NUREG-0112

Final Supplement to the final environmental statement

related to operation of

THREE MILE ISLAND NUCLEAR STATION, UNIT 2

METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER AND LIGHT COMPANY
PENNSYLVANIA ELECTRIC COMPANY

DECEMBER 1976

Docket No. 50-320

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

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PREFACE

The construction permit application for Three Mile Island Nuclear Station Unit 2 (Docket 50-320) was filed April 29, 1968, and amended, due to a site change for the Unit from Oyster Creek to Three Mile Island, on March 10, 1969. The safety evaluation was completed by the Atomic Energy Commission (AEC) on September 5, 1969, and a public hearing before an Atomic Safety and Licensing Board was held October 6 and 7, 1969. This hearing was uncontested, and the construction permit (CPPR-66) for Unit 2 was granted on November 4, 1969.

On September 9, 1971, the AEC, now the Nuclear Regulatory Commission (NRC), published in the FEDERAL REGISTER a revised Appendix D to 10 CFR Part 50 setting forth AEC's implementation of the National Environmental Policy Act of 1969 (NEPA). Paragraph E (3) of revised Appendix D requires a holder of a construction permit for a production or utilization facility issued prior to January 1, 1970, but for which neither an operating license nor opportunity for public hearing on the operating license had been issued before October 31, 1971, to furnish to the AEC within 40 days of September 9, 1971, a written statement of any reasons, with supporting factual submission, why, with reference to the criteria in Paragraph E(2) of revised Appendix D, the permit should not be suspended, in whole or in part, pending completion of the NEPA environmental review specified in Appendix D. By letter dated October 19, 1971, Metropolitan Edison Company and Jersey Central Power and Light Company submitted the statement required by Paragraph E(3) of Appendix D, relating to construction activities pursuant to CPPR-66 at their Three Mile Island Nuclear Station Unit 2.

On November 22, 1971, in accordance with the requirements of Section E of revised Appendix D, the AEC determined that certain construction activities for the Three Mile Island Nuclear Generating Station Unit 2 should be suspended pending completion of the NEPA environmental review specified in revised Appendix D. Specifically, the AEC determined that work on the off-site portions of the transmission lines for Generating Unit No. 2 should be suspended until the ongoing NEPA review was complete. With respect to all other construction activities, the AEC balanced the environmental factors and concluded that these activities need not be suspended. A formal "Determination" to this effect was forwarded to the FEDERAL REGISTER for publication (36 F.R. 23264). In reaching that determination, the AEC considered and balanced the criteria in Paragraph E(2) of Appendix D.

In December, 1972, the AEC Staff published a Final Environmental Statement (FES) reflecting the completion of the NEPA environmental review for both Three Mile Island Nuclear Station Units 1 and 2. The Staff concluded that the action called for under NEPA and Appendix D to 10 CFR Part 50 was the continuation of construction permits CPPR-40 and CPPR-66 and the issuance of operating licenses for both units. Pursuant to an application for an operating license for Unit 1, dated March 2, 1970, a Notice of Hearing was issued on July 7, 1972 (37 F.R. 13360). An operating license, DPR-50, was issued for Three Mile Island Unit 1 on April 19, 1974 (39 F.R. 14623). Since the operational date for Unit 2 had been postponed from the originally anticipated May 1975, date, that facility was not included in the March 2, 1970, application or the July 7, 1972 Notice of Hearing. The currently scheduled operational date for Unit 2 is May 1978.

On April 4, 1974, an application for an operating license for Three Mile Island Nuclear Station Unit 2 was filed with the AEC. In support of its application, the applicant also filed its Environmental Report, Supplement 2, Operating License Stage, which updated the discussion of the environmental considerations related to the operation of the Unit and indicated the results of ongoing monitoring programs. Accordingly, the NRC Staff has determined that the FES previously issued in December, 1972 should be updated by issuing a supplement to that FES and circulating it for comment.

The Staff has reviewed the updated information, has visited the site and the vicinity, and has obtained information from other sources. The Staff has then independently performed an analysis of this various information and presents its conclusions in this supplement to the FES.

The Staff recognized the difficulty a reader would encounter in trying to establish the conformance of this review with the requirements of the National Environmental Policy Act with only updating information. Consequently, a copy of the FES issued in December, 1972 accompanies this Supplement as Appendix B. In addition, introductory resumes in appropriate sections of this Supplement summarize the extent of updating. The overall conclusion is based on both the material presented in the FES, December 1972, as modified by this Supplement, and the information presented in this Supplement.

SUMMARY AND CONCLUSIONS

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

1. This action is administrative.

2. The proposed action is the continuation of construction permit CPPR-66 and the issuance of operating license to Metropolitan Edison Company, Jersey Central Power and Light Company, and the Pennsylvania Electric Company (the Applicants) for the operation of the Three Mile Island Nuclear Station, Unit 2, Docket No. 50-320, near Harrisburg in Dauphin County, Pennsylvania. The Three Mile Island Nuclear Station Unit Number 2 has a designed thermal rating of 2772 megawatts with a maximum electrical output of 959 megawatts. Two natural draft cooling towers are utilized for dissipating the waste heat from the closed cycle cooling system.

3. Summary of environmental impacts and adverse environmental effects: Attendant with the furnishing of electrical energy and with the benefits to be derived therefrom, the proposed plant will cause certain adverse environmental effects. These effects are set forth in Paragraph 3 of the Summary and Conclusions in the FES, December 1972 (see pp. i-ii of Appendix B). The most significant additional and updated of these effects are listed below.

   a. Extension of TMINS - Bechtelsville 500 kV transmission line an additional 7.36 miles from Bechtelsville to Hosensack required acquisition of additional 175 foot wide right-of-way along an existing 150 foot wide 230 kV corridor. Construction of this line segment resulted in clearing of 21 acres of woodland, spanning over 134.5 acres of agricultural land and diverting of 0.4 acres from agriculture to use under tower bases (Section 4.4.1).

   b. About 550 curies of radionuclides in liquid effluents (0.24 Ci/yr excluding tritium and 550 Ci/yr of tritium) will be released to the environment annually. Gaseous releases will be approximately 6,700 Ci/yr of noble gases, 0.01 Ci/yr of iodine-131, 560 Ci/yr of tritium, 25 Ci/yr of argon-41, and 0.06 Ci/yr of particulates (Section 3.2.1.2).

   c. No significant environmental impacts are anticipated from normal operational releases of radioactive materials. The calculated dose to the estimated year 1990 U.S. population is less than 540 manrem/yr. This value is less than the natural fluctuation in the approximately 28,000,000 manrem/yr dose this population would receive from background radiation (Section 5.4).

4. The following Federal, State, and local agencies were asked to comment on the Draft Supplemental Environmental Statement:

   Advisory Council on Historic Preservation
   Department of Agriculture
   Department of the Army, Corps of Engineers
   Department of Commerce
   Department of Health, Education and Welfare
   Department of Housing and Urban Development
   Department of the Interior
   Department of Transportation
   Energy Research and Development Administration
   Environmental Protection Agency
   Federal Power Commission
   Federal Energy Administration
   Board of Commissioners - Dauphin County, Pennsylvania
   Susquehanna River Basin Commission
   Londonderry Township Board of Supervisors
   Pennsylvania State Clearinghouse
   Pennsylvania Governor's Office of State Planning and Development
   Pennsylvania Department of Environmental Resources
   Tri-County Regional Planning Commission

5. The Draft Supplement to the Final Environmental Statement was made available to the public, to the Council on Environmental Quality, and to other specified agencies in July 1976.

6. On the basis of the analysis and evaluation set forth in FES, December 1972 and this Supplemental Statement, after weighing the environmental, economic, technical, and other benefits of Three Mile Island Station, Unit 2, against environmental and other costs and considering available alternatives, it is concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and Appendix D to 10 CFR 50 is the continuation of the construction permit CPPR-66 and the issuance of an operating license for Unit 2 of the Three Mile Island Nuclear Station, subject to the following conditions for the protection of the environment.

   Since the conditions contained in Paragraph 8 of the Summary and Conclusions in the FES, December 1972 (see page iii of Appendix B) are no longer applicable, require modifications, or are being updated they are hereby vacated and replaced in their entirety by the following conditions.

   a. License Condition

      Before engaging in additional construction or operational activities which may result in an environmental impact that was not evaluated by the Commission, the licensee will prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated, or that is significantly greater than that evaluated in the FES or any addendum thereto, the licensee shall provide a written evaluation of such activities and obtain prior approval from the Director, Office of Nuclear Reactor Regulation.

   b. Significant Technical Specification Requirements

      (1) The applicant will carry out the environmental monitoring program outlined in the Final Environmental Statement of December 1972 as modified by this Supplement which will be implemented in the Environmental Technical Specifications incorporated in the Operating License for TMINS-2. This study shall include the collection of data for at least one year prior to operation of the plant and extending for at least one year of plant operation.

      (2) If, during the operating life of the station, effects or evidence of irreversible damage are detected, the applicant will provide to the staff an analysis of the problem and a proposed course of action to alleviate the problem.

      (3) The meteorological data collection onsite shall continue throughout the entire period of plant operation.

      (4) If it is necessary to chlorinate at the permitted level, the monitoring program shall include sampling to map the distribution of chlorine in the river.

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FOREWORD

This environmental statement was prepared by the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff) in accordance with the Commission's regulation, 10 CFR Part 50, Appendix D, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

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

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

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

(i) the environmental impact of the proposed action;

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

(iii) alternatives to the proposed action;

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

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

An environmental report accompanies each application for a construction permit or a fullpower operating license. A public announcement of the availability of the report is made. Any comments by interested persons on the report are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessment, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA and Appendix D of 10 CFR Part 50.

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

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

This environmental review deals with the impact of operation of Three Mile Island Nuclear Station Unit 2. Assessments that are found in this statement supplement those described in the Final Environmental Statement (FES) that was issued in December 1972 in support of the continuation of construction permits CPPR-40 and CPPR-66 and the issuance of operating licenses to Metropolitan Edison Company, Jersey Central Power and Light Company, and the Pennsylvania Electric Company (the Applicants) for the operation of the Three Mile Island Nuclear Station Units 1 and 2 near Harrisburg in Dauphin County, Pennsylvania. The information to be found in the various sections of this supplement updates the FES by providing additional information relevant to the environmental impacts of operating the Three Mile Island Nuclear Station, Unit 2.

Single copies of this statement may be obtained by writing the:

Director of the Division of Site Safety and Environmental Analysis
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. Jan A. Norris is the NRC Environmental Project Manager for this project. Mr. Norris may be contacted at the above address or at (301) 443-6990.

1. INTRODUCTION

1.1 LICENSING HISTORY

On April 29, 1968, the Metropolitan Edison Company, Jersey Central Power and Light, and Pennsylvania Electric Company (the applicants) filed an application with the Atomic Energy Commission (AEC, now Nuclear Regulatory Commission) for a permit to construct the Three Mile Island Nuclear Station, Unit 2. Construction Permit No. CPPR-66 was issued accordingly on November 4, 1969, following reviews by the AEC Regulatory staff and the Advisory Committee on Reactor Safeguards, as well as public hearings before an Atomic Safety and Licensing Board on October 6 and 7, 1969.

On December 10, 1971, the applicants submitted an "Environmental Report Operating License Stage" for Three Mile Island Nuclear Station, Units 1 and 2 (TMINS 1 and 2). A Draft Environmental Statement for operation of TMINS 1 and 2 was issued in June 1972, and the Final Environmental Statement was issued in December 1972. On April 19, 1974, a full term operating license was issued for Unit 1.

On April 4, 1974, the applicants submitted an application for an operating license for Unit 2. On February 28, 1975, in support of their application to operate TMINS 2, the applicants filed their Environmental Report, Supplement 2, Operating License Stage, which updated the discussion of environmental considerations related to the operation of the proposed facility and indicated the results of ongoing monitoring programs.

1.2 STATUS OF PROJECT

As of November 15, 1976, construction of Unit 2 was approximately 85.7% complete, engineering was 96.5% complete, and the reactor is expected to be ready for fuel loading in July 1977.

2. THE SITE

2.1 RÉSUMÉ

The staff revisited the Three Mile Island, Unit 2 site in March 1975 to determine what changes had occurred at the site and in the surrounding environs since issuance of the Final Environmental Statement related to operation of Three Mile Island Nuclear Station Units 1 and 2 in December 1972. Supplemental information not previously presented was obtained and analyzed, also, some of the previously presented information is updated.

Additional information on land use is presented in Section 2.2. Updated information on surface water hydrology appears in Section 2.2.3. Listing of known historic sites located within one mile of the transmission line appears in Section 2.3. Additional and updated information on hydrology and meteorology is covered in Sections 2.4 and 2.5, respectively.

At the time of the issuance of the FES in December 1972 there was little information available on the terrestrial and aquatic environment of the site. Since then, the applicant has collected additional information which is summarized in Sections 2.6 and 2.7.

2.2 REGIONAL DEMOGRAPHY AND LAND AND WATER USE

2.2.1 Demography

The demographic data presented in the FES of December 1972 are still valid. The data shows that the 1970 population within 50 miles was 1,865,717. The applicant predicts that the population of this area will increase to 3,231,126 in year 2010, an increase of 73 percent. The staff estimated an increase of 32 percent using the population projections of the Bureau of Economic Analysis. The staff concludes that the applicant's projections, although somewhat higher than projections of the Bureau of Economic Analysis, are reasonable. More detailed discussion of the population can be found in the Safety Evaluation Report in Section 2.1.3.

2.2.2 Land Use

The description of land use as presented in Section II.C of the FES-OL (December 1972) is still valid. Additional information has been supplied by the applicant relating to land use.[1] A current breakdown of land use for the surrounding three county areas is presented in Table 2.1.

2.2.3 Water Use

No significant changes in water use have occurred since December 1972. The Susquehanna and tributaries are used for public and industrial water supply, power generation, boating, fishing (non-commercial), and recreational purposes. Table 2.2 summarizes current downstream public water supply and industrial users for a distance of 50 miles. Additional description of these users is included in Reference 1, pages 2.5-2 and 2.5-3.

The Commonwealth of Pennsylvania has determined that for the purpose of establishing water quality standards for the section of the Susquehanna River in the vicinity of TMI, the following water uses shall be protected (Pennsylvania Code, Title 25, Part I, Environmental Resources, Chapter 93, Water Quality Criteria):

1.2 Warm Water Fishes - Maintenance and propagation of fish food organisms and all families of fishes except Salmonidae.

1.3 Migratory fishes - Passage, maintenance and propagation of anadromous and catadromous fishes, and other fishes which ascend to flowing waters to complete their life cycle.

2.1 Domestic Water Supply - Use by humans after conventional treatment for drinking, culinary and other purposes.

2.2 Industrial Water Supply - Use by industry for inclusion into products, processing and cooling.

TABLE 2.1

LAND USE BY COUNTY[a]

Use	Dauphin Percent	Dauphin Acres	York Percent	York Acres	Lancaster Percent	Lancaster Acres
Forest & Woodland	45.7	151,504	27.7	161,148	15.7	95,054
Crops	30.6	101,445	45.2	262,956	55.4	335,413
Pasture	3.5	11,603	7.7	44,795	3.9	23,612
Urban	8.6	28,510	6.5	37,814	7.8	47,224
Water Area	0.6	1,989	0.4	2,327	0.4	2,422
Federal	0.2	663	0.2	1,164	0.1	605
Other	10.8	35,804	12.3	71,556	16.7	101,108

[a]Reference: Pennsylvania County Industrial Reports, 1972, Department of Commerce.

TABLE 2.2

DOWNSTREAM WATER USERS

User	Distance Downstream (Miles)	Use	Rate of Use
York Haven Power Co.	3	Hydroelectric generation	(a)
Pennsylvania Supply Co.(b)	(e)	Sand and gravel processing	9 hrs/day at 2200 gpm
Brunner Island	4	Steam-electric generation	1155 cfs
Wrightsville Water Supply Co.	16 1/4	Public water supply	(c)
Borough of Columbia	16 3/4	Public water supply	2 mgd
Safe Harbor Water Corp.	27 1/4	Hydroelectric generation	(a)
Village of Holtwood	34 3/4	Public water supply	22,000 gpd
Pennsylvania Power and Light Co.	34 3/4	Hydroelectric generation	6,505 cfs(f)
Muddy Run Pumped Storage	38	Hydroelectric generation	(a)
Peach Bottom Nuclear Generating Station	41	Steam electric generation	3,450 cfs
City of Baltimore	49	Public water supply	250 mgd/65 mgd(d)
Philadelphia Electric Co. (Conowingo Dam)	50	Hydroelectric generation	(d)

(a)In stream use.

(b)Withdrawal is from the mouth of Conewago Creek.

(c)Summer reserve supply.

(d)Baltimore is currently only drawing 65 mgd of its permitted 250 mgd. Their use of the Susquehanna is expected to increase.

(e)Less than 1 mile.

(f)Average flow.

2.3 Livestock Water Supply - Use by livestock and poultry for drinking and cleansing.

2.4 Wildlife Water Supply - Use for water fowl habitat and by wildlife for drinking and cleansing.

2.5 Irrigation - Used to supplement precipitation for growing of crops.

3.1 Boating - Power boating, sail boating, canoeing and rowing for recreational purposes.

3.2 Fishes - Use of the water for the legal taking of fish.

3.3 Water Contact Sports - Use of the water for swimming and related activities.

3.4 Natural Area - Use of the water as an esthetic setting to recreational pursuits.

4.1 Power - Use of the water energy to generate power.

4.3 Treated Waste Assimilation - Use of the water for the assimilation and transport of treated waste waters.

2.3 HISTORICAL SITES AND NATURAL LANDMARKS

Since the publication of the FES in December 1972, the Advisory Council on Historic Preservation established regulations pursuant to the National Historic Preservation Act of 1966 (39 Fed. Reg. 3366; 36 CFR Part 800, January 25, 1974). The regulation requires that a federal agency identify those properties which are eligible for inclusion in the National Register of Historic Places. To supplement the identification of properties near the site contained in the 1972 FES, Table 2.3 lists known historic sites located within one mile of the transmission route.

The existence of the transmission lines does not interfere with any of the listed sites. The line is visible from some of the listed locations.

2.4 HYDROLOGY

2.4.1 Surface Water Hydrology

No significant changes in regional surface water hydrology have occurred since December 1972. The following represents new and updated information. The Susquehanna River has a drainage area of approximately 25,000 square miles above the site and is rather extreme in its flow characteristics. Following is a summary of data as recorded 11 river miles upstream at the Harrisburg gage:

Minimum daily flow	1,700 cfs
Average annual flow	34,000 cfs
Mean annual flood	300,000 cfs
Maximum flood	1,020,000 cfs

The main tributaries in the vicinity of the site are the following:

Stream	Drainage Area	Average Annual Discharge
Conodoguinet Creek	483 sq. mi.	594 cfs
Yellow Breeches Creek	227 sq. mi.	290 cfs
Swatara Creek	567 sq. mi.	935 cfs
Conewago Creek (West)	510 sq. mi.	579 cfs

Additional data on the seasonal flow variation and frequency of low flows are given in Reference 1, Figures 2.5-6 and 2.5-7, respectively.

Because of the threat of flooding, the station is protected from floods up to those with flow rates of 1,100,000 cfs, which is the levee design flood, by an extensive dike system around the island. On June 24, 1972, rains from tropical storm Agnes resulted in a flood volume of about 1,000,000 cfs, considerably in excess of the previous maximum recorded flood of 740,000 cfs in

TABLE 2.3

KNOWN HISTORIC SITES LOCATED WITHIN ONE MILE OF TRANSMISSION ROUTE

LANCASTER COUNTY

Coleman Memorial Chapel. Brickerville, Elizabeth Township (1758, 1877). Original church built by Wilhelm Stiegel for use of workers of nearby Elizabeth Furnace. In 1877 a stone chapel was added. 1/3 mile.

Elizabeth Furnace. On Middle Creek off Route 322, Brickerville, Elizabeth Township (c. 1750). Begun by Jocob Huber and later owned by Baron Stiegel and the Coleman family. The first six-plate iron stove was manufactured there. 1/3 mile.

Emmanual Evangelical Lutheran Church. Route 322 east of Brickerville, Elizabeth Township (1730, 1808). Original frame church was used as a hospital during the Revolutionary War. Present 1808 structure is constructed in brick and has an excellent interior. 1/3 mile.

Salem Lutheran and Reformed Church. South Main Street, Reamstown, East Cacalico Township. (1817, 1907). Two story brick structure with fine stained glass arched windows. Bell tower and front entranceway added in 1907. 2/3 mile.

Stiegel-Coleman House. Furnace Hill Part, intersection of Pennsylvania Route 501 and U.S. Route 322, Brickerville, Elizabeth Township. (1756058, c. 1780). Located at Elizabeth Furnace, the center of early iron industry in the area, the furnace and original section of the stone house were built by William Henry Stiegel. Robert Coleman made the addition to the west side. This property is in the National Register of Historic Places and is a National Historic Landmark. 1/3 mile.

BERKS COUNTY

Jean Bertolett Memorial Monument 1-1/2 miles southeast of Oley Line, Oley Township. 1/3 mile.

Philip Christman House. One mile southeast of Bally, Washington Township (1730-50). Typical Germanic farmstead. Main house has huge fireplaces and a large vaulted basement. This property is on the National Register of Historic Places. Less than 1/2 mile.

Daniel Boone Homestead (Bertolett-Herbein Cabin; Snyder Farm). North of Route 422 Exeter Township (1735). Two story house built by Daniel Boone's father. Daniel Boone lived here for 15 years. Site also contains the Bertolett log cabin, a 1735 Huguenot cabin moved from the Bertolett Homestead. Both structures are on the National Register of Historic Places. 3/4 mile.

George De Benneville House. Two and one-quarter miles northwest of Yellow House near Limekiln, Oley Township (1745). Large two story stone farmhouse built by George De Benneville, noted Huguenot preacher, founder of Universalism in the United States. 3/4 mile.

Exeter Friends Meeting House. Meeting House Road near Stonersville, Exeter Township (1758). Small one story stone building in excellent repair. Third meeting house on the site. 125 feet.

Henry Fisher House. Route 662, 1-1/4 miles north of Yellow House. (1801) Two story, five bay, stone Georgian house particularly noted for its excellent interior woodwork, including beautiful carved stairway. Various other buildings are also found on site. This site is on the National Register of Historic places. 650 feet.

Hunter House. Two miles north of Yellow House, east on Route 662, Oley Township. (1803) T-shaped stone house done in Georgian style. House has an unusually elaborate doorway. 3/4 mile.

Abraham Knabb House and Barn. One mile southeast of Limekiln, Oley Township. (1817). Two story house of Georgian style. Has elaborately decorated main doorway. Mid-19th century barn of typical bank barn construction. One mile.

Yellow House Hotel. Intersection of Routes 662 and 562, Yellow House (early 19th century). Large two and one-half story stone building with columned porch on north and east sides. Building is stuccoed and painted. Scene of famous mule auctions. One mile.

1936, but below the probable maximum flood for the Three Mile Island location. For floods greater than the levee design flood and up to the probable maximum flood (1,625,000 cfs), the Station is designed to be shut down and waterproofed; the dike is designed to allow water to back into the plant area from the downstream (southern) end of the island. An evaluation of flooding potential and the dike erosion protection may be found in the staff's safety evaluation report.

The river and the streams in the vicinity are presently used for water supplies, both public and industrial, power generation, boating, fishing, and recreation. Sport fishing is done in all streams in the general area of the site; however, there is no commercial fishing. The applicant has identified 11 downsteam surface water users within 50 miles of the site. The nearest user of surface water is five miles downstream. Approximately 1155 cfs is withdrawn from the river at this location by the Brunner Island steam-electric generating station; a portion of the withdrawal is used as potable water.

A pump storage facility consisting of two reservoirs and dams is proposed for completion in 1983-84 on Stony Creek, approximately 13 miles northeast of Harrisburg and upstream of Three Mile Island. Detailed design data are not yet available for the project. The project will, however, afford some degree of low flow augmentation for the Susquehanna River.

2.4.2 Groundwater Hydrology

Groundwater occurs at TMINS under water table conditions. The water table reaches its maximum elevation at the highest topographic point in the center of the island and falls off toward both shores. A variation of about 5 feet occurs from either side to the center, producing a gradient of approximately 0.6 percent toward the river. At observation points in and surrounding the plant area, water levels occurred generally at a depth in excess of 15 feet and ranged from 14 to 19 feet. The groundwater level occurred at a maximum of 6.2 feet above the top of rocks with less than 1 foot of head existing above the soil-rock interface at one point of observation. The water level of the Susquehanna River, normally flowing at elevation 278 feet, controls TMINS groundwater levels. Infiltration of groundwater from the Station into the underlying Gettysburg shale and transmission to onshore water supplies is unlikely, since groundwater levels are higher on either river shore than on the island, with hydraulic gradients sloping toward the river.

2.4.3 Water Quality

The water quality of the Susquehanna River below Harrisburg is generally good. Coal mine drainage pollution which is the significant problem in the Susquehanna Basin does not impact greatly on this reach of the river because of high dilution flow. Algal blooms accociated with excessive nutrients are a recurring problem in late summer below Harrisburg. Nutrients causing the blooms originate both from municipal wastewater treatment plants and from runoff in heavily farmed regions. (Reference: "Susquenhanna River Basin Study," June 1970.)

Appendix B of the FES for the Station, dated December 1972, presented water quality data for the river near the site for the period June 1967 through November 1969. Table 2.5-1 of Reference 1 presents supplemental data for the period April through August 1974. These data are summarized in Table 2.4 for parameters of significance to the designated uses of the river (see Section 2.2.2).

The data show the water to be moderately hard although of neutral pH. Comparison of total hardness to alkalinity indicates that most of the hardness is non-carbonate hardness. More specifically it is related to the high sulfate concentration which probably is a result of the contribution of mine drainage.

Sulfate and coliform organisms are the only parameters which approach general criteria for the designated uses of the river downsteam from the plant. In a recent national study of water quality criteria it was concluded that "on the basis of taste and laxative effects...it is recommended that sulfate in public water supply sources not exceed 250 mg/l where sources with lower sulfate concentration are or can be made available."[2] The maximum sulfate concentration reported was 204.3 mg/l (see Appendix B). This occurred on August 21, 1968, when river flow was 4500 cfs.

The high concentration of fecal coliforms is generally attributed to the presence of domestic wastes. The recommended criterion for coliform organisms in surface waters to be used for public water supplies is concentration not to exceed 2000/100 ml.[2] Coliform organisms die off and reduce in concentration as distance from their source increases. Thus the only significance of the coliform concentrations is to indicate that the Susquehanna River is not an attractive source of public water supply in the vicinity of Three Mile Island.

TABLE 2.4

WATER QUALITY IN THE SUSQUEHANNA RIVER NEAR THREE MILE ISLAND FOR THE PERIOD JUNE 1967 THROUGH AUGUST 1974

Parameter	Minimum	Average	Maximum
Flow, cfs	3,600	26,779	106,100
Sodium, mg/l	2.3	12.71	52.9
Sulfates, mg/l	14.0	79	204.3
Chlorides, mg/l	5.7	12.6	20.0
Nitrates, mg/l	0.04	6.3	14.3
pH	6.5	7.2	8.2
Total Hardness as $CaCO_3$, mg/l	46	128	242
Chlorine demand[a], mg/l	1.0	2.0	5.0
Total Alkalinity (as $CaCo_3$)[b], mg/l	23	58	172
Soluble Solids[c], mg/l	78	193	397
Total Solids[c], mg/l	134	252	577
Fecal Coliforms[d], colonies/100 ml.	15	2010	21,000

[a]29 samples
[b]46 samples
[c]50 samples
[d]10 samples (Table 2.5-1 of Reference 1)

The applicant's 1974 and 1975 monitoring reports show that ambient iron concentration and pH often exceed the applicable Pennsylvania water quality standards in the vicinity of the Three Mile Island Nuclear Station. The high values are attributed to upstream surface water runoff.

2.5 METEOROLOGY

2.5.1 Regional Climatology

The climate of southeastern Pennsylvania is primarily continental in character. Although the proximity of Chesapeake and Delaware Bays, and to a lesser extent the Atlantic Ocean tends to exert a moderating influence on air temperatures over much of the region, these effects are weak as far inland as Harrisburg. Continental polar air, originating in Canada, is the predominant air mass type over the region in winter. However, these air masses are usually modified and warmed somewhat as the air descends the eastern slopes of the Appalachians before reaching the southeastern section of Pennsylvania. Maritime tropical air masses, with origins over the Gulf of Mexico or Carribbean Sea, predominate over this region in summer. Winters are relatively mild for the latitude while summers are warm and humid.[3]

Temperatures of 90F or higher may be reached on 20 to 25 days annually over the region while temperatures of 0F or lower may be expected on only one or two days. On approximately 108 days annually, temperatures of 32F or lower may be expected. Precipitation is generally well distributed throughout the year, but the greatest monthly amounts occur in summer, associated with thundershowers. On annual basis, relative humidity averages around 70 percent.[3]

2.5.2 Local Meteorology

Long term weather records from Harrisburg, Pennsylvania, record the extreme maximum and minimum temperatures as 107F in July 1966 and -14F in January 1912. Maximum 24-hour precipitation totaled 12.55 inches in June 1972 and maximum 24-hour snowfall totaled 21.0 inches in January 1945.[3]

The annual snowfall normal for Harrisburg is 37 inches, while freezing precipitation averages two to three days per year. Heavy fog (visibility one-quarter of a mile or less) occurs an average of 21 days annually.[3]

Onsite wind data at the 100-ft level (10 meters above nearby obstructions) between September 1972 and September 1973 and between November 1974 and November 1975 indicate that the predominant wind flow is northwesterly with a frequency of 12.7%. Winds from the north-northeast are least frequent (2.5%).[4]

2.5.3 Severe Weather

Most severe weather occurring in the Three Mile Island site vicinity is associated with severe thunderstorms or intense large scale winter storm systems. Tropical storms and hurricanes affect the Three Mile Island site infrequently.

Within the one degree latitude-longitude square in which the site is located, twelve tornadoes were reported between 1955 and 1967. This gives an annual mean frequency of 0.9 and recurrence interval of 1400 years.[5,6] Hail three-quarters of an inch in diameter or larger was reported on sixteen occasions during the 1955 through 1967 period within the one degree square and twenty-nine windstorms were reported with speeds of 50 knots (58 mph) or greater.[5] Between 1871 and 1974 thirteen tropical storms or hurricanes passed within 50 miles of the site.[7,8] In Harrisburg, the maximum "fastest mile" recorded was 68 mph.[3] From 1936 through 1970 there were 35 cases of air stagnation which lasted four or more days in the region in which the Three Mile site is located.[9]

2.6 ECOLOGY OF THE SITE AND ENVIRONS

2.6.1 Terrestrial Ecology

At the time of the FES-OL (December 1972) there was little information available on the terrestrial environment of the site. Additional information has been supplied by the applicant in Sections 2.7.3 and 2.7.2.2 of Reference 1.

The major types of terrestrial communities within approximately one mile of the facility are shown in Figure 2.1. The majority of the land within one mile of the site is farmland or forest. A breakdown of the various categories of agricultural land may be found in Reference 1 (Tables 2.2-5, 2.2-8, 2.2-9, 2.2-10 and 2.2-11). The major forest communities are described in detail in Section 2.7 of Reference 1.

The majority of the forest land on and within one mile of Three Mile Island can be classified as bottomland hardwood forest, stream terrace hardwood forest or black locust forest. The most frequently occurring overstory species for these three forest types are given in Table 2.5.

TABLE 2.5

MOST FREQUENT OVERSTORY SPECIES FOR MAJOR FOREST COMMUNITIES WITHIN ONE MILE OF THREE MILE ISLAND

	Bottomland Hardwood Forest	Stream Terrace Hardwood Forest	Black Locust Forest
Dominant	Silver Maple	Red Oak	Black Locust
	Ash	Chestnut Oak	Black Cherry
	River Birch	Beech	Black Walnut
Frequent	American Elm	Black Cherry	Sassafras
	Sycamore	Black Locust	Cottonwood
	Catalpa	Black Walnut	Ash
	Cottonwood	Mockernut Hickory	Staghorn Sumac
	Tulip Poplar	Silver Maple	Box Elder
		Tulip Poplar	
		Ash	

The bottomland hardwood forests are found in low lying areas where flooding from the Susquehanna River has been frequent. About two hundred and thirty acres of this forest type is found on the site. Silver maple, ash and river birch are the most common overstory species but are found in association with American elm, sycamore, catalpa, cottonwood and tulip poplar.

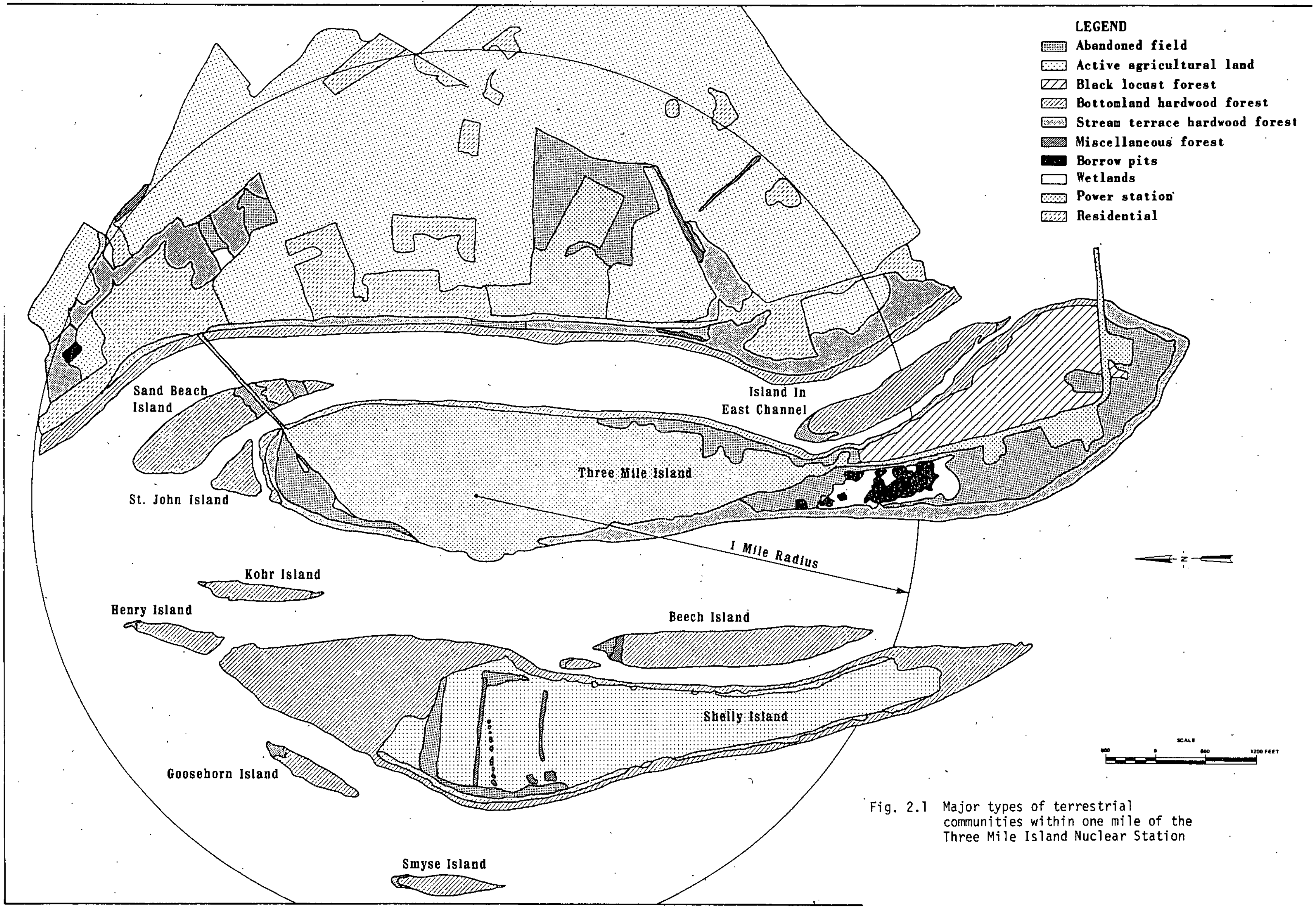

Fig. 2.1 Major types of terrestrial communities within one mile of the Three Mile Island Nuclear Station

The stream terrace hardwood forests are found on the higher bottoms and stream terraces. About ninety acres of this forest type were reported. The most frequent species present is red oak although one stand had chestnut oak and beech as dominant overstory species. Species occurring less frequently include black cherry, black locust, black walnut, mockernut hickory, silver maple, tulip poplar and ash.

Black locust forest is found mostly in a woodlot of about fifty acres on the southeastern portion of Three Mile Island. This is a relatively young second growth forest. In some areas black cherry and black walnut occur with black locust as the dominant species. In other areas black locust is the dominant overstory species. Less frequently occurring species include sassafras, cottonwood, ash, staghorn sumac and box elder.

The miscellaneous areas include a very old three-acre stand of beech on Beech Island, hedgerows and windbreaks planted between agricultural fields and a double row of red pine bordering a cart road on Shelley Island.

The most abundant understory species for the three major forest types are presented in Table 2.6. Forest and non-forest ground cover and several small wetland areas are described in Section 2.7.3 of Reference 1.

TABLE 2.6

MOST FREQUENT UNDERSTORY SPECIES FOR MAJOR FOREST COMMUNITIES WITHIN ONE MILE OF THREE MILE ISLAND

Bottomland Hardwood Forest	Stream Terrace Hardwood Forest	Black Locust Forest
Spicebush	Sassafras	Black Cherry
Poison Ivy	Flowering Dogwood	Virginia Creeper
Ash	Spicebush	Grape
Virginia Creeper	Grape	Spicebush
Grape	Virginia Creeper	Black Locust
Box Elder		
Elderberry		

The applicant has identified two hundred and twelve species of terrestrial vertebrates found in the TMINS vicinity. Of these, 179 were birds (Reference 1, Table 2.7-5) nineteen were mammals (Reference 1, Table 2.7-6), eight were reptiles (Reference 1, Table 2.7-7) and six were amphibians (Reference 1, Table 2.7-8). Small game animals were cottontail rabbit and gray squirrel. Mammalian predators were longtail weasel and red fox. White tail deer was the largest mammal on site. Four species of upland game bird found on site included ringnecked pheasant, American woodcock, mourning dove and rock dove. Whistling swan, Canada goose, nine species of dabbling duck, seven species of diving ducks and three species of mergansers were reported.

No endangered species are known to occur on site. The site does lie within the ranges of occurrence of three endangered species, southern bald eagle, peregrine falcon and Indiana bat and it is, therefore, possible that individuals could visit the site, particularly during periods of migration. Several individuals of American osprey, which has been designated of undetermined status, have been seen on site (Reference 1, Section 2.8.4) but no nesting activity has been observed.

The bog turtle, a species listed as threatened by the USDI (1973), has been identified in at least one location along the TMINS transmission line corridors. Several other areas of potential bog turtle habitat have also been identified. No significant adverse effects from transmission line construction have been noted with respect to potential or existing bog turtle habitat.

2.6.2 Aquatic Ecology

2.6.2.1 Phytoplankton

The applicants began monitoring phytoplankton in conjunction with entrainment studies in April 1974.[10] Analysis of samples collected from the intake area from April through July 1974 indicated the presence of 71 genera belonging to six algal divisions (Table C-1, Appendix C). Chlorophyta (green algae) were represented by 35 genera; Bacillariophyta (diatoms) by 27 genera; Cyanophyta (blue-green algae) by 8 genera; and Euglenophyta (euglenoids), Chrysophyta (yellow-green algae) and Pyrrophyta (dinoflagellates) by 2 genera each.

Mean density and relative abundance of phytoplankton taken at the TMINS intake and discharge during each 24-hour entrainment study is shown in Table 2.7. Samples were taken at four-hour intervals and averaged over each 24-hour collection period. Phytoplankton showed marked seasonal differences in species composition and abundance. During April and May, Bacillariophyta, mainly Asterionella formosa, Synedra spp., Cyclotella spp. and Melosira spp., accounted for up to 88% of the total population.

In June, the Chlorophyta averaged 48% while members of the Bacillariophyta made up only 33% of the populations. Ankistrodesmus falcatus and Dictyosphaeriun pulchellum (Chlorophytes) and Cyclotella spp. and Synedra spp. (Bacillariophytes) were most abundant during this month. Phytoflagellates were most numerous in early June comprising 20% of the population. Average numbers of all phyla were lower in July than in May and June with Cyanophytes averaging 16%, Bacillariophytes 34%, and Chlorophytes 40% of the total population. The Cyanophyta occurred in largest numbers in July.

2.6.2.2 Zooplankton

Sampling at the intake and discharge from April through early September 1974 have identified 80 taxa of zooplankton and other invertebrates in the TMINS vicinity (Table C-2, Appendix C).[10] Diurnal differences in numbers and composition have been noted and attributed to patchy distribution in the river. Rotifers, cladocerans and copepods were the most abundant zooplankton and accounted for 55, 22 and 22% of plankters collected in (Table 2.8).

Rotifers were collected in lowest numbers in April, May and early September. Maximum numbers were taken in early July and late August with Brochionus quadridentatus being the most abundant. Brochionus calyciflorus and B. budapestinenis, the second and third most common rotifers, were collected in greatest numbers in late July and mid-August. Cladocerans present in low numbers from April through early June increased from late June through August. Bosmina longirostris, accounting for 71% of the cladocerans, was collected in greatest numbers in late August. The second and third most common cladocerans, Moina spp. and Ilyocryptus spinifer, showed greatest abundance in August. Copepods occurred in low numbers from April through early July, increased from late July to a peak in late August and declined in early September. Cyclopoid copepodids and nauplii were most abundant and made up 57 and 21% of the total copepods collected. They were collected in greatest number in late August. The most common adult copepod, Cyclops vernalis, was most abundant in mid-August. Other zooplankton (Table 2.8) were obtained in low numbers over the study.

2.6.2.3 Ichthyoplankton

Ichthyoplankton was sampled by pumping twice per month over a 24-hour period (4-hour intervals) at the intake and discharge from April through October 1974.[10] Fish eggs and larvae were also collected by net in the center channel west of the TMINS weekly during the daytime and semimonthly in the center channel concurrent (24-hour sampling) with the 24-hour intake-discharge entrainment studies from May through September 1974. A listing of larval fish taken during all studies in included in Appendix C (Table C-3).

A total of 167 larval fish and 390 eggs were collected during pumped entrainment studies at the intake and discharge from April through July (Table 2.9). No larval fish or eggs were taken from August through October. Most fish larvae (98%) and all eggs were collected in May and June. Percids were most abundant with cyprinids, catostomids, ictalurids and centrarchids present. Numbers of larvae were greater at the intake than at the discharge while all eggs except one were collected at the discharge. Densities of larvae were always higher at night. The highest number of larvae at any one 4-hour sampling was 24.3 per m^3 in early June, while a maximum egg density of 160.4 per m^3 at the discharge occurred in late May. Percids and cyprinids accounted for 69% and 18% of the total larvae collected.

Larval fish taken concurrent with the intake-discharge entrainment studies from the center channel are summarized in Table 2.10. During this study no eggs were taken and 467 larval fish were

TABLE 2.7

MEAN DENSITY AND RELATIVE ABUNDANCE OF PHYTOPLANKTON TAKEN AT TMINS DURING EACH 24-HR ENTRAINMENT STUDY. RESULTS ARE EXPRESSED AS NUMBER/LITER X 10^{-3}.

		Mean Density		Relative Abundance (%)	
Date	Taxon	Intake	Discharge	Intake	Discharge
25-26 April	BACILLARIOPHYTA	194.6	187.1	88.3	87.3
	CHLOROPHYTA	16.5	13.0	7.4	6.1
	CYANOPHYTA	7.3	10.9	3.3	5.1
	CHRYSOPHYTA	-	2.2	-	1.0
	Phyto-flagellates	2.1	1.2	1.0	0.5
9-10 May	BACILLARIOPHYTA	6887.4	5937.7	87.1	85.8
	CHLOROPHYTA	208.3	249.5	2.6	3.6
	CYANOPHYTA	49.5	44.8	0.6	0.6
	CHRYSOPHYTA	7.5	25.4	0.1	0.4
	PYRROPHYTA	6.1	-	0.1	-
	Phyto-flagellates	748.8	663.1	9.5	9.6
23-24 May	BACILLARIOPHYTA	3706.8	3003.4	65.1	63.3
	CHLOROPHYTA	965.4	828.8	17.0	17.5
	CYANOPHYTA	264.9	246.4	4.7	5.2
	PYRROPHYTA	8.2	5.3	0.1	0.1
	CHRYSOPHYTA	4.1	8.1	0.1	0.1
	Phyto-flagellates	740.9	656.2	13.0	13.8
6-7 June	BACILLARIOPHYTA	2056.6	2001.8	34.5	38.0
	CHLOROPHYTA	2554.6	2165.4	42.9	41.1
	CYANOPHYTA	188.6	253.0	3.2	4.8
	PYRROPHYTA	12.6	11.6	0.2	0.2
	Phyto-flagellates	1147.0	831.7	19.3	15.8
20-21 June	BACILLARIOPHYTA	1750.3	1850.7	30.6	32.6
	CHLOROPHYTA	2976.4	2748.4	52.1	48.4
	CYANOPHYTA	348.3	480.3	6.1	8.5
	EUGLENOPHYTA	-	4.6	-	0.1
	PYRROPHYTA	8.3	26.5	0.2	0.5
	Phyto-flagellates	634.5	571.9	11.1	10.1
11-12 July	BACILLARIOPHYTA	1659.6	1428.4	37.8	30.4
	CHLOROPHYTA	1509.6	2081.7	34.4	44.3
	CYANOPHYTA	900.0	766.8	20.5	16.3
	PYRROPHYTA	9.5	8.0	0.2	0.2
	Phyto-flagellates	314.8	410.1	7.2	8.7
25-26 July	BACILLARIOPHYTA	1164.1	1156.2	30.4	29.0
	CHLOROPHYTA	1703.8	1962.3	44.5	49.2
	CYANOPHYTA	381.2	405.5	10.0	10.2
	EUGLENOPHYTA	-	2.8	-	0.1
	PYRROPHYTA	35.5	57.5	0.9	1.4
	CHRYSOPHYTA	4.7	5.1	0.1	0.1
	Phyto-flagellates	539.3	402.5	14.1	10.1

TABLE 2.8

SUMMARY OF THE MEAN DENSITIES (ORGANISMS PER CUBIC METER) OF THE MAJOR TAXA OF ZOOPLANKTON FOUND AT THE TMINS INTAKE AND DISCHARGE DURING ENTRAINMENT STUDIES APRIL THROUGH SEPTEMBER 1974.

	Apr 25-26	May 9-10	May 23-24	Jun 6-7	Jun 20-21	Jul 11-12	Jul 25-26	Aug 15-16	Aug 29-30	Sep 12-13
INTAKE										
	-	-	-	-	-	-	-	-	-	-
	27.42	49.28	76.24	305.32	173.75	171.55	63.79	12.01	197.70	32.13
	44.93	44.08	22.51	7.18	14.42	9.84	-	-	-	1.13
	43.54	99.15	233.34	7989.87	8236.87	62981.38	25999.56	14732.19	49951.73	2036.84
	1.70	-	4.74	-	111.20	154.45	25.74	51.59	25.00	14.34
	23.58	16.58	54.44	30.40	31.47	4.94	4.66	-	-	1.37
	45.53	47.80	34.65	91.75	38.53	18.12	-	5.79	45.29	46.60
	6.85	46.88	253.73	89.25	651.35	766.32	3130.48	14667.98	49819.05	136.60
	6.06	4.08	34.62	4.22	3.10	10.47	4.83	-	12.75	110.15
	30.92	111.45	485.69	362.48	259.15	412.26	10421.66	18011.27	37052.14	371.46
	2.72	-	2.17	-	-	-	-	-	-	-
	-	-	1.67	-	4.92	-	-	-	6.44	11.62
	41.15	61.52	225.33	112.34	191.51	189.20	96.60	88.46	92.79	51.04
	1.97	-	7.46	-	-	-	-	-	-	-
Total	276.37	480.82	1436.59	8992.81	9716.27	64718.53	39747.32	47569.29	137202.89	2813.28
DISCHARGE										
	-	-	-	5.81	-	-	-	-	-	-
	5.16	24.61	49.12	284.69	1924.11	1198.40	820.18	86.38	1589.67	660.61
	12.26	13.46	23.91	24.78	7.17	-	-	11.84	-	9.24
	37.37	95.23	293.31	5113.53	8687.72	71512.45	28533.45	12589.47	56876.61	1801.62
	-	-	-	-	11.50	99.67	33.12	68.81	25.25	11.74
	7.41	15.86	31.25	13.94	12.21	11.93	-	-	-	14.39
	11.54	3.92	48.63	95.37	75.92	54.06	23.71	18.01	47.89	166.48
	4.19	22.14	314.25	204.45	1486.74	986.47	2559.43	12829.93	41033.74	267.99
	4.11	-	14.78	-	2.47	17.11	10.17	4.25	19.16	104.69
	23.55	106.35	520.13	330.50	208.51	666.12	8060.57	16914.15	32222.42	238.41
	-	-	-	-	5.79	-	-	-	-	1.40
	-	1.81	3.56	-	4.03	-	-	4.83	7.07	1.15
	13.35	50.56	176.21	105.84	182.71	118.45	75.28	41.86	82.49	67.46
	-	-	-	-	-	-	8.83	5.87	-	4.99
Total	118.94	333.94	1475.15	6178.91	12608.88	74664.66	40124.74	42575.40	131904.30	3350.17

TABLE 2.9

SUMMARY OF LARVAL FISH TAXA TAKEN BY PUMP AT THE TMINS INTAKE AND DISCHARGE DURING ENTRAINMENT STUDIES APRIL THROUGH OCTOBER 1974. NO LARVAL FISH WERE TAKEN IN AUGUST THROUGH OCTOBER.

	Apr 11-12	Apr 25-26	May 9-10	May 23-24	Jun 6-7	Jun 20-21	Jul 11-12	Jul 25-26	Total	% of Catch
Cyprinidae	-	-	-	5	16	3	1	1	26	
<u>Cyprinus carpio/Carassius auratus</u>	-	-	-	-	1	-	-	-	1	
<u>Notropis hudsonius</u>	-	-	-	-	-	1	-	-	1	
<u>N. spilopterus</u>	-	-	-	-	-	1	-	-	1	
<u>Notropis</u> spp.	-	-	-	-	-	1	-	-	1	
subtotal	-	-	-	5	17	6	1	1	30	17.96
Catostomidae	-	-	-	6	-	-	-	-	6	
<u>Carpiodes cyprinus</u>	-	-	-	2	2	-	-	-	4	
<u>Hypentelium nigricans</u>	-	-	-	1	-	-	-	-	1	
<u>Moxostoma macrolepidotum</u>	-	-	-	2	-	-	-	-	2	
subtotal	-	-	-	11	2	-	-	-	13	7.78
(Ictaluridae)										
<u>Ictalurus punctatus</u>	-	-	-	-	-	-	-	1	1	
<u>Noturus insignis</u>	-	-	-	-	-	2	-	-	2	
subtotal	-	-	-	-	-	2	-	1	3	1.80
(Centrarchidae)										
<u>Lepomis</u> spp.	-	-	-	-	2	2	-	-	4	
<u>Micropterus dolomieui</u>	-	-	-	1	1	-	-	-	2	
subtotal	-	-	-	1	3	2	-	-	6	3.59
Percidae	-	-	-	-	4	-	-	-	4	
<u>Etheostoma</u> spp.	-	-	-	-	1	-	-	-	1	
<u>Perca flavescens</u>	-	-	1	12	14	-	-	-	27	
<u>Percina peltata</u>	-	-	-	5	33	2	-	-	40	
<u>P. flavescens/P.peltata</u>	-	-	-	22	19	-	-	-	41	
<u>Stizostedion vitreum</u>	1	-	1	-	-	-	-	-	2	
subtotal	1	-	2	39	71	2	-	-	115	68.86
Total	1	-	2	56	93	12	1	2	167	

TABLE 2.10

SUMMARY OF LARVAL FISHES TAKEN IN 0.5 M NET TOWS DURING 24-HR STUDIES
MAY THROUGH SEPTEMBER 1974

Date	May 9-10	May 23-24	Jun 6-7	Jun 20-21	Jul 11-12	Jul 25-26	Aug 15-16
Cyprinidae	4	41	35	3	18	1	4
Cyprinus carpio/ Carassius auratus	-	4	72	-	4	22	-
Notemigonus crysoleucas	-	-	-	1	-	-	-
Notropis hudsonius	-	-	-	2	-	-	-
subtotal	4	45	107	6	22	23	4
Catostomidae	-	-	1	-	-	-	-
Carpiodes cyprinus	1	114	26	-	-	-	-
Catostomus commersoni	-	1	-	-	-	-	-
Moxostoma macrolepidotum	-	1	1	-	-	-	-
subtotal	1	116	28	-	-	-	-
Ictaluridae Ictalurus punctatus	-	-	-	5	7	1	-
subtotal	-	-	-	5	7	1	-
Centrarchidae							
Lepomis spp.	-	1	-	1	1	1	-
Micropterus dolomieui	-	-	-	1	-	-	-
subtotal	-	1	-	2	1	1	-
Percidae	-	6	1	-	-	-	-
Perca flavescens	-	5	13	-	-	-	-
Percina peltata	-	11	30	4	-	-	-
subtotal	-	22	44	4	-	-	-
Unidentifiable	-	2	-	-	-	21	-
Total	5	186	179	17	30	46	4

TABLE 2.10 (Continued)

Date	Aug 29-30	Sep 12-13	Sep 26-27	Subtotal	Total	Percent of Total
Cyprinidae					106	
Cyprinus carpio/ *Carassius auratus*	NO LARVAE TAKEN				102	
Notemigonus crysoleucas					1	
Notropis hudsonius					2	
subtotal				211		45.18%
Catostomidae					1	
Carpiodes cyprinus	NO LARVAE TAKEN				141	
Catostomus commersoni					1	
Moxostoma macrolepidotum					2	
subtotal				145		31.05%
Ictaluridae						
Ictalurus punctatus	NO LARVAE TAKEN				13	
subtotal				13		2.78%
Centrarchidae						
Lepomis spp.	NO LARVAE TAKEN				4	
Micropterus dolomieui					1	
subtotal				5		1.07%
Percidae					7	
Perca flavescens	NO LARVAE TAKEN				18	
Percina peltata					45	
subtotal				70		14.99%
Unidentifiable	NO LARVAE TAKEN			23		4.93%
Total					467	

taken. Most larvae (68%) were collected at night. Greatest numbers were obtained in late May and early June with the maximum density (0.51/m^3) occurring in early June. No larvae were collected beyond mid-August. Cyprinids, catostomids and percids comprised 45, 31 and 15% of the total catch. Larval composition from 24-hour tows in the river differed from that obtained in the 24-hour pumped entrainment studies. Cyprinids and catostomids were more abundant in the former, while percids and cyprinids were more common in the latter.

Larval fish collected during weekly daytime tows are tabulated in Table 2.11. A total of 382 larval fish were obtained prior to mid-August. The composition of the weekly daytime tows was similar to the 24-hour center channel tow collections. Cyprinids and catostomids made up 58 and 34% of the total daytime tow catch. Larval composition of the tow collections were similar in the three river areas sampled. The difference between river and TMINS intake larval composition may be due to the different sampling techniques.

2.6.2.4 Benthos

Benthic studies at the TMINS for the years 1967 through 1972 have been summarized by the staff (see Appendix B) and applicants.[1] Beginning in 1974, sampling was conducted at five stations (Reference 13, Figure 1, Appendix B) on a semi-monthly basis from April through October.[1,10] About 35,000 organisms representing 39 taxa (Appendix C, Table C-4) were collected during the sampling period. Specimens accounting for 93% of those collected were Limnodrilus hoffmeisteri (70%), Chironomus sp. (17%) and Procladius sp. (6%). During the study, Limnodrilus hoffmeisteri and Chironomus sp. were most abundant at each station each month.

Diversity indices per month per station, and biomass per square meter and numbers per square meter have been calculated for selected organisms.[10] Numbers per square meter for the most abundant taxa collected are shown in Table 2.12. Highest number/m^2 for Limnodrilus hoffmeisteri at each station occurred in June at Stations 2, 4 and 5, in July at Station 3, and October for Station 1. The greatest density at a single sampling was observed in June at Station 4. From July through October L. hoffmeisteri remained relatively constant at Station 3. Levels at this station were higher than at the other stations during this period. Densities at all stations, except 3, varied throughout the sampling period. Highest densities at each station for Chironomus sp. occurred in June at Stations 2, 4 and 5, August at Station 1 and September at Station 3. Maximum numbers/m^2 were collected at Station 5 during June. For Procladius sp. greatest densities at each station were obtained in August, except for the September maximum at Station 3. Maximum density of Procladius sp. occurred at Station 2 during August. Changes in densities of the midge larva (Chironomus sp. and Procladius sp.) have been partially attributed to insect emergence.

2.6.2.5 Fish

Fish studies at the TMINS for the periods 1970 through 1972 and 1974 have been previously described in detail.[1,10,11,12] During 1970 through 1972, about 17,000 fish were collected primarily by trap nets and electrofishing. Punkinseed, channel catfish, white crappie and bluegill were most abundant and made up about 26% of the total catch. Table C-5 (Appendix C) lists the fish caught during 1970-72 and 1974 in the vicinity of the TMINS.

Beginning in 1974, fish were sampled by seine, trap net, fyke net, trawl and electrofishing. Additional efforts were initiated to characterize population size, movement, food habits and fishing pressure in the TMINS area.[12] Fish collected from March through August 1974 from four types of gear is shown in Table 2.13. Additional collection data from the various gear are available through November 1974.[1,10,11,12] During 1974 the minnows and perches were most abundant with the spottail shiner, spotfin shiner and tessellated darter predominating. Suckers and both juvenile and adult channel catfish were common in late spring and early summer. Adult white catfish and brown bullhead were about as common as adult channel catfish. Additional abundant species in the plant vicinity were rock bass, redbreast sunfish, pumpkinseed, bluegill, smallmouth bass and white crappie.

Population estimates in November 1974 indicated a higher number of redbreast sunfish upstream than downstream. Although no other species estimates were made, catch per effort data suggested that upstream fish concentrations were greater than downstream concentrations. Tagging of fish from May through November 1974 in order to determine movement patterns resulted in most fish being recaptured in the initial tagging area. Number of recaptured fish, however, was too low to draw definite conclusions. Common foods of the channel catfish were gammarids, gastropods and chironomids while the brown bullhead fed on unidentified material, crayfish and filamentous algae. Rock bass fed on gammarids, crayfish and fish; redbreast sunfish on gammarids, crayfish, mayflies and caddisflies; smallmouth bass on crayfish and fish; and walleye on fish. During the May through December 1974 creel census, 2,039 anglers were contacted over 35 survey days. About 3,000 fish of 23 species were caught with 45% being harvested. From May through December 1974 an estimated (calculation) 10,800 anglers fished 20,000 hours and caught 15,700 fish. About 39% of the fish were caught in an area including the east and west shores; islands and open waters of York Haven Pond to about 3.5 miles upstream of the dams.

TABLE 2.11

SUMMARY OF LARVAL FISHES TAKEN IN DAYTIME 0.5 M NET TOWS DURING MAY THROUGH SEPTEMBER 1976

Date	May 13	May 20	May 29	Jun 4	Jun 11	Jun 17	Jun 25	Jul 2	Jul 9	Jul 15	Jul 23	Jul 29
Cyprinidae	-	6	16	10	2	7	-	3	-	6	2	-
Cyprinus carpio	-	-	-	-	-	2	-	-	-	-	-	-
Cyprinus carpio/Carassius auratus	1	-	1	70	22	12	2	1	-	39	2	-
Notemigonus crysoleucas	-	-	-	-	-	-	1	-	-	-	-	-
Notropis spilopterus	-	1	-	-	-	3	-	-	4	1	-	3
monthly subtotal		25				132				61		
Catostomidae												
Carpiodes cyprinus	1	39	70	18	3	-	-	-	-	-	-	-
Catostomus commersoni	-	1	-	-	-	-	-	-	-	-	-	-
monthly subtotal		111				21						
Ictaluridae												
Ictalurus punctatus	-	-	-	-	-	-	6	12	-	-	-	-
monthly subtotal						6				12		
Centrarchidae												
Ambloplites rupestris	-	-	-	-	-	-	-	1	-	-	-	-
Lepomis spp.	-	-	-	-	-	-	-	1	-	-	-	-
monthly subtotal										2		
Percidae												
Etheostroma olmstedi	-	-	-	-	-	-	-	-	-	-	-	-
Etheostroma zonale	-	-	-	-	-	-	-	3 1Y	-	-	-	-
Perca flavescens	-	-	1	-	-	-	1	-	-	-	-	-
Percina peltata	1	1	-	-	-	-	-	1	-	-	-	-
Perca flavescens/Percina peltata	-	-	-	-	-	1	-	-	-	-	-	-
monthly subtotal		3				2				4		
Daily total	3	48	88	98	27	26	10	22	4	46	4	3
Monthly total		139				161				79 1Y		

TABLE 2.11 (Continued)

Date	Aug 7	Aug 12	Aug 21	Aug 27	Sep 5	Sep 9	Subtotal	Total	Young	Percent
Cyprinidae	2	-	-	-	-	-		54		
Cyprinus carpio	-	-	-	-	-	-		2		
Cyprinus carpio/Carassius auratus	-	-	-	-	-	-		151		
Notemigonus crysoleucas	-	-	-	-	-	-		1		
Notropis spilopterus	2	-	-	-	1Y	-		14	1Y	
monthly subtotal		4			1Y		222			57.96
Catostomidae										
Carpiodes cyprinus	-	-	-	-	-	-		131		
Catostomus commersoni	-	-	-	-	-	-		1		
monthly subtotal							132			34.46
Ictaluridae										
Ictalurus punctatus	-	-	-	-	-	-		18		
monthly subtotal							18			4.70
Centrarchidae										
Ambloplites rupestris	-	-	-	-	-	-		1		
Lepomis spp.	-	-	-	-	-	-		1		
monthly subtotal							2			0.52
Percidae										
Etheostoma olmstedi	-	-	-	-	-	1Y			1Y	
Etheostoma zonale	-	-	-	-	-	-		3	1Y	
Perca flavescens	-	-	-	-	-	-		2		
Percina peltata	-	-	-	-	-	-		3		
Perca flavescens/Percina peltata	-	-	-	-	-	-		1		
monthly subtotal					1Y		9			2.35
Daily total	4	-	-	-	-	-		383	3Y	
Monthly total		4			2Y			383	3Y	

TABLE 2.12

NUMBER/M^2 OF THE MOST ABUNDANT MACROINVERTEBRATES COLLECTED AT TMINS, APRIL THROUGH OCTOBER 1974*

Limnodrilus hoffmeisteri

Station Number	Apr	May	Jun	Jul	Aug	Sep	Oct
1	810	1167	886	406	525	789	1172
2	1238	888	3015	1626	820	1489	1792
3	2013	2266	1059	3381	2460	3248	3260
4	-**	2987	5565	2617	1363	1056	1329
5	1319	1727	2781	2134	1893	1352	1094

Chironomus sp.

Station Number	Apr	May	Jun	Jul	Aug	Sep	Oct
1	2	24	17	71	414	356	208
2	364	149	1172	466	404	151	110
3	215	71	85	73	241	425	28
4	-**	505	1848	227	128	1052	97
5	17	262	2557	501	399	1448	24

Procladius sp.

Station Number	Apr	May	Jun	Jul	Aug	Sep	Oct
1	-**	-**	9	-**	149	84	26
2	-**	-**	248	135	766	607	208
3	14	17	7	9	470	636	38
4	-**	38	-**	32	302	298	132
5	50	40	168	71	170	64	95

*Sampling stations shown in Figure 1, Appendix B, Reference 13.

**Indicates species not present or no measurement made.

TABLE 2.13

FISHES IN THE VICINITY OF THREE MILE ISLAND[a]

Species	Gear: Seine	Trawl	Trapnet	Shocker	Total	Rank[b]
Goldfish	-	-	-	1	1	
Carp	-	3	8	-	11	
Cutlips minnow	1	-	-	-	1	
River chub	1	-	-	-	1	
Golden shiner	13	-	18	3	34	
Comely shiner	43	-	-	-	43	
Common shiner	10	-	-	-	10	
Spottail shiner	3976	155	-	-	4131	1
Swallowtail shiner	489	22	-	-	511	6
Spotfin shiner	1447	15	22	1	1485	2
Bluntnose minnow	171	-	-	-	171	
Blacknose dace	1	-	-	-	1	
Longnose dace	1	-	-	-	1	
Creek chub	87	-	-	-	87	
Fallfish	2	-	1	-	3	
Quillback	12	18	10	21	61	
White sucker	541	1	3	23	568	4
Northern hog sucker	19	2	-	4	25	
Shorthead redhorse	15	3	-	16	34	
White catfish	1	-	7	1	9	
Yellow bullhead	-	-	3	-	3	
Brown bullhead	2	1	38	22	63	
Channel catfish	55	14	569	37	675	3
Margined madtom	-	-	1	-	1	
Rock bass	8	1	151	162	322	8
Redbreast sunfish	8	-	69	189	266	9.5
Pumpkinseed	5	1	176	240	422	7
Bluegill	35	1	46	25	107	
Smallmouth bass	81	4	2	179	266	9.5
Largemouth bass	1	-	-	3	4	
White crappie	2	-	175	3	180	
Black crappie	-	-	38	5	43	
Tessellated darter	270	289	-	-	559	5
Banded darter	1	1	-	-	2	
Walleye	-	-	-	11	11	
Total	7298	531	1138	945	10112	

[a]Fish were taken in the vicinity of TMI with four types of gear during March through August 1974.

[b]Rank was established from totals of all gear collections and should not be interpreted as relative abundance due to different amounts of effort/gear and gear selectivity.

REFERENCES FOR SECTION 2

1. Metropolitan Edison Company, Supplement II, Environmental Report, Operating License Stage - Unit 2, February 1975.

2. Water Quality Criteria, 1972, A Report of the Committee on Water Quality Criteria, National Academy of Sciences, National Academy of Engineering, Washington, D.C., 1972.

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9. Korshover, J., 1971: Climatology of Stagnating Anticyclones East of the Rocky Mountains, 1936-1970. NOAA Technical Memorandum ERL ARL-34, Silver Spring, Md.

10. Ichthyological Associates, Inc., An Ecological Study of the Susquehanna River in the Vicinity of the Three Mile Island Nuclear Station. Annual Report for 1974. February 1975. 468 p.

11. Metropolitan Edison Company et al., Environmental Report Operating License Stage. 1971.

12. Ichthyological Associates, Inc. An Ecological Study of the Susquehanna River in the Vicinity of the Three Mile Island Nuclear Station. Supplemental Report for 1974. April 1975. 209 p.

3. THE PLANT

3.1 RÉSUMÉ

There were no major changes in the design of the plant since the issuance of the FES in December 1972, consequently there were no modifications in the liquid, gaseous and solid radioactive waste treatment systems. These systems have been reassessed in Section 3.2 using revised parameters and mathematical models for calculating the releases of radioactive materials in liquid and gaseous effluents.

Additional information on chemical and biocide systems, as well as on sanitary and other waste is presented in Sections 3.3 and 3.4, respectively. Additional information on changes in the transmission system is presented in Section 3.5.

3.2 DESIGN AND OTHER SIGNIFICANT CHANGES

3.2.1 Radioactive Waste Treatment

Since the Final Environmental Statement (FES-OL) was issued (December 1972), the applicant has not modified the liquid, gaseous and solid radwaste treatment systems as described in the Final Safety Analysis Report (FSAR) and in the Environmental Report (ER).

3.2.1.1 Appendix I Requirements

On April 30, 1975, the Nuclear Regulatory Commission announced its decision in the rulemaking proceeding (RM 50-2) concerning numerical guides for design objectives and limiting conditions for operation to meet the criterion "as low as practicable" for radioactive material in light-water-cooled nuclear power reactor effluents. This decision is implemented in the form of Appendix I to 10 CFR Part 50. To effectively implement the requirements of Appendix I, the NRC staff has reassessed the parameters and mathematical models used in calculating releases of radioactive materials in liquid and gaseous effluents in order to comply with the Commission's guidance.

This guidance directed that current operating data, applicable to proposed radwaste treatment and effluent control systems for a facility, be considered in the assessment of the input parameters. The staff has completed its reassessment, and these parameters, models, and their bases are given in NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," April 1976.

3.2.1.2 Appendix I Evaluation

By letter of February 23, 1976, the applicant was requested to submit additional information concerning the means proposed to be employed to keep levels of radioactive materials in effluents from the Three Mile Island Nuclear Station, Unit No. 2, to unrestricted areas "as low as reasonably achievable" (formerly "as low as practicable") in accordance with the guidelines of Appendix I to 10 CFR Part 50 and was given the option of providing either a cost-benefit analysis or demonstrating conformance to the guidelines given in the Annex to Appendix I. The applicant's evaluation was contained in a submittal dated June 4, 1976, and in supplements to that submittal. In that submittal, Metropolitan Edison Company chose to perform the cost-benefit analysis required by Section II.D of Appendix I to 10 CFR Part 50.

The staff performed an independent evaluation of the applicant's proposed methods to meet the requirements of Appendix I. The evaluation is given in a supplement to the SER and is summarized below. The evaluation consisted of: (1) a review of the information provided by the applicant, (2) a review of the applicant's proposed radwaste treatment and effluent control systems, (3) the calculation of new source terms based on models and parameters as given in NUREG-0017 (April 1976), "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)", and (4) the calculations of the cost-benefit ratio for potential radwaste system additions, using doses based on the source terms calculated in (3) above, and guidance as given in Regulatory Guide 1.110, "Cost-Benefit Analysis for Radwaste systems for Light-Water-Cooled Nuclear Power Reactors," (March 1976).

Individual and population doses were calculated using the guidance in Regulatory Guide 1.109, "Calculation of Annual Average Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," (March 1976).

The relative concentration and deposition estimates were based on the straight-line flow method and deposition curves presented in Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Cooled Reactors," using the open terrain recirculation factors as described in this Guide.

The staff's evaluation considered releases of radioactive materials in liquid and gaseous effluents for normal operation including anticipated operational occurrences based on expected radwaste inputs over the 30 year operating life of the plant.

The principal radionuclides expected to be released in liquid and gaseous effluents are given in Tables 3.2 and 3.3 of this supplement. A list of the parameters used in these determinations is given in Table 3.1.

Based on the evaluation of the gaseous waste treatment systems, the staff calculated the total releases of radioactive materials in gaseous wastes to be approximately 6,700 Ci/yr for noble gases and 0.01 Ci/yr for iodine-131. In its evaluation, the applicant estimated the gaseous releases to be approximately 14,000 Ci/yr for noble gases and approximately 0.031 Ci/yr for iodine-131. Based on the evaluation of the liquid waste systems, the staff calculated the releases of radioactive materials in liquid wastes, including anticipated operational occurrences, to be approximately 0.24 Ci/yr, excluding tritium and dissolved gases. The staff calculated the tritium release to be approximately 550 Ci/yr. The applicant estimated the liquid release to be approximately 0.19 Ci/yr, excluding tritium and dissolved gases, and 550 Ci/yr for tritium.

Using the calculated releases of radioactive materials in liquid effluents, given in Table 3.2, and the methodology given in Regulatory Guide 1.109, the staff calculates the annual dose or dose commitment to any individual in an unrestricted area from all pathways of exposure to be less than 3 mrem to the total body or 10 mrem to any organ (see Section 5.4, Radiological Impact).

Using the calculated releases of radioactive materials in gaseous effluents given in Table 3.3, the staff calculates the annual gamma and beta air doses at or beyond the site boundary to be less than 10 mrad and 20 mrad, respectively. Using the calculated releases of radioiodine and radioactive material in particulate form, given in Table 3.3, the staff calculates the annual dose or dose commitment to any individual in an unrestricted area from all pathways of exposure to be less than 15 mrem to any organ (see Section 5.4, Radiological Impact).

In conformance with Section II.D of Appendix I, the staff considered the potential effectiveness of augmenting the proposed liquid and gaseous radwaste treatment systems for Unit 2 to reduce the dose to the population reasonably expected within 50 miles of the reactor at a cost of a $1000 per total body man-rem and a $1000 per man-thyroid-rem. Using the calculated man-rems given in Section 5.4, the cost factors given in Table 3.4, and the methodology given in Regulatory Guide 1.110, the staff's cost-benefit analysis concludes that there are no items of reasonably demonstrated technology that, when added to the system can (for a favorable cost-benefit ratio) effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor.

The applicant's evaluation, contained in the submittal of June 4, 1976, concluded that the proposed liquid and gaseous radwaste treatment systems meet the requirements of Sections II.A, B and C of Appendix I to 10 CFR Part 50 and are in conformance with Section II.D, since there are no additional augments of reasonably demonstrated technology which could be added to provide additional population dose reduction at costs less than $1,000 per total body man-rem or $1,000 per man-thyroid-rem.

Based on the staff's evaluation, the staff concludes that the liquid and gaseous radwaste treatment systems are capable of reducing releases of radioactive materials in liquid and gaseous effluents to "as low as reasonably achievable" levels in conformance with 10 CFR Part 50.34a and meet the requirements of Sections II.A, B, C and D of Appendix I to 10 CFR Part 50.

3.2.2 Solid Wastes

Based on recent studies* of the quantities of solid radioactive wastes produced at operating reactors, the staff estimates that approximately 14,000 cubic feet of solidified wet wastes, containing approximately 1,600 Ci, and approximately 4,100 cubic feet of compacted dry wastes, containing less than 5 Ci, will be transported offsite each year.

*Data extracted from semiannual operating reports on ten PWR units.

TABLE 3.1

PRINCIPAL PARAMETERS AND CONDITIONS USED IN CALCULATING RELEASES OF RADIOACTIVE MATERIAL IN LIQUID AND GASEOUS EFFLUENTS FROM THREE MILE ISLAND NUCLEAR STATION, UNIT 2

Reactor Power Level (MWt)	2800
Plant Capacity Factor	0.80
Failed Fuel	0.12%[a]
Primary System	
Mass of Coolant (lbs)	7.2×10^5
Letdown Rate (gpm)	45
Shim Bleed Rate (gpd)	1.5×10^3
Leakage to Secondary System (lbs/day)	100
Leakage to Containment Building	b
Leakage to Auxiliary Building (lbs/day)	160
Frequency of Degassing for Cold Shutdowns (per year)	2
Secondary System	1.2×10^7
Steam Flow Rate (lbs/hr)	1.4×10^3
Mass of Steam/Steam Generator (lbs)	2.7×10^4
Secondary Coolant Mass (lbs)	3.0×10^6
Rate of Steam Leakage to Turbine Building (lbs/hr)	1.7×10^3
Fraction of Feedwater Processed through Condensate Demineralizers	0.7
Containment Building Volume (ft^3)	2.1×10^6
Annual Frequency of Containment Purges (shutdown)	4
Annual Frequency of Containment Purges (at power)	20
Iodine Partition Factors (gas/liquid)	
Leakage to Auxiliary Building	0.0075
Steam Generator (carryover)	1.0
Leakage to Turbine Building	1.0
Main Condenser/Air Ejector (volatile species)	0.15

[a]This value is constant and corresponds to 0.12% of the operating power fission product source term as given in NUREG 0017 (April 1976)

[b]1%/day of the primary coolant noble gas inventory and 0.001%/day of the primary coolant iodine inventory.

TABLE 3.1 (Continued)

	Boron Recovery System (BRS)	Floor Drain Wastes, Inorganic Chemical Wastes, Regenerant Solutions	Laundry and Hot Shower Drains
I	1×10^4	1×10^4	1
Cs, Rb	2×10^4	1×10^5	1
Others	1×10^5	1×10^5	1

	All Nuclides Except Iodine	Iodine
Radwaste Evaporator DF	10^4	10^3
BRS Evaporator DF	10^3	10^2

	Anions	Cs, Rb	Other Nuclides
Boron Recycle Feed Demin. DF (H_3BO_3)	10	2	10
Primary Coolant Letdown Demin. DF (Li_3BO_3)	10	2	10
Evaporator Condensate Polishing Demineralizer (H^+OH^-) DF	10	10	10
Mixed Bed Condensate Demin.	10	2	10
Turbine Air Removal System and Containment Building Internal Recirculation System Charcoal Filter DF (Iodine Removal)			10
Fuel Handling Building and Auxiliary Building Ventilation System Charcoal Filter DF (Iodine Removal)			10

TABLE 3.2

CALCULATED RELEASES OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENTS FROM THREE MILE ISLAND NUCLEAR STATION, UNIT 2
Ci/yr/reactor

Nuclide	Ci/yr	Nuclide	Ci/yr
Corrosion & Activation Products		Fission Products (continued)	
Cr-51	1.4(-4)[a]	Te-129	7(-5)
Mn-54	1(-3)	I-130	9(-5)
Fe-55	1.4(-4)	Te-131m	5(-5)
Fe-59	8(-5)	I-131	4.6(-2)
Co-58	5.3(-3)	Te-132	1.1(-3)
Co-60	8.9(-3)	I-132	2.5(-3)
Zr-95	1.4(-3)	I-133	2.3(-2)
Nb-95	2(-3)	I-134	2(-5)
Np-239	6(-5)	Cs-134	2.6(-2)
Fission Products		I-135	4.7(-3)
Br-83	3(-5)	Cs-136	3(-3)
Rb-86	2(-5)	Cs-137	3.4(-2)
Sr-89	3(-5)	Ba-137m	9.3(-3)
Sr-91	1(-5)	Ba-140	1(-5)
Mo-99	3.7(-2)	Ce-144	5.2(-3)
Tc-99m	2.3(-2)	All Others[b]	6(-5)
Ru-103	1.4(-4)	Total (except H-3)	2.4(-1)
Ru-106	2.4(-3)	H-3	5.5(+2)
Ag-110m	4.4(-4)		
Te-127m	2(-5)		
Te-127	3(-5)		
Te-129m	1.1(-4)		

[a] Exponential notation; 1.0(-4) = 1.0×10^{-4}

[b] Nuclides whose release rates are less than 10^{-5} Ci/yr are not listed individually, but are included in the category "All Others."

TABLE 3.3

CALCULATED RELEASES OF RADIOACTIVE MATERIALS IN GASEOUS EFFLUENTS FROM THREE MILE ISLAND NUCLEAR STATION, UNIT 2
Ci/yr/unit

Nuclide	Waste Gas Processing System	Reactor Bldg	Auxiliary Bldg	Turbine Bldg	Condenser Air Removal Vent	Total
Kr-83m	a	a	a	a	a	a
Kr-85m	a	1	1	a	a	2
Kr-85	280	110	3	a	2	390
Kr-87	a	a	a	a	a	a
Kr-88	a	2	3	a	2	7
Kr-89	a	a	a	a	a	a
Xe-131m	12	50	2	a	a	64
Xe-133m	a	35	3	a	2	40
Xe-133	180	5600	250	a	160	6200
Xe-135m	a	a	a	a	a	a
Xe-135	a	10	5	a	3	18
Xe-137	a	a	a	a	a	a
Xe-138	a	a	a	a	a	a
I-131	a	1.3(-4)	5.5(-3)	1(-3)	3.4(-3)	1(-2)
I-133	a	1.3(-4)	5.8(-3)	1.1(-3)	3.6(-3)	1.1(-2)
Co-60	7(-5)[b]	1.2(-6)	2.7(-4)	a	a	3.4(-4)
Co-58	1.5(-4)	2.6(-6)	6.4(-4)	a	a	7.5(-4)
Fe-59	1.5(-5)	2.6(-7)	6(-5)	a	a	7.5(-5)
Mn-54	4.5(-5)	7.6(-7)	1.8(-4)	a	a	2.3(-4)
Cs-137	7.5(-5)	1.3(-6)	3(-4)	a	a	3.8(-4)
Cs-134	4.5(-5)	7.6(-7)	1.8(-4)	a	a	2.3(-4)
Sr-90	6(-7)	1(-8)	2.4(-6)	a	a	3(-6)
Sr-89	3.3(-6)	5.9(-8)	1.3(-5)	a	a	1.6(-5)
C-14	7	1	a	a	a	8
H-3	a	280	280	a	a	560
Ar-41	a	25	a	a	a	25

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

[b]Exponential notation: 7(-5) = 7 x 10^{-5}.

TABLE 3.4

PRINCIPAL PARAMETERS USED IN THE COST-BENEFIT ANALYSIS

Labor Cost Correction Factor, FPC Region I	1.6
Indirect Cost Factor[a]	1.75
Cost of Money[b]	10%
Capital Recovery Factor[c]	0.1061

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

[b]Applicant did not provide his cost of money; the value of 10% was derived from a recent annual Report and Prospectus.

[c]The applicant provided a value of 16% as his Capital Recovery Factor. The value of 16% is not consistent with the applicant's cost of money and a 30-year recovery period, and would be more appropriate as a fixed charge rate; therefore, the staff assumed a value of 0.1061 for the Capital Recovery Factor. This assumption does not change the results of the staff's evaluation.

3.3 CHEMICAL AND BIOCIDE SYSTEMS

Chemicals will be used at the station for the production of high purity water in the primary coolant loop and for control of scaling and fouling in the circulating water system. Evaporation will also cause an increase in concentration of chemicals in the circulating water system. The chemicals used in significant quantities at the station are listed in Table 3.5.

3.3.1 Condenser Scale Control

As water is evaporated from the circulating water system in the cooling towers, the concentration of carbonates increases toward the limit of its solubility. Concentration is prevented from reaching this critical level by a combination of chemical treatment and blowdown control. For about six months of the year when there is excess alkalinity present in the river, sulfuric acid will be added to the circulating water in the condenser cooling water circuits at an average rate of 12,200 pounds per day for both units to reduce the possibility of scale formation in the condensers. This additional rate could increase by a maximum factor of 2.5 when carbonate alkalinity of the makeup water is highest. The acid, which acts to convert bicarbonates to carbonic acid, forms sulfates in equilibrium with the various cations in the makeup water, and is eventually released with the 7,000 gpm blowdown from the two units. The blowdown is mixed with the service water before it is returned to the river. Using an average plant discharge of 36,000 gpm the average increment in the sulfate concentration of the release will be about 28 mg/l. If the maximum acid use rate should correspond to average station discharge, incremental concentration would be 70.5 mg/l. When mixed in the river with the low flow of record (1,700 cfs), the concentration increases in the river would be 1.3 and 3.3 mg/l under average maximum acid use rates. Closer inspection of the water quality data (see Appendix B of Appendix B) shows the bicarbonate ion concentration is inversely related to river flow although there is quite a lot of scatter to the data. It should, therefore, be expected that maximum acid use could occur at minimum river flow.

In addition to the acid intentionally added to the blowdown, the concentration of the naturally occurring salts in the river water will be allowed to increase by a factor of about 5 (Appendix B, page III-25) in the circulating water system as evaporation of water occurs. Blowdown will prevent it from increasing further. Because of dilution with service water flow, the water returned to the river will be at a concentration of only about 1.5 times the river concentration due to the evaporation. However, the evaporation of water at a rate of 20,000 gpm from the 1,700 cfs low flow of record only results in an increase of concentration of dissolved substances in the river of about 2.7%. This is the increase that can be expected at the greater distance downstream from the plant after mixing of blowdown with river flow is complete. Thus, the concentration effect of the cooling system will only produce measurable concentration changes in the immediate vicinity of the discharge.

TABLE 3.5

MAJOR CHEMICALS USED AT THE STATION

	Average quantity released (lbs/yr)	Incremental concentration in water released to environment during batch discharge (mg/l)	Incremental increase in concentration in Susquehanna after complete mixing with low flow of record (mg/l)
Regeneration of water treatment demineralizers (Units 1 & 2):			
H_2SO_4	485,000	29 (as SO_4)	1.3
NaOH	312,000	11 (as Na)	.5
Condensate polishers (Unit 2) only):			
H_2SO_4	210,000	30 (as SO_4)	1.4
NaOH	173,000	14 (as Na)	.5
Sulfuric acid added to cooling tower circuit for pH control (Units 1 & 2)	4,450,000	28* (as SO_4)	1.3
Concentration of river water substances in cooling tower blowdown (Units 1 & 2)	-	40*	2.7
Chlorine gas used as biocide (Units 1 & 2):			
Service water chlorination	73,000	0.3 ppm†	Undetectable
Cooling tower circuits chlorination	365,000		

*Continuous discharge at this level, see text.

†Total residual chlorine.

There are several other steam electric power stations on the Susquehanna. Appendix R of the Susquehanna River Basin Study shows 18 stations with a total projected capacity of 8,746 MWe. As a crude first approximation of the cumulative effect of power production on water quality, it can be assumed that the other stations might evaporate about the same amount of water per unit of power production as TMINS. Thus collectively steam electric power production might evaporate about 10% of the low flow of record and might thereby increase concentration of dissolved substances by the same amount.

3.3.2 Biocide Treatment

A mechanical system (Amertap) will be used to maintain condenser tube cleanliness. Approximately 1,000 pounds of chlorine per day per unit will be injected into the circulating water system for algae and plant growth control. Chlorine will be added from one to four times per day for periods of 15 to 30 minutes each. Most of the chlorine will be reduced immediately to chloride ion by various substances comprising the "chlorine demand" of the make-up water (see Table 2.5.31). The residual chlorine in the blowdown will be mixed with service water flow where dilution and further reduction will occur.

It will also be necessary to treat service water with about 200 lbs/day of chlorine to control growth of biological slimes in auxiliary heat exchangers. This chlorine will be added over several short periods as is done for treatment of the circulating water system. The two systems will not be treated simultaneously. Therefore, residual chlorine in the service water system will be diluted and reduced by substances in the circulating system blowdown. The service water flow rate is several times the blowdown flow rate; thus dilution will provide only a small decrease in residual chlorine concentration in the service water.

The chlorination system for Unit 2 is the same as that for Unit 1. The applicant has operating experience with Unit 1 which gives a better indication of expected discharge concentration. He has found consistently virtually undetectable residual chlorine in the station effluent when chlorinating the circulating water system. However, the chlorination program has failed to provide satisfactory control of algal growth in the cooling tower distribution trays. The applicant has indicated to the NRC a need to change his chlorination procedures to achieve better control. He has undertaken a study in which the chlorination program will be varied systematically to determine an effective method of control. Thus chlorination of the circulating water system is eventually likely to be somewhat different from that described above.

Operation of Unit 1 has shown that, on occasion, during chlorination of the service water system higher concentrations of residual chlorine in the discharge are produced. The total and free residuals are limited to 0.2 mg/l and 0.1 mg/l, respectively, by the Environmental Technical Specifications. Additionally, the duration of discharge of total residual chlorine in excess of 0.01 mg/l is limited to two hours per day. The limit on total residual has been exceeded twice and the limit on free residual has been exceeded five times. The single exceedence of the time limitation was attributed to a leaking chlorine carboy. These occurrences are shown in Table 3.6.

At no time did total residual chlorine exceed 0.3 mg/l. When both, total and free chlorine, were reported as being present the ratio of total to free was about 3. Since the Technical Specifications for Unit One require that chlorine residual be monitored continuously, the record indicates that the discharge concentration seldom exceeds 0.2 mg/l.

3.3.3 Demineralization

3.3.3.1 Demineralizer Regeneration Solutions

Sulfuric acid and sodium hydroxide solutions will be used for regenerating resins in the two-stage feed water demineralizers used for both Units 1 and 2. These materials will be disposed of on a batch basis; each batch, for a given unit, consists of 2,000 pounds of sulfuric acid and 1,300 pounds of sodium hydroxide diluted in 70,000 gallons of water. In the Unit 1 system the resulting solution of sodium sulfate, with a pH between 6 and 9, will be released every three days at a controlled rate over a 4-hour period (about 300 gpm flow rate). The waste solution will be diluted with the 36,000 gpm cooling water effluent of the forced-draft cooling towers prior to discharge to the river. The resulting concentration increase will be 29 mg/l. For the two units, the total discharge period will be 8 hours every three days. The Unit 2 system is designed for automatic neutralization and continual discharge. However, the system is capable of batch neutralization if the need arises.

The increase in concentration of sulfate in the effluent due to demineralizer regeneration solution will be of the same magnitude as the increase due to use of acid in the circulating

TABLE 3.6

THREE MILE ISLAND UNIT 1 OCCURRENCES OF CHLORINE CONCENTRATION EXCEEDING LIMITS IN TECHNICAL SPECIFICATIONS

Occurrence Number	Date	Conc[c]	System Chlorinated
74.02	May 29, 1974	<0.2T 0.15F	Service
74.04	June 6, 1974	0.25T	Service[a]
74.05	June 8, 1974	0.13T 0.10F	Service
74.06	June 13, 1974	0.13T 0.13F	Service
74.07	June 26, 1974	0.125T 0.125F	Service
74.09	Sept. 26, 1974	0.10F	Service
75.01	Jan. 24, 1975	<0.1F 0.29T	Service
75.03	Apr. 17, 1975	<0.04T 0.01T>2 Hrs.	(b)

(a) May have been measurement error.

(b) Leaking hypochlorite carboy.

(c) T denotes total chlorine residual concentration and F denotes free residual concentration, units are mg/l.

water system. The combined effect of the two sources of sulfate will be concentration increases in the river of 2.6 and 4.6 mg/l during average and maximum acid use. This would occur after mixing in the river during the low flow of record.

The amounts listed in Table 3.4 are the total quantities of acid and base used annually for the two units at the station. The concentrations in the second column of the table, however, occur in the 36,000 gpm cooling water effluent only during the batch discharge from a single unit, since the two units discharge their batches at different times.

3.3.3.2 Condensate Polisher Regeneration Solutions

The condensate polishers for Unit 1 are the wound element filter type precoated with powered resin. The spent resin is washed out and discharged to the sludge treatment house rather than being regenerated, hence no regeneration chemicals are used. The condensate polishers for Unit 2, however, are deep bed demineralizers and produce dilute waste solutions of sulfuric acid and sodium hydroxide from the regeneration of the demineralizers. The quantities used are 2,300 pounds of sulfuric acid and 1,900 pounds of sodium hydroxide per regeneration cycle, which occurs every fourth day. These chemicals, dissolved in 60,000 gallons of water, comprise a batch which is released over a period of four hours every four days (about 250 gpm flow rate). This batch is neutralized and diluted in the effluent from the forced draft cooling tower prior to being released to the river.

This will result in an effluent concentration increase of about 30 mg/l of sulfate and will increase concentration in the river by about 1.4 mg/l after being mixed with the low flow of record. This concentration increase is about the same as for demineralizer regeneration. The combined effect of both systems will be a discharge at the higher concentration on the average of 11 hours every three days.

3.4 SANITARY WASTES AND OTHER WASTES

At the time of submittal of the Environmental Report, the applicant was redesigning the sanitary waste system to increase its capacity and to provide means for phosphate removal as required by the Commonwealth of Pennsylvania. The system will effect pollutant removal to the level required of municipalities in the region.

The chemicals and additives used in the makeup water pretreatment system generate a sludge consisting mainly of fine silt, suspended matter from the river, and clay which is added to assist in coagulation. The sludge is separated from the carrier water by filtration which is a 95% removal efficiency, resulting in compressed dewatered "blocks". The blocks, approximately 2,000 pounds/day, will be collected and trucked off site to an approved sanitary landfill. An additional 66 pounds/day of solid sludge cake from the sanitary waste system will also be disposed in an approved offsite sanitary landfill.

Two 3,000-kW diesel generators per unit are provided for emergency use such as loss of off-site power. Each will be tested periodically for a one hour period. The test will be conducted with load on the generators to minimize diesel exhaust effects. During periods when one diesel-generator is under repair, the other is started and run for the duration of that repair. The operation of the diesel is very intermittent and diesel exhaust will consequently have little effect on the environment.

Two 125,000-lb/hr auxiliary steam boilers are provided solely for start-up purposes (the plant is electrically heated). Both boilers are required for start-up which will occur approximately once per year until TMINS-2 is operational and after that, twice per year. No. 2 fuel oil will be burned and the exhaust gas will be discharged in a single 127-ft high stack.

No refuse incinerator is now planned; solid wastes removal will be handled by a state-approved contractor.

3.5 TRANSMISSION SYSTEM

Since December 1972, the applicant has eliminated the previously proposed substation on the 500-kV line located near Bechtelsville, Pennsylvania, and extended the transmission line an additional 7.36 miles to a substation located near Hosensack, Pennsylvania. Figure 3.1 shows schematically the 500-kV transmission system. Figure 3.2 shows detailed routing of the additional 7.36 miles of the transmission line.

The 7.36 mile stretch of the transmission line runs parallel to an existing 230-kV line and required widening of the right-of-way by 175 feet. Before the decision to eliminate Bechtelsville substation was made, the subject 7.36-mile stretch was being built as part of the local transmission system. The line was being constructed as a 500-kV line but was going to be energized only to 230 kV.

There were no changes required in the design or construction due to the decision to designate Hosensack substation in lieu of Bechtelsville substation as the terminal point of the transmission line under consideration and as the interconnecting point on the existing high-voltage transmission system.

