-64, and additionally change the mean number (M^2) from 26.0 to 7.2. The number of fish larvae (M^2) found in the bottom samples varies inversely with depth (for each 3m increase in depth, the mean number of larvae decreases by a factor of 2).

   Paragraph 3, Lines 3 and 4 As indicated above there were three separate occasions during which the 11M mid-depth station was sampled, during May through August, this would include May 4, 1974.

   Paragraph 3, Lines 5 and 6 $400/m^2$ should be changed to $64/m^2$ and in addition it is not understood why a worst case condition does not mean the largest concentration found i.e., $64/m^2$, instead of evenly distributing this concentration across 4 transects.

   Paragraph 3, Lines 5-8 Although RG&E agrees that larval concentrations would increase at night, it does not seem appropriate to assume all larvae from the bottom will be evenly distributed throughout the water column during the night. This will be discussed further in a later comment.

   Page 5-35 Table 5.17 The deviation of the number 2.36 in line 2 and the number 9.09 in line 3 of this table should be fully described. It is RG&E's understanding that the 2.36 is based on the mean number of larvae (M^2) found at the 11M bottom station divided by 11M to achieve a uniform distribution throughout the water column. The 9.09 is the worst case (being 400) divided by 11M. Based on a previous comment, these figures should be revised to 0.654 instead of 2.36 and 5.81 instead of 9.09 (assuming a worst case of $64/m^2$).

The following comments concerning larvae densities are suggested by RG&E. Instead of nighttime densities being calculated based on bottom sampling, they could be estimated from the daytime sampling by using a factor of 6 as referenced on page 5-34 paragraph 2.

This number may be more valid because this ratio was established from actual field data and secondly because the movement patterns of larvae at night are not well defined. Although the 11M mid-depth tows were done only 3 times they total 10 individual samples, 7 of which contained larvae. On the other hand, the bottom samples at 11M consisted of 20 individual samples; however, only 4 contained larvae. Therefore, the tow sampling may be more accurate than the bottom samples.

Assuming nighttime larval concentrations based on the mid-depth tows, the following entrainment estimates are provided:

Line 2	0.019/0.114	.313	250	25.0
Line 3	0.051/0.306	.839	611	67.1

These calculations provide a 94.4 percent reduction in Line 2 (average larval entrainment estimate) and a 96.1 percent reduction in Line 3 (worst case larval entrainment).

Line 4 The calculation of 184,000 in line 4 is not understood.

It is recommended that line 3 of this table which is based purely on 1973 data be deleted.

The footnotes to this table should be revised to reflect any changes in the table proper. It is understood by RG&E that references to Table 5.18 should be changed to Table 5.16. This should be clarified.

Page 5-35 Paragraph 1 With regard to the fact that RG&E feels that $2X10^7$ in Line 3 should be changed to $8X10^5$, the NRC staff is basing impacts of serranidae, centrarchidae and cyprinidae on maximum entrainment losses which also include 34 percent clupeidae (probably alewives) and 8.1 percent others. Impacts of the former fish families should be based on the 57.9 percent of the maximum entrainment losses which these families represent. If the NRC staff feels that ". . . severe reductions in recruitment and standing crops of local populations of these fish would be possible. Lakewide, measurable effects on stocks of these species due to entrainment at Sterling alone would be unlikely. "Based on a withdrawal of $2X10^7$

larvae of these families per day, then entrainment of only 54.9 percent of this number, or possibly 54.9 percent of $8X10^5$, should be viewed as substantially less severe and even more unlikely.

Effects on juveniles RG&E suggests that a definition of the term juvenile be given, as this stage may incorporate a wide size range of fish from late larval stages up to just prior to attainment of sexual maturity. Although 50MM was utilized as the / marcation in the 1973 study, a more accurate definition is needed to estimate the impacts discussed.

Paragraph 2 RG&E acknowledges that the larvae to juvenile ratio for 1973 is extremely high, however, RG&E questions whether this ratio is representative of actual conditions. It should be noted that no juveniles were collected in 1974 and that the larvae to juvenile ratio for that study would therefore be similar to the estimate of .01 to 1.0 percent. Considering the numbers of larvae captured in 1974 in the tow samples (approximately 330), only 3.3 juveniles should have been caught in the nets if the maximum typical survival of 1.0 percent (as suggested by the NRC staff) is assumed. If a 60 percent ratio was valid then nearly 200 juveniles should have been captured. This comparison suggests that the more intense sampling in 1974 may be quite superior to the 1973 sampling.

Paragraph 3 RG&E questions the applicability of using the ratio of larvae between the 5M and 11M mid-depth contours to estimate the number of juveniles at the 11M mid-depth, due primarily to the increased mobility at the juvenile stage. If such an extrapolation is made, RG&E suggests that the figure of 0.015 larvae/m^3 be used for the 11M mid-depth sample. This would revise Table 5.17 Line 5 accordingly.

Paragraphs 3 and 4 RG&E believes that based on the discussions of larvae to juvenile ratios, a lower bound for potential entrainment losses also be provided. This is to say, 1.0 percent of the number of larvae found at the 11M mid-depth station or 0.00015 juveniles/M^3 (using the revised larvae concentration at that location). This would revise Table 5.17 Line 5, and would reflect some 705 juveniles withdrawn per day.

715 247
721 ~~188~~ 188

With respect to juvenile entrainment, RG&E feels that indeed most juveniles may be impinged as suggested by the NRC staff. Ginna impingement studies have collected many fish of less than 50mm in length and in fact often divide some species such as smelt, alewives and shiners into adult and juvenile classifications. Therefore it would seem more reasonable to estimate entrainment of juveniles based on Ginna impingement than to conduct extensive studies as indicated in Section 6.1.3.2 of the DES.

Page 5-36 Paragraph 1 Based on previous comments and those on Section 6.1.3.2 of the DES, this paragraph should be revised or deleted as necessary.

Line 11 It is assumed that the reference to Section 6.1.1.2 should be Section 6.1.3.2.

Paragraphs 2-6 The discussion is based primarily on hydrological phenomena and has little biological basis. Such a discussion may be appropriate, for a theoretical determination, if biological information was not available. Such biological studies have been performed by the applicant and results do not warrant further field investigations in the waterbody.

Paragraph 7 Lines 3-5 It should be added that these high densities are based upon 1973 sampling alone. If 1974 densities are considered, the resultant potential entrainment of juveniles is substantially smaller.

Page 5-37 Summary and Conclusions: This section should reflect changes, if any, in other sections.

Paragraph 2 What is impact of salmonid industry on lake; also no larval salmonids were collected at Nine Mile, Sterling or Ginna (of those identified). Some fingerlings have been impinged (extremely low numbers) and no adult salmon have been impinged.

715 249
~~721~~ 189

Page 6.1, Paragraph 1

The first sentence would be more accurate if it stated that the applicant has undertaken various studies and investigations of the hydrothermal conditions at the Sterling site.

Section 6.1.2, Paragraph 2

Staff fails to give results of atmospheric dispersion (X/Q) calculations referred to in the second paragraph.

Page 6-2, Figure 6.1

Figure is misleading; area to the left of intake structure is shown in 1 ft. contour intervals, whereas rest of map shows 6 ft. intervals. Figure reference is incorrect. 18M stations and Moon Beach transect are not shown.

Page 6-4, Table 6.1

Fish egg and larvae methods: In 1974 there was a fourth transect.

Page 6-5, Paragraph 4, Line 4

Only TSS is required in Section 4.3.2.1

Paragraph 5, Line 3

Put "Gammarus" in parentheses.

Page 6-5, Paragraph 1, Line 7-9

RG&E feels the 11M mid-depth station received adequate sampling for both larvae and juveniles to make reasonable estimate of potential larvae and juvenile entrainment.

It should be noted that juveniles were sampled by a similar method in both 1973 and 1974, and, therefore, this location was sampled for juveniles, contrary to the NRC staff's statement that this location was not sampled for this fish stage.

Paragraph 2

RG&E does not feel that a further fish egg and larvae study need be conducted at the Sterling Site. This is based upon the comments and discussion supplied for Section 5.2.2.3 of the DES. (Reference is made to "Fish Egg and Larval Study - - 1974, Ginna Nuclear Power Station and Sterling Power Site Areas.")

From the data, it can be shown that there is no difference between transects for eggs or larvae. This suggests that there is no unique areas within water near the site which can be considered as a preferred spawning area. Of the larvae sampled and identified, between 70 and 80 percent are alewives and since the total number of larvae found was relatively low (about 330 in the tows and about 178 from the bottom), it would appear that very few other fish species are spawning on the site. Alewives are known to be relatively non-selective in their spawning habits and therefore, may spawn at similar levels throughout the lake's shoreline. This is in general agreement with the NRC staff evaluation which concludes that "..Larval entrainment at Sterling should produce no measurable response in regional or lakewide stocks of alewives". The staff also concedes that "semi-protected bays and the extreme eastern areas of the lake may provide more suitable spawning and nursery areas "(compared to the Sterling area). The Sterling Site is not similar to either of these types of lake conditions. If these statements and opinions are accepted, then the 1974 study should be sufficient to evaluate potential entrainment problems.

The overall impression of the NRC staff's comments on egg, larval and juvenile entrainment is not definitive. However, indications are that such losses (as calculated) are not intolerable, nor disastrous to the present ecology. For example: "the staff foresees no adverse effects on area fish populations resulting from entrainment of eggs.", "If maximum entrainment losses exceeding 2 x 10^7 larvae per day were realized, severe reductions in recruitment and standing crops of local populations of these fish would be possible (emphasis added). Lakewide, measurable effects on stocks of these species due to entrainment at Sterling alone would be unlikely.", "Acting alone, larval entrainment at Sterling should produce no measurable response in regional or lakewide stocks of alewives." and, "Regionally, the Sterling Power Project itself is not expected to measurably alter fish stocks.

However, acting in concert with other power plants, the cumulative impact could result in significant ecological change. The staff does not expect that the addition of one more plant will sufficiently stress an important component of the Lake Ontario ecosystem so as to bring about significant change." Based upon these statements an additional, more intensive survey, therefore, will only refine an assessment that is presently acceptable.

Paragraph 3

Although 1973 sampling data indicates that high concentrations of larvae and juveniles may be found at the Sterling Site, there is no evidence that this site is a preferred spawning area. RG&E can only stress that the 1973 data has its limitations and that any analysis using 1973 data is inferior to analyses based upon the 1974 study. (Refer to pages 5-33 through 5-37, Entrainment item 2, A Review of 1973 and 1974 Studies).

Page 10-2, Section 10.1.2.1

Note that Bobwhite quail were not seen on Sterling site. Also, that succession will increase the game species only temporarily; their numbers will decrease again as woodlands are developed.

Page 10-8, Table 10.2

Under radiological impact in Table 10.2, there is no section 5.4.2.7 and the value of 3.3 man-rems per year appears to be incorrect. It should also be noted that the occupational exposure value of 450 man-rem appears in Section 5.4.2.4. Section 5.4.2.5 shows it as 500 man-rem.

Page B-3, Table B.3

Appendix B, Table B.3 is unclear. First, no distinction can be made between "Terrestrial" habitats and other upland habitats. The same reasoning is applicable to other categories in the table and the use of "urban" is misleading and inaccurate. Since several species use one or more habitats, no distinction between the listed "Totals" can be accounted for.

~~721 190~~
715 249

Page B-4, Table B.4

Appendix B, Table B.4. Several species are listed as threatened on the (Blue List) or the U.S. Department of Interior 1973 list. The following species should not be included because they are locally declining in areas very remote to the Sterling site. Their inclusion in the DES is very misleading.

Species	Area of Decline
Yellow Warbler	Northern California
Song Sparrow	Central California and Aleutian Islands
Canada Goose	Aleutian Islands
Mallard	Not in reference cited
American Coot	Hawaiian Islands
Eastern Bluebird	Central Arizona to Southern Mexico
Grasshopper Sparrow (Ps Us)	Arizona, Central Florida
Yellow-billed Cuckoo	California, South Texas
Winter Wren	Aleutian Islands
Maryland Yellowthroat	Subspecies not covered by Blue List
Yellow-bellied Flycatcher	Not on list cited

Other comments on Table B.4 include:

1. The classification "Urban" is misleading and inaccurate.
2. Henslow's sparrow was in the early stage old field habitat, not cropland.
3. Many species such as the White-tailed deer were commonly found in more than one habitat type.
4. Under the "Restricted Forest" classification, which is unclear, the listed species are not classified as to status.
5. The "Restricted Swamp" was not the area where the Eastern gray tree frog was found. It was the young hardwoods habitat.
6. Since Table B.4 leaves out ecologically important species to the Sterling area, the "staff implemented scheme for estimating potential loss of various taxa as a function of numbers and kinds of habitat in which a given species occurs" is considered invalid (see Section 4.3.1.1, page 5).

Page B-9, B-10, Tables B.9 - B.12

Use of 1974 data would provide better representation of actual impingement counts, thereby improving accuracy of impact assessments.

Page C-2, Last Paragraph

(Add) N.Y.S.D.E.C. defines thermocline to be 1°C/m vertical gradient. Use at the 10°C isotherm to characterize the stratification depth is a convenience for the discussion of lake structure.

Page F-3, Paragraph 1

The figure of 200 kg/day wet weight for ingestion of grass by cattle is considered as being unusually high by the applicant.

Page F-4, Conclusions

Additional details regarding the methods of calculaton for the doses due to C-14 and I-131 releases should be provided. For example, what population and exposure level is assumed for C-14?

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION II
26 FEDERAL PLAZA
NEW YORK, NEW YORK 10007

MAR 19 1976

Mr. Voss Moore
Assistant Director for
Environmental Projects
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Moore:

The Environmental Protection Agency has reviewed the draft environmental impact statement issued by the Nuclear Regulatory Commission in conjunction with the application of the Rochester Gas and Electric Corporation for a permit to begin construction of the Sterling Nuclear Power Project, Unit 1. Our detailed comments are enclosed.

The EPA believes that the proposed cooling system design has the potential to adversely affect the ecosystem of Lake Ontario. The large volume flow (1936 cfs) required for once-through cooling at Sterling increases the number of organisms subjected to entrainment and impingement by 490 percent over a closed cycle cooling system. This coupled with organisms lost due to the discharge plume (effects of thermal shock, cold shock due to sudden shutdown, gas bubble disease, stress of crowding, and thermal blockage) may adversely affect not only local species population but the population of Lake Ontario as a whole. Entrainment is of significant importance due to the large numbers of fish larvae and juveniles that the biological data survey indicated were in the vicinity of the Sterling site.

It is EPA's understanding that NRC will require further ecological baseline studies in order to analyze to a greater certainty the aquatic impact that may result from once-through cooling. The EPA concurs with this and recommends that the design of the proposed cooling system not be finalized until the aquatic impact effects have been analyzed. This recommendation is particularly valid in light of the applicant's requirements under Sections 301, 316(a) and 316(b) of the Federal Water Pollution Control Act Amendments of 1972.

The parameters contained in the draft statement are inconsistent with the parameters and techniques used in Draft Regulatory Guide 1.BB for gaseous source term calculations. In addition, the final statement should include the NRC's assessment of doses to maximally exposed individuals.

In light of our review and in accordance with EPA procedure, we have rated this draft statement "ER-2" signifying environmental reservations concerning the proposed project's impacts and information in the draft statement insufficient to assess fully the impacts. We would be pleased to discuss our rating or comments with you or members of your staff.

Sincerely yours,

Jerry Hansler

Gerald M. Hansler, P.E.
Regional Administrator

EPA #D-NRC-C06002-NY

ENVIRONMENTAL PROTECTION AGENCY

REGION II

NEW YORK, NEW YORK 10007

MARCH 1976

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Sterling Nuclear Power Project, Unit 1

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency has reviewed the draft environmental impact statement issued in conjunction with the application of the Rochester Gas and Electric Corporation for a permit to begin construction of the Sterling Nuclear Power Project, Unit 1. This station is planned for a site located in Cayuga County, New York, approximately 8 miles southwest of Oswego on the southeastern shore of Lake Ontario. The following are our major conclusions.

1. The EPA believes that the proposed cooling system design has the potential to adversely affect the ecosystem of Lake Ontario. The large volume flow (1936 cfs) required for once-through cooling at Sterling increases the number of organisms subjected to entrainment and impingement by 490 percent over a closed cycle cooling system. This coupled with organisms lost due to the discharge plume (effects of thermal shock, cold shock due to sudden shutdown, gas bubble disease, stress of crowding, and thermal blockage) may adversely affect not only local species population but the population of Lake Ontario as a whole. Entrainment is of significant importance due to the large numbers of fish larvae and juveniles that the biological data survey indicated were in the vicinity of the Sterling site.

2. It is EPA's understanding that NRC will require further ecological baseline studies in order to analyze to a greater certainty the aquatic impact that may result from once-through cooling. The EPA concurs with this and recommends that the design of the proposed cooling system not be finalized until the aquatic impact effects have been analyzed. This recommendation is particularly valid in light of the applicant's requirements under Sections 301, 316(a) and 316(b) of the Federal Water Pollution Control Act Amendments of 1972.

3. The parameters contained in the draft statement are inconsistent with the parameters and techniques used in Draft Regulatory Guide 1.BB for gaseous source term calculations. In addition, the final statement should include the NRC's assessment of doses to maximally exposed individuals.

CONDENSER COOLING SYSTEM AND FWPCA REQUIREMENTS

As proposed, condenser cooling at the Sterling Nuclear Power Plant will be achieved by a once-through cooling system. Under normal operating conditions, water will be withdrawn from Lake Ontario at the rate of 1936 cubic feet per second (cfs) and heated 19.7°F above ambient temperature prior to discharge. Discharge will be accomplished by means of a common shoreline surface canal. The EPA will be responsible for issuance of a discharge permit for Sterling Unit 1 under the National Pollutant Discharge Elimination System (NPDES) - Section 402 of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA). Issuance of the permit will be based upon review and analysis of all relevant information supplied by the applicant. Consideration will be given to requirements of Sections 301, 316(a), and 316(b), and all other provisions of the FWPCA, and the final permit will be conditioned accordingly.

Section 301 of the FWPCA stipulates that effluent limits for various point source discharges to navigable waters shall require the application of "Best Practicable Control Technology Currently Available" no later than July 1, 1977, and "Best Available Technology Economically Achievable" no later than July 1, 1983. The levels of technology corresponding to these terms were defined in EPA's "Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards," Federal Register of October 8, 1974. The technology corresponding to these guidelines is generally considered to be closed-cycle cooling.

Section 316(a) of the FWPCA provides for a waiver of guideline limitations if the applicant can demonstrate that the imposed limitations for the control of the thermal component are "...more stringent than necessary to assure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the bodies of water." If this can be demonstrated for Sterling, then the Administrator may impose alternative limitations which could allow the use of a once-through cooling system.

The cooling system as proposed can operate in compliance with Federally approved State water quality standards in regard to most chemical effluents. However, EPA concurs with NRC's recommendation that the amount of total residual chlorine at the point of discharge be reduced to 0.[illegible] mg/l in order to minimize adverse effects to aquatic biota. EPA has concern about the thermal discharge and the lack of adequate evaluation of alternative cooling methods. Due to the large volume of flow associated with Sterling and the potential adverse impact on biota in Lake Ontario, EPA believes that more information is needed to determine if the applicant is to qualify for the waiver as stipulated in Section 316(a).

Section 316(b) of the FWPCA requires that "...the location, design, construction, and capacity of cooling water intake structures reflect the best technology available to minimize adverse environmental impact." Closed-cycle cooling could be required pursuant to Section 316(b) as a means of achieving the best technology available.

