NUREG-1085

Draft Environmental Statement
related to the operation of Nine Mile Point Nuclear Station, Unit No. 2

Docket No. 50-410

Niagara Mohawk Power Corporation
Rochester Gas and Electric Corporation
Central Hudson Gas and Electric Corporation
New York State Electric and Gas Corporation
Long Island Lighting Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

July 1984

ABSTRACT

This Draft Environmental Statement contains the assessment of the environmental impact associated with the operation of the Nine Mile Point Nuclear Station, Unit 2, pursuant to the National Environment Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations, Part 51, as amended, of the Nuclea Regulatory Commission regulations. This statement examines the environment, environmental consequences and mitigating actions, and environmental and economic benefits and costs.

SUMMARY AND CONCLUSIONS

This Draft Environmental Statement (DES) was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (Staff).

(1) This action is administrative.

(2) The proposed action is the issuance of an operating license to Niagara Mohawk Power Corporation (hereinafter referred to as the applicant) acting as agent and representative for the owners (Niagara Mohawk Power Corporation, Central Hudson Gas and Electric Corporation, New York State Electric and Gas Corporation, Long Island Lighting Company, and Rochester Gas and Electric Corporation) for the operation of the Nine Mile Point Nuclear Station Unit 2 (NMP-2) (Docket No. 50-410). Nine Mile Point Nuclear Station Unit 2 is located in the Town of Scriba, County of Oswego, State of New York. Unit 2 will share the site with the applicant's operating Nine Mile Point Nuclear Station Unit 1. The Nine Mile Point Nuclear Station site is contiguous to the James A. FitzPatrick Nuclear Power Plant site. The James A. FitzPatrick Nuclear Power Plant is owned and operated by the Power Authority of the State of New York.

(3) The Nine Mile Point Station Unit 2 will employ a boiling water reactor (BWR) that has a plant-rated core thermal power level of 3,323 MWt, corresponding to an electrical output of approximately 1,100 MWe. All cooling water required for Unit 2 will come from and be discharged to Lake Ontario. The closed-loop circulating water system employs a single-cell, wet-evaporative, natural-draft cooling tower that uses a counterflow design. The lake intake system conveys required cooling water from Lake Ontario through two submerged intake structures that are independently connected to the screenwell by intake pipes in separate tunnels below the lake bottom.

(4) The information in this statement represents the second assessment of the environmental impacts pursuant to the Commission's regulations in Title 10 of the Code of Federal Regulations, Part 51 (10 CFR 51), which implements the requirements of the National Environmental Policy Act of 1969 (NEPA). The Niagara Mohawk Power Corporation tendered an application for a construction permit (CP) on March 8, 1972. Because more information was needed for the initial filing, the application for a CP was not officially docketed for review until June 15, 1972. After the application for a CP was docketed, the staff reviewed impacts that would occur during station construction and operation. That evaluation was issued as a Final Environmental Statement - Construction Permit Phase (FES-CP) in June 1973. After this environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards (ACRS), and a hearing before an Atomic Safety and Licensing Board (ASLB), the CP for Nine Mile Point Nuclear Station Unit 2 was issued on June 24, 1974.

The Niagara Mohawk Power Corporation acting as agent and representative for the owners, tendered an application for an operating license (OL) by letter dated January 31, 1983. The staff conducted a predocketing acceptance review and determined that sufficient information was available to begin the detailed environmental and safety reviews. The applicant's Environmental Report - Operating License stage (ER-OL) and Final Safety Analysis Report (FSAR) were docketed on April 12, 1983.

(5) The NRC staff has reviewed the activities associated with the proposed operation of the plant and the potential impacts, both beneficial and adverse. The NRC staff's conclusions are summarized as follows:

(a) NMP-2 will utilize state-of-the-art cooling system design to minimize the impacts to Lake Ontario aquatic biological resources as a result of the withdrawal of water withdrawals and the discharge of effluents. The design will include: low intake volume and velocity; offshore submerged intake structures with velocity capped-horizontal inflow; a diversion and return system for impinged fishes; and an offshore benthic diffuser discharge system. The fish diversion system will collect and return some fishes that will be impinged on the traveling screens; however, for certain size classes of some species (notably alewife and rainbow smelt), the reduction in impingement mortality may be low. Thermal and chemical effluent effects should be limited to a small area in the vicinity of the diffuser discharge. Impacts resulting from interactions between NMP-2 and either the Nine Mile Point Unit 1 or FitzPatrick power plants should be insignificant. The conclusions of the 1981 NRC study of environmental impacts resulting from the conversion from once-through cooling to closed-cycle cooling remain valid (Section 5.5.2 and Appendix G of this report.

(b) The operation of NMP-2 will have no impact on terrestrial or aquatic threatened or endangered species, because none occur within the project area (Section 5.6).

(c) Operation of NMP-2 is expected to have a negligible effect on water use and quality in Lake Ontario. On an annual basis, consumptive losses from Station operation will represent, respectively, approximately 0.001% and 0.009% of the volume of and flow through the lake. Water used from the Oswego City water supply will increase the demand on that supply by demand less than 0.02%.

The concentration of dissolved solids in the discharge from the station will have been increased by evaporation and by water treatment and corrosion. The water in Lake Ontario already exceeds the State standard for dissolved solids, but the station discharge will aggravate this condition very slightly. The lake water will quickly dilute other water quality constituents (e.g., zinc, copper, chlorine) to acceptable concentrations.

(d) The total land area of the NMP site is approximately 364 ha (900 acres). Unit 2 will occupy about 9.3 ha (22.9 acres); construction activities have disturbed about 46.7 ha (116 acres). This is an increase over the acreage anticipated in the FES-CP as a result, in part of the change to a natural draft cooling system and construction of the cooling tower. Operational impacts to land use onsite are insignificant (Sections 4.2.2 and 5.2.1).

Impacts from construction of the transmission line are less than expected because the 345-kV Unit 2 to Volney Station line was realigned so that it is parallel existing lines. About 33 ha (80 acres) in the existing right-of-way will be disturbed; 90% of this will be maintained as brushland after construction (Sections 4.2.7 and 5.2.2).

(e) There is no serious potential for impacts on climate or terrestrial ecosystems as a result of operation of the cooling tower. The effects of salt drift and the threat to bird populations as a result of collisions are insignificant (Sections 4.3.4.1 and 5.5.1), and environmental impacts as a result of operation of the transmission line are not expected (Section 5.1.2). However, the applicant will continue an infrared aerial photography program to assess potential salt drift impacts to vegetation (Section 5.14.1).

(6) This statement assesses various impacts associated with the operation of the facility in terms of annual impacts, and balances these impacts against the anticipated annual energy production benefits. Thus, the overall assessment and conclusion would not be dependent on specific operating life. Where appropriate, however, a specific operating life of 40 years was assumed.

(7) This DES is being made available to the public, to the Environmental Protection Agency, and to other agencies, as specified in Section 8.

(8) The personnel who participated in the preparation of this statement and their areas of responsibility are identified in Section 7.

(9) On the basis of the analyses and evaluations in this statement, and after weighing the environmental, economic, technical, and other benefits against environmental and economic costs at the operating license stage, the NRC staff concludes that the action called for under NEPA and 10 CFR 51 is the issuance of an operating license for NMP-2 subject to the following conditions for the protection of the environment. (Section 6.1):

(a) Before engaging in additional construction or operational activities that may result in a significant adverse impact that was not evaluated or that is significantly greater than that evaluated in this statement, the applicant shall provide written notification of such activities to the Director of the Office of Nuclear Reactor Regulation and shall receive written approval from that office before proceeding with such activities.

(b) The applicant shall carry out the environmental monitoring programs outlined in Section 5 of this statement, as modified and approved by the NRC staff, and implemented in the Environmental Protection Plan and Technical Specifications that will be incorporated in the operating license for NMP-2. Monitoring of the aquatic environment shall be as specified in the New York State Pollutant Discharge Elimination System (SPDES) permit.

(c) If adverse environmental effects or evidence of irreversible environmental damage develops during the operating life of the plant, the applicant shall provide the NRC staff with an analysis of the problem and a proposed course of action to alleviate it.

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FOREWORD

This draft environmental statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (the staff), in accordance with the Commission's regulations in Title 10 of the Code of Federal Regulations, Part 51 (10 CFR 51), which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

This environmental review deals with the impacts of operation of the Nine Mile Point Nuclear Station Unit 2 (NMP-2). Assessments relating to operation that are presented in this statement augment and update those described in the Final Environmental Statement-Construction Phase (FES-CP) that was issued in June 1973 in support of issuance of the construction permit for NMP-2.

The information in this statement updates the FES-CP in four ways by

(1) evaluating changes in facility design and operation that will result in environmental effects of operation (including those that would enhance as well as degrade the environment) different from those projected during the preconstruction review

(2) reporting the results of relevant new information that has become available since the issuance of the FES-CP

(3) factoring into the statement new environmental policies and statutes that have a bearing on the licensing action

(4) identifying unresolved environmental issues or surveillance needs that are to be resolved by license conditions

Introductions (résumés) in appropriate sections of this statement summarize both the extent of updating and the staff's assessment of the impacts.

Copies of this statement and the FES-CP are available for inspection at the Commission's Public Document Room, 1717 H Street NW, Washington, D.C., and at the Pennfield Library, State University College, Oswego, New York 13126. The documents may be reproduced for a fee at either location. Copies of this statement may be obtained free of charge by writing to the Division of Technical Information and Document Control, Nuclear Regulatory Commission, 1717 H Street, NW, Washington, DC 20555.

Comments should be filed not later than 45 days after the date on which the Environmental Protection Agency notice of availability of this statement is published in the Federal Register.

Ms. Mary F. Haughey is the NRC Project Manager for the environmental review of this project. Should there be any questions regarding the content of this statement, Ms. Haughey may be contacted by telephone at (301)492-7000 or by writing to the following address:

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Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

1 INTRODUCTION

The proposed action is the issuance of an operating license (OL) to the Niagara Mohawk Power Corporation (the applicant), acting as agent and representative for the owners (Niagara Mohawk Power Corporation, New York State Electric and Gas Corporation, Long Island Lighting Company,* Central Hudson Gas and Electric Company, and Rochester Gas and Electric Corporation), for startup and operation of Nine Mile Point Nuclear Station Unit 2 (NMP-2) in the town of Scriba, County of Oswego, State of New York.

NMP-2 employs a nuclear steam supply system (NSSS) consisting of a single-cycle, forced circulating boiling water reactor (BWR). The plant-rated core thermal power level is 3323 MWt, corresponding to an electrical output of approximately 1100 MWe.

The NSSS supplier is General Electric Company, Nuclear Energy Group. Stone & Webster Engineering Corporation, the architect-engineer, is responsible for the design and construction-management of the plant.

The containment design for NMP-2 employs the BWR Mark II concept of over-under pressure suppression with multiple downcomers connecting the reactor drywell to the water-filled pressure suppression chamber. The primary containment is a steel-lined, reinforced-concrete enclosure housing the reactor and suppression pool. The reactor building completely encloses the primary containment. This structure provides secondary containment when the primary containment is closed and primary containment when the primary containment is open, as during refueling.

All cooling water required for Unit 2 will come from and be discharged to Lake Ontario. The closed-loop circulating water system employs a single, wet-evaporative, natural draft cooling tower.

1.1 Administrative History

On March 8, 1972, Niagara Mohawk Power Corporation filed an application with the Atomic Energy Commission (AEC), now the Nuclear Regulatory Commission (NRC), for a permit to construct NMP-2. After the application was docketed on June 15, 1972, the AEC staff reviewed the environmental impacts that would occur during construction and operation. The conclusions resulting from this environmental review were issued as a Final Environmental Statement-Construction Phase (FES-CP) in June 1973. Following a public hearing before an Atomic Safety and Licensing Board (ASLB), the construction permit (CP) for NMP-2 was issued on June 24, 1974.

On January 31, 1983, the OL application for NMP-2 was submitted. It was docketed April 12, 1983. The applicant's Environmental Report-Operating License Stage (ER-OL) and Final Safety Analysis Report (FSAR) were also docketed then.**

*See Appendix K

**These documents are cited in this report as ER-OL or FSAR, followed by a section, table, or figure number. They are available for review at the NRC Public Document Room, 1717 H Street, NW, Washington, DC and at the Pennfield Library, State University College, Oswego, New York.

The applicant estimates that NMP-2 will be ready for fuel loading in March 1986.

This statement augments and updates the environmental impacts described in the FES-CP. Résumé in Sections 4 and 5 summarize the extent of updating and the staff's assessment of any impacts.

This draft statement is being issued for public comments, which should be filed no later than 45 days after the date on which the Environmental Protection Agency notice of availability is published in the Federal Register. The comments received will be considered by the staff in the preparation of its Final Environmental Statement. Section 9 of this statement is reserved for the discussion of the staff's responses to the public comments, and Appendix A is reserved for copies of the comment letters.

Appendix B contains the population radiation dose assessment according to the National Environmental Policy Act; Appendix C discussed the effects of the uranium fuel cycle; and Appendix D gives examples of the site-specific dose assessment calculations. The pollutant discharge elimination system permit issued by the State of New York (SPDES) is reproduced in Appendix E, and correspondence relationg to historic and archeologic sites in the NMP-2 area is in Appendix F. Appendix G is a copy of a report assessing the effects of changes in the design of the cooling system. Appendices H and I relate to release categories used in the consequence analysis and consequence modeling considerations, and Appendix J presents fish harvest estimates for Lake Ontario in the plant vicinity.

1.2 Permits and Licenses

In ER-OL Section 1.2 the applicant has provided a listing of the status of environmentally related permits, licenses, and approvals from Federal and state agencies in connection with the proposed project. Pursuant to Section 401 of the Federal Clean Water Act, the issuance of a water quality certification by the State of New York is a necessary prerequisite to the issuance of an operating license by the NRC. This certification was issued on February 23, 1977 and is included as Appendix 1B to ER-OL Section 1.2.

The SPDES permit was issued to the applicant by the State of New York on June 6, 1983. It became effective on July 1, 1983 and will expire on July 1, 1988. The permit is discussed in ER-OL Section 1.2 and, as noted above, is reproduced in Appendix E of this statement.

In September 1982, the State of New York received authority to administer the requirements of the Federal Coastal Zone Management Act within New York. The applicant is following the state requirements and procedures for filing an application for NMP-2 under the state's Coastal Management Program. The state must approve the application before NRC issues an OL. In the absence of any unforeseen events, the projected fuel load date of March 1986 should allow ample time for the applicant to comply with the requirements of the state's program. The status of the state's review will be updated in the FES.

2 PURPOSE AND NEED FOR THE ACTION

The Commission amended 10 CFR 51 effective April 26, 1982, to provide that need for power issues will not be considered in ongoing and future OL proceedings for nuclear power plants unless a showing of special circumstances is made under 10 CFR 2.758 or the Commission otherwise so requires (47 FR 12940, March 26, 1982). Need for power issues need not be addressed by OL applicants in environmental reports to the NRC, nor by the NRC staff in environmental impact statements prepared in connection with OL applications (10 CFR 51.53, 51.95, and 51.106).

This policy has been determined by the Commission to be justified even in situations where, because of reduced capacity requirements on the applicant's system, the additional capacity to be provided by the nuclear facility is not needed to meet the applicant's load responsibility. The Commission has taken this action because the issue of need for power is correctly considered at the CP stage of the regulatory review where a finding of insufficient need could factor into denial of issuance of a license. At the OL review stage, the proposed plant is substantially constructed and a finding of insufficient need would not, in itself, result in denial of the OL.

Substantial information exists that supports the argument that nuclear plants are lower in operating costs than conventional fossil-fueled plants. If conservation or other factors lower anticipated demand, utilities remove generating facilities from service according to their costs of operation, with the most expensive facilities removed first. Thus, a completed nuclear plant would serve to substitute for less economical generating capacity (46 FR 39440, August 3, 1981, and 47 FR 12940, March 26, 1982).

Accordingly, this statement does not consider "need for power." Section 6 does, however, consider the savings associated with the operation of the nuclear plant.

3 ALTERNATIVES TO THE PROPOSED ACTION

The Commission amended its regulations in 10 CFR 51 effective April 26, 1982, to provide that issues related to alternative energy sources will not be considered in OL proceedings for nuclear power plants unless a showing of special circumstances is made under 10 CFR 2.758 or the Commission otherwise so requires (47 FR 12940, March 26, 1982). In addition, these issues need not be addressed by OL applicants in environmental reports to the NRC, nor by the NRC staff in environmental impact statements prepared in connection with OL applications (10 CFR 51.53, 51.95, and 51.106(d)).

The Commission has concluded that alternative energy source issues are resolved at the CP stage, and the CP is granted only after a finding that, on balance, no superior alternative to the proposed nuclear facility exists. By earlier amendment (46 FR 28630, May 28, 1981), the Commission also stated that alternative sites will not be considered at the OL stage, except under special circumstances, in accordance with 10 CFR 2.758. Accordingly, this statement does not consider alternative energy sources or alternative sites.

4 PROJECT DESCRIPTION AND AFFECTED ENVIRONMENT

4.1 Résumé

This résumé highlights changes in the plant operating characteristics and design as well as new information on the local environment obtained since the FES-CP was issued in 1974.

The major change to the general description of the plant layout is the addition of a cooling tower 165 m (541 feet) high, with a bottom diameter of 123 m (405 feet) and a top diameter of approximately 83 m (273.2 feet). The addition of the cooling tower and the environmental effects of the change from a once-through to a closed-cycle cooling system were evaluated by the staff in 1981. The results of that evaluation are in a report that is included as Appendix G to this statement.

The total land area disturbed by construction activities is about 46.7 ha (116 acres). This is an increase in acreage over that anticipated in the FES-CP, a result in part of the change in the cooling system. Impacts from construction of the transmission line are less than expected at the FES-CP stage.

The temperature and precipitation extremes for the Nine Mile Point site have changed slightly from those used to evaluate the meteorology at the site in the FES-CP. These new values are discussed in Section 4.3.3 of this report. The discussion of the general climatology in Section 2.6 of the FES-CP remains valid.

4.2 Facility Description

4.2.1 External Appearance and Plant Layout

A general description of the plant layout and external appearance is in the FES-CP (Section 3). The revised plant layout showing the location of the significant structures is contained in Figure 4.1. The major changes reflected in the figure are additions of the Energy Information Center and the cooling tower. The Energy Information Center is located in the northwest corner of the site and is used for public education and as a tourist attraction. The cooling tower is 165 m (541 feet) above ground and is located to the south of the containment building.

4.2.2. Land Use

4.2.2.1 Plant Site

The Nine Mile Point site encompasses approximately 364 ha (900 acres). NMP-2 and its support facilities occupy 9.3 ha (22.3 acres) between Nine Mile Point Unit 1, which has been in operation since 1969, and the James A. FitzPatrick

Nuclear Power Plant, which is owned by the Power Authority of the State of New York and is located on about 283 ha (700 acres) immediately east of the site. The NMP-2 site was cleared and graded in 1965. Before 1965, much of the land in the vicinity of the site was farmed; however, at the time of construction, the site was covered with second growth trees and brush (FES-CP Section 2.7.1). Based on the results of a soil survey for Oswego County (USDA, 1981), the site is in an area of Scriba, Ira, and Ira-Sodus soil mapping units. Sodus is classified as prime farmland by the U.S. Soil Conservation Service, and all these areas are classified as farmland of statewide importance. This land is essentially irreversibly committed, because it is not likely to be returned to agricultural use at the end of the project.

FES-CP Section 4.1 estimated that about 6 ha (15 acres) of land would be disturbed for NMP-2 buildings and an additional 10 ha (25 acres) used for construction laydown area and parking facilities. NMP-2 structures and the cooling tower occupy 9.3 ha (23 acres), and about 46.7 ha (116 acres) are used for construction support facilities (ER-OL Section 5.1). Thus, 40 more hectares (99 acres) of land are disturbed than anticipated in the FES-CP, a result, in part, of changes in the cooling system that resulted in construction of a cooling tower on 1.5 ha (3.7 acres). Land uses within the site boundary are listed in Table 4.1.

4.2.2.2 Cooling Tower

Since the FES-CP was issued, the proposed once-through cooling system has been changed to a closed-cycle cooling system with a natural draft cooling tower. The applicant submitted more information on natural draft cooling towers, and the staff reevaluated the impacts of the cooling system (Appendix G). This assessment herein is based on that evaluation and on the ER-OL. However, the ER-OL and the 1981 NRC evaluation differ on the location of maximum salt deposition. This difference arises because the NRC evaluation was based on best available generic meterological and cooling tower information in the applicant's 1976 report (Niagara Mohawk, 1976). Subsequently, specific information on the cooling tower and site meteorology was used in the applicant's model, and the information in the ER-OL is drawn from these updated results.

4.2.3 Water Use and Treatment

4.2.3.1 Water use

When the FES-CP was issued, NMP-2 was to use once-through cooling, with an intake flow from Lake Ontario of 34,000 L/sec (535,000 gpm) (FES-CP Section 3.4). Of this flow, the only consumption (ignoring increased evaporation from the lake) would have been an estimated 0.6 L/sec (10 gpm) (FES-CP Section 3.3). The NMP-2 applicant has since changed to a closed-cycle design with a natural draft cooling tower (Section 4.2.4). As a result, the maximum anticipated intake flow from the lake for service water and fish diversion has been reduced by 89%, to 3759 L/sec (59,586 gpm). The average intake flow will be 3380 L/sec (53,600 gpm) (ER-OL Section 5.2.1.1). However, consumptive use within the station will be considerably greater than in the once-through design: evaporation from the cooling tower will average 625 L/sec (9920 gpm), with a maximum of 870 L/sec (13,800 gpm) in July and August (ER-OL Section 3.3.1 and Table 3.3-1). During normal shutdown, the service water intake flow increases from an average of

2440 L/sec (38,675 gpm) to a maximum of 3150 L/sec (49,938 gpm); during a loss-of-coolant accident (LOCA) without loss of offsite power, the service water intake flow increases to a maximum of 3387 L/sec (53,687 gpm) (ER-OL Table 3.4-1).

In addition to the water from Lake Ontario used for cooling, service water, and other station operations, water from the Oswego City Water Supply will be used for the sanitary system, personnel safety and decontamination, emergency water supplies, and humidifiers. This water use will be a maximum of 3785 L/day (1000 gpd) (ER-OL Section 5.2.1.2).

As noted above, in 1981 the NRC staff evaluated the effects of the design change from once-through to closed-cycle cooling (Appendix G). The slight changes in water use from that evaluated in Appendix G are given in Table 4.2. The current anticipated water use of the station, under average conditions, is shown in Figure 4.2.

4.2.3.2 Water Treatment

Water treatment of the circulating water consists of the addition of sulfuric acid (to control scaling in piping, the cooling tower, and the condenser) and sodium hypochlorite (to control fouling of the condenser and cooling tower by algae, fungi, and bacteria). Approximately 0.06 L/sec (1 gpm) of 93% sulfuric acid is added continuously, with manual control, to the circulating water system at the discharge side of each condenser (ER-OL Section 3.3.2.1). Sodium hypochlorite, generated on the site, is added to the circulating water system directly ahead of the condenser and is controlled automatically by a continuous chlorine analyzer (ER-OL Section 3.3.2.1). Chlorination is limited by the SPDES permit (Appendix E) to 2 hours/day (ER-OL Section 3.3.2.1), with a total residual chlorine level of 0.2 mg/L the daily average and 0.5 mg/L the daily maximum. Estimated maximum use rate of 93% sulfuric acid and sodium hypochlorite is 9957 kg/day (21,951 lb/day) and 907 kg/day (2000 lb/day), respectively (ER-OL Table 3.3-5). The once-through cooling system evaluation in FES-CP Section 3.6 did not involve treatment of the circulating water.

Makeup water for plant use in the turbine, reactor, and radwaste buildings is filtered (through anthracite and activated carbon) and demineralized (ER-OL Section 3.3.2.2).

4.2.4 Cooling System

As noted elsewhere, the NMP-2 design uses a closed-cycle cooling system with a natural draft cooling tower, rather than the once-through cooling system assessed in the FES-CP. The 1981 NRC study of this design change is included in this report as Appendix G. The following paragraphs address those features of the cooling system that have changed since or that were not described in the 1981 study.

4.2.4.1 Intake System

The current design of the two velocity cap intake structures is shown in Figure 4.3. This design is virtually identical to that of the intake structures considered in the 1981 study (Appendix G, Figure 3.5). The velocity in the intake pipes leading from the intake structures to the screenbays will be approximately 0.9 m/sec (3 fps) (ER-OL Section 3.4.2.1), which is similar to the 0.8 to 1.4 m/sec (2.5 to 4.5 fps) velocity described in the 1981 study. Although the applicant has installed a fish diversion system to reduce the number of fish impinged on the traveling screens (ER-OL Section 3.4.2.1), a water spray on the traveling screens will collect any undiverted fish (along with debris not stopped upstream at the intake structure bar racks or at the trash rack) for disposal off the site.

4.2.4.2 Cooling Tower

The applicant has constructed a wet-evaporative, natural draft cooling tower of a counterflow design. The tower is 165 m (541 feet) high, with a bottom diameter of 123 m (405 feet) and a top diameter of 83 m (273 feet) (ER-OL Section 3.4.2.3). The circulating water flow is 36,590 L/sec (580,000 gpm) (ER-OL Section 3.4.1.1.2); evaporation averages 625 L/sec (9920 gpm) (ER-OL Section 3.3.1), ranging from 290 to 870 L/sec (4560 to 13,800 gpm) (ER-OL Section 3.4.1.1.4). Drift is estimated to be no more than 0.005% of the circulating water flow (ER-OL Section 3.4.1.1.4). As shown in Table 4.2, the average evaporation is slightly less than--and the maximum evaporation slightly more than--the corresponding rates evaluated in the 1981 NRC cooling tower study.

4.2.4.3 Discharge System

Blowdown from the cooling system will be discharged to Lake Ontario along with discharge from the service water system, the chemical waste treatment system (see Section 4.2.6), and the liquid radwaste system (see Section 4.2.5) (Figure 4.2). Blowdown will average 955 L/sec (15,080 gpm) (ER-OL Section 3.3.1), ranging from 530 to 1290 L/sec (8445 to 20,440 gpm) (ER-OL Section 3.4.1.1.4). As shown in Table 4.2, the average total discharge flow now anticipated is slightly greater than--and the maximum flow slightly less than--the corresponding rates evaluated in the 1981 NRC cooling tower study. Because the dimensions of the diffuser have not changed from those described in the 1981 study, the average discharge velocity is expected to be slightly greater than the earlier estimate: 5.5 m/sec (18 fps) versus 4.8 m/sec (15.8 fps). The maximum difference in temperature between the intake and the discharge (ΔT) is now anticipated to be 15.6C° (27.99F°) (ER-OL Table 3.3-1), less than the 17C° (30.6F°) ΔT evaluated in the 1981 NRC study. During a normal shutdown, discharge temperatures drop as much as 0.7C° an hour (1.3F° an hour) for the first 12 hours, remain constant for the next 2 hours, then abruptly rise as much as 5.6C° (10F°) at 14 hours, remain at 11.7C° (21F°) above ambient until 16.5 hours, and then slowly decrease to 2.7C° (5F°) above ambient (ER-OL Section 3.4.1.3.5). Reactor scram and other shutdown situations also alter the thermal discharge pattern.

4.2.5 Radioactive Waste Management Systems

10 CFR 50.34a requires an OL applicant to include a description of the design of equipment to be installed for keeping levels of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable (ALARA). ALARA means as low as is reasonably achievable taking into account the state of technology and the economics of improvement in relation to benefits to the public health and safety and other societal and socioeconomic considerations

and in relation to the utilization of atomic energy in the public interest. Appendix I to 10 CFR 50 provides numerical guidance on design objectives for light-water-cooled nuclear power reactors to meet the requirements that the radioactive materials in effluents released to unrestricted areas be kept as low as is reasonably achievable.

To meet 10 CFR 50.34a, the applicant has provided final designs of radwaste systems and effluent control measures for keeping levels of radioactive materials in effluents to unrestricted areas within the design objectives of Appendix I to 10 CFR 50. The applicant has performed a cost-benefit analysis, as required by Section II.D of Appendix I, for NMP-2 to show conformance with Appendix I to 10 CFR 50. In addition, the applicant has provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced during normal operation, including anticipated operational occurrences.

The staff's detailed evaluation of the liquid and gaseous radwaste systems and the capability of these systems to meet the requirements of Appendix I will be in Chapter 11 of the safety evaluation report (SER). The quantities of radioactive material calculated by the staff to be released from the plant are in Appendix D of this environmental statement, along with the calculated doses to individuals and to the population that will result from these effluent quantities. The staff's evaluation concludes that the final designs of radwaste systems and effluent control measures are capable of meeting the design objectives of Sections II.A, II.B, and II.C of Appendix I to 10 CFR 50, so that radioactive materials in effluents released to unrestricted areas can be kept ALARA. The staff also concludes that there are no cost-effective design augments that would reduce the cumulative population dose at a favorable cost-benefit ratio, and, therefore, the final design of gaseous and liquid radwaste systems meets the requirements of Section II.D of Appendix I to 10 CFR 50.

When an OL is issued, the applicant will be required to submit Technical Specifications that will establish release rates for radioactive material in liquid and gaseous effluents. These specifications will also provide for the routine monitoring and measurement of all principal release points to ensure that the facility operator is in conformance with the requirements of Appendix I to 10 CFR 50.

4.2.6 Nonradioactive Waste Management Systems

4.2.6.1 Aqueous Discharges

Discharges to Lake Ontario consist of (1) a combined discharge comprising cooling tower blowdown and discharges from the service water, liquid radwaste, filter backwash, and chemical waste treatment systems; (2) a discharge from the sanitary waste treatment system; and (3) a discharge of stormwater and floor, equipment, and building drainage (Figure 4.2). Discussion of the liquid radwaste component of the combined discharge is in Section 4.2.5. Waste waters from regeneration of ion exchange resins used in the makeup demineralization water treatment system are treated by self-neutralization of the acid and caustic components in a 227,000-L (60,000-gallon) tank to pH 6.5 to 8.5. Further neutralization is achieved by the addition of sulfuric acid or sodium hydroxide, if necessary (ER-OL Section 3.6.1.1.1). Blowdown from the cooling tower is discharged to limit the buildup of dissolved solids in the circulating water.

On an annual average, dissolved solids in the cooling water will be concentrated by evaporation to 1.67 times the level in ambient lake water, with a maximum monthly concentration factor of 2.23 in July and August (ER-OL Section 3.6.1.1.4). The average concentration factor now anticipated is considerably less than the 2.5 factor assumed in the 1981 NRC study; this change results in a more dilute blowdown--and consequently a more dilute combined discharge--than that evaluated in the 1981 study.

Table 4.3 compares concentrations of constituents in the discharge that were anticipated at the time of the 1981 NRC study (Appendix G) with those now predicted by the applicant. For most of these constituents, the maximum concentrations are now predicted to be lower than the average concentrations predicted in 1981; for all the listed constituents, the mean concentration is now estimated to be lower than in the 1981 study. In addition to the constituents addressed in the 1981 study, the NMP-2 will introduce copper and zinc (from corrosion) into the discharged water at a maximum concentration of 0.105 and 0.437 mg/L, respectively, and a mean concentration of <0.027 and <0.065 mg/L, respectively (ER-OL Table 3.6-1). If total residual chlorine (TRC) is discharged in the blowdown at the regulated maximum concentration of 0.5 mg/L for 2 hours per day, the maximum TRC at the point of the effluent release to Lake Ontario may be estimated by multiplying this concentration by the maximum ratio of blowdown flow to total discharge flow, taken from flow data in ER-OL Table 3.3.1. This ratio is 0.86 (in February), yielding a concentration at the point of discharge of 0.43 mg/L TRC. This conservative estimate of the extreme volume also does not take into account chlorine demand in the nonblowdown portion of the discharge. Other constituents in the intake water would be concentrated as a result of evaporation from the cooling tower.

The SPDES permit (Appendix E) regulates discharge temperature, intake-discharge temperature difference, heat addition, total residual chlorine, and pH in the cooling tower blowdown (outfall 040). Oil and grease, suspended solids, and pH are regulated in the effluent from the filter backwash and demineralizer regeneration waste treatment system (contributors to outfall 041).

The combined sanitary wastes from Units 1 and 2 are to be treated in a proposed secondary treatment facility with maximum average design flow and peak flow of 450,000 L/day (120,000 gpd) and 900,000 L/day (240,000 gpd), respectively, that will discharge to Lake Ontario (ER-OL Section 3.6.2, Supplement 6). The SPDES permit limits the effluent (outfall 030) to a flow of 250,000 L/day (65,000 gpd) and regulates biochemical oxygen demand (BOD), suspended and settleable solids, fecal coliform bacteria, pH, and chlorine. The applicant anticipates the flow limit will be revised to 120,000 gpd (ER-OL Section 3.6.2, Supplement 6). Storm water and uncontaminated drainage is discharged without treatment via the storm water outfalls at the lake shoreline (ER-OL Section 3.6.3.3) (outfalls 001-006), for which the SPDES permit does not impose limits. Drainage from areas potentially contaminated with oil (diesel generator building, transfer pit) flows through oil-water separators before joining the storm water discharge (ER-OL Section 3.6.3.3). Floor and equipment drainage (outfall 007) is regulated by the SPDES permit with respect to oil and grease, suspended solids, and pH.

4.2.6.2 Solid Discharges

The primary solid wastes from NMP-2 will be cooling tower sludge, sanitary waste sludge, and debris from the trash racks and traveling screens. The applicant estimates that 1668 m^3 (58,900 ft^3) of cooling tower sludge will be disposed each 5 years at an offsite, state-licensed disposal facility (ER-OL Section 3.6.1.2). The applicant will have a contractor dispose of sanitary waste sludge in accordance with state regulations (ER-OL Section 3.6.2). Debris collected in the intake system will be sent to a state-approved landfill (ER-OL Section 3.4.2.1).

4.2.6.3 Gaseous Effluents

Nonradioactive gaseous emissions from operation of the plant will be negligible because the two auxiliary boilers will be heated electrically (that is, there will be no emissions) (ER-OL Section 3.6.3.4), and the three fossil-fueled diesel generators and the fire pump will be operated infrequently. The diesel generators are tested for about 2 hours a month, and the fire pump is tested for about 1/2 hour a week. Exhausts are discharged to the atmosphere through stacks. There are no Federal new-source performance standards or prevention of significant deterioration (PSD) requirements because the generators are emergency standby units. There is a New York State opacity limit, which will be achieved through proper operation and maintenance of the units (ER-OL Section 5.5.2.2). Diesel generators and fire pump emissions are listed in ER-OL Table 3.6-4. Predicted suspended particulate concentrations resulting from cooling tower drift emissions are well below Federal and state standards, Therefore, PSD requirements do not apply (ER-OL Section 5.5.2.2).

4.2.7 Power Transmission System

The power transmission system (ER-OL Section 3.7) requires construction of a new 345-kV transmission line (instead of the 765-kV line projected in the FES-CP) from Unit 2 to the Volney Station (ER-OL 3.7-1). The new line parallels existing transmission lines in a 152.4-m (500-foot) wide right-of-way (ROW). The new Scriba substation will also be located within this ROW, just south of the site. Anticipated purchase and clearance of additional land along the existing ROW (FES-CP Section 3.9) was not necessary because of the realignment of the transmission system (ER-OL Section 2.2.2). Instead of the latttice steel tower proposed in FES-CP Section 3.8, the supporting structures of the transmission line will be wood-pole, H-frame structures with tubular steel poles at angle locations (ER-OL Section 3.7.2). Construction of the new line requires clearing of an additional 23-m by 151-m (75-foot by 9.4-mile) strip within the ROW. Present and post-construction land uses within the area to be cleared for the NMP-2 line are shown in Table 4.4. The applicant estimates that there are 2.2 h (5.5 acres) of prime farmland and 0.2 ha (0.5 acre) of unique farmland in the ROW. The application for a state Certificate of Environmental Compatibility and Public Need (Article VII of the Public Service Law) requires that information be provided about the environmental impact of construction, restoration, and management of the transmission facility. This information is in the Environmental Management and Construction Plan and is outlined in ER-OL Section 5.6.1.3.

4.3 Project-Related Environmental Descriptions

4.3.1 Hydrology

4.3.1.1 Site and Facilities

NMP-2 is on the western portion of the Nine Mile Point promontory on the southeastern shore of Lake Ontario in Oswego County, New York. All elevations in this report refer to the U.S. Lake Survey 1935 datum, which is almost equivalent to mean sea level (msl) at this location, the difference being only 0.366 cm (0.144 inch). To convert elevations to 1955 International Great Lakes Datum, subtract 0.375 m (1.23 foot).

The natural grade elevation of the Nine Mile Point site varies between elevation 78.03 m (256 feet) and elevation 80.77 m (265 feet). There are no perennial streams on the site. Precipitation is carried to Lake Ontario via drainage ditches, storm sewers, and groundwater flow.

A revetment ditch system was constructed along the lake shore in front of NMP-2. The top of the revetment is at elevation 80.16 m (263 feet) and prevents possible plant flooding as a result of lake wave action (FSAR Section 2.4.5). A ditch located immediately south of the revetment collects rainfall runoff flowing north toward the lake and conveys the flow to both ends of the revetment. All personnel entrances to seismic Category I structures are at elevation 79.55 m (261 feet) or higher. A detailed description of the water level (flood) design is in FSAR Section 3.4.

4.3.1.2 Hydrosphere

4.3.1.2.1 Surface Water

Lake Ontario, which is the easternmost of the Great Lakes, is an international body of water forming part of the border between the U.S. and Canada. The lake is 310.6 km (193 miles) long and 85.3 km (53 miles) wide at its largest points, and has a surface area of 19,010.6 km^2 (7340 mi^2), or 1.901 million ha (4.7 million acres). It has a maximum depth of 244.4 m (802 feet), an average depth of approximately 86.3 m (283 feet), and a volume of 1.638 km^3 (393 mi^3) or 0.164 billion ha-m (1.34 billion acre-feet).

Inflow into the western end of Lake Ontario averages approximately 5806 m^3/sec (205,000 ft^3/sec). Runoff directly into Lake Ontario from 70,707 km^2 (27,300 mi^2) of watershed in New York State and the Province of Ontario amounts to an additional 1020 m^3/sec (36,000 ft^3/sec). The main feeder is the Niagara River; other large rivers draining into the lake are the Genesee and Oswego Rivers from the south shore, the Black River from the east shore, and the Trent River from the north shore. The outflow from the lake into the St. Lawrence River averages about 6824 m^3/sec (241,000 ft^3/sec).

During the winter, ice cover forms in the slack water bays, but the lake itself is seldom more than 25% ice-covered. Lake Ontario's outflow river, the St. Lawrence, is ice-covered from late December until the end of March, all the way from the lake to the international boundary at Massena, New York.

Before the start of flow regulation, the elevation of the lake surface was controlled by a natural rock weir located about 6.4 km (4 miles) downstream from Ogdensburg, New York, in the Galop Rapids reach of the St. Lawrence River. The 111-year record of the U.S. Lake Survey (1860 through 1970) indicates a mean lake surface elevation of 75 m (246 feet). Over this period, the maximum lake surface elevation was 75.98 m (249.29 feet), and the minimum was 73.97 m (242.68 feet), a range of 2.01 m (6.61 feet). The annual range of elevations varies between 1.09 and 0.21 m (3.58 and 0.69 feet).

Dams on the St. Lawrence River, under the authority of the International St. Lawrence River Board of Control, are now used to regulate the lake level. The low limit is set for elevation 74.37 m (244 feet) on April 1 and is maintained at or above that elevation during the entire navigation season (April 1 to November 30).

Water surface set-up and seiche are produced by winds and atmospheric pressure gradients. These short-term lake fluctuations are generally less than 0.6 m (2 feet) in amplitude. Winds are directly related to the formation of surface waves, the magnitude of which varies between 0 and 4.6 m (15 feet) in height during a given year. Tides are less than 2.5 cm (1 inch) in magnitude.

The average annual precipitation in the site area is about 92 cm (36 inches). It is estimated that approximately 46 cm (18 inches) are lost as runoff into stream flow. Of the remaining 46 cm (18 inches), approximately 41 cm (16 inches) are lost via evaporation from land and water surfaces and transpiration by plants, referred to together as "evapotranspiration." The remaining 5 cm (2 inches) is available for groundwater recharge. The relatively high runoff can be attributed to the low permeability of the glacial soils and rock formations.

Seasonal Temperature Structure of Lake Ontario

Lake Ontario is a large, temperate lake that experiences seasonal changes in its thermal structure that, in turn, alter its circulation patterns. The changes in stratification result from atmospheric heat exchange and wind-induced mixing.

Natural warming of the lake begins in mid-March and continues until mid-September. At the onset of warming, the surface water temperature in the shallow littoral zone rises more rapidly than in regions just offshore. The summer season starts in late June when the offshore surface temperature stays above 4°C (39.2°F). In general, vertical stratification over the entire basin is established at this time by the combined effects of lake warming and the advection of the warmer, near-shore water. The lake's mean surface temperature reaches 21°C (69.8°F), and the temperature of the hypolimnion (the bottom layer) varies with depth, ranging between 3.8°C and 4.0°C (38.8°F and 39.2°F), (New York, 1971).

In late September, the warming process ends. The lake's mean surface temperature drops rapidly to below 17°C (62.6°F), and the thermocline begins to weaken. The vertical temperature gradient decreases as the surface layer and deeper water effectively mix. (Mixing is the consequence of convection caused by cooling at the surface and is enhanced by the weakening of the thermocline, which permits wind-induced turbulence to extend to greater depths.) The fall cooling process resembles spring warming but in reverse. The breakdown of temperature stratification throughout the lake marks the onset of the winter season. The date of overturn differs from year to year, depending on the occurrence of storms. The lake surface is cooled below 4°C (39°F), and surface isotherms tend to be parallel to the shore. With continued cooling, ice forms in the near-shore region.

Water Circulation in Lake Ontario

The annual average large-scale circulation pattern of Lake Ontario is counterclockwise (cyclonic flow), with flow to the east along the south shore in a relatively narrow band and a somewhat less pronounced flow to the west along the north shore. The conceptual model explaining this general circulation pattern is presented in detail in the James A. FitzPatrick Nuclear Power Plant 316(a) Demonstration (ibid).

The geneneral circulation described above has been documented by observations collected over long periods (months). The circulation patterns that are observed at a specific time, however, are more complex as a result of the lake's response to the shifting winds. At times, a major shift in wind distribution can alter the currents in a matter of hours, while at other times, some features of the current pattern can continue even with an opposing wind (Csanady, 1972).

Two important examples of wind-induced changes in the general circulation pattern are upwelling and internal oscillation. Upwelling is characterized by the rising of colder, heavier, bottom water toward the surface. A variety of mechanisms have been proposed to account for the observed oscillations of the thermocline. The most direct explanation is that an upwelling displaces the thermocline from equilibrium by converting kinetic energy of the wind to potential energy of the thermocline position. When the wind stress is removed, internal waves are set in motion and contribute to the dissipation of this energy. Internal waves increase in amplitude after storms, and, in Lake Ontario, the oscillations have a period of nearly 17.5 hours, roughly three complete oscillations every 2 days. These oscillations are a common feature of lake temperature records and are prominent in intake temperature records such as those of NMP-1 and the FitzPatrick plant.

Geomorphology at Nine Mile Point

Nine Mile Point is a slight promonotory along the south shore of Lake Ontario. The offshore slope at the plant is steep (5% to 10% grade) at the beach. It flattens to a 2% to 3% grade to the 5-m (15-foot) depth, then steepens to a 4% slope lakeward. The slope at the 6-m (20-foot) depth contour is steeper at the plant than to the east or west of the plant.

A number of observations of the bottom sediments along the south shore of Lake Ontario have been made. Sutton et al. (1970) examined near-shore bottom sediments (0 to 33 m (0 to 108 feet)) in 1968 and 1969 between Rochester and Stony Point, and stated several conclusions relevant to the Nine Mile Point site:

(1) There is generally a west-to-east transport of sediment.

(2) Sites of sediment accumulation occur in near-shore shallow areas where the shoreline is irregular and where there are local deviations from the above transport pattern.

(3) In general, the coarser sands, boulders, pebbles, and cobbles lie in the beach or near-shore area, and finer sediments are found lakeward.

(4) Several small patches of sand occur offshore between Oswego and Mexico Bay, and it is hypothesized that these originate from the Oswego River.

Visual observations made in the Nine Mile Point vicinity during the 1973-1976 aquatic programs (ER Section 6.5.2.1.2.7) corroborate the earlier observations of Sutton et al.

Currents at Nine Mile Point

Current measurements were made off the Nine Mile Point promonotory from May to October 1969 and from July to October 1970 (New York, 1971; Gunwaldsen, 1970). Two fixed underwater towers were placed in the lake, one in 7.3 m (24 feet) of water and one in 14.0 m (46 feet) of water, and provided average hourly current speed and direction data. In addition, two drogue surveys were conducted in 1969 to obtain the overall current pattern at the site. Results from these studies are presented in the FitzPatrick 316(a) demonstration (New York, 1971) and are summarized in the paragraphs below. The methods used in these studies are described in ER Section 6.3.1.

The wind speed-frequency data indicate that over the year winds in excess of 9 m/sec (20 mph) occur 21.6% of the time, based on readings averaged over a 6-hour period. From June through September, winds in excess of 9 m/sec (20 mph) occur 13.9% of the time. The current speed of 6-hour duration exceeded with comparable frequency (June-September) at the 6-m (19-foot) depth is about 0.06 m/sec (0.2 fps).

The predominant current direction in the preceding studies is along the shore. On those occasions when onshore or offshore currents were observed, their magnitudes were substantially less than those of along-shore currents. Based on this near-field data, along-shore currents from the east are just slightly more likely to occur than are those from the west. Overall lake circulation patterns are typically west to east along the south shore of Lake Ontario (ER Section 2.3.1.1.3). Onshore and offshore currents each account for only about 5% of the observations. Approximatly 30% of the observations were below the meter threshold, 0.03 m/sec (0.08 fps).

4.3.1.2.2 Groundwater

Beneath the Nine Mile Point site, the hydrologic units in descending order are: Unlithifield Sediments, Oswego Sandstone, Pulaski Formation, and Whetstone Gulf Formation (NMP-2 FSAR). Groundwater is available from an unconfined aquifer and deep confined aquifers. The unconfined aquifer is composed of glacial till and fill material (Unlithified Sediments) and the upper portion of the Oswego Sandstone beneath the soil. The unconsolidated deposits rest on a permeable fractured zone at the top of the Oswego Sandstone. As the depth increases in the sandstone, the number of fractures decreases, with the formation becoming relatively impermeable within approximately 6 m (20 feet). The local water table varies from about 261 feet msl near the plant to about 244 feet msl (lake level) near the lake, with annual variations of approximately 0.6 m (2 feet). The average gradient is approximately 0.7% to the north-northwest.

The transition zone between the Oswego Sandstone and Unit A of the Pulaski Formation (FSAR Section 2.5.1.2) is a more permeable zone than the overlying and underlying strata (Nevin, 1929). It appears to have a higher piezometric head (based on boring measurements) than the unconfined water table (Niagara Mohawk, 1980). Flow in this zone is confined. Another confined zone of relatively high permeability occurs in the Pulaski Unit B. The overlying Unit A may be acting as an aquitard. Below, the Unit C zone has a very low permeability and separates the confined Unit B zone of the Pulaski Formation from the Whetstone Gulf Formation. All of the deep aquifers are confined and are charactized by artesian pressure.

4.3.2 Water Quality

This section addresses the water quality of Lake Ontario, which is (1) the source of water used at NMP-2 (in addition to a relatively minor use from the Oswego City Water Supply), as described in Section 4.2.3, and (2) the receiving water for aqueous discharges, as described in Section 4.2.6.

The 1981 NRC cooling system study (Appendix G, page 2-1) found that, through 1977, the water quality of Lake Ontario was similar to that described in the FES-CP. As shown in Table 4.5, data reported for 1978 (the most recent data reported in the ER-OL for water quality characteristics other than temperature and dissolved oxygen) are similar to those considered in the 1981 NRC study.

Copper and zinc, which will be discharged as a result of corrosion (see Section 4.2.6), are also of interest in terms of ambient water quality. For both elements, measured mean concentrations in 1978 were well below the state standards (ER-OL Table 2.3-15): for copper, <19 versus 200 μg/L and for zinc, <48 versus 300 μg/L, although the maximum zinc concentration, 675 μg/L, exceeded the standard (ER-OL Table 2.3-13).

Total dissolved solids (TDS) concentrations in Lake Ontario are above the New York State Water Quality Standard of 200 mg/L (ER-OL Section 2.3.3.3 and 2.3.3.5). High maximum pH values, attributable to photosynthetic activity, generally exceed the upper limit of the state standard (pH 8.5) (ER-OL Section 2.3.3.5). Natural water temperatures for the vicinity of the station, measured from April through December 1976 at a depth of 6 m (20 feet) at a control transect 32 km (20 miles) east of the station, range from 1.1°C (34.0°F) to 23.2°C (73.8°F) (ER-OL Section 2.3.1.1.5). During the winter, ice forms in near-shore areas (ER-OL Section 2.3.1.1.1). The existing NMP-1 and FitzPatrick power plants, each with once-through cooling, elevate surface water temperatures in the vicinity of the station (ER-OL Section 2.3.3.5).

Although mirex (a chemical used in pesticides, flame retardants, and plasticizers) is of concern in Lake Ontario from the standpoint of bioaccumulation in food webs, availability and transport from the former sources appears to be via sediments rather than water. Measured sediment concentrations in the lake have exceeded 10 μg/L near Oswego, but no detectable concentrations of mirex have been found in the water column (New York, 1978). There are now no known active sources of mirex input to the lake, and it has been estimated that the mirex now in Lake Ontario will be flushed from the ecosystem in 10 to 100 years (ibid).

4.3.3 Meterology

The discussion of the general climatology in FES-CP Section 2.6 is still appropriate, although the temperature and precipitation extremes have changed slightly. The extreme temperature values now are maximum 37°C (98°F) and minimum -32°C (-26°F), observed at the National Weather Service Office in Syracuse, New York through 1980. Total precipitation averages are 925 mm (36.4 inches) a year, with a range of from 55 mm (0.21 inch) to 312 mm (12.3 inches) for monthly extremes. Snowfall averages 2831 m (111.5 inches) a year, with a maximum monthly amount of 1844 mm (72.6 inches) in February. The greatest 24-hour snowfall measured through 1976--622 mm (24.5 inches)--occurred in January 1966. Precipitation is evenly distributed throughout the year, with about 76 mm (3 inches) a month on the average.

Winds are measured at the site at the 10- and 61-m levels. These wind measurements reflect the effects of the proximity of the site to Lake Ontario and the existence of small-scale air circulations as a result of thermal differences between the land and water temperatures (lake-land breeze circulations). The prevailing winds are from the west.

Extreme winds in the site area result from thunderstorms and intense low pressure storm systems that move over the Great Lakes and the St. Lawrence River Valley.

The highest winds observed in the area were 31 m/sec (69 mph); the average wind speed is 4 m/sec (10 mph) from the west.

4.3.4 Terrestrial and Aquatic Resources

4.3.4.1 Terrestrial Resources

The review of the terrestrial resources of the site and the transmission corridor is based on (1) 1979 aerial photographs, (2) a 1979 terrestrial field survey, and (3) review of pertinent literature (ER-OL Sections 2.4.1 and 6.5.1). The characterization of the transmission corridor was also based on consultation with local specialists, a field survey in October 1981, and information in the Article VII application for a Certificate of Environmental Compatibility and Public Need (New York State Public Service Law), which authorizes construction and operation of the line. Tables 4.1 and 4.2 summarize the terrestrial habitats of the site and the transmission corridor.

Clearing of land in the past has altered the structure of the terrestrial communities on the site and transmission corridor. Presently, much of the area is in varying stages of succession (e.g., old field communities and second-growth hardwoods), following use as crop land, pasture land, or orchards. Vegetative types in the transmission corridor and in the vicinity of the site are shown on Figure ER-OL 2.4-2. The wildlife species found on and near the site are typical of disturbed areas in the northeastern United States (FES-CP Section 2.7.1). The most common mammals trapped in the 1979 survey (ER-OL Section 2.4.1.1.3.1) were the white-footed mouse (Peromyscus leucopus) and the deer mouse (P. maniculatus). Two woodchucks (Marmota monax) and tracks of white-tailed deer (Odocoileus virginianus) were also observed during the survey.

The lake area bordering the site is part of the waterfowl winter concentration area identified by the New York State Department of Environmental Conservation as significant habitat (ER-OL Section 2.4.1.1.4). The closest wildlife management area is an Audubon bird sanctuary 3 km (1.9 miles) east of the site on the Lake Ontario shore (ER-OL Section 2.4.1.1.1). Numerous bird species breed in the area of the site (ER-OL Tables 2.4.8, -9, -11, and -12) and many other species are transient (ER-OL Table 2.4.8) during the spring and fall migrations. Raptors migrate along the shore of Lake Ontario in the spring and turn north along the eastern end of the lake east of Nine Mile Point (ER-OL Section 2.4.1.1.3.2). No wildlife concentration areas or refuges are traversed by the ROW.

4.3.4.2 Aquatic

The aquatic resources of Lake Ontario that potentially will be affected by operation of NMP-2 were reviewed in the FES-CP and in the staff's 1981 evaluation of the conversion to closed-cycle cooling. This latter document (Appendix G) forms the aquatic resource information base that will be updated in this statement.

This section updates the discussion on lake biota and fisheries. ER-OL Section 2.4.2 describes the ecology of the lake, and Section 4.6.5.2 describes the sampling program. Additionally, there is much information in the annual reports of ecological studies at both NMP-1 and the FitzPatrick power plants; this information is used where appropriate. Data on fishery harvests are in ER-OL Section 2.3.2.3 and in a study done for NRC by Oak Ridge National Laboratory (Appendix J of this statement).

4.3.4.2.1 Biota

On the basis of data collected in the Nine Mile Point area through 1976, the 1981 NRC study (Appendix G) focused on the potential effects of the cooling system on Lake Ontario fish and ichthyoplankton, particularly alewife (Alosa pseudoharengus) and rainbow smelt (Osmerus mordax). Data through 1982 are now available. This section summarizes the most current information on fish community composition and ichthyoplankton abundance and distribution in the vicinity.

Of 74 identified fish species (including sub-species and hybrids), only brassy minnow (Hybognathus hankinsoni), bloater (Coregonus hoyi), and chain pickerel (Esox niger) represent taxa taken in recent samplings (1977, 1981, and 1981, respectively) in the Nine Mile Point area that had not been taken through 1976 (Lawler, Matusky, and Skelly, 1983, and Ecological Analysts, 1983).

The 1981 NRC study (Appendix G, pages 5-1 to 5-3) found that the fish species that were most abundant in the impingement samples at NMP-1 and FitzPatrick were also the most abundant in the lake in the site vicinity. At NMP-1 (1973-1976) and at FitzPatrick (1976), alewife, rainbow smelt, spottail shiner (Notropis hudsonius), and mottled sculpin (Cottus bairdi) accounted for 80% to 97%, 2% to 7%, 0.01% to 0.36%, and 0.06% to 0.31%, respectively, of the total estimated impinged fish. These four species accounted for 88% to 99% of the total estimated number of impinged fish. During April to December 1982 gill netting in the Nine Mile Point vicinity, alewife, spottail shiner, and rainbow smelt (81%, 12%, and 3%, respectively) accounted for 96% of the total number of fish sampled. During that same year, these three species represented 80% and 97% of the total number of impinged fish at the NMP-1 and FitzPatrick power plants, respectively (Ecological Analysts, 1983).

As had been the case from 1974 through 1976, alewife and rainbow smelt were the dominant ichthyoplankters in 1977 and 1978 (Lawler, Matusky, and Skelly, 1983). These two species accounted for the majority of entrained ichthyoplankton in 1975 and 1976 (Appendix G, pages 5 to 10). The 1981 NRC study (ibid) found that ichthyoplankton abundance was highest at the approximate depth of the intake structures (6 m). However, although larval alewife were somewhat greater in abundance at 6 m than at 12 to 30 m in 1977, this difference was not apparent in 1978, nor was it apparent for rainbow smelt in either year (Lawler, Matusky, and Skelly, 1983).

In summary, based on more recent data, the fish and ichthyoplankton community in the vicinity of the station appears to be similar to that considered in the 1981 NRC study: alewife and rainbow smelt, the dominant species in terms of both impingement and larval entrainment at the adjacent power plants, represent the most abundant fish and larvae in the Nine Mile Point area.

Samples of the macroinvertebrates of the Nine Mile Point area from 1973 to 1978 did not indicate the presence of the Asiatic clam (Corbicula sp.), which is of interest because of its potential for fouling cooling systems of power plants. A 1981 survey for Corbicula near the site and at the NMP-1 intake and discharge structures also produced negative results (Niagara Mohawk, 1981). Corbicula has been reported from western Lake Erie and may spread eastward (NUREG-0884), although it may already be at the final limit of its northern distribution, based on sensitivity to minimum winter temperatures (McMahon, 1982).

4.3.4.2.2 Fisheries

Total annual commercial fish harvest from Lake Ontario from 1976 to 1980 ranged from 58,000 to 94,000 kg (129,000 to 207,000 lb) for U.S. waters and from 835,000 to 1,233,000 kg (1,841,000 to 2,719,000 lb) for Canadian districts 3, 4, 5, and 6 (central and eastern Lake Ontario) (ER-OL Tables 2.3-7 and 2.3-16 and Figure 2.3-15). The U. S. catch was dominated by eel (Anguilla rostrata), yellow perch (Perca flavescens), bullhead and catfish (Ictalurus spp.), and smelt, with the composition percentages varying from year to year (ER-OL Table 2.3-7).

These fish, plus white perch (Morone americana) and carp (Cyprinus carpio), dominated the Canadian harvest (ER-OL Table 2.3-16). These dominant fish are similar to those listed in the FES-CP Section 2.7.2, and, as reported in the FES-CP, the U.S. commercial catch was much smaller than the Canadian catch.

The U.S. Lake Ontario sport fishery, estimated at almost 5 million fish for 1976-1977, comprised 35% yellow perch, 28% panfish, 15% black bass (Micropterus spp.), 14% bullhead and catfish, and 8% others (ER-OL Table 2.3-8). Similarly, yellow perch accounted for 31% (by number) of the 1980 angling harvest in the Canadian waters of Lake Ontario between Salmon Point and Kingston, Ontario (ER-OL Table 2.3-9).

In the site vicinity, fishing occurs in the lake, in the creeks and rivers, and at the creek mouths. The areas with the most fishing pressure are Oswego Harbor, Salmon River, Sandy Pond, and the Nine Mile Point vicinity (Storr, 1977). Fishing occurs seasonally by boat anglers in the thermal discharge plumes at Nine Mile Point, where predator fishes are seeking prey species attracted to the warm water (Storr and Schlenker, 1974).

4.3.5 Endangered and Threatened Species

4.3.5.1 Terrestrial

No plant species listed as endangered or threatened by the U.S. Fish and Wildlife Service (FWS, Sections 2.4.1.1.2 and 5.6.1.1) occurs on the site or along the transmission corridor right-of-way (ROW). Several plants listed as protected by the New York State Department of Environmental Conservation have been identified at the site (ER-OL Section 2.4.1.1.2). They are: running pine (Lycopodium complanatum), Christmas fern (Polystichum archostichoides), New York fern (Thelypteris noveboracensis), and triliium (Trillium sp.). These plants are listed because they are attractive, but they are not considered endangered or threatened in New York State. Under the state Environmental Conservation Law (Section 9-1503), these plants may not be picked, plucked, severed, removed, or carried away without consent of the property owner.

Except for occasional transient species, no Federally (Hamilton, 1983) or state-listed (Bouton, 1984) endangered or threatened wildlife species are known to exist on the site or within the transmission ROW. Possible transient Federally protected species include the Indiana bat (Myotis sodalis), bald eagle (Haliaeetus leucocephalus), and peregrine falcon (Falco peregrinus). Transient species occurring in the area (ER-OL Tables 2.4-8 and 2.4-10) and listed as endangered by the state include the golden eagle (Aquila chrysaetos) and loggerhead shrike (Lanius ludovicianus). Species listed by the state as threatened that breed in the area (ER-OL Table 2.4-8) include the northern harrier or marsh hawk (Circus cyaneus) and the common tern (Sterna hirundo). Migrant species occurring in the area and listed as threatened by the state include the osprey (Pandion haliaetus), red-shouldered hawk (Buteo lineatus), and piping plover (Charadrius melodus). The timber rattlesnake (Crotalus horridus) is "likely to occur on the Unit 2 site or environs" (ER-OL Table 2.4-13) and is listed by the state as threatened.

In addition, based on Bieber et al. (1976), there are a number of species described by the applicant as "likely to occur" on the site or environs (Table 4.6) that are listed by the state as "special concern species." These are species that are not yet recognized as endangered or threatened, but for which there is documented concern for their continued welfare in New York.

4.3.5.2 Aquatic

No Federally listed endangered or threatened aquatic species were found from 1972 to 1982 in the Nine Mile Point vicinity, either in lake sampling or in impingement sampling at the NMP-1, FitzPatrick, or Oswego power plants (Lawler, Matusky, and Skelly, 1983, and Ecological Analysis, 1983). The U.S. Fish and Wildlife Service does not know of any Federally listed or proposed endangered or threatened species occurring in the vicinity of the station, except for occasional transients (Hamilton, 1983). The blue pike (Stizostedion vitreum glaucum) had been classified as endangered in the 1983 publication of the U.S. list of endangered and threatened species (FWS, 1983a). However, this fish, whose historic range included Lake Ontario, is now considered extinct (no confirmed specimens having been taken since the 1960s) and has been removed from the list. The U.S. Fish and Wildlife Service announced in 1982 (FWS, 1982) that it was considering listing as endangered or threatened the short-nose cisco (Coregonus reighardi), whose distribution includes Lake Ontario; this fish has not been collected in the Nine Mile Point vicinity, according to the aforementioned sampling data.

One state-listed threatened fish, the lake chubsucker (Erimyzon sucetta) (New York, 1984), was taken in a 1975 sample in the Nine Mile Point vicinity (Lawler, Matusky, and Skelly, 1983). That collection was of a single specimen that was taken during the summer in a seine haul at the mouth of the Salmon River (ER-OL Supplement 6 Section 5.3), a site about 13 km (8 miles) east-northeast of the station. Lake Ontario represents the northeastern limit of the distribution of the species, which is found in the central and southeastern U.S. (Pfleiger, 1975).

4.3.6 Community Characteristics

The socioeconomic descriptions of the area--including demography, land use, and community characteristics in general--in FES-CP Chapters 2, 4, 5, and 10. The Nine Mile Point site is about 10 km (6.25 miles) northeast of Oswego, New York (1980 population 19,793) and about 20 km (12.4 miles) north-northeast of Fulton, New York (13,312). Syracuse, New York (170,105), the largest city in the area, is about 53 km (33 miles) south-southeast of the site.

The applicant estimates the 1980 population within 16 km (10 miles) of the plant to have been 35,467. The staff has reviewed the applicant's demography data within 16 km (10 miles) and found it compares favorably with independent data sources.

The transient population of the area is composed of individuals associated with industrial, institutional, and recreational facilities. The major employers within 16 km (10 miles) of the site are Alcan Aluminum Corporation (1000 employees), Niagara Mohawk Power Corporation (450 employees), and four other firms, each with between 100 to 200 employees. Nearby institutions include educational and health care facilities. The majority of students within 10 miles of the site are residents of the area and do not add to the population. However, the State University College at Oswego is about 13.7 km (8.5 miles) southwest of the plant; it has an enrollment of less than 8000 students. The nearest hospital is the 132-bed Oswego Hospital in Oswego.

There area also five nursing home/extended care facilities in Oswego, having a total of 438 certified beds. With respect to recreational activity, there is the 12-acre Ontario Bible Campground 1.5 km (0.9 mile) west-southwest of the site. The camp is used by groups of about 500 people throughout the summer and by up to 1500 attendees for short periods on Sundays throughout the warm season. Selkirk Shores, a 980-acre state park, is located 16 km (10 miles) northeast of the site and has the capacity to handle about 3600 people.

There are no other significant changes in these areas from the descriptions in the FES-CP.

4.3.7 Historic and Archelogic Sites

FES-CP Section 2.3 describes historic and archeologic sites. New information developed since the issuance of the FES-CP consists of the issuance of a report documenting the results of cultural resource studies of the NMP-2 Volney transmission line right-of-way. The report concluded that there were no properties listed or eligible for listing on the National Register of Historic Places in or near the project area. Appendix F of this statement contains a revised list of sites included or eligible for inclusion in the National Register.

4.4 References

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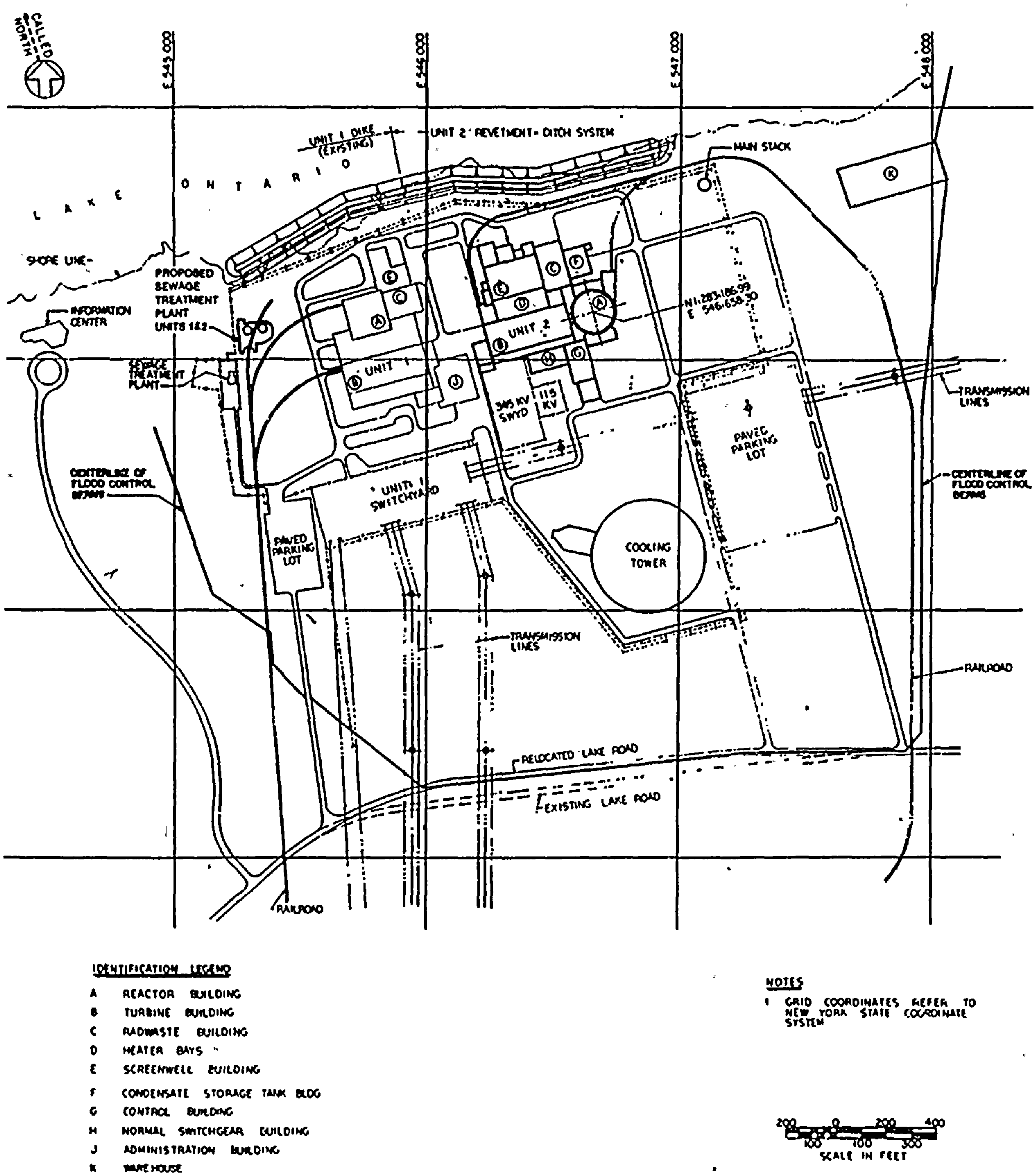

Figure 4.1 Site Layout

Source: ER-OL Figure 3.1-1

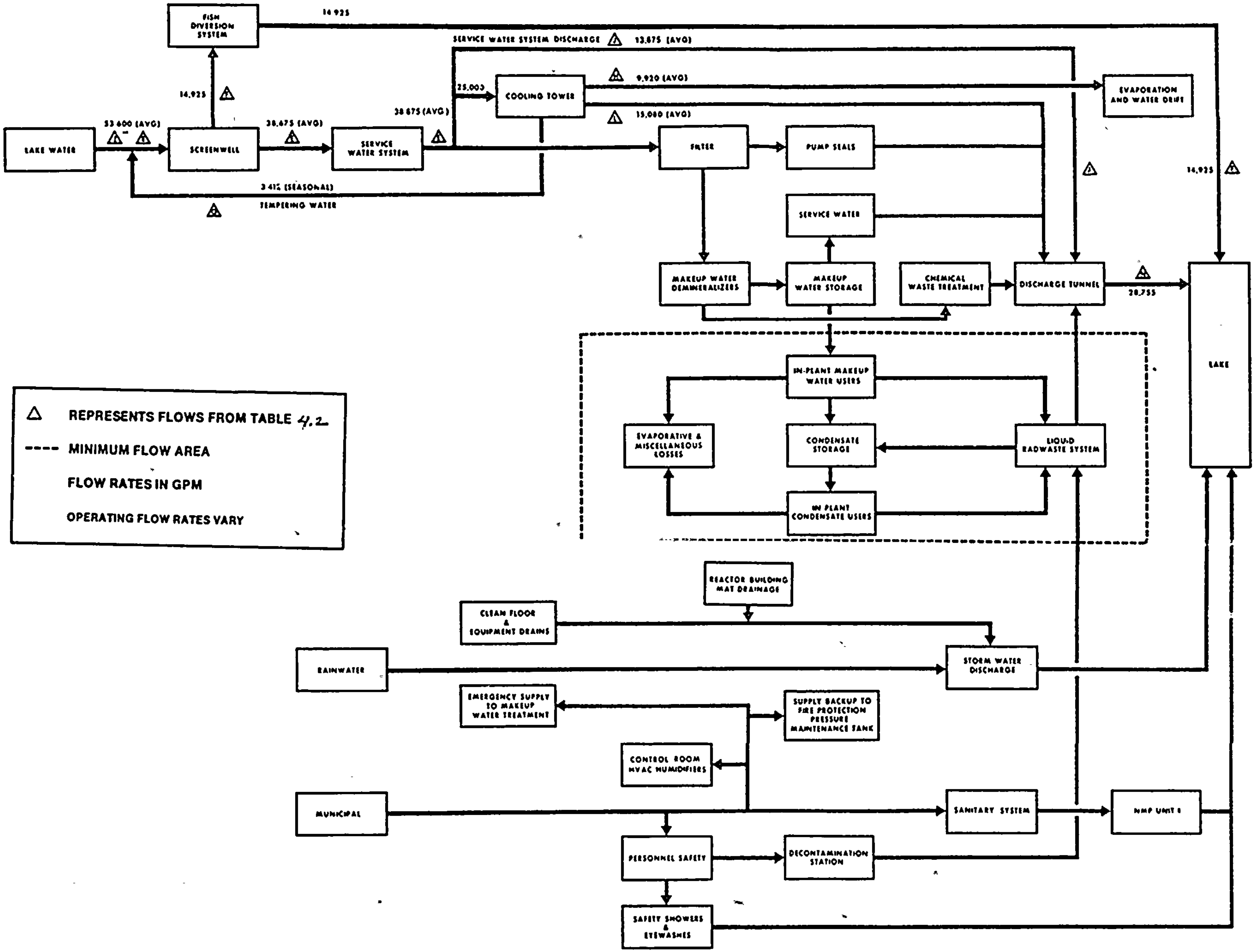

Figure 4.2 Water use diagram
Source: ER-OL Figure 3.3-1

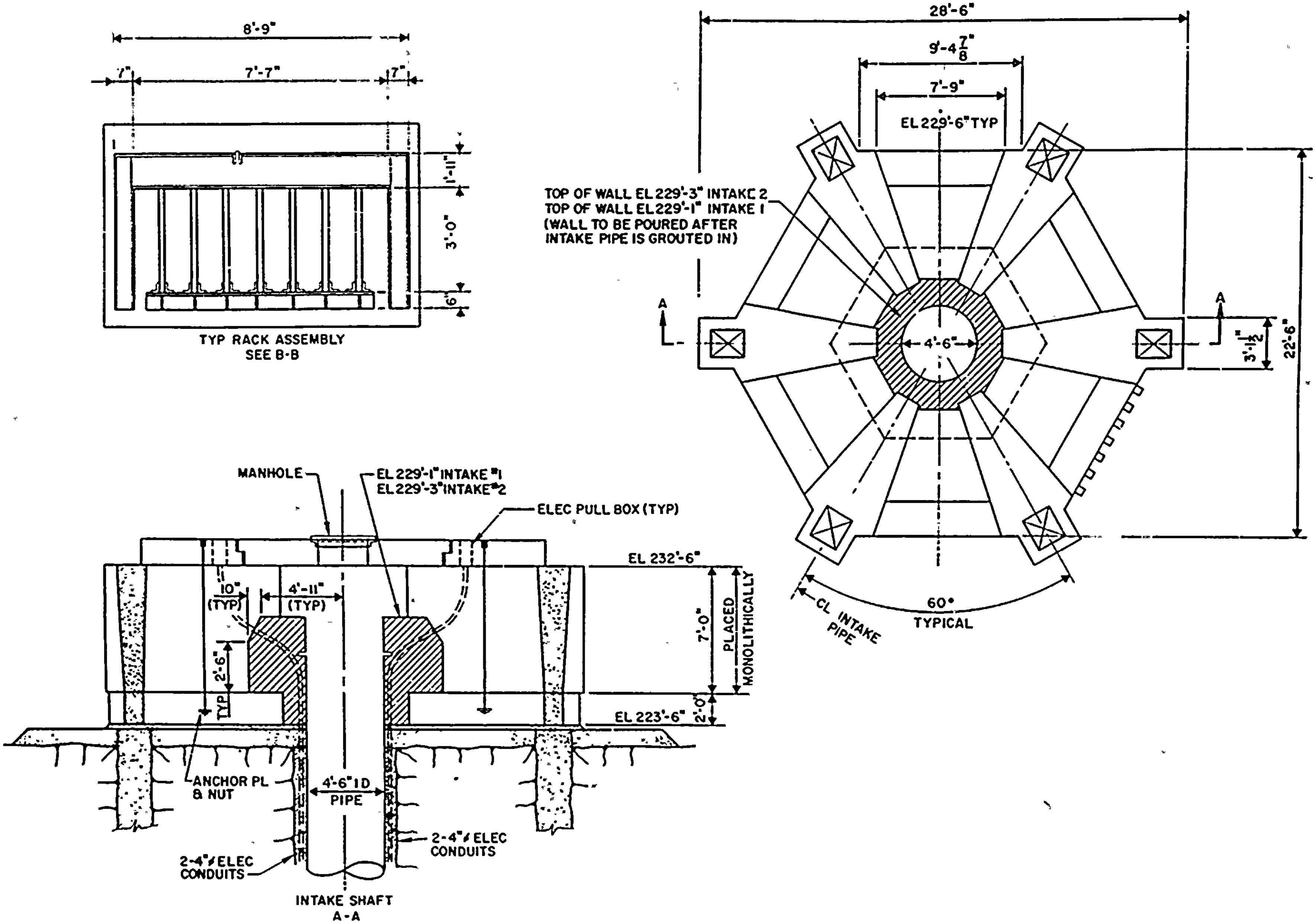

Figure 4.3 Details of intake structure

Table 4.1 Land use within the site boundary

Land use category	Area		
	Hectares	Acres	% of site*
Industrial			
Power plant facilities	76	188	21
Woodlands			
Forest	58	143	16
Brushland	101	249	28
Wetlands			
Shrub wetlands, bogs, marshes	10	25	3
Wooded wetlands	14	35	4
Active agriculture			
Orchards	≤1	2.5	≤1
Recreation			
Nine Mile Point Energy Information Center	7	17	2
Communications			
Electric power and telephone lines, microwave stations, telephone and radio towers	54	133	15
Inactive agricultural lands	43	106	12
TOTAL	364	898.5	101

*Does not equal 100% because of rounding.

