environmental statement

related to the proposed

BYRON STATION
UNITS 1 AND 2

COMMONWEALTH EDISON COMPANY

DOCKET NOS. STN50-454 AND STN 50-455

JULY 1974

UNITED STATES ATOMIC ENERGY COMMISSION
DIRECTORATE OF LICENSING

SUMMARY AND CONCLUSIONS

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

1. This action is administrative.

2. The proposed action is the issuance of construction permits to the Commonwealth Edison Company for the construction of the Byron Station, Units 1 and 2 (Docket Nos. STN 50-454 and STN 50-455), located near the Rock River in Rockvale Township, Ogle County, Illinois.

   Byron Station will employ two pressurized water reactors to produce up to 6850 megawatts thermal (MWt). Two steam turbine-generators will use this heat to provide 2240 MW (net) of electrical power capacity. The exhaust steam will be cooled by closed-cycle cooling using two natural-draft cooling towers. Makeup (92 cfs, avg) will be drawn from and blowdown (44 cfs, avg) will be discharged to the Rock River.

3. Summary of environmental impact and adverse effects:

   a. Approximately 1360 acres of land (970 cropland; 180, pasture; 210, woodland or other) will be removed from production as a result of the construction of the station; of these about 125 acres will be occupied by buildings, facilities, parking lots, etc. In addition, about 90 acres will be required for the construction of the railroad spur and (estimated) 1100 acres will be used for the transmission corridors. (Sec. 4.1.1)

   b. Construction activities will result in heavy traffic on secondary roads; this traffic could cause deterioration of these roads, and may present a safety hazard. (Sec. 4.1.1)

   c. Some erosion will result from the clearing of the transmission corridors. If chemical clearing is used, some damage to the biota will occur. A small amount (estimated to be about 3000 square feet per mile of corridor) of land at the base of the towers will be removed from production. Erection of the towers and stringing of the conductors will present a visual impact. (Sec. 4.1.2)

   d. Transitory siltation of the Rock River will occur during the construction of the river-bank facilities. (Sec. 4.2.2)

e. Minor and temporary impacts to the biota of the station area will result from construction activities. (Sec. 4.3.1)

f. Operation of the station will result in visible plumes from the cooling towers. The towers, the plumes, and the transmission lines will present a visual impact. No significant fogging and icing conditions at ground levels will result from the plumes. (Sec. 5.1.2)

g. The use of natural-draft cooling towers for the dissipation of waste heat requires the consumptive use of up to 60 cfs of Rock River water. (Sec. 5.2)

h. Small quantities of chemicals, heat, and radioactive wastes will be discharged to the Rock River. The maximum withdrawal rate will be 121 cfs; the effluent will be returned at a maximum rate of 60 cfs. The chemicals and heat added to the river will cause no significant impact. (Sec. 5.4)

i. Entrained planktonic organisms which enter the circulating water system will be killed. A maximum loss of these organisms in the river of about 7% will occur for the 7 day 10 year low flow. This is not a severe impact to the river populations and productivity should recover rapidly. (Sec. 5.4.2)

j. Direct impingement of small fish on screens is not expected to be severe, owing to the low approach velocity (0.5 fps) and the location and orientation of the intake structure. (Sec. 5.4.2)

k. Birds migrating along the Rock River valley may collide with the natural-draft towers and the containment structures; occasional mortalities may occur, but major kills are not expected. (Sec. 5.4.1)

l. The risk associated with accidental radiation exposures is very low. (Sec. 7)

m. No significant environmental impacts are anticipated from normal operational releases of radioactive materials within 50 miles. The estimated dose to the offsite population within 50 miles from operation of the station is 21 man-rem/year; this is less than the normal fluctuations in the 137,000 man-rem/year natural background dose this population would receive. (Sec. 5.3.2)

4. Principal alternatives considered:

   a. Purchase of power.

   b. Alternative energy sources.

   c. Alternative sites.

   d. Alternative methods of heat dissipation.

   e. Alternative methods of condenser cleaning.

   f. Alternative transmission systems.

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

   - Advisory Council on Historic Preservation
   - Department of Agriculture
   - Department of the Army, Corps of Engineers
   - Department of Commerce
   - Department of Health, Education and Welfare
   - Department of Housing and Urban Development
   - Department of the Interior
   - Department of Transportation
   - Environmental Protection Agency
   - Federal Power Commission
   - Illinois Institute for Environmental Quality
   - Illinois Department of Public Health
   - Chairman, Ogle County Board of Supervisors

6. This Environmental Statement was made available to the public and to the Council on Environmental Quality in addition to the above specified agencies in February, 1974.

7. On the basis of the analysis and evaluation set forth in this statement, after weighing the environmental, economic, technical and other benefits of the Byron Nuclear Station, Units 1 and 2, against environmental and other costs and considering available alternatives, the staff concluded that the action called for under the National Environmental Policy Act of 1969 (NEPA) and Appendix D to 10 CFR Part 50 is the issuance of construction permits for the facility subject to the following conditions for the protection of the environment:

    a. The applicant shall take the necessary mitigating actions, including those summarized in Section 4.5 of this Environmental Statement, during construction of the station and associated transmission lines to avoid unnecessary adverse environmental impacts from construction activities.

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

    c. A control program shall be established by the applicant to provide for a periodic review of all construction activities to assure that those activities conform to the environmental conditions set forth in the construction permit.

    d. Before engaging in a construction activity which may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this Environmental Statement, the applicant shall provide written notification to the Director of Licensing.

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

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FOREWORD

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

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

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

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

(i) the environmental impact of the proposed action,

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

(iii) alternatives to the proposed action,

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

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

An environmental report accompanies each application for a construction permit or a full-power 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 50.

This evaluation leads to the publication of a draft environmental statement, prepared by the Directorate of Licensing, which is then circulated to Federal, State and local governmental agencies for comment. 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 requested to comment on the proposed action and the draft statement.

After receipt and consideration of comments on the draft statement, the staff prepares a final environmental statement, which includes a discussion of 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.

Single copies of this statement may be obtained by writing the Deputy Director for Reactor Projects, Directorate of Licensing, U. S. Atomic Energy Commission, Washington, D. C. 20545. Dr. DeVaughn Nelson is the AEC Environmental Project Manager for this statement. (301-443-6980).

1. INTRODUCTION

1.1 THE PROPOSED PROJECT

The Commonwealth Edison Company has applied for a Construction Permit for the Byron Station, Units 1 and 2. The proposed site of the station is in a rural area two and a half miles east of the Rock River and three miles south-southwest of Byron, in Rockvale Township, Ogle County, Illinois. Units 1 and 2 will use identical Westinghouse pressurized-water reactors, rated at 3425 megawatts thermal (MWt), to produce steam to drive turbine generators and yield a net output of 1120 megawatts electrical (MWe) each.

The units will dissipate the waste or excess heat release by the condensation of the steam with water drawn from the Rock River and recirculated in a closed-cycle system. The closed-cycle cooling system will consist of one natural-draft cooling tower per unit which transfers the excess heat to the atmosphere. The maximum temperature rise of the water passing through the condenser is expected to be about 24°F. The maximum temperature elevation of the station's blowdown above ambient river temperature was calculated to be 45°F, occurring in March and April. The seasonal average temperature elevations are: 25°F (winter), 14°F (spring), 8°F (summer) and 21°F (fall). In all cases, the excess heat will be dissipated within a mixing zone sufficiently small to comply with the State of Illinois regulations.

The monthly average evaporation rates for the two natural-draft towers are estimated to range between 37 and 60 cubic feet per second (cfs), depending on weather conditions. The losses due to drift are expected to be about 1 cfs. The blowdown necessary to maintain water quality, based on these evaporative and drift losses, is calculated to range between 41 and 56 cfs. To compensate for evaporation, drift, and blowdown, makeup water will be drawn from the Rock River at a rate ranging between 83 and 121 cfs.

The applicant's plans called for construction operations to begin in mid-1974 with Unit 1 ready for commercial operation in May 1980 and Unit 2 in May 1981 (Ref. 1, Fig. 4.1-1).

On January 14, 1974, the applicant was granted an exemption to allow rock grouting of a 3.7-acre area which was requested by letter dated December 17, 1973. The basis for the exemption may be found in "Discussion and Findings by the Directorate of Licensing, U. S. Atomic Energy Commission, Relating to an Application for an Exemption from Licensing for Certain Site Preparation Activities at the Byron Station, Units 1 and 2, Prior to the Completion of the NEPA Environmental Review, AEC Docket Nos. STN 50-454 and STN 50-455, January 11, 1974." (See Appendix D)

Major documents used in the preparation of the staff environmental statement were the applicant's Preliminary Safety Analysis Report, Environmental Reports, and supplements thereto issued for both the Byron and Braidwood nuclear generating stations.

Independent calculations and sources of information were also used as a basis for the assessment of environmental impact. In addition, some of the information was gained from visits by the staff to the Byron site and surrounding areas in October 1973.

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

1.2 STATUS OF REVIEWS AND APPROVALS

A listing of applications filed by the applicant to obtain permits and licenses from various governing bodies or agencies is given in Table 1.1. The current status of each application is given, when known.

References

1. Commonwealth Edison Co., "Bryon Station, Environmental Report," including insertions, Vol. 1 and 2, Docket Nos. STN 50-454 and STN 50-455, Sept 13, 1973.

TABLE 1.1. Licenses and Permits for the Byron Station*

Agency	*Permit Required* Description	*Permit Required* Authority	*Purpose of Action*	*Date (or estimated date) of Submission*	*Date Granted or Status*
U. S. Atomic Energy Commission	Construction Permit	Atomic Energy Act of 1954; 10CFR50	Construct Units 1 and 2	Feb. 26, 1973	Action pending**
	By-product License	10CFR30	Possess nuclear by-products prior to operation	Late 1975	
	Materials License	10CFR70	Possess special nuclear materials prior to operation	Mid 1978	
	Operating License	Atomic Energy Act 1954; 10CFR50	Operate Units 1 and 2 (Submit FSAR and update ER)	Early 1977	
U. S. Army Corps of Engineers	Construction Permit	River and Harbor Act of 1899	Construct intake and discharge structures in Rock River	May 1, 1974	
U. S. Environmental Protection Agency	Discharge Permit	Fed. Water Pol Control Act, amended 1972	Discharge of waste water	Oct. 1, 1974	
Federal Aviation Administration	Approval	Civil Aeronautics Act of 1938 as amended	Construction of meteorological tower	Feb. 2, 1973	Granted for the*** period Sept. 1, 1973 to April 16, 1974
			Construction of cooling towers	Feb. 2, 1973	Granted for the period May 7, 1973-Dec. 16, 1974

TABLE 1.1. (Cont'd)

Agency	Permit Required: Description	Permit Required: Authority	Purpose of Action	Date (or estimated date) of Submission	Date Granted or Status
Ill. Commerce Commission	Certificate of Public Convenience and Necessity	Ill. Public Utilities Act, 1969	Construct, operate and Monitor Units 1 and 2	Dec. 26, 1972	July 11, 1973
	Construction Permit	Ill. Public Utilities Act, 1969	Construct transmission lines in ROW corridors	Future	
Ill. Environmental Protection Agency	Construction Permit	Environmental Protection Act 1971	Construct Units 1 and 2, sewage plant reservoir, etc.	Mar. 1974	
	Operating Permit for Discharges	Environmental Protection Act 1971	Operate water-treatment facilities	June 1, 1974	
	Construction and Operating Permits	Environmental Protection Act 1971	Construct and operate standby boilers and diesel-generators	Future	
Ill. Dept. of Transportation	Construction Permit	Ill. Commerce Act 1911	Construct intake and discharge structures in Rock River	May 1, 1974	
Ill. Dept. of Mines and Minerals	Permit	Ill. Act of July 1941	Drilling water wells	May 1974	

TABLE 1.1. (Cont'd)

Agency	Permit Required: Description	Permit Required: Authority	Purpose of Action	Date (or estimated date) of Submission	Date Granted or Status
Ill. Dept. of Aeronautics	Permit	Ill. Rev. Stat. 1971	Construction of meteorological tower	Jan. 26, 1973	Granted Mar. 6, 1973
			Construction of cooling towers	Jan. 26, 1973	Granted May 16, 1973

*Modified from the applicant's Environmental Report.
**An exemption from licensing for certain site preparation activities was granted on Jan. 14, 1974.
***An application for 18 month extension has been filed.

2. THE SITE

2.1 LOCATION OF THE STATION

Figure 2.1 shows a map of the northern Illinois area around the proposed site of the Byron Station, and Fig. 2.2 shows the site plan in the immediate vicinity of that portion of Ogle County. State Highway 2 is 1.5 miles west of the nearest boundary of the site proper and State Highway 72 is 2-1/2 miles north of the northern boundary. The nearest railroad is about three miles north.

The site proper consists of approximately 900 acres; the transmission and pipeline corridor to the Rock River requires an additional 440 acres. The exclusion area will encompass 690 acres of which 100 acres will be devoted to plant structures and features. The proposed layout of plant structures is shown in Fig. 2.3; a description of the structures is given in Section 3.1.

The topography of the site is indicated in Fig. 2.3. The northern half of the site is dissected and slopes generally to the north. In the southern half the land is more dissected and rolling; it slopes to the southwest. The elevation ranges from 906 feet (MSL) in the south-eastern portion of the site to about 770 feet (MSL) in the north porttion of the site. The grade level for the plant will be 868 feet (MSL) (Ref. 1, p. 2.1-2).

The northern portion of the site is generally wooded, with some cropland near the boundary; the southern half is largely cropland. A land-use diagram for the area immediately surrounding the site may be found in Section 2.2. There are no plans for development of the site for recreational or other public usage, as most of the site will be required for the exclusion area.

2.2 REGIONAL DEMOGRAPHY AND LAND USAGE

2.2.1 Demography

The site lies in a relatively sparsely populated area. The major center of population nearby is Rockford, Illinois (1970 population: 147,370), 17 miles northeast. All other cities within 50 miles of the site have populations of less than 50,000. The area within 10 miles of the site has a population density of 62.6 persons per square mile. The area within 50 miles has a population density of 112 persons per square mile; this is expected to grow to 175 persons per square mile by the year 2010 (Ref. 1, p. 2.2-1).

The population estimates for 1972 with projections for 1980, 1990, 2000, and 2010 for sectors within five miles of the site are shown in Fig. 2.4. These estimates are based on a house count conducted by the applicant in 1972; the population per household was taken to be three,

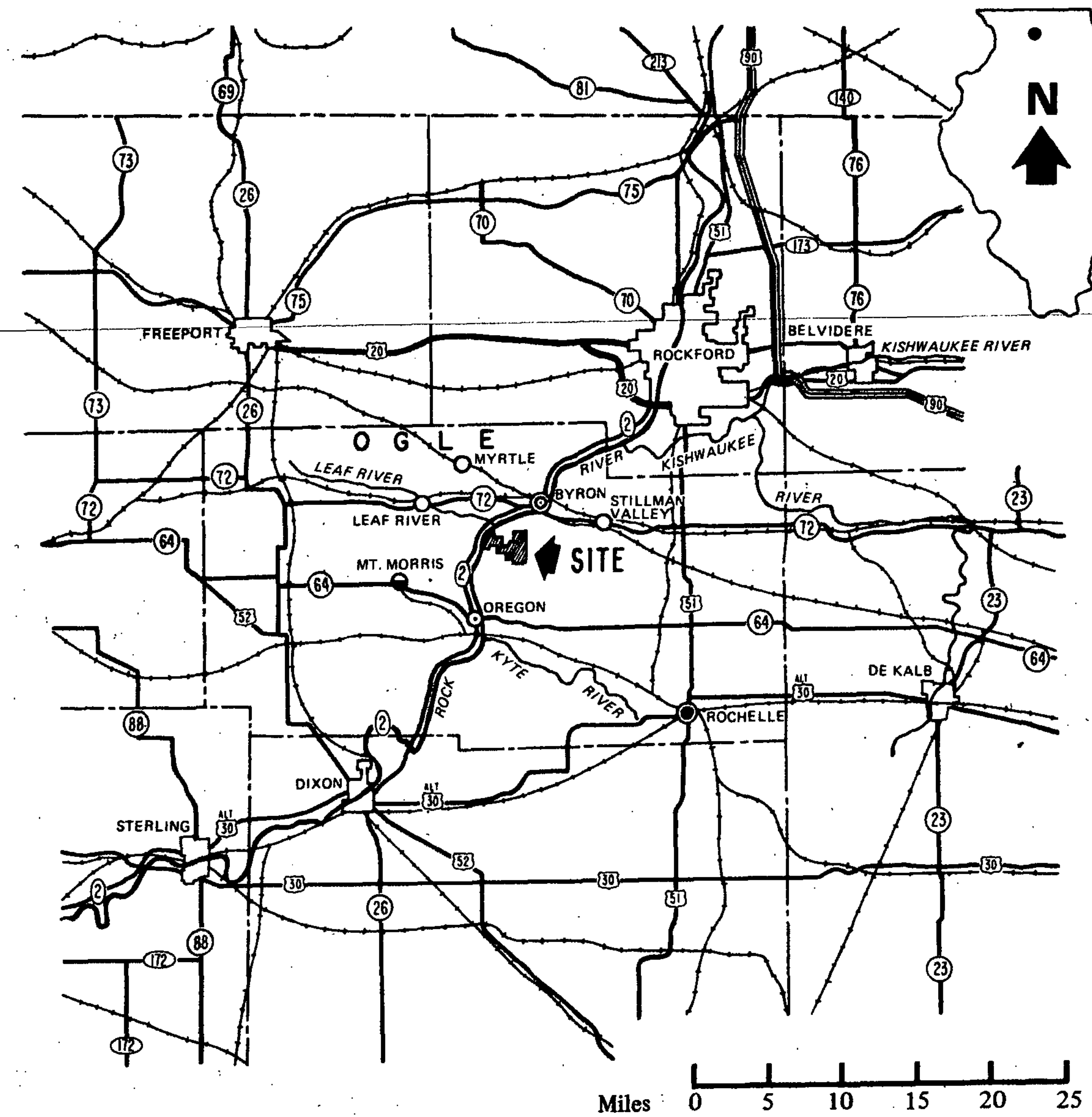
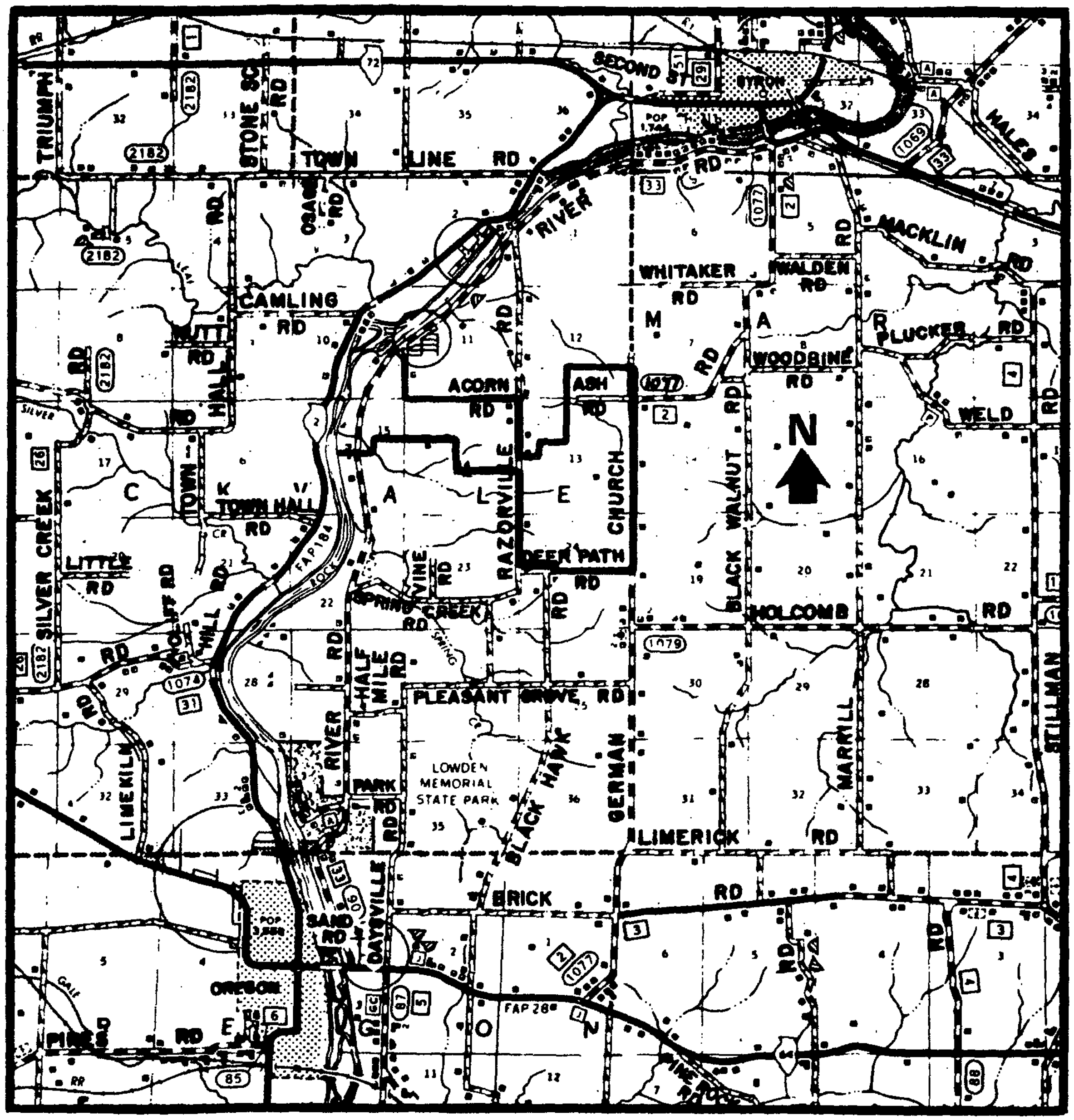


Fig. 2.1. Map of Northern Illinois Showing Location of the Byron Station.



Miles 0 1 2 3 4

Fig. 2.2 Site Plan.

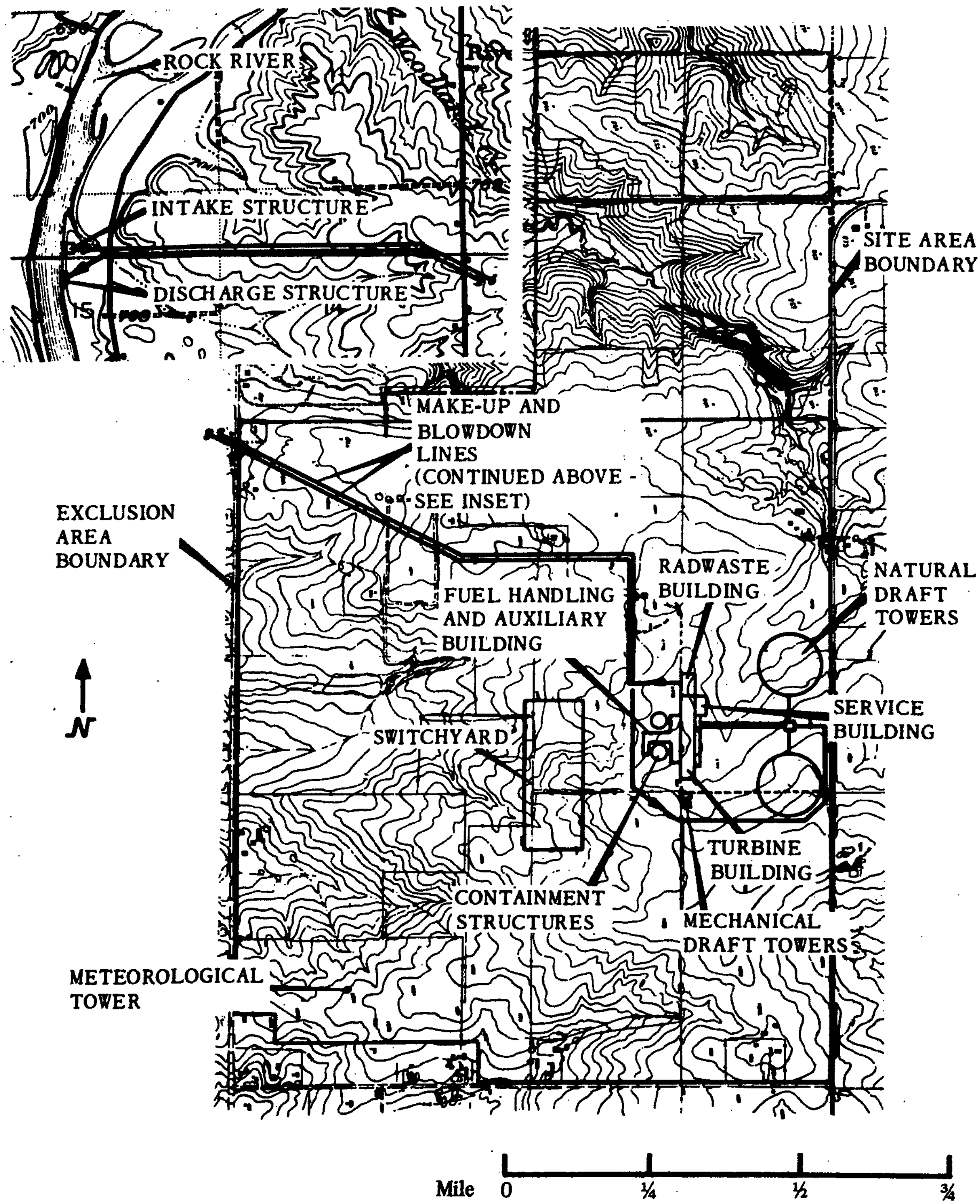


Fig. 2.3. Plot Plan of the Station. From the applicant's Environmental Report.

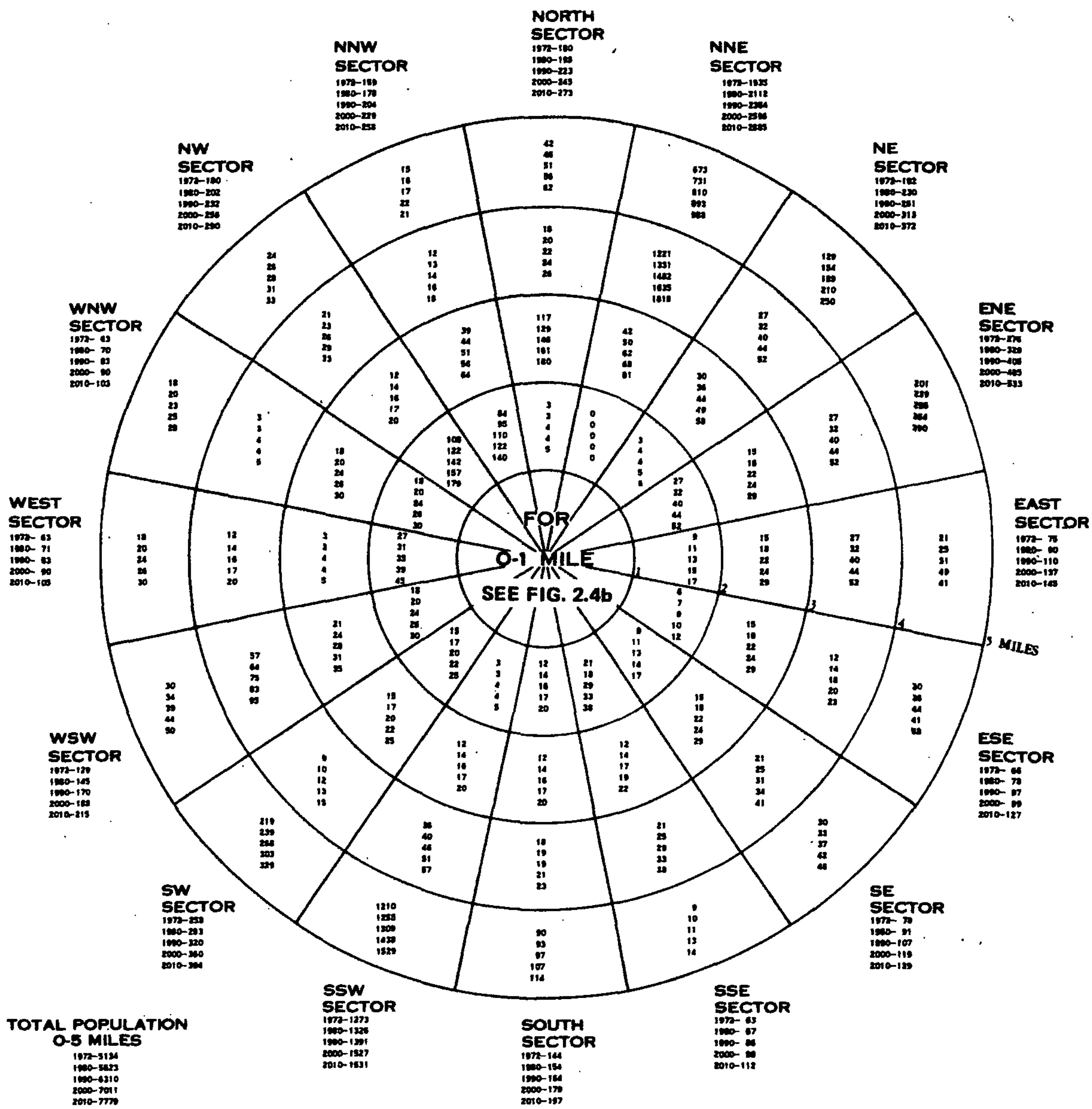


Fig. 2.4a. Population Distribution within Five Miles Based on a House Count. From applicant's Environmental Report.

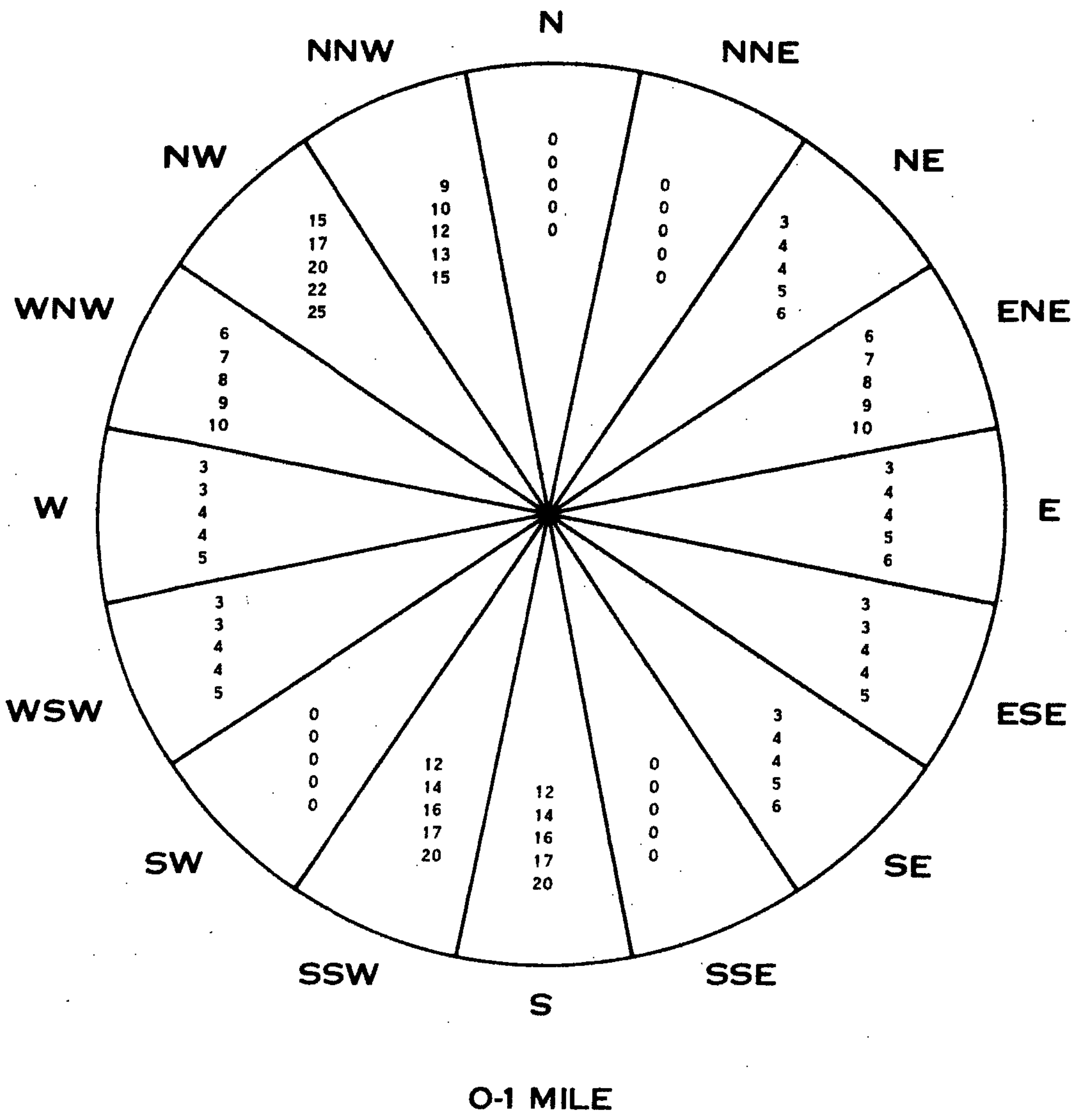


Fig. 2.4b. One-mile Insert for Fig. 2.4a.

consistent with Census Bureau statistics for the area. The predominantly rural area within five miles of the site has two small population centers: Byron (1970 population: 1749), 3.7 miles NNE of the site and Oregon (1970 population: 3539), 5 miles SSW of the site.

The population estimates within 50 miles of the site for 1970 with projections for 1980, 1990, 2000, and 2010 are presented in Fig. 2.5. These figures, provided by the applicant, are based on data obtained from the Bureau of the Census. The 1970 population within 50 miles of the site was 879,712 and is expected to grow to 1,372,718 by 2010; more than 70% of the 1970 population lives outside of a 20-mile radius.

A list of all cities within 50 miles of the site, all recreation areas within 15 miles of the site, and all schools within ten miles of the site may be found in the applicant's Environmental Report (Tables 2.2-1, 2.2-2, and 2.2-3). The nearest schools (total 1971 enrollment, 1037) are located in Byron. There are no hospitals or prisons within ten miles of the site, nor are there any major industrial facilities.

2.2.2 Land Usage

The principal land use in the region of the site is agriculture. Ogle County and two neighboring counties, Winnebago and Stephenson, have, respectively, approximately 61%, 48% and 65% of their land in agricultural production. Corn is the principal crop grown in all three counties on the basis of both acreage planted and dollar value. Cattle, hogs, and milk cows are the predominant livestock. A land use diagram for portions of Rockvale Township adjacent to the site is presented in Fig. 2.6.

In Ogle County in 1970, there were 28,646 acres of feed grain land in the Federal Feed Grain Set Aside Acreage Program.[2] In 1973 feed grain set aside acreage was reduced to 8173 acres following recent grain shortages.[3] The program was abandoned for 1974 and until further notice.

The only major industrial activities in the region of the site are those associated with principal populations centers. Of these centers only Rockford, Illinois, is within 20 miles of the site. Other major centers, Freeport and Belvidere, Illinois, and Beloit and Janesville, Wisconsin, are from 20 to 50 miles from the site. There are no nuclear power plants or facilities within 50 miles of the site; the nearest nuclear facility is the Quad-Cities Nuclear Power Station, 60 miles southwest.