715 253

721 194

WATER INTAKE STRUCTURE

The proposed water intake structure is a submerged offshore intake with ten evenly spaced vertical faces, three of which will be closed. Velocity through the seven open faces will be 1.5 fps at 1936 cfs (p. 3-7). Water drawn into the intake structure will plunge 130 ft into a tunnel about 100 ft below the lake bed. Velocity in the tunnel will be 10.3 fps with high turbulence. The water will then rise about 130 ft and enter the forebay. From the forebay, the water will pass through the traveling screens. Velocity through the screens will be 2.2 to 2.5 fps depending on the lake level.

The EPA's main concern with this intake design is the high intake velocity. According to the EIS, the applicant has incorporated some design features for environmental protection. For one, the lower edge of the intake port will be placed 6 ft above the lake bottom. It should be noted that this would most likely be done anyway in order to avoid entrainment of bottom materials into the condensers. In addition, the applicant has designed the intake structure with roughened inner walls in the intake port in order to create vibrations in an attempt to serve as a warning to fish. Further, the applicant believes that the "...unusually high intake velocity will alert fish to the danger of entrainment." The EPA does not know of any evidence to date that indicates that such approaches are effective. Instead, when fish are drawn into the intake ports, they will receive severe mechanical and physical stress due to the rapid changes in water direction, pressure, and velocity. Besides the above, the fish may be impinged upon the intake traveling screens for periods of up to one hour. There is no provision for return of the impinged fish to the lake. Thus, in EPA's opinion, for those fish entrained into the intake structure, mortality will be at or close to 100 percent.

The EPA recommends that the intake velocity be reduced to the range of 0.5 to 0.8 fps. This could be accomplished by opening the three inshore faces of the intake structure. Another alternative structure which may be considered to reduce intake velocities is the use of perforated pipes.

Regardless of the intake structure that is used, EPA recommends that the traveling screens be operated in a continuous rather than an intermittent manner and that some means of fish return be designed. The above recommendations are referenced from EPA's Development Document for Proposed Best Technology Available for Minimizing Adverse Environmental Impact of Cooling Water Intake Structure of December 1973.

BIOTIC LOSSES AND AQUATIC IMPACT ANALYSIS

INTAKE-RELATED IMPACTS

The severity of the intake-related impacts is reflected in the following excerpt from page 5-30 of the draft environmental impact statement:

> Fish approaching too near the submerged intake structure ...and unable to overcome the intake velocity of about 1.5 fps will be drawn into the structure where they will then descend approximately 130 ft in 12.6 sec. The rapid increase in pressure (nearly 3.8 atm) accompanying a dive of this magnitude probably exceeds the ability of many fish to physiologically adjust gas pressure in their swim bladders, with the consequent collapse of the bladders and possible internal injuries.
>
> Collapse of the swim bladder will cause an increase in the specific density of fish. Consequently, upon entering the horizontal portion of the intake tunnel, fish will sink to the tunnel floor where they will sustain abrasions as they are swept shoreward about 4200 ft at 10.3 fps. The momentum of the fish will probably cause them to strike the end of the horizontal tunnel. Rapid ascent through a second vertical tunnel will expose fish to the reverse of conditions encountered in the initial descent. The swim bladder's sudden expansion may occasion further injury. Eventually, fish will impinge on the traveling screens where they will be held by a current of 2.2 fps (staff calculation) for periods ranging from a few seconds to 60 min, depending on when the next screen-wash cycle begins. During this time, fish still surviving may injure themselves in their struggles to escape, suffocate due to gill closure, or sustain serious injury when washed off the screens by water jets into a shallow, concrete fish return trough. Upon release into the discharge canal, any fish surviving the above physical insults will encounter a temperature rise of 19.7°F and, possibly, gas supersaturation. Although a few fish entrained in the intake-discharge systems may survive for a few hours after discharge, the staff expects most fish subjected to the above stresses to be killed.

Impingement Effects

The draft statement estimates that mortality due to impingement will range from 5 to 15 million fish per year (based on impingement levels found at the Ginna and Nine Mile Point facilities, respectively). Over

721 195

715 258

90 percent of the impinged fish are expected to be alewives, 2 to 6 percent are expected to be smelt, and 0.3 to 0.5 percent are expected to be game and other large fish. The NRC estimates that the percent of the total lake stock of alewives impinged by all of the facilities that will be operating on the southeast shore of Lake Ontario when the Sterling facility goes on-line (excluding Oswego Unit 6) will range from 0.20 percent (based on impingement estimates at Ginna) to 4.1 percent (based on impingement estimates at Nine Mile Point). These estimates are based on alewife populations of 10^9 and 10^{10}, respectively.

According to the draft impact statement, the Sterling facility alone could impinge anywhere from 0.05 percent of the total stock (assuming 10^{10} alewives) to as much as 1.4 percent (assuming 10^9 alewives). As stated on page 5-31 of the draft statement, "Even the latter estimate appears low in relation to the total population." However, consideration of this impact should not be limited to an examination of the lakewide impact. The discussion should also focus on the area of the lake that will be most seriously affected by the operation of the Sterling plant, that is, the southeast shore. Cumulative impacts on this region will probably be severe, perhaps resulting in a loss of game and larger fish due to the loss of a major portion of the forage base.

The upper limit of the NRC's estimate of impingement losses at the Sterling facility is 15 million fish per year, for a total weight of about one million pounds. To put this number in perspective, the National Marine Fisheries Service has estimated that total landings of all fish on the American side of Lake Ontario in 1971 were about 302,600 pounds. Thus, through impingement alone, the Sterling facility could remove more than three times the weight of the current commercial fish catch on the American side of the lake.

Moreover, it is quite possible that the potential impingement losses at the Sterling facility have been underestimated. The data used by NRC to calculate impingement losses at Sterling are based on data from the Ginna and Nine Mile Point facilities. As NRC points out these data should be approached with caution because they are based upon weighted averaging of weekly or biweekly sampling efforts while daily impingement rates can vary tremendously. For example, data previously received by EPA indicate that on April 11, 1973 a kill of 496,778 fish was counted on the screens of Nine Mile Point #1. This is about 3 percent of NRC's estimate of total yearly kill, based on the data in Tables B-11 and B-12 (Appendix B). Since water use will be much higher at Sterling than at Nine Mile Point #1, an equivalent daily kill at Sterling might be 7 percent of NRC's annual estimate. We mention this to show that the figures given in the draft statement may be seriously underestimated.

The information presented in the draft statement strongly indicates that the proposed intake structure, as well as the proposed modifications to minimize impingement (such as an intake velocity of 1.5 fps and closure of the "down-wave" ports), will not be effective in reducing impingement levels, and may even aggravate the problem. For example, high intake velocities (such as 1.5 fps) have been shown to substantially increase impingement rates. In addition, all impingement estimates used in this analysis are based on the assumption that impingement is a linear function of the intake withdrawal volume. Impingement data gathered at other facilities located in this region of the lake demonstrate that impingement levels are site-specific, and not based entirely on intake withdrawal volume.

The draft statement does not discuss the possibility of redesigning the proposed intake structure to reduce the predicted levels of impingement. This alternate should be considered, particularly in light of the considerable amount of research that has been done in this area by Alden Laboratories for the existing Nine Mile Point #1 and Ginna plants, as well as the applicant's need to meet the requirements of 316(b) of FWPCA.

Entrainment Effects

Regarding entrainment, the data on egg and larval densities presented in the draft statement indicate that entrainment mortality of ichthyoplankton will place a serious stress on the nektonic community, particularly when considered in conjunction with the operation of other power plants located in the southeast sector of Lake Ontario. However, EPA has serious doubts about the quality of the ichthyoplankton data base, and feels that no accurate estimates can be made given the available information. Consequently, EPA recommends that additional studies be required. In addition, the draft statement does not clearly state where the larval data (used to predict the percent loss due to entrainment of various families of larvae) were obtained. To date, EPA has not seen any data collected at the Sterling site which have identified the larvae collected to either family or species.

Although there was limited, and somewhat sporadic sampling of the 11 meter zone (the depth and location of the intake), the bottom pump samples obtained high concentrations of fish larvae at this depth. Mean concentrations of 26 larvae per square meter were reported, with maximum densities of up to 400 per square meter. No larvae were identified as to species; however, clupeid larvae (probably alewives) constituted the largest fraction of the larval population. Substantial fractions of larvae from the serranid, centrarchid and cyprinid families were also found.

The huge number of demersal eggs (20,000 per square meter of bottom), combined with the high concentration of larvae and juveniles, and the very high juvenile/larvae ratio indicates that the area in front of the plant is a spawning/nursery area. Entrainment mortalities, particularly for fish eggs, larvae, and juveniles will approach 100 percent. The following excerpt from page 5-33 describes the stresses to which the entrained ichthyoplankton will be exposed:

> Young fish will encounter all the hazards described for entrapped adult fish as far as the traveling screens, particularly since many young fish will have already developed swim bladders.... Those immature fish avoiding impingement will risk damage in the pumps before injection into the condensers and subsequent mechanical, thermal, and chemical shocks. Upon discharge, those still alive will suffer heightened predation due to their disorientation and weakened condition and they will face further thermal exposure and possible gas bubble disease.

The method used by NRC to calculate entrainment loss to the fishery is a good one; from the number of larvae and juveniles entrained daily, NRC estimates potential pounds of 2-year-olds lost per day. Given the natural survival rate of larvae and juveniles and an assumed average weight at the end of the second year of growth, this conversion is easily done. Table 5.17 estimates that 1730 and 18,400 pounds of 2-year-olds are lost per day due to entrainment of larvae and juveniles, respectively. Since the estimate is for the months of May through August, this rate of loss corresponds to about 2.5 million pounds per summer.

Although this method of calculating entrainment loss is valid, we question the use of an assumed average weight per 2-year-old fish of 0.1 pound. This figure might be appropriate if we were discussing only clupeids (alewives) and cyprinids (shiners). However, the draft statement cites substantial numbers of larval forms of serranid (white perch), and centrarchid (sunfishes including black bass). Serranid juveniles were also abundant. Le Tendre and Schneider have reported that the average weight of two-year-old white perch taken during sampling of Lake Ontario in 1971 was 0.25 pounds.(1) Other fishes which would be affected to some degree by entrainment are not mentioned in the draft statement. A partial list of local fishes which can reach considerable weights in their second year class follows:

salmonids
smallmouth and largemouth bass
other sunfishes such as bluegills
  and crappies

~~721 196~~
715 255

carp
white sucker
yellow perch
northern pike
gar
pickerel
brown bullhead
white bass
lake whitefish
burbot
gizzard shad

We feel that NRC's estimates of entrainment losses may be low for one other reason. Table 5-17 estimates entrainment effects only for the period of May through August, or 123 days. Certainly April and September should be considered since juvenile and larval densities would also be significant during these months.

Even assuming the very conservative average weight value of 0.1 pound per two-year-old fish, the calculated entrainment loss figure is significant. According to the information presented in the draft statement, entrainment effects at the Sterling facility alone could cause a loss to the second year fish population of 2.5 million pounds per year. The combined effects of impingement and entrainment at Sterling alone could cause a loss of 3.5 million pounds per year, or about twelve times the weight of the total commercial fish landings on the American side of Lake Ontario in 1971.

Despite the large projected fish losses, the draft statement maintains that the inshore waters at the site of the Sterling facility do not appear to be relatively superior as a nursery and spawning area, and that other areas of the lake may provide more suitable spawning and nursery areas. It is then concluded that "...the implications of losses of these magnitudes may be less severe than they first appear." Regardless of other available spawning areas in that region of Lake Ontario, fish do spawn in the vicinity of the site, as demonstrated by the large concentrations of larvae. The fact that fish may spawn elsewhere in the lake does not mitigate the impact on the ichthyoplankton populations in this area, and does not necessarily diminish the mortality estimates. In addition, these statements appear to be in conflict with NRC's concluding remarks on page 5-37, "However, the available data suggest that impingement of 5 to 15 million fish per year and entrainment of up to 22 million larvae and 2 million juveniles per day are reasonable possibilities. Losses of those magnitudes could substantially reduce recruitment and standing crops on the local level."

Considering the potentially severe impacts on the local level, it is difficult to understand NRC's recommendation regarding the positioning of the intake structure at a minimum depth of 35.5 feet below mean lake level. This requirement involves no discernible change since it is the currently proposed depth of the intake structure. If the impingement and entrainment mortality levels are to be mitigated, major intake modifications will be necessary. Closed-cycle cooling should be considered as a viable alternative to the present proposed system of once-through cooling.

DISCHARGE-RELATED IMPACTS

Thermal Effects

The thermal plume from the Sterling facility and its effects on the aquatic ecosystem are not adequately discussed in the draft statement. To begin with, the analysis submitted by the applicant, which is based on observations made at the Ginna station, is deficient. From among thirty-six sets of Ginna thermal plume data, the applicant selected eight sets for analysis. These are given in Table 5.1. It should be noted that the eight sets of data average only about 80 acres inside the 3°F isotherm. Two random overflights of the area made by EPA on July 3 and August 1, 1974 show an average of 212 acres. This leads us to inquire as to how the eight sets of data were chosen. It is emphasized that Sterling will have more than double the cooling water flow of Ginna and a 25 percent higher delta t. We agree with NRC that the applicant's plots are "highly idealized." For example, Fig. 5-2 gives predicted isotherms at 6" depth with "average" surface cooling. There are 174 acres within the 3°F isotherm. This is significantly less than our random, actual data for Ginna and, as previously mentioned, is given for a unit over twice Ginna's size.

Another deficiency of the applicant's analysis is that the plots proceed directly out into the lake with no tendency to hug the shoreline. An EPA report on thermal discharges from power stations in this area showed that the plumes from all stations studied had definite shore paralleling (and shore impinging) tendencies.(2) The plume from Ginna is shown to parallel the shore but not to impinge upon it for as considerable a distance as the plumes from Oswego or Nine Mile Point. The point to be made here is that the Oswego and Nine Mile plumes impinge on shore for virtually their entire lengths. In this respect, they are much better analogs for Sterling than Ginna's, because Ginna is sheltered by Smoky Point from the prevailing west winds and west to east crosscurrent.

Based on these data, we predict that Sterling's plume will very often impinge on shore for most of its length. It is important to stress this point because New York State Regulations specify that the mixing zone shall not interfere with spawning areas, nursery areas, or fish migration routes. As previously discussed, in the EPA's opinion the available data indicate that the shallows of the lake in front of Sterling are an important spawning and nursery area. The NRC's analysis indicates that the diameter of the area inside the 3°F isotherm will at times be well in excess of one mile. Even though New York State has set no numerical limits, this is a rather large mixing zone to have to approve.

We agree with NRC's summary on page 5-11 that the area within the 3°F isotherm will lie within the range 174 to 1160 acres, as predicted by the applicant. However, we disagree with the applicant's analysis in that it suggests (as in Figure 5.2 for average surface cooling) that the low end of the range will be the average. The acreage prediction by NRC in Table 5.3 is much more in agreement with EPA data. However, both the applicant's and NRC's analyses are deficient in that they do not incorporate the shore hugging tendencies of <u>all</u> observed plumes on the southeast shore of Lake Ontario.

The draft statement is also deficient in its discussion of the effects of the thermal plume on the aquatic ecosystem. For example, the draft statement notes the dominance of bluegreen (especially <u>Oscillatoria sp.</u>) and green algae (<u>Pandorina</u>, <u>Staurastrum</u> and <u>Pediastrum</u> spp.) during the period extending from July through September. This occurrence should be related to the presence of the Sterling plume and its potential impact on the abundance of bluegreen algae during this period. The possibility of extending the bluegreen algae's period of occurrence, as well as their potential dominance (as opposed to codominance with green algal species) should also be addressed.

The temperature tolerance data cited in this review indicate a potential detrimental impact on the local yellow perch population. This species requires a temperature regime of 40°F or less for several months if normal reproductive success is to be achieved. However, NRC cites available data from Lake Michigan demonstrating that yellow perch will select temperatures known to significantly impair reproduction, as is shown by their presence in the thermal discharge zone in midwinter. This potential adverse impact should be considered in greater detail.

The draft statement indicates that the potential adverse thermal impacts on other fish species may outweigh any benefits, such as increased fishing potential as a result of attraction of fish to the plume. These adverse impacts include cold shock, overcrowding, loss of condition, reduced resistance to disease, reduced reproductive success in some species, gas bubble disease, and interference with shoreline migrations. Page 5-25 states "In conclusion, the thermal discharge may directly or indirectly reduce recruitment rates and standing crops at the local level (within a 3-mile radius). Lake Ontario fish populations as a whole should not be measurably affected."

The draft statement, although correctly indicating potential adverse thermal impacts in the above assessment, does not appear to take into account that the severity of any plume-induced impact is species-specific. Consequently, a discussion of potential thermal impacts should include consideration of a number of representative important fish species, such as alewife, rainbow smelt, smallmouth bass, spottail shiner, and salmonid spp., under both summer and winter stress conditions. Some topics that should be addressed in this discussion are:

(1) the number of days in the summer during which the tolerance limits of a given species will be exceeded;

(2) the species of fish that will be attracted to the plume during each season and the potential mortality that may result from this attraction;

(3) the chance of a facility shutdown in winter and the potential kill from such a shutdown;

(4) the cumulative impact with respect to other power plants in the vicinity of the Sterling facility (i.e. located on the southeast segment of Lake Ontario). NRC states that the Sterling discharge alone may reduce both recruitment rates and the standing crop within a three-mile radius; based on this prediction, the cumulative thermal impact may be very severe.

<u>Chemical Effects</u>

Niagara Mohawk does not chlorinate its once-through cooling water for its Lake Ontario power plants because the silt in the lake adequately prevents fouling of the condenser tubes. The applicant, however, plans to chlorinate for three 20-minute periods a day using 540 pounds per day of sodium hypochlorite. In light of the above, it is suggested that NRC discuss in the final statement the applicant's proposed chlorination practices.

COMBINED IMPACT OF POWER PLANTS LOCATED ALONG THE SOUTHEAST SHORE OF LAKE ONTARIO

The decline of the fishery in the Laurentian Great Lakes, especially with reference to Lake Ontario, has been attributed to several causes, including:

(1) initial intensive selective exploitation of certain species;

(2) modification of drainage basins and tributaries making many areas of the littoral zone unsuitable for spawning and reproductive success;

(3) exotic marine species;

(4) physical and chemical modification of the lakes as a result of industrialization and urbanization -- Much of the decline of oligotrophic piscivore species can be related to deforestation which, coupled with pollution and impoundment, leads to warming and elimination of spawning areas.(3)

The EPA believes the power generation in the southeast quadrant of Lake Ontario has significant potential to contribute to the further decline of the fishery resource of the lake.(2) The infra-red imagery survey done by EPA in the summer of 1974(2) clearly shows the need to evaluate the combined effects of thermal effluents rather than just the additive effect of each plant as it comes on-line. On August 1, 1974, the shoreline of Lake Ontario from Oswego to Nine Mile Point was flown. The imagery results showed a continuous thermal field from west of Oswego Harbor to as far east of Nine Mile Point as the flight registered. Although it is natural for inshore waters to be slightly warmer than the ambient temperature, the thermal field was on the average 4.3 to 5.6°F warmer than ambient. Moreover, these elevated temperatures are apparently caused by the power plants in this area of the lake because the same trend is not seen for inshore waters farther west on the lake.