Source: ER-OL Table 2.2-1

Table 4.2 Differences in water use and flow rates between the 1981 NRC study (Appendix G) and the ER-OL

Use	1981 NRC Study L/sec	1981 NRC Study gpm	ER-OL L/sec	ER-OL gpm
Water intake average				
Total	3110	49,400	3380	53,600*
Service water	2270	36,000	2440	38,675**
Fish diversion	845	13,400***	940	14,925
Water discharge				
Average	1590	25,200	1810	28,755†
Maximum	2260	35,900	2210	35,040††
Evaporation				
Average	695	11,000	625	9,920[c]**
Maximum	755	12,000	870	13,800[e]††

*ER-OL Section 5.2.1.1.
**ER-OL Section 3.3.1.
***For lake water temperatures less than 26°C (78°F).
†Figure 3.3.1.
††Table 3.3.1.

Table 4.3 Comparison of constituent concentrations anticipated in the combined discharge, mg/L

Constituent	1981 NRC Study*	ER-OL** Maximum	ER-OL** Mean
Na***	42.9	42	23
Ca	110.0	73	56
Mg	22.2	14	11
Mn	0.025	0.061	0.024
Cl	103.0	82	48
SO_4***	152.8	147	99
PO_4	0.48	0.028	<0.009
NO_3	0.35	0.50	<0.24
TDS***	582.7	413	272

*Appendix G, Table 5.7.
**ER-OL Table 3.6-1.
***Added during ion exchange resin regeneration, chlorination, or scale control.

Table 4.4 Existing and post-construction land uses within the transmission line corridor for NMP-2

Land use category	Existing: Hectares (acres)	Existing: Percent of total	Post-construction: Hectares (acres)	Post-construction: Percent of total
Forest brushland	19.3 (47.0)	59.0	0	0
Brushland	7.1 (17.2)	21.6	30.0 (72.6)	90.6
Mature forest	3.0 (7.2)	9.0	0	0
Agriculture	2.0 (4.8)	6.0	2.0 (4.8)	6.0
Forest wetland	1.0 (2.4)	3.0	0	0
Plantation	0.5 (1.3)	1.6	0	0
Wetland	0	0	1.0 (2.4)	3.0
Transmission line ROW	0.1 (0.2)	0.2	0.1 (0.2)	0.2
Transportation	0.1 (0.2)	0.2	0.1 (0.2)	0.2
TOTAL	33.1 (80.3)	100.6*	33.2 (80.2)	100.00

*Rounding of some of the values results in a total of 100.6%.

Source: ER-OL Table 2.2-6

Table 4.5 Comparison between water quality in Lake Ontario as described in the 1981 NRC study and in the ER-OL for 1978 data

Constituent	1981 NRC Study*	ER-OL**
Ca	44.0	41.7
Na	17.0	16.0
Mg	8.9	7.95
K	1.6	1.61
Mn	0.01	<0.018
Cl	30.0	35.4
SO_4	30.0	30.5
NO_3	0.14	<0.18
TDS	233.0	202

*Appendix G, Table 5.7
**Mean value from ER-OL Table 2.3-13

Table 4.6 New York State species of special concern listed by the applicant as "likely to occur" on the NMP-2 site or environs

Common Name	Scientific Name
Jefferson salamander	Ambystoma jeffersonianum*
Blue-spotted salamander	A. laterale*
Spotted salamander	A. maculatum*
Spotted turtle	Clemmys guttata*
Wood turtle	C. insculpta*
Common loon	Gavia immer**,***
Least bittern	Ixobrycus exilis**,***
Copper's hawk	Accipiter cooperii**,***
Upland sandpiper	Bartramia lonicauda**,***
Black tern	Chilidonias niger**,***
Common nighthawk	Chordeiles minor**,***
Common raven	Corvus corax**
Eastern bluebird	Sialia sialis**,***
Henslow's sparrow	Ammodramus henslowii**,***
Grasshopper sparrow	A. savannarum**,***
Vesper sparrow	Pooecetes graminens**,***
Small-footed bat	Myotis leibii†.

*ER-OL Table 2.4-13
**ER-OL Table 2.4-8
***ER-OL Table 2.4-10
†ER-OL Table 2.4-6

5 ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

5.1 Résumé

This section evaluates changes in predicted environmental impacts since the FES-CP was issued in June 1973. Additional impacts to land use at the site include the construction of the closed-cycle cooling system and the revetment ditch as described in Section 5.2.1. Section 5.3.2 discusses the effect of the cooling system on the water quality of Lake Ontario. Other water use impacts are discussed in Section 5.3.3, and air quality is discussed in Section 5.4. Section 5.5 addresses impacts of operation on terrestrial and aquatic resources, including the impacts from operation of the cooling tower.

Section 5.5.2 presents the staff's updated assessment of the impacts of NMP-2 on the aquatic resources of Lake Ontario since the 1981 study on the environmental effects resulting from the change to the closed-cycle cooling system (Appendix G).

Changes in the predicted socioeconomic impacts of station operation since the FES-CP was issued include an increase in the estimated operating work force, as discussed in Section 5.8.

Information in Section 5.9 on radiological impacts has been revised to reflect knowledge gained since the FES-CP was issued. The material on plant accidents includes actual experience with nuclear power plant accidents and their observed health effects and other societal impacts.

Impacts from the uranium fuel cycle, decommissioning, emergency planning impacts, and environmental monitoring are covered in Sections 5.10, 5.11, 5.13, and 5.14 respectively.

5.2 Land Use

5.2.1 Plant Site

Impacts of NMP-2 construction on land use at the site were evaluated in FES-CP Section 4.1. Additional impacts to land use since the FES-CP was issued include the construction of the plant cooling system (see Appendix G) and the revetment ditch system (ER-OL Sections 4 and 5.2.1.1). There has been a small loss (1.5 ha, 3.7 acres) of secondary-growth brush, trees, and wildlife on site as a result of construction of the cooling tower. None of the NMP-2 structures is built on the 100-year flood plain (ER-OL Figure 2.3-12). The major topographic alteration in the 100-year flood plain is the addition of the revetment ditch system on the shoreline of Lake Ontario to protect the power plant from flooding and protect the shoreline from erosion (ER-OL Section 2.3.1.1.7). The impacts of construction on the NMP-2 site are minor and generally as predicted. After construction, unoccupied site areas are to be graded and seeded; in areas not planted with trees or shrubs, ground cover of either lawn or crushed stone will be used (ER-OL Section 3.1.1). Management of the grassy areas around the power plant will result in an old field community that is useful habitat for raptors, field-dwelling birds, small mammals, and herpetofauna (ER-OL Section 2.4.1.1.5).

The impacts of NMP-2 operation relate to utilities, transportation, and communication activities and are not expected to affect the land use of the site or vicinity. The size and operation of the natural draft cooling tower and management and operation of the transmission line may affect the local terrestrial ecology. These potential impacts are evaluated in Section 5.5 below.

5.2.2 Transmission Lines

Transmission line impacts on land use as a result of operation are minimal because the line is located adjacent to an existing corridor and within existing ROWs (ER-OL Section 5.6). About 33 ha (80 acres) extending 15 km (9.4 miles) will be disturbed. The predominant plant community lost is forest brushland (59% of the total). It is anticipated that brushland will occupy about 90% of the total land disturbed after construction. The applicant states that 1 ha (2.4 acres) of forest wetland will be lost, but it will be replaced by an equal area of wetland. This means that management practices will remove trees and large shrubs and maintain the area as shrub swamps. Agricultural uses (about 6% of the area) can continue in the transmission corridor with only small areas around poles unavailable for farming.

5.3 Water

5.3.1 Water Use

NMP-2 will have no significant impacts on water use, whether from evaporative consumption, effects on water quality, or effects on aquatic resources. The latter two issues are addressed in Sections 5.3.2 and 5.5.2, respectively.

Consumptive use of water by NMP-2--a result of evaporative (and drift) losses from the natural draft cooling tower--will average 625 L/sec (9920 gpm) with a maximum of 870 L/sec (13,800 gpm) (Section 4.2.3). The total volume of Lake Ontario is 1.6×10^{12} m^3 (390 mi^3) (FES-CP Section 2.5.2), and the average flow through the lake is more than 6.9×10^6 L/sec (1.1×10^8 gpm) (ER-OL Section 5.2.1.1). On an annual basis, consumptive losses from the operation of NMP-2 will represent approximately 0.001% of the lake's volume; the evaporation rate will represent 0.009% of the average flow through the lake. Thus, even with the change in cooling design from once-through to closed-cycle and the consequent increased evaporation, consumptive water use will have a negligible quantitative effect on Lake Ontario water.

NMP-2 will use a maximum of 3785 L/day (1000 gpd) of water from the Oswego City water supply (Section 4.2.3). The average daily demand on that source is 2.12×10^7 L/day (5.6×10^6 gpd) (ER-OL Section 5.2.1.2]; thus the NMP-2 demand represents a negligible (<0.02%) increased demand on that supply.

5.3.2 Water Quality

The 1981 NRC study found that the cooling system discharge would "pose no significant threat to the water quality of Lake Ontario" (Appendix G, page 5-16). More recent information supports the data underlying this conclusion as follows:

(1) Ambient water quality, measured most recently in 1978, is similar to that measured earlier, as reported in the 1981 study (see Section 4.3.2).

(2) The aqueous discharge is now expected to be more dilute than that characterized in the 1981 study (see Section 4.2.6), although the discharge flow will be slightly larger than that anticipated in the 1981 study (Section 4.2.3).

Total dissolved solids (TDS) in the discharge (maximum 413 mg/L, mean 272 mg/L; Table 4.3) will exceed the state ambient standard of 200 mg/L; ambient TDS concentrations in the lake already exceed the standard (Section 4.3.2). In addition to returning dissolved solids to the lake, NMP-2 will discharge dissolved solids as a result of water treatment (Section 4.2.3) and corrosion (Section 4.2.6.). At the point of release, zinc concentrations will, at times, exceed the ambient criterion for zinc (0.437 mg/L versus 0.3 mg/L), although zinc concentrations in the discharge will average <0.065 mg/L (ER-OL Table 3.6-1). After 10-fold dilution by the receiving water, ambient zinc concentrations, even at maximum effluent concentrations, would meet the ambient criterion (ER-OL Table 3.6-1). The receiving water could not, of course, dilute the discharge TDS levels to within the standard.

Hydrologic modeling by the applicant (Section 5.5.2) shows that, even with no lake current (worst case), the travel time of water from the discharge to the intake would be at least 20 hours. With a west-to-east current of 0.15 m/sec (0.5 fps), there would be no movement of water from discharge to intake (ER-OL Section 5.3.1.1.3). These results suggest little or no significant recirculation of discharged water back into the cooling water intake.

The effluent from the sanitary waste treatment facility (Section 4.2.6) would, at its maximum permitted flow rate, represent <0.3 % of the average station discharge. This effluent is regulated with respect to water quality variables of concern (BOD, solids, fecal coliform bacteria, pH, and chlorine). It should have no significant effect on ambient water quality.

This analysis supports the statement in the 1981 NRC study and suggests that there could be, at most, a slight effect on ambient water quality on a localized basis. NMP-2 will represent an incremental source of dissolved solids to the lake, which already is not in conformance with the state goals for surface water quality (Section 4.3.2).

5.3.3 Hydrological Alterations and Plant Water Supply

5.3.3.1 Hydrological Alterations

Operation of NMP-2 will not significantly alter the hydrological characteristics of Lake Ontario. Water will be supplied from an intake structure in Lake

Ontario to the station service water system and cooling water system. The average rate of water withdrawal from the lake will be 3380 L/sec (53,600 gpm), and the maximum rate is 3759 L/sec (59,586 gpm). The approach velocity at the intake structure is 0.15 m/sec (0.5 fps). The induced velocity in the water around the intake is estimated to be reduced to 0.03 m/sec (0.1 fps) within 3 m (10 feet) of the structure. Water will be returned to Lake Ontario via a discharge structure. The average discharge flow rate is approximately 1817 L/sec (28,800 gpm), and the maximum discharge flow rate is approximately 2210 L/sec (35,040 gpm). Because the amounts of water withdrawn and discharged are extremely small compared to the size of the lake, there is no significant alteration to the circulation pattern of the lake.

Consumptive water use, principally the result of evaporative losses from the cooling tower, will also have a negligible effect on Lake Ontario because of the size of the lake (approximately 1.6×10^{12} m^3 (390 mi^3) and the flow through the Great Lakes system. The average and maximum evaporative losses from the station will be approximately 625 and 870 L/sec (9900 and 13,800 gpm), respectively, while the average flow through Lake Ontario and the St. Lawrence River is greater than 6.94×10^6 L/sec (1.1×10^8 gpm).

The revetment ditch system, which protects the station from flooding as a result of wave activity (including the effects of a probable maximum windstorm), also protects the shoreline from erosion. The structure follows the existing shoreline and, therefore, will not alter current patterns, significantly affect the littoral zone, or cause sedimentation.

Drainage paths for site runoff have been modified as a result of the plant drainage system and the revetment ditch system. In the immediate vicinity of the plant, the grade is sloped to a series of collection ditches and a storm drain system. Runoff collected by this system is carried by a drainage ditch to the point where it is discharged to the lake at the eastern edge of the site. Overland runoff reaching the revetment ditch system flows in the ditch to the east and is discharged to the lake at the eastern edge of the structure.

Groundwater will not be used during station operation. However, groundwater will be drawn down in the vicinity of the plant structures by a permanent dewatering system. No offsite effects are expected from station dewatering.

5.3.3.2 Plant Water Needs and Available Water Supplies

The majority of station water is used for the service water system and the cooling water system. Average and maximum combined service water and cooling water requirements are approximately 2440 and 2735 L/sec (38,675 and 43,350 gpm), respectively. Average and maximum fish diversion system water requirements are 940 and 1028 L/sec (14,925 and 16,300 gpm), respectively. The circulating water system uses the service water system as a source for the makeup requirement of approximately 1580 L/sec (25,000 gpm). Because these requirements are met by drawing water from Lake Ontario's large volume of water, no impact to other Lake Ontario water users will occur.

Potable water requirements for drinking and sanitary purposes are estimated to be a maximum of 3785 L/day (1000 gpd). There is no planned expansion that would increase this value over the expected lifetime of the plant. This water is obtained from the City of Oswego water supply, whose average daily demand is 2.12 x 10^7 L/day (5.6 x 10^6 gpd). Because the requirements for NMP-2 are small compared to this value, there are no impacts upon the Oswego water supply.

5.3.4 Water Use Impacts

5.3.4.1 Analysis of the Hydrologic Altérations Posing Potential Impacts to Water Use and Availability

5.3.4.1.1 Surface Water

Operation of NMP-2 will not have a significant impact on the use of water or its availability to the Nine Mile Point region. The plant uses Lake Ontario water, mainly for cooling, at a rate of 0.03% of the average flow through the lake. Table 5.1 details the evaporative losses associated with plant cooling water use (a maximum of 0.871 m^3/sec (13,800 gpm), a minimum of 0.246 m^3/sec (3900 gpm) and lists the maximum, average, and minimum monthly flow rates for the service water and fish diversion systems.

Lake Ontario water is used for drinking, industry, agriculture, commercial fishing, sportfishing, swimming, boating, and commercial shipping, as discussed in ER-OL Section 2.3.2. The operation of NMP-2 will not impact the availability of drinking, agricultural, and industrial water supplies, considering the low rate of consumption of Lake Ontario water. Moreover, no impact on swimming, recreational boating, or commercial shipping will occur as a result of NMP-2 operation. The facility intake structures--located approximately 290 and 320 m (950 and 1050 feet) offshore and approximately 167 and 137 m (550 and 450 feet) closer to shore than the discharge structure--are well removed from any swimming recreational use. The intake structures--located at a lesser depth than the discharge structure--are submerged 3.05 m (10 feet) below the mean low surface water elevation. Station operation will not change surface water elevations, and no significant alteration of circulation patterns is expected; thus recreational boating will not be affected by station operation. Commercial shipping vessels pass no closer than 11.3 km (7 miles) from the intake and discharge structures and will not be affected by station operation.

Commercial and sportfishing water uses will be minimally affected by hydrologic alterations resulting from NMP-2 operation, with the impacts restricted to the dilution zone of the thermal plume and localized regions of the intake structures.

5.3.1.2 Groundwater

Groundwater is used for public and private water supplies by several communities in Oswego County (ER-OL Section 2.3.2), and no other groundwater use, such as irrigation or industrial use, has been identified. No station effluents will be discharged to groundwater.

An ongoing groundwater dewatering program for the reactor containment foundation will produce a minor cone of depression.

Because all groundwater use occurs upgradient of the site and groundwater discharge onsite is toward the lake, no present or anticipated groundwater uses will be affected by station operation.

5.3.5 Floodplain Aspects

The objective of the Executive Order 11988, Floodplain Management, is "...to avoid to the extent possible the long and short term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative...."

Before the start of plant construction, the shoreline of Lake Ontario in the area of the NMP-2 site was mildly sloping to the elevation of the water level during the 100-year flood. The 100-year floodplain consisted of bare to lightly vegetated glacial fill. Figure 5.1 shows the shoreline area in the plant vicinity flooded during the 100-year flood before the start of construction.

Since the start of construction, site grading in the 100-year floodplain is somewhat less mildly sloping than before construction. The major feature at the shoreline in the 100-year floodplain is the revetment ditch system built to protect the plant from flooding and protect the shoreline from erosion. The 100-year flood elevation follows this dike in the site area after plant construction, as shown in Figure 5.2. The other structures in the 100-year floodplain are the submerged intake and discharge structures.

The 100-year flood elevation of 249.4 feet was taken from the Flood Insurance Study (FEMA, 1981).

Because the lakeshore in the plant vicinity is very wide in comparison to the revetment, the revetment will not cause any appreciable increase in stage during the high water conditions. The buried intake and discharge facilities are not considered flow impediments during a flood or high water. Thus, the staff concludes that NMP-2 will not have any measurable offsite impacts on flood conditions for events up to the severity of the 100-year flood.

5.4 <u>Air Quality</u>

Air quality in the site area has been monitored for ozone and oxides of sulfur (SO_2 and nitrogen (NO_2) and total suspended particulates (TSP) to provide a basis for compliance with Clear Air Act requirements. This monitoring was begun in 1976 and generally continued. The monitoring results indicate that air quality has been within state and Federal air quality limits, except that the secondary TSP levels (24-hour average) have been exceeded in 2 years out of 5 years of measurement at two monitoring sites out of nine in the area. The exceedances were in the vicinity of two industrial facilities and were localized rather than area wide.

5.4.1 Fog and Ice

Heavy fog and visibility less than 400 m (1/4 mile) is observed about 9 days a year at Syracuse. More frequent fog at the site is possible because of the proximity of the Lake Ontario shore, making movement of offshore fogs onto the land likely. The operation of the approximately 165-m (541-foot) natural draft cooling tower is not expected to result in any fog or ice formulation in the site area.

5.4.2 Other Emissions

Testing of standby diesel generators, high pressure core spray diesel generator, and the fire pump will result in infrequent emissions of the normal products of the operation of internal combustion engines. Emissions of carbon monoxide, nitrogen, and sulfur oxides and particulates will result from this minimal use (total of 18 hours a month) and should not result in any significant impact on offsite air quality.

5.5 Terrestrial and Aquatic Resources

5.5.1 Terrestrial Resources

With the measures and controls to limit operational impacts (ER-OL Section 5.10), unavoidable impacts on terrestrial resources will be small. These impacts include minimal effects of cooling tower drift, impacts of transmission line maintenance practices on plants and animals, and the loss of some birds as a result of collisions with transmission poles, transmission lines, the cooling tower, the radiation offgas stack, and plant buildings (ER-OL Section 5 and Table 10.1-1).

5.5.1.1 Cooling Tower Operation

Operation of natural draft cooling towers can result in impacts on terrestrial resources. These impacts include deposition of salt drift on soil and vegetation, bird impaction, and weather modification (ER-OL Section 5.3.3). As noted above, the staff evaluated the possible impacts of the change in cooling systems in 1981, and the results are in the report reproduced as Appendix G. This study found that the estimated effects on terrestrial resources were negligible and that the use of a natural draft cooling tower was acceptable.

5.5.1.2 Transmission System Operation

Because the new transmission line will be located within the existing transmission line ROW, the effects of audible (approximate 6% increase in intermittent noise at a distance of 38 m (125 feet)) and visible corona discharge, ozone discharge and electromagnetic and electrostatic fields are not new impacts to the terrestrial resource of the area (ER-OL Section 5.6.4; Lee et al., 1982). The applicant has had no significant problems in these areas and expects no significant effects to the environment from operation of the NMP-2 transmission line. No serious problems have been experienced with power line operation in the United States, even at 500-kV.

In accordance with the New York State Public Service Commission-approved system-wide ROW management program prepared by the applicant, the ROW is assessed within 4 years after the last treatment. Maintenance includes selective cutting and controlled herbicide application (stump, basal, or foliar spray). Only those herbicides approved by the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation will be used; mixtures, rates, and volumes will be in accordance with label instructions. Treatments will occur at intervals of 5 to 8 years, depending on the ROW assessment, throughout the life of the facility. These practices foster development of an old field shrub community, which is useful habitat for deer, small mammals, and song birds. However, population numbers of wildlife species may fluctuate with the treatment cycles. Protective vegetative buffers will be retained at stream and wetland areas, and herbicide use will be restricted in these areas. Traffic for maintenance will be limited to existing access roads on the ROW and an existing road crossing a stream under which a new culvert is to be installed (ER-OL).

Bird mortality will result from collisions with towers and conductors. The rate of this mortality cannot be accurately quantified, although Stout and Cornwell (1976) estimated that only 0.07% of the nonhunting mortality resulted from collison. At NMP-2, waterfowl are generally congregated north of the site and the transmission lines are south of the plant.

5.5.2 Aquatic Resources

This section presents the staff's updated assessment of the impacts of NMP-2 on the aquatic resources of Lake Ontario since the 1981 study (Appendix G), based on recent information on NMP-2 design specifications and Lake Ontario resources.

Potential effects of station operation may be divided into (1) effects of water intake, (2) effects of the thermal component of the aqueous discharge, (3) effects of the chemical component of the aqueous discharge, and (4) interactions between the NMP-2 fish return system discharge and cooling water intakes, and between NMP-2 and the adjacent power plants. These categories are discussed separately below.

The applicant's models for predicting water velocities induced by station intake and discharge and thermal/chemical dilution of discharges from the station (ER-OL Section 5.3) have been evaluated by the staff and are considered reasonably conservative for the purpose of assessing potential impacts.

5.5.2.1 Intake Effects

The 1981 NRC study concluded that fish impingement on the traveling screens "should result in minimal impact to the fish species affected." That study also found that entrainment of phytoplankton and zooplankton would have "no significant adverse effects" and that entrainment of fish eggs and larvae is "expected to be localized in the Nine Mile Point area only." The report cited the following design changes (compared with the earlier once-through cooling design) as minimizing potential intake impacts: (1) a >93% reduction in intake volume, (2) a 50% reduction in intake velocity, and (3) a fish diversion and return system. Although the reduction in intake volume now appears to be 90% if the fish diversion intake is added to the service water intake, the overall conclusion concerning the effect of reducing intake volume is unchanged.

When the 1981 NRC study was issued, it was not possible to evaluate the potential of the fish diversion system to reduce impingement mortality. A 1979 study (Cannon et al., 1979) of fish protection devices reported that "angled screens provide a potentially effective means of salvaging fish from cooling-water intakes," but recommended site-specific studies, particularly in situ investigations rather than test-flume experiments. A fish diversion system similar but not identical to that at NMP-2 has been installed at the nearby Oswego Steam Station Unit 6 (12 km west of Nine Mile Point) and tested (from April 1981 to March 1983) (Lawler, Matusky, and Skelley, 1983).

The impinged fish at Oswego are similar in species composition (primarily alewife and rainbow smelt) to the fish that have been impinged at NMP-1 and FitzPatrick. Oswego Unit 6 has a once-through cooling system with a flow of 20.48 m^3/s (325,000 gpm). By measuring the proportion of fish diverted and subsequent survival through 96 hours, the study estimated total plant efficiency (TPE) for returning impinged fish alive, which was found to vary by species, length of fish, and month. For the commonly impinged fish at the NMP-1 and FitzPatrick plants (Section 4.3.4), the TPE ranged as shown in Table 5.2.

Over the period of study, 8.4% and 12.6% of juvenile and adult alewife, respectively, and 10.0% and 54.3% of juvenile and adult rainbow smelt, respectively, were diverted and survived (ibid).

Although these data suggest the potential for reducing impingement mortality, they cannot be used directly to quantitativly estimate the effectiveness at NMP-2 for several reasons as follows:

(1) The NMP-2 fish diversion system is much smaller than the Oswego system.

(2) The NMP-2 system does not employ a secondary traveling screen and diversion, while the Oswego system does.

(3) Mortality as a result of transport during return to the lake from the screenwell must be considered, as must the possible attraction of predatory fish to the fish discharge, where relatively large densities of prey (diverted fish) are available (Cannon et al., 1979). Sampling at the Oswego station from April through November 1982 did not indicate that the abundance of predator fish--primarily lake trout (Salvelinus namaycush), smallmouth bass (Micropterus dolomieui), and brown trout (Salmo trutta)--was greater near the fish discharge than in a control location. During those same months, sampling of fish discharged into the lake demonstrated that additional mortality could occur over that observed in the estimates of TPE; the magnitude of this added mortality varied among species (Lawler, Matusky, and Skelley, 1984).

The water for operation of the fish division system is more than 25% of the total intake flow.

During periods of the year when entrainment of larvae is of more concern than impingement of adult fish, or when the concentrations of young-of-the-year or adult fish are low, the additional intake water necessary to operate the fish diversion system may cause more mortality than is saved. The applicant has indicated (during an NRC staff site visit on February 7, 1984) a willingness to consider suspending operation of the fish diversion system at such times, subject to approval by the New York State Department of Environmental Conservation.

5.5.2.2 Thermal Effects

The 1981 NRC study reiterated the FES-CP conclusion that "thermal discharge effects will be insignificant in terms of ecological relationships in the lake as a whole," adding that reduction in discharge flow and intake/discharge temperature difference (compared with the earlier once-through cooling design) would "further minimize any potential for impact." The 1981 study emphasized the role of high exit velocity, low discharge flow, and rapid mixing of the effluent in minimizing impacts. As noted in Section 4.2.4 above, the average discharge flow is slightly greater (14%) than that evaluated in the 1981 study, and the maximum flow is slightly less (2%). The average exit velocity is also now expected to be slightly greater (14%) than that anticipated in the 1981 study. Finally, maximum intake/discharge temperature differences are now expected to be slightly (1.4C° or 2.6F°) less than those anticipated in the earlier study. The condusions of the 1981 NRC study remain valid.

Modeling by the applicant shows that, under worst case conditions, the 1.4C° (2.5F°) isotherm is located approximately 19 to 20 m (62 to 66 ft) from the discharge nozzle (ER-OL Figures 5.3.6 and 5.3.7), and that the maximum difference in surface temperature is less than 1.3C° (2.3F°) (ER-OL Section 5.3.2.1.3). This rise in surface temperature is within the New York State standard of 1.7C° (3F°) (ER-OL Section 3.4.1.3.5).

5.5.2.3 Chemical Effects

Because chemical discharges from the station will cause, at most, slight effects on ambient water quality on a localized basis (Section 5.3.2), no significant chemical effects on aquatic biota would be anticipated. High exit velocity, low discharge flow, and rapid mixing (cited above as reducing the exposure of organisms to thermal stresses) will similarly reduce the exposure of organisms to chemical stresses.

The 1981 NRC study stated that "potentially toxic" concentrations of chlorine could exist at times of maximum discharge, but that dilution and reduction to chloride would reduce concentrations to "well below toxic levels." Modeling by the applicant predicts that the discharge will be diluted by 5.6:1 within 11 m (36 feet). One can calculate an approximate (conservative) velocity for organisms that might be entrained in the plume at the point of discharge by taking the plume velocity at 11 m (36 feet) from the discharge to be 0.8 m/sec (2.6 fps) (from the applicant's model, ER-OL Section 5.3.2.1.3 and Table 5.3-9). These organisms will have reached that point in less than 14 seconds. The highest concentration of total residual chlorine (TRC) at the point of discharge is estimated to be 0.43 mg/L (Section 4.2.6). Even if an organism were exposed to 0.43 mg/L TRC for the entire 14 seconds (i.e., no dilution or chlorine demand), no acute mortality would be expected based on the concentration-duration-mortality relationship for concentration of 0.43 mg/L TRC. Organisms would have to be exposed for approximately 3 minutes to reach the "acute mortality threshold." This analysis is clearly conservative in that it overestimates the exposure of the organisms to TRC; this reinforces the earlier conclusion that chemical effects would not be expected, even for the chemical constituent considered potentially most troublesome in the 1981 NRC study.

5.5.2.4 Interactions

The overall usefulness of the fish diversion system would be questionable if returned fish were likely to be taken into the cooling water intake (a second time, re-entrapped) while stunned or disoriented. Based on the applicant's estimate of maximum inducted velocity toward the tunnel 2 intake from the south (0.011 m/sec or 0.036 fps, ER-OL Figure 5.3.2) and the distance between the fish discharge and the nearest intake (46 m, or 150 feet) (ER-OL Figure 3.4-2), a calculated minimum travel time would be greater than 1 hour (see Appendix G, Figure 3.4). This analysis is also conservative in that it ignores the fact that fish are discharged with an easterly velocity, away from the intake (ER-OL Section 3.4.2.1). These results suggest that fish released to Lake Ontario from the diversion system are unlikely to be taken back into the cooling water.

There is a potential for slight interaction between the NMP-2 discharge and the discharges from the NMP-1 or FitzPatrick power plants (ER-OL Section 5.3.2.1.4). The NMP-1 discharge is approximately 360 m (1200 feet) southwest of the NMP-2 discharge; the FitzPatrick discharge is more remote (ER-OL Figure 3.4.2). Because of the relatively small discharge flow from NMP-2 compared with the discharges from the other two power plants, both of which have once-through cooling systems, this interaction may be viewed as a discharge from NMP-2 encountering an already slightly warmed ambient water (the result of thermal discharges from the other two plants).

As noted by the applicant (ER-OL Section 5.3.2.1.4), because the station is between the other two plants and prevailing lake currents are generally from the east or west, it is unlikely that the thermal plumes from both plants would affect the NMP-2 discharge area simultaneously. Surface temperature elevation from the station should not exceed 1.3C° (2.3F°) (Section 5.5.2). Maximum surface temperature elevation from NMP-1 is 6.0C° (11.0F°) (ER-OL Section 5.3.2.1.4), and from FitzPatrick is 3.6C° (6.6F°) (ER-OL Section 2.3.1.1.6.2). The thermal regime of the lake should continue to be dominated by the two existing power plants, with interaction among the plants relatively slight.

5.5.2.5 Aquatic Resource Impact Summary

NMP-2 will utilize a state-of-the-art cooling system design to minimize the impacts of water withdrawal and thermal effluent discharges to Lake Ontario aquatic biological and fisheries resources. This design includes: low intake volume; low intake velocity and horizontal inflow at the intakes due to velocity caps; submerged offshore intake structures; diversion and return system for impinged fishes; and an offshore benthic high velocity diffuser discharge system. The fish diversion system will collect and return most fishes that will be impinged on the traveling screens. The reduction in impingement mortality may be low, however, for certain size classes of some sensitive species (notably alewife and smelt). Thermal and chemical effluent effects are expected to be limited to a small area in the vicinity of the diffuser discharge. Impacts from interactions between NMP-2 and either the NMP-1 or FitzPatrick power plant should be insignificant.

The 1981 NRC study of environmental impact resulting from the conversion from once-through to closed-cycle cooling found the impacts to be minimal. On the basis of this current update of resources and impacts, the staff finds that those conclusions remain valid.

5.6 Threatened and Endangered Species

5.6.1 Terrestrial

No endangered or threatened species of plants or animals listed by the U.S. Fish and Wildlife Service is known to be present within the plant site or transmission corridor. Transient species potentially occurring in the region and protected by the Federal or state government are listed in Section 4.3.5.1. These species do not regularly occur at the site or in the transmission corridor. Thus potential impacts on these species are not expected to be significant.

5.6.2 Aquatic

The only threatened (New York State-listed) species reported for the Nine Mile Point area is the lake chubsucker, of which a single specimen was taken in 1975 at the mouth of the Salmon River (Section 4.3.5). No other threatened or endangered species, whether listed by the Federal or state government, has been taken near the station in 11 years of sampling. Because any effects of station operation on aquatic biota would be minor and localized (Section 5.5.2), adverse effects on threatened or endangered species are highly improbable.

5.7 Historic and Archeologic Impacts

The NRC staff concludes that the operation and maintenance of NMP-2 will have no significant impacts on sites listed or eligible for listing in the National Register of Historic Places. The State Historic Presentation Officer's opinion is consistent with the staff finding. (Copies of relevant correspondence can be found in Appendix F.)

5.8 Socioeconomic Impacts

The socioeconomic impacts of station operation are analyzed in FES-CP Sections 5.6 and 10. Changes that have occurred since that report was issued include an increase in the estimated operating work force to a total of 635 employees once the plant is in normal operation. The plant payroll is estimated to be $18 million (1982 dollars) per year. The staff does not expect the operating workers or their families to have any significant impact on public or private facilities in the area.

The applicant estimated annual local purchases of goods and services required for the operation of NMP-2 to be about $1 millon within an 80-km (50-mile) radius of the site. Tax payments are considered as indirect benefits of the station's operation because they are transfer payments. The applicant estimates the annual NMP-2 property taxes will range from $15.1 million in 1986 to $29.1 million in 1995 (1982 dollars). The staff anticipates no other significant socioeconomic impacts from NMP-2 operation.

5.9 Radiological Impacts

5.9.1 Regulatory Requirements

Nuclear power reactors in the United States must comply with certain regulatory requirements in order to operate. The permissible levels of radiation in unrestricted areas and of radioactivity in effluents to unrestricted areas are recorded in 10 CFR 20, Standards for Protection Against Radiation. These regulations specify limits on levels of radiation and limits on concentrations of radionuclides in the facility's effluent releases to the air and water (above natural background) under which the reactor must operate. These regulations state that no member of the general public in unrestricted areas shall receive a radiation dose, as a result of facility operation, of more than 0.5 rem in 1 calendar year, or if an individual were continuously present in an area, 2 mrems in any 1 hour or 100 mrems in any 7 consecutive days to the total body. These radiation-dose limits are established to be consistent with considerations of the health and safety of the public.

In addition to the Radiation Protection Standards of 10 CFR 20, there are recorded in 10 CFR 50.36a license requirements that are to be imposed on licensees in the form of Technical Specifications on Effluents from Nuclear Power Reactors to keep releases of radioactive materials to unrestricted areas during normal operations, including expected operational occurrences, as low as reasonably achievable (ALARA). Appendix I of 10 CFR 50 provides numerical guidance on dose-design objectives for light-water reactor (LWRs) to meet this ALARA requirement. Applicants for permits to construct and for licenses to operate an LWR shall provide reasonable assurance that the following calculated dose-design objectives will be met for all unrestricted areas: 3 mrems/year to the total body or 10 mrems/year to any organ from all pathways of exposure from liquid effluents; 10 mrads/year gamma radiation or 20 mrads/year beta radiation air dose from gaseous effluents near ground level--and/or 5 mrems/year to the total body or 15 mrems/year to the skin from gaseous effluents; and 15 mrems/yr to any organ from all pathways of exposure from airborne effluents that include the radioiodines, carbon-14, tritium, and the particulates.

Experience with the design, construction, and operation of nuclear power reactors indicates that compliance with these design objectives will keep average annual releases of radioactive material in effluents at small percentages of the limits specified in 10 CFR 20 and, in fact, will result in doses generally below the dose-design objective values of Appendix I. At the same time, the licensee is permitted the flexibility of operation, compatible with considerations of health and safety, to ensure that the public is provided a dependable source of power, even under unusual operating conditions that may temporarily result in releases higher than such small percentages but still well within the limits specified in 10 CFR 20.

In addition to the impact created by facility radioactive effluents as discussed above, within the NRC policy and procedures for environmental protection described in 10 CFR 51 there are generic treatments of environmental effects of all aspects of the uranium fuel cycle. These environmental data have been summarized in Table S-3 and are discussed later in this report in Section 5.10. In the same manner the environmental impact of transportation of fuel and waste to and from an LWR is summarized in Table S-4 and presented in Section 5.9.3 of this report.

Recently an additional operational requirement for uranium fuel cycle facilities including nuclear power plants was established by the Environmental Protection Agency in 40 CFR 190. This regulation limits annual doses (excluding radon and daughters) for members of the public to 25 mrems total body, 75 mrems thyroid, and 25 mrems other organs from all fuel-cycle facility contributions that may impact a specific individual in the public.

5.9.2 Operational Overview

During normal operations of NMP-2, small quantities of radioactivity (fission, corrosion, and activation products) will be released to the environment. As required by NEPA, the staff has determined the estimated dose to members of the public outside of the plant boundaries as a result of the radiation from these radioisotope releases and relative to natural-background-radiation dose levels.

These facility-generated environmental dose levels are estimated to be very small because of both the plant design and the development of a program that will be implemented at the facility to contain and control all radioactive emissions and effluents. Radioactive-waste management systems are incorporated into the plant and are designed to remove most of the fission-product radioactivity that is assumed to leak from the fuel, as well as most of the activation and corrosion-product radioactivity produced by neutrons in the reactor-core vicinity. The effectiveness of these systems will be measured by process and effluent radiological monitoring systems that permanently record the amounts of radioactive constituents remaining in the various airborne and waterborne process and effluent streams. The amounts of radioactivity released through vents and discharge points to areas outside the plant boundaries are to be recorded and published semiannually in the Radioactive Effluent Release Reports for the facility.

Airborne effluents will diffuse in the atmosphere in a fashion determined by the meteorological conditions existing at the time of release, and these effluents are generally dispersed and diluted by the time they reach unrestricted areas that are open to the public.

Radioisotopes in the facility's effluents that enter unrestricted areas will produce doses through their radiations to members of the general public in a manner similar to the way doses are produced from background radiations (that is, cosmic, terrestrial, and internal radiations), which also include radiation from nuclear-weapons fallout. These radiation doses can be calculated for the many potential radiological-exposure pathways specific to the environment around the facility, such as direct-radiation doses from the gaseous plume or liquid effluent stream outside of the plant boundaries, or internal-radiation-dose commitments from radioactive contaminants that might have been deposited on vegetation or in meat and fish products eaten by people, or that might be present in drinking water outside the plant or incorporated into milk from cows at nearby farms.

These doses, calculated for the "maximally exposed" individual (that is, the hypothetical individual potentially subject to maximum exposure), form the basis of the NRC staff's evaluation of impacts. Actually, these estimates are for a fictitious person because assumptions are made that tend to overestimate the dose that would accrue to members of the public outside the plant boundaries. For example, if this "maximally exposed" individual were to receive the total body dose calculated at the plant boundary as a result of external exposure to the gaseous plume, he/she is assumed to be physically exposed to gamma radiation at that boundary for 70% of the year, an unlikely occurrence.

Site-specific values for various parameters involved in each dose pathway are used in the calculations. These include calculated or observed values for the amounts of radioisotopes released in the gaseous and liquid effluents, meteorological information (for example, wind speed and direction) specific to the site topography and effluent release points, and hydrological information pertaining to dilution of the liquid effluents as they are discharged.

An annual land census will identify changes in the use of unrestricted areas to permit modifications in the programs for evaluating doses to individuals from principal pathways of exposure. This census specification will be incorporated into the Radiological Technical Specifications and satisfies the requirements of Section IV.B.3 of Appendix I to 10 CFR 50. As use of the land surrounding the site boundary changes, revised calculations will be made to ensure that the dose estimate for gaseous effluents always represents the highest dose that might possibly occur for any individual member of the public for each applicable foodchain pathway. The estimate considers, for example, where people live, where vegetable gardens are located, and where cows are pastured.

An extensive radiological environmental monitoring program, designed specifically for the environs of NMP-2, provides measurements of radiation and radioactive contamination levels that exist outside of the facility boundaries both before and after operations begin. In this program, offsite radiation levels are continuously monitored with thermoluminescent detectors (TLDs). In addition, measurements are made on a number of types of samples from the surrounding area to determine the possible presence of radioactive contaminants that might, for example, be deposited on vegetation, be present in drinking water outside the plant, or be incorporated into cow's milk from nearby farms. The results for all radiological environmental samples measured during a calendar year of operation are recorded and published in the Annual Radiological Environmental Operating Report for the facility. The specifics of the final operational-monitoring program and the requirement for annual publication of the monitoring results will be incorporated into the operating license Radiological Technical Specifications for the NMP-2 facility.

5.9.3 Radiological Impacts from Routine Operations

5.9.3.1 Radiation Exposure Pathways: Dose Commitments

The potential environmental pathways through which persons may be exposed to radiation originating in a nuclear power reactor are shown schematically in Figure 5.3. When an individual is exposed through one of these pathways, the dose is determined in part by the amount of time he/she is in the vicinity of the source, or the amount of time the radioactivity inhaled or ingested is retained in his/her body. The actual effect of the radiation or radioactivity is determined by calculating the dose commitment. The annual dose commitment is calculated to be the total dose that would be received over a 50-year period, following the intake of radioactivity for 1 year under the conditions existing 20 years after the station begins operation. (Calculation for the 20th year, or midpoint of station operation, represents an average exposure over the life of the plant.) However, with few exceptions, most of the internal dose commitment for each nuclide is given during the first few years after exposure because of the turnover of the nuclide by physiological processes and radioactive decay.

There are a number of possible exposure pathways to humans that are appropriate to be studied to determine the impact of routine releases from the NMP-2 facility on members of the general public living and working outside the site boundaries, and whether the releases projected at this point in the licensing process will in fact meet regulatory requirements. A detailed listing of these exposure pathways would include external radiation exposure from the gaseous effluents, inhalation of iodines and particulate contaminants in the air, drinking milk from a cow or eating meat from an animal that feeds on open pasture near the site on which iodines or particulates may have deposited, eating vegetables from a garden near the site that may be contaminated by similar deposits, and drinking water or eating fish caught near the point of discharge of liquid effluents.

Other less important pathways include: external irradiation from radionuclides deposited on the ground surface; eating animals and food crops raised near the site using irrigation water that may contain liquid effluents; shoreline, boating, and swimming activities near lakes or streams that may be contaminated by effluents; drinking potentially contaminated water; and direct radiation from within the plant itself.

Calculations of the effects for most pathways are limited to a radius of 80 km (50 miles). This limitation is based on several facts. Experience, as demonstrated by calculations, has shown that all individual dose commitments (>0.1 mrem/year) for radioactive effluents are accounted for within a radius of 80 km from the plant. Beyond 80 km the doses to individuals are smaller than 0.1 mrem/year, which is far below natural-background doses, and the doses are subject to substantial uncertainty because of limitations of predictive mathematical models.

The NRC staff has made a detailed study of all of the above important pathways and has evaluated the radiation-dose commitments both to the plant workers and the general public for these pathways resulting from routine operation of the facility. A discussion of these evaluations follows.

5.9.3.1.1 Occupational Radiation Exposure for Boiling Water Reactors (BWRs)

Most of the dose to nuclear plant workers results from external exposure to radiation coming from radioactive materials outside of the body rather than from internal exposure from inhaled or ingested radioactive materials. Experience shows that the dose to nuclear plant workers varies from reactor to reactor and from year to year. For environmental-impact purposes, it can be projected by using the experience to date with modern BWRs. Recently licensed

1000-MWe BWRs are operated in accordance with the post-1975 regulatory requirements and guidance that place increased emphasis on maintaining occupational exposure at nuclear power plants ALARA. These requirements and guidance are outlined primarily in 10 CFR 20, Standard Review Plan Chapter 12 (NUREG-0800), and RG 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable."

The applicant's proposed implementation of these requirements and guidelines is reviewed by the NRC staff during the licensing process, and the results of that review are reported in the staff's SERs. The license is granted only after the review indicates that an ALARA program can be implemented. In addition, regular reviews of operating plants are performed to determine whether the ALARA requirements are being met.

Average collective occupational dose information for 177 BWR reactor years of operation is available for those plants operating between 1974 and 1981. (The year 1974 was chosen as a starting date because the dose data for years prior to 1974 are primarily from reactors with average rated capacities below 500 MWe.) These data indicate that the average reactor annual collective dose at BWRs has been about 790 person-rems, although some plants have experienced annual collective doses averaging as high as 1660 person-rems/year over their operating lifetime (NUREG-0713, Vol 3). These dose averages are based on widely varying yearly doses at BWRs. For example, for the period mentioned above, annual collective doses for BWRs have ranged from 44 to 3626 person-rems per reactor. However, the average annual dose per nuclear plant worker of about 0.8 rem (ibid) has not varied significantly during this period. The worker dose limit, established by 10 CFR 20, is 3 rems/quarter (if the average dose over the worker lifetime is being controlled to 5 rems/year) or 1.25 rems/quarter if it is not.

The wide range of annual collective doses experienced at BWRs in the United States results from a number of factors such as the amount of required maintenance and the amount of reactor operations and inplant surveillance. Because these factors can vary widely and unpredictably, it is impossible to determine in advance a specific year-to-year annual occupational radiation dose for a particular plant over its operating lifetime. There may on occasion be a need for relatively high collective occupational doses, even at plants with radiation protection programs designed to ensure that occupational radiation doses will be kept ALARA.

In recognition of the factors mentioned above, staff occupational dose estimates for environmental impact purposes for NMP-2 are based on the assumption that the facility will experience the annual average occupational dose for BWRs to date. Thus the staff has projected that the collective occupational doses for each unit at NMP-2 will be 790 person-rems, but annual collective doses could average as much as twice this value over the life of the plant.

The average annual dose of about 0.8 rem per nuclear-plant worker at operating BWRs and PWRs has been well within the limits of 10 CFR 20. However, for impact evaluation, the NRC staff has estimated the risk to nuclear-power-plant workers and compared it in Table 5.3 to published risks for other occupations. Based on these comparisons, the staff concludes that the risk to nuclear-plant workers from plant operation is comparable to the risks associated with other occupations.

In estimating the health effects from both offsite (see Section 5.9.3.2) and occupational radiation exposures as a result of normal operation of this facility, the NRC staff used somatic (cancer) and genetic risk estimators that are based on widely accepted scientific information. Specifically, the staff's estimates are based on information compiled by the National Academy of Sciences Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR I). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The following risk estimators were used to estimate health effects: 135 potential deaths from cancer per million person-rems and 258 potential cases of all forms of genetic disorders per million person-rems.

The cancer-mortality risk estimates are based on the "absolute risk" model described in BEIR I. Higher estimates can be developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. Use of the "relative risk" model would produce risk values up to about four times greater than those used in this report. The staff regards the use of the "relative risk" model values as a reasonable upper limit of the range of uncertainty. The lower limit of the range would be zero because health effects have not been detected at doses in this dose-rate range. The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential cancers, according to the 1980 report of the National Academy of Sciences Advisory Committee in the Biological Effects of Ionizing Radiation (BEIR III).

Values for genetic risk estimators range from 60 to 1500 potential cases of all forms of genetic disorders per million person-rems (BEIR I). The value of 258 potential cases of all forms of genetic disorders is equal to the sum of the geometric means of the risk of specific genetic defects and the risk of defects with complex etiology.

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation-protection organizations, such as the International Commission on Radiological Protection (ICRP, 1977), the National Council on Radiation Protection and Measurement (NCRP, 1975), the National Academy of Sciences (BEIR III), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1982).

The risk of potential fatal cancers in the exposed work-force population at the NMP-2 facility is estimated as follows: multiplying the annual plant-worker-population dose (about 790 person-rems) by the somatic risk estimator, the staff estimates that about 0.12 cancer death may occur in the total exposed population. The value of 0.12 cancer death means that the probability of 1 cancer death over the lifetime of the entire work force as a result of 1 year of facility operation is about 12 chances in 100. The risk of potential genetic disorders attributable to exposure of the work force is a risk borne by the progeny of the entire population and is thus properly considered as part of the risk to the general public.

5.9.3.1.2 Public Radiation Exposure.

- Transportation of Radioactive Materials

The transportation of "cold" (unirradiated) nuclear fuel to the reactor, of spent irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to waste burial grounds is considered in 10 CFR 51.52. The contribution of the environmental effects of such transportation to the environmental costs of licensing the nuclear power reactor is set forth in Summary Table S-4 from 10 CFR 51.52, reproduced herein as Table 5.4. The cumulative dose to the exposed population as summarized in Table S-4 is very small when compared to the annual collective dose of about 60,000 person-rems to this same population or 26,000,000 person-rems to the U.S. population from background radiation.

- Direct Radiation for BWRs

Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, as well as a result of radioactive-effluent releases. Although the components are shielded, dose rates observed around BWR plants from these plant components have varied from undetectable levels to values on the order of 100 mrems/year at onsite locations where members of the general public were allowed. For newer BWR plants with a standardized design, dose rates have been estimated using special calculational modeling techniques. The calculated cumulative dose to the exposed population from such a facility would be much less than 1 person-rem/year per unit, insignificant when compared with the natural background dose.

Low-level radioactivity storage containers outside the plant are estimated to make a dose contribution at the site boundary of less than 0.1% of that due to the direct radiation described above.

- Radioactive-Effluent Releases: Air and Water

Limited quantities of radioactive effluents will be released to the atmosphere and to the hydrosphere during normal operations. Plant-specific radioisotope-release rates were developed on the basis of estimates regarding fuel performance and descriptions of the operation of radwaste systems in the applicant's FSAR, and by using the calculative models and parameters described in NUREG-0016.

These radioactive effluents are then diluted by the air and water into which they are released before they reach areas accessible to the general public.

Radioactive effluents can be divided into several groups. Among the airborne effluents, the radioisotopes of the fission product noble gases, krypton and xenon, as well as the radioactivated gas argon, do not deposit on the ground nor are they absorbed and accumulated within living organisms; therefore, the noble gas effluents act primarily as a source of direct external radiation emanating from the effluent plume. Dose calculations are performed for the site boundary where the highest external-radiation doses to a member of the general public as a result of gaseous effluents have been estimated to occur; these include the total body and skin doses as well as the annual beta and gamma air doses from the plume at that boundary location.

Another group of airborne radioactive effluents--the fission product radioiodines, as well as carbon-14 and tritium--are also gaseous but these tend to be deposited on the ground and/or inhaled into the body during breathing. For this class of effluents, estimates are made of direct external-radiation doses from deposits on the ground, and of internal radiation doses to total body, thyroid, bone, and other organs from inhalation and from vegetable, milk, and meat consumption are made. Concentrations of iodine in the thyroid and of carbon-14 in bone are of particular significance here.

A third group of airborne effluents, consisting of particulates that remain after filtration of airborne effluents in the plant prior to release, includes fission products such as cesium and strontium and activated corrosion products such as cobalt and chromium. The calculational model determines the direct external radiation dose and the internal radiation doses for these contaminants through the same pathways as described above for the radioiodines, carbon-14, and tritium. Doses from the particulates are combined with those of the radioiodines, carbon-14, and tritium for comparison to one of the design objectives of Appendix I to 10 CFR 50.

The waterborne-radioactive-effluent constituents could include fission products such as nuclides of strontium and iodine; activation and corrosion products, such as nuclides of sodium, iron, and cobalt; and tritium as tritiated water. Calculations estimate the internal doses (if any) from fish consumption, from water ingestion (as drinking water), and from eating of meat or vegetables raised near the site on irrigation water, as well as any direct external radiation from recreational use of the water near the point of discharge.

The release rates for each group of effluents, along with site-specific meteorological and hydrological data, serve as input to computerized radiation-dose models that estimate the maximum radiation dose that would be received outside the facility via a number of pathways for individual members of the public, and for the general public as a whole. These models and the radiation-dose calculations are discussed in the October 1977 Revision 1 of RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," and in Appendix B of this statement.

Examples of site-specific dose assessment calculations and discussions of parameters involved are given in Appendix D. Doses from all airborne effluents except the noble gases are calculated for individuals at the location (for example, the site boundary, garden, residence, milk cow, and meat animal) where the highest radiation dose to a member of the public has been established from all applicable pathways (such as ground deposition, inhalation, vegetable consumption, cow milk consumption, or meat consumption.) Only those pathways associated with airborne effluents that are known to exist at a single location are combined to calculate the total maximum exposure to an exposed individual. Pathway doses associated with liquid effluents are combined without regard to any single location, but they are assumed to be associated with maximum exposure of an individual through other than gaseous-effluent pathways.

5.9.3.2 Radiological Impact on Humans

Although the doses calculated in Appendix D are based primarily on radioactive-waste treatment system capability and are below the Appendix I design objective values, the actual radiological impact associated with the operation of the facility will depend, in part, on the manner in which the radioactive-waste treatment system is operated. Based on its evaluation of the potential performance of the ventilation and radwaste treatment systems, the NRC staff has concluded that the systems as now proposed are capable of controlling effluent releases to meet the dose-design objectives of Appendix I to 10 CFR 50.

Operation of the NMP-2 facility will be governed by operating license Technical Specifications that will be based on the dose-design objectives of Appendix I to 10 CFR 50. Because these design-objective values were chosen to permit flexibility of operation while still ensuring that plant operations are ALARA, the actual radiological impact of plant operation may result in doses close to the dose-design objectives. Even if this situation exists, the individual doses for the member of the public subject to maximum exposure will still be very small when compared to natural background doses (~100 mrems/year) or the dose limits (500 mrems/year - total body) specified in 10 CFR 20 as consistent with considerations of the health and safety of the public. As a result, the staff concludes that there will be no measurable radiological impact on any member of the public from routine operation of the NMP-2 facility.

Operating standards of 40 CFR 190, the Environmental Protection Agency's Environmental Radiation Protection Standards for Nuclear Power Operations, specify that the annual dose equivalent must not exceed 25 mrems to the whole body, 75 mrems to the thyroid, and 25 mrems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials (radon and its daughters excepted) to the general environment from all uranium-fuel-cycle operations and radiation from these operations that can be expected to affect a given individual. The NRC staff concludes that under normal operations the NMP-2 facility is capable of operating within these standards.

The radiological doses and dose commitments resulting from a nuclear power plant are well known and documented. Accurate measurements of radiation and radioactive contaminants can be made with very high sensitivity so that much smaller amounts of radioisotopes can be recorded than can be associated with any possible observable ill effects. Furthermore, the effects of radiation on living systems have for decades been subject to intensive investigation and consideration by individual scientists as well as by select committees that have occasionally been constituted to objectively and independently assess radiation dose effects. Although, as in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation that result from nuclear-power-plant effluents, upper bound limits of deleterious effects are well established and amenable to standard methods of risk analysis. Thus the risks to the maximally exposed member of the public outside the site boundaries or to the total population outside the boundaries can be readily calculated and recorded. These risk estimates for the NMP-2 facility are presented below.

The risk to the maximally exposed individual is estimated by multiplying the risk estimators presented in Section 5.9.3.1.1 by the annual dose-design objectives for total-body radiation in 10 CFR 50, Appendix I. This calculation results in a risk of potential premature death from cancer to that individual from exposure to radioactive effluents (gaseous or liquid) from 1 year of reactor operations of less than one chance in one million.* The risk of potential premature

*The risk of potential premature death from cancer to the maximally exposed individual from exposure to radioiodines and particulates would be in the same range as the risk from exposure to the other types of effluents.

death from cancer to the average individual within 80 km (50 miles) of the reactors from exposure to radioactive effluents from the reactors is much less than the risk to the maximally exposed individual. These risks are very small in comparison to natural cancer incidence from causes unrelated to the operation of the NMP-2 facility.

Multiplying the annual U.S. general public population dose from exposure to radioactive effluents and transportation of fuel and waste from the operation of this facility (that is, 35 person-rems) by the preceding somatic risk estimator, the staff estimates that about 0.005 cancer death may occur in the exposed population. The significance of this risk can be determined by comparing it to the natural incidence of cancer death in the U.S. population. Multiplying the estimated U.S. population for the year 2000 (~260 million persons) by the current incidence of actual cancer fatalities (~20%), about 52 million cancer deaths are expected (American Cancer Society, 1978).

For purposes of evaluating the potential genetic risks, the progeny of workers are considered members of the general public. Multiplying the sum of the U.S. population dose from exposure to radioactivity attributable to the normal annual operation of the plant (that is, 35 person-rems), and the estimated dose from occupational exposure (that is, 790 person-rems) by the preceding genetic risk estimators, the staff estimates that about 0.22 potential genetic disorder may occur in all future generations of the exposed population. Because BEIR III indicates that the mean persistence of the two major types of genetic disorders is about 5 generations and 10 generations, in the following analysis the risk of potential genetic disorders from the normal annual operation of the plant is conservatively compared with the risk of actual genetic ill health in the first 5 generations, rather than the first 10 generations. Multiplying the estimated population within 80 km of the plant (~ 121,000 persons in the year 2010) by the current incidence of actual genetic ill health in each generation (~11%), about 67,000 genetic abnormalities are expected in the first 5 generations of the 80-km population (BEIR III).

The risks to the general public from exposure to radioactive effluents and transportation of fuel and wastes from the annual operation of the facility are very small fractions of the estimated normal incidence of cancer fatalities and genetic abnormalities. On the basis of the preceding comparison, the staff concludes that the risk to the public health and safety from exposure to radioactivity associated with the normal operation of the facility will be very small.

5.9.3.3 Radiological Impacts on Biota Other Than Humans

Depending on the pathway and the radiation source, terrestrial and aquatic biota will receive doses that are approximately the same or somewhat higher than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to species other than humans, it is generally agreed that the limits established for humans are sufficiently protective for other species.

Although the existence of extremely radiosensitive biota is possible and increased radiosensitivity in organisms may result from environmental interactions with other stresses (for example, heat or biocides), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the facility. Furthermore, at all nuclear plants for which radiation exposure to biota other than humans has been analyzed (Blaylock, 1976), there have been no cases of exposure that can be considered significant in terms of harm to the species, or that approach the limits for exposure to members of the public that are permitted by 10 CFR 20. Inasmuch as the 1972 BEIR Report (BEIR I) concluded that evidence to date indicated that no other living organisms are very much more radiosensitive than humans, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this facility.

5.9.3.4 Radiological Monitoring

Radiological environmental monitoring programs are established to provide data where there are measurable levels of radiation and radioactive materials in the site environs and to show that in many cases no detectable levels exist. Such monitoring programs are conducted to verify the effectiveness of inplant systems used to control the release of radioactive materials and to ensure that unanticipated buildups of radioactivity will not occur in the environment. Secondarily, the environmental monitoring programs could identify the highly unlikely existence of releases of radioactivity from unanticipated release points that are not monitored. An annual surveillance (land census) program will be established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs or of the Technical Specifications conditions that relate to the control of doses to individuals.

These programs are discussed generically in greater detail in RG 4.1, Revision 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and in the Radiological Assessment Branch Technical Position, Revision 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program."*

5.9.3.4.1 Preoperational

The preoperational phase of the monitoring program should provide for the measurement of background levels of radioactivity and radiation and their variations along the anticipated important pathways in the areas surrounding the facility, the training of personnel, and the evaluation of procedures, equipment, and techniques. The applicant proposed a radiological environmental-monitoring program to meet these objectives in the ER-CP, and it was discussed in the FES-CP. This early program has been updated and expanded; it is presented in ER-OL Section 6.2 and is summarized here in Table 5.5.

The applicant states that the preoperational program will have been implemented at least 2 years before initial criticality of NMP-2 to document background levels of direct radiation and concentrations of radionuclides that exist in the environment. The preoperational program will continue up to initial criticality of NMP-2, at which time the operational radiological monitoring program will commence.

The staff has reviewed the preoperational environmental monitoring plan of the applicant and finds that it is generally acceptable as presented.

*Available from the Radiological Assessment Branch, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

5.9.3.4.2 Operational

The operational, offsite radiological-monitoring program is conducted to provide data on measurable levels of radiation and radioactive materials in the site environs in accordance with 10 CFR 20 and 50. It assists and provides backup support to the effluent-monitoring program recommended in RG 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants."

The applicant states that the operational program will in essence be a continuation of the preoperational program described above, with some periodic adjustment of sampling frequencies in expected critical exposure pathways. The proposed operational program will be reviewed prior to plant operation. Modification will be based upon anomalies and/or exposure pathway variations observed during the preoperational program.

The final operational-monitoring program proposed by the applicant will be reviewed in detail by the NRC staff, and the specifics of the required monitoring program will be incorporated into the operating license Radiological Technical Specifications.

5.9.4 Environmental Impacts of Postulated Accidents

5.9.4.1 Plant Accidents

The staff has considered the potential radiological impacts on the environment of possible accidents at NMP-2 in accordance with a Statement of Interim Policy published by the NRC on June 13, 1980 (45 FR 40101-40104). The following sections discuss the staff's considerations and conclusions.

Section 5.9.4.2 deals with general characteristics of nuclear power plant accidents, including a brief summary of safety measures provided to minimize the probability of their occurrence and to mitigate their consequences if they should occur. Also described are the important properties of radioactive materials and the pathways by which they could be transported to become environmental hazards. Potential adverse health effects and impacts on society associated with actions to avoid such health effects also are identified.

Next, Section 5.9.4.3 describes actual experience with nuclear power plant accidents and their observed health effects and other societal impacts. This is followed by a summary review in Section 5.9.4.4 of safety features of NMP-2 and of the site that act to mitigate the consequences of accidents.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given in Section 5.9.4.5.

Also described are the results of calculations for the NMP-2 site using contemporary probabilistic methods, with an explanation of their inherent uncertainties, to estimate the possible impacts and the risks associated with severe accident sequences of low probability of occurrence.

5.9.4.2 General Characteristics of Accidents

The term "accident," as used in this section, refers to any unintentional event not addressed in Section 5.9.3 that results in a release of radioactive materials into the environment. The predominant focus, therefore, is on events that can lead to releases substantially in excess of permissible limits for normal operation. Normal release limits are specified in the Commission's regulations in 10 CFR 20 and 10 CFR 50, Appendix I.

There are several features that combine to reduce the risk associated with accidents at nuclear power plants. Safety features provided for in design, construction, and operation comprise the first line of defense and are to a very large extent devoted to the prevention of the release of radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defense that are designed to mitigate the consequences of failures in the first line. These safety features are designed taking into consideration the specific locations of radioactive materials within the plant; their amounts; their nuclear, physical, and chemical properties; and their relative tendency for being transported into and for creating biological hazards in the environment. Descriptions of these features for NMP-2 may be found in the applicant's Final Safety Analysis Report and in the staff's Safety Evaluation Report (SER), which is scheduled for publication in December 1984. The most important mitigative features are described in Section 5.9.4.4(1) below.

(1) <u>Fission Product Characteristics</u>

By far the largest inventory of radioactive material in a nuclear power plant is produced as a byproduct of the fission process and is located in the uranium oxide fuel pellets in the reactor core in the form of fission products. During periodic refueling shutdowns, some of the assemblies containing these fuel pellets are transferred to a spent-fuel storage pool to create in this storage area the second largest inventory of radioactive material at the plant. Much smaller inventories of radioactive materials also are normally present in the water that circulates in the reactor coolant system and in the systems used to process gaseous and liquid radioactive wastes in the plant.

All these radioactive materials exist in a variety of physical and chemical forms. Their potential for dispersion into the environment depends not only on mechanical forces that might physically transport them, but also upon their inherent properties, particularly their volatility. The majority of these materials exist as nonvolatile solids over a wide range of temperatures. Some, however, are relatively volatile solids, and a few are gaseous in nature. Such characteristics have a significant bearing upon the assessment of the environmental radiological impact of accidents.

The gaseous materials include radioactive forms of the chemically inert noble gases krypton and xenon. These gases have the highest potential for release into the atmosphere. If a reactor accident were to occur involving degradation of the fuel cladding, the release of substantial quantities of these radioactive gases from the fuel is a virtual certainty. Such accidents are of low frequency, but are considered credible events (see Section 5.9.4.3). For this reason, the safety analysis of each nuclear power plant incorporates a hypothetical design-basis accident that postulates the release of the entire inventory of radioactive noble gases from the fuel in the reactor vessel into the containment structure. If these gases were further released to the environment as a possible result of failure of safety features, the hazard to individuals from these noble gases would arise predominantly through the external gamma radiation from the airborne plume. The reactor containment structure and other features are designed to minimize this type of release.

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and may be quite volatile in some chemical forms. For these reasons, they have traditionally been regarded as having a relatively high potential for release (1) from the fuel at higher than normal temperatures, or (2) from defects in fuel pins. For design-basis accident analysis, it is assumed that up to 25% of the iodines are released to the containment atmosphere. If radioiodines are released to the environment, the principal radiological hazard associated with the radioiodines is incorporation into the human body and subsequent concentration in the thyroid gland. Because of this hazard, the potential for release of radioiodines to the atmosphere is reduced by the use of special structures, components, and systems designed to retain the iodine. The chemical forms in which the fission product radioiodines are found are generally solid materials at room temperatures, so they have a strong tendency to condense (or plate out) on cooler surfaces. In addition, most of the iodine compounds are quite soluble in or chemically reactive with water. Although these properties do not inhibit the release of radioiodines from degraded fuel, they do act to mitigate the release both to and from containment structures that have large internal surface areas and that contain large quantities of water as a result of an accident. The same properties affect the behavior of radioiodines that may "escape" into the atmosphere. Thus, if rainfall occurs during a release, or if there is moisture on exposed surfaces (for example, dew), the radioiodines will show a strong tendency to be absorbed by the moisture. Although less volatile than many iodine compounds, virtually all cesium and rubidium (alkali metals) compounds are soluble in or react strongly with water, and would behave similarly in the presence of moisture. In addition, the more volatile iodine compounds are capable of reacting with vegetation and traces of organic gases and pollen normally present in air, and many alkali metal compounds are capable of reacting with siliceous materials such as concrete, glass and soil.

Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and--by comparison with the noble gases, iodine, and alkali metals--have a much smaller tendency to escape from degraded fuel unless the temperature of the fuel becomes very high. By the same token, if such materials escape by volatilization from the fuel, they tend (1) to condense quite rapidly to solid form again when they are transported to a region of lower temperature and/or (2) to dissolve in water when it is present. The former mechanism can have the result of producing some solid particles of sufficiently small size to be carried some distance by a moving stream of gas or air. If such particulate materials are dispersed into the atmosphere as a result of failure of the containment barrier, they will tend to be carried downwind and deposit on surfaces by gravitational settling (fallout) or by precipitation (washout or rainout), where they will become "contamination" hazards in the environment.

All of these radioactive materials exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 5.6). Many of them decay through a sequence or chain of decay processes, and all eventually become stable (nonradioactive) materials. The radiation emitted during these decay processes is the reason that they are hazardous materials. As a result of radioactive decay, most fission products transmute into other elements. Iodines transmute into noble gases, for example, while the noble gases transmute into alkali metals. Because of this property, fission products that escape into the environment as one element may later become a contamination hazard as a different element.

(2) Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive materials, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are depicted in Figure 5.3. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure 5.3. One pathway is the fallout onto open bodies of water, or onto land and eventual runoff into open water bodies, of radioactivity initially carried in the air. The second pathway, which is unique to an accident, is created when sufficiently high temperatures inside the reactor core cause uncontrolled or unmitigated melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This situation could create the potential for the release of radioactive material into the hydrosphere through contact with groundwater, and may lead to external exposure to radiation and to internal exposures if radioactive material is inhaled or ingested from contaminated food or water.

It is characteristic of the transport of radioactive material by wind or by water that the material tends to spread and disperse, like a plume of smoke from a smokestack, becoming less concentrated in larger volumes of air or water. The results of these natural processes are to lessen the intensity of exposure to individuals downwind or downstream of the point of release, but to increase the number who may be exposed. The bulk of radioactive releases is more likely to reach the atmosphere than to reach streams or groundwater. For a release into the atmosphere, the degree to which dispersion reduces the concentration in the plume at any downwind point is governed by the turbulence characteristics of the atmosphere, which vary considerably with time and from place to place. This fact, taken in conjunction with the variability of wind direction and the presence or absence of precipitation, means that accident consequences are very much dependent upon the weather conditions existing at the time of the accident.

(3) Health Effects

The cause-and-effect relationships between radiation exposure and adverse health effects are quite complex (National Research Council, 1979; Land, 1980), but they have been studied exhaustively in comparison with the health effects from many other environmental contaminants.

Whole-body radiation exposure resulting in a dose greater than about 10 rems for a few persons and about 25 rems for nearly all people over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about 7 or more times larger than the latter dose, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe but extremely low probability end of the accident spectrum, exposures of these magnitudes are theoretically possible for persons in close proximity to such accidents if measures are not or cannot be taken to provide protection, such as sheltering or evacuation.

Lower levels of exposures also may constitute a health risk, but the ability to define a direct cause-and-effect relationship between a known exposure to radiation and any given health effect is difficult, given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necesary to assess such effects on a statistical basis. Such effects include randomly occurring cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. The occurrence of cancer itself will not necessarily cause death, however. Occurrences of cancer in the exposed population may begin to develop only after a lapse of 1 to 15 years (latent period) from the time of exposure and then continue over the lifetime of the individual (plateau period). However, in the case of exposure to fetuses (in utero), occurrences of cancer may begin to develop at birth (no latent period) and end at age 10 (that is, the plateau period is 10 years). The health consequences model used was based on the 1972 BEIR I Report of the National Academy of Sciences (BEIR I).

Most authorities agree that a reasonable, and probably conservative, estimate of the randomly occurring number of health effects of low levels of radiation exposure to a large number of people is within the range of about 10 to 500 potential cancer deaths per million person-rems (although for low doses to individuals, zero is not excluded by the data). The range comes from the latest NAS BEIR III Report (1980), which also indicates a probable value of about 150. This value is virtually identical to the value of about 140 used in the NRC health-effects models. In addition, approximately 220 genetic changes per million person-rems would be projected over succeeding generations by models suggested in the BEIR III report. This also compares well with the value of about 260 per million person-rems used by the NRC staff, which was computed as the sum of the risk of specific genetic defects and the risk of defects with complex etiology (causes).