2.3 HISTORIC AND NATURAL LANDMARKS

There are no sites of historic significance in the immediate environs of the station;[4] however, many areas of local historical interest do exist in the general area. A table of historical sites and markers, which was compiled from information furnished by Ogle County Historical Society sources and by the States Historical Society, is given in the applicant's Environmental Report (Table 2.3-1). There are no National Historic Sites or Natural Landmarks within ten miles of the site; the

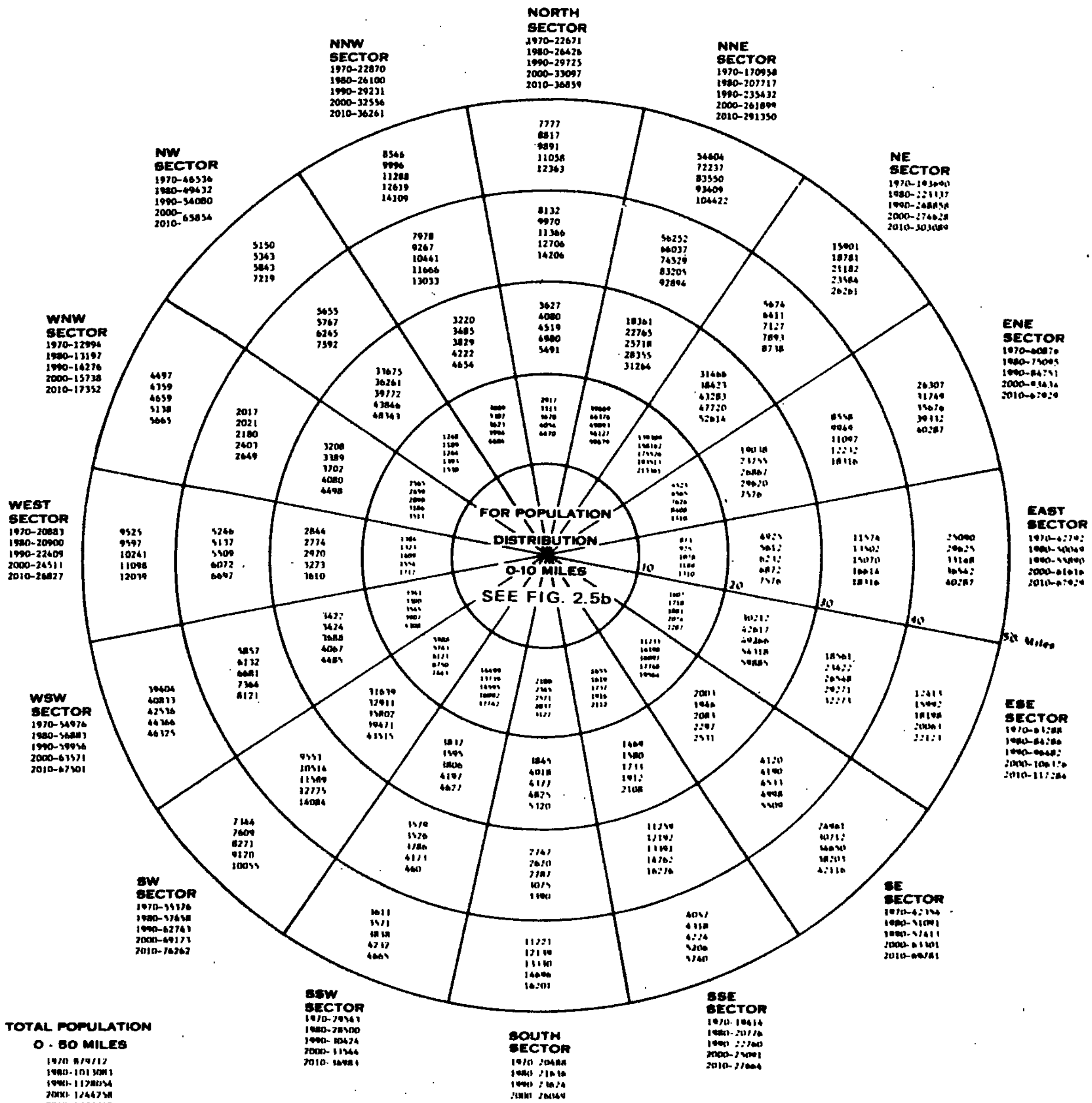


Fig. 2.5a. Present and Future Population Distributions within 50 Miles. From applicant's Environmental Report.

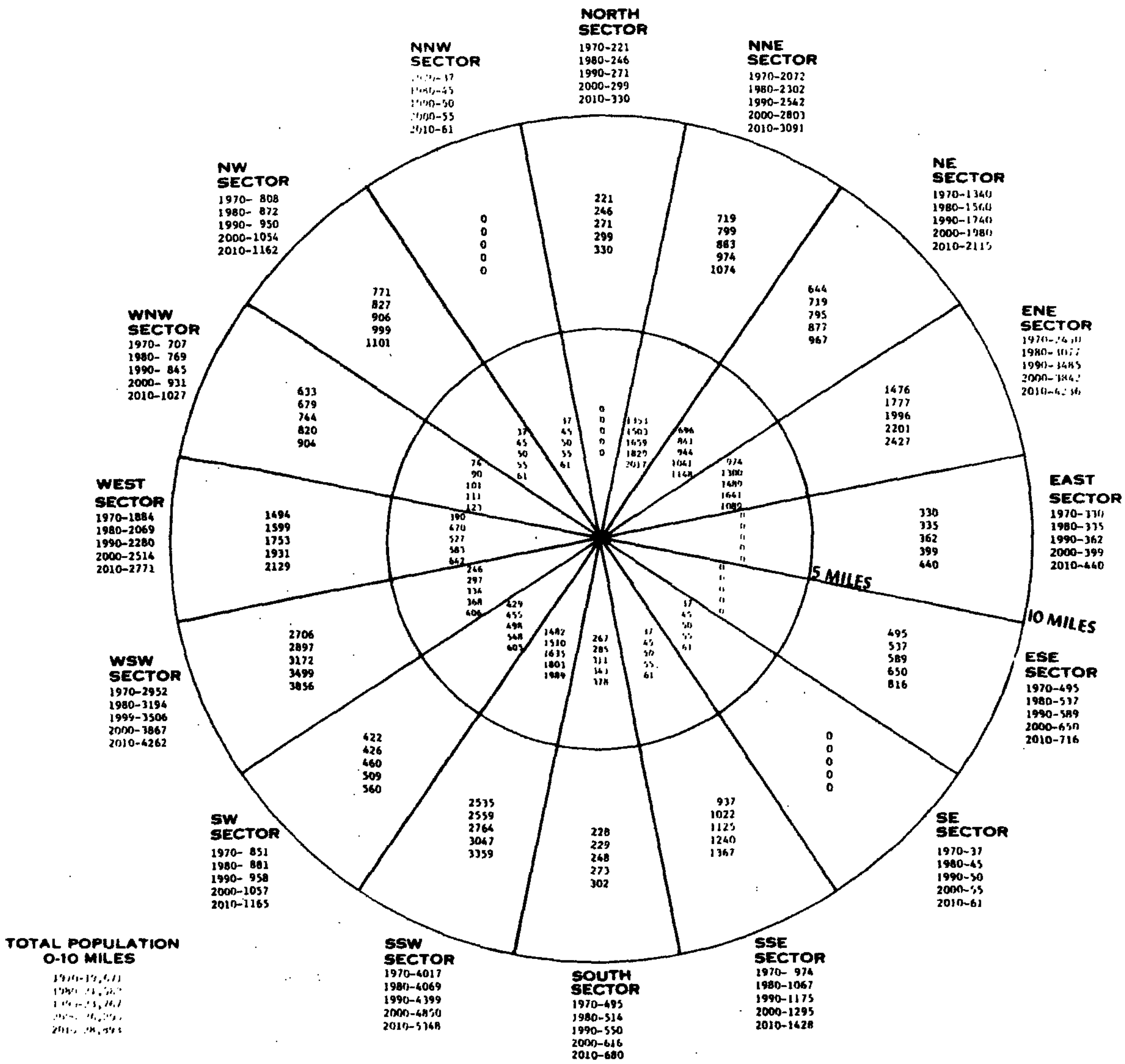


Fig. 2.5b. Ten-mile Insert for Fig. 2.5a.

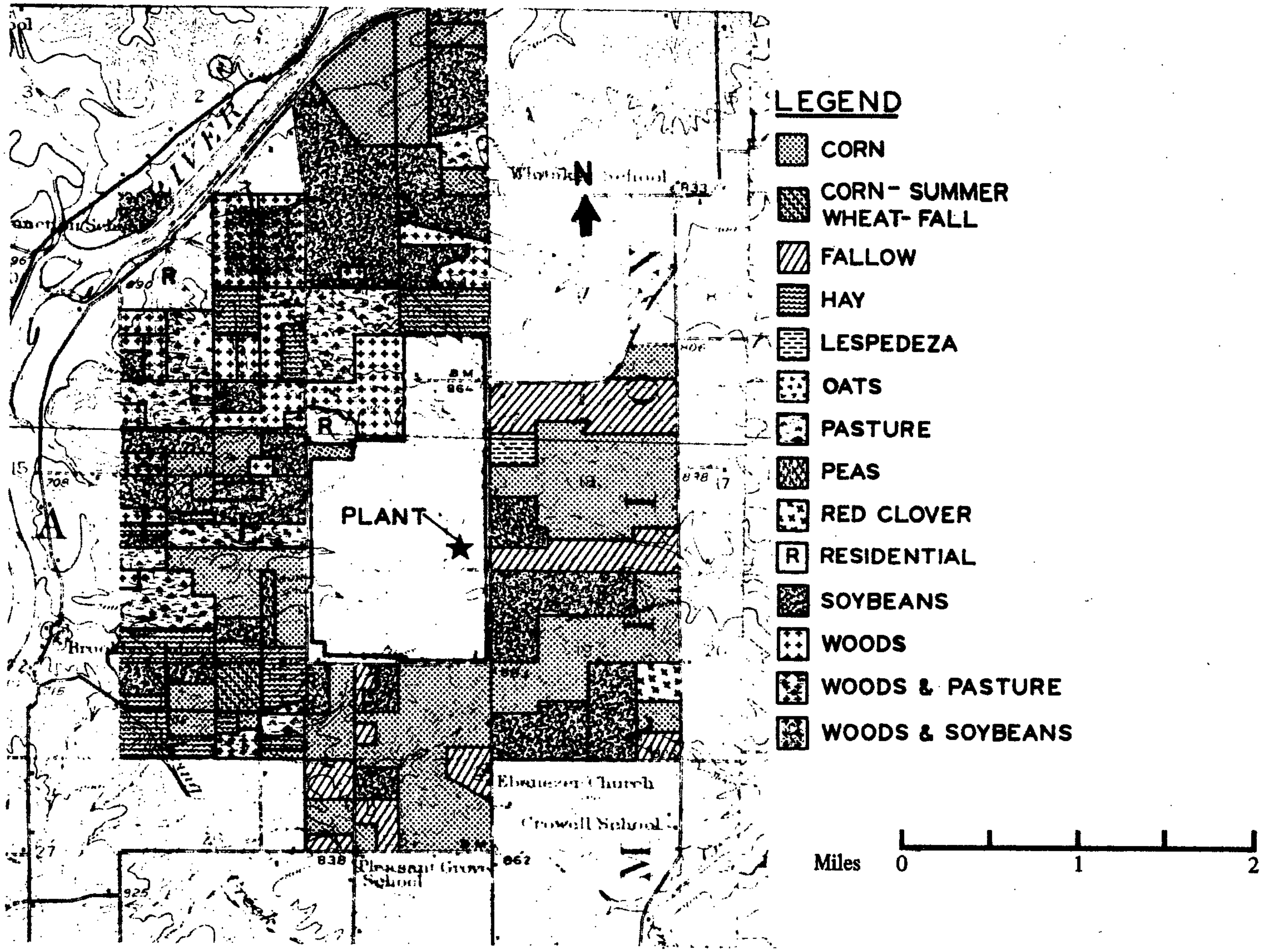


Fig. 2.6. Land-use Diagram. From applicant's Environmental Report.

only site in Ogle County listed on the National Register of Historic Places is the John Deere Shop and Home at Grand Detour, about 13 miles SSW of the site (Ref. 1, p. 2.3-1).

An archeological survey of the site was carried out in June 1973 by personnel from the University of Wisconsin, Milwaukee, under the direction of Dr. M. L. Fowler, Professor of Anthropology (Ref. 1, App. IX). This survey was conducted by walking over all the land of the site proper and the corridor to the river. Only a small portion of the land was inaccessible by virtue of being heavily timbered or covered by high grasses; furthermore, these areas were deemed to be doubtful areas for aboriginal occupation.

The survey found seven new archeological sites. A previously recorded site, Illinois Archeological Survey Number Og-55, was rediscovered and re-examined. All eight site areas are located in the pipeline corridor near the Rock River. It was recommended by the investigators that each archeological site to be altered by construction be tested prior to such activity (Ref. 1, App. IX). The staff concurs in this recommendation. The suggested test is the sinking of one-meter square pits of appropriate depth at selected points within the site. Information obtained from these test pits would be used to ascertain the relative archeological importance of the sites and, if desirable, to develop a salvage program. Any finds will be evaluated by an expert consultant and his recommendations followed.

2.4 GEOLOGY

The Precambrian basement formation in northern Illinois consists of granites and closely related rocks. After a long period of uplift and erosion of these Precambrian rocks, the entire midcontinent area began to subside. About 450 million years ago deposition of marine sediments began and continued with some breaks until about 100 million years ago. The period of subsidence then ended and the area was subjected to erosion until about one million years ago, when the area was covered by a series of continental ice sheets. Since the retreat of the glaciers, about 13,000 years ago, the region has been subjected to erosion and deposition.

The northern portion of Illinois is near the center of the Central Lowlands physiographic province, which stretches from the Appalachian Plateau on the east to the Great Plains on the west. This province has been divided into several physiographic sections: northern Illinois contains portions of the Wisconsin Driftless Section, the Till Plains Section, and the Great Lakes Section.

The general area of the proposed site is within the Till Plains Section, which is characterized by glacial deposits overlying bedrock. The Till Plains Section is further subdivided into the following physiographic subsections: The Rock River Hill Country, the Green River Lowland, the Bloomington Ridged Plain, the Galesburg Plain, the Kankakee Plain, and the Springfield Plain.

The site area is located in the Rock River Hill Country subsection. This subsection is characterized by gently rolling dissected uplands covered by thin deposits of glacial drift overlain by a thin cap of loess. The southwest-trending Rock River Valley passes through the eastern portion of the subsection. The physiography of the site area is shown in Fig. 2.7. Bedrock is exposed locally along the Rock River and its small tributary streams and valleys. The rock units include a sedimentary sequence of Cretaceous, Pennsylvanian, Mississippian, Devonian, Silurian, Ordovician, and Cambrian age strata and an igneous and metamorphic complex of Precambrian age rocks. The relationships of these strata are shown on the stratigraphic column, Fig. 2.8. There are a few minor faults within five miles of the site; the applicant states that there is no evidence of displacement within the Pleistocene deposits and no evidence of offset at the bedrock surface. The closest major fault is the Sandwich Fault Zone, which approaches within approximately seven miles of the site. This fault has been mapped on the bedrock surface and in the subsurface for approximately 85 miles; it is an essentially vertical fault with a maximum displacement of about 900 feet.[5] The last movement of this fault zone is assumed to have been at least 130 million years ago, on the basis of seismic, borehole, and surface data (Ref. 1, p. 2.4-4).

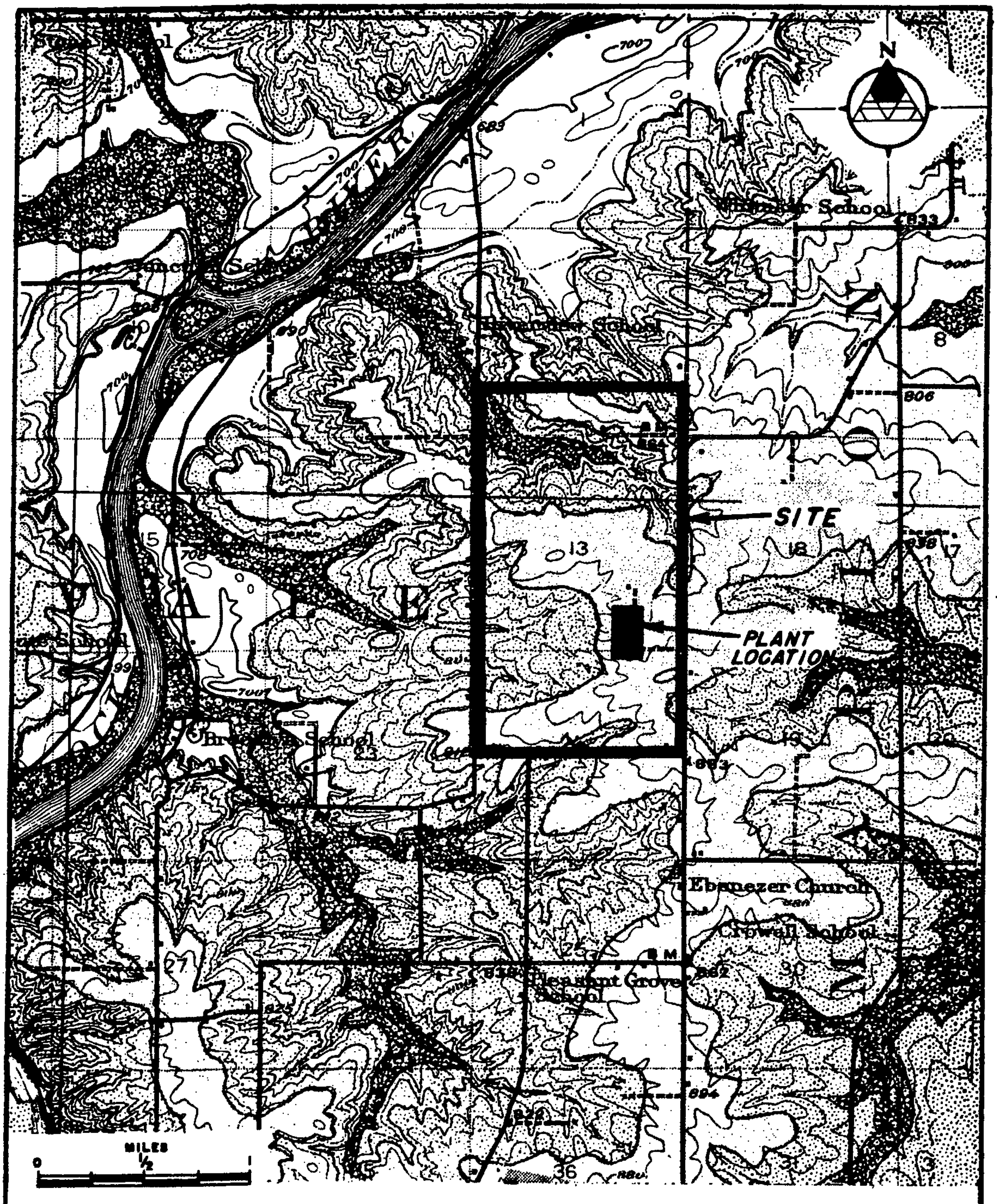
In the general site area the Pleistocene overburden that lies above the bedrock is generally thin and includes alluvium, loess, till, and residuum. The area has been covered by Wisconsinan and Illinoian glaciers; however, deposits of Illinoian age have not been identified at the site. Two tills from the Wisconsinan glaciation have been identified. They are the Esmond Till of the Woodfordian Substage and the Argyle Till of the Altonian Substage. Between these two tills is a calcareous silt, the Morton Loess. The Esmond Till is a stiff, gray silty clay to clayey silt and contains very few boulders. The Morton Loess is a stiff, gray to tan calcareous silt. The Argyle Till is characterized by its brown, pinkish tan, or salmon color and by its high sand content. This till is very stiff to hard, contains over 50% sand, over 30% silt, and few boulders. At the site, Pleistocene deposits range in thickness from 4 feet to 37 feet; the average thickness at the location of the plant structures is expected to be about 10 feet.

A more complete account of the geological features of the region may be found in the applicant's Environmental Report (Sec. 2.4). Specific aspects of the site geology are considered in the applicant's Preliminary Safety Analysis Report.[6]

2.5 HYDROLOGY

2.5.1 Surface Water Hydrology

The Rock River rises in Fond du Lac County in southeastern Wisconsin and flows in a southerly direction into Illinois. In Illinois the river changes to a southwesterly flow and joins the Mississippi River downstream from Rock Island, Illinois. Of the 293-mile course of the Rock River, approximately 164 miles are in Illinois; of the 10,900 square mile drainage basin, about 5300 square miles are in Illinois. The



LEGEND:

- LEVEL TO GENTLY ROLLING UPLANDS
- MODERATELY TO STEEPLY SLOPING UPLANDS AND VALLEY WALLS
- TERRACES
- BOTTOMLANDS AND FLOODPLAINS

REFERENCE: MODIFIED FROM: UNITED STATES GEOLOGICAL SURVEY, 1922, OREGON QUADRANGLE MAP.
SMITH, R.S., & OTHERS, 1927, OGLE COUNTY SOILS: UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION, SOIL REPORT NO.38.

Fig. 2.7.

Physiography of the Site Area. From applicant's Preliminary Safety Analysis Report.

AGE (MILLIONS OF YEARS BEFORE PRESENT)	SYSTEM	GROUP OR SERIES	FORMATION	GRAPHIC COLUMN	THICKNESS (FEET)	LITHOLOGY
1	QUATERNARY	PLEISTOCENE[1]			0-113	ALLUVIUM, LOESS, TILL
380	ORDOVICIAN	GALENA[1]	DUNLEITH		29.5-101.0	DOLOMITE, BUFF, MEDIUM GRAINED
			GUTTENBERG		3.5 - 6.0	DOLOMITE, BUFF, RED SPECKLED
		PLATTEVILLE[1]	QUIMBYS MILL		7.0 - 13.0	DOLOMITE, BUFF AND GRAY
			NACHUSA		12.5-24.0	DOLOMITE AND LIMESTONE, BUFF
			GRAND DETOUR		30.0-46.0	DOLOMITE AND LIMESTONE, GRAY MOTTLING
			MIFFLIN		13.0-26.0	DOLOMITE AND LIMESTONE, ORANGE SPECKLED
			PECATONICA		14.5-31.0	DOLOMITE, BROWN, FINE GRAINED
		ANCELL[1]	GLENWOOD		18.5-37.0	SANDSTONE AND DOLOMITE
			ST. PETER		100-600	SANDSTONE, FINE; RUBBLE AT BASE
		PRAIRIE DU CHIEN	SHAKOPEE[2]		0-67	DOLOMITE, SANDY
			NEW RICHMOND[2]		0-35	SANDSTONE, DOLOMITIC
			ONEOTA[2]		190-250	DOLOMITE, SLIGHTLY SANDY; OOLITIC CHERT
			GUNTER[2]		0-15	SANDSTONE, DOLOMITIC
420	CAMBRIAN		EMINENCE[2]		50-150	DOLOMITE, SANDY; OOLITIC CHERT
			POTOSI[2]		90-220	DOLOMITE, SLIGHTLY SANDY AT TOP AND BASE, LIGHT GRAY TO LIGHT BROWN; GEODIC QUARTZ
			FRANCONIA		(100)	SANDSTONE, DOLOMITE AND SHALE; GLAUCONITIC
			IRONTON-GALESVILLE		(150)	SANDSTONE, MEDIUM TO FINE GRAINED, DOLOMITIC IN PART
			EAU CLAIRE		(400)	SILTSTONE, SHALE, DOLOMITE, SANDSTONE, GLAUCONITE
			MT. SIMON		(1500)	SANDSTONE, FINE TO COARSE GRAINED
500 / 1,200	PRE-CAMBRIAN					GRANITE AND GRANODIORITE, PINK AND GRAY

Notes:

[1]Indicates units encountered during site exploration.

[2]Indicates presence of unit not verified at site location. Thicknesses in parentheses are inferred from isopach maps at the Illinois Geological Survey.

Fig. 2.8. Stratigraphic Column. From applicant's Environmental Report.

drainage area upstream of the site is about 8000 square miles.

The long-term average flow rate of the Rock River in the vicinity of the proposed intake is 4580 cubic feet per second. Average monthly flow rates are given in Table 2.1. The corresponding water surface elevation is 672 feet. The highest measured discharge of 31,500 cfs at Rockton, Illinois, occurred on March 30, 1916.[7] The highest recorded discharge occurring at Rockton in recent times was 23,200 cfs on April 22, 1973. The principal tributaries feeding into the Rock River between Rockton and the site are the Kishwaukee River, Leaf River, and Killbuck Creek. On April 22, 1973, these tributaries had peak discharges of 13,100 cfs, 7,600 cfs, and 5,600 cfs, respectively.

The estimated low flow rates for the Rock River at the site are given in Table 2.2. The 7-day 10-year low flow is 875 cfs. The 400-cfs flow is based on the lowest recorded 1-day flow of 440 cfs at Como in 1934. There are no low-flow control reservoirs on the river above the project area or in the drainage basin, but dams have created pools over much of the Rock River. Near the project area the Rock River is partially regulated by low dams which are located at Rockton (11 feet high), 44 miles upstream; Fordham (13 feet high), 22 miles upstream; Oregon (10 feet high), 5 miles downstream; and Dixon (12.4 feet high), 27 miles downstream.

The river is relatively shallow (maximum depth between 7 and 15 feet); moderately fast-moving (average 2.4 feet per second), and completely mixed; summer temperatures range from 70°F to 80°F while winter temperatures approach freezing. There is a high diversity of bottom types, with the predominant substrates being sand and both fine and coarse gravels. Behind the Oregon Dam and at the mouth of tributary streams the bottom is usually depositional consisting of silt, sand, muck and detritus.

Recent data taken on physical, chemical, and biological parameters of the Rock River in the vicinity of the plant intake structure are presented in Table 2.3. Dissolved oxygen ranged from 7.8 to 11.9 ppm; the water is moderately hard (range 200 to 320 ppm $CaCO_3$); pH is somewhat above neutrality (range 7.2 to 8.3 pH units); total dissolved solids are fairly high and variable 300 to 580 ppm). There is a large contribution of nitrogen and phosphorus, apparently from agricultural runoff; silica averages 8.8 ppm in the summer and 10.2 in winter.

2.5.2 Groundwater Hydrology

The most important hydrogeologic unit in the region of the site is the Cambrian-Ordovician aquifer, made up of all bedrock between the bottom of the Galena-Platteville dolomite and the top of the Eau Claire shale (see Fig. 2.8). Available data indicate that in the region of the station this entire sequence of strata behaves hydraulically as one aquifer. Table 2.4 is a generalized hydrogeologic column at the site.

The site is covered with a mantle of glacial drift consisting mainly of glacial till covered by a few feet of loess; the average thickness of this drift is 13 feet. The generally low permeability and thinness of the till precludes the development of wells. Beneath the thin mantle of drift, the site area is underlain by dolomites and limestones of the Ordovician Galena-Platteville Group. This aquifer is extensively fractured near the top, but becomes dense at greater depths.

TABLE 2.1. Rock River Average Monthly Flows the Station Area

Month	Flow, cfs	Month	Flow, cfs
January	3870	July	3490
February	5260	August	2780
March	9080	September	2940
April	7990	October	3120
May	5280	November	3430
June	4570	December	3270

From applicant's Environmental Report.

TABLE 2.2. Low Flow Data for the Rock River at Project Area

Duration-Frequency	*River Flow, cfs*
1-day lowest	400
1-day 10-year low	679
7-day 10-year low	875
30-day 10-year low	1010
60-day 10-year low	1110
274-day 10-year low	1780
Average annual flow	4580

From applicant's Environmental Report.

TABLE 2.3. Data for Rock River in Vicinity of Byron Intake

Date	Mid-channel Depth, ft	Current Vel. at Surface, ft/sec	Temp., °F	pH	Cond., µmho[a]	Susp. Sol.[a]	Dis. Sol.[a]	Total Alk.[a] as $CaCO_3$	Hardness as $CaCO_3$	Cl^-[a]	SO_4[a]	Ca[b]	Mg[b]	Na[b]
1972														
Jul.	9.5	2.3	71.6	7.45	590	58	477	269	314	25.7	55.8	63.7	37.6	11.0
Aug.	9.5	1.4	68.0	7.62	520	109	413	329	233	22.8	29.8	51.2	25.5	10.0
Sep.	9.5	1.3	67.1	8.00	560	89	422	282	318	22.1	56.2	65.7	37.3	12.4
Oct.	12.0	2.0	60.8	7.80	542	121	405	268.4	282	17.7	52.2	63.0	30.2	9.5
Nov.	9.5	NA	44.6	7.50	597	51	464	276.4	313	20.0	58.7	70.2	33.4	10.4
Dec.	7.8	1.1	32.0	7.80	640	27	408	283	322	20.5	53.0	67.2	37.4	12.0
1973														
Jan.	ice	ice	32.0	7.20	308	246	234	164	183	18.5	28.2	40.3	19.9	7.1
Feb.	ice	ice	35.5	7.20	338	954	576	156	200	21.0	46.5	43.3	22.4	8.1
Mar.	9.2	2.5	40.0	8.30	475.5	74	304	200	255	31.5	37.6	51.3	30.7	10.7
Apr.	9.5	3.3	44.6	7.42	488	164	351	227	302	21.0	32.3	69.7	31.0	7.9
May	13.9	4.0	54.5	7.84	449	68	419	200	267	19.0	30.4	60.3	28.2	8.2
Jun.	10.0	2.9	69.0	7.87	551	84	380	243	298	26.0	31.2	66.8	31.8	8.9

NOTE: All values in mg/l unless otherwise noted.
NA: Data not available.

[a] Mean of two determinations.

[b] Mean of three determinations.

TABLE 2.3. Data for Rock River in Vicinity of Byron Intake (Cont'd)

Date	SiO_2	Total PO_4[a]	Ortho PO_4	NO_3[a] as N	NO_2[a] as N	NH_3[a] as N	Secchi Depth, in.[b]	Light Penetration Depth, in., 50%	Light Penetration Depth, in., 25%	Turb., JTU[a]	Color, APHA units[a]	Dis. O_2	BOD[a]	Total Org. Sol.[a]	Total Org. C
1972															
Jul.	9.50	0.10	0.33	<0.01	0.02	0.34	NA	NA	NA	53	31	8.5	NA	158	8
Aug.	12.90	0.65	0.87	0.20	0.05	0.08	8.0	14.0	21.5	145	53	7.8	2.0	138	47
Sep.	8.12	1.52	0.67	0.65	0.29	0.51	8.0	16.3	20.5	125.5	55.5	8.8	3.1	185	NA
Oct.	13.35	1.00	0.34	0.20	<0.005	0.42	7.0	NA	NA	161	95	8.7	2.8	164	18
Nov.	11.61	1.05	0.47	50.05	0.78	0.52	13.7	11.0	20.5	50	87.5	11.0	2.8	154	58
Dec.	11.00	0.70	0.36	3.72	0.17	0.11	41.0	18.0	38.5	6.5	68	9.7	2.5	116	27
1973															
Jan.	9.05	1.15	0.21	2.00	0.03	0.36	ice	ice	ice	78.0	76	11.8	10.9	156	36
Feb.	10.05	1.79	0.55	66.10	0.90	0.27	ice	ice	ice	88.5	117	11.5	6.8	183	49
Mar.	9.61	2.39	0.65	85.70	0.21	0.57	7.7	8.8	12.0	29	76.5	11.9	5.8	221	58
Apr.	5.65	1.16	0.58	0.04	0.032	0.089	9.0	7.5	12.5	26	42.4	11.1	6.0	150	41
May	6.92	1.07	0.36	5.26	0.519	0.02	10.6	9.3	14.3	27	55.9	9.4	6.9	214	28
Jun.	4.47	0.90	0.48	0.02	0.045	<0.02	13.0	17.6	24.6	19	44.3	8.8	5.7	176	56

NOTE: All values in mg/l unless otherwise noted.
NA: Data not available.

[a]Mean of two determinations.

[b]Mean of three determinations.

TABLE 2.4. Generalized Hydrogeologic Column, values in feet

Unit	*Depth to Top*	*Depth to Bottom*	*Thickness*	*Hydrogeology*
Glacial drift	0	10	10	Not an aquifer
Cambrian-Ordovician Aquifer[a]	10	850	840	Major aquifer
Galena-Platteville	10	200	190	Minor aquifer
St. Peter	220	480	260	Important aquifer
Ironton-Galesville	700	850	150	Most important aquifer
Eau Claire Formation	850	1250	400	Not an aquifer
Mt. Simon Sandstone	1250	2750	1500	Aquifer, salty at depth

From applicant's Environmental Report.

[a]Only the most important units are listed below.

Many domestic wells in the region obtain their water from the upper part of this aquifer; the average yield is about 20 gallons per minute (gpm). Water from these limestone and dolomite aquifers is generally hard, compared to that obtained from deeper aquifers.

Below the Galena-Platteville carbonates are the thin Glenwood shales, sandstones, and limestones, grading down into the thick St. Peter Sandstone. The latter sandstone is permeable enough to supply water for several small municipalities, parks, and industries with water requirements of less than 200 gpm.

The next major aquifer below the St. Peter Sandstone is the Ironton-Galesville Sandstone, which is about 150 feet thick in the area of the station. Numerous industrial and municipal water users obtain their supplies from this aquifer. It is generally considered to be the best in Illinois because of its consistent permeability and thickness. Yields of hundreds of gallons per minute may be obtained from levels less than 1000 feet below the surface.

Below the Ironton-Galesville aquifer is the Eau Claire Formation, about 400 feet thick. The underlying Mt. Simon Sandstone, up to 1500 feet thick, is the basal Cambrian aquifer. This aquifer, which contains fresh water to depths of about 2000 feet, has been tapped by wells yielding many hundreds of gallons per minute. It is the applicant's intention to obtain water from the Mt. Simon aquifer, should yield from the Ironton-Galesville aquifer be inadequate or if tests reveal that pumping the upper units will adversely affect water levels in nearby wells.

Most of the water for domestic, municipal, and industrial use in the region is obtained from the St. Peter Sandstone, although minor supplies commonly are obtained from shallower aquifers. Total groundwater pumpage in Ogle County has been increasing at a gradually accelerating rate since 1950 (Ref. 1, p. 2.5-11). In 1967 total pumpage in Ogle County was about 9 million gallons per day (mgd); this is projected to increase to approximately 11.5 mgd in 1980 and to 17 mgd by 2020; the potential ground water supply is estimated to be 112 mgd.[8]

2.6 METEOROLOGY

2.6.1 Regional Climatology

The climate of the site area in northern Illinois can be described as continental, characterized by rapid changes in temperature and marked extremes, resulting in hot summers and cold winters. The effect of Lake Michigan, about 70 miles east of the site, is occasionally noticed during strong northeast winds, resulting in increased cloudiness and some temperature moderation. The site lies near the principal track of storms that form over the west central plains during winter and spring, and move northeastward. Spring and fall are periods of transition as the primary storm track shifts northward for the summer months, and then returns southward in October. The average date of the last 32°F temperature in the spring is April 30, and the first in the fall is

October 4. The six-month period April-September accounts for about 64% of the annual average precipitation. Snow usually begins in October and can be expected into May. Snow cover can be continuous from late December through February.

2.6.2 Local Meteorology

Climatological data from Rockford Airport[9] have been used to assess local meteorological characteristics of the site except for wind patterns. Since the Rockford Airport is within the confines of the Rock River Valley, the wind pattern within this valley is not considered representative of the Byron site.