This flight took place one and one-half years ago. Since that time, another large Oswego Unit #5 became operational at the western end of the transect, and Fitzpatrick is now operational at the eastern end. Nine Mile Point Unit #2, which is due to become operational in 1977, will add to the already high thermal loading in the southeast quadrant of the lake. In effect, the southeast quadrant of the lake is a mixing zone from Oswego to at least 4 miles east of Nine Mile Point, the limit of the survey. Acceptance of once-through cooling at other large base load units west of Oswego, such as at Sterling, could cause this situation to spread farther west along the lake, to the further detriment of the fishery.

The effects of inshore thermal pollution of natural waters are well documented:

(1) inducement of premature spawning and hatching

(2) avoidance by salmonid species; non-hatching of salmonid eggs;

(3) decreased survivability of larvae after leaving the heated area;

(4) decreased ability to avoid predation;

(5) enhancement of parasitism and disease in fishes;

(6) localized blockage of alongshore migration;

(7) enhancement of locally or regionally eutrophic conditions.

Most of these effects are not considered in the draft environmental impact statement.

The discussion of combined effects in the southeast quadrant of Lake Ontario should not be limited to thermal pollution, but should include impingement and entrainment. With respect to impingement, all plants existing, and proposed for the near future, in this quadrant will pull roughly four times the amount of water proposed for Sterling. Extrapolating our previous figures, this roughly corresponds to impingement of 4 million pounds of fish annually. With respect to entrainment, this represents an annual loss of 10 million pounds of fish, for a total of 14 million pounds annually. This is well over 45 times the total 1971 landings of all fish on the American side of the lake. Power production, specifically nuclear power production, must be viewed as the most significant artificial predator of fish on the lake.

SUMMARY

The EPA believes that the proposed cooling system design has the potential to adversely affect the ecosystem of Lake Ontario. The large volume flow (1936 cfs) required for once-through cooling at Sterling increases the number of organisms subjected to entrainment and impingement by 490 percent over a closed cycle cooling system. This coupled with organisms lost due to the discharge plume (effects of thermal shock, cold shock due to sudden shutdown, gas bubble disease, stress of crowding, and thermal blockage) may adversely affect not only local species population but the population of Lake Ontario as a whole. Entrainment is of significant importance due to the large numbers of fish larvae and juveniles that the biological data survey indicated were in the vicinity of the Sterling site.

It is EPA's understanding that NRC will require further ecological baseline studies in order to analyze to a greater certainty the aquatic impact that may result from once-through cooling. The EPA concurs with this and recommends that the design of the proposed cooling system not be finalized until the aquatic impact effects have been analyzed.

RADIOLOGICAL ASPECTS

Source Term Estimation

The gaseous waste source terms published by NRC in the draft environmental impact statement for the proposed Sterling Power Project, as given in Table 3.7, are consistent with the parameters in Draft Regulatory Guide 1.BB[4]. However, NRC has also included Table 3.5, entitled "Principal parameters and conditions used in calculating releases of radioactive material in liquid and gaseous effluent from Sterling Power Project." The use of Table 3.5 to calculate the various gaseous source terms provides substantially different results from those reported in Table 3.7. For example, EPA calculated the Iodine-131 source term for the containment building using Draft Regulatory Guide 1.BB and arrived at a source term of 0.17 Curies per year. The EPA then calculated the same source term using Table 3.5 data and arrived at a source term of 0.89 Curies per year, which is more than four and one-half times the value obtained using the Draft Regulatory Guide. Similarly, EPA calculated the Iodine-131 source term for the auxiliary building using the Draft Regulatory Guide and arrived at a value of 0.0045 Curies per year. Using Table 3.5 data, EPA arrived at a value of 0.0030 Curies per year.

The EPA realizes that the data and techniques for PWR source term calculation contained in Draft Regulatory Guide 1.BB represent much actual operating experience, and that use of this Guide can be considered the best method for source term calculations. Incorporating parameters such as those in Table 3.5, however, obscures the method by which the source terms are calculated. The result is that the draft statement does not present a clear picture of the environmental impact of the planned action.

In order to correct this situation, EPA suggests that NRC provide a table of parameters in the final environmental statement that can be used to verify the various gaseous source terms based on Draft Regulatory Guide 1.BB.

Radioactive Waste Management

It appears that NRC has underestimated the amount of "low-level solid wastes" that will be produced by the proposed plant. Several references are available pertinent to this subject. The Atomic Energy Commission's (now NRC) concluding statement to its rulemaking proceedings on Appendix I to 10 CFR 50 contains improved estimates of low level solid radwastes produced during nuclear power plant operations. The Oak Ridge National Laboratory (ORNL) has published "A Critical Review of Solid Radioactive Waste Practices at Nuclear Power Plants" (ORNL - 4924), which provides a compilation of

715 258
721 288

operational experience relative to these wastes. The EPA has also conducted extensive research on these wastes and their impacts at selected, licensed, shallow land burial sites.

Based on analyses of the available information, EPA estimates that the annual off-site shipment of "low-level solid wastes" will be comprised of approximately 25,000 ft^3 or 4000 55-gallon drums, for a 1000 MWe PWR.[5] The draft environmental statement estimates that approximately 10,700 ft^3 or 1700 55-gallon drums (7400 ft^3 per year of wet solid wastes plus 450 55-gallon drums of dry solid wastes) of "low-level solid wastes" will be generated per year. In order to clarify this apparent inconsistency, the final statement should provide the rationale for this estimate.

Dose Assessment

The draft environmental statement does not adequately reflect the potential impacts of the Sterling Nuclear Power Project in that it makes no estimates of the expected radiation doses to representative individuals in the surrounding area. Although NRC will require that the plant be operated in accordance with Appendix I to 10 CFR 50, which places an upper limit on the dose, this does not represent an assessment of the expected doses to the individual receiving maximum exposure. Further, the draft statement does not indicate whether reasonable design changes will be available to ensure that the objectives of Appendix I can be achieved without affecting the reliability of the plant. We understand that modification of NRC source terms and dose models is expected to be completed in the near future. Since the Sterling plant is not expected to become operational before 1984, NRC has sufficient time to incorporate in the final statement estimates of doses to those individuals who will receive a maximum exposure.

The EPA has calculated the doses that maximally exposed individuals are expected to receive, based on the source terms given in the draft statement. The results, which are presented in Table 1 (attached), are based on EPA's AIREM[6] computer code. We are providing these detailed dose estimates in order to stress the importance of making such evaluations early in the licensing review process. Early evaluation will indicate whether improvements in plant effluent control technology are needed, and will allow their timely implementation. Since pathways to the maximally exposed individual may change during the plant's lifetime, the applicant, as part of the operational environmental monitoring program, should periodically audit the locations of nearby lactating cows (or goats) to determine the worst-case human intake. This procedure would permit determination of the critical receptor. We have reviewed the applicant's proposed operational environmental monitoring program and have found it to be comprehensive.

We are encouraged that NRC is now calculating a potential annual dose to the U.S. population. This effort represents a partial evaluation of the total potential environmental dose commitments (EDC) of H-3, Kr-85, C-14, iodines, and "particulates," and is a determination which we have urged for several years. Of course, several of these radioisotopes, particularly C-14 and Kr-85, will contribute to long-term population dose impacts on a worldwide basis not just on a national one. Because the draft statement (1) places only an annual EDC limit on the discharge of these radioisotopes, (2) assesses the dose delivered during only the 50 years following each release, and (3) assumes a population of constant size, it does not reflect the total environmental impact. Assessment of the total impact would (1) incorporate the projected release over the lifetime of the facility (rather than just the annual release), (2) extend to several half-lives of 100 years, beyond the period of release, (3) consider, at least qualitatively or generically, the worldwide impacts, and (4) consider a growing exposed population. The EPA suggests that future assessments recognize these influences on the total environmental impact or specify the limitations of the model used.

Reactor Accidents

The EPA has examined the NRC analyses of accidents and their potential risks. The analyses were developed by NRC in the course of its engineering evaluation of reactor safety in the design of nuclear plants. Since these issues are common to all nuclear plants of a given type, EPA concurs with NRC's generic approach to accident evaluation. The NRC is expected to continue the efforts initiated by AEC to ensure safety through plant design and accident analyses in the licensing process on a case-by-case basis.

In 1972, AEC initiated an effort to examine reactor safety and the resultant environmental consequences and risks on a more quantitative basis. The EPA continues to support this effort. On August 20, 1974, AEC issued for public comment the draft Reactor Safety Study (WASH 1400), which was the product of an extensive effort to quantify the risks associated with light-water-cooled nuclear power plants. The EPA's review of this document included in-house and contractural efforts, and culminated in the release of final Agency comments on August 15, 1975. Initial comments were issued on November 27, 1974. The EPA concluded that the Reactor Safety Study represents two comprehensive and useful analyses of risks associated with light-water reactors. At present, EPA is reviewing the final Reactor Safety Study, which was released by NRC on November 4, 1975. The current review, which also involves in-house and contractual efforts, is expected to be completed in April 1976; at that time, EPA will publish final evaluations in public comments.

Fuel Cycle and Long-Term Dose Assessments

Under the President's Reorganization Plan No. 3 of 1970, EPA is responsible for establishing generally applicable environmental radiation protection standards to limit unnecessary radiation exposures and radioactive materials in the general environment resulting from normal operations of facilities that are part of the uranium fuel cycle. The EPA has concluded that environmental radiation standards for nuclear power industry operations should take into account total radiation dose to population, maximum individual dose, the risk of health effects attributable to these doses (including the future risks arising from the release of long-lived radionuclides to the environment), and the effectiveness and costs of effluent control technology. The proposed standards are expressed in terms of individual dose limits to members of the general public and limits on quantities of certain long-lived radioactive materials in the general environment.

A document entitled "Environmental Survey of the Uranium Fuel Cycle" (WASH 1248) was issued by AEC in conjunction with a regulation (10 CFR 50, Appendix D) for application in completing the cost-benefit analysis for individual light-water reactor environmental reviews (39 F.R. 14188). This document is used by NRC in draft statements to assess the incremental environmental impacts that can be attributed to fuel cycle components which support nuclear power plants. This approach appears to be adequate for plants currently under consideration, and estimates of the incremental impacts of the Sterling Power Project are reasonable. However, as suggested in our comments on the proposed rulemaking (January 19, 1973), if this approach is to be used for future plants, it is important for NRC to periodically review and update the information and assessment techniques used. The EPA intends to monitor developments in the fuel cycle area that are relevant to continued improvement in assessing environmental impacts.

The summary presentation (Table 5.9) on the environmental effects of the uranium fuel cycle addresses only the incremental environmental impacts expected to result from the operation of a nominal 1000 MWe nuclear reactor. However, there are impacts associated with the ultimate disposal of wastes which, to our knowledge, have not yet been adequately evaluated or are largely unknown. These impacts include:

- Commitment of land and resources for an ultimate disposal site;
- Economic and resource commitments of future generations, including societal and institutional commitments;
- Economic, resource, and energy costs of ultimate waste disposal as balanced against the present benefits realized by energy production.

7121-201

715 259

While EPA recognizes that the individual nuclear power plant environmental statements may not be the proper vehicle for assessing these considerations, the environmental statements can, and should, indicate any pertinent studies (and their expected completion dates) which are being conducted by NRC or other responsible agencies. If no such efforts can be documented, NRC should either include these considerations in an updated version of WASH-1248 or should urge ERDA to consider them in studies directed at developing an ultimate radioactive waste disposal technology.

High-Level Waste Management

The techniques and procedures used to manage high-level radioactive wastes will have an impact on the environment. To a certain extent, these impacts can be directly related to the individual project because the reprocessing of spent fuel from each new facility will contribute to the total waste problem. However, EPA concurs with NRC's generic approach to waste management impacts. As part of this effort, AEC, on September 10, 1974, issued for comment a draft statement entitled, "The Management of Commercial High-Level and Transuranium-Contaminated Radioactive Waste" (WASH-1539).

Though a comprehensive long-range plan for managing radioactive wastes has not yet been fully demonstrated, acceptance of the continued development of commercial nuclear power is based on the belief that the technology to safely manage such wastes can be devised. The EPA is available to assist both NRC and ERDA in their efforts to develop an environmentally acceptable waste management program to meet this critical need. In this regard, EPA provided extensive comments on WASH-1539 on November 21, 1974. Our major criticism was that the draft statement lacked a program for arriving at a satisfactory method of "ultimate" high-level waste disposal. We believe this is a problem which should be resolved in a timely manner because the United States is committing an increasingly significant portion of its resources to nuclear power, and waste materials from the operating plants are steadily accumulating. The ERDA now intends to prepare a new draft statement which will discuss waste management and emphasize ultimate disposal in a more comprehensive manner. The EPA concurs with this decision. We will review the new draft statement when it is issued and will provide public comments.

Transportation

In its earlier reviews of the environmental impacts of transportation of radioactive material, EPA agreed with AEC that many aspects of this program could best be treated on a generic basis. The NRC has codified this generic approach (40 F.R. 1005) by adding a table to its regulations (10 CFR Part 51) which summarizes the environmental impacts resulting from the transportation of radioactive materials to and from light-water reactors. This regulation permits the use of the impact values listed in the table in lieu of assessing the transportation impact for individual reactor licensing actions if certain conditions are met. Since the Sterling Power Plant appears to meet these conditions and since EPA agrees that the transportation impact values in the table are reasonable, the generic approach appears adequate for the Sterling Project.

The impact value for routine transportation of radioactive materials has been set at a level which covers 90 percent of the reactors currently operating or under construction. The basis for the impact, or risk, of transportation accidents is not as clearly defined. At present, EPA, ERDA, and NRC are each attempting to more fully assess the radiological impact of transportation accidents. As the quantitative results of these analyses become available, EPA intends to review the acceptability of the potential transportation risks. The EPA will make known its views on any environmentally unacceptable conditions related to transportation. On the basis of present information, EPA believes that there is no undue risk of transportation accidents associated with the Sterling Nuclear Power Plant.

ADDITIONAL COMMENTS

1. The effects of construction of the intake and discharge structures are potentially significant. For example, construction of the intake will involve burying a pipe 90 ft below the lake bed for a distance of 4200 ft offshore. The impact statement does not mention whether this will involve tunneling or dredging. In either case, we believe that it is unlikely that construction will disturb only 0.3 acre of benthic habitat. The discussion of construction effects should be expanded in the final statement to further detail this impact.

2. The final impact statement should include Table 3.7-2 from the applicant's environmental report to supplement the text of Section 3.7.3 on page 3-22.

3. The final statement should include comparisions of the costs to the consumer (in mils per kwh) for the proposed plant design and the alternative plant designs specified in Section 9.2, particularly the wet natural draft cooling tower alternative.

4. The proposed project is called Sterling Power Project Unit 1. The final statement should indicate how many other units are planned for this site.

Table 1

Estimated Doses To Individuals

Location	Distance/Direction(a)		Thyroid Dose (mrem/yr) Milk Ingestion(b)	Inhalation(c)	Vegetable Consumption(d)
Site Boundary	0.7 mi (1190m)	NNE	______	<1	<1
Nearest Residence(e)	0.7 mi (1190m)	NNE	______	<1	<1
Nearest Farm (Nondairy)	2.0 mi (3220m)	S	______	<1	<1
Nearest Identified Cows(f)					
a.	1.3 mi (2090m)	ESE	6.7(g)	______	______
b.	1.6 mi (2570m)	SSW	3.8(g)	______	______
c.	1.3 mi (2090m)	SSE	4.8(g)	______	______
d.	1.1 mi (1770m)	ENE	19.0(g)	______	______

(a) Based on Envirormental Report, or estimates from information contained therein.

(b) Dose to a 6 month old infant, assuming a 1 liter/day milk consumption, 50% elemental iodine, a milk/air concentration factor of 1240 and a 6 month grazing factor.

(c) Dose to a 4 year old child.

(d) Dose to a 4 year old child, assuming a 13 kilogram/year vegetable consumption.

(e) The nearest residence was assumed for conservatism to be at the closest site boundary.

(f) The nearest identified cows are currently located within the exclusion zone.

(g) EPA is currently re-evaluating available data on parameters involved in the transfer of iodine through the environment to human receptors via animals' milk. The estimates presented herein were calculated from the existing EPA model.

References

1. Le Tendre, Gerard C. and Clifford P. Schneider. n.d. "A Preliminary Report on the Status of the Major Inshore Fish Stocks in Lake Ontario in 1973." Presented at: Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Buffalo, New York, March 13, 1974. New York State Department of Environmental Conservation, Cape Vincent Fisheries Station, Cape Vincent, New York.
2. U.S. Environmental Protection Agency. April 1975. Remote Sensing Report, Lake Ontario: A Study of Thermal Discharges from Ginna Nuclear Power Station, Oswego Steam Power Station, and Nine Mile Point Nuclear Power Station. EPA-330/3-75-002. National Field Investigation Center, Denver, Colorado.
3. Wetzel, Robert G. 1975. Limnology. W. B. Saunders Company. Philadelphia, Pennsylvania.
4. Draft Regulatory Guide 1.BB, Calculation of Releases of Radioactive Material in Liquid and Gaseous Effluents from Pressurized Water Reactors (PWRs). Docket No. RM-50-2. February 20, 1974.
5. Mann, Goldberg, and Hendricks. n.d. "Low Level Solid Radioactive Waste in the Nuclear Fuel Cycle." A paper presented at the November 16-21, 1975, American Nuclear Society meeting, San Francisco, California.
6. U.S. Environmental Protection Agency. May 1974. AIREM Program Manual - A Computer Code for Calculating Doses, Population Doses, and Ground Depositions Due to Atmospheric Emissions of Radionuclides. EPA-520/1-74-004.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

MAR 2 4 1976

RECEIVED
MAR 29 1976

S+N-50-485

Director
Division of Reactor Licensing
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

This is in response to your transmittal dated January 6, 1976, inviting the Energy Research and Development Administration (ERDA) to review and comment on the Nuclear Regulatory Commission's (NRC) Draft Environmental Statement, NUREG-75/093, related to the construction of Sterling Power Project Unit #1.

We have reviewed the document and have determined that the proposed construction does not appear to impact either on known current or future ERDA programs within the geographical area of Cayuga County, New York. However, we have some comments that we would like to present to the Commission for consideration in the preparation of the final statement.

The Summary and Conclusions section (page iii) indicates that a once-through system will be used to cool the power plant exhaust steam. However, sections 1.2 and 9.2.1.7 indicate that there is significant uncertainty as to the type of cooling system to be used, arising from the need for the applicant to obtain Environmental Protection Agency approval for use of a once-through system, and from the fact that the NRC staff requires further information before reaching a conclusion on the environmental acceptability of the proposed once-through cooling system. We believe that the Summary and Conclusions section should disclose this uncertainty on this important matter.

Table 2 (page D-5) indicates lower capital cost for a nuclear plant using cooling towers as compared to a nuclear plant using once-th cooling. This does not seem reasonable considering that use of cooling towers usually involves a capital cost penalty. It is noted that the applicant has estimated (9.2.1.1, pages 9-10) a $33 million penalty for use of natural draft wet cooling towers.

715 262

721 204

3161

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

PEP ER-76/15

MAR 26 1976

S+N-50-485

Dear Mr. Regan:

Thank you for your letter of January 6, 1976, transmitting copies of the Nuclear Regulatory Commission's draft environmental statement (CP Stage) for Sterling Power Plant Project, Unit 1, Cayuga County, New York.

Our comments are presented according to the format of the statement or by subject.