(4) <u>Health Effects Avoidance</u>

Radiation hazards in the environment tend to disappear by the natural processes of radioactive decay and weathering. However, where the decay process is slow, and where the material becomes relatively fixed in its location as an environmental contaminant (such as in soil), the hazard can continue to exist for a relatively long period of time--months, years, or even decades. Thus, a possible consequential environmental societal impact of severe accidents is the avoidance of the health hazard rather than the health hazard itself, by restrictions on the use of the contaminated property or contaminated food-stuffs, milk, and drinking water. The potential economic impacts that this avoidance can cause are discussed below.

5.9.4.3 Accident Experience and Observed Impacts

As of April 1984, there were 79 commercial nuclear power reactor units licensed for operation in the United States at 52 sites, with power-generating capacities ranging from 50 to 1180 megawatts electric (MWe) (NMP-2 is designed for approximately 1100 MWe). The combined experience with all these units represents approximately 700 reactor-years of operation over an elapsed time of about 23 years. Accidents have occurred at several of these facilities (Oak Ridge, 1980; NUREG-0651). Some of these have resulted in releases of radioactive material to the environment ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any specific member of the public, nor any significant individual or collective public radiation exposure, nor any significant contamination of the environment. This experience base is not large enough to permit reliable statistical predictions of accident probabilities. It does, however, suggest that significant environmental impacts caused by accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these units, during the accident at Three Mile Island Unit 2 (TMI-2) on March 28, 1979. In addition to the release to the environment of a few million curies of noble gases, mostly xenon-133, it has been estimated that approximately 15 curies of radioiodine also were released to the environment at TMI-2 (NUREG/CR-1250). This amount represents a minute fraction of the total radioiodine inventory present in the reactor at the time of the accident. No other radioactive fission products were released to the environment in measurable quantity. It has been estimated that the maximum cumulative off-site radiation dose to an individual was less than 100 mrems (NUREG/CR-1250; President's Commission, 1979). The total population exposure has been estimated to be in the range from about 1000 to 5300 person-rems (NUREG-0558). This exposure could produce between none and one additional fatal cancer over the lifetime of the population. The population within 80 km (50 miles) of TMI-2 receives each year from natural background radiation about 240,000 person-rems. Approximately a half-million cancers are expected to develop in this group over their lifetimes (NUREG/CR-1250; President's Commission, 1979), primarily from causes other than radiation.

Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were affected.

Accidents at nuclear power plants also have caused occupational injuries and a few fatalities, but none attributed to radiation exposure. Individual worker exposures have ranged up to about 5 rems as a direct consequence of reactor accidents (although there have been higher exposures to individual workers as a result of other unusual occurrences). However, the collective worker exposure levels (person-rems) from accidents are a small fraction of the exposures experienced during normal routine operations that average about 440 to 1300 person-rems in a PWR and 790 to 1660 person-rems in a BWR per reactor-year.

Accidents also have occurred at other nuclear reactor facilities in the United States and in other countries (Oak Ridge, 1980; Thompson and Beckerley, 1964). Because of inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the one in 1966 at the Enrico Fermi Atomic Power Plant, Unit 1. Fermi Unit 1 was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. This accident did not release any radioactivity to the environment. The damages were repaired and the reactor reached full power 4 years following the accident. It operated successfully and completed its mission in 1973.

A reactor accident in 1957 at Windscale, England, released a significant quantity of radioiodine, approximately 20,000 curies, to the environment (United Kingdom Atomic Energy Office, 1957). This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor (characteristic of a graphite-moderated reactor), the fuel overheated and radioiodine and noble gases were released directly to the atmosphere from a 123-m (405-foot) stack. Milk produced in a 518-km^2 (200-mi^2) area around the facility was impounded for up to 44 days. The United Kingdom National Radiological Protection Board estimated that the releases may have caused about 260 cases of thyroid cancer, about 13 of them fatal, and about 7 deaths from other cancers or hereditary diseases (Crick and Linsley, 1982). This kind of accident cannot occur in a water-moderated and -cooled reactor like NMP-2, however.

5.9.4.4 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the NRC is conducting a safety evaluation of the application to operate NMP-2. The results of this review will be in the staff SER, now scheduled for publication in December 1984. This report will contain detailed information on the plant design. The following section, however, is provided to outline the principal design features.

(1) Design Features

NMP-2 contains features designed to prevent accidental release of fission products from the fuel and to lessen the consequences should such a release occur. These accident-preventive and mitigative features are referred to collectively as engineered safety features (ESF). To establish design and operating specifications for ESFs, postulated events referred to as design-basis accidents are analyzed.

An emergency core cooling system (ECCS) is provided to supply cooling water to the reactor core during an accident to prevent or minimize fuel damage. Means of removing heat energy from the containment to mitigate its overpressurization following an accident are also provided. The containment system itself is a passive ESF, designed to prevent direct escape of released fission products to the environment.

The NMP-2 containment structures consist of an inner primary containment and an outer secondary containment. The primary containment is designed to withstand internal pressures resulting from reactor accidents. The secondary containment surrounds the primary containment and includes all equipment outside primary containment that could handle fission products in the event of an accident. The secondary containment is designed to collect, delay, and filter any leakage from the primary containment before its release to the environment for all events of design-basis severity and for some accidents of greater security.

The secondary containment encloses plant areas that are accessible and, therefore, ventilated during normal operation. When a release of radioactivity is detected, normal ventilation is automatically isolated, and an ESF, the standby gas treatment system (SGTS), assumes control of air flow within and from the secondary containment. The SGTS filters the secondary containment atmosphere and exhausts sufficient filtered air to establish and maintain an internal pressure less than the outside atmospheric pressure. The system is designed so that this negative pressure is sufficient to prevent unfiltered air leakage from the building. Radioactive iodine and particulate fission products would be substantially removed from the SGTS flow by safety-grade activated charcoal and high-efficiency particulate air filters. A filtered exhaust system also encloses the spent fuel pool.

The mechanical systems mentioned above are designed to perform their functions given single failures, are qualified for their anticipated accident environments, and are supplied with emergency power from onsite diesel generators if normal offsite and station power is interrupted.

A more extensive discussion of these and other design features is the applicant's FSAR. In addition, the implementation of the lessons learned from the TMI-2 accident--in the form of improvements in design, procedures, and operator training--will reduce the likelihood of a degraded core accident that could result in large releases of fission products to the containment. The applicant will be required to meet the TMI-related requirements specified in NUREG-0737. As noted in Section 5.9.4.5(7), the relative improvement in safety from these actions has not been quantified in this statement.

(2) <u>Site Features</u>

The NRC Reactor Site Criteria, in 10 CFR 100, require that the site for every power reactor have certain characteristics that tend to reduce the risk and potential impact of accidents. The discussion that follows briefly describes the NMP-2 site characteristics and how they meet these requirements.

First, the site has an exclusion area, as required by 10 CFR 100. The NMP site and the James A. FitzPatrick site, which are immediately adjacent to each other, share a common exclusion area. The irregularly shaped exclusion area is formed by the combined property lines of the Niagara Mohawk Power Co. (NMPC), owner of the NMP site, and the Power Authority of the State of New York (PASNY), owner of the FitzPatrick site. These companies own the surface and mineral rights of the respective land areas. By formal agreement executed in 1970 between NMPC and PASNY, which calls for reciprocal inclusion of each party's property within the exclusion area, NMPC has the authority to control all activity within the exclusion area. This authority complies with 10 CFR 100. There are no residents living within the exclusion area. Activities unrelated to NMP-2 operations that occur within the exclusion area include activity associated with the operation of NMP-1 and FitzPatrick, visitors to the Energy Information Center and its associated picnic and playground area and nature trails, and water-related activities on Lake Ontario. There are no commercial shipping lanes, highways, or railways traversing the exclusion area. Arrangements have been made with local authorities to limit access and to control the activity and evacuation of everyone in the exclusion area. NMPC owns about 364 ha (900 acres) of the total 647 ha (1600 acres) of land in the combined exclusion area.

Second, beyond and surrounding the exclusion area is a low population zone (LPZ), also required by 10 CFR 100. The LPZ for the NMP site is a circular area with a 6.4-km (4-mile) radius measured from the NMP-1 stack. Except for Lake Ontario, the LPZ consists mostly of wooded and agricultural land. There is some limited recreational activity on the lake. Within the LPZ the applicant must ensure that there is a reasonable probability that appropriate protective measures could be taken on behalf of the residents and other members of the public in the event of a serious accident. The applicant has indicated that there were about 2093 persons residing in the LPZ in 1980, and projects the population to increase to about 4372 by the year 2030. In case of a radiological emergency, the applicant has made arrangements to carry out protective actions, including evacuation of personnel in the vicinity of the NMP station. For further details, see the following section on Emergency Preparedness.

Third, 10 CFR 100 also requires that the distance from the reactor to the nearest boundary of a densely populated area containing more than about 25,000 residents be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ. Because accidents of greater potential hazard than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to add the population center distance requirements in 10 CFR 100 to provide for protection against excessive doses to people in large centers. The city of Syracuse, New York, with its closest boundary about 44.8 km (28 miles) south-southeast of the site, is the most densely populated center near the plant. The population of Syracuse was 170,105 in 1980. The distance from the site to Syracuse is at least one and one-third times the distance to the outer boundary of the LPZ. The closest political boundary of Oswego is about 7.2 km (4.5 miles) southwest of the site, but the closest residential area is about 8.8 km (5.5 miles) away. The area between 7.2 and 8.5 km from the site is used for industrial purposes, and residential expansion in this area is unlikely. In addition, the population of Oswego decreased from 22,155 in 1960 to 19,793 in 1980. The largest city within 120 km (75 miles) of the site, other than Syracuse, is Rochester, New York. In 1980, Rochester, which is about 104 km (65 miles) west-southwest of the site, had a population of 241,741. The population density within 48 km (30 miles) of the site when the plant is scheduled to go into operation (about 1986) is projected to be 62 persons per km^2 (160 persons per square mile), and is not expected to exceed 118 persons per km^2 (305 persons per square mile) during the life of the plant.

The safety evaluation of the NMP-2 site has also included a review of potential external hazards (activities off the site that might adversely affect the operation of the plant and cause an accident). The review encompassed nearby industrial, transportation, and military facilities that might create explosive, missile, toxic gas, or similar hazards. The risk to NMP-2 from such hazards has been found to be negligibly small. Compliance with the Commission's siting criteria with respect to both natural (e.g., earthquakes and floods) and hazards resulting from industrial transportation, and military activities in the area will be discussed in more detail in the SER.

(3) Emergency Preparedness

Emergency preparedness plans including protective action measures for NMP-2 have been developed by the applicant and, for offsite areas, by state and local authorities. The onsite plans are being reviewed by the NRC, while the Federal Emergency Management Agency (FEMA) is reviewing the offsite plans. In accordance with the provisions of 10 CFR 50.47, effective November 3, 1980, an operating license will not be issued to the applicant unless a finding is made by the NRC that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Among the standards that must be met by these plans are provisions for two emergency planning zones (EPZs). A plume exposure pathway EPZ of about 16 km (10 miles) in radius and an ingestion exposure pathway EPZ of about 80 km (50 miles) in radius are required. Other standards include appropriate ranges of protective actions for each of these zones, provisions for dissemination to the public of basic emergency planning information, provisions for rapid notification of the public during a serious reactor emergency, and methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences in the EPZs of an accidental radiological release.

NMP-2 is adjacent to a licensed commercial power reactor, NMP-1, which is operated by the applicant. The offsite plans and much of the onsite plans are common to both units.

NRC and FEMA have agreed that FEMA will make a finding and determination as to the adequacy of state and local government emergency response plans. NRC will determine the adequacy of the applicant's emergency response plans with respect to the standards listed in 10 CFR 50.47(b), the requirements of Appendix E to 10 CFR 50, and the guidance in NUREG-0654, Revision 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," dated November 1980. After the above determinations by NRC and FEMA, the NRC will make a finding in the licensing process as to the overall and integrated state of preparedness. The NRC staff findings will be reported in the SER.

5.9.4.5 Accident Risk and Impact Assessment

(1) Design-Basis Accidents

As a means of ensuring that certain features important to safety of the NMP-2 facility meet acceptable design and performance criteria, both the applicant and the staff have analyzed the potential consequences of a number of postulated accidents. Some of these could lead to significant releases of radioactive materials to the environment, and calculations have been performed to estimate the potential radiological consequences to persons off site. For each postulated initiating event, the potential radiological consequences cover a considerable range of values, depending upon the particular course taken by the accident and related conditions, including wind direction and weather, prevalent during the accident.

In the NMP-2 safety analysis and evaluation, three categories of accidents have been considered by the applicant and the staff. These categories are based on probability of occurrence and include (1) incidents of moderate frequency (events that can reasonably be expected to occur during any year of operation); (2) infrequent accidents (events that might occur once during the lifetime of the plant); and (3) limiting faults (accidents that are not expected to occur, but that have the potential for significant releases of radioactivity). The radiological consequences of incidents in the first category, also called anticipated operational occurrences, are similar to the consequences from normal operation that are discussed in Section 5.9.3. Some of the accidents postulated in the second and third categories for NMP-2 are shown in Table 5.7. These events are designated design-basis accidents in that specific design and operating features such as described in Section 5.9.4.4(1) are provided to limit their potential radiological consequences. Approximate radiation doses that might be received by a person at the exclusion area boundary are also shown in the table, along with a characterization of the duration of the releases. The results shown in the table reflect a realistic estimate of the potential individual radiation exposures from the initiating accidents in Table 5.7. These estimates are only small fractions of the yearly dose guideline of 0.5 rem specified in 10 CFR 20. The applicant also made realistic calculations of the radiological doses at the exclusion area boundary (ER-OL), which yielded lower estimated doses than shown in Table 5.7.

None of the calculations of the impacts of design-basis accidents described in this section take into consideration possible reductions in individual or population exposures as a result of any protective actions.

(2) Probabilistic Assessment of Severe Accidents

In this and the following three sections, there is a discussion of the probabilities and consequences of accidents of greater severity than the design-basis accidents discussed in the previous section. As a class, they are considered less likely to occur, but their consequences could be more severe for both the plant itself and for the environment. These severe accidents are different from design-basis accidents in two primary respects: they all involve substantial physical deterioration of the fuel in the reactor core to the point of melting, and they involve deterioration of the capability of the containment structure to perform its intended function of limiting the release of radioactive materials to the environment. It should be understood that even the very severe reactor accidents, unlike weapons, would not result in blast and in high pressure- and high temperature-related consequences to the public or to the environment.

The assessment methodology employed is essentially as described in the reactor safety study (RSS, WASH-1400), which was published in 1975 (NUREG-75/014), but includes improvements in the assessment methodology after publication of the

RSS* (such as thermal-hydraulic models, core melt phenomenology, and containment response analysis).

Accident sequences initiated by internal causes that are used in the staff analysis are described in Appendix H to this report, based on a review of a similar plant (Limerick) and consideration of recent design improvements at NMP-2 to reduce the probability of anticipated transients without scram. External events that might initiate severe accidents were not considered, except for loss of offsite power. For those sites for which externally initiated events were considered, the early fatality risk from externally initiated accidents was from 2 to 30 times that of internally initiated accidents, but for other risks were comparable or less. Accident sequences are grouped into release categories based upon similarities of the sequences regarding core-melt accident progression, containment failure characteristics, and the parameters of atmospheric release of radionuclides required for consequence analysis.

Table 5.8 provides information used in the staff's consequence assessment for each specific release category and summarizes the staff analysis described in Appendix H. The information includes time estimates from termination of the fission process during the accident until the beginning of release to the environment (release time), duration of the atmospheric release, warning time for offsite evacuation, estimates of the energy associated with each release, height of the release location above the ground level, and fractions of the core inventory (see Table 5.6) of seven groups of radionuclides in each release. The radionuclide release fractions shown in Table 5.8 were derived using WASH-1400 radiochemistry assumptions of fission product releases from fuel and their attenuation through various elements of the primary system and containment (such as the suppression pool), and the methods of this derivation are outlined in Appendix H. The staff's estimate of the probability associated with each release category used in the staff analysis is also shown in Table 5.8. As described in the RSS, there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in the data base on failure rates of individual plant components (NUREG/CR-0400). These uncertainties are discussed in Section 5.9.4.5(7).

The magnitudes (curies) of radioactivity released to the atmosphere for each accident sequence or release category are obtained by multiplying the release fractions shown in Table 5.8 by the maximum amounts predicted to be in the NMP-2 core, and by a factor accounting for decay prior to release. The core inventory of radionuclides is shown in Table 5.6 for NMP-2 at a core thermal power level of 3466 MWt. This is the power level used in the FSAR for analysis of radiological consequences and is used here instead of the 3323 MWt expected maximum power to account for power density variations and instrument error in measurement of power levels normally present in operating reactors. The 54 nuclides shown in the table represent those (of the hundreds actually expected

*However, there are large uncertainties in the assessment methodology and the results derived from its application. A discussion of the uncertainties is provided in Section 5.9.4.5(7) of this statement. Large uncertainties in event frequencies and other areas of risk analysis arise, in part, from similar causes in all plant and site assessments; hence the results are better used in carefully constructed comparisons rather than as absolute values.

to be present in the operating plant) that are potentially major contributors to the health and economic effects of severe accidents. They were selected on the basis of the half-life of the nuclide, consideration of the health effects of daughter products, and the approximate relative offsite dose contribution.

The potential radiological consequences of these releases have been calculated by the computer code CRAC, based on the consequence model used in the RSS (see also, NUREG-0340 and NUREG/CR-2300), adapted and modified as described below to apply to a specific site. The essential elements are shown in schematic form in Figure 5.4. Environmental parameters specific to the NMP-2 site have been used and include

(1) meteorological data for the site representing a full year (1975) of consecutive hourly measurements and seasonal variations with good data recovery characteristics (annual average probabilities of wind blowing into 16 directions of the compass are shown in Table 5.9)

(2) projected population for the year 2010 extending throughout regions of 80-km (50-mile) and 563-km (350-mile) radius from the site

(3) the habitable land fraction within a 563-km (350-mile) radius

(4) land-use statistics on a statewide basis, including farm land values, farm product values including dairy production, and growing season information, for the State of New York and each surrounding state within the 563-km (350-mile) region

For the region beyond 563 km (350 miles), the U.S. average population density was assumed.

The calculation was extended out to 3200 km (2000 miles) from the site to account for the residual radionuclides that would remain in the atmosphere at large distances, with rain assumed in the interval between 563 km and 3200 km to deplete the plume of all non-noble-gas inventory. To obtain a probability distribution of consequences, calculations were performed assuming the occurrence of each release category at each of 91 different "start" times distributed throughout a 1-year period. Each calculation used site-specific hourly meteorological data and seasonal information for the period following each start time.

The consequence model was also used to evaluate the consequence reduction benefits of offsite emergency response such as evacuation, relocation, and other protective actions. Early evacuation and relocation of people would considerably reduce the exposure from the radioactive cloud and the contaminated ground in the wake of the cloud passage. The evacuation model used (see Appendix I) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the NMP-2 site are estimates made by the staff (see Table 5.10 for a summary of emergency response assumptions). There may be some people near a site who cannot be notified or who may choose not to evacuate. Also, there normally would be some facilities near a plant, such as schools or hospitals, where special equipment or personnel may be required to effect evacuation. Therefore, actual evacuation effectiveness could be greater or less than that characterized, but it would not be expected to be very much less, because special consideration will be given in emergency planning to any unique aspects of dealing with special facilities in the area around and the adjacent Fitz-Patrick units.

The other protective actions include (1) either complete denial of use (interdiction) or denial of use until there has been appropriate decontamination of food stuffs such as crops and milk, (2) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of contamination to protective action guide (PAG)* levels, and (3) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels are reduced to such values by radioactive decay and weathering that land and property can be economically decontaminated as in (2) above. These actions would reduce the radiological exposure to the people from immediate and/or subsequent use of, or living in, the contaminated environment, but would also result in costs of implementation. Lowering the PAG levels would lower the delayed health effects but would increase costs.

Early evacuation within and early relocation of people from outside the plume exposure pathway zone (see Appendix I) and other protective actions as mentioned above are considered essential sequels to serious nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for NMP-2 include the benefits of these protective actions.

There are also uncertainties in each facet of the estimates of consequences and the error bounds may be as large as they are for the probabilities (see Figure 5.4).

The results of the calculations using this consequence model are radiological doses to individuals and to populations, health effects that might result from these exposures, costs of implementing protective actions, and costs associated with property damage by radioactive contamination.

(3) Dose and Health Impacts of Atmospheric Releases

The results of the staff calculations of the environmental dispersion of radioactive releases to the atmosphere and the radiological dose to people and health impacts performed for NMP-2 are presented in the form of probability distributions in Figures 5.5 through 5.8 and are included in the impact summary table Table 5.11. The graphs in Figures 5.5 through 5.8 display a type of probability distribution called a complementary cumulative distribution function (CCDF). CCDFs show the relationship between the probability of a type of

*The PAG levels used in the CRAC analyses are different than those drafted by the U.S. Environmental Protection Agency (EPA-520/1-75-001, September 1975) or by the U.S. Department of Health and Human Services (47 FR 47073, October 22, 1982) for reactor accidents. The PAG levels used are defined in Table VI 11-6 of WASH-1400, and were based on the recommendations of the former U.S. Federal Radiation Council and the British Medical Research Council. However, for control of long-term external irradiation, the staff used the PAG level for urban areas in WASH-1400 Table VI 11-6 for both urban and rural areas.

accident consequence being equaled or exceeded, and the magnitude of the consequence. These graphs are useful in visualizing the degree to which the probability of occurrence of consequences decreases as the magnitude of the consequence increases. Probability per reactor-year* is the chance that a given event would occur or a given consequence magnitude would be exceeded in 1 year of operation for one reactor. Different accident releases and atmospheric dispersion conditions, source-term magnitudes, and dose effects result in wide ranges of calculated magnitudes of consequences. Similarly, probabilities of equaling or exceeding a given consequence magnitude would also vary over a wide range because of varying probabilities of accidents and dispersion conditions.** Therefore, the CCDFs are presented as logarithmic plots in which numbers varying over a large range can be conveniently shown on a graph scaled in powers of 10. For example, a consequence magnitude of 10^6 means a consequence magnitude of one million (1 followed by six zeroes); a probability of 10^{-6} per reactor-year means a chance of 1 in one million or one millionth (0.000001) per reactor-year. All release categories shown in Table 5.8 contribute to the results; the consequences of each are weighted by its associated probability.

Figure 5.5 shows the probability distribution for the number of persons who might receive whole-body doses equal to or greater than 25 rems, total bone marrow doses equal to or greater than 200 rems, and thyroid doses equal to or greater than 300 rems from early exposure,*** all on a per reactor-year basis. The 200-rem total bone marrow dose figure corresponds, approximately, to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole-body dose (which has been identified earlier as the lower limit for a clinically observable physiological effect in nearly all people) and the 300-rem thyroid dose figures correspond to the Commission's guideline values for reactor siting in 10 CFR 100.

Figure 5.5 shows in the left-hand portion that there are, approximately, 35 chances in 1 million (3.5×10^{-5}) per reactor-year that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that the three curves run almost parallel in horizontal lines initially shows that if one person were to receive such doses, the chances are about the same that up to 30 would be so exposed. The chances of larger numbers of persons being exposed at those levels are seen to be considerably smaller. For example, the chances are less than 1 in 10 million (10^{-7}) that 10,000 or more people might receive bone marrow doses of 200 rems or greater. Virtually all the doses reflected in this figure would be expected to occur to persons within a 80-km (50-mile) radius of the plant.

Figure 5.6 shows the probability distribution for the total population exposure in person-rems; that is, the probability per reactor-year that the total

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*ry in the plots means reactor-year.

**See (7) below for further discussion of areas of uncertainty.

***Early exposure to an individual includes external doses from the radioactive cloud and the contaminated ground, and the dose from internally deposited radionuclides from inhalation of contaminated air during the cloud passage. Other pathways of exposures are excluded.

population exposure will equal or exceed the values given. Most of the population exposure up to 500,000 person-rems would occur within 80 km (50 miles), but very severe releases would result in exposure to persons beyond the 80-km (50-mile) range, as shown.

For perspective, population doses shown in Figure 5.6 may be compared with the annual average dose to the population within 80 km (50 miles) of the NMP-2 site resulting from natural background radiation of about 120,000 person-rems, and to the anticipated annual population dose to the general public (total U.S.) from normal plant operation of about 35 person-rems (Appendix D, Tables D.7 and D.8).

Figure 5.7 represents the statistical relationship between population exposure and the induction of fatal cancers that might appear over a period of many years following accidental exposure. The impacts on the total population and the population within 80 km (50 miles) are shown separately. Further, the fatal latent cancer estimates have been subdivided into those attributable to exposures of the thyroid and all other organs. Less than one-third of the latent cancer (including thyroid) fatalities would occur within 80 km (50 miles) of the plant.

Figure 5.8 shows the probability distribution of early fatalities. This calculated distribution reflects the assumption of severely exposed people benefiting from supportive medical treatment. All early fatalities would be expected to be within 16 km (10 miles) of the plant. As discussed in Appendix I, because it is possible that for very severe but low probability accidents some of the people requiring supportive medical treatment may not receive it, the consequences at the low-probability end of the spectrum may be somewhat higher than shown.

An additional potential pathway for doses resulting from atmospheric release is from fallout onto open bodies of water. This pathway has been investigated in the NRC analysis of the Fermi Unit 2 plant, which is located on Lake Erie and for which appreciable fractions of radionuclides in the plume could be deposited in the Great Lakes (NUREG-0769). It was found that for the Fermi site, the computed individual and societal doses from this pathway were smaller than the interdicted doses from other pathways. Further, the individual and societal liquid pathway doses could be substantially eliminated by the interdiction of the aquatic food pathway in a manner comparable to interdiction of the terrestrial food pathway in the present analysis. Radioactive material accidentally released from NMP-2 would, depending on the wind direction, fall out onto Lake Ontario, other lakes or reservoirs, or on land and eventually run off. The staff has also considered fallout onto, and runoff and leaching into, water bodies in connection with a study of severe accidents at the Indian Point reactors in southeastern New York (Codell, 1982-1983). In this study, empirical models were developed based upon considerations of radionuclide data from samples collected after fallout from atmospheric weapons tests. As with the Fermi study, the Indian Point evaluation indicated that the uninterdicted risks from this pathway were fractions of the interdicted risks from other pathways. Further, if interdicted in a manner similar to interdiction assumed for other pathways, the liquid pathway risk from fallout would be a very small fraction of the risks from other pathways. Considering the regional meteorology and hydrology, the staff sees nothing to indicate that the liquid pathway contribution to the total accident risk from NMP-2 is significantly greater than found for Fermi 2 and Indian Point. Therefore, the staff concludes that the water pathway would be of small importance compared to the results presented here for fallout onto land.

(4) Economic and Societal Impacts

As noted in Section 5.9.4.2, the various measures for avoiding adverse health effects, including those resulting from residual radioactive contamination in the environment, are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for the NMP-2 and environs also have been made (NUREG-0340 describes the model used). Unlike the radiation exposure and health effect impacts discussed above, impacts associated with avoiding adverse health effects are more readily transformed into economic impacts.

The results are shown as the probability distribution for cost of offsite mitigating actions in Figure 5.9 and are included in the impact summary Table 5.11. The factors contributing to these estimated costs include the following:

- evacuation costs
- value of crops contaminated and condemned
- value of milk contaminated and condemned
- costs of decontamination of property where practical
- indirect costs resulting from the loss of use of property and incomes derived therefrom

The last-named costs would derive from the necessity for interdiction to prevent the use of property until it is either free of contamination or can be economically decontaminated.

Figure 5.9 shows that at the extreme end of the accident spectrum these costs could exceed billions of dollars, but that the probability that this would occur is exceedingly small (about one chance in 1 million per reactor-year).

Additional economic impacts that can be considered include costs of related health effects, cost of regional industrial impacts, costs of decontamination of the facility itself, and the costs of replacement power. Probability distributions for these impacts have not been calculated, but they are included in the discussion of risk considerations in Section 5.9.4.5(6) below.

The geographical extent of the kinds of impacts discussed above, as well as many other types of impacts, is a function of several factors. For example, the dispersion conditions and wind direction following a reactor accident, the type of accident, and the magnitude of the release of radioactive material are all important in determining the geographical extent of such impacts. Because of these large inherent uncertainties, the values presented herein are mean values of the important types of risk based upon the methodology employed in the accident consequence model (NUREG-0340; NUREG/CR-2300) and do not indicate specific geographical areas.

(5) Releases to Groundwater

A pathway for public radiation exposure and environmental contamination that would be unique for severe reactors accidents was identified above. Consideration has been given to the potential environmental impacts of this pathway for NMP-2. The principal contributors to the risk are core melt accidents such as those shown in Table 5.8, some of which will result in the core slumping out of the vessel and attacking the basemat. The penetration of the basemat of the containment building can release molten core debris to the strata beneath the plant. The soluble radionuclides in this debris can be leached and transported with groundwater to downgradient domestic wells used for drinking water or to surface water bodies used for drinking water, aquatic food, and recreation. Releases of radioactivity to the groundwater underlying the site could also occur via depressurization of the containment atmosphere or via leakage of radioactive ECCS and sump water through the failed containment.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the liquid pathway generic study (LPGS). The LPGS compares the risk of accidents involving the liquid pathway (drinking water, aquatic food, swimming, and shoreline usage) for five conventional, generic land-based nuclear plants and a floating nuclear plant (for which the nuclear reactors would be mounted on a barge and moored in a water body). Parameters for the land-based sites were chosen to represent averages for a wide range of real sites and are thus typical, but represent no real site in particular.

Doses to individuals and populations were calculated in the LPGS without consideration of interdiction methods such as isolating the contaminated groundwater or denying use of the water. In the event of surface water contamination, alternative sources of water for drinking, irrigation, and industrial uses would be expected to be found, if necessary. Commercial and sport fishing as well as many other water-related activities would be restricted. The consequences would, therefore, be largely economic or social, rather than radiological. In any event, the individual and population doses for the liquid pathway range from fractions to very small fractions of those that can arise from the airborne pathways.

The discussion in this section is a summary of an analysis performed to compare the liquid pathway consequences of a postulated core-melt accident at Nine Mile Point with that of the generic Great Lakes land-based site considered in the LPGS. The method consists of a direct scaling of LPGS population doses based on the relative values of key parameters characterizing the LPGS Great Lakes land-based site and the Nine Mile Point site. The parameters that were evaluated include the amounts of radioactive materials entering the ground, groundwater travel time, and sorption on geological media. For this site, it was not necessary to make comparisons past the lake boundary, because the long groundwater travel time will reduce the source term to essentially zero at that boundary, as explained below.

Beneath the Nine Mile Point site the hydrogeologic units in descending order are: Unlithified Sediments, Oswego Sandstone, Pulaski Formation and Whetstone Gulf Formation. Groundwater is available from an unconfined aquifer and deep confined aquifers. The unconfined aquifer is composed of glacial till and fill material (Unlithified Sediments), and the upper portion of the Oswego Sandstone beneath the soil. The unconsolidated deposits rest on a permeable fractured zone at the top of the Oswego Sandstone. As the depth increases in the sandstone, the number of fractures decreases, with the formation becoming relatively impermeable within approximately 20 feet. The local water table varies from 261 feet msl to the lake level (244 feet msl), with an annual variation of about 2 feet. The average gradient is noth-northwest toward Lake Ontario. The deep confined aquifers are within the Pulaski and Whetstone Gulf Formations. The local groundwater systems are more fully described in FSAR Section 2.4.13.

At the site, the top of bedrock is about elevation 245 feet msl and ground elevation is about 260 feet msl. The containment basemat, at about elevation 163 feet msl, is in the Pulaski Formation. The RSS (NUREG-75/014), using bounding heat transfer calculations, estimated that the core-soil mass from a postulated core melt release would form a cylinder about 15 m (50 feet) high, with a diameter of about 21 m (70 feet). The core-soil mass would thus be expected to penetrate to about elevation 113 feet msl, which is about the top of the Whetstone Gulf Formation. Because the Whetstone Gulf Formation is somewhat less permeable than the Pulaski Formation, the staff used parameters from the latter to evaluate radionuclide migration times.

NMP-2 has a permanent dewatering system that is not safety related. That is, the structural design does not take any credit for the dewatering system. The plant dewatering system consists of perimeter drains and two sumps located below the reactor building. Pumping from these sumps will be continuous during plant operation, and the groundwater table in the reactor building area will be maintained below the reactor mat elevation. The two sump pumps discharge groundwater at the rate of 0.013 m^3/sec (200 gpm) to maintain the cone of depression. This water is then discharged to Lake Ontario through a storm drain system. In the event of a core-melt release, the dewatering system could either be shut off or used to collect and process radioactivity leached from the residual core-soil mass. The staff analysis assumes that the pumps would be shut off, with no credit taken for the cone of depression that would exist and delay nuclide migration.

The staff also considered possible pathways from the confined to unconfined aquifers. The space between the reactor building walls and the excavated rock walls is backfilled with concrete from the basemat elevation (175.0 feet) to top of rock, about elevation 246.0 feet. The top 20 feet of the Oswego Sandstone (down to about elevation 226.0 feet) is permeable, but below elevation 226.0 feet the sandstone is virtually impermeable. Thus, there is no pathway along the building walls from the confined to unconfined aquifers. The dewatering system, which is below elevation 175.0 feet, directs collected groundwater to two sumps outside the reactor building walls. Each sump is connected to the surface by a 1-m (3.0-foot)-diameter steel and concrete pipe. If the dewatering system pumps are shut off following a core-melt accident, water from the confined aquifer could rise in the 1-m (3.0-foot)-diameter pipe to a static level of about elevation 250.0 feet, but could not reach the surface or the unconfined aquifer. The staff concludes that there is no credible direct pathway from the confined aquifer to the unconfined aquifer. Any contaminated water from a postulated core-melt release into the confined aquifer would thus remain in that aquifer and migrate through it in a downgradient direction toward Lake Ontario.

The surface water body of interest is Lake Ontario, the easternmost of the Great Lakes. NMP-2 is located on the western portion of the Nine Mile Point promontory, approximately 180 m (600 feet) from the southeastern shore of Lake Ontario. The groundwater travel time for the 183-meter (600-foot) distance to the lake is estimated to be 6.3 years. This groundwater travel time is based on an average permeability of 63 m (207 feet) per year, a gradient of 0.0183, and an effective porosity of 4%.

The LPGS demonstrated (NUREG-0440) that for travel times on the order of years virtually all of the population dose from the liquid pathway in an assumed core-melt accident would result from Sr-90 and Cs-137. These chemically active nuclides would, however, travel through the groundwater pathway at a much slower rate because of the process of sorption onto the soil and rock media. The degree of retardation is governed by the various physical properties such as bulk density, aquifer porosity, and species equilibrium distribution coefefficient. The retardation factors were calculated using equilibrium distribution coefficients (K_d) of 8.3 cm^3/gm for Sr-90 and 309 cm^3/gm for Cs-137.

These equilibrium distribution coefficients were derived from an extensive literature search and are at the low end of the range of values given by Isherwood (NUREG/CR-0912). The calculated retardation factors for Cs-137 and Sr-90 are 9065 and 245, respectively.

The effective radionuclide travel time to Lake Ontario is determined by multiplying the groundwater travel time by the retardation factor. The radionuclide travel times for Cs-137 and Sr-90 are 57,110 years and 1,540 years, respectively.

As a result of radioactive decay during these long travel times, virtually none of the Cs-137 and Sr-90 would reach the lake. This compares to 0.87 and 0.31 for the fractions of Cs-137 and Sr-90 that would reach the lake in the LPGS Great Lakes case. Thus, without further analysis of actual drinking water populations, aquatic food consumption, and shoreline usage, the staff can conclude that the liquid pathway consequences of an assumed core-melt accident at NMP-2 would be considerably less than that calculated in the LPGS. The staff therefore concludes that NMP-2 is not unusual in its liquid pathway contribution to risk when compared to other land-based sites in the LPGS.

Finally, there are measures that could be taken to further minimize the impact of the liquid pathway. The staff has conservatively estimated that the minimum groundwater travel time from the containment building to the nearest site boundary, which is Lake Ontario, would be about 6.3 years. This would allow ample time for engineering measures such as well point dewatering to isolate the radioactive contamination near the source and to establish a groundwater monitoring program that would ensure early detection if any contaminants should escape the immediate plant area. A comprehensive discussion of these and other mitigation methods potentially applicable to Nine Mile Point is in Harris 1982a and b.

(6) Risk Considerations

The foregoing discussions have dealt with both the probability, per year of operation, of accidents and their impacts (or consequences). Because the ranges of both factors are quite broad, it also is useful to combine them to obtain average measures of environmental risks. Such averages can permit a useful comparison of the impact on the public from radiological risks from accidental releases, both to the impact from normal operational releases, and to the impact from other forms of risk. Any comparison, however, should be tempered with consideration of the uncertainties in estimated values (see (7) below).

A common way in which this combination of factors is used to estimate risk is to multiply probabilities by the consequences. The resultant risk is then expressed as a measure of consequences per unit of time. Such a quantification of risk does not mean that there is universal agreement that peoples' attitudes about risks, or what constitutes an acceptable risk, can or should be governed solely by such a measure. However, it can be a contributing factor to a risk judgment, although not necessarily a decisive factor.

Table 5.11 shows societal risk estimates associated with population dose, early fatalities with supportive medical treatment, early fatalities with minimal medical treatment, early injuries, latent cancer fatalities, total person-rems, costs for evacuation and other protective actions, regional industrial impacts, plant costs, and land area for long-term interdiction. These risk values are obtained by multiplying the probabilities by the consequences, then summing this product over the entire range of consequences. Because the probabilities are on a per-reactor-year basis, the risks shown also are on a per-reactor-year basis.

The population exposures and latent cancer fatality risks may be compared with those from normal operation shown in Appendix D and Section 5.9.3.2 of this statement. The comparison (excluding exposure to station personnel) shows that the accident risks are about 9 times higher. For a different perspective, the latent cancer (including thyroid) fatality risks of 7×10^{-3} persons per reactor-year within the 80 km (50-mile) region (from Table 5.12) may be compared with such risks from causes other than reactor accidents. Approximately 1.2 million persons are projected to live within the 80-km region in the year 2010. The average background cancer mortality rate is 1.9×10^{-3} cancer fatality per person per year in the U.S (American Cancer Society, 1981). Therefore, at this rate, about 2300 background cancer fatalities per year are expected in the population within the 80-km region in the year 2010. Thus, the risk of cancer fatality from reactor accidents at NMP-2 is small compared to the risk of normal occurrence of such fatality.

There are no early fatality, early injury, long-term land interdiction, or economic risks associated with protective actions and decontamination for normal releases, but these risks can be associated with large accidental releases. For perspective and understanding of the meaning of the early fatality risk of 2×10^{-4} persons per reactor-year with supportive medical treatment and 4×10^{-4} persons per reactor-year with minimal medical treatment (from Table 5.11), the staff notes that occurrences of early fatalities with supportive and minimal medical treatments would be contained, approximately, within the 16-km (10-mile) and 48-km (30-mile) regions, respectively. The numbers of persons projected to live within these regions in the year 2010 are 56,000 and 280,000, respectively. The risk from non-nuclear accidents for the average individual in the U.S. is 5 x 10^{-4} accidental death per year (NUREG/CR-1916). Therefore, the expected number of non-NMP-2 accidental fatalities per year within the 16-km (10-mile) and 48-km (30-mile) regions are 28 and 140, respectively, in the year 2010. Thus, the risk of early fatality with supportive or minimal medical treatment from reactor accidents at NMP-2 is extremely small compared with that from non-NMP-2 accidents.

Figure 5.10 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the downwind distance from the plant within 80 km of the plant. The values are on a per-reactor-year basis, and all accident sequences and release categories contributed to the dose, weighted by their associated probabilities.

Evacuation and other protective actions can reduce the risk to an individual of early fatality or of latent cancer fatality. Figure 5.11 shows lines of constant risk, per reactor-year, to an individual living within the emergency planning zone of the NMP-2 site, of early fatality (as functions of distance) resulting from potential accidents in the reactor. The calculated risk of early fatality outside the 16-km radius is zero. Figure 5.12 shows curves of constant risk of latent cancer fatality. Directional variations in these plots reflect the variation in the average fraction of the year the wind would be blowing in different directions from the plant. For comparison, the following risks of fatality per year to an individual living in the United States may be noted (Nat'l Research Council, 1979, page 577): automobile accident 2.2 x 10^{-4}; falls, 7.7 x 10^{-5}; drowning, 3.1 x 10^{-5}; burning, 2.9 x 10^{-5}; and firearms, 1.2 x 10^{-5}. For comparison to the estimated latent cancer fatality risk to an individual from NMP-2 reactor accidents, note that the nonnuclear-related risk of cancer fatality in the U.S. is 0.0019 per year (American Cancer Society, 1981).

A severe accident that requires the interdiction and/or decontamination of land areas will force numerous businesses to temporarily or permanently close. These closures would have additional economic effects beyond the contaminated areas through the disruption of regional markets and sources of supplies. The following paragagraphs provide estimates of these impacts that were made using. (1) the RSS consequence model discussed elsewhere in this section, and (2) the Regional Input-Output Modeling System (RIMS II) developed by the Bureau of Economic Analysis (BEA).

The industrial impact model developed by BEA takes into account contamination levels of a physically affected area defined by the RSS consequence model. Contamination levels define an interdicted area immediately surrounding the plant, followed by an area of decontamination, an area of crop interdiction, and finally an area of milk interdiction. (The industry-specific impacts are estimated for areas representative of the accident sequences listed in Table 5.8.

Assumptions used in the analysis include

- In the interdicted area, all industries would lose total production for more than a year.
- In the decontamination zone, there would be a 3-month loss in nonagricultural output; a 1-year loss in all crop output (except no loss in greeenhouse, nursery, and forestry output); a 3-month loss in dairy output; and a 6-month loss in livestock and poultry output.
- In the crop-interdiction area, there would be no loss in nonagricultural output; a 1-year loss in agricultural output, except no loss in greenhouse, nursery, and forestry output; no loss in livestock and poultry output; and a 2-month loss of dairy output.
- In the milk-interdiction zone, there would be only a 2-month loss in dairy output.

The estimates of industrial impacts are made for an economic study area that consists of a physically affected area and a physically unaffected area. An accident which causes an adverse impact in the physically affected area (for example, the loss of agricultural output) could also adversely affect output in the physically unaffected area (for example food processing). In addition to the direct impacts in the physically affected area, the following additional impacts would occur in the physically unaffected area:

- decreased demand (in the physically affected area) for output produced in the physically unaffected area
- decreased availability of production inputs purchased from the physically affected area

Only the impacts occurring during the first year following an accident are considered. The longer term consequences are not considered because they will vary widely depending on the level and nature of efforts to mitigate the accident consequences and to decontaminate the physically affected areas. The estimates assume no compensating effects such as the use of unused capacity in the physically unaffected area to offset the initial lost production in the physically unaffected area or income payments to individuals displaced from their jobs that would enable them to maintain their spending habits. These compensating effects would reduce the industrial impacts. Realistically, these compensating effects would occur over a lengthy period. The estimates using no compensating effects are the best measures of first-year economic impacts.

Table 5.13 presents the regional economic output and employment impacts and corresponding expected risks associated with the different release categories. The estimated overall risk values using output losses as the measure of accident consequences, expressed in a per-reactor-year basis, is $3600. This number is composed of direct impacts of $1300 in the nonagricultural sector and $1900 in the agricultural sector, and indirect impacts of $400 from decreased export and supply constraints. The corresponding expected employment loss per reactor year is about one-third of a job.

It should be noted that about 20% of the expected losses or $694 results from releases occurring toward the south-southeast. On an absolute basis, the impacts from the series 4 category releases to the west-southwest are the greatest and would result in a loss of $2.8 billion and 120,000 jobs. The corresponding per-reactor-year risk is $350. Releases from the west through the north-northeast along Lake Ontario contribute nothing to the total expected loss.

The staff has also considered the health care costs resulting from hypothetical accidents in a generic model developed by Pacific Northwest Laboratory (Nieves, 1983). Based on this generic model, the staff concludes that such costs may be a fraction of the offsite costs evaluated herein, but that the model is not sufficiently constituted for application to a specific reactor site.

There are other risks that can be expressed pecuniarily that are not included in the cost calculations discussed earlier. These are accident impacts to the facility itself that result in added costs to the public. These costs would derive from decontamination and repair of the facility as well as from increased expenditures for replacement power while the unit is out of service. Experience with such costs is currently being accumulated as a result of the TMI-2 accident.

If an accident occurs during the first full year of operation of NMP-2, the associated economic penalty is estimated to total approximately $1900 million (1987 dollars) for decontamination and repair of the facility. This estimate is based on a conservative (high cost) 10% annual escalation of the $950 million (1980 dollars) repair cost estimate for TMI-2 (Comptroller General, 1981). Although insurance would cover $300 million or more of the repair costs, the insurance is not credited against this cost because the $300 million times the risk probability should theoretically balance the insurance premium. Increased annual production expenses will also be incurred by the New York Power Pool after a plant accident.

The staff requested the applicant to prepare a system cost analysis that shows the impact on production expenses resulting from the unavailability of NMP-2 (see the applicant's response to staff question No. 320.1, which was submitted under separate cover September 9, 1983). The staff's view is that the applicant's analysis provides a reasonable estimate of the Pool's increased annual production cost if NMP-2 is not available for service. The study indicates this increased cost will total approximately $160 million (1987 dollars) per year. The estimate assumes a conservatively high capacity factor of approximately 70% for NMP-2. The analysis also assumes replacement power will come primarily from coal-fueled units and interstate purchases. If it is assumed that the nuclear unit is unavailable for service for an 8-year period, replacement power costs will total about $1300 million (constant 1987 dollars).

The probability of a core melt or severe reactor damage is assumed to be about 1.1×10^{-4} per reactor-year. (This accident probability is intended to account for all severe core damage accidents leading to large economic consequences for the owner, not just those leading to significant offsite consequences.) Multiplying the sum of the previously estimated repair and replacement power costs of approximately $3100 million for an accident to the unit during the initial year of its operation by the above 1.1×10^{-4} probability results in an economic risk of approximately $350,000 during the first full year (1987 dollars, or, for the purpose of comparison with other costs presented in this section, $180,000 in 1980 dollars). This is also the approximate economic risk (in 1987 dollars) to NMP-2 during each subsequent year of operation, although this amount will gradually decrease as the nuclear unit depreciates in value and operates at a reduced annual capacity factor.

(7) Uncertainties

The probabilistic risk assessment discussed above has been based mostly on the methodology in the RSS, which was published in 1975. Although substantial improvements have been made in various facets of the RSS methodology since this publication was issued, there are still large uncertainties in the results of the analysis presented above because of the uncertainties associated with the likelihoods of the accident sequences and containment failure modes leading to the release categories, the source terms for the release categories, and the estimates of environmental consequences.

Relatively more important contributors to uncertainties in the results presented in this supplement are as follows:

- Probability of Occurrence of Accident

  If the probability of a release category were to be changed by a certain factor, the probabilities of various types of consequences from that release category would also change exactly by the same factor. Thus, an order of magnitude uncertainty in the probability of a release category would result in an order of magnitude uncertainty in both societal and individual risks stemming from the release category. As in the RSS, there are substantial uncertainties in the probabilities of the release categories. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in (1) the data base on failure rates of individual plant components, and (2) the data base on external events and their effects on plant systems and components that are used to calculate the probabilities.

- Quantity and Chemical Form of Radioactivity Released

  The models used in these calculations contain approximations to describe the physical behavior of the radionuclides, which affects the transport within the reactor vessel and other plant structures and the amounts of release. This relates to the quantity and chemical form of each radionuclide species that would be released from a reactor unit during a particular accident sequence. Such releases would originate in the fuel and would be attenuated by physical and chemical processes enroute to the environment. Depending on the accident sequence, immobilization or holdup of radionuclides in the reactor vessel, the primary cooling system, the containment, and adjacent buildings would influence both the magnitude and chemical form of radioactive releases. The releases of radionuclides to the environment, called source terms, used in the staff analysis were based on those determined from the staff's review of Limerick (see Appendix H), a BWR of very similar design. This analysis used RSS methodology. Information available in NUREG-0772 indicates that best-estimate source terms cannot be much greater than the larger source terms used in this analysis (release categories IV-T/DW and IV-T/WW of Table 5.8), but they could be substantially lower (except for noble gases) than the release categories used here for the same types of initiating accident sequences. On the other hand, some of the lower release fractions shown in Table 5.8 could be revised upward after further analysis, primarily because of the manner in which the source term was evaluated for early releases using the RSS methodology. The impact of smaller source terms would be substantially lower estimates of health effects, particularly early fatalities and injuries.

- <u>Atmospheric Dispersion Modeling for the Radioactive Plume Transport, Including the Physical and Chemical Behavior of Radionuclides in Particulate Form in the Atmosphere</u>

  This uncertainty is due to differences between the modeling of the atmospheric transport of radioactivity in gaseous and particulate states in the CRAC code and the actual transport, diffusion, and deposition or fallout that would occur during an accident (including the effects of precipitation). The phenomenon of plume rise because of heat that is associated with the atmospheric release, effects of precipitation on the plume, and fallout of particulate matter from the plume all have considerable impact on both the magnitude of early health consequences and the distance from the reactor to which these consequences would occur. The staff judgment is that these factors can result in substantial overestimates or underestimates of both early and later effects (health and economic).

- <u>Errors of Completeness, Modeling, Arithmetic, and Omission</u>

  This area of lumped uncertainty includes such topics as the omission of a model of sabotage, consideration of externally initiated accidents (except loss of offsite power), common cause failures, improvements in design or operating criteria undertaken or to be undertaken by the applicant, potential errors in the different models used to assess risks, errors associated with applying analyses from Limerick to NMP-2 (see Appendix H), statistical errors, and arithmetic errors. The impact on risk estimates of this class of uncertainty could be large, but is unknown and virtually impossible to quantify accurately (Rowsome, 1982). Uncertainties of this type are expected to be larger than for other reactors for which comprehensive probabilistic risk assessments were performed.

Other areas that have substantial but relatively less effect on uncertainty than the preceding items are

- <u>Duration and Energy of Release, Warning Time, and Inplant Radionuclide Decay Time</u>

  The assumed release duration, energy of release, and the warning and the inplant radioactivity decay times may differ from those that would actually occur during a real accident.

  For a relatively long duration atmospheric release (greater than a half-hour), the actual cross-wind spread (the width) of the radioactive plume that would develop would be likely to be larger than the width calculated by the dispersion model in CRAC. However, the effective width of the plume is calculated in the code using a plume expansion factor that is determined by the release duration. For a given quantity of radionuclides in a release, the plume and, therefore, the area that would come under its cover would become wider if the release duration were made longer. In effect, this would result in lower air and ground concentrations of radioactivity but a greater area of contamination.

The thermal energy associated with the release affects plume rise. Larger thermal energy results in relatively lower air and ground concentrations in the closer regions and relatively higher concentrations as a result of fallout in the more distant regions. Therefore, if a large amount of thermal energy were associated with a release containing large fractions of the core inventory of radionuclides, the distance from the reactor over which early health effects may occur is likely to be increased.

Warning time before evacuation has considerable impact on the effectiveness of offsite emergency response. Longer warning times would improve the effectiveness of the response.

The time from reactor shutdown until the beginning of the release to the environment (atmosphere), known as the time of release, is used to calculate the depletion of radionuclides by radioactive decay within the plant before release. The depletion factor for each radionuclide (determined by the radioactive decay constant and the time of release) multiplied by the release fraction of the radionuclide and its core inventory determines the actual quantity of the radionuclide released to the environment. Longer release times would result in release of fewer curies to the environment for given values of release fractions.

The first three of the parameters discussed above can have significant impacts on accident consequences, particularly early consequences. The staff judgment is that the estimates of early consequences and risks could be substantial underestimates or substantial overestimates, because of uncertainties in the first three parameters.

- <u>Meteorological Sampling Scheme Used</u>

The meteorological sequences used with the selected 91 start times (sampling) in the CRAC code may not adequately represent all meteorological variations that may occur over the life of the plant. This factor is judged to produce greater uncertainties for early effects and less for latent effects.

- <u>Emergency Response Effectiveness</u>

The modeling assumptions of the emergency response of the people residing around the NMP-2 site may not correspond to what would happen during an actual severe reactor accident. Included in these considerations are such subjects as evacuation effectiveness under different circumstances, possible sheltering and its effectiveness, and the effectiveness of population relocation. The staff judgment is that the uncertainties associated with emergency response effectiveness could cause large uncertainties in estimates of early health consequences. The uncertainties in estimates of latent health consequences and costs are considered smaller than those of early health consequences. A limited sensitivity analysis in this area is presented in Appendix I.

- <u>Dose Conversion Factors and Dose Response Relationships for Early Health Consequences, Including Benefits of Medical Treatment</u>

  There are many uncertainties associated with estimates of dose and early health effects on individuals exposed to high levels of radiation. Included are the uncertainties associated with the conversion of contamination levels to doses, relationships of doses to health effects, and considerations of the availability of what was described in the RSS as supportive medical treatment (a specialized medical treatment program of limited availability that would help minimize the early health effect consequences of high levels of radiation exposure following a severe reactor accident). The staff analysis shows that the variation in estimates of early fatality risks stemming from considerations of supportive medical treatment alone is about a factor of 3 for the NMP-2 site.

- <u>Dose Conversion Factors and Dose Response Relationships for Latent Health Consequences</u>

  In comparison to early health effects, there are even larger uncertainties associated with dose estimates and latent (delayed and long-term) health effects on individuals exposed to lower levels of radiation and the effects on their succeeding generations. Included are the uncertainties associated with conversion of contamination levels to doses and doses to health effects. The staff judgment is that this category has a large uncertainty. The uncertainty could result in relatively small underestimates of consequences, or it could result in substantial overestimates of consequences.

- <u>Chronic Exposure Pathways, Including Environmental Decontamination and the Fate of Deposited Radionuclides</u>

  Uncertainties are associated with chronic exposure pathways to people from long-term use of the contaminated environment. Uncertainty also arises from the possibility that the protective action guide levels that may actually be used for interdiction or decontamination of the exposure pathways may differ from those assumed in the staff analysis. Further, uncertainty arises as a result of the lack of precise knowledge about the fate of the radionuclides in the environment as influenced by such natural processes as runoff, weathering, etc. The staff's qualitative judgment is that the uncertainty from these considerations is substantial.

- <u>Economic Data and Modeling</u>

  There are uncertainties in the economic parameters and economic modeling, such as costs of evacuation, relocation, medical treatment, cost of decontamination of properties, and other costs of property damage. Uncertainty in this area could be substantial.

Fission Product Inventory

The fission product inventory presented in Table 5.6 is an approximation of that that would be present after extended operation at maximum power. The amount of each isotope listed will, in fact, vary with time in a manner dependent upon the fuel management scheme and the power history of the core. The actual inventory at the time of an accident could not be much larger for any isotope than the amount in Table 5.6, but, especially for long-lived fission products, it could be substantially smaller.

The means for quantitative evaluation of the uncertainties in a probabilistic risk analysis such as the type presented here are not well developed. The staff, however, has attempted to identify all sources of uncertainty, and to assess the net effect upon the uncertainty of the risk estimates. The risk estimates are equal to the integrals of the corresponding probability distributions of the consequences (CCDFs). As a result, errors in probabilities and consequences are partially offset. Because of the magnitude of uncertainties, the staff has concluded that estimates of the probabilities, consequences, and risks do not provide an accident perspective unless the uncertainties are also considered. It follows, therefore, that conclusions relating to the estimated value of a particular risk or consequence (e.g., the per-reactor-year chance of early fatality, or the number of early fatalities expected for a particular accident sequence, respectively) should be based also on the uncertainties associated with the estimates. Overall, it is the judgment of the staff that the risk uncertainty bounds could be well over a factor of 10 but not as large as a factor of 100.

When the accident at TMI-2 occurred in March 1979, the accumulated experience record was about 400 reactor-years. It is of interest to note that one per 400 reactor-years was within the range of frequencies estimated by the RSS for an accident of this severity (Nat'l Research Council, 1979, page 553).

It should also be noted that the TMI-2 accident has resulted in a very comprehensive evaluation of similar reactor accidents by a number of investigative groups both within and outside of the NRC. Actions to improve the safety of nuclear power plants have resulted from these investigations, including the President's Commission on the Accident at Three Mile Island, and from NRC staff investigations and task forces. A comprehensive "NRC Action Plan Developed as a Result of the TMI-2 Accident" (NUREG-0660, Vol I) collects the various recommendations of these groups and describes them under the subject areas of: Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Practices and Procedures; and NRC Policy, Organization, and Management. NUREG-0737, "Clarification of TMI Action Plan Requirements," and Supplement 1 to NUREG-0737 identified those requirements that were approved for implementation. The action plan presents a sequence of actions, some already taken, that results in gradually improving safety as individual actions are completed. NMP-2 is receiving and will receive the benefit of these actions on the schedule to be discussed in the SER. The improvement in safety from these actions has not been quantified, however.

(8) Comparison of NMP-2 Risks with Other Plants

To provide a perspective as to how NMP-2 compares in terms of risks from severe accidents with some of the other nuclear power plants that are either operating or that are being reviewed by the staff for possible issuance of a license to operate, the estimated risks from severe accidents for several nuclear power plants (including those for NMP-2) are shown in Figures 5.13 through 5.21 for three important categories of risk. The values for individual plants are based upon three types of estimates: from the RSS (labeled WASH-1400 Average Plant), from independent staff reviews of contemporary probabilistic risk assessments (Indian Point 2 and 3, Zion, and Limerick), and from generic applications of RSS methodology to reactor sites for environmental statements by the staff (for 25 nuclear power plants). Figure 5.13 indicates that the calculated risk of early fatality at NMP-2 is about at the median of the plants evaluated. Figures 5.16 and 5.19 show that the calculated risk of latent cancer fatalities and person-rems at NMP-2 is slightly higher than the median of the plants evaluated. Figures 5.14, 5.15, 5.17, 5.18, 5.20, and 5.21 explicitly show the ranges of estimated uncertainties for the three measures of risk.

5.9.4.6 Conclusions

The foregoing sections consider the potential environmental impacts from accidents at the NMP-2 station. These impacts have covered a broad spectrum of possible accidental releases of radioactive materials into the environment by atmospheric and liquid pathways. Included in the considerations are postulated design-basis accidents and more severe accident sequences that lead to a severely damaged reactor core or core melt. The applicant also considered similar accidents in the ER-OL. The staff, however, did not make use of the applicant's analysis.

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the estimated likelihood of core melt accidents, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe, but the likelihood of their occurrence is judged to be small and the resulting risks are comparable to that of other reactors. This conclusion is based on (1) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment; (2) the fact that, to obtain a license to operate, the NMP-2 station must comply with the applicable Commission regulations and requirements; (3) a comparison with the estimated core-melt probabilities of other reactors; and (4) a probabilistic assessment of the risk based upon the methodology developed in the RSS, improvements to the RSS methodology, and a sensitivity analysis of offsite emergency response modeling. The overall assessment of environmental risk of accidents, assuming protective actions, shows that the risks of population exposure and latent cancer fatality are within a factor of 9 of those from normal operation. Accidents have a potential for early fatalities and economic costs that cannot arise from normal operations; however, the risks of early fatality from potential accidents at the site are small in comparison with risks of early fatality from other human activities in a comparably sized population, and the accident risk will not add significantly to population exposure and cancer risks. Accident risks from NMP-2 are expected to be a small fraction of the risks the general public incurs from other sources. Further, the best estimate calculations show that the risks of potential reactor accidents at NMP-2 are within the range of such risks from other nuclear power plants.

Based on the foregoing considerations of environmental impacts of accidents, which have not been found to be significant, the staff has concluded that there are no special or unique circumstances about the NMP-2 site and environs that would warrant consideration of alternatives for NMP-2.

5.10 Impacts from the Uranium Fuel Cycle

The uranium fuel cycle rule, 10 CFR 51.51 (49 FR 9352) reflects the latest information relative to the reprocessing of spent fuel and to radioactive waste management, as discussed in NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," and NUREG-0216, which presents the staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the AEC report WASH-1248, "Environmental Survey of the Uranium Fuel Cycle." The NRC staff was also directed to develop an explanatory narrative that would convey in understandable terms the significance of releases in the table. The narrative was also to address such important fuel cycle impacts as environmental dose commitments and health effects, socioeconomic impacts, and cumulative impacts, where these are appropriate for generic treatment. A proposed explanatory narrative was published in the Federal Register on March 4, 1981 (46 FR 15154-15175). Appendix C to this report contains a number of sections that address those impacts of the LWR-supporting fuel cycle that reasonably appear to have significance for individual reactor licensing sufficient to warrant attention for NEPA purposes.

Table S-3 of the final rule is reproduced in its entirety as Table 5.14 herein.* Specific categories of natural resource use included in the table relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in the table for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

Appendix C to this report contains a description of the environmental impact assessment of the uranium fuel cycle as related to the operation of NMP-2. The environmental impacts are based on the values given in Table S-3, and on an analysis of the radiological impact for radon-222 and technetium-99 releases.

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*The U.S. Supreme Court has upheld the validity of the S-3 rule in Baltimore Gas & Electric Co., et al. v. Natural Resources Defense Council, Inc., No. 82-524, issued June 6, 1983, 51 U.S. Law Week 4678.

The NRC staff has determined that the environmental impact of this facility on the U.S. population from radioactive gaseous and liquid releases (including radon and technetium) due to the uranium fuel cycle is very small when compared with the impact of natural background radiation. In addition, the nonradiological impacts of the uranium fuel cycle have been found to be acceptable.

5.11 Decommissioning

The purposes of decommissioning are (1) to safely remove nuclear facilities from service and (2) to remove or isolate the associated radioactivity from the environment so that the part of the facility site is not permanently commited can be released for other uses. Alternative methods of accomplishing these purposes and the environmental impacts of each method are discussed in NUREG-0586.

Since 1960, 68 nuclear reactors--including 5 licensed reactors that had been used for the generation of electricity--have been or are in the process of being decommissioned. Although, to date, no large commercial reactor has undergone decommissioning, the broad base of experience gained from smaller facilities is generally relevant to the decommissioning of any type of nuclear facility.

Radiation doses to the public as a result of end-of-life decommissioning activities should be small; they will come primarily from the transportation of waste to appropriate repositories. Radiation doses to decommissioning workers should be well within the occupational exposure limits imposed by regulatory requirements.

The NRC is currently conducting rulemaking proceedings that will develop a more explicit overall policy for decommissioning commercial nuclear facilities. Specific licensing requirements are being considered that include the development of decommissioning plans and financial arrangements for decommissioning nuclear facilities.

The applicant's estimate of decommissioning costs is in Section 6.4.3.

5.12 Noise

An evaluation of the impact of noise from NMP-2 was included in the 1981 report on the environmental effects from the change in cooling systems (Appendix G). The conclusions of that assessment remain valid.

5.13 Emergency Planning Impacts

In connection with the promulgation of the Commission's upgraded emergency planning requirements, the NRC staff issued NUREG-0658, "Environmental Assessment for Effective Changes to 10 CFR Part 50 and Appendix E to 10 CFR Part 50; Emergency Planning Requirements for Nuclear Power Plants." The staff believes the only noteworthy potential source of impacts to the public from emergency planning would be associated with the testing of the early notification system.

The test requirements and noise levels will be consistent with those used for existing alert systems; therefore, the NRC staff concludes that the noise impacts from the system will be infrequent and insignificant.

5.14 Environmental Monitoring

5.14.1 Terrestrial Monitoring

In the analysis of the effects of changing the cooling system to a natural draft cooling tower (Appendix G), the staff concluded that no unacceptable botanical injury would result from the operation of the cooling tower (Appendix G, Section 5.1.3). The staff, nevertheless, believed it prudent to monitor for verification of the analysis (ibid). With 3 more years of experience in analyzing effects of cooling tower drift, the staff no longer believes it is necessary to monitor for possible damage when the drift deposition is as low as predicted for NMP-2. Should damage to vegetation occur, the applicant is still required to inform the NRC and provide an analysis of the problem, as well as to propose a course of action to alleviate the problem. This requirement will be specified in the Environmental Protection Plan (EPP) that will be included as an appendix to the operating license.

5.14.2 Aquatic Monitoring

The certification and permits required under the Clean Water Act provide the mechanisms for protection of water quality and aquatic biological resources in the vicinity of NMP-2. Aquatic monitoring will be required by the SPDES permit issued June 6, 1983 by the New York State Department of Environmental Conservation (Appendix E). The following are major provisions of that permit related to environmental monitoring at NMP-2:

(1) Effluent monitoring will be required for floor and equipment drains, cooling tower blowdown, and wastewater, including demineralizer regeneration wastes, filter backwash, floor drains, and treated radioactive waste (Appendix E, page 3).

(2) Effluent monitoring will be required for the discharge from the sanitary waste treatment plant (Appendix E, page 4).

(3) Water use and intake/discharge temperatures will be monitored (Appendix E, page 7).

(4) The applicant shall submit to the state a plan of study to verify the extent of the thermal plume in Lake Ontario (Appendix E, page 9).

(5) The applicant shall continue any biological studies in Lake Ontario required by regulatory agencies to monitor the effects of the Station (Appendix E, page 9).

The NRC will rely on the decisions made by the State of New York, under the authority of the Clean Water Act, for any aquatic monitoring or power plant design modification should that become necessary. An EPP that will be included as an appendix to the operating license for NMP-2 will contain requirements for prompt reporting to NRC by the licensee of any important or unusual events that potentially could result in significant environmental impact causally related to station operation. Examples of such events include fish kills; mortality of any species protected by the Endangered Species Act, as amended; increase in nuisance organisms or conditions; or any unanticipated or emergency discharge of waste water or chemical substances.

5.14.3 Atmospheric Monitoring

The pre-operational meteorological monitoring program described in the FSAR has provided wind speed and wind direction information measured at the 9-, 30-, and 61-m (30-, 100-, and 200-foot) levels.

Vertical temperature differences between the 8-m (27-foot) and 30-m (100-foot) level and the 8-m (27-foot) and 61-m (200-foot) level were also measured as an indicator of atmospheric stability to characterize gaseous effluent dispersion. In addition, dew point measurements were made on the tower at 8 m (25 feet), with precipitation and atmospheric pressure measured at ground level near the tower.

The operational meteorology program will utilize the primary 61-m (200-foot) tower used for pre-operational measurements with the addition of new sensors at the same levels. To satisfy requirements for emergency preparedness meteorological monitoring, a 27-m (90-foot) utility pole near the adjacent FitzPatrick plant provides backup wind-direction and speed measurements. Finally, an inland 10-m (33-foot) tower at the Oswego Airport provides wind speed and direction and the lateral change in wind direction(sigma-theta, a backup stability indicator).

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---, RG 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water-Cooled Nuclear Power Plants," Revision 1, June 1974.

---, RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

---, RG 4.1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," Revision 1, April 1975.

---, RG 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable," Revision 3, June 1978.