Monthly temperature summaries from the weather station at Rockford Airport are given in Table 2.5. Mean monthly temperatures range from 22°F in January to about 74°F in July. Record maximum and minimum temperatures at Rockford have been 112°F in July 1936, and -25°F in January 1924 and February 1933. Maximum temperatures may be expected to reach 90°F or above on 11 days per year, while reaching 32°F or below on 54 days per year. Temperatures may be expected to reach 0°F or below on 15 days per year.

Monthly rainfall summaries from the weather station at Rockford Airport are given in Table 2.6. The mean monthly precipitation reaches its maximum value (4.3 inches) in June. June, July, and August account for 35% of the 35.6-inch annual average, while December, January, and February account for only 14%. The maximum monthly precipitation recorded over the last 20 years was 11.8 inches in July 1952. The minimum monthly value over the same period was 0.01 inch in October 1952. The 24-hour maximum rainfall was 5.56 inches in September 1961.

The site area can expect about 32 inches of snow per year, based on data from the Rockford Airport. The mean monthly snowfall reaches its maximum value (8.2 inches) in January. Significant accumulations of snow can be expected in December and March, with mean monthly snowfalls of 7.6 and 7.4 inches, respectively. The maximum monthly snowfall recorded for the site area was 36.1 inches in January 1918. The maximum 24-hour snowfall over the last 20 years was 10.9 inches in February 1960.[9]

Wind data for the Byron site are not available at this time. The Rockford Airport wind rose indicates a pronounced valley influence and is not considered applicable to the Byron site. Wind data from nuclear facilities at Quad Cities (about 60 miles southwest of the site) and Dresden (about 70 miles southeast of the site) have been examined. The 35-ft annual wind roses, although both are fairly uniform, reflect the spatial variation between the sites. The 300-ft annual wind roses also exhibit significant differences. Figures 2.9-2.12 are annual wind roses from Quad Cities and Dresden at 35-ft and 300-ft elevations. The mean wind speed for the Byron site, as indicated by Rockford data, is about 10 mph. The "fastest mile" wind speed recorded at Rockford in the past 20 years was 54 mph reported in April 1953. The frequency of occurrences of Pasquill stability classes for the 300-ft level at Quad Cities is tabulated in Table 2.7. The data cover the period from

TABLE 2.5. Monthly Temperatures Summaries - Rockford - for the Period 1931-1960

	Average Temperature, °F			*Extreme Temperature, °F*[a]			
Month	*Maximum*	*Minimum*	*Mean*	*High*	*Year*	*Low*	*Year*
Jan.	30.2	13.7	22.0	60	1967	-22	1970
Feb.	32.7	16.1	24.4	55	1965	-16	1965
Mar.	42.9	25.1	34.0	76	1967	2	1965
Apr.	58.7	36.9	47.8	86	1970	16	1967
May	70.5	47.7	59.1	90	1969	24	1966
June	80.9	58.4	69.7	94	1970	41	1969
July	86.3	62.1	74.2	99	1965	43	1967
Aug.	84.2	60.8	72.5	93	1968	43	1965
Sept.	75.6	52.0	63.8	90	1966	33	1964
Oct.	64.1	40.9	52.5	90	1963	22	1969
Nov.	46.1	28.0	37.1	74	1964	3	1964
Dec.	33.5	17.7	25.6	65	1970	-20	1963
Year	58.8	38.3	48.6				

[a]For the period 1963-1972.

TABLE 2.6. Monthly Rainfall Summaries - Rockford - for the Period 1931-1960

Month	Mean Total	Maximum		Minimum		Maximum	
		Monthly	Year	Monthly	Year	24 Hours	Year
Jan.	1.98[a]	4.66	1960	0.18	1961	2.89	1960
Feb.	1.44	2.24	1959	0.04	1969	1.73	1966
Mar.	2.46	5.62	1961	0.52	1958	1.70	1959
Apr.	3.05	8.17	1964	1.90	1958	3.03	1963
May	3.83	5.75	1969	1.44	1961	2.64	1969
June	4.30	9.98	1967	1.45	1957	4.15	1969
July	4.14	11.81	1952	1.32	1967	5.03	1952
Aug.	4.14	9.27	1965	0.67	1970	3.58	1968
Sept.	3.51	10.68	1961	0.50	1956	5.56	1961
Oct.	2.70	8.32	1969	0.01	1952	5.22	1954
Nov.	2.37	4.83	1961	0.51	1953	3.20	1961
Dec.	1.70	3.31	1968	0.37	1955	1.91	1965
Year	35.62						

[a]Precipitation in inches.

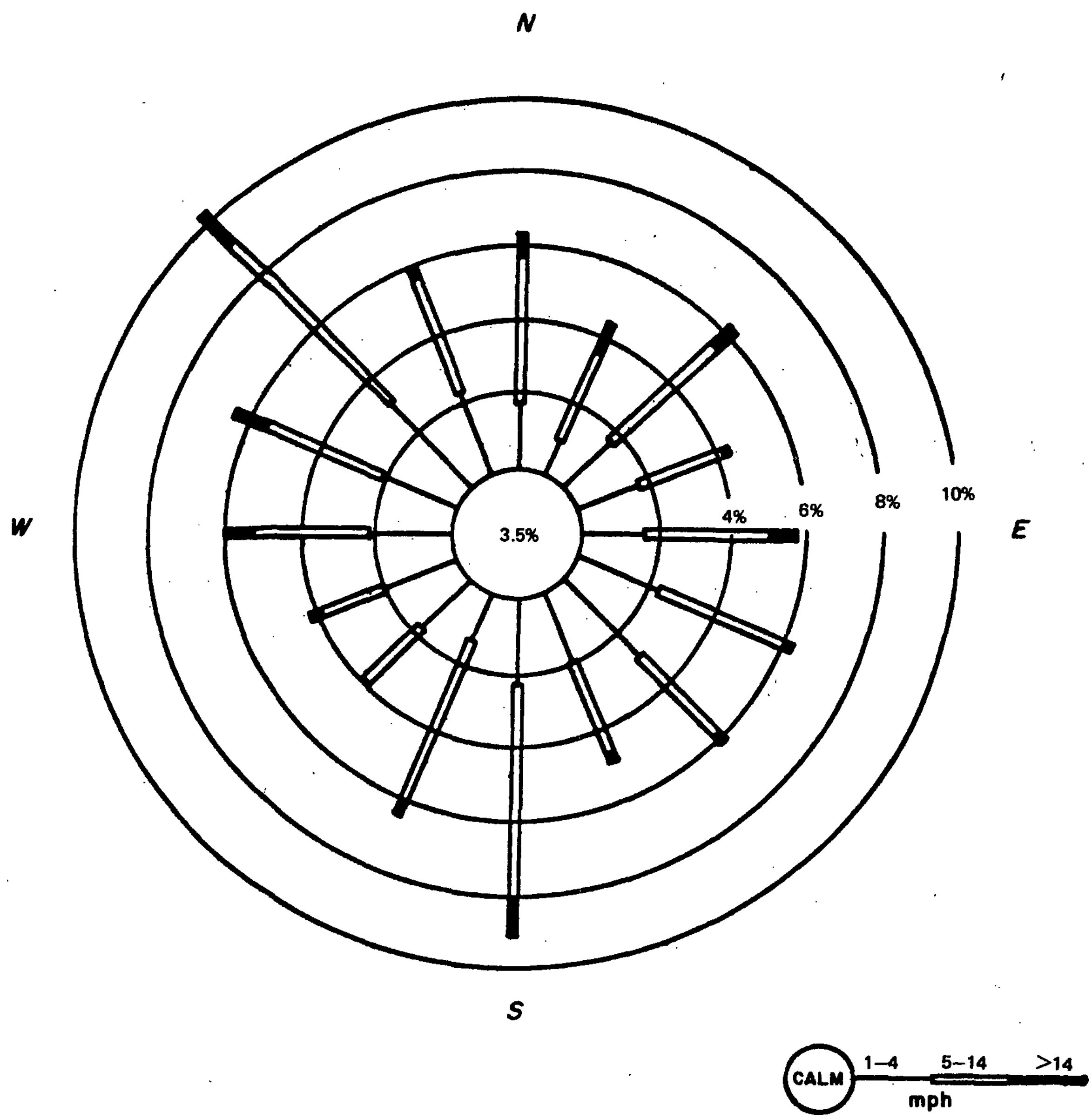


Fig. 2.9. Annual Wind Rose, 35-foot Level, Quad Cities. From applicant's Environmental Report.

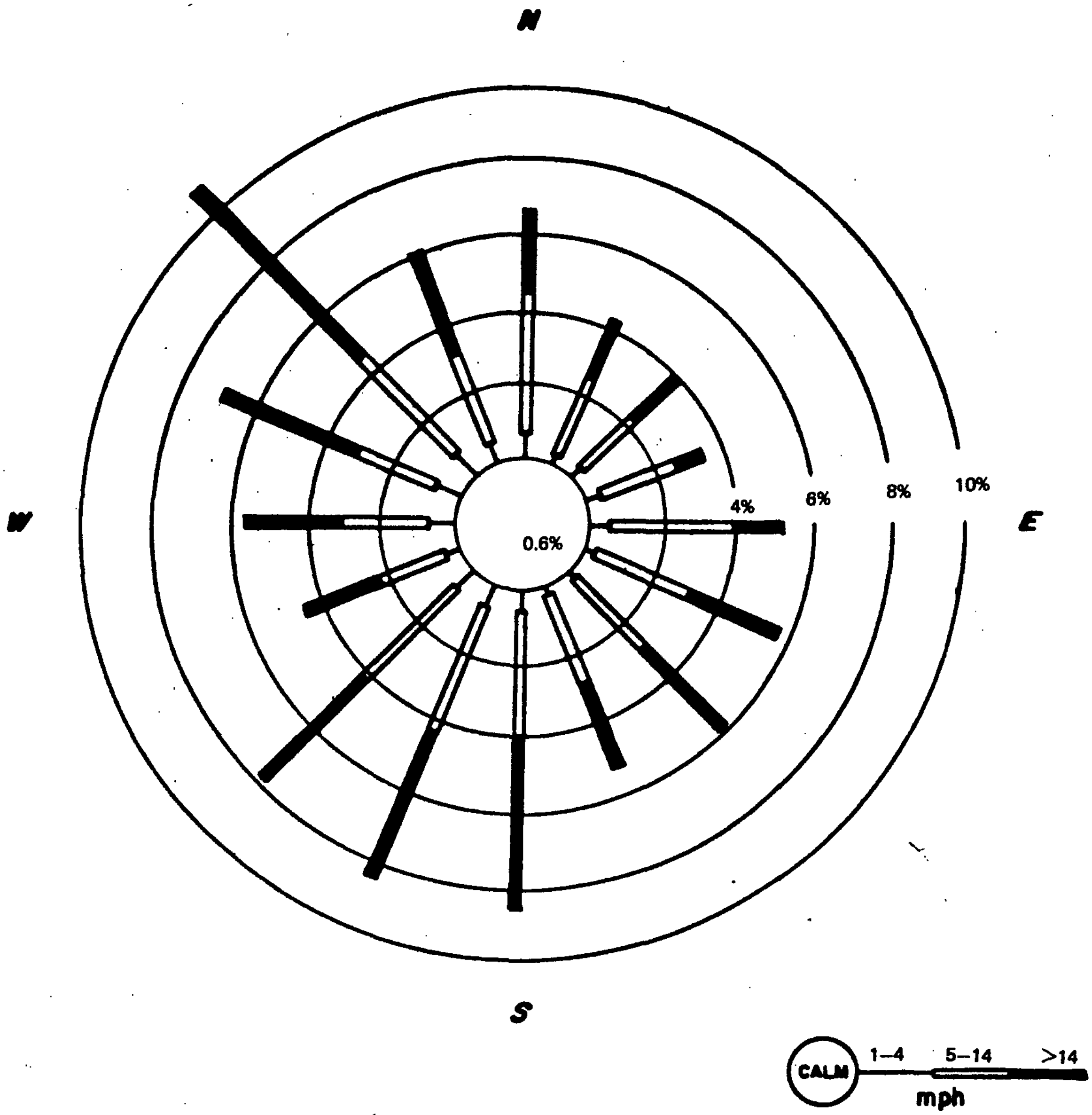


Fig. 2.10. Annual Wind Rose, 300-foot Level, Quad Cities. From applicant's Environmental Report.

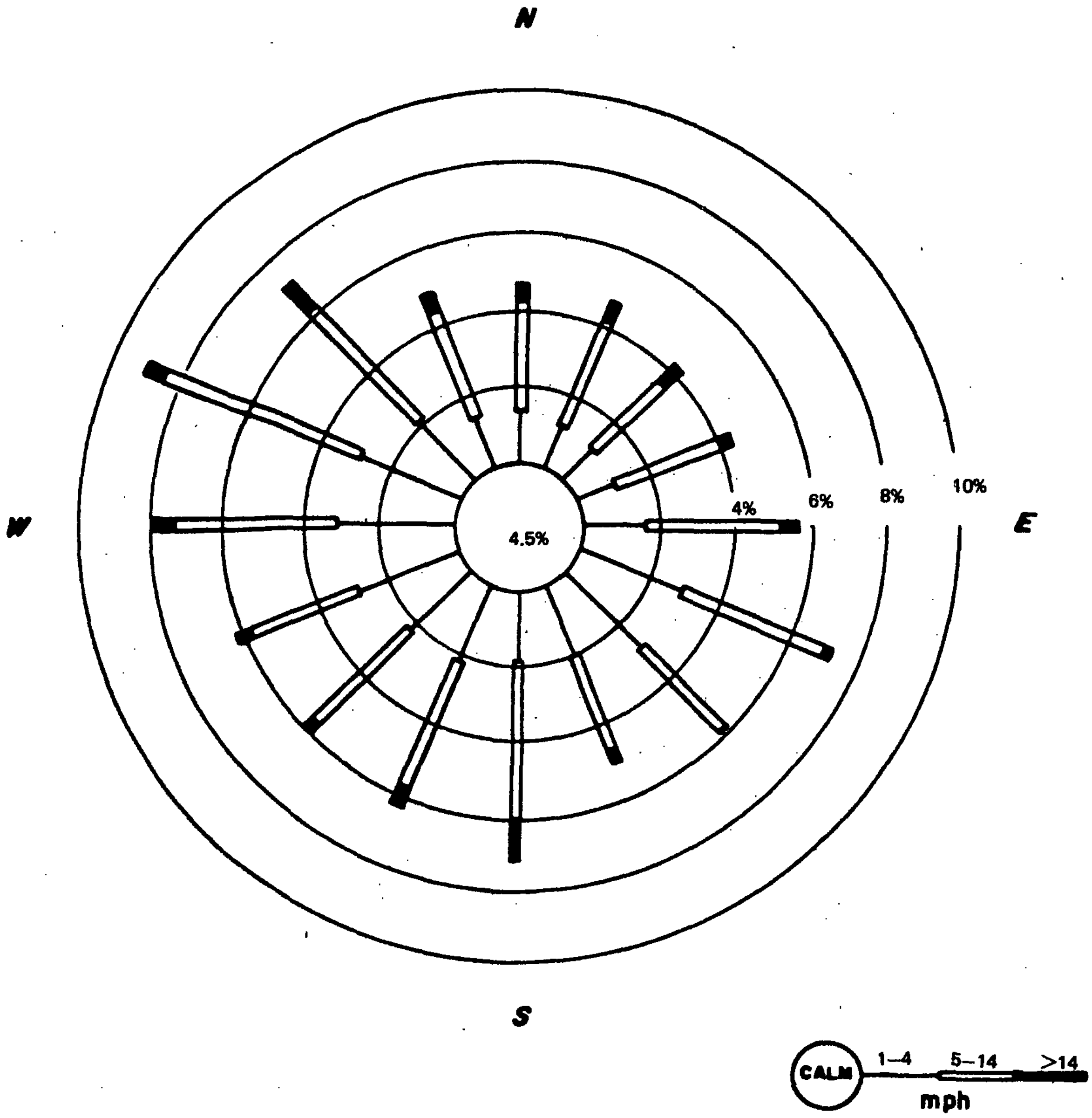


Fig. 2.11. Annual Wind Rose, 35-foot Level, Dresden. From applicant's Environmental Report.

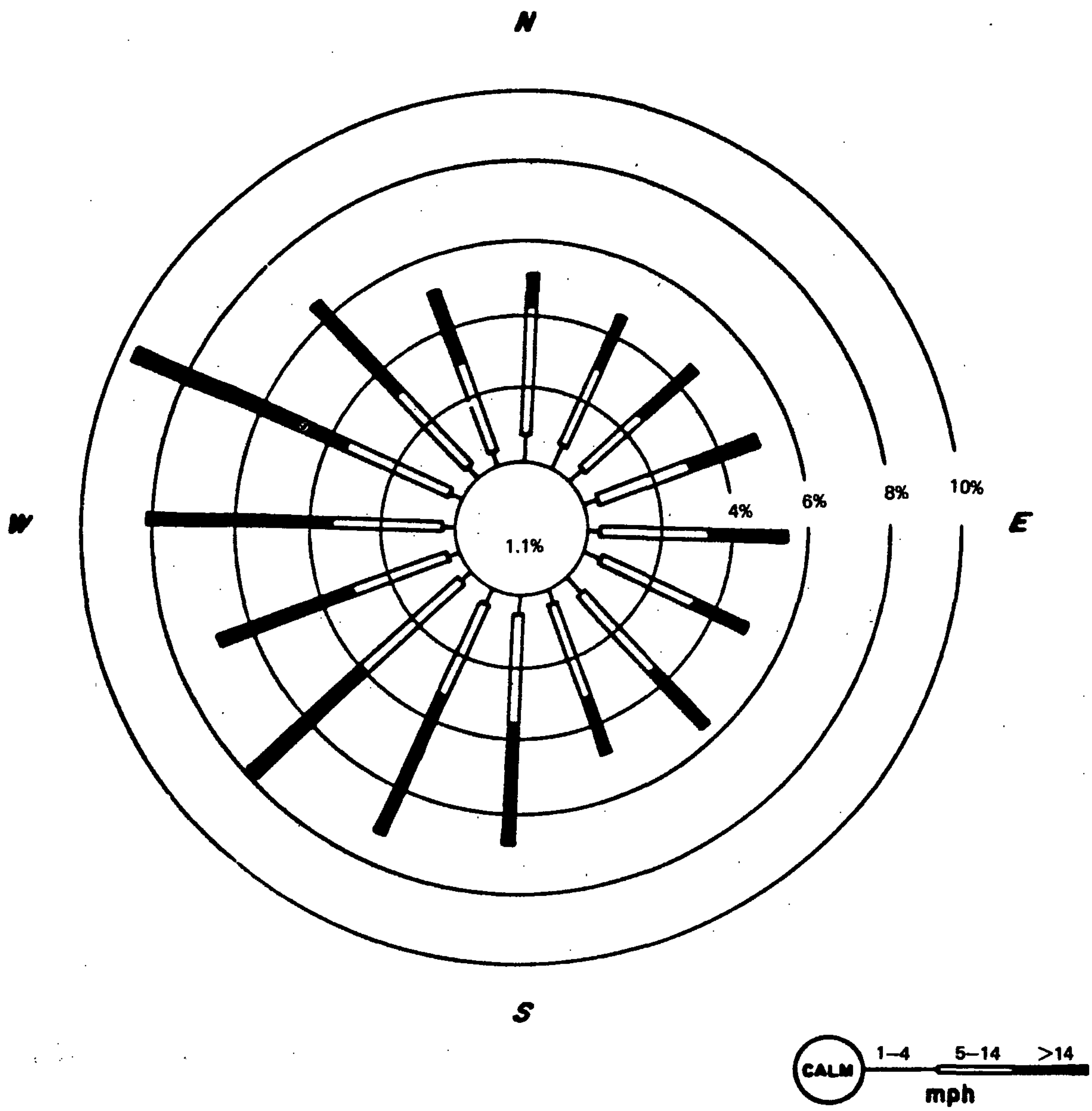


Fig. 2.12. Annual Wind Rose, 300-foot Level, Dresden. From applicant's Environmental Report.

TABLE 2.7. Meteorological Stability Data -- Quad Cities

Pasquill Stability Class	*Percent Occurrence*	*Mean Wind Speed, m/sec*
A	0.5	1.3
B	0.8	2.5
C	4.5	3.1
D	28.6	5.4
E	38.3	6.0
F	22.3	4.9
G	5.0	5.4

October 1, 1969 to September 30, 1970. In the absence of on-site data, the values in Table 2.7 were considered by the staff to be typical of that expected.

2.6.3 Severe Weather

Because of the location of the site with respect to the principal storm track, severe weather is not uncommon.

During the period 1955-1967, 27 tornadoes were reported in the one-degree latitude-longitude square containing the site, giving a mean annual frequency of about 2.1. April is the month of highest frequency of tornadoes. The computed recurrence interval for a tornado at the plant site is about 580 years.

In the period 1955-1967, there were 14 reports of hail 3/4 inch in diameter or greater and 28 windstorms of 50 knots or greater in the one-degree latitude-longitude square containing the site.

Thunderstorms can be expected to occur on about 42 days per year in the site area. The maximum average of 8 thunderstorm days per month occurs during the months of June and July. A monthly average of 5 thunderstorm days occurs during April, May, August, and September. Less than 1/2 thunderstorm day per month occurs during the winter months of December, January, and February.

Snow and ice storms are fairly common in the site area during winter months. According to studies done by the Illinois State Water Survey, severe winter storms are most frequently centered over northwestern Illinois and occur most often in January. In the period 1900-1960, 60 storms deposited more than six inches of snow (per storm) in the Ogle County area. Ogle County has about two days of ice glaze per year. An average of one storm every three years will produce glaze ice 0.75 inch or thicker on wires.

High air pollution potential (atmospheric stagnation) can be expected on about two days per year. In the period 1936-1965, there were about 59 stagnation days and about ten stagnation periods. About three stagnation periods lasted seven days or more. October had the greatest number of stagnation periods of four days or more, with four.

2.7 ECOLOGY OF THE SITE

2.7.1 Terrestrial Ecology

The Byron site is mainly an agricultural area (50% cropland), containing smaller areas of grassland and fallow fields (about 35%) and remnant forest (about 15%). An intermittent stream, Woodland Creek, flows across the northern segment of the site through a wooded area.

Woodlands on the site consist primarily of oak (*Quercus*) and hickory (*Carya*) associated with elm, black walnut, hackberry, and quaking aspen. Understory vegetation includes dogwood, hawthorn, cherry, and species of berries.

The fallow fields consist mainly of ragweed (*Ambrosia artemisiifolia*), alfalfa (*Medicago sativa*), and red clover (*Trifolium pratense*). Grasses are primarily Kentucky bluegrass (*Poa pratensis*), timothy (*Phleum pratense*), and Canada bluegrass (*Poa compressa*). A detailed description of the site vegetation can be found in the applicant's Environmental Report, based on surveys carried out in the fall of 1972, and winter, spring and summer of 1973. Natural meadows and savannahs which existed at the beginning of the study have been disrupted due to overgrazing and timber cutting. Most areas which were fallow in 1972 were plowed in the spring of 1973 (Ref. 1, p. 2.7-86).

Faunal surveys made by the applicant in the fall of 1972 and spring of 1973 indicated that several species of small mammals, primarily mice and meadow voles, and about 50 species of birds were present on the site. The mammals, birds, and insects observed on the Byron site are listed in the applicant's Environmental Report (Sec. 2.7.2.4) and are typical of fauna associated with deciduous forests and croplands of Illinois. None of the species listed is included in the U. S. Department of Interior's list of endangered wildlife.

The area surrounding the site, within a radius of about five miles, is mainly cropland, primarily corn and soybeans, interspersed with wooded areas which sometimes serve as pasture. Adjacent to the northwest corner of the site are a junkyard and a motorcycle raceway. Runoff from these areas appears to flow into Woodland Creek between the site and the Rock River.

About three miles southwest of the site is Lowden Memorial State Park. A survey of the fauna at the park, mainly deer, small mammals and birds, was made by the applicant in October 1972; the results are given in the applicant's Environmental Report (p. 2.7-786).

Vegetation and wildlife in the pipeline corridor to the Rock River were surveyed in November, 1973. Visits to the area by the staff have indicated that the corridor consists of wooded, fallow, and cropped land, similar to the site proper. About 44% (212 acres) is cultivated land, predominatly cornfields, and about 39% (189 acres) is wooded. Trees include aspen, black cherry, and box elder; the predominant understory consists of hawthorn, honey locust, and sumac. The total acreage of various species of vegetation is listed in Tables 2.7-380A and 380B of Reference 1.

The proposed use of natural-draft cooling towers on the Byron site and incidents of bird kills at tall structures[10-12] suggest that considera-tion be given to the migration of birds in the flyways of this region.

According to charts of the migration corridors for waterfowl east of the Rocky Mountains,[13] species of diving and dabbling ducks, Canada geese, and particularly blue and snow geese, use corridors that cross north central Illinois in their migrations. Passerine species (perching birds), which also migrate, and some of the other species observed on the Byron site (e.g., the ovenbird (*Seiurus aurocapillus*), Swainson's thrush (*Hylocichla ustulata*), yellow warbler (*Denroica petechia*), black-billed cuckoo (*Coccyzus erythropthalus*), and the American redstart (*Setophaga ruticilla*) have been among those killed at television towers in Illinois during nocturnal migrations in the fall.[14] (The expected effect of the Byron cooling towers on migrating birds is discussed in Section 5.)

2.7.2 Aquatic Ecology

Values of physical and chemical parameters of the Rock River in the vicinity of the proposed site were sampled monthly between April 1972 and June 1973 (Ref. 1, Sec. 2.7). These data in the vicinity of the proposed intake are presented in Table 2.3, to which reference is made. On the basis of these water quality values, the river is only slightly polluted and should support a "varied and abundant association of organisms."[15]

The applicant's baseline survey of the river phytoplankton consisted of 15 sample days (May 1972 to June 1973) at five river locations (Ref. 1, p. 2.7-15-27). Based on this information, the biomass of the phytoplankton is dominated by a group of about eight centric diatom species, which occur on two-thirds or more of the sample days. In addition, there are about 30 occasional species of diatoms which are mostly benthic pennate diatoms washed up from the stream bed. Green, blue-green, and euglenoid algae were very rare during the colder months, and often only of localized abundance on a given sample day. Filamentous blue-greens were most abundant in September and August, but they did not dominate the phytoplankton.

Most of the dominant species of diatoms are those to be typical of the upper Mississippi River Basin (e.g., *Melosira ambigua, Stephanodiscus hantzchii, S. niagarae, S. astraea minutula, Cyclotella memneghiniana*).[16] The number of species identified on a sample day ranged from seven to 37; the biovolume ranged from less than one in winter to over 40 microliters per liter in late summer. These aspects of diatom ecology indicate that the Rock River, in the vicinity of the Byron site, is a moderately eutrophic stream with a planktonic flora which is normal for the region.

The river zooplankton was sampled on 19 sample days from April 1972 to June 1973. The fauna is rich in rotifer and protozoan species. Thirty-eight rotifer species were reported; seven occurred on more than two-thirds and 29 on less than one third of the sample days. The most frequent rotifer species were in the genera *Keratella, Polyarthra,* and *Brachionus.* Thirty-one protozoan species were reported from the river.

Five species occurred on at least two-thirds and 23 on less than one third of the sample days. The most frequent species were in the genera *Centropxis*, *Difflugia*, and *Vorticella*. One species of copepod (*Cyclops biscuspidatus*) was frequent, but only three other species were reported. Nauplius larvae, however, were reported from each sample day, even when no adults were reported. The extent to which these organisms represent true plankton as opposed to bottom dwellers washed up from the stream bed is not known.

There are spring peaks of zooplankton numbers for both 1972 and 1973. There is a mid-summer low of numbers in 1972, but the data for 1973 do not cover the corresponding period. It is likely, however, that this seasonal pattern is a characteristic.

The zoobenthos of the river was sampled on seven days between May 1972 and June 1973. In terms of numerical abundance, the fauna was dominated by four groups of invertebrates (three of which are insects). These are oligochaete worms (tubuficidae -- nine taxa) and the larvae of mayflies (ephemeroptera -- five taxa), caddis flies (trichoptera -- two taxa) and midge flies (chironomidae -- 21 taxa). The average density (organisms per square meter) over this period was $147.3/m^2$ for oligochaete worms, $9.6/m^2$ for mayflies, $15.7/m^2$ for caddis flies, and $20.1/m^2$ for midge flies.

Both caddis fly and mayfly larvae showed a decline in numbers in the fall, which is a consequence of the maturation of the larvae and their emergence from the stream. The decline of caddis fly larvae in 1972 began in September, but in 1973 it was already very low by June. Similarly, the density of mayfly larvae in May and June 1973 was much lower than in May and June 1972. These variations in seasonal patterns are probably the result of several factors, such as yearly changes in river flows and temperatures, which cannot be properly assessed in a single year (or even several years) of sampling.

Ichthyoplankton densities in the river were very low (about one egg or larva per 100 m^3), which probably represents only washout from spawning areas.

2.8 NATURAL RADIATION

The United States Environmental Protection Agency has estimated the annual average background radiation dose to an individual in Illinois to be 135 mrem per year.[17] Table 2.8 gives the breakdown of this dose into individual components.

TABLE 2.8. Estimated Natural Radiation Whole-body Doses in Illinois

Type of Radiation	*Average Annual Dose, mrem/yr*
Cosmic radiation	45
Natural terrestrial radioactivity	65
Subtotal	110
Internal radiation	
Tritium	0.004
Carbon-14	1.0
Potassium-40	17
Rubidium-87	0.6
Polonium-210	3.0
Radon-222	3.0
Subtotal	25
Total	135

From USEPA Report ORP/CSD 72-1

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3. THE PLANT

3.1 PLANT DESCRIPTION

The principal structures to be built on the station site are shown in Fig. 3.1. These structures include:

. The turbine building which houses the two steam turbine-generators and associated equipment.

. The two reactor containments each of which house one pressurized water reactor (PWR), its steam generators, and the associated reactor cooling systems.

. The service building which houses the station's offices and other related service facilities.

. The auxiliary equipment building.

. The fuel storage and handling building.

. Two natural-draft cooling towers used for cooling the circulating water supply of the turbine condensers.

. Two banks of mechanical-draft cooling towers used for cooling the essential service water.

. Two pumphouses, one of which is associated with the cooling towers and one of which is associated with the water intake from the Rock River.

. Miscellaneous sheds, tanks, towers, stacks, etc., for the storage of materials and equipment, support of transmission lines and meteorological monitoring equipment, discharge of radioactive gaseous effluents, etc.

Although the major design considerations were functionality and economics, the applicant has attempted to enhance the appearance of the structures by employing variety of color and texture as part of the architectural treatment. The appearance to the casual observer will probably be that of an industrial facility.

3.2 REACTOR AND STEAM ELECTRIC SYSTEM

Both of the reactors to be employed at the Station are Westinghouse pressurized-water reactors (PWRs) with a thermal output of 3425 megawatts (MWt). However, because the containment and engineered safety features are designed and here evaluated at the power rating of 3565 MWt, the analysis of radioactive wastes in Section 3.5 is based on this power rating. Each reactor supplies pressurized heated water to the primary side of 4 heat exchangers (steam generator). The steam produced in the secondary of the steam generator is used to drive a tandem-compound six-flow exhaust, 1800-rpm turbine which employs a single high-pressure turbine and three low-pressure turbines mounted on a common shaft. The energy produced is used to drive a 1175-megawatt electrical (MWe) gross

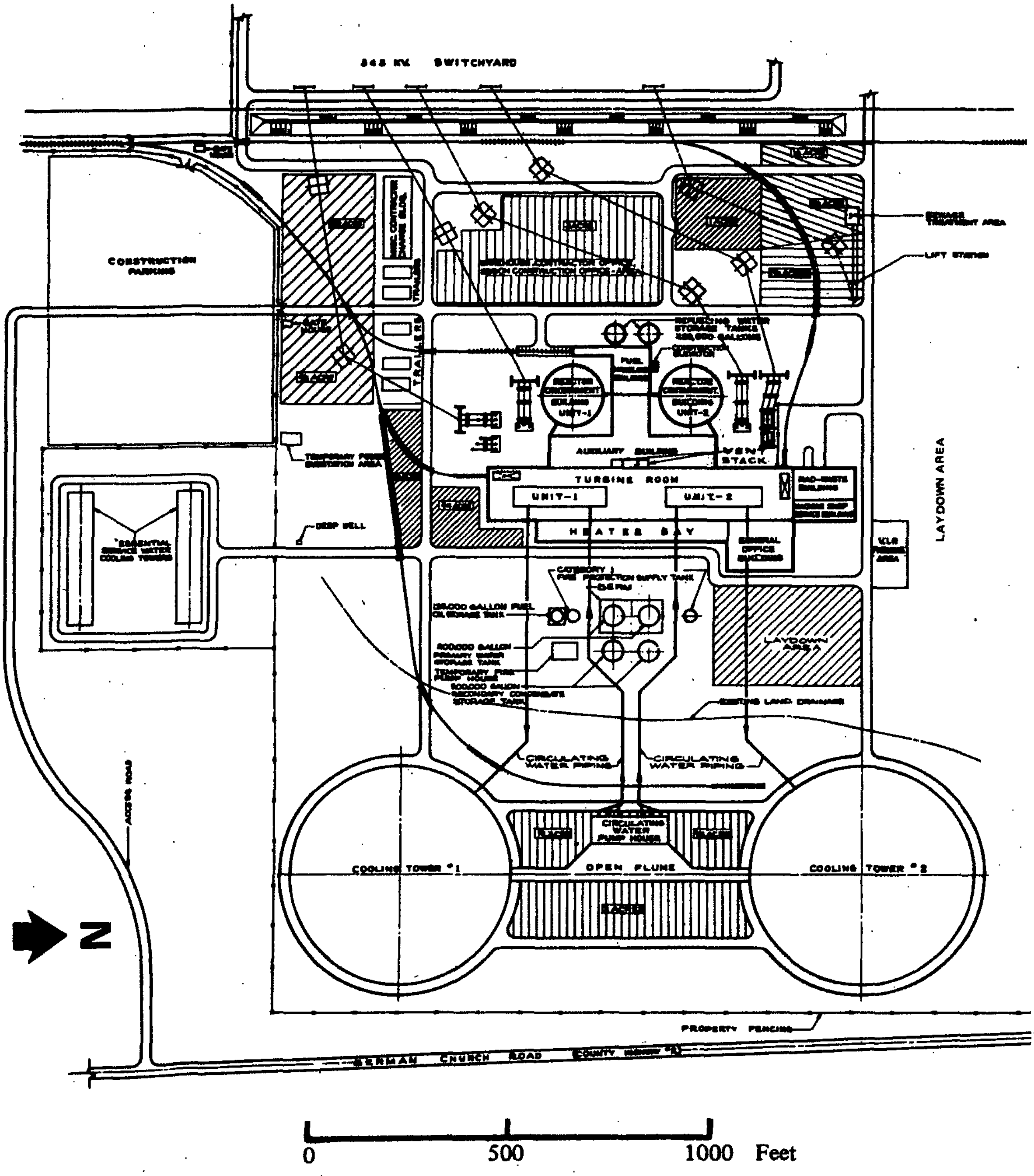

Fig. 3.1. Detail Plan of Plant Structures. From applicant's Environmental Report.

generator. The inplant consumption of energy per unit is estimated to be about 55 MWe. The net power output is, therefore, about 1120 MWe per unit or 2240 MWe for the entire station.