Cultural Resources

The negative statements on page 2-7 concerning cultural and natural resources seem adequate. Reference to contact with the State Historic Preservation Officer, the date of National Register of Historic Places consultation and citation by name and title of the archeologist consulted all appear satisfactory. However, to improve the quality and credibility of this impact evaluation, we suggest that the final environmental statement display the written commentaries of the State Historic Preservation Officer and Archeologist consulted. We also suggest including the National Register of Historic Places and any other documents used in determining the presence of cultural resources and the evaluation of impacts on them in the list of references for section 2 (pages 2-19 through 21).

Outdoor Recreation

In a letter dated October 20, 1975, comments were provided to the Nuclear Regulatory Commission (Environmental Projects Branch 2, Division of Reactor Licensing) on the Environmental Report Revisions No. 4 and No. 5, by the Bureau of Outdoor Recreation. That letter identified several recreation opportunities that could be compatible with the Sterling project, based on information provided by the applicant. The letter requested that a discussion of the feasibility of a recreation multiple-use proposal for the site be included in the draft statement. We find no evidence of a response to BOR's request. In fact, very little discussion of recreation in the project area is presented in the

715 263

~~721 205~~

3152

draft statement. The final statement should address this issue.

The final statement should contain a more thorough discussion of the visual impact to Fair Haven Beach State Park by the presence of the wet natural-draft cooling tower at the project site and any other adverse impacts to park users caused by this intrusion.

In addition, there should be a more thorough discussion in the final statement of the impacts generated from the forced relocations of 21 vacation home sites that presently accommodate 70 summer residents.

Mineral Resources

No mineral commodities are produced in the project area, although sand and gravel, limestone, and natural gas are produced in Cayuga County. The project will have no adverse affect on mineral resources or production.

Impacts on Land Use

Table 4.1 gives the land area affected by construction of the railroad spur as six acres. This should be more clearly identified as the acreage within the limits of the site, as it was stated earlier that the "railroad spur will affect 36 acres offsite" (page iii, paragraph 3a).

It is stated that "only 7 percent of the 2,600-acre site will be affected" by construction (page 4-2, paragraph 4.3.1.1), whereas the 214 acres to be disturbed comprises more than 8 percent of the site. In the same paragraph it is confirmed that the 214-acre area of impact includes 108 acres for plant, 50 acres for roads, transmission lines and railroad spur, and 47 acres for switchyard. Therefore, we believe the statement on page 5-1 that over 94 percent of the 2,600-acre site will not be altered by construction also should be revised.

Groundwater

Preoperational monitoring of groundwater is not discussed in the draft statement, except for a listing of two wells as indicator stations and another two wells as background stations. The final statement should include at least the locations of these stations and pertinent details about the wells, especially depths, static water levels, and aquifers tapped.

In regard to groundwater resources, although we agree that the effects of limited dewatering due to excavation should themselves be limited in extent and temporary, we believe that the last sentence of section 4.2 on page 4-2 is not correct in its hydrologic implications. The sentence infers that the effects of dewatering, that is, the cone of depression resulting from the drawdown of water levels, will be noted only toward Lake Ontario. Actually the cone of depression from the pumping should grow in all directions outward from the center of withdrawal, but should grow least in the direction of the lake, if any infiltration from the lake is induced. This sentence should be rewritten to clarify the nature of the impact on groundwater.

Thermal Discharges

The analyses of the thermal effects of the station on Lake Ontario by both applicant and NRC staff are based on measurements of the thermal plume in the lake caused by the discharge of condenser cooling water at the smaller Ginna Nuclear Power Station, 35 miles west-southwest. The wide scatter in the plume area heated by more than 3°F. is attributed by the applicant to variations in the transfer of heat from the water surface to the atmosphere, and by the staff to variations in the ambient lake turbulence. Data to verify either opinion is not available.

These analyses ignore the farfield heating of the lake caused by the discharge. The heat transferred from the water surface to the air from within the area of the plume, as represented for example in figures 5.2 to 5.6 (pages 5.4 to 5.7) would account for only a small fraction of the heat discharged into the lake. Most of this heat would be transferred to the air outside of this area. In other words, the temperature in a large area outside of the plume would be increased slightly. This small increase in temperature would make the precise definition of ambient temperature (i.e., temperature unaffected by the heat discharge) very difficult to measure near the plume. Yet the size of the area of the plume raised by more than 3°F., would be greatly different if the ambient temperature was changed by only 1°F. from that assumed in the observations at Ginna; this also could account for the great variability in plume size observed.

The Sterling plant would discharge about 2.7 times as much heat as the Ginna plant. The farfield thermal effects will be more widespread and should be assessed in the analysis of thermal effects.

Class Nine Accidents

A discussion of the potential impacts of a Class 9 accident should be included in the environmental statement since conditions at the

Sterling site differ from the general case described in the Reactor Safety Study as noted on page 7-2. Specifically, the proximity of Lake Ontario raises the possibility, depending on wind and precipitation during and after an accident, that radioactive material could reach the Great Lakes. This condition should be evaluated in the final statement.

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

Sincerely yours,

Stanley D Doremus

Deputy Assistant Secretary of the Interior

Mr. William H. Regan, Jr.
Chief, Environmental Projects
  Branch 3
Division of Site Safety and
  Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

POOR ORIGINAL

([illegible])

29 March 1976

4-2-76

United States Nuclear Regulatory Commission
The Capitol, (Office of Nuclear Reactor Regulation)
Washington, D.C. 20555, U.S.A.

S+N-50-485

Dear Sir [illegible] ([illegible])

Reference is made to [illegible] page copy of the Draft Environmental Statement to the construction of Sterling Power Project Unit I, Rochester Gas and Electric Company, Docket # STN 50-485 (NUREG-75/074) as published December 1975.

I am quite sorry to send my views on the very even [illegible] environmental draft on the [illegible] my change of schedule, working hours at the U.S. Government Post Office [illegible] despite [illegible] past twenty [illegible] to the Board of Directors Mental Health Association of Onondaga County plus [illegible], I [illegible] the chance nor any time [illegible], therefore this tardy report.

Not digesting the content of said draft, as I should do, wonder however a more complete & ~~[illegible]~~ precise report I read the [illegible]. I recall that the [illegible] of fish is not to my personal taste as per editorial newspaper [illegible], Syracuse Herald Journal, Saturday, 28 March 1976, page 55, re: thousands of trout stocked for Thursday's season opener ... (Editorial on next page)

3258

[illegible], K.F., M.D. ([illegible])

29 March 1976

U.S. Nuclear Regulatory Commission (NUREG 75/074 (STN 50-485)

[illegible] as editorial therein said newspaper [illegible] that the [illegible] were in abundance [illegible] the warm water expelled by [illegible] power plant located in Oswego County [illegible] for sport anglers, [illegible].

Further the said report [illegible], I [illegible] did not read in said report that [illegible] power plant [illegible] located in Oswego County [illegible] plant [illegible] the lake waters [illegible].

Said plant would be a "boon" to the county but to say [illegible] "boon" to [illegible] or [illegible] for a few dollars, is my opinion not worth the [illegible].

Sincerely hope that my limited views will help the good commission in making the correct environmental proper safe guards.

Sincerely yours,
Dr. K F [illegible], M.D.
Mental Health Association of Onondaga County, Inc.
1 Mid-Town Plaza, 700 E. Water St.,
Syracuse, N.Y. 13210
L S-1

[illegible]

715 265

721 207

Cont.

(1) Should not there have been [illegible] Cayuga County [illegible] [illegible] [illegible] [illegible] [illegible] to a [illegible] creek in the matter ??

(2) [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] surface, [illegible] [illegible] [illegible] [illegible]

(3) Some of [illegible] [illegible] [illegible] [illegible] [illegible] into the sea

Question: [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

POOR ORIGINAL

715 266

721 208

or Thursday's season opener

Outdoor World

SYRACUSE HERALD-AMERICAN, Mar. 28, 1976 59

FAYETTEVILLE-MANLIUS ROD AND GUN CLUB MEMBER DICK EBERHARD JR. helps hatchery crews stock Limestone Creek with brown trout

Lectures highlight show

There will be plenty of exhibits and lectures for the ...out enthusiasts today when ...e Cortland Chapter of Trout ...nlimited's Spring Outdoor ...ow opens at noon.

Mo..., authorities in spe...alized fields and recreation ...lated exhibits will highlight ...e eight-hour show. The pub... is invited to attend at Cort...nd-Madison Board of Cooper...ive Educational Services, ...inton Avenue extension, ...ortland.

Opening the program will be ...ovies at noon.

The lectures begin at 1 p.m. ...en "Tracing the evolution

biologist and chief project engineer on much of the salmon exploration in the region on Lake Ontario and its tributaries.

After a movie, the podium will be occupied (2:30 p.m.) by Fred David, Outdoor Editor of Syracuse Herald-American. His topic will be "New fishing regulations for 1976" which will include the present Finger Lakes regs and others that

would [illegible] angles on the trout streams.

Other speakers and thier topics include Ron Howard, Reg. vice chairman of TU for CNY., discussing the book "Fishing For Rainbows in the Great Lakes", Bill Bartlett, tackle representative, talking (4 p.m.) on "Selection of proper equipment for successfull fishing".

Proceeds from the $1 adult admission (children under 14 with adult admitted free) will be used for stream improvement projects in the Cortland County streams.

Some of the exhibits at the ...

Archery shoot

Another in the series of bicentennial theme archery shoots will be conducted ...

Catherine Creek rainbow derby

Once again, rainbow trout anglers on Catherine's Creek will compete for cash ... and trophies for ... bow.

The Montour ... of Commer... ...

STATE UNIVERSITY OF NEW YORK
COLLEGE OF ARTS AND SCIENCE AT OSWEGO, NEW YORK 13126

StN-50-485 March 16, 1976

Response to United States nuclear regulatory commission Draft Environmental Statement related to the construction of Sterling Power Project Unit 1.

To whom it may concern:

I wish to respond to the following specifics in the draft environmental statement published December, 1975:

First with regard to page 4-5 Consumers: As an active field ornithologist with nearly 10 years experience in Oswego County, I would like to contend that elimination of any nesting Sharp-shinned Hawks in our area is unwise. This species has declined drastically in this area in the past 20 years and the loss of even one nesting pair is significant in that it may represent a considerable proportion of the local county breeding population. To state that such construction will have only minor effects upon regional breeding populations is dependent upon what one defines as the region. Myself and other active field observers may note a total of 2-5 Sharp-shinned Hawks for Oswego and northern Cayuga Counties for an entire summer. I would say that one Sharpie pair would represent a considerable portion of local regional populations.

On page 5-20 the subject of bird collisions with fatalities by stating that "bird mortality" cannot be analyzed at this time, but is not expected to be severe" is a question of "severity". I wish to point out that a special set of circumstances peculiar to large bodies of water is at work along the shore of Lake Ontario. Many birds which migrate over water tend to fly very low, rising gradually to much higher heights upon encountering land. Thus, tall structures of any kind constructed within a mile or so of such bodies of water may tend to have more bird collisions than corresponding structures elsewhere. Many times in my field work I have noted birds in the fall approaching from the lake only inches above the water. I have records of considerable mortality of birds against numbers of structures on the campus of the state university, College at Oswego, during 1974-75 that I will supply upon request. Such mortality may noticeably reduce populations on each instance and when such effects are compounded cumulative. The effects here upon migratory bird populations are considerable. Such mortality, I believe, is quite significant in areas along the lakes and tall structures such as plants, cooling towers, and transmission lines will compound the problem.

It is stated on 9-8 that the Sterling Site has wetland habitat that "will be minimally effected". I suspect that even minmal effects in these days of rapid shrinkage of valuable wetlands is unnecessary when there are no wetlands to be affected on the Ginna Site.

In addition to the aforementioned considerations I feel that a very important consideration regarding the area has been overlooked. The Sterling Site is one of the largest chunks of relatively undisturbed habitat along the eastern part of Lake Ontario. In my opinion, it is one of the few sites that could successfully support

3908

a nesting pair of Bald Eagles, rare and presently in [illegible] in this part of its native range. I wish to point out that the New York State Department of Environmental Conservation, in [illegible] with [illegible] of Oswego University, are conducting a Bald Eagle [illegible]. This project will involve the [illegible] and [illegible] Bald Eagle [illegible] in preparation to possible reintroduction of this [illegible] species in our state. I believe that this project has been funded for [illegible] year. I also believe that in the habitat survey in [illegible] a [illegible] piece of Eagle habitat. Due to the need of [illegible] of large areas of relatively little disturbance to fulfill [illegible], and feeding requirements, the preservation of such areas is of [illegible] importance. I can state from personal experience that areas of [illegible] are very rare in the eastern part of Lake Ontario and that this [illegible] of the best if not the only [illegible] of such areas. Non-breeding Bald Eagles, [illegible] summer birds of the Florida population, have been [illegible] several occasions in recent years. This illustrates that the site is [illegible]. Dr. [illegible], project ecologist of [illegible], [illegible] birds in the area in 1973 in the first impact statement on the Sterling Site. I have noted Bald Eagles twice in this area in the last year. I strongly urge that the value of this site as Bald Eagle habitat, particularly in view of the [illegible] given serious consideration.

I believe that the current value and potential value of the Sterling Site to a number of birds, including the Bald Eagle, has been generally overlooked in considerations of the environmental impact of the Sterling project. The impact of construction on wildlife values would be greater than indicated in the draft environmental statement for reasons indicated previously. These adverse effects represent a direct cost to the citizens of the state of New York and the nation, but in particular to the citizens of this area. I feel that these costs are unnecessary as relocation to the Ginna site would result in no loss of [illegible] and a savings of other valuable wildlife resources. Thus, I urge the persons charged with decision making that the proposed Sterling Power Project of Rochester Gas and Electric will not be allowed to be built on the Sterling Site.

Gerald A Smith

Gerald A. Smith
Oswego, New York

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Ogden Reid,
Commissioner

721—210

715 263

March 18, 1976

Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Director,
Division of Reactor Licensing

Dear Sir:

The State of New York has completed its review of the "Draft Environmental Statement related to the construction of Sterling Power Project Unit .", (Docket No. STN 50-485). The Statement was prepared by the Nuclear Regulatory Commission's Office of Nuclear Reactor Regulation and published in December 1975.

In preparing the attached comments, we have taken into consideration the views of all appropriate State agencies including the New York State Atomic Energy Council. Many of the comments are quite detailed and directed to very specific points in the draft environmental statement with the intent of clarifying and improving the Commission's final environmental statement.

Sincerely,

TWKing

for Terence P. Curran
Director of Environmental Analysis

Enclosure

cc: N.Y.S. Atomic Energy Council members
Messrs. Seebald, Bentley, Hallman,
T. King, Rihm, Doig, Rapp,
T. McDonald, A. Coburn, E. Wagner
Ms. Cita Simian

RECEIVED

2936

STATE OF NEW YORK

Comments on the

December 1975

U.S. Nuclear Regulatory Commission

Draft Environmental Statement

related to the Construction of

Sterling Power Project Unit 1

Rochester Gas and Electric Corporation

Docket No. STN 50-485

1. General Comment

The transportation related areas of the report are fairly limited with little quantification of the impacts which will result from the increased traffic, due to construction activities and employee's commuting in the vicinity of the site. Although no serious problems are foreseen, these areas of the Statement could be more fully developed.

2. General Comment

It is noted that five categories of radionuclide groups (noble gases, radioiodines, particulates, carbon-14 and tritium) are considered in evaluating the radiological impact on man of liquid and gaseous effluents. It is suggested that the background material on models and assumptions in Appendix F be expanded to include information such as the specific radionuclides considered in the particulate releases. Are these same five radionuclide groups considered in evaluating the radiological consequences of postulated accidents?

3. P. 3-19, Section 3.5.2.6

Table 3.7 lists the gaseous source term. This table does not include carbon-14. Since carbon-14 contributes significantly to the population exposure, a detailed discussion would be in order of its formation and release along with possible control measures. Such a discussion was not included in WASH-1258 (ALAP) or other documents pertaining to light water reactors.

4. Terrestrial Ecology - Generally

Section 2.7.1, terrestrial ecology, is trivial, static, non-informative, misleading, lacks any comprehension of functional interrelationships of ecosystem components, and is inadequate for its intended purpose.

It is trivial in that it recognizes no distinctions among plant or

animal species as to their relative controlling importance or influence on the ecosystem of the site or in the region. It is a nondiscriminating exercise in taxonomy. It refers to "herpetiles"? Soils are named; no functional properties of the soils are even noted.

The section is static in that it states the presence (not abundance) of various biota without historical perspective. patterns are differentiated spacially or temporally. It simply reports the presence of biopolitically important organisms at the time the surveyors were on the site.

This discussion is non-informative in that isolated facts are repeated out of context from the ER, making it just an assortment of items of interest to the reader. For example, of what interest is it that this is prime pheasant range. Are pheasants present?; are they not present for some reason?; are plans afoot to manage pheasants in the area?; are pheasants present on the wooded plant site?; etc.

This section is misleading in several areas. The point on pheasants is an example. Other examples include mention of the site being a principle range for cottontail rabbits, labelling them "farm game" (hence by inuendo of positive significance), then noting them as a nuisance. Section 2.7.1.1 concludes ridge soils support oak, hickory, and sugar maple hardwood forest vegetation, which does not occur on the site. In 2.7.1.2, the presence of beech-maple and elm-ash forest is noted.

This section lacks any ecosystem concept whatever. Absolutely no functional interrelationships of components is given. Soils apparently have no biota and play no part in nutrient cycling, decomposition, or controlling vegetation. Vegetation apparently is only a forest classification, yet there is a wooded swamp, some pure stands of beech and conifers, and mixed intermediate age forest present. Seemingly, nothing but trees grow on site. No interpretation of status of protected plants (or animals) is given.

Under "consumers" it is stated that only 178 species of animals exist on site. An archaic definition of wildlife as meaning vertebrate species is used and the indication given that what were surveyed are the entire complement. The first paragraph under "consumers" is begun by mention of Canadian and Carolinian biota provinces, followed by the paragraph on rabbits as a nuisance, and presence of muskrats and waterfowl in the marshes. (In point of fact, march area is minor compared to the unmentioned wooded swamp.)

A new section should be prepared containing an ecosystem concept. A judgement of the dynamics of the several ecosystems present on site and of their relative ecological importance. The site must be understood well enough to judge its importance in the region, and this should be addressed. The writer of an ES should be reminded of the same obligation to the reader as did the applicant who followed U.S. NRC Regulatory Guide 42.

5. Terrestrial Ecology - Specifically

a. Figure 2.5, vegetation and land use types, does not reflect RG&E's current proposal for the site. In addition, it differs from what is described in Figure 2.1.

b. Pp. 2-12 and 4-4 refer to "...a proposed list of protected native plants for New York State...This list is now a matter of law, since it was incorporated into the DEC Rules and Regulations on April 1, 1975.

c. Reference 17 on page 2-19 is to a list that has since been updated. A current reference should be used.

d. Reference 16 on page 2-19 cites the wrong author. The correct author is R.H. Smith, not P. Robertson.

POOR ORIGINAL

e. Section 3.9.1 incorrectly refers to Figure 2.3 for information on the railroad.

f. Section [illegible].2 refers to Figures 2.2 and 2.3 for locations of access roads. These figures do not show access roads.

g. Table 4.1, a summary of land uses, refers to Table 3.9 as a data source. The latter table contains only Lake Ontario water quality data.

h. Appendix B, Table B-4 contains several errors. For example, the mallard is incorrectly listed as a "threatened" subspecies. The woodchuck is listed as both a game species and fur-bearer: it is neither under New York State Law. The yellow-bellied flycatcher is incorrectly listed as a "peripheral" subspecies. The snapping turtle is incorrectly listed as a game species. Several footnotes below the table have no corresponding reference in the table. Status category "e" refers to Sources 4 and 5, but source 5 is not presented in the appendix. In the same table there is a reference to an out-of-date source of information (Source 2.).