In addition to providing means for distribution of the Three Mile Island Unit 2 power output, this line completes third west to east 500-kV transmission path in the Pennsylvania-New Jersey-Maryland (PJM) bulk power interconnected network east of the Susquehanna River.[1] The third west-east 500-kV path consists of a circuit TMINS-Hosensack-Elroy of which TMINS-Hosensack portion is considered in this review.[1]

A study prepared in 1971 by the Mid-Atlantic Area Council (MAAC) concluded that the third west to east 500-kV line is essential to meeting the MAAC reliability criteria.[2] The study also stated that without the third west to east link outages of either of the two existing west to east 500-kV lines, Peach Botton-Whitpain and Juniata-Branchburg, would impose the most severe transmission limitation in the PJM interconnection, resulting in severe overloads in the Phiadelphia Electric System and possibly in other systems as well. The PJM Planning and Engineering Committee recommended that the construction of that line be given the utmost priority.[2]

The MAAC in its annual reliability review report of April 1973 reaffirmed the above mentioned conclusion and identified that line as one of the critical transmission lines in the MAAC region.[3] This conclusion has been restated also in MAAC system plans reports for the years 1974, 1975 and 1976.[4,5,6]

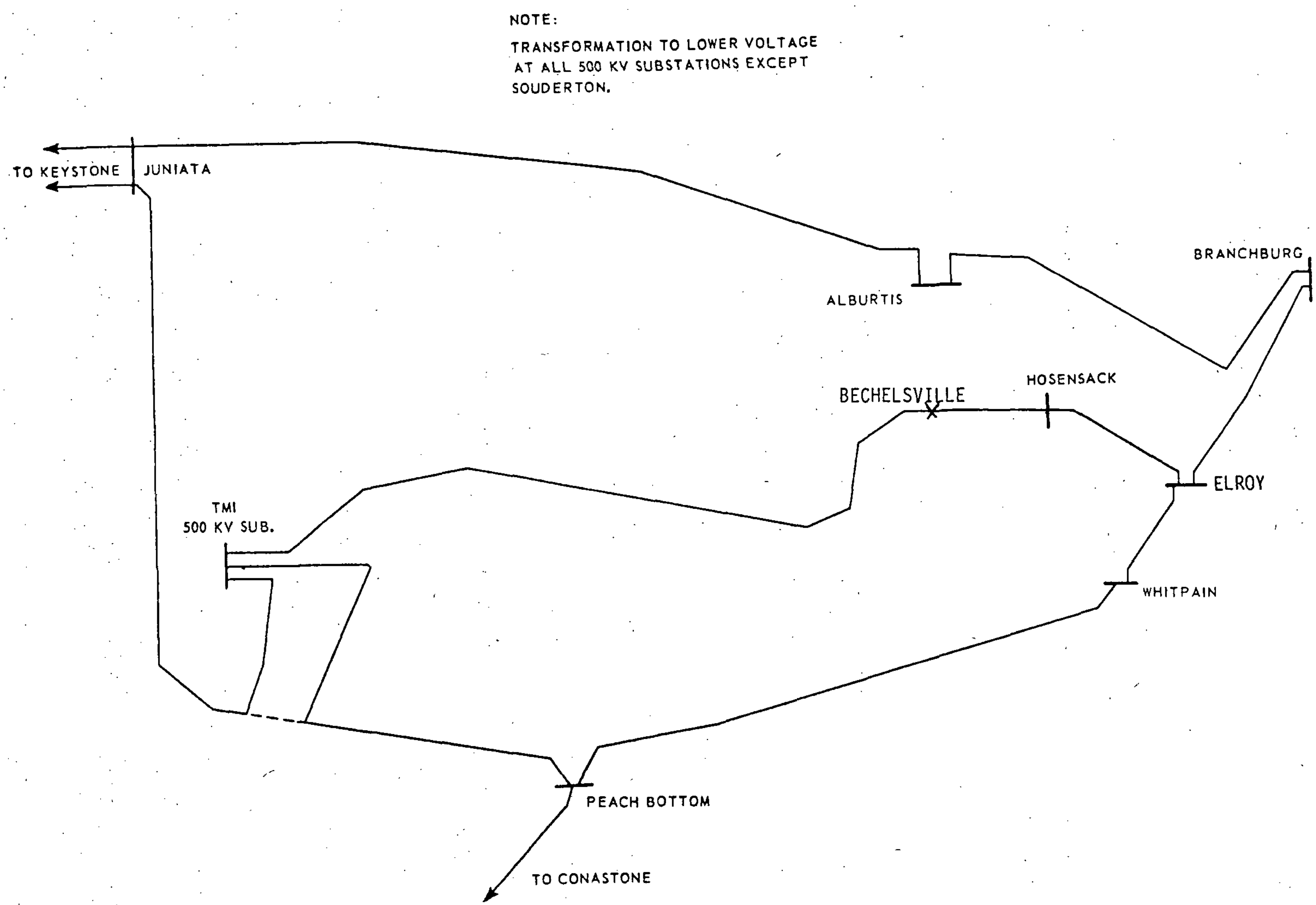

Fig. 3.1. 500 Kv Transmission, Three Mile Island Nuclear Station. From Figure 3.2-2 (AM. 2 4-30-73)

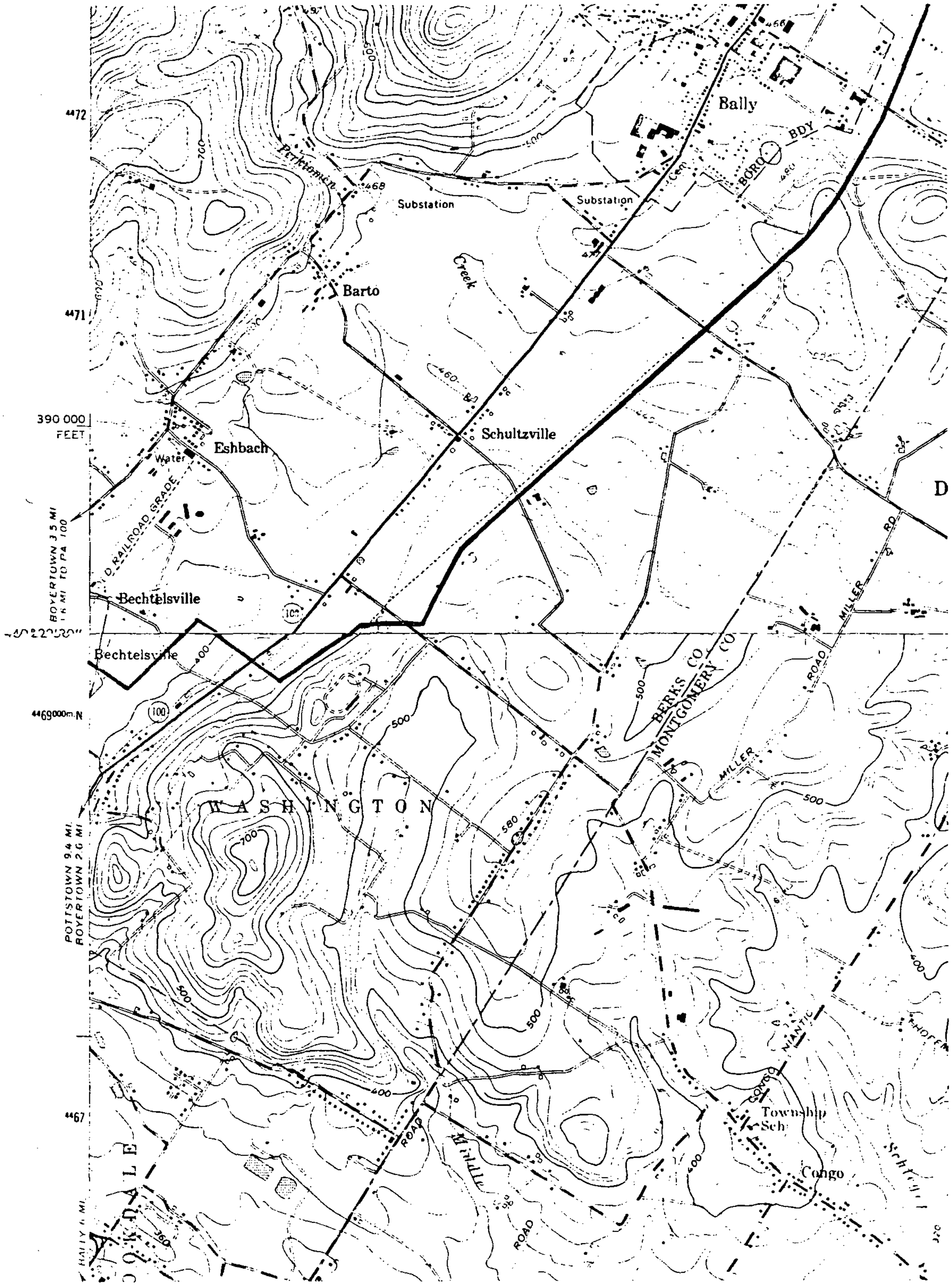

Fig. 3.2 Detailed routing of the transmission line from Bechtelsville to Hosensack - Part I

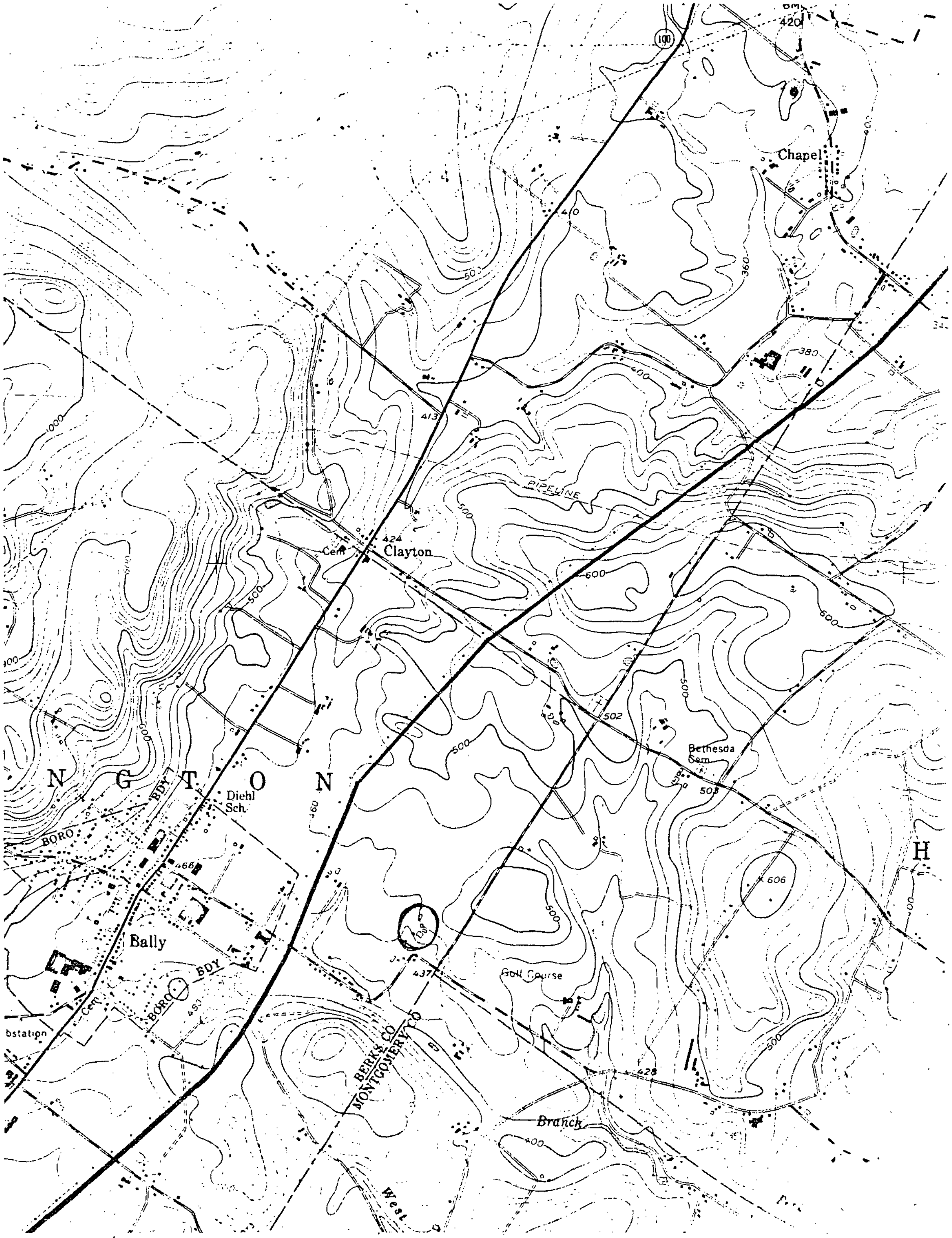

Fig 3.2a Detailed routing of the transmission line from Bechtelsville to Hosensack - Part II

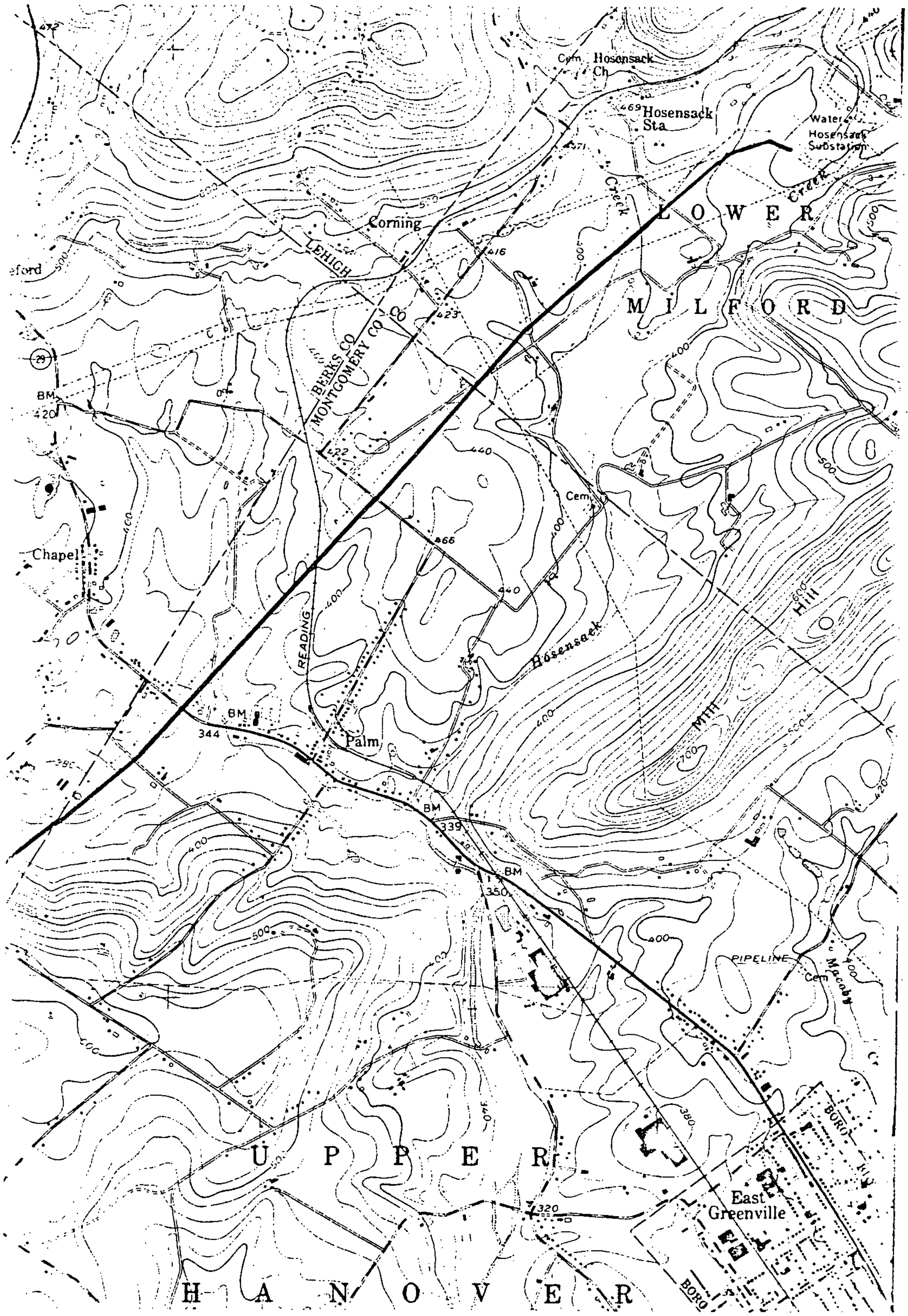

Fig 3.2b Detailed routing of the transmission line from Bechtelsville to Hosensack - Part III

REFERENCES FOR SECTION 3

1. Affidavit of Paul E. Winter, Answer to interrogatory No. 36, July 14, 1975.

2. "MAAC System Reliability Review, Fall 1971," prepared by MAAC Area Coordination Committee, November 19, 1971.

3. "MAAC System Plans," Mid-Atlantic Area Council, April 1, 1973.

4. "MAAC System Plans," Mid-Atlantic Area Council, April 1, 1974.

5. "MAAC System Plans," Mid-Atlantic Area Council, April 1, 1975.

6. "MAAC System Plans," Mid-Atlantic Area Council, April 1, 1976.

4. ENVIRONMENTAL IMPACT OF SITE PREPARATION AND CONSTRUCTION

4.1 RÉSUMÉ

As of July 1976, the exterior structures of all major buildings have been completed. The work presently under way consists of installation of interior electrical and mechanical equipment. Final grading and landscaping is planned for May 1978 at which time TMINS Unit 2 will be completed. Updated information on land use and water use is presented in Sections 4.2 and 4.3. Additional information on ecological systems is shown in Section 4.4. Findings relating to the effects of the plant construction on the community developed from the staff's discussion with local and regional officials are summarized in Section 4.5.

4.2 IMPACTS ON LAND USE

The FES-OL, December 1972, adequately discusses impacts of site preparation and construction on land use (see Appendix B, Section IV). Such impacts were restricted primarily to Three Mile Island and a small area totalling ten acres on the river east bank. The impacts on TMI were mostly restricted to land previously disturbed by farming. About twenty-eight additional acres of wooded land were disturbed. Almost all major building activity has been completed. Remaining construction activity will focus on building interiors, wiring, start-up, etc. The updated schedule for completion of the exterior portions of buildings for Three Mile Island Nuclear Station, Unit 2 is presented in Table 4.1.

4.3 IMPACTS ON WATER USE

According to the applicant, the site preparation work and the construction of facilities in adjacent waters has essentially been completed with no significant adverse effects on water quality, flood control, or navigation.[1] The applicant reported several construction activities which resulted in temporary increases in turbidity and localized siltation. Because that reach of the Susquehanna River is characterized by intermittently high turbidity and by shifting bottom sediments and because of the temporary nature of the construction effects, it is concluded that the consequences of the construction activities were not significant.

4.4 EFFECTS ON ECOLOGICAL SYSTEMS

4.4.1 Terrestrial

Construction of Station Facilities

The basic discussions presented in the FES-OL, December 1972, in Section IV.B.1.A remain valid (see Appendix B). The applicant has provided a more current description of effects on terrain, vegetation and wildlife.[1]

Approximately 190 acres of land have been removed for the duration of the plant life from use for agriculture or wildlife habitat. An additional eighteen acres were cleared for roads and storage areas and will remain thus until the end of construction. Transient conditions in the borrow pits (about 23 acres) and on site wetlands (about 3 acres) have created temporary conditions favorable to some species. Pumping of dredge slurry to the borrow pits has ceased and the pits were expected to dry up in late summer. Several acres have been filled with spoil from temporary dikes. The areas of intermittent wetland were ditched and drained incidental to station construction.

Noise and human activity have decreased the attractiveness of the uncleared areas for wildlife. Heavy traffic twice a day has contributed to highway kills of wildlife on both north and south access roads. Detailed numbers can be found in Section 4.3 of the applicant's ER (S II).[1] These problems do not represent a significant impact on the populations of the species involved and should become minimal during station operation.

Construction of Transmission Lines

Since the issuance of the FES-OL (December 1972), the applicant has decided to eliminate the planned substation at Bechtelsville. The 500-kV transmission line which was previously analyzed

TABLE 4.1

SCHEDULE FOR COMPLETION OF EXTERIOR PORTIONS OF BUILDINGS FOR THREE MILE ISLAND NUCLEAR STATION UNIT 2

BUILDING	TMI UNIT 2
Reactor Building	Completed
Auxiliary Building	Completed
Fuel Handling Building	Completed
Turbine Building	Completed
Control/Service Building	Completed
Intake Structure	Completed
Control Building Area	Completed
Circulating Water Pump House	Completed
Diesel Generator Building	Completed
Chlorinator Building	Completed
Water Pre-Treatment Building	Completed
Waste Sludge Building	Completed
Waste Treatment Building	Completed
Natural Draft Cooling Towers	Completed
Mechanical Draft Cooling Tower	Completed
Miscellaneous Yard Structures and Tanks	November 1977*
Steam Generator Chemical Cleaning Structure	December 1977*

*As of November 15, 1976

by the staff as terminating at Bechtelsville now includes a 7.36-mile segment which was originally planned to connect the Bechtelsville substation with the Hosensack substation. Since detailed review of this 7.36-mile long segment of the line was not performed for the FES-OL (December 1972), the environmental effects of the construction of this line segment and its primary alternative will be discussed here. The discussion of effects of operation of the transmission line is not changed (see Section 5.1.2, Appendix B). No other major changes in the transmission system for TMINS-2 have occurred. As of February 12, 1975, construction activities on the transmission lines were nearing completion (S II, Section 3.2.4).[1] All right-of-way had been cleared. Thirty-eight of the forty-one towers on the TMINS-Hosensack line were complete and twenty-eight of thirty-one towers on the TMINS-Juniata line were complete.

On May 10, 1976, the staff inspected the Bechtelsville-Hosensack segment of the transmission line by overflying it in a helicopter to aid in analysis of the envionmental effects of its construction. After observing the selected route, the staff also flew over the proposed alternate corridor for purposes of comparison with the route chosen by the applicant. At the time of this flight, the Bechtelsville-Hosensack line was apparently complete. All towers had been erected and the conductors had been strung. In most cases the areas disturbed by construction had been successfully seeded or were under intensive agricultural use.

The Bechtelsville-Hosensack 500-kV transmission line leaves the location of the previously planned Bechtelsville substation and proceeds in a northeasterly direction for 7.36 miles through farmland to the Hosensack substation. This line segment parallels a previously existing 230-kV transmission line for the entire length and in all except three locations the 500-kV towers have been erected adjacent to towers of the 230-kV line. This parallel construction essentially reduces the number of locations subjected to the aesthetic intrusion of transmission line towers. The applicant has stated that this effort to minimize the aesthetic intrusion of the towers required construction of two additional towers on this segment of right-of-way.[4]

Various branches of Perkiomen Creek and its tributaries are crossed several times but none would be considered a major stream crossing and there was no visual evidence of any disturbance due to construction of the line. One of the previously mentioned locations where towers are not adjacent to the 230-kV towers occurs at a stream crossing where that positioning would result in placing the tower in the stream bed.

Before the 500-kV line was built, the 230-kV corridor was 150 feet wide. During its construction 18 acres of woodland were cleared and 115.8 acres of agricultural land crossed. For the 500-kV line an additional 175 feet of right-of-way was required which resulted in the clearing of 21 acres of woodland and the spanning of over 134.5 acres of agricultural land. Aside from aesthetics, the only impact due to construction on agricultural land was the loss of the tower base area for agricultural production (about .4 acre).

The only historical site near the corridor is the Phillip Christman House located approximately one mile southeast of Bally in Washington Township. Its location places it about one-half mile from the line but the incremental aesthetic impact of the additional tower structures located adjacent to the existing 230-kV towers is not judged by the staff to be a significant adverse impact.

The continued agricultural use of the right-of-way under the lines renders the impact of construction on agricultural productivity very small. The twenty-one acres of wooded land which were cleared also constitute a minor impact on forest resources. The seeding program for the corridor appears to have been effective in most places. There were a few locations noted which may need further attention to establish a reasonable ground cover and prevent erosion. These areas should be adequately controlled under the transmission line monitoring program suggested in Section 6.5.

The only significant impact noted by the staff is the former Bechtelsville substation. Construction of this substation had proceeded to the point that many concrete structures had been placed on the site before the construction was suspended. This location was purchased from the applicant in its present condition and is no longer under his control for possible mitigative actions.

Considering the non-unique nature and the quantity of similar woodland and agricultural land available in the area (see Table 2.1) the staff concludes that the impacts from construction of the 7.36 mile segment of the transmission line are acceptable.

The alternative route parallels an existing 115-kV right-of-way for most of its length.[5] Deviations would have been required at two locations because of homes adjacent to the 115-kV corridor. The village of Corning and a necessary crossing of a paralleling 230-kV line near the Route 29 crossing might have required additional deviations and special towers for the cross over. Assuming that the 115-kV line could be removed, only an additional 100 feet would be necessary for the right-of-way. For the 2.48 miles of woodland this would mean an additional 30 acres of woodland in rolling terrain would have to be cleared. Erosion control and slope stabilization in these areas would be more difficult than on the chosen line. The agricultural land would have had the same multiple use characteristics as on the selected route although only 65.5 additional acres would have been necessary. Approximately 10.7 acres of orchard would have required additional tower height unless the trees were to be removed. Although total corridor acreage would be less, almost 50% more woodland would need to be cleared. On the chosen route, the woodland involved occurs in scattered woodlots. Along the alternate route the wooded areas are fairly continuous over a series of hills and ridges with the intrusion of an occasional farm or orchard. The existing 115-kV right-of way is in many locations difficult to find because the surrounding trees exceed the tower height. Clearing an additional 100 feet and using the larger 500-kV towers would create almost as much visual impact as cutting a corridor through virgin woodland.

The staff concludes that the increased erosion potential, the deviations that would be required, and the more severe aesthetic impact on the wooded lands make the alternate route a less desirable path for the 500-kV right-of-way than the chosen route. Visual inspection of the completed line has given the impression that environmentally it would be difficult to select a route and construct a transmission line with less significant impact than the Bechtelsville-Hosensack 500-kV transmission line segment. The occasional vegetation control and seeding activities should be continued in an attempt to maintain the low level of impact of this line.

4.4.2 Aquatic

The applicant and staff have summarized the expected site preparation and construction effects on the aquatic biota at TMINS[1] (see also Appendix B). Although there is no evidence that the applicant has conducted a monitoring program to specifically evaluate construction effects on aquatic biota, a qualitative evaluation of effects on the river ecosystem can be made by examining the 1974 biological sampling programs.[2,3] Comparison of data upstream and downstream of the intake-discharge area indicates no major differences in parameters measured that could be causally related to construction activities. This observation suggests that any construction effects that have occurred have been localized to the intake-discharge area.

Aquatic forms at all trophic levels have probably been disturbed and in some cases destroyed by construction activities in the intake-discharge area (e.g., construction of intake channel, siltation associated with cofferdam construction and removal, etc.). Although the extent of the localized impact cannot be ascertained with certainty, the staff concludes that construction impacts have been of a temporary nature and have not resulted in any irreversible adverse impacts to the local or riverwide ecosystem.

4.5 EFFECTS ON THE COMMUNITY

In discussions with individuals and local and State officials, the staff did not identify any substantial impacts on the surrounding community resulting from plant construction except for some renovation necessitated at an elementary school. Local and regional officials did not report any serious traffic congestion any impact on accident rates or growth-related concerns. The staff verified that the coincidence of the start-up of plant construction with the phasing out of Olmstead Air Force Base helped to alleviate pressures on housing and assisted in providing employment opportunities in the area.

REFERENCES FOR SECTION 4

1. Metropolitan Edison Company et al., Supplement II, Environmental Report, Operating License Stage - Unit 2. 1975.

2. Ichthyological Associates, Inc. An Ecological Study of the Susquehanna River in the Vicinity of the Three Mile Island Nuclear Station. Annual Report for 1974. February 1975.

3. Ichthyological Associates, Inc. An Ecological Study in the Susquehanna River in the Vicinity of the Three Mile Island Nuclear Station. Supplement Report for 1974. April 1975.

4. Affidavit of Jay E. Burkett, reponse to interrogatory Nos. 8 and 49, July 14, 1975.

5. Affidavit of Jay E. Burkett, response to interrogatory Nos. 4, 7 and 34, July 14, 1975.

5. ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 RÉSUMÉ

The assessment of those impacts of station operation discussed in FES of December, 1972 are still valid. Additional or new information is presented in this section. A discussion of effects of ozone produced by EHV transmission lines and of effects of induced currents, not discussed previously, appears in Section 5.2.2. Additional information and discussion of water quality standards and effluent limitations is presented in Section 5.3.3.

An evaluation of the radiological environmental impact of TMINS Unit 2 is presented in Section 5.4.

Results from the monitoring program of the cooling tower drift from the operation of Unit 1 from June to November 1974, are discussed in Section 5.5. Results from the bird impaction study are discussed in Section 5.5.1.

Additional information relating to impact on people from operation of Unit 2 is presented in Section 5.6.

5.2 IMPACT ON LAND USE

5.2.1 Station Operation

The operation of Three Mile Island Nuclear Station, Unit 2 will have minimal impact on offsite activities. Since the station is on an island wholly owned by the applicant and the applicant owns all land within the exclusion radius, station operation will not deny access to any locations that would otherwise have been accessible. Prospective recreational developments associated with the station are adequately addressed in Section V.I of the FES-OL, 1972 (see Appendix B).

5.2.2 Transmission Lines

The types and extent of land under transmission lines are summarized in Table 5.1. The property owners along the right-of-way are allowed to use the land for growing crops, grazing cattle, or growing trees to limited heights but are not permitted to erect any structures within the limits of the right-of-way. The discussion presented in the FES-OL, December 1972, Section V.A.2 (see Appendix B), remains valid for the topics addressed there.

Neither the staff in FES-OL, 1972, nor the applicant have addressed the effects of ozone production by EHV transmission lines or the effects of induced currents.

Data have been presented in the literature[2,3] indicating that ozone production by energized transmission lines up to 765 kV is highly unlikely to add detectably to existing atmospheric background levels. The staff has made an analysis of these reports and has concluded that no basis exists at present for predicting adverse biological or environmental effects due to ozone from 500-kV transmission lines.

Recent information[4] indicates that electrostatic effects in fences, metal buildings, and motor vehicles, while possible, do not present hazards of lethal electric shock to humans or animals. However, shock ranging from "barely perceptable" to "real jolt" have been received from metal structures and vehicles beneath EHV lines, and a fire hazard exists beneath EHV lines if vehicles are refueled within the right of way.

The staff concludes that eletrostatic induction could cause inconvenience and varying degree of nuisance to residents who live near the corridors but there is no likelihood of mortality caused by electrocution of persons or animals from the applicant's 500-kV lines or lines of lower voltages. There is reasonable possibility that electric shock could be involved as an indirect cause of human injury or death by aggravating a pre-existing health condition, for example, or causing a fall from or loss of control of a vehicle or by causing a fire during vehicle refueling.

The remedy for electrostatic induction is to ground all structures which could be affected such as fences, metal farm buildings and the like. The staff recommends that grounding be performed on all potentially affected structures along both 500-kV and 345-kV lines. The applicant has

TABLE 5.1

500 kV TRANSMISSION LINES ASSOCIATED WITH TMI-2

Type of R/W	TMINS 500 kV Sub. to Hosensack	TMINS 500 kV Sub. to Existing Juniata - Peach Bottom Line
Cultivated	1022 Acres	64 Acres
Uncultivated	132 Acres	9 Acres
Pasture	115 Acres	4 Acres
Scrub and Swamp Land	58 Acres	0 Acres
Wooded	449 Acres	32 Acres
	1776 Acres	109 Acres

Source: Reference 1

grounded all transmission towers and will ground fences where electrostatic induction hazards exist.

The applicant plans to use herbicides in routine right-of-way maintenance activities. Present procedures call for basal application to selected trees which may grow into the line. If the restrictions on use specified in the EPA registration of the herbicides are followed there should be no significant impact form the use of herbicides. (See Section 6.5 for reporting requirements.)

5.3 IMPACTS ON WATER USE

5.3.1 Surface Water

There is a net maximum consumption of river water by the station of 20,800 gpm due to evaporation from the four natural draft and two forced draft cooling towers. This amounts to 2.7% of the minimum river flow of 1,700 cfs (765,000 gpm), 0.23% of the median river flow of 20,000 cfs (8,960,000 gpm), and 0.14% of the mean river flow of 34,000 cfs (15,300,000 gpm). Table 2.2 shows that the greatest water loss from the Susquehanna River is for public water use by the City of Baltimore. At the current withdrawal rate by Baltimore, the amount of water lost from the River downstream of TMINS (public use, industry, evaporation due to Three Mile Island and Peach Bottom Nuclear Stations) expressed as a percentage of minimum and mean river flows respectively will be 10.5% and 0.53%. At the maximum withdrawal rate by Baltimore the losses would be 27.3% and 1.4%, respectively. Removal of water at this rate is not expected to have a significant effect on the water balance of the Susquehanna River downstream from the station since this represents a small fraction of normal seasonal variation of the river flow.

TMINS represents about one fourth of the total installed and currently planned capacity for steam electric power production for the Susquehanna River Basin. The use of water for the production of power is but one of man's activities which will ultimately require additional development of the Susquehanna watershed for increasing the availability of water. Although availability of water is not likely to limit the operation of TMINS, additional demands for water (by others) are likely to be cause for concern near the end of the useful life of the TMI Nuclear Station. There is evidence that the need for water required for power generation is being recognized adequately by those responsible for planning for the Susquehanna River Basin as exemplified by the Susquehanna River Basin Study, Susquehanna River Basin Study Coordinating Committee, June 1970. Under its regulatory authority the Susquehanna River Basin Commission has indicated intent to review impact on river flow due to consumptive withdrawals in order to develop conditions to be included in their permit.

Although there is more than ample flow available in the Susquehanna River to allow operation of the facility without interference with other users, it should be recognized that this represents a long-term commitment of the water resource (see Section 9.5.2).

5.3.2 Groundwater

All of the water at the station during operation is drawn from the Susquehanna River (see page V-10, Appendix B). Thus, no drawdown of the water table and no effect on the availability of groundwater should result from station operation.

5.3.3 Water Quality Standards and Effluent Limitations

The Commonwealth of Pennsylvania has established water quality criteria applicable to the Susquehanna River in the vicinity of the site to protect the water uses which were tabulated in Section 2.2.2. The applicable criteria are listed below (Pennsylvania Code, Title 25, Part I, Environmental Resources, Chapter 93, Water Quality Criteria):

§ 93.4 General water quality criteria.

(a) Water shall not contain substances attributable to municipal, industrial or other waste discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life.

(b) Specific substances to be controlled shall include, but shall not be limited to floating debris, oil, scum and other floating materials, toxic substances and substances which produce color, tastes, odors or settle to form sludge deposits.

§ 93.5 Specific water quality criteria.

pH - Not less than 6.0 and not more than 8.5.

Dissolved oxygen - Minimum daily average 5.0 mg/l; no value less than 4.0 mg/l.

- For the epilimnion of lakes, ponds, and impoundments, minimum daily average of 5.0 mg/l, no value less than 4.0 mg/l.

Iron - Total iron not more than 1.5 mg/l.

Temperature - Not more than a 5°F rise above ambient temperature or a maximum of 87°, whichever is less; not to be changed by more than 2°F during any one-hour period.

Dissolved Solids - Not more than 500 mg/l as a monthly average value; not more than 750 mg/l at any time.

Bacteria - The fecal coliform density in five consecutive samples shall not exceed a geometric mean of 200 per 100 ml.

Total Manganese - Not more than 1.0 mg/l.

Pennsylvania Industrial Regulations (Pennsylvania Code, Title 25, Environmental Resources, Part I, Article 2, Chapter 97, Industrial Wastes) place the following additional restrictions on the addition of waste heat:

§ 97.82 Allowable Discharges

(a) The heat content of discharges shall be limited to an amount which could not raise the temperature of the entire stream at the point of discharge 5 degrees F above ambient temperature or a maximum of 87 degrees F, whichever is less, nor change the temperature by more than 2 degrees F during any one-hour period, assuming complete mixing, but the heat content of discharges may be increased or further limited where local conditions would be benefited thereby.

(b) If downstream circumstances warrant, the specific area in which the temperature may be artificially raised above 87 degrees F or greater than 5 degrees F above ambient temperature or by more than 2 degrees F during any one-hour period shall be prescribed.

Since ambient temperature may exceed 87°F occasionally, paragraph (b) above may require the prescription of the area in which temperature may be elevated further.

Pursuant to the Federal Water Pollution Control Act (FWPCA), on January 31, 1975 Pennsylvania has issued a 401 certification indicating that in their evaluation these water quality criteria will not be violated by the proposed plant operation. In accordance with terms of the Second Memorandum of Understanding Regarding Implementation of Certain NRC and EPA Responsibilities, the staff has accepted Pennsylvania's determination.

The FWPCA calls for achievement by July 1, 1977, of effluent limitations requiring the application of the best practicable control technology currently available. By July 1, 1983, the act calls for the achievement of effluent limitations requiring application of the best available technology economically achievable. The effluent limitations for these "technologies" are defined in Title 40 CFR Part 423-Steam Electric Power Generating Point Source Category. The only difference in the two technologies applicable to nuclear stations is the requirement for closed cycle cooling by the later date. Since TMINS will operate on closed cycle cooling, the 1983 requirement regarding thermal discharge can be met. The requirements for the 1983 deadline are reproduced in Table 5.2.

FWPCA (Section 302) also requires that any other limitations be placed on the operation of the facility which are necessary to protect and propagate a balanced indigenous population and to protect other users. Again, in accordance with the Second Memorandum of Understanding, the issuance by the State of Pennsylvania on December 30, 1974 of a permit under Section 402 of the NPDES is accepted as a determination that the requirement for effluent limitations will be met.

The effluent limitations imposed by the NPDES include a value for free available chlorine but do not include a value for total residual chlorine (see Table 5.2). The toxicity of combined forms of chlorine has been recognized and limitations have been recommended for total residual (Water Quality Criteria, 1972. A report of the Committee on Water Quality Criteria, National Academy of Sciences, National Academy of Engineering, Washington, D.C., 1972). The recommended limitation for total residual chlorine, applicable to receiving water rather than to the effluent, is as follows: "Aquatic life should be protected where the concentration of residual chlorine in the receiving system does not exceed 0.003 mg/l at any time or place. Aquatic organisms will tolerate short term exposure to high levels of chlorine. Until more is known about the short term effects, it is recommended that total residual chlorine should not exceed 0.05 mg/l for a period up to 30 minutes in any 24-hour period."

Based on experience with Unit 1 (see Section 3.3.2) a free chlorine concentration of 0.5 mg/l as allowed by the permit might correspond to a total chlorine residual as high as 1.5 mg/l. However, it was noted that experience with Unit 1 has shown the actual total residual to exceed a concentration of 0.2 mg/l only rarely. Dilution with river flow and further chemical reduction of chlorine residuals will reduce the concentrations produced at Unit 2 below the recommended value of 0.05 mg/l within a short distance of the outfall.

The applicant has not been totally successful at meeting the objective of controlling biological growth within plant systems and is likely to change the chlorination program (see Section 3.3.2). Therefore, staff recommended that monitoring of total residual chlorine in the plant discharge be performed until the concentrations required for optimal chlorination can be established and evaluated. If it is necessary to operate at the permitted level of chlorination, then the applicant should monitor total residuals in the river to determine the extent of the region in which concentration exceeds the value recommended to protect aquatic life.

Pennsylvania has established a criterion for sulfate concentration of 250 mg/l for some of their water bodies but has not made it apply to the lower Susquehanna River. This is probably because ambient concentrations only rarely approach this level. As development of the river for steam electric power production and other uses continues, it is likely that additional consideration will be given to the discharge of sulfate. Based on average river conditions, station operation will increase sulfate concentration by less than 0.4 mg/l. For the conditions which prevailed when the highest ambient sulfate concentration was reported (204.3 mg/l, see Section 2.4.3), operation could have increased sulfate concentation by as much as 3.3 mg/l. These increases should not have a noticeable effect on downstream users under present conditions.

Other proposed uses of chemicals will have an insignificant effect on water quality.

5.4 RADIOLOGICAL IMPACTS

5.4.1 Radiological Impact on Man

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

5.4.1.1 Exposure Pathways

The environmental pathways which were considered in preparing this section are shown in Figure 5.1. Estimates were made of radiation doses to man at and beyond the site boundary based on NRC staff estimates of expected effluents as shown in Tables 3.2 and 3.3, site meteorological and hydrological considerations and exposure pathways at the Three Mile Island Unit 2 nuclear power station.

TABLE 5.2 Effluent Limitation Guidelines Applicable to TMINS (from Title 40 CFR)

§ 423.23 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best available technology economically achievable.

The following limitations establish the quantity or quality of pollutants or pollutant properties, controlled by this section, which may be discharged by a point source subject to the provisions of this subpart after application of the best available technology economically achievable:

(a) The pH of all discharges, except once through cooling water, shall be within the range of 6.0–9.0.

(b) There shall be no discharge of polychlorinated biphenol compounds such as those commonly used for transformer fluid.

(c) The quantity of pollutants discharged from low volume waste sources shall not exceed the quantity determined by multiplying the flow of low volume waste sources times the concentration listed in the following table:

Effluent characteristic	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
TSS	100 mg/l	30 mg/l.
Oil and Grease	20 mg/l	15 mg/l.

(d) The quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the flow of bottom ash transport water times the concentration listed in the following table and dividing the product by 12.5:

Effluent characteristic	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
TSS	100 mg/l	30 mg/l.
Oil and Grease	20 mg/l	15 mg/l.

(e) The quantity of pollutants discharged in fly ash transport water shall not exceed the quantity determined by multiplying the flow of fly ash transport water times the concentration listed in the following table:

Effluent characteristic	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
TSS	100 mg/l	30 mg/l.
Oil and Grease	20 mg/l	15 mg/l.

(f) The quantity of pollutants discharged in metal cleaning wastes shall not exceed the quantity determined by multiplying the flow of metal cleaning wastes times the concentration listed in the following table:

Effluent characteristic	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
TSS	100 mg/l	30 mg/l.
Oil and Grease	20 mg/l	15 mg/l.
Copper, Total	1.0 mg/l	1.0 mg/l.
Iron, Total	1.0 mg/l	1.0 mg/l.

(g) The quantity of pollutants discharged in boiler blowdown shall not exceed the quantity determined by multiplying the flow of boiler blowdown times the concentration listed in the following table:

Effluent characteristic	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
TSS	100 mg/l	30 mg/l.
Oil and Grease	20 mg/l	15 mg/l.
Copper, Total	1.0 mg/l	1.0 mg/l.
Iron, Total	1.0 mg/l	1.0 mg/l.

(h) The quantity of pollutants discharged in once through condenser water shall not exceed the quantity determined by multiplying the flow of once through condenser water sources times the concentration listed in the following table:

Effluent Characteristic	Maximum Concentration	Average Concentration
Free available chlorine.	0.5 mg/l	0.2 mg/l.

(i) The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of low volume waste sources times the concentration listed in the following table:

Effluent Characteristic	Maximum Concentration	Average Concentration
Free available chlorine.	0.5 mg/l	0.2 mg/l.

	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
Zinc	1.0 mg/l	1.0 mg/l.
Chromium	0.2 mg/l	0.2 mg/l.
Phosphate	5.0 mg/l	5.0 mg/l.
Other corrosion inhibiting materials.	Limit to be established on a case by case basis.	

(j) Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the regional administrator or state, if the state has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

(k) In the event that waste streams from various sources are combined for treatment or discharge, the quantity of each pollutant or pollutant property controlled in paragraphs (a) through (j) of this section attributable to each controlled waste source shall not exceed the specified limitation for that waste source.

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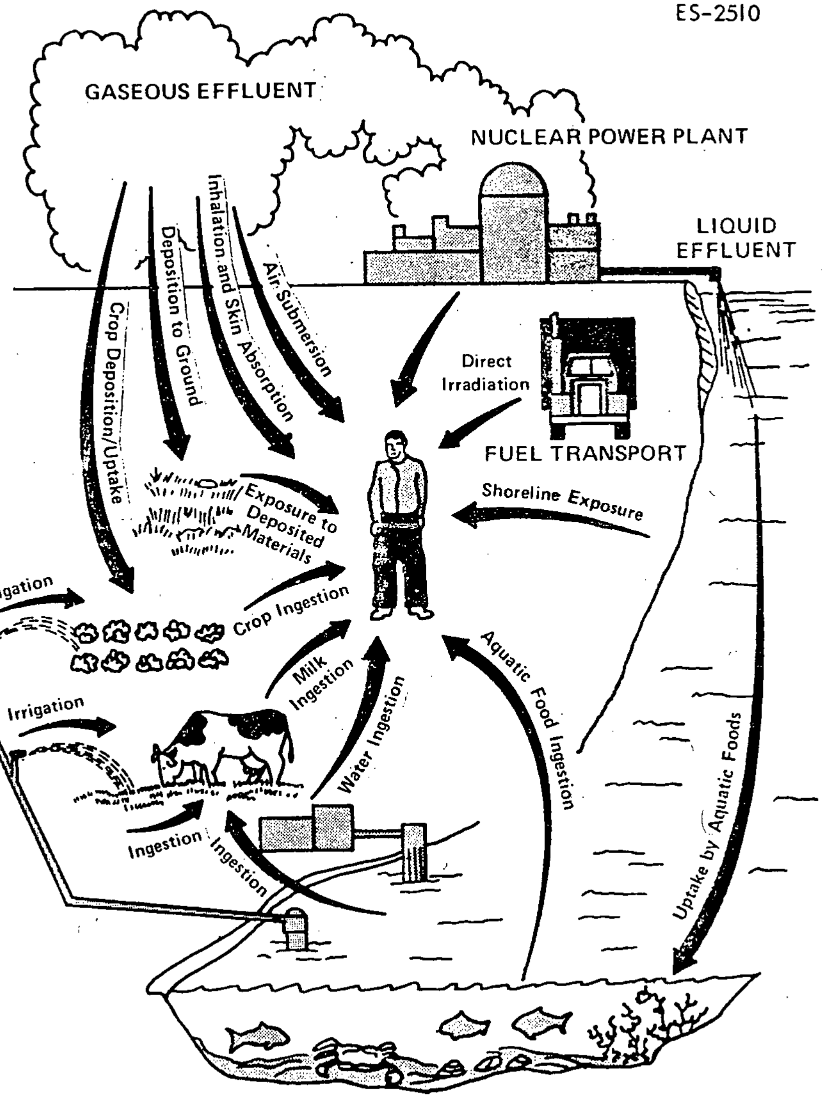

Fig. 5.1 Exposure pathways to man

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

5.4.1.2 Dose Commitments from Radioactive Releases to the Atmosphere

Radioactive effluents released to the atmosphere from the Three Mile Island Unit 2 facility will result in small radiation doses to the public. NRC staff estimates of the expected gaseous and particulate releases listed in Table 3.3 and the site meteorological considerations discussed in Section 2.5 of this statement and summarized in Table 5.3 were used to estimate radiation doses to individuals and populations. The results of the calculations are discussed below.

TABLE 5.3

SUMMARY OF ATMOSPHERIC DISPERSION FACTORS AND DEPOSITION VALUES FOR SELECTED LOCATIONS NEAR THE THREE MILE ISLAND UNIT 2 NUCLEAR POWER STATION*

LOCATION	SOURCE	X/Q (sec/m^3)	RELATIVE DEPOSITION (m^{-2})
Nearest Site	A	1.4 E-06	2.2 E-08
Land Boundary	B	6.7 E-06	1.4 E-07
(0.37 mi WNW)	C	4.5 E-05	1.1 E-07
Nearest Residence	A	1.4 E-06	2.2 E-08
and Garden	B	6.7 E-06	1.4 E-07
(0.37 mi WNW)	C	4.5 E-05	1.1 E-07

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

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

Source A is reactor Building Vent
Source B is Reactor Building Vent Purge
Source C is Turbine Building Vent

Radiation Dose Commitments to Individuals

The predicted dose commitments to "maximum" individuals at the offsite locations where doses are expected to be largest are listed in Table 5.4. A maximum individual is assumed to consume well above average quantities of the foods considered (see Table A-2 in Regulatory Guide 1.109). The standard NRC models were used in order to realistically model features of the Three Mile Island Unit 2 plant design and the site environs.

Radiation Dose Commitments to Populations

The estimated annual radiation dose commitment to the population (within 50 miles) for the Three Mile Island Unit 2 Nuclear Power Plant from gaseous and particulated releases were based on the projected site population distribution for the year 2010. Doses beyond the 50-mile radius were based on the average population densities discussed in Appendix D of this statement. The annual population dose commitments are presented in Table 5.7. Background radiation doses are provided for comparison. The doses from atmospheric releases from the Three Mile Island Unit 2 facility during normal operation represent an extremely small increase in the normal population dose from background radiation sources.

TABLE 5.4

ANNUAL DOSE COMMITMENTS TO A MAXIMUM INDIVIDUAL DUE TO GASEOUS AND PARTICULATE EFFLUENTS

LOCATION	PATHWAY	DOSE (mrem/yr)						
		TOTAL BODY	GI-TRACT	BONE	LIVER	THYROID	LUNG	SKIN
Nearest* Residence and Garden (0.37 mi WNW)	Plume	0.30	0.30	0.30	0.30	0.30	0.32	0.93
	Ground Deposit	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Inhalation (Child)	0.04	0.04	**	0.04	0.06	0.04	0.04
	Vegetation (Child)	1.4	1.4	5.9	1.4	1.5	1.4	1.4

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

5.4.1.3 Dose Commitments from Radioactive Liquid Releases to the Hydrosphere

Radioactive effluents released to the hydrosphere from the Three Mile Island Unit 2 facility during normal operation will result in small radiation doses to individuals and populations. NRC staff estimates of the expected liquid releases listed in Table 3.2, and the site hydrological considerations discussed in Section 2.4 of this statement and summarized in Table 5.5 were used to estimate radiation dose commitments to individuals and populations. The results of the calculations are discussed below.

TABLE 5.5

SUMMARY OF HYDROLOGIC TRANSPORT AND DISPERSION FOR LIQUID RELEASES FROM THE THREE MILE ISLAND UNIT 2 NUCLEAR POWER STATION*

LOCATION	TRANSIT TIME (Hours)	DILUTION FACTOR
Nearest Drinking Water Intake (16 mi. downstream Columbia, Pa)	3.	20.
Nearest Sport Fishing Location (∿.1 mi. downstream)**	<1.	2.
Nearest Shoreline (.1 mi. downstream)	<1.	1.
Nearest Irrigated** Crops (3.5 mi. downstream)	<1.	20.

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

**Assumed for purposes of an upper limit estimate--detailed information not available.

Radiation Dose Commitments to Individuals

The estimated dose commitments to individuals at selected offsite locations where exposures are expected to be largest are listed in Table 5.6. The standard NRC models given in Regulatory Guide 1.109 were used for these analyses.

Radiation Dose Commitments to Populations

The estimated population radiation dose commitments to 50 miles for the Three Mile Island Unit 2 facility from liquid releases, based on the use of water and biota from the Susquehanna River, are shown in Table 5.7. Dose commitments beyond 50 miles were based on the assumptions discussed in Appendix D.

Background radiation doses are provided for comparison. The dose commitments from liquid releases from the Three Mile Island Unit 2 facility represent small increases in the population dose from background radiation sources.

5.4.1.4 Direct Radiation

Radiation from the facility

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

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

TABLE 5.6

ANNUAL INDIVIDUAL DOSE COMMITMENTS DUE TO LIQUID EFFLUENTS

LOCATION	PATHWAY	DOSE (mrem/yr) TOTAL BODY	BONE	LIVER	THYROID	LUNG	GI TRACT
Nearest River Water Use (16 mi. downstream)	Drinking Water	0.04	**	0.04	0.08	0.04	0.04
Nearest Fish Production (.1 mi. downstream)	Fish (Outfall Area)	1.6	1.2	2.1	0.19	0.24	0.23
Nearest Shoreline (.1 mi. downstream)	Sediments	**	**	**	**	**	**
Nearest Use* of Irrigated Food Crops (3.5 mi. downstream)	Irrigation Water-Food Crops (Adult)	0.05	**	0.05	0.05	0.04	0.05

*Assumed for purposes of an upper limit estimate-detailed information on usage and productivity not available.

**Less than 0.01 mrem/yr.

TABLE 5.7

ANNUAL POPULATION DOSE COMMITMENTS IN THE YEAR 2010

Category	Population Dose Commitment (man-rem) 50 Miles	U.S. Population
Natural Radiation Background[a]	310,000.[b]	28,000,000.[c]
Three Mile Island Unit 2 Nuclear Power Plant Operation Plant Work Force	**	500.
General Public (Total)	11.	33.
Noble Gases Submersion	2.	2.
Inhalation	1.	1.
Ground Deposition	*	*
Terrestrial Foods (including irrigated crops)	5.	18.
Drinking Water	3.	5.
Aquatic Foods	*	*
Recreation	*	*
Transportation of nuclear fuel and radioactive wastes	**	7.

*Less than 1 man-rem/yr

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

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

(b) Using the average Pennsylvania state background dose (97. mrem/yr) in (a), and year 2010 projected population of 3,200,000.

(c) Using the average U.S. background dose (102 mrem/yr) in (a), and year 2010 projected U.S. population of 280,000,000 from "Population Estimates and Projections," Series II, U.S. Dept. of Commerce, Bureau of the Census, Series P-25, No. 541 (Feb. 1975).

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

Occupational Radiation Exposure

Based on a review of the applicant's safety analysis report, the staff has determined that the applicant is committed to design features and operating practices which will assure that individual occupational radiation doses (occupational dose is defined in 10 CFR Part 20) and that individual and total plant population doses will be as low as is reasonably achievable.* For the purpose of portraying the radiological impact of the plant operation on all onsite personnel, it is necessary to estimate a man-rem occupational radiation dose. For a plant designed and proposed to be operated in a manner consistent with the 10 CFR Part 20, there will be many variables which influence exposure and make it difficult to determine a quantitative total occupational radiation dose for a specific plant. Therefore, past exposure experience from operating nuclear power stations** has been used to provide a widely applicable estimate to be used for all light water reactor power plants of the type and size for the Three Mile Island Unit 2 plant. This experience indicates a value of 500 man-rem per year per reactor unit.

On this basis, the projected occupational radiation exposure impact of the Three Mile Island Unit 2 station is estimated to be 500 man-rem per year.

*10 CFR Part 20, Standards for Protection Against Radiation.

**NUREG 75/032, Occupational Radiation Exposure to Light Water Cooled Reactors 1969-1974 (June 1975).

Transportation of Radioactive Material

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

TABLE 5.8

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

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

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

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

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

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

[c]Man-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 millirems) each, the total man-rem in each case would be 1 man-rem.

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

5.4.1.5 Comparison of Dose Assessment Models

The applicant's site and environmental data provided in the Environmental Report* and in Evaluation to Demonstrate Compliance with 10 CFR 50 Appendix I was used extensively in the dose calculations.

5.4.1.6 Evaluation of Radiological Impact

The radiological impact of operating the proposed Three Mile Island Unit 2 nuclear power station is presented in terms of individual dose commitments in Table 5.7. The annual individual dose commitments resulting from routine operation of the plant are a small fraction of the dose limits specified in 10 CFR Part 20. The population dose commitments are small fractions of the dose from natural environmental radioactivity. As a result, the staff concluded that there will be no measurable radiological impact on man from routine operation of this plant.

5.4.1.7 Comparison of Calculated Doses with NRC Design Objectives

Tables 5.9 and 5.10 show a comparison of calculated doses from routine releases of liquid and gaseous effluents from the Three Mile Island Unit 2 plant with the design objectives of Appendix I to 10 CFR 50 and with the proposed staff design objectives of RM-50-2.

TABLE 5.9

COMPARISON OF CALCULATED DOSES TO A MAXIMUM INDIVIDUAL FROM THREE MILE ISLAND UNIT 2 OPERATION WITH GUIDES FOR DESIGN OBJECTIVES PROPOSED BY THE STAFF[a]

CRITERION	RM-50-2 DESIGN OBJECTIVE	CALCULATED DOSE
Liquid Effluents		
Dose to total body or any organ from all pathways	5 mrem/yr	2.3 mrem/yr
Noble Gas Effluents (at site boundary)		
Gamma dose in air	10 mrad/yr	0.5 mrad/yr
Beta dose in air	20 mrad/yr	1.5 mrad/yr
Dose to total body of an individual	5 mrem/yr	0.3 mrem/yr
Dose to skin of an individual	15 mrem/yr	1.0 mrem/yr
Radioiodine and Particulates[b]		
Dose to any organ from all pathways (Child)	15 mrem/yr	5.9 mrem/yr

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

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

*Three Mile Island Nuclear Station Unit 2 Environmental Report, Operating License Stage, Metropolitan Edison Co., Docket Number 50-320.

TABLE 5.10

COMPARISON OF CALCULATED DOSES TO A MAXIMUM INDIVIDUAL FROM THREE MILE ISLAND UNIT 2 OPERATION WITH APPENDIX I DESIGN OBJECTIVES[a]

CRITERION	APPENDIX I DESIGN OBJECTIVE	CALCULATED DOSE
Liquid Effluents		
Dose to total body from all pathways (Adult)	3 mrem/yr	1.7 mrem/yr
Dose to any organ from all pathways (Adult-Liver)	10 mrem/yr	2.3 mrem/yr
Noble Gas Effluents (at site boundary)		
Gamma dose in air	10 mrad/yr	0.5 mrad/yr
Beta dose in air	20 mrad/yr	1.5 mrad/yr
Dose to total body of an individual	5 mrem/yr	0.3 mrem/yr
Dose to skin of an individual	15 mrem/yr	1.0 mrem/yr
Radioiodines and Particulates[b]		
Dose to any organ from all pathways (Child-bone)	15 mrem/yr	5.9 mrem/yr

[a]Appendix I Design Objectives from Sections II.A, II.B. II.C of Appendix I, 10 CFR Part 50; considers doses to maximum individual per reactor unit. From Federal Register V. 40, p. 19442, May 5, 1975.

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

5.4.2 Radiological Impact on Biota Other Than Man

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

5.4.2.1 Exposure Pathways

The environmental pathways which were considered in preparing this section are shown in Figure 5.2. Dose estimates were made for biota at the nearest land and water boundaries of the site, and in the aquatic environment at the point where plant's liquid effluents mix with the Susquehanna River. The estimates were based on estimates of expected effluents as shown in Tables 3.2 and 3.3, site meteorological and hydrological considerations, and the exposure pathways anticipated at the Three Mile Island Unit 2 nuclear power station.

5.4.2.2 Doses to Biota from Radioactive Releases to the Biosphere

Depending on the pathway (as discussed in Regulatory Guide 1.109), terrestrial and aquatic biota will receive doses approximately the same or somewhat higher than man receives. Dose estimates for some typical biota at the Three Mile Island site are shown in Table 5.11. Doses to a greater number of similar biota in the offsite environs will generally be much lower.

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

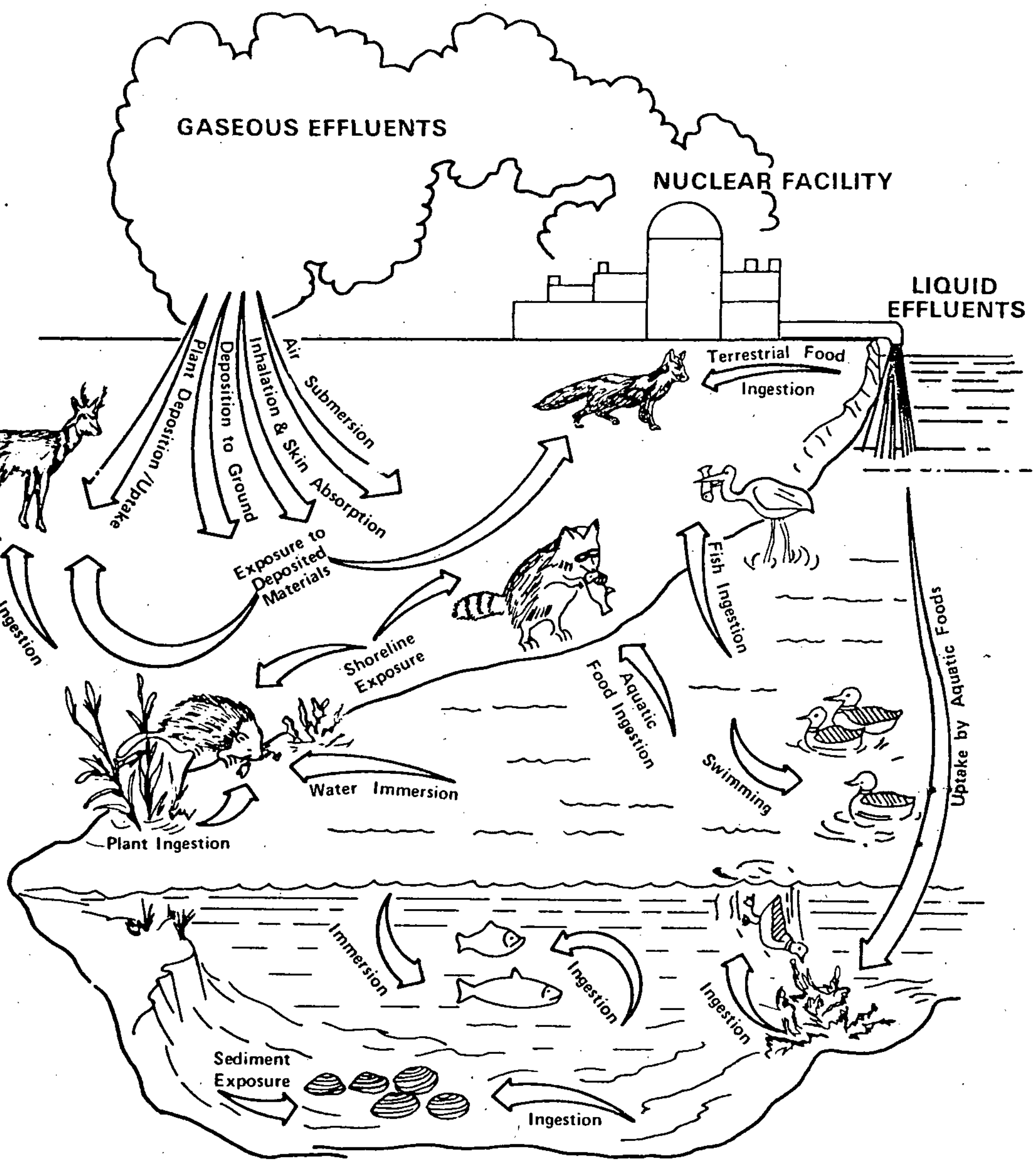

Fig. 5.2 Exposure pathways to biota other than man

TABLE 5.11

DOSE ESTIMATES FOR TYPICAL BIOTA AT THE THREE MILE ISLAND UNIT 2 SITE

BIOTA	LOCATION	PATHWAY	DOSE (mrad/yr)
Deer	Nearest Site Land Boundary (0.4 mi. WNW)	Atmosphere	0.6
Fox	"	"	1.0
Terrestrial Flora	"	"	0.2
Raccoon	"	Atmosphere Hydrosphere	2
Muskrat	"	"	10
Heron	"	"	20
Duck	Plant Outfall	"	10
Fish	"	Hydrosphere	10
Invertebrates	"	"	8
Algae	"	"	7

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

5.4.2.3 Doses to Biota from Direct Radiation

Although many of the terrestrial species may be continuously exposed, and thereby receive higher doses than man, aquatic species and some terrestrial species may receive somewhat lower doses depending on shielding by water or soil (e.g., burrows). As a result of these uncertainties, it was assumed that the direct radiation doses to biota at the site boundary will be about the same as for man. As shown on Table 5.9, direct radiation doses will generally be less than 5 mrad/yr.

5.4.2.4 Evaluation of the Radiological Impact on Biota[a,b]

Although guidelines have not been established for desirable limits for radiation exposure to species other than man, it is generally agreed that the limits established for humans are also conservative for other species. Experience has shown that it is the maintenance of population stability that is crucial to the survival of a species, and species in most ecosystems suffer rather high mortality rates from natural causes. While the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions with other stresses (e.g., heat, biocides, etc.), no biota have yet been discovered that show a sensitivity (in terms of increased disease or death) to radiation exposures as low as those expected in the area surrounding the Three Mile Island nuclear power station. The "BEIR" Report concluded that the evidence to date indicates that no other living organisms are very much more radiosensitive than man. Therefore, no measurable radiological impact on populations of biota is expected from the radiation and radioactivity released to the biosphere as a result of the routine operation of the Three Mile Island Unit 2 nuclear power station.

[a] S. T. Auerbach, "Ecological Considerations in Siting Nuclear Power Plants. The Long Term Biota Effects Problems," Nucl. Safety 12: 25 (1971).

[b] "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," NAS-NRC, 1972 ("BEIR" Report).

5.4.3 Environmental Effects of the Uranium Fuel Cycle

The Draft Environmental Statement for TMI-2, published in early July 1976, summarized the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low- and high-level wastes. These environmental effects are set out in Table S-3 of 10 CFR Part 51, which was reproduced as Table 5.5 in the TMI-2 DES.

On July 21, 1976, the United States Court of Appeals for the District of Columbia Circuit decided, in Natural Resources Defense Council v. NRC, that the Nuclear Regulatory Commission's (Commission) final fuel cycle rule (39 FR 14188, April 22, 1974) was inadequately supported by the record insofar as it treated two aspects of the fuel cycle--the impacts from reprocessing of spent fuel and radioactive waste management. The decision generally complimented other aspects of WASH-1248, the Commission's environmental survey underlying Table S-3.

In response to the Court decision, the Commission issued a General Statement of Policy (41 FR 34707, August 16, 1976). In that statement, the Commission announced its intention to reopen rulemaking proceedings on the environmental effects of the fuel cycle to supplement the existing record with regard to reprocessing and waste management, to determine whether the rule should be amended, and if so, in what respect. The Commission directed the staff to prepare a well-documented supplement to WASH-1248 to establish a basis for identifying environmental impacts associated with fuel reprocessing and waste management activities that are attributable to the licensing of a model light water reactor (LWR). The NRC staff issued NUREG-0116, Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle, in October 1976 for this purpose.

On November 5, 1976, the Commission issued a Supplemental General Statement of Policy regarding the licensing of nuclear power plants as related to the analysis of fuel cycle environmental impacts. The Commission concluded that licensing of light water reactors may be resumed on a conditional basis using existing Table S-3 for reprocessing and waste management, provided the revised values presented in the Commission's notice of proposed rulemaking of October 18, 1976 were also examined to determine the effect on the cost-benefit balance for constructing or operating the plant.

In accordance with the proposed rule, the staff has considered the revised values for reprocessing and waste management in its determination of the effect on the cost-benefit balance as presented in Chapter 10 of the Draft Supplement to the FES for the Three Mile Island, Unit 2.

In the original fuel cycle rule, the environmental impacts for fuel cycle activities were summarized in Table S-3, as shown in 10 CFR § 51.20 and presented as Table 5.5 on page 5-11 of the Draft Supplement to the Three Mile Island, Unit 2 FES. Table 5.12 of this Final Environmental Statement presents a summary of environmental considerations of the uranium fuel cycle as originally contained in Table S-3 together with the modifications given in the proposed rulemaking notice of October 18, 1976, and described in NUREG-0116. Principal changes include those in the categories of land use, chemical effluents, iodine releases, Carbon-14 releases, and buried solids.

The following describes the differences between the impacts presented in Table S-3, as it was originally promulgated in 10 CFR § 51.20, and the changes in certain impacts resulting from the revised assessment of reprocessing and waste management considerations described in NUREG-0116. The land commitment reflected in NUREG-0116 is slightly larger than that reflected in the original Table S-3. The original estimates were smaller by some 30 acres per reference reactor year in temporarily committed land and about 3 acres per year in permanently committed land for waste disposal. These revisions increase the temporary land commitment associated with the fuel cycle supporting the TMINS-2 facility over its projected 30-year operating life by some 64% of the approximately 200 acres temporarily committed for operation of the facility itself. The total annual land required for the fuel cycle supporting a model 1000 MWe LWR is approximately 100 acres (94 acres temporarily committed and 7.1 acres permanently committed). Over the 30-year operating life of the plant this amounts to about 2100 acres, which is approximately eleven times as large as the commitment for the TMINS facility itself. Considering common classes of land use in the United States the revised values do not constitute a significant change. Hydrogen chloride has been included in NUREG-0116 as a gaseous chemical effluent, resulting from incineration of plastics in the waste management systems. The amount is a small fraction of other acid gas effluents from the fuel cycle discussed in both Table S-3 and NUREG-0116. No significant impact is attributable to the change. Most of the other changes under the heading of chemical effluents have been revised downward.

Radioactive effluents released to the environment estimated to result from the reprocessing and waste management activities or other phases of the fuel cycle process are presently set forth in Table S-3. Based on these effluents, the overall gaseous dose commitment to the U.S. population from the fuel cycle for a 1000 MWe reference reactor would be approximately 250 man-rem per year.

TABLE 5.12

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS FOR URANIUM FUEL CYCLE NORMALIZED TO MODEL LWR REFERENCE REACTOR YEAR[a]

NATURAL RESOURCE USE	TOTAL WASH-1248[b]	TOTAL NUREG-0116[c]
Land (Acres)		
Temporarily Committed	63	94
Undisturbed Area	45	73
Disturbed Area	18	22
Permanently Committed	4.6	7.1
Overburden Moved (millions of MT)	2.7	2.8
Water (millions of gal.)		
Discharged to air	156	159
Discharged to water bodies	11,040	11,090
Discharged to ground	123	124
Total Water	11,319	11,373
Fossil Fuel		
Electrical energy (thousand MW-hr.)	317	321
Equivalent coal (thousand MT)	115	117
Natural Gas (million scf)	92	124
Effluents		
Chemical (MT)		
Gases (MT)		
SO_x	4,400	4,400
NO_x	1,177	1,190
Hydrocarbons	13.5	14
CO	28.7	29.6
Particulates	1,156	1,154
Other Gases		
F^-	0.72	0.67
HCl	-	0.14
Liquids		
$SO_4^=$	10.3	9.9
NO_3^-	26.7	25.8
Fluoride	12.9	12.9
Ca^{++}	5.4	5.4
Cl^-	8.6	8.5

TABLE 5.12 (Continued)

NATURAL RESOURCE USE	TOTAL WASH-1248	TOTAL NUREG-0116
Effluents (Cont'd)		
NA^+	16.9	12.1
NH_3	11.5	10.0
Tailings Solutions (thousands)	240	240
Fe	0.4	0.4
Solids	91,000	91,000
Radiological (curies)		
Gases (including entrainment)		
Rn-222	74.5	74.5
Ra-226	0.02	0.02
Th-230	0.02	0.02
Uranium	0.032	0.034
Tritium (thousands)	16.7	18.1
Kr-85 (thousands)	350	400
I-129	0.0024	1.3
I-131	0.024	0.83
Fission Products	1.0	0.021
Transuranics	0.004	0.024
C-14	-	24
Liquids		
Uranium & Daughters	2.1	2.1
Fission & Activation Products	-	5.9E-6
Ra-226	0.0034	0.0034
Th-230	0.0015	0.0015
Th-234	0.01	0.01
Tritium (thousands)	2.5	-
Ru-106	0.15	-
Solids (buried onsite)[d]		
Other than high level (shallow)	601	5,300
TRU & HLW (deep)	-	1.1E+7
Thermal (billions of Btu)	3,360	3,462
Transportation (man-rems)		
Exposure of workers and general public	0.334	2.46

[a]Reference Reactor Year (RRY) is a 1000 MWe reactor operating at 80% of its maximum capacity for one year. An RRY is equivalent to an Annual Fuel Requirement as used in WASH-1248 dated April 1974.

[b]Table S-3 values.

[c]Revised Table S-3 values.

[d]Not released to the environment.

SOURCES: Environmental Supply of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle, NUREG-0116, October 1976.

Environmental Survey of the Uranium Fuel Cycle, WASH-1248, April 1974.

This is approximately .001% of the average natural background dose of approximately 21,000,000 man-rem* to the U.S. population. The dose commitment to the U.S. population from radioactive liquid effluents due to fuel cycle operations would be approximately an additional 260 man-rem** per year for a 1000 MWe reference reactor. The combined dose commitment, therefore, would be about 510 man-rem annually.

As a result of the staff's supplemental survey, NUREG-0116, there have been increases in the estimated Carbon-14, Iodine, and Tritium release rates. Carbon-14 is the principal addition to radioactive gaseous effluents and results in a dose estimate of 110 man-rem to the U.S. population. Together, these additional releases will add some 150 man-rem to the gaseous U.S. dose commitment of 250 man-rem as determined using Table S-3. The total gaseous and liquid involuntary dose commitment to the U.S. population utilizing revised source term data presented in NUREG-0116 is comparable to the 510 man-rem dose calculated using Table S-3.

The substitution of a "throw away" cycle would increase the dose commitment accumulated to the year 2000 for the reprocessing and waste management portions of the fuel cycle. This is due principally to increased occupational exposure during fuel storage. These effects amount to some 12,000 man-rem total to the year 2000 and would have only a small effect on overall population dose commitment. Furthermore, they may not be detectable against natural background exposure during this 25 year period of some 2-3 rem for every member of the general public.***

There is an increase to the transportation dose commitment presented in Table S-3. The revised transportation dose value of some 2.5 man-rem is based upon refined calculational assumptions and modeling techniques. This dose is not considered significant in comparison to the natural background.

There has been an increase in the quantity of buried radioactive waste material (both high level and transuranic). These wastes are placed in the geosphere and are not released to the biosphere and no radiological environmental impact is expected from such disposal. Table S-3 did not include either the disposal of high level or transuranic wastes or low-level wastes which are buried.

In accordance with the Commission's directive contained in the Supplemental General Statement of Policy, the staff has assessed, as set forth above, the effect of using the revised chemical processing and waste storage values set forth in the Commission's Notice of Proposed Rulemaking of October 18, 1976, on the cost-benefit balance for the Three Mile Island Nuclear Station, Unit 2. These impacts, as discussed above, are so small that there is no significant change in impact from that associated with the effects presented in Table S-3.

5.5 NONRADIOLOGICAL EFFECTS

5.5.1 Terrestrial

The only potential source of significant environmental damage to the terrestrial environment from the operation of Three Mile Island Nuclear Station Unit 2 is the drift from the natural draft cooling towers. The FES-OL, December 1972 (see Appendix B), addressed the question of drift with simple conservative arguments and concluded that no damage should result from the operation of the TMINS towers. Nevertheless both crop and natural vegetation monitoring programs were recommended by the staff and incorporated in the license for Unit 1.

At this time more advanced models could be applied to the problem, but since TMINS Unit 1 has been in operation since June 1974 it is possible to address the results of the monitoring programs. So far the applicant has only made available the results of the studies from June 5 to November 30, 1974. Since this period coincides with plant startup, the plant factor for this period is low compared to full power operation.

Based on the limited information from 1974, no vegetative effects attributable to cooling tower drift were reported. Detailed plant pathology investigations and analyses of species composition failed to show any salt stress or shifts in species composition not due to normal succession.

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*Based upon a natural background dose rate of 100 mrem/yr.

**This number is substantially reduced by NUREG-0116, since the liquid source terms, particularly for tritium, have been revised downward.

***As a result of increased requirements for new source material due to a "throw away" cycle, estimated releases from mining and milling would be increased. This, in turn, would increase the estimated dose commitment for the total fuel cycle by some 600 man-rem per reference reactor year. Although this is larger than the dose commitment due to other elements of fuel cycle, it is still small compared to the natural background exposure level of some 21,000,000 man-rem per year.

Since Unit 2 will approximately double the salt load from drift, the staff recommends continuation of the current monitoring program for two years (termination contingent on staff review and approval) after start-up of Unit 2 and correlation of results with low altitude true and false color aerial photography. The photographic techniques will allow an inexpensive long-term check on drift effects.

Not related to operation of the towers but instead to their presence is the problem of bird impaction. Tables 5.13 and 5.14 (see Reference 1) summarize almost one year of bird impaction data for Unit 1. Neither the total numbers nor the particular species involved represent an unacceptable impact. The staff recommends that this program be terminated with the provision that any excessive cases of bird impaction (greater than 100 in any one day) be analyzed and reported to the staff within thirty days.

5.5.2 Aquatic Impacts

5.5.2.1 Intake Effects

Impingement of Fishes

Under normal and low flow river conditions and typical plant operation about 54,500 gpm of river water is withdrawn for condenser makeup and secondary service cooling requirements at the TMINS. Intake design velocity is approximately 0.2 ft/sec. Impingement monitoring twice per month (24-hour survey at 4-hour intervals) at Unit 1[1,10] from February through December 1974 resulted in a collection of 1222 fish of 25 species weighing 1930g (4.3 lbs). The number of intake pumps operating during the surveys ranged from 1-7. Most fish were either young or juvenile and were dead (88%) at the time of collection. Four species accounted for 77% of the fish impinged - tessellated darter (37%), channel catfish (17%), spotfin shiner (15%) and the spottail shiner (8%). Other species impinged in low numbers included the golden shiner, comely shiner, bluntnose minnow, quillback, white sucker, northern hog sucker, white catfish, yellow bullhead, brown bullhead, margined madtom, rock bass, redbreast sunfish, green sunfish, pumpkinseed, bluegill, smallmouth bass, largemouth bass, white crappie, black crappie, banded darter and shield darter. The highest number and weight of fish were impinged in July. It appears that peak impingement follows the spawning of each species with little difference in day/night collection frequencies.

Adjusting the February through December impingement surveys for normal operating conditions (6 pump operation) and assuming fish collection proportional to volume flow, yields a 1974 estimated loss of about 34,000 fish weighing 75 kg (165 lbs) at Unit 1. Normal operation of both units could conceivably result in twice the estimated loss at Unit 1. The staff does not expect that fish losses at the TMINS, even at the hypothetical rate presented here, will have a detrimental effect on the sport fishery of York Haven Pond and nearby vicinity. The staff's assessment and operating impact of fish impingement at the TMINS on the local fishery will be verified by continuing impingement monitoring and studies to characterize the fishery as outlined in Section 6, Environmental Measurements and Monitoring Programs.

5.5.2.2 Station Passage Effects

Entrainment of Plankton and Fish Life Stages

The assessment conducted in the FES-OL of December 1972 remains valid (see Appendix B). Phytoplankton, zooplankton, fish eggs and larvae small enough to pass through the 3/8-inch mesh traveling screens, river water pumps and 1/8-inch mesh strainers prior to the heat exchangers will be entrained in the cooling water system and killed by the combination of mechanical, thermal and biocidal effects. No specific information has been reported in the location of spawning areas in the vicinity of the power station. However, the distribution of river ichthyoplankton during 1974[11] indicated that concentrations were similar in the three zones sampled (above, near, and below the intake area). Most larvae were taken during May and June when adult fish showed a wide distribution in the river sampling areas. In July 1974, a predominance of juvenile channel catfish were found at Station 5 (Figure 6.2) downstream near York Haven Dam.[10] Similarly ripe male and female pumpkinseed were common at Station 5 during July 1975.[27] These data tend to indicate that spawning is not more concentrated in any one area in the site vicinity than another. Limited entrainment studies[10] conducted at the site indicate that some survival through some parts of the system may occur. The staff does not anticipate any adverse effects on local planktonic populations from entrainment at the TMINS. This conclusion is based on (1) the small cooling water requirements of the station, <1% and 7% of the river's average and low flow of record, respectively; (2) the apparent large quantity of favorable spawning habitat available elsewhere compared to the possible area of the TMINS influence; (3) the continued flow of water through the Three Mile Island vicinity; and (4) the rapid regenerative capacities of many of the planktonic organisms.

TABLE 5.13

Bird Mortality Caused by Impaction with TMI Cooling Towers
July 27, 1973 through June 5, 1974[a]

Species	Number
Golden-crowned kinglet	7
Red-eyed vireo	8
Ruby-crowned kinglet	7
Solitary vireo	2
Common yellowthroat	3
Common starling	2
Parula warbler	1
Margnolia warbler	2
Black throated green warbler	1
Chestnut-sided warbler	1
Bay-breasted warbler	1
Blackpoll warbler	1
Ovenbird	1
Subtotal	37
Common grackle	3
Starling	1
Rock dove	1
Mourning dove	2
Dark-eyed junco	1
Subtotal[b]	8
TOTAL	45

[a]Pre-operational sampling period.

[b]*Birds found in cooling tower number one and two trash bars.*

Chemical Discharge

Table 3.4 shows the chemical discharges from the TMINS and the resulting downstream incremental concentrations, excluding chlorine, for low flow of record conditions. In evaluating the potential impact of chemical discharges the staff has compared the expected incremental concentration with appropriate reference sources on chemical toxicities to aquatic organisms.[12,13] The comparison indicates that the Susequehanna River concentration of discharge chemicals released from the TMINS during its operation will be below those expected to cause any adverse effects on river biota.

Chlorine discharges at TMINS Unit 1 have been summarized in Section 3.3.2. Operation of both units will reduce by about half the concentration in the discharge of the unit being chlorinated. Based on the analysis of thermal plume behavior for two unit operation[1] concentration will be cut in half again within an area of about 500 square feet of the discharge and will be reduced by a factor of ten before the discharge plume extends over an area of 10,000 square feet. If chlorination is continued as now practiced at Unit 1, toxic conditions should not occur in the river at all. If it is necessary to chlorinate at the permitted level then the area in which toxic conditions are created should be at the most a few thousand square feet. Since the discharge is into the main channel of the Susquehanna River, the area in the immediate vicinity is not unique with regard to the presence of fishery resources (See Section 2.6.2.5) and the staff does not expect chlorine discharges to have a significant adverse impact on these resources. However, the staff will require that the operational monitoring program include sampling to map the distribution of chlorine in the river if discharge at the permitted level is necessary.

TABLE 5.14

TMI Cooling Tower Bird Impactions by Month, Tower, and Direction of Impact July 27, 1973 through June 5, 1974

1. Impactions by Month:

Month	Number	Month	Number
July[a]	0	January	0
August	0	February	1
September	10	March	1
October	19	April	3
November	2	May	1
December	0	June[b]	0

2. Tower and Direction of Impact:

Direction	Tower[c] 1	2	3	4	Total
North	-	-	7	5	12
East	4	1	4	4	13
South	1	-	2	4	7
West	1	-	1	3	5
TOTAL	6	1	14	16	37

[a]Three days only, beginning on July 27, 1973.

[b]June 1 through June 5 only.

[c]Towers numbered 1-4 from north to south.

5.5.2.3 Discharge Effects

Thermal Discharge

The TMINS Unit 1 thermal discharge has been mapped over power levels ranging from 0 to 100% during the period May through December 1974.[10] Discharge temperatures varied from 5.6 C (10.1 F) below to 3.9 C (7.0 F) above ambient river temperatures. Effluent characteristics were generally distinguishable to about 20m (66 ft) into the river and downstream to about 50m (164 ft) over depths up to 3m (9.9 ft). On several occasions during winter the heated discharge was detectable up to 400m (1320 ft) downstream.

The previous staff assessment that no adverse effects are expected on aquatic populations in York Haven Pond or adjacent areas from the TMINS thermal discharge remains unchanged (see Appendix B). While definitive data are not available on possible heated effluent impact on the benthos in the immediate discharge area, the staff believes any effect that occurs will be limited to within a few hundred feet of the discharge point, a relatively small impact zone compared to the total equivalent benthic habitat available in the immediate vicinity. No adverse impacts on local fish populations due to thermal shock are anticipated from normal operating or extreme winter operation conditions (see Appendix B). Marked species composition changes in resident aquatic forms presently existing in the vicinity of the discharge are not expected.

5.5.3 Atmospheric Impacts

The effects of combined thermal releases into the atmosphere from multiple electrical power facilities have not been precisely determined.[23,25] Although more study in this area is required before realistic quantitative estimates can be made,[23,25] the impact of waste heat on the atmosphere is known to be a function of heat flux density which considers the area over which the heat is discharged. Studies have indicated that as power plants become sufficiently clustered, some modifications to the local meteorology and climate could occur.[22,25] However, even with relatively close grouping as proposed in the nuclear energy center concept, experts disagree on whether the combined waste heat would have any significant effects on weather and climate, and if so, what the specific effects and the magnitude of these effects would be.[22,25] On the other hand, to date, heat rejected by a single electrical power production facility appears to have little impact on the weather.[24] The present arrangement of power plants along the lower Susquehanna is somewhere between these two cases. Present state-of-the-art knowledge does not provide definitive conclusions concerning the effects on the climate of the combined thermal releases of power generation facilities in this area. However, due to the relatively low flux density of heat rejection in the lower Susquehanna River area, major weather modifications are not expected.

Although the staff does not currently plan to study the Three Mile Island region specifically, the general study addressing weather modification resulting from operation of power plants is presently being conducted by the Pacific Northwest Laboratories.[26] Results of this research are expected later this year.

5.6 IMPACTS ON PEOPLE

The Harrisburg SMSA which includes Dauphin, Cumberland, and Perry Counties had a 1970 population of 420,626 persons.[14] The Harrisburg Labor Market Area which includes the same counties had a civilian labor force of 206,900 persons in 1974 with unemployment of about 5,700 persons.[15] According to a Tri-County Regional Planning Commission report the private sector is meeting the region's new dwellings need based on permits issued during the 1971-1973 time period.[16] The average market price for a single family detached dwelling in the region was over $43,000, based on 1973 data with the average market price for all types of dwellings being about $29,000.[17]

Assuming that the TMINS-Unit 2 operating personnel (about 165 people) will follow a residential pattern similar to that set by the TMINS-Unit 1 staff, about 45 percent will locate their residences in Dauphin County.[18] Twenty-two percent will reside in Lancaster County with about a like number also residing in Lebanon County. The remaining residences would be distributed in York County (4 percent), Berks County (over 4 percent), Cumberland County (less than 2 percent), and other counties (less than 1 percent of the total). The annual operating payroll, estimated at $3.04 million will be dispersed over these counties.[19]

The total annual estimated expenditures on supplies and materials related to the operation of TMINS-Unit 2 will be about $2,500,000 of which about 5 percent, or $125,000, is estimated to be spent locally.[20]

State taxes associated with Three Mile Island Nuclear Station, Unit 2, include public utility realty tax, capital stock tax, income tax, and gross receipts tax. Together these taxes are estimated to amount to $22.8 million in 1979.[21] Some tax revenues will accrue to local jurisdictions resulting from the 1 percent earned personal income tax levied by Pennsylvania townships. This tax would yield about $30,000 a year during the operation phase.

In discussions with local officials during a staff site visit, the officials felt that there was no significant pressure put on community services during the construction of the plant when the work force reached a peak as high as 2,000 workers. Because of the plant's proximity to a sizable metropolitan area containing a large labor force and because of the relatively small plant operating staff of 165 workers, the staff believes that impacts on community services and the local economy during operation of the plant will be relatively small and unobjectionable.

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6. ENVIRONMENTAL MONITORING

6.1 RÉSUMÉ

The Staff has evaluated the Applicant's preoperational monitoring programs. Additional information on onsite meteorological monitoring is presented in Section 6.3. In Sections 6.4 and 6.5 the staff recommends that the operational programs for Unit 1 be continued with the exception of the phytoplankton and zooplankton entrainment studies and the bird impaction program which may be terminated. Staff's recommendations for improvement of the effectiveness of the preoperational radiological monitoring program are outlined in Section 6.6.1. The operational monitoring programs will be incorporated in the Technical Specifications which will in turn be incorporated as part of the operating license.

6.2 HYDROLOGICAL

The physical parameters of the Susquehanna River near the plant site, such as temperature, conductivity, pH, dissolved oxygen, turbidity, color, odor, and other chemical properties have been studied since 1962; the data are given in ER Figures 2.5-1 through 2.5-8. Additional data are given in Table 2.5-1 of the Environmental Report, Supplement II, February 1975.

6.3 METEOROLOGICAL PROGRAM

6.3.1 Pre-Operational Onsite Meteorological Program

Meteorological data collection began onsite in May 1967 with the installation of a 100-ft high, instrumented mast about 1500 ft south of the Unit 2 containment structure. Wind speed and direction were measured at the 100-ft level on this mast. In October 1970, this mast was relocated to a position approximately 1750 ft southeast of the Unit 2 containment. Wind speed and direction continued to be measured at the 100-ft level on this mast until it was deactivated in June 1972.[1]

At the same time the 100-ft mast was moved from its original position in October 1970, another 150-ft high meteorological tower erected on the northern end of the Three Mile Island became operational. Located 2200 ft north of the Unit 2 containment building, this tower is currently in operation at the site. Wind speed and direction are measured at the 100- and 150-ft levels, ambient air temeprature at the 25-ft level, relative humidity at the 150-ft level, and vertical temperature difference between the 25- and 150-ft levels and between 50- and 150-ft levels on this tower are also measured. In addition, horizontal and vertical wind fluctuations are measured at the 100-ft level. In October 1971, the vertical temperature gradient measuring system was replaced and upgraded.[1]

Because of the limited space available on the island and the numerous structures associated with the plant facilities, the location of the lowest wind sensors are not at the 10 meter above ground level as recommended in Regulatory Guide 1.23. Instead, the 100-ft level of these sensors places them at a height 10 meters (33 ft) above nearby trees which reach heights of about 70 ft. This placement does meet the intent of Regulatory Guide 1.23.[1]

The applicant has provided joint frequency distributions of wind speed and direction by atmospheric stability class (based on vertical temperature difference) for two one-year periods of data record (4/71-3/72 and 10/72-10/73) collected onsite. The wind speed and direction measured at the 100-ft level and reduced to represent conditions at the 33-ft level, and the vertical temperature difference between the 50- and 150-levels were the bases for the staff's dispersion estimates. The joint recovery rate for these data for the two years of record was 79%.[1] A Gaussian diffusion model, assuming a ground-level release with adjustments for building wake effects was used to make staff estimates of relative atmospheric concentration (X/Q) values at the various distances and directions from the site as specified in Section 5.[3]

6.3.2 Operational Onsite Meteorological Program

Meteorological data collection is continuing onsite. The applicant has stated that recently improved instrumentation and maintenance capability will provide reasonable assurance that the data recovery from the continuing onsite meteorological program will be at least 90%. The staff requires that the applicant submit a year of onsite meteorological data, with data recovery of at least 90%, as soon as such data are available. The staff will use these data to confirm that the relative concentration values used herein for radiological impact assessment are reasonably conservative. It is intended that meteorological data collection onsite will continue throughout the entire period of plant operation.

6.4 AQUATIC BIOLOGICAL MONITORING PROGRAMS

The applicant's preoperational and operational aquatic biological monitoring programs have been described previously.[4,5] Current biological monitoring being conducted to evaluate Unit 1 impact at the TMINS, as requirements of the Environmental Technical Specifications, is presented in Appendix B to the operating license of Unit 1. Phytoplankton, zooplankton and fish egg and larvae sampling is conducted at the intake and discharge. Trap netting and shoreline seining is carried out at fish locations I - V. Figures 6.1 through 6.3 indicate additional fish monitoring being conducted by the applicants. Trawling and Fyke nets are also being used at fish locations I - IV. In addition, substantial effort in larval fish sampling and electrofishing are ongoing. Trap netting and shoreline seining is being conducted at other locations besides I - IV (see Figure 6.2).

The staff recommends that the present Unit 1 monitoring program should continue as the operational evaluation program for Unit 2 with the exception of the phytoplankton and zooplankton entrainment studies which may be terminated. The reasons for termination of planktonic studies are discussed in Section 5.5.2.2. It is also suggested that after staff evaluation of the 1975 monitoring results, at the time of preparation of the Environmental Technical Specifications for Unit 2 that all biological monitoring programs be evaluated by the staff and applicants for appropriateness at the TMINS. The results of this reevaluation will be incorporated in the Technical Specifications prior to issuance of the operating license.

6.5 TERRESTRIAL MONITORING PROGRAMS

The Environmental Technical Specifications for TMI Unit 1 describe the terrestrial monitoring programs and are presented in Appendix B to the operating license for Unit 1. Preoperational data are summarized in Sections 2.7.3 and 2.8 of Supplement II to the applicant's ER.[5] Data collection efforts were concentrated in an area within a one-mile radius of the TMINS because this was predicted as the most probable area for drift deposition effects. Figures 6.4 and 6.5 indicate sampling locations of preoperational soil and vegetation in Three Mile Island vicinity for mineral analysis. Analyses emphasized sulfur, chloride, copper and soil conductivity. Figure 6.6 indicates the transects followed for the operational plant pathology investigations. The results of the bird impaction study are discussed in Section 2.8 of the applicant's ER (S II).[5]

The staff concludes that the bird impaction-program may be terminated because the level of bird mortalities is not considered to be significant. The provisions regarding unusual or abnormal events in the Environmental Technical Specifications for Unit 2 will include explicit reference to unusual or important bird impaction events that have public or potential public interest as topics requiring special reports. The operational terrestrial monitoring program recommended for Unit 2 will specify low altitude true and false color aerial photographic studies once each year in the late summer or early fall for at least five years (termination contingent on staff review and approval). An initial ground inspection program will cover the first year of the aerial photographic monitoring program for purposes of verification of results and interpretation. The applicant may continue to existing operational terrestrial monitoring program as specified in Appendix B to the operating license for Unit 1 as the ground inspection phase of the aerial photographic monitoring program.

The staff also recommends that once each year, during normal transmission line inspections, notations be made of any areas which may require reseeding. A brief report of any such areas and confirmation of action to remedy the condition should accompany the annual report. Herbicide use in the maintenance of transmission line rights-of-way will conform to the approved use of specific herbicides as registered by the U.S. EPA and authorized by state authorities. A discussion of the use of herbicides in maintenance activities will be required in the annual report on the monitoring programs.

It is the staff's conclusion that the present data provided by the applicant and applicant's consultants (Section 5, Ref. 10 and 11) in the ER (with Supplements) augmented by the results from the ongoing preoperational monitoring program for Unit 2 and from the ongoing operational monitoring program for Unit 1 will provide an adequate data base for establishing a baseline against which the operational effects on aquatic and terrestrial biota of Unit 2 can be measured.

6.6 RADIOLOGICAL ENVIRONMENTAL MONITORING

Radiological environmental monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. Appendix I to 10 CFR Part 50 requires that the relationship between quantities of radioactive material released in effluents during normal operation, including anticipated operational occurrences and resultant radioactive doses to individuals from principal pathways of exposure be evaluated. Monitoring programs are

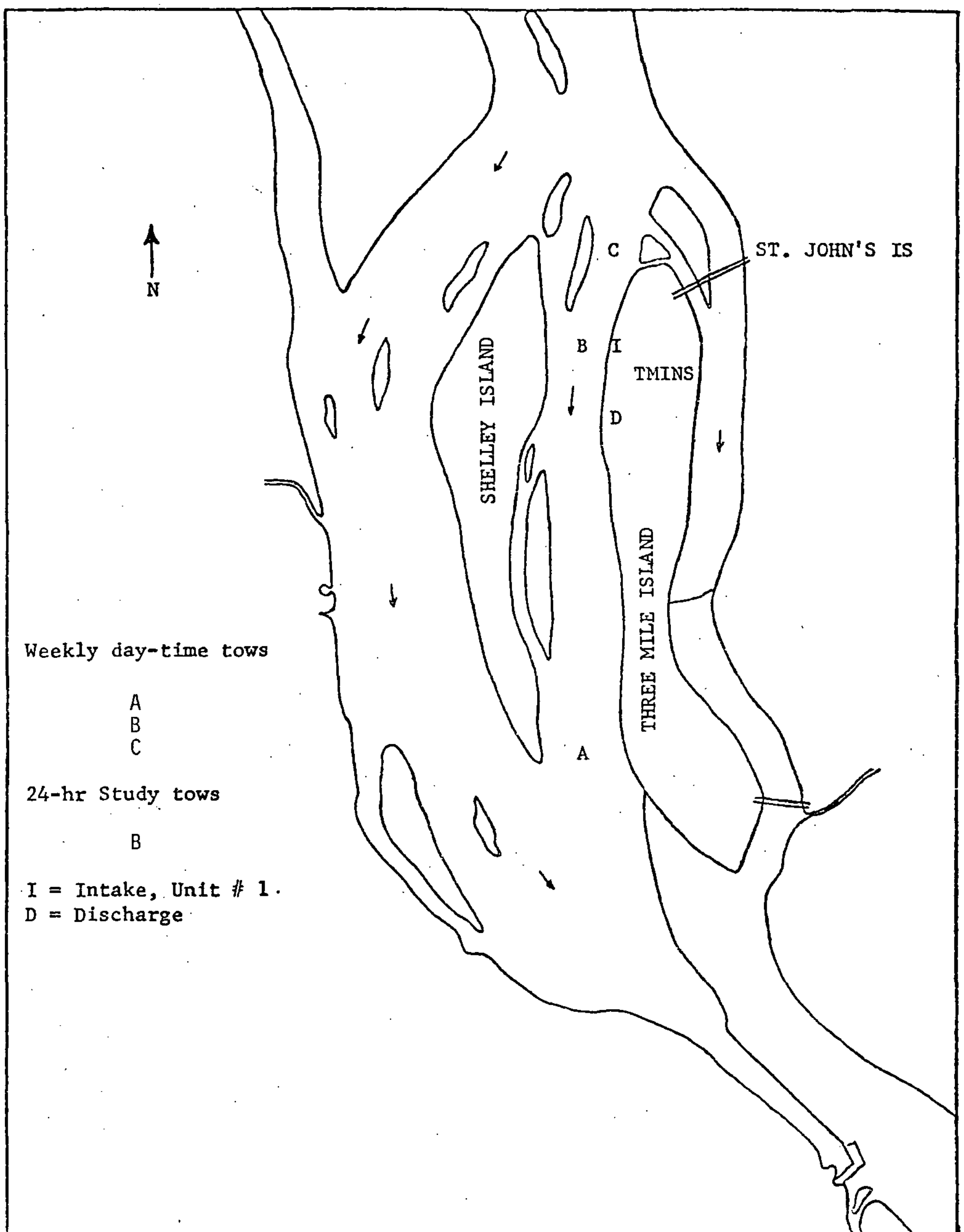

Fig. 6.1 Locations of larval fish sampling zones in the Susquehanna River near TMINS during 1974.

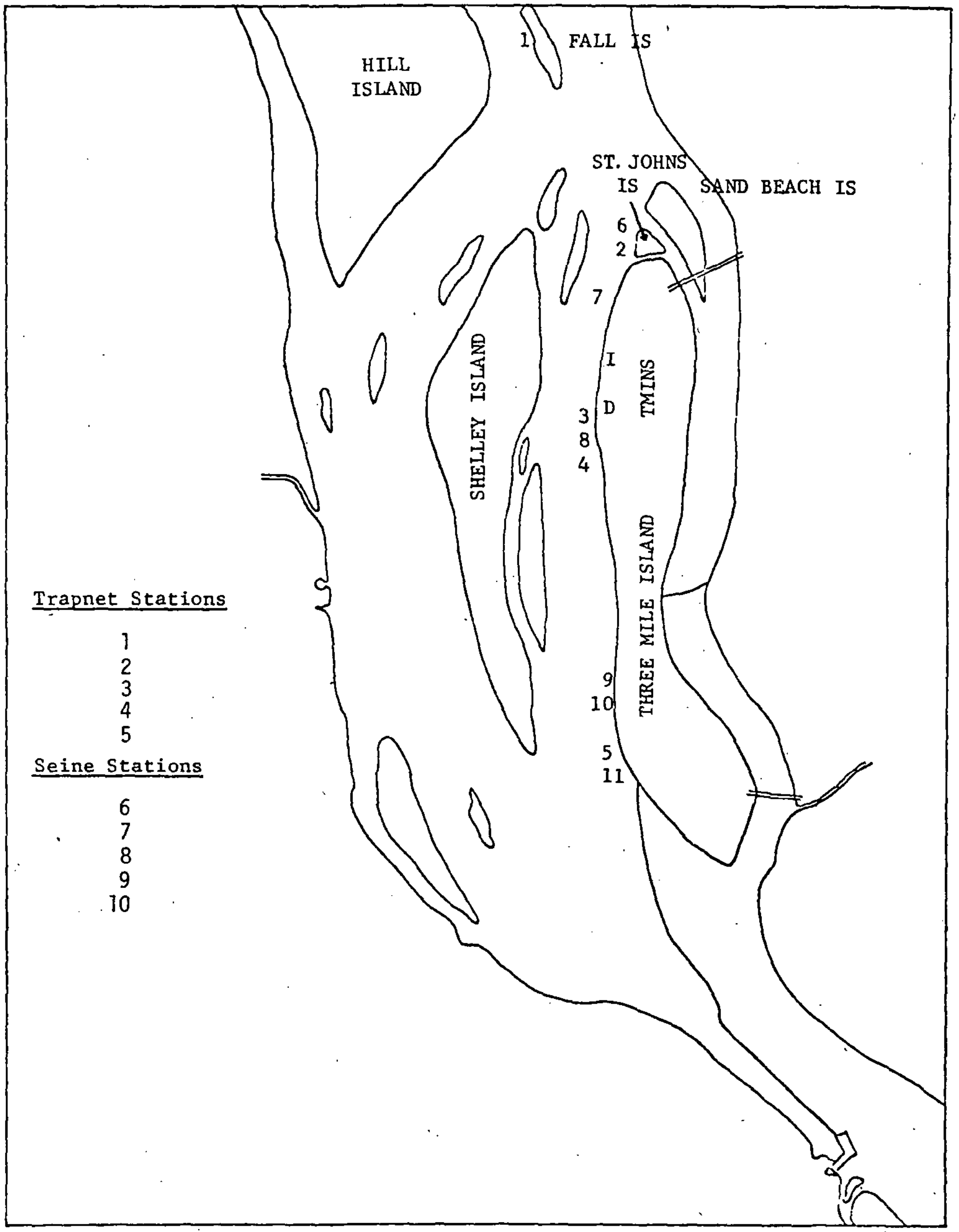

Fig. 6.2 Locations of trapnet and seine stations in the vicinity of TMINS.

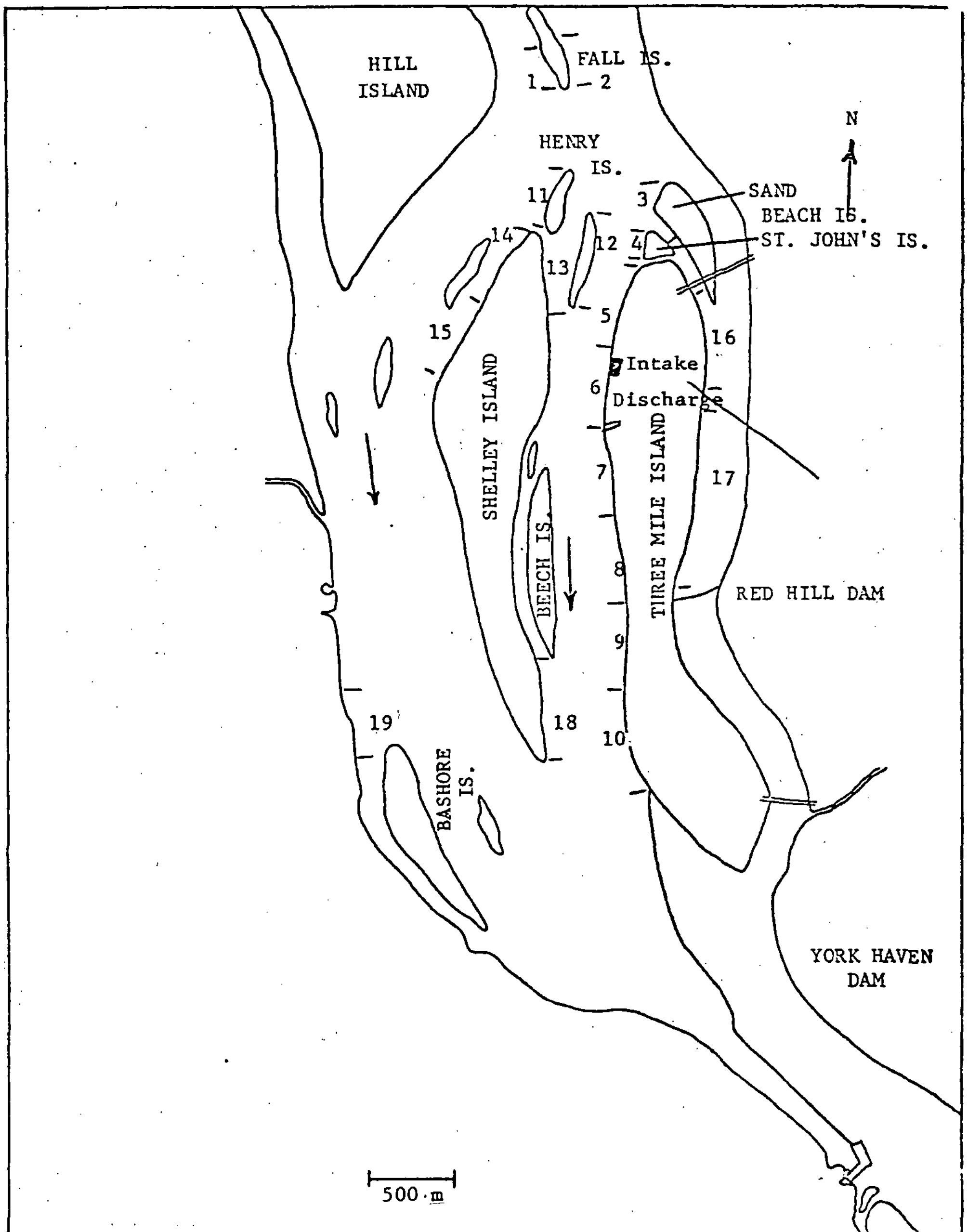

Fig. 6.3 Electrofishing zones sampled in York Haven Pond during July through November, 1974.