Each reactor contains 193 fuel rod assemblies and each fuel rod assembly contains 264 fuel rods. The 50,952 fuel rods per reactor each contain fuel pellets which are encased in pressurized Zircaloy-4 tubes with welded end caps. Each reactor requires 109 tons of uranium-238 with U-235 enrichment varying from 2.1 to 3.1% by weight. The fuel rods are 12 feet long and each of the 193 fuel assemblies weighs about 1130 lb. In regular operation about 1/3 of the fuel assemblies will be replaced each year. Thus, fuel supply for the proposed units consists of the shipping in of about 17,000 new fuel rods and the shipping out of the same number of spent fuel rods to a fuel reprocessing facility.

3.3 PLANT WATER USAGE

A diagram of the water usage at the station is given in Fig. 3.2. The quantities shown are long-term averages and may be exceeded by as much as 20% for relatively brief periods. The major water use is condenser cooling. The cooling and makeup water supply for the plant will be withdrawn from the Rock River. The anticipated makeup water requirement for the plant operating at 100% capacity is 83to 121 cfs.

The monthly average evaporation rate for the two natural-draft cooling towers are estimated to range between 37 and 60 cfs, depending on weather conditions. The losses due to drift are expected to be about 0.9 cfs. The blowdown necessary to maintain water chemistry is calculated using these evaporative and drift losses. A blowdown varying between 41 and 56 cfs is required to maintain a total dissolved solids (TDS) level at 850 mg/l, depending on the river analysis and the evaporation rate.

The makeup water will be withdrawn from the river through an intake structure, which is in the process of design. (The currently proposed version is shown in Fig. 3.4-2 of Ref. 1.) The location of the proposed intake structure, as well as that of the discharge structure, is indicated in Fig. 3.3. Three intake water pumps will be employed to supply the makeup water needs of the tower system. Two of these pumps are each capable of pumping about 54 cfs. The third pump, for standby operation, will be capable of pumping about 71 cfs.

The design (peak) velocity of the intake flow will be approximately 0.5 feet per second. To protect the water intake system and the circulating water system components from damage, two grill bar structures and a traveling screen system are located in the intake water flow path in front of the intake pumps. The first grill bar structure (trash rack) is located in front of the traveling screen system and stops large objects such as logs and floating debris from entering the intake system. This debris is removed from the trash

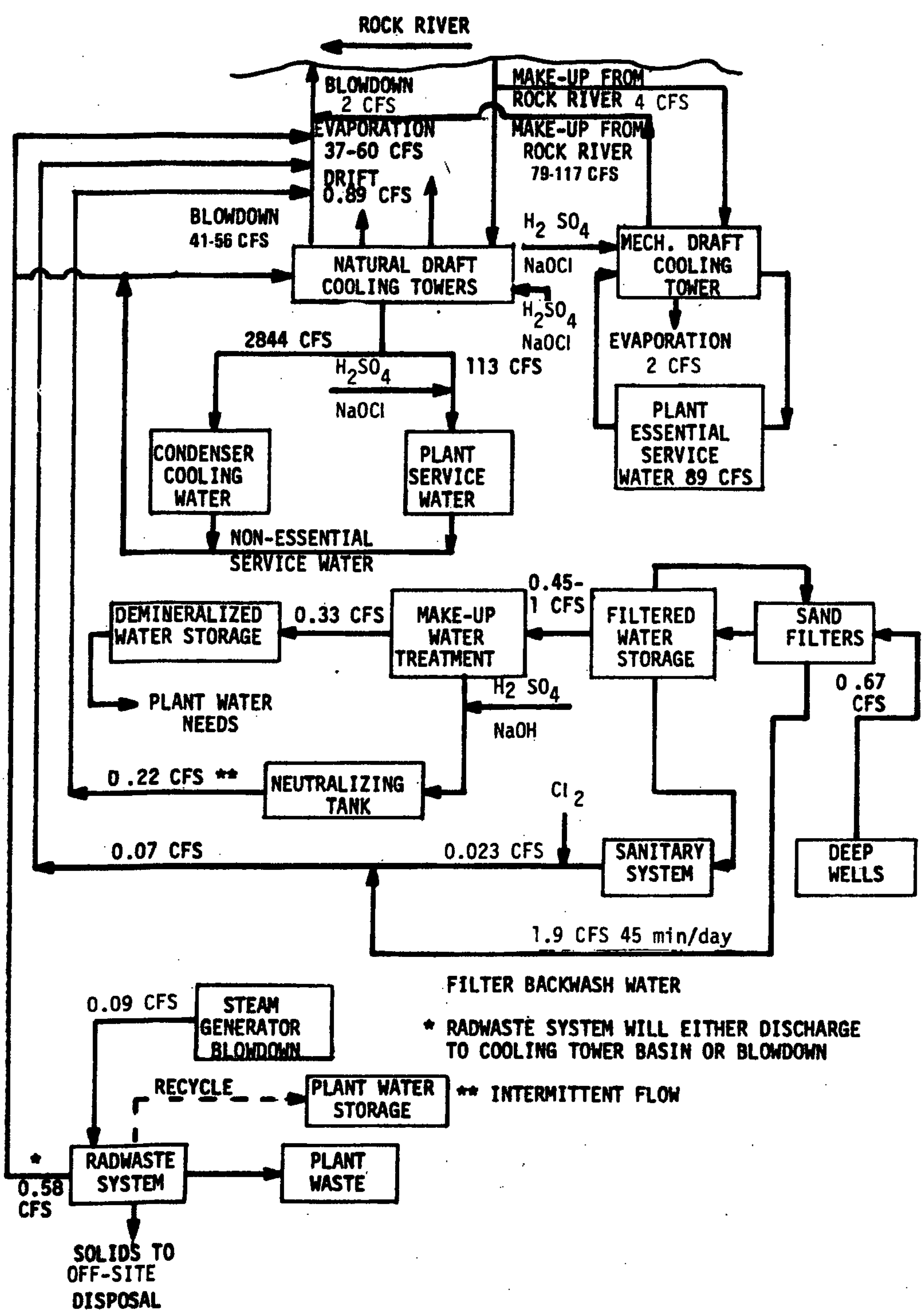

Fig. 3.2. Water Usage Flow Diagram. Modified from applicant's Environmental Report.

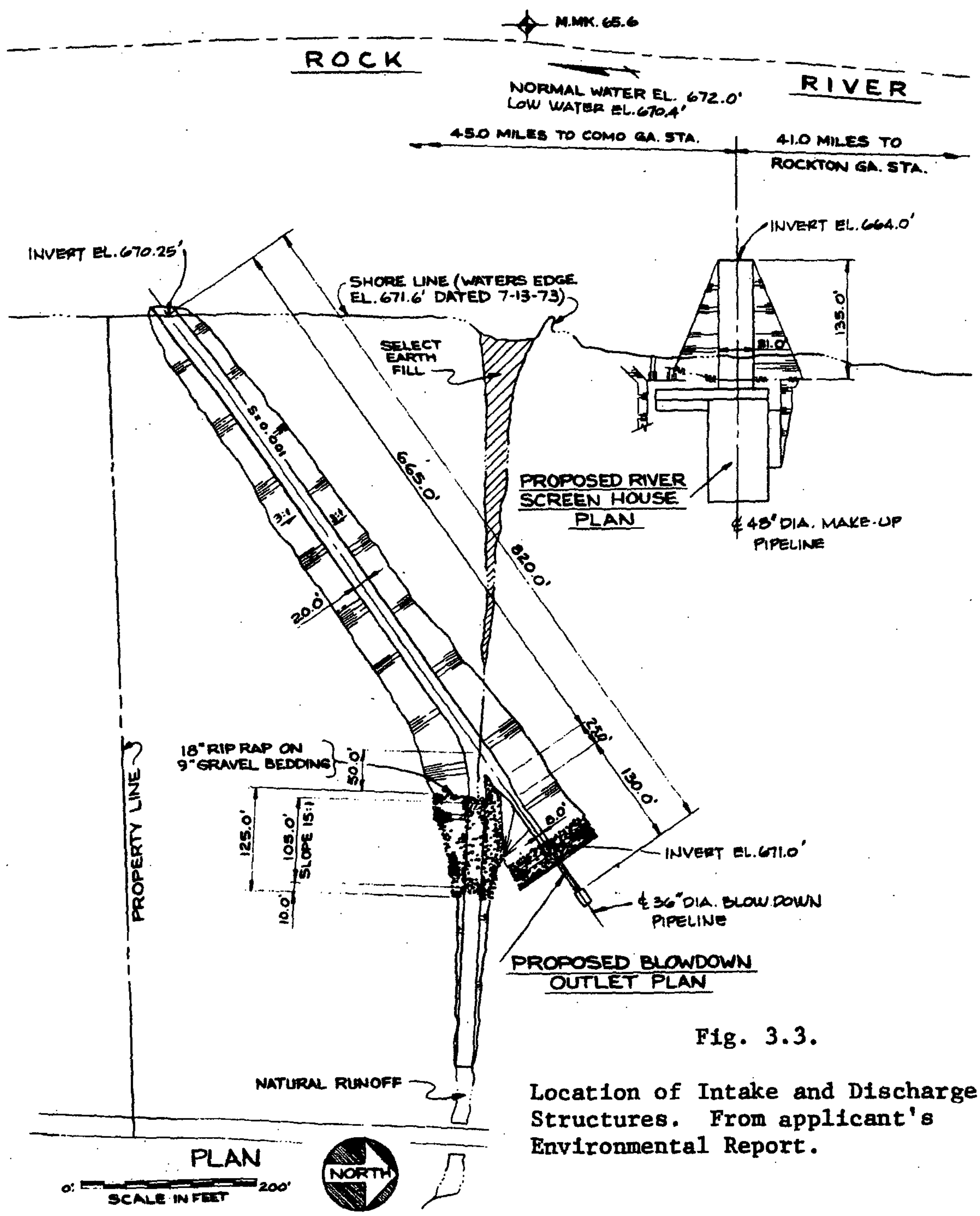

Fig. 3.3.

Location of Intake and Discharge Structures. From applicant's Environmental Report.

rack by a raking device which is part of the trash rack system. The traveling screen system is designed to automatically remove smaller debris from the system and discharge the debris into a trash cart. The second grill bar system is located behind the traveling screen and serves as a second and final stop for any objects that might inadvertently enter the system. This grill must be cleaned manually and under normal operation should remain clear due to the presence of the first grill bar system and the traveling screen. All foreign objects and debris removed by these systems will be disposed of off site by independent licensed refuse contractors (Ref. 1, p. 3.4-3).

The blowdown from the cooling towers, and the wastes from the neutralizing tank and the sanitary system, will be conveyed to the Rock River by an underground pipeline and the discharge structure shown in Fig. 3.4. The applicant states that the discharge velocity will be about two feet per second (Ref. 1., p. 3.4-2), which is comparable to the surface velocity of the river (see Table 2.3).

The Byron Station will require development of a groundwater supply for backup to the essential service water system, for potable water supply, and for demineralizer water. The essential service water use of 1600 gpm for at least 30 days would be required only in the event that water is not available from the Rock River. Water for the demineralizer will be required at the rate of 825 gpm for the first several months, and thereafter at an average rate of about 425 gpm. On the basis of a usage of 50 gallons per capita per day, the design population of 300 plant personnel will require an annual average of about 10 gpm of potable groundwater; the water supply developed will be of the order of 20 gpm, and a storage tank will be installed (Ref. 1, p. 2.5-13).

Analysis of available data indicates that all water demand requirements, including the 1600 gpm for essential core cooling, can be obtained from a single well in the Ironton-Galesville unit, or alternatively, from the deeper Mt. Simon sandstone. During construction a well will be drilled into the Ironton-Galesville sandstone and tested. If 1600 gpm cannot be developed, or if pumping 825 gpm causes significant drawdown in other wells, the well will be extended into the Mt. Simon aquifer. If the well into the Mt. Simon unit produces insufficient yield, additional wells will be developed. In any case, a redundant well will be provided (Ref. 1, p. 2.5-14).

3.4 HEAT DISSIPATION SYSTEM

The 2250-MWt (3425 MWt minus 1175 MWe) of waste heat rejected by each reactor-turbine unit is dissipated to the atmosphere via a natural-draft cooling tower which will be constructed according to the proposed plant design. The waste heat is transferred in the turbine condenser to the circulating water from the cooling tower. The circulating water is pumped through the condenser and cooling tower system at a rate of 1422 cfs (638,300 gpm). The temperature rise of the water as it passes through the condenser is about 24°F maximum.

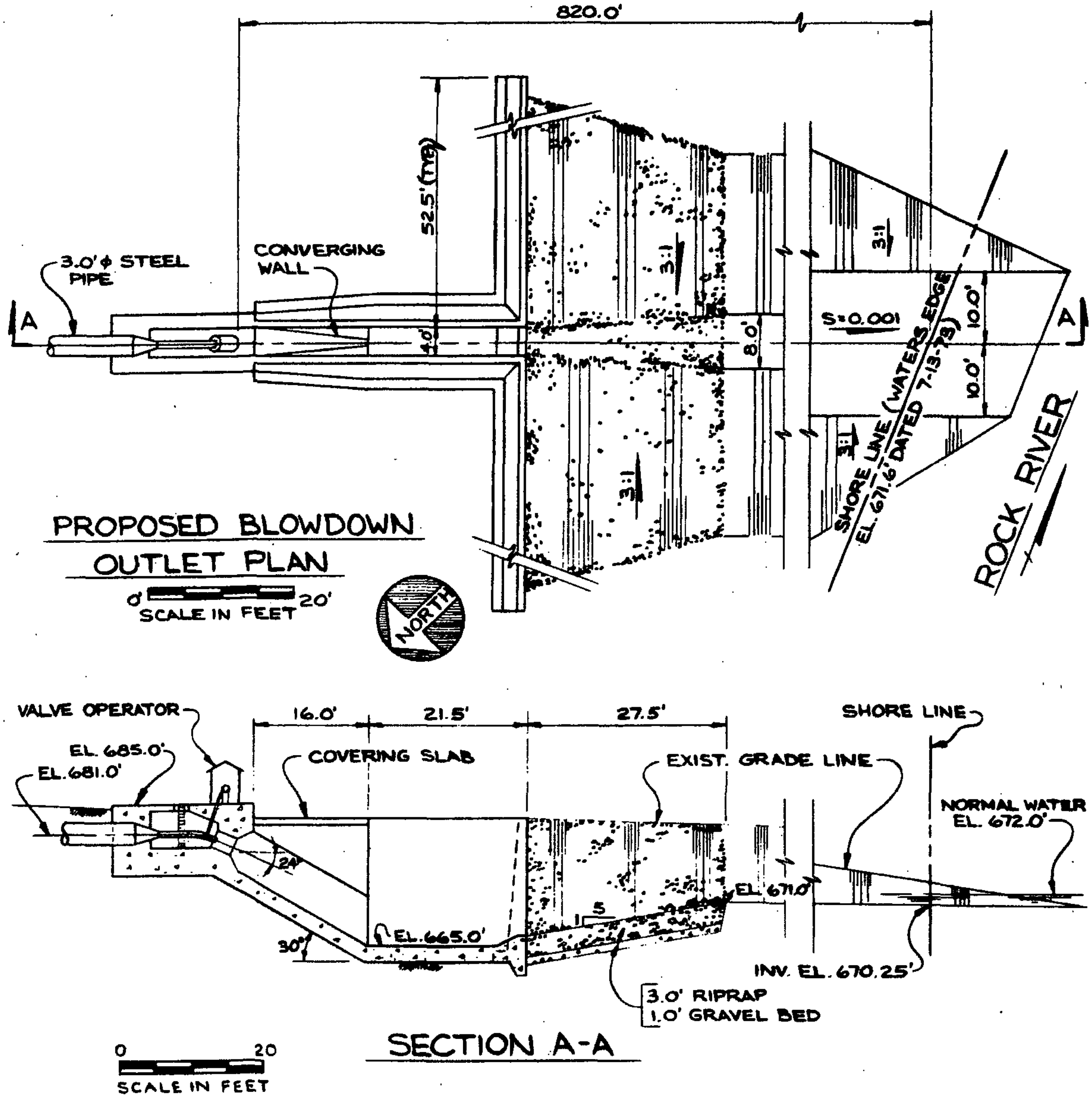

Fig. 3.4. Discharge Structure. From applicant's Environmental Report.

Each of the natural-draft cooling towers is a concrete hyperbolic structure about 500 ft high and 225 ft in diameter at the top. The towers are mounted over a 523-ft diameter concrete collecting basin which contains the cooled circulating water from the tower. Each tower is designed to dissipate approximately 7.6×10^9 Btu/hr of heat. The travel time of the circulating water through the condenser is approximately 14.2 seconds. The ratio of water flow to air flow at design conditions is approximately 2.35 to 1, on a weight basis. Figure 3.5 shows the important parts of a typical natural-draft cooling tower.

The cooling is accomplished by pumping the warmed water from the condenser into the top of the lower portion of the tower, usually about 50 feet above the ground. The water is allowed to flow by gravity through a fill material, which serves to slow the falling water and to break it into small droplets, thus greatly increasing the time and area of contact of the water with the air. Most of the cooling results from the evaporation of a small portion of the circulating water. Sensible heat transfer by conduction to air also contributes to the cooling process.

Air circulation is effected by the density difference between the inlet and the outlet air streams. The heated, moisture-laden air in the tower is less dense than the air outside, and the difference in hydrostatic pressure drives the air through the fill (packing) and up through the tower. Drift eliminators placed inside the tower trap water droplets so that the fraction of the liquid lost from the tower (called drift) compared to vapor is extremely small (<0.03%).

3.5 RADIOACTIVE WASTES

During the operation of Byron Station, radioactive materials will be produced by fission and by neutron activation of corrosion products in the reactor coolant system. From the radioactive material produced, small amounts of gaseous and liquid radioactive wastes will enter the waste streams. These streams will be processed and monitored within the station to minimize the quantity of radionuclides ultimately released to the atmosphere and to the Rock River.

The waste handling and treatment systems to be installed at the station are discussed in the applicant's Preliminary Safety Analysis Report and Environmental Report, both dated September 20, 1973. In these documents, the applicant has prepared an analysis of his treatment systems and has estimated the annual radioactive effluents.

In the following paragraphs, the waste treatment systems are described and an analysis is given based on the staff's model of the applicant's radioactive waste systems. The staff's model has been developed from a review of available data from operating nuclear power plants, adjusted to apply over a 40-year operating life. The coolant activities and flows used in this evaluation are based on experience and data from operating reactors. As a result, the parameters used and the subsequent calculated releases vary somewhat from those given in the

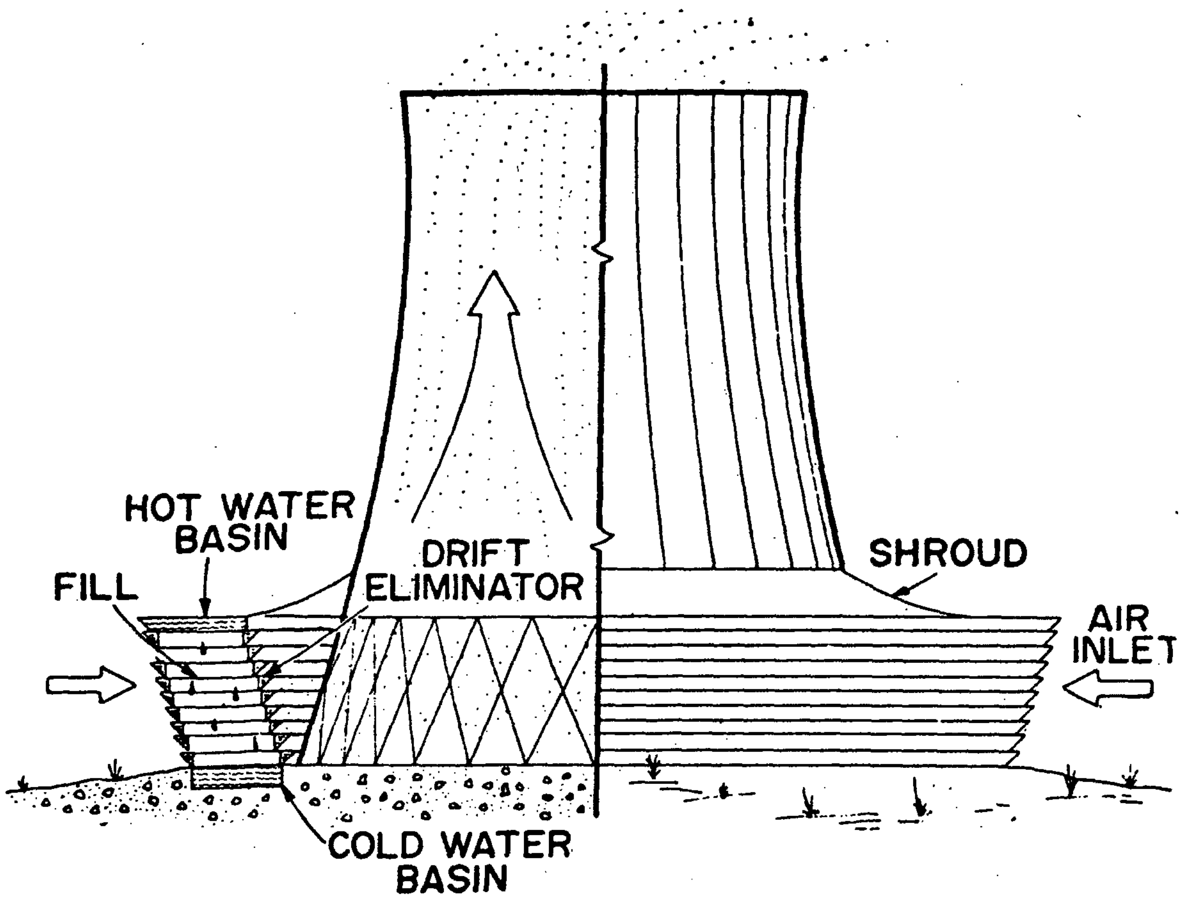

Fig. 3.5. Wet Natural-Draft Tower (crossflow type).

applicant's evaluation. The resulting differences are not considered to be important. The liquid source terms are calculated by means of a revised version of the ORIGEN code.[2] The gaseous source terms are calculated by means of the STEFFEG code.[3] The principal parameters used in the source term calculations are given in Table 3.1. The bases for these parameters are given in WASH-1256, Vol. 2, Appendix B. Based on the following evaluation, we conclude that the liquid, gaseous, and solid waste treatment systems are acceptable and that the effluents meet as low as practicable levels in accordance with 10 CFR Part 50.34(a). The term "as low as practicable" is defined in this regulation to mean "as low as is practicably achievable taking into account the state of technology and the economics of improvements in relation to benefits to the public health and safety in relation to the utilization of atomic energy in the public interest."

3.5.1 Liquid Wastes

The liquid radioactive waste treatment system will consist of process equipment and instrumentation necessary to collect, process, monitor, and recycle or dispose of radioactive liquid wastes. Prior to releasing liquid waste, samples will be analyzed to determine the type and amounts of radioactivity present. Based on the results of these analyses, the wastes will be released under controlled conditions to the Rock River, after being diluted with cooling tower blowdown, or retained for further processing. A radiation monitor will automatically terminate liquid waste discharge if radiation measurements exceed a predetermined level in the discharge line. A simplified diagram of the liquid radwaste treatment systems is shown in Fig. 3.6.

The liquid radioactive waste treatment systems will be divided into three principal systems and will be shared by Units 1 and 2: the Steam Generator Blowdown (SGB), the Radioactive Waste Drains (RWD), and the Radioactive Laundry Waste (RLW) systems. The SGB will be processed continuously through the blowdown evaporator and polishing demineralizers; this water will be reused in the plant. The RWD system collects water in individual tanks from floor drains, equipment leakage and chemical operations. After sampling and analysis, RWD water will be processed batchwise with the appropriate combinations of filtration, evaporation and ion exchange. RWD water may be reused in the plant or discharged after treatment. RLW water will be treated by reverse osmosis (RO) and evaporation to remove radionuclides and detergents. The permeate will be analyzed to determine if it is suitable to reuse or will be retreated or discharged.

In addition to the preceding three systems, the Chemical and Volume Control System (CVCS) and the Boron Recycle System (BRS) are considered in our evaluation. The CVCS and BRS process reactor grade water to control boron concentration and reactor coolant purity.

TABLE 3.1. Principal Parameters and Conditions Used in Calculating Releases of Radioactive Material in Liquid and Gaseous Effluents from Byron Station (per unit)

Reactor power level (MWt)	3565
Plant capacity factor	0.80
Failed fuel[a]	0.25%
Primary system	
Mass of coolant (lb)	5.34×10^5
Letdown rate to CVCS (gpm)	61
Shim bleed rate (gpm)	1.5
Leakage rate to secondary system (lb/day)	110
Leakage rate to Containment Building (lb/day)	240
Leakage rate to Auxiliary Building (lb/day)	160
Frequency of degassing for cold shutdowns (per year)	2
Secondary system	
Steam flow rate (lb/hr)	1.5×10^7
Mass of steam/steam generator (lb)	9.1×10^3
Mass of liquid/steam generator (lb)	1.17×10^4
Secondary coolant mass (lb)	5.05×10^5
Rate of steam leakage to Turbine Building (lb/hr)	1.7×10^3
Steam generator blowdown rate (lb/hr)	7.7×10^3
Dilution flow (gpm)	4.4×10^3
Containment Building volume (ft^3)	2.93×10^6
Frequency of containment purges (per year)	4
Iodine partition factors (gas/liquid)	
Leakage to Containment Building	0.1
Leakage to Auxiliary Building	0.005
Steam leakage to Turbine Building	1
Steam generator (carryover)	0.01
Main condenser air ejector	0.0005

Decontamination factors (DF) for liquids

	Boron Recycle	*Equipment Drains*	*Waste Drains*
I	1×10^5	1×10^3	1×10^3
Cs, Rb	2×10^3	1×10^4	1×10^4
Mo, Tc	1×10^5	1×10^6	1×10^6
Y	1×10^4	1×10^4	1×10^5
Others	1×10^5	1×10^5	1×10^4

TABLE 3.1. (Cont'd)

	All Nuclides Except Iodine		Iodine
Waste evaporator DF	10^4		10^3
BRS evaporator DF	10^3		10^2
	Cation[b]	Anion[b]	Cs, Rb
Mixed bed demineralizer (Li_3BO_3) DF	10	10	2
Mixed bed demineralizer (H^+ OH^-) DF	10^2(10)	10^2(10)	2(10)
Cation demineralizer DF	10^2(10)	1(1)	10(10)
Anion demineralizer DF	1(1)	10^2(10)	1(1)
(NOTE - for two demineralizers in series, the DF for the second demineralizer is given in parenthesis.)			

	Removal Factor
Removal by plateout	
Mo, Tc	10^2
Y	10
Containment Building internal recirculation system	
Flow rate	1.6×10^4 CFM
Operating period/purge	16 hours
Mixing efficiency	70%

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

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

3.5.1.1 Steam Generator Blowdown (SGB)

The SGB system will process steam generator blowdown from both units, and will have a capacity of 120 gpm. The blowdown water will pass through filters, an evaporator and, as needed, through mixed bed demineralizers. After treatment the stream will be returned to the condensate storage tank for reuse. Although the staff calculates that the SGB treatment system will have sufficient capacity of the blowdown stream, the analysis assumed the release of 100 percent of the treated stream since it will contain less than 0.01 curie (Ci)/yr/unit, excluding ~~tritium and~~ noble

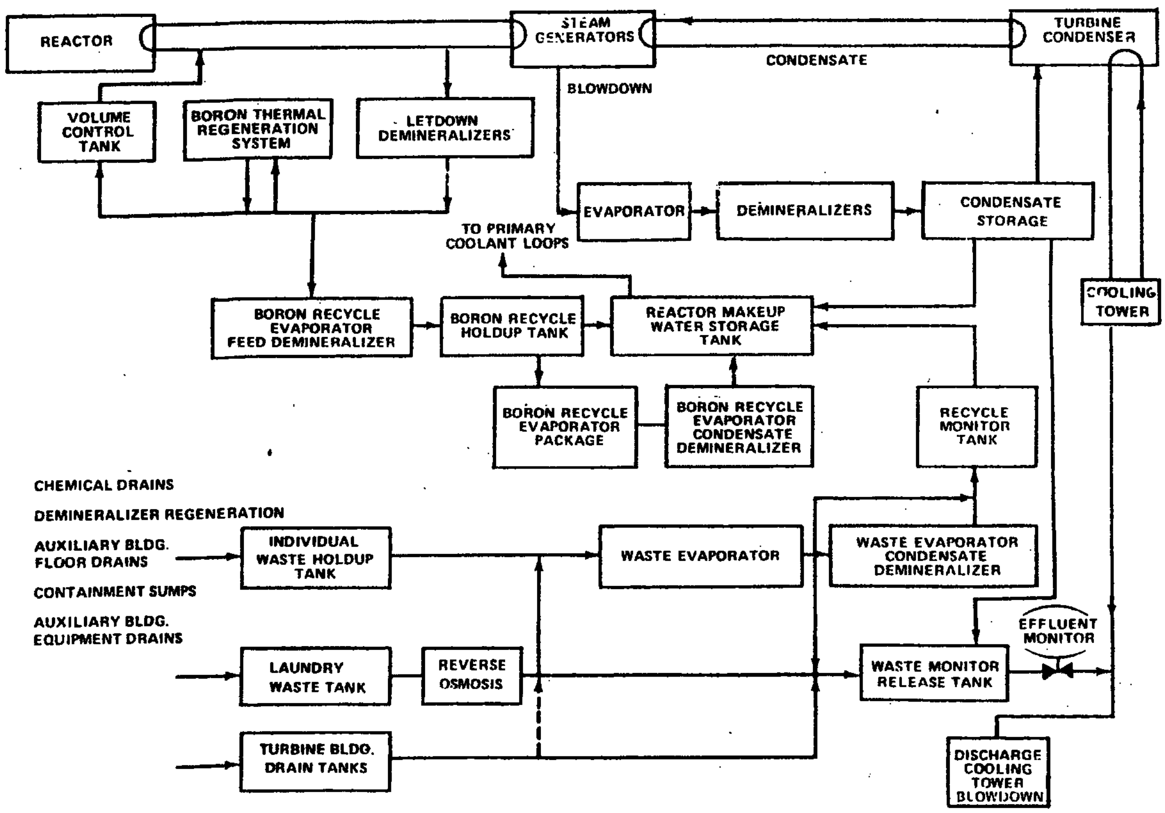

Fig. 3.6. Liquid Waste Treatment Systems.

gases. Radionuclide removal by the demineralizers was not included in the evaluation since the applicant indicated that demineralizers would be used primarily to reduce the effect of operational occurrences and not for routine processing. The applicant assumed 20% of the treated blowdown will be discharged releasing 0.0005 Ci/yr/unit other than tritium and noble gases.

3.5.1.2 Radioactive Waste Drains (RWD)

The RWD system will collect liquid from the containment sumps, auxiliary building floor drains, turbine building floor drains auxiliary building equipment drains, turbine building equipment drains, demineralizer regeneration waste drains and chemical drains. Each of these substreams will be collected in its respective drain analysis tanks where its radioactivity level and chemical composition will be ascertained and an appropriate treatment method determined. With the exception of the turbine building drains, liquid radioactive waste will normally pass in batches through a 50 gpm evaporator. The evaporator condensate will be processed through a demineralizer. The treated waste will then be discharged, reprocessed or reused based on its radioactivity content and plant water balance requirements. The liquid from turbine building drains, which are expected to have negligible activity, will be monitored and discharged without treatment unless the activity exceeds a predetermined level, in which case it will be treated prior to discharge.

The staff's evaluation assumed that all of the water from the RWD system will be discharged. This discharge will be approximately 1400 gpd/unit of treated water containing 0.01 Ci/yr/unit except tritium and noble gas, and 7200 gpd of untreated turbine building water containing an additional 0.04 Ci/yr/unit excluding tritium and noble gas. The release values were calculated using the parameters in Table 3.1. Radionuclide removal by the polishing demineralizer was not included in the calculations since the applicant indicated that the demineralizer would be used primarily to reduce the effect of operational occurrences and not for routine processing.

The applicant estimates the release of 1100 gpd of treated RWD water containing 0.006 Ci/yr/unit, excluding tritium and noble gases. The applicant also estimates the release of 300 gpd/unit of untreated turbine building liquid containing 0.0004 Ci/yr/unit, excluding tritium and noble gases.

3.5.1.3 Laundry Waste Subsystem (LWS)

Laundry wastes will be collected in the 4000-gallon laundry waste tank and processed by reverse osmosis to remove detergents and particulate matter prior to treatment in the waste evaporator. The staff estimated that the laundry tank activities would be equivalent to 10^{-10} Ci/cc prior to treatment and the generation rate to be 450 gpd/reactor. The applicant assumed that 20 percent of the treated laundry waste would be released. The staff finds this assumption to be reasonable and concludes that the release of radioactivity from the LWS will be negligible.

3.5.1.4 Boron Recycle System (BRS)

Primary coolant will be withdrawn from the reactor coolant system at approximately 61 gpm and processed through the Chemical and Volume Control System (CVCS). The letdown stream will be cooled, reduced in pressure, filtered, and processed through one of two mixed bed demineralizers. Approximately 12 percent of this letdown stream will be passed through an additional cation demineralizer to remove excess lithium and cesium. Radionuclide removal by the CVCS was evaluated by assuming 61 gpm letdown flow at primary coolant activity (PCA) through one mixed bed demineralizer (Li_3BO_3 form) and 7.5 gpm flow through one cation demineralizer in series with the mixed bed. The CVCS will be used to control the boron concentration in the primary coolant by passing a portion of the letdown stream through the boron thermal regeneration system. A side stream of approximately 1.5 gpm of the treated letdown stream is diverted to the BRS as shim bleed. In the boron thermal regeneration system, boron will be either absorbed from or desorbed into the letdown stream depending upon the stream temperature. Since the thermal regeneration demineralizer resins will desorb as well as absorb radioactivity, this system was given no credit for radionuclide removal. However, use of the thermal regeneration system will reduce the quantity of liquid waste generated from boron control.

Shim bleed from the letdown stream will be processed through one of two mixed bed demineralizers (Li_3BO_3 form) and routed to the recycle holdup tanks. Valve leakoffs and equipment drain wastes in the reactor containment as well as excess spent fuel pit water will be transferred to the recycle holdup tank and combined with the shim bleed. These streams from each reactor will form the principal inputs to the BRS and will be processed batchwise from the recycle holdup tanks. The shim bleed input activity was calculated by applying the decontamination factor (DF) for a mixed bed demineralizer in the Li_3BO_3 form to the shim bleed stream, and assuming 1.5 gpm/reactor flow and CVCS output activity. The reactor coolant drain tank input flow to the BRS was taken to be 360 gpd/reactor at PCA based on the applicant's assumption, which was found to be reasonable. Radioactive decay during collection in the recycle holdup tank is included in the ORIGEN code. The collection time was calculated to be 18 days assuming the 112,000 gallon recycle holdup tanks will be filled to 80 percent capacity by the combined shim bleed and reactor coolant drain tank flows from both reactor units. Radionuclide removal was based on the parameters in Table 3.1 for an evaporator and an anion demineralizer in series. Additional credit for radioactive decay time during processing of the contents of the recycle holdup tank through the two recycle evaporators has been given. In the evaluation, it was assumed that equipment downtime and anticipated operational occurrences will result in approximately 10 percent of the evaporator condensate stream being discharged with the cooling tower blowdown to the Rock River. The applicant assumed that the BRS stream will be recycled and did not specify a discharge fraction in his evaluation.