6. P. 3-22, Section 3.9.1 and P. 4-2, Section 4.1.3

The Statement refers to a three mile long rail spur that will be built to connect with the Hojack line, a branch of the Penn Central Railroad. It will be used to deliver construction materials to the site and, at the completion of the project, nuclear fuel and wastes. If for any reason over the road transportation has to be used more extensively for these purposes, the State and local highway network could be affected and this should be addressed more completely.

7. P. 5-13, Section 5.4.2

It is noted that "The revised specific models for a detailed assessment of individual and population doses have not been completed." The detailed

7. (continued)

evaluation should be completed and distributed as soon as possible, certainly no later than distribution of the Final Environmental Impact Statement. Radiological impact is an important part of the impact analysis required by NEPA and the draft statement is incomplete without it.

The radiological assessment of the applicant, as presented in the Environmental Report, is not evaluated by NRC in the draft Environmental Statement. Does NRC consider the applicant's assessment to be valid?

8. P. 5-17, Section 5.4.3.

Table 5.9 summarizes the environmental consideration of the uranium fuel cycle. The radiological effluents do not include carbon-14. The EPA assessment of the fuel cycle shows this to be a very significant isotope.

The land disturbed would depend on the uranium content of the ore. Since some very low grade ores may be utilized during the operation of this plant, the 18 acres of disturbed land may be a low estimate.

The ultimate disposal of high level waste is still unresolved.

9. Air Quality

a. The environmental statement does not consider the effect of auxillary boiler operations on air quality. Since the auxillary boiler will produce air pollutants, the DES should consider their impact on ambient air quality.

b. The DES does not evaluate the effect on air quality of increased motor vehicle traffic associated with plant construction and operation.

c. While the environmental statement identifies slash burning, refuse incineration and concrete batch plant operation as sources of air pollution, it does not discuss or estimate the effects of these activities on ambient

9. (continued)

air quality levels.

d. Although the DES identifies cooling tower operations as a potential source of air pollutants, it does not analyze the applicability of suspended and settleable particulate standards to those operations.

10. Aquatic Ecology

In the Summary and Conclusions section of the DES-(pp.5-37), the NRC staff suggests that the intake structure must be sited at a minimum depth of 35.5 feet to reduce fish entrainment losses. A companion requirement for a reduction in intake velocity is implied on pp. 5-29 and 5-30, but it is not specifically asserted.

11. Environmental Noise

a. There is no discussion of the noise which is likely to result from the dumping of steam during cold startup. In the Sterling case, an RG&E witness has already testified that steam dumping is likely to produce noise levels that will reach 107 dB(A) at 3000 feet from the source. Since such noise levels can last for up to eighteen or more hours during cold start-up, this is a potential source of environmental impact that should be discussed in the DES. Noise resulting from steam dumping has been a problem at the Indian Point facility, and required muffler backfitting to correct it.

b. It is possible that certain aspects of plant construction -- for example, the pouring of concrete for certain structures -- will necessitate work around the clock. The DES does not deal with the noise that would be associated with such work.

POOR ORIGINAL

c. The DES does not discuss the noise associated with the external loudspeakers that will be used during plant construction and, to a lesser extent, during plant operation.

12. Aesthetic Impacts and Site Layout

a. Figure 2.1 of the DES does not use the most current construction site plan. In its most recent proposal, the applicant proposes a shoreline buffer zone, the aesthetic impact of which should be considered.

715

b. Figure 4.1 does not include the 77 acre onsite spoils area proposed by applicant.

c. Acreage figures shown in Table 4.2 are not current and do not agree with the information on Table 4.1

272

d. The artist's conception of the project contained in Figure 5.2 is inaccurate. It does not show the proposed discharge canal and revetment.

13. Shore Impacts and Spoil Disposal

a. The DES does not discuss shore erosion, shore protection, or the impact of facility construction and operation on littoral drift.

b. There is no discussion of spoil disposal. The map of the site, Figure 4.1, does not show all of the spoil or laydown areas proposed by the applicant.

14. Water Quality

a. The proposed intake structure is somewhat different from the one described on pp.3-7, section 3.4.2. Specifically, the intake "bars" will be 3/4" extra strong pipes rather than bars.

b. The intake area, velocity, and total water use figures are inconsistent. At 170 square feet per opening, seven openings at 1.5 fps totals 1785 cfs rather than the indicated 1936 cfs. Moreover, from the dimensions provided, the open area per section appears to be somewhat larger than 170 square feet.

721 214

United States Department of the Interior
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 76-15

S+N-50-485 APR 23 1976

RECEIVED APR 27 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Dear Mr. Regan:

We wish to supplement our previous review of the draft environmental impact statement dated March 26, 1976, for Sterling Power Project, Unit 1, Cayuga County, New York.

A considerable body of literature on the aquatic resources of the Great Lakes is available. Correlations with Great Lakes data would appear to be more appropriate than comparisons with data from other areas.

We suggest an alternate location for the switchyard be considered in order to preserve as much of the existing scrub and wooded swamps as possible on the site, since the draft statement indicates the valuable productivity of these fertile areas.

Additional data should be provided to indicate the temporal and spatial distributions of phytoplankton, zooplankton and benthic communities at the site. With regard to fishes, seasonal patterns in abundance and distribution should be presented. These data are needed to assess the impacts from construction and operation of the project.

The design and operation of the cooling system should consider how best to reduce impingement and entrainment losses during outages by reduction of circulating water pump rates or recirculation of condenser cooling water.

Most of the onsite transmission line routes involve scrub swamps, wooded swamps and small streams. As noted on page 5-18, 2, 4, 5-T will be used to control scrub growth. This product should not be used onsite because of its extreme toxicity to aquatic organisms.

POOR ORIGINAL

1208

We suggest the use of cooling towers be further considered, particularly as the staff assessment on page 9-20 indicates ". . . on the basis of aquatic impacts, closed-cycle systems would be superior to the proposed system." In this regard, we do not believe the applicant has demonstrated that no significant damage to or degradation of fish and wildlife, their habitat, or human use would occur from once-through cooling. Therefore, we urge further consideration of this issue unless the applicant can satisfactorily demonstrate the acceptability of once-through cooling.

We hope these comments will be helpful to you.

Sincerely yours,

Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. William H. Regan, Jr.
Chief, Environmental Projects Branch 3
Division of Site Safety and
  Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

Appendix B

BIOTA OF AQUATIC AND TERRESTRIAL ENVIRONS

715 274

~~721 216~~

Table B.1. Summary of land use of plant associations of the Sterling site

Classification	Land	
	Acres	Percent
Beech-maple upland forest		
Natural communities		
Mature hardwoods	51	2
Young hardwood forest	695	27
Scrub	197	8
Abandoned fields	147	6
Subtotal	1090	42
Man-dominated communities		
Cultivated fields	674	26
Pastures	491	19
Orchards	71	3
Pine plantations	14	<1
Residential	49	2
Subtotal	1299	50
Total	2389	92
Elm-ash lowland forest		
Natural communities		
Wooded swamp	179	7
Shrub swamp	20	<1
Inland deep freshwater marsh	0.7	<1
Subtotal	199.7	8
Man-dominated communities		
Tilled fields	2	<1
Pasture	0.5	<1
Subtotal	2.5	<1
Total	202.2	8
Grand total	2591.2	100

Source: ER, Table 2.7-33, Rev. 3.

Table B.2. Habitat, soil conditions, and distribution of the protected plants on the Sterling site

Species	Status[a]	Habitat	Soils	Site distribution
Tree clubmoss *(Lycopodium obscurum)*	Common[b]	Moist woods and bog margins[c]	Acid[c]	Abundant in intermediate hardwoods
Ground pine *(L. complanatum)*	Common[b]	Woods and rocky slopes[c]	Acid[c]	Abundant in intermediate hardwoods
Christmas fern *(Polystichum acrostichoides)*	Common[b]	Woods and open thickets[c]		Common in wooded swamps
Lady fern *(Athyrium filix-femina)*	Common[b]	Moist woods, meadows, and streambanks[c]		Uncommon, occurring in young aspen hardwoods
Spinulose wood fern *(Dryopteris spinulosa)*	Common[b]	Moist woods and banks[c]		Abundant in wooded swamps
Stinking benjamin *(Trillium erectum)*	Common[b]	Moist woods[c,d]		Abundant in mature and intermediate hardwoods
Large-flowered trillium *(T. grandiflorum)*	Common[b]	Rich moist woods,[c] rich woods[d]		Abundant in mature and intermediate hardwoods
Rattlesnake plantain *(Goodyera sp.)*	Rare[b,e,f]	Dry woods,[c] woodlands[d]		Uncommon, one specimen collected in scrub community adjacent to a scrub–mature old field area

[a] Status refers to occurrence and abundance in New York State.

[b] J. S. Smith, personal communication with the applicant, January 15 and 17, 1975.

[c] H. A. Gleason, *New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada*, Hafner Publishing Company, Incorporated, New York, 1968.

[d] R. T. Peterson and M. McKenny, *A Field Guide to Wildflowers*, Houghton Mifflin Company, Boston, 1968.

[e] *Goodyera pubescens* is considered infrequent; all other species are rare.

[f] J. S. Smith, Contributions of the Flora of Central New York – I, Bull. No. 338, New York State Museum, The University of the State of New York, 1945.

721 218

715 276

Table B.3. Observed wildlife species and ecological groups at the Sterling site

Ecological group[a]	Herpetiles	Mammals	Birds	Total	Percent of total
Ubiquitous	1	3	17	21	11.7
Cropland–wetland	0	0	17	17	9.5
Terrestrial	2	8	17	27	15.1
Urban–woodland	0	1	32	33	18.5
Urban–cropland	0	0	1	1	0.5
Urban–farmland	0	0	3	3	1.6
Cropland–brushland	0	0	2	2	1.1
Cropland	0	0	1	1	0.5
Shrubland–woodland–wetland	4	1	8	13	7.3
Shrubland–woodland	0	2	4	6	3.3
Shrubland	0	0	1	1	0.5
Woodland	0	2	10	12	6.7
Forest	1	1	3	5	2.8
Wetland	8	1	18	27	15.1
Swamp species	1	0	0	1	0.5
Lentic wetland	0	0	6	6	3.3
Pond–freshwater marsh	0	0	2	2	1.1
Total	17	19	142	178	100

[a] Ecological groups:

Habitat distribution code	Number of habitats	Kinds of habitats (Sources 1–6)
Ubiquitous	12 to 16	All types of aquatic and terrestrial habitats
Cropland–wetland	2 to 10	Cropland, pastures, prairies, rivers, streams, marshes, ponds, lake, ocean, and tundra.
Terrestrial	7 to 11	All types of terrestrial habitats
Urban–woodland	2 to 7	Cities, towns, villages, farmyards, thickets, openwoods, forests, swamps, and bogs
Urban–cropland	2 to 5	Cities, towns, villages, farmyards, croplands, pastures, and prairies
Restricted cropland	1	Fields, abandoned fields, hayfields, croplands
Shrubland–woodland	5 to 7	Deserts, shrublands, thickets, openwoods, forests, swamps, and bogs
Woodland	2 to 5	Thickets, openwoods, forests, swamps, and bogs
Restricted forest	1	Forests
Wetland	2 to 9	Swamps, bogs, rivers, streams, marsh, ponds, lakes, oceanic, and tundra
Restricted swamp	1	Swamps and bogs
Lentic wetland	2 to 4	Marsh, ponds, lake, oceanic, and tundra
Pond–freshwater marsh	2	Marsh and ponds

Sources:

1. C. S. Robbins, B. Brun, and H. S. Zim, *A Guide to Field Identification – Birds of North America*, Golden Press, New York, 1966.
2. H. H. Collins, *Complete Guide to American Wildlife*, Harper and Brothers, New York, 1959.
3. R. T. Peterson, *A Field Guide to Western Birds*, Houghton Mifflin Company, Boston, Mass., 1961.
4. R. T. Peterson, *A Field Guide to the Birds of Texas*, Houghton Mifflin Company, Boston, Mass., 1963.
5. R. Conant, *A Field Guide to Reptiles and Amphibians*, Houghton Mifflin Company, Boston, Mass., 1958.
6. W. H. Burt and R. P. Grossenheider, *A Field Guide to the Mammals*, Houghton Mifflin Company, Boston, Mass., 1964.

715 277

~~721 219~~

Table B.4. Important wildlife species observed on the Sterling site

Species	Status[a]
Ubiquitous[b]	
Common opossum, *Didelphis marsupialis*	G
Common snipe, *Capella gallinago*	G
Cropland–wetland	
Canada goose, *Branta canadensis*	G
Mallard, *Anas platyrhynchos*	G, Ts
Marsh hawk, *Circus cyaneus*	BL
American coot, *Fulica americana*	G
Terrestrial	
Longtail weasel, *Mustela frenata*	F
Striped skunk, *Mephitis mephitis*	F
Red fox, *Vulpes fulva*	G, F
Woodchuck, *Marmota monax*	G, F
Eastern cottontail, *Sylvilagus floridanus*	G
Sparrow hawk, *Falco sparverius*	BL
Ring-necked pheasant, *Phasianus colchicus*	G
Mourning dove, *Zenaidura macroura*	G
Bewick's wren, *Thryomanes bewickii*	BL
Urban–woodland	
Eastern bluebird, *Sialia sialis*	Ps
Pine grosbeak, *Pinicola enucleator*	Ps
Restricted cropland	
Henslow's sparrow, *Passerherbulus henslowii*	BL
Shrubland–woodland	
Whitetail deer, *Odocoileus virginianus*	G
American woodcock, *Philohela minor*	G
Woodland	
Raccoon, *Procyon lotor*	F
Sharp-shinned hawk, *Accipiter striatus*	Es, BL
Ruffed grouse, *Bonasa umbellus*	G
Restricted forest	
Wood frog, *Rana sylvatica*	Re
Eastern gray squirrel, *Sciurus carolinensis*	G, Re
Goshawk, *Accipiter gentilis*	Re
Barred owl, *Strix varia*	Re
Hairy woodpecker, *Dendrocopos villosus*	Re
Wetland	
Bullfrog, *Rana catesbeiana*	G
Common snapping turtle, *Chelydra serpentina serpentina*	G
Black duck, *Anas rubripes*	G
Wood duck, *Aix sponsa*	G

~~721 220~~

715 278

Table B.4. (continued)

Species	Status[a]
Common goldeneye, *Bucephala clangula*	G
Bufflehead, *Bucephala albeola*	G
Red-breasted merganser, *Mergus serrattor*	G
Bald eagle, *Haliaeetus leucocephalus*	E
Osprey, *Pandion haliaetus*	U, BL, e
Restricted swamp	
Eastern gray treefrog, *Hyla versicolor versicolor*	Re
Lentic wetland[b]	
Old-squaw, *Clangula hyemalis*	G
White-winged scoter, *Melanitta deglandi*	G
Pond—freshwater marsh	
Blue-winged teal, *Anas discors*	G
Common gallinule, *Gallinula chloropus*	G

[a] Status categories:

E – endangered (Source 2).
Es – endangered for a subspecies (Source 1).
e – endangered within a region but not nationally (Source 4).
U – status uncertain (Source 1).
Us – status uncertain for a subspecies (Source 1).
Ps – peripheral for a subspecies (Source 1).
BL – 1976 National Audubon "Blue List" (Source 2).
G – game species.
F – fur-bearing mammals of economical importance.
Re – restricted habitat preference.

[b] See Table B.3 for description of Habitat Distribution Codes.

Sources:

1. U.S. Department of Interior, Bureau of Sport Fisheries and Wildlife, Office of Endangered Species and International Activities, *Threatened Wildlife of the United States*, U.S. Government Printing Office, Washington, D.C., 1973.
2. National Audubon Blue List, *American Birds* 27(6), National Audubon Society (December 1975).
3. United States Department of Interiur, Fish and Wildlife Service, *United States List of Endangered Fauna*, U.S. Government Printing Office, Washington, D.C., 1974.
4. L. R. Draper, ed., *Endangered and Extirpated Species in Kansas*, Sects. 1–4, draft (to be published).
5. *Environmental Plan for New York State*, New York State Department of Environmental Conservation, preliminary edition.

Table B.5. Acreage of commercial forest within New York State

Forest type	State	Ontario–Mohawk Plain	Cayuga County	5-mile radius	Site
Beech–maple	NA	NA	NA	6078	746
Elm–ash	NA	NA	NA	426	179
Subtotal	875,000	280,000	130,800	6504	925
Total forest acreage, all types	12,002,000	1,510,000	130,800	6504	925

Sources:

1. H. W. Lull, *A Forest Atlas of the Northeast*, U.S. Government Printing Office, Washington, D.C., 1968.
2. G. R. Armstrong, *The Timber Resources of New York*, U.S. Government Printing Office, Washington, D.C., 1956.
3. Rochester Gas and Electric Company, *Sterling Power Project Nuclear Unit 1*, Applicant's Environmental Report, Docket No. STN. 50-485.
4. Central New York Regional Planning and Development Board, *Existing Open Space Inventory*, 1972.
5. Ferguson and Mayer, *The Timber Resources of New York*, U.S. Government Printing Office, Washington, D.C., 1956.

715 279

~~721 221~~

Table B.6. Fish abundance at Ginna,[a] Lake Ontario, 1973 – average number of fish captured per gillnet per day and percent of total

Common name	Scientific name	Number	Percent of total
White perch	*Roccus americana*	89.1	30.5
Alewife	*Alosa pseudoharengus*	73.3	25.1
Smelt	*Osmerus mordax*	66.3	22.7
Spottail shiner	*Notropis hudsonius*	25.2	8.6
Lake chub	*Hybopsis plumbea*	8.3	2.8
White sucker	*Catostomus commersoni*	6.6	2.3
Smallmouth bass	*Micropterus dolomieui*	5.7	2.0
Carp	*Cyprinus carpio*	5.0	1.7
Gizzard shad	*Dorosoma cepedianum*	4.1	1.4
Rock bass	*Ambloplites rupestris*	4.0	1.4
Pumpkinseed	*Lepomis gibbosus*	1.3	0.4
Yellow perch	*Perca flavescens*	0.8	0.3
White bass	*Morone chrysops*	0.6	0.2
Brown bullhead	*Ictalurus nebulosus*	0.3	0.1
Emerald shiner	*Notropis atherinoides*	0.2	0.1
Freshwater drum	*Aplodinotus grunniens*	0.1	<0.1
Chinook salmon	*Oncorhynchus tschawytscha*	0.1	<0.1
Coho salmon	*Oncorhynchus kisutch*	0.1	<0.1
Rainbow trout	*Salmo gairdneri*	0.1	<0.1
Bluegill	*Lepomis macrochirus*	0.1	<0.1
Johnny darter	*Etheostoma nigrum*	0.05	<0.1
Longnose dace	*Rhinichthys cataractae*	0.05	<0.1
Goldfish	*Carassius auratus*	0.02	<0.1
Hognose sucker	*Hypentelium nigricans*	0.02	<0.1

[a] 35 miles WSW of the Sterling site.

Source: ER, p. 2. 7–10.