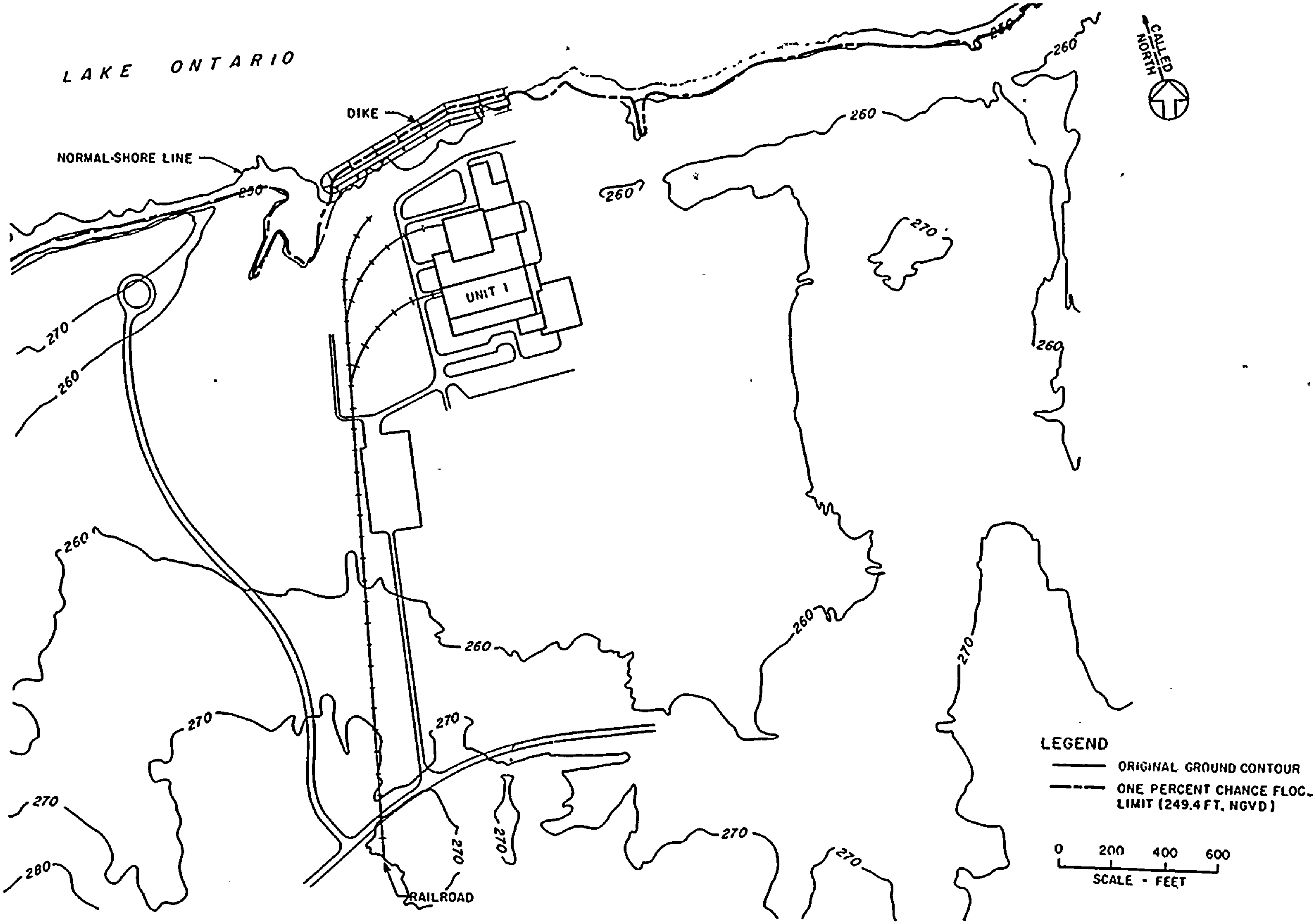

Figure 5.1 100-year floodplain, pre-construction

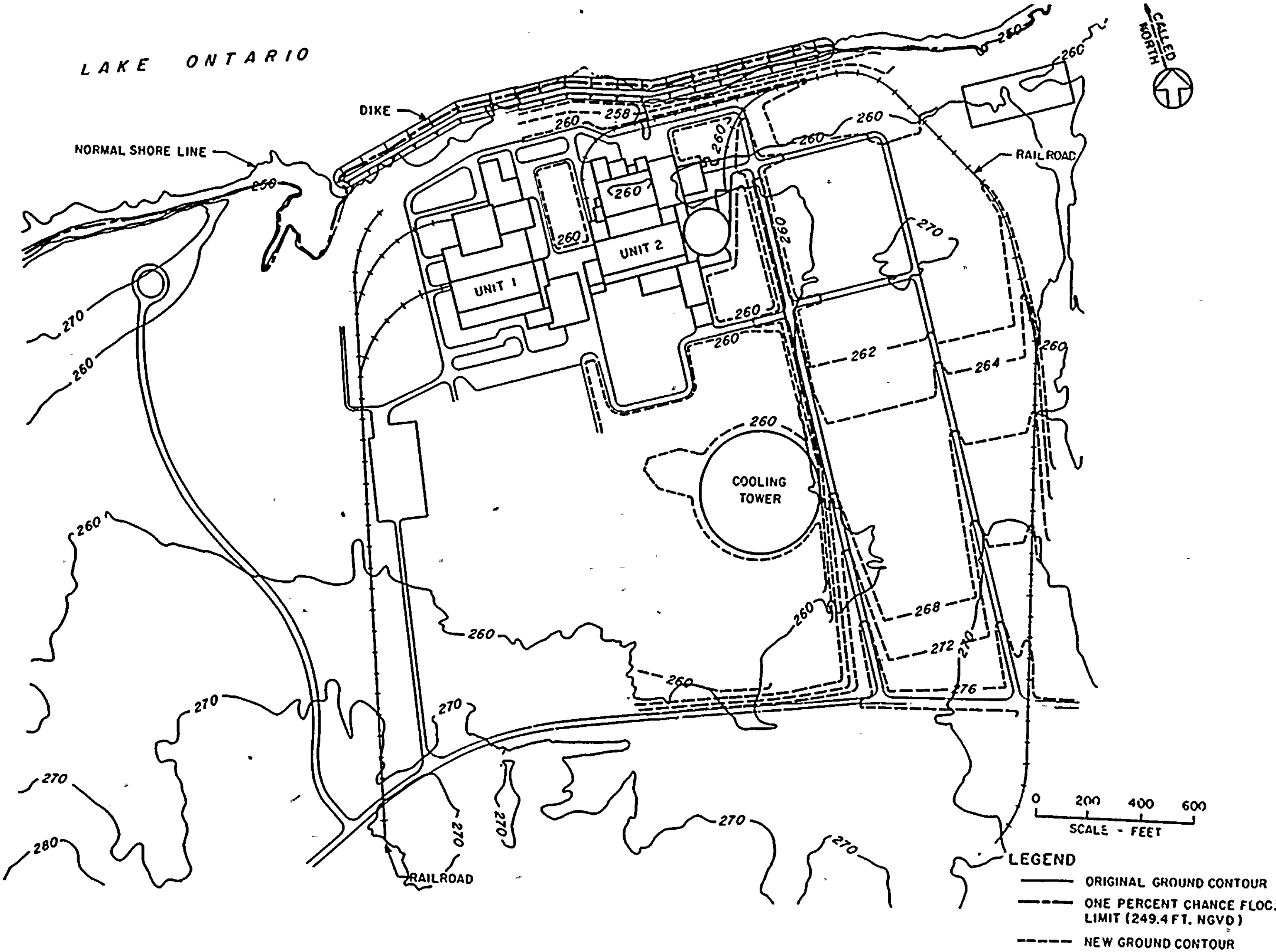

Figure 5.2 100-year floodplain, post construction

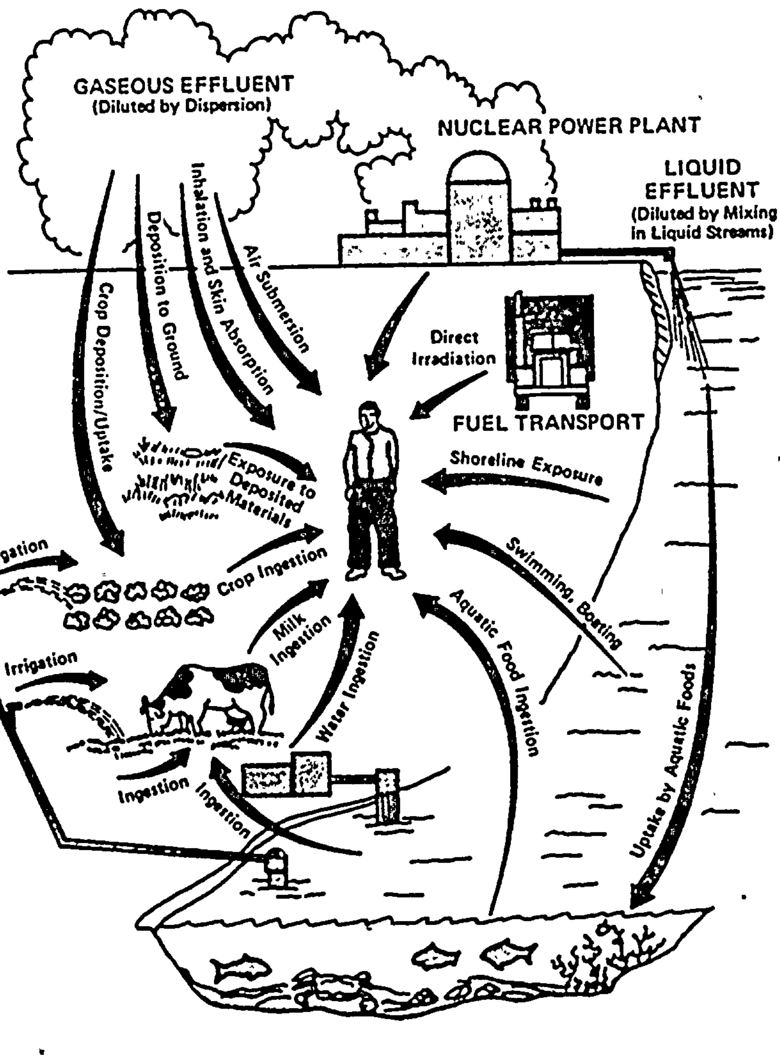

Figure 5.3 Potentially meaningful exposure pathways to individuals

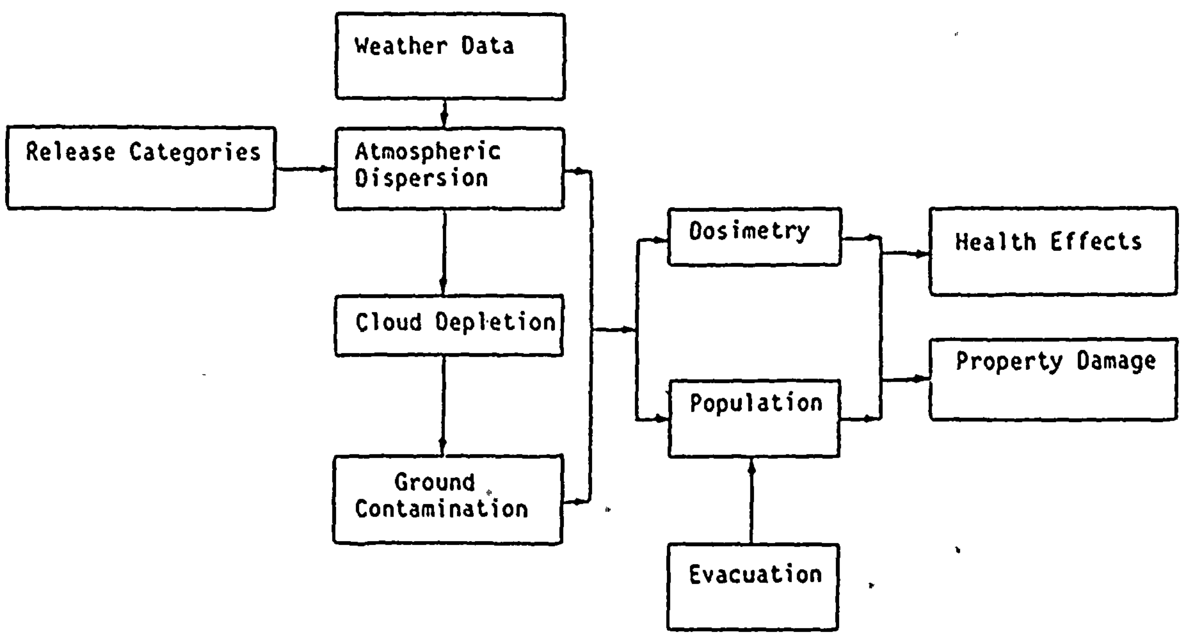

Figure 5.4 Schematic outline of atmospheric pathway consequence model

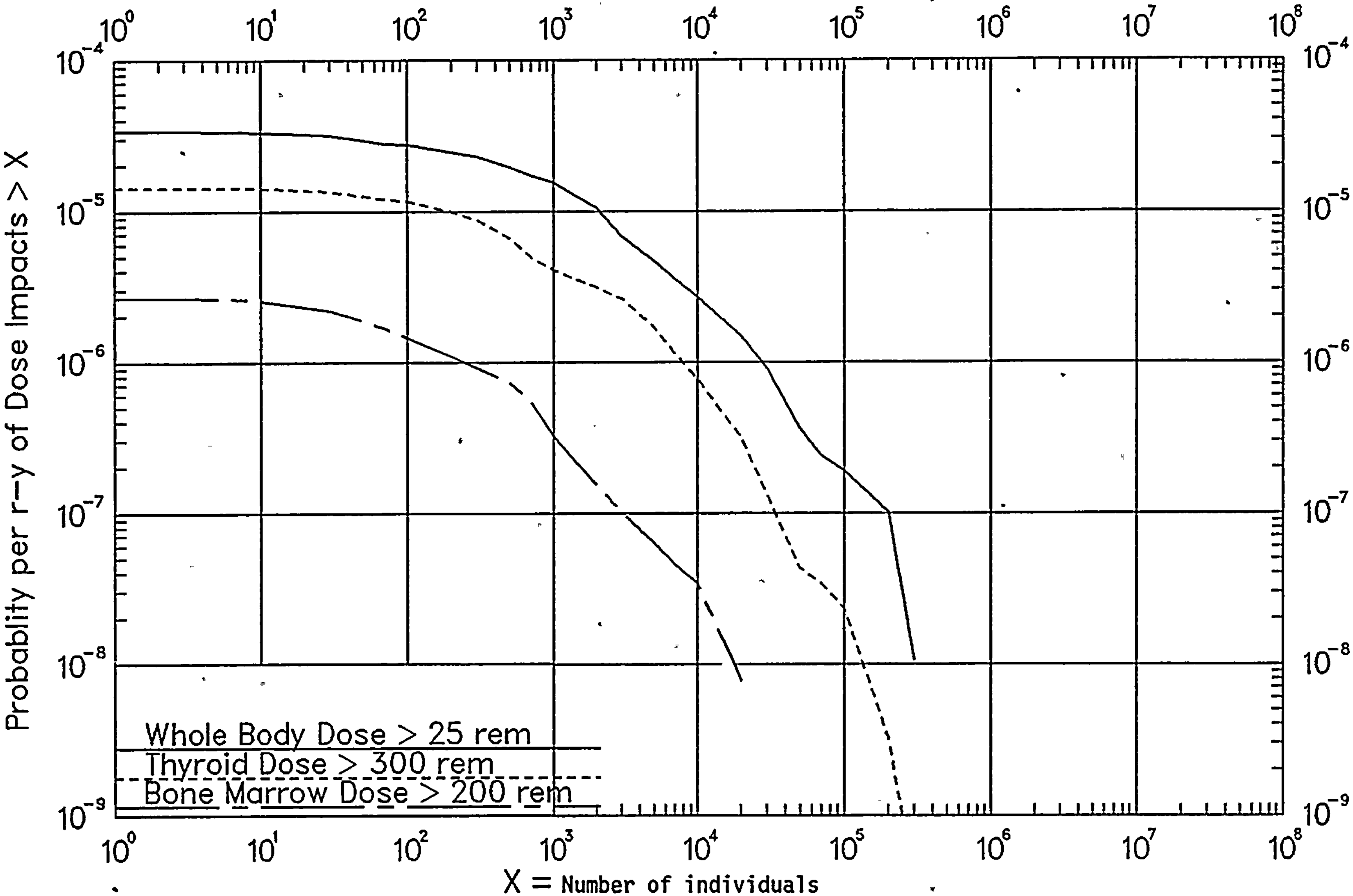

Figure 5.5 Probability distributions of individual dose impacts

NOTE: See Section 5.9.4.5(7) for a discussion of uncertainties.

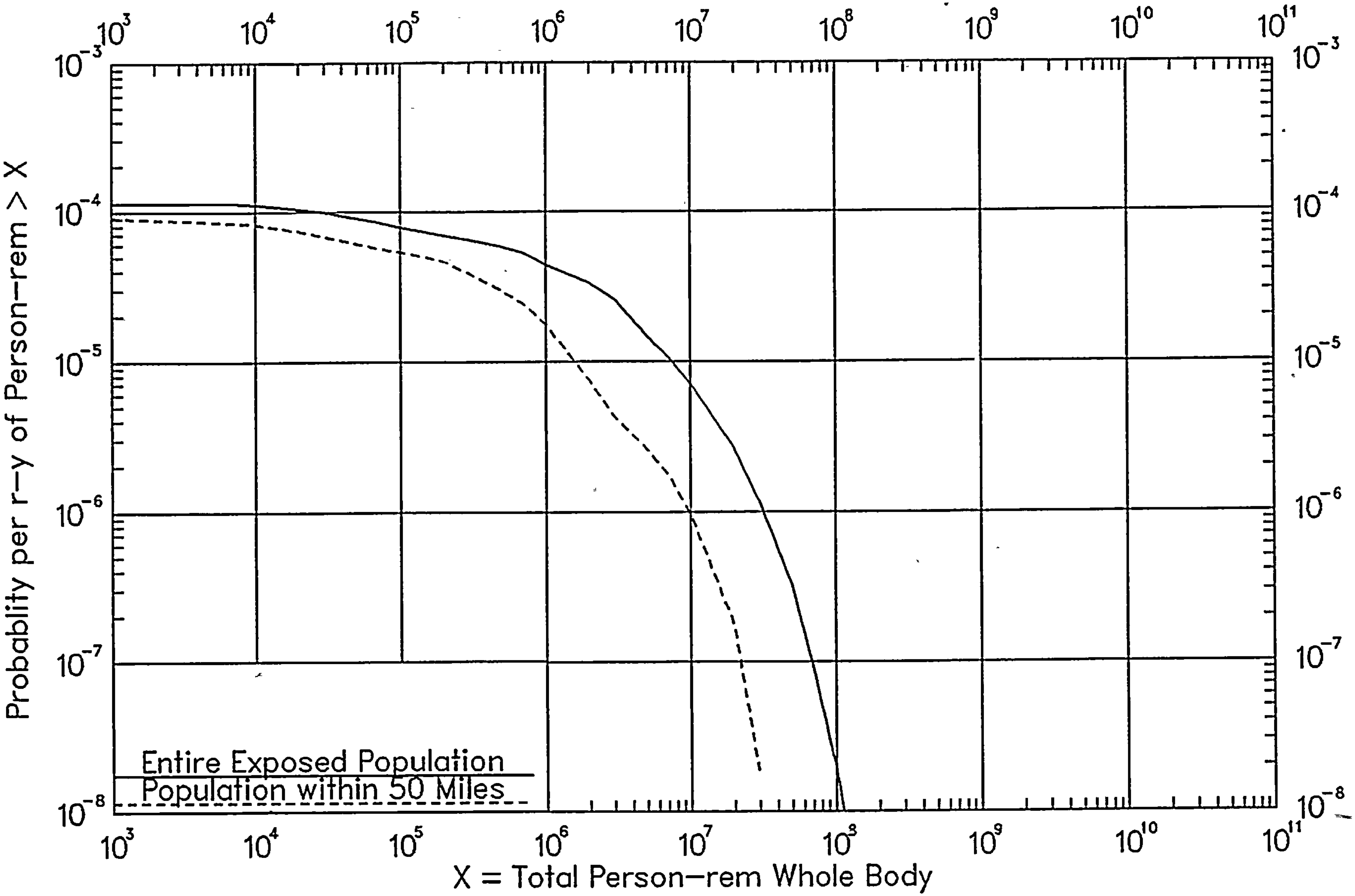

Figure 5.6 Probability distributions of population exposures

NOTE: See Section 5.9.4.5(7) for a discussion of uncertainties.

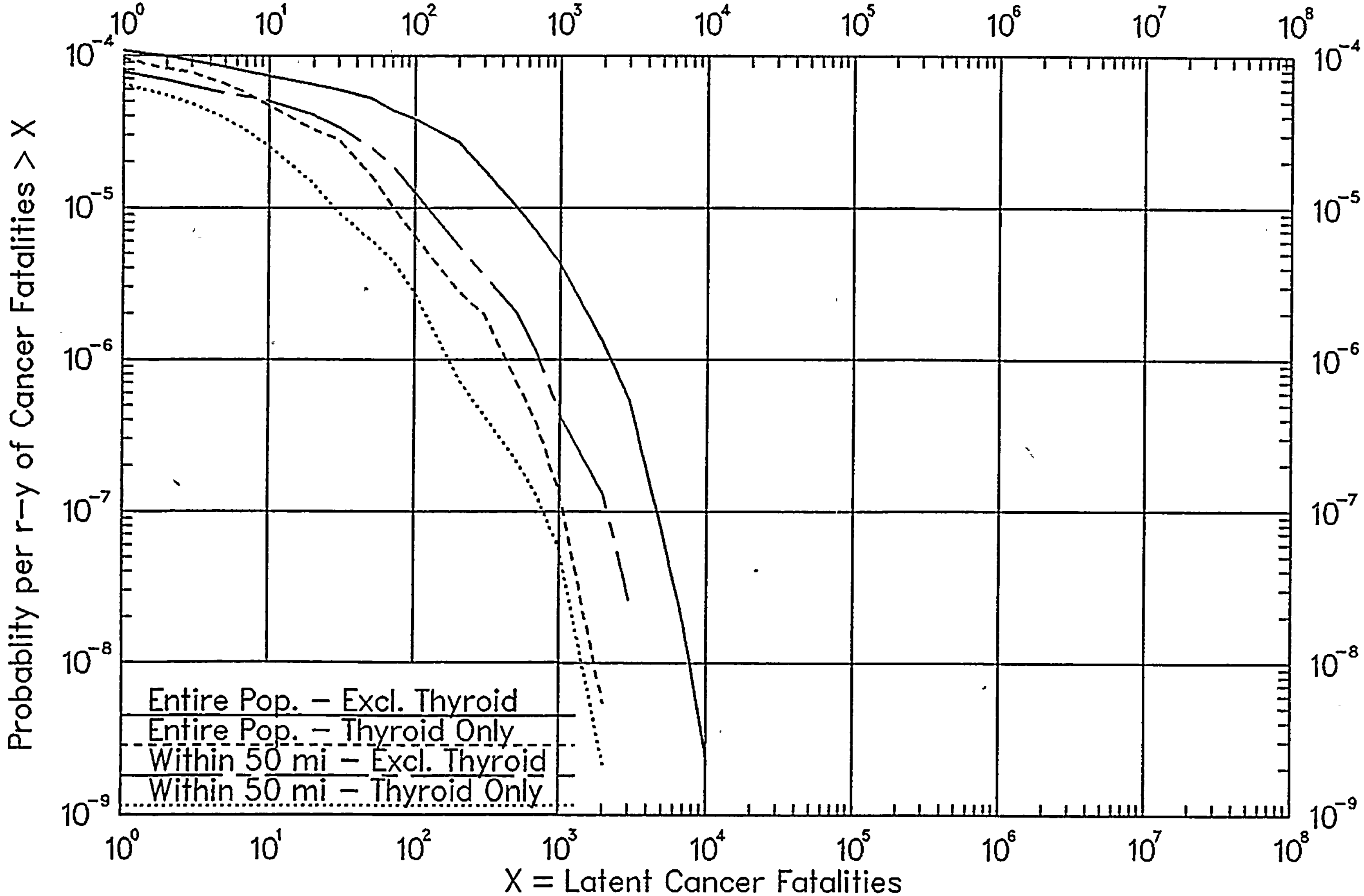

Figure 5.7 Probability distributions of cancer fatalities

NOTE: See Section 5.9.4.5(7) for a discussion of uncertainties.

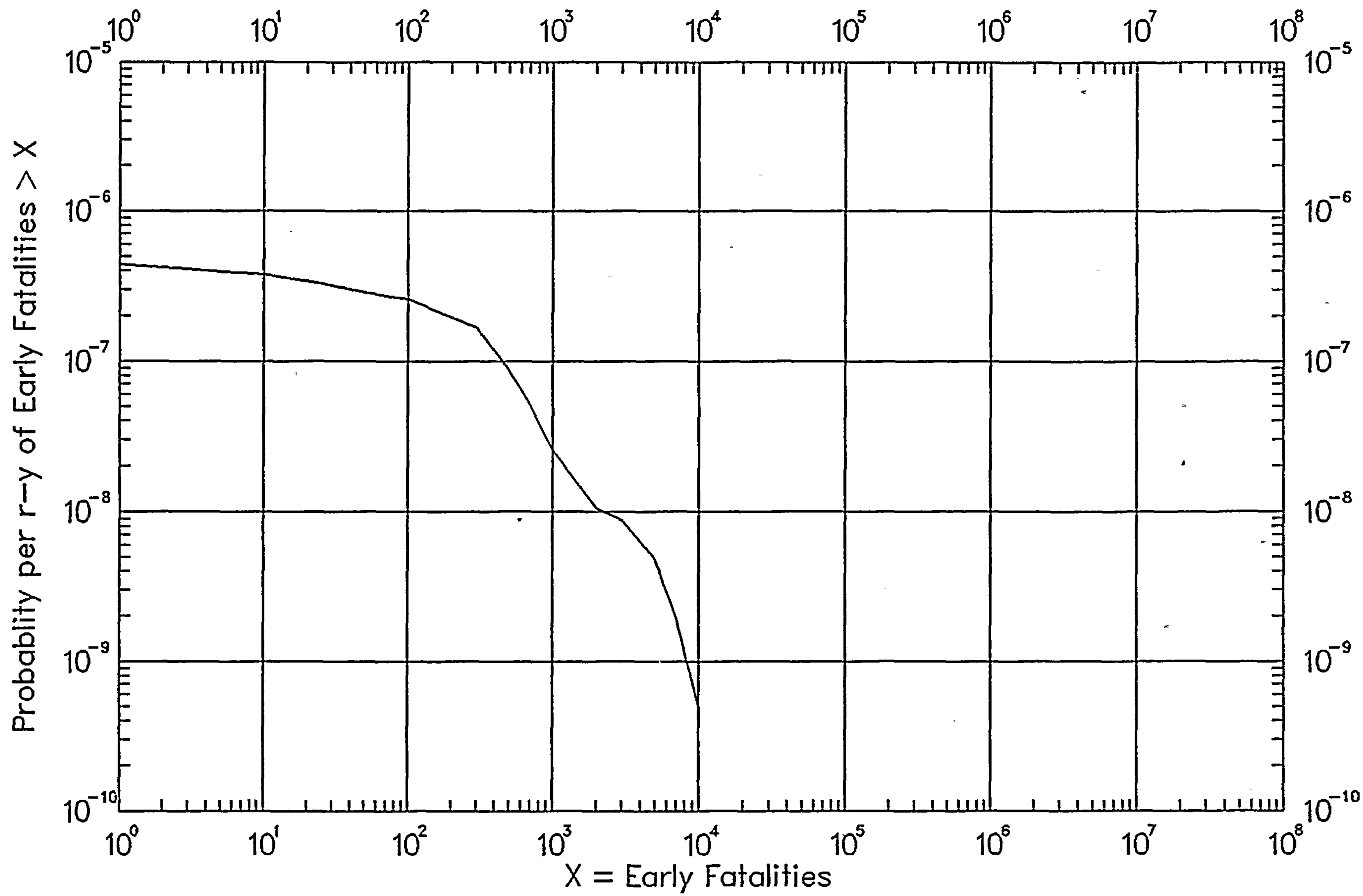

Figure 5.8 Probability distribution of early fatalities

NOTE: See Section 5.9.4.5(7) for a discussion of uncertainties.

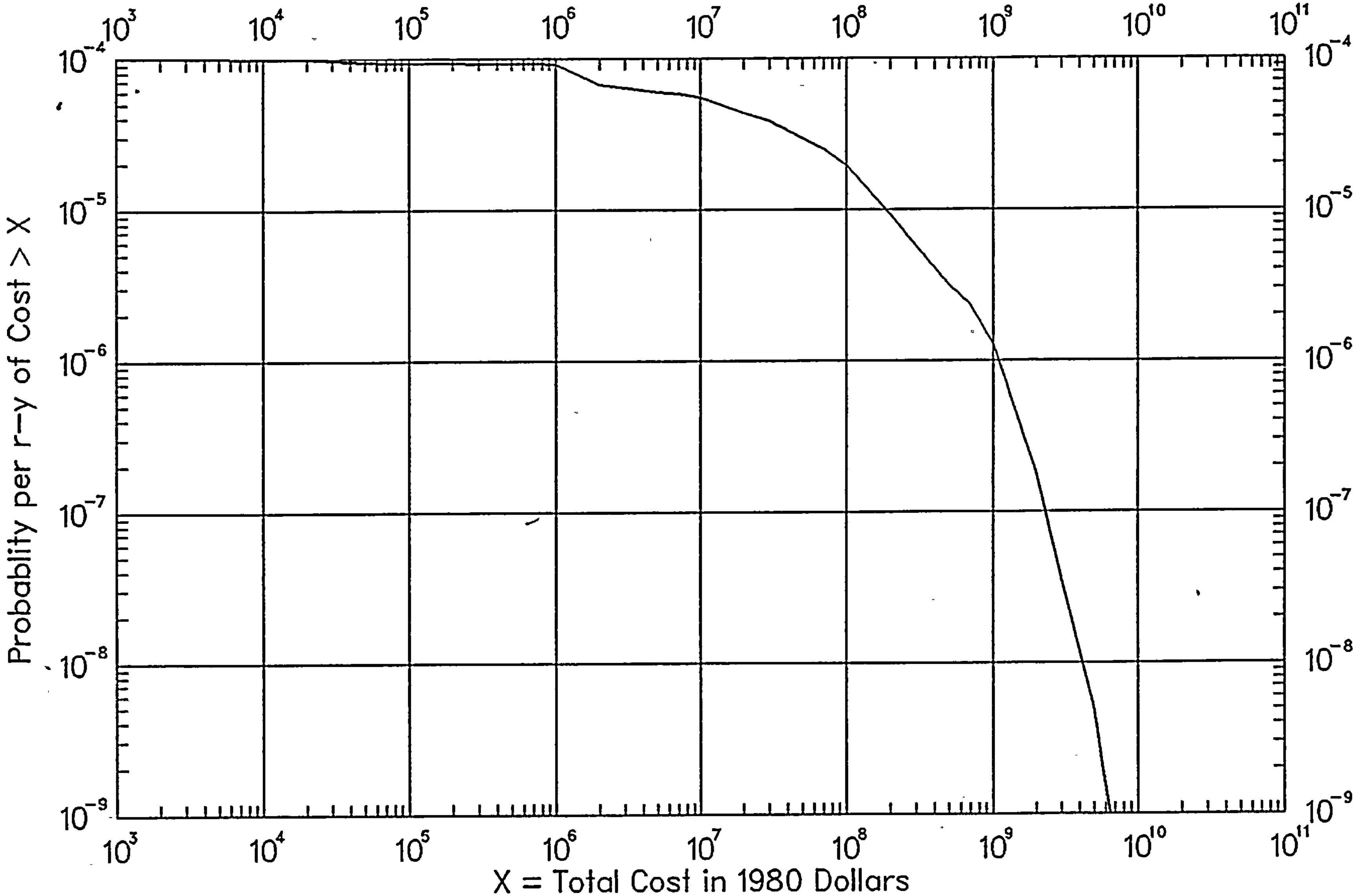

Figure 5.9 Probability distribution of mitigation measures cost

NOTE: See Section 5.9.4.5(7) for a discussion of uncertainties.

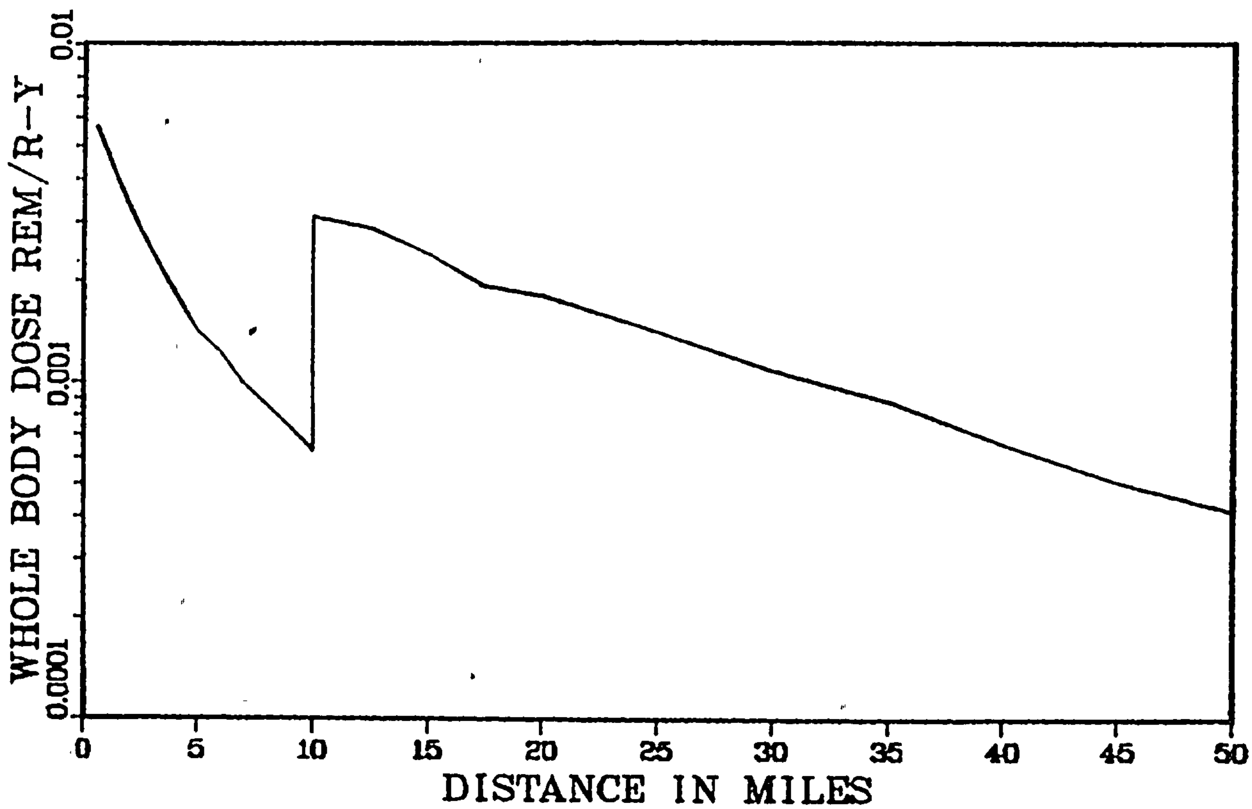

Figure 5.10 Risk of individual dose (to those downwind) versus distance

NOTE: See Section 5.9.4.5(7) for discussion of uncertainties. Also note that the 16-km (10-mile) distance marks the approximate limit of the plume exposure pathway Emergency Planning Zone. Within this radius, evacuation is assumed to begin after a 1.77-hour delay, but outside this radius, persons are assumed to receive 12 hours of ground exposure before they move to an uncontaminated area. This accounts for the sharp increase at 16 km, followed by a gradual decrease with distance.

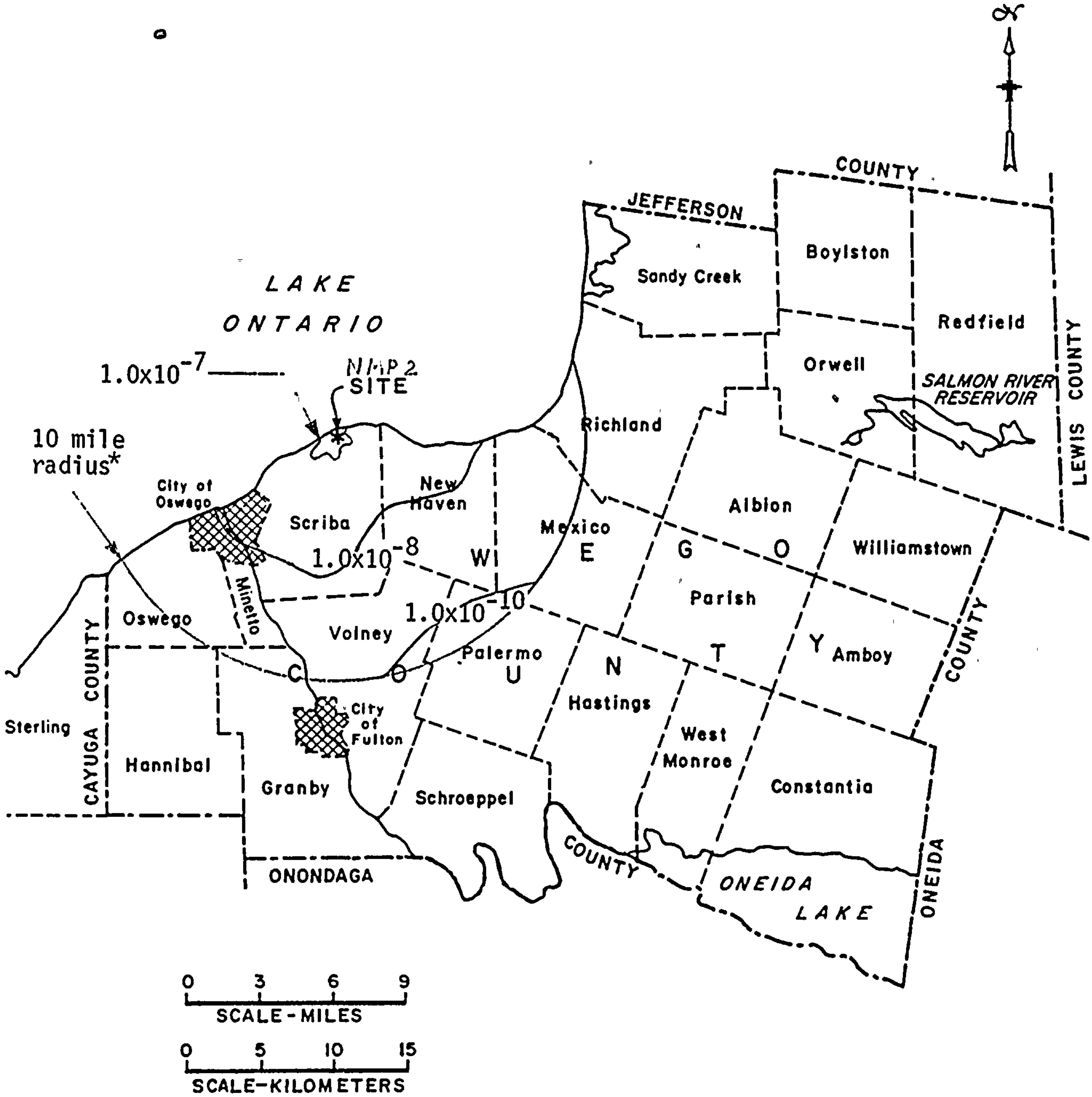

Figure 5.11 Lines of equal risk (isopleths) per reactor-year of early fatality to an individual

*The calculated risk outside 16 km is zero.

NOTES: See Section 5.9.4.5(7) for discussion of uncertainties. To change miles to km, multiply the value shown by 1.6.

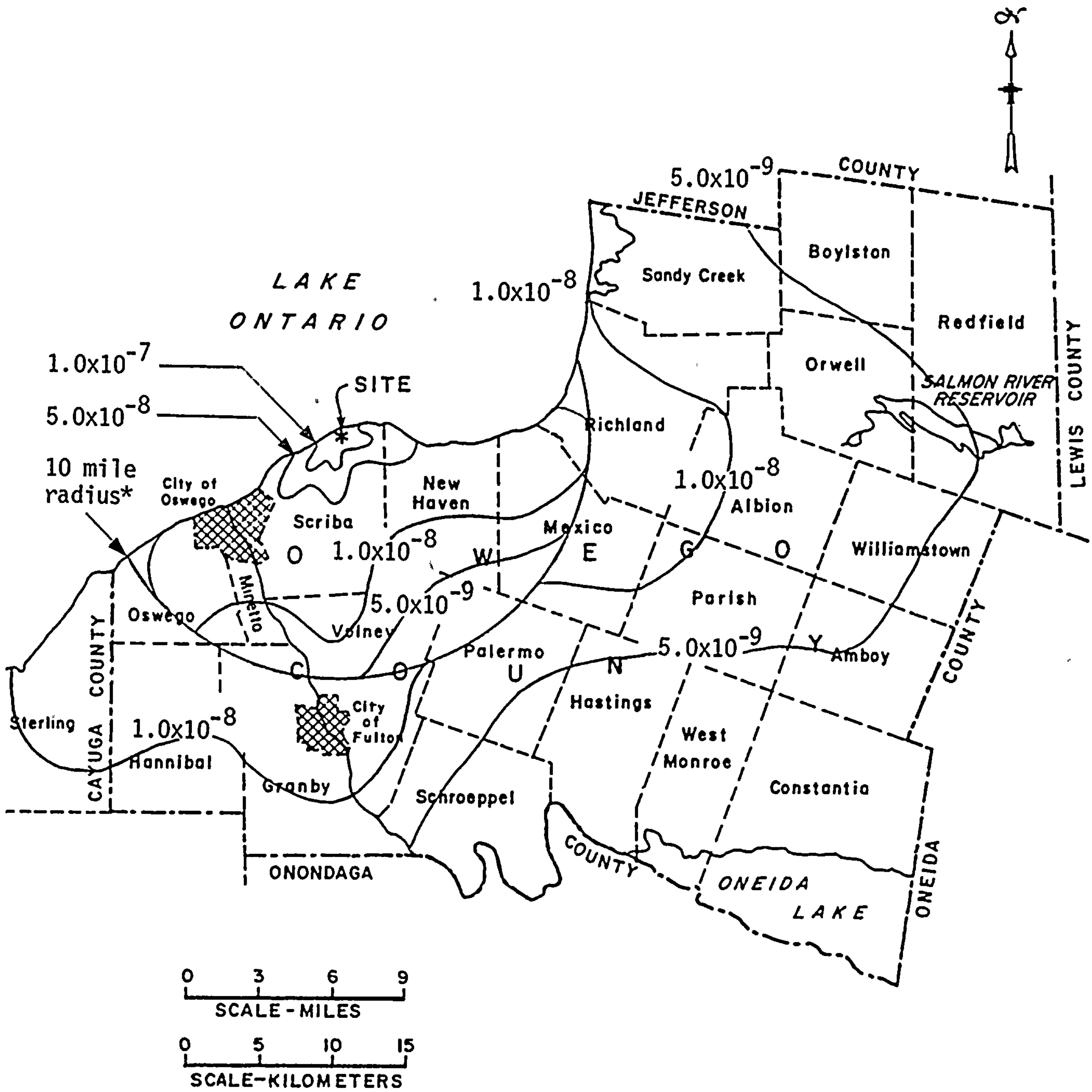

Figure 5.12 Lines of equal risk (isopleths) per reactor-year of latent cancer fatality to an individual

*This 16-km radius marks the approximate boundary of the plume exposure pathway Emergency Planning Zone. Evacuation is assumed to begin after a 1.77-hour delay within this radius, but outside this radius, persons are assumed to receive 12 hours of ground exposure. Therefore, the calculated risk increases just outside 16 km, then continues to decrease with distance.

NOTES: See Section 5.9.4.5(7) for discussion of uncertainties.
To change miles to km, multiply the value shown by 1.6.

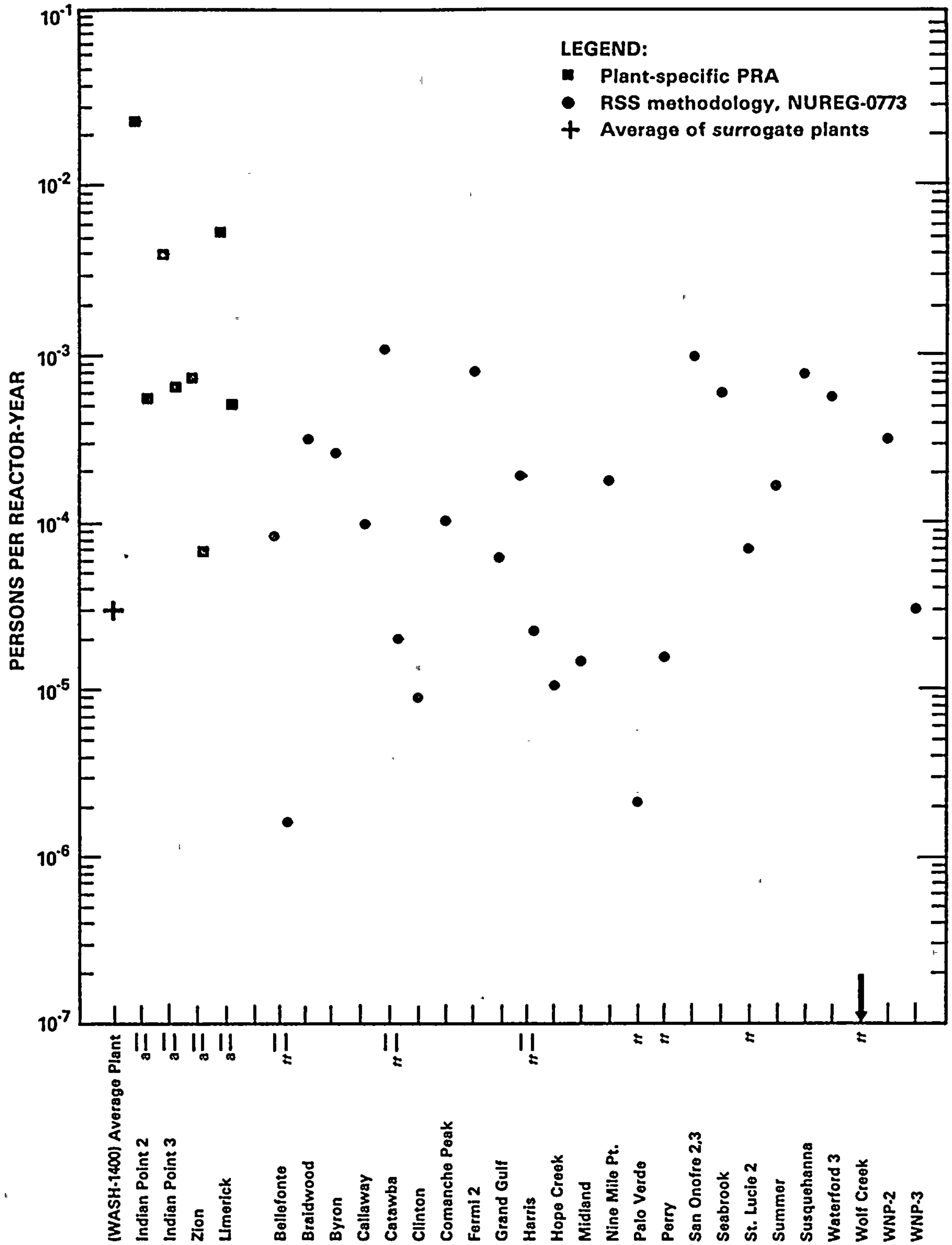

Figure 5.13 Estimated early fatality risk with supportive medical treatment (persons) from severe reactor accidents for several nuclear power plants either operating or receiving consideration for issuance of a license to operate. See footnotes following Figure 5.21.

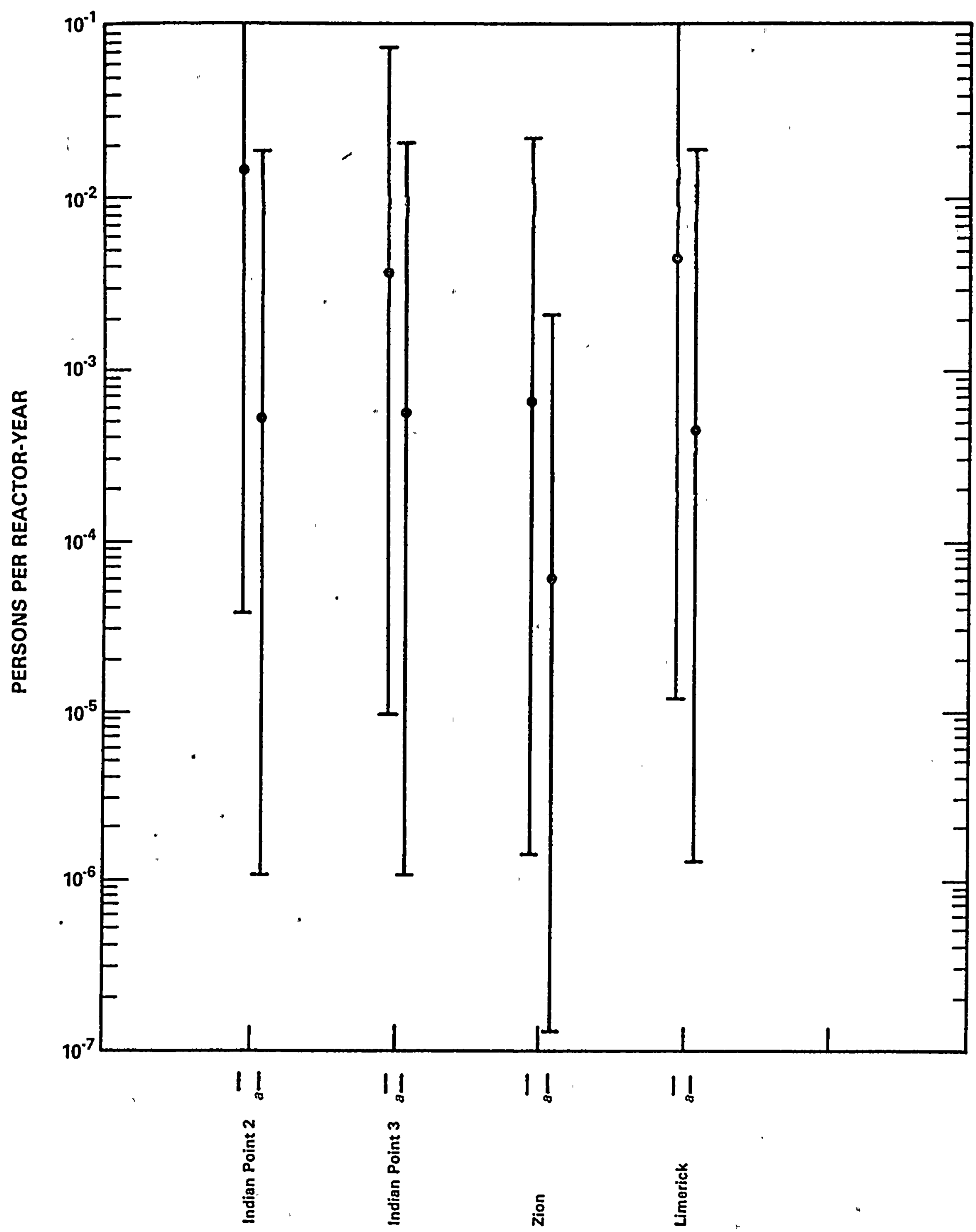

Figure 5.14 Estimated early fatality risk with supportive medical treatment (persons) from severe reactor accidents for nuclear power plants having plant-specific PRAs, showing estimated range of uncertainties. See footnotes at the end of Figure 5.21.

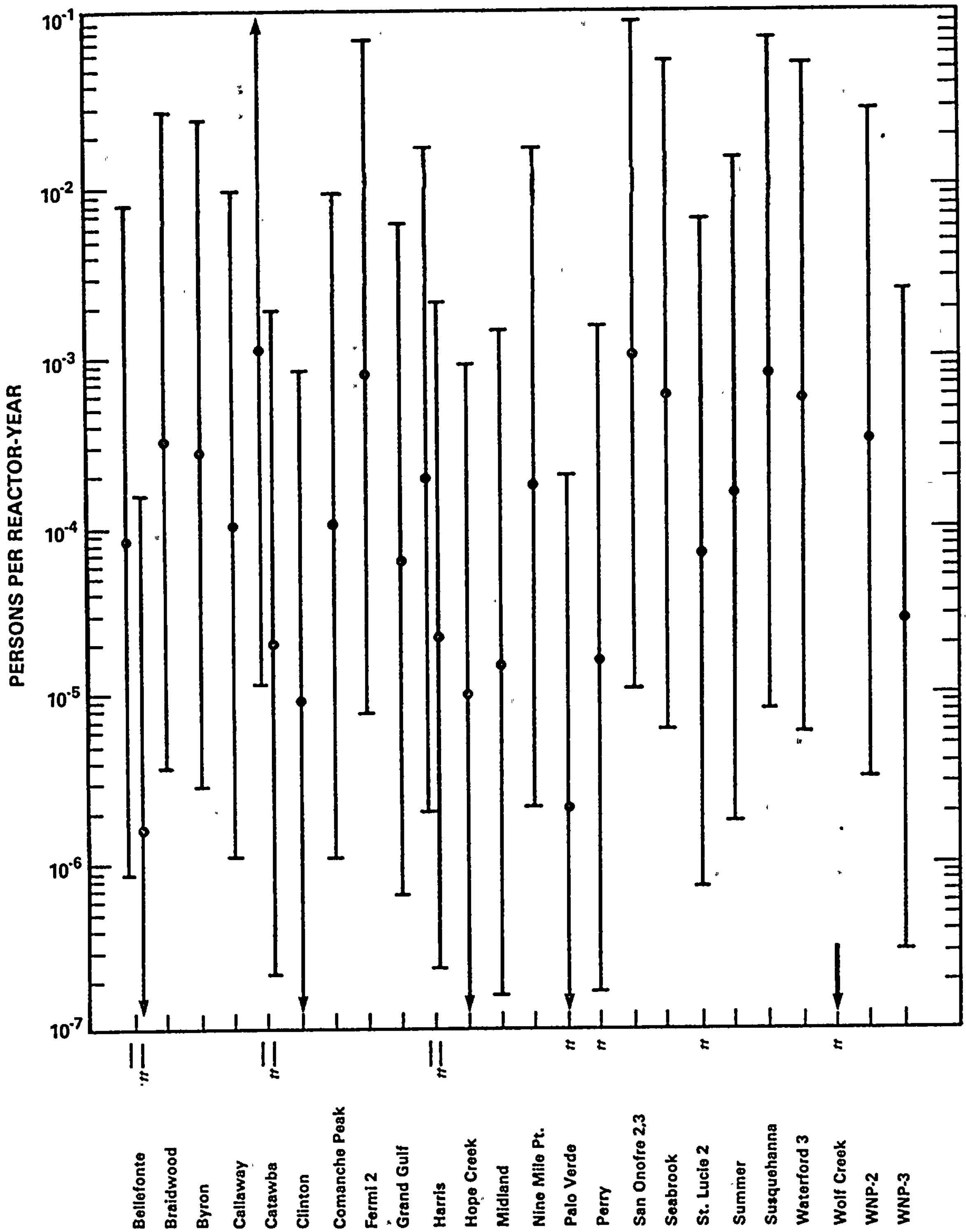

Figure 5.15 Estimated early fatality risk with supportive medical treatment (persons) from severe reactor accidents for several nuclear power plants either operating or receiving consideration for issuance of a license to operate for which site-specific applications of NUREG-0773 accident releases have been used to calculate off-site consequences. Bars are drawn to illustrate effect of uncertainty range discussed in text. See footnotes following Figure 5.21.

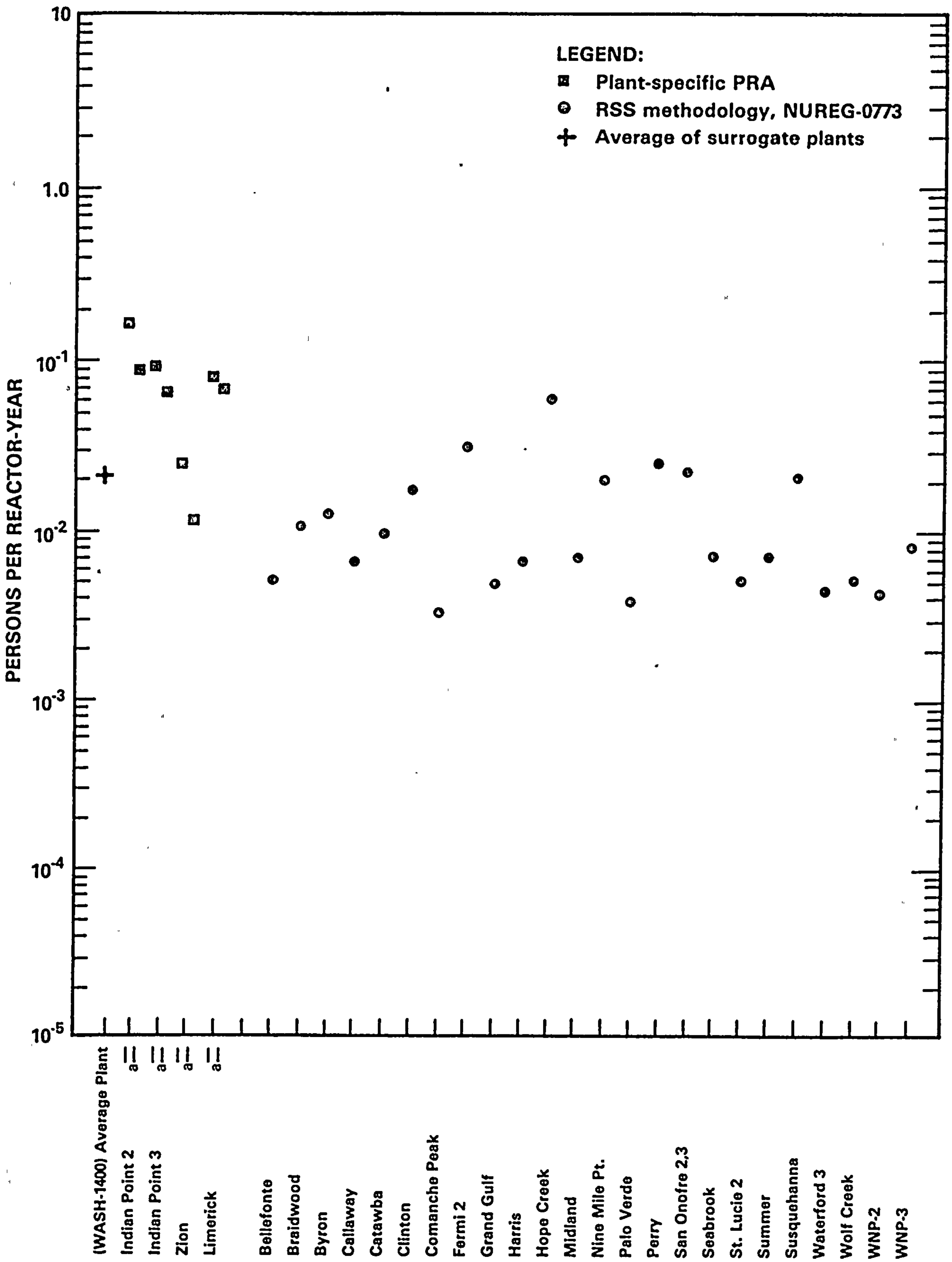

Figure 5.16 Estimated latent cancer fatality risk, excluding thyroid (persons), from severe reactor accidents for several nuclear power plants either operating or receiving consideration for issuance of a license to operate. See footnotes at the end of Figure 5.21.

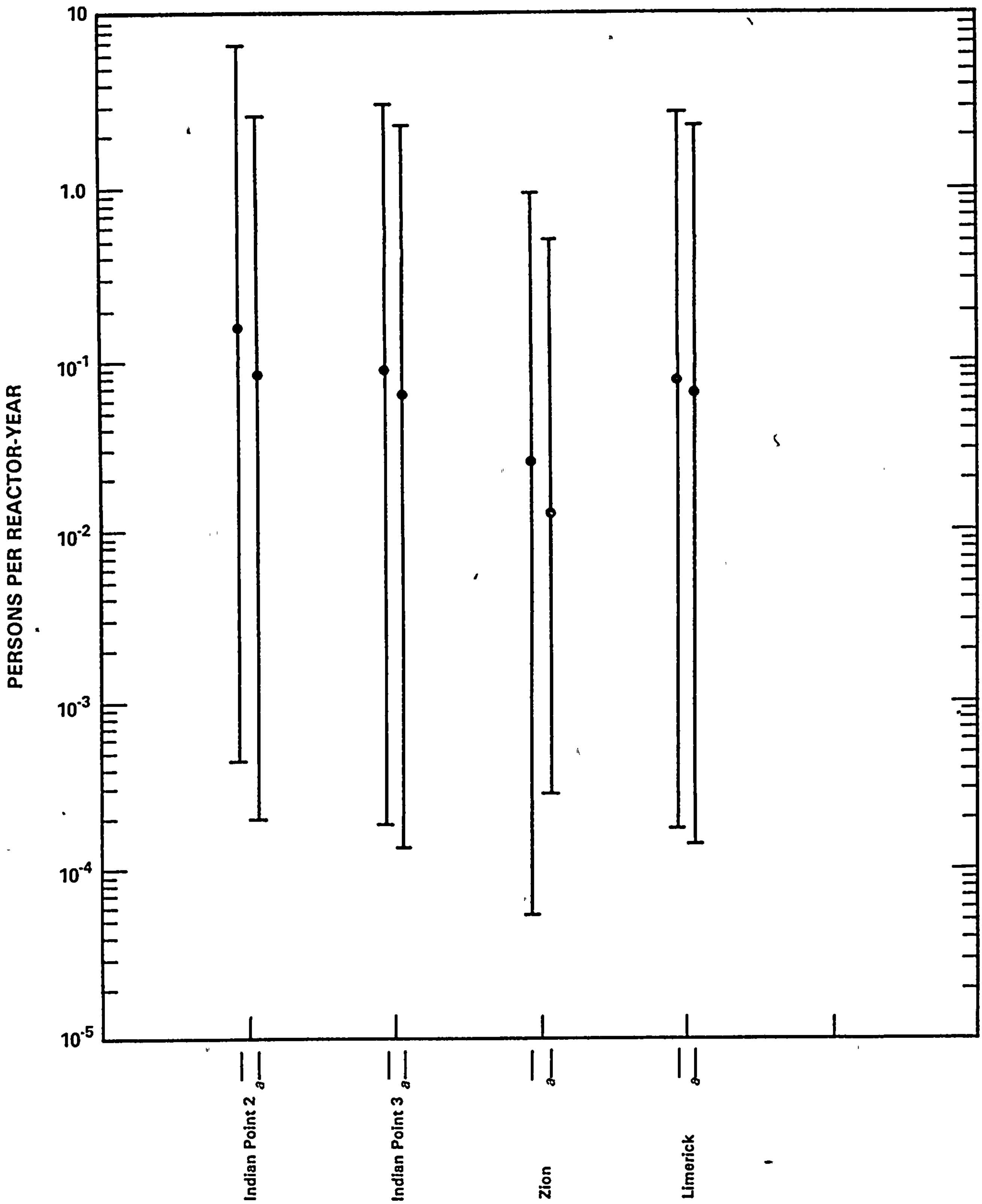

Figure 5.17 Estimated latent cancer fatality risk, excluding thyroid (persons), from severe reactor accidents for nuclear power plants having plant-specific PRAs, showing estimated range of uncertainties. See footnotes at the end of Figure 5.21.

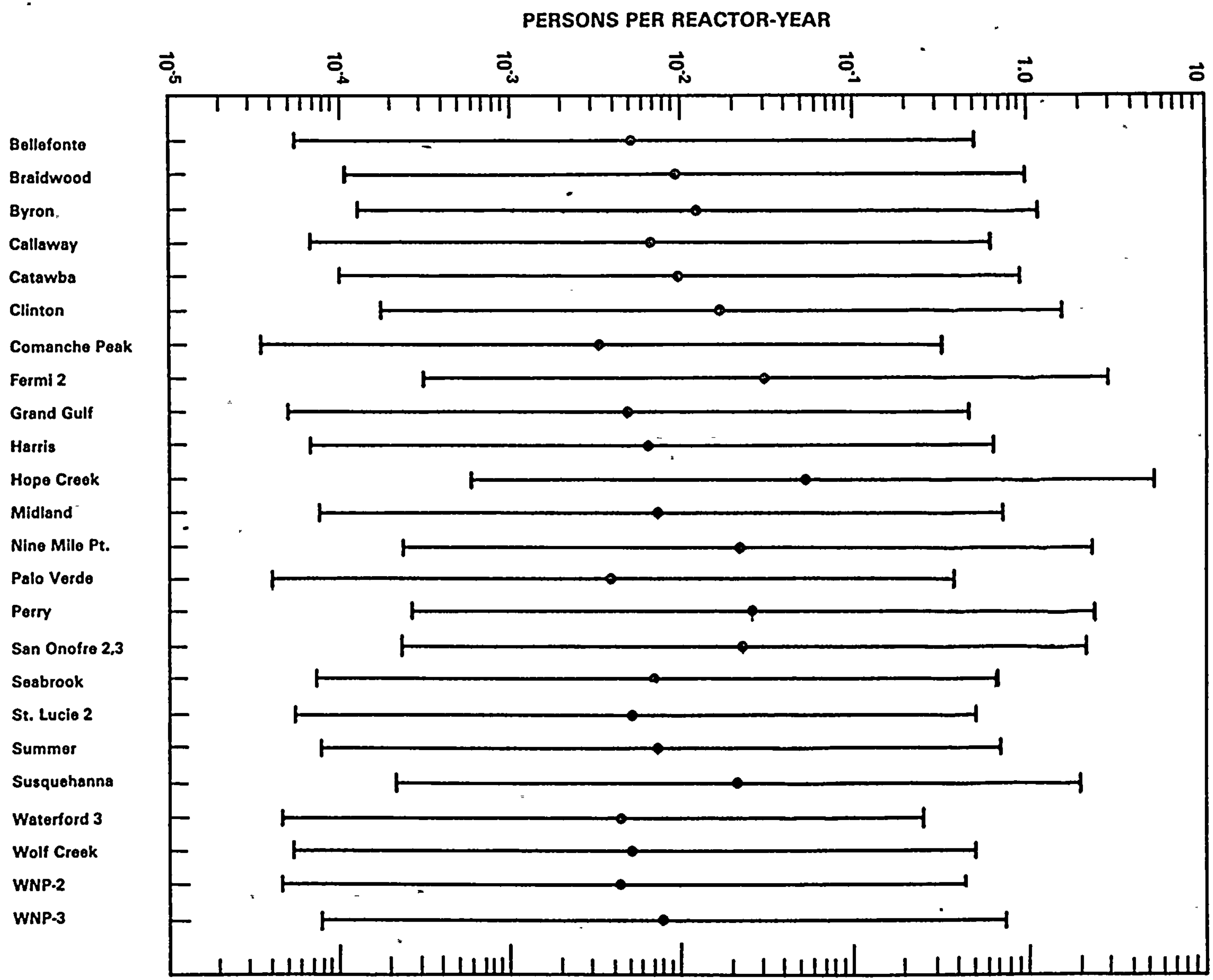

Figure 5.18 Estimated latent cancer fatality risk, excluding thyroid (persons), from severe reactor accidents for several nuclear power plants either operating or receiving consideration for issuance of a license to operate for which site-specific applications of NUREG-0773 accident releases have been used to calculate off-site consequences. Bars are drawn to illustrate effect of uncertainty range discussed in text. See footnotes at the end of Figure 5.21.

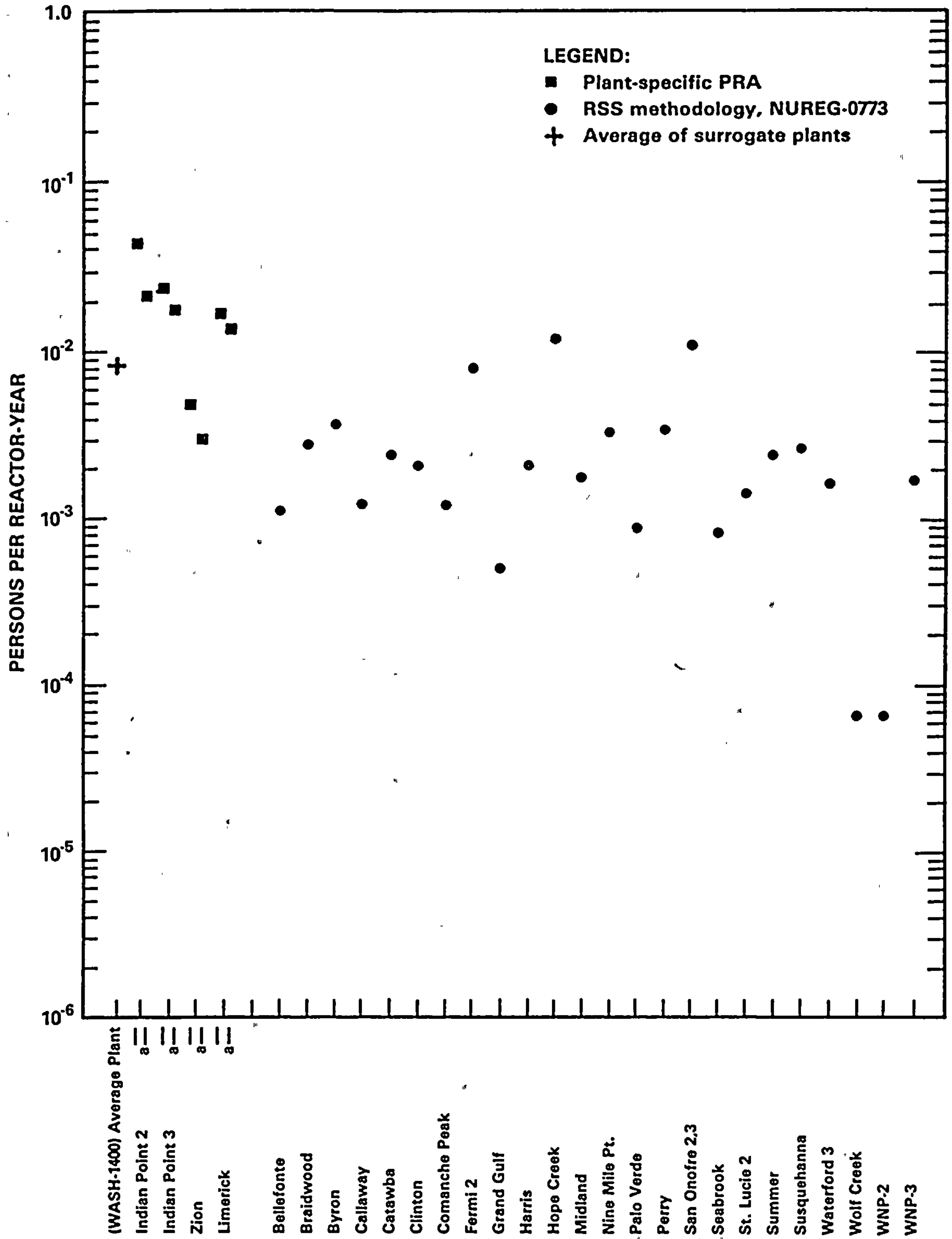

Figure 5.19 Estimated latent thyroid cancer fatality risk (persons) from severe reactor accidents for several nuclear power plants either operating or receiving consideration for issuance of a license to operate. See footnotes at the end of Figure 5.21.

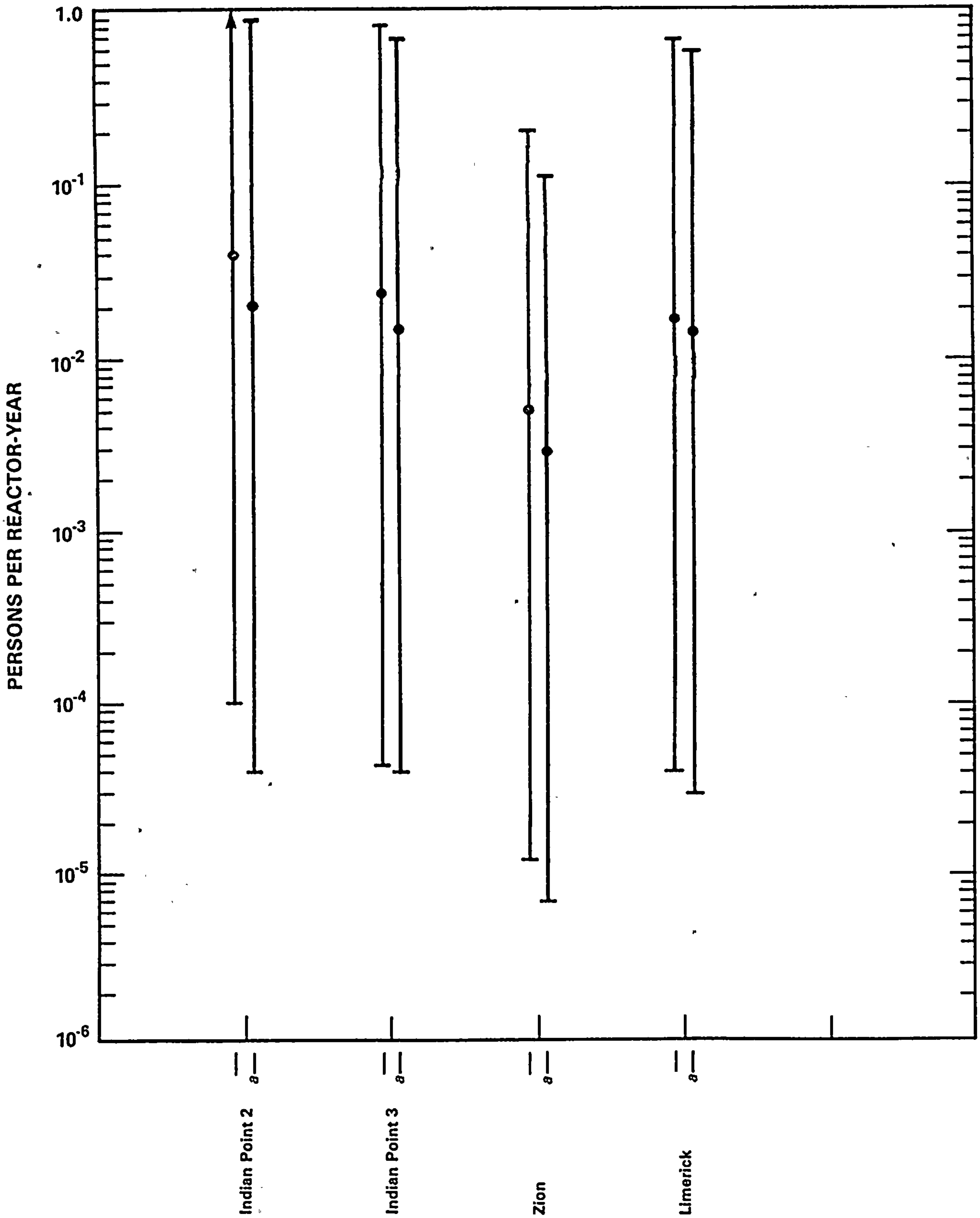

Figure 5.20 Estimated latent thyroid cancer fatality risk (persons) from severe reactor accidents for nuclear power plants having plant-specific PRAs, showing estimated range of uncertainties. See footnotes at the end of Figure 5.21.

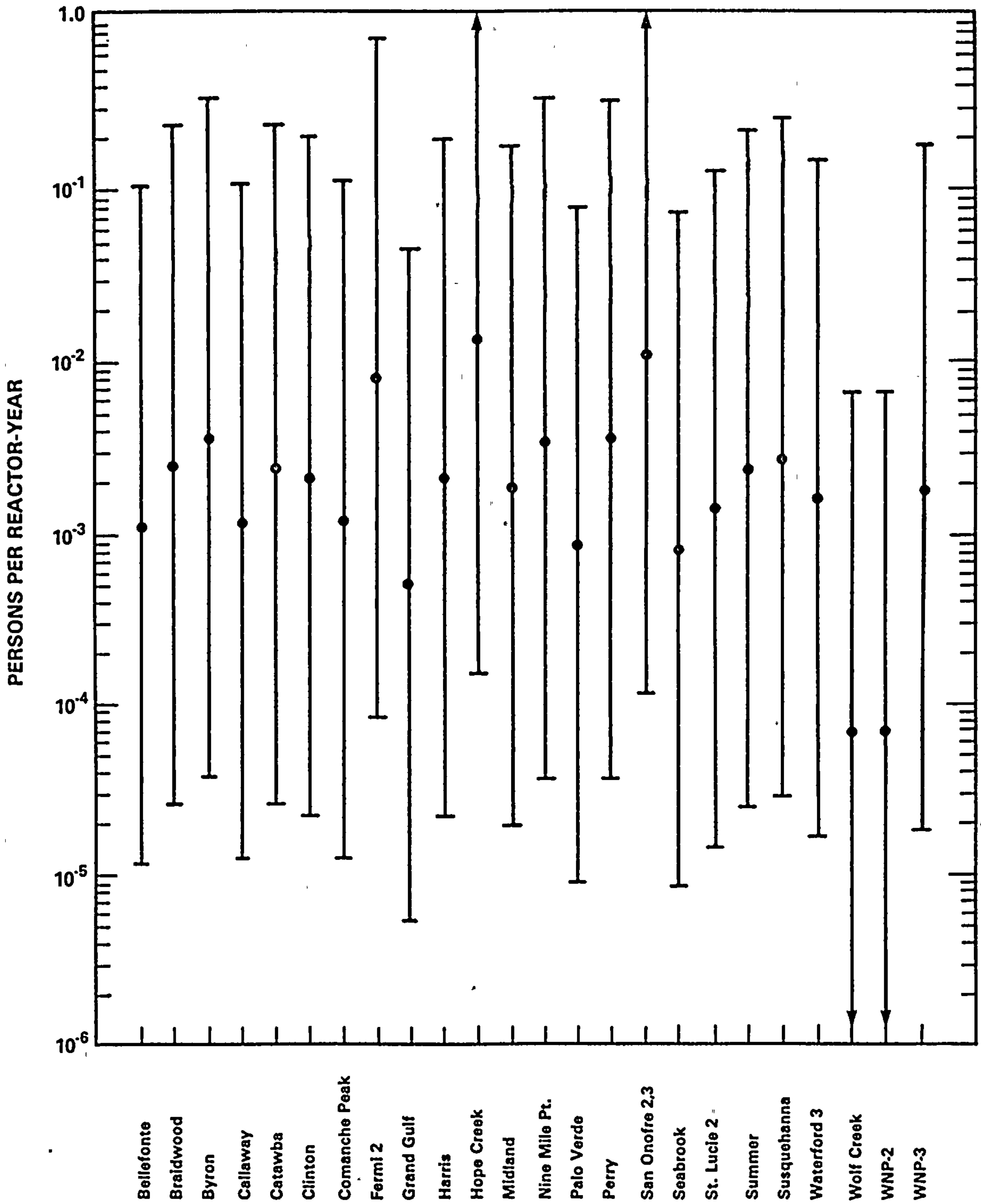

Figure 5.21 Estimated latent thyroid cancer fatality risk (persons) from severe reactor accidents for several nuclear power plants either operating or receiving consideration for issuance of a license to operate for which site-specific applications of NUREG-0773 accident releases have been used to calculate offsite consequences. Bars are drawn to illustrate effect of uncertainty range discussed in text. See footnotes on following page.