3.5.1.5 Liquid Waste Summary

The staff calculated the releases of radioactive materials in the liquid wastes to be 0.1 Ci/yr/reactor, excluding noble gases and tritium. Based on previous experience at operating reactors, the staff estimated the tritium releases to be 350 Ci/yr/reactor. The applicant estimated the releases to be 0.001 Ci/yr/reactor, excluding tritium; the tritium release was estimated to be 102 Ci/yr/reactor. The differences between the staff's values and those calculated by the applicant are due largely to the quantity of BRS waste recycle in the respective models. The staff assumed 10 percent of the BRS stream would be discharged over the life of the plant due to equipment downtime and anticipated operational occurrences, whereas the applicant assumed total recycle of this stream.

Based on the staff's evaluation, the radioactivity in liquid effluents from Units 1 and 2, exclusive of tritium and dissolved noble gases, will be less than 5 Ci/yr (see Table 3.2). The whole body and critical organ doses will be less than 5 mrem/yr. The staff concludes that the liquid radwaste treatment systems will reduce liquid radioactive effluents to as low as practicable levels in accordance with 10 CFR 50.34(a).

3.5.2 Gaseous Waste

The gaseous waste treatment and ventilation systems will consist of equipment and instrumentation necessary to reduce releases of radioactive gases and airborne particulates from equipment and building vents. The principal source of radioactive gaseous waste will be gases stripped from the primary coolant in the CVCS and BRS. Additional sources of gaseous wastes will be main condenser vacuum pump offgases, ventilation exhausts from the auxiliary, radwaste, fuel handling and turbine buildings, and gases collected in the reactor containment building. The principal system for treating gaseous wastes will be the gaseous waste processing system (GWPS). The GWPS will collect and store gases stripped from the primary coolant in a continuously recirculating nitrogen loop containing two compressors and six pressurized storage tanks. The GWPS will be shared by Units 1 and 2. The ventilation exhaust from the auxiliary, radwaste, and fuel handling buildings and the offgases from the main condenser vacuum pump will be processed through HEPA filters before release to the atmosphere. Since the auxiliary building ventilation and main condenser vacuum exhausts can also be processed through charcoal filters when necessary, such flow was assumed to meet AEC as low as practical guidelines. Offgases from the turbine building will be released without treatment. The containment atmosphere will be recirculated through filters and charcoal adsorbers prior to purging through HEPA filters to the atmosphere.

The steam generator blowdown treatment system will cool the blowdown in heat exchangers to prevent flashing. The blowdown condensate will be collected in the condenser hotwell where degassing occurs due to the relatively low pressure in the condenser. The gaseous waste treatment systems are shown schematically in Fig. 3.7.

TABLE 3.2. Byron Liquid Radioactive Source Terms

Radionuclide	*Ci/yr/unit*	*Radionuclide*	*Ci/yr/unit*
Br-82	0.00001	Cs-134	0.00594
Sr-89	0.00001	Cs-136	0.00090
Y-91	0.00009	Cs-137	0.00459
Mo-99	0.00002	Ba-137m	0.00430
Tc-99m	0.00002	Ba-140	0.00001
Te-127m	0.00001	La-140	0.00001
Tc-127	0.00001	Cr-51	0.00003
Te-129m	0.00005	Mn-56	0.00001
Te-129	0.00003	Fe-55	0.00003
Te-131m	0.00002	Fe-59	0.00002
Te-132	0.00037	Co-58	0.00028
I-130	0.00005	Co-60	0.00004
I-131	0.06245	W-187	0.00001
I-132	0.00087		
I-133	0.01738		
I-135	0.00237		
H-3	350	All others	0.00008
		Total	0.10000

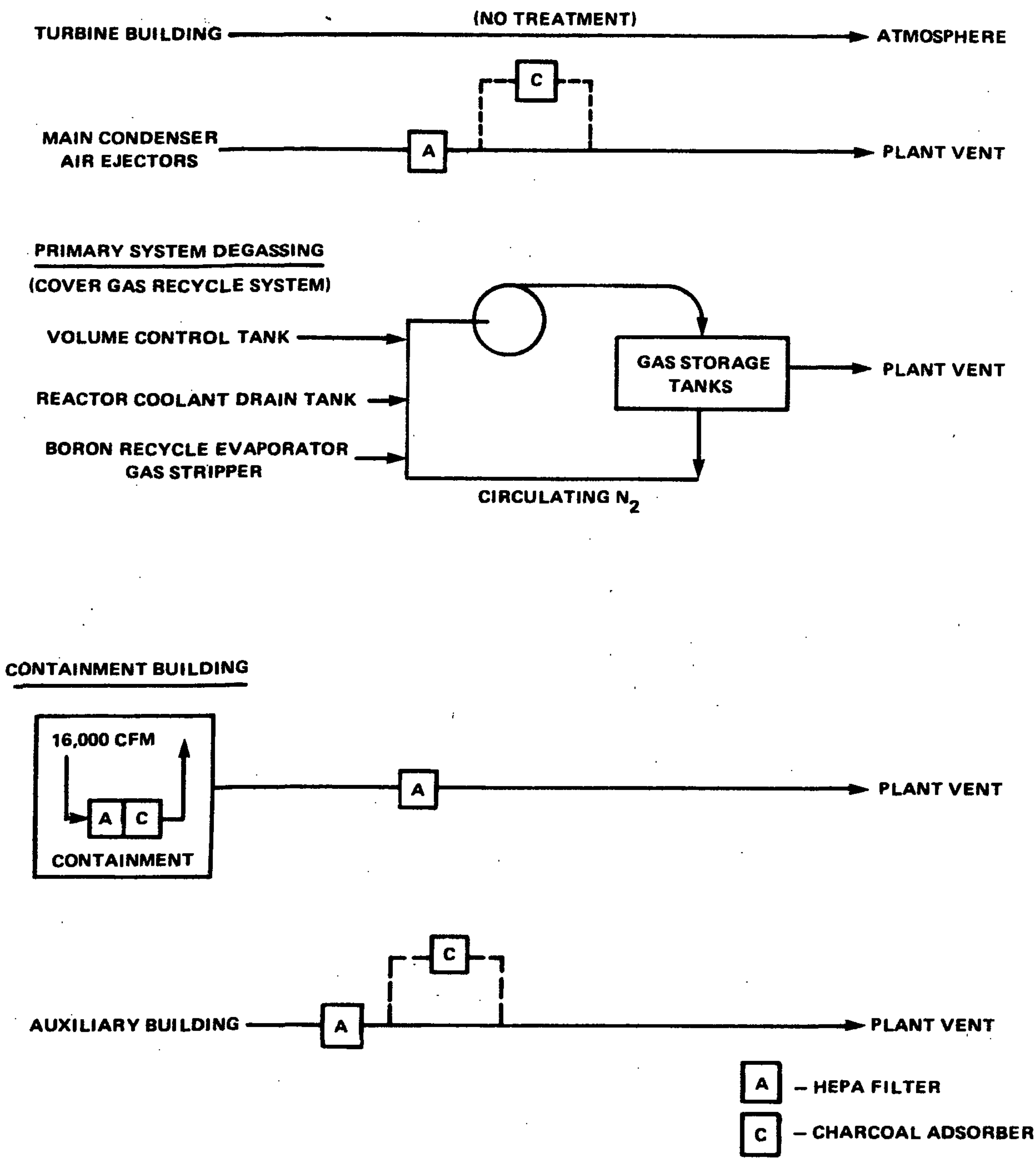

Fig. 3.7. Gaseous Waste Treatment Systems.

3.5.2.1 Gaseous Waste Processing System (GWPS)

The gaseous waste processing system will be designed to collect and process gases stripped from the primary coolant of the CVCS, BRS, and miscellaneous tank cover gases. The GWPS will contain nitrogen which will be recirculated continuously as a carrier to transport radioactive gases removed from the primary coolant. Hydrogen cover gas from the volume control and reactor coolant drain tanks, and gases stripped in the BRS degassifier will enter the nitrogen loop. The nitrogen, hydrogen and radioactive gases will be collected, compressed and stored in one of six pressurized storage tanks. After holdup, to allow short-lived radionuclide decay, the nitrogen, hydrogen, and long-lived nuclides will be reused in the loop or discharged to the environment if sufficient decay has occurred.

The applicant considers the system to be capable of retaining radioactive gases for at least 45 days. This estimate was considered to be reasonable and calculations were based on release after 45 days holdup, which will leave Kr-85 (10.7-yr half life) and Xe-133 (5.27-day half life) as the predominant radionuclides. The GWPS releases were calculated to be 1110 Ci/yr/reactor for noble gases and negligible for iodine. The applicant's corresponding estimates were 6600 Ci/yr/reactor and a negligible amount of iodine. The applicant's more conservative estimate is based on operation with one percent of the operating power fission product source term while the staff's analysis used 0.25 percent of the operating power fission product source term.

3.5.2.2 Containment Purges

Radioactive gases will be released inside the reactor containment when primary system components are opened or when leaks occur in the primary system. The gaseous activity will be sealed within the containment during normal operation but will be released periodically during containment purges. Prior to purging, the containment atmosphere will be recirculated through HEPA filters and charcoal adsorbers for particulate and iodine removal. Following this recirculation procedure, the containment will be purged to the atmosphere through HEPA filters. Calculation of the airborne activity was based on the parameters listed in Table 3.1 for primary coolant leakage to the containment. Radionuclide removal was based on 16 hours of recirculation system operation, 70 percent mixing efficiency, and a DF of 10 for the recirculation charcoal adsorber. Assuming 4 containment purges per reactor per year, the staff calculated the releases to be 190 Ci/yr/reactor of noble gases and 0.001 Ci/yr/reactor of iodine-131. The applicant estimated a release of 560 Ci/yr/reactor of noble gases and 0.008 Ci/yr/reactor of iodine-131 based on a conservative assumption of 10 purges per year for each reactor.

3.5.2.3 Auxiliary and Fuel Handling Building Vent Releases

Radioactive gases will be released to the auxiliary and fuel handling buildings due to leakage from primary system components. These two buildings will share a common ventilation system designed to ensure that air flow will be from areas of low potential to areas having a greater potential for the release of airborne radioactivity. Ventilation air will be exhausted through HEPA filters for particulate removal. The ventilation air can also be continuously exhausted through charcoal; this operation was assumed by the staff. Releases were based on the auxiliary building leakage rate and iodine partition factor listed in Table 3.1 with credit given for the charcoal adsorber in the operating stream. The staff thus calculated the auxiliary building releases to be 1100 Ci/yr/reactor of noble gases and 0.01 Ci/yr/reactor for iodine-131. The applicant estimated the releases to be 0.015 Ci/yr/reactor of iodine-131 and "small quantities of noble gases."

3.5.2.4 Turbine Building Vent Releases

Radioactive gases will be released to the turbine building from secondary system steam leakage. The turbine building ventilation system exhausts will not be treated prior to release. The calculated release values are based on 1700 lb/hr/reactor of steam leakage to the turbine building assuming that all of the noble gases and iodine remain airborne. On this basis, the turbine building vent release was calculated to be negligible for noble gases and 0.03 Ci/yr/reactor for iodine-131. The applicant estimated 0.001 Ci/yr/reactor for iodine-131 and did not specify a noble gas release.

3.5.2.5 Steam Releases to the Atmosphere

The capacity of the turbine bypass to the condenser will be 40 percent of the flow. Analysis indicates that steam releases to the environs due to turbine trips and low power physics testing will have a negligible effect on the calculated source term.

3.5.2.6 Main Condenser Offgas Releases

Offgas from the main condenser vacuum pump exhausts will contain radioactive gases resulting from primary to secondary system leakage. Iodine will be partitioned between the steam and liquid phases in the steam generators and between the condensing and non-condensable phases in the main condensers and vacuum pumps. The major concentration of iodine present in the vacuum pump exhaust will be released through a charcoal adsorber to the plant vent. The staff used 20 gpd/reactor of primary to secondary leakage, partition factors of 0.01 and 0.0005 for iodine in the steam generators and main condenser vacuum pumps, respectively, a DF of 10 for the charcoal adsorbers and calculated the main condenser vacuum pump releases to be approximately 1110 Ci/yr/reactor for noble gases and 0.01 Ci/yr/reactor for iodine-131. The applicant estimated this release to be 16,275 Ci/yr/reactor for noble gases and 0.001 Ci/yr/reactor for iodine-131. The applicant's estimated releases are somewhat higher than those calculated by the staff because a more conservative model was used. The applicant's estimate was based on operating with one percent of the fission product source term; the staff's analysis used 0.25 percent. The applicant also assumed a leak rate equivalent to 68 gpd/reactor primary to secondary leak rate, whereas the staff assumed 20 gpd/reactor.

3.5.2.7 Gaseous Waste Summary

Based on the parameters given in Table 3.1, the total radioactive gaseous releases were calculated to be approximately 3500 Ci/yr/reactor of noble gases and 0.05 Ci/yr/reactor of iodine-131. The principal sources and isotopic distributions are given in Table 3.3. The applicant has calculated an overall release of approximately 23,400 Ci/yr/reactor of noble gases and 0.03 Ci/yr/reactor of iodine-131.

Based on evaluations of the gaseous waste treatment systems, the staff calculated that the release of radioactive materials in gaseous effluents from the operation of both reactors will result in a whole body dose of less than 5 mrem/yr to individuals at or beyond the site boundary, and a dose of less than 15 mrem/yr to a child's thyroid through the pasture-cow-milk cycle from the first real cow, located 1040 feet ENE of the site. These calculations indicate that the proposed gaseous radwaste systems, as evaluated, will reduce radioactive effluents to as low as practicable levels in accordance with 10 CFR Part 50.34(a), and therefore the staff concludes that the proposed gaseous radwaste systems are acceptable.

3.5.3 Solid Waste

Solid waste containing radioactive materials will be generated during station operations. Solid wastes will be categorized as "wet" or "dry" based upon the need for moisture absorption and solidification during processing. The solid waste system will consist of a waste drumming subsystem for dry solid waste.

Wet solid wastes will consist mainly of spent demineralizer resins, filter sludges, evaporator bottoms, reverse osmosis concentrates and chemical drain tank effluents. These wastes will be combined with a cement and vermiculite mixture to form a solid matrix and sealed in 55-gallon steel drums. Since the majority of the radioactivity entering the liquid waste streams will be removed by demineralizers, evaporators, or filters and become wet solid wastes, these wastes are considered to be stored for a least 180 days for radioactive decay prior to shipment offsite.

Dry solid wastes will consist of ventilation air filters, contaminated clothing and paper and miscellaneous items such as tools and laboratory glassware. Dry solid wastes will be compressed into 55-gallon drums using a hydraulic press-baling machine. Since dry solid wastes will contain much less activity than wet solid wastes, no onsite storage of dry solid wastes was included in the evaluation.

Based on the staff's evaluation of similar reactors and operating reactor data, it was estimated that approximately 600 drums of wet solid waste containing approximately 12 Ci/drum, and 450 drums of dry solid waste containing less than 5 Ci total, for each reactor, will be shipped

TABLE 3.3. Byron Gaseous Radioactive Source Term, Ci/yr/unit

Radionuclide	Decay Tanks	Building Ventilation Reactor	Building Ventilation Auxiliary	Building Ventilation Turbine	Air Ejector Offgas	Total
Kr-38m	a	a	1	a	1	2
Kr-85m	a	a	7	a	7	14
Kr-85	960	14	7	a	7	988
Kr-87	a	a	4	a	4	8
Kr-88	a	a	12	a	12	24
Kr-89	a	a	a	a	a	a
Xe-131m	29	2	6	a	6	43
Xe-133m	a	1	13	a	13	27
Xe-133	120	170	1,025	1	1,036	2,357
Xe-135m	a	a	1	a	1	2
Xe-135	a	a	20	a	20	40
Xe-137	a	a	1	a	1	2
Xe-138	a	a	3	a	3	6
I-131	a	0.001	0.01	0.03	0.01	0.05
I-133	a	0.001	0.01	0.02	0.01	0.04

a - < 1 Ci/yr/unit noble gases, < 10^{-4} Ci/yr/unit iodine.

offsite annually. More than 90 percent of the radioactivity associated with the solid waste will be long-lived fission and corrosion products, principally Cs-134, Cs-137, Co-58, Co-60, and Fe-55. The applicant estimates that approximately 1060 drums of wet solid wastes ranging from 2 to 260 Ci/drum, and 180 drums of dry solid waste ranging from negligible activity to 3.40 Ci/drum will be shipped offsite annually.

3.5.3.1 Solid Waste Summary

All containers will be shipped to a licensed burial site in accordance with AEC and DOT regulations. The solid waste system will be similar to systems which have been evaluated and found to be acceptable in previous license applications. Based on its similarity to acceptable systems, the staff considers this solid waste system to be acceptable.

3.6 CHEMICAL AND BIOCIDE RELEASES

Chemical discharges result from (a) the evaporation of water in the cooling towers which concentrates naturally occurring impurities; (b) the addition of sulfuric acid to various water systems to control scaling; the addition of chlorine (in the form of hypochlorite) to control slimes in (c) the cooling towers and (d) the service water systems; (e) the use of sulfuric acid and sodium hydroxide and from the ions released from the makeup water ion exchanger during regeneration; (f) steam generator blowdown, (g) drift emitted by the cooling towers, (h) plant sewage, (i) the burning of oil in the auxiliary steam boilers, and, occasionally (j) the diesels driving the emergency power system.

Items (a) and (b): Using the average of the seasonal analyses of the Rock River (Ref. 1, Table 3.6-1), the staff has calculated the following average composition of the circulating water (concentrations in ppm):

Ca^{++}	119	HCO_3^-	126
Mg^{++}	63	$SO_4^=$	437
Na^+	33	Cl^-	40
		NO_3^-	21
		SiO_2	12

The total concentration of these salts is 851 ppm, approximately the level of total dissolved solids computed by the applicant. The resulting concentration factor is 2.05. The pH (7.5) is 0.1 unit less than the pH of saturation of calcium carbonate at 60°F. Some 78% of the bicarbonate originally present was calculated to be released by the addition of sulfuric acid.

The total salt concentration is in excess of that in the river water by 391 ppm. Using an average evaporation rate for both units of 47.0 cfs and a drift rate of 1 cfs (Ref. 1, Table 3.3-1), the staff computes the average makeup rate as 92 cfs and the average blowdown rate as 44 cfs. The quantity of salts returned to the river, in excess of the amount in a volume equal to that discharged in blowdown, would thus be 92,500 lb/day for full power operation. This quantity, if completely mixed in the river water, increases the dissolved solids by only 0.8%. This is not primarily a consequence of the addition of chemicals, but of a net removal (by evaporation) of water from the river.

On the basis of the same drift (0.9 cfs), the maximum monthly average evaporation rate of 60.4 cfs (Ref. 1, p. 3.3-2), and average summer river water composition, the maximum blowdown rate is calculated to be 55.5 cfs and the maximum makeup rate is 116.8 cfs. Assuming the same drift rate, the minimum monthly average evaporation rate of 37.0 cfs (Ref. 1, p. 3.3-2), and average winter river water composition, the minimum blowdown rate is calculated to be 40.7 cfs and the minimum makeup rate is 78.6 cfs.

Item (c), the intermittent addition of sodium hypochlorite to the extent required to develop a free residual chlorine concentration of 0.1 at the condenser outlet will lead to a concentration of chloramines* in the system that cannot be readily estimated. Chloramines are more persistent than chlorine and are also toxic to biota.[4] By analogy with findings for another system, the free chlorine in the cooling tower basins might be near zero and yet the combined chlorine (i.e. the chloramines) a few tenths of a part per million, decaying over a period of a few hours.[5]

Item (d): Chlorination of the non-essential service water systems will lead to the development of about 0.1 ppm of free chlorine and perhaps a few tenths of a ppm of combined chlorine. This solution will be combined with cooling tower flow and diluted by a factor of 26; the concentrations of chlorine will also be reduced by reaction with deposits and chlorine-demand constituents in the recirculating water system. The cooling tower blowdown is not expected to contain measureable free chlorine (i.e., less than 0.1 ppm) resulting from the chlorination of the non-essential service water system.

Similar chlorination procedures and schedules will be used to chlorinate the essential service water systems. In this instance the solution will be sent to mechanical draft cooling towers (MDCT) (see Fig. 3.2). The blowdown from these towers will probably contain combined chlorine at about the same concentration as the blowdown of the natural-draft cooling towers (NDCT). Assuming no chlorine will be in the NDCT blowdown when the blowdown from the MDCT is added to it, the MDCT blowdown will be diluted there by a factor of about 11 to 20; furthermore, the residual chlorine will react with chlorine-demand constituents of the water and in deposits on the system. At the point of discharge to the river, the staff estimates that the combined blowdown will contain less than a few hundredths of a part per million of residual chlorine from the essential service water system.

Item (e): Preliminary calculations (Ref. 1, Sec. 3.6.3) indicate that about 4125 lb/day of 93% sulfuric acid and 3640 lb/day of sodium

*See Ref. 1, Sec. 3.6.2.2 for discussion of the formation of these compounds.

hydroxide will be used for regeneration of the makeup water demineralizers and neutralization before discharging into the cooling tower blowdown of about 1.1 cfs for less than 10 hours per day. During the discharge the concentration of salts in the blowdown will be increased about 130 ppm, to an estimated maximum of 1010 ppm (Ref. 1, Table 3.6-6). The total discharge of salts will be about 5600 lb/day of sodium sulfate, plus approximately 800 lb/day of salts released from the demineralization resins during regeneration.

Item (f): The steam generator blowdown, at an average flowrate of about 0.01 cfs, is also added to the cooling tower blowdown. By analogy with the Zion Nuclear Power Station,[6] of the order of one lb/day of phosphate, 65 lb/day of hydrazine, and 11 lb/day of morpholine will be used as water treatment chemicals. Only a fraction of these substances is likely to be discharged, however, since most of the hydrazine and morpholine will decompose to vented gaseous products in the system and a part of the phosphate added will be retained in an ion exchanger of the radwaste system to which the steam generator blowdown will sometimes be routed before release.

Item (g): The applicant has specified that the cooling tower drift is not to exceed 0.03% of the recirculating water flowrate; the salts deposited from the solution, which contains 850 ppm dissolved solids, total about 3650 lb/day (Ref. 1, Table 3.6-3). According to the staff analysis given above (slightly different from the applicant's analysis) the anions will include about 70% sulfate, 20% bicarbonate, 6% chloride, and 3% nitrate; the cations will include about 55% calcium, 25% magnesium, and 15% sodium. About 1% will be silica or a silicate.

Item (h): The effluent from the station's tertiary sewage treatment will be chlorinated to yield a residual free chlorine concentration of about 1 ppm. When the normal effluent flow of 0.02 cfs (15000 gal/day) is added to the cooling tower blowdown (about 40 cfs) the chlorine concentration will be diluted to 0.5 parts per billion, without consideration of chemical reduction. If the sewage contains 10 ppm phosphate, about one pound per day of this nutrient will be discharged to the Rock River from this source.

Item (i): The auxiliary steam boilers, burning low-sulfur No. 2 oil, will be used intermittently during initial plant startup and during shutdown of both units. Operation of these units will result in the discharge of pollutants to the atmosphere. The requirements of the Illinois emission standards of no greater than 0.3 lb SO_2 and no greater than 0.1 lb of stack particulate matter release per million Btu will be met. During capacity operation of both units (each 75 million Btu/hr), no more than 1080 lb/day of sulfur dioxide nor more than 360 lb/day of stack particulates will be released; in addition an estimated 1440 lb/day of nitrogen oxides will be released (Ref. 1, Table 3.7-1). During normal operation, one boiler is expected to operate an average of about two weeks per year at 80% capacity. During the construction period and first year of operation, one boiler is expected to operate for a period of about 40-50 weeks.

Item (j): The emergency power system diesel engines will release an estimated 78.4 lb/hr of carbon monoxide, 48 lb/hr of sulfur dioxide, and 84 lb/hr of nitrogen oxides during periods of operation (Ref. 1, Table 3.7-1). Use of this system other than for routine testing is not anticipated during normal functioning of the station.

3.7 SANITARY WASTES

The sanitary wastes will be collected in a conventional manner and directed to a modern packaged sewage-treatment plant located within the station area. This treatment plant will be designed for a maximum of 15,000 gallons per day for permanent station service with factory installed modifications for a loading of 22,000 gallons per day during the construction period. The treated effluent from both of these systems will be combined with the blowdown from the cooling towers, when they are completed, and discharged to the Rock River. The effluents will contain a residual of 1 mg/l of free chlorine, and after mixing with the cooling tower blowdown, the residual chlorine content will be negligible. It is planned that water from on-site wells will be used for the sanitary system.

The sewage treatment unit for permanent plant service will operate as an extended aeration system designed for 300 operating personnel at 50 gallons per person per day. The effluent from this unit will be given tertiary treatment (consisting of filtration and recirculation) and then will be chlorinated. Residual sludge will be disposed of according to Title 5: Land Pollution and Refuse Disposal, the Environmental Protection Act of Illinois.

During construction, the factory installed modifications will allow the package unit to operate as a contact stabilization system designed for 1500 construction personnel at 15 gals. per person per day, or a total of 22,500 gallons for the eight-hour work day. A surge tank will assure a uniform hydraulic loading through the system. The effluent from this system will be given tertiary treatment by the same system as the effluent from the aeration unit. The effluent during the early stages of construction, prior to the completion of the cooling tower blowdown piping, will discharge into an eastern arm of Woodland Creek. Using a dilution ratio of the sewage treatment plant flow during construction to the estimated low flow in the eastern portion of Woodland Creek of less than 5 to 1, the applicant estimates that the resultant flow in Woodland Creek shall not exceed 10 mg/l of BOD and 12 mg/l of suspended solids. This meets quality standards of the Illinois EPA (Rule 404(c)).

3.8 TRANSMISSION LINES

Three new transmission line rights-of-way will be required for the station. One new substation is planned for construction and two existing substations will be further utilized. The staff reviewed the preliminary rights-of-way for the Byron corridors and the new substation locations by helicopter over-flight on October 3, 1973. No conditions were discovered which would make the route selection or substation location environmentally unacceptable. The entire length of transmission corridor passes through gently undulating countryside which is used for row-crop agriculture, cattle grazing and oak wood lots. The wood lots appear to be utilized for grazing in many cases.

The staff has viewed existing rights-of-way owned by the applicant and found that these transmission corridors generally do not interfere with agricultural production. Row-crop production and cattle grazing continue in the corridors and the only land which is irreversibly lost to production is that occupied by the tower bases. The applicant has not yet stated the exact number of towers to be used or their dimensions. Commonly used towers may have bases of 20-40 feet square and be placed at spacings of 5-8 towers per mile. The total land occupied by towers may therefore be in the range of 2000-8000 square feet per mile.

A description of corridor routes and a tabulation of conditions in the corridor has been presented by the applicant (Ref. 1, Sec. 3.9). The applicant's map of corridors has been included in this discussion for convenient reference (Fig. 3.8), and a tabulation of stream and road crossings and land areas utilized also is presented (Table 3.4). The staff inspection of the corridors did not reveal any conditions which are at variance with the information presented.

The Byron-Wempletown leg of the network (Fig. 3.8) will be approximately 30 miles long. The three-mile segment of this corridor nearest the station will be used for both a pipeline and transmission lines. Double circuit 345-kV lattice-type towers will be installed with space reserved for a future 765-kV single circuit line, not associated with Byron, to be added later. The next 23 miles of corridor will be 135 feet wide and will have either double circuit 345-kV towers or triple circuit towers with the additional circuit being of lower voltage. The northerly four miles of the corridor will require widening of an existing corridor from 80 to 205 feet.

The Byron-South leg of the network will run south from the station to the intersection with an existing corridor. The corridor will be 8.5 miles long, 270 feet wide, and will contain double or triple circuit 345-kV lattice steel towers. The additional width of this leg is intended for future system expansion not associated with the Byron Station.

The Byron-Cherry Valley leg will run due east for the first six miles from the station. The next nine miles of right-of-way will be along an existing corridor which will be widened from 145 feet to 245 feet. Double circuit 345-kV towers will be used in this corridor. Use will be made of existing towers from the Winnebago County line to the Cherry Valley substation.

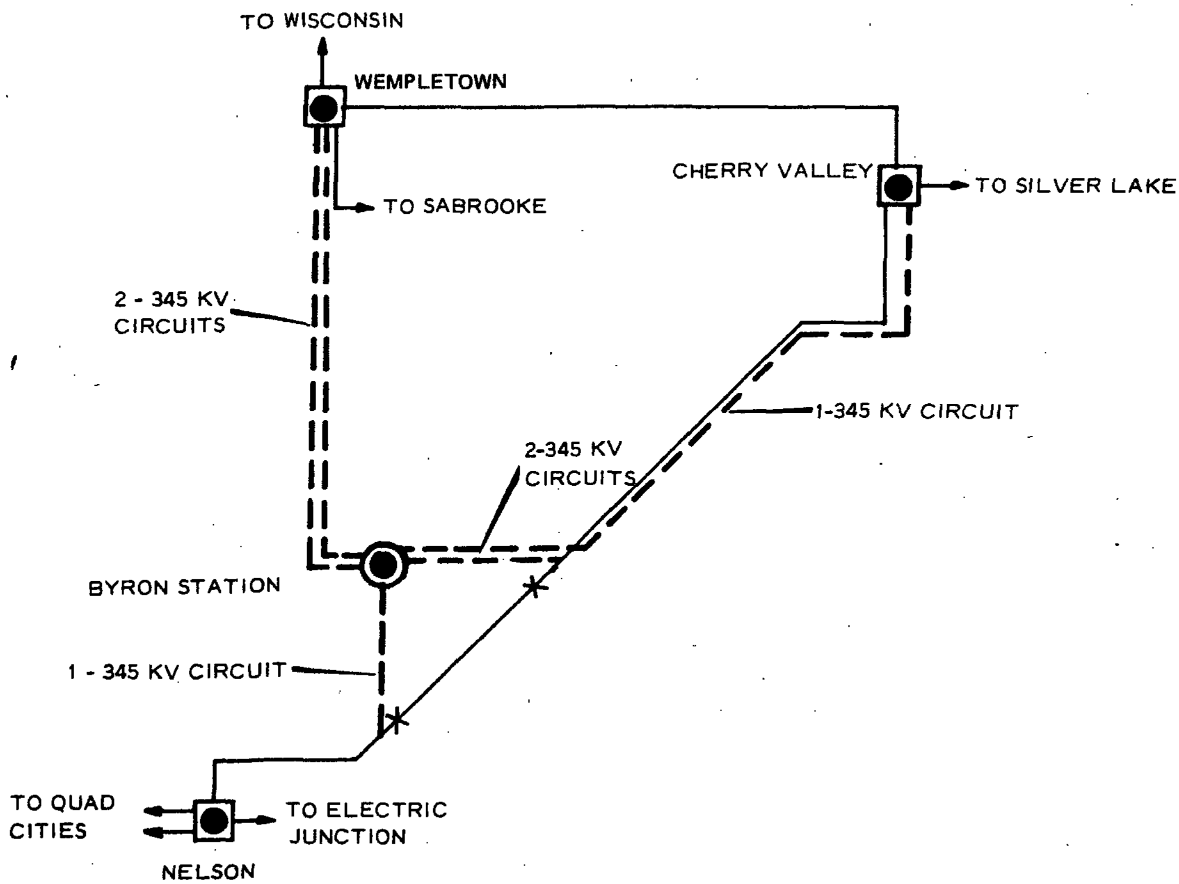

Fig. 3.8. Transmission System in the Vicinity of the Site. From the applicant's Environmental Report.

Table 3.4. Environmental Considerations of New Transmission Corridors

Line	*Byron South*			*Byron East*			*Byron-Wempletown*		
	(miles)	(%)	(acres)	(miles)	(%)	(acres)	(miles)	(%)	(acres)
1) Length	8.46		268.6	14.33		426.3	27.04		412.2
a) Forest	0.71	(8.4%)	19.2	0.63	(4.4%)	26.9	1.97	(7.3%)	32.0
b) Agric	6.18	(73.0%)	198.4	12.68	(88.5%)	377.6	22.43	(82.9%)	326.4
c) Mixed (forest - field)	1.57	(18.5%)	51.2	0.51	(3.5%)	15.4	2.64	(9.8%)	53.2
d) Indust.		--			--			--	
e) Lowland-marsh		--		0.51	(3.5%)	6.4		--	
2a) Creeks Crossed	Spring Cr.-5 Honey Cr.-2			Black Walnut Cr.-1 Stillman Cr.-2 Killbuck Cr.-2			Unnamed (1) Cr.-3 Unnamed (2) Cr.-2 Mill Cr. - 7 Middle Cr. - 3 East Fork - 2 South Fort Kent - 2 North Fort Kent - 2		
2b) Rivers Crossed	Kyte R. - 1						Leaf R. - 1 Rock R. - 1		
3) Highways Crossed									
a) Major	State 64			Third Meridian RD. State 72, US 51			State 2 - twice State 72, US 20		
b) Minor	6			14			22		
4) RR's Crossed	Burlington Northern			(1) Chicago & Northwestern (2) Chicago Milwaukee, St. Paul & Pacific (3) Burlington Northern			(1) Chic. & NW (2 separate rtes) (2) Chi., Mil., St. Paul, & Pac. (3) Ill. Central Gulf		
5) Towns	(1) Honey Creek Sec. 12-T23N, R10E			(1) Davis Junction Sec. 22 T42N, R1E			(1) Myrtle - Sec. 16 & 17, T25N, R10E (2) Westfield Corners - Sec. 33-T 26N, R11E (3) Winnebago - Sec. 8-T26N, R11E		

A new substation will be located at Wempletown in Section 14, Burrett Township, Winnebago County. This station will contain 345-kV to 138 kV, and 138-kV to 12-kV transformers. The staff has viewed this proposed site and has no environmentally based objections.

Existing rights-of-way of uncertain age passing through similar country side show no evidence of soil erosion, areas denuded of vegetation, construction damage, or damage due to access roads or maintenance work. The staff assumes that the Byron transmission corridors can be constructed with similar results by using standard engineering practices.

3.9 CONSTRUCTION PLANS

The construction schedule for the Station is shown in the applicant's Environmental Report, Fig. 4.1-1. Most of the preconstruction activities such as site selection, land purchase, site survey, core borings and construction of the meteorological tower have been completed. Detailed design work on the plant and some of its equipment is presently being undertaken. The applicant's construction plans for Unit 1 schedules 42 months to completion. In order to get Unit 1 into service as soon as possible, the Unit 2 schedule would be allowed to slip whenever necessary.

References

1. Commonwealth Edison Co., "Byron Station Environmental Report," including insertions, Vols. 1 and 2., Docket Nos. STN 50-454 and 50-455.

2. "Oak Ridge Isotope Generation and Depletion Code," Oak Ridge National Laboratory, Report ORNL-4628.

3. F. T. Binford et al., "Analysis of Power Reactor Gaseous Waste Systems," 12th Air Cleaning Conference.

4. W. A. Brungs, "Literature Review of the Effects of Residual Chlorine on Aquatic Life," USEPA National Water Quality Laboratory, 1972.

5. J. E. Draley, "Chlorination Experiments at the John E. Amos Plant of the Appalachian Power Company," Argonne National Laboratory, Report ANL/ES-23, 1973.

6. "Final Environmental Statement, Zion Nuclear Power Station Units 1 and 2," USAEC, Docket Nos. 50-295 and 50-304, Dec. 1972.