Table B.7. Fishes found in the Nine Mile Point area

Common name	Scientific name
Decreasing order of yearly abundance	
Alewife	*Alosa pseudoharengus*
Yellow perch	*Perca flavescens*
White perch	*Morone americana*
Northern redhorse sucker	*Moxostoma sp.*
Rock bass	*Ambloplites rupestris*
Smallmouth bass	*Micropterus dolomieui*
Bluegill sunfish	*Lepomis macrochirus*
Brown bullhead	*Ictalurus nebulosus*
Other fishes in the area	
Carp	*Cyprinus carpio*
Coho salmon	*Oncorhynchus kisutch*
Walleye	*Stizostedion vitreum vitreum*
Smelt	*Osmerus mordax*
Gizzard shad	*Doresoma cepedianum*
White bass	*Morone chrysops*
Bowfin	*Amia calva*
Black crappie	*Pomoxis nigromaculatus*
Minnows	*Notropis spp.*
Northern pike	*Esox lucius*
White sucker	*Catostomus commersoni*
Lake whitefish	*Coregonus clupeaformis*

Source: Directorate of Licensing, U.S. Atomic Energy Commission, *Final Environmental Statement, Nine Mile Point Nuclear Station, Unit 2,* Docket No. 50-410, June 1973.

Table B.8. Spawning, food habits, and importance of fishes abundant in the Sterling area of Lake Ontario

Species	Spawning			Food habits	Importance
	Parental care	Time/temperature (°F)	Place		
Alewife	No	55–72 Late May to early August	6–12 in. deep in vegetation	Zooplankton, insects, crustacea, small fish	Forage
Yellow perch	No	44–54 April and May	Inshore at night	Small crustaceans, insect larvae, small fish	Sport, commercial, food
White perch	No	April, May, and June	Fine gravel near shallow areas	Plankton, insect larvae, crustaceans, large invertebrates	Commercial, food, sport
Rock bass	Yes	70–78 June, July	Nest in a gravel bed	Insects and other small invertebrates, crayfishes, small fishes, large insects	Food, sport
Smallmouth bass	Yes	65 or above	Nest in a depression circular	Small animals in shallow water	Commercial, food, sport
Bluegill sunfish	Yes	80–90 June, July	Nests on sand beaches or gravel bars	Crustaceans, insects, crayfishes, fishes	Food, sport
Brown bullhead	Yes	65 or above May, June	Nest	Crustaceans, insect larvae, fish, fish eggs, mollusca, plants	Sport, food
Smelt	No	April, May at cold temperature	Shallow, sandy beaches	Plankton, fingernail clams, smelt young, shiners	Commercial, food

Source: Directorate of Licensing, U.S. Atomic Energy Commission, *Final Environmental Statement, Nine Mile Point Nuclear Station, Unit 1*, Docket No. 50-220, January 1974.

Table B.9. Impingement of alewives and rainbow smelt at Ginna Nuclear Power Plant, 1973[a]

Species	Average number of fish per day	Average weight per fish (oz)	Total weight per day (lb)	Total number of fish per year	Total weight per year (lb)
(1) Alewife[b]	6404.50	1.05	422.14	2,337,643	154,085
(2) Alewife[c]	1047.98	1.05	69.07	382,513	25,213
(3) Alewife[d]	333.10	0.83	17.33	121,582	6,325
(4) Rainbow smelt	414.47	0.64	16.71	151,282	6,103
Total (1) + (4)	6818.97		439.47	2,488,924	160,188
Total (2) + (4)	1462.45		85.78	533,794	31,316
Total (3) + (4)	747.57		34.04	272,863	12,429

[a] All Ginna estimates based on thirty-nine 24-hr counts, January–December, 1973.

[b] Including all data.

[c] Minus data of April 12–13.

[d] Minus data of April 12–13 and 26–27.

Source: ER, Appendix 2G, Table 73.1.7-3.

Table B.10. Impingement of forage fish at Ginna Nuclear Power Plant, 1973[a]

Species	Average number of fish per day	Average weight per fish (oz)	Total weight per day (lb)	Total number of fish per year	Total weight per year (lb)
Lake chub	24.33	0.97	1.48	8,881	540
Spottail shiner	50.29	0.41	1.30	18,356	473
Three-spine stickleback	46.15	0.40	1.17	16,845	427
Sculpin	23.50	0.48	0.71	8,578	259
Crayfish[b]	16.20	0.19	0.20	5,913	72
Emerald shiner	5.60	0.31	0.11	2,044	39
Longnose dace	2.57	0.40	0.07	938	23
Trout perch	0.76	0.68	0.04	277	12
Lamprey	0.09	5.16	0.02	33	11
Common shiner	0.89	0.30	0.02	325	6
Johnny darter	0.67	0.38	0.02	244	6
Mooneye	0.26	0.40		95	2
Central mudminnow	0.03	0.28		11	0[c]
Total	171.34		5.14	62,539	1860

[a] Does not include alewives and smelt.

[b] Additional organisms used as forage.

[c] Calculated to be zero.

Source: ER, Appendix 2G, Table 73.1.7-1.

715 282

~~721 224~~

Table B.11. Impingement of game and other large fish at Ginna Nuclear Power Plant, 1973

Species	Average number of fish per day	Average weight per fish (oz)	Total weight per day (lb)	Total number of fish per year	Total weight per year (lb)
White sucker	3.32	14.97	3.11	1,212	1134
White perch	18.58	0.56	0.66	6,782	239
Gizzard shad	3.52	1.96	0.44	1,285	157
Rock bass	1.81	3.47	0.40	661	143
American eel	0.15	41.52	0.40	55	142
White bass	3.42	0.65	0.13	1,248	51
Cisco	0.05	33.90	0.11	18	39
Black crappie	0.07	20.40	0.09	25	33
Smallmouth bass	0.80	1.58	0.09	292	29
Walleye	0.10	12.30	0.09	37	28
Yellow perch	0.30	3.25	0.07	110	22
Carp	0.08	10.82	0.07	29	20
American burbot	0.01	81.30	0.04	4	19
Goldfish	0.07	7.93	0.04	26	13
Pumpkinseed	0.46	0.10		168	1
Northern pike	0.05	0.08		18	1
Black bullhead	0.07	0.50		26	1
Freshwater drum	0.03	0.95		11	1
Brown bullhead	0.05	0.35		18	0[a]
Total	32.94	2.60	5.74	12,023	2072

[a] Calculated to be zero.

Source: ER, Appendix ?G, Table 73.1.7-2.

Table B.12. Estimated annual total of fish impinged on the traveling screens of Nine Mile Point Unit 1[a]

Species	Estimate[b]	Revised[c] estimate	Percent
Alewife	4,471,768	4,469,472	97.2
Rainbow smelt	88,851	89,971	1.9
Three-spine stickleback	8,869	8,876	0.2
Yellow perch	6,384	6,111	0.1
Gizzard shad	5,160	6,160	0.1
Emerald shiner	3,829	3,661	<0.1
Sculpin	3,451	3,402	
White perch	3,052	3,087	
Trout perch	1,365	1,365	
Spottail shiner	1,267	1,267	
Lamprey	1,239	1,239	
Common shiner	777	819	
Johny darter	756	742	
Smallmouth bass	644	525	
Rock bass	532	546	
American eel	462	203	
Lake Northern chub	385	358	
Brown bullhead	259	91	
White bass	245	245	
Sunfish	224	196	
Goldfish	147	147	
Others	686	728	
Total	4,601,352	4,599,233	

[a] Estimates based on biweekly 12-hr counts, May 1972–February 1973, and weekly 24-hr counts, March 1973–October 1973.

[b] From October 1 report.

[c] From November 15, 1973 report.

Source: Quirk, Lawler, and Matusky Engineers, *Fish Impingement Studies Unit 2*, Niagara Mohawk Power Corporation Water Quality Certification Report No. 1, vol. II, December 1973.

721 225

715 283

Appendix C

CHARACTERISTICS OF LAKE ONTARIO

C.1 GENERAL PHYSICAL FEATURES

Figure C.1 presents the general shoreline configuration and bathymetry[1] of Lake Ontario; in addition, the approximate locations and the generating capacities of existing or near-term planned power plants along the shore of the lake are indicated. Table C.1 lists selected physical characteristics of Lake Ontario, which has the smallest area and the lowest elevation of the Great Lakes.[2,3] The upper lakes, via the Niagara River, contribute about 83% of the average annual inflow to Lake Ontario;[4] most of the remaining inflow is received from the Genesee, Oswego, and Black Rivers.[5]

The outflow from Lake Ontario to the St. Lawrence River, and hence the lake level, is currently controlled under "Regulation of Lake Ontario-Plan 1958-D," which was put into effect in July 1963 by the International St. Lawrence River Board of Control, a Canadian-United States joint commission. During the annual hydrologic cycle, the period of minimum lake outflow and lake level and the period of maximum lake outflow and lake level correspond to December-January and July-August, respectively. These relationships are largely a result of the accumulation of ice and solid forms of precipitation during winter. Adjustment of lake levels for the years-of-record 1860-1954 according to the regulation of Lake Ontario by Plan 1958-D gives a range of stage (extremes of lake level) of 5 ft; under regulation by Plan 1958-D, Lake Ontario is expected to usually experience a seasonal range of stage of less than 2 ft with a minimum and a maximum of 243.8 and 245.7 ft, respectively (IGLD 1955).[6]

ES-1778

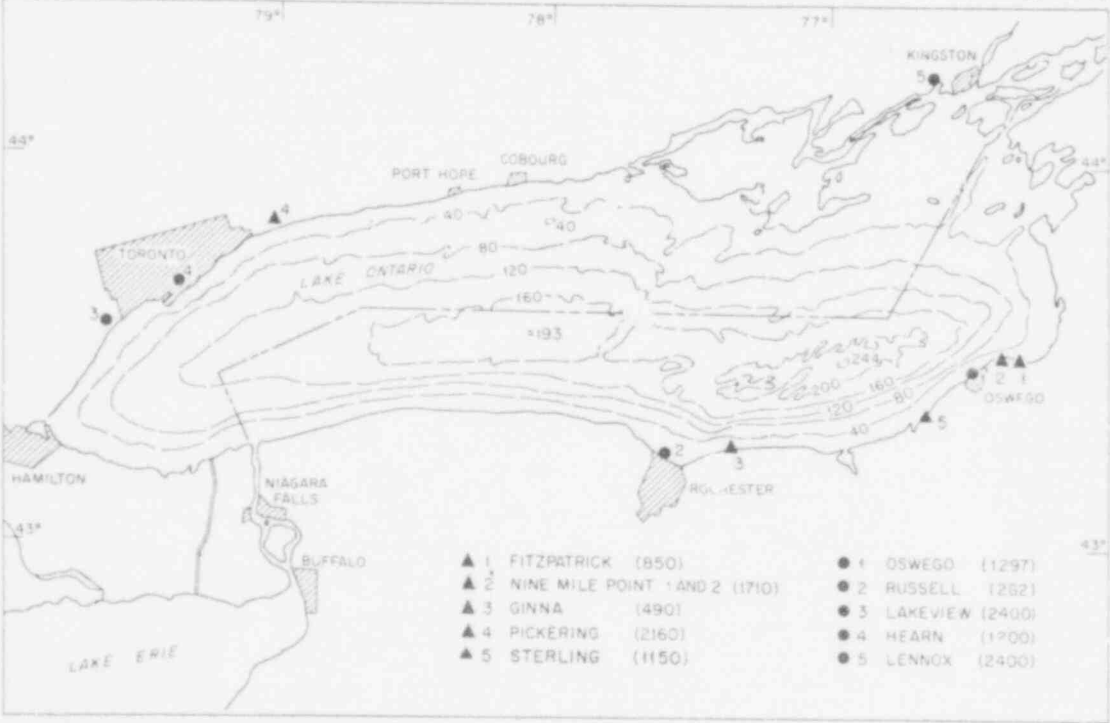


Fig. C.1. Lake Ontario bathymetry (in meters) and approximate locations and generating capacities (in MWe) of operating and planned power plants; ▲ = nuclear, ● = fossil. <u>Source:</u> N. J. Campbell et al., eds., *Lake Ontario and the International Section of the St. Lawrence River*, vol. 3 of *Report of the International Commission on the Pollution of Lake Ontario and the International Section of the St. Lawrence River*, The International Lake Erie Water Pollution Board and The International Lake Ontario-St. Lawrence River Water Pollution Board, 1959, 1.

721 226

715 284

Table C.1. Selected physical characteristics of Lake Onta...

Length, miles[a]	193
Width (maximum), miles[a]	53
Surface area, sq miles[b]	7,340
Volume, cubic miles[b]	393
Depth, ft[b]	
Maximum	802
Mean	276
Inflow from Niagara River, cfs[c]	203,000
Outflow to St. Lawrence River, cfs[d]	246,000
Rainfall (approximate annual average onto Lake Ontario), in.[b]	30
Evaporation (approximate annual average from Lake Ontario), in.[b]	27
Lake level, ft[d]	
Annual average	244.68
Annual minimum (average December)	243.83
Annual maximum (average July)	245.74
Range of stage	
Extreme-of-record	4.98
Annual average	1.91

Sources:

[a] H. J. Pincus, Ed., *Symposium on the Great Lakes Basin*, Chicago, Ill., 1959, proceedings published as Publication No. 71, American Association for the Advancement of Science, Washington, D.C., 1962, p. 4.

[b] N. J. Campbell et al., Eds., *Lake Ontario and the International Section of the St. Lawrence River*, vol. 3 of *Report to the International Commission on the Pollution of Lake Ontario and the International Section of the St. Lawrence River*, The International Lake Erie Water Pollution Board and The International Lake Ontario–St. Lawrence River Water Pollution Board, 1969, p. 1.

[c] New York State Department of Health, *Lake Ontario Surface Waters*, Lake Ontario Drainage Basin Survey Series Report No. 4, April 1958, pp. 24–27. (Average for 95 years-of-record.)

[d] International St. Lawrence River Board of Control, *Regulation of Lake Ontario, Plan 1958-D*, Report to the International Joint Commission, July 1963, pp. 39 and 45. (For the years-of-record 1860–1954 adjusted to lake level regulation under Plan 1958-D; IGLD, 1955.)

Localized short-term extremes of lake level occur in the western and eastern portions of the lake due to storm-generated seiches (oscillations of the surface), but the seiches have little influence on the lake stage along the north central and south central shores of the lake.[7] The flushing period of Lake Ontario (lake volume divided by discharge rate) is about 8 years. However, the retention time of a long-lived pollutant is considerably longer; about 20 years is the estimated time required to reduce the concentration of a pollutant by 90%.[8,9]

C.2 ANNUAL TEMPERATURE CYCLE

Lake Ontario undergoes an annual temperature cycle that is closely related to the seasons; the temperature profile of the lake can be predicted with reasonable accuracy at any time of year. However, deviations from normal seasonal weather and the passage of weather fronts can alter significantly an expected temperature profile on a short-term basis. For example, during warmer times of the year, upwelling (Sect. C.3) can cause short-term reductions in the surface-water temperature on the order of 10°C (18°F) in certain portions of the lake.[10] Following the fall overturn of Lake Ontario, the winter thermal bar develops with the onset of winter. As lake cooling continues, the thermal bar expands toward the center of the lake until the lake becomes nearly homogeneous temperaturewise; Fig. C.2 shows the extent of the thermal bar and gives representative temperatures for January 1966.[11] Ice accumulation is usually limited to the shoreline and to the northeast portion of the lake; during the most severe winters, only minor portions of the lake surface freeze.[12]

With spring warming of the lake, the spring thermal bar begins to develop.[11] As the warming continues, the thermal bar continues to develop toward the center of the lake and, by early June, begins to dissipate with the concomitant development of the summer thermocline, which leads to intense summer thermal stratification by early July.[13] Figures C.3 and C.4 show the progress of the spring thermal bar and the summer stratification and include representative temperatures for Lake Ontario.

The 10°C (50°F) isotherm of the thermocline follows a distinctive pattern in Lake Ontario; Figs. C.5 and C.6 show the pattern. Clearly, the thermocline, as shown by the 10°C isotherm, is significantly deeper in the eastern than in the western half of the lake. In addition to sloping downward toward the east, the thermocline tends to be tilted somewhat lower toward the southern shore, although this latter feature is neither as pronounced nor as dependable as the former. These characteristics of the lake's thermal structure are attributed largely to steady upwelling in the northwestern portion of the lake.[14,15] N.Y.S.D.E.C. defines thermocline to be 1°C/m vertical gradient. Use at the 10°C isotherm to characterize the stratification depth is a convenience for the discussion of lake structure.

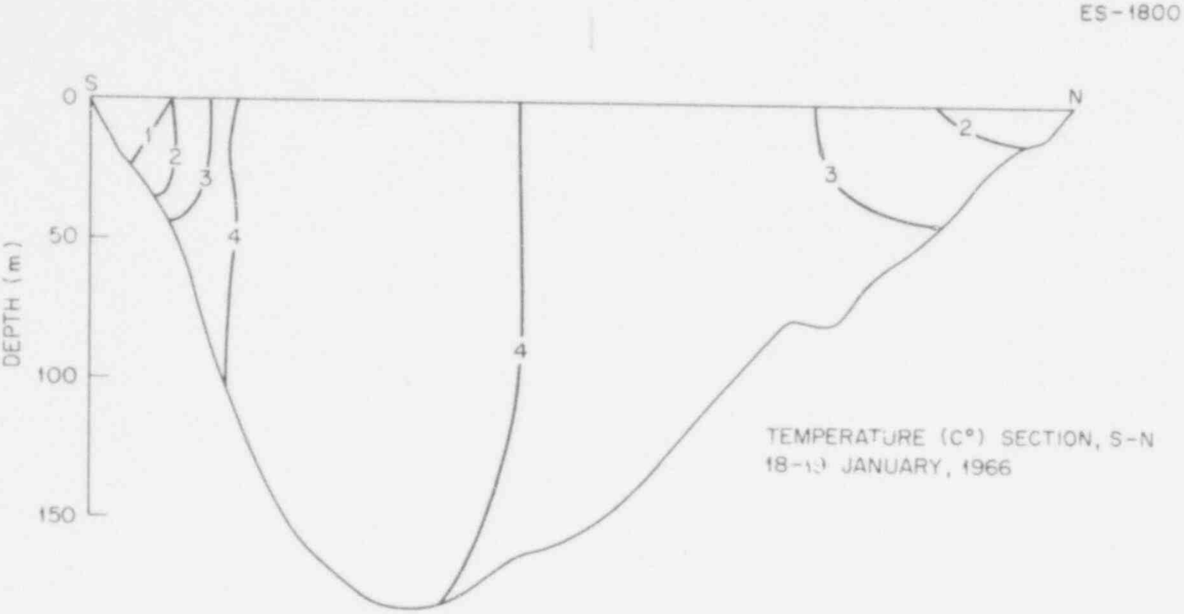


Fig. C.2. Winter thermal bar in Lake Ontario. Source: G. K. Rodgers, "The Thermal Bar in Lake Ontario, Spring 1965 and Winter 1965-66," *Publication No. 15*, Great Lakes Research Division, University of Michigan, Ann Arbor, 1966, pp. 369-374.