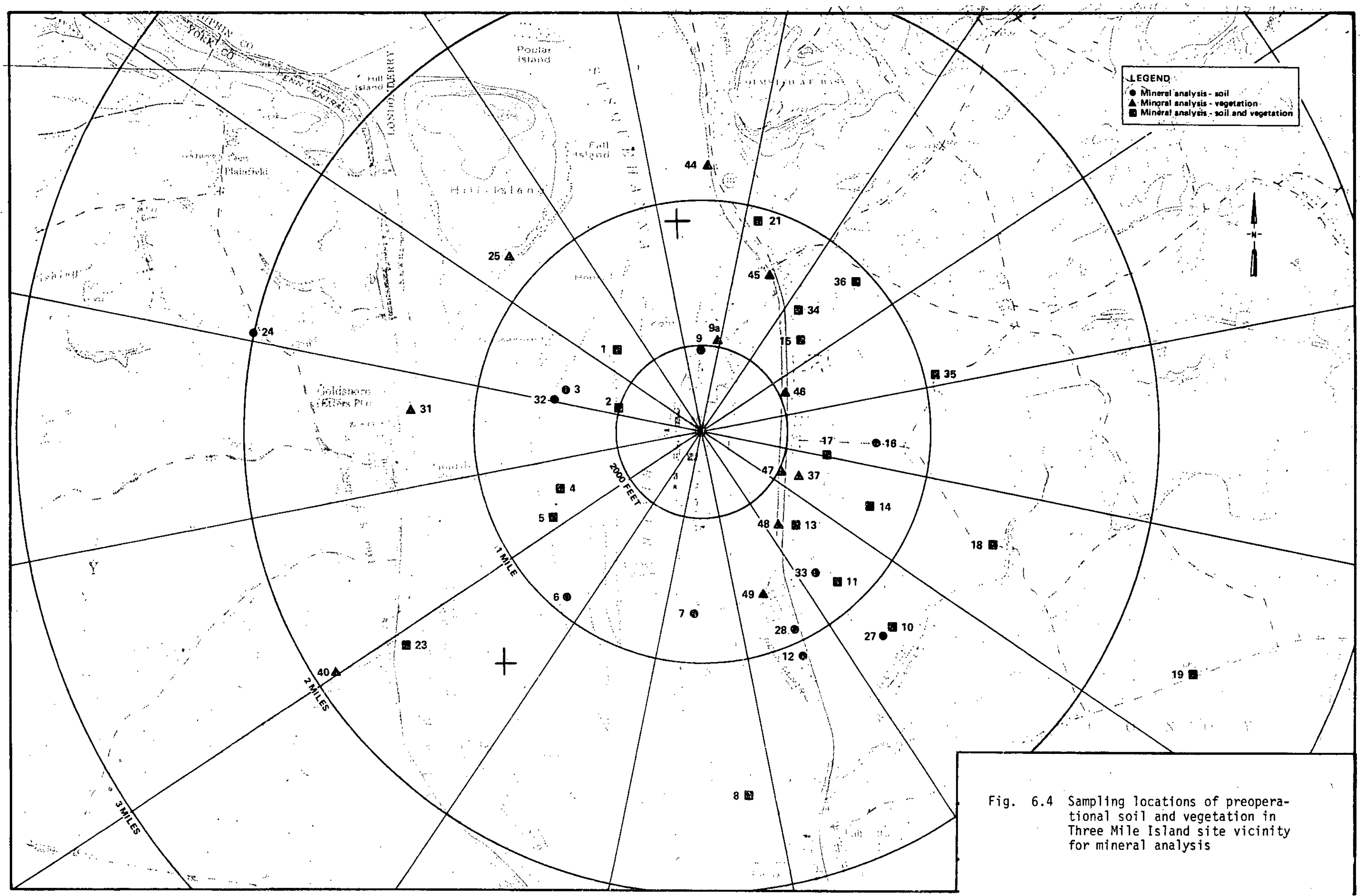

Fig. 6.4 Sampling locations of preoperational soil and vegetation in Three Mile Island site vicinity for mineral analysis

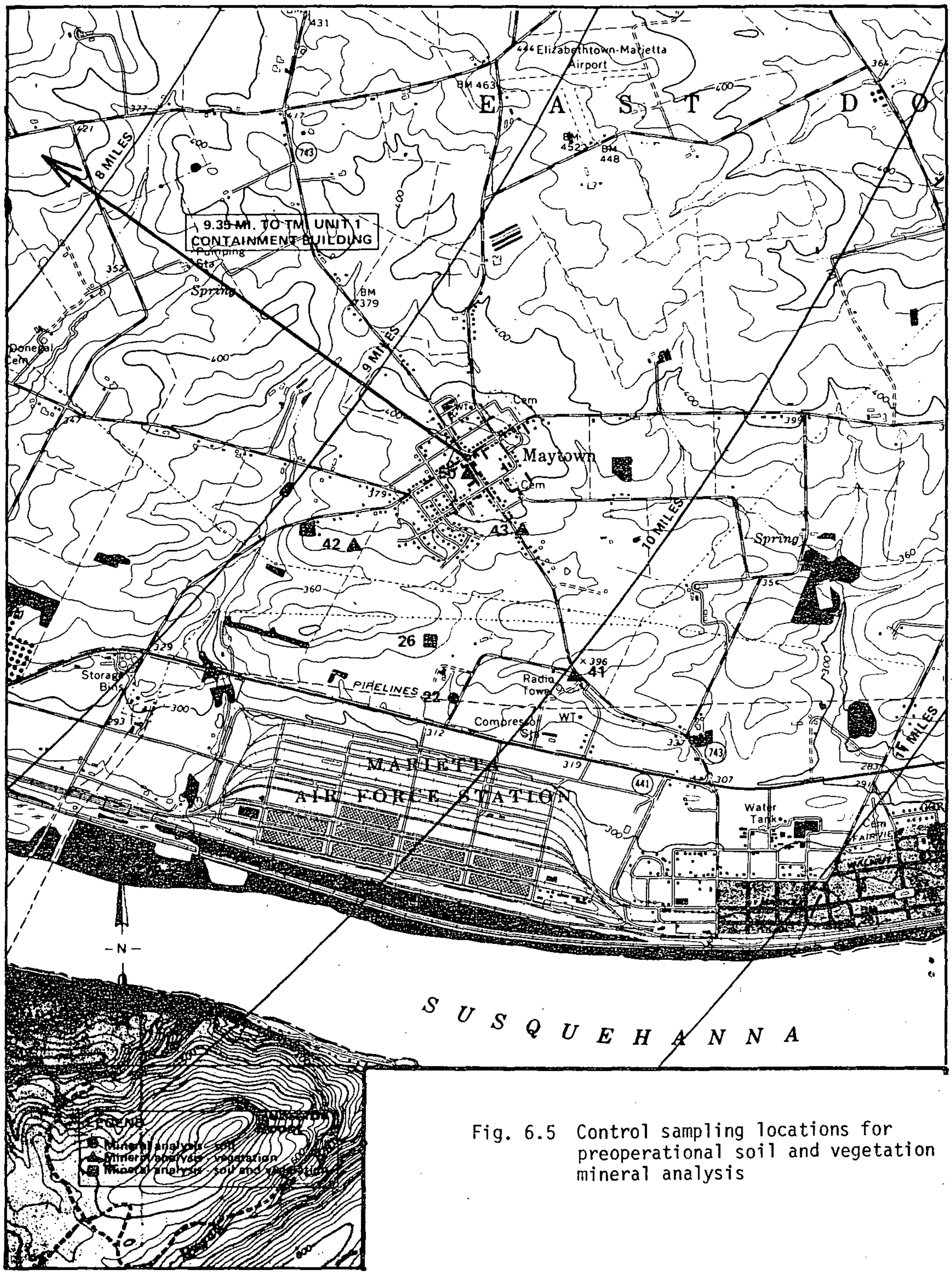

Fig. 6.5 Control sampling locations for preoperational soil and vegetation mineral analysis

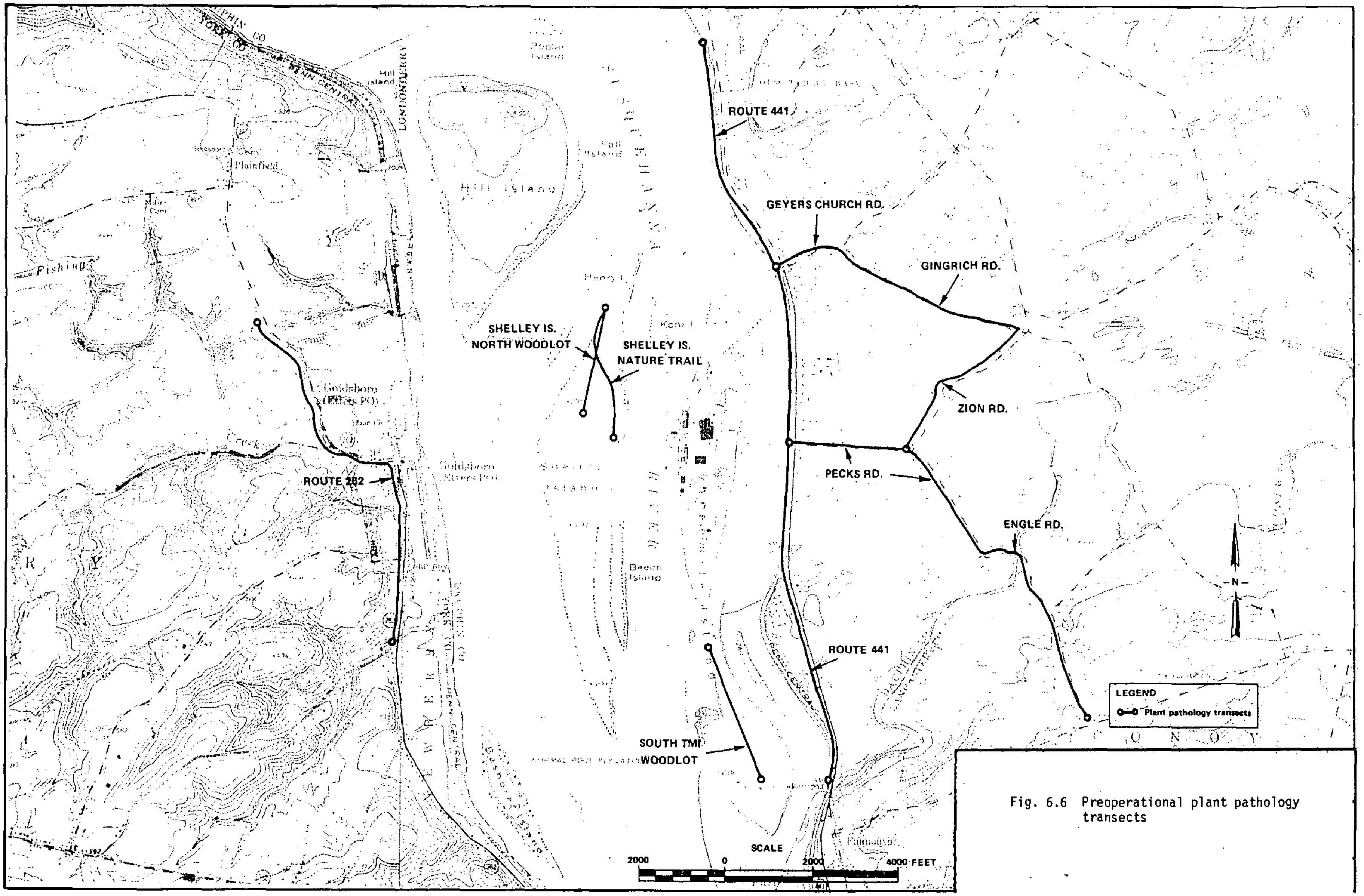

Fig. 6.6 Preoperational plant pathology transects

conducted to verify the in-plant controls used for controlling the releases of radioactive materials and to provide public reassurance that undetected radioactivity will not build up in the environment. Surveillance is established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs.

The preoperational phase of the monitoring program provides for the measurement of background levels and their variations along the anticipated important pathways in the area surrounding the plant, the training of personnel and the evaluation of procedures, equipment, and techniques.

This is discussed in greater detail in NRC Regulatory Guide 4.1, Rev. 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants."

6.6.1 Preoperational Program

The applicant has proposed a radiological environmental monitoring program to meet the needs discussed above. It is based on a continuation of the operational program for Unit 1. A description of the applicant's proposed preoperational program (as described in the technical specifications for Unit 1) is summarized in Table 6.1. More detailed information on the applicant's preoperational radiological environmental monitoring program for Unit 2 is presented in Section 4.4 of the applicant's Environmental Technical Specifications for Unit 1.

The Staff concludes that the preoperational monitoring program proposed by the applicant for Unit 2 is generally acceptable. However, consistent with Regulatory Guide 4.8, the following changes are recommended to improve the effectiveness of the program.

1. Add an air particulate sampling station in Falmouth community, and Sr-89, -90 analyses of quarterly composite air samples (Sr-89, -90 analyses of precipitation samples is not an acceptable substitute for air samples).

2. Add an iodine sampler to the above station.

3. Institute a soil sampling program in prevailing downwind sectors to monitor long-term buildup (once every 3 years). May be substituted for precipitation sampling program.

4. Composite water samples should be collected with equipment which is capable of collecting an aliquot at time intervals which are very short (e.g., hourly) relative to monthly composites. Grab samples are no longer desirable. Should add Sr-89, -90 to quarterly river water composite.

5. Milk samples collected at the location with the highest χ/Q should be taken at least semimonthly, and measured for Sr-89, -90 and gamma scanned.

6. Add at least one or two more commercially and/or recreationally important fish species (could be walleye, crappie, rockbass, sunfish, bluegill or pumpkinseed, bass (large or smallmouth), catfish or bullhead, and carp).

7. Expand vegetation sampling program to include fruits, tuberous and root vegetables near points with highest χ/Q's.

8. Should institute sampling of meat, poultry and eggs within 10 miles downwind, and gamma scan semiannually. Sample one major game species where these provide an important source of dietary protein.

9. The applicant should change the use of "sensitivity" to the more recent and preferred "lower level of detection" (LLD) terminology used by NRC, and add a table of LLD's of nuclides comparable to that in Regulatory Guide 4.8.

10. The applicant should increase the sensitivity of the tritium analyses for water samples in accordance with Regulatory Guide 4.8.

6.6.2 Operational Program

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

TABLE 6.1

PREOPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Sample Type	No. of Sample Indicator	Stations Background	Type of Analysis	Sensitivities	Collection Frequency
Air	3	1	^{131}Iodine Charcoal Cart.	$1x10^{-13}$ μCi/cc	Charcoal Cartridge-Weekly
	8	1	GB	$5x10^{-15}$ μCi/cc	Particulate Weekly
	8	1	GS	(4)	Quarterly
Precipitation	3	1	GB	$7x10^{-8}$ μCi/ml	Monthly (if available)
			GS	(4)	Quarterly (if available)
			^{89}Strontium	$5x10^{-9}$ μCi/ml	Semi-Annually
			^{90}Strontium	$1x10^{-9}$ μCi/ml	Semi-Annually
Radiation TLD	15	5	Gamma	20 mrem/yr	Quarterly
Milk	4	1	^{131}Iodine	$5x10^{-10}$ μCi/ml	Monthly*
			^{89}Strontium	$5x10^{-9}$ μCi/ml	Quarterly*
			^{90}Strontium	$1x10^{-9}$ μCi/ml	Quarterly*
Green Leavy Vegetables	3	1	^{131}Iodine	$1x10^{-8}$ μCi/ml	Annually (at harvest)
			GS	(4)	Annually (at harvest)
River Water	2	1	GS (1)	(4)	Monthly (3)
			Tritium	$2x10^{-4}$ μCi/ml	Quarterly (3)
City of Columbia Water	1	-	GS	(4)	Composite Sample Analyzed Monthly
			Tritium	$2x10^{-4}$ μCi/ml	Composite Sample Analyzed Quarterly
			^{89}Strontium	$1x10^{-9}$ μCi/ml	Composite Sample Analyzed Quarterly
			^{90}Strontium	$1x10^{-9}$ μCi/ml	Composite Sample Analyzed Quarterly

TABLE 6.1 (Continued)

PREOPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Sample Type	No. of Sample Indicator	Stations Background	Type of Analysis	Sensitivities	Collection Frequency
Sediment	2	1	GS	(4)	Semi-Annually (July and October)
			^{89}Strontium	$2x10^{-9}$ μCi/gm	Semi-Annually (July and October)
			^{90}Strontium	$1x10^{-9}$ μCi/gm	Semi-Annually (July and October)
Fish	1	1	GS	(4)	Semi-Annually, July and October (if available)
			^{89}Strontium	$2x10^{-9}$ μCi/gm	Semi-Annually, July and October (if available)
			^{90}Strontium	$1x10^{-9}$ μCi/gm	Semi-Annually, July and October (if available)
Aquatic Vegetation	2	1	GS (1)	(4)	Semi-Annually (July and October)

INDEX: GB - Gross Beta GS - Gamma Scan

(1) In the event of icing or dangerous conditions on the Susquehanna River, the sampling frequency may be extended until river conditions permit sampling.

(2) Composite of all samples for quarter in two groups - Background Samples and Indicator Samples.

(3) River water samples will be collected weekly and composited for monthly and quarterly analyses.

(4) Sensitivities are based on Met-Ed data, Vendors Data & E.P.A. Surveillance Guide ORP/SID 72-2.

*Milk Indicator sampling stations shall be restricted to pastures within a five mile radius of the plant. In the event that more than four pastures are available within this radius, the four pastures with the highest anticipated concentrations shall be sampled. If four or less pastures are available within the radius, all pastures shall be sampled.

The applicant plans essentially to continue the proposed preoperational program during the operating period. However, refinements may be made in the program to reflect changes in land use or preoperational monitoring experience.

Detailed evaluation of the applicant's proposed operational minitoring program will be performed when the applicant submits for the staff's approval the Environmental Technical Specifications which will be incorporated in the operating license. NRC Regulatory Guide 4.8 also provides detailed information on operational programs for nuclear power plants. Prior to the issuance of the operating license the staff will insure that the radiological monitoring program will comply with the applicable regulations and that it will conform to the applicable guides.

REFERENCES

1. Metropolitan Edison Co., 1974: Final Safety Analysis Report, Three Mile Island Nuclear Station - Unit 2. Docket number 50-320.

2. U.S. Atomic Energy Commission: Regulatory Guide 1.23 (Safety Guide 23), Onsite Meteorological Programs. USAEC Directorate of Regulatory Standards, Washington, D.C., 1972.

3. U.S. Atomic Energy Commission, 1974: Regulatory Guide 1.42; Interim Licensing Policy On As Low As Practicable for Gaseous Radioiodine Releases From Light-Water-Cooled Nuclear Power Reactors - Revision 1, Appendix B - Procedures for Calculation of Annual Average Relative Concentrations in Air. USAEC Directorate of Regulatory Standards, Washington, D.C.

4. United States Atomic Energy Commission, Environmental Statement on Three Mile Island Nuclear Station Units 1 and 2. Docket Numbers 50-289 and 50-320. December 1972. (See Appendix B to this statement.)

5. Metropolitan Edison Company et al., Supplement II Environmental Report Operating License Stage - Unit 2. 1975.

7. REALISTIC ACCIDENT ANALYSIS

7.1 RESUME

An updated realistic accident assessment is discussed. Estimates of man-rem exposures have been updated to reflect the population projections to the year 2010.

7.2 ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Three Mile Island Nuclear Station, Unit 2 is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system, as will be considered in the Commission's Safety Evaluation. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, even though they may be extremely unlikely; and engineered safety features are installed to mitigate the consequences of those postulated events which are judged credible.

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

The Commission issued guidance to applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The applicant's response was contained in the Three Mile Island Nuclear Station, Unit 1 and Unit 2 Environmental Report Operating License Stage, dated December 10, 1971. The applicant's report has been evaluated, using the standard accident assumptions and guidance issued as a proposed amendment to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate and those on the low potential consequence end have a higher occurrence rate. The examples selected by the applicant for these cases are shown in Table 7.1. The examples selected are reasonably homogeneous in terms of probability within each class.

Commission estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 7.2. Estimates of the integrated exposures that might be delivered to the population within 50 miles of the site are also presented in Table 7.2. The man-rem estimate was based on the projected population within 50 miles of the site for the year 2010.

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operations; and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; but events of this type could occur sometime during the 40-year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighed by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain a high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

TABLE 7.1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	AEC Description	Accident's Example(s)
1	Trivial Incidents	None
2	Small Releases Outside Containment	Spill in Sample Hood
3	Radwaste System Failure	Inadvertent Release of Waste Gas Decay Tank
4	Fission Products to Primary System (BWR)	Not applicable
5	Fission Products to Primary and Secondary Systems (PWR)	One day Operation with Primary System Leak to Reactor Building Normal Operation with Steam Generator Tube Leak and Release from Condenser
6	Refueling Accidents	Drop of Fuel Assembly or Drop of Heavy Object on Fuel Assembly
7	Spent Fuel Handling Accident	Drop of Fuel Assembly
8	Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report	Uncompensated Operating Reactivity Changes Startup Accident Rod Withdrawal Accident Moderator Dilution Accident Cold Water Accident Loss of Coolant Flow Accident Stuck-Out, Stuck-In, or Dropped Control Rod Accident Loss of Electric Load Accident Steam Line Failure Steam Line Leakage Steam Generator Tube Failure Rod Ejection Accident Loss of Coolant Accident Waste Gas Tank Rupture
9	Hypothetical Sequences of Failures More Severe Than Class 3.	None

TABLE 7.2

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS[a]

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[b]	Estimated Dose to Population in 50 mile radius man-rem
1.0	Trivial Incidents	c	c
2.0	Small releases outside containment	c	c
3.0	Radwaste System failures		
3.1	Equipment leakage or malfunction	0.073	11
3.2	Release of waste gas storage tank contents	0.29	44
3.3	Release of liquid waste storage contents	0.003	0.52
4.0	Fission products to primary system (BWR)	N. A.	N. A.

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

[b]Represents the calculated fraction of a whole body dose of 500 mrem, or the equivalent dose to an organ.

[c]These radionuclide releases are considered in developing the gaseous and liquid source term presented in Section 3 and are included in doses in Section 5.

TABLE 7.2 (Continued)

SUMMARY OF RADIOLOGICAL CONSEQUENCES
OF POSTULATED ACCIDENTS[a]

Class	Event	Estimated Fraction of 10 CFR Part 20 limit at site boundary[b]	Estimated Dose to Population in 50 mile radius man-rem
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	c	c
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	0.002	0.25
5.3	Steam generator tube rupture	0.096	14
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.015	2.3
6.2	Heavy object drop onto fuel in core	0.26	40
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel	0.01	1.4
7.2	Heavy object drop onto fuel rack	0.038	5.8
7.3	Fuel cask drop	0.21	33
8.0	Accident initiation events considered in design basis evaluation in the SAR		
8.1	Loss-of-Coolant Accidents		
	Small Break	0.16	44
	Large Break	1.2	1100
8.1(a)	Break in instrument line from primary system that penetrates the containment	N. A.	N. A.
8.2(a)	Rod ejection accident (PWR)	0.12	110
8.2(b)	Rod drop accident (BWR)	N. A.	N. A.
8.3(a)	Steamline breaks (PWR's outside containment)		
	Small Break	< 0.001	< 0.1
	Large Break	< 0.001	< 0.14
8.3(b)	Steamline break (BWR)	N. A.	N. A.

The NRC has performed a study to assess more quantitatively these risks. The initial results of these efforts were made available for comment in draft form on August 20, 1974[1] and released in final form on October 30, 1975.[2] This study, called the Reactor Safety Study, is an effort to develop realistic data on the probabilities and consequences of accidents in water-cooled power reactors, in order to improve the quantification of available knowledge related to nuclear reactor accidents probabilities. The Commission organized a special group of about 50 specialists under the direction of Professor Norman Rasmussen of MIT to conduct the study. The scope of the study has been discussed with EPA and described in correspondence with EPA which has been placed in the NRC Public Document Room (letter, Doub to Dominick, dated June 5, 1973).

As with all new information developed which might have an effect on the health and safety of the public, the results of these studies will be made public and will be assessed on a timely basis within the Regulatory process on generic or specific bases as may be warranted.

Table 7.2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary which are less than or comparable to those which would result from a year's exposure to the Maximum Permissible Concentrations (MPC) of 10 CFR Part 20. The table also shows the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident. Any of these integrated exposures would be much smaller than that from naturally occurring radioactivity. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small and need not be considered further.

7.3 TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

The transportation of cold fuel to the plant, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to burial grounds is within the scope of the NRC report entitled, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," December 1972. The environmental risks of accidents in transportation are summarized in Table 7.3.

Table 7.3. Environmental Risks of Accidents in Transport of Fuel and Waste to and from a Typical Light-Water-Cooled Nuclear Power Reactor[2]

	Environmental Risk
Radiological effects	Small*
Common (nonradiological) causes	1 fatal injury in 100 years; 1 nonfatal injury in 10 years; $475 property damage per year.

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

REFERENCES

1. "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, Draft," WASH-1400, August 1974.

2. "Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants," WASH-1400 (NUREG 75/014), October 1975.

8. NEED FOR PLANT

8.1 RESUME

The discussion of need for power presented in FES, December 1972 is still valid. An additional discussion of the applicant's relationship to the Pennsylvania-New Jersey-Maryland Interconnection (PJM) and the Mid-Atlantic Area Coordinating Council (MAAC) is presented in Section 8.2. The revised load and energy forecasts reflecting national events since the December 1972 FES and the reserve margins are discussed in Section 8.3.1. Section 8.3.2 discusses the impact of energy conservation on the applicant's system energy requirements and peak load demand while Section 8.3.3 discusses the fact that TMINS-2 provides the least cost alternative to meeting base load requirements as well as improving system reliability. The staff's conclusion that the plant should be operated remains unchanged.

8.2 APPLICANT'S SERVICE AREA AND REGIONAL RELATIONSHIPS

8.2.1 Applicant's Service Area

The General Public Utilities Corporation with its subsidiaries of the Metropolitan Edison Company, the Pennsylvania Electric Company, and the Jersey Central Power and Light Company supplies electricity to an area of about 24,000 square miles in parts of Pennsylvania, and New Jersey with a population of about 4,000,000 (see Figure 8.1).

Metropolitan Edison Conpany operates in an area of 3,274 square miles in eastern Pennsylvania. Pennsylvania Electric Company supplies an area of 17,600 square miles in western, northern, and south central Pennsylvania with Jersey Central Power and Light Company operating in an area of 3,256 square miles in north central, east central, northwestern and western New Jersey.[1]

8.2.2 Regional Relationships

The General Public Utilities (GPU) system service area is included in the Federal Power Commission (FPC) Northeast Power Survey Region and located within the FPC's power supply area, PSA5. The GPU system is a member of the Pennsylvania-New Jersey-Maryland Interconnections (PJM) which is a formal power pool that serves three-quarters of Pennsylvania, most of New Jersey, more than half of Maryland, a small part of Virginia, and all of the District of Columbia, and Delaware.[2] In addition to coordination of planning, the companies in PJM conduct economic dispatch within the pool and share in any load curtailment or voltage reduction if conditions warrant it.

The applicant is a member of the Mid-Atlantic Area Coordination Council (MAAC). The companies which compose PJM are also included in the membership of MAAC. MAAC is concerned primarily with reviewing and evaluating plans from the standpoint of bulk power reliability.[3]

8.3 BENEFITS OF OPERATING THE PLANT

8.3.1 System Peak Loads and Energy Requirements

Three Mile Island Nuclear Station, Unit 2, is a base load plant which will contribute to meeting the continuous energy demand placed on the system. Efficiency, reliability and lowest possible operating costs are critical factors which characterize baseload plants. In addition to providing an economic source of baseload generation energy, TMINS-2 will also be expected to contribute to meeting growth load demand as well as increased system reliability.

GPU and PJM determination of an adequate reserve is based on the reliability standards of the Mid-Atlantic Area Council (MAAC) which state, "On the MAAC system, sufficient megawatt generating capabilities shall be installed to insure that in each year, for the MAAC system, the probability of occurrence of load exceeding the available generating capacity shall not be greater on the average, than one day in ten years."[4] To meet this standard GPU and PJM have determined that the reserve margin responsibility will be a value of twenty percent reserve over forecast summer peak load.[5]

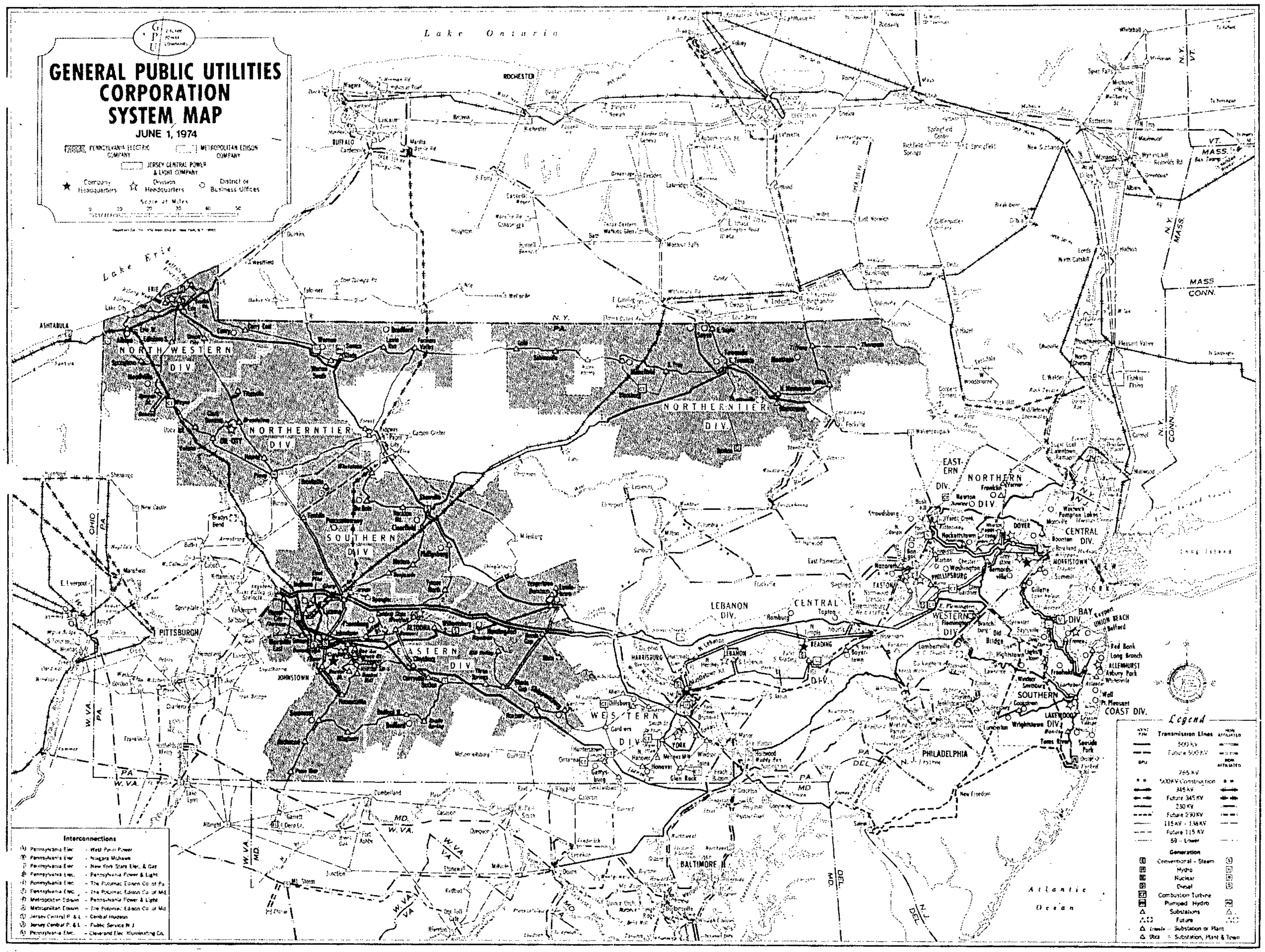

Fig. 8.1 General Public Utilities Corporation System Map

Table 8.1 shows the GPU System's planned capacity and Table 8.2 provides the installed capacity reserves for the GPU System and the PJM for the years 1977 through 1980. With the addition of TMINS-2 in 1978, the reserves in that year will stand at 28.7 percent for GPU and 31.7 percent for PJM. In 1980 the GPU System is expected to have 17.7 percent with PJM expecting 26.8 percent. Should TMINS-2 be delayed a year, the GPU Systems reserves would stand at 13.8 percent.[6]

TABLE 8.1

GPU SYSTEM - PLANNED CAPACITY
Generating Capacity - Existing, and 1977-1980 Changes
(Summer Ratings, in MW)

Year	Total
Existing 11/11/76	6484
Changes in Summer 1977	81[a]
Changes in Summer 1978	1139[b]
Changes in Summer 1979	0
Changes in Summer 1980	-35[c]
Total 1980	7669

Notes: [a]Retire Crawford 3,4 (-45 MW); add Gilbert 8 combined cycle steam postion (126 MW); transfer Gilbert 4-7 (224 MW) from combustion turbine to combine cycle category.

[b]Add Homer City 3 (325 MW); retire Crawford 1,2 (-66 MW); add Three Mile Island 2 (880 MW).

[c]Retire Front Street 2,3 (-35 MW).

SOURCE: Reference 6, Table 1.2-3

TABLE 8.2
GPU SYSTEM, INSTALLED CAPACITY RESERVES FOR 1977-1980 SUMMERS

Year	GPU Reserves Percent	PJM Reserves Percent
1977	14.1	34.1
1978	28.4	31.7
1979	23.7	29.7
1980	17.7	26.8

SOURCE: Reference 6, Table 1.2-4

Since the issuance of the FES in December 1972, the load forecasts have been revised to reflect changes in the overall energy situation. Earlier peak load forecasts have been revised downward. Table 8.3 shows the most recent load forecasts for the GPU System. In making its forecasts, GPU annually develops a twenty-year peak load forecast for each season for each GPU operating company. The base and weather-sensitive portions of the load are projected separately and then combined to derive the peak load projections. The GPU peak load forecast is developed by adding the three company forecasts and applying a reduction factor for system diversity. An annual twenty-year forecast of average week peak loads and annual energy requirements are also prepared for GPU planning purposes.[7] Also included in capacity expansion plans are considerations of optimum mix of unit types and sizes. GPU's presently installed capacity, as a percent of total capacity, is 58.9 percent baseload, 12.8 percent intermediate load and 28.3 percent peaking.[8]

TABLE 8.3

GPU SYSTEM PEAK LOADS AND ENERGY REQUIREMENTS[a]

Year	Peak Load MW Summer	Winter	Energy Requirements (GWh)
1965	2729	2919	16,112
1966	2921	3093	17,610
1967	3061	3385	18,721
1968	3540	3652	20,617
1969	3868	4113	22,730
1970	4071	4448	24,675
1971	4355	4475	26,098
1972	4772	5024	28,261
1973	5450	5007	30,350
1974	5062	4955	29,931
1975	5167	5497	29,727
1976	5180[b]	5653	31,349
1977	5752	5994	33,777
1978	5998	6228	35,779
1979	6228	6572	37,421
1980	6515	6816	39,477

[a]Actual summer peak load, 1965 through 1976 and estimated 1977-1980; actual winter peak load, 1965 through 1975 and estimated 1976-1980; actual energy requirements 1965 -1975 and estimated 1976-1980.

[b]1976 summer peak when adjusted to normal weather conditions becomes 5450 MW.

Notes:

1. Summer peaks may occur June to September, inclusive.
2. Winter peaks may occur December to February to the following year inclusive.
3. Hershey Electric Company loads are not included prior to 1967.
4. Estimated 1976-1980 loads are from the original 1977 budget.

SOURCE: Reference 6, Table 1.2-1

Table 8.3 shows an annual compound growth rate of energy requirements of 5.9 percent for 1976-1980. The applicant's energy requirements forecast appears reasonable and is below a longer-term electricity sales forecast (reference case) recently developed by FEA for the Middle Atlantic Region. Nationally, electricity consumption is projected to grow 5.4 percent per year between 1974 and 1985.[9]

FEA provides region forecasts for the time period 1974-1985 by major Census Region. The Middle Atlantic Region includes the States of Pennsylvania, New Jersey and New York. The growth rates forecasted for the region are 8.38 percent for the residential sector, 4.19 percent for the commercial sector and 7.44 percent for the industrial sector.[10] Sales to others were assumed to grow at the same rate as the average of the three sectors. Weights were assigned by the staff to the different growth rates using the present (1975) distribution of electricity by customer class in the GPU system. The proportions were assumed to be relatively unchanged over the forecast period. Thus, the annual compound growth rate was determined to be 6.9 percent for the period.

Recognizing that future changes in load and energy requirements are of some consequence to the choice of an economically optimum mix of generating capacity, Unit 2 is nevertheless one of the least cost sources of baseload power in the GPU System and, therefore, can be justified even if there is no load growth and energy requirements growth in the future.

8.3.2 Impact of Energy Conservation on Applicant's System Energy Requirements and Peak Load Demand

Recent energy shortages have focused the Nation's attention on the importance of energy conservation as well as measures to increase the supply of alternative energy sources. The need to conserve energy and to promote substitution of other energy sources for oil and gas have been recommended by the Report to the President on the Nation's Energy Future as major efforts in regaining national energy self-sufficiency by 1980.[11]

There was a slowdown in growth in the applicant's service area in 1974 and 1975 as indicated by the data in Table 8.3. Summer peak load declined from 5450 MW in 1973 to 5062 MW in 1974 and 5167 in 1975. Energy requirements declined from 30,350 GWh in 1973 to 29,931 GWh in 1974 and 29,727 GWh in 1975. While conservation was listed among the factors contributing to slower growth, the applicant further cited the economic recession and the impact on new home construction as other factors.[12]

Historically, utility rate structures were designed to encourage consumption of electricity by using the declining block rates, which reflected the declining average cost of furnishing additional kilowatt hours of electrical energy to each customer. Until recently, the economic logic for declining block rates was never seriously disputed. Today, however, under conditions of increasingly scarce fuel resources, declining block rates, by lowering the price of each additional kilowatt hour, tend to encourage greater use of electricity by individual consumers and also to encourage individual consumers to use more and more electricity instead of other energy sources.

The most commonly mentioned alternatives to declining block rates to dampen demand for electricity are peak load pricing, flat rates, and increasing block rates.

According to the applicant, the GPU System has made it a practice to design rates which are cost based and include costs associated with servicing customers and costs associated with volume of energy supplied. Costs are recovered through a minimum charge for residential rates which do not state demand charges. In rate schedules with both energy and demand charges, rates are developed so that the small customer's charges are stated separately. The costs are incorporated into the demand and energy charges for larger customers. The demand costs are usually spread uniformly across the energy blocks in rates where there is no stated demand charge. Demand costs are recovered by a demand charge where separate energy and demand rates are provided. Energy costs are designed to be recovered through base rates in the form of separate energy charges. An energy adjustment clause provides for changes in energy costs that are related to fuel costs.[13]

The applicant provides residential customers with several experimental time-of-day rates on an optional basis. This serves as part of the applicant's load management program through which the applicant is seeking more information on whether to extend time pricing techniques and seasonal differential pricing. Other experiments include peak load pricing in conjunction with the Federal Energy Administration and State of New Jersey to ascertain the demand price relationship for peak load pricing in residential power consumption.[14]

The applicant has not conducted any elasticity studies that would determine the impact of recent rate increases on the demand for electricity and has cited low industrial activity and high unemployment following the oil embargo for the general dampened growth.[15]

In addition to price and conservation, the demand for electricity is impacted by such other factors as (1) changes in the regional and national economy; (2) the substitution of electricity for scarce fuels; (3) growth in population and households; (4) technological change affecting substitute sources of energy, efficiency in the use of energy resources, and the development of new uses of electrical energy; (5) market forces affecting the demand for consumer investment or durable goods which require electricity to operate; and (6) changes in consumer values, attitudes and such practices as may be affected by laws, regulations or taxes. In the face of such a complexity of causal forces it is exceedingly difficult to factor out the extent to which price changes alone would affect the demand for electricity in the applicant's service area. The uncertainty exists in analyzing historical data and is even greater in forecasting future developments because of the perturbations of outlook fostered by the energy crisis and decisions yet to be made by customers and industrial and government agencies in relation to reducing demand for scarce fuels or developing additional reserves or new sources of energy to substitute for scarce fuels.

Load shedding is an emergency measure to prevent system collapse when peak demand placed upon the system is greater than the system is capable of providing. This measure is usually not taken until all other measures are exhausted. The Federal Power Commission's report on the major load shedding that occurred during the Northeast Power Failure of November 9 and 10, 1965, indicates that reliability of service of the electrical distribution systems should be given more emphasis, even at the expense of additional costs.[16] This report identified several areas that are highly impacted by loss of power, such as elevators, traffic lights, subway lighting, prison and communication facilities. It's the serious impact on areas such as these that result in load shedding as only a temporary method to overcome a shortage of generating capacity during an emergency.

Load staggering has also been considered by the staff as a possible conservation measure. Basically this alternative involves shifting the work hours of industrial or commercial firms to avoid diurnal or weekday peaks. However, the staff considers the interference with customer and worker preferences as well as productivity to be of significant impact to make such proposals of questionable feasibility.

For interruptible load contracts to be effective in system planning, the load reduction must be large enough to be effective in system stability planning. Thus, this type contract is primarily related to industrial customers. At the present time the applicant has two customers under contracts classified as curtailable service. The contracts are equal to 24.3 megawatts and have been included in the applicant's forecasts.[17] The acceptability of interruptible load contracts to industrial customers depends upon balancing the potential economic loss resulting from unannounced interruptions against the savings resulting from the reduced price of electricity. If the frequency or duration of interruptions increase as a result of insufficient installed capacity, the customers will convert to a normal industrial load contract.

None of the above measures can be considered as a viable alternative for required additional capacity and does little to solve the energy shortage.

8.3.3 Operating Costs

At the operating license stage a determination must be made whether it is economical to operate the plant or not. Once a plant is constructed the capital costs must be considered as sunk costs and the operating costs become the important costs to consider. Since Three Mile Island Nuclear Station, Unit 2, will be one of the least expensive base load plant in the GPU system to operate, cost savings will be realized through its operation. Only Three Mile Island Nuclear Station-Unit 1 and two small hydroelectric plants totaling 28 MWe are expected to have lower operating costs in the GPU system than TMINS-2.[18]

Table 8.4 represents the staff's comparison of a nuclear plant of 880 MW with a coal unit of 880 MW operating in 1978 at various plant capacity factors. The table provides the differential total costs and differential operating costs which show the nuclear alternative to be more economical to add to the system. The nuclear fuel costs, assuming a 50 percent plant capacity factor, amount to $14.10 per kW-year compared to the coal costs of $64.65 per kW-year for the same plant capacity factor. In terms of total operating costs (including fuel costs) the nuclear plant costs would be $56.87 per kW-year less than the coal alternative using a 50

TABLE 8.4

ECONOMICS OF ALTERNATIVE ENERGY SOURCES AS A FUNCTION OF CAPACITY FACTOR - (NUCLEAR UNIT AND COAL UNIT 880 MW, OPERATION IN 1978)

	Nuclear				Base Coal			
Capacity factor	50	60	70	80	50	60	70	80
Costs[a]								
1. Investment Cost[b], annual costs $/kW	107.40	107.40	107.40	107.40	69.75	69.75	69.75	69.75
2. Fixed O & M, annual costs $/kW	11.76	11.76	11.76	11.76	7.35	7.35	7.35	7.35
3. Variable O & M, $/kW-yr	5.39	6.46	7.54	8.62	16.12	19.34	22.57	25.79
4. Fuel, $/kW-yr	14.10	16.92	19.75	22.57	64.65	77.58	90.51	103.44
Total Cost, $/kW-yr[c]	138.65	142.54	146.45	150.35	157.87	174.02	190.18	206.33
Differential Cost, $/kW-yr	BASE	BASE	BASE	BASE	19.22	31.48	43.73	55.98
Total Operating Cost, $/kW-yr (2 + 3 + 4)[c]	31.25	35.14	39.05	42.95	88.12	104.27	120.43	136.58
Differential Operating Cost, $/kW-yr	BASE	BASE	BASE	BASE	56.87	69.13	81.38	93.63

SOURCE: Calculated from revised data in ER, Table 8.4-1.

[a]All costs are 1978 estimated values.

[b]Based on levelized fixed charge of 15 percent.

[c]To obtain costs per kilowatt hour, divide numbers by the hours of operation per year appropriate for the given capacity factor.

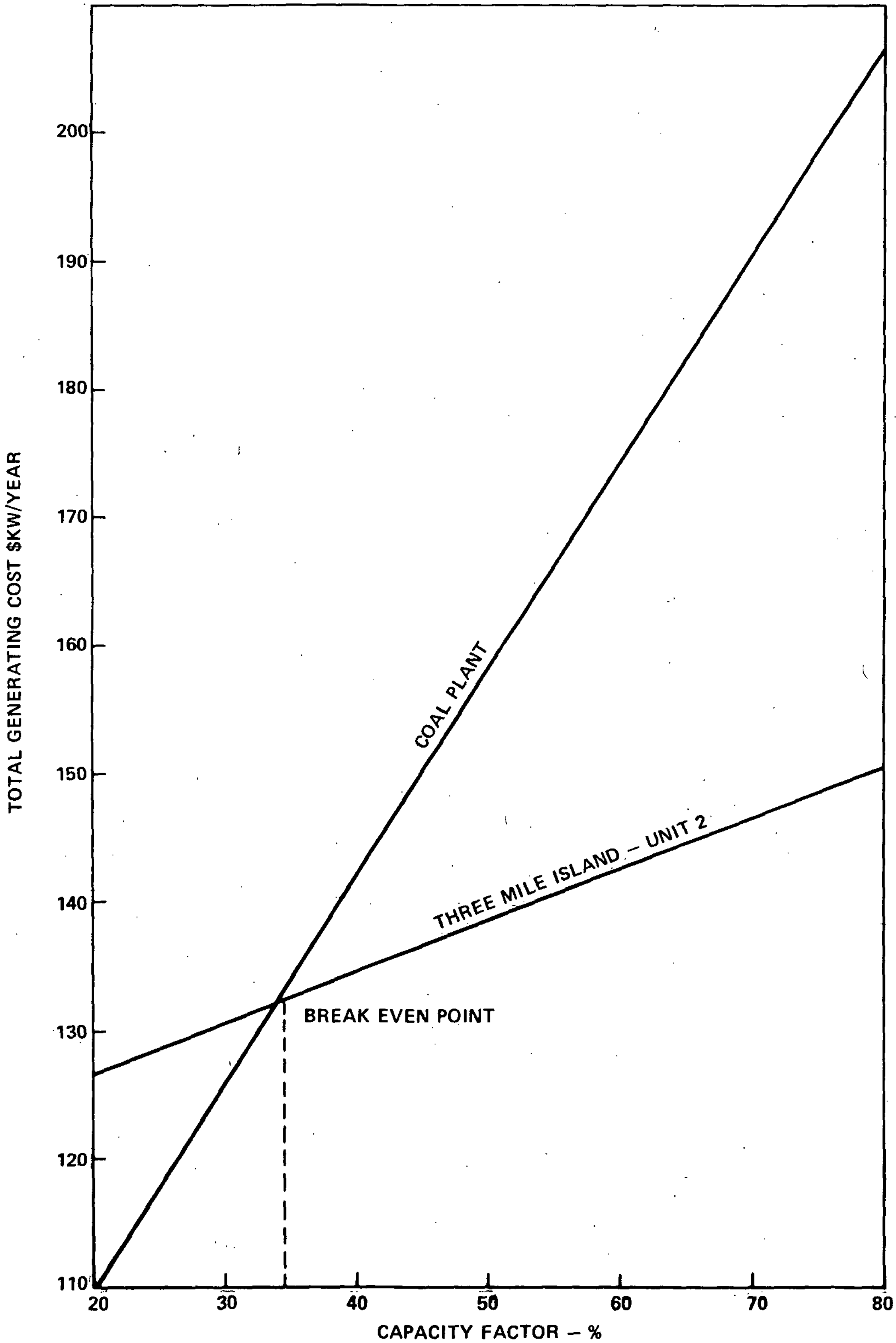

Fig. 8.2 – Total Generating Cost $kw/Year as a Function of Plant Capacity Factor

percent plant capacity factor. The savings in operating costs increase at higher capacity factors. Figure 8.2 (plotted from Table 8.4) provides a comparison of the total generating cost between the nuclear and coal plant as a function of plant capacity factor with the break-even point estimated at 34 plus percent.

Even if the assumption were made that system energy requirements did not grow after 1974, TMINS-2 should still be operated because of fuel and operating cost savings. With TMINS-2 on line in May 1978, the applicant estimated an overall system operating cost savings of over $55 million in 1978 based on assumption of no growth in system energy requirements from 1974 through 1978.[19] The overall staff's conclusion that the plant should be operated remains unchanged.

REFERENCES

1. Moody's Public Utility Manual, Moody's Investor's Service, Inc., 1974, pp. 1556, 1565, 1577, 1578.
2. Federal Power Commission, "The 1970 National Power Survey, Part II Electric Power in the Northeast, 1970, 1980, 1990," p. II-1-78.
3. Ibid., p. II-1-84.
4. Mid-Atlantic Area Council, MAAC Systems Plans, FPC Order 383-3, Docket R-362, April 1, 1976, p. III-C-1.
5. Metropolitan Edison Company, Jersey Central Power and Lighting Company, Pennsylvania Electric Company, Environmental Report, Operating License Stage, Three Mile Island Nuclear Station, Unit 2, Supplement II, Docket No. 50-320, February, 1975, p. 1.2-8.
6. Letter to Jan Norris from GPU Service Corporation, November 30, 1976, Table 1.2-4.
7. Reference 5, pp. 1.2-4 and 5.
8. Reference 6, page 3.
9. Federal Energy Administration, National Energy Outlook, U. S. Government Printing Office, February, 1976, p. 238.
10. Ibid., Table 13a, p. 6-29.
11. D. L. Ray, Chairman, United States Atomic Energy Commission, The Nation's Energy Future, U. S. AEC Report WASH-1281, U. S. Government Printing Office, Washington, D. C., December 1, 1973.
12. Reference 6, page 7.
13. Reference 6, page 33.
14. Ibid.
15. Reference 6, page 28.
16. Federal Power Commission, "Northeast Power Failure," U. S. Government Printing Office, Washington, D. C., December, 1965.
17. Reference 6, page 34.
18. Reference 5, Appendix V, p. v-i.
19. Reference 5, Appendix V, p. v-ii.

9. ALTERNATIVES CONSIDERED AND CONSEQUENCES OF THE PROPOSED ACTION

9.1 RESUME

The discussions of alternatives presented in the FES, December 1972, still remain valid. An additional discussion of alternative practices for operation of the cooling system are presented in Section 9.3. Additional discussion of unavoidable adverse effects on terrestrial and aquatic biota is in Section 9.4. Additional information relating to irreversible and irretrievable commitment of resources is provided in Section 9.5.

9.2 ALTERNATIVE ENERGY SOURCES AND SITES

In the FES of December 1972, the staff evaluated the alternative energy sources and sites. Alternative energy sources considered were hydroelectric potential, fossil-fired generating plants, including oil, natural gas and coal-fired plants, and the purchase of power from other companies. The applicant's site selection was also evaluated. There have been no major changes in the information relied upon by the staff for the previous evaluations that would materially alter the consideration of alternative energy sources and alternative sites at the operating license review stage. No feasible alternative energy source requiring capital investment as well as operating and fuel cost is economically competitive with TMINS-2.

9.3 ALTERNATIVE OPERATING PRACTICES

9.3.1 Cooling Systems

Design alternatives were discussed in the December 1972 FES (see Appendix B). There are limited operating alternatives which have been considered in reviewing the application for an operating license for the station. These alternatives include the selection of makeup and blowdown rates and the selection of chemicals to be used in the circulating water system for control of scaling and fouling. The selection of the makeup and blowdown rates include a determination of the concentration factor in the circulating water system. This in turn affects the requirement for chemicals to control scaling.

Operation at a higher concentration factor would reduce makeup requirements and would thereby reduce entrainment and possibly impingement losses. The higher factor would require the use of more acid to control scaling. Both the discharge concentration and the total release rate of sulfates would thereby be increased. Furthermore, the potential for an impact due to drift increases as solids concentration increases. There is a limit on the concentration factor beyond which the formation of scale cannot be controlled by acid addition. Acid addition controls the carbonate scale which would otherwise form at a low concentration factor. The sulfate or silica scale which might form at a higher concentration factor is less readily controlled.

Alternatively, operation at a lower concentration factor might reduce or eliminate the acid requirements. This would be done at the expense of entrainment and impingement losses.

There are alternatives to the selection of chemicals proposed by the applicant. For example, hydrochloric acid could be used in place of sulfuric acid for controlling scale. This would be significantly more costly but would substitute chlorides for sulfates in the blowdown and drift. Conceivably this could be preferable in the blowdown but would be less desirable in the drift since vegetation tends to be more sensitive to chlorides.

The biocides which might be used as an alternative to chlorine for control of fouling would also be more costly. Furthermore, they would be of questionable effectiveness and would introduce environmental concerns similar to those regarding chlorine (Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Steam Electric Power Generating Point Source Category, EPA, October, 1974). Since the need for fouling control in the circulating water system is confined to the problem of algal growth in the distribution trays of the cooling towers, the need for biocide treatment of this system might be eliminated entirely by constructing a shade over the trays. Since experience with Unit 1 indicated virtually immeasurable chlorine in the plant discharge due to circulating system treatment, there would be no environmental benefit derived by pursuing alternatives for this system.

Review of impact of the operating practices proposed by the applicant determined that they are acceptable based on present knowledge of requirements for protecting the other uses of the

Susquehanna River. It is also noted that the proposed practices are consistent with general practices for steam electric power production.

In the judgment of the staff, the alternative operating productives include tradeoffs among benefits and impacts which upon balance do not justify a recommendation to modify the proposed operating practices at the present time.

9.4 ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

9.4.1 Terrestrial Effects

Unavoidable adverse effects of operation were addressed in Section VII of the FES-OL, December, 1972. Salt deposition from cooling tower drift (Section 5.5.1) and an increase in hours of fog (Section V.3.b, FES, December, 1972) which is small with respect to the natural variation in such occurrences are acceptable effects associated with operation of the cooling towers. Low levels of ozone production and minor electric field effects will be associated with proximity to the operating EHV transmission lines (Section 5.1.2). None of these effects are expected to result in unacceptable damage to the terrestrial environment.

9.4.2 Aquatic Effects

During the construction phase localized damage occurred in the areas affected by installation of the intake and discharge systems. Biota at all trophic levels were probably disturbed and in some cases destroyed. Although the extent of this impact cannot be accurately stated, it is estimated that it did not result in any irreversible adverse effects to the aquatic system.

During plant operation a small number of planktonic species including fish eggs and larvae will be entrained in the cooling water system. The loss of less than 1% of these organisms at average river flows and about 7% at the low flow of record is not expected to have adverse effects on either the local or riverwide ecosystem. The loss of a relatively small amount of fish due to impingement is not anticipated to affect the river's sport fishery. The river bottom in the immediate discharge area may be unsuitable for benthic organisms; however, upstream and downstream benthic communities will not be affected. Other adverse effects from the station's thermal and chemical discharges (e.g., cold shock, change in species composition, chemical toxicity, etc.) are not expected on either the local or riverwide ecoysystem.

9.5 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

9.5.1 Aquatic Biological Resources

Various aquatic organisms found in the vicinity of the plant will be entrained in the cooling water system, impinged on the intake screens and possibly affected by the thermal discharge. An insignificant amount will be lost to the local and riverwide ecosystem. The loss of aquatic biota is considered to be a retrievable resource commitment.

9.5.2 Water and Air Resources

The commitment of 44 cfs of water which will be evaporated in the cooling system can be considered irreversible for the life of the station. It is conceivable but not likely that other types of users could usurp the water currently being used for power production. Projections of growth in water demand during the life of the station do not indicate that water will be in limited supply during the design life (Susquehanna River Basin Study). The projections of growth recognize that there will be an increase in the requirements for water for power generation. Thus, it is reasonable to expect that the use of water for power production at TMINS will continue for that purpose beyond the design life of Units 1 and 2. Those responsible for planning for the water resources of the Susquehanna have recognized the requirements for power generation (e.g., Susquehanna River Basin Study).

Because of the availability of alternate operating practices (see Section 9.3), the commitment to water quality effects of the station are thought to be reversible and are likely to be reversed should considerations regarding impact on other uses arise.

Commitment of the air resource, although trivial relative to present air standards, is reversible by adoption of alternate technology. It is not expected that concerns regarding air quality effects will arise during the design life of Units 1 and 2.

9.5.3 Uranium Resources

The estimate of 48 metric tons of U-235 to be consumed assuming 30-year lifetime of the station which is discussed in greater detail in December 1972 FES (see Appendix B) remains unchanged.

9.5.3.1 Uranium Resources Availability

This section reviews information available from the Energy Research and Development Administration (ERDA) on the domestic uranium resource situation and the outlook for development of additional domestic supplies, availability of foreign uranium, and the relationship of uranium supply to planned nuclear generating capacity.

Analysis of uranium resources and their availability has been carried out by the government since the late 1940s. The work was carried out for many years by the Atomic Energy Commission. The activity was made part of the Energy Research and Development Administration (ERDA) when the agency was created in early 1975.

U.S. Resource Position

To establish some basic concepts, a review of resource concepts and nomenclature would be worthwhile. Table 9.1 is a chart of resource categories based on varying geologic knowledge and on varying economic availability. Resources designated as ore reserves have the highest assurance regarding their magnitude and economic availability. Estimates of reserves are based on detailed sampling data, primarily from gamma ray logs of drill holes. ERDA obtains basic data from industry from its exploration effort and estimates the reserves in individual deposits. In estimating ore reserves, detailed studies of feasible mining, transportation, and milling techniques and costs are made. Consistent engineering, geologic, and economic criteria are employed. The methods used are the result of over 25 years effort in uranium resource evaluation.

Resources that do not meet the stringent requirements of reserves are classed as potential resources. For its study of resources, ERDA subdivides potential resources into three categories: probable, possible, and speculative.[4] Probable resources are those contained within favorable trends, largely delineated by drilling, within productive uranium districts (i.e., those having more than 10 tons U_3O_8 production and reserves). Quantitative estimates of potential resources are made by considering the extent of the identified favorable areas and by comparing certain geologic characteristics with those associated with known ore deposits.

Possible potential resources are outside of identified mineral trends but are in geologic provinces and formations that have been productive. Speculative resources are those estimated to occur in formations or geologic provinces which have not been productive but which, based on the evaluation of available geologic data, are considered to be favorable for the occurrence of uranium deposits.

The reliability of the estimates of potential uranium resources differs for each of the three potential classes. The reliability of probable potential estimates is greatest in view of the more complete information, a result of the extensive exploration and development in the major uranium districts. It is least for speculative potential for areas with no significant uranium deposits, for which favorability is determined from available knowledge on the characteristics of the geologic environment.

Since any evaluation of resources is dependent upon the availability of information, the estimates themselves are, to a large degree, a score card on the state of development of information. Thus appraisal of United States uranium resources is heavily dependent upon the completeness of exploration efforts and the availability of subsurface geologic data. Since the geology of the United States as it relates to mineral deposits can never be completely known in detail, it will not be possible to produce a truly complete appraisal of domestic uranium resources. Given the nature and current status of ERDA estimates, however, so far as an overall appraisal of the United States is concerned, it is more likely that the total resources eventually will prove larger than present estimates than that they will be less. The key question may be the timeliness with which resources are identified, developed and produced.

Conceptually, a resource, whether uranium or other mineral commodity, would initially be in the potential category. Development of additional data and clarification of production techniques and economics is required until the point is reached that specific ore deposits are delineated and understood to a degree that they can be categorized as reserves.

We can expect that there will be a dynamic balance between anticipated markets and prices and the extent to which exploration and reserve delineation will be done. There is no economic incentive

Table 9.1 ERDA Uranium Resource Categories

CUTOFF COST	ORE RESERVES	NURE POTENTIAL			ULTIMATE POTENTIAL
		PROBABLE	POSSIBLE	SPECULATIVE	
		(Known Districts-Identified Trends)	(Productive Provinces, in Productive Formations)	(New Provinces or New Formations)	
$8					
$10					
$15					
$30					
HIGHER COST					

DECREASING KNOWLEDGE AND ASSURANCE

for industry to expand reserves, if the additional uranium will not be needed for many years ahead, especially if the long-term market is uncertain. This has been so for uranium. The mining companies are concentrating on markets for the next 5 to 15 years. The utilities and government are concerned with the outlook for the next 30 to 40 years. Conversion of the presently estimated potential resources into ore reserves will take many years and will cost several billion dollars. It would be difficult to economically justify accelerating such an effort to delineate ore reserve levels equal to lifetime requirements of all planned reactors covering some 30-40 years in the future simply to satisfy planners.

Supply assurance through continued timely additions to reserves and maintenance of a resource base adequate to support production demands, couples with carefully developed information on potential resources is considered to be adequate and a more realistic and economic approach. The conversion of potential resources to ore reserves and expansion of production facilities can be accomplished when needed as markets expand and production is needed.

The vertical dimension in Table 9.1 relates to the impact of increasing production costs on resource availability. Higher prices are needed to produce ores of lower quality and those with more difficult mining or milling characteristics. Such reserves, though well delineated, are not available if prices are too low.

The domestic uranium industry has, over most of its lifetime, been concerned with discovery and production of uranium at costs in the $8-$10/lb. range or less. Average prices for uranium deliveries in 1975 are reported to be $10.50 per pound of U_3O_8.[15] In view of the economic acceptability of higher cost uranium in reactors, resource estimates by ERDA in recent years have included resources that would be available at $15 and $30 production cutoff costs. However, because of the lesser experience with $15 and $30 resources, they are not as fully delineated or as well understood as the $10 resources.

At cost levels above $30 per pound, there has been little effort at appraisal of resources or in exploration. Therefore, these resources are poorly known at present and quantitative estimates are not possible (with the exception of the Chattanooga shale to be discussed later). Such resources are known to exist, and efforts are under way to appraise them.

In Table 9.2 are tabulated ERDA estimates of domestic uranium resources following the conceptual arrangement of Table 9.1. These estimates reflect the results of the preliminary phase of the ERDA National Uranium Resource Evaluation (NURE) program. The resources estimates in the preliminary phase of the NURE program totaled 3.7 million tons up to a production cost of $30. Of this 640,000 tons are in the ore reserve category. An additional estimated 140,000 tons is attributed to byproduct material through the year 2000.

Table 9.2 U.S. Uranium Resources
Tons U_3O_8

	RESERVES	POTENTIAL PROBABLE	POSSIBLE	SPECULATIVE	TOTAL
$10	270,000	440,000	420,000	145,000	1,275,000
$15	430,000	655,000	675,000	290,000	2,050,000
$30	640,000	1,060,000	1,270,000	590,000	3,560,000
	140,000[a]	-	-	-	-
	780,000	1,060,000	1,270,000	590,000	3,700,000

[a]Byproduct of phosphate and copper production.

In this evaluation program, the nation has been divided into study areas as shown in Figure 9.1. For comparison, the major known uranium areas in the U.S., such as the Colorado Plateau, Wyoming Basins and Texas Gulf Coastal Plain, are shown in Figure 9.2.

The geographic distribution of estimated potential resources is shown in Figure 9.3.

Only limited data are available for much of the country and estimates for these areas will be largely in the speculative category, or unassessed, for some time. The preliminary phase of the NURE program has identified additional areas with geologic characteristics favorable for the occurrence of uranium deposits, but for which data was inadequate for evaluation of potential resources. The location of areas with estimated potential resources and other favorable areas is shown in Figure 9.4. The NURE program will develop considerable additional basic information, in the next several years, which will lead to a more comprehensive, in-depth evaluation of the U.S. long-term resource outlook.

Attainable Production Levels and Reactor Capacity

The domestic industry currently has a production capacity of around 16,000 tons U_3O_8 per year. Plans have been reported to expand capacity to 24,000 tons per year by 1978. Study of attainable production capability from currently estimated $15 U.S. ore reserves and probable potential resources indicates that production levels of 50,000 tons to 60,000 tons U_3O_8 per year can be achieved with agressive resources development and exploitation. While the level may be achievable by use of domestic $15 resources alone, development and utilization of $30 resources would provide added assurance that the levels could be attained and sustained. Considering that some imported uranium will add to supplies, it is considered realistic to plan on the basis that a 60,000 tons per year supply is achievable from currently estimated resources. Such a level could be reached by the early 1990s.

The level of nuclear generating capacity supportable with this amount of uranium, as shown in Figure 9.5, will vary with enrichment tails assay and recycle assumptions. Without recycle of uranium or plutonium and a 0.30% U-235 enrichment tails assay, about 260,000 MWe could be supported. Without recycle, and at 0.20 tails, 310,000 MWe could be supported. With recycle of uranium and plutonium and a 0.20 tails assay, about 520,000 MWe could supported. As shown in Figure 9.5, all the levels of supportable capacity are well above the 237,000 MWe of capacity in operation (40,000 MWe), under construction (88,000 MWe), on order (83,000 MWe), and announced (26,000 MWe) as of January 1, 1976. Thus, presently estimated resources can provide adequate uranium supplies for a sizable expansion to U.S. nuclear generating capacity.

The cumulative lifetime (30 years) uranium requirements for all these reactor cases would be about equal to the 1.8 million tons in $30 ore reserves, byproduct, and probable potential resources. Evaluation of long-term fuel commitments on the basis of ore reserves and probable potential resources is considered a prudent course for planning. The lifetime commitment would be only about half of currently estimated $30 domestic resources, including the possible and speculative categories.

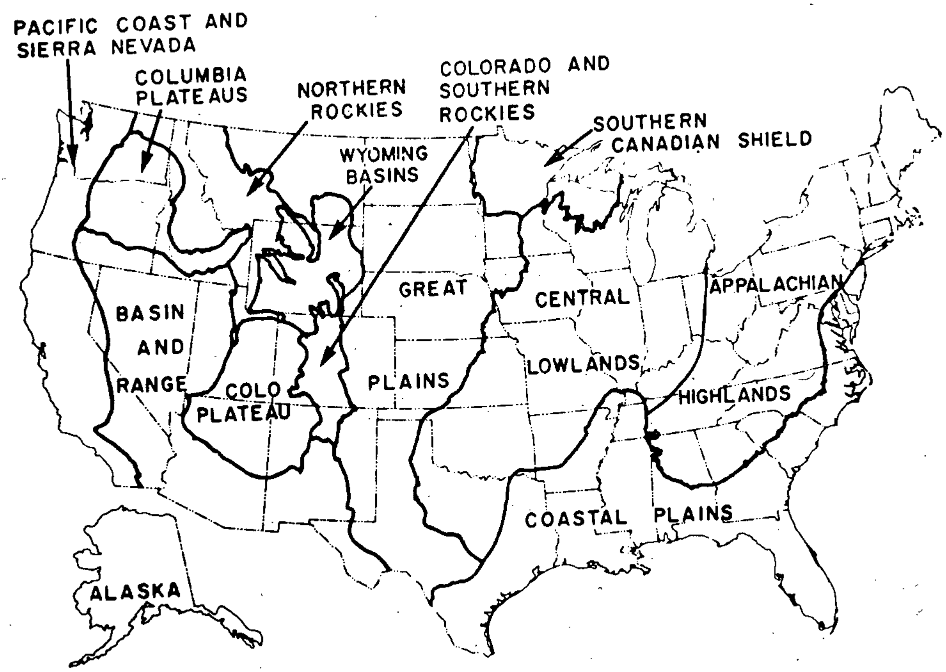

Fig. 9.1 National Uranium Resource Evaluation (NURE) Regions

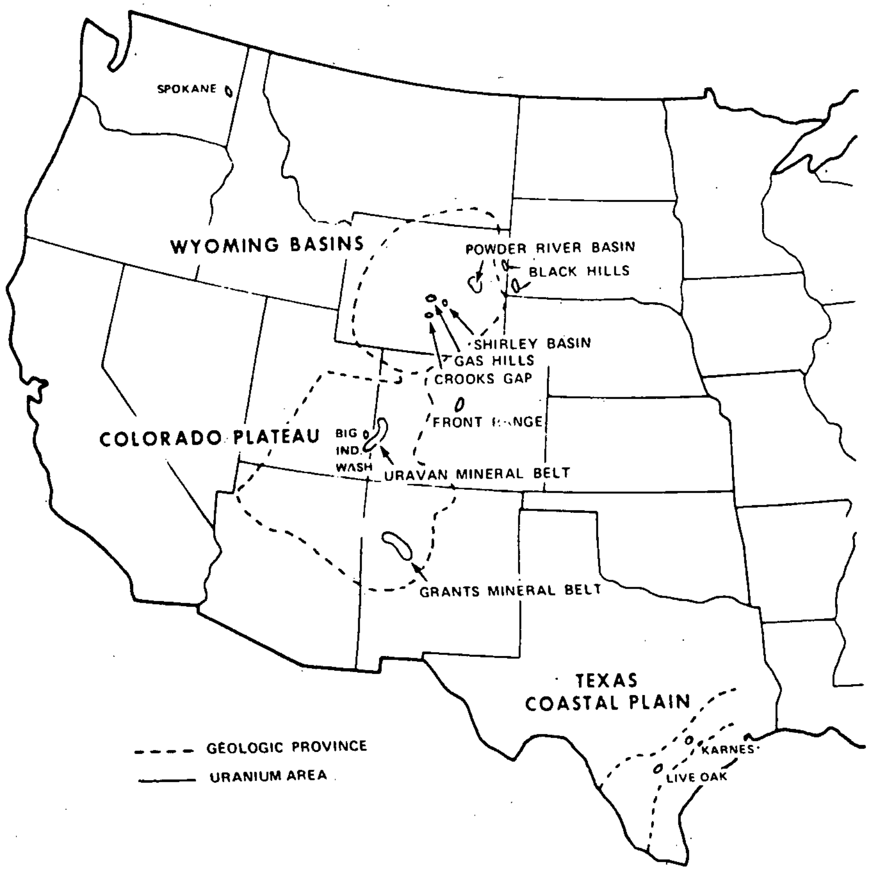

Fig. 9.2 Principal U.S. Uranium Areas

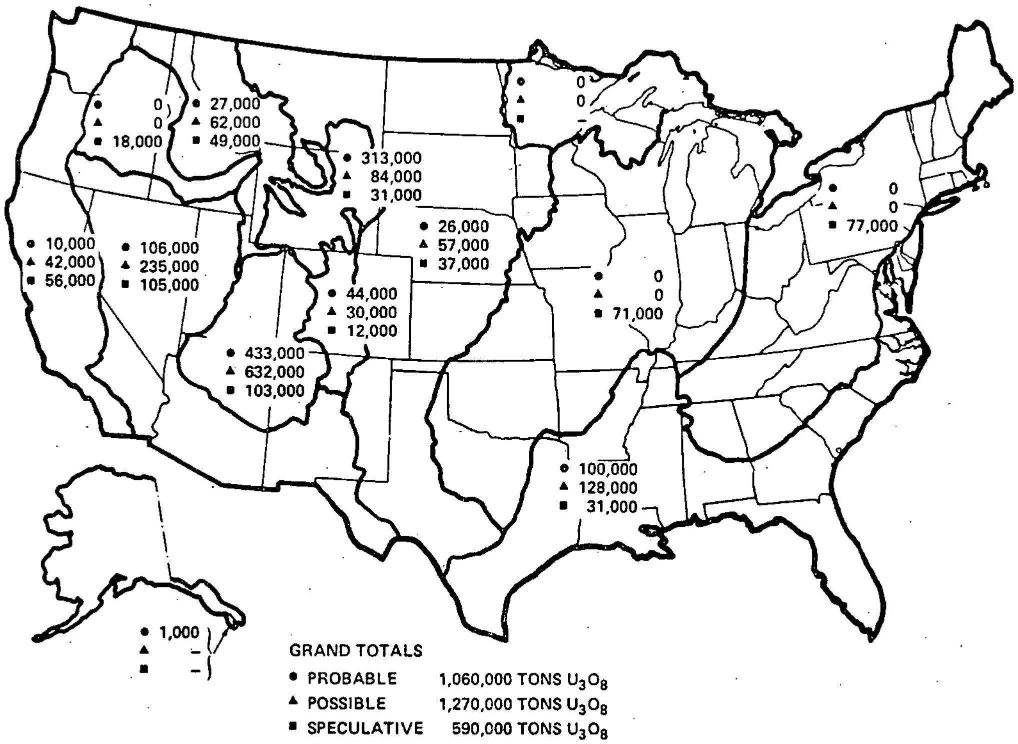

Fig. 9.3 Potential Uranium Resources By Region ($30/lb. U_3O_8)

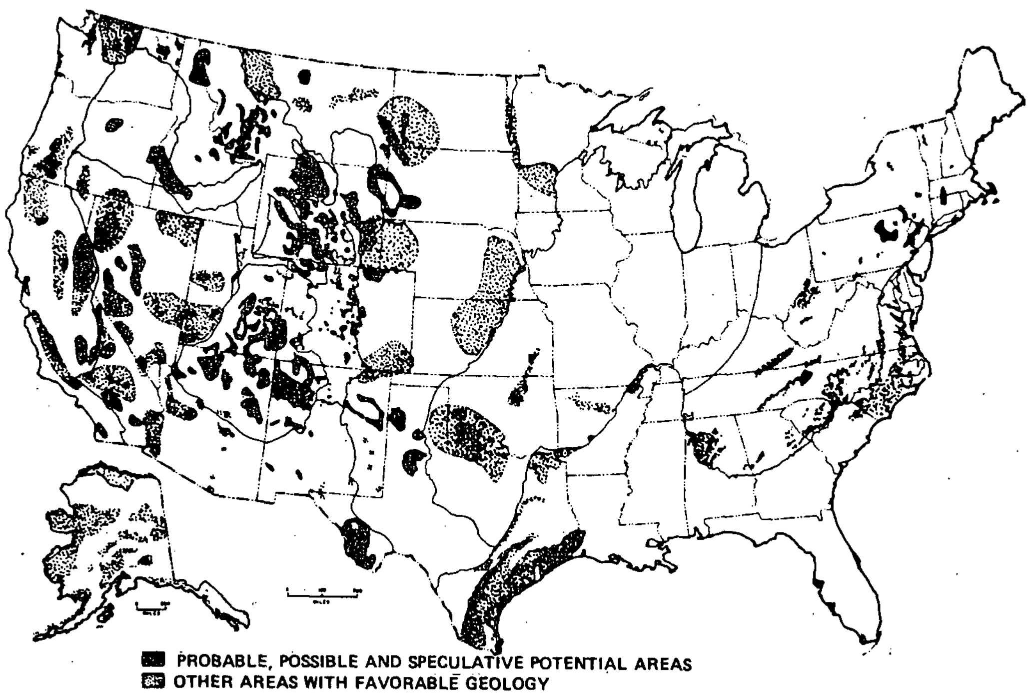

Fig. 9.4 National Uranium Resource Evaluation
Preliminary Potential And Favorable Areas

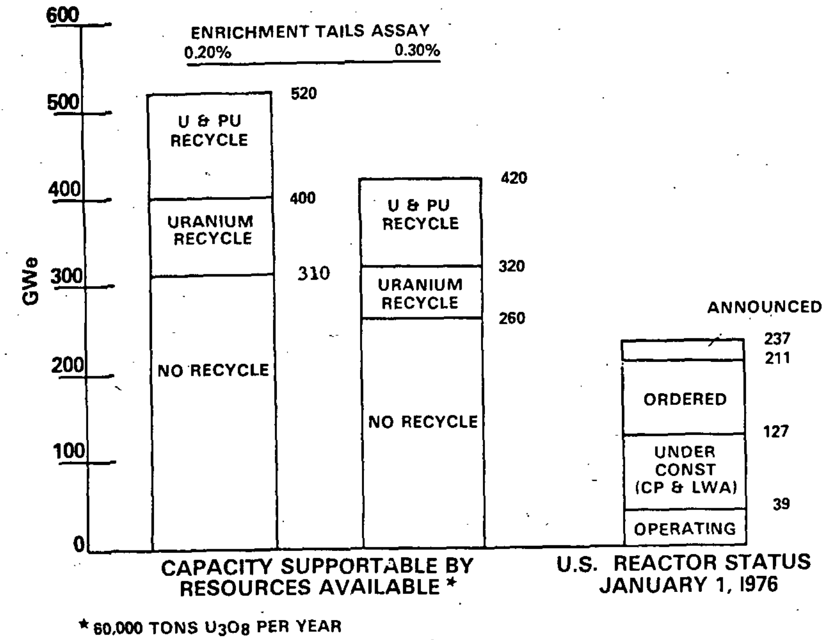

Fig. 9.5 Nuclear Reactor Capacity (GWe)

Prospects for Expanding U.S. Supply

The long-range (through the rest of the centrury and beyond) supply outlook will be largely influenced by the extent to which the present resource position is modified in the decades ahead. There are three prinicpal means by which the supply position can change. First, through the identification of additional resources in the less than \$30/lb category; second, through utilization of already identified higher cost resources; and third, through utilization of foreign uranium supplies. These means will be examined separately.

Domestic Low-Cost Resources

An evaluation of the potential for developing additional domestic low-cost uranium resources beyond those now estimated involves the following considerations:

1. Experience generally has been that mineral resources ultimately prove larger than can be estimated at any time. We are limited by what occurs in nature but also, and perhaps more so, by the degree of our knowledge. Development of information of unknown or poorly explored areas is likely to increase the estimate of resources. As previously noted, there is no complete assessment of the U.S. uranium position. The NURE effort is scheduled to produce a nationwide in-depth assessment in 1981.

   Comparing the U.S. uranium resource position 10 years ago with today's can illustrate the point. In 1966, \$10 ore reserves were estimated to be 195,000 tons U_3O_8. Potential resources then estimated, which correspond to the current "probable" potential category plus a portion of the "possible" category, were 325,000 tons U_3O_8. Since the 134,000 tons of U_3O_8 have been produced. The present estimates are 270,000 tons of reserves and 440,000 tons of probable potential. Thus, in the 10 years over 320,00 tons were added to these categories of resources. During the period, the value of the dollar has declined to about 60% of its 1966 value. Since inflation increases costs, moving some material to higher cost categories, the 1976 resource estimates would have been higher measured in 1966 dollars.

2. Expansion of resources will depend on the level of effort expended. Increased exploration activity can be expected to improve the resource position. Exploration success per unit of effort has been less in recent years, but inflation has exaggerated the reduction since increasingly higher grade ores must be found at a given cost of offset inflation. In addition, there has been a trend toward deeper drilling, which increases the effort required. Exploration results in 1975 show improved discovery rates.

   Industry investment activities will be influenced by nuclear power growth and acceptance, uranium demand, and price movements. As is the case of other raw materials commodities, incrasing demands and higher prices should lead to increased efforts by industry to expand supplies.

3. Known U.S. uranium resources are in a few comparatively small areas as shown in Figure 9.2. The comparatively small geographic areas of the mining districts within these areas suggests that significant undiscovered districts can be overlooked.

4. Domestic uranium resources in sandstone deposits make-up over 95% of known U.S. low-cost resources. The bulk of resources in other parts of the world are in other types of geologic environments. A listing of significant types of uranium deposits is shown in Table 9.3. The possibility exists for identification of additional types of deposits in the U.S.

Industry Exploration Activity

The major responsibility for discovering new uranium deposits needed in the years ahead is with private industry. The footage drilled in search for uranium deposits in the U.S. for the last several years is shown in Figure 9.6. In the period 1967-69, a sharp increase in exploration occurred. Exploration decreased in the early 1970s due to softening in the uranium market as a consequence of the slippage in uranium demands. In 1973, utilities contracted for 52,000 tons of U_3O_8,[6] a far greater procurement effort than had been previously seen, firming prices and rekindling exploration interest. As a result, exploration began to increase again.

As shown in Figure 9.6, expenditures for land acquisition, drilling and related activities reached a peak of about \$59 million in 1969, dropped to \$32 million in 1972 but increased to an all time high of \$122 million in 1975. Plans to expend \$156 million in 1976 and \$168 million in 1977 have been reported to ERDA. Although expenditures are increasing, the footage drilled per dollar of expenditure has been decreasing because of higher costs and a trend toward deeper drilling.

Table 9.3 Uranium Deposits

Type	Average Deposit Grades PPM	Size Range	United States	Foreign
Massive Vein-like	3,000-25,000	10,000-250,000	?	Saskatchewan, Canada; Alligator River, Australia
Vein	1,000-25,000	1,000-40,000	Colorado Washington	Great Bear Lake, Canada; Shinkolobwe, Zaire; France
Sandstone	500-5,000	100-50,000	Colorado Plateau Wyoming, Texas	Niger, Gagon Argentine
Calcrete	1,000-3,000	1,000-50,000	?	Yeelirrie, Australia
Quartz-Pebble Conglomerate	200-1,500	10,000-200,000	?	Elliot Lake, Canada; Witwatersrand, South Africa
Alaskite	300-400	75,000-150,000	?	Rossing, South West Africa
Syenite	100-400	10,000-50,000	?	Illimaussaq, Greenland
Phosphate Rock	60-200	0.5-2.0 million	Florida, Idaho	North Africa
Shale	50-300	1-5 million	S.E. United States	Ranstad, Sweden
Granite	10-200	1-10 million	New Hampshire Colorado	Brazil
Sea Water	.003	4 billion		

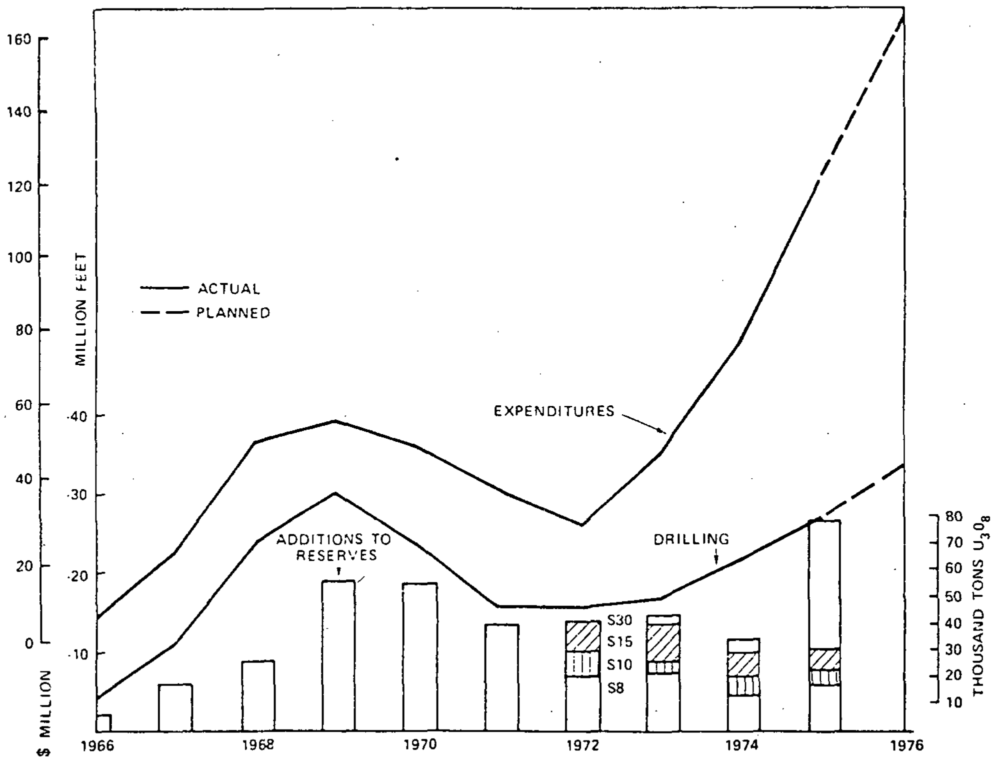

Fig. 9.6 U.S. Exploration Activity and Plans

The results of drilling are shown at the bottom of Figure 9.6 in terms of annual additions to ore reserves. It should be noted that inflation during this period has been high, therefore, the discovery rate measured in terms of $8 reserves are added in 1975 is not directly comparable to those added in 1969 and 1970. The 1969 $8 reserves are comparable in 1975 to reserves at a cost of around $15 per pound. The additions of $10, $15, and $30 reserves in the 1972-1975 period are also shown in Figure 9.6. The additions to $30 reserves increased substantially in 1975 even though not all the data from industry was available and a number of additional deposits are known to have been discovered.

Expenditures for uranium exploration have not been large in comparison to the expenditures in other phases of nuclear power. For example, the cost of a typical large reactor alone (over $800 million) will be substantially larger than the total of $520 million spent in uranium exploration (including land acquisitions, drilling and related activities) in the entire country over the period 1966 through 1975.

Technology Development

Improved technology has in the past provided a means for expanding available resources of minerals. There have been a number of developments in uranium that are improving the supply situation and others are likely to be developed in the years ahead. Of current interest is the use of in situ leaching methods where the extraction of the uranium is accomplished by pumping leach solutions down drill holes, through the ore zone, and back to the surface for treatment. Such plants are operating in Texas and others are planned.

An additional development is the improved process for recovery of uranium from phosphoric acid. A plant is starting operation in Florida, and several others are planned. If all the phosphoric acid currently produced in the large plants in Florida were treated, about 3,000 tons U_3O_8 per year could be recovered. Production may reach this level by the early 1980s, and future increases will follow as phosphoric acid production expands.

Government Uranium Resource Activities

In view of the need to understand better the long-range prospects for expanded domestic uranium supply for reactor development strategy and planning and to assure adequate uranium supplies to fuel nuclear power growth, the ERDA is carrying out programs to assess more completely domestic resources and to improve technology for discovery, assessment, and production of these resources. The basic elements in the ERDA resource program are illustrated in Figure 9.7.

Starting in the upper left hand corner of the diagram, knowledge of about known uranium occurrences will be augmented by gathering and generating new data by use of surface, aerial, subsurface and remote sensing techniques. This will allow improved estimates in known areas and identification of other areas where know types and postulated new types of deposits may exist. This will increase knowledge about uranium occurrences in the United States, improve estimates of the resource position, and expand and solidify the base of nuclear fuel supplies. Information is routinely made available to industry for development of their exploration and mining programs. Industry efforts will generate additional data which will also be used by ERDA in continuing resource studies.

An important part of this strategy is research and development to improve the technology involved in uranium discovery, assessment, mining and milling. ERDA uranium raw materials budgets to carry out this program are increasing. In FY 1976, expenditures will be around $14 million. In fiscal year 1977 $27 million has been requested.

Two activities underway to generate new data systematically are the aerial radiometric reconnaissance program and the national hydrogeochemical survey. Features of the airborne program are highlighted in Table 9.4. This program will involve some 870,000 line miles of aerial surveys flown on an average line spacing of five miles utilizing gamma ray spectrometric techniques. Data generated are being made publicly available upon the completion of individual projects.

The hydrogeochemical survey features are listed in Table 9.5. This will be a systematic national survey of the uranium and associated trace element content of surface and underground waters, being carried out by ERDA laboratories. Data generated will provide a means of identification of areas of favorability particularly when coupled with other available data.

The ERDA programs involve a continuing review of the uranium resource situation, analysis of the activities and success of industry and their relation to the desirable resource levels needed in the years ahead to assure adequate uranium supplies to meet the country's needs. The program is geared to providing information to government and industry so that sound decisions can be made on energy policy.

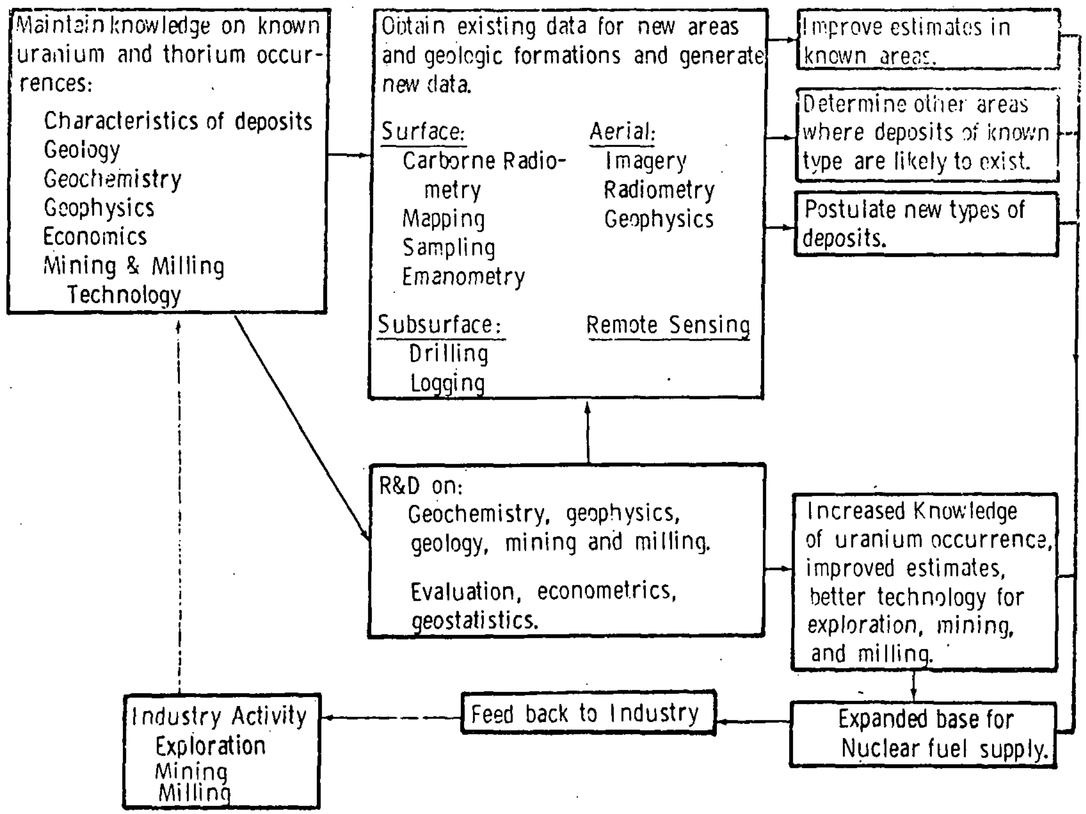

Fig. 9.7 Uranium Resource Strategy

Table 9.4 ERDA Aerial Radiometric Reconnaissance Program

GOAL - Complete airborne radiometric survey of U.S., including Alaska, on wide-spaced flight lines, by 1-1-80, to aid in identifying faborable areas.

PROGRAM--Minimum total flight lines mines--conterminous U.S., 760,000; Alaska, 110,000

FLIGHT LINE SPACING--1-12 miles: Average 5 miles

ALTITUDE--200-800 feet above ground level, optimum 400 feet

SYSTEMS--Computerized high-sensitivity gamma-ray spectrometric and magnetic detectors, mounted in fixed-wing and rotary-wing aircraft operated by private firms

OUTPUT--Radiometric equivalent of uranium, thorium, and potassium, and magnetic characteristics of enclosing rock, statistically evaluated by geologic units

DATA HANDLING

PUBLICATION--*Open file upon completion of each survey*

SUMMARIZED DATA BANK--Los Alamos scientific laboratory

TENTATIVE SCHEDULE

FISCAL YEAR	LINE MILES
1974-76	150,000
1977	147,000
1978	362,000
1979	210,000
	870,000

Table 9.5 Hydrogeochemical and Stream Sediment Reconnaissance Program

GOAL - A systematic determination of the distribution of uranium and associated trace elements in surface and underground waters and in stream sediments in the U.S., including Alaska, to identify areas favorable for uranium mineral occurrence.

PARTICIPANTS: National laboratories; universities; State agencies; U.S.G.S.; E.P.A.

OPERATING PARAMETERS:

SAMPLE SPACING - 10 sq. mi. (wide area) - 1/2 sq. mi. (detailed) depending on geologic homogeneity of area.

ANALYSIS - Field concentration of elements from water; measurement of conductivity and pH; determination of specific elements.

DATA TREATMENT - Statistical analysis.

DATA INTERPRETATION - Relate anomaly data to geologic environments.

OUTPUT - Areas of favorability; open-filing of maps and data; national data bank.

TENTATIVE SCHEDULE:

FISCAL YEAR - 1975 -- Literature search and limited R&D.
1976 -- Pilot studies; statistical methods development; staffing.
1977-1979 -- Large-scale surface and subsurface sampling; data analysis, interpretation, and reporting.

High-Cost Resources

As previously noted, an alternative to identification of additional low-cost resources is the utilization of higher cost resources. The highest cutoff cost category included in ERDA resources, in Table 9.2, is $30/lb. U_3O_8. This level was selected a few years ago as an upper range of what might be of interest for utilization in light water reactors over the next decade or more.

The increased price of oil and coal in the last few years has increased the cost of uranium economically acceptable in light water reactors. This results from the relative insentivity of nuclear electric power costs to increased in uranium prices. The cost of fuel is only a fraction of the cost of power from a nuclear plant. In turn, the cost of natural uranium is only a fraction of the fuel cost; enrichment, fabrication, reprocessing and carrying charges making up the balance. As a result, large increases in uranium prices result in comparatively small increases in power costs. This is an important advantage for nuclear power and provides additional assurance that uranium supplies will be adequate.

Knowledge of U. S. resources in the above $30 category is meager largely because of the lack of past economic interest. There has been virtually no industry activity to search for or develop such resources. Prospects for discovery of higher cost resources in the U. S., including those types of deposits known elsewhere in the world, such as those listed in Table 9.3, are considered promising at this stage of U. S. exploration. The magnitude of such resources is, however, uncertain. The ERDA assessment program will also consider these types of resources.

There are, in addition, large very low grade deposits which have been studied in some detail in the past. These include shales, granites and phosphates.

The Chattanooga shale in Tennessee is of particular interest because of its large size. This deposit was extensively drilled, sampled, and studied in the 1950s. The higher grade part of the Chattanooga shale has a uranium content of about 60-80 ppm. It contains in excess of 5,000,000 tons of U_3O_8 that may be producible at a cost of $100 or more per pound of U_3O_8. While additional work developing production technology will be needed, it is of interest that plans have been announced to exploit a similar but considerably higher grade deposit (300 ppm) in Sweden. The mining and milling technology has been developed and the deposits are economic. A plant of 20,000 tons of ore per day capacity is planned.

Similar production technology could be used for the Chattanooga shale at higher prices. As an example, if shale were mined to fuel a 1,150 MWe reactor, assuming recycle of uranium but not plutonium and a 0.3% enrichment tail, about 12,600 tons of shale would have to be processed each day, or with uranium and plutonium recycle and 0.20% enrichment tails, about 8,500 tons per day. An average of about 11,300 tons of coal would need to be burned each day if 8,700 btu/lb. coal were used.

Utilization of the very low-grade resources such as Chattanooga shale would, of course, involve mining and processing very much larger quantities of ore than is currently mined to produce the same amount of uranium. From an environmental as well as from an economic point of view, identification and utilization of additional higher grade ores would be preferable. However, the shales are available if their use should become necessary.

Foreign Uranium

In October 1974, the AEC announced its plan for allowing enrichment of foreign uranium intended for use in domestic reactors.[7] The plan would allow 10% of an enrichment customer's feed to be of foreign origin in 1977. The allowable percentage would increase in subsequent years as shown in Table 9.6. In 1874, there would be no restriction on use of foreign uranium. Foreign uranium, therefore, will be an additional source of uranium to meet domestic needs. During 1975, 1,100 tons of foreign uranium were delivered to U. S. buyers and 44,000 tons of foreign uranium were under contract at the beginning of 1976 for delivery to U. S. customers through 1990.[5]

Resources of foreign countries, up to the $30/lb. category, are tabulated in Table 9.7. The "resonably assured" category corresponds closely to the domestic ore reserve category and the "estimated additional" category corresponds to the domestic probable potential. As will be noted in the table, foreign resources are largely contained in five countries: Australia, Canada, South Africa, South West Africa and Swededn. All except Sweden and to some extent Canada will be essentially uranium exporting countries as their own needs will be comparatively small. The Swedish uranium is contained in low-grade shale as previously noted and is not likely to be available for export in significant quantities.

Table 9.6 Allowable Foreign Uranium Enrichment Feed
(Domestic End Use)

Tons U_3O_8

Calendar Years	Schedule of Percentage of Feed Allowed to be Foreign
1974	0
1975	0
1976	0
1977	10%
1978	15%
1979	20%
1980	30%
1981	40%
1982	60%
1983	80%
1984	No Restriction

Table 9.7 Foreign Resources
Thousand Tons U_3O_8

	Reasonably Assured	Estimated Additional
	$15/lb U_3O_8	
Autralia	430	104
S & SW Africa	242	8
Canada	189	394
Niger	52	26
France	48	33
Algeria	36	--
Gabon	26	6
Spain	13	11
Argentina	12	20
Other	56[a]	26
Total (Rounded)	1,100	630
	$30/lb U_3O_8	
Australia	430	104
Sweden	390	--
S & SW Africa	359	96
Canada	225	887
France	71	52
Niger	65	39
Algeria	36	--
Spain	30	55
Argentina	27	50
Other	150[b]	110
Total (Rounded)	1,780	1,390

[a]Includes Brazil, Central African Republic, Germany, India, Japan, Mexico, Portugal, Turkey, Yugoslavia and Zaire.

[b]Includes, in addition to [a], Denmark, Finland, Italy, Korea and the United Kingdom.

Foreign uranium demand, principally for the countries of Western Europe and Japan, is projected to grow even more rapidly than in the United States. ERDA projections indicate cumulative non-Communist foreign requirements through the year 2000 could be 2,100,000 to 2,800,000 tons of U_3O_8 U_3O_8 with annual demand in 1980 of 45,000 tons and in 1990 of 90,000 to 120,000 tons (at 0.3 tails and with recycle).

Existing foreign production capacity is about 20,000 tons per year. Considering the magnitude of known foreign uranium resources and production expansion plans, foreign capability could be increased to over 50,000 tons per year in the early 1980s. Although foreign resources are large, there are limitations on attainable production levels from Canadian and South African resources, and continued growth of foreign production capability will require enlargement of the foreign resource base or use of higher cost resources.

The prospects for expansion of foreign uranium supplies from a geologic point of view are good. The experience in Australia where large new resources were identified in just a few years effort is an example. The absence of substantial known resources in South America and in many African and Asiatic countries as seen in Figure 9.8 emphasizes the lack of exploration effort that has been done in these areas. There are, however, political limitations on the degree to which exploration will be accomplished in such places and the degree to which uranium supplies can be exported. Nationalistic policies towards resources has made access to supplies difficult in recent years. The improvement of world prices and markets should assist in opening up new areas to uranium exploration. However, since uranium demand will be low in many countries, material should be available in the world market place in time to make a useful contribution to U. S. needs.