Notes for Figures 5.13 through 5.21

- Except for Indian Point, Zion, Limerick, Braidwood, Hope Creek, NMP-2, and WNP-3, risk analyses for other plants in these figures are based on WASH-1400 generic source terms and probabilities for severe accidents and do not include external event analyses. The staff and the applicant extensively reviewed Indian Point 2 and 3, Zion, and Limerick, including externally initiated accidents. The staff briefly reviewed Braidwood, Hope Creek, NMP-2, and WNP-3 to determine plant-specific release category probabilities considering internal events only. Any or all of the values could be under- or over-estimates of the true risks.
- 1-01 = 1 x 10-1

††With evacuation within 16 km (10 miles) and relocation from 16 to 40 km (10-25 miles).

[a]Excluding severe earthquakes and hurricanes.

NOTE: See Section 5.9.4.5(7) for discussion of uncertainties.

Table 5.1 Monthly water use data for NMP-2

Month	Wet Bulb Temperature (°F)	Relative Humidity (%)	Lake[2] Temperature (°F)	Lake Level (ft)	Est. Average Service Water Flow (gpm)	Fish System Flow (gpm)	Tempering Water Flow (gpm)	Cooling Tower Evaporation (gpm)	Total Lake Intake (gpm)	Service Water Discharge Flow (gpm)	Service Water Discharge ΔT (°F)	Cooling Tower Blowdown Flow[3] (gpm)	Cooling Tower Blowdown ΔT[4] (°F)	Combined Plant Flow[5] (gpm)	Combined Plant ΔT[4] (°F)
January	41.0 (Max)	47.0 (Min)	32.0 (Min)	244.63	39,600	14,925	4,960	10,550 (Max)	49,565	14,600	17.35	9,490	35.8	24,090	24.62
	21.5 (Avg)	78.3 (Avg)	35.0 (Avg)	244.63	39,600	14,925	3,210	7,800 (Avg)	51,315	14,600	14.35	13,990	24.0	28,590	19.07
	-16.0 (Min)	100.0 (Max)	42.0 (Max)	244.63	39,600	14,925	-	4,560 (Min)	54,525	14,600	11.35	20,440	10.6	35,040	10.56
February	43.0 (Max)	33.0 (Min)	32.0 (Min)	244.63	39,600	14,925	5,050	11,200 (Max)	49,640	14,600	17.35	8,915	37.2	23,515	24.90
	23.0 (Avg)	78.4 (Avg)	33.0 (Avg)	244.63	39,600	14,925	4,885	8,000 (Avg)	49,375	14,600	16.35	11,950	27.0	26,550	21.14
	-15.0 (Min)	100.0 (Max)	41.0 (Max)	244.63	39,600	14,925	-	4,731 (Min)	54,525	14,600	11.35	20,269	12.0	34,869	11.15
March	57.0 (Max)	37.0 (Min)	32.0 (Min)	244.73	39,610	14,925	4,305	12,250 (Max)	50,230	14,610	17.35	8,445	46.4	23,055	27.99
	29.4 (Avg)	75.0 (Avg)	34.0 (Avg)	244.73	39,610	14,925	3,830	8,650 (Avg)	50,705	14,610	15.35	12,520	30.0	27,130	22.11
	-4.0 (Min)	100.0 (Max)	42.0 (Max)	244.73	39,610	14,925	-	3,928 (Min)	54,535	14,610	11.35	19,072	11.0	33,682	11.73
April	63.0 (Max)	24.0 (Min)	34.0 (Min)	245.43	39,682	14,925	2,730	13,150 (Max)	51,877	14,682	15.33	9,120	46.4	23,802	27.23
	41.5 (Avg)	69.9 (Avg)	38.0 (Avg)	245.43	39,682	14,925	-	9,950 (Avg)	54,607	14,682	11.33	15,050	32.0	29,732	21.79
	16.0 (Min)	100.0 (Max)	42.0 (Max)	245.43	39,682	14,925	-	7,508 (Min)	54,607	14,682	11.33	17,492	11.7	32,174	11.69
May	76.0 (Max)	28.0 (Min)	40.0 (Min)	246.13	39,754	14,925	-	13,700 (Max)	54,679	14,754	11.31	11,300	47.2	26,054	26.88
	59.0 (Avg)	66.9 (Avg)	43.0 (Avg)	246.13	39,754	14,925	-	10,850 (Avg)	54,679	14,754	11.31	14,150	33.0	28,904	21.93
	28.0 (Min)	100.0 (Max)	52.0 (Max)	246.13	39,754	14,925	-	8,100 (Min)	54,679	14,754	11.31	16,900	10.0	31,654	10.61
June	71.0 (Max)	29.0 (Min)	42.0 (Min)	246.43	39,784	14,925	-	13,400 (Max)	54,709	14,784	11.30	11,600	46.1	26,384	26.60
	59.0 (Avg)	67.6 (Avg)	56.0 (Avg)	246.43	39,784	14,925	-	11,500 (Avg)	54,709	14,784	11.30	13,500	25.0	28,284	17.84
	36.0 (Min)	100.0 (Max)	63.0 (Max)	246.43	39,784	14,925	-	8,750 (Min)	54,709	14,784	11.30	16,250	3.0	31,034	6.95
July	79.0 (Max)	28.0 (Min)	46.0 (Min)	246.43	39,784	14,925	-	13,800 (Max)	54,709	14,784	11.30	11,200	45.0	25,984	25.83
	63.4 (Avg)	68.9 (Avg)	69.0 (Avg)	246.43	39,784	14,925	-	11,750 (Avg)	54,709	14,784	11.30	13,250	14.0	28,034	12.58
	41.0 (Min)	100.0 (Max)	78.0 (Max)	246.43	43,316	14,925	-	9,100 (Min)	59,586	18,316	10.38	15,900	-9.0	34,216	1.37
August	79.0 (max)	27.0 (Min)	48.0 (Min)	246.13	39,754	14,925	-	13,800 (Max)	54,679	14,754	11.31	11,200	39.6	25,954	23.52
	62.4 (Avg)	72.4 (Avg)	70.0 (Avg)	246.13	39,754	14,925	-	11,550 (Avg)	54,679	14,754	11.31	13,450	12.0	28,204	11.64
	43.0 (Min)	100.0 (Max)	74.0 (Max)	246.13	39,754	14,925	-	9,300 (Min)	54,679	14,754	11.31	15,700	-4.0	30,454	3.42
September	76.0 (Max)	27.0 (Min)	45.0 (Min)	245.63	39,702	14,925	-	13,700 (Max)	54,627	14,702	11.32	11,300	36.0	26,000	22.05
	56.2 (Avg)	73.7 (Avg)	63.0 (Avg)	245.63	39,702	14,925	-	11,100 (Avg)	54,627	14,702	11.32	13,900	16.0	28,602	13.59
	30.0 (Min)	100.0 (Max)	72.0 (Max)	245.63	39,702	14,925	-	8,200 (Min)	54,627	14,702	11.32	16,800	-8.0	31,502	1.02
October	71.0 (Max)	33.0 (Min)	42.0 (Min)	245.13	39,651	14,925	-	13,300 (Max)	54,576	14,651	11.34	11,700	34.5	26,351	21.62
	47.1 (Avg)	72.8 (Avg)	54.0 (Avg)	245.13	39,651	14,925	-	10,350 (Avg)	54,576	14,651	11.34	14,650	19.0	29,301	15.17
	25.0 (Min)	100.0 (Max)	63.0 (Max)	245.13	39,651	14,925	-	7,800 (Min)	54,576	14,651	11.34	17,200	-2.0	31,851	4.14
November	60.0 (Max)	38.0 (Min)	38.0 (Min)	244.83	39,620	14,925	-	12,600 (Max)	54,545	14,620	11.35	12,400	37.3	27,020	23.26
	37.4 (Avg)	76.1 (Avg)	45.0 (Avg)	244.83	39,620	14,925	-	9,300 (Avg)	54,545	14,620	11.35	15,700	23.0	30,320	17.38
	9.0 (Min)	100.0 (Max)	52.0 (Max)	244.83	39,620	14,925	-	6,816 (Min)	54,545	14,620	11.35	18,184	1.0	32,804	5.61
December	52.0 (Max)	46.0 (Min)	35.0 (Min)	244.83	39,620	14,925	2,340	11,550 (Max)	52,205	14,620	14.35	11,110	34.2	25,730	22.92
	25.9 (Avg)	78.3 (Avg)	38.0 (Avg)	244.83	39,620	14,925	-	8,250 (Avg)	54,545	14,620	11.35	16,750	23.0	31,370	17.57
	-7.0 (Min)	100.0 (Max)	43.0 (Max)	244.83	39,620	14,925	-	5,586 (Min)	54,545	14,620	11.35	19,414	13.5	34,034	12.58

(2) Based on data from 1972 Nine Mile Point Unit 1 for maximum and minimum temperatures and Unit 2 Environmental Report Construction Permit Stage Figure 2.5-1 for average temperature.

(3) Average and maximum cooling tower blowdown flows are based on Rochester, New York, weather data from 1955 to 1964. Cooling tower blowdown flows for maximum ΔT are based on Rochester, New York, weather data for 1955. Maximum discharge flow will not be exceeded during normal operation.

(4) ΔT is the difference between discharge temperature and lake temperature. Maximum ΔT will be exceeded less than 5% of the time. Maximum ΔT could occur during the month of May, resulting in a maximum blowdown ΔT of 49°F and a combined plant ΔT of 27.66°F.

(5) These flows are associated with normal plant operation. The maximum combined plant discharge flow will occur during a normal plant shutdown.

Table 5.2 Total plant efficiency for returning alive commonly impinged fish at Oswego Steam Station Unit 6

Species	Size	TPE
Alewife	<10 cm	0 - 16.1%
	>10 cm	0 - 55.8%
Rainbow smelt	<10 cm	3.1 - 23.8%
	>10 cm	0 - 64.6%
Spottail shiner		67.2 - 76.4%
Mottled sculpin		38.0 - 54.8%

Source: Lawler, Matusky, and Skelley (1983)

Table 5.3 Incidence of job-related mortalities

Occupational Group	Mortality rates, premature deaths per 10^5 person-years
Underground metal miners*	1300
Uranium miners*	420
Smelter workers*	190
Mining**	61
Agriculture, forestry, and fisheries**	35
Contract construction**	33
Transportation and public utilities**	24
Nuclear-plant worker***	23
Manufacturing**	7
Wholesale and retail trade**	6
Finance, insurance, and real estate**	3
Services**	3
Total private sector**	10

*The President's Report on Occupational Safety and Health, "Report on Occupational Safety and Health by the U.S. Department of Health, Education, and Welfare," E. L. Richardson, Secretary, May 1972.

**U.S. Bureau of Labor Statistics, "Occupational Injuries and Illness in the United States by Industry, 1975," Bulletin 1981, 1978.

***The nuclear-plant workers' risk is equal to the sum of the radiation-related risk and the nonradiation-related risk. The estimated occupational risk associated with the industry-wide average radiation dose of 0.8 rem is about 11 potential premature deaths per 10^5 person-years due to cancer, based on the risk estimators described in the following text. The average non-radiation-related risk for seven U.S. electrical utilities over the period 1970-1979 is about 12 actual premature deaths per 10^5 person-years as shown in Figure 5 of the paper by R. Wilson and E. S. Koehl, "Occupational Risks of Ontario Hydro's Atomic Radiation Workers in Perspective," presented at Nuclear Radiation Risks, A Utility-Medical Dialog, sponsored by the International Institute of Safety and Health in Washington, D.C., September 22-23, 1980. (Note that the estimate of 11 radiation-related premature cancer deaths describes a potential risk rather than an observed statistic.)

Table 5.4 (Summary Table S-4) Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor[1]

NORMAL CONDITIONS OF TRANSPORT

	Environmental impact
Heat (per irradiated fuel cask in transit)	250,000 Btu/hr.
Weight (governed by Federal or State restrictions)	73,000 lbs. per truck; 100 tons per cask per rail car.
Traffic density:	
Truck	Less than 1 per day.
Rail	Less than 3 per month.

Exposed population	Estimated number of persons exposed	Range of doses to exposed individuals [2] (per reactor year)	Cumulative dose to exposed population (per reactor year) [3]
Transportation workers	200	0.01 to 300 millirem	4 man-rem.
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem.
Along Route	600,000	0.0001 to 0.06 millirem	

ACCIDENTS IN TRANSPORT

	Environmental risk
Radiological effects	Small [4].
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

[1] Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. I, NUREG-75/038 April 1975. Both documents are available for inspection and copying at the Commission's Public Document Room, 1717 H St. NW., Washington, D.C., and may be obtained from National Technical Information Service, Springfield, Va. 22161. WASH-1238 is available from NTIS at a cost of $5.45 (microfiche, $2.25) and NUREG-75/038 is available at a cost of $3.25 (microfiche, $2.25).

[2] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[3] 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 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

[4] 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.

Table 5.5 Preoperational radiological environmental monitoring program summary*

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Airborne			
Radioiodine and particulates	Samples from 5 locations: 3 samples from offsite locations in different sectors of the highest calculated site average D/Q 1 sample from the vicinity of a community having the highest calculated site average D/Q 1 sample from a control location 14.5-32.1 km (9-20 mi) distant and in a least prevalent wind direction	Continuous sampler operation with sample collection weekly or as required by dust loading, whichever is more frequent.	Radioiodine canisters: analyze weekly for I-131 Particulate samplers: Gross beta radioactivity following filter change, composite (by location) for gamma isotopic quarterly (as a minimum)
Direct radiation	40 stations with two or more dosimeters to be placed as follows: an inner ring of stations in the general area of the site boundary and an outer ring in the 6.4- to 8.0-km (4- to 5-mi) range from the site with a station in each land-based sector of each ring (16 sectors and 2 rings = 32 stations). The balance of the stations (8) should be placed in special interest areas, such as population centers, nearby residences, and schools, and in 2 or 3 areas to serve as control stations.	Quarterly	Gamma dose quarterly
Waterborne			
Surface	1 sample upstream 1 sample from the site's most downstream cooling water intake	Composite sample over 1-month period	Gamma isotopic analysis monthly; composite for tritium analysis quarterly
Sediment from shoreline	1 sample from a downstream area with existing or potential recreational value	Twice per year	Gamma isotopic analysis

*Source: ER-OL Table 6.2-1

Table 5.5 (continued)

Exposure Pathway and/or Sample	Number of Samples and Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Ingestion			
Milk	Samples from milking animals in 3 locations within a 5.6-km (3.5-mi) distance having the highest calculated site average D/Q. If there are none, then 1 sample from milking animals in each of 3 areas 5.6-8.0 km (3.5-5.0 mi) distant having the highest calculated site average D/Q.	Twice per month, April-December (samples will be collected in January-March if I-131 is detected in November and December of the preceding year)	Gamma isotopic and I-131 analysis twice per month when animals are on pasture (April-December); monthly at other times, if required
	1 sample of milking animals at a control location 14.5-32.1 km (9-20 mi) distant and in a less prevalent wind direction		
Fish	2 samples of commercially or recreationally important species in the vicinity of a site discharge point	Twice per year	Gamma isotopic analysis of edible portions
	1 sample each of the same species (or of a species with similar feeding habits) from an area at least 8.0 km (5 mi) distant from the site		
Food products	3 samples of broadleaf vegetables will be collected from available offsite locations of highest calculated site average D/Q for elevated release points. In addition, 3 samples will be collected from available offsite locations of highest calculated site average D/Q for ground-level release points.	Once during harvest season	Gamma isotopic analysis of edible portions (isotopic to include I-131)
	1 sample each of similar broadleaf vegetation grown 14.5-32.1 km (9-20 mi) distant in a less prevalent wind direction	Once during harvest season	Gamma isotopic analysis of edible portions (isotopic to include I-131)

Table 5.6 Activity of radionuclides in the NMP-2 reactor core at 3466 MWt

Group/radionuclide	Radioactive inventory, millions of curies	Half-life, days
A. NOBLE GASES		
Krypton-85	0.6	3,950.
Krypton-85m	30.	0.183
Krypton-87	50.	0.0528
Krypton-88	70.	0.117
Xenon-133	200.	5.28
Xenon-135	40.	0.384
B. IODINES		
Iodine-131	90.	8.05
Iodine-132	100.	0.0958
Iodine-133	200.	0.875
Iodine-134	200.	0.0366
Iodine-135	200.	0.280
C. ALKALI METALS		
Rubidium-86	0.03	18.7
Cesium-134	8.	750.
Cesium-136	3.	13.0
Cesium-137	5.	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	6.	0.391
Tellurium-127m	1.	109.
Tellurim-129	30.	0.048
Tellurim-129m	6.	34.0
Tellurium-131m	10.	1.25
Tellurium-132	100.	3.25
Antimony-127	7.	3.88
Antimony-129	40.	0.179
E. ALKALINE EARTHS		
Strontium-89	100.	52.1
Strontium-90	4.	11,030.
Strontium-91	100.	0.403
Barium-140	200.	12.8
F. COBALT AND NOBLE METALS		
Cobalt-58	0.8	71.0
Cobalt-60	0.3	1,920.
Molybdenum-99	200.	2.8
Technetium-99m	200.	0.25
Ruthenium-103	100.	39.5
Ruthenium-105	80.	0.185
Ruthenium-106	30.	366.
Rhodium-105	50.	1.50

Table 5.6 (Continued)

Group/radionuclide	Radioactive inventory, millions of Ci	Half-life, days
G. <u>RARE EARTHS, REFRACTORY OXIDES, AND TRANSURANICS</u>		
Yttrium-90	4.	2.67
Yttrium-91	100.	59.0
Zirconium-95	200.	65.2
Zirconium-97	200.	0.71
Niobium-95	200.	35.0
Lanthanum-140	200.	1.67
Cerium-141	200.	32.3
Cerium-143	100.	1.38
Cerium-144	90.	284.
Praseodymium-143	100.	13.7
Neodymium-147	60.	11.1
Neptunium-239	2000.	2.35
Plutonium-238	0.06	32,500.
Plutonium-239	0.02	8.9×10^6
Plutonium-240	0.02	2.4×10^6
Plutonium-241	4.	5,350.
Americium-241	0.002	1.5×10^5
Curium-242	0.5	163.
Curium-244	0.02	6,630.

Note: The above grouping of radionuclides corresponds to that in Table 5.8.

Table 5.7 Approximate doses during a 2-hour exposure at the EAB*,**

Accidents and faults	Duration of release	Whole-body dose rems***
INFREQUENT ACCIDENTS <u>Category 2</u>		
Fuel-handling accident (fuel cask drop)	<2 hours	0.02
LIMITING FAULTS <u>Category 3</u>		
Main steamline break	<2 hours	0.002
Small-break LOCA	hours-days	<0.0005
Large-break LOCA	hours-days	0.0005

*1381 m (4531 feet) from the center of the reactor building.
**Estimated by the staff for the NMP-2 FES-CP
***The calculated whole-body dose, or the equivalent dose to an organ.

Table 5.8 Summary of the atmospheric release specifications used in consequence analysis for NMP-2

Release Category[a]	Probability per r-y	Release time (hr)	Release duration (hr)	Evacuation warning time (hr)	Energy release (10^6 Btu/hr)	Fractions of core inventory released							
						Xe-Kr	Organic I[b]	Inorganic I	Cs-Rb	Te-Sb	Ba-Sr	Ru[c]	La[d]
I-T/DW	4(-5)	5	0.5	4	100	1	7(-3)*	2(-3)	2(-2)	8(-2)	1(-3)	5(-3)	1(-3)
I-T/WW	2(-5)	5	0.5	4	100	1	7(-3)	1(-4)	3(-4)	1(-3)	2(-5)	7(-5)	1(-5)
I-T/$\overline{WW}$	2(-6)	5	0.5	4	100	1	7(-3)	2(-4)	9(-4)	2(-3)	8(-5)	1(-4)	3(-5)
I-T/HB	8(-7)	2	0.5	1	100	1	--	2(-1)	6(-2)	1(-1)	7(-3)	8(-2)	1(-5)
I-T/DW	4(-8)	5	0.5	4	100	1	7(-3)	3(-3)	5(-3)	3(-3)	6(-4)	3(-4)	4(-4)
I-T/$\overline{LGT}$	2(-5)	2	3	0	1	0.7	--	2(-2)	1(-1)	5(-2)	2(-3)	3(-3)	6(-4)
II-T/WW	2(-6)	20	4	5	1	1	7(-3)	7(-1)	3(-1)	2(-1)	4(-2)	4(-2)	3(-3)
III-T/WW	4(-6)	3	1	2	100	1	7(-3)	8(-2)	2(-1)	6(-1)	2(-2)	4(-2)	7(-3)
III-T/HB	9(-8)	2	0.5	1	100	1	--	2(-1)	6(-2)	1(-1)	7(-3)	8(-2)	1(-5)
III-T/LGT	2(-5)	0.5	4	0	1	0.7	--	3(-3)	1(-4)	5(-4)	2(-5)	3(-5)	6(-6)
III-T/$\overline{LGT}$	2(-6)	0.5	4	0	1	0.7	--	2(-2)	1(-1)	5(-2)	2(-3)	3(-3)	6(-4)
IV-T-DW[e]	5(-7)	1	3	0.5	1	1	7(-3)	5(-1)	5(-1)	5(-1)	6(-2)	9(-2)	7(-3)
IV-T-WW	4(-7)	1	3	0.5	1	1	7(-3)	5(-1)	5(-1)	5(-1)	6(-2)	8(-2)	6(-3)
S-H20/$\overline{WW}$[f]	1(-8)	0.5	4	0.5	1	1	7(-3)	2(-1)	4(-1)	3(-1)	4(-2)	5(-2)	4(-3)
S-$\overline{H20}$/$\overline{WW}$[f]	1(-8)	0.5	3	0.5	1	1	7(-3)	5(-2)	3(-1)	4(-1)	3(-2)	7(-2)	6(-3)

Notes: See Section 5.9.4.5(7) for discussion of uncertainties. Estimated numbers were rounded to one significant digit only for the purpose of this table.

7(-3) = 7 x 10^{-3} = 0.007.

Release height = 30 m.

[a]See Appendix H for designations and descriptions of the release categories.

[b]Organic iodine is added to inorganic iodine for consequence calculations because organic iodine is likely to be converted to inorganic or particulate forms during environmental transport.

[c]Includes Ru, Rh, Co, Mo, Tc.

[d]Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

[e]Because of their similarity, IV-T/DW, IV-T/$\overline{WW}$, and IV-A/DW were grouped together.

[f]These release categories represent slight corrections made since the publication of the Limerick FES, from which this information was taken.

Table 5.9 Annual average wind-direction probabilities for the NMP-2 site based on data for 1975

Wind blowing toward the direction	Probability (fraction of the year)
N	0.0982
NNE	0.0428
NE	0.0406
ENE	0.0907
E	0.1095
ESE	0.0648
SE	0.0852
SSE	0.0349
S	0.0283
SSW	0.0277
SW	0.0472
WSW	0.0202
W	0.0334
WNW	0.0737
NW	0.1236
NNW	0.0792
Total	1.00

Table 5.10 Summary of emergency response assumptions for NMP-2

Emergency response characteristic	Value used in CRAC analysis	Comments
Evacuation distance	10 miles	To convert to km, multiply by 1.609.
Delay time	1.8 hour	
Effective evacuation speed	1.1 mph	Same as 0.47 m/sec.
Effective downwind distance moved	15 miles	An artificial parameter used only to represent a realistic path length over which radiation exposure to each evacuee is calculated in the CRAC code.
Relocation zone	All areas more than 10 miles from the plant	The area outside the 10-mile plume exposure pathway emergency planning zone.
Relocation time, after plume passage	12 hours	A separate calculation, with a relocation time of 24 hours, was also performed; see Appendix I.
Relocation dose criterion (7-day projected bone marrow dose from ground shine)	200 rems	
Factors by which unshielded exposures are multiplied to correct for shielding		
Plume exposure during evacuation	1.	See Footnote 1.
Groundshine exposure during evacuation	0.5	See Footnote 1.
Plume exposure, other times	0.75	See Footnote 2.
Groundshine exposure, other times	0.33	See Footnote 2.

[1]During evacuation, automobiles are assumed to provide essentially no shielding to gamma rays from the plume and some shielding to gamma rays from the contaminated ground. The selected values of shielding protection factors for the plume and the ground during evacuation are taken from Table VI, 11-13 of Appendix VI of WASH-1400.

[2]At other times than during evacuation, shielding protection factors are the average values representative of normal activities of the people during which some people are indoors and some are outdoors. The selected values of the shielding protection factors for the plume and the ground for this situation are taken from Table VI, 11-13, of Appendix VI of WASH-1400.

Table 5.11 Summary of environmental impacts and probabilities

Probability of impact per r-y	Persons exposed over 200 rems	Persons exposed over 25 rems	Early fatalities	Population exposure millions of person-rems,* 80 km/total	Latent cancers, 80 km/total	Cost of offsite mitigating actions, $ millions
10^{-4}	0	0	0	0/.003	0/2	0.003
10^{-5}	0	2,000	0	2/8	160/580	200
5×10^{-6}	0	5,000	0	3/15	290/1,100	350
10^{-6}	250	28,000	0	10/34	920/2,800	1,300
10^{-7}	3,000	200,000	50	25/69	3,100/6,100	2,500
10^{-8}	19,000	300,000	2,000	40/150	4,900/10,000	4,700
Related figure	5.5	5.5	5.8	5.6	5.7	5.9

*About 260 cases of genetic effects may occur in the succeeding generations per million person-rems to the exposed generation.

Note: See Section 5.9.4.5(7) for discussion of uncertainties.

Table 5.12 Estimated values of societal risks from severe accidents, per reactor-year

Consequence type	Estimated risk within the 80-km region	Estimated total risk
1. Early fatalities with Supportive medical treatment (persons)	2.E-4*	2.E-4
2. Early fatalities with minimal medical treatment (persons)	4.E-4	4.E-4
3. Early injuries (persons)**	0.002	0.002
4. Latent cancer fatalities (excluding thyroid) (persons)	0.006	0.02
5. Latent thyroid cancer fatalities (persons)	0.001	0.003
6. Total person-rems	70.	300.
7a. Cost of offsite mitigation measures (1980 $)	6000.	8000.
7b. Regional industrial impact costs (1980 $)	4000.	4000.***
7c. Plant costs (1980 $)	200,000.	200,000.
8. Land area for long-term interdiction (m^2)**	20,000.	200,000.

*2.E-4 = 2×10^{-4} = 0.0002.
**See WASH-1400, Appendix VI, 9-11 to 9-20, for a discussion of "early morbidity" (injury).
***Excludes costs of crop and milk interdiction, which are included in 7a.
****About 2.6 million m^2 equals to 1 mi^2.

NOTE: See Section 5.9.4.5(7) for discussion of uncertainties. Estimated numbers were rounded to one significant digit only for the purpose of this table.

Table 5.13 Regional economic impacts of output and employment

Release specification*	Wind direction	Direct losses** Nonagricultural	Agricultural	Indirect losses	Total losses**	Loss in employment, annualized jobs	Expected loss in output/ r-y, $ 1980
				Maximum losses			
1	WSW	2200	250	310	2800	120,000	53
2	SSE	1500	170	200	1800	95,000	408
3	SW	40	90	16	140	42,000	116
4	SW	40	90	16	140	42,000	277
				Minimum losses			
All	W - NNE	0	0	0	0	0	0
				Expected losses per reactor-year			
1	All	230	74	38	350	<1	***
2	All	690	360	130	1200	<1	
3	All	160	550	87	800	<1	
4	All	270	920	150	1300	<1	
All	All	1300	1900	400	3600	0.3	

*Release specifications include:

1. IV-T/DW, and all other IV category releases
2. II-T/WW, III-T/WW, S-H20/$\overline{\text{WW}}$, S-H$\overline{\text{20}}$/$\overline{\text{WW}}$
3. I-T/$\overline{\text{LGT}}$, III-T/$\overline{\text{LGT}}$
4. I-T/DW, I-T/HB, III-T/HB

**1980 $ millions.
***Not applicable, because the expected loss is in the "Total" column for this portion of the table.

Source: NUREG/CR-2519

Table 5.14 (Summary Table S-3) Uranium fuel cycle environmental data1

[Normalized to model LWR annual fuel requirement (WASH-1248) or reference reactor year (NUREG-0116)]

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
NATURAL RESOURCES USE		
Land (acres):		
Temporarily committed[2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once-through cooling
Fossil fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe LWR output
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
EFFLUENTS—CHEMICAL (MT)		
Gases (including entrainment):[3]		
SO_x	4,400	
NO_x[4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F	.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HCl	.014	
Liquids:		
SO_4^-	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3—600 cfs. NO_3—20 cfs. Fluoride—70 cfs.
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
Cl^-	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.

Table 5.14 (Continued)

[Normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116]]

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
EFFLUENTS—RADIOLOGICAL (CURIES)		
Gases (including entrainment):		
Rn-222	....	Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	.02	
Uranium	.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	.83	
Tc-99	....	Presently under consideration by the Commission.
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^{7}	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4,063	<5 percent of model 1,000 MWe LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

[1] In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.

Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248), and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

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

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

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

6 EVALUATION OF THE PROPOSED ACTION

6.1 Unavoidable Adverse Impacts

The staff has reassessed the physical, social, biological, and economic impacts that can be attributed to the operation of NMP-2. These impacts are summarized in Table 6.1.

The FES-CP required several modifications to the aquatic biological monitoring program at both Nine Mile Point 1 (NMP-1) and FitzPatrick Nuclear Stations for the purpose of impact assessment for NMP-2. These modifications have been made, and the results of the studies conducted at both facilities are evaluated in Sections 4.3.4 and 5.5.2 and Appendix G of this report.

The radiological impacts from the operation of NMP-2 have been re-evaluated and are discussed in Section 5.9 of this report.

The applicant is required to adhere to the following conditions for the protection of the environment:

(1) Before engaging in any additional construction or operational activities that may result in any significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this statement, the applicant will provide written notification of such activities to the Director of the Office of Nuclear Reactor Regulation and will receive written approval from that office before proceeding with such activities.

(2) The applicant will carry out the environmental monitoring programs outlined in Section 5 of this statement, as modified and approved by the staff and implemented in the Environmental Protection Plan and Technical Specifications that will be incorporated in the operating licenses.

(3) If an adverse environmental effect or evidence of irreversible environmental damage is detected during the operating life of the plant, the applicant will provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

6.2 Irreversible and Irretrievable Commitments of Resources

Construction activities at NMP-2 disturbed more land than was anticipated in the FES-CP (in part resulting from changes in the cooling system design). Impacts from construction of the transmission lines are less than expected because the 365-kV NMP-2-to-Volney-Station line was realigned so that it is parallel to existing lines. These changes in land use are discussed in Sections 4.2.2 and 5.2.1 of this report.

The FES-CP required monitoring of fish kills at NMP-1 and FitzPatrick so potential fish kills at NMP-2 could be better monitored. This monitoring was performed as part of the aquatic biological monitoring program discussed in Section 6.1 above.

6.3 Relationship Between Short-Term Use and Long-Term Productivity

There have been no significant changes in the staff's evaluation for NMP-2 since the construction permit stage environmental review.

6.4 Benefit-Cost Summary

6.4.1 Benefits

A major benefit to be derived from the operation of NMP-2 is the lower production cost for approximately 5.2 billion kWh of baseload electrical energy that will be produced annually. (This projection assumes that the unit will operate at an annual average capacity factor of 55%.) The addition of the unit will also improve the applicant's ability to supply system load requirements by contributing 1080 MW of capacity (design electric rating, net) to the New York Power Pool's bulk power supply system.

The staff estimates that production costs avoided on existing fossil-fired generating units will be approximately 24.7 mills per kWh on 5.2 billion kWh, resulting in a total avoided cost per year on existing generation facilities of $128 million (1987 dollars).

6.4.2 Economic Costs

The economic costs associated with station operation include fuel costs and operation and maintenance costs (O&M), which are expected to average approximately 6.7 mills per kWh and 12.2 mills per kWh, respectively. Total production costs for the 5.2 billion kWh per year produced by the nuclear unit would be $98 million per year (1987 dollars). The estimate for fuel is derived from applicant's response to staff question 320.2, which was submitted under separate cover September 9, 1983. The estimate of O&M cost is based on a 3% annual escalation of the 1982 average cost for nuclear plants in the northeast region of the U.S. (DOE, 1983).

The applicant estimates that decommissioning costs will total $123 million (1982 dollars).

6.4.3 Socioeconomic Costs

No significant socioeconomic costs are expected from either the operation of NMP-2 or from the number of station personnel and their families living in the area. The socioeconomic impacts of a severe accident could be large; however, the probability of such an accident is small.

6.5 Conclusion

As a result of its analysis and review of potential environmental, technical, and social impacts, the NRC staff has prepared an updated forecast of the effects of operation of NMP-2. The NRC staff has determined that NMP-2 can be operated with minimal environmental impact. To date, no new information has been obtained that alters the overall favorable balancing of the benefits of station operation versus the environmental costs that resulted from evaluations made at the construction permit stage.

6.6 Reference

U.S. Department of Energy, "DOE Update, April-June 1983: Nuclear Power Plant Program Information and Data," DOE/NE0048/3, August 1983.

Table 6.1 Benefit-cost summary for NMP-2

Primary impact and effect on population or resources	Quantity (Section)*	Impacts**
BENEFITS		
Direct		
Additional generating capacity	1080 MWe	Large
Operating cost avoided on existing system generation	5.2 billion kWh/yr @ 24.7 mills/kWh or $128 million/yr	Moderate
COSTS		
Economic		
Fuel	6.7 mills/kWh†	Small
Operation and maintenance	12.2 mills/kWh†	Moderate
Total	$98 million/yr†	Moderate
Decommissioning	$123 million††	Small-Moderate
Adverse socioeconomic effects		
Loss of historic or archeologic resources	(Section 5.7)	None
Increased demands on public facilities and services	(Section 5.8)	Small
Increased demand on private facilities or services	(Section 5.8)	Small
Adverse nonradiological health effects		
Water quality changes	(Section 4.3.2)	
Air quality changes	(Section 5.4)	
Adverse radiological health effects		
Routine operation	(Section 5.9.3)	Small
Postulated accidents	(Section 5.9.4)	
Uranium fuel cycle	(Section 5.10)	Small
Environmental		
Damages suffered by other water users		
Surface water consumption	(Section 5.3)	Small
Surface water contamination	(Section 5.3, 4.3.2)	Small
Groundwater consumption	(Section 5.3)	None
Groundwater contamination	(Section 5.3, 4.3.2)	None

Table 6.1 (continued)

Primary impact and effect on population or resources	Quantity (Section)*	Impacts**
Damage to aquatic resources		
Impingement and entrainment	(Section 5.5.2)	Small
Thermal effects	(Section 5.5.2)	Small
Chemical discharges	(Section 5.5.2)	Small
Damage to terrestrial resources		
Station operations	(Section 5.5)	Small
Transmission line maintenance	(Section 5.5.1.2)	Small
Cooling tower operation	(Section 5.5.1.1)	Small

*Where a particular unit of measure for a benefit/cost category has not been specified in this statement or where an estimate of the magnitude of the benefit/cost under consideration has not been made, the reader is directed to the appropriate section of this report for further information.

**A subjective measure of costs and benefits is assigned by reviewers where quantification is not possible: "Small"=impacts that, in the reviewer's judgment, are of such minor nature, based on currently available information, that they do not warrant detailed investigation or consideration of mitigative actions; "Moderate"=impacts that, in the reviewer's judgment, are likely to be clearly evident (mitigation alternatives are usually considered for moderate impacts); "Large"=impacts that in the reviewer's judgment, represent either a severe penalty or a major benefit. Acceptance requires that large negative impacts should be more than offset by other overriding project considerations.

†1987 dollars

††1982 dollars

7 LIST OF CONTRIBUTORS

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8 LIST OF AGENCIES, ORGANIZATIONS, AND PERSONS TO WHOM COPIES OF THIS ENVIRONMENTAL STATEMENT ARE BEING SENT

Advisory Council on Historic Preservation
Brookhaven National Laboratory
Central New York Regional Planning and Development Board Clearinghouse
Director, Canadian Atomic Energy Control Board
Federal Emergency Management Agency
Federal Energy Regulatory Commission
New York State Attorney General
New York State Clearinghouse
New York State Department of Envronmental Conservation
New York State Technical Development Programs
Supervisor, Town of Scriba
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U.S. Department of Agriculture
U.S. Department of Commerce
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Housing and Urban Development, Region 2
U.S. Department of the Interior
U.S. Department of Transportation
U.S. Environmental Protection Agency

9 RESERVED FOR NRC STAFF RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

APPENDIX A

RESERVED FOR COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

APPENDIX B

NEPA POPULATION-DOSE ASSESSMENT

APPENDIX B

NEPA POPULATION-DOSE ASSESSMENT

Population-dose commitments are calculated for all individuals living within 80 km (50 miles) of the Nine Mile Point Unit 2 (NMP-2) facility, employing the same dose calculation models used for individual doses (see RG 1.109, Revision 1), for the purpose of meeting the "as low as reasonably achievable" (ALARA) requirements of 10 CFR 50, Appendix I. In addition, dose commitments to the population residing beyond the 80-km region, associated with the export of food crops produced within the 80-km region and with the atmospheric and hydrospheric transport of the more mobile effluent species, such as noble gases, tritium, and carbon-14, are taken into consideration for the purpose of meeting the requirements of the National Environmental Policy Act 1969 (NEPA). This appendix describes the methods used to make these NEPA population-dose estimates.

1. Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind; thus the concentration of these nuclides remaining in the plume is continuously being reduced. Within 80 km of the facility, the deposition model in RG 1.111, Revision 1, is used in conjunction with the dose models in RG 1.109, Revision 1. Site-specific data concerning production and consumption of foods within 80 km of the reactor are used. For estimates of population doses beyond 80 km, it is assumed that excess food not consumed within the 80-km area would be consumed by the population beyond 80 km. It is further assumed that none, or very few, of the particulates released from the facility will be transported beyond the 80-km distance; thus, they will make no significant contribution to the population dose outside the 80-km region, except by export of food crops.

2. Noble Gases, Carbon-14, and Tritium Released to the Atmosphere

For locations within 80 km of the reactor facility, exposures to these effluents are calculated with a constant mean wind-direction model according to the guidance provided in RG 1.111, Revision 1, and the dose models described in RG 1.109, Revision 1. For estimating the dose commitment from these radionuclides to the U.S. population residing beyond the 80-km region, two dispersion regimes are considered. These are referred to as the first-pass-dispersion regime and the world-wide-dispersion regime. The model for the first-pass-dispersion regime estimates the dose commitment to the population from the radioactive plume as it leaves the facility and drifts across the continental U.S. toward the northeastern corner of the U.S. The model for the world-wide-dispersion regime estimates the dose commitment to the U.S. population after the released radionuclides mix uniformly in the world's atmosphere or oceans.

(a) First-Pass Dispersion

For estimating the dose commitment to the U.S. population residing beyond the 80-km region as a result of the first pass of radioactive pollutants, it is assumed that the pollutants disperse in the lateral and vertical directions along the plume path. The direction of movement of the plume is assumed to be from the facility toward the northeast corner of the U.S. The extent of vertical dispersion is assumed to be limited by the ground plane and the stable atmospheric layer aloft, the height of which determines the mixing depth. The shape of such a plume geometry can be visualized as a right cylindrical wedge whose height is equal to the mixing depth. Under the assumption of constant population density, the population dose associated with such a plume geometry is independent of the extent of lateral dispersion; it is only dependent upon the mixing depth and other nongeometrical related factors (NUREG-0597). The mixing depth is estimated to be 1000 m, and a uniform population density of 62 persons/km^2 is assumed along the plume path, with an average plume-transport velocity of 2 m/s.

The total-body population-dose commitment from the first pass of radioactive effluents is due principally to external exposure from gamma-emitting noble gases, and to internal exposure from inhalation of air containing tritium and from ingestion of food containing carbon-14 and tritium.

(b) World-Wide Dispersion

For estimating the dose commitment to the U.S. population after the first-pass, world-wide dispersion is assumed. Nondepositing radionuclides with half-lives greater than 1 year are considered. Noble gases and carbon-14 are assumed to mix uniformly in the world's atmosphere (3.8×10^{18} m^3), and radioactive decay is taken into consideration. The world-wide-dispersion model estimates the activity of each nuclide at the end of a 20-year release period (midpoint of reactor life) and estimates the annual population-dose commitment at that time, taking into consideration radioactive decay and physical removal mechanisms (for example, carbon-14 is gradually removed to the world's oceans). The total-body population-dose commitment from the noble gases is due mainly to external exposure from gamma-emitting nuclides, whereas from carbon-14 it is due mainly to internal exposure from ingestion of food containing carbon-14.

The population-dose commitment as a result of tritium releases is estimated in a manner similar to that for carbon-14, except that after the first pass, all the tritium is assumed to be immediately distributed in the world's circulating water volume (2.7×10^{16} m^3), including the top 75 m of the seas and oceans, as well as the rivers and atmospheric moisture. The concentration of tritium in the world's circulating water is estimated at the time after 20 years of releases have occurred, taking into consideration radioactive decay. The population-dose commitment estimates are based on the incremental concentration at that time. The total-body population-dose commitment from tritium is due mainly to internal exposure from the consumption of food.

3. Liquid Effluents

Population-dose commitments due to effluents in the receiving water within 80 km of the facility are calculated as described in RG 1.109, Revision 1. It is assumed that no depletion by sedimentation of the nuclides present in the receiving water occurs within 80 km. It also is assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the ALARA evaluation for the maximally exposed individual. However, food-consumption values appropriate for the average, rather than the maximum, individual are used. It is further assumed that all the sport and commercial fish and shellfish caught within the 80-km area are eaten by the U.S. population.

Beyond 80 km, it is assumed that all the liquid-effluent nuclides except tritium have deposited on the sediments so that they make no further contribution to population exposures. The tritium is assumed to mix uniformly in the world's circulating water volume and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

4. References

U.S. Nuclear Regulatory Commission, NUREG-0597, K. F. Eckerman, et al., "User's Guide to GASPAR Code," June 1980.

---, RG 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

---, RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Reactors," Revision 1, July 1977.

APPENDIX C

IMPACTS OF THE URANIUM FUEL CYCLE

APPENDIX C

IMPACTS OF THE URANIUM FUEL CYCLE

The following assessment of the environmental impacts of the LWR-supporting fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 (see Section 5.10 of the main body of this report), and the NRC staff's analysis of the radiological impact from radon and technetium releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of the Nine Mile Point (NMP-2) Nuclear Station Unit 2.

1. Land Use

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 460,000 m^2 (113 acres). Approximately 53,000 m^2 (13 acres) per year are permanently committed land, and 405,000 m^2 (100 acres) per year are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant, such as a mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 405,000 m^2 per year of temporarily committed land, 320,000 m^2 are undisturbed and 90,000 m^2 are disturbed. Considering common classes of land use in the United States,* fuel-cycle land-use requirements to support the model 1000-MWe LWR do not represent a significant impact.

2. Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43 x 10^6 m^3 (11.4 x 10^9 gal), about 42 x 10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (for example, evaporation losses in process cooling) of about 0.6 x 10^6 m^3 (16 x 10^7 gal) per year and water discharged to the ground (for example, mine drainage) of about 0.5 x 10^6 m^3 per year.

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the model 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6 x 10^6 m^3 per year is about 2% of that from the

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*A coal-fired plant of 1000-MWe capacity using strip-mined coal requires the disturbance of about 810,000 m^2 (200 acres) per year for fuel alone.

model 1000-MWe LWR using cooling towers. The maximum consumptive water usé (assuming that all plants supplying electrical energy to the nuclear fuel cycle used cooling towers) would be about 6% of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

3. Fossil Fuel Consumption

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

4. Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents associated with fuel-cycle processes are given in Table S-3. The principal species are sulfur oxides, nitrogen oxides, and particulates. On the basis of data in a Council on Environmental Quality report (CEQ, 1976), the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with the same emissions from the stationary fuel-combustion and transportation sectors in the United States; that is, about 0.02% of the annual national releases for each of these species. The staff believes that such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. The flow of dilution water required for specific constituents is specified in Table S-3. Additionally, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in the pollutant discharge elimination system permit issued by the State of New York (SPDES; see Appendix E).

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

5. Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste-management activities and certain other phases of the fuel-cycle process are set forth in Table S-3. Using these data, the staff has calculated for 1 year of operation of the model 1000-MWe LWR the 100-year involuntary environmental dose commitment* to the U.S. population from the LWR-supporting fuel cycle.

It is estimated from these calculations that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222 and technetium-99) would be approximately 400 person-rems for each year of operation of the model 1000-MWe LWR (reference reactor year, or RRY). Based on Table S-3 values, the additional involuntary total-body dose commitments to the U.S. population from radioactive liquid effluents (excluding technetium-99) as a result of all fuel-cycle operations other than reactor operation would be about 100 person-rems per year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is about 500 person-rems (whole-body) per RRY.

At this time the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities. The staff has determined that radon-222 releases per RRY from these operations are as given in Table C-1. The staff has calculated population-dose commitments for these sources of radon-222 using the RABGAD computer code described in Volume 3 of NUREG-0002, Appendix A, Chapter IV, Section J. The results of these calculations for mining and milling activities prior to tailings stabilization are listed in Table C-2.

When added to the 500 person-rems total-body dose commitment for the balance of the fuel cycle, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is approximately 640 person-rems. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about 3 billion person-rems to the U.S. population.**

The staff has considered the health effects associated with the releases of radon-222, including both the short-term effects of mining and milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that after completion of active mining, underground mines will be sealed, returning releases of radon-222 to background levels. For purposes of providing an upper bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore were produced from open-pit mines, releases from them would be 110 Ci per RRY. However, because the distribution of uranium-ore reserves available by conventional mining methods is 66% underground and 34%

*The 100-year environmental dose commitment is the integrated population dose for 100 years; that is, it represents the sum of the annual population doses for a total of 100 years.

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

open pit (Department of Energy, 1978), the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 0.34 x 110 or 37 Ci per year per RRY.

Based on the above, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37,000 Ci per RRY, respectively. The total dose commitments for a 100- to 1000-year period would be as shown in Table C-3.

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

For long-term radon releases from stabilized tailings piles, the staff has assumed that these tailings would emit, per RRY, 1 Ci per year for 100 years, 10 Ci per year for the next 400 years, and 100 Ci per year for periods beyond 500 years. With these assumptions, the cumulative radon-222 release from stabilized-tailings piles per RRY would be 100 Ci in 100 years, 4090 Ci in 500 years, and 53,800 Ci in 1000 years (Gotchy, 1978). The total-body, bone, and bronchial epithelium dose commitments for these periods are as shown in Table C-4.

Using risk estimators of 135, 6.9, and 22 cancer deaths per million person-rems for total-body, bone, and lung exposures, respectively, the estimated risk of cancer mortality resulting from mining, milling, and active-tailings emissions of radon-222 is about 0.11 cancer fatality per RRY. When the risk from radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities per RRY is estimated over a 1000-year release period. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon-induced cancer fatalities per RRY change as follows:

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

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

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP, 1975), the staff calculates the average radon-222 concentration in air in the contiguous United States to be about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 millirems. For a stabilized future U.S. population of 300 million, this represents a total lung-dose commitment of 135 million person-rems per year. Using the same risk estimator of 22 lung-cancer fatalities per million person-lung-rems used to predict cancer fatalities for the model 1000 MWe LWR, the staff estimates that lung-cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year, or 300,000 to 3,000,000 lung-cancer deaths over periods of 100 to 1000 years, respectively.

The staff is currently in the process of formulating a specific model for analyzing the potential impact and health effects from the release of technetium-99 during the fuel cycle. However, for the interim period until the model is completed, the staff has calculated that the potential 100-year environmental dose commitment to the U.S. population from the release of technetium-99 should not exceed 100 person-rems per RRY. These calculations are based on the gaseous and the hydrological pathway model systems described in Volume 3 of NUREG-0002, Chapter IV, Section J, Appendix A. When these figures are added to the 640 person-rem total-body dose commitment for the balance of the fuel cycle, including radon-222, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is about 740 person-rems. Over this period of time, this dose is equivalent to 0.00002% of the natural-background total-body dose of about three billion person-rems to the U.S. population.*

The staff also considered the potential health effects associated with this release of technetium-99. Using the modeling systems described in NUREG-0002, the major risks from technetium-99 are from exposure of the gastrointestinal tract and kidney, although there is a small risk from total-body exposure. Using organ-specific risk estimators, these individual organ risks can be converted to total-body risk equivalent doses. Then, by using the total-body risk estimator of 135 cancer deaths per million person-rems, the estimated risk of cancer mortality due to technetium-99 releases from the nuclear fuel cycle is about 0.01 cancer fatality per RRY over the subsequent 100 to 1000 years.

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

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

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

6. Radioactive Wastes

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

7. Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rems. The staff concludes that this occupational dose will have a small environmental impact.

8. Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small in comparison with the natural-background dose.

9. Fuel Cycle

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

10. References

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

Gotchy, R., testimony from "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

National Council on Radiation Protection and Measurements (NCRP), "Natural Background Radiation in the United States," NCRP Report No. 45, November 1975.

U.S. Department of Energy, "Statistical Data of the Uranium Industry," GJO-100(8-78), January 1978.

U.S. Nuclear Regulatory Commission, NUREG-0002, "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors," August 1976.

---, NUREG-0116 (Supplement 1 to WASH-1248), "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," October 1976.

Table C-1 Radon releases from mining and milling operations and mill tailings for each year of operation of the model 1000-MWe LWR*

Radon source	Quantity released
Mining**	4060 Ci
Milling and tailings*** (during active mining)	780 Ci
Inactive tailings*** (before stabilization)	350 Ci
Stabilized tailings*** (several hundred years)	1 to 10 Ci/year
Stabilized tailings*** (after several hundred years)	110 Ci/year

*After three days of hearings before the Atomic Safety and Licensing Appeal Board (ASLAB) using the Perkins record in a "lead case" approach, the ASLAB issued a decision on May 13, 1981 (ALAB-640) on the radon-222 release source term for the uranium fuel cycle. The decision, among other matters, produced new source term numbers based on the record developed at the hearings. These new numbers did not differ significantly from those in the Perkins record, which are the values set forth in this table. Any health effects relative to radon-222 are still under consideration before the ASLAB. Because the source term numbers in ALAB-640 do not differ significantly from those in the Perkins record, the staff continues to conclude that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural background sources. Subsequent to ALAB-640, a second ASLAB decision (ALAB-654, issued September 11, 1981) permits intervenors a 60-day period to challenge the Perkins record on the potential health effects of radon-222 emissions.

**R. Wilde, NRC transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)," Docket No. 50-488, April 17, 1978.

***P. Magno, NRC transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)" Docket No. 50-488, April 17, 1978.

Table C-2 Estimated 100-year environmental dose commitment per year of operation of the model 1000-MWe LWR

Radon source	Radon-222 releases (Ci)	Dosage (person-rems) Total body	Bone	Lung (bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total	5200	140	3600	2900

Table C-3 Population-dose commitments from unreclaimed open-pit mines for each year of operation of the model 1000-MWe LWR

Time span (years)	Radon-222 releases (Ci)	Population dose commitments (person-rems) Total body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

Table C-4 Population-dose commitments from stabilized-tailings piles for each year of operation of the model 1000-MWe LWR

Time span (years)	Radon-222 releases (Ci)	Population dose commitments (person-rems) Total body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

APPENDIX D

EXAMPLES OF SITE-SPECIFIC DOSE ASSESSMENT CALCULATIONS

APPENDIX D

EXAMPLES OF SITE-SPECIFIC DOSE ASSESSMENT CALCULATIONS

1. Calculational Approach

As mentioned in the main body of this report, the quantities of radioactive material that may be released annually from the Nine Mile Point Unit 2 (NMP-2) facility are estimated on the basis of the description of the design and operation of the radwaste systems in the applicant's FSAR and by using the calculative models and parameters described in NUREG-0016. These estimated effluent release values for normal operation, including anticipated operational occurrences, along with the applicant's site and environmental data in the ER-OL and in subsequent answers to NRC staff questions, are used in the calculation of radiation doses and dose commitments.

The models and considerations for environmental pathways that lead to estimates of radiation doses and dose commitments to individual members of the public near the plant and of cumulative doses and dose commitments to the entire population within an 80-km (50-mile) radius of the plant as a result of plant operations are discussed in detail in RG 1.109, Revision 1. Use of these models with additional assumptions for environmental pathways that lead to exposure to the general population outside the 80-km radius is described in Appendix B of this statement.

The calculations performed by the staff for the releases to the atmosphere and hydrosphere provide total integrated dose commitments to the entire population within 80 km of this facility based on the projected population distribution in the year 2000. The dose commitments represent the total dose that would be received over a 50-year period, following the intake of radioactivity for 1 year under the conditions existing 20 years after the station begins operation (that is, the mid-point of station operation). For younger persons, changes in organ mass and metabolic parameters with age after the initial intake of radioactivity are accounted for.

2. Dose Commitments from Radioactive Effluent Releases

The NRC staff's estimates of the expected gaseous and particulate releases (listed in Table D-1) along with the site meteorological considerations (summarized in Table D-2) were used to estimate radiation doses and dose commitments for airborne effluents. Individual receptor locations and pathway locations considered for the maximally exposed individual in these calculations are listed in Table D-3.

Meteorological data for 1 year were used in the calculation of concentrations of effluents. The calculation followed guidance given in RG 1.111, Revision 1. Onsite meteorological data collected from January 1975 through December 1975, with wind speed and direction measured at elevations of 62 m and 10 m and the vertical temperature gradient measured between 9.1 and 61 m, were used as a measure of atmospheric stability. A straight line Gaussian dispersion model, corrected for effluent recirculation, was utlzed for the routine gaseous release dispersion calculation. Releases evaluated were continuous at ground level and from the 131-m stack. Periodic releases (5 to 24 hours a year) from the stack were also evaluated.

The NRC staff estimates of the expected liquid releases (listed in Table D-4), along with the site hydrological considerations (summarized in Table D-5), were used to estimate radiation doses and dose commitments from liquid releases.

(a) Radiation Dose Commitments to Individual Members of the Public

As explained in the text, calculations are made for a hypothetical individual member of the public (that is, the maximally exposed individual) who would be expected to receive the highest radiation dose from all pathways that contribute. This method tends to overestimate the doses because assumptions are made that would be difficult for a real individual to fulfill.

The estimated dose commitments to the individual who is subject to maximum exposure at selected offsite locations from airborne releases of radioiodine and particulates, and waterborne releases are listed in Tables D-6 and D-7. The maximum annual total body and skin dose to a hypothetical individual and the maximum beta and gamma air dose at the site boundary are presented in Tables D-6 and D-7.

The maximally exposed individual is assumed to consume well above average quantities of the potentially affected foods and to spend more time at potentially affected locations than the average person as indicated in Tables E-4 and E-5 of Revision 1 of RG 1.109.

(b) Cumulative Dose Commitments to the General Population

Annual radiation dose commitments from airborne and waterborne radioactive releases from the NMP-2 facility are estimated for two populations in the year 2000: (1) all members of the general public within 80 km (50 miles) of the station (Table D-7) and (2) the entire U.S. population (Table D-9). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix B. For perspective, annual background radiation doses are given in the tables for both populations.

3. References

U.S. Nuclear Regulatory Commission, NUREG-0016, F. P. Cardile and R. R. Bellamy (editors), "Calculation of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors," Revision 1, January 1979.

---, RG 1.109, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Revision 1, October 1977.

---, RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Reactors," Revision 1, 1977.

Table D-1 Calculated releases of radioactive materials in gaseous effluents from NMP-2 (Ci/yr)

Nuclide	Main stack[1] (continuous)	Mechanical vacuum pump[2] (intermittent)	Radwaste/reactor building vent[3] (continuous)
Ar-41	225	a	15
Kr-83m	160	a	a
Kr-85m	7200	a	1
Kr-85	240	a	a
Kr-87	130	a	a
Kr-88	6400	a	1
Kr-89	581	a	29
Xe-131m	98	a	a
Xe-133m	130	a	a
Xe-133	24500	1300	247
Xe-135m	445	a	545
Xe-135	38	500	313
Xe-137	1072	a	228
Xe-138	1000	a	4
Total noble gases		45000	
Cr-51	0.0002	b	0.0009
Mn-54	0.00044	b	0.0007
Co-58	0.0001	b	0.001
Fe-59	0.00009	b	0.00011
Co-60	0.0011	b	0.002
Zn-65	0.001	b	0.006
Sr-89	b	b	0.006
Sr-90	0.000003	b	0.00002
Nb-95	0.001	b	0.0001
Zr-95	0.0003	b	0.00006
Mo-99	0.006	b	0.0026
Ru-103m	0.0002	b	0.00009
Ag-110m	0.0000004	b	b
Sb-124	0.000021	b	0.0001
Cs-134	0.00072	b	0.00027
Cs-136	0.0001	b	0.00011
Cs-137	0.001	b	0.0011
Ba-140	0.002	b	0.01
Ce-141	b	b	0.01
Total particulates		0.0054	
I-131	0.038	0.15	0.24
I-133	0.51	1.6	3.09
H-3	26.0	b	26.0
C-14	b	b	9.5

[1] The main stack is 430 feet above grade, which is 2.5 times the height of the reactor building.
[2] Discharged via the main stack, five 24-hour purges per year.
[3] Ground-level releases (vent stack is approximately 170 feet above grade).
Notes: a = less than 1.0 Ci/yr for noble gases; b = less than 1% of total for this nuclide.

Table D-2 Summary of atmospheric dispersion factors (χ/Q) and relative deposition values for maximum site boundary and receptor locations near NMP-2*

Location**	Source***	χ/Q (sec/m^3)	Relative Deposition (m^{-2})
Nearest effluent-control boundary (1.6 km E)	A	3.5×10^{-8}	4.8×10^{-9}
	B	2.0×10^{-6}	2.1×10^{-9}
	C	4.5×10^{-8}	6.0×10^{-9}
Nearest residence and garden (1.6 km SW)	A	9.6×10^{-9}	8.8×10^{-10}
	B	2.5×10^{-6}	9.2×10^{-9}
	C	2.0×10^{-8}	1.9×10^{-9}
Nearest milk cow (2.6 km ESE)	A	2.3×10^{-8}	1.4×10^{-9}
	B	6.1×10^{-7}	3.7×10^{-9}
	C	6.1×10^{-8}	3.7×10^{-9}
Nearest milk goat (3.8 km SSE)	A	9.6×10^{-9}	5.0×10^{-10}
	B	1.4×10^{-7}	8.0×10^{-10}
	C	4.2×10^{-8}	2.2×10^{-9}
Nearest meat animal (2.3 km SW)	A	7.8×10^{-9}	4.6×10^{-10}
	B	1.1×10^{-6}	3.7×10^{-9}
	C	3.2×10^{-8}	1.9×10^{-9}

*The values presented in this table are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," July 1977.

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

***Sources:
A - Main stack, Unit 2, continuous.
B - Radwaste/reactor building ventilation exhaust, continous release.
C - Main stack, Unit 2, intermittent releases, 5 releases per year, 24 hours each release.

Table D-3 Nearest pathway locations used for maximally exposed individual dose commitments for NMP-2

Location	Sector	Distance (km)
Nearest effluent-control boundary*	E	1.6
Residence and garden**	SW	1.6
Milk cow	E	2.6
Milk goat	SSE	3.8
Meat animal	SW	2.3

*Beta and gamma air doses, total body doses, and skin doses from noble gases are determined at the effluent-control boundaries in the sector where the maximum potential value is likely to occur.

**Dose pathways including inhalation of atmospheric radioactivity, exposure to deposited radionuclides, and submersion in gaseous radioactivity are evaluated at residences. This particular location includes doses from vegetable consumption as well.

Table D-4 Calculated release of radioactive materials in liquid effluents from NMP-2

Nuclide	Ci/yr*
Corrosion and Activation Products	
Na-24	0.0064
P-32	0.00082
Cr-51	0.029
Mn-54	0.0048
Mn-56	0.00003
Fe-55	0.013
Fe-59	0.0018
Co-58	0.01
Co-60	0.017
Cu-64	0.015
Ni-3	0.0025
Zn-65	0.00069
Zn-69m	0.0011
W-187	0.00035
Np-239	0.017
Fission Products	
Sr-89	0.00045
Sr-90	0.00008
Sr-91	0.0011
Y-91	0.00038
Y-92	0.00017
Y-93	0.0012
Zr-95	0.0015
Nb-95	0.0018
Mo-99	0.0047
Tc-99m	0.056
Fission Products (cont'd)	
Ru-103	0.00038
Ru-105	0.00004
Ru-106	0.003
Ag-110m	0.0006
Te-129m	0.00013
Te-131m	0.00015
I-131	0.024
Te-132	0.00004
I-132	0.00004
I-133	0.053
Cs-134	0.013
I-135	0.0049
Cs-136	0.0012
Cs-137	0.021
Ba-140	0.0022
Ce-141	0.00031
CE-143	0.00005
Pr-143	0.00013
CE-144	0.0035
All Others	0.0058
Total (except H-3)	0.27
H-3	52.0

*Nuclides whose release rates are less than 10^{-5} Ci/yr are not listed individually but are included in "all others."

Table D-5 Summary of hydrologic transport and dispersion for liquid releases from NMP-2*

Location	Transit time (hours)	Dilution factor
Nearest drinking-water intake (Onondaga County)	39	364
Nearest sport-fishing location (discharge area)**	0	6
Nearest shoreline (Lake Ontario near discharge area)	46	263

*See Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

**Assumed for purposes of an upper-limit estimate.

Table D-6 Annual dose commitments to a maximally exposed individual near NMP-2

Location	Pathway	Doses (mrems/yr per unit, except as noted)				
		Noble gases in gaseous effluents				
		Total body	Skin	Gamma air dose (mrads/yr/unit)	Beta air dose (mrads/yr/unit)	
Nearest* site boundary (1.6 km E)	Direct radiation from plume	0.18	0.34	0.27	0.18	
		Iodine and particulates in gaseous effluents**				
		Total body		Organ		
Nearest*** site boundary (1.6 km SW)	Ground deposition	a	(T)	a	(C)	(thyroid)
	Inhalation	a	(T)	1.29	(C)	(thyroid)
Nearest residence and garden (1.6 km SW)	Ground deposition	a	(C)	a	(C)	(thyroid)
	Inhalation	a	(C)	0.80	(C)	(thyroid)
	Vegetable consumption	0.34	(C)	1.96	(C)	(thyroid)
Nearest milk cow (2.6 km ESE)	Ground deposition	a	(I)	a	(I)	(thyroid)
	Inhalation	a	(I)	0.27	(I)	(thyroid)
	Vegetable consumption	a	(I)	a	(I)	(thyroid)
	Cow milk consumption	0.15	(I)	12.90	(I)	(thyroid)
Nearest milk goat (3.8 km SSE)	Ground deposition	a	(C)	a	(I)	(thyroid)
	Inhalation	a	(C)	a	(I)	(thyroid)
	Vegetable consumption	a	(C)	a	(I)	(thyroid)
	Goat milk consumption	a	(C)	11.0	(I)	(thyroid)
Nearest meat animal (2.3 km SW)	Meat consumption	a	(C)	a	(C)	(thyroid)
		Liquid effluents**				
		Total body		Organ		
Nearest drinking water	Water ingestion	a	(C)	a	(C)	(bone)
Nearest fish at plant-discharge area	Fish consumption	0.41	(A)	1.66	(C)	(bone)
Nearest shore access near plant-discharge area	Shoreline recreation	a	(T)	a	(T)	(bone)

a=Less than 0.1 mrem/year.
*"Nearest" refers to that site boundary location where the highest radiation doses as a result of gaseous effluents have been estimated to occur.
**Doses are for the age group and organ that results in the highest cumulative dose for the location: A=adult, T=teen, C=child, I=infant. Calculations were made for these age groups and for the following organs: gastrointestinal tract, bone, liver, kidney, thyroid, lung, and skin.
***"Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

Table D-7 Calculated Appendix I dose commitments to a maximally exposed individual and to the population from operation of NMP-2

	Annual dose per reactor unit	
	Individual	
	Appendix I design objectives*	Calculated doses**
Liquid effluents		
Dose to total body from all pathways	3 mrems	0.4 mrem
Dose to any organ from all pathways	10 mrems	1.7 mrems (bone)
Noble-gas effluents (at site boundary)		
Gamma dose in air	10 mrads	0.27 mrad
Beta dose in air	20 mrads	0.18 mrad
Dose to total body of an individual	5 mrems	0.18 mrem
Dose to skin of an individual	15 mrems	0.34 mrem
Radioiodines and particulates* **		
Dose to any organ from all pathways	15 mrems	13.2 mrems (thyroid)
	Population dose within 80 km, person-rems	
	Total body	Thyroid
Natural-background radiation~	120,000	
Liquid effluents	2.0	0.3
Noble-gas effluents	1.57	1.57
Radioiodine and particulates	0.74	12.63

*Design Objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR Part 50 consider doses to maximally exposed individual and to population per reactor unit.

**Numerical values in this column were obtained by summing appropriate values in Table D-6. Locations resulting in maximum doses are represented here.

***Carbon-14 and tritium have been added to this category.

~"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average background dose for New York of 107 mrems/yr, and year 2000 projected population of 1,100,000.

[a]Less than 0.1 mrem/year.

[b]Less than 0.1 mrad/year.

[c]Less than 0.1 personrem.

Table D-8 Annual total-body population dose commitments, year 2000

Category	U.S. population dose commitment, person-rems/yr
Natural background radiation*	26,000,000*
NMP-2 operation	
Plant workers	790
General public	
Liquid effluents**	2.0
Gaseous effluents	30
Transportation of fuel and waste	3

*Using the average U.S. background dose (100 mrems/yr) 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. 704, July 1977.

**80-km (50-mile) population dose

APPENDIX E

SPDES PERMIT
NINE MILE POINT NUCLEAR STATION UNITS 1 AND 2
NIAGARA MOHAWK POWER CORPORATION

Copies: R7 - K. DelPrete
B. Garvey
R. Baker
R. Spear
Oswego County Hlth. Dept.
Niagara Mohawk - Lycoming
DRA - R7 Mr. Geisendorfer, Rm. 308, BWFD

Facility ID No. : NY- 000 1015
Effective Date (EDP) : July 1, 1983
Expiration Date (ExDP) : July 1, 1988

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
STATE POLLUTANT DISCHARGE ELIMINATION SYSTEM (SPDES)
DISCHARGE PERMIT

Special Conditions
(Part I).

This SPDES permit is issued in compliance with Title 8 of Article 17 of the Environmental Conservation Law of New York State and in compliance with the Clean Water Act, as amended, (33 U.S.C. §1251 et. seq.) (hereinafter referred to as "the Act").

Permittee Name: Niagara Mohawk Power Corp. Attn: Mr. J. M. Toennies, Env. Affairs Director

Permittee Street: 300 Erie Boulevard West

Permittee City: Syracuse State: N.Y. Zip Code: 13202

is authorized to discharge from the facility described below:

Facility Name: Nine Mile Pt. Nuclear Generating Station Units #1 and 2

Facility Location (C,T,V): Scriba (T) County: Oswego

Facility Mailing Address (Street): Lake Road

Facility Mailing Address (City): Lycoming (T) State: N.Y. Zip Code: 13093

into receiving waters known as:

Lake Ontario Class A Special

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

This permit and the authorization to discharge shall expire on midnight of the expiration date shown above and the permittee shall not discharge after the expiration date unless this permit has been renewed, or extended pursuant to law. To be authorized to discharge beyond the expiration date, the permittee shall apply for permit renewal as prescribed by Sections 17-0803 and 17-0804 of the Environmental Conservation Law and Parts 621, 752, and 755 of the Departments' rules and regulations.

By Authority of Alternate Permit Administrator
Designated Representative of Commissioner of the Department of Environmental Conservation

6-6-83
Date

Robert P. Porter
Signature

91-20-2(6/80)Pg.1

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning July 1, 1983
and lasting until July 1, 1988
the discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

Outfall Number & Effluent Parameter	Discharge Limitations Daily Avg.	Discharge Limitations Daily Max.	Units	Monitoring Reqmts. Measurement Frequency	Monitoring Reqmts. Sample Type
010 Condenser Cooling Water Unit #1					
Flow*				Continuous	Calculated
Discharge Temperature		115	°F	Continuous	Metered
Intake - Discharge Temperature Difference [a]		35	°F	Continuous	Metered
Net Rate of addition of heat [a]		1.11	10^9 kcal/hr.	Hourly	Calculated
Cyanide [d]		0.1	mg/1	Monthly	12.-hr. Composi
011 Unit #1 Wastewater					
Flow*				Batch	Calculated
				Batch before discharge	
Oil and Grease		15	mg/1	"	Grab
Suspended Solids	30	50	mg/1	"	"
pH	6.0 - 9.0 (Range)[e]		SU	"	"
Cyanide [d]	0.4		mg/1	"	"
020 Storm Drainage (No Monitoring Required) Unit #1					
021 Filter Backwash & Makeup Demineralizer Water Supply					
Flow*				Batch	Calculated
Oil & Grease		15	mg/1	Batch each	Grab
Suspended Solids	30	50	mg/1	" discharge	"
pH	6.0 - 9.0 (Range)		SU	"	"
022 Security Building Air Conditioning [b]					
Oil and Grease		15	mg/1	Bimonthly	Grab
Suspended Solids	30	50	mg/1	"	"
pH	6.0 - 9.0 (Range)		SU	"	"

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning with initiation of preoperational testing (Unit #2) and lasting until EDP + 5 Years the discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

Outfall Number & Effluent Parameter	Discharge Limitations Daily Avg.	Discharge Limitations Daily Max.	Units	Monitoring Reqmts. Measurement Frequency	Monitoring Reqmts. Sample Type
001-006 Storm Drainage (No Monitoring Required)					
007 Floor and Equipment Drains					
Oil and Grease		15	mg/l	2/Month	Grab
Suspended Solids	30	50	mg/l	"	"
pH	6.0 - 9.0 (Range)		SU	"	"
008 Screen Well Fish Diversion System (No Monitoring Required)					
040 Cooling Tower Blowdown (Unit #2)[c]					
Flow*				Continuous	Recorder
Discharge Temperature		110(43.3)	°F(°C)	"	"
Intake - Discharge Temperature Difference		30(16.7)	"	"	"
Net Addition of Heat		0.12×10^9	kcal/hr.	Daily	Calculated
Total Residual Chlorine	0.2	0.5	mg/l	Continuous	Recorder
pH	6.0 - 9.0 (Range)		SU	2/Week	Grab
041 Unit #2 Wastewater (Including Demineralizer Regeneration Wastes, Filter Backwash, Floor Drains, & Treated Radioactive Wastes[e].)					
Flow*				Batch	Calculated
Oil and Grease		15	mg/l	"	Grab (once before discharge)
Suspended Solids	30	50	mg/l	"	"
pH	6.0 - 9.0 (Range)		SU	"	"

FOOTNOTES

*Monitoring Requirement Only

[a]The intake temperature shall be considered that temperature existing after intake water tempering.

[b]These limits and monitoring requirements shall not apply if this wastewater is discharged upstream of the sewage treatment facility.

[c]There shall be no discharge of heat from the main condensers except heat may be discharged in blowdown from recirculated cooling water systems provided the temperature at which the blowdown is discharged does not exceed at any time the lowest temperature of recirculated cooling water prior to the addition of the makeup water.

[d]Monitoring and limits may be deleted following DEC evaluation of monitoring data.

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[e]pH range of 4.0 - 9.0 is allowable for wastewater having a conductivity of less than 10 μmho/cm

EFFLUENT LIMITATIONS

During the period beginning EDP and lasting until EDP + 5 Years discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

TABLE I

Outfall Number	Effluent Limitations (Maximum Limits except where otherwise indicated)		
030	(X) Flow	30 day arithmetic mean	65,000 ( )MGD (X)GPD
	(X) BOD_5	30 day arithmetic mean	25 mg/l and ____ lbs/day (1)
	( ) BOD_5	7 day arithmetic mean	____ mg/l and ____ lbs/day
	(X) BOD_5	Daily	45 mg/l and ____ lbs/day
	( ) UOD_5 (2)	Daily	____ mg/l and ____ lbs/day
	(X) Suspended Solids	30 day arithmetic mean	25 mg/l and ____ lbs/day (1)
	( ) Suspended Solids	7 day arithmetic mean	____ mg/l and ____ lbs/day
	(X) Suspended Solids	Daily	45 mg/l and ____ lbs/day

(X) Effluent disinfection required: (X) all year
( ) Seasonal from ____________ to ____________
Fecal Coliform 30 day geometric mean shall not exceed 200/100 ml
Fecal Coliform 7 day geometric mean shall not exceed 400/100 ml
Fecal Coliform 6 hour geometric mean shall not exceed 800/100 ml (3)
Fecal Coliform No individual sample may exceed 2400/100 ml (3)

The chlorine residual in the final discharge shall not exceed 0.5 mg/l.