4. ENVIRONMENTAL EFFECTS OF CONSTRUCTION

4.1 IMPACTS ON LAND USE

4.1.1 Onsite Construction

The staff estimates that approximately 300 acres will be disturbed during plant construction activities (including construction of buildings, roads and railroad, parking lots, intake and discharge pipelines, laydown areas, etc.). Almost all of the activities will be on farmland. Vegetation will be removed from the actual construction areas and will be disturbed somewhat in adjacent areas. This will result in a loss of habitat and some of the attendant wildlife. Some of the more mobile animals will move out of the construction areas, but if the area into which they move is already supporting maximum healthy populations, either the invading animals or some of the resident animals will be lost. The applicant's plan to allow unused portions of the site to revert to natural conditions could help mitigate this stress; the present methods of clean farming without fencerows are not conducive to the maintenance of large and diverse wildlife communities. The ongoing monitoring programs should document the major changes in vegetation and animal life associated with onsite construction.

The site as defined by the applicant, (Ref.1, p. 2.1-1), contains approximately 1360 acres including the corridor to the Rock River. Of this area about 970 acres (71%) are cropland, 180 acres (13%) are pasture, 143 acres (10%) are woodland and 67 acres (5%) are used for other purposes such as house and barn lots. The remaining 139 acres of woodlands are not at present managed for production purposes. It is doubtful that any economic loss from this woodland will occur, but proper management of this resource by the applicant during the life of the Station is recommended to maximize future benefits. If the simplifying but conservative assumption is made that all cropland consists of the most productive soil (73 Ross)[2] found anywhere on the site, an average annual long-term loss in corn yield of about 135 bushel/acre, or 45 bushel/acre of soybeans would result. Thus, the maximum estimated loss in production of the cropland would be less than 130,950 bushels of corn or 43,650 bushels of soybeans per year. The corresponding maximum economic loss at a price of $2.635/bushel for corn and $6.75/bushel soybeans[3] would be less than $350,000 and $ 300,000 respectively. Assuming an economic loss of $7.00/acre[2] for pastureland rent, the maximum total economic loss would be less than $351,000. Since most of the land is inferior to the 73 Ross soil, a total economic loss of less than $175,000 is considered by the staff to be a more realistic estimate. Thus, a relatively small overall product loss as a result of the proposed project is anticipated by the staff.

Acreage, production, and yield for major crops of Ogle County are given in Table 4.1 for the period 1970-1973. Land devoted to corn production during that period varied from 185,000 to 199,200 acres. The variation is due primarily to yearly variations in anticipated returns by farmers at the time of planting and the incentives then acting for their participation in feedgrain set aside programs. The 970 acres to be taken out of cropland production by the Byron Station is less than the normal variation in acreage which takes place in the county through action of market processes. Similar arguments hold in the cases of soybeans, grains, and hay. The diversion of 970 acres from crop production in Ogle County would not affect the marginal value of crops produced in the county. Production of major crops for the State of Illinois is given in Table 4.2. The values for 1972 (the latest year for which state-wide data are available) show that over 1 billion bushels of corn were produced. Further increase in state-wide production can be anticipated in 1974 and subsequent years due to the termination of payments under the federally subsidized feedgrain set-aside program for 1974. The staff's estimate of 131,000 bushels of corn to be lost on the Byron project constitutes only 0.01% of the state production. The lost production is 0.7% of the county totals for 1973.

Recent production statistics do not indicate strong trends in the acreage devoted to various crops in the county or the state. Corn remains a preferred crop by farmers because of well developed markets and because of the high yield potential relative to other crops. There is considerable potential for increasing the yield of corn and other major crops through added technological inputs as indicated in Table 4.3. Technological inputs are achieved primarily in the form of added energy subsidies which go into the production of fertilizers, machinery, pesticides, and fuel.

The principal economic inputs to corn production are given in Table 4.4. Inputs aregiven in units of energy per acre (K Cal/Ac) in order to facilitate comparison of one factor to another and to emphasize the fact that the high yields of modern agricultural production are highly dependent on technological energy subsidies. These energy subsidies constitute only 11% (in 1970) of the total solar energy involved in production but these are the inputs which are under man's control and which are primarily responsible for the dramatic increase in corn yield during the period 1950-1970. Overall energy inputs increased by 140% during this period while overall corn yields increased by 113%. This indicates that a diminishing returns relationship may exist between energy input and energy return in corn production. The 1970 figures show however that production was still an energy favorable enterprise since the caloric ratio of output to input had a value of 2.82. The diminishing returns relationship cannot be avoided unless there is some new technological breakthrough in

TABLE 4.1 Recent Agricultural Production in Ogle County, Illinois

	1970	1971	1972	1973
Corn				
Acres (Ac)	195,200	199,200	187,600	185,000
Production (Bushels)	16,830,000	19,957,900	20,966,800	17,737,300
Bu/Ac	86	100	112	96
Soybeans				
Acres (Ac)	44,500	50,000	55,800	95,200
Production (Bu)	1,659,400	1,650,700	2,089,400	3,331,000
Bu/Ac	37	33	37	35
Wheat				
Acres (Ac)	500	300	400	400
Production (Bu)	18,000	11,800	16,400	17,300
Bu/Ac	36	39	41	43
Oats				
Acres (Ac)	29,100	24,700	21,300	23,300
Production (Bu)	1,855,000	1,573,600	1,259,900	1,103,000
Bu/Ac	64	64	59	47
Hay				
Acres (Ac)		30,000	28,400	34,700
Production (Tons)		95,300	96,200	115,100
Yield (T/Ac)		3.18	3.39	3.32

Source: Illinois Agricultural Statistics: Farm Income and Marketing for 1972 With Comparisons. Illinois Coop. Crop Reporting Service Bull. 73-74.

TABLE 4.2. Recent Production of Major Crops in Illinois

	1965	1966	1967	1968	1969	1970	1971	1972
Corn (x 10^6 Bu)	919	848	1,122	908	989	736	1,067	1,004
Soybeans (x 10^6 Bu)	178	160	186	210	229	211	236	262
Wheat (x 10^6 Bu)	56.8	61.0	71.9	51.2	48.4	38.1	46.8	54.0
Hay (x 10^6 Tons)	4.3	3.7	3.8	3.6	3.3	3.3	3.2	3.4

TABLE 4.3. Average, Top, and Record Crop Yields (Bushels per Acre) in the USA in 1973

Crop	Average	Top	Record
Corn	94	230	306
Wheat	32	135	216
Oats	49	150	296
Soybeans	28	80	110
Sorghum	63	200	320

Source: Wittwer, S.H., Maximum Production Capacity of Food Crops, Bioscience 24, pp. 216-224, 1974.

TABLE 4.4. Energy Requirements for the Production of the United States Average Corn Crop (Kilocalories per Acre: Kcal/Ac)

Input	1950	1959	1970	% Change, 1950 to 1970
Labor	9,800	7,600	4,900	- 200
Machinery	250,000	350,000	420,000	+ 68.0
Gasoline	615,800	724,500	797,000	+ 29.4
Nitrogen	126,000	344,400	940,800	+ 647
Phosphorus	15,200	24,300	47,100	+ 210
Potassium	10,500	60,400	68,000	+ 548
Seeds	40,400	36,500	63,000	+ 55.9
Irrigation	23,000	31,000	34,000	+ 47.8
Insecticides	1,100	7,700	11,000	+ 900
Herbicides	600	2,800	11,000	+1733
Drying	30,000	100,000	120,000	+ 300
Electricity	54,000	140,000	310,000	+ 474
Transportation	30,000	60,000	70,000	+ 133
Total Input	1,206,400	1,889,200	2,896,800	+ 140
Corn Yield	3,830,400	5,443,200	8,164,800	+ 113
Energy Return/ Unit Input	3.18	2.88	2.82	- 11.3

Source: Pimentel, David, L. E. Hurd, A. C. Bellotti, M. J. Forster, I. N. Oka, O. D. Sholes and R. J. Whitman. Food Production and Energy Crisis, Science 182, pp. 443-449, 1973.

crop production. However, the present favorable output-input ratio and the favorable biological margin for potential increases in corn and other crops (Table 4.3) suggests that it will be feasible to continue investing increasing increments of energy in corn production in the future with the with the expectation that yields will continue to increase for some time. This assessment is clouded to some extent by the uncertain availability of fossil fuels required for both on-the-farm consumption and for the production of fertilizers. Thus, while it is clearly feasible to increase yields through added energy inputs, actual yields may not increase in the future because the inputs are not available. Agriculture accounts for about 2.3% of the total electrical consumption on a national basis while about 10% of the total energy expenditure for corn production in 1970 was in the form of electricity. This does not account for the electrical energy used in fertilizer or machinery production so it seems reasonable to assume that electrical energy plays an even larger role in crop production than the above figures indicate.

In Ogle County Illinois the loss of about 131,000 bushels of corn not produced on 970 acres of land could be replaced by an increase in production of only 0.7% based on 1973 acreage. At constant acreage this would require a yield increase from 96 to 96.7 bu/acre based on 1973 production values. This increase is well within the normal year to year variation in yield and would be detectable only in long-term analysis. Historical yield variations have been much larger than this (Tables 4.2 and 4.4).

In view of the efficacy of energy input in increasing the yield of corn, the favorable output-input yields, and the prominent role that electrical energy plays in agricultural production, it is not clear that the construction of an electrical generating station constitutes an adverse impact on agricultural production when minor amounts of productive land are preempted.

The staff doesn't believe that the foregoing analysis would be valid for the indefinite future and has already alluded to the apparent diminishing relationships between energy input and output in the form of food. The day will probably come when the monetary value of energy input will no longer be repaid in the value of increased food energy output. In that case, the obvious option for increasing total production would be to increase the acreage under cultivation. The staff concludes that that situation does not obtain at present. Agricultural yields are highly dependent on energy inputs and substantial gains are still technologically and biologically feasible. Although the exact future allocation of energy from the Byron facility is not known, it is reasonable to assume that additional increments of available energy will have a positive effect on agricultural production which may compensate for the losses due to the preemption of relatively minor amounts of productive land.

The applicant states that after completion of construction all land, excluding the 125 acres for actual plant operation activities, will be allowed to return to its natural state (Ref. 1, p. 4.1-1). The term "natural state" is not defined but noxious weeds will be controlled through the Illinois Noxious Weed Law [P.A. 77-1037-effective July 1, 1972].

In addition to the site proper the applicant will also acquire about 90 acres of land for the construction of the railroad spur. Since this strip of land will cross about 3 miles of farmland, good planning and/or construction practices will be necessary to prevent detrimental impacts to the area by interrupting drainage patterns, destroying drainage tiles, and creating unnatural water impoundments. For these reasons, whatever steps are necessary to assure that all impacts of the railroad spur are minimized shall be taken.

Construction of the Byron Station is expected to last about five years[1] during which time as many as 1500 workers/day are anticipated. The transportation of these workers and the materials of construction (e.g., concrete, steel, components, etc.) are anticipated to have an adverse impact on local traffic and (perchance) highway safety in the rural area surrounding the site. Such impacts could be greatly reduced by the incorporation of intensive traffic safety programs for the workers and drivers of the transport equipment. The problem, however, cannot be totally eliminated. Thus the applicant shall take the necessary steps to assure that safety hazards and a detrimental impact to the traffic patterns in the region of the Byron site do not result.

A few residential structures (now vacated) are located on the site; No additional displacement of persons will result from the proposed project. The remaining vacated structures and all debris, including stumps, boulders, pieces of concrete, paper, wood logging and any other waste materials generated during construction, shall be removed in accordance with applicable local, State and/or Federal regulations.

Proper precautions must be taken for storage, handling, and disposal of all flammable, toxic or explosive materials used during construction. Particular care must be exercised to assure that all potentially harmful materials are properly disposed of and not simply discharged to the nearest convenient creek bed or the Rock River. Monitoring of the area ground water will assure that no construction contamination occurs.

All concrete batch plant and other particulate storage and processing equipment shall be adequately covered and shielded to assure that wind blown particulate emmissions are minimized. All major excavation and earth moving operations shall be properly controlled and monitored to comply with appropriate standards and regulations governing these operations. Regardless of the precautions taken, wind blown particulates will occur; however, the effects of such occurrences are likely to be local in nature and of short duration. Also associated with these activities will be the unavoidable generation of some noise; this, too, will be of a temporary nature.

When any of the archeological sites described in the applicant's Environmental Report (Ref. 1, App. IX.) or any other archeological artifacts are disturbed during construction of the station, the procedures described in Sec. 2.3 are to be followed.

4.1.2 Transmission Line Construction

The Illinois countryside is not well suited to hiding or screening of the transmission lines because of generally low topographic relief and agricultural cropping. The lines will be highly visible from long distances in many cases. This aesthetic impact is essentially unavoidable because no practical alternatives are known which could reduce it. [See Section 9.2.4] The applicant appears to have minimized visibility from highways as much as feasible by selecting routes which pass along property boundaries and section lines whenever possible.

The esthetic impact of the lines may bear more heavily on local residents who live near the transmission corridors than on highway travellers. The rural community has many farmsteads along the proposed corridors and there are many cases in which lines may pass within several hundred feet of them. The exact number of farmhomes is not known but visual estimates suggest that there are two to four per square mile. The staff counted at least 34 times in which the corridor could approach a farm home within 100-200 yards.

General impacts on the environment resulting from the construction of transmission facilities include: clearing of rights-of-way, grading of access roads, movement of heavy equipment for delivery of tower components, erection of towers, and stringing of conductors. Most impacts can be minimized or eliminated by following published guidelines for construction of transmission facilities. The applicant shall follow appropriate sections of AEC Regulatory Guideline 4.2 and Guidelines for the construction of Transmission Facilities of the U. S. Department of Interior.[4] The clearing of right-of-way will be minimal or unnecessary for those large segments which pass through agricultural land. Some clearing by mechanical or chemical means will be necessary mainly in the forest groves. The staff believes that this clearing should not result in appreciable soil erosion since the guidelines recommend that low growing vegetation be left intact where possible.

The applicant has indicated his intent to use one or more of four herbicides to aid the clearing operation. Two of these, 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) are commonly sprayed on brush, trees, or stumps and two others Dibar and Ural are pelleted materials which are spread at the base of vegetation and act by root absorption. The staff recommends that, should it prove necessary to use these materials in the construction of the transmission lines, they be used: at State or federally approved rates; for spot, not broadcast application; not in the vicinity of houses, bodies of water, food supplies, domestic animals or recreation areas. The staff believes that no adverse effects should result from application of herbicides in accordance with State or Federally approved rates. The applicant has not yet indicated a final selection of the herbicide to be used. The staff recommends that if 2,4,5-T is selected the content of the impurity dioxin (2,3,7,8-tetrachlorodibenzo-1, 4-dioxin) be limited to a concentration no greater than 0.1 ppm of the undiluted 2,4,5-T (see Sec. 5.4.1-7). The applicant plans the removal of litter and debris which accumulates during clearing and construction and restoration of the corridor by grading of ruts and reseeding where needed (Ref. 1, Sec. 4.2.8 and 4.2.9). These plans are acceptable to the staff.

The staff concludes from its survey of October 3, 1973 that the movement of machinery in the corridors for tower delivery and construction and for the stringing of conductors presents no undue hazard to the environment in most locations. During the survey, some locations of limited extent which appeared to have a history of intermittent standing water were noted. These areas are particularly susceptible to rutting, compaction of soils, and destruction of vegetation if traversed by heavy machinery during wet periods. These areas should be protected as much as possible by working in dry periods or by routing machinery around instead of across the areas when they are wet.

Existing corridors in similar country-side have been viewed by the staff for the purpose of observing the impact of access and maintenance roads. In most cases, no road could be seen from the helicopter and it is concluded that there is no detectable long-term impact which should be associated with vehicle access roads. The applicant's commitment to restoration and subsequent seeding is sufficient to insure that no foreseeable problems with these roads will occur. Special problem areas, such as wet spots, stream crossings and the like, can be managed through adherence to recommended guidelines.

There is probably little need to recommend procedures for wildlife protection in the area of the lines since the region is predominantly agricultural and the indigenous wildlife is reasonably well adapted to co-existence with human activities. Since the amount of habitat to be disturbed is small with respect to that available, no detectable impact of construction on wildlife species of the region is expected.

When any of the archeological sites described in the applicant's Environmental Report (Ref. 1, App. IX.) or any other archeological artifacts are disturbed during construction of the transmission facilities, the procedures described in Sec. 2.3 are to be followed.

In summary, the staff concludes that the proposed Byron transmission corridors can be constructed without undue environmental hazard. There do not appear to be any irreversible or irretrievable adverse effects due to construction. The principal effects of construction can be ameliorated with adherence to appropriate guidelines and staff recommendations.

4.2 IMPACTS ON WATER USE

4.2.1 Impacts on the Rock River

The impacts of construction activities along the banks of the Rock River to the biota are evaluated in Section 4.3. Since the construction area of the Byron site is about two and a half miles from the Rock River, impacts to the physical, chemical, and biological qualities of the river are expected to result only from construction of the intake and discharge structures and from erosion of the disturbed earth.

The requirements of the U. S. Army Corps of Engineers and the U. S. Environmental Protection Agency will be followed during construction of the intake and discharge structures. Dredging operations will be local in nature; the applicant estimates that about 1600 cubic yards of material will be removed from about 1/2 acre. The dredged material will be deposited in a designated area on the site (Ref. 1, p. 4.1-4). Some siltation will result from the riverbank earthwork connected with the intake and discharge structures, but it is expected to be small and within the range accommodated by the Rock River during high flow. Should siltation or washout become excessive, sheet steel cofferdams will be constructed (Ref. 1, p. 4.1-4).

Construction of the intake and discharge structures will require about one year; however, the earthwork and dredging, which impact the river more severely, can be accomplished in a few months.

There are no municipal water supplies drawn from the Rock River in this region, nor is there any commercial navigation. The staff concludes, following consideration of the local nature and the brief duration of riverbank operations, that any disruption of normal uses of the river (fishing, boat traffic, swimming, etc.,) will be minimal and transitory.

4.2.2 Impacts on Groundwater

A principal impact of construction activities on water use might be experienced by users of ground water. A common effect is a lowering (usually temporary) of the water table resulting from dewatering of the site. In response to a question from the staff the applicant has stated "There will be no effect on local groundwater uses due to dewatering during construction. There will be little excavation below the water table (Ref. 1, p. 2.5-11a). The staff concurs that the impact of dewatering on local groundwater users will probably be minimal, but will require, nonetheless, that the level of the water table be monitored and corrective measures be taken, to assure that no wells in the neighborhood of the site be materially affected.

Since the site is located up the hydraulic gradient from some of the private wells in the area, the quality of water in these wells could be impaired by leakage of oil and chemicals into the aquifers. This contamination is particularly likely during construction, because of the presence of excavated areas where the protective layer will have been removed. Monitoring (see Sec. 6.1.4) of groundwater quality will be required to ensure that no deterioration of the quality of the water in the aquifers occurs.

4.3 ECOLOGICAL EFFECTS

4.3.1 Terrestrial

Construction of the Byron Station buildings and cooling towers will affect about 300 acres of cultivated land (corn and clover) and four acres of woodland from which all trees will be removed. The site preparation work will be completed in two stages, (a) stripping, excavating, and backfilling in the areas occupied by structures and roadways, and (b) developing the site with all necessary facilities to support construction such as construction offices, trackwork, large unloading facilities, construction power, and construction drainage. These activities will create noise and disrupt the soils and vegetation of these acres which will give rise to dust and erosion. Controlled levels of these effects are unavoidable and must be considered acceptable if the station is to be constructed.

The remainder of the site proper, which will be allowed to return to native vegetation, is expected to serve as habitat for small mammals, deer, and birds, since the site will no longer be accessible to farmers and hunters.

The 440-acre corridor from the site to the Rock River will be disrupted due to construction of the 2-1/2-mile-long intake and discharge system which will consist of buried pipelines (except for about the last 100 feet). Trenching, pipe laying and backfilling will be done in segments. The trench will be backfilled with compacted material and the area regraded and replanted (Ref. 1, p. 4.1-2). As in construction of the station proper, measures to prevent excessive soil erosion must be taken.

Serious consideration must be given to the adequate treatment and disposal of sanitary wastes from about 1500 construction workers. The applicant plans to provide tertiary treatment of the wastes (contact stabilization) with a packaged treatment facility designed to treat 22,500 gallons of sewage per day. The applicant proposes to discharge the effluent into the eastern arm of Woodland Creek. The effluent is not expected to exceed 10 mg/liter of 5-day BOD, 12 mg/liter of suspended solids, and 1 mg/liter residual free chlorine (Ref. 1, p. 4.1-5).

Woodland Creek is an intermittent stream and the applicant has not specified the method, if any, for providing supplemental water to the creek to maintain a flow volume for adequate dilution of the sewage effluent until operation of a cooling tower begins. (At that time, the effluent will be routed into the discharge canal and diluted with the blowdown before discharge to the Rock River.)

No permit from the State of Illinois EPA to discharge the sewage effluent to Woodland Creek has been obtained as yet (see Table 1.1). The applicant states that "the quality of effluent discharge into Woodland Creek will comply with the IEPA Part IVV, Effluent Standards," and considers Woodland Creek to be a Restricted Use Stream under IEPA, Part III, Section 302k. On this basis, the applicant states that "therefore flow is not necessary" (Ref. 1, p. 4.1-5). The staff questions this characterization of Woodland Creek. As stated in the IEPA Part III Section 302k, Restricted Use Waters include "all waters in which, by reason of low flow or other conditions, a diversified aquatic biota cannot be satisfactorily maintained even in the absence of contaminants."[5] The data collected by consultants of the applicant during the 1972-1973 aquatic sampling program, indicate that Woodland Creek does support a diverse biota despite its low flow. Dissolved oxygen ranged between 6.5 to 14.5 mg/liter at all months of the year except July and August, for which no data were obtained. Phytoplankton, mainly diatoms, were present at all sampling periods, and in some cases the biovolume diversity was higher in Woodland Creek than in the other tributary streams (Ref. 1, Sec. 2.7.1.2). Although zooplankton were sparse, benthos, mainly chironomids, occurred in numbers comparable to those in the Rock River.

In the absence of a definition of Woodland Creek by or a permit from the Illinois EPA, and on the basis of available data, the staff concludes that Woodland Creek may be classified General Use Waters. Effluent releases to General Use Waters are not allowed to exceed 4 mg/liter of 5-day BOD and 5 mg/liter suspended solids, when the dilution ratio is less than one to one.[6] Also, the effluent should not contain more than 0.1 mg/liter residual chlorine (free and combined). When sufficient dilution cannot be provided to meet these standards, it may be necessary to provide portable toilets during construction and to dispose of sanitary wastes off site through licensed contractors.

4.3.2 Aquatic

Potential adverse but temporary construction impacts on the aquatic biota in the Rock River could result from increases in siltation and turbidity in adjacent water ways.

The soils on the Byron site belong primarily to the Catlin-Tama-Saybrook and Fayette-Strawn-Lawson associations, soil series which are subject to severe erosion when cultivated.[7] Loss of soil from a Tama silt loam on a 6% slope of 400 feet length under a corn-corn-oats-meadow rotation has been estimated to be 8.8 tons/acre/year, which is above the four-ton maximum recommended for this soil.[8] Erosion in the station area will be reduced due to the withdrawal of about 600 acres from cultivation and a return to vegetation. During the first three to five years of construction, however, some erosion will occur, estimated by the applicant to be about 4 tons/acre/year. This estimate appears to be low. It has been shown, for example, that construction of developments and highways can increase erosion-derived sediment by 30,000 to 40,000 times that from farms and woodlands in an equivalent period of time.[9] Although the staff does not expect these orders of magnitude increases in erosion due to construction at the Byron site, the applicant must carry out the methods it has suggested to minimize erosion, e.g., rocking, bank buildup, construction of drainage systems, grading and seeding of steep slopes, watering of roads, and use of cofferdams in the Rock River. Supervision of construction activities must be sufficient to assure compliance with erosion control practices. Siltation from erosion may reduce primary production, bury organisms, increase respiratory stress, and so forth. However, if the precautions described above are taken, increases in siltation and turbidity in the Rock River due to site construction activities should not have a significant effect on the indigenous aquatic biota.

Construction activities near or on the river may lead to local and temporary increases of particulate matter in the river. About 235 feet of river shoreline will be disturbed in construction of the intake and discharge structure. About 1600 yards of earth may be removed from a 1/2-acre area by dredging. Siltation from these operations can be minimized to protect the aquatic biota by using approved siltation control.

4.4 SOCIAL AND ECONOMIC EFFECTS

The undertaking of a project of this magnitude in a primarily rural area can result in notable social and economic effects. Much of the work probably will be accomplished using multishift labor forces, which could result in around the clock transportation of workers and, perhaps, material. A spur from the Chicago Northwestern Railroad to the plant will be constructed, with sidings and sheds provided at the station. It is anticipated that heavy loads will be transported by rail, although highway transport probably will be the most widely used mode of transportation. Corrective measures should be taken to minimize traffic congestion, noise and safety hazards. The increased traffic plus loads transported to the site will very likely increase the rate of deterioration of paved secondary highways; consequently the time, effort and money required for road repairs in the area will increase. Unless maintenance is properly planned, transportation routes of the area could be seriously degraded. The applicant should continue close communication with the local highway departments and provide cooperative assistance with maintenance programs.

The staff believes that the life style of the area residents living two or more miles distant from the site and off the main transportation arteries should be relatively unchanged. However, the residents living along the main transportation routes and within two miles of the site will probably experience some daily awareness of the project's activity.

Economically, construction of the station should prove to be an important stimulus to the community. The additional payrolls, local purchases of goods and services by the workers, and local purchases of materials and supplies by the applicant and its contractors are anticipated by the staff to improve greatly the economic situation of the area.

No severe impacts on the housing or schools and other public facilities of the local area are expected. The project is fairly close to northwest metropolitan Chicago and Rockford and easily accessible via major highways. It is thus thought that relatively few workers will elect to take up residence in the immediate area. Those who do so will have a choice of several small towns within the environs so that no severe impact to the facilities of any one town should result.

4.5 MEASURES AND CONTROLS TO LIMIT ADVERSE EFFECTS DURING CONSTRUCTION

4.5.1 Applicant Commitments

The following is a summary of the commitments made by the applicant to limit adverse effects during construction of the proposed Byron Station.

1. During the construction phase, sewage will be treated by the contact stabilization process. Initially, the effluent will be discharged into Woodland Creek; after completion of the cooling-tower blowdown piping, the effluent will be discharged directly to the Rock River.

2. Clearing will be conducted in a manner designed to minimize erosion; erosion will be further controlled by a construction drainage system incorporated into the site development plan.

3. Temporary gravel roads, in addition to permanent roads, will be installed with appropriate grading and drainage facilities.

4. Observation wells will be used to demonstrate that dewatering operations will not cause a significant lowering of the existing groundwater level. This precaution assures that wells and vegetation in the site vicinity will not be affected.

5. In construction laydown areas, temporary diversions will be constructed to intercept and divert runoff. 1 Existing steep slopes will be graded and seeded to retard runoff.

6. Dust control measures will be used during the construction period. Entry of cement dust, fly ash, etc., into the air will be minimized. Watering of or spraying of bituminous coatings on roads will be used to control dust.

7. Spoil in the area will be reused for plant fill.

8. Trash from the site area will be hauled to an offsite commercial dump. Any onsite burning will comply with all Federal, State, and local regulations.

9. Siltation and washout resulting from work at the riverbank will be controlled by the use of cofferdams, if necessary.

10. The amount of dredged material will be small, about 1600 cubic yards. All dredged material will be deposited in a designated diked area on the site.

11. For transmission corridors:

    (a) Woods will be cleared using minimal clearing practices to save as many trees as practicable.

    (b) If the use of herbicide is necessary, the herbicide will be selected from 2.4-D, 2.4.5-T, Dibar, or Ural in compliance with and approval of the appropriate State of Illinois authorities. The tree or brush will be cut at the ground line and the stumps will be sprayed locally.

    (c) No application of herbicide will be made immediately before, after, or during a heavy rain or irrigation of cropland along the right-of-way, nor when wind is greater than 5 mph. Herbicides will not be applied within 100 feet of any body of water, nor in areas where contamination of water supplies is likely.

    (d) The amount of land committed to the use of access roads will be minimized; there will be no continuous road along the rights-of-way.

    (e) Erosion problems will be handled on an individual basis as they arise; measures used to control erosion will be similar to those described in 2 and 5 above.

    (f) Any debris resulting from the construction operation is to be collected, immediately removed from the right-of-way, and disposed of in a legal manner. Burning of debris or vegetation will not be permitted.

12. All areas disturbed by construction activities, road building, clearing of rights-of-way, etc., will be restored to their preconstruction condition. That part of the construction area not occupied by permanent structures will be landscaped and replanted

or rocked as needed. All land of the site not needed for construction will be allowed to return to its natural state through succession. Upon completion of construction, the pipeline trench will be backfilled and regraded; the entire corridor will be replanted and the land will be disturbed no further. All ruts or depressions deeper than six inches will be graded immediately, and any plowing or disking required will be carried out before reseeding.

4.5.2 Staff Evaluation

The staff has reviewed the anticipated construction activities and the expected environmental effects therefrom, and has concluded that the measures and controls committed to by the applicant, as summarized above, are adequate to ensure that adverse environmental effects will be at the minimum practicable level with the following additional measures:

1. Design and construction of the railway spur shall assure acceptable surface water drainage and erosion control.

2. Close communication and cooperative liaison should be maintained with local highway departments.

3. If the sewage effluent cannot be discharged into Woodland Creek, portable toilets will be provided and the sanitary wastes will be disposed of offsite through licensed contractors.

4. Groundwater in the observation wells will be monitored for quality as well as level. Remedial action will be taken to protect offsite groundwater users should detrimental changes be detected.

5. The bird-kill surveys, described in Sec. 6.2.1(b), shall begin when plant buildings or cooling towers exceed an elevation of 30 meters above grade.

6. The herbicide used to spray vegetation shall contain less than 0.1 ppm of dioxin (2,3,7,8-tetrachlorodibenzo-1, 4-dioxin) in the undiluted herbicide.

7. When any archeological artifacts are likely to be disturbed by construction activities at the station or in the transmission line corridors, the procedures described in Sec. 2.3 are to be followed.

9. The guidelines of the U. S. Dept. of the Interior and the U. S. Dept. of Agriculture regarding routing and construction of transmission lines shall be followed.

References

1. Commonwealth Edison Co., "Byron Station Environmental Report" including insertions, Vols. 1 and 2, Docket Nos. STN 50-454 and STN 50-455.

2. Soil Conservation Dept., U. S. Dept. of Agriculture, Oregon, Ill.

3. Farm Market Report, in Rockford Morning Star, p. B-4, Sept. 25, 1973.

4. "Guide to the Preparation of Environmental Reports for Nuclear Power Plants," USAEC (1972), and "Environmental Criteria for Electric Transmission Systems," U. S. Dept. of Interior (1970).

5. "Water Pollution Regulations of Illinois," Ill. Environmental Protection Agency, Mar. 7, 1972.

6. Ibid., Pt. IV, 404f.

7. "Resource Study of Northwestern Illinois, Area 1," Soil Conservation Dept., U. S. Dept. of Agriculture, 1973.

8. B. D. Blakely et al., "Erosion on Cultivated Land," Soil Yearbook of Agriculture, Sup't. Docs., Gov't Printing Off., Washington, D. C., 1957.

9. M. G. Wolman and P. A. Shick, "Effects of Construction on Fluvial Sediment, Urban and Suburban Areas of Maryland," Water Resources Research, 3(2):451-462, 1967.

5. ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 IMPACTS ON LAND USE

5.1.1 Public Use

Operation of the Byron Station will result in a 30 to 40 year diversion of the site lands to industrial purposes. The lost agricultural products and the attendant economic loss noted in Section 4.1.1 will continue throughout the life of the station. This land use diversion is not considered by the staff to be a severe impact either for present conditions or probable future conditions. The land in question was privately owned, and no public use existed previously.

Because of the site's rural location and relatively small size, public use of the land such as nature trails, recreational facilities, visitor part, or hunting, does not appear to be appropriate during the lifetime of the station.

Approximately 15,000 gpd of well water will be used by the Station during normal operation for potable and sanitary purposes. The sewage treatment system (see Section 5.2.2) is judged by the staff to be adequate to assure that proper sanitation is provided and that all sanitary discharge will meet the applicable State standards.

There are no archeological or historic features on or in the near vicinity of the site (see Sec. 2.3).

5.1.2 Visual Impact

The site meteorological tower is 250 ft tall and is located where the natural elevation is about 840 ft (Ref. 1, Fig. 2.1-4). The elevation of the top of the meteorological tower is about 1090. The tops of the cooling towers will be approximately 500 ft above grade (Ref. 1, p. 3.4-1). The towers will be situated in the area of the site having an elevation of about 870 ft (Ref. 1, p. 2.1-2). The elevation of the tops of the cooling towers will be approximately 1370 ft. The tops of the cooling towers therefore will be about 280 ft higher than the top of the meteorological tower. During a tour of the area on October 23, 1973, the staff noted that the meteorological tower, which is already in place, was visible from many locations in the area. These locations are noted on Fig. 5.1. Table 5.1 gives the height of the observed portion of the meteorological tower at each of the locations and an estimate of the height of that portion of the cooling towers which will be visible from each of these locations.

Considering these observations, the staff concluded that an esthetic impact to the panoramic view from Route 2 will occur along this scenic drive between Byron and Oregon. Similarly, an esthetic intrusion occasionally will occur to the view of the landscape in about a 50-sq mile area around the site. These intrusions, however, are not considered to be as great as that on the scenic view along Route 2 due to the

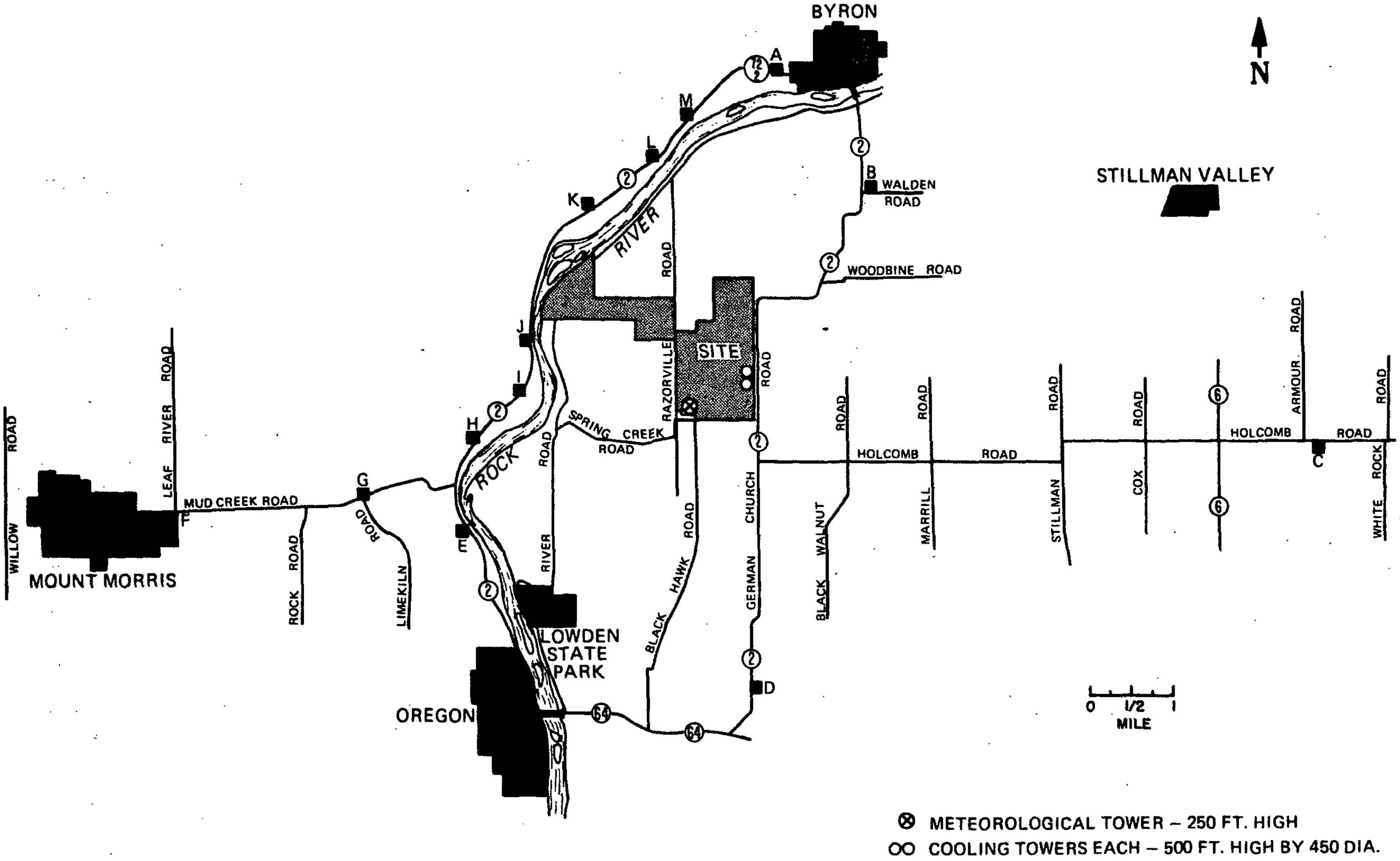

Fig. 5.1. Locations Where Visible Cooling Tower Heights Were Estimated.