Fuel Cycle Practice

There are a number of management and technical decisions relating to nuclear power utilization which will have significant impact on uranium demand. An important factor relating to operation of light water reactors involves the selection of tails assay at the enrichment plants. For example, enrichment with a 0.2% tails assay instead of the 0.3% reduces uranium demand by about 20%. Recycle of uranium and plutonium would allow more efficient use of fuel and reduce demands for newly mined uranium. Successful development of a commercial breeder reactor would in time reduce growth in uranium demand. This reactor may not require any natural uranium for centuries being able to use the several hundred thousand tons of depleted uranium which will be accumulating in the next few decades at enrichment plants. In time additional plutonium could also be available from breeders in sufficient quantities that plutonium could become the primary fuel in water reactors.

Finding made by the Federal Energy Resources Council

The subject of uranium availability has been considered by the Federal Energy Resources Council which had participation by the Council on Environmental Quality, the Department of Commerce, Department of Interior (U. S. Geological Survey), Environmental Protection Agency, ERDA, and FEA. A report issued by the Council, "Reserves, Resources and Production," June 15, 1976, states "available data indicates that there are sufficient economically recoverable uranium resources on which to base an expanding national program. The adequacy of uranium to provide fuel (over their 30-year lifetime) for all existing plants and additional reactors which may be placed into service by 1990 is a reasonable planning assumption."

Conclusion

In conclusion, ERDA assessment of uranium resources indicates that currently estimated U. S. resources would be adequate to allow fueling of substantially more nuclear power plants than all those now operable, under construction, on order and announced, without recycle of uranium or plutonium and with high enrichment tails assays. Lower tails assays and recycle could significantly increase the supportable capacity. Further expansion of U. S. uranium supplies is possible by discovery of new low-cost resources, utilization of higher cost resources or importation of foreign uranium. ERDA programs are designed to improve understanding of current resources and to aid in identification of new resources, seeking to assure that uranium supplies will be available when needed.

Prices have increased to levels that make exploration and production economically attractive. Industry exploration and development activities are increasing. Foreign uranium supplies will be available to augment domestic resources. There is a high probability that additional intermediate cost resources can also be identified and there are known domestic high cost resources which could be used if needed.

9.6 DECOMMISSIONING AND LAND USE

In the long-term, beyond the useful life of the proposed generating station, this site may continue to be used for generation of electrical energy. At the termination of such use, the land areas occupied by the nuclear facilities would be removed from productive use, unless decommissioning measures included removal of all radioactive equipment are adopted. Although the details of decommissioning may not be worked out for several years, the various alternatives should not be diminished by the proposed action of licensing operation. The range of beneficial uses of the site by future generations will not be curtailed, provided the applicant has the capability for removing all radioactively contaminated equipment if and when that step may be desirable.

NRC regulations prescribe procedures whereby a licensee may voluntarily surrender a license and obtain authority to dismantle a facility and dispose of its component parts.[1] Such authorization would normally be sought near the end of the nuclear plant's useful life. In any event, the Commission requires that a qualified licensee maintain valid licenses appropriate to the type of facility and materials involved. Under current regulations, the Commission generally requires that all quantities of source, special nuclear, and by-product materials not exempt from licensing under Parts 30, 40 and 70 of Title 10, Code of Federal Regulations, either be removed from the site or secured and kept under surveillance.

To date, experience has been gained with decommissioning of six nuclear electric generating stations which were operated as part of the Atomic Energy Commission's power reactor development program: Hallam Nuclear Power Facility, Piqua Nuclear Power Facility, Boiling Nuclear Superheat Power Station, Elk River Reactor, Carolinas-virginia Tube Reactor, and Pathfinder Atomic Power Plant. The last two facilities were licensed under 10 CFR Part 50; the others were Atomic Energy Commission-owned and operated under the provisions of the Part 115.

Several alternative modes of decommissioning have been experienced in those cases. They may be summarized generally as four alternative levels of restoration of the plant site, each with a distinct level of effort and cost.

In decommissioning at any level, economically salvageable equipment and all reactor fuel elements would be removed, some equipment would be decontaminated, and wastes of the type normally shipped during operation would be sent to waste repositories. In addition, the respective levels of restoration would involve the following measures:

Lowest level. There would be minimal dismantling and relocation of equipment. All radioactive material would be sealed in containment structures (primarily existing ones), which would require perpetual, continual surveillance for security and effectiveness.

Second level. Some radioactive equipment and materials would be moved into existing containment structures to reduce the extent of long-term contamination. Surveillance as in the lowest level would be required.

Third level. Radioactive equipment and materials would be placed in a containment facility approaching a practically minimum volume. All unbound contamination would have been removed. The containment structure would be designed to need minimal perpetual maintenance, surveillance, and security.

Highest level. All radioactive equipment and materials would be removed from the site. Structures would be dismantled and disposed of onsite by burial or offsite to the extent desired by the tenant. No further Commission license would be required.

Estimated costs of decommissioning at the lowest level are about $1 million plus an annual maintenance charge on the order of $100,000.[2]

Complete restoration, including regrading, has been estimated to cost $70 million.[3] Hence, there is wide variation, arising from differing assumptions as to level of restoration. At present land values, it is not likely that consideration of an economic balance alone would justify a high level of restoration. Planning required of the applicant at this stage will assure, however, that variety of choice for restoration is maintained until the end of useful plant life.

Units 1 and 2 of the Three Mile island Nuclear Station are designed to operated for about 30 years, and the end of their useful life will be approximately in the year 2008. The applicant has made no firm plans for decommissioning but assumes that the following steps would be taken as minimum precautions for maintaining a safe condition.

1. All fuel would be removed from the facility and shipped offsite for disposition.

2. All radioactive wastes - solid, liquid, and gas - would be packaged and removed from the site insofar as practical.

A decision as to whether the facility would be further dismantled would require an economic study involving the value of the land and scrap value versus the cost of complete demolition and removal of the complex. However, no additional work would be done unless it is in accordance with rules and regulations in effect at the time.

In addition to personnel required to guard and secure the facility, concrete and steel would be used to prevent ingress into any building, particularly the radioactive areas.

REFERENCES

1. Title 10, "Atomic Energy," Code of Federal Regulations, Part 50, Licensing of Production and Utilization Facilities, Section 50.82, "Applications for Terminations of Licenses."

2. Atomic Energy Clearing House, Congressional Information Bureau, Inc., Washington, D.C., 17(6):42, 17(10):4, 17(18):7, 16(35):12.

3. "Pacific Gas and Electric Company, Supplement No. 2 to the Environmental Report, Units 1 and 2, Diablo Canyon Site," July 28, 1972.

4. "Uranium Industry Seminar," USAEC, Grand Junction, Colorado Office, GJO-108(74), October 1974.

5. "Survey of U. S. Uranium Marketing Activity," ERDA 76-46 April 1976.

6. "Survey of U. S. Uranium Marketing Activity," USAEC, WASH-1196(74) April 1974.

7. USAEC Press Release No. T-517, October 25, 1974.

10. BENEFIT-COST ANALYSIS

10.1 RESUME

The Benefit-Cost Analysis presented in the FES issued in December 1972 remains valid with the updated information on the benefits presented in Section 10.2 and with the updated and additional costs presented in Sections 10.3 through 10.6. The overall staff's recommendation that the construction permit should be continued and the operating license be granted remains unchanged.

10.2 BENEFITS

The primary benefit from the operation of Three Mile Island Nuclear Station, Unit 2, will be the addition of 906 MWe (880 MW summer rating) net generating capacity which will provide increased production of electrical energy at a fuel, and operation and maintenance cost lower than all but three other base load units in the GPU system. This unit will produce electricity at considerably less per kWe of output than will a large efficient base load coal-fired plant scheduled to come on line at approximately the same time. Any reduction in base load operation due to an unlikely decline in need for base load capacity would be achieved with existing units even less efficient than the coal-fired unit used for comparison.

Secondary benefits include tax revenues, increased local employment and payroll, and local purchase of materials and supplies. Tax revenues related to Three Mile Island Nuclear Station, Unit 2, that will accrue to the Commonwealth of Pennsylvania will amount to about $22.8 million in 1979. The one percent earned income tax will yield a total of about $30,000 a year to the townships in which the workers will reside. The 165 new permanent jobs are expected to have an annual payroll estimated at $3.04 million. Local purchase of operating supplies and materials are estimated to amount to $125,000 per year.

10.3 ECONOMIC COSTS

The project costs related to plant operation include fuel costs and operation and maintenance, and are estimated by the applicant to be $8,529,000 and $6,538,000, respectively, in 1978 for an assumed net generation of 3,068,000 MWh. There will be no significant economic costs imposed on surrounding communities due to operation of TMI-2.

10.4 ENVIRONMENTAL COSTS

The environmental costs as discussed in FES (December 1972) are still valid with the following modifications: (a) the comparison of total operating costs between nuclear and coal baseload plants is now shown in Section 8.3.3 of this supplement in lieu of Section XI.B.1; (b) the environmental costs associated with radioactive effluents are those discussed in Section 5.4 of this supplement in lieu of those discussed in Section V.D. of FES, December 1972; (c) additional environmental cost involves acquisition of a 175 foot wide right of way along an existing 150 foot wide 230-kV transmission line corridor for a 7.36 mile extension of the 500-kV transmission line from Bechtelsville to Hosensack. This consists of clearing of 21 acres of woodland; spanning over 134.5 acres of agricultural land; and diverting of 0.4 acres from agriculture to use under tower bases (Section 4.4.1).

10.5 SOCIETAL COSTS

No significant economic or social costs are expected from plant operating personnel living in the area.

10.6 ENVIRONMENTAL COSTS OF THE URANIUM FUEL CYCLE AND TRANSPORTATION

The contribution of environmental effects associated with the uranium fuel cycle are indicated in Table 5.12 and the effects of transportation of fuel and waste to and from the facility are summarized in Section 5.4.1.5. These effects are sufficiently small as not to affect significantly the conclusion of the Cost-Benefit Balance.

10.7 SUMMARY OF BENEFIT-COST

As the result of this supplemental review of potential environmental, economic, and social impacts, the staff has been able to forecast more accurately on the effects of the plant's operation. The additional and the updated information provided in this supplement does not alter the staff's previous position related to the overall balancing of the benefits of this plant versus the environmental costs. Consequently, it is the staff's belief that this plant can be operated with only minimal environmental impacts. The staff finds that the primary benefits of minimizing system production costs and/or the addition to base-load generating capacity greatly outweigh the environmental and social costs.

Based on this evaluation, the staff's recommendation that the construction permit CPPR-66 should be continued and that the operating license for Unit 2 should be granted, as expressed in FES, December 1972 (Summary and Conclusions), remains unchanged.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR Part 51.25 the Draft Supplement to the Final Environmental Statement for the Three Mile Island Nuclear Station, Unit 2, was transmitted with a request for comments to:

- Advisory Council on Historic Preservation
- Department of Agriculture
- Department of the Army, Corps of Engineers
- Department of Commerce
- Department of Health, Education and Welfare
- Depart of Housing and Urban Development
- Department of the Interior
- Department of Transportation
- Energy Research and Development Administration
- Environmental Protection Agency
- Federal Power Commission
- Federal Energy Administration
- Board of Commissioners - Dauphin County, Pennsylvania
- Susquehanna River Basin Commission
- Londonderry Township Board of Supervisors
- Pennsylvania State Clearinghouse
- Pennsylvania Governor's Office of State Planning and Development
- Pennsylvania Department of Environmental Resources
- Tri-County Regional Planning Commission

In addition, the NRC requested comments on the Draft Supplement to the Final Environmental Statement from interested persons by a notice published in the Federal Register. Comments in response to the requests referred to above were received within the 45 day comment period from:

- Department of Agriculture, Agricultural Research Service (AGARS)
- Department of Agriculture, Economic Research Service (AGERS)
- Department of Health, Education and Welfare (HEW)
- Department of Housing and Urban Development (HUD)
- Department of the Interior (DOI)
- Department of Transportation (DOT)
- Energy Research and Development Administration (ERDA)
- Environmental Protection Agency (EPA)
- Susquehanna River Basin Commission (SRBC)
- Tri-County Regional Planning Commission (TCRPC)
- Metropolitan Edison Company (MEC)
- Mr. Chauncy Kepford, Jackson, Wyoming

The Staff consideration of comments received and the disposition of the issues involved are reflected in part by text revisions in other sections of the Final Supplement to the Final Environmental Statement (FSFES) and in part by the following discussion which will reference the comments by use of the abbreviations indicated above. The reference includes the abbreviation of the commentor and the page in Appendix A where the comment appears. As noted previously, all comments received are included in Appendix A of this statement.

11.1 RESPONSES TO COMMENTS BY FEDERAL AND STATE AGENCIES, APPLICANT AND OTHER INTERESTED PARTIES

11.1.1 Summary and Conclusions

11.1.1.1 Determination of distribution of chlorine in the river (MEC - A11)

The applicant's understanding is correct. The proposal for monitoring is acceptable.

11.1.2 The Site

11.1.2.1 Flood Protection (SRBC - A18, TCRPC - A2)

Because of the threat of flooding, the station is protected from floods by an extensive dike system surrounding the island. This system is designed to withstand the effects of a flood as great as 1,100,000 cfs, without overtopping or damage. A minimum of approximately one foot of freeboard is provided for this flood. Details of the dike elevations and locations may be found in the FSAR (Sect. 2.4). For floods greater than the levee design flood of 1,100,000 cfs, emergency procedures provide for a safe and orderly shutdown of the plant. Additionally, the station is designed for and protection is provided for a flood as severe as the Probable Maximum Flood (PMF). The PMF has a discharge of 1,625,000 cfs and a water surface elevation of 309 ft. above mean sea level at the Unit 2 intake structure. All plant structures subject to flooding are fully designed for the effects of statis water level and also the dynamic effects associated with coincident wind waves. An evaluation of flooding potential may be found in the staff's Safety Evaluation Report. Discussions of the shutdown and waterproofing procedures to be followed in the event of a large flood may be found in the FSAR.

11.1.2.2 Historical Sites (DOI - A16)

With regard to the above comment from the Department of the Interior the applicant provided the following response:

> "In response to the above comment, the Applicant has recently requested the Pennsylvania State Historic Preservation Officer to furnish an up-to-date evaluation as to whether Three Mile Island Nuclear Station will have an adverse effect on any historical sites on the National Register of Historic Places or eligible for inclusion. The Applicant will furnish the NRC a copy of this evaluation upon its receipt."

Appendix E contains a letter which the applicant received from the Pennsylvania Historical and Museum Commission.

11.1.2.3 Outdoor Recreation (DOI - A16)

With regard to the above comment from the Department of the Interior the applicant provided the following response:

> "The area of TMI reserved for recreational use and access is a part of Project Number 1888, as licensed by the Federal Power Commission. The application, filed February 27, 1970, with the Federal Power Commission to supplement an application for a new license for Project Number 1888, included Exhibit R, Recreation, in which there appeared the following:
>
> "Consultation
>
> Development of the recreation resources of this project has been reviewed with the following:
>
> Howard A. Miller, Administrative Assistant, Pennsylvania Fish Commission
>
> Dr. Maurice Goddard, Secretary of Forests and Waters
>
> Conrad R. Lickel, Director, Bureau of State Parks
>
> Burl Gries, Planner, York County Planning Commission
>
> Oliver Fanning and Mr. Cotter, Planners, Tri-County Planning Commission
>
> Albert Reese, Planner, Lancaster City/County Planning Board"
>
> Subsequently, contact was made, and continues, with the Dauphin County Parks and Recreation Board."

11.1.3 The Plant

11.1.3.1 Compliance with Requirements of Appendix I to 10 CFR Part 50 (EPA - A28)

The staff has completed its evaluation as to the capability of the radwaste systems to meet the requirements of Appendix I to 10 CFR Part 50. The evaluation is incorporated in this Final Supplement to the Final Environmental Statement. With respect to operating experience for Unit No. 1, such information was not included, since under the provision of Appendix I, applicants electing the Section II.D cost-benefit analysis base their evaluation on the effluents from each unit and not on the combined effects of the effluents from all units located on the plant site.

11.1.3.2 Management of Solid Radioactive Waste (EPA - A28, DOI - A16)

The staff has reassessed the radiological quantities in solid wastes to be shipped to licensed land burial sites based on recent operating data* applicable to Three Mile Island Nuclear Generating Station, Unit No. 2. Based on this reassessment, the staff has provided a value for radioactivity content of solid wastes in this Final Supplement to the Final Environmental Statement.

11.1.4 Environmental Impact of Site Preparation and Construction

There were no comments made on this chapter which require staff's written response.

11.1.5 Environmental Effects of Station Operation

11.1.5.1 Individual Dose Commitments and Compliance with Appendix I to 10 CFR Part 50 (HEW - A4, EPA - A27)

The individual doses and the evaluation of TMINS compliance with Appendix I to 10 CFR Part 50 are included in this Final Supplement to the Final Environmental Statement (See Sect. 5.4).

11.1.5.2 Omission of an Appendix Discussing Dose Models and Pathways (ERDA - A32, EPA - A26)

Appendix D which includes description of models used and pathways considered in calculating population doses is included in this Final Supplement to the Final Environment Statement. The information included in Appendix D is available now in the NRC Regulatory Guide 1.109 (March 1976).

11.1.5.3 Dose Commitments from H-3, Kr-85, and C-14 (EPA - A27)

Dose commitments from H-3, Kr-85 and C-14 distributed on a world-wide basis are included in Appendix D in this Final Supplement to the Final Environmental Statement. Projected releases are now considered to the midpoint of the expected lifetime of nuclear power plants. The assessed impact over a period of 50 years is being used. Present life expectancy does not warrant use of a 100 year period. The description of models used in the assessment for enviromental dose impact are also discussed in Appendix D.

11.1.5.4 Inclusion of Radiological Impact from Unit 1 (EPA - A27)

This Final Supplement includes a summary of individual and population radiological doses, which are considered as environmental impact. In addition the applicant offered the following response:

> "The operational Radiological Environmental Monitoring Program conducted by Met-Ed and its consultant, Radiation Management Corporation, has been collecting data since June 5, 1974. To date, the Radiological Environmental Monitoring Reports, which have been submitted to the NRC, indicate that TMI-1 has had very little affect on the surrounding environment.
>
> Although the Radiological Environmental Monitoring Programs considered many other possible dose pathways to man in the environs of the TMI site, Tritium, CO-60, I-131, and CO-58 were the only radionuclides of TMINS origin detected above background levels with only CO-58 and CO-60 potentially contributing to dose. The radiation dose to people from ambient Gamma radiation, as measured by thermoluminescent dosimeters, averaged 5.3 mrem/month to date and showed no evidence of a TMINS contribution since the unit began operation.
>
> The radiation dose to people in the TMINS environs reported to date is as follows:

Source of Exposure	Annual Dose in mrem
Tritium in Water	0.002
CO-60 in Water	<0.1
CO-58 in Sediment	<0.1

> The TMI-1 dose contribution to population exposure is very small (approximately 0.1% of that from other sources). Therefore, it can be concluded that operation of TMI-1 did not significantly alter the radiological characteristics of the TMINS environs. The radionuclides and radiation levels observed were principally due to natural radioactivity and global fallout."

11.1.5.5 Chlorination (MEC - A13)

The applicant's understanding is correct. The proposal for monitoring is acceptable.

*Data extracted from semiannual operating reports on ten PWR units.

11.1.5.6 Aquatic Impacts (DOI - A16)

The staff discussed the fish kill problem with the Fish and Wildlife Service of the U.S. Department of the Interior and with the Department of Environmental Resources of the Commonwealth of Pennsylvania. It was learned that no details were recorded on the incidents. Without more information, an assessment relative to the operation of Three Mile Island Nuclear Station is not possible. The applicant further investigated the alleged "fish kill" and provided the following additional information:

"Further investigation by the Applicant as to the source of the U.S. Department of the Interior's comment pertaining to "fish kills", revealed that the local Pennsylvania Fish Commission's waterway patrolman observed a number of dead fish along the western shore to Three Mile Island (TMI) downstream from the station during the spring of 1974 and 1975. A telephone conversation between the Applicant and the waterway patrolman who observed these occurrences identified the following: (1) the dead fish were observed between April and May of 1974 and 1975, (2) the number of dead fish observed during these occurrences was roughly 200 in 1974 and 300 in 1975, and (3) the dead fish, although observed downstream from the station discharge, could not be attributed to station operation since the fish observed were dead for several days, which suggests they died at a more distant upstream location and were washed ashore at TMI.

Although the Applicant cannot determine the exact cause of these occurrences, we do wish to point out that fish die regularly throughout the year in large rivers like the Susquehanna due to natural causes, such as old age, parasites, disease, etc. Dead fish are observed more often in the spring of the year. The deaths of many of these fish can be attributed to bacterial diseases, such as Aeromones.

The Applicant wishes to emphasize the fact that "fish kills" did not occur during the spring of 1974 and 1975, or at any other time which could be attributable to thermal or chemical discharges from Three Mile Island Nuclear Station as suggested by the U.S. Department of the Interior."

11.1.5.7 Meteorology and Climatology (EPA - A30)

The applicant has stated that the 150 foot wind sensor, which does not meet the instrument specification recommended in Regulatory Guide 1.23, is not part of the nuclear meteorological program. Therefore, EPA's comment concerning recalculation of the relative atmospheric concentration (X/Q) values is no longer relevant, since the meteorological sensors used to provide data for our X/Q calculations meet the instrument specifications recommended in Regulatory Guide 1.23.

11.1.5.8 Meteorological Program (MEC - A13)

Since the applicant has stated that wind instrumentation at the 150 foot level (aerovane) is not part of the nuclear meteorological program, references to wind sensors at this elevation were deleted.

11.1.5.9 NPDES Permit (EPA-A29)

To the following comment: "The NPDES Permit issued by EPA to TMINS, effective December 30, 1974, imposed an effluent limitation of 87°F for the protection of the aquatic community. Pennsylvania later approved Metropolitan Edison's request to discharge at the ambient receiving stream temperature when the temperature is above 87°F. The company is trying to negotiate a workable application of the 5°F rise limitation (see FES Paragraph 5.3.3) with the State. The final statement should report how this proposed variance will affect the application of thermal standards at TMINS." The staff's response is as follows.

The outcome of this negotiation has not yet become available. Because of the operation of the mechanical draft cooling tower which maintains discharge temperature close to ambient and because of the large flow in the Susquehanna River which quickly dilutes the station discharge, temperature is likely to exceed ambient by more than 2°F in only a very small zone in the river. Paragraph 5.5.2.3 of the FES reports observations of the thermal plume. There it is noted only that: "Effluent characteristics were generally distinguishable to about 20 m (66 feet) into the river and downstream to about 50 m (164 feet) over depths up to 3 m (9.9 feet)." In warmer months the area in which temperature exceeds ambient by more than 2°F should generally be contained within the above described region.

In addition the applicant offered the following response: "Section 97.82 (a) of the regulations limits the discharge from raising or changing the temperature of the entire stream at the point of discharge by said amounts. All data collected by the Applicant's consultant to date, support the contention that the TMI-1 discharge will not exceed these limits, nor is it expected that the additional discharge volume that will result from the operation of TMI-2 will exceed these limitations.

The requirements for compliance with these limitations assume measurement after complete mixing. The term complete mixing is not defined in the regulation. As a result, it is not clear how or where the discharge limitations should be applied.

Since the 5°F ΔT and the 2°F/hour change limitation cannot be met consistently at the point of discharge, Met-Ed is planning to negotiate with the DER in order to define a thermal mixing zone, at the edge of which these limitations would apply. By monitoring at the point of discharge and meeting the applicable limits within a few degrees at the discharge, compliance with the limits at the edge of the mixing zone will be assured."

11.1.5.10 Thermal Limitation (EPA-A30)

EPA comment raises a question whether thermal limitation imposed on Unit No. 1 mechanical draft cooling tower will be applied to Unit No. 2. It will not. The NPDES Permit is accepted as a determination that State water quality standards will be met. The FES concludes (Paragraph 5.5.2.2) that thermal impacts will be quite limited. Since this evaluation was based on the proposed operation of the mechanical draft cooling tower, any alternative operational plan, especially abandonment of the mechanical draft towers, will be evaluated by NRC.

11.1.5.11 Location of Intake Structure Relative to Spawning Areas (EPA-A30)

In addition to a change in Section 5.5.2.2 made by the staff in response to this comment, the applicant offers the following response: "Presently, there are no specific data available to identify major spawning locations within Lake Frederic. Field observations made in the immediate vicinity of the intake structures and results of ichthyoplankton entrainment studies as carried out as part of the TMI-1 Environmental Technical Specifications by the Applicant's consultant, Ichthyological Associates, Inc., indicate that there are no major spawning areas in the immediate vicinity of the intake structures."

11.1.5.12 Health Hazards Due to Induced Electric Field (EPA-A30)

In addition to a change in Section 5.2.2 made by the staff in response to this comment, the applicant offers the following response:

"As the EPA suggests, the Applicant will include that section of the 500 kV transmission line which crosses Pennsylvania Routh 100 east of Bechtelsville in its safety implementation plans. These plans include informing property owners of possible electrostatic effects and precautions that can be taken to minimize such effects prior to line operation. The Applicant will also take field measurements at the crossing of Route 100 once this line becomes energized to identify the potential for such occurrences. The Applicant wishes to point out that these actions are consistent with the Applicant's normal practices."

11.1.6 Environmental Monitoring

11.1.6.1 Monitoring of Doses to Members of the Public (Chauncy Kepford - A5)

The operational offsite radiological monitoring program results are used to calculate doses to the public for existing pathways associated with liquid and gaseous effluents. The environmental monitoring required by 10 CFR 50 (Appendix I, Sections 3 and 4) implemented by the requirements of the Technical Specifications which are made a part of a license to operate the plant provides the NRC with site-related data for determining that doses to the public are as low as reasonably achievable.

11.1.6.2 Monitoring of the River for Radioactive Releases (DOI - A17)

The Three Mile Island station environmental monitoring program includes the capability of collecting short time interval river water aliquot samples. This will provide a means of identifying and assessing radioactive releases entering the river in the vicinity of this plant site.

11.1.6.3 Preoperational Monitoring Program (MEC - A15)

The applicant's agreement to change the radiological environmental monitoring program as proposed by the NRC staff is satisfactory for the preoperational phase of this program.

11.1.7 Relative Accident Analysis

11.1.7.1 Reactor Safety Study (Chauncy Kepford - A5)

Staff's overall assessment of the Reactor Safety Study is that it provides an objective and meaningful estimate of the probable risks associated with the operation of present-day light-water nuclear power plants in the U.S. The staff believes the Study's methodology as it applies to the calculation of both accident probabilities and consequences has received a broad and increasing endorsement by the informed scientific community. It should be noted that the Study was referenced as a source of data and did not by itself form the basis for the staff's evaluation of postulated accidents in the Draft Supplement to the Final Environmental Statement.

11.1.7.2 Environmental Effects of Accidents (DOI - A17)

The Interior Department suggests that a specific study of the consequences of a Class 9 accident at Three Mile Island, Unit No. 2 upon the Susquehanna River should be made. The staff disagrees with this view. A general discussion of Class 9 accidents has been given in the Reactor Safety Study. This study deals primarily with dose consequences via the airborne pathway, since this has been judged to be the pathway of primary importance. The staff is also conducting a generic study on the dose consequences that could be conducted via the liquid pathway. The staff believes, in view of the remote possibility of occurrence of a Class 9 event, that the environmental risk of such an event is acceptably low, and that generic discussion of these events are adequate.

11.1.7.3 Effect of Reactor Accidents on Recreation Areas (EPA - A27)

The EPA commented that a proposed recreation area at the south end of the island could pose difficulties in the remote event that evacuation of people was required, and stated that no balancing of visks vs. benefits had been made in the DES. It is true that no balancing of risks vs. benefits was made in the DES. The staff did investigate possible evacuation of the exclusion area, including the proposed recreation area and concluded that evacuation could be carried out such that little risk to the public would result from the use of the south end of island as a recreation area. In view of the remote probability of an accident occurring and the fact that evacuation could be carried out with little risk to the public in the event of an accident, the staff concludes that the risks of such a facility are far outweighed by the recreational benefits to be derived from it.

11.1.8 Need for Plant

11.1.8.1 Cost Comparison of Nuclear and Coal (Chauncy Kepford - A6)

Table 8.2 has been clarified by (1) labeling the investment cost and fixed operation and maintenance costs as "annual costs $/Kw" rather than $/kW-yr (these costs are incurred regardless of level of output); and (2) by inclusion of a footnote to explain how to obtain costs per kilowatt hour of output.

11.1.8.2 Generation and Maintenance Costs (Chauncy Kepford - A6)

The coal operation and maintenance costs included estimates for operating scrubbing equipment and are therefore higher than present operation and maintenance costs for plants using high sulfur coal without such equipment (See ER, Section 8.4).

11.1.8.3 Price-Anderson Act (Chauncy Kepford - A5)

The comment discusses Subsection 170b. of the Atomic Energy Act of 1954, as amended. This subsection along with other subsections of Section 170, the Price-Anderson Act, was modified by Public Law 94-197, enacted into law on December 31, 1975. This legislation, which extends the present Price-Anderson legislation for ten years to August 1, 1987 provides, among other things, for the phasing out of Government indemnity through a mechanism whereby the utility industry would collectively share in the risk of damages from a nuclear incident exceeding the basic amount of private insurance available through the payment of a retrospective premium to the insurance pools.

The Commission must establish, before December 31, 1976, a retrospective premium figure of between $2 million and $5 million per reactor. On September 20, 1976 the Commission published in the Federal Register (41 F.R. 40512) a notice of proposed rule making which would, among othe things, establish this premium figure at $5 million per reactor.

This retrospective premium of $5 million per reactor per incident would be paid in the event of a nuclear incident resulting in damages exceeding the amount of the current $125 million primary insurance layer. This premium was not meant to replace the indemnity fee of $30 a thermal megawatt paid by reactor operators. The premium was established to phase out Government indemnity by the mid-1980s. There is also provision, however, in P.L 94-197 which authorizes the Commission to reduce the annual indemnity fee as the financial protection layer increases and Government indemnity is reduced.

While the retrospective premium is not a "one-time fee," there is a maximum amount proposed by Commission in the notice of proposed rule making of $10 million per reactor that can be assessed in any one calendar year. This figure was chosen, as explained in the notice of proposed rule making (41 F.R. 40512), not so much to provide funds for a second nuclear incident in a single calendar year, an occurrence which we feel is extremely remote, but to provide funds for claims arising from a nuclear incident in an earlier year.

11.1.9 Alternatives Considered and Consequences of the Proposed Action

11.1.9.1 Decommissioning and Land Use (DOI - A17)

Staff's position is covered in Section 9.6 of this Final Supplement. Additionally, the applicant furnished the following response to the above comment:

> "Since we do not anticipate having to decommission TMI-2 until the year 2010, it is difficult to forecast regulatory requirements which may be imposed at that time. There will be many changes in technology and social concerns between 1976 and 2010 which will influence plans for decommissioning. The Applicant is convinced that when the time comes to decommission TMI-2, this activity will be accomplished in a socially, environmentally, and economically acceptable manner consistent with the regulatory requirements in effect at that time."

11.2 LOCATION OF PRINCIPAL CHANGES IN THE STATEMENT IN RESPONSE TO COMMENTS

Topic Commented Upon	Section Where Topic Addressed
Holtwood Dam (EPA - A30)	Table 2.2
Location of Generating Stations (MEC - A11)	Table 2.3
Water Quality (MEC - A12)	2.4.3
Ichthyoplankton (MEC - A12)	2.6.2.3
Demineralizer Regeneration Solution (MEC - A12)	3.3.3.1
Bechtelsville Substation (MEC - A12, A13)	4.4.1
Electrostatic Induction (MEC - A13)	5.2.2
Electric Field Effects (EPA - A30)	5.2.2
Surface Water (SRBC - A18)	5.3.1
Water Quality (EPA-A30, A26)	5.3.3
Impingement Monitoring (MEC - A13)	5.5.2.1
Location of Intake Structure (EPA - A29)	5.5.2.2
Meteorological Program (MEC - A13)	6.3.2
Sampling Location (MEC - A15)	Fig. 6.2
Terrestrial Monitoring (MEC - A14)	6.5
Appendix Discussion Dose Calculation Models (MEC - A13, EPA - A26)	Appendix D

APPENDIX A

COMMENTS ON

DRAFT ENVIRONMENTAL STATEMENT

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UNITED STATES DEPARTMENT OF AGRICULTURE
ECONOMIC RESEARCH SERVICE
WASHINGTON, D.C. 20250

50-32

July 27, 1976

JUL 23 1976

SUBJECT: Draft Environmental Statement

TO: William H. Regan, Jr., Chief
Environmental Projects Branch 3
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C.

We have no comments on the Draft Environmental Statement related to operation of Three Mile Island Nuclear Station, Unit 2.

Velmar W. Davis

VELMAR W. DAVIS
Deputy Director
Environmental Studies

7595

TRI-COUNTY REGIONAL PLANNING COMMISSION

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Staff Telephone 234-2639

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August 4, 1976

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 3
Division of Site Safety and Environmental Analysis
United States Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Draft Supplement to the Final Environmental Statement
Three Mile Island, Nuclear Station, Unit 2;
Metropolitan Edison Co. and others; Nuclear Regulatory
Commission; Docket No. 50-320

Dear Mr. Regan:

We have received the "Draft Supplement to the Final Environmental Statement" noted above, and dated July, 1976.

The Commission has found that the Environmental Statement, as prepared in accordance with the statement of general policy and procedure on implementation of the National Environmental Policy Act of 1969, as set forth in the Commission's regulations in 10 CFR Part 51, considers many aspects of the environment as required. Further, the Commission can only concur in general with the contents of the statement since the Commission does not have the expertise to review the technical aspects of this statement.

Further, the Commission is pleased to find that consideration has been given to historic sites, national landmarks, existing land use, recreational use and overall safety. Related to the last, we have noted comments of other agencies on the protection of the plant from flooding. The Commission believes that such protection should be verified as adequate. Another concern of the Commission is the protection from accidents relating to radioactive materials in transportation and in use or storage.

Very truly yours,

Charles M. Ruth, Chairman

CMR/clf
cc: Rosemary White

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DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WEP-7/73)
WASHINGTON, D.C. 20590
PHONE: 202-426-3301

5922/9.a.162
26 AUG 1976

RECEIVED AUG 31 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

U. S. Nuclear Regulator Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20545

Gentlemen:

The concerned staff and operating elements of the U. S. Coast Guard have reviewed the Draft Environmental Impact Statement for the Three Mile Island Nuclear Station, Unit 2. The Coast Guard has no comment concerning the proposed project at this time.

Thank you for the opportunity to review your draft statement.

Sincerely,

R. F. EIDEN
Commander, U. S. Coast Guard
Acting Chief, Marine Environmental
Protection Division
By direction of the Commandant

AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

UNITED STATES DEPARTMENT OF AGRICULTURE

OFFICE OF ADMINISTRATOR

September 1, 1976

Mr. Wm. H. Regan, Jr.
Division of Site Safety and
Environmental Analysis
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Regan:

In response to your letter of July 22, we have no additional comments to make on the Draft Supplement to the Final Environmental Statement related to the operation of the Three Mile Island Nuclear Station, Unit 2.

Sincerely,

H. L. Barrows
Deputy Assistant Administrator

RECEIVED 9-7-76 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
PHILADELPHIA AREA OFFICE
CURTIS BUILDING, 625 WALNUT STREET
PHILADELPHIA, PENNSYLVANIA 19106

REGION III
Curtis Building
6th. and Walnut Streets
Philadelphia, Pennsylvania 19106

September 9, 1976

IN REPLY REFER TO: 3.4SS

50-320

Mr. William H. Regan, Jr.
Chief, Environmental Projects Branch 3
Division of Site Safety and
Environmental Analysis
U.S. Neclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Regan:

Subject: NRC Draft Supplement (July, 1976) to the
Final Environmental Statement,
Three Mile Island Nuclear Station, Unit 2.

This office has evaluated the subject Supplement and we have no substantive comments to offer. Further, to our knowledge, your proposal will not directly affect any projects sponsored by this Department.

Thank you for the opportunity to review your Statement.

Sincerely,

James R. Treadwell
James R. Treadwell
Environmental Officer

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

SEP 10 1976

50-320

Mr. William H. Regan, Jr., Chief
Environmental Projects Branch 3
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Regan:

This Department has reviewed the draft supplement to the Three Mile Island Nuclear Station, Unit 2 final environmental impact statement. We support the ten recommendations in paragraph 6.6.1 on pages 6-9 for improving the preoperational radiological environmental monitoring program.

In discussing the radiological impact on man of this facility, there is no data presented on the maximum exposure to an individual living in the immediate vicinity of the site or in the surrounding region. The only actual numbers given are for the U.S. population dose commitment in man/rems. While this is valuable information from an overall population-dose standpoint, it does not provide sufficient information concerning projected exposure to individuals or small groups of persons residing in the areas mentioned above who would be subject to the highest possible exposures from the plant operations.

Thank you for the opportunity to review the document.

Sincerely,

Charles Custard
Director
Office of Environmental Affairs

9/17/76

September 12, 1976.

50-320

Dear Sir:

I have reviewed the Draft Supplement to the Final Environmental Statement for Three Mile Island, Unit 2. In my opinion it is a typical work of the N.R.C., a very non-critical assessment of the materials supplied the NRC by the applicant, Metropolitan Edison Co. It does not appear that the NRC staff is capable of questioning the supplied information. This follows apparently from the long standing habit of the AEC/NRC staff of believing everything the staff is told by the nuclear industry. I doubt if there is another industry in country where the potential hazards to the public are so great and the regulation so haphazard and non-violent with such minimal penalties for major rules infractions.

This attitude was clearly evident during recent rulemaking hearing on the Environmental Effects of the Uranium Fuel Cycle, Docket RM-50-3. Court decisions of July 21, 1976, sent the subject back to the NRC for a fuller airing. Attached to these comments is a petition recently filed with the NRC requesting the reopening of the construction permit hearing for TMI, unit 2. While the petition is partly based on the above mentioned Court decisions, it is also based on uranium fuel supply problems not yet acknowledged to be problems by the NRC. As a result, paragraph 5.4.3 of the Draft, page 5-13, is grossly inadequate.

Paragraph 6.6.2, page 6-9, reveals a continuation of the NRC policy of refusing to

2

monitor real doses to real members of the public from the nuclear power program. Of course, to monitor such doses might reveal that many nuclear power plants operate at levels of radioactivity emissions which exceed the 10 CFR 50 Appendix I guidelines for doses to members of the public. It is difficult to escape the conclusion that the public relations" image of a clean nuclear industry is more important to the NRC than the health and safety of the public.

This attitude of the NRC is broadened in Chapter 7 of the Draft, page 7-1, paragraph 7.2. The NRC would, it appears, have the public accept as true and correct the "Reactor Safety Study." However, many of the conclusions of this study have been severely criticized by independent groups, as the American Physical Society Review Committee, the Union of Concerned Scientists, and the Environmental Protection Agency. My concerns are more fundamental than any of these groups criticisms. I am concerned with how the industry operates in the real world. And in this world, the industry, the NRC, and the Congress showed their complete lack of faith in the past, present, and future safety of the industry in supporting and enacting into law the 1975 Amendments to Sec. 170 of the Atomic Energy Act of 1954, as amended, commonly known as the Price-Anderson Act.

Subsection (b) of the Act (Price-Anderson) was amended to modify the charges to the electric utility industry using nuclear power in the event of a serious accident. Under the new law, a utility would be assessed at one time for [illegible] [illegible] to [illegible] [illegible] [illegible] by the NRC. This fee is to replace the annual indemnity fee, and would be collected only after an accident takes place. The fee is called a "deferred premium". The fact that this fee bears no relationship whatsoever to the possible damages from an accident is still a matter for real concern. But the implications for the safety of the public are far deeper. The new law now contains the sentence, still in subsection (b), which reads

> "The Commission is authorized to establish a maximum amount which the aggregate deferred premiums charged for each facility within one year may not exceed."

Without this sentence in the law, if there were two, three, or ten serious accidents in one year, the utilities would be charged a deferred premium for each accident. But as the law now reads, the Commission, the NRC, can set a maximum value for the deferred premiums charged to the utilities in one year. Or, looking at it another way, the NRC can relieve the nuclear utilities from even the minimal responsibility they now bear for even a second accident in one year.

Since the law carries more weight than the pronouncements of safety by all segments of the nuclear industry, I suggest that such pronouncements are merely empty words, cheap rhetoric, designed to mislead and deceive the public. I believe it then follows that the "Reactor Safety Study" is nothing but a complicated public relations document bearing no relationship to real nuclear reactors operating in the real world under the law as it presently exists.

The almost ridiculous lengths the NRC staff will go to to cover and protect its bungling industry is exemplified in Table 8.2 and Figure 8.2. The costs for the plant are all given in dollars for each installed kilowatt for a year's operation. But an installed kilowatt produces nothing unless the plant operates, and the data from the table plotted in the figure suggests that the cheapest operating costs for the coal and nuclear power plants are obtained when both are inoperative. The NRC has seemingly forgotten that ~~costs~~ some vary with the production from the plants. For a nuclear plant, the biggest variable cost is the investment cost, and it cannot be treated as a fixed production cost, as is shown in the table and figure. For a coal plant the biggest variable cost is fuel, as is properly shown. When the investment costs are treated as they should for both plants, as cost per unit of electrical production, as cents per kilowatt-hour, a very different picture emerges. In the table below are listed, for the coal and nuclear plants, the same of the data from Table 8.2, adjusted to represent electricity generation costs in cents per kilowatt-hour. Only corrected numbers are given. The only correction is made by multiplying both the "Investment Cost" and the "Total Operating Cost" by $\frac{100\text{¢}/\$}{8760\ \text{hours per year} \times \text{cap. factor}}$ for the "Investment Cost", and by the same factor without the capacity factor for the "Total Operating Costs." The capacity factor is left out of the latter factor since it is already included in the table.

Table 8.2
Corrected

Costs, ¢/kwhr	Nuclear Capacity factor 50	60	70	80	Coal Capacity factor 50	60	70	80
Investment Cost	2.45	2.05	1.75	1.53	1.59	1.33	1.14	1.00
Total Operating Cost	.36	.40	.45	.49	1.01	1.19	1.37	1.56
Sum	2.81	2.45	2.20	2.02	2.60	2.52	2.51	2.56

Clearly, a different picture emerges when the real cost of capital is considered. At a capacity factor of 50%, which is about the average for the large new nuclear power plants, a coal plant is better if only these costs are considered. For its Final Environmental Statements in the past the NRC has used generating costs in cents or mills per kilowatt hour (see, for instance, page B-78 of this Draft). One conclusion that can be drawn from this data is that the problem of nuclear power economics has deteriorated so far that the NRC must aid the utilities in misrepresenting their data to justify building nuclear power plants.

Furthermore, this analysis ignores two important items — the direction and magnitude of the listed variable operating and maintenance costs in Table 8.2. In the original FES, contained in the Draft as Appendix B, the total lifetime O and M costs are over twice as for a coal fired plant as for a nuclear plant (cf. Page B-70 of this Draft) in the text of the Draft, a factor of three is used. Yet to the best of my knowledge, experience in the industry has shown that O and M costs are at least as high, if not considerably higher for a nuclear plant because of the radiation

hazard for repair workers.

In addition, for any plant operating at a high capacity factor, variable O and M costs should be smaller than for one operating at a lower factor since, for base loaded plants, a reduced capacity factor is often related to increased unanticipated malfunctions, leading to increased variable O and M costs. This is the reverse of the NRC trend in Table 8.2.

Thank you for the opportunity to comment on this Draft FES. My comments would have arrived sooner had I received the Draft in August. Apparently there was a mix-up between the NRC, Post Office, and me as to my address.

Yours sincerely

Chauncey Kepford
Box 1093
Jackson, Wyo. 83001

UNITED STATES NUCLEAR REGULATORY COMMISSION

In the matter of   Docket No. 50-320

Metropolitan Edison Company
Jersey Central Power and Light Company
Pennsylvania Electric Company

Three Mile Island Nuclear Generating Station, Unit II

9/17/76

PETITION FOR INTERVENTION

The Environmental Coalition on Nuclear Power, an unincorporated organization of individuals and groups of individuals, on behalf of its members do hereby petition the U.S. Nuclear Regulatory Commission for leave to intervene in this proceeding. The authority for this request is granted in the Atomic Energy Act of 1954, as amended, Part 2.714 of Title 10 of the Code of Federal Regulations, and decisions 73-1776, 73-1867, 74-1385, and 74-1586 of the United States Court of Appeals for the District of Columbia.

1. The Environmental Coalition on Nuclear Power is a non-profit, public interest organization composed of individuals and groups of individuals who share a concern about the purpose, magnitude, and direction of the civilian nuclear power program. Members of the Coalition live in the vicinity of Three Mile Island, Unit II. The names of the co-executive directors, the authorized representative of the Coalition before the Commission, and five members who live within approximately 20 miles of Three Mile Island II are listed below.

1. Judith H. Johnsrud
   433 Orlando Drive, State College, Pennsylvania

2. George L. Boomsma
   R.D. 1, Peach Bottom, Pennsylvania

3. Chauncy Kepford, Authorized Representative before the Commission
   2576 Broad Street, York, Pennsylvania

4. Mary V. Southard
   3514 Walnut Street, Harrisburg, Pennsylvania

5. John J. Simon
   603 Cascade Road, Mechanicsburg, Pennsylvania

6. Linda (Mrs. Donald) Fortna
   R.D. 1, Dauphin, Pennsylvania

7. Chuck Gassert
   832 East Chocolate Ave., Hershey, Pennsylvania

8. Hans and Rhoda Hercher
   21 Westmont Bldg., Briarcrest Gardens, Hershey, PA 17033

The members who live in the neighborhood of Three Mile Island, Unit II feel that the operation of this facility poses an undue threat to their lives and material possessions. Due to the recent decisions of the United States Court of Appeals, District of Columbia Circuit, 73-1776, 73-1867, 74-1385, and 74-1586, these members, and the Coalition as a whole, feel the continued operation of Three Mile Island II is illegal because the construction permit for the facility was issued without proper consideration of the "alternative" of energy conservation, with its effect on the cost-benefit analysis, and without proper consideration of the yet unsolved, and possibly unsolvable problem of radioactive waste disposal. This petition is based on the contention that there are defects in the cost-benefit analysis used by the Applicant to justify construction and operation of Three Mile Island II and approved by the Commission.

2. The Petitioners (the Environmental Coalition on Nuclear Power and its members) contend that the cost-benefit analysis of the Applicant and the Commission is faulty because the recipients of the "costs" and "benefits" have not been properly identified. It is claimed that the sale of electricity by the Applicant constitutes the primary benefit of the facility, with the customers receiving the benefit and, therefore, being the beneficiaries of the plant.

No reading of a dictionary definition of either "benefit" or "beneficiary" can produce such a meaning as applied by the applicant or the Commission. The true beneficiaries of a nuclear power plant are stockholders who receive profits (if any) due to the plant's operation. Thus, the only true benefits from the operation of a nuclear power plant are the dividends paid out by a utility as a result of the operation of the power plant. Furthermore, the "costs" are underestimated by the refusal of the Applicant and the Commission to determine the actual radiation doses delivered to real people from the entire fuel cycle.

3. Petitioners contend that the stated costs of nuclear power by the Applicant and the Commission assume catastrophic accident-free operation of nuclear power plants. Such an assumption is at odds with the revised conclusions of "The Reactor Safety Study," WASH-1400, better known as the Rasmussen Report, and with Section 170(b) of the Atomic Energy Act. The U.S. Congress, with the passage of the 1975 amendments to the Price-Anderson Act, has acknowledged that there may be more than one nuclear accident requiring payments under the Price-Anderson Act in one year. Cost-benefit analysis of nuclear power plants should include the costs of accidents.

4. Petitioners contend that the cost-benefit analysis of the Applicant and the Commission assumes a virtually infinite supply of relatively low cost "yellow cake," or U_3O_8. In reality, the United States is now grossly over-committed as far as the "known" and "estimated" reserves of the U_3O_8 are concerned. The fuel requirements for the 238 nuclear reactors operable, being built, or planned (ERDA News Release, July 28, 1976) with a capacity of 237,000 MW(e) will require 1,159,000 tons of U_3O_8 for their 30-year lifetimes at a 0.55 capacity factor. The total estimated reserves of U_3O_8 are 640,000 tons of minable U_3O_8. (ERDA News Release, April 2, 1976).

Neither the Applicant nor the Commission has yet faced the problem of either very high U_3O_8 prices -- as $100 to $1,000 per pound of U_3O_8 -- or a simple unavailability of U_3O_8. Nor has the enormous environmental impact, net energy cost, and dollar cost of mining low grade coals, shales, granites, or even sea water for uranium been acknowledged by the Commission or the Applicant. Petitioners contend that availability of fuel and energy and environmental costs of its extraction are an integral part of the nuclear fuel cycle and therefore must be included in a full and proper cost-benefit analysis of this reactor.

5. The Petitioners contend that the rate structure of the Applicant is a promotional rate structure designed to increase the consumption of electricity by offering declining rates for increased consumption. Such a rate structure minimizes the possibility and practicality of worthwhile energy conservation efforts. Petitioners contend that a flat rate structure -- one price for all levels of consumption and for all customers -- or a declining block rate structure would make conservation a viable and practical alternative to Three Mile Island, Unit II.

6. The Petitioners contend that the Commission has been totally negligent in its handling of the problem of radioactive wastes in the granting of a construction permit for Three Mile Island II. As a result, it has been impossible to determine accurately the costs of electricity generated by nuclear plants because the costs of solidification of spent fuel reprocessing waste solutions and storage of solidified wastes were ignored or grossly underestimated. Estimates of the costs of solidifying and disposing of wastes from the Nuclear Fuel Services range from a low of $67,000 per year per 1000 MW(e) plant to $36,000,000 per year per 1000 MW(e) plant. (See "Alternative Processes for Managing Existing Commercial High-Level Radioactive Wastes," NUREG-0043.) While the $67,000 figure may represent an insignificant addition to the annual

reactor operation costs, the $36,000,000 could easily double the annual operating costs. If past experience for estimating costs by the AEC/NRC can serve as a guide, the high figure may prove to be the low. Such costs should be included in the cost-benefit analysis.

7. Petitioners contend that the cost-benefit analysis of Three Mile Island II has been biased in favor of nuclear power by greatly underestimating spent fuel reprocessing costs and by the Commission offering a credit for recovered plutonium. Since there has not yet been any successful, economical, and complete reprocessing of reactor wastes to the solid stage, costs must be largely unknown. Since the recycling of plutonium is not presently a commercial reality, the offering of a plutonium credit for yet unrecovered plutonium which may not be recycled is premature.

8. Petitioners therefore contend that, due to the above unresolved issues regarding compliance with Sec. 102 of the National Environmental Policy Act by the Commission, the construction permit for Three Mile Island, Unit II should be rescinded immediately, and construction halted pending resumption of public hearings and resolution of these matters.

9. Petitioners further request the Commission to grant financial assistance to the intervenors under the authority of Sec. 102 of the National Environmental Policy Act. Petitioners have made similar requests in the past, and have met with only denial or delay. Petitioners call the attention of the Commission to the recent court decision, York Committee for a Safe Environment, et. al., vs. Nuclear Regulator Commission, No. 74-1923, and the comments therein regarding public interest litigants. Petitioners request the amount necessary in order to meet legal, technical, and procedural expenses otherwise not available.

Met-Ed POWER FOR PROGRESS

ETROPOLITAN EDISON COMPANY SUBSIDIARY OF GENERAL PUBLIC UTILITIES CORPORATION

FICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

September 13, 1976
GQL 1295

RECEIVED SEP 15 1976 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

Director of Nuclear Reactor Regulation
Attn: Mr. W. H. Regan, Jr.
Environmental Projects Branch No. 3
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Gentlemen:

SUBJECT: THREE MILE ISLAND NUCLEAR STATION
UNIT 2
DOCKET NUMBER 50-320

Enclosed please find comments on the Commission's Draft Environmental Statement for Three Mile Island Nuclear Station Unit 2.

The enclosed responses to the Draft Environmental Statement summarizes Metropolitan Edison's position with regard to the issues raised in that document, generally describes alterations to Environmental Monitoring Program or procedure that will be implemented and gives detailed comments on the DES.

We would be pleased to discuss any of these matters with your staff should the need arise.

Very truly yours,

R. C. Arnold
Vice President

asb
Enclosure

9410

APPLICANT'S COMMENTS

on the

NUCLEAR REGULATORY COMMISSIONS'

Draft Supplement to the Final

Environmental Statement

RELATED TO THE OPERATION OF

THREE MILE ISLAND NUCLEAR STATION, UNIT 2

DOCKET NO. 50-320

September, 1976

COMMENT 1

Summary and Conclusions (Page iii, Item 6.b.(4))

Quotation: *"If it is necessary to chlorinate at the permitted level, the monitoring program shall include sampling to map the distribution of chlorine in the river."*

Comment:

It is the Applicant's understanding that this proposed licensing condition requires the sampling to map the distribution of chlorine within the river only if it is necessary to chlorinate at the permitted level. Permitted level, as stated in this proposed licensing condition, is understood by the Applicant to mean the Three Mile Island Nuclear Station (TMINS) NPDES permit level which are 0.2 ppm average and 0.5 ppm maximum free available chlorine.

TMI-1 is limited by its Environmental Technical Specifications to 0.2 ppm total residual chlorine and 0.1 ppm free available chlorine concentration at the point of discharge to the river. Presently, the Applicant does not plan to discharge in excess of these limits at TMI-1, nor is it anticipated that these limits will be exceeded when TMI-2 becomes operational. However, if at some future time it is necessary to chlorinate at the NPDES permit level in order to assure adequate defouling, the Applicant will notify the staff and will sample the discharge plume in an attempt to map the distribution of chlorine in excess of the .05 mg/l value recommended to protect aquatic life defined on page 5-3 of the Draft Supplement to the Final Environmental Statement.

COMMENT 2

2.2.3 *Water Use* (Page 2-2, Table 2.3)

Comment:

Table 2.2 indicates that the York Haven Power Company's Hydroelectric Generating Plant and Brunner Island Steam-Electric Generation Station is less than one mile downstream from the Three Mile Island Nuclear Generating Station. The York Haven Hydroelectric Generating Station and the Brunner Island Steam-Electric Generating Station are approximately three and four miles, respectively, downstream from Three Mile Island Nuclear Station.

COMMENT 3

2.4.3 *Water Quality* (Page 2-5)

Comment:

The Applicant suggests that the staff mention in this section of the report the Fe values in the river often exceed 1.5 mg/l and on occasion river pH values are greater than 8.5, which are Pennsylvania water quality criteria limits applicable to that portion of the Susquehanna River in the vicinity of TMINS. These high values are attributed to upstream surface water runoff. Ambient values in excess of these water quality criteria limits have been reported in the Applicant's 1974 and 1975 annual reports.

COMMENT 4

2.6.2.3 Ichthyoplankton (Page 2-10, Line 1)

Quotation: *"Ichthyoplankton was sampled by pumping every two weeks. . ."*

Comment:

Ichthyoplankton samples were not collected every two weeks as the Draft Environmental Statement states, but were sampled semi-monthly (twice a month).

COMMENT 5

3.3.3.1 Demineralizer Regeneration Solutions and
3.3.3.2 Condensate Polisher Regeneration Solutions (Page 3-9)

Comment:

Both 3.3.3.1 and 3.3.3.2 refer to batch neutralization of regenerant waste from both make-up water demineralizers and the condensate polishing system. The TMI-2 system is designed for automatic neutralization and continual discharge, however, the system is capable of batch neutralization if the need arises.

COMMENT 6

4.4 Effects on Ecological Systems, Construction of Transmission Lines (Page 4-3, Paragraph 5)

Quotation: *"The seeding program for the corridor appears to have been effective in most places. There were a few locations noted which may need further attention to establish a reasonable ground cover and prevent erosion. These areas should be adequately controlled under the transmission line monitoring program suggested in Section 6.5."*

Comment:

The Applicant agrees with the staff's suggestion on a transmission line monitoring program in Section 6.5, Terrestrial Monitoring Programs. Once each year, during normal transmission line inspection, areas that need additional attention to adequately control erosion attributed to transmission line construction will be noted. With the landowner's permission, areas will then be revegetated (or other actions taken) in order to control excessive erosion. As suggested by the staff, a brief report of any such area and confirmation of action to remedy the condition will accompany the annual report.

COMMENT 7

4.4 Effects on Ecological System, Construction of Transmission Lines (Page 4-3, Paragraph 6)

Quotation: *"The only impact noted by the staff is the former Bechtelsville substation. Construction of this substation had proceeded to the point that many concrete structures had been placed on the site before the construction was suspended. If this area is not to be used for construction, it should be promptly returned to some form of vegetative cover."*

Comment:

The site of the former Bechtelsville substation is no longer owned by the Applicant. The site has been sold in a condition which was acceptable to the buyer for his needs.

COMMENT 8

Construction of Transmission Lines (DES Page 4-3, Paragraph 1)

Quotation: *"The crossing of Route 29 occurs adjacent to a farm dealership establishment. Farm implements of various types appear to be routinely parked beneath the line. Major buildings are located some distance from the line. Before this line becomes operational, the Applicant should inform the owner of this business establishment of the hazards due to minor shocks from induced voltages on this equipment and of any precautions which would be taken to minimize such hazards (see also discussion in Section 5.2.2). After the lines become energized, field measurements should be taken to establish the actual potential for such occurrences."*

Comment:

As the staff suggests, the Applicant will inform the owner of the farm equipment dealership, prior to the operation of this line, of possible electrostatic effects and precautions that can be taken to minimize such effects. The Applicant will also take field measurements at this location once the line becomes energized to identify the potential for such occurrences. These actions are consistent with the Applicant's normal practices.

COMMENT 9

4.4 *Effects on Ecological System, Construction of the Transmission Lines (Page 4-4, Paragraph 2)*

Quotation: *"It should be noted, however, that the avoidable impact of the abandoned Bechtelsville substation can and should be mitigated. The occasional vegetation control and seeding activities should be continued in an attempt to maintain the low level of impact of this line."*

Comment:

See comments 6 and 7.

COMMENT 10

5.2.2 *Transmission Lines* (Page 5-1, Paragraph 11)

Quotation: *"The Applicant has committed to: (a) grounding transmission towers, (b) grounding fences which run both parallel and transverse to the right of way."*

Comment:

The Applicant has not committed to the above, however, the Applicant has grounded all transmission towers and will ground fences where electrostatic induction hazards exist.

COMMENT 11

5.3.3 *Water Quality Standards and Effluent Limitations* (Page 5-5, Top of Page)

Quotation: *"If it is necessary to operate at the permitted level of chlorination, then the Applicant should monitor total residuals in the river to determine the extent of the region in which concentrations exceed the value recommended to protect aquatic life."*

Comment:

See comment 1.

COMMENT 12

5.4.1.3 *Dose Commitments from Radioactive Liquid Releases to the Hydrosphere (Page 5-8, Top of Page)*

Comment:

This section of the Draft Supplement to the Final Environmental Statement gives reference to a tritium discussion in Appendix C that applies to all tritium sources from the plant. No Appendix C was included as part of this report. The Applicant wishes to reserve the right to comment on this tritium discussion prior to its inclusion in the Final Supplement Environmental Statement.

COMMENT 13

5.5.2.1 *Intake Effects, Impingement of Fishes* (Page 5-14, Line 3)

Quotation: *"Impingement monitoring every two weeks. . ."*

Comment:

Impingement monitoring was conducted semi-monthly (twice a month), not every two weeks.

COMMENT 14

5.5.2.2 *Station Passage Effects, Chemical Discharge* (Page 5-16, Paragraph 1)

Quotation: *"If it is necessary to chlorinate at the permitted level, then the area in which toxic conditions are created should be at the most a few thousand square feet. The staff does not expect this to have a significant adverse impact on the local fishery resources from chlorine discharges. However, the staff will require that the operational monitoring program include sampling to map the distribution of chlorine in the river if discharge at the permitted level is necessary."*

Comment:

See comment 1.

COMMENT 15

6.3 Meteorological Program
6.3.1 Preoperational Onsite Meteorological Program (Page 6-1, Paragraph 3)

Quotation: *"The present wind speed and direction measuring instrument installed at the 150-ft level does not meet the instrument specification recommended in Regulatory Guide 1.23."*

Comment:

The instrumentation at the 150 foot level (aerovane) was not part of the nuclear meteorological program and, therefore, did not fall within the scope of recommended instrument specifications of Regulatory Guide 1.23.

COMMENT 16

6.4 Aquatic Biological Monitoring Program (Page 6-2, Paragraph 2)

Quotation: *"The staff recommends that the present Unit 1 monitoring program should be continued as the operational evaluation program for Unit 2 with the exception of the phytoplankton and zooplankton entrainment studies which may be terminated. The reasons for termination of planktonic studies are discussed in Section 5.5.2.2. It is also suggested that after staff evaluation of the 1975 monitoring results, at the time of preparation of the Environmental Technical Specifications for Unit 2, that all biological monitoring programs be evaluated by the staff and applicants for appropriateness at the TMINS. The results of this reevaluation will be incorporated in the Technical Specifications prior to issuance of the operating license."*

Comment:

The Applicant agrees with the staff's evaluation of the present Unit 1 aquatic biological monitoring programs and will continue these programs with the exception of the phytoplankton and zooplankton entrainment studies as recommended by the staff to evaluate the operational impact of TMI-2. The Applicant also agrees with the staff's suggestion of reevaluating all biological monitoring programs for their appropriateness at TMINS, by the staff and the Applicant, for incorporation of changes in the proposed station Environmental Technical Specifications.

-6-

COMMENT 17

6.5 Terrestrial Monitoring Programs (Page 6-2, Paragraph 4)

Quotation: *"The staff concludes that the operational programs for Unit 1 should be continued for two years after start-up of Unit 2 (termination contingent on staff review and approval) with the exception of the bird impaction program which may be terminated. In place of the bird impaction program, a provision should be adopted requiring analysis and report for staff review within thirty days of any occurrence of impaction in excess of 100 events per day. A low altitude true and false color aerial photography program should be implemented for correlation with the vegetational surveys. This will provide the basis for a long-term evaluation of any adverse terrestrial effects.*

Comment:

The Applicant agrees with the staff that the operational terrestrial monitoring program for Unit 1 be continued for two years after the start up of Unit 2 with the exception of the bird impaction program. However, the Applicant suggests that the reporting provision to replace the bird impaction program be reworded so not to give reference to a specific number of events (number of birds impacted) per day. By referencing a specific number of events per day, the Applicant would have to perform a bird impaction survey every day to determine whether the number in the provision was exceeded. Therefore, if a specific number of events per day is referenced, the staff would not be terminating, but increasing the scope of the bird impaction program. The Applicant suggests that the sentence in the above quotation from the DES in relation to this provision be changed to read as follows:

> "In place of the bird impaction program, a provision should be adopted requiring analysis and report for staff review within thirty days of any abnormal occurrence of cooling tower bird impaction."

It is the Applicant's understanding from conversation with the staff that a low altitude true and false color (infrared) aerial photography program, if implemented, would take the place of the plant pathology transect and quantitative vegetation analysis programs that the Applicant presently conducts. The Applicant understands the many advantages of implementing such a program and, therefore, agrees with the staff's suggestion. Although details of this study have not been finalized, it is the Applicant's understanding that the program will begin during 1977 and continue for two years after Unit 2 start up. It is estimated that the study area will cover approximately a two-mile radius around the TMINS site and consist of one or two overflights per year that will be verified by ground truth surveys (one for each overflight) along selected transects within the study area.

-7-

COMMENT 18

6.5 *Terrestrial Monitoring Programs* (Page 6-2, Paragraph 5)

Quotation: "*The staff also recommends that once each year, during normal transmission line inspections, notations be made of any areas which may require reseeding. A brief report of any such areas and confirmation of action to remedy the condition should accompany the annual report.*"

Comment:

See comment 6.

COMMENT 19

Figure 6.2 (Page 6-4)

Comment:

In Figure 6.2, station number 11 should be listed under Seine Stations. The figure represents sampling locations only applicable to 1974. The figure title, therefore, should be changed to read: "Trapnet and Seine Stations Sampled in the Vicinity of TMINS during 1974".

COMMENT 20

6.6 *Radiological Environmental Monitoring*
6.6.1 *Preoperational Program* (Page 6-9)

Comment:

Item 1 and 2

The Applicant has an air particulate sampling station in the Falmouth community and will perform analyses of quarterly composite air samples for Sr-89 and Sr-90. An iodine sampler will also be located at the Falmouth station as suggested by the staff.

Item 3

As suggested by the staff, the Applicant will institute a soil sampling program in prevailing downwind sectors to monitor long term build-up to replace the precipitation sampling program.

Item 4

The Applicant will install a composite sampler as suggested by the staff at the York Haven Hydroelectric Station to replace grab samples presently taken at the TMI end of York Haven dam and the west shore of TMI.

Item 5

The Applicant will comply with the staff's recommendation that milk samples collected at the location with the highest X/Q should be taken at least semi-monthly during the grazing season, each sample measured for I-131 and monthly composites measured for Sr-89, Sr-90, and gamma scanned.

Item 6

The Applicant will comply with the staff's suggestion of sampling one recreationally important fish species in the monitoring program. No commercially important fish species exist in the TMINS vicinity.

Item 7

The Applicant agrees with the staff that fruits should be part of the vegetation sampling program and will sample fruits in the future. However, tuberous and root vegetables are not a significant pathway in the TMINS vicinity and, therefore, the Applicant should not be required to sample these vegetables.

Item 8

The Applicant is presently sampling deer, the major source of supplemental protein in the TMINS vicinity. A deer is collected and sampled from road kills that occur in the vicinity of the site. This sampling is conducted at indicator and background distances from the site on an annual basis. The Applicant should not be required to sample poultry and eggs, for it is not a significant pathway in the TMINS vicinity. A study conducted by the Applicant's consultant showed that 91% of the feed consumed by poultry, for both meat and eggs, in the vicinity of TMINS, is imported from outside the area.

Item 9

The Applicant will eliminate the use of "sensitivity" in favor of the "lower level of detection" (LLD) terminology suggested by the NRC. In addition, a table of LLD's similar to that used in Regulatory Guide 4.8 will be developed for each radionuclide in the analyses performed. The Applicant recommends the use of the LLD proposed by the National Bureau of Standards of 3σ background as opposed to the NRC LLD of 4.66σ background. The National Bureau of Standard's number is recognized by industry and the Applicant. It is the Applicant's opinion that the NRC number is too costly for the minimum additional benefit gained.

Item 10

The Applicant agrees with the staff and will increase the sensitivity of the tritium analyses for water samples as proposed by draft Regulatory Guide 4.8 (December, 1975).

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 76/718

50-320 SEP 15 1976

RECEIVED SEP 17 1976

Dear Mr. Regan:

Thank you for your letter of July 22, 1976, requesting our comments on the draft supplement to the final environmental statement related to the operation of the Three Mile Island Nuclear Station, Unit 2, Dauphin County, Pennsylvania.

Our comments are submitted according to the format of the statement or by subject.

Historical Sites

To update compliance with the National Historic Preservation Act of 1966 and Executive Order 11593, the State Historic Preservation Officer should be requested to furnish an evaluation as to whether any sites now on or currently eligible for inclusion on the National Register of Historic Places will be affected by the proposed project. If so, review and comment must be requested from the Advisory Council on Historic Preservation. The Advisory Council on Historic Preservation should be requested to review and comment in relation to effects on St. Peter's Church.

Outdoor Recreation

The draft supplement does not contain any additional information relative to outdoor recreation interests. Our comments on the draft statement, page B-89 under Land Use, relative to outdoor recreation, still apply.

As a follow-up to the recommendations made, the regional office of the Bureau of Outdoor Recreation contacted the applicant to inquire about the current status of the proposed recreation development plans for Three Mile Island. It was learned that construction of the power facility is scheduled for completion by the end of 1977, at which time recreation development will commence. The need was expressed to the applicant to begin initiating coordination with all interested parties in order to facilitate timely implementation of the recreation plan.

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Aquatic Impacts

According to Sections 5.5.2.2 and 5.5.2.3, chemical and thermal discharges from the plant are not expected to have significant adverse effects on aquatic life. It is difficult to reconcile these statements with the fact that fish kills occurred during the spring of 1974 and 1975 along the western side of Three Mile Island downstream from the plant. Sunfishes, smallmouth bass, and channel catfish were affected. Location of the kills suggests they were attributable to the plant's thermal and chemical discharges. The relationship of these fish kills to the plant operations should be assessed.

Radioactive Wastes

In response to an earlier comment on radioactive waste disposal sites, the final statement, page B-75, indicated that all details concerning shipping points for spent fuel and solid radwastes will be completed before plant operation. We wish to emphasize that our question, page B-90, concerned disposal sites and their environmental assessment and not shipping points. In any case, now that Unit 1 is operating, the completed details should have included identification and environmental assessment of solid radioactive waste disposal sites. This is not evident, however, from the draft supplement, which contains no information on disposal sites.

The management of low- and high-level wastes is mentioned on pages 5-12 and 5-13, by reference to Table 5.5 extracted from 10 CFR 51. However, this table contains no information on specific disposal sites, does not include solid wastes produced at the reactor, and does not mention high-level wastes.

Solid wastes, other than high-level, are mentioned in the final statement, page B-30, but the radiological quantities involved are not given. The supplement should indicate quantities, identify disposal sites, and assess the environmental suitability of the sites. Similarly, the quantity of high-level wastes arising from the reactor operation and an assessment of the proposed disposal method and site should be discussed.

Decommissioning and Land Use

The 1972 draft statement, page B-90, noted the lack of plans for the eventual decommissioning of the reactor. New information on such plans of a very general nature is provided in the draft supplement, pages 9-3 and 9-4; however, there is no attempt to assess the environmental problems that would remain at the site or at disposal sites elsewhere. The major concern is the radioactive materials left at the site, even if buried. Three Mile Island is subject to overflow during Susquehanna River floods as indicated on page 2-5, and any plans to dispose of long-lived radioactive materials at the site would require the most stringent environmental analysis. Such an analysis is lacking in the draft supplement. Since there are no firm plans, one is left with the impression on page 9-4 that massive equipment and structures that are radioactively contaminated are likely to be left on the island. In the absence of a commitment to remove all radioactive materials from the island, the scope of the radioactivity which may be left behind and the ensuing environmental considerations should be discussed in reasonable detail in the final supplement.

Environmental Effects of Accidents

The additional information on severe accidents in the draft supplement, page 7-5, consists of a reference to the Rasmussen Reactor Safety Study (WASH 1400). This still does not provide an evaluation of the consequence on the Susquehanna River, the lack of which was noted in our earlier comments on page B-90, C-19. The Rasmussen study evaluated the probability of accidents that result in the melting of the radioactive fuel (the core) in the reactor. The molten fuel would then generate heat sufficient to melt through the base of the containment building and into the ground for a distance of from 10 to 50 feet (WASH 1400, p. VIII-13, par. 1).

In response to comments on the draft of WASH-1400, the final Reactor Safety Study includes a generalized evaluation of consequences of a core melt-through to a nearby river (WASH 1400, p. XI 10-1). The peak concentration for strontium-90 in ground water reaching the river is given as 23 times greater than the maximum permissible concentration. Elsewhere in the report, however, this peak concentration is shown to be 2,300 times greater than maximum permissible (WASH 1400, p. VII 47, table VII 3-10). More importantly, the river

evaluation fails to mention another strontium-90 contribution, due to liquids and gases from the containment structure, which would result in peak concentrations 2,300,000 times the maximum permissible (WASH 1400, p. VII-47, table VII 3-9). Dilution at median flow, 20,000 cfs, would then result in the Susquehanna River having a strontium-90 concentration 15 times greater than the maximum permissible, and at minimum flow 175 times greater.

It should be emphasized that the evaluations from which these numbers were drawn were based on a generalized site having different conditions than the Three Mile Island site. A study of the consequences at the Three Mile Island site might show greater or lesser consequences. Such a study should be made. It should also evaluate the long-term effectiveness of potential mitigating measures.

It is indicated on pages 6-9 to 6-11, that ground water will be monitored and the hydrological situation suggests that river monitoring should ultimately intercept contaminants moving through the aquifer(s). We suggest, however, that in the event of any accidental release the delay in movement of a contaminant through the aquifer(s) and probable paths to the river should be considered in sampling.

We hope these comments will be helpful to you.

Sincerely yours,

Stanley D. Doremus

Deputy Assistant Secretary of the Interior

Mr. William H. Regan, Jr.
Chief, Environmental Projects Branch 3
Division of Site Safety and Environmental Analysis
Nuclear Regulatory Commission
Washington, D. C. 20555

SUSQUEHANNA RIVER BASIN COMMISSION
5012 Lenker Street • Mechanicsburg, Pennsylvania 17055

From the Office of the
Executive Director

September 21, 1976

Mr. William H. Reagan, Jr., Chief
Environmental Projects - Branch 3
Div. of Site Safety & Env. Analysis
U.S. Nuclear Regulatory Commission
1717 "H" Street, NW
Washington, DC 20555

In re: Docket No. 50-320 -- Three Mile Island
Nuclear Power Plant, Pennsylvania

Dear Mr. Reagan:

This is in reply to your letter of July 22, 1976, transmitting a draft supplement to the final environmental impact statement on the referenced project. As you are aware from our earlier telephone conversations with you and other members of your staff, this staff reply has been pending until there was an opportunity to bring the matter formally before our Commissioners for their attention and action at our September 14, 1976 meeting.

The proposed administrative action by the Nuclear Regulatory Commission necessitating an EIS relates to the continuation of a construction permit and the issuance of an operating license to Metropolitan Edison Company, Jersey Central Power and Light Company, and the Philadelphia Electric Company (the applicants) for the operation of the Three Mile Island Nuclear Station, Unit #2, near Harrisburg in Dauphin County, Pennsylvania. The facility is comprised of two reactors with Unit #1 having been on-line since 1974. Unit #2 is scheduled for service in 1978. While the draft supplement EIS is only for impacts from Unit #2, the thrust and focus of our comments are directed toward the entire facility.

The first issue that concerns this agency is to state our intention to exercise the regulatory authority and powers granted to the Susquehanna River Basin Commission concerning all projects located within the Susquehanna River basin. Therefore, the Commission will review this project for the purposes of controlling withdrawals and diversions from surface waters of the basin such as now exists and/or is being proposed for the project so that all basin water user interests are assured ade-

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quate supplies of water for present and future needs. Toward that river basin management goal, you should be aware of ongoing activity by this Commission as regards recently adopted regulations that establish requirements and procedures for compensation for consumptive withdrawals of basin water resources during low flow periods. The Three Mile Island project will be affected by the regulations. (Copy attached) It is the intention of this Commission to apply these regulations to the project (both units). The findings of our review, in terms of impact on surface stream flow conditions due to consumptive withdrawals, will determine the appropriate operational conditions for issuance of a permit by this agency.

With regard to the technical content of the supplemental EIS on the project for Unit #2, staff review focuses on two areas:

1) water consumption; and
2) the adequacy of flood protection.

Concerning consumptive withdrawals for water for cooling purposes, part of the problem has been discussed already relative to Commission regulations requiring compensation for consumptive uses during low flow periods. Additionally, the EIS suggests that ample flows of water are available for project operation (in Sections 5 and 9). However, there is no determination about the impact of the project's consumptive loss of 44 cfs or relationships to the cumulative impact or synergisms with other consumptive withdrawals, particularly at and during low river flow periods.

Available data indicates the project's detrimental impact is "minimal" during "average" conditions. An effective evaluation should be made of the project's impact on the river, related aquatic ecosystems and other water resource users during critical or system stress situations such as during river low flow periods.

Part of Section 9 (5.2) could be interpreted to mean that the SRBC has already allocated water for power production by the project. This is not yet the case as indicated earlier wherein we stated that the Commission will exercise its regulatory authority and review the project in the near future. It should be noted that the Commission's Comprehensive Plan states that "Domestic water supply purposes shall have priority for surface and groundwater sources" (Guideline #16). Therefore, any potential misconception related to these issues should be clarified appropriately in the EIS.

Under the topic of flood protection for the project, staff review concerns the adequacy or sufficiency of the levee scheme, lack of detail within the EIS on the flood protection system, and facility and operational safety procedures in the event of flooding which exceeds the design capacity of the levee system intended to protect the project. The levee flood protection scheme for this project is designed against a recurrence of the Agnes-type flood or a discharge of about 1,100,000 cfs. This flood has a recurrence interval of about 300 years. For a facility of this type it might be advisable to consider providing flood protection against the maximum probable flood (1,625,000 cfs) which other information suggests that the NRC requires now in the Tennessee Valley. The Final Safety Analysis Report on the project assumes that "the (levee) freeboard is ample". There is no indication however, of what problems would result from floods exceeding the levee design.

The rationale for the flood protection scheme seems somewhat weak in the statements referring to the infrequent affect that hurricanes and tropical storms would have on the project site. Considering that five hurricanes have passed through Southcentral Pennsylvania during the past eighty years, each could have affected the site.

Regardless of the probability of occurrence of hurricanes or frequency of floods of certain magnitude, the EIS should contain more detail on the flood protection scheme, the waterproofing system, and shutdown procedures in the event of a major flood.

We appreciate your cooperation and coordinative efforts concerning our interests on this project.

Very truly yours,

Robert J. Bielo
Executive Director

Attachment

TITLE 18 - CONSERVATION OF POWER AND WATER RESOURCES

CHAPTER VIII
SUSQUEHANNA RIVER BASIN COMMISSION

PART 803 - REVIEW OF PROJECTS
CONSUMPTIVE USES OF WATER

The Commission is charged with the responsibility for overall management of the water and related resources of the Susquehanna River Basin. A Comprehensive Plan to coordinate, direct and review public and private planning, management, use and development of the water resources of the basin was issued as required by the Susquehanna River Basin Compact. The Plan identifies objectives and goals for all program areas of water use and management and is designed to provide for the optimum use or combination of uses of the basin's water resources in an effort to meet all foreseeable immediate and long-range demands in an efficient and timely manner.

Guidelines and criteria as presented in the Plan are management principles that the Commission had determined to be necessary to achieve optimum utilization of the water resources. The guidelines and criteria are included in the Plan to be used to evaluate proposed projects and programs. Review and approval of proposed projects in the basin by the Commission as required by Compact Section 3.10 will assure implementation of these water management principles.

The regulation amplifies one of these Guidelines - Guideline 13 which states that "Compensation shall be required for consumptive uses during periods of low flow". An understanding of the Commission's intention with respect to Guideline 13 will facilitate planning by future consumptive users.

On June 4, 1976, these proposed rules appeared in the FEDERAL REGISTER (41 FR 22598). Comments were received at four public hearings and by letters. The final date for submission of comments was August 16, 1976.

In consideration of the foregoing and all comments received, 18 CFR 803 is amended to read as follows:

Subpart D - Standards for Review

803.60 Purpose of this Subpart

803.61 Consumptive Uses of Water

Authority: Sec. 3.4, 3.10 and 15.2, Pub.L. 91-575 (84 Stat. 1509 et seq.)

1. By revising paragraph (a)(2) of §803.3 to read as follows:

§803.3 Projects requiring applications.

* * * *

(a)(2) Any project involving either the consumptive use of water (as described in §803.61), or the transfer of water into or from the basin.

2. By revising paragraph (a)(2) of §803.4 to read as follows:

§803.4 Projects requiring review.

* * * *

(a)(2) Any project involving either the consumptive use of water (as described in §803.61), or the transfer of water into or from the basin.

3. By adding a new subpart to Part 803 to read as follows:

<u>Subpart D - Standards for Review</u>

§803.60 Purpose of this subpart.

The purpose of this subpart is to set forth standards that shall be used by the Commission to evaluate proposed projects pursuant to its authority detailed in sections 803.1 to 803.6. This subpart does not identify all the aspects of a proposed project that will be evaluated. Nor should it be construed as a self-imposed limitation upon the Commission's authority and scope of review. These standards shall be used for review of projects in conjunction with and in addition to the Compact, Comprehensive Plan, Water Resources Program, and appropriate regulations.

§803.61 Consumptive Uses of Water

(a) <u>Definitions</u>. For purposes of this section the words listed below are defined as follows:

(1) Consumptive Use. Water withdrawn from its source, via a man-made conveyance system, but not directly returned thereto making it unavailable for other water users.

(2) Dedicated Augmentation. Release from an upstream storage facility which is intended for another instream or withdrawal use.

(b) Requirement. (1) Compensation shall be required for consumptive uses of water during periods of low flow. Compensation is required during periods of low flow for the purposes of protection of public health; stream quality control; economic development; protection of fisheries; recreation; dilution and abatement of pollution; the prevention of undue salinity; protection of the Chesapeake Bay; and other purposes as determined by the Commission.

(2) Consumptive uses by a project not exceeding 20,000 gpd from a total withdrawal of less than 100,000 gpd from surface or groundwaters are exempt from the requirement unless such uses adversely effect the purposes outlined in (1).

(c) Method of Compensation. (1) Methods of compensation acceptable to the Commission will depend upon the character of the project's source of water supply and other factors noted below.

(i) Stream source. Compensation in an amount equal to the project's total consumptive use shall be required when the stream flow at the point of taking equals or is anticipated to equal the low flow criterion which is the 7-day 10-year low flow plus the project's total consumptive use and dedicated augmentation. The Commission reserves the right to apply a higher low flow criterion for a particular stream reach when it finds, as the result of evidence presented at a public hearing, that it is needed to serve the purposes outlined in (b)(1).

(ii) Groundwater source. Compensation shall be required for consumptive use from aquifers hydraulically related to stream flows when the stream flow is less than the applicable low flow criterion. For the purposes of implementing this regulation, withdrawals from limestone or unconsolidated alluvial aquifers shall be considered hydraulically related to surface stream flows.

(iii) The required amount of compensation shall be provided by the applicant or project sponsor at the point of taking or another appropriate site if satisfactory evidence is presented that the purposes outlined in (b)(1) are not adversely affected thereby. If compensation is to be provided upstream from the point of taking such compensation shall maintain the flow downstream from the point of taking in the amount which would exist naturally, plus any other dedicated augmentation, were there no consumptive use by the project and no replacement therefor. Compensation may be provided by one, or a combination of the following:

a. Construction or acquisition of storage facilities.

b. Purchase of available water supply storage in existing public or private storage facilities, or in public or private facilities scheduled for completion prior to completion of the applicant's project.

c. Purchase of water to be released as required from a water purveyor.

d. Releases from an existing facility owned and operated by the applicant.

e. Other alternatives.

(2) Alternatives to compensation may be appropriate such as discontinuance of that part of the project's operation that consumes water, imposition of conservation measures, or utilization of an alternative source that is unaffected by the compensation requirement.

(3) The Commission shall, in its sole discretion, determine the acceptable alternatives to or manner of compensation for consumptive uses by a project. Such a determination will be made after considering the project location, anticipated amount of consumptive use and its effect on the purposes set forth in (b)(1), and any other pertinent factors.

(d) Quantity of Consumptive Use. For purposes of evaluating a proposed project the Commission shall require estimates of anticipated consumptive use from the project sponsor.

The Commission, as part of the project review, shall evaluate the proposed methodology for monitoring consumptive losses and compensating flows including flow metering devices, stream gages, and other facilities used to measure the consumptive use of the project or the rate of streamflow. If the Commission determines that additional flow measuring devices are required these shall be provided at the expense of the applicant and shall be subject to inspection by the Commission at any time.

When the project is operational, the project sponsor shall be responsible for determining when compensation is required and shall notify the Commission immediately when compensation releases commence and cease. The project sponsor shall provide the Commission with periodic reports in the time and manner as it requires showing actual consumptive uses associated with the project. The Commission may use this data to modify, as appropriate, the magnitude and timing of the compensating releases initially required when the project was approved.

(e) Quality of Compensation Water. The physical, chemical and biological quality of water used for compensation shall at all times meet the quality requirements for the purposes listed in (b)(1), as applicable.

(f) Effective Date. This section shall apply to all consumptive uses initiated since January 23, 1971. Any project that has initiated consumptive use after the effective date is subject to this requirement. Such users or projects which will begin consumptive uses in the near future must comply

with the requirement within a time period to be set by the Commission for individual projects.

Dated: September 14, 1976

Robert J. Bielo, Executive Director
Susquehanna River Basin Commission

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
6TH AND WALNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

OCT 18 1976

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Mr. Harold Denton
Director
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Denton:

The Environmental Protection Agency has reviewed the U.S. Nuclear Regulatory Commission's Draft Environmental Impact Statement issued July 22, 1976, in conjunction with the application of Metropolitan Edison Company for a license for the start up and operation of Three Mile Island Nuclear Station. Our detailed comments are enclosed.

The Draft Environmental Impact Statement did not adequately discuss:

1. radiological dose assessments including estimates of the expected radiation dose to representative individuals in the surrounding population;

2. the potential impact of the radioactive gaseous and liquid discharges from both Units No. 1 and No. 2; and,

3. state thermal standards and the manner and location they will be applied pursuant to Section 97.82 a. and b. of the Pennsylvania State Water Law.

EPA is reviewing its positions on high-level waste management and related aspects of the fuel cycle in light of the recent decisions of the U.S. Court of Appeals for the District of Columbia with respect to Vermont, Yankee and Midland nuclear power plants. Therefore comments on high-level waste management issues do not appear in this review.

In view of the above and in accordance with our procedures, we have classified the project "ER" (Environmental Reservations) and have rated the Draft Environmental Impact Statement "Category 2" (Insufficient Information). If you have any questions concerning our classification or comments, we will be happy to discuss them with you.

Sincerely,

Daniel J. Snyder, III
Regional Administrator

Enclosure

DS-NRC-D-AC0059-PA

ENVIRONMENTAL PROTECTION AGENCY

REGION III

Philadelphia, Pa.

September, 1976

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

THREE MILE ISLAND NUCLEAR STATION

UNIT NO. 2

TABLE OF CONTENTS

I. INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency has reviewed the Nuclear Regulatory Commission's Draft Environmental Impact Statement issued July 22, 1976, in conjunction with the application of Metropolitan Edison Company for permit to continue construction and a license for the start up and operation of Three Mile Island Nuclear Station (TMINS) Unit No. 2. The plant is located on an island in the Susquehanna River in Dauphin County, Pennsylvania near Harrisburg. TMINS Unit No. 2 will produce up to 2800 megawatts thermal and will dissipate 1813 MW(t) as waste heat using a natural draft tower in a closed cycle cooling system. Make-up water for this system will be taken from the Susquehanna River. Blowdown and discharge of other liquid effluents from Unit No. 2 will be mixed with those from Unit No. 1 and discharged to the Susquehanna River. The following are our major conclusions.

The proposed gaseous and liquid treatment systems appear to represent "state-of-the-art" radiological effluent control technology, and we believe the facility can be operated with radioactivity releases consistent with Nuclear Regulatory Commission's low as practical releases - 10 CFR Part 50. However, the draft statement contains several deficiencies in the dose assessment analysis which should be corrected in the final statement. These include: a.) the omission of estimated doses to representative or maximum individuals; and b.) failure to consider the combined effects from both Units No. 1 and No. 2 of the TMINS.

II. RADIOLOGICAL ASPECTS

A. Radiological Effluents and Dose Assessments

The draft supplement section titled "Radiological Impacts" is deficient in several respects. In our opinion, it is difficult to assess and to place in perspective the radiological impacts indicated in the draft supplement.

The first of these deficiencies appears to be an editorial error. An Appendix C is referred to for description of the models and considerations for environmental pathways. The Appendix C in the draft supplement describes biota collected in the vicinity of Three Mile Island. There is no appendix describing radiation exposure pathways. The final statement should be corrected to include a discussion of radiation exposure pathways, a definition of terms and of models used.

The radioactive effluents used in the dose computations were those estimated by the staff to reasonably characterize the annual release of radioactive material. It would have been helpful to compare these with actual release data from the companion plant, TMI Unit No. 1. There is one comparison with reported values [(1)], admittedly not the best data, because this was the Unit No. 1 start up period. The radioactive releases range from a factor 33 greater to several orders of magnitude less for liquid effluents, and consistently less by factors of 5 to 10,000 for gaseous effluents (when actual releases are compared to calculated releases). A staff comparison with comparable operating data would be useful in the final statement.

(1) Three Mile Island, Unit No. 1, Semi-Annual Operation Report, 7/1/74 to 12/31/74.

No doses to individuals from various activities or pathways are presented. A table (Table 5.3) purports to summarize population dose commitments, but appears to be an estimate of annual population exposure for the year 1990. Also 10 CFR 20 and Appendix I to 10 CFR 50 are cited in the evaluation of radiological impact and the source term development, but no summary of what these regulations require for radiation dose limits to individuals and populations is given; this makes interpretation of the impact statement by members of the public difficult.

We are encouraged that the NRC is now calculating annual population dose commitments to the U. S. population which is a partial evaluation of the total potential environmental dose commitments (EDC) of H-3, Kr-85, C-14, iodines and "particulates". This is a big step toward evaluating the EDC, which we have urged for several years. However, it should be recognized that several of these radionuclides (particularly C-14 and Kr-85) will contribute to long-term population dose impacts on world-wide basis, rather than just in the U. S. Assessment of the total impact would (1) incorporate the projected releases over the lifetime of the facility (rather than just the annual release), (2) extend to several half-lives or 100 years, beyond the period of release, (3) consider, at least qualitatively or generically, the world-wide impacts where appropriate. Thus, we suggest that future assessments recognize these influences on the total environmental impact or specify the limitations of the model used.

The staff reaches the conclusion that there will be no measurable impact on man from routine operation of TMI Unit 2. Radiological environmental monitoring reports from Unit 1 have shown a very small, but measurable impact[2]. It would be helpful in the final statement if all information bearing upon the radiological impact is summarized.

B. Reactor Accidents

It appears that a recreation area is proposed for the south end of Three Mile Island. This could pose difficulties in the remote event that evacuation of people using the recreation area is needed. There is no balancing of this risk versus the benefits of the proposed recreation area.

The EPA has examined the NRC's analyses of accidents and their potential risks. The analyses were developed by NRC in the course of its engineering evaluation of reactor safety in the design of nuclear plants. Since these issues are common to all nuclear plants of a given type, EPA concurs with NRC's generic approach to accident evaluation. The NRC is expected to continue the efforts initiated by AEC to insure safety through plant design and accident analyses in the licensing process on a case-by-case basis.

In 1972, the AEC initiated an effort to examine reactor safety and the resultant environmental consequences and risks on a more quantitative basis. The EPA continues to support this effort. On August 20, 1974, the AEC issued for public comment the draft Reactor Safety Study (WASH-1400),

(2) Radiological Environmental Monitoring Report for the Three Mile Island Nuclear Station, 1975 Semiannual Report, August, 1975, p. 17

which was the product of an extensive effort to quantify the risks associated with light-water-cooled nuclear power plants. The EPA's review of this document included inhouse and contractual efforts, and culminated in the release of final Agency comments on the draft report on August 15, 1975. Initial comments were issued on November 27, 1974.

EPA completed its review of the final Reactor Safety Study on June 11, 1976, and issued a public report of its findings. In general, our previous conclusions on WASH-1400 are still valid. We identified apparent errors, omissions and questionable assumptions regarding health effects analyses, emergency remedial measures and failure analyses which would generally increase the calculated probabilities or consequences and, thus, the risks. We are working with NRC to resolve these points so that a consensus may be attained regarding the validity of the risk estimates given in WASH-1400. A generic analysis of the acceptability of the present risks or whether increased levels of safety are necessary has not yet been made. In the meantime, we have identified no reason serious enough to call for an immediate restriction in the application of nuclear power.

C. Radioactive Waste Management

The NRC staff is evaluating recently furnished information concerning the capability of the liquid and gaseous waste systems to meet the requirements of Appendix I to 10 CFR 50. It is hoped that this evaluation could be incorporated into the Final Environmental Statement, as well as operating experience for Unit 1, so that the Final Statement reflects the best current estimate of the radiological impact upon the environment for the complete plant.

It would also be helpful to provide the most recent information on low-level solid wastes. Several references are available to this subject. The Atomic Energy Commission's (now NRC) concluding statement to its rulemaking proceedings on Appendix I to 10 CFR Part 50 contains improved estimates of low-level solid radwastes produced during nuclear power plant operations. The Oak Ridge National Laboratory (ORNL) has published "A Critical Review of the Solid Radioactive Waste Practices at Nuclear Power Plants" (ORNL-4924), which provides a compilation of operational experience relative to these wastes. The EPA has also conducted extensive research on these wastes and their impacts at selected, licensed, shallow land burial sites. Based on analysis of available information, EPA estimates that the annual offsite shipment of "low-level solid wastes" will be comprised of approximately 18,600 feet^3 for a PWR operated at Unit 2's design power with 80 percent capacity factor (3). We believe the final statement should provide the rationale for an estimate based upon present waste management practices. We understand that another study is being conducted on this subject by the Atomic Industrial Forum. We encourage the NRC to update the estimates of low-level solid waste quantities using the most appropriate and current experience.

(3) Mann, Goldberg, and Hendricks, "Low-Level Solid Radioactive Waste in Nuclear Fuel Cycle," a paper presented at the November 16-21, 1976, American Nuclear Society meeting in San Francisco, California.

D. Transportation

In its earlier reviews of the environmental impacts of transportation of radioactive material, EPA agreed with AEC that many aspects of this program could best be treated on a generic basis. The NRC codified this generic approach (40 F.R. 1005) by adding a table to its regulations (10 CFR Part 51) which summarizes the environmental impacts resulting from the transportation of radioactive materials to and from light-water reactors. This regulation permits the use of the impact values listed in the table, in lieu of assessing the transportation impact for individual reactor licensing actions, if certain conditions are met. Since Three Mile Island appears to meet these conditions, and since EPA agrees that the transportation impact values in the table are reasonable, the generic approach appears adequate for this plant.

The impact value for routine transportation of radioactive materials has been set at a level which covers 90 percent of the reactors currently operating or under construction. (The basis for the impact, or risk, of transportation accidents is not as clearly defined.) The EPA will make known its views on any environmentally unacceptable condition related to transportation. On the basis of present information, EPA believes that there is no undue risk of transportation accidents associated with operation of the Three Mile Island Nuclear Station, Unit No. 2.

III. NON-RADIOLOGICAL ASPECTS

A. Water Quality Impacts

EPA's analysis of all Water Quality data and information presented in the Draft Supplement to the EIS for TMINS, shows that this section of the EIS was well written and very adequate. However, EPA is concerned with the appropriate state thermal discharge standards and their application at Three Mile Island Nuclear Station.

The draft supplement indicates on page 5-3, that the following state thermal water quality standard is applicable to TMINS:

> Temperature - Not more than a 5°F rise above ambient temperatures or a maximum of 87°F, whichever is less; not to be changed by more than 2°F during any one-hour period.

The state thermal standard is inadequately defined in the report. It does not specify how or where this standard will be applied pursuant to Section 97.82 a. and b. of the Pennsylvania State Water Laws.

The NPDES permit issued by EPA to TMINS, effective December 30, 1974, imposed an effluent limitation of 87°F for the protection of the aquatic community. Pennsylvania later approved Metropolitan Edison's request to discharge at the ambient receiving stream temperature when the temperature is above 87°F. The company is trying to negotiate a workable application of the 5°F rise limitation with the State. The final supplement should report how this proposed variance will affect the application of thermal standards at TMINS.

The technical specifications for Unit No. 1 require that the temperature of the discharge from the mechanical draft cooling tower be no more than 7°F above or less than 3°F below the ambient temperature of the river water.

In addition, the discharge temperature must be maintained at or below the ambient river water temperature when the intake water temperature is 87°F or greater. The final supplement should indicate whether thermal limitation imposed on Unit No. 1 mechanical draft cooling tower will be applied to Unit No. 2.

In light of the recent biological data collected at the site, the final supplement should show the location of the intake structure in relation to known spawning areas in the vicinity of the power plant.

B. Transmission Lines and Their Field Effects

It is encouraging to see a discussion of the possible health hazards due to induced electric field effects and to read that the applicant is committed to undertake a series of safety steps in this area. EPA is concerned, however, with the 500 KV transmission line that crosses Pennsylvania Route 100 east of Bechtelsville, and would like to have this transmission line included in all safety implementation plans regarding induced field effects.

EPA has been given notice[5] that it desires to collect the data necessary to define possible health and environmental effects of EHV power transmission. It is hoped that the applicant and others will provide the information and operating data necessary for the safety of the public in the transmission of electrical power.

(5) Federal Register, Vol. 40, p. 12323, March 18, 1975.

C. Meteorology and Climatology

We concur with the NRC staff opinion that present state-of-the-art knowledge does not provide definitive conclusions concerning the effects on climate due to atmospheric dispersion of heat and moisture from the power station, although major weather modifications are not expected to result from the operation of the Three Mile Island Nuclear Station. We make the observation that any future projects involving large heat releases into the atmosphere in the lower Susquehanna Basin should utilize the growing body of knowledge on macroscale weather modification. The environmental impact of the large aggregation of power generation facilities in the area should be analyzed on a regional basis for future environmental impact.

Estimates of relative atmospheric concentration (χ/Q) values at various distances and directions from the site should be recomputed using on-site meteorological data, when the meteorological monitoring system conforms with the recommendations of Regulatory Guide 1.23.

IV. MISCELLANEOUS COMMENTS

A. Table 2-2 of Section II "Site Analysis" lists all downstream water users. The Holtwood Dam and hydroelectric power station was not included in this listing. The facility's distance downstream from TMINS, and its rate of use should be included in the inventory.

B. The final supplement should include the fact that an NPDES permit for Three Mile Island Nuclear Station was issued on December 30, 1974.

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

RECEIVED 9-20-76 U.S. NUCLEAR REGULATORY COMMISSION Mail Section

SEP 1 6 1976

50-320

Mr. William H. Regan, Jr.
Chief, Environmental
Projects Branch 3
Division of Site Safety and
Environmental Analysis
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Regan:

This is in response to your transmittal dated July 22, 1976, inviting the U.S. Energy Research and Development Administration (ERDA) to review and comment on the Nuclear Regulatory Commission's draft supplement to the final environmental statement related to the construction of Three Mile Island Nuclear Station, Unit 2.

We have reviewed the draft supplement and have determined that the proposed action will not conflict with current or known future ERDA programs. However, on page 5.5, paragraph 5.4.1.2 refers to appendix C for population exposure pathways, but appendix C is on biota. The final statement should include a discussion of the methods and intent to minimize release of globally-distributed long-lived radioactive effluents, such as krypton-85, carbon-14, or tritium.

Thank you for the opportunity to review this supplement.

Sincerely,

W. H. Pennington, Director
Office of NEPA Coordination

cc: CEQ (5)

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Final

environmental statement

related to operation of

THREE MILE ISLAND NUCLEAR STATION UNITS 1 and 2

METROPOLITAN EDISON COMPANY
PENNSYLVANIA ELECTRIC COMPANY
JERSEY CENTRAL POWER AND LIGHT COMPANY

DOCKET NOS. 50-289 and 50-320

December 1972

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

Summary and Conclusions

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

1. This action is administrative.

2. The proposed actions are the continuation of construction permits CPPR-40 and CPPR-66 and the issuance of operating licenses to Metropolitan Edison Company, Jersey Central Power and Light Company, and the Pennsylvania Electric Company (the Applicants) for the operation of the Three Mile Island Nuclear Station Units 1 and 2 near Harrisburg in Dauphin County, Pennsylvania.