( ) Total Coliform	Daily	____ /100 ml
( ) Total Kjeldahl Nitrogen	Daily	____ /mg/l as N
( ) Ammonia	Daily	____ /mg/l as NH_3
( ) Dissolved Oxygen	Minimum	greater than ____ mg/l
(X) pH	Range	6.0 to 9.0
(X) Settleable Solids	Daily	0.1 ml/l
( ) Phosphorus	Daily	____ mg/l as P
( ) Total Nitrogen	Daily	____ mg/l as N
( ) ____________		

TABLE 2

Monitoring Requirements

Parameter	Frequency	Sample Type	Sample Location Influent	Sample Location Effluent
(X) Total Flow, MGD	2/Month	Grab		
(X) BOD_5, mg/l	"	"		
(X) Suspended Solids, mg/l	"	"		
(X) Fecal Coliform, No./100 ml	"	"		
( ) Total Coliform, No./100 ml				
( ) Total Kjeldahl Nitrogen, mg/l as N				
( ) Ammonia, mg/l as NH_3				
( ) Dissolved Oxygen, mg/l				
(X) pH	2/Month	Grab		
(X) Settleable Solids, ml/l	"	"		
(X) Residual Chlorine, mg/l	"	"		X
( ) Phosphorus, mg/l as P				
( ) Temperature, °C				
( ) Total Nitrogen, mg/l as N				
( ) Visual Observation				
( ) ____________				

(1)and effluent values shall not exceed ________% of influent values.
(2)UOD (Ultimate Oxygen Demand) shall be computed and reported as follows:
$UOD = 1\frac{1}{2} \times BOD_5 + 4\frac{1}{2} \times TKN$ (Total Kjeldahl Nitrogen).
(3)applicable only in the Interstate Sanitation District.
(4)sample contact chamber effluent and final effluent if limits are specified for both.

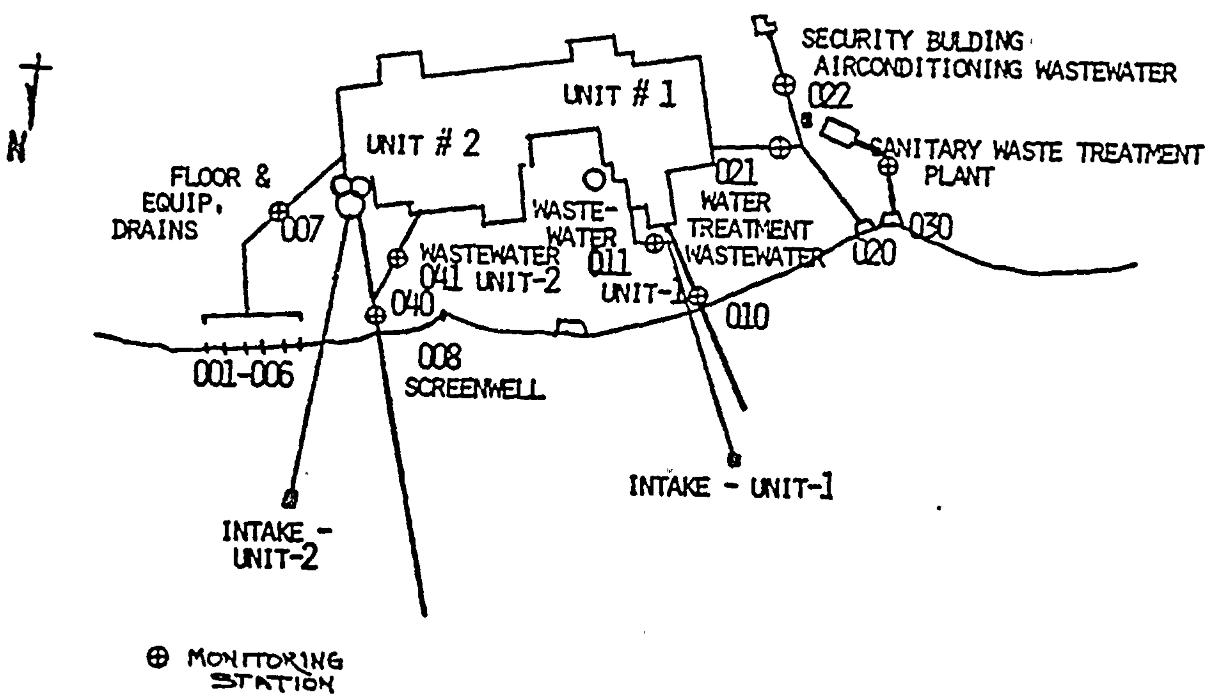
Definition of Daily Average and Daily Maximum

The daily average discharge is the total discharge by weight or in other appropriate units as specified herein, during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges in appropriate units as specified herein divided by the number of days during the calendar month when the measurements were made.

The daily maximum discharge means the total discharge by weight or in other appropriate units as specified herein, during any calendar day.

Monitoring Locations

Permittee shall take samples and measurements to meet the monitoring requirements at the location(s) indicated below: (Show locations of outfalls with sketch or flow diagram as appropriate).



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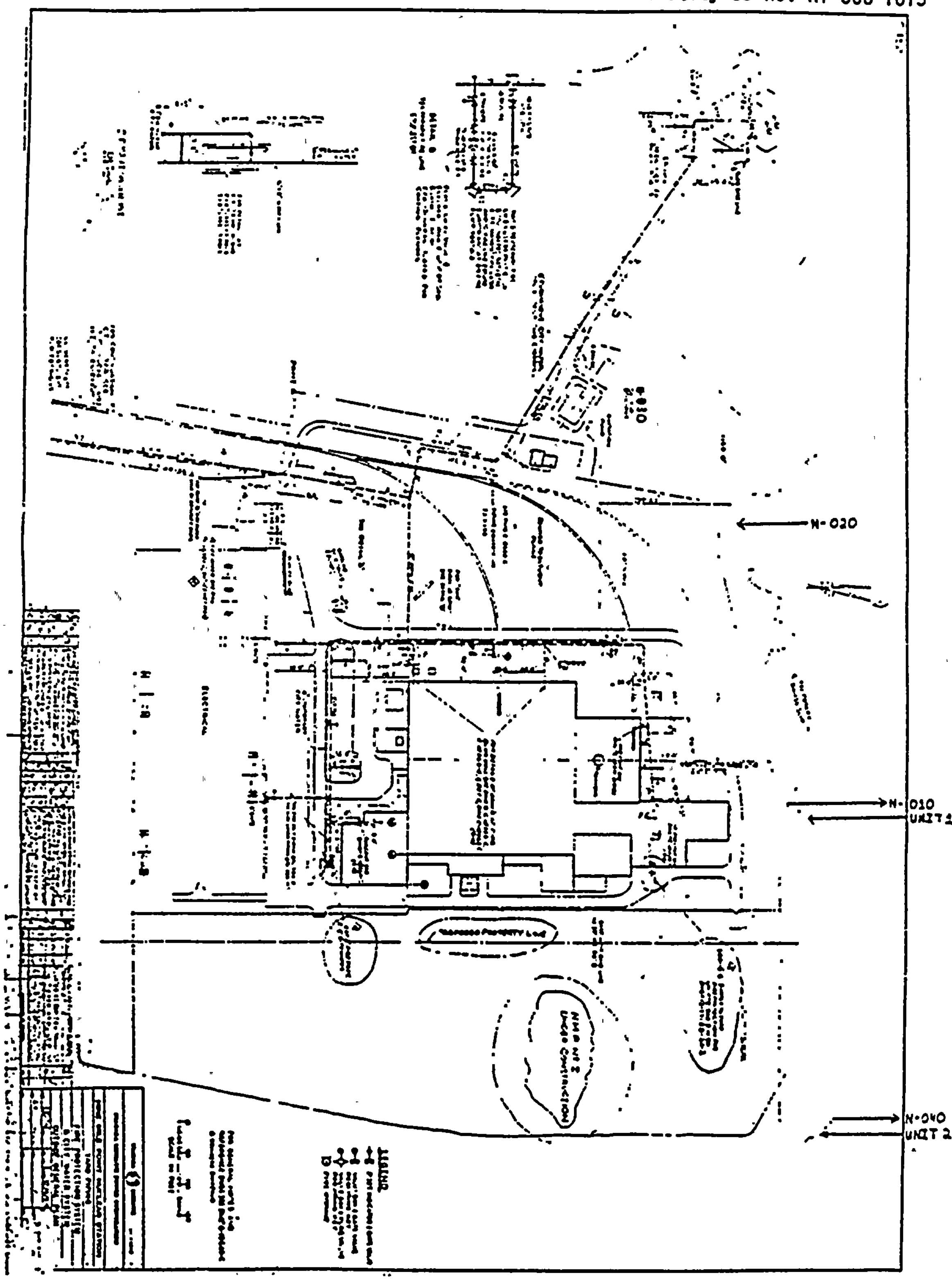

ADDITIONAL REQUIREMENTS:

I. The following requirements are applicable to Units #1 and #2.

1. There shall be no discharge of PCB's from this facility.

2. In regard to general conditions 11.5, items #3 and #4 shall be reported semi-annually to NYSDEC offices in Cortland and Albany.

3. There shall be no discharge of boiler chemical cleaning compounds, metal cleaning wastewater, or boiler blowdown from this facility.

4. Radioactivity

   a. Gross Beta - Shall not exceed 1,000 picocuries per liter in the absence of Sr^{90} and alpha emitters.

   b. Radium 226 - Shall not exceed 3 picocuries per liter.

   c. Strontium 90 - Shall not exceed 10 picocuries per liter.

5. The permittee shall submit on a trimesterly basis a report to the Department's offices in Cortland and Albany by the 28th of the month following the end of the period. Submission of reports for Unit #2 shall commence with the initiation of reactor low power testing.

   a. Daily minimum, average, and maximum station electrical output shall be determined and logged.

   b. Daily minimum, average, and maximum water use shall be directly or indirectly measured or calculated and logged.

   c. Daily minimum, average, and maximum intake and discharge temperatures shall be logged.

   d. Measurements in a, b, and c shall be taken on an hourly basis.

6. The location, design, construction, and capacity of cooling water intake structures, in connection with point source thermal discharges, shall reflect the best technology available for minimizing adverse environmental impact.

7. All thermal discharges to the waters of the state shall assure the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife in and on the body of water.

8. Niagara Mohawk shall notify the Department within one week from the time of submission to the Nuclear Regulatory Commission of any requested changes to the Environmental Technical Specifications requirements which could in any way affect the requirements of this permit.

9. Niagara Mohawk shall also submit concurrently to the Department any water-related report on the environment it submits to any federal, state, or local agency.

10. Niagara Mohawk shall provide access to the Nine Mile Point Site at any time to representatives of the Department subject to site security regulations to assess the environmental impact of the operation of the Nine Mile Point Nuclear Facility and to review any sampling program, methodology, and the gathering and reporting of any data.

11. No biocides, slimicides, or corrosion control chemicals are authorized for use, except for those listed by parameter in the permit. Prior Department approval is required for any additional use of these chemicals as well as for the use of any new water treatment chemicals.

II. <u>The following requirements are applicable to Unit #1.</u>

1. By August 1, 1983, the permittee shall submit final plans, signed and sealed by an engineer licensed to practice in New York State, describing the addition of storage capacity for discharges 011 and 021. Construction to be initiated by October 1, 1983.

2. The Department has approved the applicant's request pursuant to Section 316(a) of the Clean Water Act (CWA) for alternative effluent limitations at this facility. The thermal effluent limitations on page 2 of this permit reflect this approval.

3. The water temperature at the surface of Lake Ontario shall not be raised more than three Fahrenheit degrees over the temperature that existed before the addition of heat of artificial origin except in a mixing zone consisting of an area of 425 acres from the point of discharge, this temperature may be exceeded.

4. The Department has contingently approved the applicant's consideration of intake impacts submitted pursuant to Section 316(b) of the CWA. Completion of the biological monitoring program described in Additional Requirement Section IV and demonstration of impacts similar to previous studies is required to obtain final approval of the 316(b) request.

III. The following requirements are applicable to Unit #2.

1. By initiation of reactor lower power testing, the company shall file for approval with the Department at its offices in Albany and Syracuse an updated report on all Unit #2 water treatment, corrosion inhibitor, anti-fouling, slimicide, biocide, and boiler cleaning chemicals or compounds. Such report shall identify each product by chemical formula and/or composition, annual consumption, frequency of use, maximum use per incident, effluent concentration, bioassay and toxicity limits, and procedures for use. Approval shall only be granted for those circumstances and uses which do not contravene New York State Water Quality Standards. No substitutions will be allowed without prior approval. Wastewaters containing chemicals and oil shall be collected and treated prior to dilution with non-contact cooling water in facilities which shall be approved by the Department.

2. No discharge from this facility shall cause violation of the New York State Department of Health regulations contained in 10 NYCRR Part 170 at the source of intake of any water supply used for drinking, culinary or food processing purposes.

3. Pursuant to Part 704 Criteria Governing Thermal Discharges, Section 704.3-Mixing Zone Criteria, upon the presentation of a final design for the discharge, the Department shall specify, as appropriate, definable numerical limits for the mixing zone, including linear distances from the point of discharge, surface area involvement, and volume of receiving water entrained in the thermal plume.

4. Not less than 180 days prior to the initiation of discharge from the Nine Mile Point Nuclear Generating Station Unit #2, Niagara Mohawk shall submit for approval to the Department of Environmental Conservation a plan of study for:

   Verification of the extent of the thermal plume in the receiving waters by conducting thermal surveys in alternate months except for December through March during the first two years of operation.

5. Existing biological studies in Lake Ontario as required by regulatory agencies shall continue. Such study programs shall be adjusted as required by regulatory agencies to assess the operating impact of Unit #2. Requirements to submit reports, frequency of submission, and content shall be established at the time of approval of the study programs.

6. Not less than 180 days prior to the initiation of discharges from the Nine Mile Point Nuclear Generating Station Unit #2, Niagara Mohawk shall submit to the NYSDEC office in Albany three copies of the following plans and specifications. Plans shall be stamped by an engineer licensed in New York State.

   a. Plans of proposed structures, including intake structure, diffuser, tunnel cross section, cooling tower, screenwell building, and equipment (including pumps).

   b. Plans of all on-site treatment facilities including oil/water separators.

   c. Piping and/or flow diagrams for all facility waste streams, including any piping to or from Nine Mile Point Unit #1 and contaminated plant and site drainage.

   d. Flow diagram of circulating cooling water system from the intake to the diffuser.

IV. Biological Monitoring and Related Matters - Unit #1

A. Previous Biological Monitoring Data - EDP + 3 Months, the permittee shall file with the Chief, Bureau of Environmental Protection in Albany; Fishery Section head in Cape Vincent; and with the Regional Supervisor of Fish and Wildlife in Syracuse a report containing and/or identifying all previous reports regarding this facility which contain biological data relating to the ecological effects of plant operation from March 31, 1975 to the present. Previously submitted reports need not be duplicated, but title, date, and data location must be completely identified. A copy of all unsubmitted reports and data shall be sent to the above offices by EDP + 3 Months. Data to be reported should include, but is not necessarily limited to cooling water flows, dates, times, available operating and meteorological conditions, and species, numbers and other available biological information.

B. Impingement Monitoring - The permittee shall conduct a program to determine the numbers and total weights by species of fish impinged on all intake traveling screens.

   1. Collections shall be made seventy-eight (78) days each year, provided that the circulating water pumps are in operation. When collection days coincide with shut down of the main circulating water pumps, collections need not be taken. Collections shall be obtained at the following intensity on days randomly selected within each month. Should the randomly selected dates result in a period in excess of 10 days during any month in which sampling does not occur,

additional sampling is required so that periods in excess of 10 days without a sample do not occur.

Month	Number of Sample Days
January	4
February	4
March	4
April	16
May	20
June	4
July	4
August	6
September	4
October	4
November	4
December	4

2. Collections shall be conducted for a minimum period of 24 hours. The beginning of the 24-hour period shall be selected and held constant by the permittee for all collections. A collection period shall be no longer than 26 hours. Impingement collection shall be calculated and reported on a 24-hour basis.

3. Travelling screens shall be washed until they are clean prior to the start of the 24-hour collection period.

4. Individual length (cm) and weight (g) measurements shall be made on white perch, smallmouth bass, yellow perch, alewife, rainbow smelt, and each species of salmonid in order to characterize the size distribution for each 24-hour collection. No less than 25 organisms of each species shall be measured unless fewer than 25 individuals occur in the collection.

   If more than 25 individuals of a single species are collected, except for smallmouth bass, yellow perch and each species of salmonid which are to be processed separately, a representative subsample of 25 fish shall be removed and lengths and weights recorded for the subsample. In the event of high impingement numbers, an estimate of the numbers and total weights by species fish shall be calculated as follows:

$$\text{Estimated No. of Fish} = \frac{(\text{Volume of Total Sample}) \times (\text{No. of Fish in Subsample})}{\text{Volume of Subsample}}$$

   The total sample volume shall be determined by repeatedly filling a volumetrically graduated 20-gallon plastic container and then recording and summing the values. The total volume is then thoroughly mixed by hand or with a shovel and spread out evenly over a flat surface. An aliquot of the total sample is randomly selected and this sample portion is removed from the flat surface and measured in the graduated container to determine its approximate volume. The total number of fish in the subsample is then determined.

In the event of extremely large impingement loads, the permittee may request regional staff to make adjustments to or suspend the above subsampling procedures.

5. Electrical output and operation of the condenser cooling water system including intake and discharge temperature and total flow shall be recorded on a daily basis and tabulated as required in the following section on reporting.

6. By EDP + 3 Months, the permittee shall file for approval at the office in Section IV.A. above, a plan which will determine the collection efficiency of the following impinged organisms: white perch, smallmouth bass, yellow perch, alewife, and rainbow smelt. Prior collection efficiency data specific to this plant may be substituted for the above plan provided that it is submitted by EDP + 3 Months, to the NYSDEC and approved by the NYSDEC.

C. Reporting

1. All data required by Section IV or incorporated by reference in Section IV shall be included in an annual biological monitoring report.

2. The annual report shall be submitted by six months from the last month of data collection.

3. The following shall be included in the annual report in addition to (1) above:

   a. Monthly and annual totals of impingement by species and grand total over all species. The calculations to be done are as follows:

      - Monthly "mean" is equal to the total number of fish impinged by species on the sampling days in the month divided by the total number of sampling days.

      - Annual "mean" is equal to the total number of fish impinged by species on the sampling days in the year divided by the total number of sampling days.

Similar calculations shall be made for grand total over species. The total number of fish and sampling days shall be clearly indicated in any table reporting the "totals".

b. An estimate of the collection efficiencies to be determined pursuant to Section IV.B.6. above. If sufficient time is not available to include these estimates in the first annual report, the permittee may, upon written request and substantiation and with NYSDEC approval, extend this reporting requirement into an annual report other than the initial.

c. Estimates shall be developed of the average monthly impingement rate based on the number of sampling days and total volume of water pumped during these days, and also of the total monthly impingement based on the average monthly rate and the volume of water pumped during the month, for each species impinged.

4. All measurements shall use the metric system, e.g., flows should be in cubic meters/sec. (m^3/s).

5. Copies of all reports regarding water and biological parameters related to intake and discharge considerations, whether generated for this permit or otherwise, shall be sent to the offices in Section IV.A. above.

6. Report(s) submitted in fulfillment of permit conditions shall clearly identify on the title page the permit number and the specific section(s) by character and number that the report(s) fulfill. Each section of the text of such report(s) shall identify the section(s) of the permit that it fulfills.

7. NYSDEC reserves the right to have more frequent submittal of the data required to be reported, provided that the permittee is given at least one (1) month prior notice of such more frequent reporting requirements.

8. The measures the permittee instituted, if any, in the reporting year to accomplish minimization of facility impacts on aquatic biota shall be sent to the offices in Section IV.A. above.

9. The formats for reporting the following data are included in Appendix A. Data sheets and formats for reporting the following data:

   a. Flow
   b. Temperature
   c. Circulator operation
   d. Electrical output

are available from the office of Environmental Protection.

D. Biological specimens may be required to be submitted to the NYSDEC upon request.

E. The facility shall be operated in such a manner as to minimize facility impacts on aquatic biota.

F. As a result of the NYSDEC's review of the biological monitoring program, the permittee may be required to implement appropriate methods and procedures to reduce to the fullest extent possible the effects of facility operation on aquatic organisms.

SCHEDULE OF COMPLIANCE FOR EFFLUENT LIMITATIONS

(a) Permittee shall achieve compliance with the effluent limitations specified in this permit for the permitted discharge(s) in accordance with the following schedule:

Action Code	Outfall Number(s)	Compliance Action	Due Date
02	011 & 021	Approvable Final Plans-Waste Storage Tanks (Additional Requirement # II.1.)	8/1/83
04	011 & 021	Commencement of Construction (Additional Requirement #II.1)	10/1/83
01	All	Chemical Use Report-Unit #2 (Additional Requirement #III.1)	Initiation of reactor low power testing.
44	040	Plan of Study-Thermal Plume Verification (Additional Requirement #III.4).	180 days prior to initiation of discharge.
02	040	Final Plans-Circulating Cooling Water & Waste Treatment (Additional Requirement #III.6)	180 days prior to initiation of discharge.
39	NA	Compliation of Reports containing Biological Data (Additional Requirement #IV.1.a)	EDP + 3 Months
44	NA	Plan of Study-Collection Efficiency (Additional Requirement #IV.6)	EDP + 3 Months

(b) The permittee shall submit to the Department of Environmental Conservation the required document(s) where a specific action is required in (a) above to be taken by a certain date, and a written notice of compliance or noncompliance with each of the above schedule dates, postmarked no later than 14 days following each elapsed date. Each notice of noncompliance shall include the following information:

1. A short description of the noncompliance;

2. A description of any actions taken or proposed by the permittee to comply with the elapsed schedule requirement without further delay;

3. A description of any factors which tend to explain or mitigate the noncompliance; and

4. An estimate of the date permittee will comply with the elapsed schedule requirement and an assessment of the probability that permittee will meet the next scheduled requirement on time.

91-18-1 (9/78)

MONITORING, RECORDING AND REPORTING

a) The permittee shall also refer to the General Conditions (Part II) of this permit for additional information concerning monitoring and reporting requirements and conditions.

b) The monitoring information required by this permit shall be summarized and reported by submitting a completed and signed Discharge Monitoring Report form once every months to the Department of Environmental Conservation and other appropriate regulatory agencies at the offices specified below. The first report will be due no later than Thereafter, reports shall be submitted no later than the 28th of the following month(s):

Water Division
New York State Department of Environmental Conservation
50 Wolf Road - Albany, New York 12233

New York State Department of Environmental Conservation
Regional Engineer
7481 Henry Clay Blvd.
Liverpool, New York 13088

Oswego County Dept. of Health
70 Bunner Street
Oswego, New York 13126

[X] (Applicable only if checked):
Dr. Richard Baker, Chief - Permits Administration Branch
Planning & Management Division
USEPA Region II
26 Federal Plaza
New York, New York 10278

c) If so directed by this permit or by previous request, Monthly Wastewater Treatment Plant Operator's Reports shall be submitted to the DEC Regional Office and county health department or county environmental control agency specified above.

d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

e) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR 136 or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Discharge Monitoring Reports.

f) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in the permit.

g) Unless otherwise specified, all information submitted on the Discharge Monitoring Form shall be based upon measurements and sampling carried out during the most recently completed reporting period.

h) Blank Discharge Monitoring Report Forms are available at the above addresses.

SCHEDULE OF COMPLIANCE FOR EFFLUENT LIMITATIONS
(Continued)

c) The permittee shall submit copies of the written notice of compliance or noncompliance required herein to the following offices:

Chief, Compliance Section
New York State Department of Environmental Conservation
50 Wolf Road
Albany, New York 12233

Regional Engineer #7
New York State Department of Environmental Conservation
7481 Henry Clay Boulevard
Liverpool, NY 13088

Oswego County Dept. of Health
70 Bunner Street
Oswego, New York 13126

USEPA Region II
Planning and Management Division
26 Federal Plaza
New York, New York 10278

The permittee shall submit copies of any engineering reports, plans of study, final plans, as-built plans, infiltration-inflow studies, etc. required herein to the New York State Department of Environmental Conservation Regional Office specified above unless otherwise specified in this permit or in writing by the Department or its designated field office.

91-18-2 (9/76)

APPENDIX F

HISTORIC AND ARCHEOLOGIC SITES

- Sites listed or eligible for listing in the National Register of Historic Places that are located in towns with 15 km of Nine Mile Point
- Letter from Stephen J. Raiche, State Historic Preservation Officer (SHPO), to P. D. Patel, Stone & Webster Engineering, December 11, 1979
- Letter from J. A. Miakisz, Environmental Analyst, Niagara Mohawk Power Corporation, to Stephen J. Raiche, SHPO, January 18, 1984
- Letter from Julia S. Stokes, Deputy Commissioner for Historic Preservation, to J. A. Miakisz, Environmental Analyst, Niagara Mohawk Power Corporation, February 24, 1984

SITES LISTED OR ELIGIBLE FOR LISTING IN THE NATIONAL REGISTER OF HISTORIC PLACES THAT ARE LOCATED IN TOWNS WITHIN 15 km OF NINE MILE POINT

AREA	PROPERTY
Constantia	Trinity Church
Mexico Village	Gustin-Earle Factory
Oswego	Fort Ontario Franklin Square Historic District Market House Musico Motors Building Oswego City Hall Oswego City Library Oswego West Side Archelogical District Pontiac Hotel Richardson-Bates House Sheldon Hall U.S. Customhouse Walton and Willette Stone Store
Pulaski	Pulaski Village Historic District

Source: U.S. Department of Interior, National Park Service, National Register, 1979, 1980, 1981, 1982, 1983, and 1984

NEW YORK STATE PARKS & RECREATION Agency Building 1 Empire State Plaza Albany, New York 12238 Information 518 474 0456
Orin Lehman Commissioner

December 11, 1979

Mr. P.D. Patel
Lead Environmental Engineer
Stone & Webster Engineering
Cherry Hill Operations Center
3 Executive Campus, P. O. Box 5200
Cherry Hill, NJ 08034

Dear Mr. Patel:

Operating Permit
Nine Mile Point Nuclear Station - Unit 2
Scriba, Oswego County

The State Historic Preservation Officer (SHPO) has reviewed the above project in accordance with the Advisory Council on Historic Preservation's regulations, "Protection of Historic and Cultural Properties," 36 CFR 800.

Based upon this review, it is the opinion of the SHPO that this project will have no effect upon cultural resources included in or eligible for inclusion in the National Register of Historic Places.

Should you have any questions, please contact the project review staff at 518-474-3176.

Sincerely,

STATE HISTORIC PRESERVATION OFFICER

By Stephen J. Raiche
Director
Historic Preservation Field Services

LRK:mr
3/79

NIAGARA MOHAWK

NIAGARA MOHAWK POWER CORPORATION/300 ERIE BOULEVARD WEST, SYRACUSE, N.Y. 13202/TELEPHONE (315) 474-1511

January 18, 1984.

Mr. Stephen J. Raiche, Director
Historic Preservation Field Services
NYS Parks and Recreation
Agency Building 1
Empire State Plaza
Albany, NY 12238

RE: Nine Mile Point Nuclear Station Unit 2

Dear Mr. Raiche:

Presently, Niagara Mohawk's application for an operating license for the Nine Mile Point Nuclear Station Unit 2 is pending approval by the Nuclear Regulatory Commission. In December of 1979, your office reviewed the Unit 2 project and concluded, based on that review, that it will not have any effect upon cultural resources included in or eligible for inclusion in the National Register of Historic Places (see attached correspondence).

It is my understanding that your 1979 review was limited to the Nine Mile 2 project boundary per se and did not include a review of the transmission line that will be constructed to serve this project. The Nine Mile 2-Volney 345kV Transmission Line has, however, been reviewed under Article VII of the NYS Public Service Law and was approved by the Public Service Commission on August 12, 1983.

The enclosed reports document the results of cultural resource studies of the Nine Mile 2-Volney Transmission Line right-of-way and Scriba Substation. These studies were performed for Niagara Mohawk by Pratt and Pratt Archaeological Consultants, Inc., in support of the Article VII Certification proceedings.

Would you please review these reports and advise me of any comments or concerns that you may have concerning construction of the Nine Mile 2-Volney transmission line facilities. Niagara Mohawk will then forward any comments

NEW YORK STATE OFFICE OF PARKS AND RECREATION AND HISTORIC PRESERVATION
Orin Lehman
Commissioner

New York State Office of Parks, Recreation and Historic Preservation
The Governor Nelson A. Rockefeller Empire State Plaza
Agency Building 1 Albany, New York 12238 5[illegible]

February 24, 1984

J.A. Miakisz, Environmental Analyst
Niagara Mohawk Power Corp.
300 Erie Boulevard West
Syracuse, NY 13202

Dear Mr. Miakisz:

NRC Project
Nine Mile Point
Nuclear Station, Unit 2
Cultural Resource Survey
Scriba, Oswego County

The State Historic Preservation Officer (SHPO) has reviewed the above project in accordance with the Advisory Council on Historic Preservation's regulations, "Protection of Historic and Cultural Properties," 36 CFR 800.

Based upon this review, it is the opinion of the SHPO that this project will have no effect upon cultural resources included in or eligible for inclusion in the National Register of Historic Places.

Should you have any questions, please contact the project review staff at 518-474-3176.

Sincerely,

Julia S. Stokes

Julia S. Stokes
Deputy Commissioner for Historic
Preservation

ARH:mr

#1
11/82

you have concerning the transmission line along with your 1979 comments concerning the Unit 2 Project to the Nuclear Regulatory Commission in order that they may meet their obligations under 36CFR800.

Please do not hesitate to contact me if you have any questions regarding this matter.

Sincerely,

J. A. Miakisz

J. A. Miakisz
Environmental Analyst

JAM/km
Enclosure
xc: J. M. Toennies/T. J. Rooney
A. F. Zallnick/N. L. Rademacher
NMP2 Project File

APPENDIX G

EVALUATION OF THE ENVIRONMENTAL EFFECTS DUE TO THE CHANGE IN COOLING SYSTEMS AT NINE MILE POINT UNIT 2 FROM A ONCE-THROUGH SYSTEM TO A CLOSED CYCLE SYSTEM UTILIZING A NATURAL DRAFT COOLING TOWER

RELATED TO THE OPERATION OF
NINE MILE POINT NUCLEAR STATION, UNIT 2
DOCKET NO. 50-410
NIAGARA MOHAWK POWER CORPORATION

APRIL 1981

Prepared by the Nuclear Regulatory Commission,
Office of Nuclear Reactor Regulation
Washington, D.C.

APPENDIX G

The following NRC persons contributed to the preparation of the report.

W. Britz, Health Physicist

M. Fliegel, Hydrologist

G. Gears, Land Use Analyst

J. Goll, Meteorologist

C. Hickey, Senior Fishery Biologist

T. Johnson, Hydrologist

M. Kaltman, Regional Planning Analyst

K. Kiper, Project Manager

J. Norris, Environmental Project Manager

R. Samworth, Environmental Engineer

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SUMMARY AND CONCLUSIONS

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

The proposed change in the cooling mode for the Nine Mile Point Nuclear Station, Unit 2, from the previously reviewed once-through system to a closed cycle system utilizing a natural draft cooling tower (NDCT) will cause certain changes in environmental effects. The most significant of these effects and their differences from those resulting from the once-through system are summarized below.

(a) The reduction in the intake volume and velocity will reduce the potential for fish impingement. This reduction, coupled with the capability for guiding entrapped fish back to Lake Ontario, should result in minimal impact to the fish species affected by impingement.

(b) Similarily, the environmental risk associated with entrainment of organisms is expected to be reduced in approximate proportion to the fractional flow reduction. The effects of entrainment on aquatic biota are now expected to be so low as not to be measurable. Any effects which may be incurred are expected to be localized in the Nine Mile Point area only.

(c) The proposed system will cause discharge of a much larger quantity of chemicals into Lake Ontario than would have resulted from the once-through system. There are no applicable criteria or standards which would prohibit these substances from being discharged.

(d) The operation of the cooling tower will cause deposition of salt drift. It is expected that salt deposition from drift in the amounts projected at Nine Mile Point will not result in unacceptable botanical damage either through soil contamination or through foliar interception pathway. There is no salt drift associated with once-through cooling mode.

(e) The proposed change will cause an increase in the estimated radiological total body dose commitment to the maximum individual. These doses are higher than those estimated for the once-through system. However, they are within the guidelines of Section II.A, Appendix I to 10 CFR Part 50, and are therefore acceptable.

(f) The estimated annual radiological total body dose commitment to the population within 80 km of the NMP-2 will also be higher than those estimated for the once-through system. However, they are cost-beneficial according to Section II.D, Appendix I to 10 CFR Part 50, and are therefore acceptable.

(g) The massive tower and the plume will represent a very large visual intrusion over a large area. In contrast, the once-through system, not having a massive tower or visible plume associated with its operation, is less visually intrusive and, therefore, is aesthetically preferred.

(h) The noise produced by the operation of the NDCT will be of higher levels than from the once-through system. However, it is expected to be within HUD noise guidelines and, therefore, acceptable.

(i) The proposed NDCT will cost more than the presently approved once-through system. Niagara Mohawk Power Corporation estimates the difference to be $19.4 million.

The staff finds that both the NDCT and the once-through systems are environmentally acceptable. The proposed NDCT is ranked by the staff as preferable to the once-through system with respect to potential for fish impingement and for entrainment of aquatic organisms. The once-through system is ranked by the staff as preferable to the NDCT with respect to chemical load into the Lake Ontario, drift and local weather modification, noise, radiological doses, and visual aesthetics. However, considering the environmental effects in total, neither system is ranked by the staff as preferable over the other.

The staff's analysis indicated also that the NDCT is $19.4 million more expensive to build and operate than the once-through system. This differential cost between the systems represents a commitment of resources--materials, equipment, manpower, and incremental fuel requirements--that would not occur if the once-through system were built and operated as previously approved. However, the staff has determined that this incremental cost does not tip the balance between the costs and the benefits derived from the plant, but maintains the current cost-benefit balance for the project as a whole.

Inasmuch as the environmental costs and benefits are not greatly changed by this action, the staff has no objection to the modification in the cooling system as described herein.

1 INTRODUCTION

On June 24, 1974 the Construction Permit No. CPPR-112 was issued to the Niagara Mohawk Power Corporation (NMPC) to construct Nine Mile Point Nuclear Station, Unit 2 (NMP-2) utilizing a once-through cooling system.

In February 1976, NMPC informed the Nuclear Regulatory Commission of their intent to revise the cooling system for NMP-2 from a once-through cooling to a closed cycle system utilizing a cooling tower. This was followed by a "Report On Circulating Water Cooling System Employing a Natural Draft Cooling Tower" submitted to the NRC in July 1976. On September 30, 1977 the report was supplemented by "Responses to NRC Requests Dated April 22, 1977 for Additional Information Regarding the Proposed Cooling System Design Change." In addition, NMPC supplied NRC requests for further information in letters dated January 16, 1978, April 18, 1978, and November 21, 1980.

This report summarizes the staff's environmental review and sets out the staff's technical evaluation of the proposed change.

2 ENVIRONMENTAL DESCRIPTIONS

2.1 Water Use

The station is located in the northeast portion of the Lake Ontario Plain drainage basin. The section that further describes surface water, 2.5.1, has not changed and can be found on page 2-10 of the Final Environmental Statement (FES) for the Nine Mile Point, Unit 2.[1]

Additional water quality data for Lake Ontario has been provided by Niagara Mohawk Power Corporation in the form of several annual monitoring reports for Nine Mile Point, Unit 1. A recent report, Nine Mile Point Aquatic Ecology Studies 1977 Data Report, indicates that no basic water quality changes have occurred in Lake Ontario since the publication of the Nine Mile Point Unit 2, FES.[1]

2.2 Ecology
2.2.1 Terrestrial Ecology

The description of terrestrial ecology of the site and vicinity included in Section 2.7.1 of the Final Environmental Statement issued in June 1973 is still valid.[1] The staff has reviewed the list of threatened and endangered species (Federal Register: Vol. 45, No. 99, May 20, 1980) and concludes that the site and vicinity contain no threatened or endangered species.

2.2.2 Aquatic Ecology

The aquatic biota of Lake Ontario and the Nine Mile Point area were discussed in Section 2.7.2 of the FES[1] based upon preoperational studies described in the Applicant's Environmental Report of January 1973 and pertinent published literature. Additionally, the FES Summary and Conclusions (p. iv) and Section 6.1 (pp. 6-1 to 6-5) recommended several modifications in the aquatic biological monitoring programs at both Nine Mile Point and FitzPatrick Nuclear Stations for the purposes of impact assessment. These modifications have been made, as reflected in the operational studies conducted at both facilities.[2,3,4,5,6,7]

The ecological and in-plant sampling programs are summarized in Tables 2.1 and 2.2, with the farfield stations illustrated in Figure 2.1. Species occurrence and composition are discussed in relation to potential impacts in Sections 5.1.1 and 5.1.2.

2.3 Socioeconomics
2.3.1 Introduction

This section summarizes the staff's evaluation of the social and economic impacts of two alternative heat dissipation systems, once through and natural draft cooling towers. The potential impacts of alternative heat dissipation systems for Nine Mile Point, Unit 2 are evaluated with consideration given to the construction and operation of a single natural draft cooling tower as a replacement for the once-through system which the staff had evaluated in its June 1973 FES. The staff's objective in the present analysis is to determine

FIGURE 2.1 Nine Mile Point Ecological Study Area.
Source: Reference 6, Vol. 1, Fig. III-1.

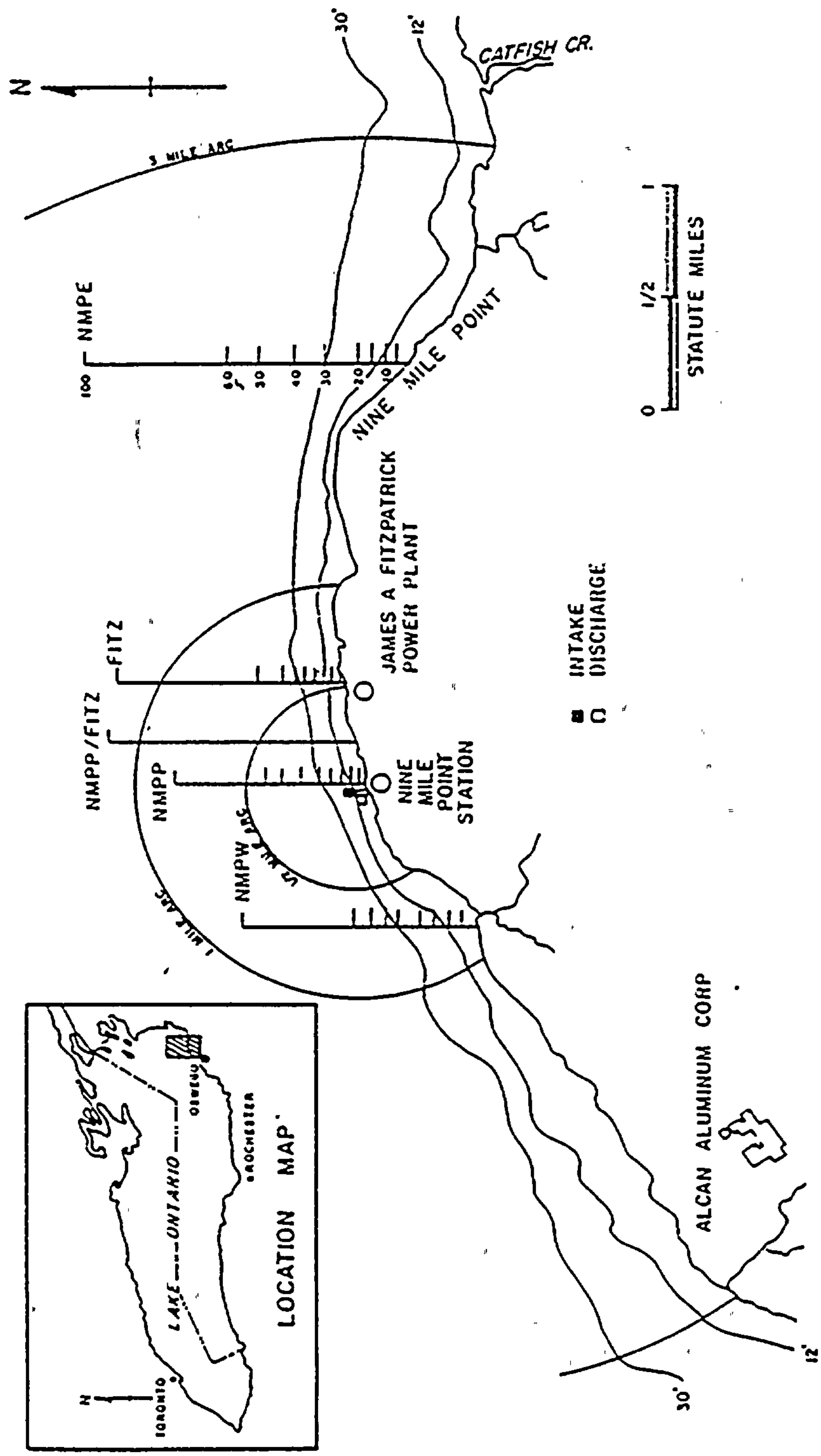


TABLE 2.1. Scheduled frequency of Sampling for Ecological Studies in Nine Mile Point Area of Lake Ontario (1976). Source: Reference 6, Vol. 1, Table III-10.

STUDY	FREQUENCY[a]	PERIOD
A. GENERAL ECOLOGICAL SURVEY		
Fish - Trawls	Twice monthly (D/N)	April-December
Comparative trawl study	Yearly	June
Seines	Twice monthly	April-December
Gill nets (general ecol.)	Twice monthly (48-hour period: 12-hour retrievals)	April-December
(gut analysis)	Yearly	August
Benthos		
Natural Habitats		
non-*Cladophora* Community	Alternate months	April-December
Bottom sediment (grain size analysis)	Twice Yearly	June, October
Sediment accumulation	Monthly	May-December
Bottom quality (organic carbon)	Alternate Months	April-December
Artificial Substrates[b] (Periphyton)		
Bottom	Monthly	May-December
Buoy	Monthly	May-December
Water Quality		
Monthly (11 & 48 parameters)	Monthly	April-December
Bimonthly (17 parameters)	Twice monthly	April-December
Thermal stratification	Weekly	April-December
Radiological water	Monthly	April-December
Plankton		
Phytoplankton		
Chlorophyll *a*, C-14, community	Monthly (D)	April-December
Zooplankton	Monthly (D)	May-December
Macrozooplankton[b]		
enumeration of all taxa	Monthly (D)	April-December
enumerate *Pontoporeia*, *Gammarus*, and *Mysis*	Monthly (N)	June-September
Ichthyoplankton	Weekly (D/N)	June-mid-September
	Weekly (D)	April, May, mid-September-December
B. NINE MILE POINT NUCLEAR STATION UNIT 1		
Entrainment		
Ichthyoplankton (forebay only)[c]	Weekly (2 D/2 N)	May-September 3
	Twice monthly (2 D/2 N)	April, September 3-October
Impingement	Three times/week[d]	January-December

TABLE 2.1 (Continued)

STUDY	FREQUENCY[a]	PERIOD
C. JAMES A. FITZPATRICK NUCLEAR POWER PLANT		
Entrainment		
Phytoplankton: discharge aftbay, enumeration	Monthly (D)	April-December
C-14 and Chlorophyll a: phytoplankton viability, intake & discharge bays[e]	Twice monthly (D/N)	April-December
Zooplankton (> 76µ)		
enumeration: discharge aftbay viability[f]	Monthly (D) Twice monthly (D/N)	April-December April-December
Gammarus: intake forebay, enumeration[c]	Monthly (2 D/2 N) Monthly (D/N)	January-September October-December
Ichthyoplankton: intake forebay, enumeration[c]	Weekly (2 D/2 N) Twice monthly (2 D/2 N) Twice monthly (D/N)	May-September 8 January-April September 22-December
Viability of Gammarus[c]: intake forebay & discharge aftbay	Twice monthly (N) Monthly (N)	May-September April, October-December
Viability of Ichthyoplankton: intake forebay & discharge aftbay	Monthly (D/N) Twice monthly (D/N)	April May-September
Simulated Laboratory Studies (3°F Mixing Zone & 2°F Area) (scheduled)[g]		
C-14 & Chlorophyll a	Monthly (D) Twice monthly (N)	April-December
Zooplankton[e]	Monthly (D) Twice monthly (N)	April-December
Ichthyoplankton	Twice monthly (N) Monthly (N)	April-May September
Gammarus	Twice monthly (N) Monthly (N)	April-September 30 October-December
Lake Viability Studies (3°F Mixing Zone & 2°F Area)		
C-14 & Chlorophyll a	Monthly (D)	April-December
Zooplankton	Monthly (D)	April-December
Ichthyoplankton	Twice Monthly (D) Twice Monthly (N) Monthly (D/N)	April-August 31 June-August 31 September
Impingement	Three times/week[d,h]	January-December

[a] Sampling contingent on weather conditions
[b] Macrozooplankton analyzed from ichthyoplankton collection
[c] Sampling date and time the same for Nine Mile Point and FitzPatrick Nuclear Stations (Hours: 1100, 1700, 2300, 0500, or 1100 and 2300); 30 minute sample
[d] Monday and Friday: 24-hr composite sample; Wednesday: 24 hourly samples; frequency increased during periods of high impingement (>20,000 fish)
[e] Incubation periods: 2, 24, 48, and 72 hous for day and night collections for C-14 & Chlorophyll a analyses (after 22 September); 4 hours for day collections for C-14 only; immediate analysis for day and night collections for Chlorophyll a analyses; 2 replicates
[f] Viability: ~6 hours after collection (sample maintained in ambient water); enumeration of the same sample
[g] Additional samples if lake conditions are hazardous
[h] Wednesday: day/night collections as of 2 June
D = Day collection
N = Night collection

TABLE 2.2 Summary of Sampling Locations for Ecological Studies in Nine Mile Point Area of Lake Ontario (1976). Depth Contours and Transects Correspond to those in Figure 2.1. Source: Reference 6, Vol. 1, Table III-13.

DEPTH CONTOUR (ft)	PROGRAM: STUDY	PROGRAM: SAMPLE DEPTH	TRANSECTS: NMPW	TRANSECTS: NMPP	TRANSECTS: NMPP/FITZ	TRANSECTS: FITZ	TRANSECTS: NMPE
Shore	Seines		B	B		B	B
5	Bottom Periphyton	BOT	D	D		D	D
10	Benthos (non-*Cladophora* community)	BOT	D	D		D	D
	Bottom Periphyton	BOT	D	D		D	D
	Phytoplankton*	S	C	C		C	C
	Zooplankton (>76µ)	oblique tow	C	C		C	C
15	Gill Nets (Fish)	BOT	B	B		B	B
	(Stomachs)	BOT	B	B		B	B
20	Trawls (Otter)	BOT	B		B		B
	Benthos (non-*Cladophora* community)	BOT	D	D		D	D
	Twice monthly H_2O quality (17 parameters)	S	A		A		A
	Monthly H_2O quality (11 parameters) & Radiological	S	A		A		A
	Bottom Periphyton	BOT	D	D		D	D
	Phytoplankton	S	C	C		C	C
	Zooplankton (>76µ)	oblique tow	C	C		C	C
25	Monthly H_2O Quality (48 parameters) & Radiological	S BOT			A A		
30	Gill Nets (Fish)	BOT	B	B		B	B
	Benthos (non-*Cladophora* community)	BOT	D	D		D	D
	Bottom Periphyton	BOT	D	D		D	D
40	Trawls (Otter)	BOT	B		B		B
	(Standard Yankee Trawl)	BOT					B
	Gill Nets (Fish)	S-night; BOT-day	B	B		B	B
	Benthos (non-*Cladophora* community & grain size)	BOT	D	D		D	D
	Sediment (organic carbon)	BOT	D			D	D
	Buoy Periphyton	2 ft 7 ft 12 ft 17 ft	D		D		D
	Sediment Accumulation	BOT	D		D		D
	Monthly H_2O Quality (11 parameters) & Radiological	S	A		A		A
	Bottom Periphyton	BOT	D	D		D	D
	Phytoplankton*	S	C	C		C	
		S/BOT [illegible] [illegible] separate					C
	Zooplankton (>76µ)	oblique tow	C	C		C	C
45	Monthly H_2O Quality (48 parameters) & Radiological	S BOT			A A		
50	Trawls (Otter)	BOT	B		B		B
	(Standard Yankee Trawl)	BOT					B
	Gill Nets (Fish)	BOT	B	B		B	B
	Benthos (non-*Cladophora* community)	BOT	D	D		D	D
	Twice monthly H_2O Quality (17 parameters)	S	A		A		A
	Phytoplankton*	S	C	C		C	C
	Zooplankton (>76µ)	oblique tow	C	C		C	C
100	Thermal Stratification		A		A		A

A = Water Quality Program
B = Fish Program
C = Plankton Program
D = Benthic Program (Benthos and Periphyton)
S = Surface
BOT = Bottom
*Phytoplankton program = Species enumeration, C-14, and chlorophyll *a* determination

whether the natural draft cooling tower produces impacts in the human environment which are significantly worse than those produced by a once-through system. If the staff finds that the natural draft cooling tower produces impacts which are significantly worse than impacts associated with a once-through system, the staff must then determine whether the mitigation of the cooling tower impacts or the selection of an alternative system can be justified in a cost-benefit framework.

2.3.2 Community Characteristics

For the purposes of this discussion, the staff has analyzed impacts within an area approximately 10 miles from the plant site. Within this area are the Towns of Mexico, Minetto, New Haven, Richland, Scriba, and Volney; and the City of Oswego. These jurisdictions are within Oswego County. In the staff's judgment, an area with a 10-mile radius is a conservative approximation within which most of the local impacts attributable to alternative heat dissipation systems are expected to occur.

2.3.2.1 Physical Ambiance

Nine Mile Point Station is located on the south shore of Lake Ontario in the Town of Scriba, Oswego County. The station is in the Erie-Ontario Lowlands physiographic province, a relatively flat plain which rises gently from Lake Ontario to the Appalachian Uplands at the site's southern border. The station is located in an area that is approximately 260 feet MSL; one mile due south of the station's major structures--at the southern boundary on the site--the ground rises to 310 feet. One and one-half miles further to the south, the land rises more rapidly to 400 and more feet.

Almost 75 percent of the land in Oswego County is presently either forest, wetlands, or residual vacant land (see Table 2.3). Significant forest tracts exist in the Towns of New Haven, Scriba, and Volney.[8] Much of this land was farmed in an earlier period but is now covered with second growth trees and brush. Table 2.4 provides data on agricultural acreage within the local impact area. As the table indicates, only one-half of the land in commercial farming is actually used for the production of crops.

The temperature, humidity, precipitation, and cloud cover of the area are controlled by the St. Lawrence Valley storm track and moderated by Lake Ontario. Climate is continental in character, with long, cold winters (average temperature near 25°F) and short summers (average temperature close to 70°F). The average annual precipitation is thirty-four inches and the average annual snowfall is eighty-eight inches. With the exception of the winter months, the prevailing winds are from the southwest and follow a course nearly parallel to the long axis of Lake Ontario. During the winter months, the predominant wind direction shifts to the west.

2.3.2.2 Municipalities and Other Government Organizations in the Area

In addition to the towns listed in Section 2.3.2, the impact region contains the incorporated villages of Pulaski in Richland and Mexico in the Town of Mexico. All towns in the County elect a supervisor and are governed by an elected Town Board headed by the supervisor. Seven school districts serve the

TABLE 2.3 OSWEGO COUNTY LAND USE INVENTORY

Category	% of Total
High Density Residential	0.4
Low Density Residential	1.2
Public and Semi-Public	0.4
Commercial	0.1
Industrial	0.5
Transportation and Utilities	0.6
Agriculture and Forestry	16.1
Other*	73.4
Water	7.1
Outdoor Recreation	0.2
	100.0%

SOURCE: Final Oswego County Subplan, Central New York Regional Planning and Development Board, May 1979.

* "Other" includes forest, wetlands, residual vacant land (which is composed of inactive agricultural land, other inactive land, land under construction, sand and rock land).

TABLE 2.4 AGRICULTURAL ACREAGE IN THE NINE MILE POINT IMPACT AREA: 1972

	Total Land Area (Acres)	Farm Land*	Cropland	% Farm Land To Total Land Area	% Cropland To Farm Land
Towns:					
Mexico	30,016	6,641	3,854	22.1	58.0
Minetto	3,840	-	-	-	-
New Haven	20,096	2,521	1,199	12.5	47.6
Richland	34,816	7,505	3,934	21.6	52.4
Scriba	26,368	926	384	3.5	41.5
Volney	31,552	1,616	860	5.1	53.2
Oswego City	5,120	564	181	11.0	32.1
Oswego County	619,520	66,704	31,827	10.8	47.7

SOURCE: Oswego County Planning Board. Oswego County Data (1977). p. 4; and Oswego County Planning Board. Oswego County: 1985 & 1990 Land Use Plan (June 1977). p. 16.

* Data is limited to farms that have an income in excess of $10,000 per year.

impact area; these districts are the Enlarged School District of Oswego, Mexico Academy and Central School, Altmar-Parish-Williamstown Central, Sandy Creek Central, Central Square, Pulaski Central School, and the Fulton Consolidated School District. The Nine Mile Point site is located in the Oswego School district. In 1955 the New York State Legislature created the Port of Oswego Authority for the purpose of developing, operating, and promoting shipping facilities in the port district. The district includes the City of Oswego and the westernmost part of the Town of Scriba.[9]

2.3.2.3 Population and Existing Land Use Patterns

The six towns and the City of Oswego had a population of 45,000 in 1970. Table 2.5 presents 1970 population data and 1990 projected population figures by community. Communities in the impact area are expected to grow at a slower rate than Oswego county, with the result that this area would constitute approximately 43% of the County's total population in 1990.

In addition to the year-round resident population, a limited weekend and vacation population occupies cottages along the lake shore. Lakeview, a summer camp located less than one mile southwest of the station, is operated by the Ontario Bible Conference and is used by up to 1500 people for limited periods. In both instances, this transient activity occurs during the summer and fall months.

The Nine Mile Point Station site comprises approximately 900 acres and is adjacent to the 700-acre site for the James A. FitzPatrick Nuclear Power Plant immediately to the east. Within 10 miles of the site, the land use can be generally characterized as rural residential and agricultural. The nearest concentration of population is in Lycoming which is located at the intersection of Miner Road and County Route 29, approximately 8400 feet from the proposed location of the natural draft cooling tower. The largest population center is the City of Oswego, seven miles southwest of the site; in 1970, Oswego had a population of 23,844.

Approximately 750 people are employed at the Alcan Aluminum Corporation plant; this facility is the nearest large manufacturing plant and is about 3-1/4 miles southwest of the plant site in Scriba. The most intensively developed industrial area within 10 miles of the station is the lake shore on the east side of Oswego.

Electric power stations represent an important component of the industrial use of the Lake Ontario shoreline. In addition to the three nuclear units at Nine Mile Point, six fossil units are located in Oswego on a site adjacent to the College. The proposed Sterling nuclear plant site is located approximately 16 miles west of the Nine Mile Point Station in Cayuga County. It should be noted that the Oswego area is at the midpoint of the cross-state transmission system and is an ideal location for supplying loads in the western, central, or eastern portion of the Niagara Mohawk system.[10]

TABLE 2.5 POPULATION IN IMPACT AREA: 1960-1990

	Actual		Projected	
	1960	1970	1980	1990
Towns:				
Mexico	3,435	4,174	5,075	6,206
Minetto	1,290	1,688	2,124	2,563
New Haven	1,478	1,845	2,242	2,698
Scriba	2,489	3,619	4,485	5,397
Volney	3,785	4,520	5,430	6,341
Richland	4,554	5,324	6,374	7,556
Oswego City	22,155	23,844	25,379	26,986
Oswego County	86,118	100,897	117,089	135,459

SOURCE: Oswego County Planning Board. Oswego County Data (1977). p. 14.

Data for Oswego County indicate that agriculture is playing an increasingly less important role in the economy (see Table 2.6). Poor soil conditions have generally discouraged investment in new commercial farms and within the 10-mile area of the plant few areas are considered to have "high" economic viability for agriculture (ER, Fig. 2.2-1).

Within the impact area there is a variety of recreational and wildlife resources. State parks at Battle Island near Fulton and Selkirk Shores, both approximately 10 miles from the Nine Mile Point Station, attract more than 250,000 visitors a year (see Table 2.7). There are no Federal or county parks or recreation areas within the impact area; however, the City of Oswego contains a number of small recreation areas. The Town of Scriba has developed a 47-acre park with facilities for both active and passive recreation; the park is approximately 5.5 miles south of the plant site.

The State University College at Oswego is a major provider of recreational services and facilities. In addition to on-campus facilities for tennis, swimming, and track, the College owns Fallbrook, a 55-acre facility containing horseback riding trails, ski slopes, and picnic areas; Fallbrook is located 9.5 miles southwest of the plant site. Adjacent to Fallbrook is the Rice Creek Biological Field Station, a 56-acre outdoor classroom that is only available to the public on a restricted basis (PSAR, p. 2.1-6).

Waterborne recreation activity is focused on Lake Ontario. The Oswego Marina, a privately-owned facility, has 68 berths and during the peak of the pleasure-boating season, approximately 30 boats stop for overnight berthing. In addition, New York State owns and operates a boat launching site at Mexico Pont about seven miles east of the plant (PSAR, p. 2.1-7). The site and adjacent areas along the shore near the site, however, have little potential for water-based recreation. In this area, the Lake is not suitable for swimming as the bottom is composed primarily of bedrock and there are few natural harbors or landings.

Niagara Mohawk's site plan included the development of a visitors center. This facility, called the "Progress Center," shares part of the site west of Unit 1 and provides educational exhibits, picnic and playground areas, and nature study trails. Since its completion in 1967 the Center has attracted 50,000 visitors annually.

2.3.2.4 Transportation Facilities

The nearest major road, U.S. 104, is more than 3-1/2 miles south of the site and connects the City of Oswego and Mexico Village. County route No. 29, which forms the eastern boundary of the FitzPatrick plant site, is located approximately one mile from Unit 2 buildings. Rail service to the plant is provided on a Penn Central Railroad (Ontario Branch) spur.

The Port of Oswego is located 6.5 miles southwest of the station site and provides linkage to all the ports on the Great Lakes and the St. Lawrence River and to the ports of the world via the St. Lawrence Seaway. As the easternmost port on Lake Ontario, the Port of Oswego is a transshipment point to the largest concentration of people and markets on the continent.[11] Ships in the normal commercial lanes would pass no closer than six miles from the site.

TABLE 2.6 SELECTED FARM CHARACTERISTICS FOR OSWEGO COUNTY: 1969 AND 1974

	1969	1974
Total number of farms	1,000	979
With sales of $2500 and over	607	529
With sales less than $2500	393	450
Dairy farms with sales of $2500 and over	380	270
Value of dairy products sold	$7,106,000	$9,104,000
Acreage:		
Total in farms	161,347	154,465
Harvested croplands	48,388	50,550

SOURCE: Oswego County Planning Board. Oswego County Data (1977). p. 44.

TABLE 2.7 INVENTORY OF PUBLIC RECREATION FACILITIES IN IMPACT AREA

Name	Approximate Acreage	Activities
City of Oswego:		
Fort Ontario	15	Baseball, playground, track, swimming pool, tennis
Leighton School	7	Baseball, football, playground
Fitzhugh Park	3	Baseball, tennis, playground, ice skating
Riley School (Peglow Park)	2	Ballfield, playground, ice skating
East Park	7	Playground
Kingsford Park	5	Ballfield, playground, ice skating rink and pavillion
South Park	4	Baseball, playground
West Park	7	Ballfield, playground
Charles C. Crisafulli Park	3	Ballfield, playground
Veterans Park	3	Passive
Municipal Beach	N.A.	Swimming
Town of Scriba Park	46	Tennis, playground, baseball
State of New York:		
Battle Island	240	Golf
Selkirk Shores	980	Beach, hiking, playfield, camping, fishing
State University College	N.A.	Tennis, swimming, track, riding trails, ski slopes

N. A. - Information Not Available

Regular commercial air service is provided at the Clarence E. Hancock Airport which is located 31 miles southeast of the plant near Syracuse. The nearest flight corridor associated with this airport is 13.8 miles east of the station (PSAR, Suppl. 6, p. R 2.2-1). Light plane traffic is handled at the Fulton Municipal Airport in the Town of Volney, approximately 12 miles south of the site.

2.3.2.5 Taxes and Community Services

The basic support of local government is the combined town-county real property tax levy which is used to meet county and town legislative, judicial, and administrative costs. Each of the towns collects the local property tax revenues which are subsequently dispersed to other governmental levels and special districts. The major categories of services financed by the town revenues are public works, debt redemption, fire protection, highway projects, snow removal, and sanitation. In addition, county revenues support health and social services, highway projects, and police protection. Special purpose districts, such as those established to meet educational needs, sewer construction, and street lighting have their own tax rates, which are typically collected at the town level.

Both the Town of Scriba and the County have experienced a dramatic tax windfall as a result of the Nine Mile Point Station. The total of assessed values in the Town is second only to that in the City of Oswego among all jurisdictions in the County (see Table 2.8). Although the staff does not have a distribution of real property values by ownership, Niagara Mohawk's property at Nine Mile Point is assumed to constitute the overwhelming percentage of assessed values in Scriba.

2.3.2.6 Future Development and Planning Objectives of the Local Communities

In New York State, counties do not have zoning powers with which to implement comprehensive plans. As a consequence, each town and village establishes its own planning and zoning policies through the creation of a planning board and the adoption of development codes and regulations. The county planning function serves to facilitate local planning and development efforts through the preparation of land use plans which are generalized guides for directing potential growth. However, the initiative for detailed planning and zoning efforts must come from the town or village level. Table 2.9 summarizes the status of administrative and regulatory instruments for controlling local growth and development.

The County's land use plan is reasonably explicit in its treatment of future development within the impact area. An analysis of soil capabilities and the acceptability of septic tank leach fields and basements in specific soils indicates that severe development limitations exist in the shoreline area, southeast Mexico, and eastern Richland; slight to severe limitations are to be found in Minetto, Scriba, New Haven, and Richland. Only north central Volney, northeast Mexico, and southwest Richland are subject to slight development limitations.[12] The plan proposes additions to existing sewer and water systems that would increase development opportunities within limited areas in the Towns of Scriba and Volney.[13]

TABLE 2.8 ASSESSED VALUE AND TAXES LEVIED IN 1976 FOR PAYMENT IN 1977

		Tax Rates Per $1000 Assessed Valuation		Tax Levied	
	Assessed Value	County	Town	County	Town
Towns:					
Mexico	$ 4,939,654	79.20	61.30	$ 391,358	267,402
Minetto	2,239,348	115.00	40.60	257,702	115,062
New Haven	1,324,185	136.80	71.30	181,081	104,524
Richland	5,911,849	88.70	37.32	524,346	202,765
Scriba	29,783,373	90.80	12.80	2,701,427	454,987
Volney	12,396,246	61.20	12.60	759,014	216,151
City of Oswego	87,167,423	68.51	-----	5,971,466	-------
County Total	$214,027,516	-----	-----	$16,500,667	3,442,445

SOURCE: Oswego County Planning Board. Oswego County Data 1977). p. 78-9.

TABLE 2.9 EXISTENCE OF PLANNING BOARDS AND DEVELOPMENT REGULATIONS IN THE IMPACT AREA: 1977

	Planning Board	Zoning	Sanitary	Mobile Home	Mobile Home Park	Junk-yard	Signs	Sub-division	Building Code	Flood Plain
Towns (Villages):										
Mexico	Yes	Yes	Yes						Yes*	Yes
(Mexico)	Yes	Yes		Yes					Yes	
Minetto	Yes	Yes		Yes**	Yes**	Yes**	Yes**	Yes		Yes
New Haven	Yes									Yes
Richland	Yes	Yes		Yes**	Yes**	Yes**	Yes**			Yes
(Pulaski)	Yes	Yes	Yes	Yes	Yes**	Yes**	Yes**	Yes	Yes*	Yes
Scriba	Yes									Yes
Volney	Yes	Yes		Yes**	Yes**	Yes**			Yes	Yes
City of Oswego	Yes	Yes	Yes	Yes**	Yes**	Yes**	Yes**		Yes*	Yes

SOURCE: Oswego County Planning Board. <u>Oswego County Data</u>. p. 106.

* State Code.

** In zoning ordinance.

The synthesis of the data and policies listed in the plan is a conclusion that development should be encouraged to locate in growth centers by 1990. Oswego City, the eastern portion of Scriba, Minetto, and southwestern Volney are proposed as major centers in the Oswego River Valley. Intermediate growth centers are proposed for the Villages of Mexico and Pulaski.[14] The remainder of the impact area is proposed to remain in the low density, rural/agricultural category.[15]

2.3.3 Historic, Natural, and Scenic Points of Interest

The New York State Historic Trust and the Oswego County Planning Board provided the Applicant with a list of points of interest in the County (see ER, Appendix C). As of December 31, 1977, seven properties within 10 miles of the station were included in the National Register of Historic Places; two additional properties are under consideration for inclusion (see Table 2.10). In addition, eight properties have been identified as having historic significance. Appendix E of the Applicant's Environmental Report indicates no points of scenic or natural interest within the 10-mile impact area.

There are no known archeological values associated with either the Nine Mile Point site or the immediate vicinity of the site. Although lakeshore beaches and streams have yielded relics of prehistoric settlements, the rocky bluffs of the shore at the site probably had discouraged settlement by native Americans.

TABLE 2.10 INVENTORY OF HISTORIC SITES WITHIN IMPACT AREA

Name	Town
Oswego City Library*	Oswego
Fort Ontario*	Oswego
Oswego Market House*	Oswego
Fort Oswego	Oswego
Oswego Harbor	Oswego
Oswego City Hall*	Oswego
Richardson-Bates House*	Oswego
U.S. Custom House*	Oswego
Walton and Willet Stone Store*	Oswego
Musico-Motors Building**	Oswego
Battle Island State Park	Granby
Spy Island	Mexico
Arthur Tavern	Mexico
Allen-Conklin House	Mexico
Chandler-Brown-Roop House	Mexico
Shubal and Lucinda Alfred House	Mexico
Colosse	Mexico
Gustin-Earle Factory Site**	Mexico
Selkirk Lighthouse	Richland
Shepard Estate	New Haven Township

SOURCE: ER, Appendix C; National Register of Historic Places: Annual Listing of Historic Properties, February 7, 1978; telephone conservation with Ellen Miller, Historic Preservation Field Services Office, N.Y.S., Department of Parks and Recreation, 3-9-78.

*Properties in the National Register.

**Properties under consideration for inclusion in the National Register.

<u>References for Section 2</u>

1. U.S. Atomic Energy Commission. June 1973. Final Environmental Statement Related to Construction of Nine Mile Point Nuclear Station Unit 2. Docket No. 50-410. USAEC, Directorate of Licensing, Wash., D.C.

2. Quirk, Lawler, and Matusky Engineers. 1974. 1973 Nine Mile Point Aquatic Ecology Studies - Nine Mile Point Generating Station. Prepared for Niagara Mohawk Power Corp.

3. Lawler, Matusky, and Skelly Engineers. December 1975. 1974 Nine Mile Point Aquatic Ecology Studies. LMS Project 191-21, 22, 23. Prepared for Niagara Mohawk Power Corp. and Power Authority of the State of New York.

4. Lawler, Matusky, and Skelly Engineers. April 1975. Impingement Studies at Nine Mile Point Nuclear Station Unit 1. Prepared for Niagara Mohawk Power Corp.

5. Lawler, Matusky, and Skelly Engineers. May 1976. 1975 Nine Mile Point Aquatic Ecology Studies. LMS Project Nos. 191-31, 32, 33. Prepared for Niagara Mohawk Power Corp. and Power Authority of the State of New York.

6. Lawler, Matusky, and Skelly Engineers. May 1977. 1976 Nine Mile Point Aquatic Ecology Studies. LMS Project Nos. 191-40, 41, 42. Prepared for Niagara Mohawk Power Corp. and Power Authority of the State of New York.

7. Texas Instruments Incorporated. February 1978. Nine Mile Point Aquatic Ecology Studies 1977 Data Report. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York.

8. Oswego County Planning Board, <u>Oswego County 1985 & 200 Land Use Plan</u>, June 1977, p. 17.

9. Oswego County Planning Board, <u>Oswego County Data</u>, 1977, pp. 53-4.

10. <u>1976 Report of Member Electric Systems of the New York Power Pool and the Empire State Electric Energy Research Corporation</u>, Vol. 2, Long Range Generation and Transmission Plan, April 1976, pp. 132-134.

11. Oswego County, <u>County Data</u>, p. 52.

12. Oswego County, <u>Plan</u>, p. 29.

13. Ibid., pp. 31 and 32.

14. Ibid., p. 50.

15. Ibid., pp. 48 and 49.

3 PLANT DESCRIPTION

3.1 Plant Water Use

All water used at the station will be drawn from Lake Ontario and returned to the lake after completing its function. With the proposed closed cycle cooling system for Unit 2, the annual average water consumption will be 11,000 gpm and the estimated maximum rate will be 12,000 gpm. This will result in about 31% of the average intake flow rate be lost due to evaporation. With the original once-through cooling system less water consumption due to evaporation was expected (see FES 3.3).

The location of the cooling tower with respect to the rest of the Unit 2 facility is shown in Figure 3.1. The water usage for Unit 2 operating in the closed cycle cooling mode is shown schematically in Figure 3.2; the service water and circulating water systems are shown in Figure 3.3.

In the original once-through cooling system for Unit 2, no chemicals or inhibitors were to be added to the circulating or service water systems. Chemicals would be used in the makeup water treatment, analytical sampling, and decontamination systems. However, for the closed-cycle cooling system in addition to the chemical use mentioned above, chlorine and sulfuric acid will be added to the circulating water system. Chlorine will be used to control biological fouling, while sulfuric acid will control scaling.

3.2 Cooling System

3.2.1 Intake System

The cooling water intake system will consist of two identical offshore intake structures, two intake pipes, and an onshore intake screenwell and pump house containing traveling screens and a fish return system.

Cooling water will be withdrawn from Lake Ontario through the two intake structures placed approximately 400 feet apart, each at a depth of 19.5 feet and located approximately 1000 feet offshore (Figure 3.4). The east intake is to be located approximately 200 feet to the southeast of the previously proposed once-through intake location which was to be at a depth of 26.5 feet. The currently proposed west intake will be located approximately 480 feet shoreward of the current discharge structure (Figure 3.4). The Unit 2 intake specifications as currently proposed,[1,2] the previous once-through design, and the designs of Nine Mile Point Unit 1 and FitzPatrick Nuclear Stations compare as follows:

Figure 3.1 Cooling Tower Location, Nine Mile Point, Unit 2.
Source: Reference No. 3.

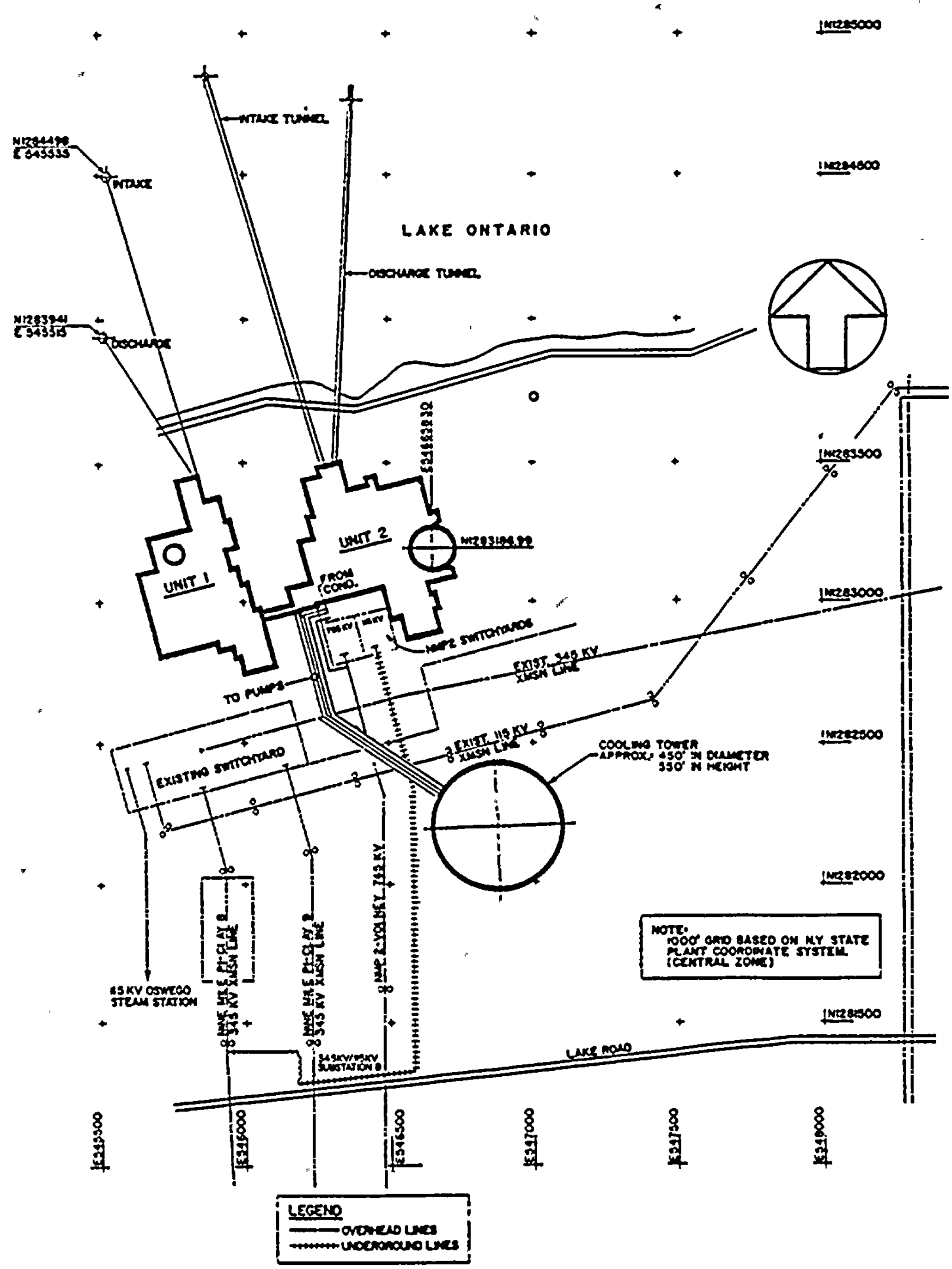


FIGURE 3.2 Schematic of Water Flow, Yearly Average. Nine Mile Point, Unit 2. Source: Reference No. 1.