TABLE 5.1. Staff Observations and Estimations of Visible Portion of Tower Heights

Location (See Fig. 5.1)	*Distance from Towers, miles*	*Visible Portion of Meteorological Tower, feet*	*Estimated Visible Portion of Cooling Towers, feet*
A	3-1/2	150	430
B	2-1/2	250	500
C	7	200	480
D	3-1/2	140	420
E	4	200	480
F	7	200	480
G	5	200	480
H	3-1/4	200	480
I	2-1/2	200	480
J	2-1/2	125	405
K	3	50	330
L	2-1/2	120	400
M	3	120	400

smaller number of persons who will be affected and to the lesser scenic value at these other locations.

The vapor plumes from the cooling towers will also produce a visual impact. These plumes, which are anticipated by the staff to remain aloft and therefore not to produce significant ground level fogging, are expected to drift downwind for 5-20 miles (Ref. 1, p. 5.1-12; see also Sec. 5.4.1.1 of this statement) depending on the meteorological conditions and the quantity of waste heat being dissipated.

Associated with the operation of the station will be the visual impact of the six 345-kV transmission line systems and their associated towers which are part of this proposal. This impact, which has been discussed in Sec. 4.1.2, will continue at least throughout the lifetime of the station.

Because of the location of the site and the relatively low height of the other structures, the cooling towers, their plumes, and the transmission facilities, as noted above, are expected to present the only important visual impacts.

5.2 IMPACTS ON WATER USE

5.2.1 General

The Byron Station will draw most of the water it consumes from the Rock River; a small portion used for the makeup water system will be pumped from wells. The primary usage of the Rock River is recreational; it is not used for public water supply in Illinois and there is no commercial navigation. There is one known commercial fisherman who fishes the stretch of the river near the Oregon dam southwest of the site. The only identified irrigation use in the five-county vicinity of the plant (Lee, Ogle, Boone, Winnebago, and Whiteside Counties) is less than 1/2 cfs during the summer by one farmer, near Prophetstown, about 55 miles downstream.

Except for Commonwealth Edison, there are only two companies that withdraw water from the Rock River. Medusa Cement in Dixon has an average withdrawal of 0.25 cfs, and Northwestern Steel and Wire in Sterling has an average withdrawal of 41 cfs, an average return flow of 39 cfs, with an average consumption of 2 cfs. The Sabrooke Generating Station about 15 miles upstream withdraws a maximum of 235 cfs and a minimum of about half that, consuming about 1 cfs. The applicant states that this consumptive use is planned to be eliminated by October 1974, when the plant is converted to oil. The generating station in Dixon has a maximum withdrawal of 250 cfs, an average withdrawal of 140 cfs, and an average return flow of 139 cfs. The hydroelectric plant at Dixon has a maximum throughput of 5000 cfs. There are no other operating power plants between Wisconsin and Prophetstown. Finally, about 100 cfs (range 70-120) is diverted from the river near Rock Falls into the Illinois and Mississippi Canal.

Within five miles of the site there are six municipal or other public water supply systems that use groundwater. These average slightly greater than a combined 0.85 Mgd pumpage (Ref. 1, Table 2.5-8). In addition there are 33 recorded wells east of the Rock River within two miles of the site. The exact usage of each well is not known, but it is probable that all are used for private domestic and agricultural purposes.

5.2.2 Water Consumption

At full power, the plant is expected to withdraw water from the Rock River at a variable rate for makeup for the cooling tower system, with an annual average of 78 cfs (Ref. 1, Table 3.3-1). The consumptive use, due to evaporation in the cooling tower, will vary seasonally, from an average of 39 cfs in the winter to an average of 54 cfs in the summer. The annual average consumptive use will be 47 cfs. These quantities are relatively low (ca. 5%) in comparison with the Rock River 7-day 10-year low flow of 875 cfs,; the high consumptive summer use would be about 8% of the 1-day 10-year low river flow. Consumptive uses other than by the Byron Station are relatively small and would add comparatively little to the impact on the river. The 100 cfs diversion to the Illinois and Mississippi Canal is taken near Rock Falls, too far downstream to influence the flow characteristics of the river near the Byron site. The staff concludes that the use of water by the Byron Station will cause only a minor impact on the Rock River.

The required makeup for the station's process water as well as potable water probably will be provided from deep wells at the site. Indications are that the deep ground water supply is adequate for this purpose; the staff does not anticipate significant impairment of the supply for nearby wells to result from these usages (see, however, Sec. 4.2).

5.2.3 Water Quality

The State of Illinois requires that the quality of the water in rivers be maintained to certain standards and that additional standards for effluents be met. Whenever a water quality standard is more restrictive than an effluent standard, a mixing zone is allowed within which the water quality standard need not be met. The size of the mixing zone is set on a case-by-case basis to meet the purpose of the regulation; it normally will not be allowed to exceed the area of a circle with a radius of 600 feet. The water quality standards apply at all times except during periods when flows are less than the average minimum seven day low flow which occurs once in ten years.

Two specific restrictions or standards of the "Water Pollution Regulations of Illinois," which were adopted by the State of Illinois Pollution Control Board in 1973, apply to the waters of the Rock River at the Byron Station. These are (a) General Standards, Section 203, and (b) Public and Food Processing Water Supply maximum permissible levels identified in Section 204 based on U. S. Public Health Service Drinking Water Standards. These restrictions are itemized in Table 5.2. Wherever the same substance is restricted in both sections of the regulations, the more restrictive limit

TABLE 5.2. Standards Applicable to the Rock River from Water Pollution Regulations of Illinois

Substance Regulated	*Concentration not to Exceed*	*Section of Reg. More Restrictive*
Unnatural sludge, bottom deposits, floating debris, visible oil, odor, unnatural plant or algal growth, unnatural color or turbidity	None	203
pH	6.5-9.0[a]	203
Dissolved oxygen	5.0 mg/l always 6.0 mg/l 16/hrs/day	203
Ammonia nitrogen	1.5 mg/l	203
Arsenic (total)	0.01 mg/l	204(b)
Barium (total)	1.0 mg/l	204(b)
Boron (total)	1.0 mg/l	203
Cadmium (total)	0.01 mg/l	204(b)
Chloride	250 mg/l	204(b)
Carbon chloroform extract	0.2 mg/l	204(b)
Chromium (total hexavalent)	0.05 mg/l	203
Chromium (total trivalent)	1.0 mg/l	203
Copper (total)	0.02 mg/l	203
Cyanide	0.01 mg/l	204(b)
Fluoride	1.4 mg/l	203
Iron (total)	0.3 mg/l	203
Lead (total)	0.05 mg/l	204(b)
Manganese (total)	0.05 mg/l	204(b)
Methylene blue active substance	0.5 mg/l	204(b)
Mercury	0.0005 mg/l	203
Nickel (total)	1.0 mg/l	203
Nitrate plus nitrite (as N)	10.0 mg/l	204(b)
Phenols	0.001 mg/l	204(b)
Selenium (total)	0.01 mg/l	204(b)
Silver (total)	0.005 mg/l	203
Sulfate	250 mg/l	204(b)
Zinc	1.0 mg/l	203
Total Dissolved Solids	500 mg/l	204(b)
Fecal coliform bacteria	200/100 ml (Geometric mean) 400/100 ml (10% of samples)	203
Toxic Substances	0.1 of 48-hour TLm for fish or fish food organisms	203
Temperature	5°F above natural; also monthly maximum[b] as follows:	203

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
60°	60°	60°	90°	90°	90°	90°	90°	90°	90°	90°	60°

[a]*Except from natural causes.*
[b]*See text for actual restrictions.*

is cited. The monthly temperature limits "shall not (be exceeded) during more than one percent of the hours in the 12-month period ending with any month. Moreover, at no time shall the water temperature at such locations exceed the maximum (monthly) limits by more than 3°F."

Effluent standards are applicable directly to plant discharges on the basis of 24-hour composite samples. In addition, no contaminant shall at any time exceed five times the numerical standard. Compliance is "not required when effluent concentrations in excess of the standards result entirely from influent contamination, evaporation, and/or the incidental addition of traces of materials not utilized or produced in the activity that is the source of the waste." Applicable restrictions on effluents, from Sections 403-408 of the Regulations are given in Table 5.3.

Referring to the chemical and radioactive releases identified in Section 3, no violation of the standards for the Rock River (Table 5.2) or for the plant effluent (Table 5.3) is anticipated. With respect to total dissolved solids (TDS) in the river, the discharge of an 850 ppm solution (the cooling tower blowdown) at an average of 44 cfs will increase the average TDS of the river from 337 to 342 ppm at the average flowrate of 4580 cfs, or to 361 ppm at the 7-day average 10-year low flowrate of 875 cfs. These are well below the maximum permitted level of 500 ppm. The applicable effluent standard is not to exceed 3500 ppm (see Table 5.3); the lower standard of 750 ppm does not apply because the increase in TDS of the blowdown over that of the source water is due to a particular kind of recycling. The addition of sulfuric acid to the recirculating water for carbonate reduction decreases the concentration of dissolved salts, rather than increasing it. In any event the expected 850 ppm TDS is substantially below the 3500 ppm standard.

Conformance to thermal standards is considered in Section 5.4.

The staff considers the impact of operation of the plant on water use to be acceptably small. In addition, the Illinois standards provide adequate protection for use of the waters of the Rock River, and no violation of these standards is anticipated.

5.3 RADIOLOGICAL IMPACT

5.3.1 Radiological Impact on Biota other than Man

5.3.1.1 Exposure Pathways

The pathways by which biota other than man may receive radiation doses in the vicinity of a nuclear power station are shown in Fig. 5.2. Two recent comprehensive reports[2,3] have been concerned with radioactivity in the environment and these pathways. They can be read for a more detailed explanation of the subjects that will be discussed below. Depending on the pathway considered, terrestrial and aquatic organisms will receive either approximately the same radiation doses as man or somewhat greater doses. Although no guidelines have been established for desirable limits for

TABLE 5.3. Standards Applicable to Byron Effluents From Water Pollution Regulations of Illinois

Substance Regulated	*Concentration not to Exceed*	*Pertinent Section of Regulations*
Settleable solids, floating debris, visible oil, grease, scum, or sludge solids.	None	403
Color, odor, turbidity	Obvious levels	403
5-day BOD	30 mg/l	404(a)
Suspended solids having oxygen demand	37 mg/l	404(a)
Fecal coliform bacteria	400/100 ml	405
Arsenic (total)	0.25 mg/l	408(a)
Barium (total)	2.0 mg/l	408(a)
Cadmium (total)	0.15 mg/l	408(a)
Chromium (total hexavalent)	0.3 mg/l	408(a)
Chromium (total trivalent)	1.0 mg/l	408(a)
Copper (total)	1.0 mg/l	408(a)
Cyanide	0.025 mg/l	408(a)
Fluoride (total)	2.5 mg/l	408(a)
Iron (total)	2.0 mg/l	408(a)
Iron (dissolved)	0.5 mg/l	408(a)
Lead (total)	0.1 mg/l	408(a)
Manganese (total)	1.0 mg/l	408(a)
Mercury (total)	0.0005 mg/l	408(a)
Nickel (total)	1.0 mg/l	408(a)
Oil (hexane solubles or equivalent)	15.0 mg/l	408(a)
pH	range 5-10[a]	408(a)
Phenols	0.3 mg/l	408(a)
Selenium (total)	1.0 mg/l	408(a)
Silver	0.1 mg/l	408(a)
Zinc (total)	1.0 mg/l	408(a)
Suspended solids other than those having oxygen demand	15 mg/l	408(a)
Total dissolved solids	750 mg/l above background with exceptions;[b] 3500 mg/l, no exception	408(a)

[a]*The pH limitation is not subject to averaging and must be met at all times.*

[b]*Unless caused by recycling or other pollution abatement practices.*

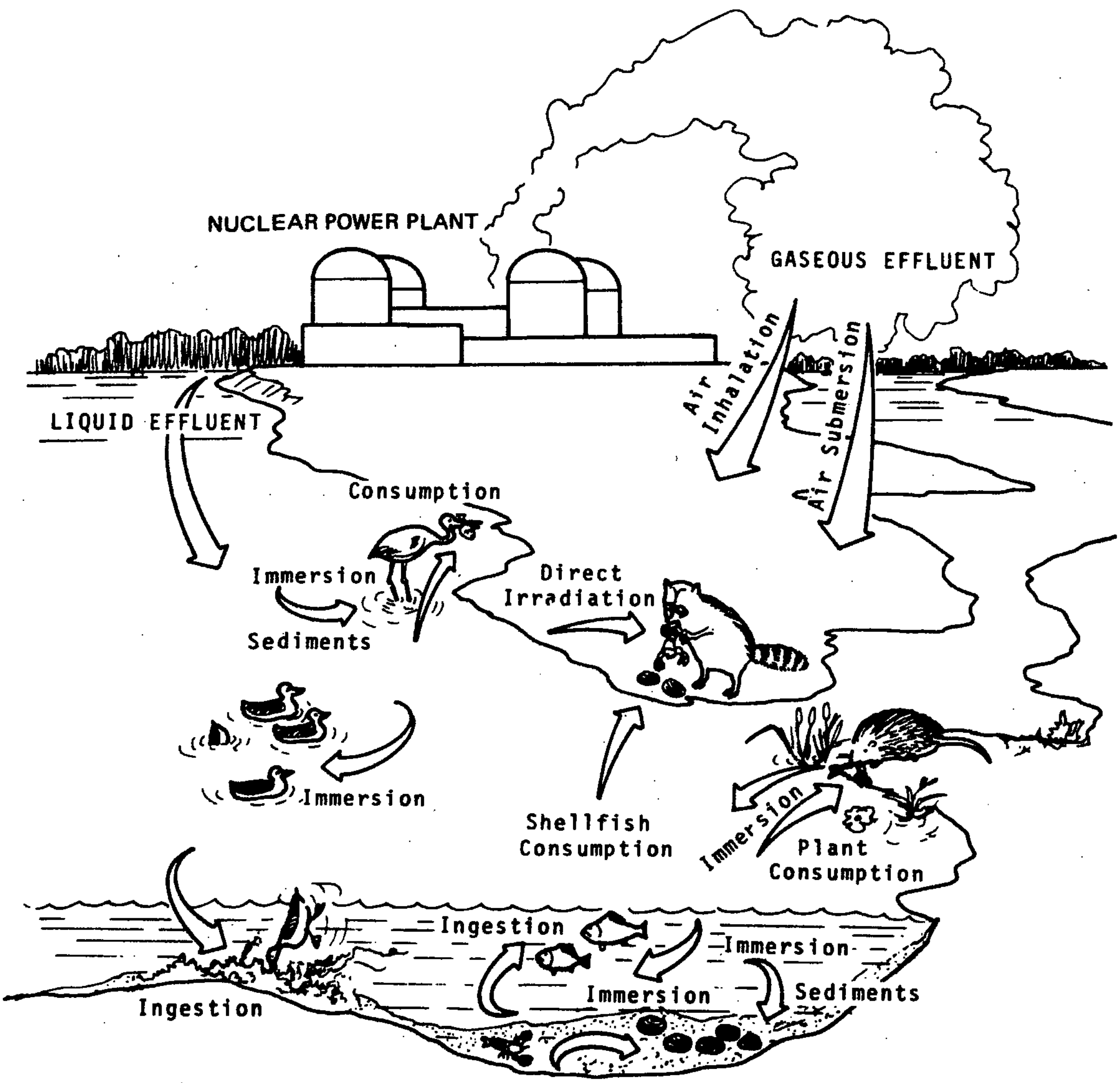

Fig. 5.2. Exposure Pathways to Biota Other Than Man.

radiation exposure to species other than man, it is generally agreed that the limits established for humans are also adequate for these species.[4]

5.3.1.2 Radioactivity in the Environment

The quantities and species of radionuclides expected to be discharged annually by the Byron Station in liquid and gaseous effluents have been estimated by the staff and are given in Tables 3.2 and 3.3, respectively. The basis for these values is discussed in Section 3.5. For the determination of doses to biota other than man, specific calculations are done primarily for the liquid effluents. The liquid effluent quantities, when diluted in the Byron Station discharge, would produce an average gross activity concentration, excluding tritium, of 7.4×10^{-3} picocuries per milliliter. Under the same conditions, the tritium concentration would be 2.7×10^{1} pCi/ml. Additional discussion concerning liquid dilution is presented in Section 5.3.2..

Doses to terrestrial animals, such as rabbits or deer, due to the gaseous effluents are quite similar to those calculated for man (Sect. 5.3.2). For this reason, both the gaseous effluent concentrations at locations of interest and the dose calculations for gaseous effluents are discussed in detail in Section 5.3.2.

5.3.1.3 Dose Rate Estimates

The annual radiation doses to both aquatic and terrestrial biota including man were estimated on the assumption of constant concentrations of radionuclides at a given point in both the water and air. As shown in Fig. 5.2, radiation dose has both internal and external components. External components originate from immersion in radioactive air and water and from exposure to radioactive sources on surfaces, in distant volumes of air and water, in equipment, etc. Internal exposures are a result of ingesting and breathing radioactivity.

Doses will be delivered to aquatic organisms living in the water containing radionuclides discharged from the power station. This is principally a consequence of physiological mechanisms that concentrate a number of elements that can be present in the aqueous environment. The extent to which elements are concentrated in fish, invertebrates, and aquatic plants upon uptake or ingestion has been estimated. Values of relative biological accumulation factors (ratio of concentration of nuclide in organisms to that in the aqueous environment) of a number of waterborne elements for several organisms are provided in Table 5.4.

Doses to aquatic plants and fish living in the discharge region due to water uptake and ingestion (internal exposure) were calculated to be 6.8 and 12 mrads/yr, respectively, for operation of the Byron Station. The discharge region concentrations were those given above and it was assumed that these organisms spent all of the year in water of maximum concentrations. All calculated doses are based on standard models.[5] The doses are quite conservative since it is highly unlikely that any of the mobile life forms will spend a significant portion of their

TABLE 5.4. Freshwater Bioaccumulation Factors

Element	Fish,	Invertebrates,	Plants,
	PCi/kg organism per PCi/liter water		
C	4,500	9,100	4,550
Na	100	200	500
P	100,000	20,000	500,000
Sc	2	1,000	10,000
Cr	200	2,000	4,000
Mn	400	90,000	10,000
Fe	100	3,200	1,000
Co	50	200	200
Ni	100	100	50
Zn	2,000	10,000	20,000
Rb	2,000	1,000	1,000
Sr	30	100	500
Y	25	1,000	5,000
Zr	3	7	1,000
Nb	30,000	100	800
Mo	10	10	1,000
Tc	15	5	40
Ru	10	300	2,000
Rh	10	300	200
Ag	2	770	200
Sn	3,000	1,000	100
Sb	1	10	1,500
Te	400	150	100
I	15	5	40
Cs	2,000	100	500
Ba	4	200	500
La	25	1,000	5,000
Ce	1	1,000	4,000
Pr	25	1,000	5,000
Nd	25	1,000	5,000
Pm	25	1,000	5,000
Sm	25	1,000	5,000
Eu	25	1,000	5,000
Gd	25	1,000	5,000
W	1,200	10	1,200
Np	10	400	300
Pu	4	100	350
Am	25	1,000	5,000
Cm	25	1,000	5,000

From Report UCRL-50564 Rev. 1, 1972.

life span in the maximum activity concentration of the discharge region. No credit was given for additional dilution by the average flow rate of 4580 cfs in the river.

External doses to terrestrial animals other than man are determined on the basis of gaseous effluent concentrations and direct radiation contributions at the locations where such animals may actually be present. Terrestrial animals in the environs of the station will receive approximately the same external radiation doses as those calculated for man. Table 5.6 given later lists the doses due to the gaseous effluents.

An estimate can be made for the ingestion dose to a terrestrial animal, such as a duck, which is assumed to consume only aquatic vegetation growing in the water in the discharge region. The duck ingestion dose was calculated to be about 40 mrads/yr, which represents an upper limit estimate since equilibrium was assumed to exist between the aquatic vegetation and all radionuclides in water. A nonequilibrium condition for a radionuclide in an actual exposure situation would result in a smaller bioaccumulation and therefore in a smaller dose from internal exposure. As stated above, neglecting average flow rate in the river results in a very conservative estimate of dose.

The literature relating to radiation effects on organisms is extensive, but very few studies have been conducted on the effects of continuous low-level exposure to radiation from ingested radionuclides on natural aquatic or terrestrial populations. The most recent and pertinent studies point out that, while the existence of extremely radiosensitive biota is possible and while increased radiosensitivity in organisms may result from environmental interactions, no biota have yet been discovered that show a sensitivity to radiation exposures as low as those anticipated in the area surrounding the plant. In the "BEIR" report,[6] it is stated in summary that evidence to date indicates that no other living organisms are very much more radiosensitive than man. Therefore, no detectable radiological impact is expected by the staff in the aquatic biota or terrestrial mammals as a result of the quantity of radionuclides to be released into the Rock River and into the air by the Byron Station.

5.3.2 Radiological Impact on Man

5.3.2.1 Exposure Pathways

Routine power generation by the Byron Station will result in the release of small quantities of fission and activation products to the environment. This evaluation will provide dose estimates which can serve as a basis for determination that releases to unrestricted areas are as low practicable in accordance with 10 CFR 50 and within the limits specified in 10 CFR 20. The staff has estimated the probable nuclide releases from the Byron Station based upon experience with comparable operating reactors and an evaluation of the radwaste system. These releases have been discussed in Section 3.5.

Estimations were made of radiation doses to man at and beyond the site boundary via the most significant pathways among those diagrammed in Fig. 5.3. The calculations are based on conservative assumptions regarding the dilutions of effluent gases and radionuclides in the liquid discharge, and the use by man of the plant surroundings. Radiation doses calculated by the staff are intended to apply to an average adult. Specific persons will receive higher or lower doses, depending upon their age, living habits, food preferences, or recreational activities.

An estimate of the occupational radiation exposure received in operating the plants was made. This estimate was based on exposures received at comparable operating reactors.

5.3.2.2 Liquid Effluents

Expected nuclide releases in the liquid effluent have been calculated for the plant and are listed in Table 3.2. In the Byron Station discharge, the gross activity concentration, exclusive of tritium, is estimated to be 7.4×10^{-3} pCi/ml. Under the same conditions, the tritium concentration would be 2.7×10^{1} pCi/ml, as stated in Section 5.3.1.2. The radionuclide concentrations in the river about the discharge region would be further reduced by the average river flow rate of 4580 cfs. No credit was given for dilution by river flow.

During normal reactor operations, a fraction of the noble gases produced will be released in the liquid effluent and subsequently discharged into the Rock River. The AEC Directorate of Regulatory Operations has analyzed operating reactor radioactive liquid effluents for noble gas content and under conditions of highest annual average noble gas concentrations in the discharge water, no significant doses would be delivered to human beings.

Consumption of water represents a potential exposure pathway to the population. However, there are no drinking water supplies within 100 miles of the plant that could be affected by the effluents. In addition, no potential exists for ground water contamination.

Other pathways of relative importance involve recreational use of the river in the vicinity of the discharge zone. Individual doses from consuming fish caught in the immediate discharge area were evaluated using the biological accumulation factors listed in Table 5.4 and standard models.[5] Swimming, boating, and fishing in the discharge region were also included in the evaluation. There is no significant consumption of freshwater invertebrates from the Rock River in the plant area.

Table 5.5 summarizes the potential individual doses from the liquid effluents.

5.3.2.3 Gaseous Effluents

Radioactive effluents released to the atmosphere from the plant will give rise to exposure pathways to the public. The staff

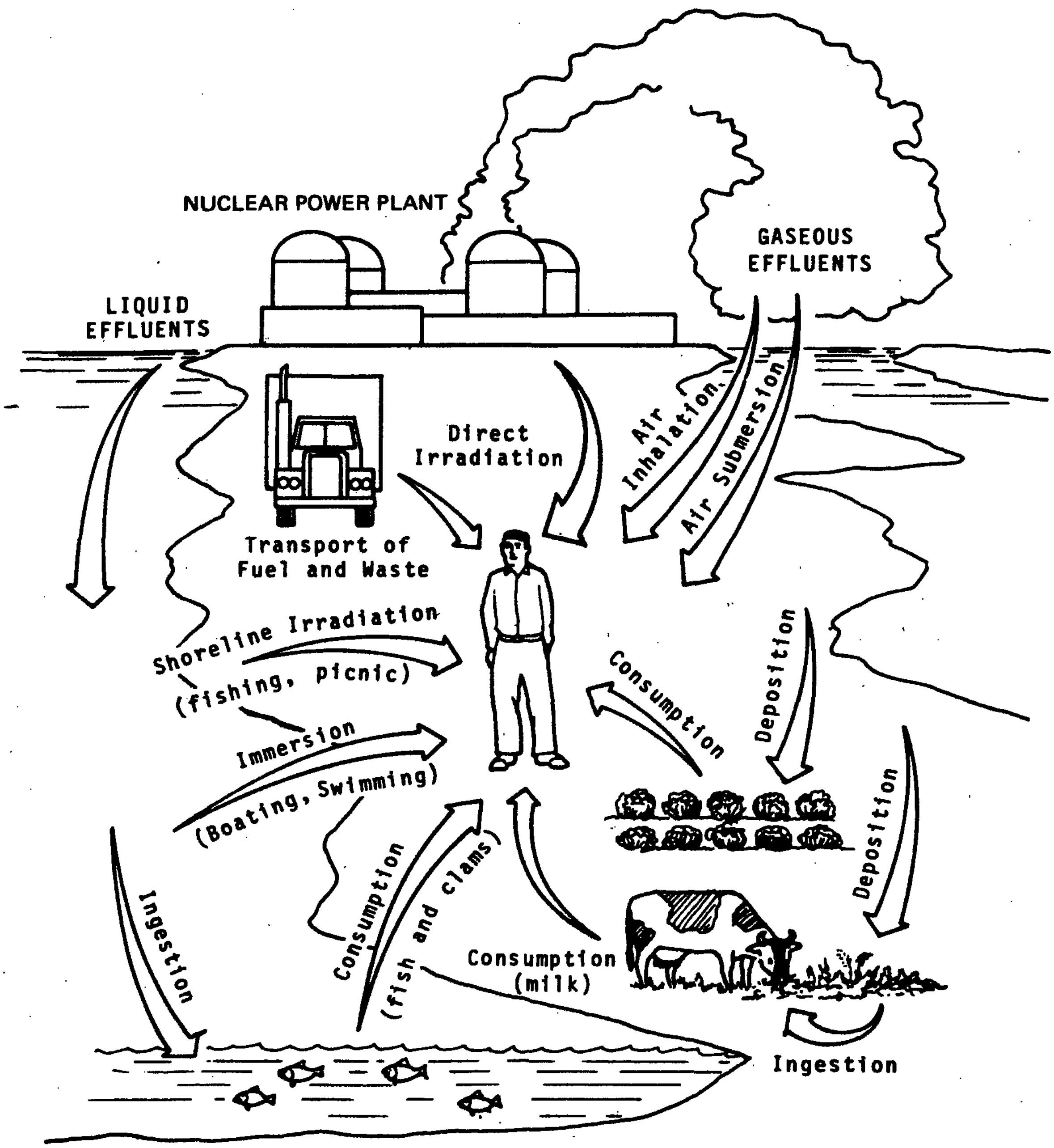

Fig. 5.3. Exposure Pathways to Man.

TABLE 5.5. Annual Individual Doses from Liquid Effluents

		Dose, mrem/yr			
Location	*Pathway*	*Total Body*	*GI Tract*	*Thyroid*	*Bone*
Coolant	Fish ingestion	2.5	1.2×10^{-1}	2.4	1.7
Discharge	Swimming (100 hr/yr)	7.3×10^{-4}			
Region	Fishing (500 hr/yr)	7.1×10^{-2}			

TABLE 5.6. Annual Individual Doses due to Gaseous Effluents

		Dose, mrem/yr			
Location	χ/Q, sec/m^3	*Total Body*	*Skin*	*Thyroid*	(*)
Site boundary[e] (495 m SE)	9.2×10^{-6}	7.0×10^{-1}	2.4	4.8×10^{-1}	(a)
Nearest farm (1040 m ENE)	1.5×10^{-6}	1.0×10^{-1}	3.5×10^{-1}	8.6	(b)
Nearest residence (579 m SE)	7.4×10^{-6}	5.5×10^{-1}	1.9	3.7	(c)
Motosport[d] (1310 m NNW)	1.4×10^{-6}	8.4×10^{-2}	2.9×10^{-1}	6.7×10^{-2}	(a)
Rockford drag strip[d] (4800 m NNE)	3.0×10^{-7}	1.8×10^{-2}	6.5×10^{-2}	1.4×10^{-2}	(a)

(*) Pathway

[a]Dose to adult thyroid from inhalation.

[b]Dose to infant thyroid via cow-milk pathway.

[c]Dose to adult thyroid from eating leafy vegetables.

[d]No correction made for occupancy factor.

[e]The gamma and beta air doses at the site boundary are 0.9 and 3.3 mrad/yr, respectively.

estimates of the probable gaseous and particulate releases listed in Table 3.3 were used to evaluate potential doses. All dose calculations were performed using annual average site meteorological conditions and assuming that releases occur at a constant rate.* Radioactive gases are released near ground level from the plant. Thus, doses result from immersion in the dispersed radioactive gases.

The primary food pathway to man involves the ingestion by dairy cows of radioiodine deposited onto grazing areas. Consumption of milk from these cows can result in exposure to the human thyroid. Doses to a child's thyroid which would result from consuming one liter of milk daily from a cow grazing six months annually were calculated for the nearest farm using recognized models.[7]

Another food pathway to man of secondary importance involves the consumption of leafy vegetables subject to deposition of the radionuclides released to the atmosphere. The thyroid dose to an adult from consumption of leafy vegetables grown at the nearest residence during the three-month growing period was evaluated.

All doses due to gaseous effluents are summarized in Table 5.6.

5.3.2.4 Direct Radiation

5.3.2.4.1 Radiation from the Facility. The plant design includes specific shielding of the reactor, holdup tanks, filters, demineralizers, and other areas where radioactive materials may flow or be stored, primarily for the protection of plant personnel. Direct radiation from these sources is therefore not expected to be significant at the site boundary. Confirming measurements will be made as part of the applicant's environmental monitoring program after plant startup. Low-level radioactivity storage containers outside the plant are estimated to contribute less than 0.1 mrem/yr at the site boundary.

5.3.2.4.2 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 AEC report entitled *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*. The environmental impact of such transportation are summarized in Table 5.7.

5.3.2.4.3 Occupational Radiation Exposure. Based on a review of the applicant's Safety Analysis Report, the staff will determine that there is reasonable assurance that individual occupational doses can be maintained within the limits of 10 CFR 20. Radiation dose limits of 10 CFR 20 are based on a thorough consideration of the biological risk

*Meteorological data obtained at Quad Cities, elevation 300 feet, 1971-1972, wind speed adjusted to 10 meters.

TABLE 5.7. Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor[a]

			Environmental Impact
Normal conditions of transport (heat, weight, and traffic density)			Negligible
Exposed Population	*Estimated Number of Persons Exposed*	*Range of Doses to Exposed Individuals*[b] *(per reactor year)*	*Cumulative Dose to Exposed Population (per reactor year)*[c]
Transportation workers	200	0.01 to 300 millirem	4 man-rem
General public			
Onlookers	1,100	0.003 to 1.3 millirem)	3 man-rem
Along route	600,000	0.0001 to 0.06 millirem)	

[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.

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

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

of exposure to ionizing radiation. Maintaining radiation doses of plant personnel within these limits ensures that the risk associated with radiation exposure is no greater than those risks normally accepted by workers in other present day industries.[8] Using information compiled by the Atomic Energy Commission[9,10] and others[11,12] of past experience from operating nuclear reactor plants, it is estimated that the average collective dose to all on-site personnel at large operating nuclear reactor plants will be approximately 450 man-rem per year per unit. The total dose for this plant will be influenced by several factors for which definitive numerical values are not available, but the aggregate of which are expected to lead to lower doses to on-site personnel than estimated above. Improvements in effluent treatment systems to maintain offsite population doses as low as practicable may cause a small increase in on-site personnel doses, all other factors remaining unchanged. However, the applicant's implementation of Regulatory Guide 8.8[13] and other guidance provided through the staff review process is expected to result in an overall reduction of total doses from those currently experienced.

5.3.2.5 Summary of Annual Radiation Doses

The population dose (man-rem) due to gaseous effluents to all individuals living within a fifty mile radius of the plants was calculated using the projected 1980 population data furnished by the applicant (Ref. 1, Sec. 2.2). Values for the population dose at various distances from the plants are summarized in Table 5.8.

The cumulative dose resulting from the consumption of fish harvested from the Rock River was estimated. It was conservatively assumed that 100 percent of the commercial fish catch, 92,000 pounds per year, was consumed by the population within 50 miles of the plant. These fish were assumed to live in the plant discharge region of the river.

The population doses from all sources including natural background, cloud immersion, consumption of fish, transportation and occupational exposures are summarized in Table 5.9.

5.3.2.6 Evaluation of Radiological Impact

The average annual total body dose due to gaseous effluents to persons living in unrestricted areas within 50 miles of the plant is less than 0.001 mrem/yr as shown in Table 5.8. Maximum individual total body doses due to liquid and gaseous effluent releases are less than 5 mrem/yr (Tables 5.5 and 5.6). These values are only a few percent of the natural background dose rate of 135 mrem/yr (0.135 rem/yr[14]) and are below the normal variation in background dose.