The Three Mile Island Nuclear Station is comprised of two pressurized water reactor units. Unit Number 1 has a designed thermal rating of 2535 megawatts with a maximum electrical output of 871 megawatts. Unit Number 2 has a designed thermal rating of 2772 megawatts with a maximum electrical output of 959 megawatts. Four natural draft cooling towers, two per unit, are utilized for dissipating the waste heat from the closed cycle cooling water system.

3. Summary of environmental impact and adverse effects:

a. Construction and site development has and will cause some temporary disturbance of land onsite and of adjacent waters.

b. About 36,000 gpm of auxiliary services cooling water and blowdown from the cooling towers will be discharged to the Susquehanna River. This liquid effluent from the Station is approximately 5% of the minimum river flow. The effluent will average 3°F or less above ambient river temperature depending upon the season of the year. Following relatively infrequent reactor shutdowns during unusual weather conditions (high air and low water temperatures) the effluent could be as much as 19°F above river ambient for periods not exceeding a few hours.

c. About 20,800 gpm of river water will be evaporated from the cooling towers.

d. About 7555 curies of radionuclides in gaseous effluents and 2008 curies of radionuclides in liquid effluents (including 2000 curies of tritium) will be released to the environment annually.

e. Increased local fog and occasional augmentation of natural fog at Harrisburg International Airport from operation of cooling towers.

f. A very low likelihood of accidental radiation exposure to nearby residents will be created.

g. Small amounts of chemicals will be released in the liquid effluents and cooling tower drift from the Station; but, aside from residual chlorine which will place organisms in the near vicinity of the outfall at significant risk if not carefully controlled, expected maximum concentrations to be discharged will be sufficiently low as not to pose a hazard to aquatic or human life.

h. Operation of intake and discharge systems will cause some localized destruction of minute aquatic organisms, and some local alteration of fish populations.

i. There will be some visual impact from the cooling towers and transmission lines.

4. Principal alternatives considered were:

- Alternative power sources
- Construction of the Station at an alternate site
- Alternative land uses
- Use of alternate cooling methods

5. Comments on "Environmental Report-Operating License Stage, Three Mile Island Nuclear Station Unit 1 and Unit 2" dated October 1, 1970, have been received from the following agencies and used in the preparation of this Final Environmental Statement:

Department of Agriculture
Department of Defense
Department of Health, Education and Welfare
Department of the Interior
Federal Power Commission
Pennsylvania Department of Health

6. The following Federal, State and local agencies were requested to comment on the Draft Detailed Environmental Statement:

Advisory Council on Historical Preservation
Department of Agriculture
Department of Army, Corps of Engineers
Department of Commerce
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Federal Power Commission
Environmental Protection Agency
Pennsylvania Department of Health
Board of Commissioners - Dauphin County, Pennsylvania
Pennsylvania Historical and Museum Commission

Comments received on the Draft Detailed Environmental Statement are incorporated in this Final Statement in Appendix C. Comments received were forwarded to the Applicants. Their replies are incorporated in this Final Statement in Appendix D.

7. This Final Detailed Environmental Statement is being made available to the public, to the Council on Environmental Quality, and to the other agencies, as noted above, in December, 1972.

8. On the basis of the evaluation and analysis set forth in this statement, and after weighing the environmental, economic, technical, and other benefits of the Three Mile Island Nuclear Station Units 1 and 2 against environmental and other costs and considering available alternatives, it is concluded that the actions called for under NEPA and Appendix D to 10 CFR Part 50 are continuation of construction permits CPPR-40 and CPPR-66 and the issuance of operating licenses for Unit 1 and Unit 2, subject to the following conditions for the protection of the environment:

a. The Applicants will perform preoperational measurements of the distributions of aquatic species to establish base-line data adequate for determining adverse effects the Station might have on the environment.

b. The Applicants will define an environmental monitoring program for inclusion in the Environmental Technical Specifications considered by the Regulatory staff to be adequate to disclose any changes which may occur in land and water ecosystems as a result of plant operation.

c. The Applicants will monitor the total residual chlorine concentration in the Station effluent during and immediately following chlorination. If this concentration exceeds 0.1 ppm, the Applicants should take all practical measures to reduce it below this value. Should these efforts fail, the Applicants should determine the extent of the zone in the river within which the total residual chlorine concentration exceeds the EPA recommended criteria. The Environmental Technical Specifications for the Station will further describe the procedures to be followed in this situation.

d. The Applicants will take appropriate measures through monitoring, administrative measures and/or design changes to insure that the thyroid dose to critical segments of the general population through the grass-cow-milk chain does not exceed 5 mrem/year.

e. The Applicants will define a radiological monitoring program considered by the regulatory staff to be adequate to determine any radiological effects on the environment from operation of the Three Mile Island Nuclear Station, Units 1 and 2.

f. If harmful effects or evidence of irreversible damage are detected by the monitoring programs, the Applicants will provide an analysis of the problem and will develop a course of action to be taken to alleviate the problems. If the ecology of the river significantly changes at a future date as, for example, by major changes in water chemistry or reintroduction of shad, the Applicants will provide an analysis of expected impacts and a course of action to minimize the impacts.

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FOREWORD

This Final Detailed Statement of the environmental considerations applies to the Three Mile Island Nuclear Power Station (the Station). This Station is being built for Metropolitan Edison Company, Jersey Central Power and Light Company and Pennsylvania Electric Company (the Applicants). The Station is to consist of Unit 1 and Unit 2 (Docket Nos. 50-289 and 50-320). Construction Permits were issued May 18, 1968 and November 4, 1969 for Units 1 and 2, respectively. The next stage is a request for operating license with commercial operation scheduled for Unit 1 by November 1973 and for Unit 2 by May 1975.

This Statement has been prepared by the U. S. Atomic Energy Commission's Regulatory staff pursuant to the Commission's regulations, 10 CFR Part 50, Appendix D, implementing the National Environmental Policy Act of 1969 (NEPA). Section 102(2)(c) of the NEPA calls for a detailed statement on:

i. The environmental impact of the proposed action,

ii. Any adverse environmental effects, which cannot be avoided should the proposal be implemented,

iii. Alternatives to the proposed action,

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

v. Any irreversible and irretrievable commitments of resources which could be involved in the proposed action should it be implemented.

The Applicants submitted an "Environmental Report Operating License Stage" for Three Mile Island Nuclear Station Units 1 and 2 in October 1970. The Commission forwarded copies of this report to appropriate Federal and State agencies for review and comment. The Applicants responded to the comments of the agencies. A revised environmental report for Three Mile Island Nuclear Station Units 1 and 2 was submitted by the Applicants in December 1971 to take into account the provisions of the revised Appendix D regulations. In March 1972 Amendment No. 1 to the revised environmental report was submitted by the Applicants and Supplement No. 1 was submitted in August 1972.

This Draft Environmental Statement takes all of the above writings into account as well as the Preliminary and Final Safety Analysis Reports. These documents are available in the Commission's Public Document Room, 1717 H Street, N.W., Washington, D. C. and in the State Library of Pennsylvania Government Publication Section, Education Building, Harrisburg, Pennsylvania.

As part of the safety evaluation conducted by the Commission's staff prior to the issuance of construction permits and operating licenses, a

detailed analysis is made of the Applicants' plans and facilities for minimizing and controlling the release of radioactive materials under normal operating and potential accident conditions. This includes an evaluation of the adequacy of proposed effluent and environmental monitoring programs and the potential radiation exposure that might be received by plant workers and members of the public. Inasmuch as these aspects are considered fully in other reports, only the salient features that bear directly on the environmental impact of the Station are discussed herein.

Dr. J. D. Jenkins is the AEC Environmental Project Manager (301-973-7263) for this statement.

I. Introduction

Metropolitan Edison Company (Met-Ed), Jersey Central Power and Light, and Pennsylvania Electric Company, the Applicants, are wholly-owned subsidiaries of General Public Utilities Corporation (GPU). GPU, a New York corporation, registered under the Public Utility Holding Company Act, is composed of four utilities and is operated as an integrated system -- the GPU Integrated System. The fourth GPU subsidiary corporation is the New Jersey Power and Light Company. A major fraction of the State of Pennsylvania and a portion of New Jersey are served by the GPU system, which has a peak generating capacity at the present time of about 5,900 MWe.

Capital costs for construction of the Three Mile Island Nuclear Power Station (the Station) are being shared by the Applicants: Met-Ed (50%), Jersey Central Power and Light (25%), and Pennsylvania Electric (25%). Met-Ed, however, has complete responsibility for the engineering, design, construction, operation, and maintenance of the Station. The three participating companies will share undivided ownership of the Station as tenants in common without right of partition.

The Station occupies part of an 814-acre site consisting of Three Mile Island (TMI) and adjacent islands in the Susquehanna River, approximately 10 miles southeast of Harrisburg, Pennsylvania. Location of the generating station with respect to regional features is shown in Figure 1, and in more detail in Fig. 2.

The two nuclear power units (Unit 1 and Unit 2), presently under construction, have gross capacities of 871 MWe and 959 MWe, respectively, and both employ pressurized water-type nuclear reactors supplied by Babcock and Wilcox Company. As of September 1972, construction of Unit 1 is approximately 90% complete, and construction of Unit 2 is about 31% complete.

The application for a construction permit for Unit 1 (Docket 50-289) was filed on May 3, 1967, and an AEC Exemption for limited construction below grade was granted on November 29, 1967. The Division of Reactor Licensing (DRL) safety evaluation was completed on February 5, 1968. A public hearing before the Atomic Safety and Licensing Board (ASLB) was held April 10 and 11, 1968. The public hearing was uncontested, and the construction permit (CPPR-40) was issued on May 18, 1968. The operating license application for Unit 1 was filed with the AEC on March 2, 1970.

The construction permit application for Unit 2 (Docket 50-320) was filed April 29, 1968, and amended, due to a site change for the Unit from Oyster Creek to the Station, on March 10, 1969. An AEC Exemption to construct the tendon access gallery was granted on June 27, 1969. The DRL safety evaluation was completed on September 5, 1969, and a public hearing before the ASLB was held October 6 and 7, 1969. This hearing was also uncontested, and the construction permit (CPPR-66) for Unit 2 was granted on November 4, 1969.

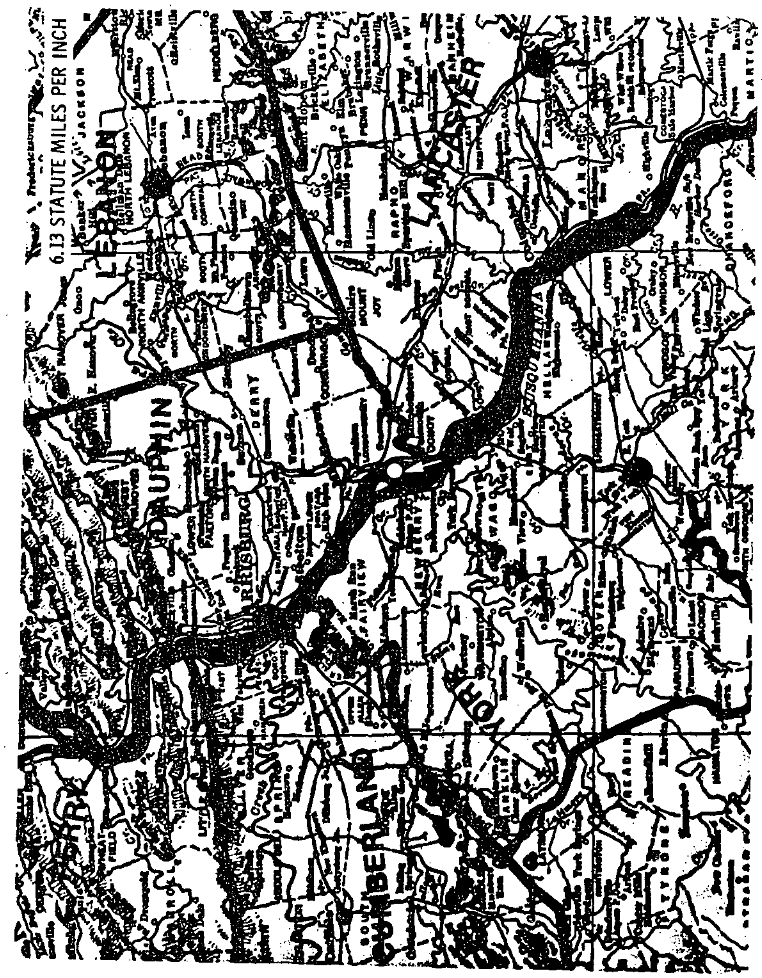
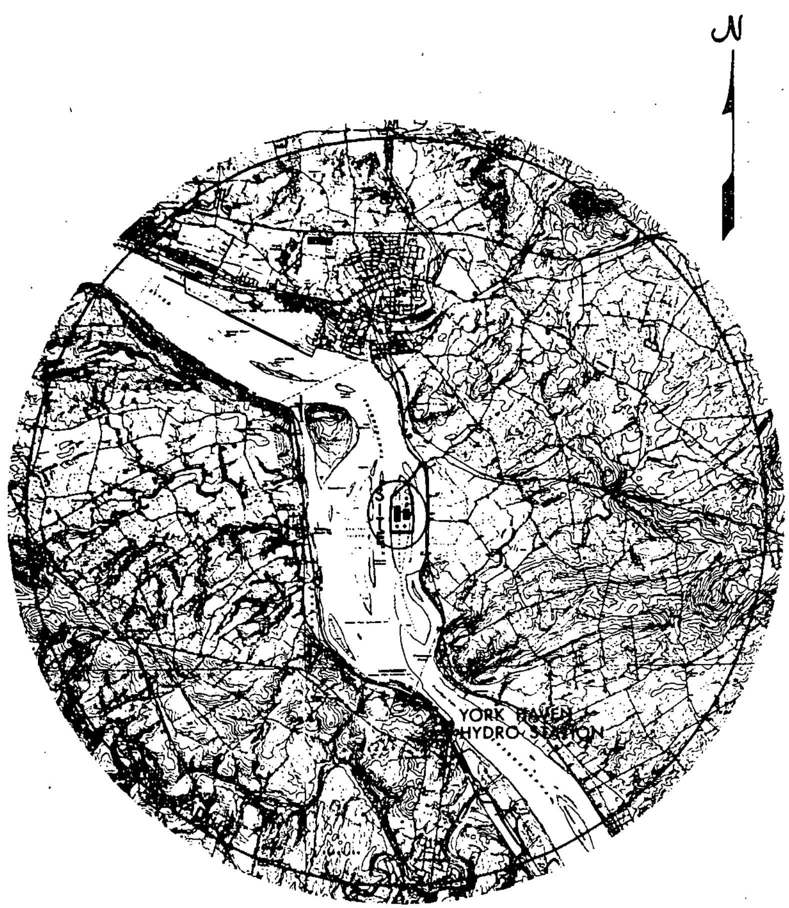


Figure 1 — COUNTIES AND MUNICIPALITIES IN THE THREE MILE ISLAND AREA



CONTOUR INTERVAL 20 FEET

1 ½ 0 1 MILE

0 4000 8000 FEET
2000 6000

APPROX. SCALE

SITE TOPOGRAPHY - 5 MILE RADIUS
THREE MILE ISLAND NUCLEAR STATION

Figure 2

A. Site Selection

The Station site was purchased by a predecessor company of Met-Ed in the early 1900's. In the course of selecting a site for installation of one or more large generating units, the Applicants initially considered twenty different locations; this list was narrowed to six for more intensive study. Three Mile Island was finally selected because of a combination of favorable factors, including:

1. Availability of cooling water from the Susquehanna River.
2. Close proximity to existing high voltage transmission facilities (1.5 miles to Middletown junction substation) and central location in the GPU service area.
3. Close to existing highway and rail transportation.
4. A suitably large and readily controllable exclusion area.
5. The absence of nearby regions of high population density. The area is predominantly rural.
6. Availability of the land since the company already owned it.

The decision to build a nuclear plant rather than a fossil fuel plant was primarily economic; the estimates of overall costs of power generation were lower for nuclear fuel than for fossil. Since 1967, when the decision was taken, revised estimates of cost for the two types of power generation favor nuclear power even more. For example, typical fuel costs today for the region in which the plant is located are:

Oil (used for peak load demand) - 74¢/million BTU
Coal - 30¢/million BTU
Gas - Unavailable in sufficient quantities
Nuclear - 17¢/million BTU.

In addition the sulfur dioxide discharge standards of the Commonwealth of Pennsylvania require coal containing the equivalent of 0.7% sulfur or less for new plants. Since such low-sulfur coal is not readily available locally, the additional transportation cost further worsens the economic picture for coal.

There are a number of other power-generating facilities in the immediate vicinity of the Station which uses the Susquehanna River for cooling water. The Met-Ed Crawford Station at Middletown (about three miles upstream) is an older 115 MWe fossil plant, recently converted from coal to oil, which uses river water for direct condenser cooling. The Brunner Island coal-fired plant of the Pennsylvania Power and Light Co. is located several miles downstream from the Station. The Brunner Island Station, consisting of three units that produce a total of 1,500 MWe, uses river water for direct cooling of the condensers. In addition to the two fossil plants, there is the Met-Ed York Haven Hydro Power Station, located at the dam that extends across the river from the southern end of TMI. This small, 20 MWe, station is presently used to help meet peak load demand in the GPU system.

Other major industrial activities in the immediate vicinity of the Station are a Bethelem Steel pipe fabrication plant at Steeltown, a Bethlehem Steel plant at Lebanon and the Hershey Chocolate Company at Hershey, Pa. In addition, there is some small diversified industry in the area, although none of this is in the immediate vicinity of the Station.

As part of the general development of recreational area in the vicinity of the plant, the Applicants are proposing to locate a recreational facility at the southern end of Three Mile Island. In the course of planning the development of the recreation resources of this project, a number of individuals in the State and local governments were consulted.

There have been contacts between the Applicants and persons in the Pennsylvania Fish Commission and the Department of Environmental Resources regarding the pre- and postoperational biological and radiological monitoring programs for the Station.

There are no special populations such as hospitals or schools in the immediate vicinity of the site. The nearest public facility is a school located approximately 4 miles north of the site in Middletown.

B. <u>Applications and Approvals</u>

A list of the Federal, State, and local applications and permits for the Station is given in Table 1.

Three public hearings have been held concerning the Station, two before the Atomic Safety and Licensing Board as part of the construction permit approval, noted above, and an FAA-Pennsylvania Aeronautics Commission hearing (April, 1968) on matters relating to the effect of the large cooling towers on operations at Harrisburg International Airport.

The Federal Aviation Administration (FAA) and the Pennsylvania Aeronautics Commission were consulted with regard to construction of the cooling towers, and the FAA has given a permit for construction of the cooling towers at the site. In addition, design changes were made in the plant buildings so that all critical structures have been "hardened" to withstand direct impact of a large commercial jet aircraft.

TABLE 1

LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

A. Federal

Permit No.	Purpose	Authority	Status
Docket No. 50-289	Licensing of Plant	U. S. Atomic Energy Commission	FSAR submitted
Docket No. 50-320	Construction Permit Unit 1	U. S. Atomic Energy Commission	PSAR submitted, Issued May 18, 1968
	Construction Permit Unit 2	U. S. Atomic Energy Commission	Issued November 4, 1969
	Special Nuclear Material License	U. S. Atomic Energy Commission	Application submitted June 8, 1972
	Byproduct Material License	U. S. Atomic Energy Commission	Application issued November 30, 1971
NYC-OE-68-61	Determination of No Hazard to Air Navigation - Unit 1 Cooling Towers	Federal Aviation Administration	Issued April 23, 1968
70-EA-150-OE	Determination of No Hazard to Air Navigation - Unit 2 Cooling Towers	Federal Aviation Administration	Issued July 29, 1970
Project No. 1888	Amendment to York Haven Power Project License to Permit Joint Use of Project Waters	Federal Power Commission	Unit 1 approved October 8, 1969 - Unit 2 application submitted July 1970
NABOP-P (Met-Ed Co.) 13	Intake, Screen, and Pump House and Temporary Earth-fill Cofferdam- Unit 1 (Section 10, Refuse Act of 1899)	U. S. Army Corps of Engineers	Issued May 22, 1969

LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

B. COMMONWEALTH OF PENNSYLVANIA

Permit No.	Purpose	Authority	Status
18875	Construct an Intake, Screen House, and Pump House for Unit 2 and Intake Channel for Units 1 & 2	Department of Environmental Resources	Issued July 14, 1970
2270204	Industrial Wastes Permit Units 1 and 2	Department of Environmental Resources	Issued August 17, 1971
2270408	Sanitary Wastes - Units 1 and 2	Department of Environmental Resources	Issued January 5, 1971
22-302-015	Two Auxiliary Boilers Unit 1 Plan Approval Operating Permit	Department of Environmental Resources	Issued May 14, 1970 Has not been inspected
22-301-037	Incinerator Plan Approval Operating Permit	Department of Environmental Resources	Issued January 14, 1971 Has not been inspected
22-301-137	Unit 2 - Radioactive Gaseous Wastes Plan Approval	Department of Environmental Resources	Application dated 1971
No. 67	Scientific Collectors Permit	Pennsylvania Fish Commission	Issued February 3, 1971
No. 85	Underwater Blasting for Intake Channel - Units 1 and 2	Pennsylvania Department of	
162,562	3 - 4,000 gallon underground gas and diesel fuel oil tanks	Pennsylvania State Police Fire Marshall Division.	Issued October 17, 1968
166,468	2,000 and 3,000 gallon fuel oil tanks - underground	Pennsylvania State Police Fire Marshall Division	Issued August 4, 1969

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LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

A. FEDERAL

Permit No.	Purpose	Authority	Status
NABOP-P (Met-Ed Co.) 21	Intake, Screen and Pump House and Temporary Earthfill Cofferdam - Unit 2 and Intake Channel - Units 1 & 2 (Section 10, Refuse Act of 1899)	U. S. Army Corps of Engineers	Issued March 10, 1971
2SD OXU 3 000719	Discharge of Plant Effluent Units 1 & 2 (Section 13, Refuse Act of 1899)	U. S. Army Corps of Engineers	Section I and Section II Part A submitted August 25, 1971. Section B submitted November 10, 1971

B. COMMONWEALTH OF PENNSYLVANIA

Permit No.	Purpose	Authority	Status
17145	Temporary Access Bridge Extension for use of bridge thru 1973	Department of Environmental Resources	Issued July 11, 1967 Issued April 30, 1969
17259	Temporary Pump Intake Facility	Department of Environmental Resources	Issued October 10, 1967
17421	Temporary Cofferdam and Causeway to construct the Permanent Access Bridge Extension of six months	Department of Environmental Resources	Issued March 13, 1968
17291	Construct and Maintain a Permanent Railroad and Highway Access Bridge	Department of Environmental Resources	Issued October 10, 1967
17948	Construct an Intake, Screen House, and Pump House for Unit 1 Extension to December 1971	Department of Environmental Resources	Issued April 8, 1969 Issued December 11, 1970

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LIST OF LICENSES, PERMITS AND APPROVALS OF CONSTRUCTION AND OPERATION OF THREE MILE ISLAND NUCLEAR STATION REQUIRED BY FEDERAL, STATE AND LOCAL AUTHORITIES

B. COMMONWEALTH OF PENNSYLVANIA

Permit No.	Purpose	Authority	Status
165,220	Cancelled by 166,468	Pennsylvania State Police Fire Marshal Division	Issued January 17, 1969
165,822	4 - 4,000 gallon diesel fuel underground tanks	Pennsylvania State Police Fire Marshal Division	Issued May 5, 1969
166,246	Cancelled by 165,822	Pennsylvania State Police Fire Marshal Division	Issued June 27, 1969
168,465	30,000 gallon underground diesel fuel tank - Unit 1	Pennsylvania State Police Fire Marshal Division	Issued June 12, 1970
168,466	50,000 gallon above ground fuel oil tank	Pennsylvania State Police Fire Marshal Division	Issued June 12, 1970
166,622	3 - 4,000 gallon and 2 - 4,000 gallon underground diesel fuel tanks	Pennsylvania State Police Fire Marshal Division	Issued August 26, 1969
MA 133198	Occupancy of Service Building	Pennsylvania Department of Labor and Industry	Issued September 15, 1971
P-83401	Temporary Access Bridge Highway Occupancy Permit	Pennsylvania Department of Highways	Issued July 13, 1967
P-84381	Permanent Private Access Road Highway Occupancy Permit	Pennsylvania Department of Highways	Issued October 13, 1967
S-16013	Extension of Permit		Issued January 30, 1968
132408	Permanent Access Road	Pennsylvania Department of Highways	Issued January 16, 1970

C. LOCAL

278	Building Permit	Londonderry Township	Issued July 10, 1967

II. THE SITE

A. GENERAL

The Station will occupy about 200 acres of the 472-acre Three Mile Island (**TMI**). **The tract owned by the Applicants**, a total of 814 acres, includes **several adjacent islands** in the Susquehanna River as well as the whole of Three Mile Island (Figure 3). The islands were purchased as part of a regional power development plan. TMI is about 11,000 ft. long and 1,700 ft. wide. Its long axis is oriented approximately north-south, paralleling the flow of the river. It lies about 900 ft. from the east bank of the river and about 6,500 ft. from the west bank. South and east of the island the river is transected by the York Haven Dam, the island itself serving as part of the dam. There are no locks.

On the east bank of the river is a single track line of the Penn-Central Railroad and State Highway 441, a two-lane, blacktop, medium-duty road. A multitrack Penn-Central line and a two-lane blacktop road parallel the river's edge of the west bank.

A bridge connecting the north end of the island with State Highway 441 near the junction of Highway 441 and Geyers Church Road, is used by Station personnel. A one-track railroad spur across the bridge provides for transportation of heavy equipment. Other Station personnel, visitors, and construction equipment have access to the island from the south by a temporary bridge connecting the island with Highway 441 near Falmouth in Lancaster County.

B. LOCATION

TMI is located in Londonderry Township of Dauphin County about three miles south of Middletown, Dauphin County, and about 1.25 miles east of the small community of Goldsboro, York County at latitude 40° 9'10", longitude 76° 43'25" (Figure 2).

Between 1957 and the start of construction, 270 acres on TMI were leased for farming. The flat, rich, sandy silt soil was used to grow corn and tomatoes. Since there was no access to the island by bridge, the farmer transported his equipment and produce by barge.

Seventy cabins on the island were also leased; 53 on the west side and 17 on the east side. There was also a picnic area with five tables, two fireplaces, two toilets, a boat dock, and a well for drinking water. The periphery of the island and a tract of the southeast part of the island, about 200 acres in all, were wooded.

No electricity was supplied to TMI.

II-2

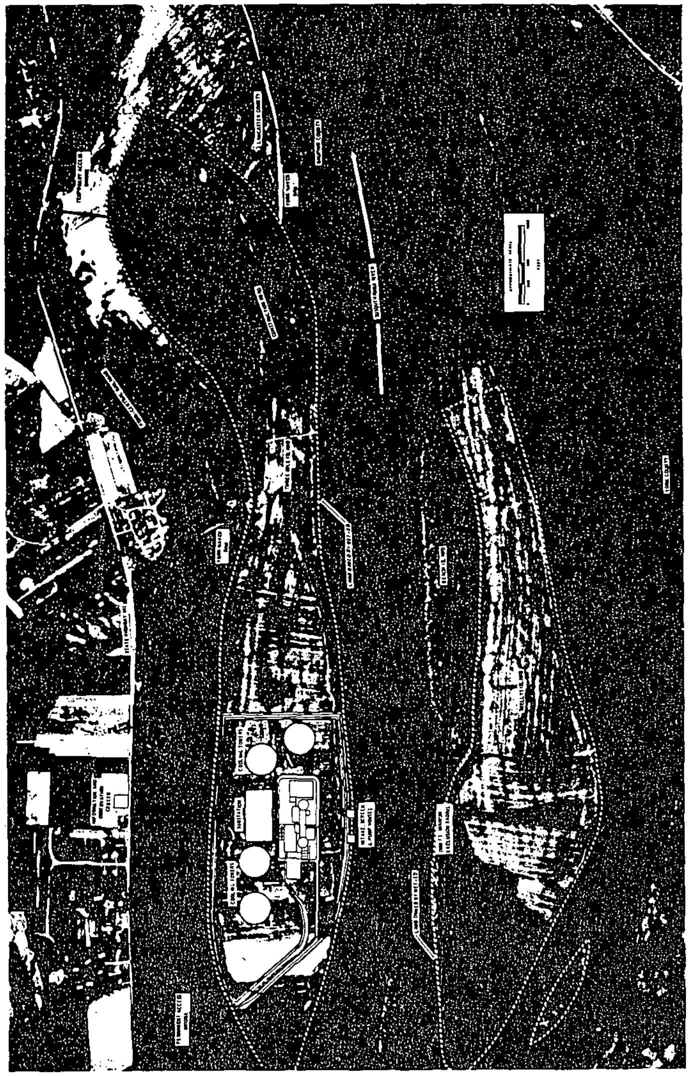

Figure 3 – THREE MILE ISLAND SITE

C. REGIONAL DEMOGRAPHY AND LAND USE

The location of the Station with respect to nearby counties and municipalities is shown in the map of Figure 1. The highest density of population in Dauphin County, where the Station is situated, is northwest of TMI and includes Harrisburg and the adjacent municipalities along the east bank of the Susquehanna River, i.e., Steelton, Highspire, Middletown and Royalton (Table 2).

Goldsboro, with 576 people, is the municipality closest to the Station (about 1 mile) and is located directly opposite TMI on the west shore of the Susquehanna. In 1970 the total population within 20 miles of the Station was about 621,000.

Land throughout the area is used primarily for dairy farming, poultry farming, and for growing tobacco, vegetables, fruit, alfalfa, corn and wheat. About 75% of Dauphin, York, and Lancaster counties is either farmland or forest and woodland, with the major forest and woodland areas located in the mountain range in the north region of Dauphin County. About 50% of the land in the three-county area is used for crops and about 8% for dairy farming.

The largest employer in the area is the Commonwealth of Pennsylvania. Harrisburg is the State capital and is thus the location of the legislature and executive branches of State government. Most of the administrative and regulatory agencies have their main offices within the City of Harrisburg. Industrial employers in the area manufacture a wide range of products consisting of leather goods, clothing, food products and candy, shoes, and chemicals. Other major industrial activities nearby are a Bethlehem Steel pipe fabrication plant at Steelton and a Bethlehem Steel plant at Lebanon, Pennsylvania.

There are two airports in the immediate vicinity of the Station; Harrisburg International (formerly Olmsted State Airport) and Harrisburg-York Airport. The former handles primarily commercial and the latter primarily light aircraft. In terms of passengers served, Harrisburg International is the third largest airport in Pennsylvania, and the area it serves extends beyond the six-county region centered around the Station. The average scheduled departures for 1971 are about 33 per day, or about 66 jet airplane landings and takeoffs per day. Present indications are that this airport's operations will grow rapidly within the next 5 to 10 years. Lancaster Airport also serves scheduled airlines, but its primary function is to provide connections to Harrisburg and Baltimore. The stimuli for growth of Harrisburg International are (1) the proposed introduction of international flight operations and (2) the limitations on scheduled operations at Lancaster Airport.

Table 2

1970 Populations and Growth Since 1960

of Municipalities Within 10-Mile Radius of the Station

Municipality	County	1970 Population	1960-1970, % Change	Distance from TMI (Miles)
Goldsboro	York	576	+6.3	1
Royalton	Dauphin	1,040	-7.8	2
Middletown	"	9,080	-18.8	2-1/2
Highspire	"	2,947	-1.7	4
Yorkhaven	York	671	-8.8	4
Elizabethtown	Lancaster	8,072	+19.1	6
Manchester	York	2,391	+64.4	6-1/2
Steelton	Dauphin	8,555	-24.1	7
New Cumberland	Cumberland	9,803	+5.9	9
Harrisburg	Dauphin	68,061	-14.6	9
Hummelstown	"	4,723	+5.6	9
Hershey	"	7,407	+8.1	10

Under grants from the Federal Housing and Urban Development Agency (HUD) the counties in the area surrounding the Station have recently developed comprehensive land use plans that are intended as guides for the establishment of local zoning codes.

D. HISTORICAL SIGNIFICANCE

There are no historic structures on the site. The National Register of Historic Places[8] was consulted and the nearest one listed was the Walnut Street Bridge in Harrisburg, about 11 miles from the Station. Also listed was the Cornwall Iron Furnace in Lebanon County, 17 miles from the site and Billmeyer House in York, about 14 miles from the site. St. Peter's Evangelical Lutheran Church in Middletown about 3 miles north of the site and a cemetery slightly further away bear historic markers and are candidates for inclusion in the National Register. A representative of the Pennsylvania Historical and Museum Commission, with concern for historic sites not listed in the National Register, indicated no knowledge of other sites.

Since the island was formed by deposition of materials washed down the river over many years, it is not a unique source of fossil deposits, but it does have some archaeological interest. Susquehannock Indians once lived nearby in a large town, Sasquesahanaugh, on the east side of the Susquehanna River at Washington Boro, downstream from TMI. Their influence extended over a large area.

Construction of the plant provided both the incentive and the means to carry out limited archaeological excavations that might not have been undertaken otherwise. The Applicants provided a $2,500 grant to help finance the work which was carried out by scientists of the Pennsylvania Historical and Museum Commission during the latter part of 1967. As many as possible of the known areas of prehistoric occupation on TMI were excavated. Over a thousand artifacts, projectile points, knives, drills, scrapers, and pieces of broken pottery were found. From these artifacts it was deduced that the site had an Archaic Period component, dating about 4000 B.C. to 1500 B.C., Early and Middle Woodland cultures of about 1000 B.C. to 1000 A.D., and a minor Late Woodland period of occupation (post 1000 A.D.). The most important artifacts were from the Early and Middle Woodland cultures, because these are poorly known eras of Pennsylvania prehistory.

Although the finds were important additions to understanding the way of life of an early people, they were not as useful as they might have been if the site had not been disturbed in the past by flooding and cultivation, which mixes artifacts of one culture with another.

E. ENVIRONMENTAL FEATURES

TMI was formed by deposition of materials carried by the river. Boulders, probably the nucleus for formation of the island, are present in the soil at the north end of the island.

1. River Characteristics

The drainage area of the Susquehanna River above the Station is estimated to be 25,000 square miles. The Susquehanna collects surface runoff and ground water seepage, as well as their respective contaminants, from a total watershed of approximately 27,400 square miles of which 21,000 lie within Pennsylvania. A summary of the characteristics of the main tributaries in the vicinity of the Station is given in Table 3.

Table 3. Characteristics of Streams in the Vicinity of the Station

Stream	Drainage Area	Average Rate of Flow (cfs)
Conoduguinet Creek	483 sq. mi.	580
Yellow Breeches Creek	227 sq. mi.	285
Swatara Creek	567 sq. mi.	940
West Conewago	510 sq. mi.	560

The Juniata River enters the Susquehanna River about 25 miles upstream from the site. Its drainage area is about 3,426 sq. mi. and its average flow rate is 4,32[illegible] cf[illegible].

The Susquehanna River is rather extreme in the variability of its flow characteristics as shown by the following summary of data recorded at Harrisburg over the period 1891-1965:

Minimum flow (Sept. 28, 1964)	1,700 cfs
Median annual flow	20,000 cfs
Average flow	34,000 cfs
Mean annual flood	300,000 cfs
Maximum flood (March 19, 1936)	740,000 cfs

Additional data on the seasonal flow variation of the river are given in Figure 4. The data show mean monthly flows for recurrence intervals of 2, 5, 10, 20 and 50 years. It will be noted that characteristically the low flows occur in the late summer and fall and that the minimum monthly flow of record, in general, follows the 50-year curve.

On June 24, 1972 rains from tropical storm Agnes resulted in a flood volume of 1,000,000 cfs, considerably in excess of the maximum recorded in the 1891-1965 period but below the probable maximum flood for the TMI location.

The average river level of 278 ft.* is about 25 ft. below the highest point on the island. Because of the danger of flooding, therefore, dikes have been constructed around the perimeter of the north end of the island.

The Station is to be protected from floods up to those with flow rates of 1,100,000 cfs by an extensive dike system around the northern part of the island. The northern or upstream portion of the dike was completed prior to the June 24, 1972 flood, but had not been completed on the downstream or southern portion of the island. The June 1972 flood, as a result of the presence of only a partial dike around the plant, flooded the westerly portion of the Station construction area around the four cooling towers by backing in through downstream uncompleted dike areas. For floods greater than the dike design flood and up to the probable maximum flood (1,645,000 cfs), the Station is designed to be shut down, waterproofed, and the dike is designed to allow water to back into the plant area from the downstream southern end of the island. The PMF (probable maximum flood) is based on the maximization of numerous hydro-meteorological parameters, of which storm precipitation and its time and space distribution are only a few. Comparison of the Agnes precipitation with similar data used in the PMF determination indicates no need for modification of extreme precipitation estimates and, therefore, no need to modify PMF runoff estimates accordingly.

Preliminary high water data from the June 1972 flood in the site vicinity have been reviewed to determine the adequacy of coefficients used to determine both the dike design water surface profile, and the PMF water surface used to assure that water will back into the plant area (rather than overtop the dike upstream). In both cases, it is concluded that conservative coefficients have been selected and the flood design bases for the plant are conservative. For instance, the Agnes water level at the intake structure was approximately elevation 300.0 ft. MSL, while the computed level is about elevation 302 ft. MSL.

During FSAR review of the plant the adequacy of riprap protection for the levee, and general maintenance of flood protection, was reviewed extensively. Inspection of the levee after the June 1972 flood indicated that although the riprap in place at the time appeared generally adequate, periodic maintenance of both the rock and the earth levee should indeed be undertaken at the intervals proposed by the Applicants (annually and after every major flood). It was noted that removal of riprap fines by floods, and extensive vegetative growth in the levee as now exists, could reduce flood control effectiveness.

*Elevations are above mean sea level (MSL).

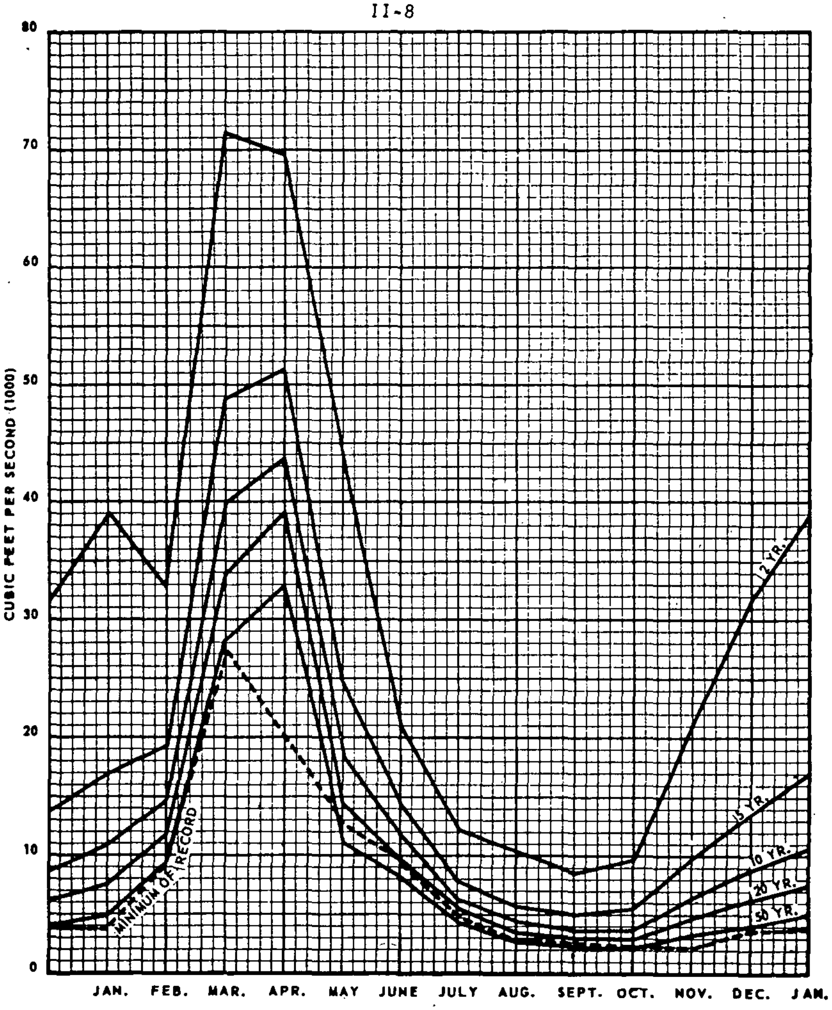

Figure 4 - SUSQUEHANNA RIVER AT HARRISBURG MEAN MONTHLY LOW FLOW SUMMARY

The hypothetical PMF is considered the upper limit of potential flooding at a particular site. The staff does not consider larger floods credible and, therefore, does not require the design of nuclear facilities for more severe events. It is concluded that the flood design bases for TMI have been conservatively estimated as a result of a review of the record June 1972 floods on the Susquehanna River.

A pumped storage facility consisting of two reservoirs and dams is proposed for completion in 1983-84 on Stony Creek, approximately 13 miles northeast of Harrisburg and upstream of TMI. Detailed design data are not yet available for the project. Since the Federal Power Commission has the responsibility to insure the safety of all facilities downstream of the pumped storage project, it should not affect TMI.

The river and the streams in the vicinity are presently used for water supplies, both public and industrial, power generation, boating, fishing, and recreation. Sport fishing is done in all streams in the general area of the site; however, there is no commercial fishing.

2. Groundwater

Groundwater occurs at TMI under water table conditions. The water table reaches its maximum elevation at the highest topographic point in the center of the island and falls off toward both shores. A variation of about 5 ft. occurs from either side to the center, producing a gradient of approximately 0.6 percent toward the river. At observation points in and surrounding the plant area, water levels occurred generally at a depth in excess of 15 ft. and ranged from 14 to 19 ft. The groundwater level occurred at a maximum of 6.2 ft. above the top of rocks with less than 1 foot of head existing above the soil-rock interface at one point of observation. The water level of the Susquehanna River, normally flowing at elevation 278 ft., controls TMI groundwater levels. Since a positive head exists on the island, any movement of groundwater from the Station site would be toward the river, and would eventually enter the stream. The river would act as a natural boundary; the dispersal of island groundwater would be limited to the river.

The bedrock underlying the general area, Gettysburg shale of Triassic Age, is composed of shales, sandstones, and siltstones. The sandstones are normally the best aquifers, although relatively high yields may also be obtained in jointed or fractured shale. Alluvial deposits are not believed to be a major source of groundwater in the region. Infiltration of contaminated groundwater from the Station into the underlying Gettysburg shale and transmission to onshore water supplies is unlikely, since a maximum head of six feet exists above the impervious (relative to soils) Gettysburg formation, and groundwater levels are higher on either river shore than on the island, with hydraulic gradients sloping toward the river. Surface and aerial examinations have revealed no geologic faults in the area that might facilitate infiltration of groundwater into an aquifer.

3. Meteorology

General climatic conditions in the site region are characterized by a continental type climate, modified and protected somewhat from more severe weather by the Appalachian Mountain Range to the north. Summers tend to be warm and humid, and winters are cool, with frequent periods of precipitation.

An on-site meteorological data collection program has been in operation at the Station since May 1967. Wind speed and direction have been continuously recorded 100 ft. above grade on TMI and 2-1/2 miles north 25 ft. above grade at Crawford Station. A two-year period of record has been analyzed, ending in May 1969, to provide a basis for evaluation of routine radioactive gas release limits.

In more than seventy-five years of record at the U. S. Weather Bureau in Harrisburg, the highest and lowest temperatures recorded were 104° and -14°F. Maximum monthly rainfall was 18.55 in.; maximum 24-hour rainfall 12.55 in., and maximum 24-hour snowfall 21.0 in. Maximum snow accumulation was 81.3 in. Average annual rainfall is 40 in.

During the 92-year period 1871 through 1963, thirty-three hurricane or tropical storm center paths passed within about 100 miles of the site. Most of these were in dissipation stages. The most severe was "Hazel", the center of which passed just west of Harrisburg on October 15, 1954. A peak gust of 80 miles per hour was recorded at the Harrisburg-York Airport during the passage of "Hazel". Winds from hurricane Agnes in 1972 did not exceed these values.

4. Geology

The TMI site lies within the Gettysburg Basin section of the physiographic division known as the Piedmont Province. The topography of the area immediately surrounding TMI is of slightly undulating nature with maximum relief of about 200 ft. and highest elevation seldom above 500 ft. From the east, drainage is largely represented by the southwesterly flowing Swatara Creek, which has its mouth near Middletown, and by the more westerly flowing Conewago Creek, which empties into the Susquehanna River at the south end of TMI. Fishing Creek flows into the Susquehanna west of the site, and the northwesterly flowing Conewago Creek terminates at York Haven. TMI has very little relief, with elevations ranging from about 280 ft. at the water's edge to slightly more than 300 ft. in the north-central portion.

The site is located in the Triassic lowland of Pennsylvania, one of a series of long narrow basins of Triassic deposits which extend in broken patches from Connecticut to North Carolina. The Triassic lowland in the vicinity of the site is referred to as the Gettysburg Basin. North and west of the Triassic lowland are the folded and thrust faulted Paleozoic rocks which comprise the Appalachian Mountains. Southeast of the Triassic lowland is the Piedmont, of Pre-Cambrian and Early Paleozoic Age, composed of granites, gneisses, and schists.

The site is underlaid by the sedimentary rocks of the Gettysburg shale. The bedrock surface, at the site, is essentially flat and lies at approximately elevation 277 ft. One to three feet of weathered rock occurs at the overburden-bedrock interface. No evidence of faulting transects the island as seen in the field from available rock exposures along the east bank of the river, or along the western periphery of the island. Aerial photographs as well give no suggestion of faulting through the island. A comprehensive evaluation of major tectonic elements in south central Pennsylvania has been prepared. It is concluded that the site is not deleteriously affected by faulting, and further, that regional tectonic elements are inactive and present no threat to the structural integrity of the local geology.

The island, as a whole, is composed of fluvially stratified sand and gravel containing varying amounts of silt, clay, and clean sand. Density values range from loose to very dense, as established by Standard Penetration Tests. Boulders are present at depth and are mainly confined to the lower portions of the soil zone on the north end of the island. Soil depths vary from approximately 6 feet at the south end of the island to a maximum of 30.0 feet near the axial intersection of the island. Depth of soil is relatively constant at about 20 feet in the vicinity of the plant site. From one-half to one foot of topsoil, composed of sandy silt with much organic material, covers the island.

F. ECOLOGY OF THE SITE AND ENVIRONS

Terrestrial communities are essentially those of the flood plain sere; aquatic habitats are those of a warm water stream - falls, riffles, ponds, or mud-bottom pools. Somewhat less than half of the area within a 1.5 mile radius of the Station is aquatic, the rest terrestrial. Of the terrestrial habitat, about two-thirds is farm land devoted to the production of dairy or poultry products, vegetables, fruits, alfalfa, corn, wheat or tobacco. The combination of wooded and farmed area forms a forest edge community.

1. Terrestrial

a. Flora - Dominant vegetation on the east shore of the river near the Visitors Center consists of the following species:

Ash (white)
Ailanthus (some 24" diameter)
Basswood
Black locust (common)
Black oak
Black walnut (18" diameter few)
Box elder
Cherry (black)
Elm (American)
Hackberry
Mulberry
Poison ivy (luxuriant)
Poplar (cottonwood)
Pokeberry
Silver maple
Sugar maple
Sumac
Sycamore
Wild grape

The composition of the forest indicates a stage in succession of a flood plain sere between the cottonwood-willow and oak-hickory stages. Estimated age for a plant community of this type is somewhat less than 80 years.[2] The Applicants have provided a floristic analysis of Three Mile Island.[1]

b. Fauna - Most game animals of interest to the sportsman belong to the forest edge. Species found on the island were the cottontail rabbit, fox squirrel, deer, bobwhite, pheasant, and dove. Pheasant were especially abundant. They feed upon waste grains, weed seeds, insects (including grasshoppers, Japanese beetles, and corn borers), fruits of shrubs and vines, various greens derived from native plants, and farm crops such as clover.

The Applicants have provided a faunistic list of the terrestrial fauna of Three Mile Island.[1] This list includes several bird species which are endangered,[2] namely the peregrine falcon and the bald eagle. However, the Pennsylvania Game Commission[3] has indicated that the peregrine probably no longer occurs in the state and that the bald eagle is occasionally seen, but probably does not breed along the Susquehanna. The osprey, another species causing some concern, is described as unusual, but not rare in the state; a single individual was recently seen in the Harrisburg area. Because the latter two species are only rare transients in the area, plant construction and operation should not further endanger them.

2. Aquatic

The aquatic habitat in the vicinity of TMI is primarily of interest as a fishery. The area may be subdivided into three areas on the basis of their importance as fisheries.

Area 1: The reservoir above York Haven dam between the island and the east bank of the river is not fished very much, except in the fall when smallmouth bass may be caught. As a stream habitat it is a mud-bottom pool.

Area 2: The area southwest of TMI just above the dam, also a mud-bottom pool, is most popular, with muskellunge, smallmouth, and largemouth bass, redbreast sunfish, and rock bass being taken. Rock bass and redbreast sunfish predominate.

Area 3: The area below the falls on the east shore near Falmouth is popular for muskellunge during the winter. It is a pool at the end of a rifle habitat.

The area below the TMI impoundment is more popular as a fishery than the TMI impoundment because of easier access. Downstream, the area below the Brunner Island fossil fuel power station provides good year-around fishing.

The quantity, quality, and variety of fish in a stream are indicators of the ecological balance of the stream and the quality of the water. The Applicants have contracted for fish population studies to be carried out: 1) to describe the present fish population of the river in the vicinity of TMI, 2) to detect any changes in this population after the Station goes into operation, and 3) if such changes do occur, to determine whether they were caused by the Station. The species composition of fish in the local waters as reported by the Applicants (Appendix A) suggests a healthy warm water river community containing several game species, as well as coarse fish such as carp.

Analysis of benthic invertebrates by C. B. Wurtz,[4] consultant to the Applicants, indicates a diverse and stable community. The number of species varied between 79 and 145 in the study years from 1967 to 1970, and were distributed among the major taxonomic groups expected in such a habitat. A species list with distribution by sampling station is available in the cited literature. A decline in species abundance occurred during these studies, which apparently reached maximum in 1969 although later analysis indicates recovery is taking place. Wurtz suggests[4] that: "There are strong indications that a toxicant has been introduced into the river from above the study area." Since the Susquehanna at this point lies below areas of intensive agricultural, urban, and industrial development, such degradation is not surprising. The maintenance of an aquatic community which is capable of recovering after stress provides additional evidence of the basic health of the community. The observation of such a substantial change in the benthos over a several year period will be important in interpreting Station operating effects on the stream biota.

The Applicants have provided[1] a list of aquatic plant species; they are what one would expect in this environment.

No information has been provided about diatoms, protozoa, or other physically small organisms in the areas likely to be affected by Station operations. However, because of the interrelated nature of natural community dynamics, observation of some portions of that ecosystem will provide information on the functioning and organization of the entire community.[5]

Reptile and amphibia species known to be in the area are also provided by the Applicants.[1] The only species of note is the bog turtle, *Clemmys muhlenbergii*, which is described as "known to be in the area." Its habitat requirements are described[6] as "partial to sphagnum bogs and clear meadow streams." It is doubtful that any suitable habitat was disturbed by transmission line routing does not appear to have been investigated by the Applicants. While this species is not formally listed as endangered at this time, its status is of some concern to the U.S. Department of Interior.[7]

REFERENCES FOR SECTION II

1. Environmental Report, Operating License Stage, Three Mile Island Nuclear Station Unit 1 and 2, Metropolitan Edison Company, Jersey Central Power and Light Company, October 1971.
2. Endangered Species of the United States, U. S. Department of the Interior, 1970.
3. Personal Communication, Ronald Sutherland, October 19, 1972.
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5. Kaesler, R. L. and Cairns, J., "Cluster Analysis of Data from Limnological Surveys of the Upper Potomac River," American Midland Naturalist, 88, 1, (1972).
6. Netting and Richmond, Pennsylvania Reptiles and Amphibians, Pennsylvania Fish Commission Booklet, (1950).
7. Personal Communication, Earl Baysinger, U. S. Department of Interior, October 19, 1972.
8. U. S. Department of Interior, National Register of Historic Places, Federal Register 37(51), as amended, Federal Register 37(129), 1972.

III. THE PLANT

A. EXTERNAL APPEARANCE

An indication of the functional design and external appearance of the finished Station is given by the architectural rendering presented in Fig. 5. A detailed plant layout is presented in Fig. 6. Certain buildings for each unit are designed to withstand direct impact of a jet aircraft (class I structures). They are the reactor building, auxiliary building, fuel handling building, control building, diesel generator building, intake screen and pump house, heat exchanger vault and the air intake structure. The turbine buildings, cooling towers, and service building are not designed to withstand aircraft impact (class III structures).

The most conspicuous structures on the site are the four 370 ft. high, hyperbolic, natural draft cooling towers. The towers are made of reinforced concrete and are left with a natural concrete finish. They are shown in Fig. 7, a photograph of the site taken during construction in August 1971. The two finished towers for Unit 1 are to the left. The nighttime lighting of the towers consists of four flashing red lights at the top and four steady red lights at the midpoint. The Unit 1 containment building and partially completed fuel handling and control buildings are in front of the turbine building at the left center. The partially completed containment building for Unit 2 is to the right of Unit 1 and the partially constructed forced draft cooling towers for Unit 2 are located to the right. Highway 441 is visible in the background.

Also shown in the photograph is the flood protection dike which is being built between the main plant area and the river at the upstream end of the island. The dike is an earth embankment constructed of clay and silt that has been compacted to produce a stable and relatively impervious wall. The dike exterior is protected from erosion by a layer of stone riprap on top of a layer of gravel and sand that is embedded in the clay.

Although all the major Station structures can be seen from the balcony of the Visitors Center, the dense foliage along the river screens all but the cooling towers from the view of the observer on the highway. From the river bank the tops of the major structures are visible, but most of the structures at and slightly above grade level are not.

The Applicants have plans for landscaping upon completion of construction. Because most of the site at grade level cannot be seen from the surrounding areas, this will probably not have an appreciable effect on the appearance of the Station to its neighbors.

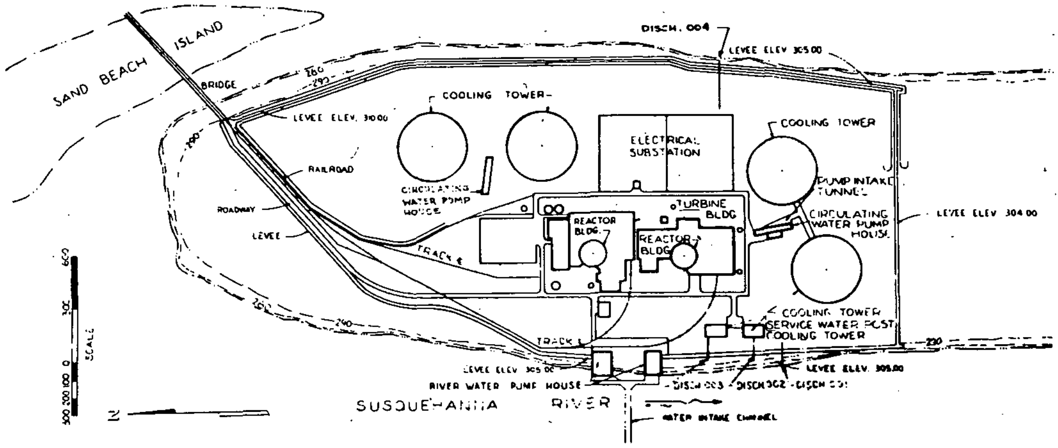

Figure 6 - THREE MILE ISLAND NUCLEAR STATION - PLOT PLAN

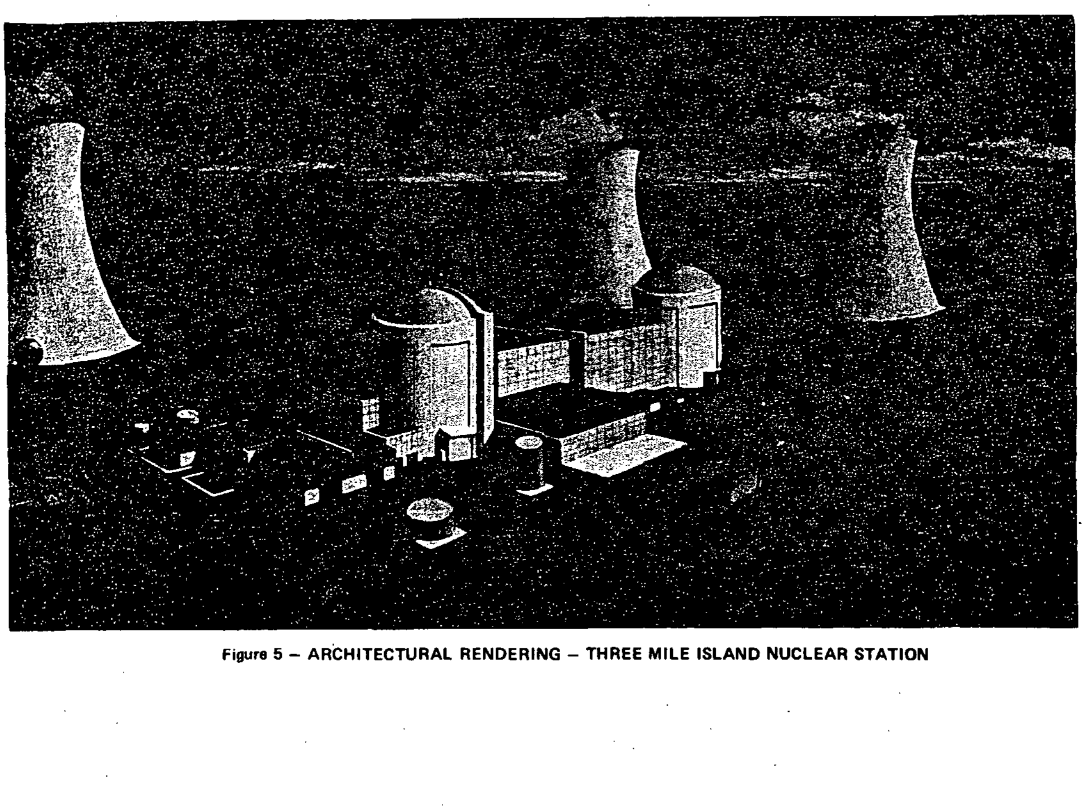

Figure 5 – ARCHITECTURAL RENDERING – THREE MILE ISLAND NUCLEAR STATION

Figure 7 — VIEW OF STATION DURING CONSTRUCTION

B. TRANSMISSION LINES

Unit 1 generates electric power, at 19 kilovolts, which is fed through an isolated bus phase to the unit main transformer bank where it is stepped up to 230 kV transmission voltage and delivered to the substation. In the case of Unit 2, the power is to be fed through the main transformer bank, where it i stepped up to 500 kV transmission voltage and delivered to the substation. Unit 1 is connected to the Met-Ed 230 kV transmission network by two lines, each 1.4 miles long, from the site to Middletown junction, and a 4.1 mile line, which connects to an existing line to Cly. In summary, for Unit 1 approximately 7 miles of 230 kV line have been constructed. All of the new circuits are installed on double circuit 230 kV lattice-type combination steel/aluminum towers except for two structures which are modified Dreyfus designed steel pole-type structures. The towers range in height from 66 ft. to 175 ft. and are approximately 35 ft. square at the base. There are about six structures per mile and the right of way for all the 230 kV line construction is 150 ft. wide.

Unit 2 will be tied into the existing Met-Ed 500 kV transmission network by a 0.7 mile line to the new TMI substation located east of the visitors center. From the substation, two 500 kV lines will extend on diverging paths to the existing Peach Bottom-Juniata 500 kV line. One connection is 7.1 miles long and the second is 11.1 miles long. This second line is to be constructed, owned, and operated by Pennsylvania Power and Light Company, which is not a GPU Company and which is not involved in the construction or operation of the Three Mile Island Nuclear Generating Station. When these lines are installed, the 500 kV tie between Peach Bottom and Juniata will be made at the TMI substation. In addition to this, clearing has been completed and construction is underway on a 67.3 mile, 500 kV line from the new substation east to Bechtelsville. Thus, for Unit 2, a total of 74.4 miles of new 500 kV line will be constructed. These circuits will be installed on single circuit 500 kV lattice-type all steel or combination steel/aluminum towers. The towers range in height from 87 to 177 ft. and the base dimensions vary from 10 ft. 7 in. x 24 ft. 9 in. to 64 ft. square. There are about 4.5 towers per mile and the right of way for all the 500 kV line construction is 200 ft. wide.

The original plans for Unit 2 called for a 230 KV transmission system. However, studies carried out by the Mid-Atlantic Area Coordination Committee (MAAC) on the transmission facilities of the Pennsylvania - New Jersey - Maryland (PJM) interconnection, indicated the need for a third west to east 500 KV transmission line east of the Susquehanna irrespective of the TMI project. There are already two west to east 500 KV lines west of the Susquehanna. As a result, the transmission lines for Unit 2 were designed at 500 KV for a dual purpose: to transmit energy from Unit 2 and to serve as part of the third west-east link.

The 500 KV line from TMI 500 KV Substation to Bechtelsville, together with the extension of that line by other PJM companies to Souderton, Pennsylvania (a point on the Whitpain - Branchburg 500 KV line) and the looping of the Juniata - Peach Bottom 500 KV line to the TMI 500 KV Substation would provide the third west-east line. All these segments are necessary for the third west-east line to exist.

Routing and clearing for the transmission lines has, wherever practicable, followed the recommendations incorporated in the U. S. Departments of Agriculture and Interior's booklet, "Environmental Criteria for Electric Transmission Systems".

Permits have been obtained from the U.S. Army Corps of Engineers and the Pennsylvania Department of Environmental Resources for the Susquehanna River crossings where necessary. The Pennsylvania Department of Transportation and the Pennsylvania Turnpike Commission will be requested to grant permits for road crossings. The Federal Aviation Administration has approved an application to construct the lines in the vicinity of the Harrisburg International Airport.

C. REACTOR AND STEAM ELECTRIC SYSTEM

The two reactors for the TMI Station are pressurized-water type supplied by the Babcock and Wilcox Company. Unit 1 has a thermal rating of 2535 megawatts corresponding to a gross output of 871 MWe, while Unit 2 has a thermal rating of 2772 MW corresponding to a gross output of 959 MWe. Since the details of the two cores are essentially the same, the following description applies to both Units 1 and 2. The nominal operating pressure for the reactor is 2155 psig with an average coolant temperature of 579°F. The reactor coolant system is designed for a pressure of 2500 psig at a temperature of 650°F.

The core reactivity is controlled by a combination of 69 movable control rod assemblies and a neutron absorber (boric acid) dissolved in the coolant. The control rods are silver-indium-cadmium alloy encapsulated in stainless steel. The control rods are used for short-term reactivity control associated with the changes in power level and also with changes in fuel burnup between periodic adjustments of dissolved boron concentrations. The reactor can be shut down by the movable control rods from any power level at any time. Each movable control rod assembly contains 16 control pins and is actuated by a separate control rod drive mechanism mounted above the reactor vessel. On receiving a trip signal the 69 control rod assemblies fall into the core by gravity.

Two outlet coolant loops are connected to the reactor vessel by nozzles located near the top of the vessel. Each loop contains one steam generator, two coolant pumps, and the interconnecting piping. Reactor coolant is pumped

from the reactor through each steam generator and back to the reactor inlet via two parallel loops by two centrifugal pumps located at the outlet of each steam generator.

The steam generator is a vertical straight tube and shell heat exchanger which produces superheated steam at constant pressure over the reactor operating power range. Reactor coolant flows downward through the tubes and steam is generated on the shell side.

For Unit 1 the steam flows from the steam generator to an 1800 rpm, tandem compound, six-flow steam turbine generator manufactured by General Electric. The turbine generator for Unit 2 is a tandem compound machine, 1800 rpm, with reheat and four-flow exhaust manufactured by Westinghouse.

The following organizations have been engaged by the Applicants as principal contractors for construction of the Station:

Gilbert Associates, Inc., Architect-Engineer, Unit 1 and
Burns and Roe, Inc., Architect-Engineer, Unit 2 --
authorized to design and engineer the entire nuclear power generating station, excluding the nuclear steam supply system, which will be designed by Babcock and Wilcox for the Applicants.

Babcock and Wilcox, Reactor Vendor --
authorized to design, build, and deliver the necessary components for the nuclear steam supply system.

United Engineers and Constructors, Inc., Construction Contractor--
authorized to manage the construction of the Station to the specifications established by the Applicants, Gilbert Associates, Inc., Burns and Roe, Inc., and Babcock and Wilcox. Authorized to procure material and engage subcontractors for construction.

Pickard and Lowe, Consultants--
consult on general nuclear and environmental engineering matters. The Applicants' project manager is responsible for coordination of the activities of the foregoing named principal contractors.

D. EFFLUENT SYSTEMS

1. Heat

The Station utilizes four hyperbolic natural draft cooling towers for dissipating the heat rejected from the plant steam cycle. Virtually all the heat from the turbine exhaust condensers is dissipated to the atmosphere through these towers. In addition to this major heat load there are several other cooling systems which dissipate heat from other portions of the plant. These include the secondary services cooling system, the nuclear services cooling system, and the decay-heat cooling system. A flow diagram of the Station cooling system showing the flow balance for both units is shown in Fig. 8.

Makeup for cooling tower evaporation, drift, and blowdown is obtained from the secondary services river water pumping system. After passing through the secondary services heat exchangers, water is mixed with circulating water in the cooling tower open flume. The maximum makeup flow is approximately 27,000 gal/min. which includes the approximately 20,000 gal/min. (44 cfs) evaporated by the four cooling towers and a minimum of 4,000 gal/min. blowdown from the cooling tower basins. The cooling tower water pump building is located between the condensers (in turbine building) and the cooling towers; it contains six circulating water pumps arranged so that three pump through each of two 103 in. diameter mains. The secondary services heat exchangers, located in the turbine buildings, cool equipment such as air compressors, lube oil coolers, sample coolers, heater drain pumps, hydrogen coolers, etc.

A flow of river water is also provided for the nuclear services heat exchangers, located in an underground vault next to the auxiliary building. These heat exchangers are used for decay heat removal from Unit 2 and for cooling nuclear equipment, such as reactor coolant pump motors, reactor building cooling units, fan motors, the spent fuel pool cooler, evaporator distillate cooler, waste gas compressors, etc. The river water used for cooling the nuclear services heat exchangers, along with the excess secondary system heat exchanger water and the condenser cooling circuit blowdown, is passed through a forced draft cooling tower before being returned to the Susquehanna River.

The Unit 1 decay heat removal system removes decay heat from the core and sensible heat from the reactor cooling system during the latter stages of a cooldown. The system also provides an auxiliary spray to the pressurizer for complete depressurization, maintains the reactor coolant temperature during refueling, and provides a means for filling and draining the fuel transport canal. In the event that the forced draft tower freezes up, the decay heat services cooling for both Units can be maintained by passing cooling water directly through the tower basin.

The river water, upon entering the intake structures, passes under a skimmer wall, through automated trash racks with 1 inch vertical bar spacings, through traveling screens with 3/8 inch mesh, through the river water pumps, and finally through strainers of 1/8 inch mesh, before passing to the heat exchangers. The intake river-water structure is provided with a deicing water line. Under normal operation in sub-freezing weather, condenser circulating water discharge will be the source of deicing water. The flow velocity at the intake structure under normal and low river flows and normal operating conditions is 0.2 ft/sec.

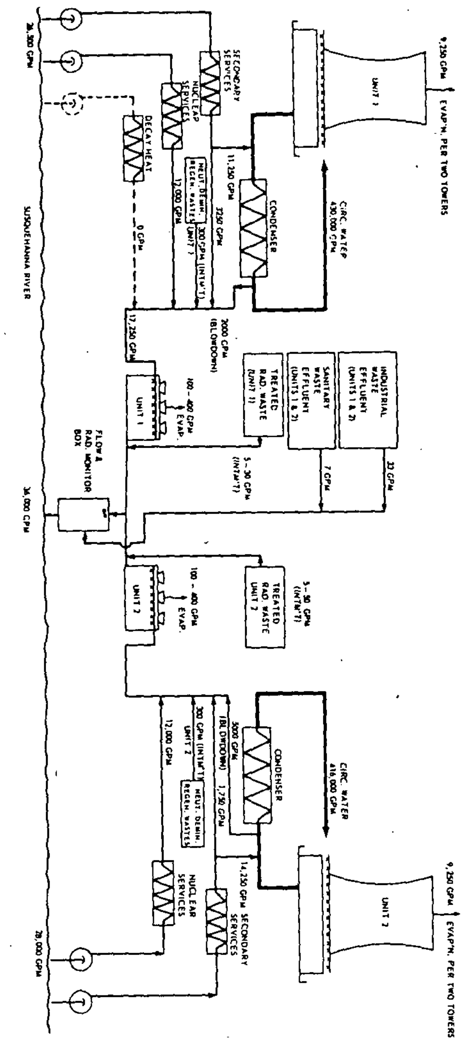

Figure 8 — WATER USE DIAGRAM, THREE MILE ISLAND NUCLEAR STATION

The river pumping systems are designed to pump from a minimum river level ("loss of York Haven Dam") of 271 ft., from the normal level of 278 ft., and also from flood levels. They pump to a high point in the plant and drain by gravity through a double-ended 48-inch diameter discharge line through the forced draft cooling tower. The discharge flow rate from the tower basin is measured by a propeller meter. Flow rate and radiation level of the Station radioactive waste are measured and the effluent is then mixed with this discharge. The mixture passes 100 ft. to a weir box where the radiation level is monitored as it is discharged to the river. The cooling water is finally released through a 72 inch diameter pipe line that discharges directly into the river behind the natural shore line. Under normal conditions the pipe is half submerged and the nominal discharge velocity is 2.7 ft./sec. with a maximum value of 5.2 ft./sec.

The river water temperature at the intake structure varies from a minimum of 33°F in the winter to a maximum of 85°F in the summer. As stated, all of the cooling water effluent from the plant is passed through a forced draft cooling tower (one for each unit) prior to discharge to the river. tThe temperature rise (over river ambient) of the effluent from the forced draft cooling towers varies daily and seasonally because of changes in cooling tower operation dictated by varying ambient air and river water temperatures. In the summer the forced draft towers will be operated so that the discharge is at essentially the ambient river temperature during normal Station operation. During a reactor cooldown* in summer, the discharge could be 2°F higher than river ambient, but would never exceed 87°F.

In the winter, because of the necessity for operating the cooling towers in the "deicing mode" (wherein a curtain of hot water is passed around the outside of the cooling tower fill to prevent freeze up), the effluent will average 3°F above river ambient during normal plant operation, although this could be as high as 10°F during an extreme river/air temperature mismatch. During a reactor cooldown in winter the initial discharge will, on the average, be 12°F above ambient, but under extreme river/air temperature mismatch conditions it could be as high as 19°F. A typical cooldown transient is such that the initial 12°F temperature difference would decrease to about 2°F within 12 hours (~ 1°F/hr). Under the extreme temperature conditions, effluent temperatures would decrease at a rate of approximately 1.5°F/hr. Furthermore, the usual operational mode will be to shut down only one unit at a time and, therefore, the initial effluent temperature difference will be the average of 3°F and 12°F or about 8°F.

The transit time from the intake to the discharge through the secondary and nuclear service heat exchanger circuits is about 13 minutes and the temperature rise is 10 to 15°F. The residence time of the coolant in the large basins under the natural draft cooling towers (capacity 8×10^6 gallons) is approximately 70 minutes and the temperature rise in the condenser cooling circuits is 28°F.

*Cooling down of the reactor primary coolant loop by the nuclear decay heat system following a reactor shutdown.

The maximum consumption of river water when the two units are operating at full power is 20,800 gal/minute. This is evaporated from the four natural draft cooling towers, and the two small forced draft towers.

2. Radioactive Waste

In the operation of nuclear power reactors, radioactive material is produced by fission and by neutron activation reactions of metals and material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes enter the effluent streams, which are monitored and processed within the Station to minimize the radioactive nuclides that will ultimately be released to the atmosphere and into the Susquehanna River at low concentrations under controlled conditions. The Limitations of 10 CFR Part 20 and the "As Low As Practicable" requirements of 10 CFR Part 50 with respect to radioactive releases will be met during the operation of the Station at full power.

The waste treatment systems for the Station, described in the following paragraphs, are designed to collect and process the gaseous, liquid, and solid waste which may contain radioactive materials. These waste handling and treatment systems are discussed in detail in the Final Safety Analysis Report for Unit 1 (March 2, 1970), in the Preliminary Safety Analysis Report for Unit 2 (March 1969), and in the Applicant's Revised Environmental Report dated December 1971.

a. Gaseous Waste. During power operation of the facilities, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor and particulate material including both fission products and activated corrosion products. The systems for the processing of radioactive gaseous waste and ventilation paths are shown schematically in Figures 9-11.

Concentrations of various solutes, such as hydrogen and boron, in the primary coolant are maintained at specified values, and the buildup of fission and activation products is limited by withdrawing coolant at a normal rate of 45 gpm (the letdown stream). A side stream from this coolant is cooled, depressurized, and diverted to the makeup and purification system and, as necessary, to the boron management system or the liquid waste disposal system, Figure 12. Normally, the vent valves on the makeup and purification system equipment are closed and the system is operated at positive pressure. By this procedure the inventories of noble gases in the coolant increase to steady-state values except in the case of long-lived krypton-85. Only the coolant that is diverted to the boron control system is normally degassed.

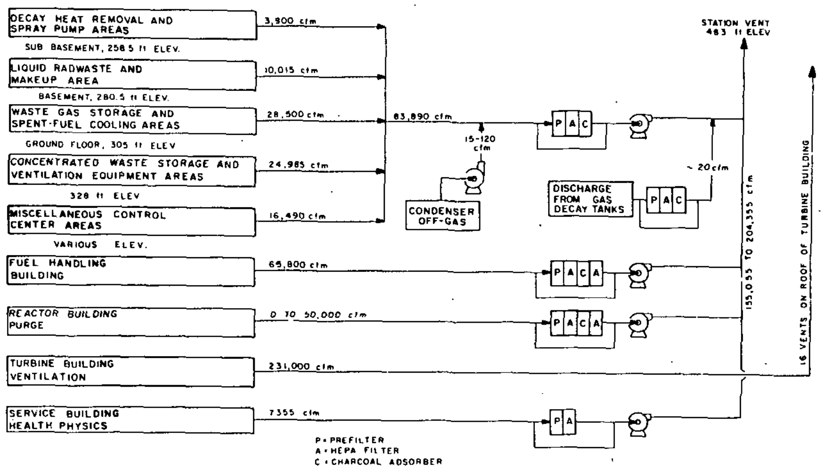

Figure 10 - VENTILATION SYSTEM, THREE MILE ISLAND NUCLEAR STATION - UNIT 2

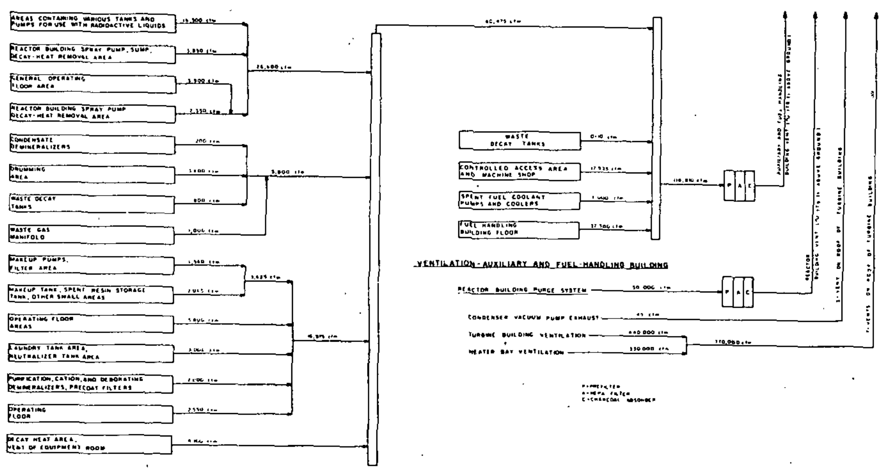

Figure 9 – VENTILATION SYSTEMS, THREE MILE ISLAND NUCLEAR STATION UNIT 1

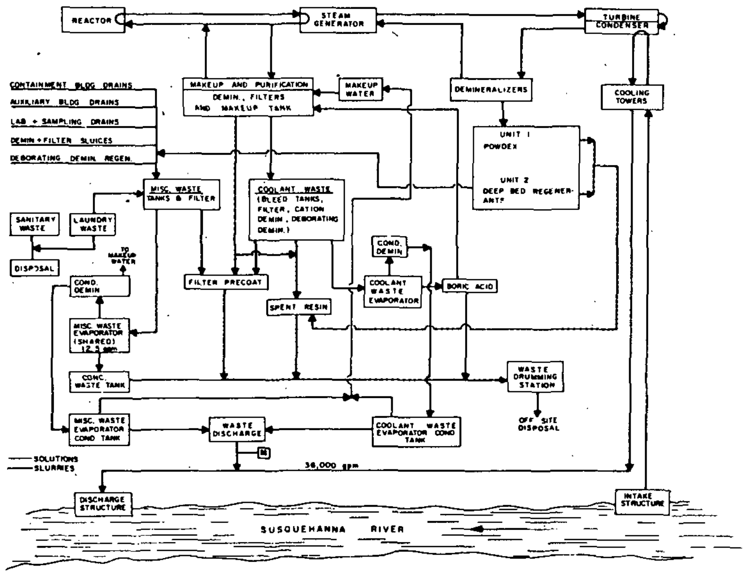

Figure 12 - LIQUID RADIOACTIVE WASTE TREATMENT SYSTEM, THREE MILE ISLAND, UNITS 1 AND 2

III-15

B-26

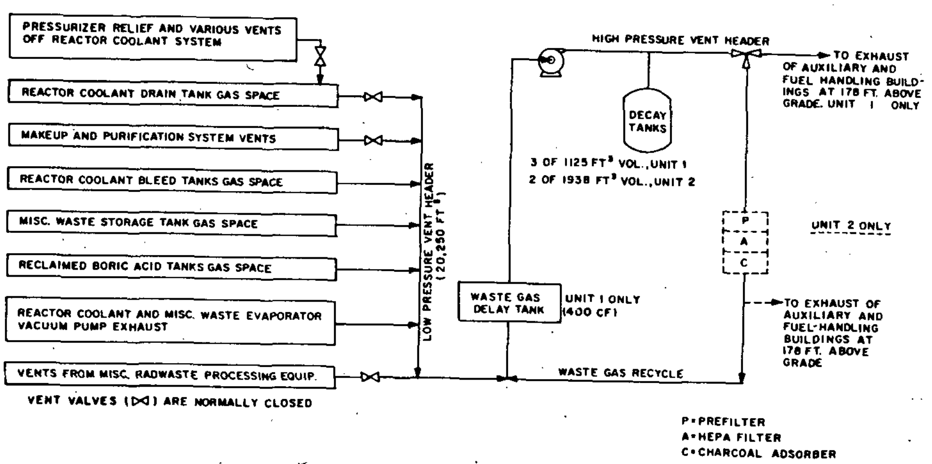

Figure 11 – GASEOUS RADIOACTIVE WASTE COLLECTION SYSTEMS, THREE MILE ISLAND UNITS 1 AND 2

III-14

Gases stripped from the recycled reactor coolant together with cover gases are collected, compressed, and stored in pressurized tanks for radioactive decay. With the exception of long-lived krypton-85, the gases will decay to a small fraction of the original amount prior to being released. The gas is filtered through high efficiency particulate filters and charcoal adsorbers and released to the atmosphere through the auxiliary building vent stack. The holdup system was evaluated based on the Applicants' statement that a minimum holdup of 30 days will be used.

Additional sources of radioactive gases which are not concentrated enough to permit collection and storage include the auxiliary building exhaust, the turbine building exhaust, the reactor building containment air, and the main condenser air ejectors, which remove radioactive gases which have collected in the condenser as a result of primary to secondary system leakage. The air ejector exhaust from the main condenser of Unit 1 is discharged through the turbine building exhaust without treatment. The ejector exhaust from Unit 2 is routed through demisters to the auxiliary building filter train and released to the station vent.

The auxiliary building is maintained at a slightly negative pressure with respect to ambient pressure. All the exhaust air is filtered through high efficiency particulate filters (HEPA) prior to being discharged through the auxiliary building vent stack. Areas within the auxiliary building which have possible contamination have the capability to be exhausted through charcoal adsorbers in addition to HEPA filters.

The steam generators are once-through units with no blowdown and with full flow demineralizers on the condensate return. Turbine building ventilation is discharged to atmosphere without treatment through roof-mounted exhaust fans.

Calculations of expected normal discharges of noble gases and iodines are summarized in Tables 4 and 5. The bases for these calculations are presented in Table 8.

b. Liquid Wastes. All equipment relevant to the liquid waste processing system is duplicated in the two units except the miscellaneous waste evaporator which is located in Unit 1 and shared by Unit 2. A notable difference between the two units is the method of condensate demineralization. Unit 1 uses Powdex; whereas, Unit 2 uses deep-bed demineralizers. Due to the constraints on waste processing in the miscellaneous waste subsystem, we assumed in our evaluation that 10% of the deep-bed regenerant solution and 100% of the Powdex sluice water will be released to the environment without treatment.

In both units a make-up and purification system maintains the quality and boron concentration of the primary coolant. A stream is continuously "letdown," cooled, demineralized in a mixed bed ion exchanger,

Table 4
ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE NUCLIDES IN GASEOUS EFFLUENT FROM THREE MILE ISLAND UNIT 1

	Discharge Rate (Ci/yr)				
Isotope	Containment Purge	Gas Processing System	Steam Generator Leak	Auxiliary Building Leak	Total
Kr-83m	-	-	1	1	2
Kr-85m	-	-	5	5	10
Kr-85	20	665	10	10	705
Kr-87	-	-	2	3	5
Kr-88	-	-	9	9	18
Xe-131m	2	53	6	5	66
Xe-133m	-	-	10	10	20
Xe-133	140	890	860	850	2740
Xe-135	-	-	15	15	30
Xe-138	-	-	20	20	40
I-131	.04	-	.01	.08	.13
I-133	-	-	.01	.08	.09

Table 5
ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE NUCLIDES IN
GASEOUS EFFLUENT FROM THREE MILE ISLAND UNIT 2

Discharge Rate (Ci/yr)

Isotope	Containment Purge	Gas Processing System	Steam Generator Leak	Auxiliary Building Leak	Total
Kr-83m	-	-	1	1	2
Kr-85m	-	-	5	5	10
Kr-85	20	725	10	10	770
Kr-87	-	-	3	3	6
Kr-88	-	-	9	10	19
Xe-131m	2	60	6	6	74
Xe-133m	-	-	1	1	2
Xe-133	160	970	940	930	3000
Xe-135	-	-	16	16	32
Xe-138	-	-	2	2	4
I-131	.04	-	-	.08	.12
I-133	-	-	-	.09	.09

filtered, and fed to the make-up tank from which it is returned to the reactor. When the boron concentration is being lowered, a "bleed" stream from the "letdown" stream is directed to the coolant waste system. This stream is processed through a demineralizer, filter and evaporator. The condensate from the evaporator passes through a mixed bed demineralizer to a storage tank from which it may be recycled or discharged. The concentrated boric acid (evaporator bottoms) is stored for re-use in a subsequent core cycle or sent to the radioactive waste drumming station for off-site disposal.

During the last portion of the core cycle, when the boron concentration is the lowest, the entire "letdown" stream is also passed through a deborating demineralizer to effect reduction of boron content, rather than by use of a "bleed" stream. This mode of operation does not produce a waste stream directly; however, this deborating bed is regenerated, and the neutralized regenerants and rinses are processed through the miscellaneous waste system. No other demineralizers processing radioactive streams are regenerated except the main condensate demineralizers in Unit 2, mentioned above. Other waste-water containing boric acid from reactor shutdowns, startups, and refueling operations is also processed through the coolant waste disposal system equipment.

Wastes collected in the containment and auxiliary building drains, lab and sampling drains, demineralizer resin and filter precoat sluice water, deborating bed regenerants, and decontamination and other miscellaneous wastes are processed in the miscellaneous waste system. These wastes are collected, filtered, and evaporated. The condensate from this evaporator is passed through a polishing demineralizer and then routed to recycle or to hold-up for discharge. Bottoms from this evaporator are stored in the concentrated waste tank until they can be processed through the waste drumming station.

Laundry wastes will be collected, filtered, monitored, and normally routed with the sanitary wastes. The turbine building drains are monitored and discharged to the cooling tower effluent stream. From an accumulative leak rate of 5 gpm from all systems in the turbine building that contain secondary coolant we expect less than .05 Ci/yr.

Controlled discharges will be made from the radwaste systems into the cooling tower effluent stream. This flow is 36,000 gpm on an annual average basis for the combined units. Unit 1 can discharge waste at up to 30 gpm while Unit 2 can achieve a maximum of 50 gpm. Activity monitors and flow controllers will maintain approximate activity levels. Discharges cannot be made from both units simultaneously. No discharge will be made unless the cooling tower effluent flow is at least 5000 gpm.

Based on the assumptions noted above and shown on Table 8, the releases from the primary sources for normal operation were calculated to be less than 5 Ci/year per unit. To compensate for treatment equipment

Table 6

ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE MATERIAL
IN THE LIQUID EFFLUENT FROM THREE MILE ISLAND UNIT 1

Nuclide	Curies/yr
Rb-86	0.00055
Sr-89	0.00044
Y-90	0.00005
Y-91	0.0099
Zr-95	0.00007
Nb-95	0.00007
Mo-99	0.037
Tc-99m	0.037
Ru-103	0.00005
Rh-103m	0.00005
Sb-124	0.00005
Te-125m	0.00003
Te-127m	0.00032
Te-127	0.00035
Te-129m	0.0016
Te-129	0.0010
Te-131m	0.00074
Te-131	0.00014
Te-132	0.019
I-130	0.0013
I-131	1.8
I-132	0.020
I-133	0.21
I-135	0.025
Cs-134	0.21
Cs-136	0.083
Cs-137	0.17
Ba-137m	0.16
Ba-140	0.00048
La-140	0.00042
Ce-141	0.00007
Ce-144	0.00005
Pr-143	0.00007
Pr-144	0.00005
Nd-147	0.00002
Na-24	0.00007
P-32	0.00007
Cr-51	0.0011
Fe-55	0.0010
Fe-59	0.0006
Co-58	0.0097
Co-60	0.0012
Ni-63	0.00009
W-185	0.00005
W-187	0.00058
Np-239	0.00035

TOTAL ∿ 3.0 Tritium-1,000 Ci/yr

Table 7

ANTICIPATED ANNUAL RELEASE OF RADIOACTIVE MATERIAL
IN LIQUID EFFLUENTS FROM THREE MILE ISLAND UNIT 2

Nuclide	Ci/yr	Nuclide	Ci/yr
Rb-86	.0012	Pm-147	.000054
Sr-89	.0041	Na-24	.000089
Sr-90	.00012	P-32	.00048
Sr-91	.000018	Cr-51	.0088
Y-90	.000072	Mn-54	.000036
Y-91	.0082	Fe-55	.011
Zr-95	.00072	Fe-59	.0054
Nb-95	.00080	Co-58	.095
Mo-99	.032	Co-60	.013
Tc-99m	.030	Ni-63	.011
Ru-103	.00048	Zn-65	.000054
Ru-106	.00014	W-185	.00045
Rh-103m	.00048	W-187	.00082
Rh-106	.00014	Np-239	.00075
Sb-124	.00036		
Sb-125	.000036	TOTAL ∿ 5.0	
Te-125m	.00034		
Te-127m	.0036		
Te-127	.0034	Tritium 1,000 Ci/yr	
Te-129m	.014		
Te-129	.0088		
Te-131m	.0012		
Te-131	.00021		
Te-132	.050		
I-130	.0013		
I-131	2.7		
I-132	.052		
I-133	.20		
I-135	.021		
Cs-134	.54		
Cs-136	.15		
Cs-137	.41		
Ba-137m	.39		
Ba-140	.0030		
La-140	.0032		
Ce-141	.00066		
Ce-143	.00002		
Ce-144	.00045		
Pr-143	.00039		
Pr-144	.00045		
Nd-147	.00014		

Table 8

ASSUMPTIONS USED IN DETERMINING RELEASES OF RADIOACTIVE EFFLUENTS AT THREE MILE ISLAND

	Unit 1	Unit 2
Reactor Power, MWt	2535	2772
Plant Capacity Factor	0.8	0.8
Fuel with Defective Cladding, %	0.25	0.25
Leak of Primary Coolant into Steam Generators, gpd	20	20
Leak of Primary Coolant to the Auxiliary Building, gpd	40	40
Frequency of Containment Purge, times/yr	4	4
Waste Gas Holdup for Decay, days	30	30
Cold Shutdowns, times/year	2	2
Coolant Volumes Degassed and Processed During Cold Shutdowns and Normal Operations	5	5
Miscellaneous Waste Processed, gallons/year	600,000	600,000

downtime and expected operational occurrences, the values shown in Tables 6 and 7 for the waste systems have been normalized to 3 curies per year for Unit 1 and 5 curies per year for Unit 2.

c. Solid Wastes. The following types of solid wastes will be treated in Unit 1 (Unit 2 wastes that require solidification will be transferred to Unit 1):

(1) Compressible wastes - paper, rags, clothing, and charcoal filters.

(2) Incompressible wastes - metal parts from inside the reactor, wires, cables, and spent filter cartridges.

(3) Evaporator concentrates.

(4) Spent resins and used filter precoat.

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

3. Chemical and Sanitary Wastes

The chemicals used in significant quantities at the Station are listed in Table 9.

a. Demineralizer Regeneration Solutions. Sulfuric acid and sodium hydroxide solutions are used for regenerating resins in the two-stage feed water demineralizers used for both Units 1 and 2. These materials are disposed of on a batch basis; each batch, for a given unit, consists of 2,000 pounds of sulfuric acid and 1,300 pounds of sodium hydroxide diluted in 70,000 gallons of water. The resulting solution of sodium sulfate, with a pH between 6 and 9, is released every three days at a controlled rate over a 4-hour period (about 300 gpm flow rate). The waste solution is diluted with the 36,000 gpm cooling water effluent of the forced-draft cooling towers prior to discharge to the river. The amounts listed in Table 8 are the total quantities of acid and base used annually for the two units at the Station. The concentrations in the second column of the Table, however, occur in the 36,000 gpm cooling water effluent only during the batch discharge from a single unit, since the two units discharge their batches at different times.

b. Condensate Polisher Regeneration Solutions. The condensate polishers for Unit 1 are the wound element filter type precoated with powdered resin. The spent resin is washed out and discharged to the sludge treatment house rather than being regenerated, hence no regeneration

Table 9. Major Chemicals Used at the Station **

	Average quantity released (lbs./yr.)	Incremental concentration in water released to environment during batch discharge (mg/1)
Regeneration of water treatment demineralizers (units 1 &2):		
H_2SO_4	485,000	29 (as SO_4)
NaOH	312,000	11 (as Na)
Condensate polishers (unit 2 only):		
H_2SO_4	210,000	30 (as SO_4)
NaOH	173,000	14 (as Na)
Sulfuric acid added to cooling tower circuit for pH control (units 1 & 2)	4,450,000	28* (as SO_4)
Concentration of river water solids in cooling tower blowdown (Units 1 and 2)	----	107*
Chlorine gas used as biocide (units 1 & 2):		
Service water chlorination	73,000	0.3 ppm†
Cooling tower circuits chlorination	365,000	

*Continuous discharge at this level, see text.

†Total residual chlorine.

**See Appendix B for Susquehanna Water Quality Data at TMI.

chemicals are used. The condensate polishers for Unit 2, however, are deep bed demineralizers and produce dilute waste solutions of sulfuric acid and sodium hydroxide from the regeneration of the demineralizers. The quantities used are 2300 pounds of sulfuric acid and 1,900 pounds of sodium hydroxide per regeneration cycle, which occurs every fourth day. These chemicals, dissolved in 60,000 gallons of water, comprise a batch which is released over a period of four hours every four days (about 250 gpm flow rate). This batch is neutralized and diluted in the effluent of the forced draft cooling tower prior to being released to the river. The quantities of materials listed in Table 8 are the total quantities of sulfuric acid and sodium hydroxide used for Unit 2 and the concentrations in the last column of the Table are the values in the 36,000 gpm of cooling water during the time of the batch release.

c. Sulfuric Acid for Cooling Tower Circuits. Sulfuric acid is added to the circulating water in the condenser cooling water circuits, for pH control, at an average rate of 12,200 pounds/day for both units, and the Applicants have stated that this quantity could increase to a maximum 2.5 times greater under some circumstances. This acid, which forms sulfates with the various cations in the cooling tower water, is eventually released with the 4,000 gpm blowdown from the two units and mixed with the Station cooling water before it is returned to the river. The total quantity of sulfuric acid listed in Table 8 is based upon the average addition and the concentration in the last column of the Table is the resulting sulfate in the cooling water effluent due to the continuous addition of acid.

In addition to the acid added to the blowdown there is a concentration of the naturally occurring salts in the river water by about a factor of 5 in the cooling tower basin. This also leads to an increase in dissolved solids in the blowdown water which, in turn, increases the dissolved solids content of the 36,000 gpm cooling water effluent returning to the river. The average concentration of dissolved salts in the river is 238 mg/1. This is concentrated to about 1200 mg/1 in the blowdown, which, after dilution with the cooling water, results in a final concentration of about 345 mg/1 in the effluent from the station.

d. Chlorination. The water taken from the river (54,500 gpm total for both units) is treated with approximately 200 pounds/day of chlorine to prevent the growth of biological slimes in the service water heat exchangers. Although a program for these chlorine additions has not yet been established, experience with other plants indicates that it will be added over several one-half hour periods during a 24 hour day. An average of 1,000 pounds/day per unit of chlorine will also be injected into the cooling tower circulating water system for control of biological slimes and plant growth. The chlorine will be injected one to four times a day for periods of 15 to 30 minutes each. The Applicants have also stated that the 1,000 pounds/day average value could increase to a maximum of 2,000 pounds/day.

In the recirculating water (natural draft cooling tower) system it is unlikely that chlorine released in the blowdown will exist at a level such as to cause violation of the EPA recommended criteria* for the river. The chloramines produced in the recirculating water system and in the makeup water before addition to the system will largely be lost by volatilization in the cooling towers. The free chlorine present at the position immediately downstream of the condensers will at least partly be destroyed by reaction with organic slimes in the piping, in the cooling towers, and in the collecting basins beneath the cooling towers.

However, some of the effluent from the secondary services and all of the nuclear services effluent are discharged after only one pass through the forced draft cooling towers (i.e. does not pass through the natural draft cooling tower circuit) and the flow and radiation monitor-box. The chlorine level in the service waters (during periods of chlorination) will be high because of the necessity to defoul a series of heat exchangers, and the degree to which the chloramines will be removed by evaporation and the free chlorine removed by reaction with slimes and other substances in the forced draft cooling towers cannot be predicted accurately. The Applicant states that the total residual chlorine at the point of discharge to the river cannot be guaranteed to be below 0.3 ppm. The Staff believes that by careful control of the levels and duration of chlorine additions the residual total chlorine in the discharge can be kept to a level of 0.1 ppm that would be required to assure conformity to the EPA recommended criteria for the river.* If in fact experience indicates that it will not be possible so to maintain the residual chlorine in the discharge, alternative methods of operation can be considered, including the passage of all service water into the recirculating condenser cooling water circuits. This would lead to the large residence time in those circuits (prior to blowdown) that will be required for evaporation and decomposition of the chlorine species. This would lead to greater blowdown rates and more dilute solutions in the recirculating water systems.

e. Sanitary Wastes. The sanitary waste system is designed to handle about 10,000 gal/day (sized to handle a normal population at the site of about 120 persons). The treatment plant is an activated-sludge system with tertiary treatment. The system consists of two aeration tanks and an aerobic digester which produce an odor-free sludge that will be used for land fill. With proper operation it is expected that 93% of the biological oxygen demand (BOD) in the intake will be removed. The remaining BOD is further reduced by the addition of sodium hypochlorite. The chlorine applied to the sewage varies from 0 to 8 ppm, but the Applicants state that the residual chlorine is always less than 1 ppm. The treated sanitary waste is mixed with the service water and blowdown before discharge to the river as shown in Figure 8.

Since the nonradioactive laundry waste water passes into this system, the control of phosphate discharges is also of interest. The tertiary stage of the system includes a lime process removal of the phosphate ions, and it is expected to remove 80% of the input phosphate. The discharge from the treatment plant contains about 6 ppm of phosphate ion.

*See Section V-C-2.

4. Other Wastes

The chemicals and additives used in the makeup water pretreatment system generate a sludge consisting mainly of fine silt, and suspended matter from the river along with clay added to assist in coagulation. The sludge is separated from the carrier water by filtration at a 95% removal efficiency, resulting in compressed dewatered blocks. The blocks, approximately 2,000 pounds/day, will be collected and trucked off site to an approved sanitary land fill. An additional 66 pounds/day of solid sludge cake from the sanitary waste system is also disposed of in an approved off site sanitary land fill.

There is a small oil fire incinerator at the site for disposing of nonradioactive combustible trash; the ashes from the burning of 400 pounds per day of wastes are hauled off site for disposal in a licensed land fill. The solid waste and trash from the river water removed from the plant intake screens is also hauled off site and disposed of in a land fill.

IV. ENVIRONMENTAL IMPACT OF SITE PREPARATION AND PLANT CONSTRUCTION

A. SUMMARY OF PLANS AND SCHEDULES

1. Plant Construction

Construction started in the fall of 1967. The original plan was for Unit 1 only, but GPU decided to move Oyster Creek Unit 2 to TMI. Construction of Unit 1 should be completed by early 1973, but Unit 2 construction will continue well into 1974. Manpower for construction has increased to a current peak of about 2,200 workers, and this level should remain fairly constant through December 1972. Throughout 1973 the level of employment is expected to decrease, and by early 1974 will be half of the current requirements.

2. Bridges and Highways

Two bridges provide access to the Station. Both span the east channel of the river and lead to State Highway 441. The bridge at the north end of the island is the permanent private access road. The permit was issued on October 13, 1967. This bridge provides access for a one-track Penn. Central R.R. spur, as well as an asphalt surface two-lane road, and has evidently been in service from the date at which construction began. It is of all concrete construction with some of the columns supported at Sandy Beach Island, which is spanned by the bridge. Excavation on this island and on the east shore was exposed at the time of the aerial photograph (Fig. 13) but no evidence of construction effects or erosion was observed at the time of the site visit by members of the staff.