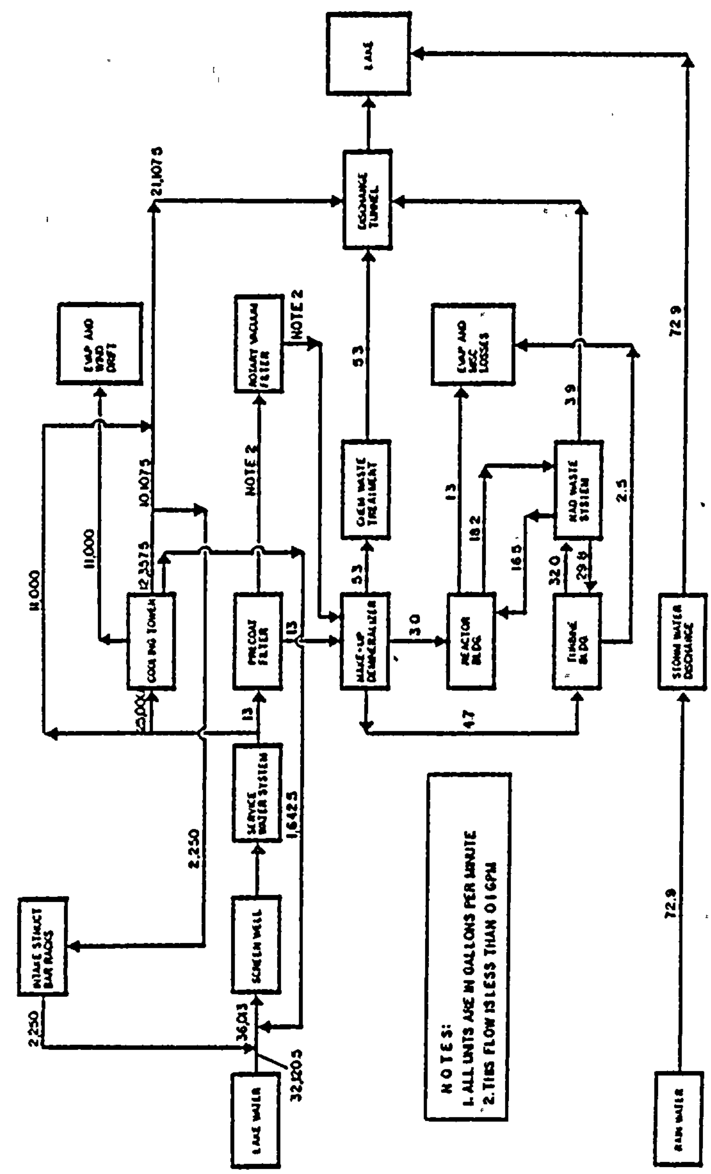
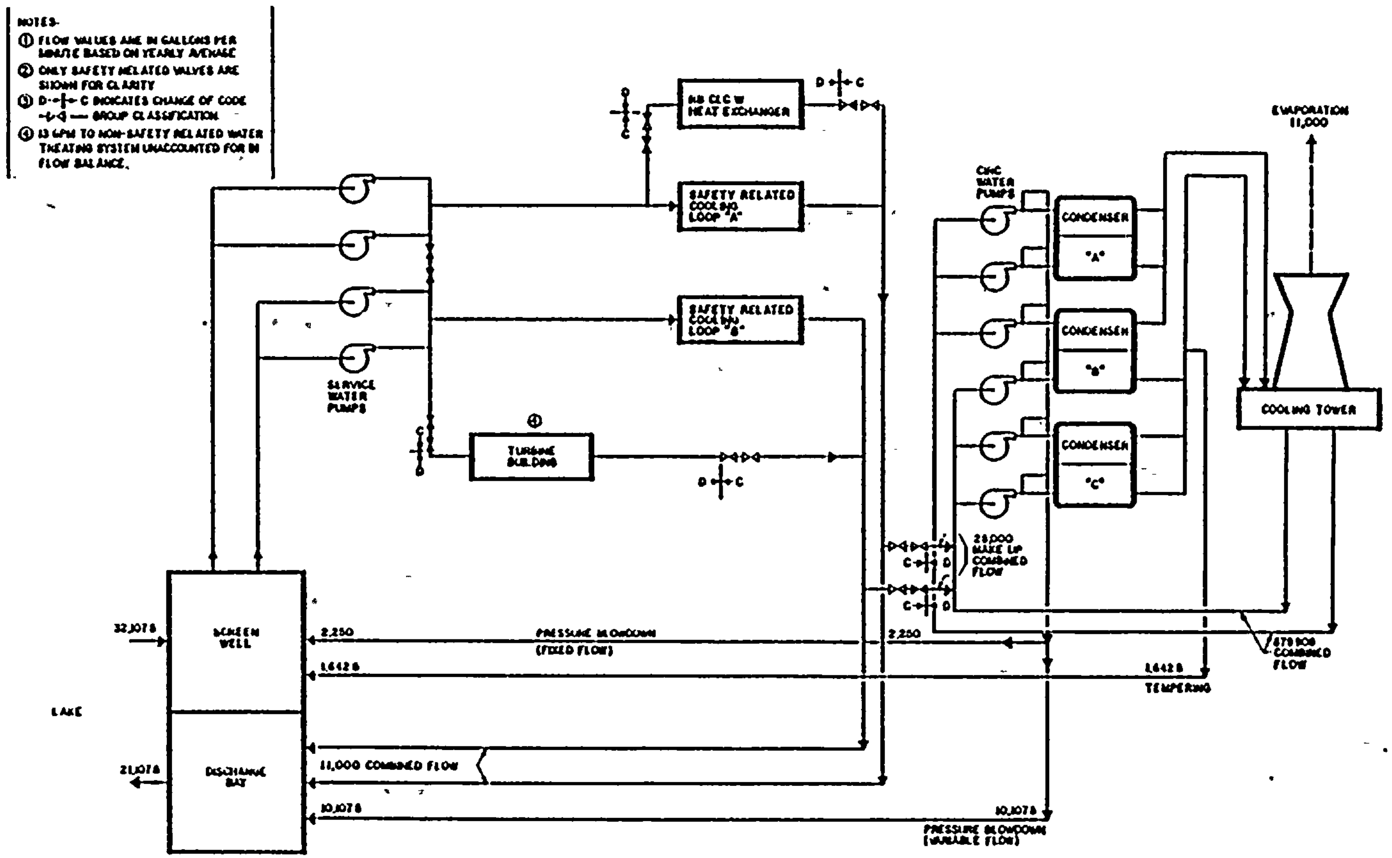


FIGURE 3.3



Flow Diagram, Service Water and Circulating Water System. Nine Mile Point, Unit 2.
Source: Reference No. 1.

FIGURE 3.4 Relative Locations of Cooling Water Intake and Discharge Structures for Nine Mile Point, Unit 1 and 2 (Previous once through and current closed - cycle designs). Source: Reference 2, Figure R11-1.

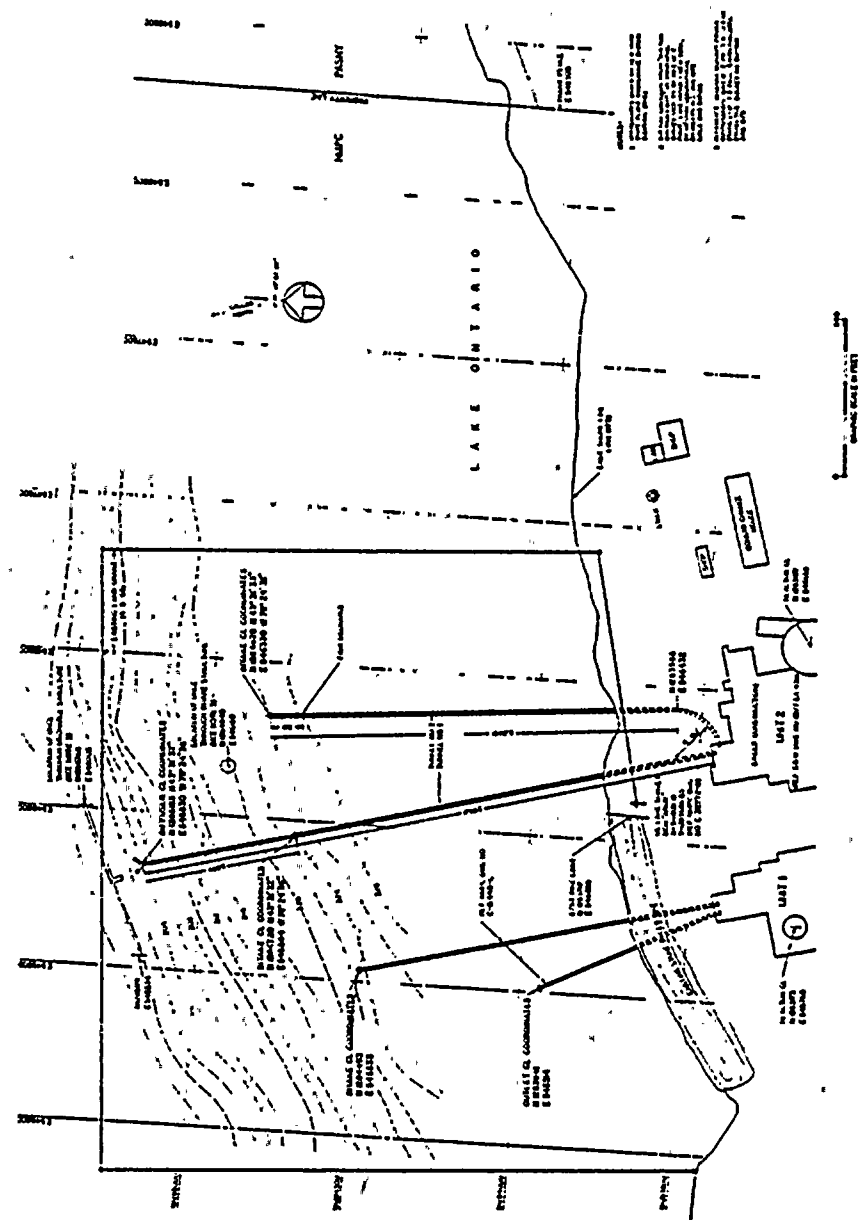
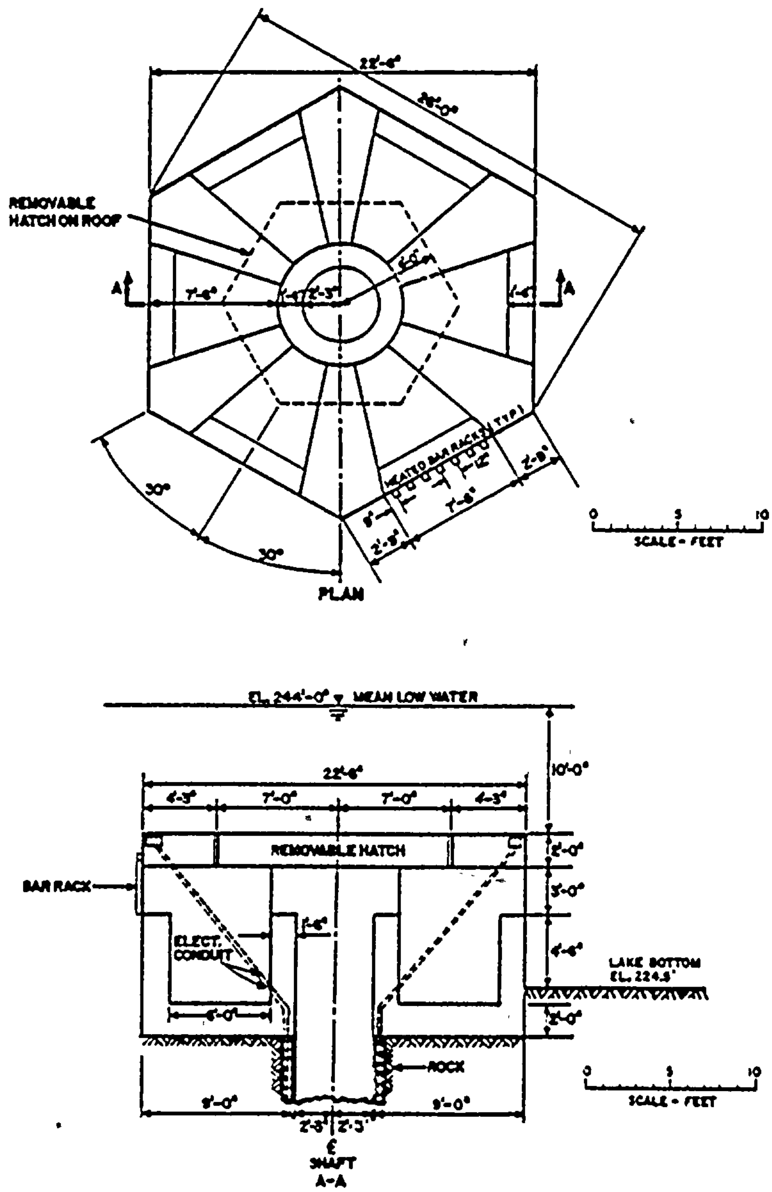


FIGURE 3.5. Closed - Cycle Cooling System Intake Structure Design. Source: Reference 2, Figure R12-1.



	Cooling System Type	Intake Vol in GPM (cfs)	Intake Velocity (fps)	Depth of Intake (ft)	Distance Offshore (ft)
NMP-1	once-through	268,000(598)	2.0	18.0	850
NMP-2	once-through	535,000(1194)	1.0	26.5	1200
NMP-2	closed cycle	36,000(80)	0.5	19.5	1000
FitzPatrick	once-through	370,200(826)	1.2	24.0	900

Details of the two intake structures are shown in Figure 3.5. The structures will have a 4.5-ft sill at the bottom to prevent silt from entering the intakes. Each structure will have six intake openings 7.5 ft wide by 3 ft high, a 2-ft roof thickness, and a 10-ft clearance between the top of the structure and the lake surface at the mean low water level of 244 ft. The width of each structure will be 22.5 ft between opposite openings. The six intake openings on each structure will be equipped with electrically heated bar racks to prevent the formation of frazil ice. The total area of the twelve openings is designed to provide a maximum intake velocity approaching the bar racks of 0.5 feet per second (fps) while drawing water through both structures.

Each intake will be independently connected to the onshore screenwell by a 4.5-foot diameter concrete intake pipe located within tunnels drilled through the bedrock beneath Lake Ontario (Figures 3.4, 3.6, 3.7). The concrete pipes have a design velocity of 2.5-4.5 fps while drawing water through both intake structures. The velocity is dependent on lake temperature and whether or not the fish removal system is operating, as follows:

Lake Temperature °F	Cooling Water Intake Flow for Normal Operation		Fish Return System Flow		Total Intake Flow	
	GPM	CFS	GPM	CFS	GPM	CFS
32-38	31,400- 36,000	70.1- 80.4	13,400	29.9	44,800- 49,400	100- 110.3
38-78	36,000	80.4	13,400	29.9	49,400	110.3
>78	45,000	100.4	16,600	37.1	61,600	137.5

Note: During normal plant shutdown, the cooling water intake flow rate will be 48,750 gpm (108 cfs).

At the onshore screenwell, the intake pipes will connect to two vertical shafts, each pipe connecting to a separate shaft. The screenwell arrangement is shown on Figure 3.8. Two motor operated rectangular butterfly gates, normally open, will be located between the north shaft and the intake bay. When the gates are closed, no flow will enter the intake bay from the north shaft. Downstream of these butterfly gates, flow from both vertical shafts will merge into a common bay and then divide into two 4-ft wide screenbays. Trash racks equipped with a rake and angled flush-mounted traveling water screens will be located in each screenbay. Two motor operated valves will be located upstream of the trash racks to bypass the two screenbays and provide a redundant flow path to the service water pumps. The bypass valves will be in parallel and connected to separate Class 1E electrical buses to ensure opening of one valve. A trash rack will be located between the valves and the service water pumps.

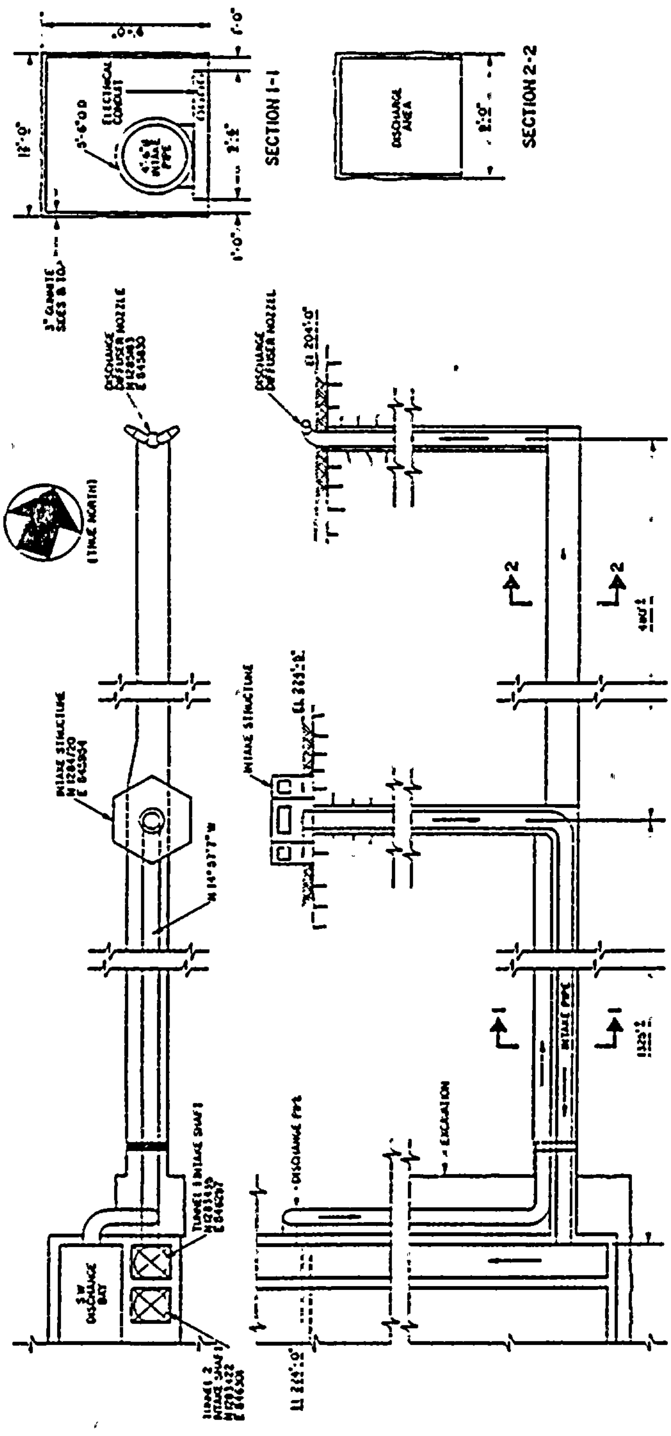
The intake structures, intake pipes, screenwell substructure, bypass valves, trash racks, and butterfly gates will be designed to withstand the design basis earthquake. The traveling water screens will not be designed for seismic loadings. If a single failure of an intake structure or intake pipe is postulated, the total flow will be transported through the remaining intake system. During this postulated single failure, the plant discharge will follow the normal flow path through the diffuser to the lake. If a single failure in the discharge system is postulated, two level switches in the discharge bay, each connected to a separated butterfly gate, will close the gates, and the discharge water will overflow the weir into the north shaft. A stop log extending from the weir crest to the deck (elevation 285.0 ft) will prevent flow into the south vertical shaft. The discharge will flow to the lake through the west intake structure, while the intake requirement will flow through the east intake structure and the south shaft.

During normal plant operation, the intake flow required for the service water pumps will be conveyed through both intake structures to the onshore screenwell.

The minimum water surface elevation in the intake bay is 233.0 ft while drawing water through both structures with the postulated lake elevation of 236.5 ft. Drawing the safe shutdown flow requirements through one structure will result in a water surface elevation of 234.7 ft in the intake bay. The service water pumps will be designed to operate at the minimum water elevation of 233.0 ft with the centerline of the horizontal suction pipes at elevation 226.17 ft.

The screenwell fish removal system is shown in Figure 3.8. There will be two screenbays, each 4 ft wide. Fish entering the screenwell will pass through trash racks made up of 3 in. by 1/2 in. bars with 3 in. clear spacing between the bars. After passing through the trash racks, the fish will be guided by angled, flush-mounted, traveling water screens into bypass slots. The two traveling water screens will be angled 25 degrees to the upstream direction of flow with their downstream ends converging, but separated by a 5-ft wide pier. The screens are similar to conventional vertical traveling water screens except that the screen panels and frames are designed to form flush surfaces along

FIGURE 3.6. Number 1 Intake Tunnel and Diffuser. Source: Reference 2, Figure R15-1.



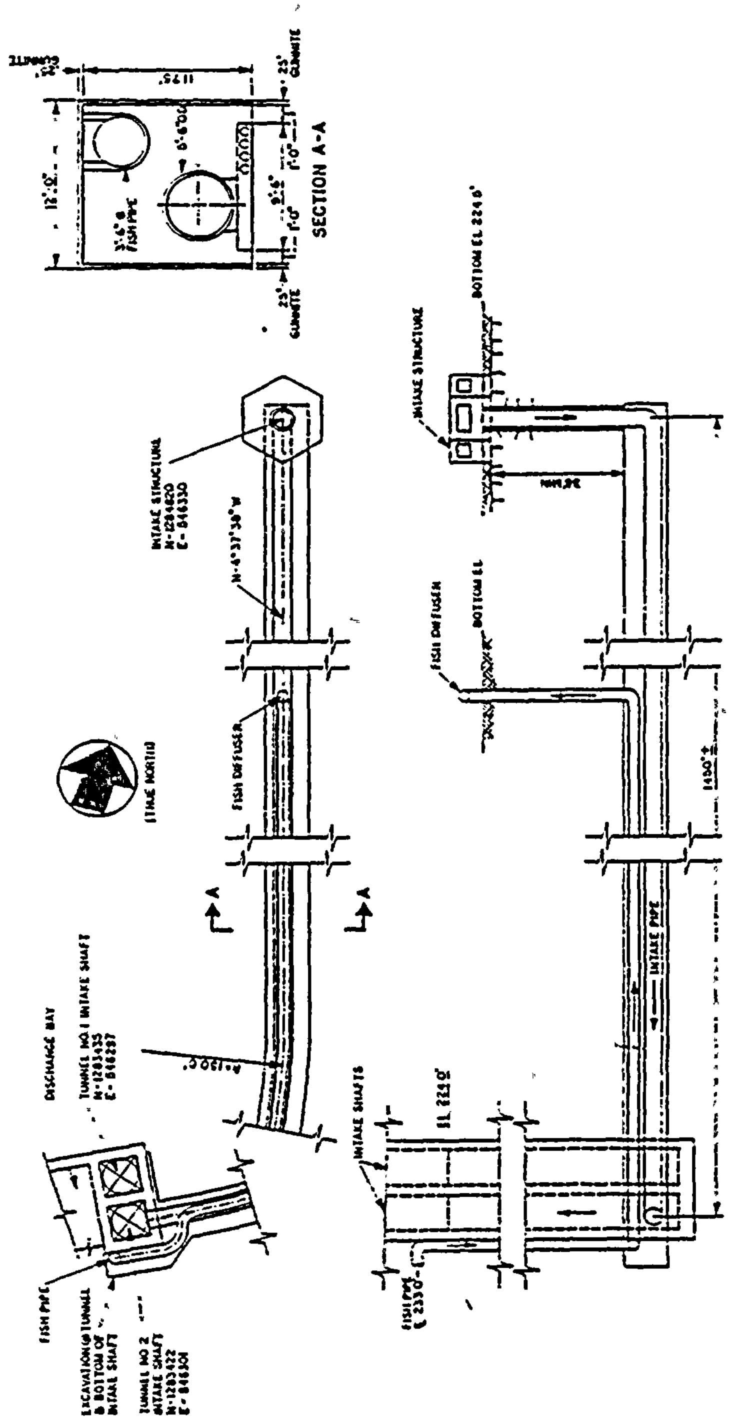
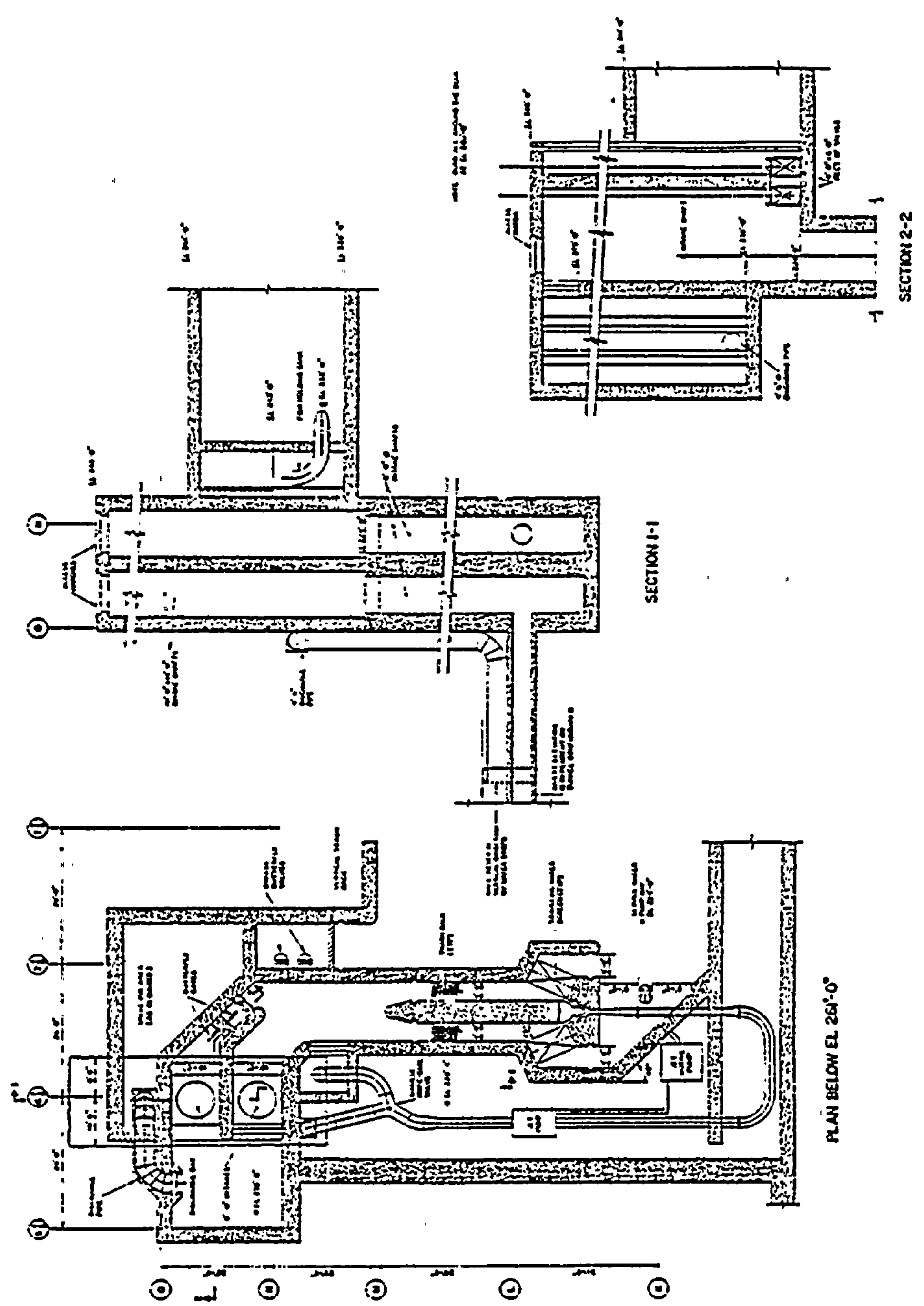


FIGURE 3.7. Number 2 Intake Tunnel and Fish Return System. Source: Reference 2, Figure R15-2.

FIGURE 3.8 Design of Screenwell, Fish Removal System and Associated Structures. Source: Reference 2, Figure R12-2.



the screen face. At the downstream end of each screen and extending the full depth of the water column, there will be a 6-inch wide bypass slot. The two slots will converge, and at their junction a funnel-shaped transition will converge in the vertical plane at a 30 degree angle to 18-inch diameter pipes. The two pipes will manifold into a single 24-inch diameter suction pipe leading to a peripheral jet pump. The jet pump will discharge into a 42-inch diameter fish return pipe within the east tunnel for approximately 1300 ft, where it will rise vertically and terminate horizontal to the lake bottom in an easterly direction. A fish sampling area will be provided downstream of the jet pump.

3.2.2 Discharge System

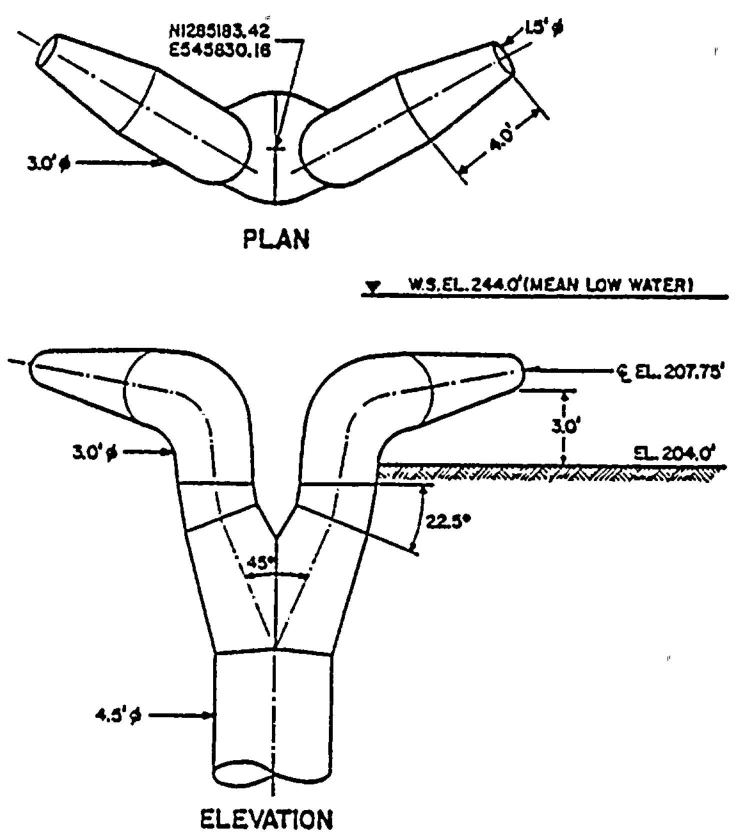
Cooling tower blowdown will be combined with that part of the service water system discharge not used as cooling tower makeup, and will be discharged to Lake Ontario via the discharge diffuser. The discharge diffuser will be located 480 feet further offshore than the west intake structure in about 40 feet of water. See Figure 3.4. Total distance offshore will be about 1525 feet.

The diffuser will have two nozzles, with ports 18 inches in diameter, branching from a single riser and diverging at a 120 degree horizontal angle. The nozzles will be elevated upward at a 5 degree angle from horizontal with the centerline of the port 45 inches off the lake bottom. See Figure 3.9.

The applicant states that the discharge flow rate will vary between 18,000 gallons per minute and 35,900 gallons per minute with an average flow of 25,200 gallons per minute. The resulting nozzle exit velocity will range between 11.3 feet per second and 22.6 feet per second with an average velocity of 15.8 feet per second.

The Applicant states that the size and location of the discharge nozzles were designed to meet the New York criteria governing thermal discharges (6NYCRR704) applicable to Lake Ontario. That regulation limits the surface temperature rise outside the mixing zone to 3 degrees Fahrenheit above the temperature that existed before the addition of heat of artificial origin. The applicant states that the annual average ΔT is 19°F and that the maximum ΔT is 30.6°F. The applicant calculated the maximum surface ΔT for the latter case as 2.8°F. We have independently calculated the surface ΔT for both cases and conclude that the maximum temperature rise will be below 3°F and that the discharge system should, therefore, meet the New York State criteria.

FIGURE 3.9 Discharge Diffuser



References for Section 3

1. Niagara Mohawk Power Corporation. July 1976. Report on Circulating Water Cooling System Employing a Natural Draft Cooling Tower. Nine Mile Point Nuclear Station - Unit 2. Docket No. 50-410. 19 p. and Tables and Figures.

2. Niagara Mohawk Power Corporation. September 1977. Responses to NRC Requests Dated April 22, 1977, for additional Information Regarding the Proposed Cooling System Design Change. Nine Mile Point Nuclear Station - Unit 2. Docket No. 50-410.

3. Niagara Mohawk Power Corporation, Responses to NRC Request for Additional Information, November 21, 1980.
Docket No. 50-410.

4 ENVIRONMENTAL IMPACTS OF CONSTRUCTION

4.1 Ecological Impacts

4.1.1 Terrestrial Ecosystems

Areas to be cleared consist primarily of land formerly farmed but now covered with trees and brush characteristic of secondary growth. The wildlife species found near the site are typical of the northeastern United States. The most common small mammals on site which may experience a reduction in numbers due to construction activities include cottontail rabbit, eastern chipmunk, and squirrel. The effect of plant construction on wide-ranging large mammals, such as deer and raccoon, should be nominal if surrounding habitats are not already stressed in terms of population numbers.

Since the proposed cooling tower site will occupy habitats that are not unique to either the station site or the region, the loss of vegetation during construction will result in only a small reduction of individuals of the various species present, but not totally exclude any from the site. The remaining undisturbed site vegetation should provide some habitat for a variety of animal species that are found onsite.

The applicant has used mitigative measures to ensure that erosion impacts will be minimized (FES, Nine Mile Point Unit 2). The staff finds them satisfactory.

4.1.2 Aquatic Ecosystems

The potential effects upon the lake bottom and associated biota in relation to construction of the previously proposed once-through cooling intake and discharge structures were discussed in the June 1973 FES (Section 4.2, pages 4-3 to 4-4)[1] and by the Applicant.[2]

Substrate composition along the western sampling transects NMPW and NMPP (Figure 2.1) are typically composed of flatrock or cobble substratum overlain with a layer of silt. Sand and silt are more prevalent at the eastern transects (FITX and NMPE)[3] and progressively thin out in a westerly direction.[4] The eastern transect has the most unstable sediments.[4] The currently proposed closed-cycle intake and discharge structures are in close proximity to those previously considered (difference in depth contours ∿ 4-5 feet) and thus the benthic populations would not be expected to differ substantially.

The intake and discharge structures designed for the previous once-through system were considerably larger than those currently proposed and would have required the disturbance of more lake bottom area during construction. The disturbance to benthic communities, therefore, should be less under the new design. Such disturbance will be temporary and restricted to the immediate construction areas. The nature of the more coarse sediments in the westerly areas of Nine Mile Point should result in relatively low levels of turbidity and siltation during construction. As such, the previous FES assessment of construction impacts as "minor and temporary" remains valid. Similarly, impacts to Lake Ontario from offshore construction activities at Ginna and FitzPatrick Nuclear Power Plants were considered to be minimal and acceptable.[5,6]

4.2 Socioeconomic Impacts

4.2.1 Stress on Community Services

After reviewing the proposal for Nine Mile Point Nuclear Station Unit 2, the staff concluded that local public services and facilities would experience little impact as most of the construction craftsmen and laborers will be drawn from nearby communities (FES, p. 4-4). This review assumed that heat dissipation would be accomplished through a once-through cooling system which would eject waste heat from turbine condensers and the service water cooling system to Lake Ontario and subsequently to the atmosphere. As of April 1980, construction on Nine Mile Point Unit 2 was estimated to be 37% complete.[7]

The major potential sources of impact on community services are associated with the number and activities of the construction force and with the physical and financial impacts directly associated with construction activity. Data on manpower, scheduling, and wages for constructing an NDCT and for a once-through cooling system indicate that site labor hours and labor cost are similar for both alternatives.[8]

The applicant has indicated a 32-month construction period for the NDCT. Employment on the NDCT would peak at 90 workers while the total number of construction workers at the site would be approximately 2500.[9]

The commutation pattern of workers required to design and construct the NDCT or the once-through system will follow the pattern of station construction workers in general: most will travel from labor pools within 50 to 60 miles of the plant site. Moreover, the similarity in labor requirements for both heat dissipation systems indicates that the differential impact of construction workers on community services in the impact area will be insignificant. The staff concludes that the public service demands of construction workers does not provide the basis for differentiating the cooling system options.

4.2.2 Highways and Traffic

The staff estimates that as many as 200 cars per day at peak for commuting traffic and up to 100 or more truck passages per day will be associated with the construction of either cooling system. This volume of traffic will have to be managed so as to limit the congestion on vehicular arteries both on and off site. Although the complete route to be taken by trucks is dependent upon the final decision of where to dispose of the spoils, County Roads 29 and 1, Middle Road, and U.S. Route 104 may constitute part of the route.

Although a sound emission impact study has not been conducted by the applicant, the only construction-related noise of potential concern is that of truck traffic along the selected route. There will be a noticeable increase in sound levels from truck traffic for a period of approximately six months to a year.

With respect to auto and truck traffic and sound emissions, it should be noted that neither the NDCT or the once-through system enjoys an advantage. Moreover, both effects are small in relation to overall construction at the site.

4.2.3 Tax Revenues

Real estate taxes from the Nine Mile Point Station accrue to the Town of Scriba, Oswego County, the State of New York, and the Enlarged City School District of Oswego. Real estate taxes are assessed on the value of plant (structure) in-place in each taxing period. The staff has not estimated the possible flow of tax revenues during the construction period. However, it should be noted that under present New York State law closed cycle cooling systems are eligible for local tax exemption as pollution control devices. The applicant has yet to apply to the State for a ruling on this matter.

4.2.4 Employment and Income Benefits

The staff anticipates that cooling system construction workers associated with either system alternative will not number more than 250 at peak and nearly all will commute from their present residences within a 50- to 60- mile radius. The number of skilled workers required is a small fraction of the total number available in the region, and thus, little impact is anticipated on the labor market.

Wages will be distributed over the region in the same pattern as other workers on the Nine Mile Point Station. Only a small portion of the payments to labor will go into the communities that comprise the impact area.

4.2.5 Impact of Aesthetic on Recreation and Land Uses

Aesthetic impacts during the early stages of constructing the natural draft tower will be mainly confined to the site. Construction activity during this period will be visible from the Lake but hidden by vegetation from land locations outside the applicant's property. As construction progresses, the tower will become increasingly visible as it reaches its design height of approximately 540'. However, because of the low density resident population and the limited use of the Lake in the immediate vicinity of the station, the significance of any aesthetic impact during the construction period will be negligible.

4.2.6 Summary Comparison of Impacts of Alternative Cooling Systems

Community and regional impacts during construction of a cooling system will be quite limited with either the once-through or NDCT alternatives. Although differences in community impacts may exist between the alternatives, these differences are not considered of major importance in the cost-benefit balancing of the alternatives. The aesthetic impact of the NDCT is the only variable differentiating the cooling system alternatives. Toward the end of the construction period, the NDCT will become visible over a wide area. In contrast, the once-through system will have no highly visible structure and, consequently, no impacts on the aesthetics of the environment (ER, p. 8.5.3). However, as stated above, the significance of the aesthetic impact during the construction period is considered by the staff to be negligible.

References for Section 4

1. U.S. Atomic Energy Commission. June 1973. Final Environmental Statement Related to Construction of Nine Mile Point Nuclear Station Unit 2. Docket No. 50-410. USAEC Directorate of Licensing Washington, D.C.

2. Niagara Mohawk Power Corporation. September 1977. Responses to NRC Requests Dated April 22, 1977, for Additional Information Regarding the Proposed Cooling System Design Change. Docket No. 50-410.

3. Lawler, Matusky, and Skelly Engineers. May 1977. 1976 Nine Mile Point Aquatic Ecology Studies. LMS Project Nos. 191-40, 41, 42. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York.

4. Lawler, Matusky, and Skelly Engineers. May 1976. 1975 Nine Mile Point Aquatic Ecology Studies. LMS Project Nos. 191-31, 32, 33. Prepared for Niagara Mohawk Power Corporation and Power Authority of the State of New York.

5. U.S. Atomic Energy Commission. December 1973. Final Environmental Statement Related to the Operation of R. E. Ginna Nuclear Power Plant Unit 1. Docket No. 50-244. USAEC Directorate of Licensing, Washington, D.C.

6. U.S. Atomic Energy Commission. March 1973. Final Environmental Statement Related to the Operation of James A. Fitzpatrick Nuclear Power Plant. Docket No. 50-333. USAEC Directorate of Licensing, Washington, D.C.

7. U.S. Nuclear Regulatory Commission, <u>Construction Status Report: Data as of April 30, 1980</u>, NUREG-0030, Vol. III, No. 2, June 1980, p. 2-27.

8. The staff's principal source of information comes from an NRC-sponsored study of nuclear station construction costs undertaken by United Engineer and Constructors, Inc. of Philadelphia (<u>Cooling Systems Addendums: Capital and Total Generating Cost Studies Series 7</u>. NUREG-0247. COO-2477-11. Preliminary Draft). In this study the reference plant is a 1190 MWe BWR constructed in the Northeast. The cost basis is July 1976.

9. Niagara Mohawk Power Corporation, Response to NRC Request for Additional Information, November 21, 1980. Docket No. 50-410.

5 ENVIRONMENTAL IMPACTS OF STATION OPERATION

5.1 Cooling System Impacts

5.1.1 Intake System; Aquatic Impacts

Impingement of Fishes

The June 1973 FES[1] discussed potential intake effects of the proposed once-through design and predicted that it should have little or no noticeable effect on the fish population as a whole (p. i), but expressed concern that "...Fish kills due to impingement at Unit 2 may become unacceptable when added to the fish killed at Unit 1 and FitzPatrick Plants" (p. 5-33). This concern was expressed for the following reasons:

(1) "Studies...have shown a general tendency for fish to concentrate along the 25-foot contour where the intake will be situated or in slightly deeper water" (p. 5-29);

(2) "An average intake velocity of 1.0 fps at the face of the bar racks cannot be considered low enough for the protection of fish..." (p. 5-29);

(3) At that time (1973) there was "...insufficient data to demonstrate that the Unit 2 intake, as designed, precludes possibilities of substantial fish kills due to impingement..." (p. 5-33).

Since the publication of the 1973 FES, several years of operational studies have been conducted at both Nine Mile Point, Unit 1, and FitzPatrick. Environmental Impact Appraisals (EIA) have been performed on intake and discharge related impacts in association with changes in the monitoring programs.[40,41] In the EIAs, the staff determined that operational impacts at both power plants have been minimal and acceptable.

Additionally, FES Summary and Conclusions (p. iv), Section 5.5.2 (p. 5-33), and Section 9.2.7 (pp. 9-28 to 9-29) recommended "...changes in intake design, modification of existing intakes, and/or development and implementation of other preventive methods..." as necessary to minimize impacts to fish populations. Section 9.2.7 specifically recommended examination of alternative intake designs to include:

(1) reduction in average intake velocity;

(2) relocation of the intake to a different depth;

(3) use of a fish guidance system to guide fish away from the area of impingement and return them to the Lake.

These design modifications have been implemented as described in Section 3.4.2.

Ecology studies at Nine Mile Point, Unit No. 1, and at FitzPatrick have shown that the fish species most abundant in impingement samples have also been among

TABLE 5.1 SUMMARY OF FISH IMPINGEMENT ESTIMATES (MAJOR SPECIES) AT NINE MILE POINT UNIT 1 AND FITZPATRICK NUCLEAR POWER PLANTS DURING THE PERIOD 1973-1976.

	Alewife	Rainbow Smelt	Spottail Shiner	Mottled Sculpin	Total Fish
		NINE MILE POINT UNIT 1			
1973[1]	4,931,566	116,277	683	2,946	5,079,603
1974[1]	2,001,698	83,771	7,468	4,405	2,120,761
1975[1]	780,738	65,570	1,892	2,996	970,321
1976[2]	3,060,580	136,151	12,507	7,390	3,436,085
		FITZPATRICK			
1975[3] (Sept.-Dec.)	59,257	11,099	1,068	892	84,411
1976[2]	3,877,550	259,783	11,683	7,301	4,313,562

[1] Sharma, R. K. and R. F. Freeman III. March 1977. Survey of Fish Impingement at Power Plants in the United States. Volume I. The Great Lakes. ANL/ES-56. 218 p.

[2] 1976 Nine Mile Point Aquatic Ecology Studies. May 1977. LMS Project Nos. 191-40, 41, 42, Volume 1, Chapter IX. Niagara Mohawk Power Corp. and Power Authority of the State of New York.

[3] 1975 Nine Mile Point Aquatic Ecology Studies. May 1976. LMS Project Nos. 191-31, 32, 33. Chapter IX. Niagara Mohawk Power Corp. and Power Authority of the State of New York. Estimated numbers impinged are expanded from the raw data presented by licensee.

the most abundant and most prolific in the Lake in the site vicinity. Alewives have accounted for 80% to 97% of the annual total estimated fish impinged, followed by rainbow smelt which comprised 2% to 6% of the annual total.

The species composition and abundance of the fishes impinged were similar at both power plants during 1976, which is to be expected since the plants are nearby and of very similar design and water withdrawal capacity. Examination of the impingement catches in units of effort shows that during 1976 the number of alewives impinged per million gallons (mg) of water withdrawn (during the sampling periods) were similar at both plants (Table 5.2). Likewise, the total fish (all species) impinged per mg were similar. The fish impinged per hour of sampling effort was greater at FitzPatrick, however, presumably as a result of a greater water withdrawal requirements for cooling purposes. This corresponds to a greater annual impingement at FitzPatrick during 1976. The numbers of alewives impinged per volume of water withdrawn at each plant on a monthly basis during 1976 varied, but were similar during May when 68% and 72% of the total annual alewife impingement occurred at Nine Mile Point, Unit No. 1, and FitzPatrick, respectively.

The similarities in catch per volume and the differences in catch per hour suggest that alewife impingement (and perhaps total impingement for all species) may be related to volume of water withdrawn, intake velocity, or a combination of both. The lengths of alewives impinged during the spring of 1976 generally were between 2.5 inches and 7 inches long, with the majority being about 5.5-6.5 inches long in May. Examination of swim speed data for alewive (Table 5.3) suggests that the larger spring fish might be non-susceptible to entrapment at both FitzPatrick (intake velocity 1.2 fps) and Nine Mile Point Unit 1 (intake velocity 2.0 fps) at warm water temperatures. At lower water temperatures, however, alewife cruising speed is reduced,[2] so that during the April-May period when ambient lake temperatures are $\sim 6°-11°C$, alewife might be highly susceptible to entrapment and impingement. It is likely that environmental and stress-inducing factors which influence spring mass mortalities of alewives in several of the Great Lakes and nearby water bodies[3,4,5,6,7,8] also contribute to the spring impingement of alewives. Similarly, the maximum sustained swim speed for rainbow smelt of 1.15 fps (length 5.3 inches; 6°C)[9] renders that species susceptible to entrapment at high intake velocities.

Alewife and rainbow smelt have been the dominant species in impingement samples at power plants on Lake Michigan.[10,11] Two such plants with offshore intakes and design similar to Nine Mile Point are the Palisades and Cook plants on Lake Michigan's eastern shore (Table 5.4). During the years 1972-1973 the Palisades plant operated with a once-through cooling system, but converted to closed-cycle after that time. In discussing the effects of impingement under the altered design, the Final Addendum to the Palisades FES[12] stated that "Impingement of fish can be conservatively assumed to be reduced in proportion to the reduction of total intake flow which is a factor of about 5.5... The actual reduction should be even more significant than indicated by just the flow reduction because of the effect of reducing the intake approach velocity." Examination of impingement catches at Palisades before and after the conversion to closed-cycle does show a marked reduction in the loss estimates for the most susceptible species (Table 5.5). Comparison of these data with those at the nearby Cook

TABLE 5.2 COMPARISON OF THE ANNUAL TOTAL NUMBER OF FISHES (ALL SPECIES) AND ALEWIVES IN IMPINGEMENT SAMPLES DURING 1976 AT NINE MILE POINT AND FITZPATRICK NUCLEAR POWER PLANTS,[1] ADJUSTED FOR HOURS SAMPLED AND VOLUME OF WATER WITHDRAWN DURING SAMPLING

	NMP	Fitz
Total Alewives (No)	1,935,168	2,270,274
Total Fish (All spp)	2,150,563	2,504,002
Total Hours sampled	4080.10	4056.26
Total Vol. Sampled (MG)	60982	72986
Average withdrawal MG/hr	14.95 (556 cfs)	17.99 (669 cfs)
Alewives/hr	474.29	559.70
Alewives/MG	31.73	31.11
Total Fish/hr	572.09	617.32
Total Fish/MG	35.26	34.31

[1] 1976 Nine Mile Point Aquatic Ecology Studies. May 1977. LMS Project Nos. 191-40, 41, 42. Volume 1, Chapter IX. Niagara Mohawk Power Corp. and Power Authority of the State of New York.

TABLE 5.3 CRITICAL SWIMMING SPEEDS OF ALEWIFE[1]

Length in.	Swimspeed fps	Acclimation Temp. °C
3.5	1.34	24.0
3.6	1.20	24.0
3.9	1.78	25.0
4.3	0.87	25.0
5.0	2.77	20.0
5.4	1.78	20.0
5.4	2.12	20.0
5.6	1.67	20.0

[1] Wyllie, M. C., E. R. Holmstrom, and R. K. Wallace. 1976. Temperature Preference, Avoidance, Shock and Swim Speed Studies with Marine and Estuarine Organisms from New Jersey. Ichthyological Associates, Inc. Bulletin No. 15. 76 pp.

TABLE 5.4 DESIGN SPECIFICATIONS OF PALISADES NUCLEAR GENERATING PLANT AND DONALD C. COOK NUCLEAR PLANT UNIT 1, LAKE MICHIGAN

	Cooling System Type	Intake Vol. in GPM(cfs)	Intake Velocity (fps)	Depth of Intake (ft)	Distance Offshore (ft)
Palisades	Once-through	405,000(900)[1]	0.69-0.95[2]	382	3300[2]
Palisades	Closed cycle[3]	80,000(179)	0.1	38	3300
Cook	Once-through[3]	1,645,000(3,672)	1.3-1.9	24	2250

[1] USAEC. June 1972. Final Environmental Statement Related to the Operation of Palisades Nuclear Generating Plant. Docket No. 50-255.

[2] Consumers Power Company. May 1975. Summary of the effects of once-through cooling at the Palisades Nuclear Power Plant.

[3] Sharma, R. K. and R. F. Freeman III. March 1977. Survey of Fish Impingement at Power Plants in the United States. Vol. I. The Great Lakes. ANL/ES-56. 218 pp.

TABLE 5.5 SUMMARY OF FISH IMPINGEMENT ESTIMATES (MAJOR SPECIES AT PALISADES NPP DURING THE PERIOD OF ONCE-THROUGH COOLING (1972-73) AND CLOSED CYCLE COOLING (1974 TO 1977)

Year (Months Samples)	Alewife	Rainbow Smelt	Spottail Shiner	Slimy Sculpin	Total Fish
1972[1] (Jan-Dec)	71,529	886	23,672	9,061	119,744
1973[1] (Jan-Oct)	311,870	6,747	23,225	171,187	534,188
1974[2] (Mar-Dec)	1,116	*	49	5,887	7,220
1975					
(Jan-Mar)[2]	71	*	47	51	217
(July-Dec)[3]	198	20	0	184	450
9 mo. total	269	20+	47	235	667
1976[4] (May-Dec)	1,113	29	35	385	1,750
1977[5] (Jan-Sept)	568	0	7	72	855

[1] Consumers Power Company. May 1975. Summary of the effects of once-through cooling at the Palisades Nuclear Power Plant.

[2] Sharma, R. K. and R. F. Freeman III. March 1977. Survey of fish impingement at power plants in the United States. Vol. I. The Great Lakes. ANL/ES-56. 218 p.

[3] Consumers Power Company. March 1976. Palisades Plant - First Annual Report of Operations, January 1 through December 31, 1975. Numbers impinged are expansions of the raw data presented by licensee.

[4] Consumers Power Company. April 1977. Palisades Plant - Radioactive Effluents and Environmental Monitoring Sections to Second Annual Report. Numbers impinged are expansions of the raw data presented by licensee.

[5] Letter dated October 28, 1977 from D. P. Hoffman, Consumers Power Company, to A. Schwencer, USNRC. Numbers impinged are expansions of the raw data presented by licensee.

* Not reported by Sharma and Freeman (1977), but reported to be 113 fish by CDM/Limnetics (1977): The Lake-Wide Effects of Impingement and Entrainment on the Lake Michigan Fish Populations; March 21, 1974 through March 25, 1975.

facility (Table 5.6) shows the differences and the comparative ability of closed-cycle cooling to reduce impingement losses.

It has been recognized that fish impingement is an unavoidable result of the screening of water taken from water bodies inhabited by fish.[10] This is especially applicable to the most susceptible species of Great Lakes fish (e.g., alewife, smelt, etc.), as indicated by their occurrence and abundance at industrial,[13,14] municipal[13,14] and power utility[10,11,13,14] intake screening devices of varying design, capacity, and location. Where fish impingement has been documented, the use of fish bypass facilities may improve performance, and at new intakes where it is not clear that impingement can be avoided, such facilities may be desirable.[15]

The current proposal to place the intake structures at a depth of 19.5 feet may have some advantage for reducing potential impingement of fishes, since some species appear to be more abundant seasonally in deeper water. This depth does not appear to be unique with respect to species occurrence or habitat when compared with the previously assessed 26.5-foot location or the present Unit No. 1 location at a 25-foot depth. The species composition of the fish impingement catch at Unit No. 2, therefore, may be expected to be similar to that observed at Unit No. 1. The reduction in design intake volume (1194 to 80 cfs) and velocity (1.0 to 0.5 fps) at Unit No. 2 under the closed cycle mode and the comparable reductions compared with Unit No. 1 design will be chiefly responsible for reducing potential impingement losses (especially to the most susceptible species). The >85% reduction in intake volume and 75% reduction in intake velocity compared with Unit No. 1 may likely result in comparable impingement levels at Unit No. 2 of less than 15% of those observed at Unit No. 1. This reduction coupled with the capability for guiding entrapped fish past the traveling screens and returning them to Lake Ontario should result in minimal impact to the fish species affected. Minimization of impact to the most susceptible species should result in minimized impact to other species as well. As such, the low level of impingement losses which might occur at Unit No. 2 should not become unacceptable when added to those of Unit No. 1 and FitzPatrick which have been minimal. Therefore, the June 1973 FES Conclusion (page i) that fish impingement at Unit No. 2 "...should have little or no noticeable effect on the fish population of the Lake as a whole..." remains valid.

Entrainment of Plankton

The Unit No. 2 FES of June 1973[1] evaluated the potential effects of once-through cooling entrainment on the plankton populations (Section 5.5.2.b, pages 5-33 to 5-35). With respect to phytoplankton and zooplankton, the following conclusions were stated:

(1) "...a comparatively small percentage of the total volume of water available in the vicinity of the three plants under static or current conditions will be withdrawn for cooling in a day" (p. 5-35);

(2) "Most planktonic forms have a short generation time and can respond to changes in the population in a short period" (p. 5-35);

TABLE 5.6 SUMMARY OF FISH IMPINGEMENT ESTIMATES (MAJOR SPECIES) AT COOK NPP DURING THE PERIOD 1975-1976

Year (Months Sampled)	Alewife	Rainbow Smelt	Spottail Shiner	Slimy Sculpin	Total Fish
1975[1] (Jan-Dec)	172,827	3,911	10,295	8,233	221,892
1976[2] (Jan-Oct)	94,318	2,045	22,889	5,384	151,342

[1] Indiana and Michigan Power Company. Environmental Operating Report. Donald C. Cook Nuclear Power Plant Unit 1. January 1, 1976 through June 30, 1976.

[2] Indiana and Michigan Power Company. Environmental Operating Report. Donald C. Cook Nuclear Power Plant Unit 1. July 1, 1976 through December 31, 1976.

(3) "Zooplankton are expected to suffer a high mortality rate in the summer. However, even if the rate were 100%, the impact of such mortality among organisms with a short generation time will not be measurable in the area" (p. i);

(4) "...the staff anticipates that no significant adverse effects on the Lake's planktonic populations will result from the operation of the three plants [Nine Mile Point Units 1 and 2 and Fitzpatrick] with once-through cooling" (p. 5-35).

Under the current closed cycle proposal, the reduction in withdrawal volume at Unit No. 2 to <7% of the originally proposed once-through volume should further minimize potential impact to planktonic populations. The FES conclusions of "no significant adverse effects" therefore remain unchanged.

With respect to entrainment of fish eggs and larvae, the FES concluded (p. 5-35):

(1) The assessment of "...no significant adverse effects on the lake's planktonic populations...is not applicable to entrainable forms of fish life";

(2) Adequate studies on plankton near the site and on plankton entrainment were not conducted.

Operational monitoring studies at Nine Mile Point Unit No. 1 for the years 1975[16] and 1976[17] indicated that ichthyoplankton species which constituted the majority of those entrained were alewife and rainbow smelt. Species occurring in lower numbers were white perch, yellow perch, and others. Generally, species occurrence in entrainment samples coincided with periods of abundance and occurrence in the lake far field samples, although densities in entrainment samples often exceeded those of lake samples. Based on the presence of fish eggs and larvae in the water, alewife spawning may have occurred as far offshore as the 100 foot depth contour (~one mile offshore, the maximum offshore point sampled), with highest densities occurring near the 20-foot contour (the most inshore point sampled). Rainbow smelt eggs and larvae were most abundant inshore of the 40-foot contour, but larvae occurred beyond the 60-foot contour. White perch larvae occurred in low numbers and were most abundant at the 20-foot contour. White perch eggs were in very low abundance. Yellow perch larvae were most abundant at the 20-foot contour, but were collected offshore to the 60-foot contour. These species all utilize nearshore areas of the lake for spawning, which probably includes the area shoreward of the 20-foot contour. Based on the data collected, ichthyoplankton abundance generally has been greatest at the most inshore area sampled (20-foot contour), which also corresponds to the approximate location of the proposed closed-cycle intake structures (19.5-foot contour). Abundance shoreward of the 20-foot contour was not investigated. Although location of the intakes at a depth greater than 19.5 feet would reduce the level of ichthyoplankton potentially entrained with makeup water, a significant reduction for the major species (with respect to abundance at the 20-foot contour) might not be assured unless the intake depth exceeded 40 feet (>1500 feet offshore). The feasibility of siting the intakes at such depths and distances offshore apparently has not been investigated, and doing so might necessitate re-siting of the discharge structure as well. Although no sampling occurred at the 26.5-foot contour (depth of the previously proposed once-through intake), it would not appear that this depth is substantially different from the 19.5-foot depth with respect to ichthyoplankton composition or abundance.

The environmental risk associated with entrainment is related, in large part, to the volume of water passing through a cooling water intake structure, and thus reduction of intake volume (capacity) is one of the most effective methods for reduction of adverse environmental impacts.[15] Such a reduction should, in most cases, reduce the number of organisms that are subject to entrainment in direct proportion to the fractional flow reduction.[15] Reduction in intake volume at Palisades Nuclear Generating Plant (due to conversion from once-through to closed-cycle cooling) was predicted to conservatively result in about a two-thirds reduction in the total number of fish eggs and larvae killed.[12] Similarly, the low makeup water requirements at Nine Mile Point Nuclear Station Unit 2 will serve to minimize impacts to Lake Ontario fish eggs and larvae. The prolific nature of alewife and the abundance of littoral zone shallows suitable for its spawning precludes any measurable effect upon lake populations as a result of entrainment at Unit 2. Similarly, rainbow smelt and yellow perch utilize the vast nearshore areas and should not be measurably affected by Unit 2 operation. Any effects which may be incurred are expected to be localized in the Nine Mile Point area only.

5.1.2 Discharge System; Aquatic Impacts

Thermal

The June 1973 FES[1] evaluated the potential effects of a combined once-through cooling discharge of Units 1 and 2 as previously designed (Section 5.5.2c; p. 5-36 to 5-38), and concluded "...thermal discharge effects will be insignificant in terms of ecological relationships in the lake as a whole" (p. ii; 5-38). The design reduction in closed cycle discharge volume (mean of 56.2 cfs for Unit 2 vs 1792 cfs for Units 1 and 2 once-through) and ΔT (mean of 10.5°C of Unit 2 vs >17°C for Units 1 and 2 once-through) should further minimize any potential for impact.

The FES further concluded (p. ii) that significant fish kills due to one reactor shutdown and cold shock would be prevented due to the common two-unit discharge. Under the current proposed design each unit will have a separate discharge, thus the potential for cold shock due to a Unit 2 winter shutdown will be increased in relation to that discussed in the FES. Such occurrences, however, should not result in any measurable impact to fish populations. The thermal effluent from Unit 1 has been shown to attract fishes,[18] but no mortality due to cold shock has been observed (1969-1975).[19] The high exit velocities at the discharge structure (11.3-22.6 fps) should be sufficient to preclude fishes from maintaining a position in the hottest part of the plume. This was also hypothesized to be the case for the offshore discharge at the Davis-Besse Nuclear Power Station on Lake Erie, at an exit velocity of 6.6 fps.[20] High exit velocity, low discharge volume, and rapid mixing of the effluent to meet New York State Standards should minimize impacts upon Lake Ontario fishes.

It should be noted that the closed cycle cooling design meets the New York State requirements for protection of the environment under Section 316(a) of the Clean Water Act.

Chemical

In the original design, chemicals would not be added to the Nine Mile Point Unit 2 once-through circulating and service water system, FES, Section 3.6.[1] However, sodium hydroxide and sulfuric acid would be used for the demineralizer regeneration. Further, ferric sulfate would appear in the clarification waste, and phosphates in the sanitary wastes. These chemicals would eventually be discharged to Lake Ontario.

Additional chemical waste to Lake Ontario consists of intermittent blowdown of solids from the Unit 1 clarifier, backwashings from the pressure and activated carbon filters, and neutralized acid and caustic solutions from ion exchange regeneration cycles. Unit 2 (once-through) would use diatomaceous earth filtration from which there would be no discharge to the lake. Clarifier blowdown from Unit 1, which is discharged in the settling basin, contains ferric hydroxide, calcium carbonate, and suspended material initially present in lake water. Backwashing water used for the filters contains suspended matter and is also discharged to the settling basin and Lake Ontario.

However, with the possible exception of the levels of total dissolved solids and the phosphate concentration in the sewage discharge rivulet, which are near effluent standards, the effluents of Unit 2 (once-through) would conform to all criteria and standards of the State of New York, EPA, and the International Agreement on Great Lakes Quality between the United States and Canada (1972), FES, Section 5.2.1.[1]

The average expected chemicals discharged to Lake Ontario from Unit 2 operating in a closed-cycle cooling mode are shown in Table 5.7. The chemical constituents shown in this table are mainly removed from lake water during the dimineralization process and discharged as part of the regeneration waste. This is not the case for chlorine (Cl^-) which is added as a control from biological fouling and sulfuric acid ($SO_4^=$) added as a control for scaling. However, when these chemicals are added to the circulating water, along with the chemicals originally removed from the lake water, the total dissolved solid (TDS) level would increase by an average of 282%. Hence, the TDS in the station discharge would be significantly increased over ambient by operation of Unit 2 as a closed-cycle cooling system.

Section 9.2 of the FES discusses plant design alternatives and specifically mentions advantages and disadvantages of the closed cycle cooling systems.

With regard to water quality the main disadvantages of the closed cycle cooling system are the following:

1. The cycle of concentration is estimated to be 2 to 2.5 times the once-through discharge levels. That is, the closed cycle system would produce a dissolved solids buildup of about 2.5 times that of the present once-through level. This concentration buildup would be noticed for most water quality parameters.

TABLE 5.7 CHEMICALS DISCHARGED FROM UNIT 2 - CLOSED CYCLE

Ion (or TDS)	Effluent - Unit 2, Closed Cycle: Source of Ion	Pounds/Day	Conc., ppm*	Conc. in Lake Ontario, ppm	Percent Increase
Ca^{++}	Lake water**	11.8	110.0	44.0	250%
Na^{+}	Sodium hydroxide for regeneration	114.9	42.9	17.0	252
Mg^{++}	Lake water**	2.5	22.2	8.9	250
K^{+}	Lake water**	0.5	4.0	1.6	250
Mn^{++}	Lake water**	0.003	.025	0.01	250
Cl^{-}	Lake water**	706.6	103.0	30.0	343
$SO_4^{=}$	Sulfuric acid for regeneration and scale control	23525.3	152.8	30.0	509
HCO_3^{-}	Lake water**	14.7	142.5	57.0	250
$RO4^{\equiv}$	Lake water**	0.057	0.48	0.19	253
NO^{-}_{3}	Lake water**	0.042	0.35	0.14	250
TDS	Lake water**	70.1	582.7	233.0	250

* Calculated by incorporating the 2.5 concentration factor.

** Collected from lake water on ion exchange resins, then released during regeneration.

2. The original once-through design did not require additives to control scaling or algae growth (FES, p. 3-35).[1] However, in the proposed closed cycle cooling system scaling will be controlled by sulfuric acid, with an additional 77 ppm sulfate concentration or 23500 pounds/day in the blowdown (Niagara Mohawk responses to NRC questions dated July 19, 1976).[21] The licensee's response further mentions that algae, fungi, and bacteria growths will be controlled by chlorination. This will produce an additional 28 ppm chloride concentration or 706 pounds/day in the blowdown. It appears that the scaling control agent and the algicide will be used under regulation of the appropriate State and Federal agencies.

3. With the original once-through design for Unit 2, and the combined discharge of both units, the benefit in "in plant" dilution was possible. Now, with the proposed closed cycle cooling system for Unit 2, this benefit is not possible. Hence, without the water volume from Unit 2, the sole discharge of Unit 1 may not be in compliance with certain water quality standards; especially total dissolved solids.

4. The proposed closed cycle cooling system will pump 32,110 gpm of water from Lake Ontario.[21] Niagara Mohawk Power Corporation has estimated that 11,000 gpm will be lost to the atmosphere due to Natural Cooling Tower evaporation. This results in a water consumptive loss due to evaporation of about 34% of the entire water entering Unit 2. The water loss due to evaporation in the original once-through cooling system would be much less, FES Section 3.3.

5. Table 5.7 indicates that TDS in the closed-cycle discharge for Unit 2 would be significantly increased (about 250%) over ambient. This increase could be an issue of possible long-term concern. With Unit 2 operating in a once-through cooling system, the TDS increase over ambient would be less than 1%, FES Section 3.6.[1]

The main advantages of the closed cycle cooling system are the following:

1. The expected plant water use for the closed cycle cooling system is 32,100 gpm, while 535,000 gpm were expected to be used in the once-through cooling system. This indicates that the total plant water use for the proposed closed-cycle cooling system is 6% of the once-through system.

2. Only a fraction of the original circulating cooling water will be discharged as blow-down from Unit 2 operating with a closed cycle cooling system. The once-through cooling system had an expected discharge of 535,000 gpm (1194 cfs). On the other hand, the closed cycle cooling system has an estimated discharge of 21,110 gpm (47 cfs), this would be 3.9% of the original once-through discharge from the station to Lake Ontario. The closed-cycle cooling system discharge is only 3.9% of the once-through circulating discharge. However, the closed cycle cooling system will have a chemical concentration factor of 2.5X.

The expected pounds per day of chemicals added to the lake will be greater with the closed cycle system, Table 5.8. This table indicates that over 24,000 pounds/day or over 44 times more TDS substances will be added to and discharged from

TABLE 5.8 COMPARISON OF CHEMICALS DISCHARGED FROM UNIT 2, ONCE-THROUGH AND CLOSED-CYCLE COOLING SYSTEMS

Substance (Ion or TDS)	Pounds/Day: Once-Through 1194 cfs	Pounds/Day: Closed Cycle 56 cfs
Ca^{++}	11.8	11.8
Na^{+}	114.9[a]	114.9[a]
Mg^{++}	2.5	2.5
K^{+}	0.5	0.5
Mn^{++}	0.003	0.003
Cl^{-}	11.5	11.5[b]
$SO_4^{=}$	240.5[c]	23500[d]
HCO_3^{-}	14.7	14.7
NO_3^{-}	0.042	0.042
Fe^{+++}	96.7[e]	96.7[e]
TDS	70.1	70.1
Chlorine	0	706.6[f]
TOTAL	563.2	24529.3

a - Added as NaOH for regeneration

b - Additional increase due to chlorine use

c - Added as H_2SO_4 for regeneration

d - Added as H_2SO_4 for regeneration and control for scaling

e - Added as $Fe_2(SO_4)_3$ for clarification

f - Most is discharged as chloride ion

the closed cycle than from the once-through cooling system into Lake Ontario. The reduced blowdown in the closed cycle cooling system with the addition of chemicals for scaling and algae control and the expected 2.5 concentration factor, results in a discharge at a higher concentration for closed cycle operation.

The addition of chlorine to control biological fouling within the closed cycle cooling system will be within EPA effluent limitation guidelines (40 CFR 423). These guideline limits require that the average free available chlorine concentration be less than 0.2 mg/l and the maximum be less than 0.5 mg/l. Neither free available nor total residual chlorine will be discharged for more than two hours per day. Most of the added chlorine will be reduced to chloride ion. Based on previous experience, all residual chlorine discharge concentrations should be well within the effluent limitation guidelines. Discharge concentrations at the guideline levels although expected infrequently could be potentially toxic. Dilution and further chemical reduction in the mixing zone should result in concentrations well below toxic levels even when discharging at a free available concentration of 0.5 mg/l.

Also, it cannot be overlooked that some chemical substances will accumulate in the cooling tower basin sludge. Eventually, the towers will be cleaned and the sludge must be disposed.

The chemicals remaining in the sludge could become a terrestrial concern and the disposal of such sludge must be done in a sound manner as to avoid a threat to the environment.

In conclusion, as previously evaluated in the FES, the chemical discharges of the once-through cooling system of Nine Mile Point Unit 2 would pose no environmental threat to the aquatic biota or water quality of Lake Ontario. Even though the closed cycle cooling system would minimize the amount of blowdown entering the lake, but not necessarily the amount of chemicals, it appears that this system would also pose no significant threat to the water quality of Lake Ontario. The chemical discharges from either cooling system would conform to all criteria and standards of the State of New York, EPA, and the International Agreement on Great Lakes Quality between the United States and Canada (1972).

5.1.3 Heat Dissipation Systems; Impacts to Terrestial Ecosystems

The staff reviewed the potential impacts from drift generated from closed cycle cooling systems on terrestrial biota in Section 9 of the FES.[1] It concluded that the postulated values for drift deposition would have negligible impact on the surrounding biota. The applicant has submitted a report[21] on its proposed cooling system design change and additional information[22] in response to staff questions. The purpose of this evaluation is to address in more detail the effects of salt drift from the proposed natural draft tower on the surrounding environment.

The botanical consequences of drift deposition depend on the amounts deposited and on the distribution of salt tolerant and intolerant plant species. It is expected that salt deposition from drift in the amounts expected at Nine Mile Point will not create saline soils and that botanical damage because of soil contamination is unlikely. The only significant pathway for potential botanical injury at the Nine Mile Point site is by direct foliar interception of drift particles from the atmosphere. The difference between the two pathways is important since, if soil contamination were important, it could lead to chronically deteriorating biota over the life of the plant while foliar contamination could result in a series of damaging episodes, which are largely independent of one another. In many such cases, foliar recovery could take place between episodes. The situation would not be a progressively deteriorating one unless the damaging episodes were repeated in sufficiently rapid succession to prevent foliar recovery in the intervals. The applicant has presented both yearly and monthly drift deposition values predicted by a model using onsite meteorological data.[22] The maximum salt deposition rate was calculated to be 0.27 lbs/acre/year, 6750 feet northwest of the proposed tower. The staff believes that thresholds for the appearance of foliar symptoms will not be reached at this rate of salt deposition and, therefore, concludes that no unacceptable botanical injury would result from the operation of the proposed natural draft cooling tower at Nine Mile Point Nuclear Station, Unit 2. The staff, however, believes it is prudent to monitor for verification of the analyses even though serious effects are not expected.