C.3 CIRCULATION

Discharge from Lake Ontario to the St. Lawrence River creates an overall water movement from west to east. From data collected between Rochester and Sodus Point, the applicant estimates that a steady drift to the east of about 0.05 knot occurs during periods of calm.[16] The dominant currents are wind-driven and more or less mask the currents that result from the discharge. Because the winds over Lake Ontario characteristically have a large eastward component (Sect. 2.6), the dominant direction of the surface currents is also toward the east. The speed of the wind-driven currents is related directly to the speed of the causative wind. The speed of a current under steady conditions is estimated to be about 1.6 to 2.3% of the wind speed, depending on the height of the anemometer.[16]

Figure C.7 shows hypothetical circulation patterns for Lake Ontario under different wind conditions and the resulting regions of upwelling. Evidence of submerged countercurrents is apparent from the regions of upwelling. Under certain wind conditions (one being a prevailing southwesterly), surface countercurrents are observed in the northwestern portion of the lake.[17] Typically, the surface currents respond to changes in wind velocity within 6 to 24 hr, the speed of response being mainly a function of the change in wind direction; subsurface currents and upwellings respond much more slowly. Consequently, significant lakewide redistribution of water masses in Lake Ontario, as a result of a major and persistent change in wind direction, requires several days to a week.[16,17]

ES - 1852

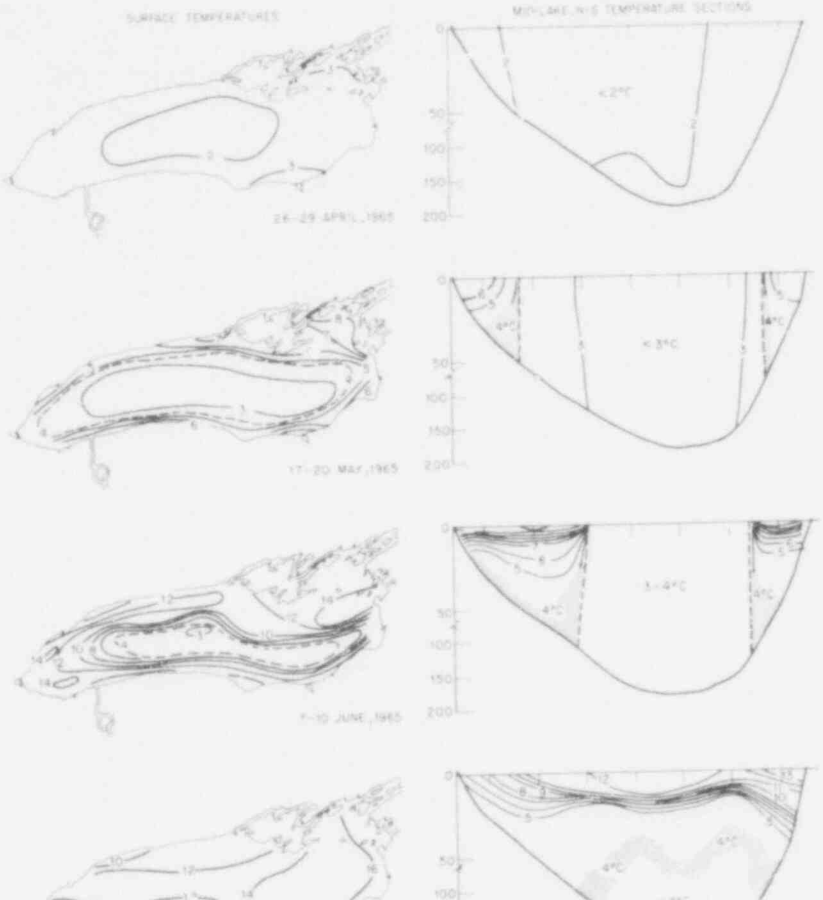


Fig. C.3. Progress of the spring thermal bar in Lake Ontario from early spring to full summer thermal stratification. Source: G. K. Rodgers, "The Thermal Bar in Lake Ontario, Spring 1965 and Winter 1965-66," *Publication No. 15*, Great Lakes Research Division, University of Michigan, Ann Arbor, 1966 pp. 369-374.

715 207

721 229

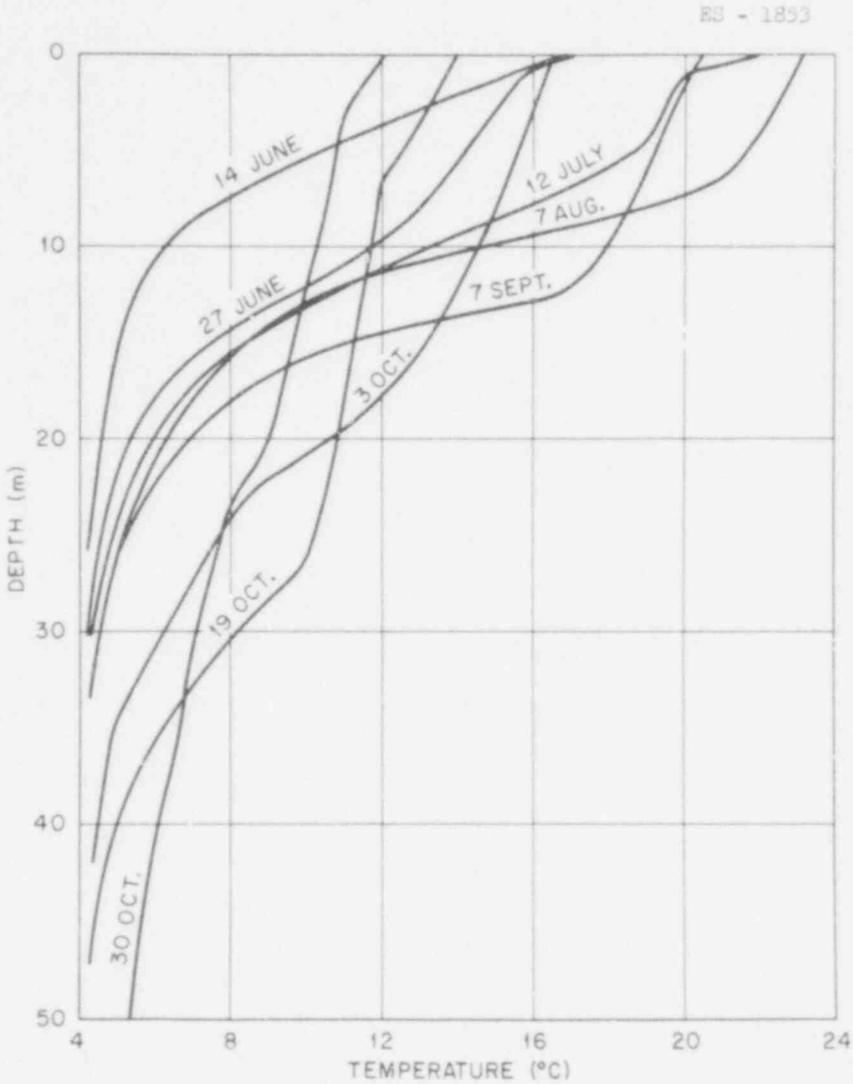


Fig. C.4. Mean vertical temperature profiles for Lake Ontario, 1967. Source: H. E. Sweers, *Structure, Dynamics, and Chemistry of Lake Ontario*, Manuscript Report Series No. 10, Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada. 1969, Fig. 27.

ES - 1854

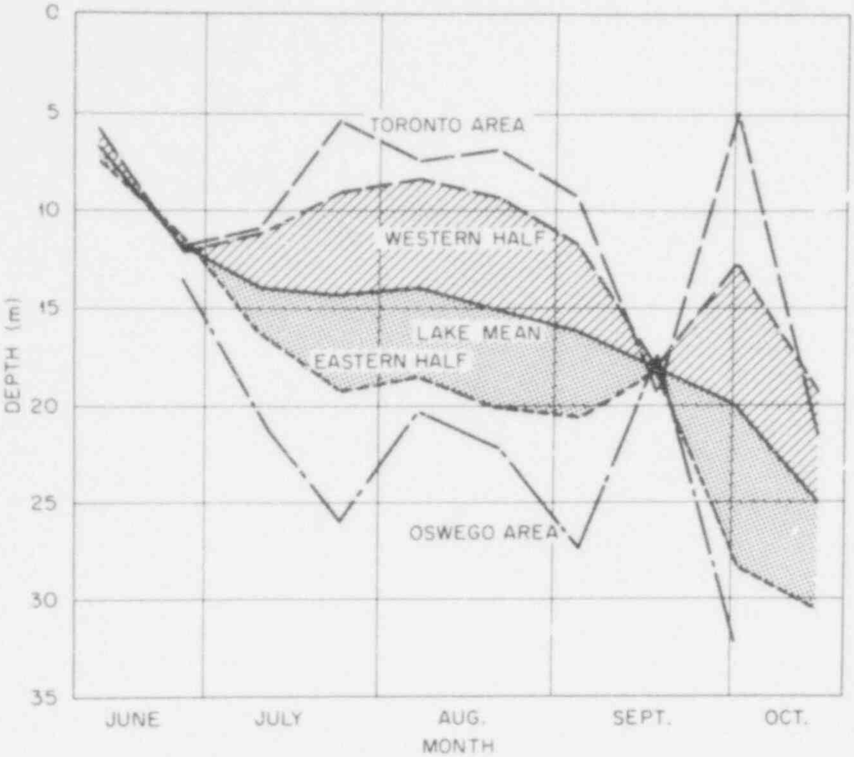


Fig. C.5. Mean depth of the 10°C (50°F) isotherm of Lake Ontario for June-September 1967, compared with the same for the eastern and western halves of the lake. Source: H. E. Sweers, *Structure, Dynamics, and Chemistry of Lake Ontario*, Manuscript Report Series No. 10, Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada, 1969, Fig. 12.

ES - 1855

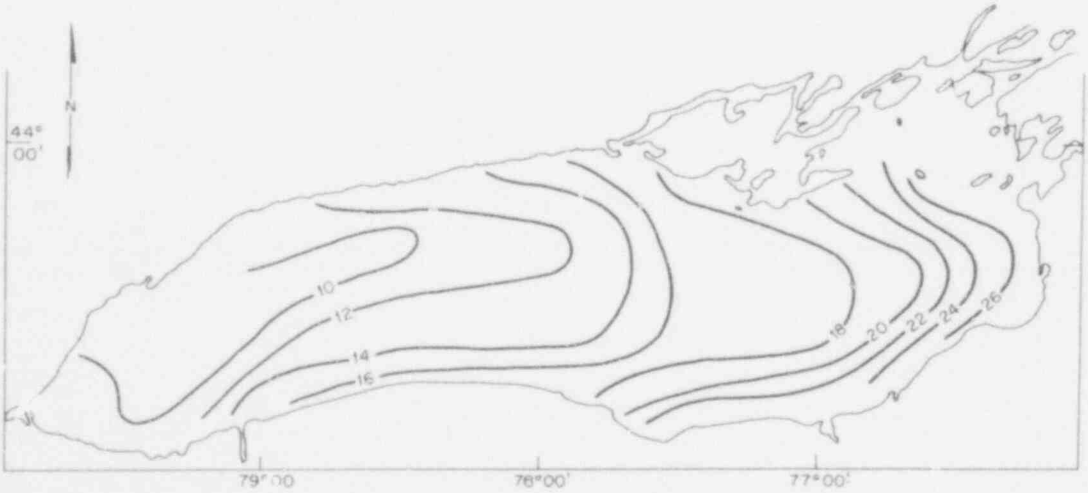


Fig. C.6. Summer mean distribution of the depth (in meters) of the 10°C (50°F) isotherm of Lake Ontario for July 10-September 10, 1967. Source: H. E. Sweers, *Structure, Dynamics, and Chemistry of Lake Ontario*, Manuscript Report Series No. 10, Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada, 1969, Fig. 27.

ES - 1856

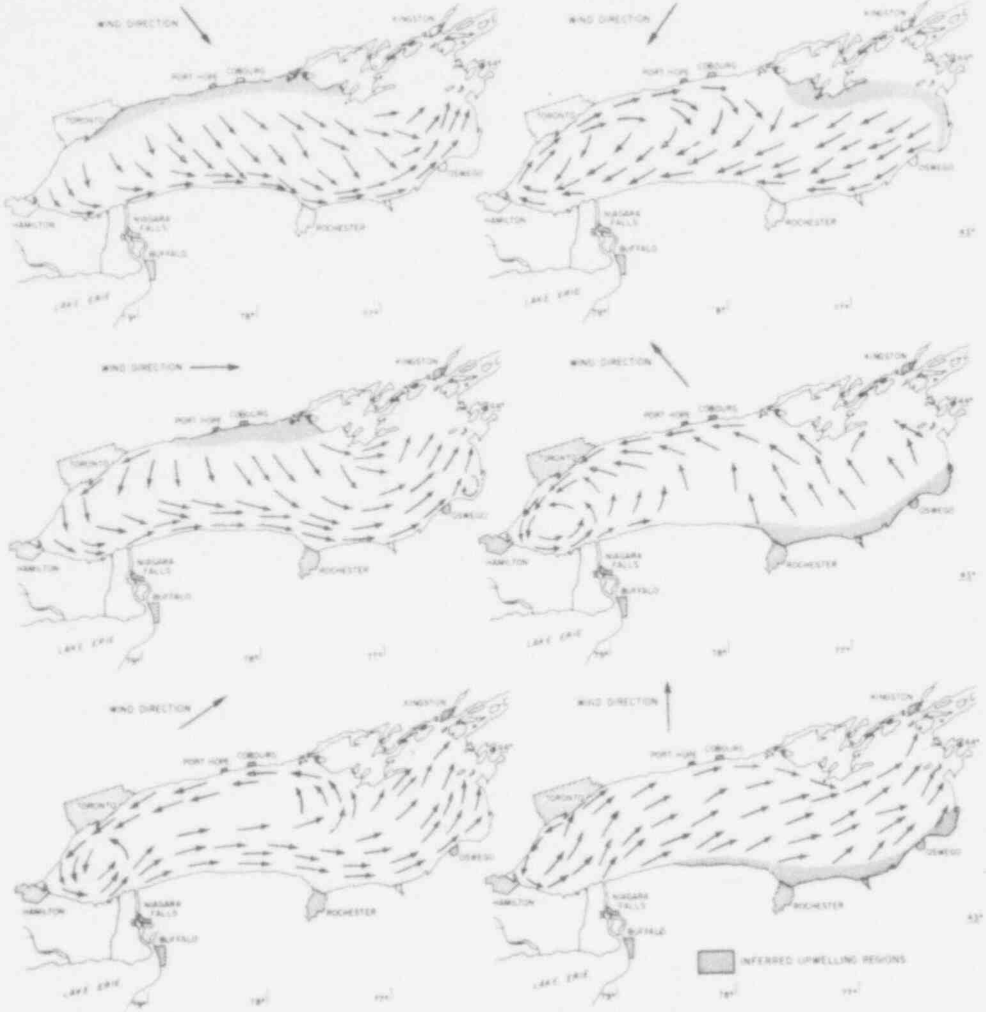


Fig. C.7. Hypothetical surface circulation patterns of Lake Ontario under different wind conditions. Source: N. J. Camptell et al., eds., *Lake Ontario and the International Section of the St. Lawrence River*, vol. 3 of *Report to the International Commission on the Pollution of Lake Ontario and the International Section of the St. Lawrence River*, The International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence River Water Pollution Board, 1969, p. 1.

REFERENCES FOR APPENDIX C

1. N. J. Campbell et al., eds., *Lake Ontario and the International Section of the St. Lawrence River*, vol. 3 of *Report to the International Commission on the Pollution of Lake Ontario and the International Section of the St. Lawrence River*, The International Lake Erie Water Pollution Board and the International Lake Ontario-St. Lawrence Water Pollution Board, 1969, Fig. 1.1.1.

2. H. J. Pincus, ed., *Symposium on the Great Lakes Basin*, Chicago, Illinois, 1959, proceedings published as Publication No. 71, American Association for the Advancement of Science, Washington, D.C., 1962, p. 4.

3. N. J. Campbell et al., eds., *Lake Ontario and the International Section of the St. Lawrence River*, vol. 3 of *Report to the International Commission on the Pollution of Lake Ontario and the International Section of the St. Lawrence River*, The International Lake Erie Water Pollution Board and The International Lake Ontario-St. Lawrence River Water Pollution Board, 1969, p. 1.

4. New York State Department of Health, *Lake Ontario Surface Waters*, Lake Ontario Drainage Basin Survey Series Report No. 4, April 1958, pp. 24-27.

5. H. E. Sweers, *Structure, Dynamics, and Chemistry of Lake Ontario*, Manuscript Report Series No. 10, Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada, 1969, pp. 89-90.

6. International St. Lawrence River Board of Control, *Regulation of Lake Ontario, Plan 1958-D*, Report to the International Joint Commission, July 1963, pp. 39 and 45.

7. Rochester Gas and Electric Corporation, *R. E. Ginna Nuclear Power Plant Unit 1, Environmental Report*, Docket No. 50-244, August 1972, vol. 2, Appendix C, p. 2C-10.

8. R. H. Rainey, "Natural Displacement of Pollution from the Great Lakes," *Science* 155: 1242-1243 (1967).

9. H. E. Sweers, *Structure, Dynamics, and Chemistry of Lake Ontario*, Manuscript Report Series No. 10, Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada, 1969, pp. 127-130.

10. Ibid., p. 3.

11. G. K. Rodgers, *The Thermal Bar in Lake Ontario, Spring 1965 and Winter 1965-66*, Publication No. 15, Great Lakes Research Division, University of Michigan, Ann Arbor, 1966, pp. 369-374.

12. N. J. Campbell et al., eds., *Lake Ontario and the International Section of the St. Lawrence River*, vol. 3 of *Report to the International Commission on the Pollution of Lake Ontario and the International Section of the St. Lawrence River*, The International Lake Erie Water Pollution Board and The International Lake Ontario-St. Lawrence River Water Pollution Board, 1969, p. 33.

13. H. E. Sweers, *Structure, Dynamics, and Chemistry of Lake Ontario*, Manuscript Report Series No. 10, Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada, 1969, Fig. 27.

14. Ibid., Fig. 12.

15. Ibid., Fig. 24.

16. Ref. 7, vol. 2, Appendix B, p. 2A-2.

17. N. J. Campbell et al., eds., *Lake Ontario and the International Section of the St. Lawrence River*, vol. 3 of *Report to the International Commission on the Pollution of Lake Ontario and the International Section of the St. Lawrence River*, The International Lake Erie Water Pollution Board and The International Lake Ontario-St. Lawrence River Water Pollution Board, 1969, pp. 35-45.

18. H. E. Sweers, *Structure, Dynamics, and Chemistry of Lake Ontario*, Manuscript Report Series No. 10, Department of Energy, Mines, and Resources, Ottawa, Ontario, Canada, 1969, p. 131.

Appendix D

COST ESTIMATES FOR ALTERNATIVE BASE-LOAD GENERATION SYSTEMS

A recently developed computer program was used to rough check the applicants' capital cost estimate for the proposed nuclear power facility and to estimate the costs for fossil-fired alternative generation systems.

This computer program, called CONCEPT,[1,2,3] was developed as part of the program analysis activities of the AEC Division of Reactor Research and Development, and the work was performed in the Studies and Evaluations Program at the Oak Ridge National Laboratory. The code was designed primarily for use in examining average trends in costs, identifying important elements in the cost structure, determining sensitivity to technical and economic factors, and providing reasonable long-range projections of costs. Although cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates for specific projects, the code has been organized to facilitate modifications to the cost models so that costs may be tailored to a particular project. Use of the computer provides a rapid means of calculating future capital costs of a project with various assumed sets of economic and technical ground rules.

DESCRIPTION OF THE CONCEPT CODE

The procedures used in the CONCEPT code are based on the premise that any central station power facility involves approximately the same major cost components regardless of location or date of initial operation. Therefore, if the trends of these major cost components can be established as a function of plant type and size, location, and interest and escalation rates, then a cost estimate for a reference case can be adjusted to fit the case of interest. The application of this approach requires a detailed "cost model" for each facility type at a reference condition and the determination of the cost trend relationships. The generation of these data has comprised a large effort in the development of the CONCEPT code. Detailed investment cost studies by an architect-engineering firm have provided basic cost model data for light water reactor nuclear facilities,[4,5] and fossil-fired plants.[6,7] These cost data have been revised to reflect facility design changes since the 1971 reference date of the initial estimates.