The south bridge is wood and provides auxiliary access during construction. It is less than two years old and it is intended to use this bridge for access to the recreational site that will be developed subsequent to plant construction (see Section V). This bridge is the property of the York Haven Power Company, a wholly owned subsidiary of Met-Ed.

3. Transmission Line Construction

The towers and 230-kV lines to the Middletown and Cly junctions from Unit 1, a distance of 6.9 miles, are completed. From Unit 2, there will be one 500-kV and one 230-kV line, both taken to a 500 kV substation 0.7 miles east, on Applicant's property on the east side of State Highway 441. The area containing the transmission line substation, about 20 acres, has been cleared and closed in with cyclone fence. Selective clearing of 393 acres of right-of-way for the 500 kV line extending from this substation 67.3 miles to the Bechtelsville junction has been completed, and construction of the line is well underway. The major impact of the construction of the Bechtelsville transmission line has already taken place, that is, the clearing of the right-of-way. The incremental impact of the remaining construction is not considered to be substantial or unduly adverse. No clearing or construction has taken place for the 500 kV line running between the TMI Unit 2 substation and the

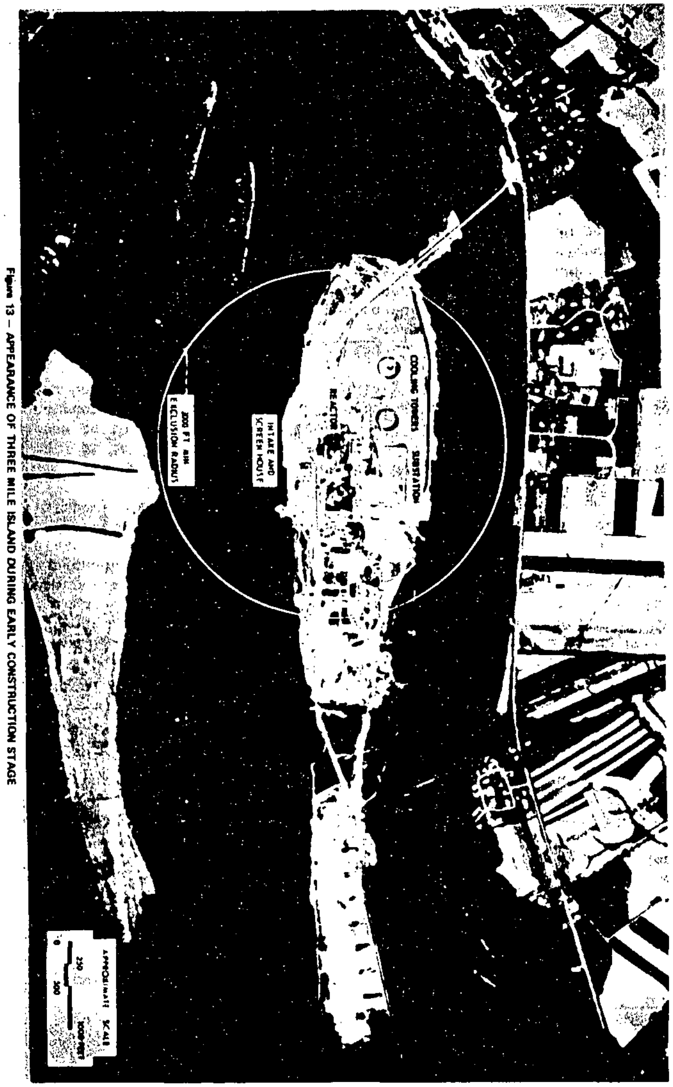

Figure 13 — APPEARANCE OF THREE MILE ISLAND DURING EARLY CONSTRUCTION STAGE

PLOT PLAN AND LOCAL AREA PHOTO
THREE MILE ISLAND NUCLEAR STATION UNIT 1
FIGURE 2-3

Juniata-Peach Bottom line. All of the transmission line construction is scheduled for completion by the winter of 1973. The ground under existing towers shows no effects of excavation during construction.

4. Visitors Center

The Applicants own approximately eight acres of property, including three farm buildings, along the east side of Highway 441, directly east of the Station. The visitors center and observation platform is in a newly constructed building about 80' wide x 100' deep with sloping roof. This building, along with landscaping and asphalt parking lot for about 25 cars, was completed during 1971 and is in use. The farm buildings purchased with the property appear to be newly painted and are being used for housing the quality control group. There is a gravel road that leads to the rear of the property, for access from the highway to the 500-kV substation area at the rear of the property. Some heavy equipment for construction of the Station was on the premises during the fall of 1971, but because this part of the property is at lower elevation than the highway, the construction cannot be seen from the highway.

B. IMPACTS ON LAND, WATER, AND HUMAN RESOURCES

1. Land

a. Impact on TMI

Site preparation and plant construction have affected only the 472 acres on TMI with no evident effect on Shelley or the other islands in the 814 acre site. A small (200' x 800') section of the State-owned Sandy Beach island, northeast of TMI, has been affected by construction of piers for the concrete bridge. Major impact has fallen on the north half of TMI, approximately 200 acres. Most of the land occupied by the Station was formerly farmed. The extent of the farm land is shown in the aerial photograph of the island, taken before the start of construction (Fig. 3). The part of the farm area that was excavated during the construction is shown in Figure 13. In addition to the 200 acres that surround the plant facilities, the remainder of the farm land, about 100 acres, is being used during construction for automobile parking, construction shacks, road to the south bridge, and for fill needed during site preparation.

Most of the forest land, about 172 acres, (Fig. 3) remains untouched. Tree damage has occurred mainly on the east and west shores of the island that abut the Station site, where trees were removed for railroad track and bridge construction, for construction of the water intake and pump houses and for effluent trench facilities. The shore to the west of the reactor locations is almost completely stripped of tree cover. The trees on the east shore have been thinned out and the existing trees provide very little landscape screening. In total, about 28 acres of wooded land were disturbed by construction.

A factor that both adds to prevention of wind and rain erosion and indicates considerable moisture at the surface is the rapid growth of vegetation. The flood control dike system that was constructed from the fill and that surrounds the facility area on three sides is completely covered over. The older borrow pit areas are also covered by a variety of weeds. The measures that were instituted to control dust, mud silt runoff, and flood waters are described in Section IV-C.

Construction rubbish - large rocks and pieces of wood and metal scrap - is widely dispersed in the borrow pit area and can be seen from the road that leads from the construction area to the south bridge.

Another major effect on land use was the removal of 70 recreational cabins on the island, that were built and in use by a lease arrangement. All but two of the cabins were moved to nearby islands at the Applicants expense. A small picnic area, consisting of five tables, two fireplaces, two toilets, one boat dock, and a drinking-water well, was destroyed by the construction.

The area of construction activity must be presumed to be totally lost as a wildlife habitat for the lifetime of the Station. Other parts of the island will be less suitable than formerly because of the large numbers of people and machinery traversing the island. The effect is similar to any large scale construction in a rural area. It is difficult to assess the influence of noise, but since jet flights to and from Harrisburg fly near the island, and since there is a railroad and well-traveled highway nearby, noise sensitive species would already have been affected.

b. Impact on Shore (Mainland) Property

The shore property disturbed by construction includes 8 acres of farmland purchased by the Applicants for the Visitors Center, and about 2 acres of woodland west of Highway 441 on the river east bank. About one-half acre of farmland was used for the Visitors Center building, the adjacent paved parking lot and the grass landscape. The impact of this construction was relatively minor. The land relief change was evidently insignificant. Similarly, the Unit 2 substation will not require a significant degree of cut or fill. On the west side of the highway, the trees were removed to provide a view of the Station from the Visitors Center.

2. Water

The impact of construction on silting of the river water and changes in topography of the island shore line and river bottom arise primarily from dredging the intake channel and installation of the intake water pump houses located at the west shore of the island, opposite the reactor buildings. Some temporary damage was also caused by the bridge pier construction in the east channel of the river. Some silting can, and probably does, result from the storm water drainage system that empties into the east channel. Pollution of the river by uncontrolled disposal of solid or liquid wastes may also occur but there is no evidence that the precautionary measures described below in Section IV-C have been violated.

The impact of the water intake building construction comes from several sources. The formation of water intake channels required blasting that caused temporary turbidity of the water, disturbance of the natural riverbed silt and some fish kill. There was some disturbance of the river banks caused by the blasting and dredging operations. The cofferdams that were constructed before foundations and housing buildings could be poured caused temporary silting of the river and changes in the shoreline. The material used for cofferdam construction and the rock formed by the blasting created foreign matter in the river.

3. Human Resources

The impact on human resources in the area arises primarily from the need for skilled labor for the construction of the Station. About 65% of the 2,000 or so construction employees had to be brought in from outside the area. Staff members of the Tri-County Planning Commission in Harrisburg have stated that the rate of residential construction in the Harrisburg area has been significantly reduced through the absorption of skilled labor by the Station construction and the highway construction in the Harrisburg area.

The migration of construction workers to this area has affected the supply and cost of housing relatively little. Workers without families who are looking for rental rooms or apartments in the immediate area, primarily Middletown and Royalton, report that such accommodations are in short supply and quite expensive. There are, however, a large number of trailer units in the area that were formerly occupied by service personnel and civilian employees at Olmsted Air Force Base. The closing of this base has made reasonable cost housing available for the families of Station construction workers. There are no reports or evidence that the families of Station construction workers have concentrated sufficiently in any one area to cause overcrowding of school or hospital facilities. Again, the lack of pressure may be partly due to the coincidence of the closing of the Air Force base.

C. CONTROLS TO LIMIT IMPACT OF PLANT CONSTRUCTION

Several provisions have been taken to minimize dust formation due to exposure of soil and to control storm water drainage so as to minimize river silting caused by storm water drainage. Excess surface water is collected by an underground piping system in the main plant area and drained into ditches at the periphery of the main site. The collecting ditch drains through a 60-inch diameter culvert into the east channel of the river. The culvert is

so designed that at heavy runoff the flow from the trench is impeded, causing heavy silt to settle to the bottom of the trench instead of being carried into the river. The borrow pits, sources of construction fill, and their surrounds were shaped to that eroded soil is carried toward the pit rather than into the river.

The flood protection dikes, constructed from the fill excavation to the south of the main site, were carefully finished to minimize erosion by storm water and wind. The exterior slopes have a heavy stone riprap finish on an embedded layer of gravel and sand, and they are already partially covered by natural vegetation. The interior slopes were planted with crown vetch.

The exposed surfaces in the main plant area intended for automobile parking are paved with an asphalt surface, as are the main roads. Heavily travelled paths between buildings are covered with crushed stone, and much of the lesser travelled surface is covered with weeds that seem to grow readily in the whole area.

Damage to the river bottom from the intake channel blasting was minimized by removing the shot rock to the borrow pits from which the land fill was excavated. Erosion of the river banks adjacent to the intake water facilities was minimized by a covering of stone riprap. The two cofferdams that were constructed on the west bank of TMI before intake water facility housing could be erected were made from packed truckloads of earth and finished with a layer of riprap to prevent river silting.

The construction crews are ordered not to dispose of waste soil or solids into the river. Liquid and solid wastes from the latrines in the temporary and permanent facilities are stored and carried off the island pending completion of the permanent sanitary sewage treatment facility.

Heavy truck traffic to and from the Station has been minimized by use of the railroad spur onto the site for hauling in the large components and construction materials. A major factor in diminishing heavy truck traffic and highway damage has been the location of a concrete plant on the site.

V. ENVIRONMENTAL IMPACTS OF PLANT OPERATION

A. LAND USE

1. Access and Recreation

Since the Station is on an island wholly owned by the Applicants, and since the exclusion radius for each of the two reactors extends over land owned by the Applicants, the operation of the Station will deprive no one of access to land that he would otherwise have been free to enter. The major impact on TMI and adjacent Shelley Island is that about 400 acres of farmland will be lost to further production and about 70 summer homes have been relocated to Beshore Island, also owned by the Applicants. The Applicants have proposed to begin development of an extensive "recreational resource" on TMI and other islands in the vicinity that will expand the summer-home land lease program and replace the lost forest and farmland on the south end of TMI with a multi-use recreational area that will benefit the whole Harrisburg area. The pool, or reservoir, created by the York Haven Dam, raises the level of the river about 22 ft. To exploit the recreational potential of the river in this area, new facilities such as boat launchways, docks, and car parking facilities are needed. The Pennsylvania Fish Commission has recognized this need by acquiring shore land adjacent to Goldsboro, on the west shore, that will be used as a start for providing the above mentioned facilities. The recreational facilities on TMI that are proposed by the Applicants are shown in Fig. 14. Initially, these will include all circulatory roads, a marina (excavation), 80 boat slips and docks, parking for 50 cars and boat trailers or 275 cars, 125 picnic sites, 2 comfort stations, 2 group picnic areas, 2 picnic shelters with comfort stations, a shoreline trail, general landscape development around use areas, drinking water distribution, and a sewage disposal system (septic tanks).

The Applicants plan to spend about $750,000[3] on development in addition to that already completed.

A longer range, more extensive recreational resource development project has been proposed by the Applicants after consultation with several state agencies and county planning commissions (Tri-County, York and Lancaster). Most of the acreage to be used in the new development will be Applicants' property, but the cost of the future developments will be only partially covered by Applicants' contribution. Some local and federal tax money will be necessary to complete the project. Formal agreements between the Applicants and interested agencies have not been completed at this time.

2. Transmission Lines

The 6.9 miles of 230 kV transmission lines associated with TMI Unit 1, which are completely built and ready for service, have little impact other than aesthetic since they traverse open farmland and no significant change in land use is involved.

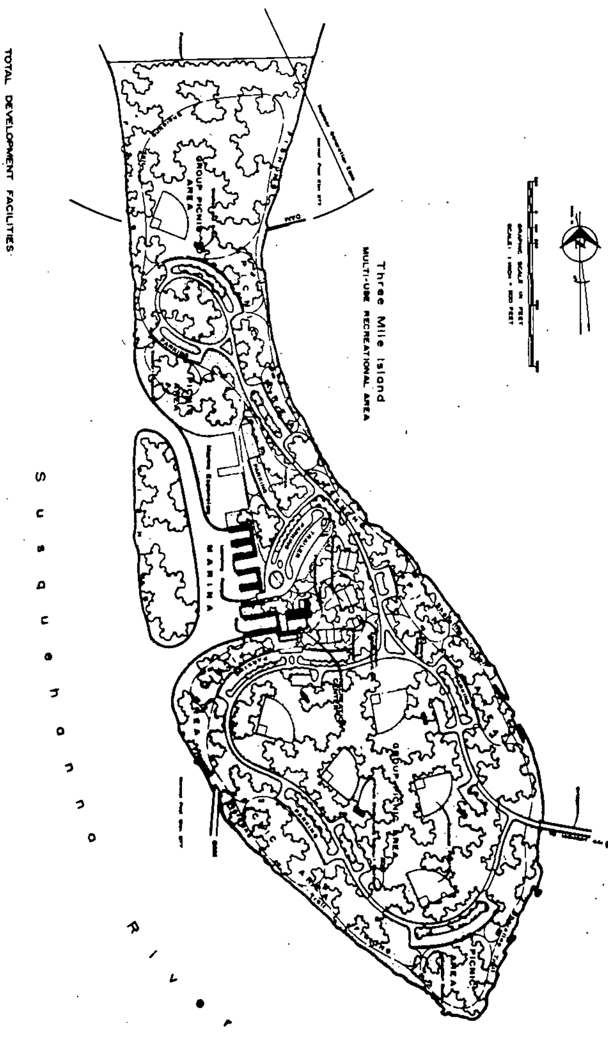

Figure 14 — PROPOSED MULTI-USE RECREATIONAL AREA AT THREE MILE ISLAND

The right-of-way for the 67.3 mile 500 kV TMI Unit 2-Bechtelsville line occupies about 1620 acres. The Applicants have stated that route selection was carried out using techniques and procedures which factored in the need to minimize relocation of property owners, to maximize use of existing rights-of-way, to avoid high points and long paralleling of highways, and to minimize environmental impact. Although existing rights-of-way could have been paralleled or utilized for most of the line, this approach was rejected because it would have required the removal of a large number of homes. The route which was finally chosen parallels or uses existing transmission corridors for 15 miles, and traverses primarily rolling farmland with some scattered woodland. The purchase of one home and the selective clearing of 393 acres of right-of-way were required. Of this 393 acres, 233 acres were second, third, fourth, or fifth growth forests, and the remainder abandoned pasture or agricultural land, brush and scrub field growth, overgrown meadows, fencerows, and the like.

Clearing was carried out in accordance with "Specifications for Right-of-way Clearing", developed in 1969 by one of the Applicants, which are fully consistant with the U. S. Departments of Agriculture and Interior's guidelines entitled "Environmental Criteria for Electric Transmission Systems". These procedures, largely prepared by professional company foresters, call for selective clearing by the preservation of desirable species, screening at all road crossings, steep slope cutting, and preservation and care for streams, paths, and trails.

The route does not cross public lands, and does not pass through areas of historic or recreational value. For 64.6 miles of the 67.3 mile route, easements have been obtained which permit the owners of the right-of-way to use the land for growing crops, grazing cattle, or growing trees to a limited height. Accordingly, little change in land use should result, in view of the predominantly agricultural nature of the land through which the right-of-way passes.

The TMI Unit 2-Juniata 500 kV transmission line extends 7.16 miles from the TMI 500 kV line, west of the Susquehanna River, between Juniata and Peach Bottom. The proposed right-of-way will occupy about 170 acres, half of which is farmland and the remainder woodland and river crossing. Six homes must be acquired, and condemnation proceedings undertaken for the 1.26 miles of right-of-way not already owned or covered by easements.

From TMI the proposed route would run southeast and south for about 1-3/4 miles, paralleling or utilizing existing right-of-way for most of this distance, and then cross the Susquehanna River. The point chosen for the river crossing is adjacent to crossings by four other transmission lines, the furthest 1/2 mile away, so visual impact will not be significantly altered.

West of the river the route traverses 1/2 mile of wooded property owned by the Applicant to a point opposite an existing substation, where it begins a parallel run with an existing 230 kV line for about 3 miles. Near the substation, crossing of a state highway is required, and since there is considerable strip development along the road, impact on homes and/or commercial property is unavoidable. The route chosen, paralleling the existing right-of-way, will necessitate the purchase of four homes located on that road. The final mile of the line diverts from the 230 kV parallel in order to avoid a juncture with the Juniata-Peach Bottom line at a point which would have required acquisition of a number of homes. This section traverses open farmland.

According to the Applicants, route selection has followed, to the extent possible, the recommendations of the U. S. Departments of Agriculture and Interior cited above, and selective clearing procedures will be in accordance with these guidelines and the Applicants' "Specifications for Right-of-way Clearing", also discussed above.

After reviewing the route chosen by the Applicants and comparing it with the available alternatives, and after balancing the factors relating to environmental impact, the staff has concluded that the proposed route for the TMI-Juniata transmission line represents the preferable approach and will not have a significant adverse impact on the environment.

Since a large proportion of the land traversed by the Station transmission lines is open farmland, and selective clearing procedures which largely retain low growing trees and shrubs have been used in the woodland sections, the impact on wildlife is expected to be minimal.

3. Effect of Cooling Tower Operation

Four large natural draft cooling towers, two for each unit, will be used to dissipate most of the condenser heat from the Station. In addition, two three-cell wet mechanical draft cooling towers (one for each unit) will be used to cool the combined service water effluent and the blowdown from the natural draft units so that there will be small thermal discharges to the Susquehanna River. At full load, 11.5×10^9 BTU/hr will be discharged to the atmosphere. Each tower will discharge a maximum 5000 gallons/minute of water in vapor form per minute.

Because of the large quantities of water vapor they discharge, concern has been expressed about the possibilities of weather modification, such as fogging, precipitation and humidity increase, icing, etc., which might be produced by the towers. Since the total operating experience with such towers in the U. S. is small, techniques for predicting weather modifications are still relatively primitive. Natural draft cooling towers have been used for at least two decades in Europe, expecially in England. Decker[6] has made a survey of European operating experience and has uncovered little evidence of adverse weather modifications attributable to natural draft cooling towers. Experience in the USA to date has revealed no significant problems.[5,7,8,9,10,11] Operational experience both in the USA and in Europe has shown that, of the various alternate cooling procedures, natural draft cooling towers have the lowest adverse meteorological impact.[4,5]

a. Cooling Tower Plume Model

The Applicant has developed a numerical model to predict the length and other dimensions of the visible plume generated by the cooling towers;[12] a summary of the model was published earlier.[7] This formulation is similar to other models, such the EG&G model,[13] in that plume motion is divided into two phases; (1) a plume rise portion describing the plume behavior in the immediate vicinity of the tower, followed by (2) an atmospheric diffusion calculation, describing the lateral dispersion of the plume once it has reached its point of maximum rise (zero upward velocity).

The plume rise section of the Applicant's model (within two km of the tower) is basically the isolated cumulus cloud model developed by Weinstein and Davis.[14] Further from the tower, where dispersion of the tower effluent is controlled by ambient wind and turbulence conditions, calculations of diffusion are made using the standard dispersion procedures.[15] The dispersion model predicts the change in absolute humidity (mass of water vapor per unit volume) as a result of the tower effluent. If this increment is more than the ambient saturation deficit,* some of the excess moisture will condense and a visible plume will form. Since the water vapor content of saturated air varies from 2.1 g/m^3 at -10°C to 17.3 g/m^3 at +20°C, it is clear that the potential for a visible plume is much greater during the conditions of low temperature and high humidity which typically occur during winter months. These meteorological conditions also contribute to the production of natural fog.

Typical results of cumulus cloud model calculations[13] give plume heights of 1,000 to 3,000 ft, even for stable lapse rates. Because of this high penetration altitude, the calculated subsequent lateral dispersion of the plume rarely results in a visible plume at an altitude lower than the top of the cooling tower. The calculations predict that meteorological conditions of moderate winds, stable lapse rates, and low saturation deficits favor the generation of visible plumes which, if they reach the ground, become fog.

*The saturation deficit is the water vapor content of saturated air minus the actual content or $(W_s - W)$ g/m^3.

Comparisons between the results of calculations using the cumulus cloud model and actual observations have rarely been published. Hosler[7] reports one observation of plume penetration to 1500 ft at the Keystone Plant, in agreement with calculated plume height based on atmospheric soundings (temperature and humidity measurements vs. altitude) taken at the Pittsburgh airport 50 miles away.

b. Fogging

The question of production of fog by cooling towers is of paramount interest, particularly with regard to possible effects on nearby population centers, roads and, in the case of the TMI Station, airports. Large natural draft towers have some inherent advantages over smaller mechanical draft towers in this respect. A natural draft tower releases a relatively large diameter plume at a high altitude from a single source, and the resulting plume, having a low surface-to-volume ratio, maintains its buoyancy and upward travel (because of a lower rate of mixing and resulting buoyancy loss due to turbulent interchange) to a higher altitude. The result is that the plume from a natural draft tower is able to penetrate very stable atmospheric conditions (inversions) and send plumes hundreds of meters into the air before leveling off. The plume then travels downwind from the tower, sometimes oscillating vertically about the lateral direction of motion, and because of its height, touches the ground infrequently. This behavior is in contrast to the forced-draft towers, which typically release plumes at lower elevations with higher velocities. This leads to turbulence and mixing at low altitudes so that plumes often contact the ground. Hosler[7] gives the only reported instance where the plume from a natural draft cooling tower was seen returning to the ground.

Using the cumulus cloud model, the Applicant has calculated the potential fogging effects at nearby Harrisburg International Airport from cooling tower operation to be 29 hours per year for the operation of one unit and 39 hours for the operation of two units. They further state that on any given day the effects persist for 6 to 10 hours. This yields 3 to 5 days per year when there is fogging potential for operation of one tower, and 4-6 days per year for two towers. The atmospheric sounding data (radiosonde) used in these calculations was U.S. Weather Bureau data from Washington, D.C. (100 miles away) and Pittsburgh (170 miles away). Later, the Applicants obtained atmospheric sounding data at the Station with an instrumented light aircraft for three 30-day periods, starting October 1, 1969, January 1, 1970, and March 15, 1970. They state that the results of calculations using the new atmospheric data verify the earlier predictions of fogging potential at Harrisburg International Airport (29 and 39 hours/year for the operation of one and two units, respectively). This implies that the atmospheric soundings at the Station were not greatly different from those at Pittsburgh and Washington, D.C. The Applicants also state that the new calculations indicate that about half of the 39 hours are before sunrise.

The Staff considers these estimates of surface fogging to be conservative, since experience at operational cooling towers shows that plumes rarely, if ever, reach the surface.[6,7,8,9,10,11,16] On those cold winter days when the plume is long enough to reach the airport, the base of the plume will usually be 300 to 500 feet above the runway.

Some indication of the impact of the cooling towers near the Station is given by the observations of plume length and frequency at the Keystone Plant. Bierman, et al.[11] report results of a study at Keystone based on observations of the cooling tower plumes for a 6-month period, February through July 1969. During this study, which included 144 individual observations, photographs of the towers were taken daily to explore the general characteristics of the plumes. The results showed that 81% of the time the plume evaporated to invisibility in the atmosphere; most of the remaining time it was absorbed in the overcast. The breakdown of the observations in the cases where it evaporated to invisibility (81%) was as follows:

a) Plume length less than five tower heights (1,625 ft) -- 87%;

b) Plume length five to fifteen tower heights — 10%;

c) Plume length greater than fifteen tower heights (> 1 mile) -- 3%.

Only one of the three winter months, when long plume formation is most likely, were included in the survey. However, if it can be assumed that the months of December and January are no worse than February and March, then the percentages given, on a yearly basis, would presumably still be valid or conservative.

Both the Keystone Plant and the Station are in geographic regions classified as having high fogging potential.[13] [A region of high fogging potential is defined in the study as one in which heavy fog is observed over 45 days/year, the maximum mixing depths are low (400 to 600 meters) from October through March, and the frequency of low-level inversions is at least 20 to 30%]. The topography of the two sites is similar; both are essentially wide valleys with hills about 200 ft. high on either side (but still well below the top of the cooling towers). Therefore, it is not unreasonable to expect that plume observations at Keystone would be useful in predicting results at the Station. According to the Bierman study, most of the time (70%) the plume would be well within the confines of the river banks and shadows would not be cast on the surrounding land. Approximately 10% of the time, or 36 days per year, when the plume evaporates to invisibility, the plumes would extend over the land, but they would be longer than one mile on only seven days. Of the total frequency of disappearance into the overcast (16.5%) given in the study, the plumes were greater than 1,625 ft long 87% of the time. This gives an incidence of 14% or 52 days/year under overcast conditions when the plumes will extend beyond the river to the land. Since

the skies are already overcast there would probably be no additional shadow produced by the plumes under these circumstances. The total number of days when the plume length would be longer than one mile would be about 14 days; 7 each under overcast conditions and evaporation to invisibility.

The atmospheric conditions tending to produce long cooling tower plumes are the same as those favoring the formation of natural fog and clouds. In general, however, because of their height, the towers release heat and vapor above the surface inversion which contributes to fog, and the plumes tend to rise above fog. Consequently, the most probable effect at the Station from the cooling towers is some enhancement of natural fog at some distance from the plant, particularly during the winter months when the atmospheric saturation deficit is low. The smaller forced-draft cooling towers at the Station on the other hand, will produce some local fog since their plumes do not have the capability for penetrating to high altitudes. They are not expected to have an effect except at the Station itself, since the nearest land areas which could be affected are 2,000 ft away, and the heat load on these towers is very low.

c. Precipitation

Operating experience with natural-draft cooling towers indicates no measureable enhancement of precipitation attributable to the operation of the towers. A study by IIT Research Institute[16] showed a negative correlation between rainfall measured at a number of measuring stations within 20 miles of the Keystone Plant after the start of tower operation. Increases in humidity at upper altitude levels beyond the visible plume have been measured with aircraft, but increases in humidity at the surface have not been detected.[16]

d. Drift and Salt Fallout

Although most of the water leaving the cooling tower leaves as vapor (evaporation accounts for 60-70% of the cooling effect) a small percentage of the water circulated is carried out of the tower as entrained droplets. In the more recent cooling tower designs, by the installation of drift eliminators (baffles above the cooling tower fill) the windbreaks around the fill, manufacturers claim that drift has been reduced to 0.03% or less of the water circulated. Drift values as low as 0.005% have been measured in operational cooling towers. Thus, the Applicants' stated drift rate (0.03%) is conservative.

At the Station the cooling tower basin is operated with sufficient blowdown to maintain a dissolved salt concentration of five times the normal river water concentration. Water containing these dissolved salts is carried out as drift and produces some salt fallout from the plume as the water droplets evaporate. Using conservative values for the river water of 100 ppm of sulfate, 100 ppm of carbonate and 20 ppm of chloride, assuming a five-fold concentration in the cooling tower basin and 0.03% drift, the staff obtains a total salt fallout with both units operating of approximately 1.2×10^6 lbs/yr. Making the pessimistic assumption that all of this is deposited evenly within a one-mile radius of the Station, total salt fallout would be about 600 lbs/acre/yr.

It is observed that, under most conditions, the drift particles evaporate completely before falling to the surface and that their salt is dispersed over a very large area before being swept from the atmosphere by rain or snow. Calculations of salt deposition from a salt water cooling tower show that there should be no significant problem at the Station.[17,18]

Discussions with personnel at the Paradise and Keystone Plants, both of which use river water for cooling tower makeup, indicate that there has been no noticeable salt fallout. It is concluded that the quantities likely to be deposited from the plumes at the Station would be undetectable visually.

4. Airport Use

In the following discussion, only the impact on the Harrisburg International Airport, 3 miles away, is considered since the Harrisburg-York Airport, 8 miles distant, is far enough so that it is essentially unaffected by the presence of the Station. While cooling tower plumes could occasionally extend aloft as far as this airport, it is well beyond the distance where ground effects from cooling towers have been observed.

a. Interference with Airport Traffic Patterns

The Station is well within the normal 5-mile radius which defines an airport traffic area. For light planes operating under VFR (Visual Flight Rules) conditions, the airport traffic pattern is normally 800 ft. above the surface. Thus the presence of the towers themselves does not constitute an inconvenience to air navigation, since VFR aircraft in the traffic area would be 400 ft. above the top of the towers when approaching or departing the airport. However, the plume rise would normally be higher than 800 ft. above the surface, and aircraft approaching from or departing to the south would have to fly around the plume. Since the towers are 3 miles south of the airport and the plume is likely to be less than 1 mile long most of the time, it does not appear that this would cause any particular problem to VFR traffic.

The position of the Station relative to the airport is well out of the existing instrument approach corridors as indicated by the following description of the current instrument approach procedures at the Harrisburg International Airport:

1. Runway 13 (the southeast runway) is a full Instrument Landing System runway (i.e., has electronic glide slope equipment). The approach minima applying to large jet aircraft are a decision height of 900 ft MSL (about 600 feet above the surrounding terrain) and a visibility of 1 mile. Aircraft using this instrument approach would not come near the Station during the approach and the point of closest approach to the Station would be upon landing at the airport.

2. Runway 31 (the northwest runway) is a localizer approach only (back course) without electronic glide slope information; however, the approach procedure stipulates that radar contact is required. The instrument minima for heavy jet aircraft are a minimum descent altitude of 860 ft MSL (about 560 ft above the surrounding terrain) and a visibility of 1-1/4 miles. The flight path of aircraft using this approach would be approximately 1.5 miles north of the site; however, the minimum descent altitude for the approach (the altitude below which aircraft are not permitted to go until visual sighting of the airport occurs) is 200 ft above the height of the cooling towers, which are at 670 ft MSL.

b. Effects on Instrument Flight Rules (IFR) Operations

The Applicants have calculated a probable fogging incidence of 39 hr/yr attributable to the operation of the Station cooling towers. Based on the cooling tower operating experience cited above, this is probably conservative. It is difficult to assess the impact of this on IFR operations at the airport in terms of delays that might be caused. On overcast days the plumes tend to merge into the overcast and, therefore, the effect at the airport on days with a low ceiling might be a slight lowering of the ceiling and/or slight reduction in visibility. Thus, the airport conditions would have to be borderline for the instrument approach minima in order for the cooling towers to affect the situation enough to prevent instrument approaches and departures. Since, at most airports, the number of days when conditions are exactly at instrument minima is relatively small, the impact is not expected to be large.

B. IMPACT ON RIVER WATER USAGE

All of the water used at the Station is drawn from the Susquehanna River.

1. Water Consumption

There is a net maximum consumption of river water by the Station of 20,800 gpm due to evaporation from the four natural draft and the two forced draft cooling towers. This amounts to 2.7% of the minimum river flow of 1,700 cfs (765,000 gpm) and 0.23% of the mean river flow of 20,000 cfs. Removal of water at this rate is not expected to have a significant effect on the water balance of the Susquehanna River in the vicinity of the Station since this is a small perturbation of the normal seasonal variation of the river flow (see Section II.E.).

2. Thermal Discharges

There is a nominal flow of 36,000 gallons per minute of cooling water returned to the river when both Units 1 and 2 are operating. Normally this effluent is cooled to river ambient temperature by the forced draft cooling towers. During winter operation, however, the effluent will average 3°F warmer than the river (see Section III-D), resulting in a heat load of 900,000 BTU/minute. This gives a mixed mean temperature increase for the minimum river flow condition (1,700 cfs) of 0.28°F and for the mean flow condition (20,000 cfs) of 0.024°F. Under unusual weather conditions, immediately after reactor shutdown the effluent could be as much as 19°F above river ambient for several hours. This could lead to an increase of approximately 1°F in the mixed river temperature at minimum flow conditions for a period of a few hours. In view of the small average temperature increases and relative infrequency of reactor shutdowns, and since the heat load will be added to the river during the winter, the staff concludes that the thermal discharges of the Station to the Susquehanna River will have a negligible effect in terms of the present use of the river for recreation, municipal water supplies, etc. The Commonwealth of Pennsylvania water quality criteria for this section of the Susquehanna River are given in Table 10. The staff concurs that these criteria should result in minimal impact on the environment.

3. Chemical Effluents

As discussed in Section III, the major chemical wastes discharged from the Station (exclusive of liquid radioactive wastes and treated sewage) are:

(1) Sodium sulfate from the demineralizer and condensate polisher regeneration steps,

(2) Sulfuric acid added to the cooling tower condenser circuit for pH control (discharged as soluble sulfates),

(3) Concentrated dissolved solids from normal river water in the cooling tower blowdown water, and

(4) Residual chlorine resulting from chlorine injections to the cooling tower-condenser circuit and the Station service water to prevent the growth of biological slimes.

Table 9 gives the total quantities of these chemicals released to the Susquehanna River annually and the concentrations in the Station cooling water effluent during discharge. Table 11 presents a summary of the total concentrations in the cooling water effluent and the resulting well mixed concentrations in the Susquehanna River for both the normal (20,000 cfs) and low flow (1,700 cfs) conditions. As shown, the total incremental dissolved solids in the river are 8.4 mg/l and 0.7 mg/l for the low and normal river flow conditions, respectively. This condition would prevail for the 15% fraction of time during which demineralizer or polisher wastes are being discharged. At other times the concentrations decrease to 6.3 mg/l and 0.5 mg/l, respectively. Considering that these concentrations will be diluted to values slightly above the natural levels of dissolved solids in the river, we conclude that the salt addition would not change the suitability of the Susquehanna River for the uses for which it is presently employed.

Table 10. Water Quality Criteria for the Susquehanna River - Juniata River to the Pennsylvania-Maryland State Line

Item	Criteria
pH	Not less than 6.0 and not more than 8.5.
Dissolved Oxygen	Minimum daily average 5.0 mg/l; no value less than 4.0 mg/l in the epilimnion.
Iron	Total iron not more than 1.5 mg/l.
Temperature	Not more than 5°F rise above ambient temperature or a maximum of 87°F, whichever is less; not to be changed by more than 2°F in any one hour period.
Dissolved Solids	Not more than 500 mg/l as a monthly average value; not more than 750 mg/l at any time.

The Pennsylvania Water Quality Criteria for this portion of the Susquehanna River (Table 9) give a specification for total dissolved solids but not for sulfate per se. Both the monthly average value of 500 mg/l and the maximum value of 750 mg/l specified for total dissolved solids are above the average and maximum values of 373 mg/l (238 natural river water +135 incremental) and 417 mg/l (238 natural river water + 179 incremental) in the Station effluent.*

Chlorine is added to the service water and cooling tower condenser circuit water to prevent the buildup of biological slimes in the cooling circuits. The total quantities of chlorine added are given in Table 9. As indicated, the chlorination systems will be operated intermittently for several 15 minute periods per day, and the Applicants indicate that these additions will result in a total residual chlorine in the effluent cooling water stream of 0.3 ppm or less. Normally, the residual chlorine reacts with other materials (chlorine demand) in the water, and persists for a relatively short period of time. While this level of chlorine is not detrimental to the use of the river water for the variety of human activities for which it is now employed, the impact on the biota of the river may be significant (see Section V-C).

The sewage treatment plant which is being constructed is a tertiary treatment activated sludge system and is the only known tertiary plant in the area. This plant has the capability of removing 93% of the biological oxygen demand (BOD). This is further reduced by the addition of sodium hypochlorite up to 8 ppm with a stated residual chlorine content of 1 ppm in the effluent. As in the case of the other wastes, the treated sewage is mixed with the cooling water prior to discharge to the river, and this results in a minimum 1000-fold dilution (for 5,000 gpm cooling water flow) prior to reaching the river. Under the minimum river flow conditions, further dilution by a factor of 150 is obtained upon complete mixing. Under nominal flow conditions for cooling water effluent and the river, a further dilution factor of about 15 would be obtained. The tertiary stage of the process will remove 80% of the input phosphate ion, resulting in an effluent containing 6 ppm of phosphate ion. In summary, it appears that the small quantity of treated sewage which the Station will return to the river will produce a negligible impact on the river. It is expected that there will be no effect on surrounding groundwater due to discharges from the Station to the Susquehanna River. This is because groundwater levels are higher on either shore of the river with hydraulic gradients sloping toward the river. In order for groundwater to move from TMI to the mainland it would be necessary to reverse the hydraulic gradient on the mainland.

* See Appendix B for Susquehanna River Water Quality Data at TMI.

Table 11. Summary of Average Incremental Concentrations of Dissolved Salts in the Susquehanna River Due to Operation of the Station

	Concentrations (mg/l)		
		Well Mixed in River	
Continuous Discharges	In Cooling Water Effluent	Minimum River Flow	Normal River Flow
Sulfates due to H_2SO_4 additions to cooling tower circuit (as SO_4)	28	1.3	0.1
Concentrated river dissolved salts in cooling tower blowdown	107	5	0.4
Sub-total	135	6.3	0.5
Additional Intermittent Discharges			
Unit 2 condensate polisher*			
SO_4	30	1.4	0.13
Na	14	0.7	0.07
Total	179	8.4	0.7

*There are additional intermittent discharges from the unit 1 and 2 water treatment demineralizers; however, since the concentrations are less and the Applicants have indicated that only one batch of waste will be released at a time, the maximum values occur during the discharge of the condensate polisher wastes.

C. BIOLOGICAL IMPACT

1. Terrestrial Ecosystem

The plant community on the island is not unique. It is less than 80 years old and resembles many others in the region, so its removal or disturbance by construction of the Station has not destroyed anything of remarkable economic, aesthetic, or educational value.

The proposed conversion of the plant community into a recreation area with marina, playing fields, roads, parking areas, comfort stations, etc., and the accompanying people, could have a greater effect on the ecosystem than construction or operation of the Station. The impact of Station operation on the terrestrial ecosystem will not be ascertainable from studies on Three Mile Island itself because the proposed recreation area will itself cause extensive alteration of the natural vegetation resulting in what appears to be[19] a tree/meadow park development. For this reason, the suggested monitoring program should be located in the nearest possible forested area such as on one of the adjacent islands owned by the Applicant.

a. Cooling Tower Impacts

The physical size and presence of the towers have been of some concern as a possible source of harm to migrating birds. However, in the two years since two of the towers have been built, no bird fatalities have been noted. Tower collisions have most often occurred during migration in association with a complex of meteorological conditions leading to low overcast, fog, and greatly reduced visibility. The greatest mortalities have occurred at night at lighted towers, brightly lit buildings (e.g., formerly at the Empire State Building), and airport ceilometers. One report[35] indicates that red navigation lights may cause confusion among migrating birds resulting in impact under conditions of poor visibility. Because this type of nighttime lighting is used on the cooling towers at TMI, the Applicants should monitor the base of the cooling towers during periods of peak migration under conditions of limited visibility to assess this impact.

During operation of the cooling towers, moisture is discharged into the atmosphere. Since drift is essentially equivalent to spraying five-fold concentrated river water over the surrounding countryside, it is considered in assessing impacts because:

1. High content of dissolved solids in the water tends to increase the osmotic pressure of the soil solution, thereby rendering water less available for plant growth.

2. The water may contain elements that are toxic to plants at certain concentrations.

3. The water may contain certain elements that impair soil quality, directly or indirectly (pollutants).

Studies of natural salt fallout have been based on fallout from sea water and the application of salt to roads for snow melting.

Highway salting research has shown that applications of 500 to 1,000 lbs./acre/year can be detrimental to vegetation, depending on conditions of leaching. In Connecticut, leaching removes salt applied at the rate of 1000 lbs./acre/year by April 1.[11] Such comparisons are somewhat misleading, however, because highway application is concentrated in a several month period while drift occurs at a low rate over a longer period. Moreover, the chemical composition of the two differs, with highway salt consisting mostly of chlorides.

At the Station, with 0.03% drift, and with an extremely conservative assumption of fallout over an area within a one-mile radius of the Station, about 270 lbs./acre/year of sulfate and 54 lbs./acre/year of chloride from a total salt fallout of 600 lbs./acre/year would be expected to fall. Much of this would fall into the river. Actually, the value would be less because dispersal is over a greater area. Nearby farms could be affected. However, because of the buffering capacity of the soil, it is unlikely that soil pH would be affected by the sulfate.

Table 12 indicates total anion deposition on area soils using extremely conservative calculations. More realistic but less conservative assumptions would result in an increment from drift, several orders of magnitude lower. Even using these conservative estimates, the total increment from all sources is still well within accepted limits of no damage to vegetation, as is demonstrated in the last column of the table. Likewise copper addition to the soil will only be 1.08 lbs./acre over a 50-year period. This is less than 0.003 ppm when dissolved by precipitation, compared with a threshold irrigation water concentration[20] of 0.1 ppm.

The above cited concentrations should not cause damage to area soils or crops. Nevertheless, the Applicant should monitor both crop and natural vegetation for damage from salt drift in order to confirm the staff's appraisal.

2. Aquatic Ecosystem

A major concern of fishermen and fisheries specialists is the effect the water intake may have on fish. The design of the screened intake (Sect. III-D) is expected to minimize fish entrainment because of the low velocity (0.2 ft/sec) of the water entering the intake. All but the smallest fish should be able to avoid being trapped by the inflow. However, since there is more than a 30 foot distance from the intake orifice to the trash rack, a small number of fish may enter the structure and be unable to find their way out. Monitoring should investigate this effect. The skimmer wall, designed to prevent the entrance of material floating near the water surface, may be of some value in reducing the intake of floating eggs, larval fish, or other organisms favoring the water near the surface of the stream as a habitat. However, predominant species in the fishery from which the cooling water is drawn (and to which it is returned) lay eggs in sheltered bottom areas.

Table 12. Estimated Maximum Yearly Anion Increments to Soil near Station

Anion	Naturally Occurring in Rainwater[21]	Increment Due to Cooling Towers	Total	Minimal Conc. for Irrigation Water Demonstrating Damage[20]
SO_4	2.37 (upper value)	32	35	192
Cl	0.30 (upper value)	7	8	62
	(all figures ppm)			

*Assuming all drift deposited within one mile radius, and dissolved in normal year's precipitation.

The plankton, small fish, and other small floating or swimming organisms that enter the cooling system circuits will be killed by the sodium hypochlorite added to the water of the cooling system. Since less that 1% of the river's flow passes through the Station under average flow conditions, and even under record low flow conditions, only about 7% of the river's flow would be used, plankton loss of the same relative proportion can be expected. Since the dead organisms are returned to the river, they can still be used as nutrients for fish production. It seems unlikely that this will significantly affect the fish population. The Applicants' monitoring program should quantify the effects of such entrainment.

Under normal operating conditions, the discharge will be in the 2-3°F range over ambient and will meet the maximum temperature criterion of the commonwealth of Pennsylvania set forth in Table 9. The best information available, because it is based on a similar species complex from a nearby geographical area, was performed in the Delaware River.[22] Examination of these data suggest that there should be no mortality associated with Station operation due to high temperature effects, at least for the species tested. In local areas of the water where there is a prolonged temperature shift, even if only of a few degrees, there may be a shift in comparative abundance of species, with perhaps some species near the limit of their preferendum disappearing.[23] This effect, however, will only be local and minimal because of the small thermal increment, and because of the small size of the thermal plume relative to the river area. However, in light of the postulated presence of toxins in the water[33] as mentioned in II-F-2, if these toxins are affecting the fish population, it appears likely that increased environmental temperatures will augment their impact.[34]

Data from the Delaware River[37] lead one to expect that the effects of the heated discharge on benthic organisms will be minimal and local. There may be a change in the periphyton community toward blue-green algae and diatoms of the family Fragillariaceae with, once again, no wide ranging consequences. These changes will only occur if the discharge plume touches bottom for an extended period.

The Applicants have provided information concerning a set of unusual circumstances which will result in a temperature differential of up to 19°F in winter (Section III-D). While specific information to make a definitive prediction is lacking, data on 45°F acclimated fish appear able to withstand temperature increments of more than 20°F.[22] It appears reasonable that fish acclimated to water ten or more degrees colder than this experimental temperature would have a similar absolute difference between acclimation and lethal temperatures. In any case, the time to lethality is never less than 19.5 hours, which is ample time not only for the fish to leave the plume and return to their preferenda, but also for the Station to resume normal operation. Other observers agree that rapid temperature changes of 20°F can generally be tolerated by warm water fishes so long as the upper lethal limit is not exceeded.[36] Diseased fish, however, are somewhat susceptible to lethal effects under these conditions. Consequently, it is concluded that unusual operating conditions will not harm healthy fish, but might result in the death of some which are already diseased. If deleterious effects result from such unusual Station operation, as determined from the monitoring program, corrective action should be taken. Similarly, corrective action should be taken to minimize the effects of winter shutdown. The increment of temperature by the discharge over river ambient should not cause mortality during shutdown, but if mortality occurs, the monitoring program should detect it.

Probably some fish will be attracted to the warmer discharge in all months.[22] Such concentration may result in increased predation, disease, and loss of condition. Such effects will be ascertainable from the fish monitoring program. If the monitoring program indicates deleterious effects on the fishery, corrective action should be taken.

Major chemical wastes are sodium sulfate and residual chlorine (Sect. V.B.). The sodium sulfate discharged would increase the sulfate in the river downstream from the Station by about 0.4 mg/l during normal river flow and up to 5 mg/l under low flow conditions. Normal variations in the sulfate content of the water have been far greater than this. We do not have data on tolerances of sunfish and catfish, but ninety-six hour toxicity limits for fathead minnows are 13,500 ppm sodium sulfate in hard water and 9,000 ppm in soft water.[24] A change from 100 mg/l present in the river on the average to 100.4 or 105 mg/l does not appear significant.

The Applicants propose intermittent discharges of total residual chlorine of 0.3 ppm or less, to be produced by chlorination of 15 minutes, 3-4 times per day. This figure exceeds EPA recommendations[25] of "A. 0.1 ppm <u>not to exceed</u> 30 minutes per day and B. 0.05 ppm <u>not to exceed</u> 2 hours per day." This recommendation is based upon an extensive review of the literature[27] which further notes: "However, there is a minimal, as yet, amount of data that indicate the possible necessity of lowering the intermittent concentration recommendations."

The Applicants, in their response to Agency comments, in part justify the residual chlorine release level on literature values for toxic effects on aquatic organisms. It must be noted that the fact that one or many organisms may not be singly affected by a toxin does not preclude ecosystem damage because of toxic effects on other of its members. Moreover, the observation has been made[27] that much of the older literature is based upon inadequate experimental design.

The National Water Quality Staff explicitly makes the point that:[25] "The recommendations for discontinuous total residual chlorine in fresh water are on less firm ground due to the scarcity of data on toxic effects during a few minutes to a few hours of exposure". However, they continue: "Probably the most

pertinent data were developed by the Michigan Water Resources Commission. They observed erratic swimming by fish of several species in a power plant discharge canal within 6 minutes of the initiation of chlorination by the plant. At this time the total residual chlorine was 0.09 (Truchan, 1971).[26] After 15 minutes there were dead fish at a total chlorine residual of 0.28 ppm." Some other adverse effects mentioned[27] at the levels predicted by the Applicants are gross reduction of fish species diversity and a reduction of plankton photosynthesis.

The fact that salmonids will avoid a chlorine discharge[28] is sometimes offered as a justification of excess chlorine level in discharge on the basis that the fish will avoid potentially toxic situations. This argument is inadequate because (1) Fish in the plume may be poisoned at the onset of chlorination as mentioned above, (2) The sensory response of salmonids has not been demonstrated in other fish, and (3) Even in the salmonids, there are some toxic concentrations referred to as sensory traps which are attractive to the fish.

It is consequently anticipated that chlorination at the levels stated by the Applicants may result in notable mortality of fish, as well as more subtle effects such as changing the aquatic community's composition and productivity.

Accordingly, the staff recommends that chlorine levels be limited to 0.1 ppm at the point of discharge in order to meet the EPA water quality recommendations of 0.05 ppm (for discharges up to 2 hours per day) for receiving waters. If this concentration exceeds 0.1 ppm the Applicants should take all practical measures to reduce it below this value. Should these efforts fail, the Applicants should determine the extent of the zone in the river within which the total residual chlorine concentration exceeds the EPA recommended criteria. The Environmental Technical Specifications will define a monitoring program for chlorine to insure compliance with the staff's recommendations.

3. <u>Biological Monitoring Program</u>

a. <u>Terrestrial</u>

The Applicants have not made preoperational terrestrial surveys which will be useful in assessing effects of Station operation. Since no assessment of impact on the terrestrial ecosystem is possible in the absence of such study, the staff recommends that a study be initiated. A forested area typical of the region should be selected as close to the Station as possible, possibly on Shelley Island if this appears suitable. This recommendation does not preclude the use of a more remote area to serve as a control.

b. Aquatic

Annual biological surveys of the Susquehanna River in the vicinity of Three Mile Island were begun in 1967 for the Applicants by Dr. Charles B. Wurtz, Philadelphia, Pennsylvania, a consulting biologist with more than 20 years experience in the study of effects of discharges on aquatic ecosystems. The Applicants have planned to continue these studies into the post-operational period . Macroinvertebrate fauna (bottom organisms) are studied at a series of sampling stations extending from above Three Mile Island downstream to the Haldeman Riffle. Water quality characteristics are also monitored at the same stations. The variability in species diversity found from year to year during the pre-operational periods constitutes the pre-existing milieu in which interpretation of future effects of the Station must be made. This program appears adequate and should be continued.

In addition to the Wurtz survey, an expanded survey is being undertaken by Dr. G. Hoyt Whipple of the School of Public Health, University of Michigan, aided by personnel from Millersville State Teachers College.

The survey consists of the following:

1. A fish population study to determine population density, number of species, and condition factors.

2. A study of macro and microinvertebrate fauna in the water and sediments to determine composition, relative abundance, and general distribution.

3. An analysis of the area for some twenty chemical elements (stable isotopes) in conjunction with the biological phases of the survey. The objective of the stable isotope study is as follows:

   a. To "map" the area with respect to the distribution of the elements in the water sediments, suspended material, and living organisms.

   b. To develop a routine sampling program that will represent the area.

   c. To determine areas of high and low inputs of these elements and the concentration gradients in those locales relative to Three Mile Island.

   d. To determine the ratios of some of the elements in the water, sediments and indicator organisms.

   e. To attempt to correlate the data obtained in the stable isotope study with the biological population data from the the other phases of this survey.

The Staff finds the Applicants' monitoring program deficient in several respects, especially sampling station locations, frequency of data collection and reporting, and methodology of sampling and analysis. Full details of a final biological monitoring program acceptable to the Staff will be specified in the Environmental Technical Specifications.

If significant changes in the ecology of the river are made at a future date, such as reintroduction of the shad or major changes in water chemistry, the Applicant should submit to the Staff an estimate of environmental impact of plant operations in the light of such changes, and propose a course of action to minimize such impact.

4. Radiation Dose to Species Other than Man

Terrestrial organisms in the environs of the plant would receive approximately the same radiation doses as those calculated for man. Aquatic organisms living in water containing released radionuclides will also be expected to receive radiation doses. Using the bioaccumulation factors given in Table 13, and assuming an additional dilution of 100 for the radioisotopes in the Susquehanna River, fish and aquatic invertebrates will each receive about 5 mrads/yr.

At this time, no guidelines for radiation exposure to biota have been established. Many investigations have been performed at higher dose rates than the above calculated values. However, no organisms have shown detectable sensitivity to radiation levels expected around the plant.[29]

Thus, it is concluded that no detectable adverse effects are expected on biota as a result of the radionuclide release from the Three Mile Island site.

D. RADIOLOGICAL IMPACT OF ROUTINE OPERATION

1. Introduction

In the operation of nuclear power reactors, radioactive material is produced by fission and by neutron-activation reactions of metals and material in the reactor system. Small amounts of gaseous and liquid radioactive wastes enter the waste streams which are monitored and processed within the plant to minimize the amount of radioactive nuclides that will ultimately be released. The gaseous and liquid wastes will be released to the atmosphere and to the Susquehanna River, respectively, at low concentrations under carefully controlled conditions. The quantity of radioactivity that is released to the environment will be a small fraction of the limits set forth in 10 CFR Part 20 of the Commission's Regulations, and the amounts will be kept as low as practicable in accordance with 10 CFR Part 50.36a. These regulations apply to the combined releases from all systems connected with both Units 1 and 2. The Staff has made calculations of the radiation dose using the estimated release rates of

TABLE 13

BIOACCUMULATION FACTORS FOR RADIONUCLIDES
IN FRESH WATER SPECIES*

Radionuclides	Fish	Invertebrates
Rh	2,000	2,000
Sr	40	700
Y	100	1,000
Zr	100	1,000
Nb	30,000	100
Mo	100	100
Ru	100	2,000
Rh	100	2,000
Sb	40	16,000
Te	400	150
I	1	25
Cs	1,000	1,000
Ba	10	200
Ce	100	1,000
Pr	100	1,000
Nd	100	1,000
Pm	100	1,000
Sm	100	1,000
H	1	1
Cr	200	2,000
Mn	25	40,000
Fe	300	3,200
Co	500	1,500
Ni	40	100
Zn	1,000	40,000
Ag	3,000	3,000

* UCRL-50564, Lawrence Radiation Laboratory, "Concentration Factors of Chemical Elements in Edible Aquatic Organisms," Wm. H. Chapman, H. Leonard Fisher, Michael W. Pratt, Dec. 30, 1968.

radionuclides listed in Tables 4, 5, 6 and 7 using stated assumptions relative to dilution, biological reconcentration in food chains, and use factors by people.

2. Radioactive Materials Released to the Atmosphere

The most significant radiation dose to the public will result from the radionuclides in the gaseous effluents from the plant. The radioactive materials released to the atmosphere are principally the fission-product noble gases, krypton and xenon. Nearly all of the dose received by persons living, working or using recreational facilities in the vicinity of the plant will result from radioactive krypton and xenon in the air surrounding the individual. The postulated gaseous effluents from the plant are listed in Tables 4 and 5. We have calculated the potential annual doses using averages for meteorological conditions and assuming releases of the listed isotopes at a constant rate.

During normal operation of the plant at full power, the maximum dose rate due to cloud immersion at the plant's exclusion boundary on the river bank (2170 ft. ESE) where the $X/Q = 9.1 \times 10^{-6}$ sec/m^3, is calculated to be about 0.72 mrem/yr while the dose at the nearest community (Goldsboro, 1-1/2 miles W) is less than 0.10 mrem/yr. The annual dose (outside) at the nearest home (2340 ft. E, $X/Q = 4.8 \times 10^{-6}$ sec/m^3) is estimated to be 0.38 mrem/yr. However, a higher dose of 0.58 mrem/yr will be received at another home located 2460 ft. ESE, where a higher X/Q of 7.4×10^{-6} sec/m^3 is calculated. Assuming an occupancy of 3 months annually, the total body dose to campers at Beach Island (2080 ft. SW) and Shelley Island (2000 ft. W), both normally uninhabited, would be about 0.52 mrem/yr and 0.14 mrem/yr, respectively. The dose also based upon three months per year occupancy, at the proposed recreational area at the southern end of Three Mile Island will range from about 0.10 mrem/yr at a point near York Haven Dam (3500 ft. S) to about 0.05 mrem/yr at the southern tip of the Island (8500 ft. S). A fisherman, pleasure boater or sunbather who spends 500 hours per year just outside the exclusion line at the nearest point on Shelley Island would receive less than 0.04 mrem/yr due to gaseous effluents. Higher doses, of course, would be received by a fisherman, swimmer, or boater who inadvertently violated the plant exclusion circle. For example, at a shore on Three Mile Island nearest the plant (inside the exclusion circle 830 ft. SW, where the X/Q is as high as 1.4×10^{-4} sec/m^3), a fisherman or boater spending 500 hours per year would receive about 0.63 mrem/yr from gaseous effluents.

Based on an annual release rate of 0.25 Ci/yr of iodine-131, the thyroid dose due to inhalation would be less than 1.1 mrem/yr at the exclusion line (2170 ft. ESE), less than 0.9 mrem/yr at the nearest home, 0.3 mrem/yr at the nearest town (Goldsboro) and 0.7 mrem/yr at the proposed recreation area (3500 ft. S).

Radioactive iodine may be ingested by milk cows after deposition in grazing areas. Radiation exposure to the thyroid gland can result from drinking milk from these cows. A liter of milk consumed daily from a cow grazing five months per year at the nearest dairy farm (1-1/2 miles ESE, $X/Q = 1.6 \times 10^{-6}$ sec/m^3) would result in a calculated dose to an infant's thyroid of about 19 mrem/yr. Monitoring, administrative measures and/or design changes will be required to insure that the actual dose does not exceed 5 mrem/yr.

If in the future a cow is located closer to the plant than at present the Applicant will be required to evaluate the thyroid radiation doses likely to result from consumption of milk produced at the new location, and to take whatever steps are necessary to assure that these doses will be compatible with the then-existing limits for human exposure.

3. Radioactive Materials Released to Receiving Water

During normal operation of the plant, the liquid radwaste effluent will be combined with the forced draft cooling tower blowdown before release into the Susquehanna River. Calculation of radiation doses from radionuclides released into the liquid effluent requires estimating the concentrations of these radionuclides at the point of discharge. A nominal flow rate of 36,000 gallons per minute (80 cfs) for the cooling tower blowdown was used to calculate the liquid radwaste dilution in the discharge canal. The river flow ranges from a low of 1,600 cfs to a maximum flood level of 740,000 cfs with an average annual flow of 34,000 cfs. Thus, an additional factor of 100 was conservatively assumed in order to estimate the effluent dilution after mixing with the river water.

The principal pathways leading to exposure doses to man are drinking water from the river, consuming fish and invertebrates caught in the river, and swimming, boating, and picnicking in or on the shore of the river. Bioaccumulation factors used to calculate doses from fish and invertebrate consumption are listed in Table 11. The doses to individuals resulting from the previously mentioned pathways are calculated using the estimated annual nuclide liquid releases given in Table 6 and dilution factors described above. In addition, it was assumed that each person drinks 1,200 cc of water per day, consumes 20 grams of fish per day, 5 grams of invertebrates per day, swims 100 hours per year, and goes boating and picnicking on the shoreline for 500 hours per year. A delay of twenty-four hours is assumed between release and consumption. No delay factor is considered for recreational use. The results of the individual dose calculations are summarized in Table 14.

4. Radioactive Materials Stored on Site

The dose contribution at and beyond the site boundary due to radioactive storage areas on site is expected to be negligible.

5. Population Doses From All Sources

Values of the cumulative dose to the population from gaseous effluents based on 1970 census figures are listed in Table 15 for various distances from the Station. The combined dose to all individuals living within fifty miles of the Station (1,868,000) from exposure to radioactive gaseous effluents is

TABLE 14

ANNUAL DOSES AT EQUILIBRIUM CONDITIONS
TO INDIVIDUALS AT VARIOUS LOCATIONS

LOCATION	PATHWAY	DOSE (MREM/YR) GI TRACT	THYROID	TOTAL BODY
Exclusion Boundary (2170' ESE)	Cloud	—	1.1	0.72
Residence[1] (2340' E)	Cloud	—	0.62	0.38
Residence[1] (2460' ESE)	Cloud	—	0.83	0.58
Goldsboro (nearest town 1.5 miles W)	Cloud	—	0.15	0.10
Three Mile Island Recreation Area[2] (3500' S)	Cloud	—	0.15	0.10
Shelley Island (2000' W)	Cloud	—	0.21	0.14
Dairy Farm[3] (1.5 miles E)	Cloud, Ingestion of milk	—	18.5	0.13
Susquehanna River	Drinking water	0.009	0.50	0.025
	Fish Consumption	0.010	0.010	0.14
	Invertebrate Consumption	0.003	0.050	0.034
	Swimming	—	—	0.0001
	Picnicking and fishing on shoreline	—	—	0.041

[1]No shielding was assumed.
[2]Dose calculation assumes an occupancy of 3 months per year.
[3]Dose to a child's thyroid based on consuming one liter of milk daily from a cow grazing five months per year at that particular farm.

TABLE 15

CUMULATIVE ANNUAL POPULATION DOSE AND AVERAGE DOSE FROM GASEOUS EFFLUENTS TO THE POPULATION UP TO 50 MILES FROM THE STATION

Radius (miles)	Cumulative Population*	Cumulative Dose (man-rem/yr)	Average Individual Dose (mrem/yr)
1	580	0.050	0.086
2	2,350	0.12	0.049
3	9,000	0.23	0.025
4	17,300	0.29	0.017
5	24,500	0.34	0.014
10	136,400	0.76	0.0056
20	621,300	1.43	0.0023
30	995,200	1.79	0.0018
40	1,235,000	1.85	0.0015
50	1,868,000	2.05	0.0011

*Based on 1970 Census Data given in Three Mile Island Environmental Report, Operating License Stage.

estimated to be 2.1 man-rem per year. It was assumed that 5 percent of this total population would be exposed while fishing, boating or picnicking in the immediate vicinity of the plant.

The dose from ingesting fish and invertebrates was estimated by assuming that 10 percent of the total population within a fifty mile radius of the Station obtained 25 percent of this intake from the Susquehanna River. Thus, the effective exposed population via this pathway is 47,000. The combined annual population dose via the drinking water, fish, invertebrate, recreation and transportation (of nuclear fuel and solid radioactive waste) pathways is calculated to be 31 man-rem.

The population dose from all of the above pathways is summarized in Table 16.

6. <u>Radiological Environmental Monitoring</u>

The Applicants' proposed radiological monitoring program is based on consideration of potential radiation sources from the Station and potential modes of radioactive material transport in air, water and food. The environmental radiation monitoring program is divided into three preparatory phases followed by an operational phase. The program is described in detail in pages 5.5-6 through 5.5-10 of the Applicants' 1971 Environmental Report (operating license stage). The tentative schedule for postoperational environmental monitoring is listed in Table 17.

Measurements are being made of the ratios of stable element concentrations in river fish compared to river water to determine biological concentration factors in the water-fish-man pathway. Studies have been made for the selection of sampling station locations and the type of samples to be taken. In addition, sediment, fish, soil, vegetation, airborne dust, airborne iodine precipitation, and external radiation will be measured as indicated in Table 15. Two terrestrial pathways are under consideration. They involve the air-pasture-cow-milk-child pathway and the river-irrigation-crop-human pathway for the liquid radioactive wastes.

The Commonwealth of Pennsylvania is also conducting an environmental monitoring program, under partial AEC sponsorship, at three plant sites: Three-Mile Island, Saxton, and Peach Bottom. This program is summarized in Table 18.

7. <u>Evaluation of Radiological Impact</u>

Using conservative estimates, the annual total man-rem dose from all pathways received by the approximately 1,868,000 people who live within a fifty-mile radius of the plant would be about 31 man-rem. By comparison, an annual total of about 233,000 man-rem to the same population results from an annual average natural background dose of 0.125 rem in the Commonwealth o Pennsylvania.

TABLE 16

ANNUAL DOSE TO THE GENERAL POPULATION
FROM THE OPERATION OF THE THREE MILE ISLAND PLANT

Pathway	Exposed Population	Cumulative Dose (man-rem/yr)
Cloud Immersion	1,868,000	2.1
Drinking Water	200,000	5.0
Ingestion of Fish	47,000	6.6
Ingestion of Invertebrates	47,000	1.6
Recreation:		
Swimming	93,000	>0.1
Fishing and Picnicking	93,000	3.8
Transportation of Nuclear Fuel and Solid Radioactive Waste	400,000	12.0
	TOTAL	∿31

TABLE 17. Tentative Schedule for Post-Operational Environmental Monitoring†

	NUMBER OF		REGIME		
	Indicator Stations	Background Stations	I	II	III
Air	6	6	C-1	C-1	C-1
Precipitation	6	6	C-13	C-4	C-4
Radiation	30	10	F-4	F-4	F-4
Milk	4	2	G-13	G-4	G-1
Crops**	2	1	G-13	G-13	G-4
River Water	2	1	C-13	C-4	C-1
Sediment*	2	1	P-13	P-13	P-4
Columbia Intake	1	-	C-13	C-4	C-1
Clams or Snails*	2	1	G-13	G-13	G-4
Fish	1	1	G-13	G-13	G-4
Aquatic Plants*	2	1	G-13	G-13	G-4

Key: C-1 (C-4, C-13): Collect continuously for 1 week (4 weeks, 13 weeks) and analyze.

F-4: Film badge or TLD exposed for 4 weeks and read.

G-1 (G-4): Grab sample taken at 1-week (4-week) intervals and analyzed.

P-4 (P-13): Underwater gamma scintillation scan at 4-week (13-week) interval.

G-13: A grab sample taken 3 times a year (spring, summer, and fall) at approximately 13-week intervals and analyzed.

* Still under investigation.

** Types of crops and related appropriate sampling times will be determined during phases 2 and 3 of the program.

† From TMI E.R, 1971.

TABLE 18

SAMPLING AND ANALYTICAL REQUIREMENTS FOR THE INDEPENDENT MEASUREMENTS PROGRAM AT SELECTED SITES WITHIN THE COMMONWEALTH OF PENNSYLVANIA

	MEDIUM	SAMPLE LOCATION	OPERATIONAL REACTORS: SAMPLING FREQUENCY	OPERATIONAL REACTORS: FREQUENCY OF ANALYSES	OPERATIONAL REACTORS: ANALYSES	NONOPERATIONAL REACTORS: SAMPLING FREQUENCY	NONOPERATIONAL REACTORS: FREQUENCY OF ANALYSES	NONOPERATIONAL REACTORS: ANALYSES
ONSITE	LIQUIDS	WASTE TANK	QUARTERLY GRAB (BEFORE DISCHARGE)	QUARTERLY	GAMMA ISOTOPIC GROSS BETA STRONTIUM 90 TRITIUM	—	—	—
		DISCHARGE CANAL	QUARTERLY GRAB (DURING DISCHARGE)	QUARTERLY	GAMMA ISOTOPIC GROSS BETA TRITIUM	—	—	—
	AIR	GAS-STACK OR HOLDUP TANK	QUARTERLY GRAB	QUARTERLY	GAS ISOTOPIC TRITIUM(HTO,T_2)	—	—	—
		CHARCOAL FILTER-STACK	QUARTERLY GRAB	QUARTERLY	IODINE	—	—	—
		PARTICULATES	QUARTERLY	QUARTERLY	CESIUM 134,137 BA-LA 140 STRONTIUM 90	—	—	—
OFFSITE	LIQUIDS	1-UPSTREAM 2-DOWNSTREAM	MONTHLY GRAB	MONTHLY	GAMMA ISOTOPIC GROSS BETA TRITIUM	QUARTERLY	QUARTERLY	GAMMA ISOTOPIC GROSS BETA TRITIUM
	AIR PARTICULATE	1-AT OFFSITE MAX. CONC. 1-BACKGROUND	WEEKLY (FILTER CHANGE)	QUARTERLY (COMPOSITE)	CESIUM 134,137 BA-LA 140 STRONTIUM 90	WEEKLY (FILTER CHANGE)	QUARTERLY (COMPOSITE)	CESIUM 134-137 BA-LA 140 STRONTIUM 90
	TLD DOSE	6-STATIONS AT SITE 1-BACKGROUND	QUARTERLY EXPOSURE	QUARTERLY CHANGEOUT	READOUT	—	—	—
	FOOD MILK & FISH	LOCAL (FARMS & STREAMS)	QUARTERLY (SPRING, SUMMER, FALL)	QUARTERLY	CESIUM 134,137 STRONTIUM 90 I-131(MILK ONLY)	QUARTERLY (SPRING,SUMMER, FALL)	QUARTERLY	CESIUM 134-137 STRONTIUM 90 I-131(MILK ONLY)

Operation of the plant will contribute only an extremely small increment of the radiation dose that persons living in the area normally receive from natural background radiation. Normal fluctuation of the natural background dose is expected to exceed the small dose increment contributed by the plant. Thus, the incremental increase will be difficult if not impossible to measure and will constitute no meaningful risk.

E. TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for the two reactors at Three Mile Island near Harrisburg, Pennsylvania, is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy fuel rods. Each year in normal operation, about 60 fuel elements are replaced in each unit.

The Applicants have indicated that cold fuel for the reactors will be transported by truck from Lynchburg, Virginia. The Applicants have not indicated where the irradiated fuel or solid wastes will be shipped, but they did indicate irradiated fuel will be transported by rail and solid wastes by truck. The staff assumed a distance of 800 miles for shipping the irradiated fuel and 600 miles for shipping the solid radioactive wastes.

1. Transport of Cold Fuel

The Applicants have indicated that cold fuel will be shipped in AEC-DOT approved containers which hold two fuel elements per container. About 10 truckloads of 6 containers each will be required each year to meet the needs of both reactors for replacement fuel.

2. Transport of Irradiated Fuel

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

Although the specific cask design has not been identified, the Applicants state that the irradiated fuel elements will be shipped after at least 4 months cooling period in approved casks designed for transport by rail. The cask will weigh perhaps 100 tons. To transport the irradiated fuel from both reactors, the Applicants estimate 15 rail carload shipments per year with 8 fuel elements per cask and 1 cask per carload. An equal number of shipments will be required to return the empty casks.

3. Transport of Solid Radioactive Wastes

The Applicants estimate that about 2740 cubic feet of solid radioactive wastes will be generated by the two reactors each year. Spent resins and evaporator bottoms will be solidified, and soft, solid wastes compacted in drums and 50 ft^3 containers for shipment and disposal. The Applicants estimate from 50 to 200 truckloads of wastes each year from the Station.

4. Principles of Safety in Transport

Protection of the public and transport workers from radiation during the shipment of nuclear fuel and waste is achieved by a combination of limitations on the contents (according to the quantities and types of radioactivity), the package design, and the external radiation levels. Shipments move in routine commerce and on conventional transportation equipment. Shipments are therefore subject to normal accident environments, just like other non-radioactive cargo. The shipper has essentially no control over the likelihood of an accident involving his shipment. Safety in transportation does not depend on special routing.

Packaging and transport of radioactive materials are regulated at the Federal level by both the Atomic Energy Commission (AEC) and the Department of Transportation (DOT). In addition, certain aspects, such as limitations on gross weight of trucks, are regulated by the States.

The probability of accidental releases of low level contaminated material is sufficiently small that, considering the form of the waste, the likelihood of significant exposure is extremely small. Packaging for these materials is designed to remain leakproof under normal transport conditions of temperature, pressure, vibration, rough handling, exposure to rain, etc. The packaging may release its contents in an accident.

For larger quantities of radioactive materials, the packaging design (Type B packaging) must be capable of withstanding, without loss of contents or shielding, the damage which might result from a severe accident. Test conditions for packaging are specified in the regulations and include tests for high-speed impact, puncture, fire, and immersion in water.[30]

In addition, the packaging must provide adequate radiation shielding to limit the exposure of transport workers and the general public. For irradiated fuel, the package must have heat-dissipation characteristics to protect against overheating from radioactive decay heat. For fresh and irradiated fuel, the design must also provide nuclear criticality safety under both normal and accident damage conditions.

Each package in transport is identified with a distinctive radiation label on two sides, and by warning signs on the transport vehicle.

Based on recent accident statistics,[31] a shipment of fuel or waste may be expected to be involved in an accident about once in a total of 750,000 shipment-miles. The staff has estimated that only 1 in 10 of those accidents which involve Type A packages or 1 in 100 of those involving Type B packages might result in any leakage of radioactive material. In case of an accident, procedures which carriers are required[32] to follow will reduce the consequences of an accident in many cases. The procedures include segregation of damaged and leaking packages from people, and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipped and trained personnel. These teams, dispatched in response to calls for emergency assistance, can mitigate the consequences of an accident.

5. Exposures During Normal (No Accident) Conditions

a. Cold Fuel

Since the nuclear radiations and heat emitted by cold fuel are small, there will be essentially no effect on the environment during transport under normal conditions. Exposure of individual transport workers is estimated to be less than 1 millirem (mrem) per shipment. For the 10 shipments, with two drivers for each vehicle, the total dose would be about 0.02 man-rem* per year. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 6 feet from the truck. A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of about 0.005 mrem per shipment. The dose to other persons along the shipping route would be extremely small.

b. Irradiated Fuel

Based on actual radiation levels associated with shipments of irradiated fuel elements, we estimate the radiation level at 3 feet from the rail car will be about 25 mrem/hr.

Train brakemen might spend a few minutes in the vicinity of the car at an average distance of 3 feet, for an average exposure of about 0.5 millirem per shipment. With 10 different brakemen involved along the route, the cumulative dose for 15 shipments during the year is estimated to be about 0.08 man-rem.

*Man-rem is an expression for the summation of whole body doses to individuals in a group. In some cases, the dose may be fairly uniform and received by only a few persons (e.g., drivers and brakemen) or, in other cases, the dose may vary and be received by a large number of people (e.g., 10^5 persons along the shipping route).

A member of the general public who spends 3 minutes at an average distance of 3 feet from the rail car might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the cumulative annual dose for the 15 shipments would be about 0.2 man-rem. Approximately 240,000 persons who reside along the 800-mile route over which the irradiated fuel is transported might receive an annual dose of about 0.3 man-rem. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 feet from the vehicle was used to calculate the integrated dose to persons in an area between 100 feet and 1/2 mile on both sides of the shipping route. It was assumed that the shipment would travel 200 miles per day and the population density would average 330 persons per square mile along the route.

The amount of heat released to the air from each cask will be about 250,000 Btu's/hr. For comparison, 115,000 Btu's/hr is about equal to the heat output from the furnace in an average size home. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, because the amount of heat is small and is being released over the entire transportation route, no appreciable thermal effects on the environment will result.

c. Solid Radioactive Wastes

The Applicants estimate that from 50 to 200 truckloads of solid radioactive wastes will be shipped to a disposal site per year from the two reactors. Under normal conditions, the individual truck driver might receive as much as 15 mrem per shipment. If the same driver were to drive 25 truckloads in a year, he could receive an estimated dose of about 400 mrem during the year. The cumulative dose to all drivers for the year, assuming 2 drivers per vehicle, might be from about 1.5 to 6 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose might be about 0.6 to 2.6 man-rem. Approximately 180,000 persons who reside along the 600-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.7 to 3 man-rem These doses were calculated for persons in an area between 100 feet and 1/2 mile on either side of the shipping route, assuming 330 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

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VI. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

A. PLANT ACCIDENTS

A high degree of protection against the occurrence of postulated accidents in the Three Mile Island Nuclear Station, Unit 1 and Unit 2, is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system as will be considered in the Commission's Safety Evaluation for each unit. Deviations that may occur are handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, in spite of the fact that they are extremely unlikely; and engineered safety features are installed to mitigate the consequences of these postulated events.

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

The Commission issued guidance to Applicants on September 1, 1971, requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The Applicants' response is contained in "Environmental Report - Operating License Stage" for the Three Mile Island Nuclear Station, Unit 1 and Unit 2, dated December 10, 1971.

The Applicants' report has been evaluated using the standard accident assumptions and guidance issued as a proposed Annex to Appendix D of 10 CFR Part 50 by the Commission on December 1, 1971. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate, and those on the low potential consequence end have a higher occurrence rate. The examples selected by the Applicants for these classes are shown in Table 20. The examples selected are reasonably homogeneous in terms of probability with two exceptions. It was considered to be more appropriate to classify (1) the failure of the waste gas decay tank as an accident in Class 3 (Applicants use Class 8) and (2) the steam generator tube rupture as an accident in Class 5

(Applicants use Class 8). The following assumptions made by the Applicants are questionable: (1) no steam generator tube leaks prior to the steam generator tube rupture are considered, (2) the primary coolant activity is based on 0.1% failed fuel, and (3) the consequences of various releases are evaluated based on release rates applicable for specified times. However, the use of alternative assumptions does not significantly affect overall environmental risks.

The postulated occurrences in Class 9 involve failures more severe than those required to be considered for the design basis of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture, and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

Staff estimates of the dose which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions in the proposed Annex to Appendix D, are presented in Table 20. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in Table 20. The man-rem estimate was based on the projected population around the site for the year 2014. The estimates presented in Table 20 refer to a single unit.

To rigorously establish a realistic annual risk, the calculated doses in Table 20 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operation and their consequences, which are very small, are considered within the framework of routine effluents from the plant. Except for a limited amount of fuel failures and some steam generator leakage, the events in Classes 3 through 5 are not anticipated during plant operation; but events of this type could occur sometime during the 40-year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 through 5 but are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 20 are weighed by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design basis of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design all are applied to provide and maintain the required high degree of assurance that potential accidents in this class are, and will remain sufficiently small in probability that the environmental risk is extremely low.

Table 20 indicates that the realistically estimated radiological consequencee of the postulated accidents would result in exposures of an assumed individual at the site boundary to concentrations of radioactive materials within or comparable to the Maximum Permissible Concentrations (MPC) of Table II of 10 CFR Part 20. The table also shows that the estimated integrated exposure of the population within 50 miles of the plant from each postulated accident would be orders of magnitude smaller than that from naturally occurring radioactivity, which corresponds to approximately 394,000 man-rem/yr based on a natural background level of 130 mrem/yr. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of the exposure from natural background radiation and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small.

B. TRANSPORTATION ACCIDENTS

1. New Fuel

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

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

The probability that an accident could occur under conditions that could result in accidental criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 feet from the accident might receive a serious exposure but beyond that distance, no detectable radiation effects would be likely. Persons within a few feet of the accident could receive fatal or near-fatal exposures unless shielded by intervening material. Although there would be no nuclear explosion, heat

TABLE 19

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	AEC Description	Applicant's Example(s)
1	Trivial Incidents	None
2	Small Releases Outside Containment	Spill in Sample Hood
3	Radwaste System Failure	Inadvertent Release of Waste Gas Decay Tank
4	Fission Products to Primary System (BWR)	Not applicable
5	Fission Products to Primary and Secondary Systems (PWR)	One day Operation with Primary System Leak to Reactor Building Normal Operation with Steam Generator Tube Leak and Release from Condenser
6	Refueling Accidents	Drop of Fuel Assembly or Drop of Heavy Object on Fuel Assembly
7	Spent Fuel Handling Accident	Drop of Fuel Assembly
8	Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report	Uncompensated Operating Reactivity Changes Startup Accident Rod Withdrawal Accident Cold Water Accident Loss of Coolant Flow Accident Stuck-Out, Stuck-In, or Dropped Control Rod Accident Loss of Electric Load Accident Steam Line Failure Steam Line Leakage Steam Generator Tube Failure Rod Ejection Accident Loss of Coolant Accident Waste Gas Tank Rupture
9	Hypothetical Sequences of Failures More Severe Than Class 8	None

TABLE 20

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS

(Single Unit Only)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[1/]	Estimated Dose to Population in 50 Mile Radius, man-rem
1.0	Trivial incidents	2/	2/
2.0	Small releases outside containment	2/	2/
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.073	10
3.2	Release of waste gas storage tank contents	0.29	40
3.3	Release of liquid waste storage tank contents	0.003	0.47
4.0	Fission products to primary system (BWR)	N.A.	N.A.
5.0	Fission products to primary and secondary systems (PWR)		
5.1	Fuel cladding defects and steam generator leaks	2/	2/
5.2	Off-design transients that induce fuel failure above those expected and steam generator leak	.002	0.23
5.3	Steam generator tube rupture	0.096	13

TABLE 20 (cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[1/]	Estimated Dose to Population in 50 Mile Radius, man-rem
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.015	2.1
6.2	Heavy object drop onto fuel in core	0.26	36
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	0.01	1.3
7.2	Heavy object drop onto fuel rack	0.038	5.3
7.3	Fuel cask drop	N.A.	N.A.
8.0	Accident initiation events considered in design basis evaluation in the safety analysis report		
8.1	Loss-of-coolant accidents		
	Small Break	0.16	40
	Large Break	1.2	1000
8.1(a)	Break in instrument line from primary system that penetrates the containment	N.A.	N.A.
8.2(a)	Rod ejection accident (PWR)	0.12	100
8.2(b)	Rod drop accident (BWR)	N.A.	N.A.
8.3(a)	Steamline breaks (PWR's-outside containment)		
	Small Break	<0.001	<0.1
	Large Break	<0.001	0.13

TABLE 20 (cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[1/]	Estimated Dose to Population in 50 Mile Radius, man-rem
8.3(b)	Steamline breaks (BWR)	N.A.	N.A.

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

2/ These releases will be comparable to the design objectives indicated in the proposed Appendix I to 10 CFR Part 50 for routine effluents (i.e., 5 mrem/yr to an individual from either liquid or gaseous effluents).

generated in the reaction would probably separate the fuel elements so that the reaction would stop. The reaction would not be expected to continue for more than a few seconds and normally would not recur. Residual radiation levels due to induced radioactivity in the fuel elements might reach a few roentgens per hour at 3 feet. There would be very little dispersion of radioactive material.

2. Irradiated Fuel

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

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

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

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

In such an accident, the amount of radioactive material released would be limited to the available fraction of the noble gases in the void spaces in the fuel pins and some fraction of the low level contamination in the coolant. Persons would not be expected to remain near the accident due to the severe conditions which would be involved, including a major fire. If releases occurred, they would be expected to take place in a short period of time. Only a limited area would be affected. Persons in the downwind region and within 100 feet or so of the accident might receive doses as high as a few hundred millirem. Under average weather conditions, a few hundred square feet might be contaminated to the extent that it would require decontamination (that is, Range I contamination levels) according to the standards[1] of the Environmental Protection Agency.

3. Solid Radioactive Wastes

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

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

4. Severity of Postulated Transportation Accidents

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

5. Alternatives to Normal Transportation Procedures

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

References For Section VI

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

VII. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED

A. LAND USE

The precise impact of the cooling towers on fogging and, hence, operations at the Harrisburg International Airport cannot be determined with certainty. As indicated, Applicants have estimated a maximum of 39 hours/year (involving 4 to 6 days/year) of potential fogging attributable to operation of the cooling towers. This is believed to be conservative, and that the actual effect will be less than this. The effect on commercial flight operations is minimized by the fact that the hours most likely to be affected by fogging (night and early morning) are a period of minimum activity at the airport. At the present time there is one commercial flight arriving daily after 10:00 p.m. and three arriving before 8:00 a.m. Although this picture could change in the future if commercial air traffic increases, it now appears that there would be at most 10 incoming flights per year that might be diverted to alternate airports as a direct result of cooling tower operation.

B. PHYSICAL APPEARANCE IN SURROUNDINGS

The question of the physical appearance of an industrial plant involves areas of judgment and opinion which are virtually impossible to quantify. The four large cooling towers at the station are imposing structures which significantly alter the appearance of the landscape. We can do no more at this time than suggest that some will judge this impact to be very adverse while others will consider it to be minimal. The number of persons now affected, however, is relatively small since the immediately surrounding area is predominantly rural. While this situation may change in the future, at least persons who do choose to take up residence near the Station will do so with full knowledge of the surroundings and environment they are choosing.

Likewise, the appearance of the transmission line towers is a subject which is likely to provoke a wide range of reaction among individuals. On the positive side, the Applicants have made attempts to minimize the impact by using special towers at visible points (such as highway crossings) which are more attractive than the ordinary towers. The impact of the transmission line towers lies primarily in their appearance, involving consideration of aesthetics, since land use in general is relatively unaffected by their installation.

C. SURFACE WATER

The aquatic ecosystem will be affected by passage of water through the cooling system and by chemical treatment. Viable plankton and larval forms of other organisms will be entrained in proportion to the amount of river flow used by the station. This will range from less than 1% under normal flow conditions to about 7% under low flow conditions. Most of the dead

organisms will be returned to the river as nutrients for the ecosystem. Downstream from the effluent discharge, species composition of benthic organisms may be altered because of the change in part of their energy source from living organisms to detritus. There may be local changes in fish populations due to direct temperature effects as well as from increased diseases and predation from indirect effects such as attraction to the discharge plume.

On an intermittent basis total residual chlorine concentrations in the Station effluent will be 0.3 ppm. Residual chlorine discharges at these levels will cause disturbances to the ecosystem in the immediate vicinity of the Station.

D. AIR

The presence of cooling tower plumes in the atmosphere is not considered to be detrimental to the general health and well being of surrounding inhabitants. Any effects, and they are believed to be minimal, would be in the nature of an occasional annoyance caused by shadows or a slight augmenting of natural fog. Since the prevailing winds at the Station are from the west and northwest, the plume would probably extend to the east of the site most frequently. Land in this direction is essentially rural with no population centers for a considerable distance; therefore the impact is expected to be minimal.

VIII. SHORT TERM USES AND LONG TERM PRODUCTIVITY

The island property occupied by the Station, and the adjacent islands, are situated in a relatively picturesque part of the river valley that is bordered by forest land. This part of the river is classified by officials at the Commonwealth Fish Commission as a good sport fishing area. The best use of this land for the general population would be as recreational area, including cabin sites, boat docks, and picnic grounds. Neither the farm production nor the value of the land as a recreational site will necessarily be lost to future generations.

On a scale of time reaching into the future through several generations, the life span of the Station would be considered a short term use of the natural resources of land and water. The resource which will have been dedicated exclusively to the production of electrical power during the anticipated life span of the Station will be the land itself.

Approximately 200 acres of the site will be devoted to the production of electrical energy for the next 30 to 40 years.

At some future date, the TMI Station will become obsolete and be retired. Many of the disturbances of the environment will cease when the Station is shut down, and a rebalancing of the biota will occur. Thus, the "trade-off" between production of electricity and small changes in the local environment is reversible. Recent experience with other experimental and developmental nuclear plants has demonstrated the feasibility of decommissioning and dismantling such a plant sufficiently to restore its site to its former use. The degree of dismantlement, as with most abandoned industrial plants, will take into account the intended new use of the site and a balance among health and safety considerations, salvage values, and environmental impact.

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

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

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

Although the Applicants have not formulated plans for permanent shutdown of the Three Mile Island Station, they have estimated for Unit 1 that the cost of shutdown measures comparable to those for Hallam would not exceed $6,000,000 based on current dollar values, plus $50,000 per year to cover the cost of round-the-clock surveillance and periodic maintenance to fences and barriers. (Application for operating license as revised on May 26, 1971.)

IX. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

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

Major resources to be committed irreversibly and irretrievably due to the operation of the Station is the uranium consumed by the reactor. Only that portion of the nuclear fuel which is burned up or not recovered in reprocessing is irretrievably lost to other uses. This will amount to approximately 48 metric tons of uranium-235 assuming a 30-year lifetime for the Station. Plutonium generated during the course of reactor operation will be recovered, and this plutonium could either be recycled in the plant and thus reduce the U-235 consumed or could be used elsewhere as nuclear fuel. Most other resources are either left undisturbed, or committed only temporarily as during construction or during the life of the Station and are not irreversibly or irretrievably lost.

Long-lived radioactive materials will be produced by fission of nuclear fuel in the core of the reactor and neutron activation of reactor parts near the core. The eventual disposal and storage of radioactive materials will require a certain amount of space, probably in an area remote from this Station for a very long period of time, and could for all practical purposes be considered as an irreversible commitment of resources.

Of the land used for Station buildings, it would appear that only a small portion beneath the reactor, control room, radwaste and the turbine-generator buildings would be irreversibly committed. Also, some components of the facility such as large underground concrete foundations and certain equipment are, in essence, irretrievable due to practical aspects of reclamation and/or radioactive decontamination. The degree of dismantlement of the Station, as previously noted, will be determined by the intended future use of the Site, which will involve a balance of health and safety considerations, salvage values, and environmental effects.

The use of the environment (air, water, land) by the Station does not represent significant irreversible or irretrievable resource commitments, but rather a relatively short-term investment. The use of chlorine at the levels anticipated by the Applicants will result in modification of the aquatic biota which will continue for the life of the Station. Accordingly, as discussed in Section V, the Staff recommends that the Applicants reduce the total residual chlorine in the Station's effluent to a maximum of 0.1 ppm during the chlorination periods. Other effects of Station operation will result in only minor and localized changes in the biota without anticipated long-term damage.

Should an unanticipated significant detrimental effect to any of the biotic communities appear, the monitoring programs are designed to detect it, and corrective measures would then be taken by the Applicants.

X. THE NEED FOR POWER

The Applicants are subsidiaries of GPU which is a holding company comprised of four utilities, operated as an integrated system. The GPU service area, shown in Fig. 15, extends from Lake Erie in Pennsylvania, at its western extremity, to the Atlantic Coast of New Jersey on the east, and includes more than half of the state of Pennsylvania. In the past decade or so, GPU has found it economically attractive to install modern mine-mouth, coal-fired plants in western Pennsylvania (Pennsylvania Electric area) and transmit sizable blocks of power to eastern load centers via high voltage transmission facilities. The more recent addition of new capacity at the eastern edge of the GPU service area in New Jersey close to eastern load centers, has produced a concentration of generating capacity at the eastern and western edges of the GPU service area. The location of the Station at Middletown (see Fig. 15) will tend to reduce the system dependence on this east-west transmission pattern and, therefore, will increase system reliability. The GPU system load demand is composed of: residential, 32.8; commercial, 19.7%; industrial, 41.9%; and miscellaneous, 5.6%.

The Applicants are members of the Pennsylvania, New Jersey, Maryland Interconnection (PJM) Power Pool which consists of the following companies:

- Atlantic City Electric Company,
- Baltimore Gas and Electric Company,
- Delmarva Power and Light Company,
- General Public Utilities System:
  - Jersey Central Power and Light
  - Metropolitan Edison Company
  - New Jersey Power and Light Company
  - Pennsylvania Electric Company,
- Pennsylvania Power and Light Company,
- Philadelphia Electric Company,
- Potomac Electric Power Company,
- Public Service Electric and Gas Company,
- UGI Corporation - Luzerne Electric Division.

The PJM Pool is operated from a central dispatch office at Valley Forge, Pennsylvania as a single system without regard to ownership of the facilities of member companies in meeting the overall load demand. There is frequent flow of interchange power between the member companies and they share in any required voltage reduction or curtailment of load. The PJM pool also maintains ties with neighboring power pools so that power may be interchanged on an emergency basis. The pool serves a population of about 20 million in a 48,000 sq mile area which includes 3/4 of Pennsylvania, most of New Jersey, more than half of Maryland, all of Delaware and the District of Columbia, plus a small part of Virginia. The total PJM capacity in 1971 was 31, 094 MWe.

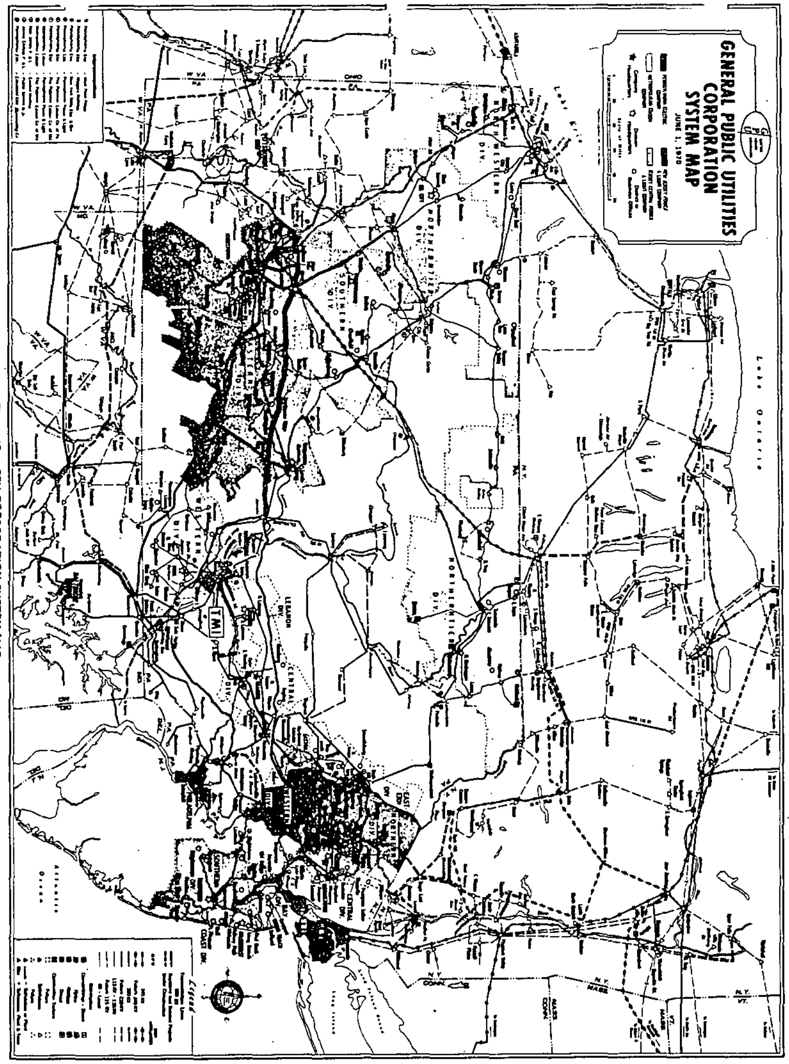

Figure 15 – GPU CORPORATION SYSTEM MAP

The Applicants are also members of the Mid-Atlantic Area Coordinating Group (MAAC) which is one of nine regional groups of the National Electric Reliability Council. MAAC, composed of the same companies which comprise the PJM Pool, functions to set standards and to continually assess present and future plans which affect the reliability of the electric power service.

The projected GPU system load demand and generating capacity for the next decade is summarized in Table 21. The projected capacities required are based upon the system summer peak load plus a 20% reserve margin--this reserve margin having been adopted as the minimum desirable by the PJM Pool. As shown by the data in the Table, some purchase of power is planned for 1973, 1974, and 1975 to meet the peak summer load demand. The goal of 20% reserves (excluding the purchased power in 1974) is not met until the summer of 1975 when TMI-2 comes on line. The percentage reserve figures in the last two columns of Table 1 shows the effect of successive numbers of years delay for one or both TMI units. For example, if Unit 1 is delayed one year, the reserves drop to 7.5%; if Unit 1 is delayed two years and Unit 2 is delayed one year, reserves are 2%; if Unit 1 is delayed three years and Unit 2 is delayed two years, reserves are -0.5%; etc.

No utility in the power pool would be able to provide large blocks of firm power when it is needed by GPU. On a short term basis it appears that sizable amounts of power may be available, but this would not resolve the system's long term power problems.

The projected load demand and generating capacity for the PJM Pool for the next decade is presented in Table 22, which gives the same type of presentation as Table 21, for the PJM Pool instead of the GPU system. As shown by the data in the Tables, while the delay of TMI-1 and 2 causes a serious reduction in the reserve capacity of the GPU system, the effect on the PJM Pool is much less severe. For example, if one unit at TMI is not operating in 1976 as scheduled, the reserve capacity of the PJM Pool is reduced from 28.3% to 26.2%. If both TMI-1 and 2 are not operating at that time, there is a further drop in reserves to 23.9%. This comparison, of course, does not consider the increased reliability resulting from location of generating capacity in a region where there is presently a shortage, nor does it consider the effect of delays in installation of new PJM generating capacity, 42% of which between the years 1972 and 1976 is comprised of nuclear units.

The commercial service dates of this nuclear capacity are currently estimated to be as follows:

	MW	Date
Calvert Cliffs 1	845	Jan. 1973
Peach Bottom	1065	Mar. 1973
Three Mile Island 1	830	Nov. 1973
Calvert Cliffs 2	845	Jan. 1974
Calvert Cliffs rerating	20	Jan. 1974
Peach Bottom 3	1065	May 1974
Salem 1	1095	Oct. 1974
Calvert Cliffs rerating	20	Jan. 1975
Salem 2	1107	May 1975
Three Mile Island 2	830	May 1975
Limerick 1	1055	Mar. 1976
Three Mile Island 2 rerating	120	Mar. 1976
TOTAL	8897	

The effect of a one and two year delay in startup of these plants on PJM reserves would be as follows:

	Reserves with one year delay		Reserves with two year delay	
	MW	%	MW	%
1972	5972	20.7	5972	20.7
1973	4987	15.8	4987	15.8
1974	5574	16.3	3664	10.7
1975	8157	21.9	5397	14.5
1976	10298	25.5	7246	17.9

While a two year delay for all plants is unlikely, some delays are probable and it is clear from the above data that the PJM reserve capacity projected in Table 22 could be significantly altered by perturbations in construction and operation schedules of a relatively small number of plants.

TABLE 21 PROJECTED GPU SYSTEM LOAD AND GENERATING CAPACITY

Year	Projected Peak Summer Load (MWe)	Dependable Capacity (MWe): GPU Internal	Dependable Capacity (MWe): Purchases	Dependable Capacity (MWe): Total	Reserve Capacity (%): With TMI-1&2	Reserve Capacity (%): Without TMI-1	Reserve Capacity (%): Without TMI-1&2
1971	4326 (actual)	4945		4945	--	14.3	14.3
1972	4934	5625		5625	--	14.0	14.0
1973	5379	5873	350	6223	—	15.7	15.7
1974	5863	6935[1]	200	7135	21.7	7.5	7.5
1975	6377	7765[2]	400	8165	28.0	15.0	2.0
1976	6954	8696[3]		8696	24.9	13.1	-0.5
1977	7583	9090		9090	19.9	8.9	-6.0
1978	8269	10230		10230	23.4	13.7	2.2
1979	9022	10885		10885	20.6	11.4	1.0
1980	9851	11841		11841	20.2	11.8	2.1

[1]TMI-1 on line + 830 MWe.
[2]TMI-2 on line + 830 MWe.
[3]Rerate TMI-2 + 120 MWe.