The staff has analyzed data on bird impaction from operating plants located near or along migratory flyways. From the data collected and analyzed, the staff finds no evidence to conclude that cooling towers and meteorological structures present a hazard to bird populations. Specific terrestrial monitoring programs will be determined at the operating license review by the staff.

5.2 Radiological Impacts of Normal Operation

5.2.1 Dose Evaluation for Cooling Tower Operation

The liquid radwaste dose evaluation for NMP-2 was presented in the June 1973 Final Environmental Statement. The evaluation considered the radwaste to be diluted and discharged with the plant cooling water discharge flow of 1788 cubic feet per second (CFS). A change from once-through cooling to the use of a cooling tower will result in less cooling water being discharged and thus less dilution before mixing in Lake Ontario. The dose evaluation for the liquid pathway has therefore been reevaluated and is presented here. The dose via the gaseous pathways will not be significantly affected.

The major differences between this analysis and the one presented in the June 1973 FES are the dilution flows and mixing ratios. This analysis uses a cooling tower discharge flow of 46 cfs instead of 1788 cfs. The mixing ratio (referred to as dilution factor in the FES) for the discharge area was changed from 0.1 to 0.5, and for the nearest drinking water intake was changed from 0.067 to 0.01, to reflect current procedures in use for evaluating doses. The liquid source term from Table 3.5 in the FES was used for this evaluation.

The estimated total body dose commitment to the maximum individual from all pathways due to liquid radwaste releases is calculated to be 0.58 mrem/yr. The estimated dose commitment from all pathways to the maximum organ is calculated to be 0.84 mrem/yr to the bone. These doses are higher than those presented in the FES but are within the guidelines of Section II.A, Appendix I to 10 CFR Part 50, which became effective May 5, 1975, and are therefore acceptable. This analysis was performed using conservative values for the mixing ratios. Lower doses could be calculated by developing more representative mixing ratios, but this was not deemed a necessary effort to demonstrate acceptability of the doses to the maximum individual.

The estimated annual total body dose commitment to the population within 50 miles of the NMP-2 site from all pathways due to liquid radwaste releases is calculated to be 0.12 man-rem/yr. The thyroid dose commitment is calculated to be 1.7 man-rem/yr. These doses are also higher than those presented in the FES, but are cost-beneficial according to Section II-D, Appendix I to 10 CFR Part 50, and are acceptable.

The staff concludes that the change from once through cooling to cooling towers will be acceptable in regard to its effect on radiological dose commitments to individuals and to the population within 80 km of the NMP-2 site.

5.3 Socioeconomic Impacts

5.3.1 Physical

The staff has reviewed the New York State ambient air quality standard for settleable particulates of 0.3 mg/sq cm/mo and concludes that the proposed tower would not contravene this standard.

The staff further concludes that State and Federal primary suspended particulate concentrations will also be met throughout the predicted drift field.

Contributions of moisture from cooling tower operation will be insignificant in comparison to the daily fluctuations in the local moisture regime. The average offsite incremental relative humidity (RH) due to two natural draft towers was calculated to be about 0.02-0.03% (in % RH above ambient RH) for the Indian Point site.[23] The staff, therefore, concludes that these moisture changes are insignificant to the surrounding environment at the Nine Mile Point site.

5.3.2 Social and Economic

In this section, the staff will evaluate four impacts of operating the alternative heat dissipation systems; these impacts are concerned with changes in the visual aesthetic environment, noise, drift and local weather modifications, and tax revenues. As the text below will indicate, the change in the visual aesthetic environment resulting from the operation of an NDCT is an impact that differentiates the dissipation systems.

5.3.2.1 Visual and Aesthetic Impacts

The once-through cooling system does not have any components that are significantly visible and, therefore, would not have visual or aesthetic impacts. However, the operation of an NDCT would have two generalized impacts. The first is related to the physical attributes of the tower itself and its siting in the environment. The second visual impact involves the tower plumes which will have a variable impact apart from the relatively unchangeable impact of the tower. These aspects of impact are discussed as well as an attempt to determine their significance in the human environment.

The applicant is proposing to construct and operate a 536-foot hyperbolic NDCT on the Nine Mile Point site. The cooling tower will be 273 feet across at the lip and approximately 445 feet across at the base.[42] The great bulk and height of the towers can be appreciated if we consider that it will be as tall as a 50-story office building and would be able to support a football field.

Visual Intrusion

Within the local impact area, the tower would be out of proportion with the natural environment. Because of the relatively flat topography and decreasing visibility, the staff considers that a 10-mile viewshed would be appropriate. Approximately 48,500 people will live in the impact area by 1985, one-half in the City of Oswego. It should be mentioned that most people will not be able to view the tower; from many vantage points within the viewshed, the full or partial extent of the tower would be obscured by topography, vegetation, and/or buildings.

The tower will be visible from an extensive area on Lake Ontario and could, in fact, become a navigational landmark. Because of its massive size the tower will eliminate sections of forest background. However, these alterations are part of a transformation of the natural shoreline of the Lake. Completion of three nuclear plants at Nine Mile Point and six fossil-fired plants in Oswego and expansion of Oswego port facilities will successively alter the lake's shoreline.

In contrast to the relatively constant impact of the tower, visible plumes are a variable impact controlled by atmospheric conditions. Several points should be raised when discussing the visible plumes from the NDCT proposed for Nine Mile Point Unit 2. First, the accompanying plume will extend the visibility of the tower as the plumes rise more than 1000 feet under certain circumstances. Thus, the viewshed of the tower and plume is considerably more extensive than the tower's viewshed. Second, the frequency of overhead plumes is inversely related to distance from the cooling tower: as the viewer moves away from the tower, the incidence of a visible plume overhead decreases. Third, the applicant's data indicates that the visible plumes would move beyond the site boundaries and appear overhead for only a small percentage of time during the year. For instance, a visible plume would be overhead in the E-SSE quadrant for less than 10 percent of the winter and spring months. In all other situations overhead plumes would be visible less than five percent of the time. Finally, recognition of cooling tower plumes under conditions of high humidity and/or low cloud cover is difficult as the plumes tend to become indistinguishable from ambient conditions. Also, the difficulty of recognizing visible plume from an NDCT increases with distance from the plume source.

On the basis of the evidence available on visual and aesthetic intrusiveness of alternative cooling systems for the Nine Mile Point Station, the staff would rate the once-through system as being superior to the NDCT. The plume of the NDCT taken alone will be a moderate visual intrusion a large percentage of time and over a large area, although its visibility will depend upon meteorological conditions. In contrast, the operation of a once-through system does not result in a plume. The NDCT structure, which is not only massive in its proportions but also out of proportion with the existing viewscape, will be seen by a small number of residents within a 10-mile radius.

Property Values

The staff investigated the potential for a change in visual quality resulting from an NDCT to have adverse impacts on the local economy, especially the real estate market, land development, historic resources, and recreation. County planners and assessors in each county where an operational nuclear power station with a natural draft tower is located were contacted to determine the nature and extent of impacts that could be attributed to the tall towers.[24] The plants involved are Beaver Valley 1, Davis Besse 1, Rancho Seco, Three Mile Island, and Trojan (see Table 5.9). The staff contacted the relevant public officials for Arkansas One, Unit 2 and Zimmer which are not yet operational, although natural draft cooling towers had been constructed at those sites. Those interviews indicate that reaction to tower visual aesthetics is mixed, with some residents reacting negatively, others positively. In no instance could an assessor indicate that the tower adversely influenced property values or that the community discounted the values of properties because of their location in the tower viewshed. Finally, in no community could the contacted official identify any adverse impacts on land use and development attributable to the tower or the plant itself.

The staff's concludes from these interviews that tall cooling towers have had no discernible adverse impact on community property values. This conclusion does not necessarily mean that some people do not feel that their aesthetic environment had been degraded. Rather, the absence of observed impacts may indicate that, for most people in the communities contacted, other considerations were balanced against a change in aesthetics. The staff assumes that where property tax revenues from the station are gained by the local community, residents decide that such benefits more than compensate for the external costs (aesthetic decline) of the cooling towers.

Land Development

Real estate development decisions are based on numerous considerations; the significance of the visual impact of an NDCT must be evaluated in terms of a specific investment decision. Although the staff recognizes the possibility that a highly visible cooling tower may inhibit the development of uses which are particularly sensitive to visual intrusion and which are proximately located to the towers, this impact should be minimal considering both the low density throughout the impact area and the low potential for growth in the immediate vicinity of the plant. Much of the land adjacent to the site is presently used for agricultural activities. The County land use plan has designated most of the land within the impact area as rural/agricultural, the major exceptions being the areas immediately adjacent to Oswego City, southwestern Volney, and the Villages of Mexico and Pulaski.

A recent study of community change subsequent to the siting of an energy facility indicated that opportunities for growth and development are determined by the area's competitive advantages.[25] This study concluded that the extent to which growth occurs in a community depends upon a variety of factors such as:

TABLE 5.9 Visibility of Natural Draft Cooling Towers at Nuclear Power Stations

Station	County	State	Date of Commercial Operation	Tower Height	Population Within 10 Miles (1970)	Visibility
Davis Besse 1	Ottawa	Ohio	11-20-77	493'	15,528	Tower visible for at least 10 miles.
Arkansas One, Unit 2	Pope	Ark.	[1/]	475'	25,000 (approx.)	Tower visible within 10 mile area.
Rancho Seco	Sacramento	Calif.	4-17-75	425'	6,061	Towers visible within 10 mile area.
Beaver Valley 1	Beaver	Pa.	10-1-76	500'	67,996[2/]	Tower visible for 1.5 miles north and south on river and visible from Town Midland (1.5 miles away).
Trojan	Columbia	Oregon	5-20-76	499'	38,669[3/]	
Three Mile Island 1 & 2	Dauphin	Pa.	9-2-74	370'	124,326[4/]	Four towers visible from limited immediate area but is visible from high points about 5-6 miles away.
Zimmer	Clermont	Ohio	Under Construction	479'	24,073	Tower visible for at least 5 miles along river from hillside houses and Town of Moscow (1/2 mile away).
Nine Mile Point Unit 2	Oswego	N.Y.	Proposed	536'	45,014	Tower will be visible within 10 miles.

Source: Applicants' Environmental Reports and staff comments.

[1/] Unit 1 operational since 12-19-74 with once-through, Unit 2 under construction but tower has been completed at least 2 years.

[2/] Total of 4 population centers within 10 miles of plant: East Liverpool, Ohio; Aliquippa, Pa.; Ambridge, Pa.; Beaver Falls, Pa.

[3/] Total population for Kelso and Longview cities.

[4/] Total population for 10 municipalities within 10-mile radius.

-- Amount of open land available for residential development.

-- Access to regional highways.

-- Commuting access to significant job centers.

-- Proximity to resort/recreational activities of major regional significance.

-- Extent of property tax and service levels before and after construction.

-- Inherent strength and application of land use controls prior to, during, and after construction.

-- Extent of past and expected population migration within and into the county or general area.

-- Type and level of public and private services in the town prior to construction.

-- Extent of the existing and expected real property tax differential (accounting for possible Federal income tax deductions) and service level differential between the nuclear plant town and surrounding town.

-- Need to "import" construction workers from noncommutable distances.

This conclusion is consistent with the conclusion reached in a series of staff interviews with county planners in communities where natural draft towers are located. In those communities, none of the planners could cite the towers as a factor in retarding housing or commercial development. In two of the communities, Sacramento County and Ottawa County, the towers were looked upon by the public as landmarks.

The growth-inducing effects of nuclear power plants arise from their large tax payments to municipalities. Such payments permit beneficiary counties and special districts to implement policies leading toward the improvement of services and facilities, the lowering of taxes, or a combined policy of service improvement and tax reduction. Without counteractive growth control policies, communities can expect to attract an increased increment of regional growth and rising property values, all other considerations being equal.[26] Also, the staff assumes that land development decisions are made soon after a firm decision to construct the power plant. Table 5-10 shows population growth in all communities that host nuclear power stations with closed cycle cooling systems. Although the data do not prove a causal relationship between power plants and growth, the table does indicate two points. First, in all but one situation the host county experiences a population change which parallels the general pattern of population change in the surrounding counties. Second, of the six communities with natural draft towers, three had a higher percentage of population growth

TABLE 5.10 POPULATION CHANGE IN AREAS WITH NUCLEAR POWER STATIONS AND CLOSED CYCLE HEAT DISSIPATION SYSTEMS: 1965-1970 AND 1970-1975

Plant	Location		Year of Operation	Cooling Tower Type	Host County Population Density			Adjacent Counties	Host County Population Density			Adjacent Counties
	County	State			1965	1970	%Change	%Change	1970	1975	%Change	%Change
Beaver Valley 1	Beaver	Pa.	1976	NDCT	204.9	208.7	1.8	0.6	208.7	207.6	-0.5	-3.3
Browns Ferry 3	Limestone	Ala.	1977	(6)MDCT	41.1	41.8	1.7	2.5	41.8	43.5	4.0	2.4
Davis-Besse 1	Ottawa	Ohio	1977	NDCT	34.7	37.1	6.9	4.6	31.1	38.8	4.5	1.3
Duane Arnold	Linn	Iowa	1975	(2)MDCT	152.0	163.6	7.6	3.3	163.6	166.3	1.6	1.9
Farley 1	Houston	Alabama	1977	(3)MDCT	54.4	56.7	4.2	14.7	56.7	69.3	22.2	-0.5
Fort St. Vrain	Weld	Colo.	1974	MDCT	78.0	89.9	15.2	16.3	89.9	107.7	19.8	20.4
Hatch 1	Appling	Ga.	1975	MDCT	12.8	12.8	0	0	12.8	14.4	12.5	7.1
Monticello	Wright	Minn.	1971	(2)MDCT	33.0	39.0	18.1	9.3	39.0	46.7	19.8	20.4
Palisades	Van Burren	Mich.	1971	(2)MDCT	51.6	56.3	9.1	9.4	56.3	62.1	10.3	3.1
Peach Bottom 2/3	York	Pa.	1974	(3)MDCT	257.0	273.1	6.2	8.1	273.1	285.6	4.5	5.1
Prairie Island 1/2	Goodhue	Minn	1974	(4)MDCT	33.2	34.9	5.1	15.2	34.9	37.3	6.8	13.1
Rancho Seco	Sacramento	Calif	1975	(2)MDCT	601.4	634.7	5.5	9.6	634.7	688.0	8.3	6.9
Three Mile Island	Dauphin	Pa.	1974	(4)NDCT	224.4	224.4	0	4.2	224.0	224.2	0	6.0
Trojan	Columbia	Oregon	1976	NDCT	23.6	28.9	22.4	9.6	28.9	31.1	7.6	3.7
Vermont Yankee	Windham	Vt.	1972	(2)MDCT	42.9	44.2	3.0	11.9	44.2	46.1	4.2	9.3
Arkansas One-Unit 2	Pope	Ark	*	NDCT	26.7	28.7	7.4	2.6	28.7	34.1	18.8	10.7

Source: Population figures are from the Bureau of the Census.

*Plant not operational; however, tower had been constructed several years ago.

than their surrounding neighbors in the 1965-1970 period; this number rose to five during the 1970-1975 period. For the 16 plants listed in the table, the host county had a higher percentage change in population for the earlier period than adjacent counties in six instances; during the 1970-1975 period, the number rose to 10.

After reviewing the published studies, available statistical data, and interviews with local planners in communities with natural draft cooling towers, the staff's judgment is that the visual aesthetic impact of the towers will be subordinated to other considerations, notably taxes. Moreover, in the absence of strong growth controls, the competitive advantages of the town which arise from the station will influence the level of development in the impact area and in Oswego County.

Recreation and Historic Resources

Within 10 miles of the tower location are a number of recreational facilities including two state parks, Lake Ontario, and Fallbrook; these facilities are listed in Table 2.7. These facilities offer a variety of activities throughout the year to hikers, campers, beachgoers, fishermen, skiiers, and athletes.

Aesthetic impacts that reduce recreational activity in the impact area could negatively affect jobs, services, income, and the County's sense of well-being. However, research into the relationship between aesthetic perception and recreational activity has not produced conclusive findings. One study has concluded that man-made or man-induced development has a notable effect on the preferences expressed for pictures of outdoor recreation landscapes and that preference varies inversely with the level or extent of that development.[27] Other research has indicated that campers in the Mid-West and beach users in Cape Cod consider the quality of scenery (aesthetics) to be an important determination in selecting a specific facility.[28] Others who have studied outdoor recreation activity suggest that both the level of participation and the motivation for that participation is changing. For instance, among campers, there is a growing segment for whom direct contact with the natural environment is of lesser importance than the social aspects of the camping experience.[29] The staff is not aware of published longitudinal studies that have evaluated changes in the use of recreational facilities subjected to a negative aesthetic impact.

The NRC staff has undertaken an analysis of recreation data from facilities within 10 miles of the following plants: Connecticut Yankee, Vermont Yankee, Maine Yankee, Indian Point (New York), Three Mile Island (Pennsylvania), Cook (Michigan), Brunswick (North Carolina), Millstone Point (Connecticut), San Onofre (California), St. Lucie (Florida), and Zion (Illinois).[30] Specific causal relationships between a facility and tourist and recreational use patterns in the vicinity could not be adequately verified because of the relatively low quality of data and the lack of "control" facilities. The staff depended upon response data gathered through telephone interviews with public officials and businessmen. The interviews served to explain probable causes in attendance fluctuations at state park facilities and describe the uses at each facility.

The staff concluded that, in general, people do not avoid recreational and tourist areas in the vicinity of nuclear power plants to a measurable extent. The staff was able to document instances in which plants might have even enhanced the recreational environment. Several interview respondents noted that warm water discharged from nuclear stations seemed to improve the size of the fish catch and the length of the fishing season. With respect to state park attendance, the staff concluded that the data could not adequately support statements about causality. On the other hand, the subjective judgments of officials and businessmen familiar with tourism and recreational behavior in each locality discounted the possibility that the stations negatively influenced recreational and tourist behavior.

The staff believes that the future of recreational opportunities in the Oswego region will be determined in some measure by their competitiveness with alternate recreational opportunities especially with respect to cost, management, and the quantity and quality of services and facilities offered.[31] The impact which a highly visible cooling tower would have on the quality of the recreational experience and ultimately on the use of facilities is less certain, although the information available to the staff indicates that the adverse impact to recreation resulting from cooling tower aesthetics would be minimal if, in fact, such impact does occur.

Table 2.10 lists the historic resources within the 10-mile impact area. The nearest historic sites are within approximately seven to eight miles of the towers. The staff assumes that the plume will not reach these resources except under the most unusual circumstances. The staff concludes that physical damage to historic resources from tower effluent is highly unlikely. Further, the towers would not directly produce change in the study area that would reduce the enjoyment of these resources. Although visitors may be aware of the presence of the tower, the distance to the tower will not significantly decrease the enjoyment of these resources. The staff does not expect the NDCT to reduce visitation to historic resources in the impact area.

Conclusion on Visual Aesthetic Impact

The staff concludes that the once-through cooling system is less visually intrusive and, therefore, is aesthetically preferred. However, the staff has also presented information which strongly suggests that the visual intrusion and adverse aesthetic impact of the NDCT would not have significance in terms of altering human behavior.

5.3.2.2 Noise

The staff has evaluated noise levels produced by Nine Mile Point Unit 2 with respect to (a) the proposed New York State Noise Code which requires that nighttime sound levels not exceed 45 dBA at a commercial-industrial property line, and (b) threshold differences of 5 dBA above ambient noise levels which is considered the minimum level at which residents would notice a change.

Neither the once-through system nor the NDCT would produce noise contours of 45 dBA at the property boundary. The NDCT, which produces higher noise levels than the once-through system, would impact the Lakeview Road corridor from Lake Ontario to the plant's southern boundary with noise within the 35 to 40 dBA range; other nearby residential areas would be impacted with less than 35 dBA sound levels. With respect to the incremental increase in noise as a result of operating a NDCT, sound increments of 5 dBA or more over ambient would be produced at measurement stations 5 and 6, along Lakeview Road.[32]

Although the NDCT is environmentally acceptable in terms of HUD noise guidelines, the tower noise would produce a greater awareness of plant operation than the once-through system. However, as the number of people living along Lakeview Road or other areas adjacent to the plant boundary is limited, the staff attaches no significance to the noise differentials between the cooling system options.

5.3.2.3 Drift and Local Weather Modifications

The NDCT system will not produce a downwashing of the plume to the ground and, therefore, will neither stimulate nor augment natural fog conditions.[34] Effluent from the NDCT has the potential for causing icing in the vicinity of the tower as a result of water deposition or splashing through of cooling water at the air inlet louvers. The applicant has indicated that icing as a result of deposition would be less than 0.002 inches per year, an amount which is considerably less than ice deposits of a single storm in this area. The applicant concludes that incidents of icing as a result of splashing or blow through would not be of long duration or extensive.[35] The once-through cooling system does not rely primarily on evaporation or heat transfer to the atmosphere; therefore, episodes of fogging should be less frequent than such occurrences from the NDCT.

Induced fog, if it does occur, will tend to occur during periods of relatively low visibility and early in the morning; thus, the intrusion of additional fog will be severely limited. The staff does not expect such episodes to hinder boat or automobile travel. Because of the insignificance of their occurrence, icing and fogging are not an important consideration in the selection of an alternative cooling system.

The applicant's analysis of salt deposition indicates that the maximum amount of salt to be deposited by the NDCT system was predicted to be 0.27 lbs/acre/yr at 6750 feet northwest of the tower; deposition rates for distances closer to the tower are lower, as expected.[36] It should be noted that the maximum deposition rate is well below threshold levels normally associated with damage to vegetation and soil. Maximum water deposition was predicted to be 690.6 lbs/acre/yr (0.0030 inches/yr) occurring 6750 feet northwest of the tower. The staff concludes that the contributions of moisture to the total moisture regime from the NDCT will be insignificant in comparison with daily fluctuations. Neither water or salt deposition provides the basis for differentiating between the cooling system alternatives.

Several studies of plume behavior have indicated that the increase in shadowing caused by visible plumes would be less than 6 percent within 1970 feet; beyond 3300 feet, shadowing effects would be negligible. Using the location of nearby gardens in each sector, the applicant has concluded that the shadowing effects solely due to the plume should not occur. However, on cloudy days, cooling tower plumes may combine with natural cloud conditions to shadow these nearby gardens.[37]

Incidents of light, fluffy snowfall induced by cooling towers have been noted. However, such incidents have been characterized by short duration and by paralleling the trajectory of the visible plume. Further, the impact on agriculture should be negligible as none of the observations occurred during the growing season.[38]

Although drift and weather modifications are characteristic of NDCTs and not once-through cooling systems, the staff concludes that such impacts are without social or economic significance in the Nine Mile Point environment.

5.3.2.4 Tax Revenues

The applicant has not estimated real estate taxes for the once-through cooling system. However, during its operating life, local property taxes would be collected by the Town of Scriba and distributed to: the Town, Oswego County, and the Enlarged City School District of Oswego. The amount to be paid would be determined by the assessment of the improvement and applicable rates established by the tax levying jurisdictions in the Town.

The staff has been informed that the NDCT system might be eligible for tax exemption under the provisions of Section 477 of the New York State Real Property Tax Law.[39] Section 477 holds that the local assessor shall approve the exemption pursuant to his evaluation and certification by state officials that the cooling system is an industrial waste treatment facility. For the purposes of the law, industrial waste treatment facilities shall encompass:

> "...facilities for the treatment, neutralization or stabilization of industrial waste (as the term "industrial waste" is defined in section 17-0105 of the environmental conservation law) from a point immediately preceding the point of such treatment, neutralization or stabilization to the point of disposal, including the necessary pumping and transmitting facilities, but excluding such facilities installed for the primary purpose of salvaging materials which are usable in the manufacturing process or are marketable."

Exemption from local taxation can be granted for a 10-year period during which the percentage of exemption decreases by 10 percent annually. The staff has not uncovered any State property tax provisions that would reduce the local tax burden on a once-through cooling facility.

5.3.2.5 Summary Comparison--Impacts of Alternative Systems on the Human Environment

The staff has evaluated the possible social and economic impacts of operation of two alternative cooling systems for Nine Mile Point Unit 2. In its analysis, the staff has considered the construction and operation of a single NDCT of approximately 540 feet in height and a once-through cooling system. Five areas of potential impacts investigated are visual aesthetics, noise, drift and local weather modification, and tax revenues.

With respect to noise, drift and local weather modifications, the once-through cooling system performed in a more acceptable manner; however, the impacts associated with the NDCT were without socioeconomic significance and are considered environmentally acceptable. Visual aesthetics proved to be the one impact which most clearly differentiated the cooling system alternatives. The once-through alternative would not have components that are visually obtrusive; therefore, adverse aesthetic impact is not possible. On the other hand, the NDCT would represent a visual intrusion over a large viewshed area as a result of a massive tower structure and a variable plume that would be visible a large percentage of the time. Despite this intrusion, the staff concludes that impacts to property values, land development, historic sites, and recreation will be minimal.

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24. The following persons were contacted by telephone:

Arkansas One, Unit 2 - Judge Ermil Grant, Pope County Judge (Telephone conversation on 2-3-78); Stanford Lee, Pope County Assessor (2-8-78). Beaver Valley 1 - Michael Van Doren, Chief Assessor of Beaver County (2-2-78), Edward Blanarike, Assistant Director of Planning of Beaver County (2-2-78). Three Mile Island - Bill Collins, Appraisal Consultant in County Assessors Office (2-2-78); James Zeiter, Staff Planner of the Tri-County Regional

Planning Commission (2-2-78). Rancho Seco - Emmeron Wallner, Sacramento County Assessors Office (2-2-78); Stewart Wilson, Sacramento County Planning Department (2-2-78). Davis Besse - Walter Wehenkel, Assistant Director, Regional Planning Commission (2-2-78); Don Zucker, Ottawa County Appraiser (2-3-78). Trojan - Henry T. Hudson, Columbia County Assessors Office (2-3-78); Don Ludroot, Acting Planning Director of Columbia County (2-3-78).

25. Harbridge House, Inc., The Social and Economic Impact of a Nuclear Plant Upon Montague, Massachusetts, and the Surrounding Area (Boston: Harbridge House, 1974), pp. I-7 and I-8.

26. Wallace E. Oates, "The Effects of Property Taxes and Local Public Spending on Property Values: An Empirical Study of Tax Capitalization and the Tiebout Hypothesis," Journal of Political Economy, November/December, 1969, pp. 957-71.

27. E. Glenn Carls, "The Effects of People and Man-Induced Conditions on Preferences for Outdoor Recreation Landscapes," Journal of Leisure Research, Vol. 6, No. 1, Winter 1974, pp. 237-50.

28. Charles E. Taylor, and Douglas M. Knudson, "Area Preferences of Midwestern Campers," Journal of Leisure Research, Vol. 5 No. 2, Spring 1973, pp. 39-48, and Richard D. Hecock, "Recreation Behavior Patterns as Related to Site Characteristics of Beaches," Journal of Leisure Research, Vol. 2, No. 4, Fall 1970, pp. 237-50.

29. Roger N. Clark, John C. Hendee, and Frederick L. Campbell, "Values, Behavior, and Conflict in Modern Camping Culture," Journal of Leisure Research, Vol. 3, No. 3, Summer 1971, pp. 143-59.

30. Draft manuscript by Ellen Aronson of the NRC.

31. Warren E. Johnston, and Gary H. Elsner, "Variability in Use Among Ski Areas: A Statistical Study of the California Market Region," Journal of Leisure Research, Vol. 4, No. 1, Winter 1972, pp. 43-9. See also the Taylor and Hecock articles referenced above.

32. Niagara Mohawk Power Corporation, Report on Circulating Water Cooling System Employing a Natural Draft Cooling Tower: Nine Mile Point Nuclear Station Unit 2, July 1976, Docket No. 50-410, Figs. 13, 14, and 15, and Table 1.

33. Ibid., Table 1, and Figure 13.

34. Ibid., pp. 9 and 10.

35. Ibid., p. 11.

36. Niagara Mohawk Power Corporation, "Responses to NRC Requests Dated April 22, 1977, For Additional Information Regarding the Proposed Cooling System Design Change," September 30, 1977, Docket No. 50-410, p. 4-1 and Fig. R4-1.

37. Ibid., p. 8-1.

38. Ibid., p. 8-2.

39. Telephone communication with Thomas Quinn, Bureau of Energy Waste Coordination, N.Y.S. Department of Environmental Conservation, on March 9, 1978 and McKinney's Consolidated Laws of New York, Vol. 49A, Section 477, pp. 216-17.

40. U.S. Nuclear Regulatory Commission. September 1978. Environmental Impact Appraisal by the Office of Nuclear Reactor Regulation Supporting Amendment No. 29 to Facility License No. DPR-63, Niagara Mohawk Power Corporation, Nine Mile Point Nuclear Station, Unit 1. Docket No. 50-220. Washington, D.C.

41. U.S. Nuclear Regulatory Commission. March 1979. Environmental Impact Appraisal by the Office of Nuclear Reactor Regulation Supporing Amendment No. 46 to Facility License No. DPR-59, Power Authority of the State of New York, Fitzpatrick Nuclear Power Plant. Docket No. 50-333. Washington, D.C.

42. Niagara Mohawk Power Corporation, Responses to NRC Requests for Additional Information, November 21, 1980.
Docket No. 50-410

6 ECONOMIC EVALUATION

Nine Mile Point Unit 2 is a nuclear fueled boiling water reactor supplying steam to a turbine generator rated at a nominal 3,323 MWt and approximately 1,100 MWe net. The ultimate expected capability is 3,489 MWt and 1,150 MWe net. Commercial operation is planned for the second quarter of 1986 to meet predicted system electrical power demands.

In the FES Section 9.2 a once-through condenser cooling system was selected because it was concluded after extensive evaluation that this type of system best balanced economic generation of power with proper concern for environmental protection. Other cooling methods considered in detail were a natural draft cooling tower system, a mechanical draft cooling tower system, and a cooling pond system. A dry cooling tower, a spray pond, and supplementary cooling were discussed and rejected as being less desirable alternatives.

Recent U. S. Environmental Protection Agency effluent guides require applicants to demonstrate that no harm will occur to the aquatic community of the receiving water body as a result of operating a once-through system.[1] Niagara Mohawk has modified the Unit 2 design to incorporate a natural draft cooling tower (NDCT), a system which conforms to the best technology economically available as required by the Environmental Protection Agency. The estimated cost differential associated with incorporating this system is summarized in Table 6.1 and the details are discussed in following paragraphs.

The overall cost of the NDCT system is estimated to be $19,421,000 more in 1975 than the once-through system. Based on a 19% fixed charge rate and 70% capacity factor this would increase the cost of generating electricity about 0.52 mills/kWh. (Note that the dollar estimates that follow are based on 1975 costs.)

6.1 Expenditures Previously Committed to the Once-Through System

A. The engineering and design work completed, which was abandoned with the adoption of cooling towers, is estimated to have cost $495,000.

B. The model studies completed to prove that the once-through discharge complies with thermal criteria set forth by the NYDEC have cost $563,000.

6.2 Direct Cost Differential

The once-through system is slightly more costly to build than the NDCT because of increased water flow which results in larger structures and equipment and the requirements for fish diversion. The closed loop system requires the additional cost of the NDCT. Table 6.2 presents the comparison of direct cost of once-through versus NDCT.

TABLE 6.1 Summary of Differential Cost of Once-Through Versus Cooling Tower

• Expenditures Previously Committed		
	A. Engineering & Design Services	$ 495,000
	B. Once-through Thermal Discharge Model Studies	563,000
	TOTAL	$1,058,000
• Direct Cost Differential		($ 712,000)
• Engineering Services Cost Differential		$ 142,000
• Operational Cost Penalties (Capitalized)		$18,933,000
		$19,421,000

TABLE 6.2 Direct Cost Comparison of Once-Through Versus Closed Loop Cooling System-Estimate (D)

	Once-Through	Closed Loop (B,C)
Chemical Treatment System	$ NA	$ 425,000
Circulating Water System, Intake and Discharge Tunnel, Screenwell	41,004,000 (A)	53,058,000 (E)
Intake Structure (Structural Cost)	9,040,000	940,000
Intake Structure (Equipment and Piping	392,000	15,000
Special Screens for Fish Removal	432,000	144,000
Piping and Fish Removal Equipment in Screenwell	86,000	86,000
Fish Diversion-Motive Force Pumps	235,000	29,000
Booster Pump House @ Unit 1	1,280,000	NA
Piping (650 ft. of 120 in. Pipe)	600,000	NA
Tunnel (Add 200 ft. to Unit 2 Tunnel)	300,000	NA
Larger Diffuser Tunnel With Additional Risers	2,000,000	NA
Cooling Tower Discharge Structure Model Study	NA	50,000
Totals	$55,459,000	$54,747,000

Notes:

A. "Once-Through Cooling" design includes offshore fish diversion and screenwell fish diversion.

B. Cooling Tower based on 16 degree approach 27 degree range, natural draft tower.

C. "Closed Loop Cooling" design includes screenwell fish diversion.

D. All costs for equipment and structures are September 15, 1975, direct costs only.

E. Includes cost of cooling tower (approximately $16,000,000).

TABLE 6.3 Operational Cost Penalties Associated with Closed-Loop Cooling System-Estimate

Differential capitalized fuel costs	$ 3,377,000
Differential capability cost (yearly avg.)	15,286,000
Differential capability due to fish removal energy	(730,000)
Capitalized cost of additives over life of plant	1,000,000
Total	$18,933,000

Notes:

A. Fuel Cost based on $24,085/Btu of unit heat rate.

B. Capability cost based on $990/kw.

C. "Once-Through Cooling" design includes offshore fish diversion and screenwell fish diversion.

D. "Closed Loop Cooling" design includes screenwell fish diversion.

6.3 Engineering Services Cost Differential

The earlier effort on once-through design is conceptually complete as is the present closed loop design, and the estimate to complete either system as of April 1, 1976, differs by only $142,000 additional for once-through design.

6.4 Operational Cost Penalties

The differential operating costs associated with the cooling tower, as compared to once-through cooling over the life of plant, are $18,933,000 as outlined in Table 6.3.

References to Section 6

1. U.S. Environmental Protection Agency, "Effluent Guides and Standards for the Steam Electric Power Generating Point Source Category," 40 CFR 42, October 1974.

APPENDIX H

NINE MILE POINT 2 RELEASE CATEGORIES USED IN CONSEQUENCE ANALYSIS

APPENDIX H

NINE MILE POINT 2 RELEASE CATEGORIES USED IN CONSEQUENCE ANALYSIS

The release categories used in this consequence analysis are a subset of those used for the Limerick consequence analysis (NUREG-0974). This choice was based on (1) the design similarities between Nine Mile Point Unit 2 (NMP-2) and Limerick 1 or 2 and (2) the fact that indepth probabilistic risk analyses (PRAs) were performed by the Limerick applicant and reviewed by the staff. To account for differences between NMP-2 and Limerick, the staff adjusted the probabilities for some of the release categories and dropped others.

The release categories selected for NMP-2 are discussed below. The differences in the probabilities used for this study and those used for Limerick are also discussed. A more detailed description of the methodology used in determining the magnitudes of releases is given in NUREG-0974, Appendix H. Externally initiated accidents were included in the Limerick study, but not in this study of NMP-2. Otherwise, the methodology described in NUREG-0974, Appendix H applies to NMP-2.

Table H.1 is a description of the plant damage states used in this study. Each plant damage state will lead to one or more release categories, based on the location of containment failure (see Table H.2). Each release category is described in Table H.3.

References

Papazoglou, I. A., et al., "Review of Limerick Generating Station Probabilistic Risk Assessment," U.S. Nuclear Regulatory Commission, NUREG/CR-3028, February 1983.

U.S. Nuclear Regulatory Commission, "Final Environmental Statement related to the operation of Limerick Generating Station, Units 1 and 2," NUREG-0974, April 1984.

Table H.1 Description of damage states

Designator	Description
I-S	These are LOCA (loss-of-coolant accident)-initiated sequences (medium and small pipe breaks only) involving loss-of-coolant inventory makeup. They would result in a relatively fast core melt, with the containment intact at the time of core melt.
I-T	These are sequences initiated by transient events* involving loss-of-coolant inventory makeup. Core melt is expected to be relatively fast and the containment to be intact at the time of core melt.
II-T	These are transient- or LOCA-intiated sequences involving loss of containment heat removal or inadvertent steam relief valve opening accidents with inadequate heat removal capability. Core melt is expected to be relatively slow as a result of the lower decay power level, with the containment failing before core melt.
III-T	These sequences are transients involving loss of scram (fast shut-down of reactor) function and inability to provide coolant makeup, large LOCAs with insufficient coolant makeup, transients with loss of heat removal, and long-term loss-of-coolant inventory makeup. Core melt is expected to be relatively fast, and the containment intact at core melt. For NMP-2, all the release categories in this damage state were assigned a higher probability than for Limerick, based on site-specific differences in the estimated probability of anticipated transients without scram.
IV-T	These sequences are transients that involve loss of scram function and a loss of containment heat removal or all reactivity control, but with coolant makeup capability. Core melt is expected to be relatively fast with the containment failing before core melt because of overpressure. As for III-T above, the release categories in this group were assigned a higher probability than for Limerick.
IV-A	As above but initiated by large LOCAs.
S-H2O	These sequences are seismically induced reactor vessel failures (plus random reactor-vessel failure), coupled with immediate containment failure. Core melt is fast, with the vessel and containment both failed at the time of core melt. This sequence assumes the vessel break is high, which would allow water to be retained in the bottom of the vessel before core slump.

*See next page for footnote.

Table H.1 (Continued)

Designator	Description
S-$\overline{H20}$	As above, but with a vessel failure location that results in complete draining of the water from the vessel.

*In general, the term reactor transient applies to any significant deviation from the normal operating values of any of the key reactor operating parameters. More specifically, transient events can be assumed to include all those situations (except for the LOCA, which is treated separately) that could lead to fuel heat imbalances. When viewed in this way, transients cover the reactor in its shutdown condition as well as in its various operating conditions. The shutdown condition is important in the consideration of transients because many transient conditions result in shutdown of the reactor, and decay heat removal systems are needed to prevent fuel heat imbalances as a result of core decay heat.

Transients may occur as a consequence of an operator error or the malfunction or failure of equipment. Many transients are handled by the reactor control system, which would return the reactor to its normal operating condition. Others would be beyond the capability of the reactor control system and would require reactor shutdown by the reactor protection system to avoid damage to the reactor fuel.

In safety analyses, the principal areas of interest are increases in reactor core power (heat generation), decreases in coolant flow (heat removal), and increases in reactor coolant system (RCS) pressure. Any of these could potentially result from a malfunction or failure, and they represent a potential for damage to the reactor core and/or the pressure boundary of the RCS. The analysis of reactor transients has been directed at identifying those malfunctions or failures that can cause core melting or rupture of the RCS pressure boundary. Regardless of the way in which transients might cause core melting, the consequences are essentially the same; that is, the molten core would be inside the containment and would follow the same course of events as a molten core that might result from a LOCA.

Each potential transient is assessed to fall into either one of two general categories, the anticipated (likely) transients and the unanticipated (unlikely) transients. The most probable group of potential transients are those that have become commonly known as anticipated transients. All other transients are considered to fall into the unanticipated transients category. The relatively low probability (unanticipated) transients can be eliminated from the risk determination because their potential contribution to risk is small compared to that of the more likely (anticipated) transients that would produce the same consequences.

The anticipated transient initiators for which successful reactor scram could be accomplished have been divided into five groups for this analysis. These groups are

Table H.1 (Continued)

(1) transients resulting in turbine trip
(2) transients leading to isolation of the reactor vessel from the main condenser, a main steamline isolation valve (MSIV) closure, and loss of feedwater
(3) transients resulting from loss of offsite power
(4) transients resulting from inadvertent open relief valve (IORV)
(5) orderly and controlled manual shutdown

Thirty-seven BWR transients identified from operating experience data are listed in Table 2.9 of NUREG/CR-3028 (Papazoglou, 1983) and are included in the first four of the above groups. If the reactor protection system fails to scram the reactor after an initiating event in any of the first four transient groups, then an anticipated transient without scram (ATWS) condition results. The following four groups of ATWS initiators were, therefore, considered:

(1) turbine trip ATWS
(2) MSIV closure ATWS
(3) loss of offsite power ATWS
(4) IORV ATWS

Table H.2 Containment failure mode and release path notation

Designator	Description
DW	Containment failure via overpressurization. Failure location in the drywell.
WW	Containment failure via overpressurization. Failure location in the wetwell above the suppression pool.
$\overline{WW}$	Containment failure via overpressurization. Failure location in the wetwell below the suppression pool resulting in loss of suppression pool water.
SE	Failure via in-vessel steam explosion-generated missiles.
HB	Failure via hydrogen burning during the periods when the containment atmosphere is de-inerted. This failure mode also includes hydrogen detonation and ex-vessel steam explosion failure modes, which are of very low frequency.
LGT	Containment leakage rates sufficiently low to allow the standby gas treatment system (SGTS) to operate effectively.
$\overline{LGT}$	Containment leakage rates so high that the SGTS is ineffective.

Table H.3 Description of the release categories

Category	Description
1. RELEASE CATEGORIES ASSOCIATED WITH DAMAGE STATE I-T	The damage state I-T is defined in Table H.1 and basically consists of transients with loss-of-coolant inventory makeup. Core melt in such situations is expected to be relatively fast and occurs within an intact containment. After vessel failure, the majority of the core materials are retained on the diaphragm floor below the reactor vessel. Containment failure occurs via gradual overpressurization (except for SE, HB, LGT and LGT release -- see Table H.2) several hours after vessel failure as a result of core/concrete interactions.
I-T/DW	This release category assumes an overpressure failure in the drywell wall. The gap and melt releases would be directed to the suppression pool and subjected to a DF of 100 (water is subcooled) before they reach the wetwell airspace. The vaporization release would be directed to the drywell without any pool scrubbing. All fission products in the drywell and wetwell would be subjected to agglomeration and settling as predicted by the CORRAL code, before containment failure (which occurs several hours after the pressure vessel failure).
I-T/WW	This release category assumes a failure in the wetwell above the suppression pool. The gap, melt, and vaporization releases would be released to the drywell and wetwell as described above. The only difference is that when the containment fails, fission products in the drywell must pass through the downcomers and suppression pool before they are released to the atmosphere.

Table H.3 (Continued)

Category	Description
I-T/$\overline{WW}$	This release category assumes a failure in the wetwell below the suppression pool, which drains the water. The gap, melt, and vaporization releases would be released to the containment as described above. The only difference is that at containment failure the suppression pool would be drained so that fission products in the drywell no longer have to pass through the suppression pool (as in the I-T/WW release path) before they are released to atmosphere.
I-T/SE	This release category results from an in-vessel steam explosion-generated missile. All release categories involving a steam explosion were judged to be so unlikely for NMP-2 that they would make only a negligible contribution to risk.
I-T/HB	This release category could result from hydrogen burn failures during the time when the containment atmosphere is deinerted. BNL used the same release category as in the LGS-PRA, but reduced the core fraction associated with the oxidation releases in a manner consistent with WASH-1400. (Note in the LGS-PRA, this release category was representative of ex-vessel steam explosions.)
I-T/LGT and I-T/$\overline{LGT}$	These release categories result from containment leakage and assume that the SGTS operates (LGT), or that it does not operate ($\overline{LGT}$). BNL used the LGS-PRA releases, but changed the timing to correspond to the BNL MARCH analysis.
2. RELEASE CATEGORIES ASSOCIATED WITH DAMAGE STATE II-T	The damage state II-T is defined in Table H.1 and basically assumes loss of containment heat removal. Eventually, the containment would fail and cause the loss of inventory makeup. As the containment would fail prior to core melt and the suppression pool is saturated (DF of 1), the location of containment failure (DW, WW or $\overline{WW}$ -- see Table H.2) is of rather less importance than it is for the I-T damage states.

Table H.3 (Continued)

Category	Description
II-T/WW	This release category assumes a failure in the wetwell above the suppression pool. The melt release would be directed to the suppression pool, but would not be subjected to pool decontamination because the water would be saturated. The vaporization release would be directed to the drywell, then through the downcomers to the wetwell air space, and finally to the atmosphere. This one failure location was also used to represent failures in the drywell (DW) and wetwell below the suppression pool ($\overline{WW}$). This assumption is reasonable because, as the pool is saturated, the different flow paths would not result in significant differences in calculated release fractions (see IV-T below).
3. RELEASE CATEGORIES ASSOCIATED WITH DAMAGE STATE III-T	The damage state III-T corresponds to a transient event coupled with loss of scram function (see Table H.1). Core melt would be rapid and into an intact containment. Containment failure is predicted to occur after vessel failure as a result of overpressurization. However, the suppression pool would be saturated so that the gap, melt, and vaporization releases would not be subjected to decontamination by the pool. Consequently, again (as for the II-T damage state) one failure location was used to represent the three potential locations.
III-T/WW	This release category is similar to the I-T/WW sequence; however, because the pool is saturated, the melt release would not be subjected to pool scrubbing.
III-T/HB, III-T/LGT and III-T/$\overline{LGT}$	These release categories are also considdered as possible and would be similar to I-T/HB, I-T/LGT and I-T/$\overline{LGT}$, respectively.

Table H.3 (Continued)

Category	Description
4. RELEASE CATEGORIES ASSOCIATED WITH DAMAGE STATE IV-T	The damage state IV-T is defined in Table H.1 and essentially consists of ATWS sequences in which continued coolant makeup was postulated to result in overpressurization failure of the containment before core melt. The suppression pool would be saturated for these sequences and hence the DF would be unity.
IV-T/DW, IV-T/WW and IV-T/$\overline{\text{WW}}$	For these release categories, the impacts of the three potential failure locations (DW, WW, and $\overline{\text{WW}}$) were analyzed. Because of the saturated pool, similar release fractions were estimated. These calculations support the use of only one failure location for the II-T and III-T damage states. The release paths (DW, WW, and $\overline{\text{WW}}$) for the three locations are discussed in detail above.
5. RELEASE CATEGORIES ASSOCIATED WITH DAMAGE STATES I-S AND IV-A	The damage states I-S and IV-A are defined in Table H.1 and correspond to LOCA-initiated sequences. They were calculated to have a low frequency but, because of differences in flow paths relative to transients, were analyzed separately.
I-S/DW	This release category would result in the release of the melt and vaporization releases to the drywell, thus bypassing pool scrubbing. However, because the containment would fail several hours after vessel failure, the release fractions are not significantly different from the I-T/DW flow path (in which the gap and melt releases were subjected to suppression pool scrubbing.)
IV-A/DW	This release category is similar to IV-T/DW except that the initiating event is a large LOCA.

Table H.3 (Continued)

Category	Description
6. RELEASE CATEGORIES ASSOCIATED WITH SURROGATE DAMAGE STATES S-H20 AND S-$\overline{\text{H20}}$	The damage states S-H20 and S-H20 are defined in Table H.1; they also would be earthquake induced. The RHR suction lines would be severed, but the vessel also could fail at the start of the accident. Thus, the core would melt into a failed containment and none of the releases would be subjected to pool scrubbing. The only differences between the S-H20 and S-$\overline{\text{H20}}$ sequences relate to the location of possible failure in the vessel. For the S-H20 sequence, water would remain in the vessel and be available for interacting with core debris as slumping occurs. This would affect movement of the fission products and allow the potential for an in-vessel steam explosion. The S-$\overline{\text{H20}}$ damage state involves a failure of the vessel so that the water would be completely drained at the start of the accident. Thus, there would be no in-vessel debris/water interaction and no potential for an in-vessel steam explosion.
S-H20/$\overline{\text{WW}}$ and S-$\overline{\text{H20}}$/$\overline{\text{WW}}$	These release categories are considered possible. Assignment of $\overline{\text{WW}}$ failure mode to damage states S-H20 and S-$\overline{\text{H20}}$ relates only to similarity of fission product release path and lack of suppression pool scrubbing, rather than the actual failure location.

APPENDIX I

CONSEQUENCE MODELING CONSIDERATIONS

APPENDIX I

CONSEQUENCE MODELING CONSIDERATIONS

I.1 Evacuation Model

"Evacuation," used in the context of offsite emergency response in the event of a substantial amount of radioactivity release to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation," which denotes a post-accident response to reduce exposure from long-term ground contamination after plume passage. The reactor safety study (RSS) (NUREG/75/014, originally WASH-1400) consequence model provides for incorporating radiological consequence reduction benefits of public evacuation. The benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in a reduction of early health effects associated with early exposure; namely, in the number of cases of early fatality (see Section I.2) and acute radiation sickness that would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400 as well as in NUREG-0340 and NUREG/CR-2300. The evacuation model that has been used herein is a modified version of the RSS model (Sandia, 1978) and is, to a certain extent, site-emergency-planning oriented. The modified version is briefly outlined below.

The model uses a circular area with a specified radius (the 16-km (10-mile) plume exposure pathway emergency planning zone (EPZ)), with the reactor at the center. It is assumed that people living within portions of this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactivity to the atmosphere.

Significant atmospheric releases of radioactivity would in general be preceded by one or more hours of warning time (postulated as the time interval between the awareness of impending core melt and the beginning of the release of radioactivity from the containment building). This warning time is given for each release category in Table 5.8. For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor) within the circular zone with the downwind direction as its median--that is, those people who would potentially be under the radioactive cloud that would develop following the release--would leave their residences after lapse of a specified amount of delay time* and then evacuate. The delay time is reckoned from the beginning of the warning time and is recognized as the sum of the time required by the reactor operators to notify the responsible authorities; the time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate; and the time required for the people to mobilize and get under way.

*Assumed to be a constant value, 1.77 hours, that would be the same for all evacuees.

The model assumes that each evacuee would move radially outward* away from the reactor with an average effective speed** (obtained by dividing the zone radius by the average time taken to clear the zone after the delay time) over a fixed distance from the evacuee's starting point. This travel distance is selected to be 24 km (15 miles), which is 8 km (5 miles) more than the 16-km (10-mile) plume exposure pathway EPZ radius. After reaching the end of the travel distance, the evacuee is assumed to receive no further radiation exposure.

The model incorporates a finite length of the radioactive cloud in the downwind direction that would be determined by the product of the duration over which the atmospheric release would take place and the average windspeed during the release. It is assumed that the front and back of the cloud would move with an equal speed that would be the same as the prevailing windspeed; therefore, its length would remain constant at its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time were less than the warning time, then all evacuees would have a head start; that is, the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time were more than the warning time, then depending on initial locations of the evacuees there are possibilities that (1) an evacuee would still have a head start, or (2) the cloud would already be overhead when an evacuee starts to leave, or (3) an evacuee would be initially trailing behind the cloud. However, this initial picture of cloud/people disposition would change as the evacuees travel, depending on the relative speed and positions between the cloud and people. The cloud and an evacuee might overtake one another one or more times before the evacuee would reach his/her destination. In the model, the radial position of an evacuating person, either stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclides would be deposited continually from the cloud as it passed a given location, a person who is under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the model assumes that persons are: (1) exposed to the total ground contamination concentration that is calculated to exist after complete passage of the cloud, after they are completely passed by the cloud; (2) exposed to one-half the calculated concentration when anywhere under the cloud; and (3) not exposed when they are in front of the cloud. Different values of the shielding protection factors for exposures from airborne radioactivity and ground contamination have been used.

Results shown in Section 5.9.4.5 of the main body of this environmental statement for accidents involving significant release of radioactivity to the atmosphere were based upon the assumption that all people within the 16-km (10-mile) plume exposure pathway EPZ would evacuate according to the evacuation scenario

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*In the RSS consequence model, the radioactive cloud is assumed to travel radially outward only, spreading out as it moves away.

**Assumed to be a constant value 0.47 meters per second (1.05 mph), that would be the same for all evacuees.

described above. For some public or private institutions (nursing homes, etc.) not all persons may be quickly evacuated. However, it is not expected that detailed modeling of any such facility near a specific plant site would significantly alter the conclusions, because the sheltering these facilities provide would mitigate the doses more than is assumed in CRAC. For the delay time before evacuation, a value of 1.77 hours was used. The staff believes that such a value appropriately reflects the Commission's emergency planning requirements. The applicant has provided estimates of the time required to clear the 16-km (10-mile) zone (see Parsons, et al., 1981).

From these estimates, the staff has conservatively estimated the effective evacuation speed to be 0.47 meter per second (1.05 mph). It is realistic to expect that the authorities would aid and encourage evacuation at distances from the site where exposures above the threshold for causing early fatalities could be reached regardless of the EPZ distance. The potential benefits of this were not calculated, however. As an additional emergency measure for the NMP-2 site, it was also assumed that all people beyond the evacuation distance who would be exposed to the contaminated ground would be relocated after passage of the plume. A modification of the RSS consequence model was used, which incorporates the assumption that if the projected ground dose to the total marrow over a 7-day period would exceed 200 rems, then this high dose rate would be detected by actual field measurements following plume passage, and people from these regions would be relocated immediately. For this situation the model limits the period of ground dose calculation to 12 hours; otherwise, the period of ground exposure is limited to 7 days for calculation of early dose.

Figure I.1 shows the early fatalities for a pessimistic case for which no early evacuation is assumed, and all persons are assumed to be exposed for the first 24 hours following an accident and are then relocated. These results can be compared to the more realistic results shown in Figure 5.8.

The CRAC model has the same provision for calculation of the economic cost associated with implementation of evacuation as the original RSS model. For this purpose, the model assumes that for atmospheric releases of durations of 3 hours or less, all people living within a circular area of 8-km (5-mile) radius centered at the reactor plus all people within a 45° angular sector within the plume exposure pathway EPZ and centered on the downwind direction will be evacuated and temporarily relocated. However, if the duration of release were to exceed 3 hours, the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would be evacuated and temporarily relocated. For either of these situations, the cost of evacuation and relocation is assumed to be $225 (1980 dollars) per person, which includes cost of food and temporary sheltering for a period of 1 week.

I.2 Early Health Effects Model

The medical advisors to the RSS (WASH-1400, Appendix IV, Section 9.2.2 and Appendix F) proposed three alternative dose-mortality relationships that can be used to estimate the number of early fatalities that might result in an exposed population. These alternatives characterize different degrees of post-exposure medical treatment from "minimal," to "supportive," to "herioc"; they are more fully described in NUREG-0340. There is uncertainty associated with the mortality relationships (NUREG/CR-3185) and the availability and effectiveness of different classes of medical treatment (Elliot, 1982).

The calculative estimates of the early fatality risks presented in the text of Section 5.9.4.5(3) of the main body of this report and in Section I.1 of this appendix used the dose-mortality relationship that is based upon the supportive treatment alternative. This implies the availability of medical care facilities and services that are designed for radiation victims, for those exposed in excess of 170 rems, the approximate level above which the medical advisors to the RSS recommended more than minimum medical care to reduce early fatality risks. At the extreme low probability end of the spectrum (i.e., at the one chance in 10 million per reactor-year level), the number of persons involved might exceed the capacity of facilities that provide the best such services, in which case the number of early fatalities might have been underestimated. To gain perspective on this element of uncertainty, the staff has also performed calculations using the most pessimistic dose-mortality relationship based upon the RSS medical expert's estimated dose-mortality relationship for minimal medical treatment and using identical assumptions regarding early evacuation and early relocation as made in Section 5.9.4.5(3). This shows an overall 2 to 3-fold increase in annual risk of early fatalities (see Table 5.12). The major fraction of the increased risk of early fatality in the absence of supportive medical treatment would occur within 16 km (10 miles), and virtually all would be within 48 km (30 miles) of the NMP-2 site. However, the hospitals now in the U.S. are likely to be able to supply considerably better care to radiation victims than the medical care on which the minimal medical treatment relationship is based. Further, a major reactor accident at NMP-2 would certainly cause a mobilization of such medical services with a high national priority to save the lives of radiation victims. Therefore, the staff expects that the mortality risks would be less then those indicated by the RSS description of minimal treatment (and much less, of course, for those who will be given the type of treatment defined as "supportive"). For these reasons, the staff has concluded that the early fatality risk estimates are bounded by the range of uncertainties discussed in Section 5.9.4.5(7).

I.3 References

Elliot, D. A., Andrulis Research Corp., Task 5 letter report on Technical Assistance Contract No. NRC-03-82-128, to A. Chu, NRC, December 13, 1982.

Parsons, Brinckerhoff, Quade, and Douglas, Inc., "Evacuation Time Estimates for Areas Near the Site of Salem and Hope Creek Nuclear Generating Stations," report prepared for Public Service Electric & Gas Company, February 1981.

Sandia Laboratories, "A Model of Public Evacuation for Atmospheric Radiological Releases," SAND 78-0092, June 1978.

U.S. Nuclear Regulatory Commission, NUREG-75/014 (WASH-1400), "Reactor Safety Study," October 1975.

---, NUREG-0340, "Overview of the Reactor Safety Study Consequences Model," October 1977.

---, NUREG/CR-3185, "Critical Review of the Reactor Safety Study Radiological Health Effects Model," March 1983.

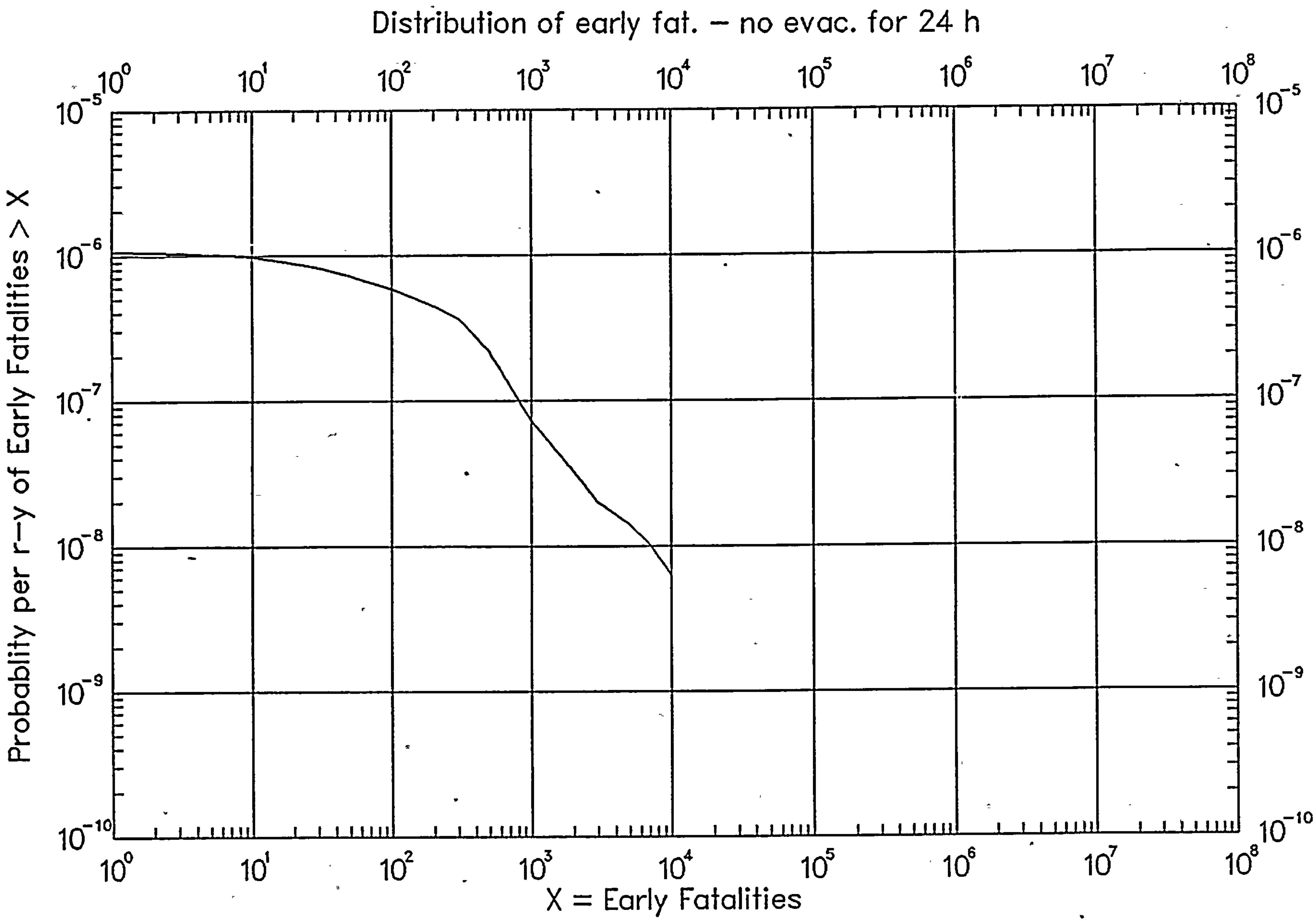

Figure I.1 Sensitivity of early fatalities to evacuation characteristics

NOTE: See Section 5.9.4.5(7) for a discussion of uncertainties.

APPENDIX J

FISHERY HARVEST ESTIMATES FOR LAKE ONTARIO
(NINE MILE POINT)

APRIL 30, 1984

Prepared for the NRC staff by
Richard B. McLean, Ph.D.
Oak Ridge National Laboratory

APPENDIX J

FISH HARVEST ESTIMATES FOR LAKE ONTARIO

(Nine Mile Point)

Nine Mile Point Units 2 and 3 will be located on the south shore of Lake Ontario in the Town of Scriba, Oswego County, New York. The fisheries yield of Lake Ontario has steadily and, at times, dramatically declined since white men came into the region. The reasons for the decline are many, but can be primarily classified into three categories: (1) lamprey introduction, (2) overfishing, and (3) chemical contamination. The synergistic stress that these factors produced has resulted in extinction of species and a shift from dominance of salmonids, whitefish, chubs, deepwater sculpins, ciscok and lake sturgeon to yellow perch, white perch, eel, bullhead and carp.[1] The commercial fishery on the U.S. side of the lake is declining, and the sport fishery is centered on the smallmouth bass. On the Canadian side, the commercial fishery is also declining and the sport fishery is limited to the coastal zone.[2]

Research Method

U.S. commercial fishing data for 1976-1980 have been reported by the National Marine Fisheries Service,[3,4] and the average catch over these years has been used in this analysis. Commercial data for the Canadian side of the lake are also available for 1976-1980.[5] Canadian sport harvest data are available, but for the U.S. side, only numbers of fish caught in 1977 and an indirect reference to a multimillion dollar recreational fishery[1] are available. Canadian data are available for the Napanee District (Figure 1), which represents about one-half of Lake Ontario. However, the reported catch includes fish caught in Lake Ontario as well as in warm water and cool water streams in the watershed. Thus, the total number of fish caught in the Napanee District is an overestimate of the Canadian recreational catch of Lake Ontario proper. Because the Napanee District represented about one-half of the Canadian side of Lake Ontario, the recreational catch data has been multiplied by a factor of 2 for a conservative estimate of the Canadian sport catch. This estimated catch also was used for the U.S. catch.

Results

Commercial Fishery

Table 1 shows the Canadian landings of Lake Ontario fish for 1978-1980. The mean total landings were 982,310 kg (2,165,624 lbs). Table 2 shows the species caught in U.S. waters during the same period. In 1976-1980, the average U.S. landings were 89,986 kg (198,386 lbs). In 1977 the catch was highest at 93,760 kg (206,740 lbs), and it declined to 72,985 kg (160,733 lbs) by 1980. There were only one commercial vessel and 49 commercial fishermen in 1976.[3]

- Sport Fishing

Within the Napanee District, cool and warm water fisheries yielded 123,300 kg (271,300 lbs) of predominately pike and panfish. Thus, the total Canadian Lake Ontario sport fishery is estimated to be 123,300 kg x 2 = 246,600 kg (543,660 lbs). The U.S. sport catch is assumed to be the same.

Summary

	U.S.		Canada	
	kg	lbs	kg	lbs
Commercial	89,986	198,386	982,310 kg	2,165,624
Sport	246,600	543,660	246,600 kg	543,660
Total	336,586	742,046	1,228,910 kg	2,709,283

TOTAL U.S. and Canada 1,565,496 kg (3,451,328 lbs)

References

[1]U.S. Great Lakes Basin Commission, "Report of the Great Lakes Basin Framework Study," Appendix 8, "Fish," Ann Arbor, Michigan, 1975.

[2]Ministry of Natural Resources, "Napanee District, Land Use Guidelines," 1983.

[3]U.S. Department of Commerce, "Fishery Statistics of the United States, 1976," Statistical Digest No. 70, Washington, DC, October 1980.

[4]National Marine Fisheries Service, "General Canvass Catch by Year, State, and Species, 1977-1980," U.S. Department of Commerce, Washington, DC.

[5]Ontario Commercial Fish Industry, "Statistics on Landings, 1976-1980," Ministry of Natural Resources, Ontario.

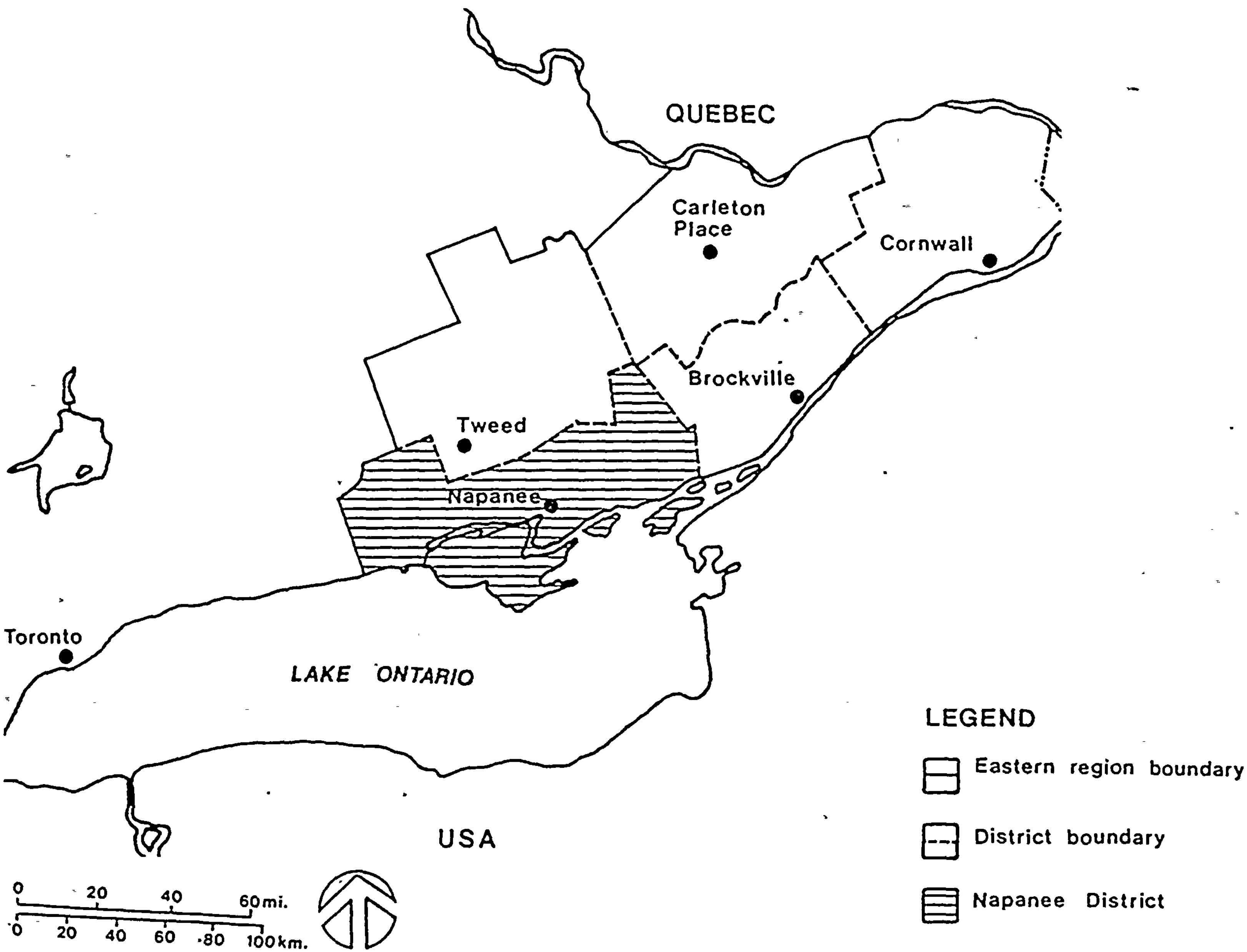

Figure 1 Regional setting

Table 1 Canadian landings of Lake Ontario fish

Species	1978 weight kg	1978 weight lb	1979 weight kg	1979 weight lb	1980 weight kg	1980 weight lb
Bowfin	4,655	10,262	984	2,170	54	120
Bullhead	163,924	361,390	163,786	361,087	166,889	367,927
Carp	4,154	9,157	3,791	8,358		
Catfish	1,688	3,721	125	276	10,817	23,847
Coho	296	652	754	1,662		
Crappie	6,256	13,793	6,832	15,063	8,270	18,233
Eel	230,527	508,225	223,295	492,282	165,341	364,514
Lake herring	5,515	12,159	13,494	29,749	5,311	11,709
Lake trout	304	670	134	296	5	11
Lake whitefish	2,120	4,674	1,299	2,863	4,133	9,111
Northern pike	11,645	25,673	18,893	41,653	20,015	44,126
Rock bass	16,943	37,354	10,630	23,436	6,190	13,647
Smelt	27,190	59,943	26,435	58,279	22,402	49,387
Sturgeon	1,803	3,975	12	27	369	813
Sucker	4,385	9,668	8,361	18,432	4,919	10,844
Sunfish	67,988	149,887	70,646	155,748	72,910	160,738
White bass	4,868	10,733	1,704	3,756	3,319	7,318
White perch	227,443	501,427	46,530	102,580	55,395	122,124
Yellow perch	320,777	707,193	298,093	657,182	267,582	589,918
Yellow pickerel	7,347	16,197	23,919	52,732	57,387	126,517
Other	11,045	24,351	7,525	16,589	27,509	60,646
TOTAL	1,120,873	2,471,104	927,242	2,044,220	898,815	1,981,550

MEAN, ALL SPECIES, 1978, 1979, 1980 982,310 kg (2,165,624 lb)

Source: Ontario Commercial Fish Industry, "Statistics on Landings 1976-1980," Ministry of Natural Resources, Ontario.

Table 2 Average U.S. commercial landings of Lake Ontario fish, 1976-1980

Species	Weight	
	kg	lb
Bullheads and catfish	15,207	33,526
Carp	987	2,176
Crappie	4,406	9,802
Eels	20,813	45,884
Rock bass	3,548	7,822
Freshwater drum	166	367
Smelt	9,119	20,104
Suckers	1,125	2,481
Sunfish	3,084	6,800
White bass	68	150
White perch	17,094	37,687
Yellow perch	13,783	30,386
Walleye	545	1,201
TOTAL	89,986	198,386

Sources: U.S. Department of Commerce, "Fishery Statistics of the United States 1976," Statistical Digest No. 70. October 1980, Washington, DC; National Marine Fisheries Service, "General Canvass Catch by Year, State, and Species, 1977-1980," U.S. Department of Commerce, Washington, DC.

APPENDIX K

LETTER FROM MIAGARA MOHAWK POWER CORPORATION
ON CURRENT FINANCIAL COMMITMENT FOR NINE MILE POINT
UNIT 2

NIAGARA MOHAWK

NIAGARA MOHAWK POWER CORPORATION/300 ERIE BOULEVARD WEST, SYRACUSE, N.Y. 13202/TELEPHONE (315) 474-1511

March 28, 1984
(NMP2L 0017)

Mr. Darrell G. Eisenhut
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20005

Dear Mr. Eisenhut:

Subject: Nine Mile Point Unit 2
Docket 50-410

This letter responds to an oral request by your Staff.

The owners and ownership of Nine Mile Point Unit 2 have not changed. However, as an interim measure, Niagara Mohawk Power Corporation is paying for Long Island Lighting Company's current financial commitment for the cost of Nine Mile Point Unit 2. We will keep you apprised of any change in contract status through license amendments if such contract changes occur.

Sincerely,

C Mangan

C. V. Mangan
Vice President
Nuclear Engineering & Licensing

CVM/ca

NRC FORM 335 (2-84) NRCM 1102, 3201, 3202 — U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

SEE INSTRUCTIONS ON THE REVERSE.

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NUREG-1085

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12. SUPPLEMENTARY NOTES
Docket No. 50-410
Niagara Mohawk Power Corporation
Rochester Gas & Electric Corp.
Central Hudson Gas & Elec. Corp.
N.Y. State Elec. & Gas Corp., L.I. Lighting Co.

13. ABSTRACT (200 words or less)

This Draft Environmental Statement contains the assessment of the environmental impact associated with the operation of the Nine Mile Point Nuclear Station, Unit 2, pursuant to the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations, Part 51, as amended, of the Nuclear Regulatory Commission regulations. This statement examines the environment, environmental consequences and mitigating actions, and environmental and economic benefits and costs.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS
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Nine Mile Point Nuclear Station, Unit 2

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