The cost model is based on a detailed cost estimate for a reference facility at a designated location and a specified date. This estimate includes a detailed breakdown of each cost account into costs for factory equipment, site materials, and site labor. A typical cost model consists of over a hundred individual cost accounts, each of which can be altered by input at the user's option. The AEC system of cost accounts[8] is used in CONCEPT.

To generate a cost estimate under specific conditions, the user specifies the following input: facility type and location, net capacity, beginning date for design and construction, date of commercial operation, length of construction workweek, and rate of interest during construction. If the specified facility size is different from the reference facility size, the direct cost of each two-digit account is adjusted by using scaling functions which define the cost as a function of facility size. This initial step gives an estimate of the direct costs for a facility of the specified type and size at the base date and location.

The code has access to cost index data files for 20 key cities in the United States. These files contain data on cost of materials and wage rates for 16 construction crafts as reported by trade publications over the past 15 years. These data are used to determine historical trends of site labor and material costs, providing a basis for projecting future costs of site labor and materials. These cost data may be overridden by user input if data for the particular project are available.

This technique of separating the facility cost into individual components, applying appropriate scaling functions and location-dependent cost adjustments, and escalating to different dates is the heart of the computerized approach used in CONCEPT. The procedure is illustrated schematically in Fig. D.1

ESTIMATED CAPITAL COSTS

The assumptions used in the CONCEPT calculations for this project are listed in Table D.1. Table D.2 summarizes the total plant capital investment estimates for the proposed nuclear facility utilizing mechanical-draft evaporative cooling towers.

Estimated costs for alternative fossil-fired plants are presented in Table D.3. The estimated costs for SO_2 removal equipment are based on a study performed by Oak Ridge National Laboratory.[9]

As stated previously, the above cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates, but were prepared as a check on the applicants' estimate and to provide consistent estimates for the nuclear facility and fossil-fired alternatives.

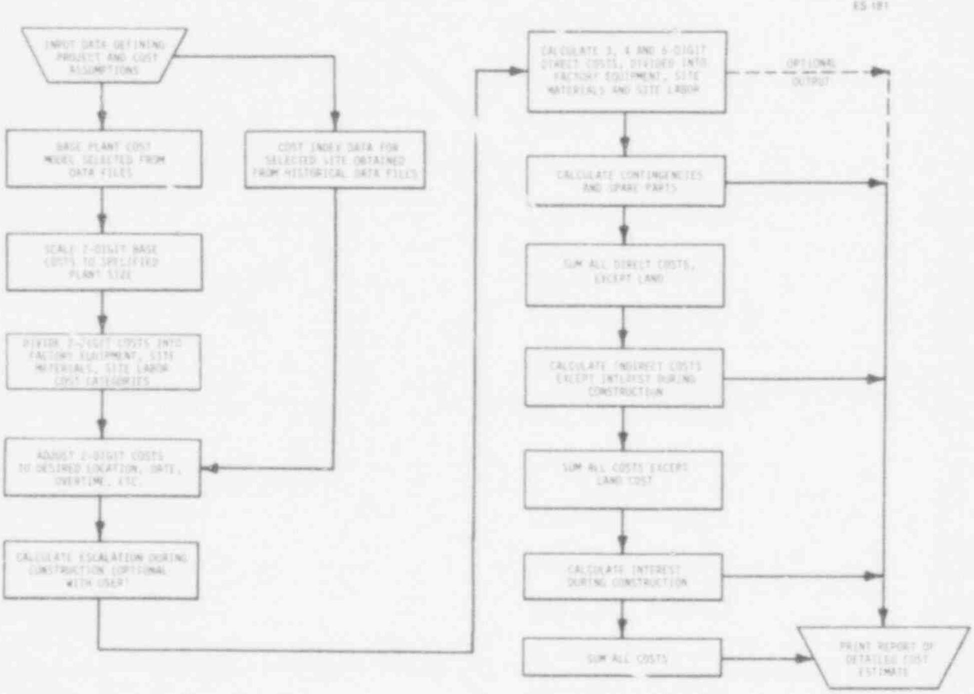


Fig. D-1. Use of the CONCEPT program for estimating capital costs.

715 293
~~721 235~~

Table D.1. Assumptions Used in CONCEPT Calculations
(June 9, 1976)

Plant name	Sterling Power Project, Unit 1
Plant type	PWR with once-through cooling
Alternate plant types	Coal
Unit size	1150 MWe-net and 600 MWe-net
Plant location	
Actual	Northern Cayuga County, New York
CONCEPT calculations	New York City
Interest during construction	9%/year, compound
Escalation during construction	
Site labor	7.4%/year
Site materials	5.3%/year - nuclear, 5.9%/year - fossil
Purchased equipment	6%/year
Site labor requirements	10 manhours/kWe - 1150-MWe nuclear 8 manhours/kWe - 1150-MWe coal with FGD 6.5 manhours/kWe - 1150-MWe coal without FGD 9.3 manhours/kWe - 600 MWe coal with FGD 7.5 manhours/kWe - 600 MWe coal without FGD
Length of workweek	40 hours
Start of design and construction date	
NSS ordered	July 1973
Fossil alternatives	April 1978
Commercial operation dates	
Unit 1	April 1984

Table D.2. Plant Capital Investment Summary for Pressurized Water Reactor Nuclear Power Plant

(Revised June 9, 1976)

(Rochester Gas and Electric Company, Sterling Power Project)

	Once-through cooling	Natural draft cooling
Net capability, MWe	1150	1127
Direct Costs (Millions of Dollars)*		
Land and land rights	6	6
Physical plant		
Structures and site facilities	93	83
Reactor plant equipment	128	128
Turbine plant equipment	132	136
Electric plant equipment	48	49
Miscellaneous plant equipment	9	9
Subtotal (physical plant)	416	411
Spare parts allowance	5	5
Contingency allowance	41	41
Subtotal (total physical plant)	462	457
Indirect Costs (Millions of Dollars)*		
Construction facilities, equipment and services	26	65
Engineering and construction management services	66	26
Other costs	21	21
Subtotal (indirect costs)	113	112
Total Costs (millions of dollars)		
Total direct and indirect costs*	575	569
Allowance for escalation	166	164
Allowance for interest	274	272
Plant capital cost at commercial operation		
Millions of dollars	1015	1005
Dollars per kilowatt	883	892

---

*In 1976 dollars

Table D.3. Total Plant Capital Investment Cost Estimated for a 1150-MWe Coal-Fired Plant as an Alternative to the Sterling Power Project

(June 9, 1976)

	Once-through Cooling	
	With FGD	Without FGD
Direct Costs (Millions of Dollars)*		
Land and land rights	6	6
Structures and site facilities	60	53
Reactor/boiler plant equipment	152	146
Turbine plant equipment	98	94
Electric plant equipment	33	26
Miscellaneous plant equipment	7	7
Subtotal	356	332
Spare parts allowance	4	4
Contingency allowance	35	33
Subtotal (direct costs)	395	369
Indirect costs (Millions of Dollars)*		
Construction facilities, equipment, and services	26	19
Engineering and construction management services	33	31
Other costs	13	11
Subtotal (indirect costs)	72	61
Total costs (Millions of Dollars)		
Total direct and indirect costs*	467	430
Allowance for escalation	172	156
Allowance for interest	165	151
Plant capital cost at commercial operation		
Millions of dollars	804	737
Dollars per kilowatt	699	641

*In 1976 dollars

715 296

721 238

Table D.4. Total Plant Capital Investment Cost Estimated for a 600 MWe Coal-Fired Plant as an Alternative to the Sterling Power Project

(June 9, 1976)

	Once-through Cooling With FGD	Once-through Cooling Without FGD
Direct Costs (Millions of Dollars)*		
Land and land rights	6	6
Structures and site facilities	36	32
Reactor/boiler plant equipment	87	83
Turbine plant equipment	59	56
Electric plant equipment	22	18
Miscellaneous plant equipment	5	5
Subtotal	215	200
Spare parts allowance	2	2
Contingency allowance	21	19
Subtotal (direct costs)	238	221
Indirect Costs (Millions of Dollars)*		
Construction facilities, equipment, and services	17	14
Engineering and construction management services	22	20
Other costs	9	8
Subtotal (indirect costs)	48	42
Total Costs (Millions of Dollars)		
Total direct and indirect costs*	286	263
Allowance for escalation	102	91
Allowance for interest	102	92
Plant capital cost at commercial operation		
Millions of dollars	490	446
Dollars per kilowatt	817	743

*In 1976 dollars

Table D.5. Sensitivity of Total Estimated Capital Costs
to Labor Content, Interest Rates, and Escalation
Rates for the 1150-MWe Sterling Power Project
Utilizing Once-through Cooling

(June 9, 1976)

	Base	Low Labor Content	High Labor Content	Low Interest & Escalation	High Interest & Escalation
Interest rate, %/year	9	9	9	8	10
Site labor requirements, mh/kWe					
Nuclear plant	10	8	12	10	10
Coal plant with FGD	8	6.4	9.6	8	8
Coal plant without FGD	6.5	5.2	7.8	6.5	6.5
Site labor rate in June 1976, $/hour					
Nuclear plant	13.95	13.95	13.95	13.95	15.34
Coal plants	14.03	14.03	14.03	14.03	15.43
Escalation rates, %/year					
Equipment	6	6	6	4	8
Site labor	7.4	7.4	7.4	5.4	9.4
Site materials (nuclear plant)	5.3	5.3	5.3	3.3	7.3
Site materials (coal plants)	5.9	5.9	5.9	3.9	7.9
Total estimated capital cost, millions of dollars					
Nuclear plant	1015	927	1103	910	1173
Coal plant with FGD	804	738	868	716	935
Coal plant without FGD	737	683	787	658	855
Total estimated capital cost, $/kWe					
Nuclear plant	883	806	959	791	1020
Coal plant with FGD	699	642	755	623	813
Coal plant without FGD	641	594	684	572	743

REFERENCES FOR APPENDIX D

1. *CONCEPT: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Status Report*, USAEC Report WASH-1180 (April 1971).

2. R. C. DeLozier, L. D. Reynolds, and H.I. Bowers, *CONCEPT: Computerized Conceptual Cost Estimates for Steam-Electric Power Plants — Phase I User's Manual*, USAEC Report ORNL-TM-3276, Oak Ridge National Laboratory, October 1971.

3. H. I. Bowers, R. C. Delozier, L. D. Reynolds, and B. E. Srite, *CONCEPT II: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Phase II User's Manual*, USAEC Report ORNL-4809, Oak Ridge National Laboratory, April 1973.

4. *1000-MWE Central Station Power Plant Investment Cost Study, Volume I, Pressurized Water Reactor Plant*, USAEC Report WASH-1230 (Vol. I), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

5. *1000-MWE Central Station Power Plant Investment Cost Study, Volume II, Boiling Water Reactor Plant*, USAEC Report WASH-1230 (Vol.II), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

6. *1000-MWE Central Station Power Plant Investment Cost Study, Volume III, Coal-Fired Fossil Plant*, USAEC Report WASH-1230 (Vol. III), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

7. *1000-MWE Central Station Power Plant Investment Cost Study, Volume IV, Oil-Fired Fossil Plant*, USAEC Report WASH-1230 (Vol. IV), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

8. *Guide for Economic Evaluation of Nuclear Reactor Plant Designs*, USAEC Report NUS-531, NUS Corporation, January 1969.

9. M. L. Myers, *Cost Estimate for the Limestone-Wet Scrubbing Sulfur Oxide Control Process*, USAEC Report ORNL/TM-4142, Oak Ridge National Laboratory, July 1973.

715 299

~~721 241~~

Appendix E

COMPARISON OF GINNA MEASUREMENTS AND PRITCHARD MODEL CALCULATIONS

The purpose of this appendix is to compare the predictions of Pritchard's model[1,2] with field measurements of the Ginna thermal plume to judge whether this model will yield reasonable predictions for Sterling. This model is based largely on the personal observations of D. W. Pritchard; it has no firm theoretical basis. Consequently, its range of validity cannot be known a priori. One purpose of this exercise is to see whether conditions in southeastern Lake Ontario lie within that range.

As discussed in Sect. 5.3.1.1.1, the applicant has mapped more than 36 thermal plumes at Ginna, using boat-mounted thermistors. Nineteen of these included sufficient information for Pritchard model calculations to be made. The required data included the intake temperature, discharge temperature, ambient lake temperature, wind speed, and heat rejection rate reported by the applicant. To specify the discharge depth (Z_o), width, and velocity, the lake level reported for that day at Rochester, New York,[3-5] was used. The discharge width was taken to be the average width of the trapezoidal cross section. Heat loss to the atmosphere was accounted for by an overall heat transfer coefficient K. This quantity was calculated from a well-known correlation recommended in Ref. 1, which uses wind speed and excess temperature as input. Thus, the value varied for each isotherm. Typical values ranged from 3 to 7 Btu/ft^2-hr-°F.

The only other parameter to be specified was Z_c, the critical mixing depth. This parameter reflects the diluting effect of ambient turbulence and is related to the vertical spreading of the plume. In practice, it is a "fudge" factor chosen to yield good results. Table E.1 shows the measured areas within the 3°F excess temperature isotherm and the areas computed assuming $Z_c = Z_o$ and Z_c = 10 ft. This latter value has been recommended by Pritchard.[1] The 3°F area was selected for comparison because it is the legally restricted quantity. Examination of Table E.1 shows that the model may be high or low, usually within a factor of 3. The Pritchard model prediction should not be considered a highly conservative worst case. On the average, the agreement is much better. Keeping in mind the great variability of the Ginna plume, even under nominally similar conditions, this performance is impressive. The staff concludes that, on the average, predictions for these critical mixing depths will bracket the true answer.

Table E.1. Comparison of Ginna measurements and Pritchard model calculations

Case number	Date	Measured 3°F area (acres)	Computed 3°F area (acres)	
			$Zc = Zo$	Zc = 10 ft
1	5-21-71	101	62	55
2	6-28-71	229	63	38
3	7-15-71	128	134	80
4	8-31-71	100	79	38
5	9-30-71	63	142	65
6	11-11-71	50	160	51
7	12-1-71	71	230	69
8	7-19-72	36	96	94
9	8-30-72	55	87	70
10	11-22-72	54	106	41
11	4-16-73	73	228	
12	5-14-73	29	129	
13	6-20-73	107	92	
14	7-18-73	138	250	
15	8-16-73	31	141	117
16	9-13-73	62	162	115
17	10-1-73	37	177	99
18	11-13-73	54	211	87
19	12-5-73	94	199	99
Average		80	148	75

721 242

715 300

Cases 2, 3, 4, 5, 8, and 9 are six of the eight plumes of Ginna used to formulate the Acres American model described in Sect. 5.3.1.1. The average measured 3°F area for these cases is 102 acres. The average of the computed values for $Zc = Zo$ is 100 acres. Thus, the Pritchard model should show better agreement with the Acres American predictions than with the real plume because it agrees with the input plumes more closely than with other measured cases.

REFERENCES FOR APPENDIX E

1. B. A. Benedict, J. L. Anderson, and E. L. Yandell, Jr., *Analytical Modeling of Thermal Discharges. A Review of the State-of-the-Art*, ANL/ES-18, Argonne National Laboratory, April 1974, pp. 128-149.

2. A. J. Policastro and J. V. Tokar, *Heated Effluent Dispersion in Large Lakes: State-of-the-Art of Analytical Modeling. Part I. Critique of Model Formulations*, ANL/ES-11, January 1972, pp. 254-278.

3. U.S. Department of Commerce, *Great Lakes Water Levels 1971*, National Oceanic and Atmospheric Administration, National Ocean Survey.

4. U.S. Department of Commerce, *Great Lakes Water Levels 1972*, National Oceanic and Atmospheric Administration, National Ocean Survey.

5. U.S. Department of Commerce, *Great Lakes Water Levels 1973*, National Oceanic and Atmospheric Administration, National Ocean Survey.

715 301

721 243

Appendix F

NEPA POPULATION DOSE ASSESSMENT

Population dose commitments are calculated for all individuals living within 50 miles of the facility employing the same models used for individual doses (see Draft Regulatory Guide 1.AA, in preparation). In addition, population doses associated with the export of food crops produced within the 50-mile region and the atmospheric and hydrospheric transport of the more mobile effluent species such as noble gases, tritium, and carbon-14 have been considered.

F.1 NOBLE GAS EFFLUENTS

For locations within 50 miles of the reactor facility, exposures to these effluents are calculated using the atmospheric dispersion models in Draft Regulatory Guide 1.DD (in preparation) and the dose models described in Sect. 5.1 and Regulatory Guide 1.AA. Beyond 50 miles, and until the effluent reaches the northeastern corner of the United States, it is assumed that all the noble gases are dispersed uniformly in the lowest 1000 m of the atmosphere. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than one year (e.g., Kr-85) were assumed to completely mix in the troposphere of the world with no removal mechanisms operating. Transfer of tropospheric air between the northern and southern hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemispheric mixing. Since this time constant is quite short with respect to the expected mid-point of plant life (15 years), mixing in both hemispheres can be assumed for evaluations over the life of the nuclear facility. This additional population dose commitment to the U.S. population was also evaluated.

F.2 IODINES AND PARTICULATES RELEASED TO THE ATMOSPHERE

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind, which continuously reduces the concentration remaining in the plume. Within 50 miles of the facility, the deposition model in Draft Regulatory Guide 1.DD was used in conjunction with the dose models in Draft Regulatory Guide 1.AA. Site specific data concerning production, transport and consumption of foods within 50 miles of the reactor were used. Beyond 50 miles, the deposition model was extended until no effluent remained in the plume. Excess food not consumed within the 50-mile distance was accounted for, and additional food production and consumption representative of the eastern half of the country was assumed. Doses obtained in this manner were then assumed to be received by the number of individuals living within the direction sector and distance described above. The population density in this sector is taken to be representative of the Eastern United States, which is about 160 people/sq mile.

F.3 CARBON-14 AND TRITIUM RELEASED TO THE ATMOSPHERE

Carbon-14 and tritium were assumed to disperse without deposition in the same manner as krypton-85 over land. However, they do interact with the oceans. This causes the carbon-14 to be removed with an atmospheric residence time of four to six years, with the oceans being the major sink. From this, the equilibrium ratio of the carbon-14 to natural carbon in the atmosphere was determined. This same ratio was then assumed to exist in man so that the dose received by the entire population of the United States could be estimated. Tritium was assumed to mix uniformly in the world's hydrosphere, which was assumed to include all the water in the atmosphere and in the upper 70 m of the oceans. With this model, the equilibrium ratio of tritium to hydrogen in the environment can be calcuated. The same ratio was assumed to exist in man and was used to calculate the population dose, in the same manner as with carbon-14.

F.4 LIQUID EFFLUENTS

Concentrations of effluents in the receiving water within 50 miles of the facility were calculated in the same manner as described above for the Appendix I calculations. No depletion of the nuclides present in the receiving water by deposition on the bottom of Lake Ontario was

715 303

~~721 244~~

assumed. It was also assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the Appendix I evaluation. However, food consumption values appropriate for the average individual, rather than the maximum, were used. It was assumed that all the sport and commercial fin and shell fish caught within the 50 mile area were eaten by the U.S. population.

Beyond 50 miles, it was assumed that all the liquid effluent nuclides except tritium have deposited on the sediments so they make no further contribution to population exposures. The tritium was assumed to mix uniformly in the world's hydrosphere and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.