TABLE 22 PROJECTED PJM POOL LOAD AND GENERATING CAPACITY

Year	Projected Peak Summer Load (MWe)	Generating Capacity (MWe)	Reserve Capacity (%): With TMI-1&2	Reserve Capacity (%): Without TMI-1	Reserve Capacity (%): Without TMI-1&2
1971	25,529	31,094	--	21.8	21.8
1972	28,870	34,842	--	20.7	20.7
1973	31,470	38,367	--	21.9	21.9
1974	34,240	42,574[1]	24.3	21.9	21.9
1975	37,290	48,499[2]	30.1	27.9	25.6
1976	40,500	51,973[3]	28.3	26.2	23.9
1977	43,940	56,212	27.9	26.0	23.9
1978	47,630	60,736	27.5	25.7	23.8
1979	51,470	66,231	28.7	27.0	25.2
1980	55,660	70,357	26.4	24.9	23.2

[1]TMI-1 on line.
[2]TMI-2 on line.
[3]Rerate TMI-2.

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

The Applicants have provided a discussion of alternatives and a cost benefit analysis in their Environmental Report.[1] The Staff's independent review is summarized below. In many cases the staff found the Applicants' estimates adequate and these were used in the discussion. In other cases the estimates were made independently.

A. SUMMARY OF ALTERNATIVES

1. Abandonment of the Project

Abandonment of the project is an alternative to be considered in evaluating the impact of both plant construction and subsequent plant operation. In the case of Three Mile Island Station we have concluded that abandonment of the project is not a practicable alternative for the following reasons:

- Construction of the Station has progressed to the point where environmental impact associated with this phase has already been absorbed.
- The identifiable environmental costs of plant operation are insignificant when compared with the unsalvageable cost of $350 million involved in abandonment (see B.1. below).

2. Alternative Power Sources

a. Purchase of Power

The applicants state that there was and is no possibility of a power purchase in an amount equivalent to the capacity and energy of the TMI project. The staff notes that while PJM pool reserves appear substantial (table 22), such pool reserves do not generally include provisions for long term firm power transactions. In addition, projected PJM reserves are uncertain, because of the possibility of delay in new generating capacity now under construction. The uncertainties of maintaining construction schedules and the steady extension of demand in this area make dependence on this external base-load power source highly questionable. In addition, the Applicants state that no nearby public or private utilities outside of the PJM pool have large amounts of power for sale on a long term continuing basis.

b. Alternative Methods of Generating Power

Coal Fired, Base Load Generation

Economic studies performed by the Applicants in 1965 indicated that mine mouth coal fired generation in western Pennsylvania provided short term economic advantages over an equivalent nuclear unit located in the eastern portion of the state. Based on these studies a decision was made to proceed with construction of the Homer City unit, a coal-fired mine mouth generating plant in western Pennsylvania.

In 1966 the Applicants re-examined the economics of additional nuclear generation, but this time in comparison with a coal-fired unit at the same site as would be selected for the nuclear unit. The Applicants state that there were two reasons for this shift in the basis of comparison:

(1) The particularly attractive conditions applicable to the Homer City plant were no longer available as an alternative, and

(2) Coal suppliers had suggested that fuel might be delivered to the GPU site for 20 cents per million Btu, although this was not a firm offer of such a supply.

Even on the basis of this low delivered fuel price, a nuclear unit installation was found to be advantageous. In November 1966, the decision was made to proceed with a nuclear installation for service in 1971; in December 1966, the TMI site was selected for this installation.

A comparison of a coal fired plant with the Three Mile Island Nuclear Plant is given in part B of this section.

Oil-Fired, Base Load Generation

The Applicants did not consider this alternative in the 1965-66 economic studies, because of the relatively high cost of oil fuel as compared to coal delivered in the area for which the unit was then planned.

A comparison of an oil burning plant with the Three Mile Island Nuclear Plant is given in part B of this section.

Hydroelectric Generation

The geography and flow of the Susquehanna River are such that it is impossible to find the combination of head and water quantity that can produce the capacity and energy equivalent of TMI.

Gas-Fired Generation

The Applicants state and the staff agrees that this fuel can be dismissed from further consideration, since gas fuel is not available for boiler use within the company's service territory.

Thermal Peaking Capacity

The Applicants state that peaking capacity is not considered as an alternative because of the high cost and inefficient use of fuel, if such units are used for long hours of generation, comparable to those expected of a nuclear plant. Combustion turbines, combined cycle units and oil-fired cycling units are intended for a different type of service and GPU is planning on a long-term basis for limited use of such capacity to provide for a balanced development of its system. Currently, however, very large combustion turbine installations are being made because of delays in installations of other capacity.

The environmental cost of such peaking units are quite similar to those for an oil-fired base load unit.

The staff concurs with this evaluation and notes that it is essential to add to base load generating capacity at the present time if the applicant is to be capable of meeting its projected loads.

Other Sources

The production of energy by MHD, solar heat, fuel cells, wind power or tidal power must be dismissed as not feasible in the time period and in the area that will be served by TMI. Pumped storage is not a viable alternative since such facilities are net consumers of electrical energy.

3. Alternate Sites

Five sites were considered by the Applicants during the initial planning (1965-66) for Unit 1, the nuclear station that was to provide the 1973-74 power need for GPU. These sites were:

(1) Three Mile Island,
(2) Gilbert Station site on the Delaware River in New Jersey,
(3) Portland Station site on the Delaware River in Pennsylvania,
(4) Monocacy site on the Schuylkill River, south of Reading, Pennsylvania, and
(5) Berne site on the Schuylkill River, north of Reading.

A major consideration in the selection of a nuclear plant site is its relation to centers of population. There was not much choice among the available sites in this respect. All possible sites were sufficiently far from major cities, but not very far removed from one or more small communities that cover most of Met Ed's area. From this point of view, one site was just about as good as any other that could be given serious consideration, and no difference in cost was assumed to arise from nuclear safety considerations.

Foundation conditions, including exposure to seismic disturbances, likewise vary in no important respects at the sites investigated.

Conditions which varied among the sites considered and on which selection of the Three Mile Island site was based included:

(1) Availability and cost of cooling water,
(2) Transmission investment and transmission losses,
(3) Cost of site and site preparation, and
(4) Construction labor rates and productivity.

The discussion of these several criteria in the following sections is based on information provided by the Applicants.

a. Cooling Water

Cooling towers for Unit 1 will require approximately 22 cfs as make-up for evaporation and other losses. Water can be obtained at this rate not only from the Susquehanna and Delaware, but also from the Schuylkill and even smaller streams. The smaller the drainage area considered, the more likely it would be that a reservoir is needed for flow augmentation. The Applicants state that one of the sites considered required such a reservoir in addition to cooling towers.

b. Transmission

A study was made by the Applicant of GPU system transmission losses with the nuclear plant in various locations. Because of the pattern of west to east flow of energy in the GPU and PJM systems, the losses are progressively higher as the nuclear plant is moved farther west, thus adding more to this energy flow.

In addition, there was a need for a third east-west 500 Kv line to meet the MAAC reliability criteria. The location of the TMI site was advantageous in that it allowed the line then to fulfill a dual function: to transport TMI-2 output and to provide additional system reliability.

c. Cost of Site Preparation

Several of the possible locations for the nuclear plant involved existing sites, where all or nearly all of the necessary land area was already owned by the Applicants (or an affiliate) and little if any additional capital expenditure for land would be necessary. These differences in land cost (as well as other site differences) are reflected in the comparison of sites.

There were also differences among the sites in road and railroad access, flood protection, grading, etc., which the Applicants evaluated in the estimate of plant cost.

d. Construction

A most important difference considered by the Applicants between the several sites was the influence of labor rates and productivity on plant construction costs. This is a difference which is evident from comparison of union wage scales and is one which has affected the construction costs of existing plants of the Applicants and their affiliates in GPU. A fairly reliable background was, therefore, available upon which an estimate could be based for relative construction costs in New Jersey, eastern Pennsylvania, and in the Susquehanna River region. The lowest construction labor costs were expected to be available at Three Mile Island.

e. Other Differences

Other differences that might be significant were related only to the Gilbert site, and these were unfavorable to its use by the Applicants. This site is in New Jersey and is owned by an affiliate company. Use of this site by the Applicants would involve some reduction in the Pennsylvania taxes paid (income tax), but a more than offsetting increase in New Jersey taxes. It is also likely that this location would involve higher expenses for operation and maintenance because of differences in wage rates. An evaluation of these differences is not necessary to the selection of the Three Mile Island site.

f. Summary

The evaluation of each of the above criteria by the Applicants indicated the relative cost of the several sites to be:

SITE	ADDITIONAL COST ($1,000,000)
Three Mile Island	Base
Gilbert	1.2
Monocacy	2.5
Portland	2.5
Berne	8.9

The decision to locate the second unit at TMI, then scheduled for service in 1973, was made in December 1968. Studies of the site for this unit were begun by the Applicants in 1967 with comparisons being made among the following locations:

- Oyster Creek, N. J. (existing site)
- Union Beach, N. J. (on Raritan Bay)
- Gilbert, N. J. (existing plant on Delaware River)
- Portland, Pa. (existing plant on Delaware River)
- Scottsville, Pa. (on upper Susquehanna River)
- TMI, Pa.

The Applicants state that these studies showed a very small advantage (less than the error inherent in such estimates) for TMI as compared to Oyster Creek, assuming that discharge temperature requirements for the second unit at Oyster Creek would be somewhat more severe than for the first unit. Nevertheless, tentative selection was made of the Oyster Creek location, based largely on the local need for additional generation and the associated transmission.

Compared with a nuclear plant at various sites, the addition of a third unit to the mine-mouth plant then under construction at Homer City showed the lowest overall cost; but the advantage of this site could be further enhanced if use of this site were delayed several years until load growth in the western Pennsylvania area of GPU could absorb this capacity, making it

again unnecessary to construct long transmission lines to eastern load centers. Consequently, it was desirable to delay the Homer City installation (and in fact it was delayed, this third unit now being scheduled for service in 1976) and to remove it from further consideration in connection with the 1973 unit.

During 1968, further studies were carried out by the Applicants with respect to:

(1) The cooling water problem at Oyster Creek,
(2) The need for extensive 500 Kv transmission additions, and
(3) Possible delays in both plant and transmission construction.

The Applicants state that the results of these studies pointed up certain disadvantages in the Oyster Creek site for 1973 capacity and added to the earlier marginal advantage of TMI. Finally, in December 1968, decision was made to shift the location of this 1973 unit to TMI.

In the series of site studies, extending from 1965 through 1968, it was apparent that there were relatively small cost differences among many of the sites that were investigated, and several of those sites that were not then selected for immediate use were considered as likely locations for the next nuclear unit. The small differences among sites is to be expected from the nature of the areas in which the plants were to be located; and these small differences have been confirmed by more recent studies by the Applicants of additional sites.

No comparisons were made by the Applicants in 1965-68 with off-shore sites, for such locations for large nuclear units did not then appear to be feasible, either for plant construction or transmission connection. However, as is evident from the above discussion, TMI was compared with coastal sites at Oyster Creek and Union Beach and was found to be economically advantageous in comparison with either one.

4. Alternative Land Uses

Three Mile Island is in a relatively picturesque landscape and it is quite probable that the land would be used for residential and/or recreational facilities, if it had not been owned and reserved for its present use. There are then several uses of this land that should be considered in a cost-benefit analysis:

(1) nuclear power station,
(2) fossil-fueled power station,
(3) other industrial uses,
(4) commercial uses, i.e., restaurants, boat clubs, etc.,
(5) residential uses,
(6) public park and recreational uses,
(7) farm land.

Among the more important benefits to be considered in land use, the economic benefits would include the productivity in terms of the gross dollar income from sales, wages brought to the local area, and the increased dollar activity in the local business community from sales to the industries or persons occupying the land in question. Other benefits that can be qualitatively evaluated on the basis of needed services provided are electrical power, food, living area, recreational area and commercial establishments. Table 21 presents a summary of comparative benefits and environmental costs from the alternative land uses. For purposes of comparison it is presumed that other industry would be attracted to this area and that the total sales would be comparable to that from the sale of electricity. Similar presumptions are made with regard to the attraction to TMI of commercial and residential developers. Without a great increase in population near the site, it is in fact doubtful that any large economic benefits could be extracted from a shopping center or other commercial enterprises on TMI. In view of the large amount of undeveloped land to the east and west of TMI, it is also doubtful that TMI would be in demand as a site for a large housing development. It is, however, quite possible that TMI could be developed as a site for vacation homes or for a one-acre lot development. The estimate of $10 million from sales and development of residential homes is based on 270 lots of one acre, with an average cost of $40,000.

The principal conclusion of this comparison is that, whereas the 1660 Mw nuclear station will produce a relatively large economic benefit, the environmental costs compared to the use of TMI for other industry or for commercial or residential uses will be relatively small, except for the aesthetic impact. The recreational and farm uses are to be preferred from the environmental cost basis, but their economic benefits are negligible. The recreational use would, however, satisfy what is perhaps the greatest need for the area.

5. Alternatives to Natural Draft Cooling Towers

The probable fog impact from the four natural draft cooling towers, based on experience with comparable facilities and model calculations, is considered slight. However, because of the proximity of the Station to Harrisburg International Airport, the possibility of cooling by other methods should be considered as a means for correcting any serious problems that may arise. Given present technology, the following methods of heat dissipation are possible substitutes for the natural-draft wet cooling tower method:

(1) Once-through cooling,
(2) Cooling pond,
(3) Spray-canal,
(4) Mechanical-draft towers, wet,
(5) Dry cooling towers.

Table 23: COST-BENEFIT ANALYSIS OF ALTERNATIVE LAND USES

Benefits	1660 Mw Nuclear Power Station	Other Industry	Commercial	Residential	Recreational	Farm
Sales (10^6 dollars)	250/yr	N250/yr	<250/yr	~10	Neg.	<0.2
Wages (10^6 dollars)	1.2/yr	>1.2/yr	>1.2/yr	Included above	Small	Neg.
Local Business (10^6 dollars)	.050/yr	Probably much greater	Greater	~2/yr	1/yr	Neg.
Electricity	X	—	—	—	—	—
Other Products	—	X	X	—	—	X
Living Area	—	?	?	X	X	Neg.
Recreational Area	X	?	?	?	X	—
Commercial Services	—	?	X	?	X	—
Need, for this Area	~X	X	—	—	X	—
Costs						
Aesthetic Impact	High	High	Medium	Medium	Neg.	Neg.
Aquatic Life Cost	Medium to Small	High to Neg.	Small	Medium	Neg.	Small
Bird and Animal Life Cost	Small	High to Neg.	Small	Medium	Neg.	Small
Noise Cost	Neg.	High to Neg.	Medium	Medium	Small	Neg.
Shoreline Erosion Cost	Neg.	High to Neg.	Neg.	Small	Neg.	Neg.
Atmospheric Cost	Medium	High to Small	Medium	Medium	small	Neg.
Population Increase	Neg.	High to	High	High	Small	Neg.

Among these five alternatives, the spray-canal and wet mechanical draft towers have greater potential for ground fog than the present system. The cooling pond system is impractical at the present site because of the large land area that would be necessary. It is estimated that a 3400-acre pond would be necessary for both TMI-1 and 2. Once-through cooling would put an excessive thermal load on the Susquehanna River and would not comply with Pennsylvania thermal discharge standards for the River.

The alternative that would probably least affect the environment is the dry cooling tower. The dry heat that is emitted from such towers should produce no adverse fogging impact, although it is possible that a change may occur in local precipitation or storm frequency from the large volumes of rising dry air. Dry cooling systems are not included in the following cost-benefit analysis, since the designs are not at the stage where they can be considered as practical alternatives.

6. Alternative Transmission Lines

The route originally considered for the transmission line from the TMI Plant to Bechtelsville paralleled existing lines of lower voltage and would have required additions to the width of the right-of-way. For the portion of that route west of Reading, at least ten homes would have had to be purchased and removed and thirty homes were within 300 feet of the existing line. The portion of the route east of Reading would have passed fairly close to the towns of Seyfert, Gibraltar, Lorane, and Stonetown, and many homes would have had to be removed. For the transmission line from the TMI Plant to Juniata, following existing rights-of-way would have interfered with a farmhouse, a rendering plant, several houses in the village of Falmouth and a road and numerous homes near the junction with the Juniata - Peach Bottom line. These impacts necessitated changes in the routing of the transmission lines to put them through less developed areas.

The alternative of putting the transmission lines underground has problems of technology and of economics. The use of underground cable for high-voltage transmission of bulk power has generally been limited to the short lengths required in extremely congested areas and to voltages of less than 500 kv. The cost of underground lines can range from ten to forty times that of overhead lines of equal capacity. The Federal Power Commission in "The 1970 National Power Survey" (Part IV, Chapter 7) states that the prospects for major reductions in this cost ratio are not encouraging.

B. SUMMARY OF COST-BENEFIT ANALYSIS

The generating costs and the environmental effects of the TMI nuclear plant are compared with those for a coal-burning plant and for an oil-burning plant in the discussion below and in Table 24. The benefits of the TMI plant are then discussed and balanced against its costs.

Table 24

COMPARISON OF THE TMI NUCLEAR PLANT WITH ALTERNATIVE FOSSIL-FUEL PLANTS

Generating Costs a/ ($ million)	TMI Nuclear Plant	Coal-Burning Plant	Oil-Burning Plant
Capital	645	561 b/	374
Operating c/	234	526	953
Total	879	1,087	1,327
Use of Natural Resources			
Land (acres)	200	More than 200.	More than 200.
Water (gal/min consumed)	20,800	14,000	14,000
Fuel (t is tons)	U_3O_8: 1,200 t + 330 t/yr	4,500,000 t/yr.	17,000,000 bbl/yr.
Impact on Air and Land			
Fogging	Possibly 39 hr/yr at Harrisburg Airport.	Depends on location	Depends on location.
Chemicals in drift	Insignificant	Insignificant	Insignificant
Noise	Acceptable on-site, negligible off-site.	Somewhat less than for nuclear plant.	Somewhat less than for nuclear plant.
Gaseous radwaste	2.1 man-rem/yr to population within 50 miles.	Comparable with nuclear plant.	None.
Combustion products (tons per year)	None	SO_2: 50,000 NO_x: 34,000 Particulates: 5,400	SO_2: 43,000 NO_x: 16,000 Particulates: 5,400
Impact on Water			
Intake from river	Intake velocity of 0.2 ft/sec and volume equal to 0.4% of average yearly river flow should have insignificant effect on river aquatic life.	Similar to nuclear.	Similar to nuclear.

a/The fact that construction of the TMI plant is in progress is not considered here but is discussed at the end of subsection B.1 below.

b/Includes the cost of equipment to reduce SO_2 emission and additional transmission costs associated with mine-mouth plant in western Pennsylvania.

c/Present worth computed for 30 years of operation at a discount rate of 8.75%/yr.

Table 24 (cont'd)

COMPARISON OF THE TMI NUCLEAR PLANT WITH ALTERNATIVE FOSSIL-FUEL PLANTS

	TMI Nuclear Plant	Coal-Burning Plant	Oil-Burning Plant
Impact on Water			
Discharge to river Thermal	No appreciable increase above river ambient temperature, except for a few degrees in winter.	Similar to nuclear.	Similar to nuclear.
Chemical	Possibility of adverse effect on biota near discharge point.	Similar to nuclear	Similar to nuclear
Radiological	17.1 man-rem/yr to population within 50 miles.	None	None.
Accidents	Exceedingly small risk of release of radioactivity.	Small risks associated with massive transport of fuel, for example, chance of oil spillage.	
Aesthetics	Adverse effect of buildings, cooling towers, and transmission lines.	Similar to nuclear, plus adverse effect of facilities for transport and storage of fossil fuel.	

The plants are assumed to operate at the equivalent of full capacity for 80% of the time or 7,000 hours per year. The "present worth" of annual operating costs for 30 years of operation is obtained by using a discount rate of 8.75% per year. The base year is taken as 1973, when TMI Unit 1 is expected to start commercial operation, and allowance is made for the start of operation of Unit 2 a year later. The result is that the cost of operation of both units for one year is multiplied by 10.05 to obtain the present worth of the cost of operation for 30 years.

1. Generating Costs

The capital cost of the TMI nuclear plant (Units 1 and 2 together) is estimated at $645,000,000, which corresponds to $362 per kilowatt for the ultimate capacity of 1,780 megawatts (830 megawatts for Unit 1 and 950 megawatts for Unit 2).* The annual operating cost is estimated as $23,300,000 including nuclear fuel at 1.3 mills per kilowatt hour, and nuclear insurance, operation and maintenance at 0.57 mills per kilowatt hour. The present worth for 30 years of operation is $234,000,000. The generating cost, which is the total of capital cost and present worth of operating cost, is then $879,000,000.

The capital cost of a coal-burning plant of the same capacity as TMI is estimated $401,000,000 ($225 per kilowatt) plus $71,000,000 ($40 per kilowatt) for equipment to reduce oxides of sulfur plus $89,000,000 ($50 per kilowatt) for additional transmission costs associated with location of the plant at the mouth of a coal mine in western Pennsylvania, which is more economical than transporting coal to a location near the load center. The total capital cost is then $561,000,000 ($315 per kilowatt). The annual operating cost is estimated as $52,400,000 including fuel at 3.7 mills per kilowatt hour and operation and maintenance of 0.51 mill per kilowatt hour; the present worth for 30 years of operation is $526,000,000. The generating cost, capital plus operating, is then $1,087,000,000.

The capital cost of an oil-burning plant of the same capacity as TMI is estimated as $374,000,000 ($210 per kilowatt). The annual operating cost is estimated as $94,900,000 including fuel at 7.2 mills per kilowatt hour and operation and maintenance at 0.41 mill per kilowatt hour, and the present worth for 30 years of operation is $953,000,000. The generating cost, capital plus operating, is then $1,327,000,000.

The result is that, on a present-worth basis, the generating cost for 30 years of operation is about $200,000,000 less for the TMI nuclear

* This cost estimate and the others given below are based on the Applicants' Environmental Report submitted to the AEC in December 1971. In a Quarterly Progress Report on Status of Reactor Construction as of September 30, 1972, provided to the AEC by the GPU Service Corp., the total cost of the nuclear production plant for TMI Units 1 and 2 was indicated at $780,000,000, of which about $402,000,000 was the cumulative cost at a time when completion of physical construction was 90% for Unit 1 and 31% for Unit 2. A current comparison with the costs of a coal-burning or an oil-burning plant would need to include the effects of cost escalation on those plants.

plant than for a coal-burning plant and about $450,000,000 less for the nuclear plant than for an oil-burning plant.

The above discussion deals with the situation before construction of the TMI plant began. The actual situation in late 1971 was that $278,000,000 had already been invested in the TMI plant, leaving $367,000,000 to complete the plant. Abandonment of the plant at that stage would mean payment of $70,000,000 in cancellation charges and $95,000,000 to restore the site to its original condition. The net result is that completing the plant would cost only $202,000,000 more than abandoning it. Furthermore, there would be a delay of about four years before new fossil-fuel plants with a capacity equal to that of TMI could be built, and during this period the applicant would have to increase production in existing coal-burning plants that are less economical to operate and would have to purchase power, the cost being approximately $70,000,000 per year for four years with a present worth of $228,000,000. This situation is summarized below.

Completion and Operation of TMI Plant	Incremental Cost in Millions of Dollars
Completion of Construction	367
Operation for 30 years[a]	234
Total	601

Abandonment of TMI Plant[b] and Construction and Operation of Fossil-Fuel Plant	Coal-Burning	Oil-Burning
TMI cancellation charges	70	70
Capital cost of fossil-fuel plant[c]	457	305
Replacement power for 4 years[a]	228	228
Operation of fossil-fuel plant for 26 years[a]	363	657
Total	1,118	1,260

a/ Present worth

b/ Does not include cost of site restoration which Applicants estimate at $95 million.

c/ Present worth based on average annual construction cost during a four-year period.

The conclusion is that incremental costs for abandonment of the TMI plant and construction and operation of a fossil-fuel plant would be $600,000,000 to $650,000,000 more than for completion and operation of the TMI plant.

2. Use of Natural Resources

Land. Of the 470 acres of Three Mile Island, about 200 acres are to be used for the TMI plant. The 270 acres of the island previously leased for farming yielded a corn crop having an annual value of $10,000, but farming ceased as plant construction started. Land required for a coal-burning or oil-burning plant of the same capacity as the TMI nuclear plant would be somewhat greater to accommodate facilities for storing fossil fuel.

Water. The maximum rate of evaporation of water from the TMI cooling towers will be 20,800 gallons per minute, amounting to 2.7% of the minimum river flow or 0.23% of the mean river flow. A coal-burning or oil-burning plant of the same capacity would have a higher thermal efficiency than the nuclear plant and would dissipate some heat through a smokestack, so that the water evaporation would be about two-thirds as much or 14,000 gallons per minute.

Fuel. In order to provide the initial loadings of nuclear fuel for Units 1 and 2 of the TMI plant, sufficient uranium ore will have to be mined and refined to produce about 1,200 tons of U_3O_8 (yellowcake), which will then be converted to uranium hexafluoride and enriched in U-235 content in an isotope separation plant. In addition, about 330 tons of U_3O_8 will be needed each year for replacement loadings. The AEC Report to Congress for 1971 gives on page 136 a preliminary figure of 275,000 tons as of the end of 1971 for U.S. reserves of U_3O_8 recoverable at costs of $8 per pound, representing a 10 year forward supply. Potential resources at costs of $10 per pound or less were estimated at 650,000 tons, but this additional supply will require a major exploration effort to discover, develop, and bring into production. Alternatively, fuel requirements for a coal-burning plant of the same capacity as TMI would be about 4,500,000 tons of coal per year, which would be mined in western Pennsylvania. Fuel requirements for an oil-burning plant would be about 17,000,000 barrels of oil per year, presumably obtained from foreign sources.

3. Impact on Land and Air

Fogging and Icing. The four natural-draft cooling towers for TMI Units 1 and 2 will produce a visible plume when the atmosphere is already near saturation. Under the most adverse meteorological conditions, occurring approximately 39 hours per year, there may be an effect at or near ground level of partial obscuration of the east end of the runway at Olmsted Airport about 2.5 miles away. The runway is 10,000 feet long, and the west end may still be used unless natural fog, which may occur under the same conditions, is already obscuring the runway. Similarly, there may be partial obscuration of some local roads, but this should be less frequent than in the case of the runway and should not severely restrict traffic. The concentration of water in the atmosphere near the ground will be too low for icing to occur.

Chemicals in Drift Water. The natural-draft cooling towers will contain two-pass herringbone drift eliminators, guaranteed to keep the drift within 0.1% of the circulating water flow. Some recent data indicate that the drift will not exceed 0.03%, and this is being further tested by the manufacturer. There will also be drift eliminators in the small mechanical-draft cooling towers in the blowdown circuit. The drift is expected to be concentrated in the area immediately around the towers. Much of it will fall into the river, and some could fall on nearby farms. The concentration of dissolved and suspended solids in the drift water should be between two and five times the concentration in the river water. However, the amounts of these materials deposited per acre per year are much smaller than would result from using the river water for irrigation and will probably have little adverse impact and possibly a beneficial impact in providing nutrients.

Noise. The principal source of noise will be the fans in the small mechanical-draft cooling towers. The effect of this noise will be acceptable on-site and will be negligible off-site.

Gaseous Radioactive Effluents. The average dose to an individual at the site boundary of the TMI Plant is estimated as 0.72 millirems per year, including direct exposure to radioactive gases and inhalation of radioactive iodine. The total population dose within 50 miles of the plant is estimated as 2.1 man-rems per year. These doses may be compared with a natural background of 125 millirems per year for an individual and 233,000 man-rems per year for the population involved. The radioactive releases from the TMI plant will be "as low as practicable" in accordance with the criteria proposed in 10 CFR 50. Radioactive emissions to the air from coal-burning plants depend on the composition of the coal but may be comparable with the emissions from nuclear plants. No radioactive emissions are expected from oil-burning plants.

Combustion Products. A coal-burning plant in the Applicants' area would discharge to the atmosphere 50,000 tons of sulfur dioxide per year, even with equipment installed to remove 80% of the material. The discharge of oxides of nitrogen would be 34,000 tons/yr and of particulates would be 5,400 tons/yr. The corresponding figures for an oil-burning plant are 43,000 tons/yr of sulfur dioxide, 16,000 tons/yr of oxides of nitrogen, and 5,400 tons/yr of particulates.

4. Impact on Water

Intake from River. Water taken from the river amounts to 54,500 gallons per minute. The normal entrance velocity to the intake is 0.2 feet per second, which is low enough to allow all but the smallest fish to escape. Any fish, fish larvae and eggs, and plankton entrained in the intake water will probably be killed by mechanical, chemical, and thermal effects in the plant. However, the intake corresponds to only 0.5% of the average yearly flow of the river or 6% of the minimum daily flow expected to occur once in 25 years. The impact on aquatic life should therefore not be significant.

Discharge to River. Use of the natural-draft cooling towers together with mechanical-draft cooling towers for plant effluents results in a temperature of the discharged water a few degrees above the ambient river temperature in cold weather (deicing mode of operation) and essentially equal to ambient river temperature otherwise. The addition of sulfates and chlorine in the plant and the concentration of dissolved solids in the cooling towers will not be significant after the discharged water is mixed with river water, but there will be some adverse effects on aquatic life in the immediate vicinity of the discharge point. The radioactivity in the discharged water is estimated to result in an individual average dose of 0.23 millirem per year and a total dose to the populations of 17.1 man-rems per year, including the effects of drinking water, fish consumption, and water recreation. These figures are within the proposed AEC criteria for "as low as practicable" given in 10 CFR Part 50.

5. Radiological Effects of Accidents

The possibility of accidents involving radioactive materials either within the plant or during transportation is discussed in Section VI. The conclusion is that the measures taken to prevent accidents and the measures taken to contain radioactive materials safely if accidents did occur make the environmental risks exceedingly small.

6. Transmission Lines

The rights-of-way for the transmission lines from the TMI plant will consist of about 1,900 acres, mostly of cultivated farm land with some scattered woodland. The property owner is permitted to use the land for growing crops, grazing cattle, or growing trees to a limited height, but not for any structures. No historical or archaeological sites, virgin forests, or wild-life preserves are involved.

The route for the TMI-Bechtelsville line required the purchase of one home, and the route proposed by the applicant for the TMI-Juniata line would require the purchase of six homes. The authorized cost under the construction schedule existing in November 1971 was about $16,000,000 for the TMI-Bechtelsville line and about $2,000,000 for the TMI-Juniata line.

7. Aesthetics

Changes in the site from a rural area to an industrial area with buildings, cooling towers, and transmission lines will have an adverse aesthetic effect. The Applicants are trying to minimize this effect by the design of the plant and transmission system and by landscaping. A fossil-fuel plant at this site would have had the additional adverse features of smokestacks and large facilities for fuel transportation and storage.

8. Benefits

The primary benefits of the TMI plant are associated with the installed capacity and the output of electrical energy. The capacity of 1,780 megawatts will assist in meeting reliably the electrical load on the Applicants' system and will contribute substantially to the reserves of the interconnected systems. The generation of about 12.5 billion kilowatt hours per year will supply electrical energy for industrial, commercial, and residential uses.

There are substantial benefits to the local economy from expenditures during construction. About $5,000,000 a year is being spent for materials and equipment within a 100-mile radius of the site. Employment is being provided for 2,200 men at the peak of the construction work force. The wages expected to be paid are about $35,000,000 in 1972, tapering off in subsequent years as construction is completed. This payroll is especially important to an area that has been economically depressed as a result of the closing of the Olmsted Air Force Base.

Operation of the plant will give employment to about 150 men at wages of about $2,500,000 per year. Property taxes are paid to the state on the depreciated value of the plant, and will initially amount to about $3,000,000 per year.

An educational benefit is the Information and Observation Center located on the mainland, directly across from the plant site. More than 52,000 people have visited this center by December, 1971 and have participated in a number of educational programs. The Applicants propose to spend about $750,000 on new recreational facilities on Three Mile Island, including a marina, picnic grounds, and athletic facilities.

9. Balancing of Costs and Benefits

The main environmental considerations for the TMI plant are the change from rural to industrial use of the site, the possibility that plumes from the cooling towers would contribute to fogging at the end of a runway at a nearby airport under meteorological conditions expected to occur infrequently, the possibility of adverse effects on aquatic life in a small fraction of the river flow, radiological doses that are within the proposed AEC criteria of being "as low as practicable" and are a very small fraction of natural background, and an exceedingly small environmental risk of accidents involving radioactive materials. These effects are greatly outweighed by the benefits of supplying needed electricity at large savings in costs compared with those of fossil-fuel plants and without attendant air pollution by combustion products.

XII. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

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

- Advisory Council on Historical Preservation
- Department of Agriculture
- Department of Army, Corps of Engineers
- Department of Commerce
- Department of Health, Education, and Welfare
- Department of Housing and Urban Development
- Department of the Interior
- Department of Transportation
- Federal Power Commission
- Environmental Protection Agency
- Pennsylvania Department of Health
- Board of Commissioners - Dauphin County, Pennsylvania
- Board of Supervisors of Londonderry Township, Pennsylvania
- Pennsylvania Historical and Museum Commission
- Pennsylvania Department of Environmental Resources

In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the Federal Register on July 22, 1972 (37 FR 14734).

Comments in response to the requests referred to above were received from:

- Advisory Council on Historical Preservation
- Department of Agriculture
- Department of Army, Corps of Engineers
- Department of Commerce
- Department of Health, Education and Welfare
- Department of the Interior
- Department of Transportation
- Federal Power Commission
- Environmental Protection Agency
- Pennsylvania Historical and Museum Commission
- Pennsylvania Department of Environmental Resources

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

A. SPECIFICATION OF VEGETATION MONITORING PROGRAM (AGRICULTURE, P C-6 AND HEW, P C-13

As stated in one of the Table 17 footnotes, appropriate crops will be selected for analysis during the preparational phases of the environmental monitoring program. Operational monitoring requirements will be explicitly stated in the Technical Specifications section of the operating license.

B. ADEQUACY OF METEOROLOGICAL DATA (COMMERCE, P C-11)

A comment was made that X/Q values and their probabilities should be provided. The meteorological conditions used in the analysis approximate the dispersion conditions which would prevail at least 50% of the time at a typical site. The value used for a short duration release at 610 meters agrees with the Applicants' value. However, use of alternative meteorological assumptions, such as indicated in the Department of Commerce comment, does not significantly affect the overall environmental risk.

C. HOLDUP TIMES FOR ^{131}I EFFLUENT (HEW, P C-13, EPA, P C-34)

Our evaluation shows that 30 days holdup for gaseous effluents is sufficient for this plant to meet the low as practicable criteria. Holdup for 90 days would reduce the releases to approximately 750 curies of Kr-85 for each unit. The incremental environmental effect of this reduction is inconsequential.

The I-131 releases to water previously reported resulted in a dose of 2 mrem/yr from drinking water. Since the I-131 releases in the revised source term are smaller than previously reported, the doses will be smaller and are also acceptable. We conclude that the releases are as low as practicable and that no additional waste storage tanks or treatment are required.

D. POPULATION DISTRIBUTION (HEW, P C-14)

The power company's Environmental Report lists two population distributions within a 50 mile radius of the plant in Figure 2.2-1. The two values stated refer to the 1970 Census (1,867,736) and to a projected total in the year 2014 (3,028,527). The AEC staff based the radiological impact on the population determined by the 1970 Census.

E. RADIOLOGICAL EFFECTS FROM NEARBY PLANTS (HEW, P C-14)

The Environmental Impact statements are concerned with the effects produced by a plant or plants on one site. Additive effects are generally very difficult to quantify unless the sites are adjacent, in which case this question is addressed.

F. LOCATION OF RADIOACTIVE DISPOSAL AND FUEL REPROCESSING SITES (HEW, P C-14, DI, P C-19)

Certainly all details concerning shipping points for spent fuel and solid radwastes will be completed before plant operation.

G. DIFFERENCES IN RADWASTE EFFLUENTS: (DI, P C-18)

The releases of radioactive isotopes in the liquid and gaseous effluent in tables 4, 5 and 6 of this document represent the results of an independent evaluation by the AEC Staff.

H. DOSE TO INDIVIDUALS IN EXCLUSION AREA (EPA, P C-38)

The highest calculated value of the atmospheric dispersion value ($X/Q = 1.4 \times 10^{-4}$ sec/m^3) which could apply to people using the Susquehanna River occurs on the southwest shore of Three Mile Island. The total body dose would be less than 9 mrem/yr if a person spent all of his time at this location; therefore, there does not seem to be any potential for excessive exposure to persons utilizing this section of the river.

I. EFFECTS OF ADDITIONAL DEEP BED DEMINERALIZER (EPA, P C-36)

When the Applicants submit a revision to the present treatment system, the environmental effects of this modification will be evaluated.

J. DOCUMENTATION OF CONTACT WITH PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION (ADVISORY COUNCIL ON HISTORIC PRESERVATION, P C-2)

Comments on the Draft Statement from the Pennsylvania Historical and Museum Commission are included in Appendix C of this Final Statement.

K. USE OF ADDITIONAL STRIPPING COLUMNS FOR CS-137 AND SR-90 (HEW, P C-13)

Operating plants have demonstrated that demineralizer efficience is a function of water qualtiy, sampling method and operating conditions. The most important of these, however, is water quality. The polishing demineralizer decontamination factor of 10 for Cs and Sr used in our evaluation for average water quality conditions during the 40 year life of a nuclear plant. The calculated Sr-90 releases from Units 1 and 2 and Cs-137 releases from Unit 1 are less than .000005 of the 10 CFR 20 limits. The Cs-137 release from Unit 2 is .00002 times 10 CFR 20, because of the assumption in our evaluation that 10% of the condensate demineralizer regenerate solution is released untreated. This assumption was made to reduce the processing load on the Miscellaneous Waste Evaporator to reasonable levels. We conclude that the removal process for Cs-137 and Sr-90 in the liquid radwaste system is adequate.

L. DIMENSIONS OF FLOOD PROTECTION DIKES (DI, P C-17)

This information is included in Appendix D as part of the Applicants' response to comments.

M. ENVIRONMENTAL IMPACTS OF ACCIDENTAL RELEASES TO WATER (DI P C-20)

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

N. LOCATION OF PRINCIPAL REVISIONS OF TEXT IN RESPONSE TO COMMENTS

	Topics Commented Upon	Section Where Topics are Addressed
a.	Citation for National Register of Historic Places (Advisory Council on Historic Preservation, p. C-4)	References, Section II
b.	Flood Protection and Drainage (Agriculture, p. C-8, HEW, p. C-13, DI, p. C-16, EPA, p. C-35, Pa. Dept. of Environmental Resources, p. C-54)	II.E.1
c.	Discussion of June, 1972 Flood (Corps of Engineers, p. C-9, HEW, p. C-13, DI, p. C-16, EPA, p. C-35, Pa. Dept. of Environmental Resources, p. C-54)	II.E.1
d.	Results of Applicants Fish Population Studies (Corps of Engineers, p. C-9)	II.F.2
e.	Implementation Procedures for Recreational Area Construction (Corps of Engineers, p. C-10, DI, p. C-18)	V.A.1
f.	Species Lists of Local Wildlife (DI, p. C-16)	II.F.1 & II.F.2
g.	Endangered Species (DI, p. C-17)	II.F.1 & II.F.2
h.	Intake Water Velocity at Low Flow Conditions (DI, p. C-17)	III.D.1
i.	Temperature Effects During Abnormal Operating Conditions (DI, p. C-17)	III.D.1 & V.C.2
j.	Effects of TMI on Wildlife Populations (DI, p. C-18)	IV.B.1

	Topics Commented Upon	Section When Topics are Addressed
k.	Discussion of Class 9 Accidents (DI, p. C-19)	VI.A.
l.	Discussion of Final Decommissioning (DI, p. C-20)	VIII
m.	Chlorine Discharges (EPA, p. C-34, Pa. Dept. of Environmental Resources, p. C-52)	V.B.3
n.	Congregation of Fish at Outfall (EPA, p. C-35)	V.C.2
o.	Discharge of Demineralizer Waste Solutions (EPA, p. C-34)	III.D.2.b
p.	Turbine Leak Rates (EPA, p. C-35)	III.D.2.b
q.	Implications of Stoney Creek Pumped Storage Facility (EPA, p. C-40)	II.E.1
r.	Entrainment of Organisms (EPA, p. C-46)	V.C.2
s.	Bird Collisions With Cooling Towers (EPA, p. C-47)	V.C.1.a
t.	Copper Toxicity Effects from Cooling Tower Drift (Pa. Dept. of Environmental Resources, p. C-52)	V.C.1.a
u.	Restoration of Shad in the Susquehana (DI, p. C-18)	V.C.3.b

	Topics Commented Upon	Section When Topics are Addressed
k.	Discussion of Class 9 Accidents (DI, p. C-19)	VI.A.
l.	Discussion of Final Decommissioning (DI, p. C-20)	VIII
m.	Chlorine Discharges (EPA, p. C-34, Pa. Dept. of Environmental Resources, p. C-52)	V.B.3
n.	Congregation of Fish at Outfall (EPA, p. C-35)	V.C.2
o.	Discharge of Demineralizer Waste Solutions (EPA, p. C-34)	III.D.2.b
p.	Turbine Leak Rates (EPA, p. C-35)	III.D.2.b
q.	Implications of Stoney Creek Pumped Storage Facility (EPA, p. C-40)	II.E.1
r.	Entrainment of Organisms (EPA, p. C-46)	V.C.2
s.	Bird Collisions With Cooling Towers (EPA, p. C-47)	V.C.1.a
t.	Copper Toxicity Effects from Cooling Tower Drift (Pa. Dept. of Environmental Resources, p. C-52)	V.C.1.a
u.	Restoration of Shad in the Susquehana (DI, p. C-18)	V.C.3.b

APPENDIX A

Fishes in the Site Vicinity

ORDER AMIIFORMES

Amiidae

Amia calva - bowfin - only two adults taken.

ORDER CLUPEIFORMES

Salmonidae

Salmo trutta - brown trout - only one taken, likely came from a stream.

Esocidae

Esox masquinongy - muskie, uncommon, stocked.

ORDER CYPRINIFORMES

Cyprinidae

Cyprinus carpio - carp - common, up to 23-1/2 pound taken.
Carassius auratus - goldfish - uncommon.
Notemigonus crysoleucas - golden shiner - common.
Semotilus atromaculatus - creek chub - common in tributaries.
Semotilus corporalis - fallfish - rare in the river.
Hybopsis micropogon - river chub - uncommon.
Rhinichthys atratulus - blacknosed dace - rare in the river.
Notropis cornutus - common shiner - uncommon in the river.
Notropis spilopterus - spotfin shiner - uncommon in the river.
Notropis hudsonius - spottail shiner - uncommon in the river.
Pimephales notatus - bluntnose minnow - uncommon in the river.

Catostomidae

Carpiodes cyprinus - quillback carpsucker - common, spawns in tributaries.
Maxostoma macrolepidotum - pealip red horse - common.
Catostomus commersoni - white sucker - common, spawns in tributaries.
Hypentelium nigricans - hog sucker - uncommon, spawns in tributaries.

APPENDIX A (continued)

Ictaluridae

Ictalurus punctatus - channel catfish - very abundant.
Ictalurus catus - white catfish - common but not abundant.
Ictalurus natalis - yellow bullhead - common but not abundant.
Ictalurus nebulosis - brown bullhead - abundant.
Shilbeodes insignis - margined madtom - rare, only one adult taken.

ORDER ANGUILLIFORMES

Anguillid
Anguillidae

Anguilla rostrata - American eel - rare, three adults taken.

ORDER PERCIFORMES

Centrarchidae

Micropterus dolomieui - smallmouth bass - common in running water.
Micropterus salmoides - largemouth bass - common in quiet water.
Lepomis cyanellus - green sunfish - uncommon but increasing in the area.
Lepomis gibbosus - pumpkinseed - abundant, particularly in quiet water.
Lepomis auritus - redbreasted sunfish - abundant near east shore of river.
Lepomis macrochirus - bluegill - common, particularly in quiet water.
Enneacanthus gloriosus - blue-spotted sunfish - only one taken.
Ambloplites rupestris - rockbass - common, particularly in slow waters.
Pomoxis nigromaculatus - black crappie - abundant.
Pomoxis annularis - white crappie - abundant.

Percidae

Stizostedion vitreum - walleye - common but sporadic in distribution.
Perca flavescens - yellow perch - rare.
Etheostoma nigrum - johnny darter - common but not caught with Applicants' gear.

APPENDIX B

WATER QUALITY DATA TAKEN

AT THREE MILE ISLAND

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND 1968
THREE MILE ISLAND NUCLEAR STATION

ANALYSES OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		234718	234915	235207	235207	235634	235875	236342	236515	236733	236874	236884	237131
Flow, cubic feet/second		35000	69100	40000	15000	92700	55400	19100	74200	81200	28500	28300	18500
Sampling Date		1-24 1968	2-7 1968	2-21 1968	3-6 1968	3-20 1968	4-3 1968	5-1 1968	5-15 1968	5-29 1968	6-11 1968	6-12 1968	6-26 1968
Calcium	Ca	30.4	15.2	28.8	36.8	16.0	19.2	24.0	21.2	16.8		24.8	36.0
Magnesium	Mg	11.2	5.4	10.7	14.6	4.9	6.3	7.8	6.6	5.4		12.7	10.7
Sodium	Na	10.8	2.3	7.2	14.5	14.1	5.8	7.5	8.5	6.7		5.9	6.2
Hydrogen	H_2												
Bicarbonates	HCO_3	51.2	29.3	42.7	63.4	32.9	35.4	64.6	47.6	30.5		32.9	78.0
Sulfates	SO_4	75.7	25.9	74.3	99.9	14.0	41.2	32.0	41.2	39.0		82.4	60.3
Chlorides	Cl	14.0	8.0	11.0	15.0	32.2	8.0	10.0	10.0	7.0		8.0	11.0
Nitrates	NO_3	6.3	3.3	4.7	7.9	4.6	4.3	9.7	3.1	3.8		3.5	6.6
Conductivity	Mmho	312	165	295	375	178	190	220	210	168		270	322
Hydrogen Ion Conc.	pH	6.8	7.1	7.1	7.3	6.5	7.3	7.7	7.2	7.0	7.2	7.1	7.4
Free Carbon Dioxide	CO_2	14	3	7	5	7	5	4	5	6		4	7.0
Total Hardness	$CaCO_3$	122	60	116	152	60	74	92	80	64		114	134.0
Free Mineral Acid	$CaCO_3$												
Silica - soluble	SiO_2	3.8	3.8	4.2	3.9	2.4	3.8	4.9	0.8	3.0		2.8	3.1
Silica - colloidal	SiO_2												
Iron - soluble	Fe	0.10	0.10	0.08	0.06	0.08	0.19	0.05	0.07	0.10		0.05	0.31
Iron - total	Fe	1.75	1.97	0.44	0.46	2.88	1.10	0.72	1.11	1.97		3.81	1.64
Iron & Alum. Oxides	R_2O_3	0.4	0.4	0.4	0.4	0.6	0.8	0.4	0.4	0.4		0.4	0.50
Manganese	Mn	0.08	0.33	0.82	0.92	0.29	0.32	0.22	0.03	0.03		0.26	0.01
Chlorine Demand	Cl_2	(15 min.)								1.22	1.70	2.50	1.3
Chemical Oxygen Demand		3.46	9.81	3.0	10.5	17.4	10.7	11.0	5.3	5.0		8.75	9.31
Chlorine Demand	(60 min.)										2.15		
M.O. Alkalinity	$CaCO_3$	42	24	35	52	27	29	53	39	25		27	64
Color		10	10	10	10	15	8	5	5	10		10	5
Turbidity		10	60	5	20	60	40	20	25	40		20	15
Suspended Solids		25.2	69.0	2	26	190	29	18	33	135		15	28.4
Soluble Solids		178	78	162	224	105	107	128	115	97		157	172.8
Total Solids		203	147	164	250	295	136	146	148	232		172	201.2
Calcium	$CaCO_3$	76.0	38.0	72.0	92.0	40.0	48.0	60.0	53.0	42.0		62.0	90.0
Magnesium	$CaCO_3$	46.0	22.0	44.0	60.0	20.0	26.0	32.0	27.0	22.0		52.0	44.0
Sodium	$CaCO_3$	23.5	4.9	15.6	31.5	30.7	12.6	16.3	18.4	14.6		12.8	13.5
Hydrogen	$CaCO_3$												
Total Cations	$CaCO_3$	145.5	64.9	131.6	183.5	90.7	86.6	108.3	98.4	78.6		126.8	147.5
Bicarbonates	$CaCO_3$	42.0	24.0	35.0	52.0	27.0	29.0	53.0	39.0	25.0		27.0	64.0
Sulfates	$CaCO_3$	78.7	26.9	77.3	103.9	14.6	42.8	33.3	42.8	40.6		85.7	62.7
Chlorides	$CaCO_3$	19.7	11.3	15.5	21.2	45.4	11.3	14.1	14.1	9.9		11.3	15.5
Nitrates	$CaCO_3$	5.1	2.7	3.8	6.4	3.7	3.5	7.9	2.5	3.1		2.8	5.3
Total Anions	$CaCO_3$	145.5	64.9	131.6	183.5	90.7	86.6	108.3	98.4	78.6		126.8	147.5

Sample of 4/17 lost in transit

Issue: 1-2-3-4-5

All results expressed in parts per million except pH, Mmho & Turbidity

B-3

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND 1967-1968
THREE MILE ISLAND NUCLEAR STATION

ANALYSES OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		230815	231077	231258	231510	231738	232485	232706	233057	233232	233476	233[illegible]15	234[illegible]	**234433
Flow, cubic feet/second *		11800	11500	13500	15400	23400	6300	17000	9600	34400	26100	46400	27000	16400
Sampling Date		6-15 1967	6-29 1967	7-13 1967	7-27 1967	8-10 1967	9-22 1967	10-5 1967	10-19 1967	11-1 1967	11-15 1967	11-29 1967	12-27 1967	1-10 1968
Calcium	Ca	40.0	36.8	22.4	24.8	27.2	46.4	39.2	40.8	18.4	24.0	20.4	24.0	41.6
Magnesium	Mg	15.1	14.6	7.3	7.8	10.2	13.1	14.1	14.1	7.3	10.2	5.1	8.8	15.1
Sodium	Na	9.3	9.2	9.1	10.6	11.7	15.5	9.4	13.9	7.3	11.7	9.2	8.1	16.9
Carbonates	CO_3	4.8												
Bicarbonates	HCO_3	70.7	70.7	53.7	61.0	53.7	113.4	65.9	75.6	34.1	17.4	40.2	35.4	56.1
Sulfates	SO_4	91.7	84.3	40.6	45.5	68.2	80.0	96.0	97.9	49.7	81.7	38.9	66.9	125.5
Chlorides	Cl	12.0	15.5	10.0	10.0	11.0	15.0	13.0	14.0	7.0	7.0	9.0	8.0	15.0
Nitrates	NO_3	4.8	5.3	6.7	6.8	6.0	7.8	5.4	8.2	2.8	4.3	4.4	4.5	6.2
Conductivity	Mmho	387	409	230	240	290	410	373	400	202	255	190	243	402
Hydrogen Ion Conc.	pH	8.2	7.3	7.2	6.8	7.4	7.6	6.8	6.9	7.3	6.8	6.9	6.5	6.0
Free Carbon Dioxide	CO_2		12	6	7	6	3	7	12	5	5	7	7	10
Total Hardness	$CaCO_3$	162	152	86	94	110	170	156	160	76	102	72	96	166
Free Mineral Acid	$CaCO_3$													
Silica - soluble	SiO_2	2.4	4.0	4.6	4.4	4.1	2.8	3.1	3.7	3.7	4.1	3.0	3.8	5.0
Silica - colloidal	SiO_2													
Iron - soluble	Fe	0.04	0.02	0.04	0.11	0.05	0.22	0.04	0.10	0.06	0.14	0.07	0.08	0.15
Iron - total	Fe	1.33	1.12	2.25	2.36	1.75	1.08	2.51	1.21	1.63	5.97	1.65	0.64	1.22
Iron & Alum. Oxides	R_2O_3	0.8	0.6	0.4	0.6	0.4	1.2	0.6	0.8	0.4	0.6	0.4	0.4	0.6
Manganese	Mn	0.12	0.04	0.07	0.05	0.07	0.03	0.08	0.04	0.12	1.12	0.05	0.22	0.97
Chlorine Demand	Cl_2													
Chemical Oxygen Demand		7.23	8.3	10.6	8.4	8.2		10.0	8.6	9.4	5.6	11.1	4.4	7.9
P. Alkalinity	$CaCO_3$	4												
M.O. Alkalinity	$CaCO_3$	66	58	44	50	44	93	54	62	28	29	33	29	46
Color		10	10	10	10	5	20	25	15	20	10	10	10	10
Turbidity		40	40	70	120	25	25	25	25	25	150	20	10	40
Suspended Solids		29	30	72	75	49	32	40	32	46	416	31	7	185
Soluble Solids		216	205	128	141	165	238	213	231	113	161	109	142	254
Total Solids		245	235	200	216	214	270	253	263	159	577	140	149	439
Calcium	$CaCO_3$	100.0	92.0	56.0	62.0	68.0	116.0	98.0	102.0	46.0	60.0	51.0	60.0	104.0
Magnesium	$CaCO_3$	62.0	60.0	30.0	32.0	42.0	54.0	58.0	58.0	30.0	42.0	21.0	36.0	62.0
Sodium	$CaCO_3$	20.2	19.9	19.7	22.9	25.3	33.7	20.5	30.1	15.9	25.4	17.9	17.5	36.7
Total Cations	$CaCO_3$	182.2	171.9	105.7	116.9	135.3	203.7	176.5	190.1	91.9	127.4	89.8	113.5	202.7
Carbonates	$CaCO_3$	8.0												
Bicarbonates	$CaCO_3$	58.0	58.0	44.0	50.0	44.0	93.0	54.0	62.0	28.0	29.0	33.0	29.0	46.0
Sulfates	$CaCO_3$	95.4	87.7	42.2	47.3	70.9	83.2	99.3	101.3	51.7	85.0	40.5	69.6	130.5
Chlorides	$CaCO_3$	16.9	21.9	14.1	14.1	15.5	21.2	18.3	19.7	9.9	9.9	12.7	11.3	21.2
Nitrates	$CaCO_3$	3.9	4.3	5.4	5.5	4.9	6.3	4.4	6.6	2.3	3.5	3.6	3.0	5.0
Total Anions	$CaCO_3$	182.2	171.9	105.7	116.9	135.3	203.7	176.5	190.1	91.9	127.4	89.8	113.5	202.7

Sample of 12-13-67 broken in transit

* Harrisburg Gaging Station 7:00 am
** Sample taken at Crawford Station intake
Issue: 1-2-3-4-5

All results expressed in parts per million except pH, Mmho & Turbidity

B-2

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND 1969

THREE MILE ISLAND NUCLEAR STATION

ANALYSES OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		241822	242008	242339	242548	242818	243166	243432	243692	243934	244138	244413	244575	244 939	245 237
Flow, cubic feet/second		49200	25900	23800	13100	17000	8500	30000	14000	9500	6500	4000	5300	3600	12100
Sampling Date		4-23 1969	5-7 1969	5-28 1969	6-11 1969	6-25 1969	7-11 1969	7-31 1969	8-14 1969	8-27 1969	9-10 1969	9-24 1969	10-9 1969	10-22 1969	11-7 1969
Calcium	Ca	21.6	28.0	26.4	33.6	36.0	44.8	28.0	40.0	45.6	41.6	52.0	49.6	52.0	40.0
Magnesium	Mg	6.8	10.7	11.7	11.7	10.7	15.1	10.2	13.6	15.6	13.1	16.1	16.5	16.1	13.1
Sodium	Na	12.9	10.6	10.3	17.3	52.9	28.1	25.2	13.2	15.9	20.5	26.6	24.7	16.2	20.1
Bicarbonates	HCO_3	42.7	38.3	30.5	72.0	82.9	91.5	39.0	91.5	98.8	102.4	112.2	92.7	124.4	90.2
Sulfates	SO_4	57.3	87.1	90.1	81.1	148.7	123.7	104.8	77.8	96.7	83.8	121.0	127.8	87.2	91.9
Chlorides	Cl	9.0	9.0	10.0	16.0	14.0	18.0	12.0	14.0	16.0	15.0	19.0	20.0	19.0	15.0
Nitrates	NO_3	3.2	3.3	4.4	4.4	7.1	7.3	10.8	11.1	10.4	12.5	11.3	10.4	14.3	8.4
Conductivity	Mmho	210	273	275	300	326	411	293	358	412	392	474	473	482	383
Hydrogen Ion Conc.	pH	7.1	7.2	7.2	7.4	7.3	7.0	6.9	7.5	7.4	7.3	7.4	7.2	7.2	7.4
Free Carbon Dioxide	CO_2	6	5	8	3	5	12	5	3	8	7	9	12	14	4
Total Hardness	$CaCO_3$	82	114	114	132	134	174	112	156	178	158	196	192	196	154
Silica - soluble	SiO_2	3.0	1.9	2.9	3.3	4.6	2.5	4.4	5.8	2.4	6.0	3.4	4.5	3.9	5.5
Silica - colloidal	SiO_2														
Iron - soluble	Fe	0.13	0.13	0.05	0.03	0.03	0.02	0.04	0.06	0.04	0.07	0.03	0.03	0.04	0.11
Iron - total	Fe	5.33	1.74	0.97	1.14	0.76	1.05	0.96	0.98	1.01	2.00	1.18	1.30	2.86	0.98
Iron & Alum. Oxides	R_2O_3	0.4	0.6	0.2	0.2	0.2	0.2	0.1	0.1	0.4	0.2	0.2	0.2	0.2	0.4
Manganese	Mn	0.36	0.44	0.48	0.51	0.42	0.60	0.39	0.73	0.65	0.75	0.65	0.80	0.64	0.54
Chlorine Demand	Cl_2	1.77	1.83	1.0	1.16	2.41	1.1	1.0	1.4	1.52	0.88	1.80	2.77	1.54	3.00
Chemical Oxygen Demand		2.43	2.91	13.6	14.7	23.0	14.9	19.1	16.6	13.76	12.99	19.68	15.21	10.18	14.36
Color		10	5	10	10	5	5	10	10	15	8	10	5	5	5
Turbidity		15	15	40	40	25	20	20	50	25	40	30	25	40	25
Suspended Solids		23	13	15	29	46.5	34	26	56	69	78	53.2	45	84	25
Soluble Solids		135	170	171	203	315	285	215	221	252	243	305	299	270	239
Total Solids		158	183	186	232	362	319	241	279	321	321	358	344	354	264
Calcium	$CaCO_3$	54.0	70.0	66.0	84.0	90.0	112.0	70.0	100.0	114.0	104.0	130.0	124.0	130.0	100.0
Magnesium	$CaCO_3$	28.0	44.0	48.0	48.0	44.0	62.0	42.0	56.0	64.0	54.0	66.0	68.0	66.0	54.0
Sodium	$CaCO_3$	27.9	23.0	22.4	37.5	114.9	60.9	54.6	28.6	34.6	44.5	57.8	53.5	35.1	43.6
Total Cations	$CaCO_3$	109.9	137.0	136.4	169.5	248.9	23[illegible].9	166.6	134.6	212.6	202.5	253.8	245.5	231.1	197.6
	$CaCO_3$														
Bicarbonates	$CaCO_3$	35.0	31.0	25.0	59.0	68.0	75.0	32.0	75.0	81.0	84.0	92.0	76.0	102.0	74.0
Sulfates	$CaCO_3$	59.6	90.6	93.7	84.3	154.6	128.6	109.0	80.9	100.6	87.2	125.8	132.9	90.7	95.6
Chlorides	$CaCO_3$	12.7	12.7	14.1	22.6	19.7	25.4	16.9	19.7	22.6	21.2	26.8	28.2	26.8	21.2
Nitrates	$CaCO_3$	2.6	2.7	3.6	3.6	6.6	5.9	3.7	9.0	8.4	10.1	9.2	8.4	11.6	6.8
Total Anions	$CaCO_3$	109.[illegible]	137.0	136.4	169.5	248.9	234.9	166.6	134.6	212.6	202.5	253.8	245.5	[illegible]1.1	197.6

Issue: 1-2-3-4

All results expressed in parts per million except pH, conductivity, color & turbidity

B-5

ANALYSIS OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND 1968-1969

THREE MILE ISLAND NUCLEAR STATION

ANALYSES OF SAMPLES TAKEN FROM SUSQUEHANNA RIVER AT THREE MILE ISLAND
METROPOLITAN EDISON COMPANY

Laboratory Number		237304	237540	237761	238011	238188	238410	238682	238839	239078	239268	239453	239642	241538
Flow, cubic feet/second		15400	7800	4300	4500	3200	14200	4800	4660	12800	32700	40400	39400	106100
Sampling Date		7-10 1968	7-24 1968	8-27 1968	8-21 1966	9-4 1968	9-18 1968	10-2 1968	10-16 1968	10-30 1968	11-13 1968	11-27 1968	12-11 1968	4-9 1969
Calcium	Ca	39.2	47.2	52.0	60.8	58.4	33.6	50.4	52.0	44.0	24.8	20.0	20.0	13.6
Magnesium	Mg	16.5	16.5	19.0	21.9	21.9	9.7	20.9	20.4	18.5	7.8	7.3	6.8	4.9
Sodium	Na	7.8	9.2	14.0	35.9	12.8	9.7	10.9	22.1	5.2	4.6	5.3	5.9	5.4
Carbonates	CO_3	3.6												
Bicarbonates	HCO_3	87.8	82.9	97.6	91.5	124.4	82.9	89.0	97.6	82.9	43.9	32.9	40.2	28.0
Sulfates	SO_4	78.8	107.1	128.0	204.3	122.9	48.0	127.4	138.4	96.0	46.1	48.0	43.1	28.7
Chlorides	Cl	11.0	15.0	16.0	19.5	20.0	12.0	16.0	18.0	16.0	12.0	8.0	7.0	7.0
Nitrates	NO_3	9.2	6.6	3.2	6.2	7.0	12.6	9.2	9.8	8.5	3.8	3.9	3.9	3.7
Conductivity	Mmho	368	433	470	572	537	303	475	510	420	233	208	202	140
Hydrogen Ion Conc.	pH	8.0	7.2	7.4	7.0	7.8	7.6	7.8	7.4	7.6	7.2	6.9	6.8	7.3
Free Carbon Dioxide	CO_2		10	7	6	2	5.0	7	8	4	7	7	6	6
Total Hardness	$CaCO_3$	166	186	208	242	236	124	212	214	186	94	80	78	54
Free Mineral Acid	$CaCO_3$													
Silica - soluble	SiO_2	2.7	3.0	3.6	3.1	2.6	5.[illegible]	1.7	2.4	3.0	2.9	4.2	3.9	2.9
Silica - colloidal	SiO_2													
Iron - soluble	Fe	0.05	0.02	0.07	0.07	0.06	[illegible]	0.18	0.06	0.06	0.07	0.15	0.17	0.23
Iron - total	Fe	2.18	2.25	1.27	1.22	1.56	3.78	1.32	1.75	0.90	4.25	1.84	1.42	5.68
Iron & Alum. Oxides	R_2O_3	0.4	0.6	0.4	0.4	0.8	0.3	0.2	0.4	0.5	0.4	0.1	0.2	0.4
Manganese	Mn	0.10	0.03	0.18	0.03	0.17	0.03	0.01	0.19	0.03	0.14	0.05	0.27	0.76
Chlorine Demand	Cl_2	2.66	5.01		2.4		3.65	0.81	2.59	2.78	2.73	2.35	3.28	1.33
Chemical Oxygen Demand		7.93	11.4	10.28	15.1		11.70	14.9	17.5	18.4	14.3	6.5	9.6	25.4
P. Alkalinity	$CaCO_3$	3												
M.O. Alkalinity	$CaCO_3$	78	68	80	75	102	68	73	80	68	36	27	33	23
Color		10	10	15	10	10	10	10	15	15	20	5	15	15
Turbidity		25	30	50	60	20	40	15	20	20	80	20	10	190
Suspended Solids		54	76	60	35	35	70.0	19	28	28	106	34	23	231
Soluble Solids		212	246	284	397	308	173	281	302	233	124	113	111	80
Total Solids		266	322	344	432	343	243	300	330	261	230	147	134	311
Calcium	$CaCO_3$	98.0	118.0	130.0	152.0	146.0	84.0	126.0	130.0	110.0	62.0	50.0	50.0	34.0
Magnesium	$CaCO_3$	68.0	68.0	78.0	90.0	90.0	40.0	86.0	84.0	76.0	32.0	36.0	28.0	20.0
Sodium	$CaCO_3$	17.0	19.9	30.3	7[illegible].0	27.7	21.0	23.6	48.0	11.3	9.9	11.4	12.9	11.7
Total Cations	$CaCO_3$	183.0	205.9	238.3	320.0	263.7	145.0	235.6	262.0	197.3	103.9	87.6	90.9	65.7
Carbonates	$CaCO_3$	6.0												
Bicarbonates	$CaCO_3$	72.0	68.0	80.0	75.0	102.0	68.0	73.0	80.0	68.0	36.0	27.0	33.0	23.0
Sulfates	$CaCO_3$	82.0	111.4	133.1	212.5	127.8	4[illegible]	132.5	148.7	99.8	47.9	46.1	44.8	29.8
Chlorides	$CaCO_3$	15.5	21.2	22.6	27.5	28.2	16.[illegible]	22.6	25.4	22.6	16.9	11.3	9.9	9.9
Nitrates	$CaCO_3$	7.5	5.3	2.6	5.0	5.7	10.2	7.5	7.9	6.9	3.1	3.2	3.2	3.0
Total Anions	$CaCO_3$	183.0	205.9	238.3	320.0	263.7	145.0	235.6	262.0	197.3	103.9	87.6	90.9	65.7

Issue: 1-2-3-4-5-6-7

All results expressed in parts per million except pH, Mmho & Turbidity

B-4

APPENDIX C

COMMENTS

ON

DRAFT ENVIRONMENTAL STATEMENT

FOR

THE THREE MILE ISLAND NUCLEAR STATION, UNITS 1 & 2

DOCKET NOS. 50-289 AND 50-320

ADVISORY COUNCIL
ON
HISTORIC PRESERVATION
WASHINGTON, D.C. 20240

50-289
50-320

AUG 14 1972

AUG 15 1972

Dear Mr. Muller:

This is in response to your request for comments on the environmental impact statement identified by a copy of your cover letter attached to this document. The staff of the Advisory Council has reviewed the submitted impact statement and suggests the following, identified by checkmark on this form:

✓ The final statement should contain (1) a sentence indicating that the National Register of Historic Places has been consulted and that no National Register properties will be affected by the project, or (2) a listing of the National Register properties to be affected, an analysis of the nature of the effects, a discussion of the ways in which the effects were taken into account, and an account of steps taken to assure compliance with Section 106 of the National Historic Preservation Act of 1966 (80 Stat. 915) in accordance with procedures of the Advisory Council on Historic Preservation as they appear in the Federal Register, March 15, 1972.

_____ In the case of properties under the control or jurisdiction of the United States Government, the statement should show evidence of contact with the official appointed by your agency to act as liaison for purposes of Executive Order 11593 of May 13, 1971, and include a discussion of steps taken to comply with Section 2(b) of the Executive Order.

✓ The final statement should contain evidence of contact with the Historic Preservation Officer for the State involved and a copy of his comments concerning the effect of the undertaking upon historical and archeological resources.

✓ Specific comments attached.

Comments on environmental impact statements are not to be considered as comments of the Advisory Council in Section 106 matters.

Sincerely yours,

Robert R. Garvey, Jr.
Executive Secretary

Enclosure

cc: Mr. William J. Wewer, Deputy Executive Director, Pennsylvania Historical Museum Commission, William Penn Memorial Museum & Archives Building, P. O. Box 1026, Harrisburg, Pennsylvania 17108 w/cy inc.

THE COUNCIL is charged by the Act of October 15, 1966, with advising the President and Congress in the field of Historic Preservation, recommending measures to coordinate governmental with private activities, advising on the dissemination of information, encouraging public interest and participation, recommending the conduct of special studies, advising in the preparation of legislation, and encouraging specialized training and education. The Council also has the responsibility to comment on Federal or Federally-assisted undertakings that have an effect on cultural property listed in the National Register.

cc: Dr. S. K. Stevens, Chairman, Advisory Council on Historic Preservation,
20 Center Street, Camp Hill, Pennsylvania 17011 w/cy inc.

Comments:

The draft environmental statement states that the 1969 edition of the National Register of Historic Places has been consulted. As this list has been considerably revised since then, the final statement should specify that the current listings of the National Register as published in the Federal Register, March 15, 1972, as supplemented, have been consulted.

C-5

50-289
50-320

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

RECEIVED AUG 28 1972

August 25, 1972

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

Dear Mr. Muller:

We have had the draft environmental statement for the Three Mile Island Nuclear Station, Units 1 and 2, Metropolitan Edison Company and Jersey Central Power and Light Company, reviewed in the relevant agencies of this Department. Comments from the Forest Service, an agency of the Department, are enclosed.

The Soil Conservation Service, also an agency of the Department, has not yet completed its review. If it has any comments, they will be sent to you when available.

Sincerely,

T. C. Byerly

T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosure

C-6

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Washington, D. C. 20250

Re: Three Mile Island Nuclear Station, Units 1 and 2
Metropolitan Edison Co. and Jersey Central Power
and Light Company

We have reviewed the draft environmental statement for Three Mile Island Nuclear Station, Units 1 and 2, Metropolitan Edison Company and Jersey Central Power and Light Company.

As described in the draft environmental statement, the nuclear plants at Three Mile Island Nuclear Station should have little impact on vegetation. This impact will probably be considerably less than that of a comparable plant using coal or oil.

Periodic monitoring of vegetation on the east bank of the Susquehanna River could be used to establish whether or not harmful levels of chlorides or sulfates had been reached. On Page V-28, Table 15, of the draft environmental statement, monitoring of crops is mentioned. Trees along the river and elsewhere could be monitored at the same time.

It is good to note that the company has plans to landscape the plant site once construction is completed.

We would like to receive a copy of the final environmental statement when it is printed.

C-7

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

RECEIVED
SEP 26 1972
U.S. ATOMIC ENERGY COMMISSION

50-289
50-320

September 25, 1972

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

Dear Mr. Muller:

Attached are comments from the Soil Conservation Service on the draft environmental statement for the Three Mile Island Nuclear Station, Units 1 and 2, Dauphin County, Pennsylvania. Comments from the Forest Service on the same station were sent to you on August 25, 1972. This completes the Department of Agriculture review.

Sincerely,

T C Byerly

T. C. BYERLY
Coordinator, Environmental
Quality Activities

Enclosure

C-8
SOIL CONSERVATION SERVICE

COMMENTS ON DRAFT ENVIRONMENTAL STATEMENT PREPARED BY THE ATOMIC ENERGY COMMISSION FOR THREE MILE ISLAND NUCLEAR STATION UNITS 1 AND 2, DAUPHIN COUNTY, PENNSYLVANIA, DOCKET NUMBERS 50-289 AND 50-320

September 11, 1972

1. The statement should mention that 270 acres of farm land will be lost to construction of the plant.

2. No presently measurable adverse effects on farm enterprises are expected unless abnormal radioactive waste discharges occur from plant operation or accident conditions.

3. It should be mentioned that a continuous supply of electricity is expected to benefit the local rural community.

4. Erosion and sediment control measures and effects -- The provision for sediment control, as outlined on page IV-5, Part C, appears to be adequate.

5. Agricultural land use trends are not expected to show any changes. These changes will depend on the operational history of the plant.

6. It should be mentioned that the operation of the plant under normal operating conditions is not expected to impair the use of local surface water for irrigation purposes.

7. The presence of the dikes around Three Mile Island and the access bridge to the island will reduce the cross sectional area available for carrying water during flood flows. There is no mention in the environmental statement of increased backwater elevations in agricultural areas upstream from the plant. No impairment of agricultural drainage is expected.

8. No mention is made of internal drainage pumping facilities for eliminating runoff within the diked area during high river stages.

9. Within the scope of present-day knowledge, no measurable agricultural pollution is expected to occur during normal operation of the plant. The amount of radioactive pollution of local agricultural land will depend on the number and size of abnormal releases or accidents.

RECEIVED
SEP 26 1972

C-9

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 1715
BALTIMORE, MARYLAND 21203

NABPL-E

6 September 1972

RECEIVED SEP 11 1972 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

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

Dear Mr. Muller:

In reply to your letter of 23 June 1972, the Baltimore District, Corps of Engineers has reviewed the draft environmental statement on the Environmental Considerations Related to the Proposed Issuance of an Operating License for the Three Mile Island Nuclear Station Units 1 and 2. Our comments are submitted in accordance with provisions contained in the National Environmental Policy Act of 1969 (Public Law 91-190).

There are no comments on the Probable Maximum Flood flow since we furnished this data. The maximum flood of record at Harrisburg is shown on page II-6 occurring on 19 March 1936. Due to the recent flooding, this should be changed to 24 June 1972 with an estimated peak flow of 860,000 cfs. There does not appear to be any effects from the Three Mile Island project on any constructed or proposed flood control projects.

On page I-8, the word "Pump" is spelled incorrectly under the column for purpose and next to permit number NABOP-P (Met-Ed Co) 21.

On page II-6, Swatara Creek is misspelled in Table 3.

The maximum monthly and 24-hour rainfall given on page II-8 should be revised based on the June 1972 storm.

Results of the fish population studies referred to on page II-11 should be included in the final environmental impact statement for this project.

C-10

NABPL-E
Mr. Muller

6 September 1972

The map on page III-3 is of poor quality and should be improved for the final environmental impact statement.

The plans for the recreation area being proposed in conjunction with the nuclear station does not include identification of implementation procedures. It would be helpful to identify the agency or interests which will construct, operate, and maintain these facilities.

These comments are offered as suggestions to aid your office in preparing a final environmental impact statement. As requested, the Council on Environmental Quality has been furnished copies of this correspondence.

Sincerely yours,

WILLIAM E. TRIESCHMAN, Jr.
Chief, Planning Division

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

50-289
50-320

August 9, 1972

RECEIVED AUG 10 1972 U.S. ATOMIC ENERGY COMMISSION

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The draft environmental impact statement for the "Three Mile Island Nuclear Station Units 1 and 2 (Docket No. 50-289 and 50-320)" which accompanied your letter of June 23, 1972, has been received by the Department of Commerce for review and comment.

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

From meteorological data presented by the applicant in the Final Safety Analysis Report, we have computed an annual average relative concentration value of 6 X 10^{-6} sec m^{-3} at the site exlusion distance of 610 miles. This is somewhat less conservative than the value of 9 X 10^{-6} sec m^{-3} found in the Atomic Energy Commission's analysis on page V-22.

We are unable to assess the estimates of the consequences of postulated accidents which are listed in table 18. We need to know, specifically, the meteorological assumptions used in the analysis, the resulting relative concentration values (sec m^{-3}), and the probability of occurrence of these values. The applicant, in table 6.9-1 of the Environmental Report, has listed such concentration values as a function of time of release and chance of occurrence. For example, the applicant has estimated that at the site boundary a concentration value of 3 X 10^{-5} sec m^{-3} has a fifty percent chance of occurrence for an assumed release period of 1 hour. Our estimate is 6 X 10^{-5} sec m^{-3}. We are unable to make such comparisons with the Atomic Energy Commission's analysis.

We hope these comments will be of assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

50-289
50-320

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20201

RECEIVED SEP 25 1972

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

Dear Mr. Muller:

This is in response to your letter of June 23, 1972, wherein you requested comments on the draft environmental impact statement for the Three Mile Island 1 and 2, Metropolitan Edison Company, Docket Numbers 50-289 and 50-320.

This Department has reviewed the health aspects of the above project as presented in the documents submitted. The following comments are offered:

1. River Characteristics: What was the maximum flow rate (cfs) of the Susquehanna River at TMI during Agnes of 1972? The use of flood gates which "can be set in place in the unlikely event that 1,100,000 cfs PMF is exceeded" is not clear (pp. II 6-8).

2. Liquid Wastes:

   a. Table 6 indicates that 60% of the liquid effluent, H^3 excepted, to be I^{131} (page III 18). Table 3-6.3 of the Power Company's environmental report, item 11, states an average hold up time of 14 days. Why cannot the liquid effluent be held an additional 6 weeks, thereby reducing the 60% factor to 2.4% for Iodine 131?

   b. Cesium 137 and Strontium 90 are long-lived isotopes relative to biological systems. What is the efficiency of the polishing demineralizer for cations of cesium and strontium? If the efficiency is not the maximum available for these cations, then final stage high efficiency cesium and strontium exchange columns should be installed.

3. Radiological Environmental Monitoring: Table 5.5-4 lists "crops" as the only type of vegetation to be sampled at 13-week intervals three times a year. Some crops may only be available for a single sampling. Vegetation, particularly grasses which may be present for a long period of time, should be specified.

Page 2 -- Mr. Daniel R. Muller

4. Radiological Impact:

   a. The draft statement gives 1.868 x 10^6 people within the 50 mile radius (pg. V 27). The power company's report gives 3.03 x 10^6 people within the same area (6.9-1, March 1972). How many people live within the 50 mile radius of the site?

   b. The Peach Bottom Nuclear Plant is about 35 miles downstream, therefore, the 50 mile radii of TMI and Peach Bottom overlap. Both include Harrisburg, Pennsylvania. The report should show the number of people who will be receiving additional radiation from the other plant and the magnitude of the additional dose.

5. Transportation: "The applicants have not indicated where the irradiated fuel or solid wastes will be shipped, etc." (pg. V 30). Does a terminus exist? What are the site options? Plant operation should not be permitted until site(s) for waste and recycled materials are specified.

The opportunity to review the draft environmental impact statement is appreciated.

Sincerely yours,

Merlin K. DuVal, M.D.

Merlin K. DuVal, M.D.
Assistant Secretary for
Health and Scientific Affairs

C-15

50-289
50-320

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 72/790

SEP 1 8 1972

Dear Mr. Muller:

This is in response to your letter of June 23, 1972, requesting our comments on the Atomic Energy Commission's draft statement, dated June 1972, on environmental considerations for Three-Mile Island Nuclear Station Units 1 and 2, Dauphin County, Pennsylvania.

Historical Significance

The draft statement adequately assesses the effects of the nuclear plant on historic and archaeological resources.

The operation of the station will not affect any existing or proposed unit of the National Park System nor any site eligible for registration as a National Historic, Natural, or Environmental Education Landmark.

River Characteristics

Protection from floods is a particular problem at this site on an island in the Susquehanna River. The design of the dikes on the northern end of the island was based on a preliminary estimate by the Corps of Engineers of the probable maximum flood of 1,100,000 cfs. Later calculations by the Corps showed that the PMF should be much higher, 1,750,000 cfs unregulated, or 1,625,000 cfs when regulation from existing reservoirs is taken into consideration. Since the draft statement was issued, tropical storm Agnes caused a flood on the Susquehanna River which reached about 1,000,000 cfs at Three-Mile Island on June 24, 1972. A review of the PMF calculations may be made by the Corps and further upward revisions are likely.

The Geological Survey reviewed hydrologic and geologic aspects of the construction permit application on request from AEC and transmitted their comments by memoranda of January 10, 1968, and June 30, 1969. In the earlier of

these reviews the applicant's calculations of stage for the estimate of 1,100,000 cfs were reviewed. However, stage calculations for the applicable PMF discharge have not yet been reviewed.

The draft statement indicates, on page II-8, that it is not practical to increase the dike height for the PMF and that the applicant has chosen to provide flood gates to be set in place should a discharge of 1,100,000 cfs be exceeded. However, the statement contains no evaluation of the adequacy of such measures. Such an evaluation should be added to the statement; it should consider the velocity and depth of water around the reactor and ancillary structures during a PMF; the safety of structures, waste tanks, etc.; and the possibility of debris production which could endanger downstream structures.

It should also be noted that the flood studies section of the applicant's environmental report contains a number of misleading statements. Among these, that large floods on the lower Susquehanna River would not result from storms of tropical origin. This contradicts "Hydrometeorological Report No. 40, Probable Maximum precipitation, Susquehanna River Drainage above Harrisburg, Pa." (U.S. Department of Commerce, Weather Bureau, 1965) which states, "although no really severe hurricane rains have been observed in the basin in the last 75 years the risk is evident from storms near the basin." It concludes after considering such storms that, "it must be assumed, therefore, that storms of tropical origin constitute a real threat to the basin . . . ." Further, the applicant's characterization of the design flood of 1,100,000 cfs as having a "frequency of occurrence in excess of 10,000 years" is misleading. On the basis of flood records available the extrapolation of flood frequencies beyond, at the most, a few hundred years is meaningless.

Terrestrial Fauna

This paragraph on page II-11 should be expanded to include song birds, raptors, waterfowl, shore birds, reptiles, amphibians, furbearers, and other non-game species. It should be noted that at least three of the species that are found in or breed in the area are on the Federal list of Rare or Endangered Species. These are the bog turtle (Chemmys muhlenbergi), the bald eagle (Haliaeetus lencocephalus), and the osprey (Pandion haliaetus). The peregrine falcon (Falco peregrinus anatum) is on the Pennsylvania list of endangered species.

Aquatic

Delete the last sentence of the first paragraph in this section since fly fishing is not popular in winters.

Delete the last sentence of the first paragraph on page II-12 and substitute the following. "There is no commercial fishing in the area at the present time; however, the Susquehanna River has historically supported large runs of the anadromous American shad (Alosa sapidissima), an important commercial and sports fish. It should be noted that the Susquehanna has been studied and is considered suitable for the restoration of shad. The planning for this restoration has reached the stage of design of fish passage facilities at the dams which now block the fish runs. We think that the restoration of the runs is imminent."

External Appearance

The third paragraph of page III-1 describes the dike and materials to be used in its construction. We suggest that this paragraph be expanded to give the dimensions of the dike and the height above normal water surface levels.

Heat

The third paragraph on page III-8a gives the cooling water velocity at the intake as 0.2 fps under normal conditions. This paragraph should be expanded to include the velocity during minimum river discharge and the probable frequency of occurrence for this velocity. A river discharge-duration curve and a corresponding intake velocity-duration curve would be of value in this regard.

It is important that the extreme temperature, discharge, and intake velocity conditions be considered since fish kills are not normally caused by "normal" conditions but extrémes. It also appears that a discussion should be included on the impacts expected during certain emergency

situations when the cooling water discharge may be 28°F above the river temperatures.

Radioactive Wastes

The anticipated annual releases of radioactive isotopes in the liquid and gaseous effluent as given in tables 4, 5, and 6, appear to be in disagreement with the equivalent data on pages 5.5-15 and 5.5-16 of the applicant's report dated December 1971.

Solid Wastes

The disposal of fish and other debris caught on the intake trash racks and screens is not discussed. It is recommended that such accumulations be handled as non-contaminated wastes and the method of disposal described in the final environmental statement under the section on Solid Wastes.

Impact on TMI

This section should be expanded to include a more complete and quantitative discussion of the effects of construction on the pre-project environment. Loss of wildlife habitat and its attendent wildlife resource, disruption of wildlife life patterns due to impacts such as noise, and intensified human intrusion should be discussed in a more quantitative manner in this section.

Water

Loss of fish and other wildlife habitat due to sedimentation from construction activities and erosion of denuded areas, dredging in shallow areas of the river, and disruption of fish behavior patterns, including spawning activities, due to construction activities should also be discussed in a more quantitative manner.

Land Use

We commend the applicants for including recreation development as part of the total project. These recreation development plans were previously reviewed by personnel from our Philadelphia Regional Office of the Bureau of Outdoor Recreation. The proposal as given on page V-1 and V-2 of the environmental statement is also in accord with the Pennsylvania Statewide Comprehensive Outdoor Recreation Plan.

We recommend that the development of the proposed recreation facilities be stipulated in the operating licenses for Units 1 and 2.

We also recommend that the final environmental statement include an outline of plans and responsibilities for future or ultimate recreation development on the site. This outline should include details regarding such matters as cost of future development, development schedules, and operation and maintenance responsibilities by public agencies and the applicants.

<u>Terrestrial Ecosystem</u>

The second paragraph of this section on page V-15 is confusing. It should assess the project caused impacts on the terrestrial ecosystem even if much of the impacts are the result of recreation development. It may be appropriate to estimate the percentage of these impacts that are caused by the operation of the plant.

<u>Transportation of Nuclear Fuel and Solid Radioactive Wastes</u>

This section in the final environmental statement should identify the disposal sites of the irradiated fuel or solid wastes in order to permit an accurate assessment of the effects of disposal.

<u>Environmental Effects of Accidents</u>

This section contains an adequate evaluation of impacts resulting from plant accidents through Class 8 for airborne emissions. However, the environmental effects of releases to water is lacking. Many of these postulated accidents listed in Tables 17 and 18 could result in releases to the Susquehanna River and should be evaluated in detail.

We also think that Class 9 accidents resulting in both air and water releases should be described and the impacts on human life and the remaining environment discussed as long as there is any possibility of occurrence. The consequences of an accident of this severity could have far-reaching effects on land and in the Susquehanna River which could persist for centuries affecting millions of people.

<u>Land Use</u>

This section on page VII-1 should be expanded to include loss of wildlife, wildlife habitat, disruption of wildlife patterns and increased sewage and waste disposal problems.

<u>Short-Term Uses and Long-Term Productivity</u>

It is stated on page VIII-1 that if the reactors are decommissioned complete restoration of the site is possible but may be deterred or delayed by cost. It is not clear if contaminated structures or reactor parts would be removed from the site, left above ground or buried at the site. The plans for such an event should be indicated in the final environmental statement.

<u>Irreversible and Irretrievable Commitments of Resources</u>

This section should include the annual loss of fish and wildlife resources which would be lost due to project implementation.

<u>Summary of Cost-Benefit Analysis</u>

The combustion products are given on page XI-13 for the alternative coal-burning and oil-burning plants. The sulfur content of the coal and oil is not given. However, the applicants' report does contain this information on page 11.2-1. This report assumes that 80 percent of the 860 tons per day of SO_2 and 115 tons per day of NO_x will be removed by air pollution control equipment. The report indicates that the remaining 20 percent of these air pollutants will not exceed the limitations of the "national ambient air quality standards." It is suggested that the final environmental statement include the calculations involved in the prediction of the ground level SO_2 and NO_x concentrations so that these values can be compared with those stipulated by the Environmental Protection Agency in its ambient air quality standards reported in the Federal Register of April 30, 1971.

We hope these comments will be helpful to you in the preparation of the final environmental statement.

Sincerely yours,

Deputy Assistant Secretary of the Interior

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

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (GWS)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: 202/426/2262

50-289
50-320

26 JUL 1972

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

Dear Mr. Muller:

This is in response to your letter dated 23 June 1972 addressed to Mr. Herbert F. DeSimone, Assistant Secretary for Environment and Urban Systems, concerning the draft environmental impact statement and pertinent papers on the Three Miles Island Nuclear Station, Units 1 and 2, Dauphin County, Pennsylvania.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted and the Federal Aviation Administration noted the following:

> "We have reviewed the subject Draft Environmental Impact Statement, and other than the comments noted in the Draft Detailed Statement by the U. S. Atomic Energy Commission on the environmental considerations, Pages B9 and B10, Paragraphs 4a and 4b, we find no additional environmental impact on aeronautical activities.
>
> "The question of the effect of smoke plumes on aircraft approaching from or departing to the south is still not definitive with respect to VFR traffic. In addition, the probable instance of fogging due to the operation of the cooling towers, which is estimated to be 39 hours a year, is extremely difficult to assess as to the impact on IFR operations in terms of delay; however, some minimal impact should be expected. It is our opinion that the tradeoff of the minimal delay versus the requirements for electrical power in the area must be balanced by the agency issuing the operating license.

The Department of Transportation has no objection to the issuance of an operating license for this project. The draft statement, however, did not indicate a resolvement of the fogging problem due to the plume emanating from the cooling towers which may interfere with aircraft operations at the Harrisburg Airport. This aspect of the project should be addressed in the final environmental impact statement.

So as to not unduly delay issuance of the operating license, it is recommended that the applicant resolve the situation by direct coordination with the Administrator, Eastern Region of the Federal Aviation Administration. He may be contacted as follows:

Administrator
Eastern Region, Federal
Aviation Administration
Federal Building
John F. Kennedy International Airport
Jamaica, New York 11430

The opportunity for this Department to review and comment upon the draft statement and other material submitted on the Three Miles Island Nuclear Station is appreciated. We would be pleased to receive a copy of the final statement and it is requested that a copy of the final statement also be sent to the Eastern Regional Administrator of Federal Aviation Administration.

Sincerely,

W. M. BENKERT
Rear Admiral, U. S. Coast Guard
Chief, Office of Marine Environment
and Systems

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426
August 22, 1972

50-289
50-320

IN REPLY REFER TO:
PWR-PSA

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

Dear Mr. Muller:

This is in reference to your letter of June 23, 1972, requesting comments on the AEC's "Draft Environmental Statement Related to the Proposed Issuance of an Operating License to the Metropolitan Edison Company, Jersey Central Power and Light Company and Pennsylvania Electric Company for the Three Mile Island Nuclear Station Units 1 and 2 (Docket Nos. 50-289 and 50-320)."

The Federal Power Commission's Bureau of Power has previously commented on the need for the Three Mile Island Units 1 and 2 in letters dated January 28, 1971 and February 25, 1972. In preparing these comments, the Bureau of Power staff has considered the AEC Draft Environmental Statement; the Applicant's Environmental Report and amendments thereto; related reports made in response to the Commission's Statement of Policy on Reliability and Adequacy of Electric Service (Order No. 383-2); Power System Statements submitted by the Applicant to this Commission; and an analysis of these documents by FPC staff, together with related information from other FPC reports. The staff of the Bureau of Power generally bases its evaluation of the need for a specific bulk power facility upon the load-supply situation for the critical load period immediately following the availability of the facility, as well as upon long-term considerations. The useful lives of such facilities are generally 30 years or longer, and they will continue to serve the utilities' needs during their service lives.

These comments are made by the staff in accordance with the National Environmental Policy Act of 1969, and the Guidelines of the President's Council on Environmental Quality dated April 23, 1971. They are directed toward a review of the need for the electrical capacity of the facilities as concerns the adequacy and reliability of the affected electric bulk power systems, and matters related thereto.

Mr. Daniel R. Muller

Need for the Facilities

The three utility company Applicants and the New Jersey Power and Light Company are subsidiaries of the General Public Utilities Corporation. Together they comprise the GPU System which is operated on a fully integrated basis. The staff analysis includes both the GPU System and the Pennsylvania-New Jersey-Maryland Interconnection (PJM), in which the Applicants are members. The staff's evaluation of the need for the electric output of the Three Mile Island Units 1 and 2, scheduled for commercial operation in November 1973 and May 1975 respectively, is for the summer peak load period following the planned availability of the units. The GPU System is a winter-peaking system while PJM is a summer-peaking system. The capacity resources and system loads reported for both GPU and PJM in the draft environmental statement are in general agreement with data reported to the Commission. All of the systems involved are members of the Mid-Atlantic Area Coordination Group (MAAC) which provides coordinated planning for the interconnected bulk power facilities for those member systems, as the PJM Interconnection provides coordinated operation of the interconnected systems.

The following tabulation shows the electric system loads to be served by the Applicants and by the entire PJM Interconnection. It also shows the relationship of the electrical output of the Three Mile Island Units 1 and 2 to the available reserve capacity at the times of the 1974 and 1975 summer peak load periods. These peak load periods occur during the anticipated initial service periods of the new units, but the lives of these units are expected to be some 30 years or more, and they are expected to contribute to the Applicants' total generating capacity throughout that period. Therefore, these units will be depended upon to supply power to meet future demands over a period of many years beyond the initial service needs discussed in this report.

Mr. Daniel R. Muller

Forecasted 1974 Summer Peak Situation

	GPU System	PJM Interconnection 1/
Conditions With Three Mile Island Unit No. 1 (850 Megawatts)		
Net Total Capability - Megawatts	7,155	42,494
Estimated Peak Hour Load - Megawatts	5,863	34,110 2/
Reserve Margin - Megawatts	1,292	8,384 3/
Reserve Margin - Percent of Peak Load	22.0	24.6
Conditions Without Three Mile Island Unit No. 1		
Net Total Capability - Megawatts	6,305	41,644
Estimated Peak Hour Load - Megawatts	5,863	34,110
Reserve Margin - Megawatts	442	7,534 3/
Reserve Margin - Percent of Peak Load	7.5	22.1
Desired Reserve Margin (20 Percent of Peak Load) - Megawatts	1,173	4/
Deficiency - Megawatts	731	

1/ Data Source - April 1, 1972 Response by MAAC to FPC Order 383-2
2/ MAAC Coincident load
3/ Reserve before scheduled maintenance of 800 MW
4/ The 24.6 percent reserve margin in 1974 with Three Mile Island is currently considered adequate by PJM.

Mr. Daniel R. Muller

Forecasted 1975 Summer Peak Load Situation

	GPU System	PJM Interconnection 1/
Conditions With Three Mile Island Units Nos. 1 and 2 (1,800 Megawatts)		
Net Total Capability - Megawatts	8,285	48,512
Estimated Peak Hour Load - Megawatts	6,377	37,085 2/
Reserve Margin - Megawatts	1,908	11,427 3/
Reserve Margin - Percent of Peak Load	29.9	30.8
Conditions Without Three Mile Island Unit No. 2		
Net Total Capability - Megawatts	7,335	47,562
Estimated Peak Hour Load - Megawatts	6,377	37,085 2/
Reserve Margin - Megawatts	958	10,477 3/
Reserve Margin - Percent of Peak Load	15.0	28.6
Desired Reserve Margin (20 Percent of Peak Load) - Megawatts	1,275	4/
Deficiency - Megawatts	319	

1/ Data Source - April 1, 1972 Response by MAAC to FPC Order 383-2.
2/ MAAC coincident load.
3/ Before scheduled maintenance of 850 MW.
4/ The 30.8 percent reserve margin is somewhat higher than the 24.6 percent reserve margin considered adequate for 1974 by PJM.

Mr. Daniel R. Muller

The Applicants state that the reserve criteria used on the integrated GPU System is that adopted from the PJM Interconnection, in which the Applicants are members. MAAC and PJM are essentially totally overlapping entities and even though there may be small differences in their areas of operation for this purpose they may be considered identical. This minimum reserve criteria is equal to the summer peak load plus a 20 percent reserve margin. These reserve margins are gross and include provisions for scheduled maintenance requirements of the members, forced outages of generating equipment, and ordinary operating requirements which may be shared by pool participants when operating contingencies occur. Generally, such pool reserves do not include provisions for long term, firm power transactions. The staff of the Bureau of Power notes that for systems of the PJM Pool considering the types and sizes of generating facilities, it would not be unusual if a 20 percent reserve margin at the summer peak resulted in the probability of system load exceeding the electric supply once in about ten years.

The tabulations for the 1974 and 1975 summer peak periods on the GPU Systems show that failure to bring the Three Mile Island Unit No. 1 into commercial service prior to the 1974 summer peak will result in a reserve margin of 442 megawatts or 7.5 percent of peak load, and failure to bring Unit No. 2 into commercial operation prior to the 1975 summer peak will result in a reserve margin of 953 megawatts or 15 percent of peak load. With respect to the desired 20 percent reserve margin, a deficiency of 731 megawatts will occur on the GPU System at the 1974 summer peak period without the Three Mile Island Unit No. 1. Similarly, a deficiency of 319 megawatts will occur at the 1975 summer peak period without Three Mile Island Unit No. 2.

The loss of these units would also reduce reserves in the PJM Pool; the effect is to reduce the pool's reserves by about two percent for each unit. The reserve margins of both the GPU System and the PJM Pool through 1975 are dependent not only upon the timely commercial operation of Three Mile Island Units 1 and 2 but also on the timely commercial operation of six other new nuclear base-load units totaling approximately 6,000 megawatts and 12 new fossil base-load units totaling approximately 5,400 megawatts of capacity. In addition, a large amount of gas turbine peaking capacity is being added to the Pool's available generating resources. Capacity reserves for the PJM Pool are forecasted at 24.6 and 30.8 percent of peak load for the 1974 and 1975 summer peak periods, respectively, provided that the generation expansion plans of the Pool's member systems are realized.

Mr. Daniel R. Muller

Transmission Facilities

The associated transmission system to integrate the Three Mile Island Unit No. 1 into the existing transmission network is completed and consists of approximately 7 miles of 230-kilovolt lines in three circuits. These overhead lines are supported on lattice-type combination steel and aluminum towers on 150-foot wide rights-of-way. Unit No. 2 output will be integrated into the GPU System with two 500-kilovolt circuits approximately 75 miles in length. The overhead lines will be supported on combination steel and aluminum towers on 200-foot wide rights-of-way. A third 500-kilovolt line, 11 miles in length, will be constructed, owned and operated by the Pennsylvania Power and Light Company which is not a GPU company.

The routes of the 230-kilovolt and 500-kilovolt lines traverse open farmland and second growth woodlands. The Applicants' practices in design and construction of transmission lines have used the techniques now generally accepted for reducing the impact of overhead transmission lines on the environment and are fully consistent with the Department of Agriculture's and Department of Interior's joint publication, "Environmental Criteria for Electric Transmission Systems".

The 230-kilovolt system integrates the plant output into the local Metropolitan Edison Company's system. The 500-kilovolt system integrates the plant's output into the GPU System's and other PJM Interconnection members' bulk power network for delivery of energy to more distant load centers in eastern Pennsylvania and New Jersey making a significant contribution to system reliability in the total area.

Alternatives and Costs

The Applicant, in determining the need for additional generation to meet its projected demands, considered purchase of firm power and a number of practical alternatives including alternate locations, plant types, environmental effects and economics. The decision evolved into a choice of base-load generation, either nuclear-fueled at the Three Mile Island site or a coal-fired fossil plant located at a mine in western Pennsylvania. In the economic studies which resulted in the selection of the nuclear-fueled plant, the Applicants used capital costs of $362 per kilowatt of capacity and fuel costs of 1.3 mills per kilowatt hour for the nuclear-fueled plant and capital costs of $315 per kilowatt of capacity, which includes costs of sulfur-dioxide gas-cleaning

Mr. Daniel R. Muller

equipment and additional transmission costs, and fuel costs of 3.7 mills per kilowatt hour for the coal-fired alternative plant located at the mine. The staff of the Bureau of Power finds these costs within the range of similar costs reported by the industry.

Conclusions

The staff of the Bureau of Power concludes that the electric power output of the Three Mile Island Units 1 and 2 is needed to meet the Applicants' future demands for power, particularly during the 1974 and 1975 summer peak load periods, and to provide reasonable reserve margins for adequacy and reliability of electric service on the GPU System and the PJM Interconnection. Prudent and responsible electric utility operations require system operating reserve margins sufficient to meet various operating contingencies that could result in abnormal bulk power system conditions. These new units are needed to provide the Applicants' system with the reserve margin capacity to meet its stated criteria.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

50-289
50-320

16 AUG 1972

RECEIVED
AUG 17 1972
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

OFFICE OF THE ADMINISTRATOR

Mr. L. Manning Muntzing
Director of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muntzing:

The Environmental Protection Agency has reviewed the draft environmental statement for the Three Mile Island Nuclear Station Units 1 and 2, and we are pleased to provide our comments.

It is anticipated that the Three Mile Island plant, which will employ a closed-cycle cooling system, will be able to operate in compliance with thermal criteria of the Federally approved state standards. We are concerned, however, that excessive levels of residual chlorine in the cooling system discharge may lead to a serious adverse effect on aquatic biota in the Susquehanna River. Thus, in our opinion, steps should be taken to reduce or eliminate the discharge of chlorine to the environment.

The recent flooding on the Susquehanna River has raised concerns regarding the adequacy of the flood protection at Three Mile Island. We request the AEC to reassess the probable maximum flood and to reconfirm the adequacy of the flood protection at this facility.

In our judgement the Three Mile Island radioactive waste management systems are capable of providing effluents which are within guidelines of the proposed Appendix I to 10 CFR Part 50. However, the proposed discharge of untreated radioactive condensate demineralizer regeneration wastes cannot be accepted as "low as practicable."

It seems appropriate that the provisions of Safety Guide 21 be applied to the effluent monitoring scheduled at Three Mile Island. As written, the draft environmental

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statement indicates that several potentially radioactive effluent streams may not be sampled or monitored before their discharge to the Susquehanna River.

We will be pleased to discuss our comments with you or members of your staff.

Sincerely,

for Sheldon Meyers
Director
Office of Federal Activities

Enclosure

50-289
50-320

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20460

AUGUST 1972

EPA#D-AEC-00059-1

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Three Mile Island Nuclear Station Units 1 and 2

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4555

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental statement for the Three Mile Island Nuclear Station Units 1 and 2 prepared by the U.S. Atomic Energy Commission (AEC) and issued on June 26, 1972. Following are our major conclusions:

1. Disposing of the radioactive waste solutions created by regeneration of the Unit 2 condensate demineralizer to the Susquehanna River without processing them through the radwaste system cannot be construed as "low as practicable."

2. The AEC is encouraged to apply the provisions of Safety Guide 21 to the effluent monitoring requirements for Three Mile Island.

3. The releases of liquid and gaseous radioactive waste from Three Mile Island are expected to be "low as practicable" if due consideration is given to the recommendations made by EPA. Since the plant has the necessary equipment, the ultimate release of radioactivity will depend on the waste management practices applied by the operator and the requirements of the AEC.

4. In our opinion, the most serious impact that may result from the operation of the plant will be due to the release of residual chlorine and chlorine by-products (e.g., chloramines) in the cooling water discharge. We recommend, therefore, that the nature and extent of such impacts be evaluated and measures be taken to eliminate or substantially reduce the amounts of chlorine released.

5. We believe the closed-cycle cooling system employing two natural draft cooling towers per unit will enable the Three Mile Island plant to operate in compliance with federally approved state thermal standards. Although no impacts on aquatic biota directly attributable to thermal releases are expected, there may be impacts that arise from the congregation of fish in the vicinity of the discharge point. It is recommended that these potential impacts be addressed in the final statement.

6. As a result of the flooding on the Susquehanna River following Hurricane Agnes, we suggest that the probable maximum flood for the river at Three Mile Island be reevaluated and the adequacy of the plant flood protection be reconfirmed.

RADIOLOGICAL ASPECTS

Radioactive Waste Management

In most respects the capabilities provided by waste management equipment for Three Mile Island Units 1 and 2 are consistent with the concept of "as low as practicable." Two notable exceptions are the discharge of the neutralized regenerant solution from the Unit 2 condensate demineralizer and the discharge of untreated sluice water from the Unit 1 powdex filter-demineralizer to the Susquehanna River.

The intended procedure of discharging untreated radioactive liquids from the sluicing and regenerating operations indicated above is not, in our opinion, "as low as practicable." We strongly encourage the AEC to insure that these radioactive liquids will be treated in the waste management system. A significant portion of the radionuclides from these sources will be long-lived and, thus, will accumulate in the environment, if discharged. The annual contribution of the sluice waste to the total annual discharge of radionuclides cannot be determined from the environmental statement. In order to indicate the potential environmental impact from the discharge of untreated sluice water, the final statement should provide an estimate of the quantities of radionculides expected from this source.

It is noted that there are provisions for the future addition of a deep-bed condensate demineralizer for Unit 1. If a deep-bed demineralizer is added for Unit 1, the yearly discharge of untreated regenerate solutions could contribute as much as 30 curies to the aquatic environment. It would be appropiate for the final statement to indicate the criteria for the installation of this demineralizer and to provide the result of an evaluation of the environmental effects of its use.

Similarly, the liquid waste from the turbine building drains (presumably both floor and equipment drains) will be discharged to the river without treatment. Although the turbine building is in a "non-nuclear" area, contaminated leakage is anticipated from the condensate pumps, steam line valves, and other sources. It is recommended that the final statement provide detailed information about leak rates, activity levels in the leakage and in the discharge, and the possibility of treatment before discharge.

The gaseous effluent control systems proposed for Units 1 and 2 are expected to be capable of maintaining the gaseous effluents from the facility at levels below the guidelines of the proposed Appendix I to 10 CFR Part 50. According to the environmental statement, a minimum decay time of 30 days for the reactor coolant off-gases will be provided even though the waste gas decay tanks are designed to provide 90 days decay. We encourage the applicant to fully utilize the off-gas decay tanks to minimize environmental effects from discharges of gaseous radionuclides. This would be consistent with the concept of "as low as practicable" and would appear consistent with the provisions of 10 CFR Part 50.36a.

Effluent Monitoring

It does not appear that all potential pathways for the release of radioactive effluents are being sampled and monitored. For example, it is not apparent that the liquids from the secondary coolant system (turbine building drain, powdex filter-demineralizer sluice water, and deep-bed demineralizer regenerate solutions) will be sampled and analyzed prior to their release to the Susquehanna River. We believe that such analyses should be made to these potentially contaminated liquids prior to their release. The application of Safety Guide 21 recommendations for effluent monitoring would seem appropriate for this nuclear station. Furthermore, a tabulation should be provided of the quantities of radionuclides (unidentified and ^{131}I) which could be released undetected from any effluent release point due to instrument sensitivity limitations.

Since the exclusion area for Three Mile Island includes a substantial area of the Susquehanna River to which public access is uncontrolled, it is possible for individuals to spend considerable time within the exclusion area where the dose rates will be significantly higher than at the exclusion area boundary. The final statement should include details of how the applicant intends to determine that the doses to such individuals are within the applicable guidelines and regulations.

Transportation and Reactor Accidents

In its review of nuclear power plants, EPA has identified a need for additional information on two types of accidents which could result in radiation exposure to the public: 1) those involving transportation of spent fuel and radioactive wastes and 2) in-plant accidents. Since these accidents are common to all nuclear power plants, the environmental risk for each type of accident is amenable to a general analysis. Although the AEC has done considerable work for a number of years on the safety aspects of such accidents, we believe that a thorough analysis of the probabilities of occurrence and the expected consequences of such accidents would result in a better understanding of the environmental risks than a less-detailed examination of the questions on a case-by-case basis. For this reason, we have reached an understanding with the AEC that they will conduct such analyses with EPA participation concurrent with the review of impact statements for individual facilities and will make the results available in the near future. We are taking this approach primarily because we believe that any changes in equipment or operating procedures for individual plants, required as a result of the investigations, could be included without appreciable change in the overall plant design. If major redesign of the plants to include engineering changes were expected or if an immediate public or environmental risk were being taken while these two issues were being resolved, we would, of course, make our concerns known.

The statement concludes "...that the environmental risks due to postulated radiological accidents are exceedingly small." This conclusion is based on the standard accident assumptions and guidance issued by the AEC for light-water-cooled reactors as a proposed amendment to Appendix D of 10 CFR Part 50 on December 1, 1971. EPA commented on this proposed amendment in a letter to the Commission on January 13, 1972. These comments essentially raised the necessity for a detailed discussion of the technical bases of the assumptions involved in determining the various classes of accidents and expected consequences. We believe that the general analysis mentioned above will be adequate to resolve these points and that the AEC will apply the results to all licensed facilities.

Even though we agree that accidents should be evaluated on a general basis, the possibility of flood damage at the Three Mile Island site would seem to warrant specific consideration. At least a comparison of flood protection with an updated probable maximum flood (PMF) estimate, which takes into account the floods caused by Hurricane Agnes, should be presented in the final statement. In addition, details of the protection provided for safety-related equipment from floods exceeding the level of the plant dike system, including those equal to and exceeding the PMF, would be particularly appropiate in the final statement. We note also that a large pumped-storage facility is to be constructed on Stony Creek upsteam from Three Mile Island, but information on the flood protection provided is not available. The final statement should include consideration of the adequacy of flood protection measures at Three Mile Island relative to the possible failure during the PMF of the planned, upstream pumped-storage project.

NON-RADIOLOGICAL ASPECTS

Chemical Effects

It is probable that the most significant impact from operation of the Three Mile Island plant may be due to the release of effluent containing residual chlorine and chloramines to the Susquehanna River. This will occur as a result of the use of elemental chlorine in plant systems to control slime growth. As indicated in the draft statement, the chlorination systems "...will be operated intermittently for several 15 minute to half-hour periods per day, and the additions will be controlled so that the residual chlorine in the effluent cooling water stream is maintained between 0.5 and 1 ppm (parts per million)." Further, it is indicated that if the effluent stream is completely mixed with the receiving water, chlorine levels of .004 ppm and 0.05 ppm are expected under conditions of normal and low river flow, respectively. Such levels, should they routinely occur over an appreciable portion of the receiving water, could constitute a hazard to aquatic biota. Thus, we are inclined to agree with the draft statement that "...the impact on the biota of the river (due to chlorine releases) may be significant." In our opinion, however, additional information is necessary in order to determine the character and extent of the impact. This information should be provided in the final statement.

The assumption of complete mixing used in the draft statement to determine the levels of residual chlorine represents an idealized situation which would rarely, if ever, be realized in the Susquehanna River. Thus, it is unlikely that constant levels of residual chlorine would be observed across the entire width of the river, or York Haven Pool, at points immediately downstream of the discharge. Also, it is

unlikely that concentrations would uniformly decrease with distance away from the plant site as the chlorine residuals were consumed or dissipated. A more realistic assumption would be that the characteristics of the chemical discharge plume will vary as discharge levels and conditions in the receiving water change. The final statement, in our opinion, should present an analysis of the release of chlorine and consequent effects based on such an assumption. This analysis should be supported by the following information:

details of the schedule for chlorine additions specifying amounts to be added and indicating the frequency and duration of each addition;

predictions of the shape, size, location, and behavior of the discharge plume under various conditions of river flow and chlorine residual discharge rates;

descriptions of the chemistry of free chlorine and chlorine by-products (e.g., chloramines) in the receiving water including concentrations and persistence times;

details of an effective program for monitoring residual chlorine levels in the Susquehanna River; and

additional biological base-line data concentrating on the important species likely to be significantly affected by chlorine releases; this should emphasize those biological aspects of each species likely to undergo change (e.g., feeding habits, reproductive processes and migratory patterns).

Such information would facilitate determinations as to the chlorine levels which will provide adequate protection for the aquatic biota near the Three Mile Island site and portions of the river downstream.

As a general guide, EPA has recommended in the past the fo..owing criteria for residual chlorine levels in the receiving water:

TYPE OF CRITERIA	RECOMMENDATION FOR TOTAL RESIDUAL CHLORINE	LEVEL OF PROTECTION
continuous	0.01 mg/liter	This level would probably not protect trout during reproduction, some important fish food organisms, and could prove lethal to sensitive fish species during certain life stages.
continuous	0.002 mg/liter	This level should protect most aquatic organisms.
intermittent	A. 0.1 mg/liter not to exceed 30 minutes per day B. 0.05 mg/liter not to exceed 2 hours per day.	These levels should not result in significant kills of aquatic organisms or adversely affect the aquatic ecology.

It should be understood, however, that even the above criteria may not provide an adequate degree of protection in all instances. In our opinion, whether these or more restrictive criteria are appropriate must be determined on a case-by-case basis. Thus, experience at the Three Mile Island plant may indicate that in order to reduce adverse impacts to acceptable levels, the amounts of residual chlorine in the receiving water must be kept substantially below those recommended above. For example, some species of fish show "avoidance" reactions to chlorine (chloramines) at concentrations as low as 0.001 ppm. Should this occur, the effect may make some portion of the York Haven Pool unsuitable as a fish habitat. In addition, possible changes in other aspects of the life patterns of important species could prove significant. We recommend, therefore, considering the importance of this pool as a recreational resource for the Harrisburg, York, and Lancaster area,

that additional studies be instituted to specifically iden..fy the nature and extent of the impact that can be expected should chlorine or chloramines be released at the planned 0.5 to 1 ppm levels. Such studies would aid in determining the degree to which discharge concentrations must be reduced or in estimating the environmental benefits provided by entirely avoiding the use of chlorine as a biocide. In this regard, the final statement should consider and evaluate in detail the following possible alternatives:

significantly reducing the amounts of chlorine used or the frequency of addition, and

removal of chlorine prior to release by employing an appropriate treatment process.

The Pennsylvania state water quality standards provide that discharges to high quality waters "...should be required to provide the highest and best practicable means of waste treatment..." and also that "the standards seek to assure optimum, not marginal, conditions to protect uses associated with clean water." In view of such non-degradation strictures, the possible effects of the discharge of dissolved solids should be further considered in the final statement. This should include, in our opinion, any dissolved substance that may cause a significant effect regardless of whether an appropriate state standard exists. For example, the effects of sulfate releases should be considered.

Thermal Effects

The Three Mile Island Nuclear Station Units 1 and 2 will use a closed-cycle cooling system incorporating two natural draft cooling towers per unit. Blowdown from these towers will be combined with effluent from the nuclear and secondary service systems and routed through two small mechanical (forced) draft towers before discharge to the Susquehanna River. The draft statement indicates that blowdown temperatures will, in general, be approximately equal to the ambient river temperature during most of the year and no greater than 3°F above ambient during the winter months. Thus, in our opinion, this system provides the capability for plant operation in compliance with federally approved state standards which allow a 5°F rise and a maximum of 87°F.

Since, in general, discharge temperature will be close to ambient river temperatures during most of the year, no significant impact on aquatic biota directly attributable to thermal effects is expected. It is possible, however, that during the winter months when discharge temperatures will be appreciably above ambient conditions, certain impacts, related to the presence of warmer water in the discharge plume, may occur. For example, the warm water will undoubtedly cause fish to congregate near the discharge point. This situation could lead to:

exposure of greater numbers of fish to higher residual chlorine levels,

depletion of avilable food supplies, and

greater susceptibility to thermal shock should it become necessary to shut down the plant or to temporarily curtail the cooling tower anti-icing flow.

Any or all of these possibilities could result in increased species mortality or reduced vitality. The final statement should address such possibilities and indicate methods by which the adverse effects could be avoided.

Entrainment and Impingement Effects

Due to the low intake velocity (0.2 feet/sec.), it is anticipated that there will be no appreciable impingement of fish. It is likely, however, that entrainment of larval fish, fish eggs, and fish food organisms could lead to a significant environmental impact, particularly during periods of low-flow in the Susquehanna River. The final statement should discuss this potential problem and indicate changes in operational methods or plant systems that would mitigate or avoid any adverse impact that may develop. For example, should entrainment effects result in an unacceptable impact during low-flow periods, it may be possible to operate the cooling towers at higher concentration factors and, consequently, reduce the requirements for make-up water.

ADDITIONAL COMMENTS

During the review we noted in certain instances that the statement does not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Three Mile Island facility. The cumulative effects, however, could be significant. It would, therefore, be helpful in determining the impact of the plant if the following information were included in the final statement:

1. A description of the treatment and ultimate disposal of the filtrate from the pressure filters for the sludge treatment;
2. A description of the lighting provisions for the natural draft cooling towers and the measures undertaken to avoid potentially harmful effects on migrating birds;
3. A description of a program for the prevention of spills and the containment and recovery of hazardous materials spilled at Three Mile Island. Additional details are needed concerning the methods used to store and handle hazardous substances (e.g., oil, chlorine, acids, alkalis) so that a reviewer can ascertain that the possibility of spillage has been adequately evaluated and that effective measures to prevent, contain, and counteract such spills have been instituted;
4. The impact of high voltage transmission lines discussed in the draft statement does not mention the production of ozone by the lines. Since little information concerning the production of ozone by high voltage transmission lines is available, the EPA is preparing to study this problem. It would also be desirable for the AEC to provide whatever available information the utility companies may have in the final statement.
5. A description of the air pollution control techniques provided for the onsite concrete plant; and
6. A description of the annual fuel quantities used and sulfur content of fuel used in the diesel generators.

C-49

COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION
WILLIAM PENN MEMORIAL MUSEUM AND ARCHIVES BUILDING
BOX 1026
HARRISBURG, PENNSYLVANIA 17108

50-289
50-320

October 24, 1972

RECEIVED
1972 OCT 27 AM 9 55
U.S. ATOMIC ENERGY COMM.
REGULATORY
MAIL & RECORDS SECTION

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

Dear Mr. Muller:

A review has been made of the Draft Environmental Statement for Three Mile Island Nuclear Station Units 1 and 2. That section of the draft statment which concerns itself with "historical significance" is in agreement with our findings.

The basic significance of Three Mile Island stems from its encroachment with Indian culture and the archaeological remains on the island. Our staff conducted archaeological investigations on the island prior to construction of the nuclear plant.

There are no National Register sites in the immediate vicinity of Three Mile Island. The closest registered site is St. Peter's Church in Middletown and the generating plant will have no apparent adverse effect on this site.

Very truly yours,

WILLIAM J. WEWER
Deputy Executive Director

W s

C-50

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES
P. O. Box 2351
Harrisburg 17105
August 31, 1972

RECEIVED
1972 SEP 6 AM 8 39
U.S. ATOMIC ENERGY COMM.
REGULATORY
MAIL & RECORDS SECTION

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

Re: USAEC Docket Nos. 50-289 and 50-320

Gentlemen:

This is in response to your notice of opportunity to comment on the Applicant's Environmental Impact Report and the Draft Detailed Statement by the USAEC on the environmental considerations related to the proposed issuance of an operating license for the Three Mile Island Station Units 1 and 2.

The comments as contained in the attached Staff Report include comments as appropriate from the Department of Environmental Resources and other pertinent State agencies.

They are submitted for your attention and consideration.

Very truly yours,

Wesley E. Gilbertson
Deputy Secretary for Environmental
Protection

Enclosure

September 1, 1972

PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES COMMENTS ON ENVIRONMENTAL IMPACT OF THREE MILE ISLAND UNITS I AND II

This report is prepared for submission to the United States Atomic Energy Commission, pursuant to the Environmental Policy Act of 1969, and in response to a request for comments from the USAEC. The comments reflected in this report are those received in the Office of Radiological Health on or before September 1, 1972.

Specific Comments:

1. The Department of Environmental Resources has issued a permit to the applicant severely limiting the level of contaminants in the discharge. This permit restricts radioactive effluents to less than 1% of present AEC standards. These requirements are considered maximum limits. The Department's philosophy is that all releases of environmental pollutants should be held to the absolute minimum. The applicant has been previously notified by the Department that it must review any additional measures which could be incorporated into the plant waste management systems and install any and all systems which would further reduce both radioactive and non-radioactive pollutants.

   On the basis of the information indicated on page V-14 and V-18, 19 of the draft detailed statement, we believe that chlorine in the effluents should be reduced to non-detectable levels. In lieu of this, it should be shown that the levels proposed would not adversely affect the aquatic ecosystem.

   This position is re-stated as the most important comment on the environmental report.

2. In reference to page 2.4-5 of the Applicant's Environmental Report and page II-8 of the Draft Detailed Statement, it is stated that any waters (contaminated or not) added to the groundwater of the area would follow the water table gradient to the river and be discharged to the river.

   This would be true only for surface disposal, and not for sub-surface disposal. No sub-surface disposal has been authorized by the State for this plant.

3. On pages V-15, 16, 17 of the Draft Detailed Statement, there is listed the expected plume dispersal to the countryside of salt, copper, cobalt, iron, zinc and manganese. The statement in paragraph 4 on page V-17, "If a problem of copper toxicity should develop, it would be controllable by the addition of phosphates to the land. The same would be true for zinc and manganese."

   These remarks cited above indicate, 1) a clear uncertainty in the prediction of what will develop, 2) no consideration of the combined effect resulting from the contaminants (even though past research may indicate that the dosage of the contaminants individually are acceptable), 3) no consideration of the undesirable aspects of adding phosphates to the water environment, and 4) no stated plans for continuous trace-element monitoring of the soils, waters, and organisms.

4. The effects of the cooling tower plume on Harrisburg International Airport visibility is a question raised previously during the construction permit hearings. The possibility of an

effect on the airport does exist, as reported by the applicant. The probability is extremely low. In the unlikely event that airport safety is jeopardized by cooling tower fogging, some remedy to this situation must be implemented.

5. With one exception, the meteorological contents of the report appear to be acceptable. In Appendix II of the Environmental Report, a sector average model is used to describe dispersion of radioactive materials over a short period of time for determination of concentrations and dose at the site boundary. The use of sector averaging is acceptable for long term dispersion phenomena description. In the case of accidental releases (Section 6) of short duration (e.g., 2 hour doses), center line plume concentration is important in the estimating of actual doses under differing meteorological conditions. Based upon the consideration that high center concentrations and doses could be observed, it appears that the normalized doses shown in Tables 6.9.1 and 6.9.2 are low by a factor ranging between 10 and 20.

6. Section 2.5-3 should be updated to include the June, 1972 flood as the flood of record. It is remarkable how closely the design flood of 1.1 million cfs was duplicated by the flood waters produced by Hurricane Agnes. This does not appear to be the maximum flood that can occur at the site.

It is noted that no information is given to show what increase in river flow elevations would result from the construction of dikes for the protection of flood plain communities on the Susquehanna water shed, thereby eliminating a part of the flood-

way. Based on limited information it appears that the net back-water condition would not be great.

Applicant should, however, demonstrate that plant and auxiliary facility integrity will be maintained in the event of a flood to the order of the new flood of record and probable maximum flood in conjunction with adequate dike protection of upstream flood plain communities.

METROPOLITAN EDISON COMPANY SUBSIDIARY OF GENERAL PUBLIC UTILITIES CORPORATION

POST OFFICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

August 28, 1972

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

Dear Mr. Muller:

SUBJECT: THREE MILE ISLAND NUCLEAR STATION
UNITS 1 AND 2
DOCKET NOS. 50-289 AND 50-320

We have reviewed the Commission's Draft Environmental Statement for the Three Mile Island Nuclear Station Units 1 and 2. We wish to forward to you the following comments on the statement:

1. Item 3.b of the Summary and Conclusions states that the blowdown from the cooling towers will be discharged to the river at a maximum of 3°F above ambient river conditions. The word "maximum" should be changed to "average" in this statement.

2. Paragraph 1 on Page III-9 indicates that the river water temperatures vary from a minimum of 35°F in the winter to a minimum of 87° in the summer. These temperatures should read 33°F winter minimum and 85°F summer maximum. (See Page 3.5-1 of Environmental Report.)

3. Figure 10, Ventilation System, Three Mile Island Nuclear Station Unit 2, on Page III-11 should be revised as shown on the attached sketch.

4. Figure 12, Liquid Radioactive Waste Treatment System, Three Mile Island Units 1 and 2, on Page III-14 should be revised to indicate the capability to direct the Powdex sluice water and the deep bed resins and effluent to the radwaste system as shown on the attached sketch.

Very truly yours,

J. G. Miller
Vice President

mw
Enclosures

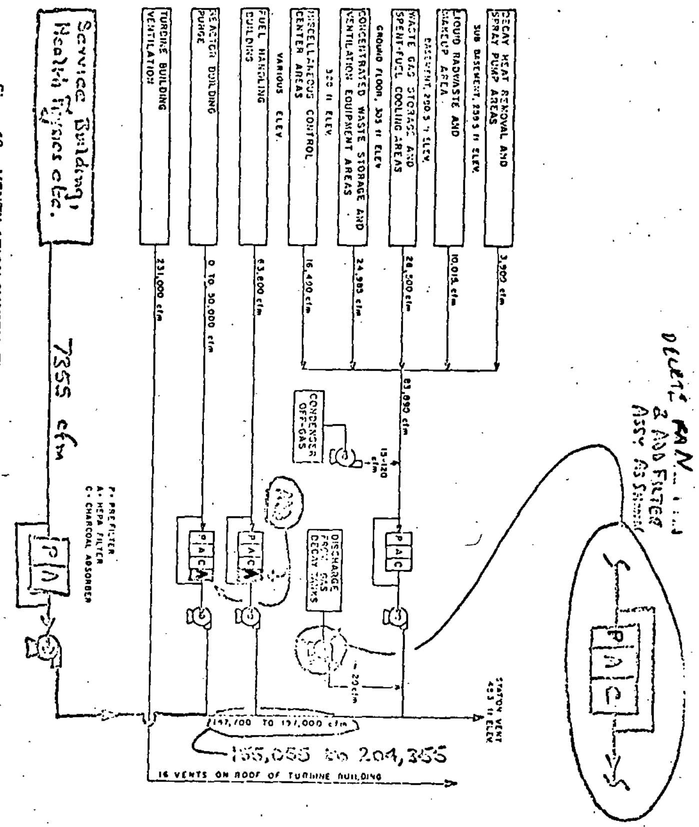


Figure 10 — VENTILATION SYSTEM, THREE MILE ISLAND NUCLEAR STATION UNIT 2

III-11

Attachment for S/N 303-GP
dated 8/2/72

C-56

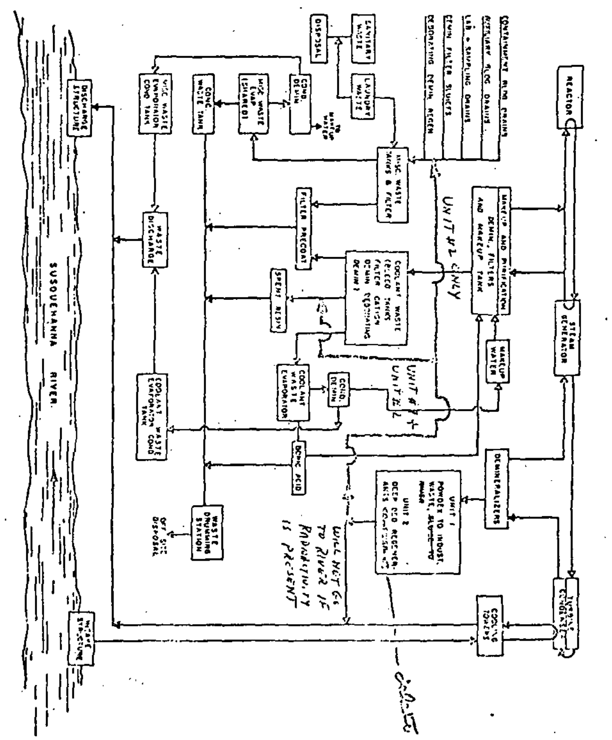


Figure 12 – LIQUID RADIOACTIVE WASTE TREATMENT SYSTEM, THREE MILE ISLAND UNITS 1 AND 2

Attachment for S/N 303-GP dated 8/2/72

III-14

C-57

APPENDIX D

APPLICANTS' RESPONSES
TO COMMENTS
ON
DRAFT ENVIRONMENTAL STATEMENT

D-2

METROPOLITAN EDISON COMPANY *SUBSIDIARY OF GENERAL PUBLIC UTILITIES CORPORATION*

POST OFFICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

50-289
50-320

September 22, 1972

RECEIVED SEP 26 1972 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

Mr. Daniel R. Muller
Assistant Director for Environmental Projects
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller

Enclosed please find forty (40) copies of responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

This submittal includes only a partial response to these comments. The applicant will submit additional information with regard to these comments by September 29, 1972.

Very truly yours,

J. G. Miller
Vice President

mw
Enclosure

D-3

METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER & LIGHT COMPANY
AND
PENNSYLVANIA ELECTRIC COMPANY

RECEIVED SEP 26 1972 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2

Application For
Class 104b Utilization Facility Operating License

DOCKET NOS. 50-289 AND 50-320

Applicant herewith submits 40 copies of responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

METROPOLITAN EDISON COMPANY

ATTEST:

Secretary

By
Vice President

Sworn to and subscribed before me this 22nd day of September 1972.

Notary Public

RESPONSE TO EPA QUESTIONS ON
TMI ENVIRONMENTAL REPORT, AEC DRAFT
IMPACT STATEMENT

Radioactive Waste Management

Comment, Item #1

The intended procedure for handling radioactive liquids from sluicing and regeneration operations is considered "as low as practical" in that it is the intention of the Metropolitan Edison Company to process as much as these liquids, when radioactive, as can be handled by Units 1 miscellaneous radwaste evaporator. These wastes will be discharged only if they are non-radioactive or the quantity exceeds the capacity of the evaporator-demineralizer processing system.

Comment, Item #2

Space was provided in Unit 1 to add a deep bed demineralizer condensate polishing system. The addition is dependent upon whether the existing Powdex filter/demineralizer can effectively function with condenser tube leakage. In the event this system is added, the regenerate solution, when radioactive, will be treated by miscellaneous radwaste system to the extent practical.

Comment, Item #3

In general, liquid waste from the turbine building drains are not expected to contain significant radioactive contamination. The possibility of contamination does exist in the event of plant operation with both defective fuel and a primary to secondary system leak.

The quantity of liquids entering the turbine building drains had previously been estimated(1) to be 7200 gal/day for both Units 1 and 2. Assuming 0.1 percent defective fuel and 10 gpd primary to secondary leak, a conservative estimate of the activity content of this waste is approximately .001 uc/cc for mixed isotopes. These wastes will be discharged without treatment to the river via the effluent

(1) Source Term Input (Oak Ridge Questions)

from the tower blowdown and nuclear and secondary service systems. Under these conditions, the average annual concentration in the discharge, prior to dilution in the Susquehanna River, will be 4.5×10^{-10} uc/cc.

Effluent Monitoring

Comment, Item #5

The normal and potential paths for release of radioactive materials during normal reactor operations will be monitored. The release of liquids from the secondary coolant system (turbine building drains, powdex filter, demineralizer sluice water and deep bed demineralizer regenerate solutions) will be discharged via the flow and radiation monitor box. In the event of plant operation with defective fuel and a primary to secondary system leakage, these wastes will be sampled and analyzed on a regularly scheduled basis. It is the intention of the Metropolitan Edison Company to comply with the recommendations of Safety Guide 23 regarding effluent monitoring to the extent practicable.

A tabulation of the quantities of radionuclies which could be released undetected due to instrument sensitivity limitations from the various release points in the plant are as follows:

Release Point	Undetected Quantity (uc) or Release Rate (uc/sec)
1. Condenser Vacuum Pump Exhaust via Monitor Rm-A5	
Noble Gasses (Kr-85)	1.4×10^{-2} uc/sec
Iodine (I-131)	1.4×10^{-2} uc/sec
Particulates (Cs-137)	1.4×10^{-2} uc/sec

Note: Any one or combination of the above that results in a release rate of 1.4×10^{-2} uc/sec will be detected. Anything less than this activity flow rate could go undetected. If the release consists of iodine and/or particulates, this would be detected at the first scheduled sampling interval after the release occurs.

Release Point	Undetected Quantity (uc) or Release Rate (uc/sec)
2. Auxiliary and Fuel Handling Bldg. Exhaust-via Monitor Rm-A8	
Noble Gases (Kr-85)	225 uc/sec
Iodines (I-131)	160 uc*
Particulates (Cs-137)	800 uc*
*Between sampling intervals	
3. Reactor Building Purge Exhaust-via Monitor Rm-A9	
Noble Gases (Kr-85)	50 uc/sec
Iodines (I-131)	68 uc*
Particulates (Cs-137)	340 uc*
*Between sampling intervals	
4. Plant Liquid Effluent Discharge via Monitor Rm-L7	
Mixed Isotopes	4.5 uc/sec

This release rate corresponds to a concentration of 2×10^{-6} uc/cc in the plant discharge to the river. Anything less than this activity concentration will be released undetected.

Comment, Item #6

An analysis of flood discharge-frequency relationship was made using data gathered by the U.S. Geological Survey on past floods dating back to 1786. Until recently, the flood of record was that of March 19, 1936, which, according to the U.S. Geological Survey, was the highest known flood to have occurred since 1784 and probably the highest since 1740. The 1936 flood at Harrisburg was gaged at 740,000 cfs and resulted from a large scale snow melt over the entire area of Pennsylvania.

On June 24, 1972, a record flood of approximately 1,000,000 cfs occurred at Harrisburg as the result of tropical storm "Agnes" moving slowly up the eastern seaboard and depositing an average rainfall of 8 inches on the Susquehanna River basin. Maximum rainfall depth in the basin totaled 17.7 inches during a period of 48 hours. During this period, about 12 inches was incident on the site at Three Mile Island.

Preliminary estimates of the 1972 flood at Harrisburg place the frequency of occurrence at approximately once in 500 years, as indicated by the curve shown in Figure 2.5-12.

The design flood established for the site is 1,100,000 cfs, which was based upon the provisional probable maximum flood established by the Corps of Engineers prior to 1969. The hydraulic design of the plant inundation protection facilities is based upon the design flood to provide adequate protection with an ample margin of free-board. The generating station and its facilities will not have any significant effect on local conditions during the design flood.

The conservatism used in designing the facilities to protect the plant from the design flood was evidenced during tropical storm "Agnes", which in effect produced a flood approaching the design flood in magnitude. The maximum water surface in the river at the site during the 1972 flood was at elevation 300.5. The curves shown on Figure 2.5-13 of the Environmental Report indicate that for a flow of 1,000,000 cfs the water surface at the site (Goldsboro) would be at elevation 302. Thus a 3.5 foot freeboard has been provided in design against overtopping for an Agnes flood, since the lowest dike elevation south of the site is 304. Had Three Mile Island Nuclear Station been completed and operable during the 1972 flood, it would not have experienced any adverse effects, since the dike system would have afforded adequate flood protection.

Metropolitan Edison Company and Pennsylvania Power and Light Company are planning a joint pumped storage project on Stony Creek, approximately 13 miles northeast of Harrisburg. The project consists of a lower dam and reservoir on Stony Creek and an upper reservoir between Stony and Sharp Mountains, providing a head of 975 ft. for peak-power generation of 1,100 MW. The project will have no known adverse effect on Three Mile Island, but will improve conditions on the Susquehanna River by affording some degree of flood protection and augmentation of low flows.

The Stony Creek Pumped Storage Project is in the preliminary design state. Final design is expected to begin in about two years, based upon a presently planned in-service date of 1983-84. Detailed design data is therefore not available; however, it is planned to provide sufficient spillway capacity to pass its local probable maximum flood, based upon the applicable basin PMF, Consideration will also be given in the design to enable the dams to withstand seismic effects, but neither the design criteria or material properties has been established.

Stony Creek dam will be approximately 100 feet in maximum height and will impound about 24,000 acre feet of water depending upon the final pool elevation. The dam will be an earth embankment constructed with local materials and have a concrete spillway. Assuming a seismically-induced dam failure at times of normal stream flow, and the consequent loss of the reservoir volume during a conservative one-hour period, the resulting average downstream flow would be in the order of 300,000

cfs. The 24-mile flow route to the plant site would serve to attenuate both the peak flow and flood wave, especially in the broad 4,000 ft-wide Susquehanna River. A flow increase of 300,000 cfs at the plant site would raise the river level about 7 feet above the normal elevation of 280. Such an occurrence will not have any adverse effect on the plant since the dikes are at a minimum elevation of 304 and provide a 24 foot protection for such an event.

Page 3.7-2 of the Environmental Report states that, "The filters pas 2,000 gph each of the clear filtered water to the cooling water discharge." The flow from two filters will be 66 gpm maximum. This water is essentially the same or better than that taken from the river except suspended matter is removed. It will be blended with 36,000 gpm of plant cooling water. The effect on the river will be insignificant unless a high concentration of any particular contaminant is present in the filtrate. This is not the case.

Radioactivity to the sludge treatment building from spent Powdex waste solution will be controlled. If there is a primary to secondary steam generator tube leak, the contaminated Powdex waste will not be transferred to the sludge treatment building. It will be pumped to the radwaste system for treatment.

D-10

RESPONSE TO PARAGRAPH 4 OF THE

JULY 26th LETTER OF REAR ADMIRAL
W. M. DENKERT TO MR. DANIEL R. MULLER

It is here pointed out as a matter of record and clarification that the plumes which will emanate from the cooling towers at Three Mile Island are not smoke, in the most commonly accepted usage of that word, which has to do with some sort of combustion or other particle producing process. The effluent from the cooling towers consists of water, in the form of very small droplets and as a vapor, mixed with atmospheric air which merely passes through the tower.

With regard to the potential effect of the estimated 39 hours per year, this may be more accurately described as a persistent but elevated plume rather than fogging which infers a ground level effect. Experience at other locations with operating towers comparable to those at Three Mile Island indicates there is a very minimal effect on even the lightest air craft in penetrating the plume, comparable to penetration of a cumulus cloud. The persistent plume will be adequately elevated (of the order of 700 to 1,000 feet above grade) to permit VFR landing and because of the relative position of the towers with respect to the air-port approaches it is not conceivable that the plumes would align their longest dimension with the approaches. Due to the random direction of wind it may some-times be necessary for approaching aircraft to penetrate the plumes, but this will be along their short dimension for a very brief interval, and they will emerge from the plume well before any lower limit of VFR restrictions. This is the potential effect which is estimated to be 39 hours per year.

We concur with the opinion of Rear Admiral Denkert that this impact is minimal and that an operating license should be issued.

D-11

METROPOLITAN EDISON COMPANY *SUBSIDIARY OF GENERAL PUBLIC UTILITIES CORPORATION*

POST OFFICE BOX 542 READING, PENNSYLVANIA 19603 TELEPHONE 215 – 929-3601

October 19, 1972

RECEIVED
OCT 24 1972

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

Dear Mr. Muller:

SUBJECT: THREE MILE ISLAND UNITS 1 AND 2
DOCKETS NO. 50-289 AND 50-320

Enclosed please find forty (40) copies of responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

This submittal includes the remainder of the responses to these comments, as indicated in our letter of September 22, 1972.

Very truly yours,

F. J. Smith
Vice President

mw
Enclosure

D-12

METROPOLITAN EDISON COMPANY
JERSEY CENTRAL POWER & LIGHT COMPANY
AND
PENNSYLVANIA ELECTRIC COMPANY

RECEIVED OCT 24 1972 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2

Application For
Class 104b Utilization Facility Operating License

DOCKET NOS. 50-289 AND 50-320

Applicant herewith submits 40 copies of the balance of the responses to comments made by Federal and State Agencies in connection with the Commission's Draft Impact Statement for Three Mile Island Nuclear Station Units 1 and 2.

METROPOLITAN EDISON COMPANY

ATTEST:

Secretary

By Vice President

Sworn to and subscribed before me this 19th day of October 1972.

Notary Public

D-13

APPLICANT'S RESPONSE

TO

QUESTIONS RAISED BY GOVERNMENTAL AGENCIES

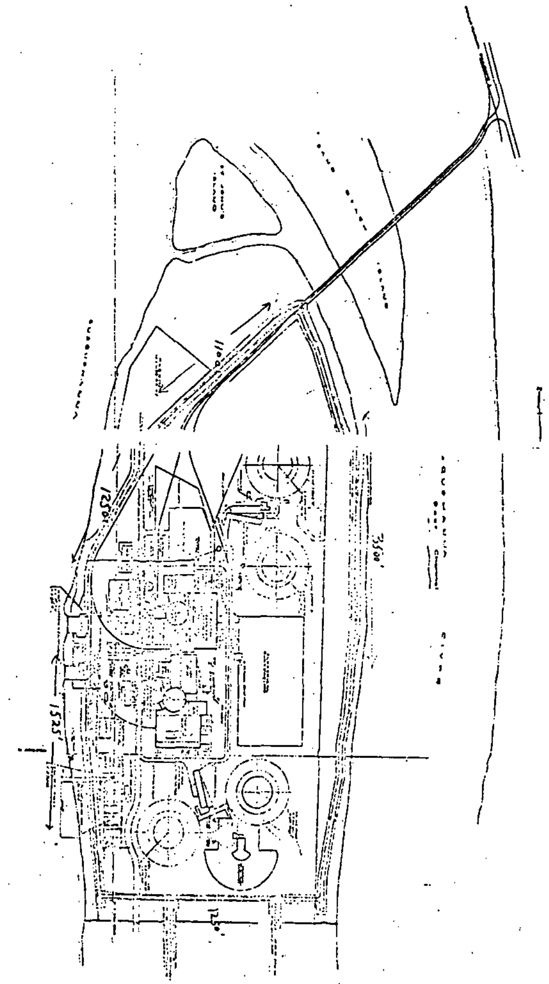
ON THE

COMMISSION'S DRAFT ENVIRONMENTAL IMPACT STATEMENT

RESPONSE TO THE DEPARTMENT OF INTERIOR'S REQUEST FOR DIMENSIONS OF THE DIKE AT THREE MILE ISLAND

The approximate dimensions of the periphery of the dike are as shown on the attached Figure 1-1. The following additional dimensions will be of interest:

1. Normal river water level in Yorkhaven pool - 278' above sea level.
2. Elevation to top of dike North end - 310' above sea level.
3. Elevation to top of dike on both the east and west sides of the island - Slopes from 309' to 305' above sea level.
4. Elevation to top of dike South end - 304' above sea level.
5. The dike is 20' wide with a 2:1 side slope.



PLOT PLAN
THREE MILE ISLAND NUCLEAR STATION UNIT 1
FIGURE 1-1

RESPONSE TO EPA QUESTION ON CHLORINATION

CHLORINATION AT THE THREE MILE ISLAND PLANT

I. INTRODUCTION

Chlorine, as a gas or in some compound form, has been used in the United States for the disinfection of water since 1908. In addition to its use as a disinfectant, chlorine is also used as a biocide to prevent the development of fouling growths in condenser tubes and cooling towers. In addition to acting as a biocide, chlorine reduces and removes objectionable tastes and odors and oxidizes iron, manganese and hydrogen sulfide aiding in the removal of these materials.

Chlorine hydrolizes in water to produce hypochlorous acid, which provides the disinfecting and oxidizing properties of the solution.

Residual chlorine occurs in both free and combined forms. Free available residual chlorine exists in water as hypochlorous acid. Combined available residual chlorine is represented by compounds such as the chloramines. The bactericidal properties of free and combined chlorine residual differ. Approximately 25 times as much combined chlorine residual is required for complete bactericidal effect as is required for free residual chlorine. Further, for combined residual chlorine to be an effective bactericide contact time must be about 100 times greater than what is required for free residual chlorine to be effective.

Chlorine demand is the difference between the amount of chlorine supplied and the amount of total residual chlorine. Chlorine demand varies with water quality, contact time, pH, and temperature. Bacterial kill is usually accomplished when chlorine is added to produce a residual of 0.2 to 0.5 ppm after a minimum ten minute contact period at temperatures at and above 68°F (20°C). Higher residual values may be necessary if the residual chlorine exists as combined chlorine residual.

Free available chlorine is toxic to aquatic organisms. Chlorine compounds involving ammonia, phenols, cyanide, or other substances may have equal or greater toxicity levels. This circumstance has led to concern about the use of chlorine as a disinfectant. Alternative methods of biological control are being studied. Other biocides exist, but little is known of their effect on aquatic life. Ozonization is being used experimentally at a few sewage treatment plants as is radiation by cobalt 60. The application of these latter two techniques to generating stations apparently has not been investigated.

II. RESIDUAL CHLORINE EFFECT ON AQUATIC LIFE

A. Literature Annotation

McKee and Wolf[1] presented annotations of earlier literature on the effects of chlorine on aquatic life. Results reported by various workers include:

1. Aquatic plants are harmed by concentrations of chlorine of 3.0 mg/l or more.

2. Most algae can be controlled by chlorine concentrations of 0.25 to 3.0 mg/l. Synura, a flagellate alga, was killed by 5 to 10 mg/l.

3. Midge larvae (Chironomus), important fish food organisms, were killed by doses of chlorine of 15 to 50 mg/l.

4. Small invertebrate organisms (crustaceans, rotifers) were killed by chlorine at 1.0 mg/l, but larger organisms (worms, mollusks) were not killed by this concentration.

5. Freshwater clams, snails and sponges in cooling systems were killed by 2.5 mg/l.

From the material presented by McKee and Wolf it would appear that the primary producers and fish food organisms of aquatic communities would not be affected by free available residual chlorine of less than 1 ppm.

Fish, however, in some cases appear to be more sensitive to chlorine than do lower forms of life. The fish data presented by McKee and Wolf appear somewhat contradictory. Concentrations of chlorine as mg/l that caused kills or permitted survival as reported by McKee and Wolf are tabulated below:

	DEATH CONCENTRATIONS	SURVIVAL CONCENTRATIONS
Trout	0.03, 0.08, 0.3, 0.8, 1.0	0.1, 0.5
Carp	0.15 to 0.2	1.0
Goldfish	1.0, 2.0	0.25, 1.0, 5.0
Minnows	0.8	0.3, 1.0

As McKee and Wolf point out, the apparent contradictions stem from differences in water quality among the various studies reviewed as well as the time of duration of exposure.

In an early (1950) literature review Doudoroff and Katz[2] summarized the effects of chlorine on fish. Methods of analysis for measuring chlorine or chlorine residuals were not presented. The authors did observe that there was no very great difference between the toxicity of free chlorine and that of chloramines. Among the concentrations they found reported as having adverse effects were:

1. Free chlorine at 0.3 ppm killed rainbow trout in two hours.

2. Eels and tench* were resistant to residual chlorine of about 1 ppm for long periods.

3. Trout and pike died at concentrations of residual chlorine at 1 ppm in 40 hours.

4. Chloramine concentrations of 0.76 to 1.2 ppm were fatal to hardy minnows, carp and bullheads while 0.4 ppm killed trout, sunfish and some bullheads.

Jones[3] said that chlorine was found toxic to rainbow trout at less than 0.2 ppm while eels and tench* were more resistant. Roach* had a threshhold toxicity of about 0.4 ppm. Jones did not identify the methods of analysis. The work he cited was experimental laboratory work by the Water Pollution Research Laboratory (England). Apparently these were investigations on the effect of chlorine as an inorganic gas in aqueous solution rather than residual chlorine following its use as a disinfectant. Jones also referred to an earlier (1958) work by Merkens[4] who felt that for pollution control purposes it should be assumed that all residual chlorine was present as free chlorine. Merkens found 0.08 ppm chlorine fatal to trout in seven days and assumed, based on extrapolation of a survival curve, that the safe threshhold (for trout) was as low as 0.004 ppm chlorine. A trout population, of course, is not resident in the Susquehanna River at the Three Mile Island site. In spite of this experimental work in England, the Mersey River Board (England) has proposed that the free chlorine residual of discharges should be limited only to the extent that it should not exceed 1.0 mg/l.

Zillich[5] studied the toxicity of combined residual chlorine to fathead minnows. He found the lowest concentration to produce an adverse effect was 0.04 mg/l residual chlorine. (The iodometric method was used to measure the residual chlorine.) The chlorinated effluents used in his investigation were toxic after diluting to two to four percent. Zillich observed that avoidance reaction by fish prevented fish kills below

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* British fish species not found in North America.

chlorinated discharges. He went on to say: "It seems probable that the greatest effect of discharging chlorinated wastewater to a stream is not that it is lethal to fish but that its presence renders the water unavailable to many fish."

Tsai[6] studied the effect of sewage pollution in the upper Patuxent River. He found that chlorinated effluents are toxic and reduce fish populations below the effluent outfalls. Tasi did not measure the amounts of residual chlorine present, but his text suggests that toxicity was due to combined residual chlorine and particularly the chloramines. Tsai did find 29 fish species occurring below sewage outfalls. Of these, 15 are included among the 37 Susquehanna River fish species presented in Section 2.7.1 of the Environmental Report. (The ecological differences between the Susquehanna River and the upper Patuxent River waters are pronounced and would account for differences between the respective fish communities.)

Basch et al[7] studied the effect of chlorinated municipal waste on caged rainbow trout and fathead minnows below four sewage treatment plant outfalls in Michigan. Total residual chlorine was measured by amperometric titration. They found the trout to be more sensitive to the effluent than the minnow. The latter species, however, was adversely affected by the discharge in one instance for a distance of 0.6 mile below the outfall. In two of the four cases fathead minnows were not affected by the chlorinated discharges. In the two where these fish were affected, toxicity concentrations of residual chlorine were given as less than 0.1 mg/l in the Conclusions (p. 1) and as less than 0.2 mg/l in the General Discussion (p. 34). Tabular data in the publication show calculated lethal levels of total residual chlorine for fathead minnows as 0.007 (with 120 hours of exposure) and 0.072 (with 96 hours of exposure) mg/l. Apparently the 20 experimental fish (10 trout; 10 minnows), caged in a one cubic foot box, were not fed during exposure. Differences, of course, would be expected if the nature of the combined residual chlorine differed between the two outfalls, which appears probable.

The four plants studied by Basch et al apprently practiced continuous chlorination. Operator practice at the plants was to chlorinate to a chlorine residual of 0.5 (Plants 1 and 2), 1.5 (Plant 4) and 2.0 - 2.5 (Plant 3) mg/l as measured by the orthotolidine arsenite color comparator. This technique has been established as one of the poorest analytical methods for the determination of residual chlorine (Lishka and McFarren[8]).

Most of the literature on the effect of residual chlorine fails to identify the analytical method used. The orthotolidine arsenite method is one of the commonest in use. Where this method has been used, the results expressed are probably much lower than actual concentrations. This should be borne in mind when considering older literature.

The total residual chlorines found in the effluents studied by Basch et al as measured by amperometric titration were: 0.96 to 2.94 mg/l (Plant 1), 0.95 to 1.89 mg/l (Plant 2), 5.01 to 32.5 mg/l (Plant 3), and 1.82 to 3.89 mg/l (Plant 4).

The volume of discharge for the four plants in relation to the receiving streams was 3.84 percent (Plant 1), 1.50 percent (Plant 2), 0.06 percent (Plant 3), and 5.00 percent (Plant 4). Toxic effects for fathead minnows were associated with Plants 1 and 4.

B. Three Mile Island Discharge

The average annual flow of the Susquehanna River at the Three Mile Island site is 34,000 cfs and the average discharge from the Three Mile Island Plant is 80 cfs, which represents 0.24 percent of the total river flow.

At the Three Mile Island site the Susquehanna River is about 7,000 feet wide and divided by islands into three channels. These islands represent about 4,000 of the 7,000 foot width of the river. The plant draws from and discharges to the center channel. The eastern channel, smallest of the three, is blocked at its lower end by the York Haven Dam. At times of normal flow all river water would flow downstream through the center and western channels.

Anderson[9] published on variations in the chemical characteristics of the Susquehanna River at Harrisburg where City Island forms an eastern and western channel. Anderson found strong chemical differences through the cross section of the river. Water samples from the western side of the river were alkaline and characteristic of water drained from limestone regions. Samples from the center of the river resembled water quality of the West Branch Susquehanna River. The eastern part of the river had water quality characteristics associated with mine drainage from eastern tributaries. The great width of the river in conjunction with its relatively shallow nature prevents lateral mixing and these various waters forming the river retain their identity for long distances. Anderson found that the various waters were still separate masses at least as far downstream as Columbia. This continuity to the thread of flow from tributaries entering the river would also exist for any entering discharge. Thus, when a plume develops it will, in effect, squeeze into the river flow at its point of origin but have minimal lateral spreading until its identity is lost.

The extent of a theoretical plume has been calculated for the discharge from the Three Mile Island Plant. This theoretical plume was developed for winter conditions. The choice of winter is appropriate since it has been suggested (though inconclusively) that chlorine is most harmful at low temperatures (Ebeling and Schrader[10] and Ebeling[11] in Doudoroff and Katz).

The plume was calculated with a discharge of 80 cfs into a low river flow of 10,000 cfs, with a temperature increment of 3°F above an ambient river temperature of 38°F. The plume is virtually lost after a flow distance of 220 feet, and at that distance the discharge would have been subject to a tenfold dilution.

Other plumes calculated for beginning of cooldown and 12 hours later, with a discharge of 113 cfs into 10,000 cfs, varied slightly. At the beginning of cooldown the discharge would be 12°F above river ambient, but 12 hours later this would have decayed to 3°F. These two plumes would extend for about 300 feet and 280 feet respectively. Again, at these distances dilution would be tenfold. The maximum width of the calculated plumes would be about 75 feet. The center channel into which the discharge enters is more than 1,000 feet wide.

Residual chlorine in the discharge will, of course, be intermittent, correlating with the chlorination schedule of the Three Mile Island Plant. Chlorination is expected to occur about three or four times per 24 hour day for 15 minute periods. No aquatic life would be subject to persistent, long-term exposure to chlorine residuals. The maximum area of possible influence would be a plume two or three feet deep extending for a distance of 300 feet with a width of 75 feet (<7.5 percent of channel width) for one hour a day under flow conditions of less than one-third normal river flow.

The total chlorine residual at the plant cooling water discharge will nominally be less than 0.3 ppm as measured by the orthotolidine method. Chlorine injection will occur intermittently not more than two hours per unit over a 24 hour period. Monitoring of chlorine residual will be performed by analysis of grab samples in the discharge. Analysis will be logged during a chlorination period at regular intervals.

Accumulated field experience clearly demonstrates that a discharge containing a total of 0.3 ppm total residual chlorine, as measured by the orthotolidine method, creates no biologically adverse conditions.

Lishka and McFarren state that 0.05 mg/l free chlorine is about the minimum amount that can be measured by analysis suing the following methods: leuco crystal violet, stabilized neutral orthotolidine, DPD-titrimetric, amperometric titration, DPD-coloimetric, methyl orange, and orthotolidine-arsenite. In the literature where chlorine residual values are expressed as lower than 0.5 ppm they have been based on controlled feeding in laboratory experiments or extrapolations from data observed at higher concentrations. Those values given as direct readings must be considered highly suspect.

C. Susquehanna River Biota

Since the discharge plume from the Three Mile Island plant will have a slight temperature increment over ambient temperatures the plume, with any entrained residual chlorine, will float over cooler, deeper waters. As a result, aquatic life associated with the river bottom will not be subjected to exposure to residual chlorine. With the exception of fish, the vast majority of Susquehanna River species of aquatic life, representing all trophic levels, is associated with the substrate material. No true plankton is found in the Susquehanna River. Plankters are associated with non-flowing waters. Those found in flowing waters are tychoplankton, which are drift organisms flushed into the river from ponds, lakes, etc., in the watershed area. Such forms are not major biological components of the river's biological community except sporadically as transient conditions associated with periods of heavy runoff.

The macroinvertebrate species (bottom organisms) found by Wurtz[12] at four sampling stations in the area of Three Mile Island during the course of annual surveys numbered as follows:

1967	43 species
1968	37 species
1969	23 species
1970	39 species
1971	29 species

The coefficient of variation ($V = 100\ s/\bar{x}$) for the successive years was found to be:

1967	13.3%
1968	36.1%
1969	43.9%
1970	34.2%
1971	36.8%

Coefficient of variation values of less than about 25 percent reflect biological stability. Thus, from 1968 through 1971 environmental conditions during the time of sampling (first week of August each year) were in flux and the macroinvertebrate population was lagging in adjustment to biological equilibrium with the environment. This phenomenon was independent of activity at the Three Mile Island site.

When collections across the center channel at the head of Three Mile Island and between Three Mile Island and the foot of Shelley Island are compared strong environmental differences are found. For example, in 1971 a total of 36 species was found at the upper station but only 17 species were found at the lower station. Eleven species were common to both stations, giving a similarity coefficient of 0.261. The difference rests in the greater diversity of habitats at the upper station. This would support a more diverse invertebrate fauna.

The species of macroinvertebrates found in the York Haven Pool are characteristic of upland waters in the temperate zone of eastern North America. Included in the 1971 collections (and earlier years) were worms, leeches, bryozoans, clams, snails, scuds, crayfish; nymphs of mayflies, dragonflies and samselflies; water striders and water bugs; caddisflies nymphs; beetles and their larvae; various fly larvae, and midge larvae.

Personnel from Millersville State College[13] have been making biological studies of the Three Mile Island site. Two center channel stations have been collected; one above and one below the proposed discharge. Fish

were collected at these stations in June and October, 1971, (the most recent available data). No long-range migratory species of fish were found. The species found, and the number of individual of each species taken, are presented below:

Catfish (Ictaluridae)			
1.	Channel catfish	*Ictalurus punctatus*	1059
2.	Brown bullhead	*Ictalurus nebulosus*	165
3.	Yellow bullhead	*Ictalurus natalis*	31
4.	White catfish	*Ictalurus catus*	29
			1284 Subtotal
Sunfish and bass (Centrarchidae)			
5.	Pumpkinseed	*Lepomis gibbosus*	157
6.	Rock bass	*Ambloplites rupestris*	68
7.	White crappie	*Pomoxis annularis*	29
8.	Black crappie	*Pomoxis nigromaculatus*	15
9.	Bluegill	*Lepomis macrochirus*	9
10.	Redbreast sunfish	*Lepomis auritus*	5
11.	Smallmouth bass	*Micropterus dolomieui*	1
12.	Largemouth bass	*Micropterus salmoides*	1
			285 Subtotal
Minnows (Cyprinidae)			
13.	Golden shiner	*Notemigonus crysoleucas*	20
14.	Carp	*Cyprinus carpio*	2
			22 Subtotal
Suckers (Catostomidae)			
15.	White sucker	*Catostomus commersoni*	10
16.	Quillback	*Carpiodes cyprinus*	9
17.	Northern redhorse	*Moxostoma macrolepidotum*	1
			20 Subtotal
Perches (Percidae)			
18.	Walleye	*Stizostedion vitreum*	8
			8 Subtotal
Pikes (Esocidae)			
19.	Muskellunge	*Esox masquinongy*	1
			1 Subtotal
			1620 TOTAL

It is evident from the 1971 Milersville data that 80 percent of the resident fish taken were bottom dwelling forms (catfish and suckers). These fish would not be subjected to plume influence. Piscivorous, predator fish (walleyes, the introduced muskellunge, smallmouth and largemouth bass) represented less than one percent of the fish community. These species are highly mobile and would very readily evade stress conditions if any were present in the plume. The sunfish and bass along with the minnows represented 19 percent of the catch. These fish are also evasive and would avoid stress conditions.

None of the fish found deposit bouyant eggs that could drift into the discharge plume.

The catfish, sunfish and bass prepare nests in coarse sand, gravel or stone substrate material or deposit eggs in substrate crevices. In the case of the catfish, the eggs are adhesive and cemented to substrate surfaces. The bottom under the area of inundation by the plume is soft, and eggs would not be deposited in such materials.

Suckers spawn in riffles over gravel. The nearest sucker spawning ground to the discharge would be about a mile above the discharge.

The minnows present scatter adhesive eggs over vegetation and hard substrate materials. Such an area is found at the head of Shelley Island but not in the area of the discharge plume.

The walleye spawns in shoal water on the edges of bars, or on hard or gravel bottoms. Such bottom conditions are not found under the plume area.

The muskellunge is not known to reproduce in the Susquehanna River (though it may do so) where it has been stocked. In its native haunts the muskellunge scatter their eggs along a shoreline for several hundred yards in water six to thirty inches deep. The shoreline nearest the discharge plume is the western shore of Three Mile Island. This shoreline has a steep angle of repose and is not suited to muskellunge spawning.

In their larval stage the young of the fish species collected seek shelter in shoal waters or in aquatic vegetation. The discharge plume will not inundate any such nursery grounds.

The fish sampling stations in the center channel were above and below the proposed discharge and roughly approximate the sampling sites for bottom organisms. All 19 species were found at the upper station while 15 species were found at the lower station. For the fish the coefficient of similarity between the two stations was 0.789; much higher than that found for the bottom organisms. This reflects the ranging capacity of fish as compared to invertebrate animals. Obviously such life forms could avoid a discrete slug of water such as the discharge plume if they found the water of the plume irritating.

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14. A memorandum from G. H. Whipple to John G. Miller, GPU Service Corporation relative to a report prepared by Millersville State College personnel titled: Biological and Chemical Survey of the Three Mile Island Area, a Report to the Metropolitan Edison Company. Dated June 7, 1972.

RESPONSE TO EPA COMMENTS ON THERMAL EFFECTS

The draft statement indicates that blowdown temperature (we prefer to designate this M.D. cooling tower effluent or discharge) will, in general, be approximately equal to the ambient river temperature during most of the year and no greater than 3°F above ambient during the winter months. This is not a correct statement and was corrected by Metropolitan Edison Company's letter of August 28, 1972, to reflect the wording "maximum" to "average" in Item 3b of the Summary and Conclusions.

Table 3.7-1 of the Environmental Report tabulates a winter intake temperature of 39.3°F and an average winter discharge temperature of 41.5°F[(1)]. The footnote [(1)] states "Based upon <u>average</u> winter wet bulb temperature of 28.1°F and <u>average</u> winter river temperature of 39.3°F". It can only be concluded from these two (2) average temperatures that the difference or rise is an average value.

On page 5.1-3 of the Environmental Report is stated - "A sudden warm day in winter (with a very cold river) or extremely cold weather will preclude effective tower operation". On such a sudden warm day in winter, tower operation could <u>add</u> additional heat and operation would be terminated for a few hours until air ambient temperatures would again provide some cooling. This statement was specifically included in the Environmental Report to denote the extreme of weather variation over which one has no control.

Average river and discharge temperatures have been provided in the Environmental Report to best understand the effectiveness of the mechanical draft towers. It should be understood that several variables exist in the tower operation in a given day and often in varying directions. Ambient air temperature may cycle 30°F in a 28 hour period while the river ambient lags and cycles through a lesser total temperature variation. Cloud cover or the absence thereof, also affects river temperature. Since the tower discharge is a function of both inlet temperature to the tower (which is a function of river temperature) and air ambient (wet bulb), the tower may discharge both above and below river ambient in that 24 hour period. Secondly, the weather may tend to become progressively warmer (or colder) over several days duration with the river naturally tracking but lagging the air temperature. (During very cold winter weather, the river temperature tends to be more stabilized in a 33° - 41° range.) Hence, cycling variation in both air and river temperature occur daily and further vary in several day trends. It is thus impractical to define a "normal" variation of discharge vs. river temperature.

A description of the planned operation of the tower would be helpful to further understand tower capability in summer and winter together with temperature variation and durations.

During summertime, the towers will be operated manually. Under normal operation, the towers have the capability to reduce the discharge to river ambient and can produce 5 - 8°F colder discharge on an average weather/river basis. The operator will, however, try to match the discharge to river ambient by varying fan speed or by shutting off any combination of three (3) fans per tower. Under cooldown conditions, the tower capability is adequate to prevent the discharge from exceeding 87°F. On an average river/air basis, the discharge could be 2° higher than river ambient in a 75 - 80° discharge range during cooldown. Since the Susquehanna River is not a trout stream, the species of fish present are warm water fish. The low temperature differential obtainable through the use of the cooling towers will have no adverse effect on the fish.

During wintertime, the towers will be operated manually down to 34°F D.B. air temperature. Below 34°F, the towers will be operated automatically to achieve cooling without experiencing freezing in the tower fill. The automation basically senses dry bulb temperature and actuates fan operations of three fans full speed, 3 fans half speed, two fans half speed, one fan half speed, all fans off with water free falling over the fill. A few degrees may be sacrificed in the automatic mode to preclude freezing. Wintertime normal operation will provide discharge water 3°F (average) higher than river ambient on an average river/air basis above 4°F D.B.; this can hardly be considered an appreciable rise. At 4°F, a discharge 7° above river ambient is experienced when all fans are tripped which reduces to 4°F rise with continuing colder weather. In the manual mode, it is also possible for the discharge to be several degrees colder than river ambient. The maximum rise that can be achieved during normal operation in winter is approximately 10°F with both plants operating with the M.D. towers ineffective due to a postulated river/weather extreme mismatch and it is considered reasonable to expect these to come back into a more natural balance in 6 - 12 hours. At the beginning of cooldown in winter, the towers will discharge water, an average of 12°F higher than river ambient, and this will reduce to 2°F differential in 12 hours. (If only one unit is cooling down with the other at normal operation, the mixture from both towers is 8°F instead of 12°F - this will be the usual probability.) At the beginning of cooldown, the heat rise through the delay heat coolers can reach 36°F; selecting a freak winter warm day (March 23, 1966 - 50°F river and 67°F D.B.), the tower serving the cooldown would discharge 69°F water or a 19° rise over river ambient. It should be mentioned that the air temperature dropped as follows in 3 hour intervals following the 67°F D.B. maximum on March 23, 1966 - 56, 50, 47, 44°F. When both the decaying heat load and the dropping air temperature is considered simultaneously, it can be seen that the duration of this condition is a relatively short one. It is also to be noted that cooldown results in a temperature rise as compared with a fossil plant or any power plant with the condensers "operated run-off river". This value is further reduced to 15.2°F difference when the discharge of the cooldown is mixed with the second, normally operating unit.

Winter operation provides an average discharge +3°F above river ambient and with the cooling effect of evaporation on the river surface, this 3°F would be further reduced downstream of the discharge point. It is not an established

fact that this is conducive to fish congregation at the point of discharge at the surface on the shoreline. Further, the temperature change encountered at the beginning of cooldown is a temperature rise; fish are far more tolerant of a sudden temperature increase than decrease. The cooldown over a 12 hour period provides a gradual decrease (from the 36° rise across the decay heat coolers to a 4°F rise or a tower discharge of 15.2°F to 2 - 3°F or less than 1°/hour at the discharge. State and Federal restrictions limit changes to 2°/hour mixed river discharge temperature. It should also be borne in mind that the discharge volume is small as compared to a run of river plant (less than 5 percent).

Throughout the above, no credit is taken for dilution by running spare river water pumps (or systems nor normally running during cooldown). The State of Pennsylvania takes a dim view of dilution and does not consider "dilution the answer to pollution". The State does permit mixing of wastes and considers a heated discharge a waste. Therefore, no attempt will be made to run additional, spare pumps during normal operation to achieve temperature dilution. However, it is permissible to continue to run the secondary services cooling water system during cooldown and this may be done in winter, particularly on the freak warm days.

In all of the above, discharge temperatures measured at the plant discharge are discussed. Both State and Federal restrictions apply to the mixed river discharge temperatures, i.e.: +5°F rise, 87°F max. and 2°F/hr rate of change.

COOLING TOWER EFFLUENT & COOLING WATER PLUME ANALYSIS

IN RESPONSE TO EPA QUESTION ON PLUMES

The objective of this analysis is to determine chlorine and temperature concentrations resulting from the discharge of cooling tower effluent and cooling water from Three Mile Island Nuclear Plant to the Susquehanna River.

The discharge of tower effluent and cooling water fro a normal cooldown condition is to center channel of the Susquehanna River. The plumes resulting under the following conditions were determined:

1. Cooling tower effluent: ΔT = 3.0°F Q = 80.0 cfs

2. Normal cooldown @ t = 0.0 hrs. ΔT = 12.0°F Q = 113 cfs

e. Normal cooldown @ t = 12.0 hrs. ΔT = 3.0°F Q = 113 cfs.

All were computed for the following winter river conditions:

1. Low river flow of 10,000 cfs - 10 yr. avg. flow for December, January, and February center channel flow is 2700 cfs.

2. Natural river water temperature of 38°F.

Initial chlorine concentration at point of discharge was taken to be 0.30 ppm.

The technique utilized to determine the extent of the plumes is based on a widely accepted method of analysis* of turbulent mixing of a horizontal jet discharged at the surface of the receiving water body. Concentrations of substances throughout the plume are determined assuming they are conserved. Therefore, the results of the analysis are conservative. Reductions in concentration are accomplished solely by dilution which results from the entrainment of ambient water into the turbulent jet. Jet trajectory is determined by vectorially summing jet and river water velocities.

Cooling tower effluent is discharged continuously and, therefore, the plume shown in Figure 1 represents steady state conditions. The magnitude of the plume may be described in terms of the dimensions of the river and island. At the point of discharge the river is 1200 ft. wide, while the

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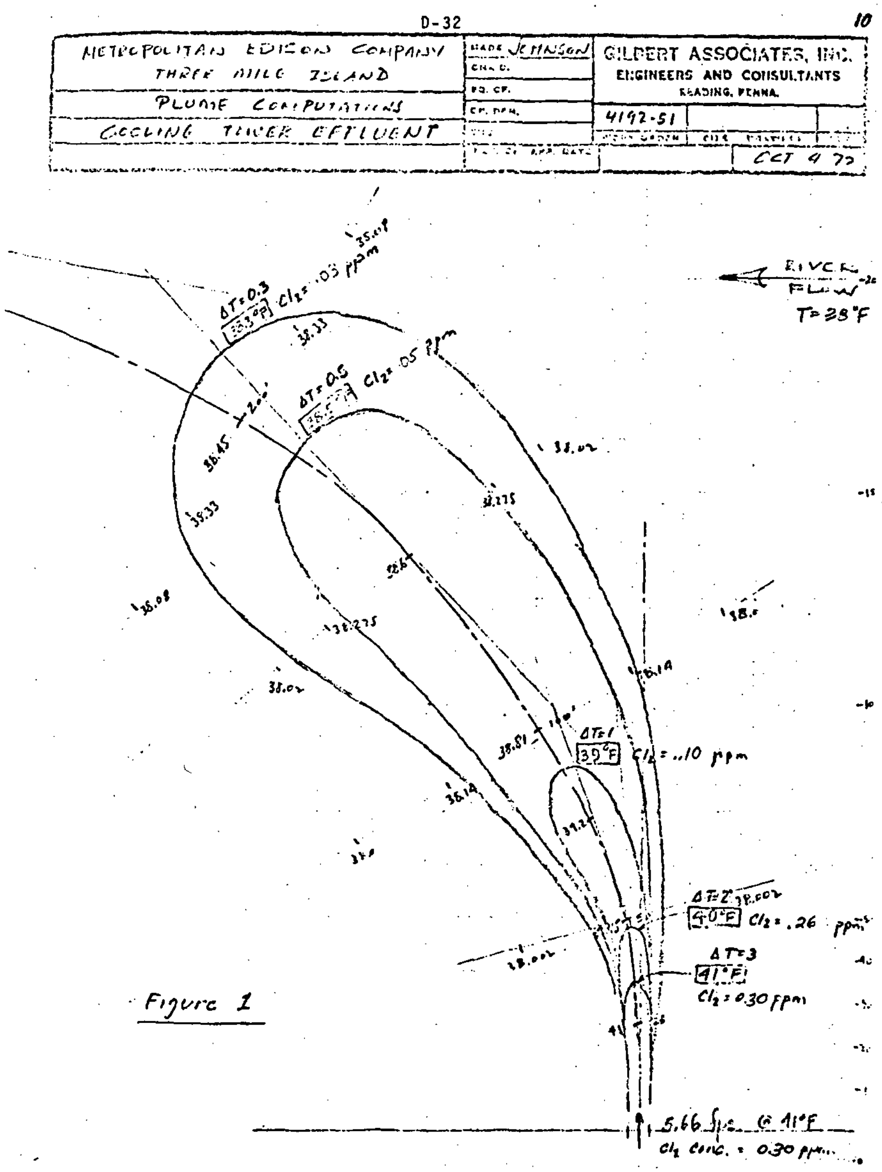
* Jen, Y., Wiegel, R. L., and Mobarek, I., "Surface Discharge of Horizontal Warm Water Jet," Journal of the power Division, A.S.C.E., Vol. 92, No. PO2, Proc. Paper 4801, April 1966, pp. 1-28.

plume, as defined by the 10 dilution contour, projects only 200 ft. into th river. The plume extends downstream about 120 ft. as compared to the length of Three Mile Island which is about 12,000 ft. The conditions of cooldown are, however, time dependent. The plumes resulting from these transient conditions are presented in Figures 2 and 3. Initially the cooldown flow is at a ΔT of 12.0°F (Figure 2). This temperature reduces to 3°F within 12 hrs. (Figure 3). The plumes under these conditions are not significantly larger than the tower effluent plume. The plume extends about 225 ft. into the river and about 220 ft. downstream.

It can be seen in reviewing Figure 1 that substances will undergo 10 dilutions in about 220 ft. of plume travel. The cooling water discharge at a ΔT = 12°F (Figure 2) reaches 10 dilutions after about 300 ft. of travel. The cooling water discharge at a ΔT of 3°F (Figure 3) reaches 10 dilutions after about 250 ft. of travel.


10
METROPOLITAN EDISON COMPANY
THREE MILE ISLAND
PLUME COMPUTATIONS
COOLING TOWER EFFLUENT
MADE JOHNSON
GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PENNA.
4192-51
OCT 4 72
RIVER FLOW
T=38°F
ΔT=0.3
38.3°F
Cl2=.03 ppm
ΔT=0.5
38.5°F
Cl2=.05 ppm
ΔT=1
39°F
Cl2=.10 ppm
ΔT=2
40°F
Cl2=.26 ppm
ΔT=3
41°F
Cl2=0.30 ppm
5.66 fps @ 41°F
Cl2 conc. = 0.30 ppm
Figure 1

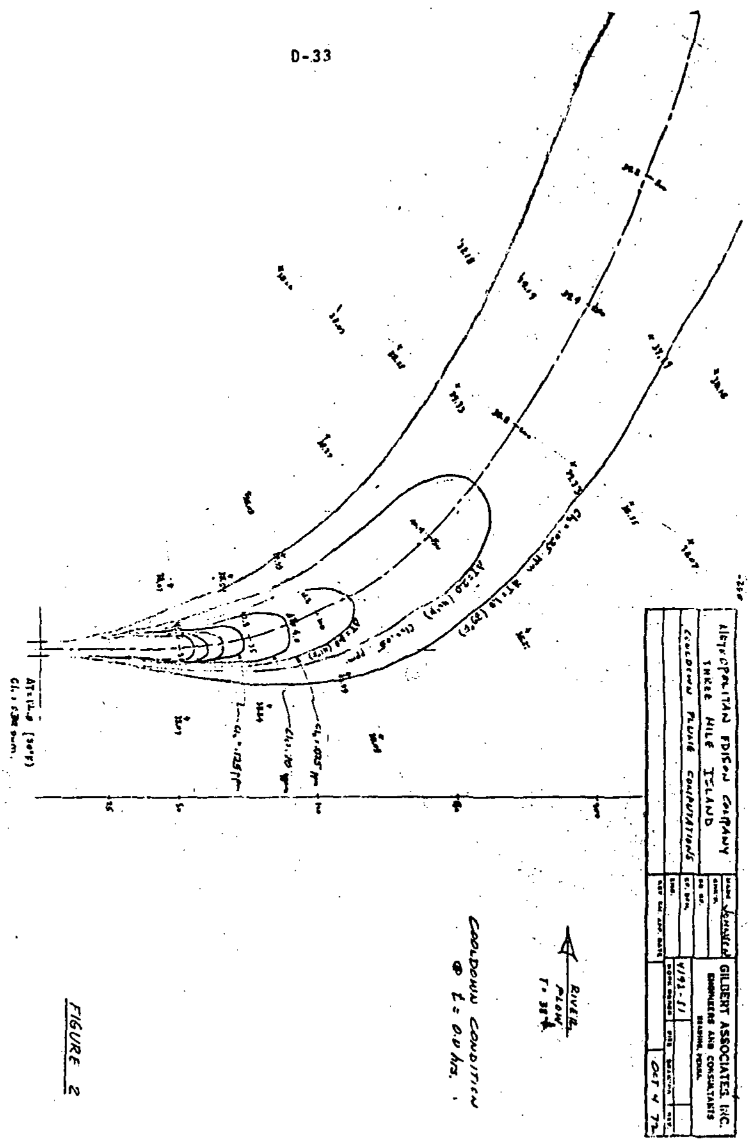


FIGURE 2

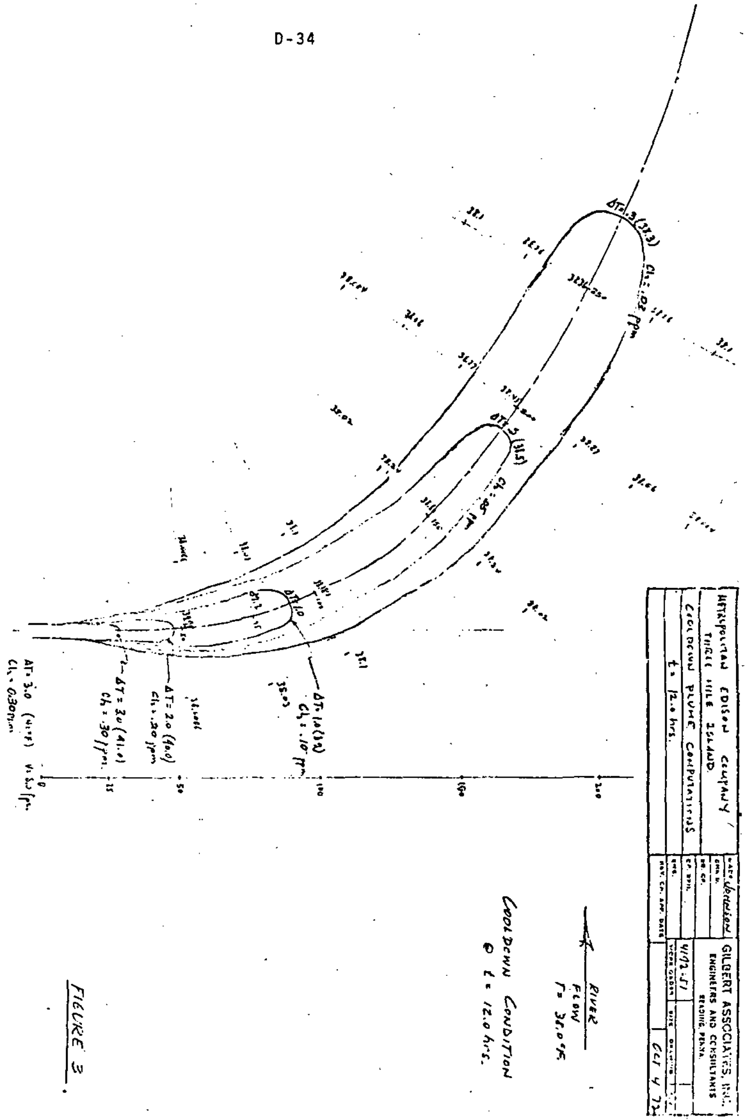


FIGURE 3

ENTRAINMENT AND IMPINGEMENT EFFECTS - EPA QUESTION

The applicant has performed a study to determine intake velocities under various adverse conditions. The results of the study are as follows:

1. Low river water level - normal plant operation = .2 fps.
2. Loss of Yorkhaven Dam - normal plant operation = .3 fps.
3. Cooldown flow - normal plant cooldown = .25 fps.
4. Cooldown flow - Loss of Yorkhaven Dam = .4 fps.

It can be seen that even during extreme conditions the intake velocities experienced are still very low. The biological studies performed on the river have shown that the intake structure is not located in the spawning grounds for any species of fish in the Yorkhaven pool. In addition, the fish study has shown that the species of fish found in the pool do not lay buoyant eggs. When the eggs hatch the larvae will remain in the vicinity of the nests in shoal water.

RESPONSE TO EPA COMMENT ON BIRD KILLS

After three years experience with Unit 1, natural draft towers, and two years with Unit 2, no evidence of bird kills have been reported by the plant operating staff. If such had occurred, one would expect to find the remains on the canopy joining shell and fill neck; no dead birds were found.

APPENDIX C

BIOTA COLLECTED IN THE VICINITY OF THREE MILE ISLAND NUCLEAR STATION

APPENDIX C

BIOTA COLLECTED IN THE VICINITY OF THREE MILE ISLAND NUCLEAR STATION

TABLE C-1

Phytoplankton taken in the Susquehanna River at TMINS from April through July 1974

CHLOROPHYTA
- Volvocales
  - Chlamydomonadaceae
    - *Chlamydomonas* spp.
  - Volvocaceae
    - *Eudorinia elegans*
    - *Gonium* sp.
    - *Pandorina morum*
  - Spondylomoraceae
    - *Pyrobotrys gracilis*
- Tetrasporales
  - Palmellaceae
    - *Spaerocystis schroeteri*
- Chlorococcales
  - Chlorococcaceae
    - *Chlorococcum* sp.
  - Micratiniaceae
    - *Golenkinia radiata*
    - *Micractinium pusillum*
  - Dictyosphaeriaceae
    - *Dictyosphaerium pulchellum*
    - *Dimorphococcus lunatus*
  - Characiaceae
    - *Charcium* sp.
    - *Schroederia setigera*
  - Hydrodictyaceae
    - *Pediastrum biradiatum*
    - *P. boryanum*
    - *P. duplex*
    - *P. simplex*
    - *P. tetras*
  - Coelastraceae
    - *Coelastrum sphaericum*
  - Botryococcaceae
    - *Botryococcus braunii*
  - Oöcystaceae
    - *Ankistrodesmus falcatus*
    - *Chlorella vulgaris*
    - *Chlorella* sp.
    - *Closteriopsis longissima*
    - *Franceia droescheri*
    - *Kirchneriella contorta*
    - *K. obesa*
    - *Kirchneriella* sp.
    - *Lagerheimia ciliata*
    - *L. quadriseta*
    - *L. subsalsa*
    - *Oöcystis* spp.
    - *Quadrigula lacustris*
    - *Quadrigula* sp.
    - *Selenustrum gracile*
    - *S. minutum*
    - *Tetraëdron caudatum*
    - *T. trigonum*
    - *Tetraëdron* sp.
    - *Treubaria triappendiculata*
    - *Treubaria* sp.
  - Scenedesmaceae
    - *Actinastrum hantzschii*
    - *Crucigenia* sp.
    - *Scenedesmus acuminatus*
    - *S. bernardii*
    - *S. bijuga*
    - *S. denticulatus*
    - *S. dimorphus*
    - *S. opoliensis*
    - *S. quadricauda*
    - *Tetrallantos lagerheimii*
    - *Tetrastrum elegans*
    - *Tetrastrum* sp.
    - *T. heterocanthum*
    - *T. staurogeniaeforme*
- Zygnematales
  - Desmidiaceae
    - *Closterium* sp.
    - *Cosmarium* sp.
    - *Staurastrum curvatum*
    - *S. natator*
    - *Staurastrum* sp.

EUGLENOPHYTA
- Euglenales
  - Euglenaceae
    - *Euglena* sp.
    - *Phacus* sp.

CHRYSOPHYTA
- Heterococcales
  - Gloeobotrydiaceae
    - *Gloeobotrys limnetica*
- Chrysomonadales
  - Ochromonadaceae
    - *Dinobryon* sp.

BACILLARIOPHYTA
- Centrales
  - Coscinodisaceae
    - *Coscinodiscus subtilis*
    - *Cyclotella* spp.
    - *Melosira* spp.
    - *Stephanodiscus* spp.
- Pennales
  - Tabellariaceae
    - *Tabellaria fenestrata*
  - Meridionaceae
    - *Meridion circulare*
  - Diatomaceae
    - *Diatoma* sp.
  - Fragilariaceae
    - *Asterionella formosa*
    - *Fragilaria crotonensis*
    - *Fragilaria* sp.
    - *Synedra* spp.
  - Eunotiaceae
    - *Ceratoneis arcus*

TABLE C-1 (Continued)

BACILLARIOPHYTA (cont.)
- Achnanthaceae
  - *Cocconeis* sp.
  - *Rhoicosphenia curvata*
- Naviculaceae
  - *Amphipleura* sp.
  - *Frustulia* sp.
  - *Gyrosigma* sp.
  - *Navicula* spp.
- Gomphonemataceae
  - *Gomphonema* sp.
- Cymbellaceae
  - *Amphora* sp.
  - *Cymbella* sp.
- Nitzschiaceae
  - *Nitzschia* spp.
- Surirellaceae
  - *Suriella* spp.

PYRROPHYTA
- Gymnodiniales
  - Gymnodiniaceae
    - *Gymnodinium* sp.
- Dinocapsales
  - Gloeodiniaceae
    - *Gloedinium montanum*

CYANOPHYTA
- Chroococcales
  - *Agmenellum* sp.
  - *Anacystis* spp.
  - *Coelosphaerium kuetzingianum*
  - *C. naegelianum*
  - *Gomphosphaeria lacustris*
- Oscillatoriales
  - Oscillatoriaceae
    - *Lyngbya* sp.
    - *Oscillatoria* spp.
    - *Spirulina* sp.
  - Nostocaceae
    - *Anabaena* sp.

TABLE C-2

List of zooplankton and other invertebrates collected at the TMINS Unit 1 Intake and Discharge during entrainment studies from April through October 1974

- Protozoa
  - Scarcomastigophora
    - Rhizopoda
  - Ciliophora
    - Ciliata
- Nemata
- Rotifera
  - Bdelloidea
    - *Rotaria* sp.
  - Mongonata
    - *Brachionus* sp.
    - *B. angularis*
    - *B. bennini*
    - *B. bidentata*
    - *B. budapestinensis*
    - *B. calyciflorus*
    - *B. caudatus*
    - *B. havanaensis*
    - *B. nilsoni*
    - *B. plicatilis*
    - *B. quadridentatus*
    - *Euchlanis* sp.
    - *Kellicottia bostoniensis*
    - *K. longispina*
    - *Keratella cochlearis*
    - *K. quadrata*
    - *K. valga*
    - *Notholca* sp.
    - *Platyias patulus*
    - *Trichotria* sp.
    - *Lecane* sp.
    - *Cephalodella* sp.
    - *Notommata* sp.
    - *Trichocerca* sp.
    - *Gastropus* sp.
    - *Asplanchna* sp.
    - *Polyarthra* sp.
    - *Filinia* sp.
    - *Testudinella* sp.
    - *Ptygura* sp.
    - *Conochiloides* sp.
- Bryozoa
  - *Urnatella gracilis*
- Tardigrada
  - *Hypsibius* sp.
- Annelida
  - Oligochaeta
- Arthropoda
  - Crustacea
    - Cladocera
      - *Diaphanosoma brachyurum*
      - *D. leuchtenbergianum*
      - *Latona setifera*
      - *Ceriodaphnia quadrangula*
      - *Daphnia parvula*
      - *Moina affinis*
      - *M. brachyurum*
      - *Scapholeberis kingi*
      - *Simocephalus serrulatus*
      - *Bosmina longirostris*
      - *Ilyocryptus sordidus*
      - *I. spinifer*
      - *Macrothris laticornis*
      - *Alona* spp.
      - *A. affinis*
      - *A. guttata*
      - *Chydorus sphaericus*
      - *Leydigia quadrangularis*
      - *Pleuroxus denticulatus*
      - *P. hamulatus*
    - Ostracoda
    - Copepoda
      - Calanoida
        - *Diaptomus pallidus*
      - Harpacticoida
        - *Attheyella illinoisensis*
        - *Canthocamptus* sp.
        - *Elaphoidella bidens coronata*
      - Cyclopoida
        - *Cyclops bicuspidatus thomasi*
        - *C. vernalis*
        - *Eucyclops* sp.
        - *E. agilis*
        - *E. prionophorus*
        - *E. speratus*
        - *Macrocyclops* sp.
        - *Paracyclops affinis*
        - *P. fimbriatus*
        - *Tropocyclops prasinus*
    - Amphipoda
      - *Gammarus* sp.
    - Hydracarina
  - Insecta
    - Ephemeroptera
    - Trichoptera
    - Diptera
      - Chironimidae
      - Chaobridae
        - *Chaoborus* sp.
- Mollusca
  - Gastropoda

TABLE C-3

A list of scientific and common names of larval fishes taken at the TMINS during 1974 (names according to Bailey et al, 1970).

Scientific Name	Common Name
Cyprinidae	Minnow family
Carassius auratus (Linnaeus)	Goldfish
Cyprinus carpio (Linnaeus)	Carp
Notemigonus cyrsoleucas (Mitchill)	Golden shiner
Notropis hudsonius (Clinton)	Spottail shiner
Notropis spilopterus (Cope)	Spotfin shiner
Notropis spp.	Shinner species
Catostomidae	Sucker family
Carpiodes cyprinus (Lesueur)	Quillback
Catostomus commersoni (Lacepede)	White sucker
Moxostoma macrolepidotum (Lesueur)	Shorthead redhorse
Hypentelium nigricans (Lesueur)	Northern Hog sucker
Ictaluridae	Catfish family
Ictalurus punctatus (Rafinesque)	Channel catfish
Noturus insignis (Richardson)	Margined madtom
Centrarchidae	Sunfish family
Ambloplites rupestris (Rafinesque)	Rock bass
Lepomis spp.	Sunfish species
Micropterus dolomieui (Lacepede)	Smallmouth bass
Percidae	Perch family
Etheostoma olmstedi (Storer)	Tessellated darter
Etheostoma zonale (Cope)	Banded darter
Etheostoma spp.	Darter species
Perca flavescens (Mitchill)	Yellow perch
Percina peltata (Stauffer)	Shield darter
Stizostedion vitreum	Walleye

Bailey, R. M., J. E. Fitch, E. S. Herald, E. A. Lachner, C. C. Lindsey, C. R. Robins, and W. B. Scott, 1970. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication No. 6. 150 p.

TABLE C-4

Macroinvertebrates taken from the Susquehanna River in the vicinity of Three Mile Island, April through October 1974.

Platyhelminthes (Flatworms)
  Tricladida
    Planariidae
      Dugesia tigrina

Annelida
  Tubificidae (Sludge worms)
    Branchiura sowerbyi
    Limnodrilus cervix
    L. claparedianus
    L. hoffmeisteri
    L. profundicola
    L. udekemianus
    Peloscolex ferox
    P. multisetosus
    Tubifex sp.
Hirudinea (Leeches)
  Rhynchobdellida
    Glossiphonidae
      Helobdella sp.
  Pharyngobdellida
    Erpodellidae
      Erpobdella punctata

Arthropoda
  Amphipoda (Scuds)
    Gammaridae
      Gammarus fasciatus
  Decapoda (Crayfish)
    Astacidae
      Orconectes obscurus
  Hydracarina (Water Mites)
Insecta
  Ephemeroptera (Mayflies)
    Baetiscidae
      Baetisca sp.
    Ephemeridae
      Hexagenia sp.
    Ephererellidae
      Ephemerella sp.
    Heptageniidae
      Stenonema sp.
  Odonata (Dragonflies and Damselflies)
    Gomphidae
      Dromogomphus submedianus
      Gomphus submedianus
    Libellulidae
      Macromia illinoiensis
    Agrionidae
      Hetaerina sp.

Odonata (Cont.)
  Coenagrionidae
    Argia sp.
Plecoptera (Stoneflies)
  Perlidae
Neuroptera
  Corydalidae
    Corydalus sp.
  Sialidae
    Sialis sp.
Trichoptera (Caddisflies)
  Psychomyiidae
    Nereclipsis sp.
  Hydropsychidae
    Hydropsyche sp.
    Macronemum sp.
Coleoptera
  Chrysomelidae (Leaf beetles)
    Donacia sp.
  Hydrophilidae (Water scavenger beetle)
    Berosus sp.
  Elmidae (Riffle beetle)
    Dubiraphia sp.
    Stenelmis sp.
    Stenelmis decorata
Diptera
  Psychodidae (Mothflies)
    Pericoma sp.
  Culicidae (Mosquitoes and Phantom midges)
    Aedes sp.
    Chaoborus punctipennis
  Chironomidae (Nonbiting midges)

  Tanypodinae
    Ablabesmyia sp.
    Coeltanypus concinnus
    Procladius sp.
    Tanypus sp.
  Chironominae
    Chironomus sp.
    Cryptochironomus sp.
    Parachironomus sp.
    Paracladopelma sp.
    Polypediium sp.
  Orthocladiinae
    Cricotopus sp.
  Ceratopogonidae (Biting midges)

Mollusca
  Basommatophora
    Physidae (Pouch Snails)
      Physa integra
    Planorbidae (Orb snails)
      Helisoma sp.
  Mesogastropoda
    Pleuroceridae (River snails)
      Goniobasis sp.
  Eulamellibranchia
    Unionidae (Freshwater mussels)
      Elliptio complanatus
      Lampsilis sp.
  Heterodonta
    Sphaeriidae (Fingernail clams)
      Pisidium sp.
      Sphaerium sp.

TABLE C-5

List of common and scientific names of fishes observed in the Susquehanna River in the vicinity of TMINS. (Names according to Bailey, et al, 1970).

Common Name	Scientific Name
Fresh water eels	Anguillidae
American eel	Anguilla rostrata (Lesueur)
Trouts	Salmonidae
Brown trout	Salmo trutta Linnaeus
Pikes	Esociade
Muskellunge	Esox masquinongy Mitchill
Minnows and Carps	Cyprinidae
Goldfish	Carassius auratus (Linnaeus)
Carp	Cyprinus carpio Linnaeus
Cutlips minnow	Exoglossum maxillingua (Lesueur)
River chub	Nocomis micropogon (Cope)
Golden shiner	Notemigonus crysoleucas (Mitchill)
Comely shiner	Notropis amoenus (Abbott)
Common shiner	Notropis cornutus (Mitchill)
Spottail shiner	Notropis hudsonius (Clinton)
Swallowtail shiner	Notropis procne (Cope)
Spotfin shiner	Notropis spilopterus (Cope)
Bluntnose minnow	Pimephales notatus (Rafinesque)
Blacknose dace	Rhinichthys atratulus (Hermann)
Longnose dace	Rhinichthys cataractae (Valenciennes)
Creek chub	Semotilus atromaculatus (Mitchill)
Fallfish	Semotilus corporalis (Mitchill)
Suckers	Catostomidae
Quillback	Carpiodes cyprinus (Lesueur)
White sucker	Catostomus commersoni (Lacepede)
Northern hog sucker	Hypentelium nigricans (Lesueur)
Shorthead redhorse	Moxostoma macrolepidotum (Lesueur)
Fresh water catfishes	Ictaluridae
White catfish	Ictalurus catus (Linnaeus)
Yellow bullhead	Ictalurus natalis (Lesueur)
Brown bullhead	Ictalurus nebulosus (Lesueur)
Channel catfish	Ictalurus punctatus (Rafinesque)
Margined madtom	Noturus insignis (Richardson)
Sunfishes	Centrarchidae
Rock bass	Ambloplites rupestris (Rafinesque)
Redbreast sunfish	Lepomis auritus (Linnaeus)
Green sunfish	Lepomis cyanellus Rafinesque
Pumpkinseed	Lepomis gibbosus (Linnaeus)
Bluegill	Lepomis machrochirus Rafinesque
Smallmouth bass	Micropterus dolomieui (Lacepede
Largemouth bass	Micropterus salmoides (Lacepede)
White crappie	Pomoxis annularis Rafinesque
Black crappie	Pomoxis nigromaculatus (Lesueur)

TABLE C-5 (Continued)

Common Name	Scientific Name
Perches	Percidae
Tessellated darter	*Etheostoma olmstedi* Storer
Banded darter	*Etheostoma zonale* (Cope)
Yellow perch	*Perca flavescens* (Mitchill)
Shield darter	*Percina peltata* (Stauffer)
Walleye	*Stizostedion vitreum vitreum* (Mitchill)

Bailey, R. M., J. E. Fitch, E. S. Herald, E. A. Lachner, C. C. Lindsey, C. R. Robins, and W. B. Scott, 1970. A list of common and scientific names of fishes from the United States and Canada. American Fisheries Society Special Publication No. 6. 150 p.

APPENDIX D. NEPA POPULATION DOSE ASSESSMENT

Population dose commitments are calculated for all individuals living within 50 miles of the facility employing the same models used for individual doses (see Regulatory Guide 1.109). In addition, population doses associated with the export of food crops produced within the 50-mile region and the atmospheric and hydrospheric transport of the more mobile effluent species, such as noble gases, tritium, and carbon-14, have been considered.

Noble Gas Effluents

For locations within 50 miles of the reactor facility, exposures to these effluents are calculated using the atmospheric dispersion models in Regulatory Guide 1.111 and the dose models described in Section 5.1 and Regulatory Guide 1.109. Beyond 50 miles, and until the effluent reaches the northeastern corner of the United States, it is assumed that all the noble gases are dispersed uniformly in the lowest 1,000 meters of the atmosphere. Decay in transit was also considered. Beyond this point, noble gases having a half-life greater than one year (e.g., Kr-85) were assumed to completely mix in the troposphere of the world with no removal mechanisms operating. Transfer of tropospheric air between the northern and southern hemispheres, although inhibited by wind patterns in the equatorial region, is considered to yield a hemisphere average tropospheric residence time of about two years with respect to hemispheric mixing. Since this time constant is quite short with respect to the expected mid-point of plant life (15 years), mixing in both hemispheres can be assumed for evaluations over the life of the nuclear facility. This additional population dose commitment to the U.S. population was also evaluated.

Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind, which continuously reduces the concentration remaining in the plume. Within 50 miles of the facility, the deposition model in Regulatory Guide 1.111 was used in conjunction with the dose models in Regulatory Guide 1.109. Site-specific data concerning production, transport and consumption of foods within 50 miles of the reactor were used. Beyond 50 miles, the deposition model was extended until no effluent remained in the plume. Excess food not consumed within the 50-mile distance was accounted for, and additional food production and consumption representative of the eastern half of the country was assumed. Doses obtained in this manner were then assumed to be received by the number of individuals living within the direction sector and distance described above. The population density in this sector is taken to be representative of the eastern United States, which is about 160 people per square mile.

Carbon-14 and Tritium Released to the Atmosphere

Carbon-14 and tritium were assumed to disperse without deposition in the same manner as krypton-85 over land. However, they do interact with the oceans. This causes the carbon-14 to be removed with an atmospheric residence time of four to six years with the oceans being the major sink. From this, the equilibrium ratio of the carbon-14 to natural carbon in the atmosphere was determined. This same ratio was then assumed to exist in man so that the dose received by the entire population of the U.S. could be estimated. Tritium was assumed to mix uniformly in the world's hydrosphere, which was assumed to include all the water in the atmosphere and in the upper 70 meters of the oceans. With this model, the equilibrium ratio of tritium to hydrogen in the environment can be calculated. The same ratio was assumed to exist in man, and was used to calculate the population dose, in the same manner as with carbon-14.

Liquid Effluents

Concentrations of effluents in the receiving water within 50 miles of the facility were calculated in the same manner as described above for Appendix I calculations. No depletion of the nuclides present in the receiving water by deposition on the bottom of the Verdigris River was assumed. It was also assumed that aquatic biota concentrate radioactivity in the same manner as was asssumed for the Appendix I evaluation. However, food consumption values appropriate for the average individual, rather than the maximum, were used. It was assumed that all the sport and commercial fish and shellfish caught within the 50-mile area were eaten by the U.S. population.

Beyond 50 miles, it was assumed that all the liquid effluent nuclides except tritium have deposited on the sediments so they make no further contribution to the population exposures. The tritium was assumed to mix uniformly in the world's hydrosphere and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

APPENDIX E

COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA HISTORICAL AND MUSEUM COMMISSION
WILLIAM PENN MEMORIAL MUSEUM AND ARCHIVES BUILDING
BOX 1024
HARRISBURG, PENNSYLVANIA 17120

October 27, 1976

Mr. D. Callahan
Environmental Engineer
GPU Service Corporation
260 Cherry Hill Road
Parsippany, New Jersey 07054

Dear Mr. Callahan:

As far as we can tell the continued operation of the Three Mile Island Nuclear Generating Station will not affect any historic or archaeological site.

Sincerely yours

Vance P. Packard
Office of Historic Preservation

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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