Using conservative assumptions, the population dose from all effluent pathways, received by the estimated 1980 population of 1,011,748 persons

TABLE 5.8. Cumulative Population, Annual Cumulative Dose, and Average Annual Total Body Dose due to Gaseous Effluents in Selected Annuli about the Station

Cumulative Radius, miles	*Cumulative Population*	*Annual Cumulative Dose, man-rem*	*Average Annual Dose, millirem*
1	90	0.01	1.0×10^{-1}
2	498	0.03	5.2×10^{-2}
3	949	0.04	3.8×10^{-2}
4	2,649	0.06	2.3×10^{-2}
5	5,596	0.08	1.4×10^{-2}
10	20,247	0.13	6.0×10^{-3}
20	284,778	0.51	1.8×10^{-3}
30	515,413	0.66	1.3×10^{-3}
40	706,070	0.74	1.0×10^{-3}
50	1,011,748	0.83	8.0×10^{-4}

TABLE 5.9. Summary of Annual Total Body Doses to the Population within 50 Miles

Category	*Cumulative Dose, man-rem/yr*
Population dose from background	137,000
Restricted area	
Occupational radiation exposure	900
Unrestricted area	
Transportation of nuclear fuel and wastes	14
Gaseous cloud	.83
Fish ingestion	5.7

living within a 50-mile radius of the Byron Station, would be about 21 man-rem per year. By comparison, an annual total of about 137,000 man-rem is delivered to the same population as a result of the average natural background dose rate of about 135 mrem/year in the vicinity of the plant.

Operation of the Byron Station will result in a minor contribution to the dose received by the population in the plant area from natural background radiation. The estimated radiation doses to individuals and to the population from normal operation of the station support the conclusion in Sec. 3.5 that the releases of radioactive materials in liquid and gaseous effluents are as low as practicable.

5.4 NONRADIOLOGICAL EFFECTS ON ECOLOGICAL SYSTEMS

5.4.1 Effects on the Terrestrial Environment

A portion of the site proper will be converted from farmland to industrial usage during the life of the station. Once major construction is completed, eorsion problems will be eliminated by establishment of grass and natural ground cover. The staff anticipates that erosion from the site during plant operation will be much less than that which occurred while the land was under row-crop cultivation.

Transmission line corridors, traversing several types of biomes, present more diverse ecological considerations. With proper maintenance procedures, the effects during station operation should be much smaller than those associated with construction.

Plant operations will produce other minor impacts on the environment -- impacts differing from those encountered during construction. These are primarily associated with operation of the cooling towers.

5.4.1.1 Cooling Tower Effects

Cooling towers discharge large amounts of heat and water vapor from a small area. Theoretically, possible environmental effects include the generation of visible plumes, clouds, fog, icing, and precipitation. In addition, it is sometimes contended that the fallout of salts from the drift could produce adverse effects on plants in the area. As will be discussed below, studies made at operational natural-draft cooling towers indicate that, except for the generation of visible plumes aloft, none of these postulated effects does, in fact, occur. The natural-draft cooling towers at Byron Station are not expected to have a significant influence on local meteorology. This is due primarily to the height of discharge (approximately 500 ft above plant grade).

5.4.1.1.1 Plume Behavior. Because of its momentum and buoyancy, the air rising from a cooling tower will usually continue to rise far above the top of the tower. Under most meteorological conditions the discharge from the towers will continue to condense upon leaving the tower and will be visible (as condensed water vapor) until it is evaporated to invisibility after mixing with the drier (unsaturated) air in the atmosphere. The length of the visible plume depends on the temperature and humidity of the atmosphere. Colder and more humid weather is conducive to longer plumes. Because air at lower temperatures has a smaller capacity to hold water vapor, visible plumes will be most pronounced and extensive in winter. Most of the time the visible plume will extend only a short distance from the tower and disappear by evaporation. On very humid days, when longer plumes are expected, there would probably be a naturally occurring overcast. On such occasions it is often difficult to distinguish the cooling tower plume from the overcast.

Spurr[15] reports on a one-year study of the length of plumes from a group of eight cooling towers serving 250-MWe units in England. The plumes were photographed three times daily and related to surface relative humidity ranges. When the humidity was less than 75%, all plumes were short (less than 300 m or 984 ft). With humidities of 75-90%, 40% were short, 40% medium (300-900 m) and only 20% persistent (longer than 900 m). At humidities above 90%, no short plumes were observed, 20% were of medium length and the remaining "80% were seen to persist or, because of low level fog preventing observation, were assumed to be persistent."

Aynsley[16] has observed that cooling tower plumes can, if meteorological conditions are proper, create cumulus clouds. He concludes that this is a "rare occurrence," and that these man-made clouds only precede natural cloud formation. He discussed the possibility that a cooling-tower plume could somehow trigger an existing atmospheric instability and create extra cumulus congestus clouds and precipitation miles downwind of the release point. As the number and size of cooling towers on a given site increase, the probability of significant alteration of cloudiness and precipitation patterns will increase.[17,18] The state of the art in cloud physics is such that meteorologists cannot say with any degree of certainty that there will be any increase in rainfall amounts due to cooling-tower plumes.[11] There are at least several reported occurrences of snow showers or ice crystals being generated by cooling towers but in all cases, the amounts were very small.[19] Sunshine, rainfall, humidity, and fog have been observed since 1916 at weather stations in England near power stations with cooling towers; no detectable change in these observations has been demonstrated since the towers were put in operation.[15] The staff expects no detectable change in the amounts of sunshine, rainfall, humidity or fog due to the operation of the natural draft cooling towers at Byron Station.

Other than the appearance of an extended plume, the main impact of the elevated plume is a small reduction of sunshine reaching the area it covers. Bøgh et al.[20] show that, on the annual average, sunshine could be reduced about 10% very near the base of the tower due to shadowing by the plume. During the summer growing season, when plumes are generally quite short, the effect of shadowing should be even less. This estimate is conservative in that shadowing due to natural clouds is not included. At distances of one mile or more, the staff expects shadowing to be negligible.

Figure 5.4 shows the applicant's estimate of the number of hours that the visible plume will be over a given spot per year. This figure is based on a published plume-length model,[21] tower operational parameters, and meteorological data from the Rockford and Peoria airports. The latter airport data were used to provide information on the upper air. The number of hours per year, given on the figure, are conservative; that is, cases in which the plume will either merge or occur with natural cloud cover are ignored. Figure 5.4 also shows the locations of airports near the site. The staff expects the impact of the plumes on airports and air traffic will be minimal, because of the relative infrequency of long plumes over and near the airports and because of the small diameter and high elevation of long cooling-tower plumes.

5.4.1.1.2 <u>Fogging and Icing</u>. Practically every article on natural-draft cooling towers includes a statement such as "Towers have the potential to cause or to increase the frequency of ground-level fog and icing." On the other hand, available reports of observations near natural-draft towers indicate that the plumes rarely, if ever, reach the ground. For example, Colbaugh et al. report that there have been no cases of visible plumes reaching the ground during two years of operation of the Paradise, Kentucky, Steam Plant.[22] The Central Electricity Generating Board of Great Britain[23] reported its findings on the environmental effects of cooling towers. No measureable change in surface relative humidity was detected downwind. The visible plume sometimes persisted for a number of miles downwind, altering sunshine in the area. No drizzle was observed from the towers. Cumulus clouds were sometimes formed, but no cases of showers or precipitation being generated by the plume have been observed. The same results have been reported from elsewhere in Europe and in the United States.[15,19,20,22-27] Hosler[28] does report one occasion on which the visible plume from a natural-draft cooling tower did reach the ground; this is the only reported case in the literature. Nevertheless, contrary to actual observations, many theoretical analyses, such as the model used by the applicant,[21] predict frequent tower-induced ground-level fog.

Spurr,[15] basing his conclusion on several decades of operation of a large number of natural-draft towers in England, states, "Apart from the aesthetic impact of the cooling towers and their plumes there are no other significant adverse environmental effects as investigations in England and Wales have shown." Bøgh et al.,[20] considering cooling tower observations in Switzerland, conclude that ground-level fog will not be produced by the operation of natural-draft cooling towers in areas of level terrain; this is in part due to the larger plume-rise under humid conditions as a result of greater release of latent heat. The applicant, on the basis of his model, predicts 12 to 30 hours of fog per year due to operation of the Byron cooling towers. The staff feels that this estimate is too high, and is contrary to experience at operating cooling towers, as discussed above.

During high wind conditions, aerodynamic downwash will cause the plume to descend in the lee of the tower. Scorer[25] and Spurr[15] report that the visible portion of the plumes evaporate before reaching ground

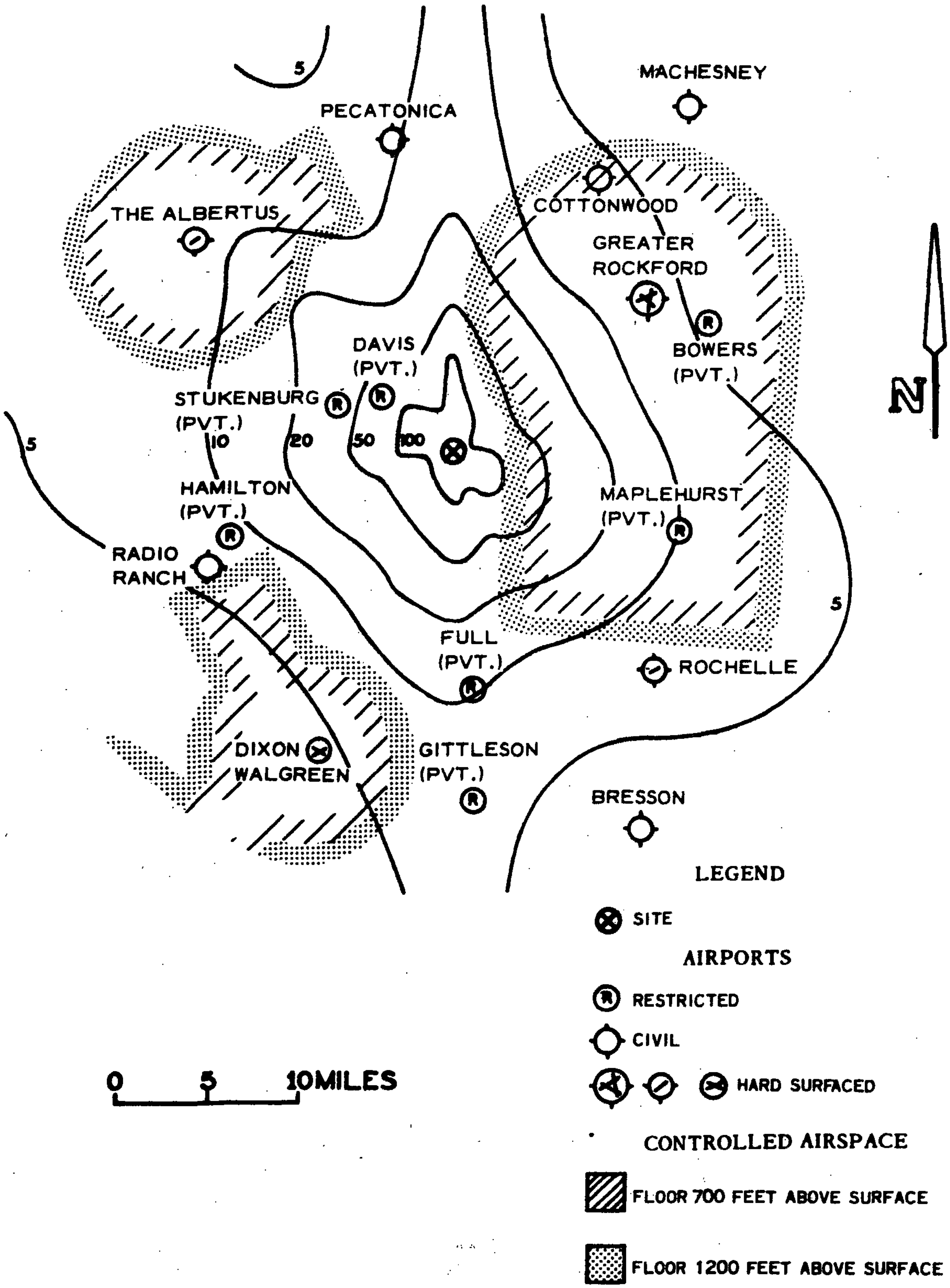

Fig. 5.4. Duration of Visible Moisture Plume (hr/yr) from Two Natural-Draft Towers. From applicant's Environmental Report.

level due to rapid mixing with unsaturated ambient air and heating due to descending motion. Scorer[25] indicated that the plumes do not descend lower than half the tower height.

Icing caused by natural-draft cooling tower plumes is not observed, since ground level fog is not generated. Icing is occasionally formed near (within 100 m or so) cooling towers due to water being blown out of the fill at the base of the tower. Such icing could occur on portions of German Church Road, and the applicant should take proper precautions to ensure that traffic along this road is properly controlled.

There are two other potential sources of ground-level fog and icing at the site: the two mechanical-draft units and the open flume associated with the primary condenser cooling system. The impact of the forced-draft towers will be minor and confined to the site due to both the small thermal load and the location of the units. The three-acre retention pond is quite close (about 250 ft) to German Church Road. However, based on experience at Dresden, the pond will be too small and too cool to generate significant fog over the road.

5.4.1.1.3 Drift. The entrainment of water as liquid droplets (as distinct from recondensed water vapor) in the air flow from a cooling tower is known as drift. If the drift loss is high and the droplets are sufficiently large, the effect could cause local fogging or icing. Concern has also been expressed regarding the deposition on the ground of the salt content of the droplets. Natural-draft towers of modern design are equipped with drift eliminators which reduce the drift loss to a very small percentage of the water flow. Drift losses as small as 0.002% have been reported.[23] A supplier for the towers proposed for the station has not yet been selected, but the applicant will specify a maximum value of 0.03% from the chosen vendor. This figure has been used in the staff's analysis even though experience indicates that actual operation of the tower will result in a value far lower than this. With efficient drift eliminators, the residual droplets are very small, and are carried along with the plume, producing little additional fogging or icing effects. These droplets will eventually evaporate, leaving a residue of extremely fine particles which remain airborne and disperse over a large area before being carried to the ground by precipitation.

Experience with cooling towers with modern drift eliminators, both in Europe and this country, indicates that drift will not create an environmental problem. Despite decades of use of such towers in England and Switzerland,[15,20,23] there are no reported cases of public complaint about drift. The peak deposition rate of drift at a location with eight 250-MWe cooling towers in England was only 0.01 mm/hr at a distance of 300 meters. Bøgh et al.[20] could neither observe nor measure the fallout of drift from two towers with state-of-art drift eliminators.

The drift droplets will carry along whatever impurities are contained in the cooling water circuit. Most of the drift will evaporate in the atmosphere, and the dissolved solids will remain airborn as a dust-like residue and be dispersed by the winds. Under humid conditions, such as natural fog and precipitation, some of these drops and the solids will be deposited on the ground near the plant. However, the quality of the water in the tower will be such that it will contain less than 850 mg/liter extraneous matter, which is less than the content currently allowed for "good" irrigation water. Rain will tend to dilute these drops and any salt buildup on plants and in the soil.

5.4.1.2 Chemicals in the Plume

The natural-draft towers proposed for the Byron Station are expected to have drift on the order of 0.03% of the circulating water flow. This corresponds to about 0.9 cfs or about 400 gpm drift from both units. Drift from the two mechanical-draft towers is estimated to be about 0.05% of the circulating water, i.e., 0.04 cfs or 20 gpm from both units. Since this is a small fraction (4.5%) of the drift from the natural-draft towers, it will be neglected in the subsequent discussion.

Dissolved in the drift will be those salts present in the makeup water from the Rock River, with an increment of sulfate resulting from the sulfuric acid added to the water to maintain the pH close to 7. These salts will include sulfates, carbonates, nitrates, and chlorides of calcium, magnesium, sodium, and trace amounts of other elements.

Table 5.10 lists estimates of salt deposition made by the applicant using a method proposed by Hosler et al.[29] The estimates depend greatly on the figures used for the particle size distribution of the drift. These are usually supplied by the tower manufacturer or determined *in situ*, but since the specific towers for the station have not been selected, the applicant made assumptions in this regard, based on values given for other natural-draft towers. These and other assumptions used in the estimates are given in Appendix VIII of Ref. 1. The staff has reviewed these assumptions and the method of calculation. The latter is partly graphical and though imprecise is in the staff's opinion adequate for estimates of deposition.

The salts deposited will be primarily sulfates, and the amounts are comparable to sulfates added in rainfall (i.e., 6 lb/acre-yr in mid-western rural areas to more than 100 lb/acre-yr in industrial areas). The amount of sulfate added to cropland in rainfall is inadequate to replenish sulfate losses due to crop removal, leaching, and erosion; therefore, sulfate is also added in fertilizer. Thus the total amount of salts deposited on soils from the drift is not expected to cause any adverse effects. Nevertheless, the concentration of salt in the drift will be much higher than the salt concentration usually found in rain, hence, deposition of drift on leaf surfaces and subsequent evaporation of the water can leave isolated salt particles on the leaf which may result in some leaf damage (e.g., necrotic brown or white spots). Since most of the larger drift particles are expected to fall within the station's exclusion area, the staff anticipates no adverse effects on surrounding crops, except possibly on the crops grown adjacent to German Church Road directly opposite the natural-draft towers in the direction of the prevailing wind. The applicant will be required to monitor for this effect (see Section 6) and to take ameliorative action, if necessary.

TABLE 5.10. Estimated Total Salt Deposition Rates for Natural-Draft Towers at Byron Station

Circular Distance From Tower, Miles	*Area Involved, Acres*	*Average Salt Deposition, lb/acre-month*
0.4 - 4.2	3.52×10^4	0.35
4.2 - 8.3	1.03×10^5	0.29
8.3 - 18	5.13×10^5	0.11
18 - 32	1.41×10^6	0.018

From applicant's Environmental Report.

TABLE 5.11. Microorganisms in Air

Source	*Number of Microorganisms per Cubic Foot of Air*	*Reference*
Urban atmosphere	58 bacteria, fungi, actinomycetes	30
Sewage treatment plant trickling filters:		
a. < 25 feet downwind	2 - 144 bacteria including *E. coli* and *A. aerogenes*	31
Control	28	
b. 140 feet downwind	26 coliforms	32
140 feet upwind	< 1	
Activated sludge plant:		
100 feet downwind	24	33
Upwind	< 1	

In addition to the compounds mentioned above, the circulating water may contain elements added to the makeup water for slime and corrosion control. Some of these compounds, e.g., chromates and other heavy metals, can build up in the soil from drift fallout to concentrations toxic to plants and the animals that consume these plants. The applicant will submit to the staff the finalized cooling tower design and operating characteristics, a list of the chemicals to be added, and their concentrations in the circulating water, and the estimated amounts that may be deposited on the terrestrial environment. The staff will utilize this information in evaluating the proposed operational monitoring for drift effects.

5.4.1.3 Pathogenic Organisms in Drift

Entrained in the water droplets of drift will be microorganisms originating in Rock River makeup water. Most microorganisms found in natural waters are harmless to man, but sewage discharges to these waters add fecal bacteria, viruses, and amoebic cysts that can cause disease, given the right conditions. It is possible therefore that the presence of viable pathogens in the drift could cause disease in human beings and animals ingesting the drift particles; the staff is of the opinion, however, that this eventuality is highly unlikely, as discussed below.

Present in the feces of warm-blooded animals, including man, are bacteria belonging to a group called "fecal coliforms". These microorganisms are not usually pathogenic to man but they are used as indicators of recent fecal contamination of surface waters because they occur in large numbers and analyses are made routinely. Certain microorganisms that can be pathogenic to human beings may or may not be present concurrently in the fecal matter, depending on the geographical area and health of the community discharging sewage to the water. Analyses for specific pathogens are complex, particularly in the case of viruses, and require specialized methods, equipment, and personnel. Additionally, a negative result does not necessarily mean that a particular pathogen is absent. The use of fecal coliform to indicate the sanitary quality of water has its limitations, but is nevertheless a major criterion used at present in most water treatment plants. Drinking water standards require the absence of any coliforms; in the state of Illinois, a maximum of 200 fecal coliforms per 100 ml (geometric mean) in waters used for primary and secondary contact must not be exceeded (except for Lake Michigan).

The applicant's analyses in 1972 and 1973 gave a range of about 200 to 1300 fecal coliforms per 100 ml in the Rock River at the vicinity of the proposed intake of makeup water to the Byron Station (see Table 2.7-363, Sampling Stations R-2, R-3, and R-4, Ref. 1). Using the maximum figure of 1300 fecal coliforms per 100 ml, the staff has estimated that drift from the cooling towers at the Byron Station may contain up to six fecal coliforms per cubic foot of air <u>at the exit</u> from each natural-draft tower. This calculation conservatively assumed no death of the micro-organisms during passage through the station. This figure (6 fecal coliforms per cubic foot) can be compared to data from other sources (see Table 5.11).

After exit from the towers, the drift will deposit largely within about 1000 ft. The relative isolation of the Byron site makes ingestion of drift particles an improbable occurrence. A portion of the drift mass containing smaller sized drops will be subject to atmospheric dispersion, depending on the meteorological conditions prevailing at any given time. Survival of microorganisms in air appears to decrease under solar radiation, high temperatures, and relative humidities of 40-60%,[34] and also depends on the species and condition of the organism. The occurrence of a disease in a particular individual ingesting a pathogen also depends on several factors, including the condition of the host and the virulence of the organism ingested. For example, it has been shown that only 1 to 2% of persons ingesting the typhoid fever bacterium *(Salmonella typhosa)* develop the disease.[35]

The staff concludes that occurrence of human disease due to the drift from the Byron Station cooling towers is highly unlikely. The likelihood may increase, however, during an epidemic of enteric disease in communities upstream of the Byron Station intake if such communities discharge their sewage into the Rock River or tributaries, particularly if the sewage receives a low level of treatment. Table 5.12 lists the sewage discharges within 40 miles upstream of the Station intake, and the present level of sewage treatment. Distance has a disinfecting action on human pathogens in water, since these do not usually multiply outside a host but die off with time. Sewage discharge from the town of Byron, which receives only primary treatment, is four miles upstream. For this reason, during the rare occurrence of an epidemic of enteric disease such as infectious hepatitis or salmonellosis at Byron or even further upstream, the applicant should consult with the Illinois Department of Public Health as to appropriate action to be taken. In addition, the applicant shall carry out routine water quality analysis of the cooling tower water that will include determinations of fecal coliform and *Salmonella* counts; these data will be available to the State health agency.

These requirements may be dispensed with if future research carried out at cooling towers using sewage effluent as makeup (there are presently at least three of these in the U. S. and several in Europe) demonstrates that no hazard exists.

5.4.1.4 Bird Kills at Cooling Towers and Other Station Structures

Under adverse weather conditions (low and thick cloud cover, fog or precipitation, frontal passage) ceilometer* lights, the navigational lights on tall (∿1000 feet) television towers, and brightly lit buildings apparently attract nocturnal migrating birds (primarily songbirds) which become confused and fly into the ground, buildings, or in

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*A ceilometer is a device used for measuring the cloud height by beaming a collimated light vertically and using triangulation to obtain the distance above ground.

TABLE 5.12 Sewage Treatment Plants on the Rock River and Tributaries within 40 Miles of the Byron Station

Treatment Facility	*Annual Av. Flow (1972) mgd*	*Future Flow mgd*	*Type of Treatment*	*Approximate Distance from Power Plant, Miles*
Byron	0.16		Primary	4
Rockford (municipal)	40.7	72 (By 2000)	Secondary*	15
South Beloit (municipal)	3.57	--	Secondary	40
Rockton (municipal)	0.128	--	Secondary	36
On Tributary, Kishwaukee River (mouth of river is 9.5 miles upstream from power plant).				
Cherry Valley (municipal)	0.061	--	Secondary	20.5
Belvidere (municipal)	2.2	--	Secondary	29.5

From applicant's Environmental Report.

*By 1975, expect to have a tertiary treatment facility.

particular, television tower guy wires.[36-40] Intervals between major kills (several thousand in one night) average several years, but small losses can occur intermittently during peak periods of migration, even on clear nights with good visibility. Bird kills at television towers in central Illinois have been documented.[41,42]

The cooling towers at Byron will be approximately 500 feet tall and the reactor buildings will be 200 feet tall. These structures will be lighted at night as required by FAA regulations, the standard red navigational lightning and a high intensity strobe light. The station is located in relatively flat country near the Rock River, which birds possibly use as a migrating guide.

Studies of bird mortalities are being conducted at the Davis-Besse Nuclear Power Station on the southwest end of Lake Erie.[43,45] This station is under construction and has a 500-ft hyperbolic natural-draft cooling tower and a 225-ft reactor building. Thus far, observations have been conducted during the fall of 1972 and the spring and fall of 1973, and involved almost daily pickup of birds during songbird migrations and some intensive all-night monitoring when particularly adverse weather conditions were forecast. Based on a review of the literature and undocumented experience with bird kills at the Perry Monument (a 352-ft monument on an island a few miles offshore in Lake Erie), it was expected that the Davis-Besse structures would be a hazard to warblers and vireos. So far, a total of 157 dead birds have been found, mostly warblers and kinglets, the observations extend over three migration peiods.[44] If the data from one night in the fall of 1973 (which accounted for over half that season's mortalities of 103 birds) is discounted, there is apparently little or no correlation of bird mortaliities with either weather conditions or migration potential. As in the referenced bird mortality cases, the Davis-Besse structures apparently are not a hazard to waterfowl, even though the station is immediately adjacent to the Navarre Marsh.

Considering this experience at Davis-Besse, and considering that the structures at Byron are not as tall as the television towers or buildings where major mortalities have occurred nor do they have the guy wires which appear to be particularly lethal, the staff does not expect major bird kills at Byron. Occasional mortalities may occur, and the monitoring program suggested in Section 6 should indicate if significant mortalities do occur.

5.4.1.5 Shading Effects of the Cooling Tower Plumes

A decrease in sunlight intensity reaching the ground due to the cooling tower plumes may, at times, be detectable. This could be of concern because of the possibility of a decrease in crop production from reduced photosynthesis. The shadowing effects of natural-draft cooling towers at Kaiseraugst and Leibstadt in Switzerland have been investigated by means of measurements and mathematical models.[20] It was shown that the shadowing distribution depended on the prevailing local wind conditions, and resulted in a reduction of sunshine at particular sites between 0.35% and 1%, the latter value occurring closer to the towers. Isocurves indicated reductions of sunlight for one hour per day within 1/2 mile of the towers to two minutes per day at about four miles from the towers. The sunshine reduction during the summer half year was "markedly smaller" than during the winter half year.[20]

Other conditions being equal, crop plants generally require only about 30% of full sunlight to become light-saturated.[46] The staff concludes that during the growing season in Illinois, a reduction in sunlight intensity of 1% for an hour per day will not decrease yield of corn or soybeans to a degree measureable within the normal fluctuations of yield.

5.4.1.6 Cooling Tower Noise

Sound produced during the operation of the Byron Station will arise mainly from the two mechanical-draft towers and the two natural-draft towers. Sound from the former results from the fans and water splashing through the fill. Fan noise carries farther and is more noticeable than water noise. Sound from the natural-draft towers arises from water falling free and splashing into the collection basins at the base of the towers. Sounds are classified as noise if they prove annoying to auditors.

Sound level data for mechanical and natural-draft towers are available from cooling tower manufacturers. Using those data and information on noise calculation methods,[47] the staff estimates that at a distance of 1000 ft from the two mechanical-draft towers, the sound pressure levels will correspond to about that in commercial or business areas; at one-half mile from the towers the sound pressure levels will be indistinguishable from those due to outdoor rural area sounds. At 1000 ft from the natural-draft towers, the sound level will correspond roughly to that in urban areas with no nearby traffic; at one-half mile from the towers, the sound will be below sound levels in rural areas either at night or day.

Since the applicant has not made a choice of towers, the above estimates must be considered preliminary. However, the towers must be designed to meet Illinois Noise Pollution Control Regulations and, therefore, should not be a nuisance.

5.4.1.7 Transmission Line Effects

Operation of the transmission lines may be of concern with regard to acoustical and electrical noise, production of ozone and the use of herbicides during line maintenance. The applicant states that acoustical and electrical noise will be held to a low level by engineering methods which include selection of the conductor diameter sufficiently large to hold corona discharge and line losses to a low level.

Electrical transmission lines may induce electrical currents in metal pipelines, railroad cars and other metal objects near the lines. The degree to which this happens is dependent on the degree of parallelism between the line and object, soil conditions and other factors. The problem occurs with greatest frequency in urban areas where there is a large number of objects which could become charged. The applicant claims that the problem will be minimal with the Byron lines because they pass over few chargeable objects in the rural countryside (Ref. 1, Sec. 3.9.8). The staff concurs with this view in the statistical sense that there will be a low frequency of events relative to the urban setting, however, this still permits the possibility that individual cases of severe nuisance could occur. Such cases would be considered "serious" by those involved even though in the system sense there is a low frequency of occurrence. There is no reliable method for predicting individual adverse effects from this phenomenon. The staff recommends that the applicant review its plans for construction of the corridor with the objective of reducing the number of near approaches to dwelling units to as low as possible. All transmission lines adjacent to or crossing railroad rights-of-way will be designed by the applicant with the advice and consultation of the railroad companies concerned and will meet applicable standards and guides. Administrative Rule 4 of the Illinois Commerce Commission General Order 160 requires Advance Notice and Co-operation by utilities where proposed transmission lines cross the tracks of a railroad.

The question of ozone production from 345- and 765-kV transmission lines has been reviewed by the staff. Ozone is produced naturally in the atmosphere by a variety of reactions; there is always a finite concentration in ambient air. Ozone is also produced by corona discharge from energized high voltage transmission lines. The questions of interest to the staff were:

1. Does corona discharge add appreciably to the regional atmospheric inventory of ozone and,

2. does the discharge cause elevated concentrations of ozone in the immediate vicinity of the lines?

The staff has estimated the production of ozone from energized 765-kV lines using the data of Scherer et al.[48] Ozone production in foul weather was found to be about 0.68 lb/mile/hr and 0.015 lb/mile/hr for fair weather conditions. A calculation of the regional inventory was made by assuming that production was uniformly dispersed in a volume of air one mile on a side parallel to the line, 10 miles long (corresponding to the distance of transport in one hour by a transverse wind moving at 10 mph) and 100 meters deep. The steady state concentration of uniformly dispersed ozone in this volume of air was found to be 0.05 parts per billion (ppb) during foul weather and 0.001 ppb during fair weather. Under relatively stagnant conditions of wind moving at 1 mph, the corresponding concentrations are 0.5 ppb and 0.01 ppb for foul and fair weather conditions respectively.

EPA air quality standards (Appendix D of 42 CFR 410) define ozone limits of 0.08 ppm (80 ppb) maximum one hour concentration not to be exceeded more than once per year. The staff concludes that 765-kV or lower voltage lines have practically zero likelihood of producing ozone in excess of the defined limits at the regional scale under any foreseeable conditions of operation. This conclusion holds also for the total concentration of ozone when natural levels, which may commonly range from 10 to 50 ppb in non-urban areas are added.

Maximum theoretical ozone concentrations in the immediate vicinity of 765-kV lines have been calculated[48] based on laboratory measurements and an atmospheric diffusion model. The highest concentrations, based on foul weather assumptions and transverse winds, range from 1.2 ppb to 0.1 ppb for wind speeds ranging from 1 to 10 mph. In the case of winds parallel to the lines, they compute theoretical foul weather concentrations of 19.3 to 1.9 ppb for winds ranging from 1 to 10 mph. The highest theoretical concentration occurs for the rare case in which a very light wind moves exactly parallel to the transmission line. Even under these rare conditions, it is unlikely that ozone produced by the lines will cause ambient concentrations to exceed EPA limits of 80 ppb when added to background concentrations (concentrations possibly ranging up to 50 ppb in rural areas).

The calculations have been confirmed in the field by Frydman et al.[49] who attempted to measure increases in ambient ozone levels due to an energized 765-kV line. No increase in ambient levels were found even when detectors were placed six meters downwind from the conductor at the conductor height. Tests were performed under a variety of weather conditions with similar results. The staff concludes that theoretical calculations and laboratory and field studies on 765-kV lines constitute "worst case" conditions and ozone production around lines carrying lesser voltages will be less than the values shown. Ozone could build to possibly critical local ambient levels under rare atmospheric conditions which include nearly stagnant air moving slightly on a path exactly parallel to the corridor during foul weather. Such conditions would almost certainly be rare and short-lived. These conditions have not been reported in actual field studies and the staff concludes that no basis exists at present for predicting adverse biological or environmental effects due to ozone from either 765-kV or 345-kV transmission lines.

The staff concludes that the corridors and substations can be constructed in an environmentally acceptable manner with ordinary good engineering practice and in conformance with the Department of the Interior Guidelines for Construction of Transmission Lines.[50] The staff knows of no alternate routes which would be superior to the ones chosen; however, the possibility for minor adjustments in routing to prevent close approach to houses should be considered.

The selective use of herbicides has several advantages over physical removal of obstructing vegetation during transmission line maintenance, particularly where the use of heavy equipment could damage soil and plant cover, or in areas inaccessible to motor vehicles. Also, selective use of herbicides is generally less expensive than manual trimming and cutting. However, there are potential environmental hazards associated with the use of certain herbicides, particularly the phenoxy herbicides 2,4-D and 2,4,5-T. Both these compounds have been implicated as possible teratogens (agents capable of causing birth defects or abnormalities).[51] Commercial preparations of 2,4,5-T may contain up to 0.5 ppm dioxin, a compound that has been reported to be acutely toxic at 0.0006 mg per kg body weight in tests with guinea pigs.[52] Although the Federal EPA permits the use of these herbicides for rights-of-way, the Department of Interior prohibits the use of 2,4,5-T on any of its lands or in projects funded by it.[53]

The applicant has described a plan for the use of 2,4-D and 2,4,5-T (Ref. 1, Sec. 4.2.3) during transmission line construction and maintenance. The plan includes precautions to be used in the application of these herbicides. However, the staff kis of the opinion that use of herbicides in the Byron Station transmission corridors is generally unnecessary and they should be used sparingly. Most of the corridors cross cropland where no interfering vegetation is present. Where the lines will cross wooded areas and there is a stream flowing through the area, the use of herbicides should be prohibited. There may be steep or inaccessible slopes not near streams, where the use of phenoxy herbicides could be advisable to avoid endangering the safety of the maintenance crew. Should such occasion arise, the applicant must adhere strictly to the plan referred to above, with the added limitation that no formulation will be used whose dioxin contamination exceeds 0.1 ppm.

5.4.2 Effects on Aquatic Biota

Overall, the staff anticipates no significant adverse effects on the aquatic biota of the Rock River, although certain local changes in distribution and abundance may occur. The monitoring program of the applicant should be sufficient to verify that these changes, if detectable, are not of significance to the river ecosystem (see Table 6.6).

5.4.2.1 Effects due to the Withdrawal of Water for Cooling

The plant intake structure is discussed in Section 3.3.

It is usually assumed that all organisms small enough to pass the traveling screens are subsequently killed in passage through a closed-cycle cooling system. That this is a conservative assumption is shown by reports of organisms (including fish) living in cooling tower basins.[54] However, for making an assessment, the staff assumes there would be a loss of planktonic organisms (including some small drift invertebrates) proportional to the ratio of intake flow to river flow. During the summer this maximum loss would be about 2% and 7% of the plankton passing the plant intake at average and 7 day 10 year low flow, respectively. Because the generation time of plankters is short (hours to few days) and the proportion lost is small, the plankton productivity in the river should recover rapidly. Although the ichthyoplankton loss will not recover in the same manner, the total mortality is expected to be negligible.

Direct impingement of small fish on the traveling screens is not anticipated to be of significance because of the low approach velocities (0.5 fps) and direction of flow at the intake structure. The intake velocity is low enough so that almost any healthy fish, large enough to swim, could avoid impingement onto the screens. In addition, the orientation of the intake structure in the river flow should provide an adequate sweep current to which fish maintaining themselves in the intake flow can turn.

Some data for fish impingement at the applicant's Dixon plant, located about 25 miles downstream of the site, have been reported (Ref. 1, p. 5.1-8). A comparison of predictive utility with the proposed Byron Station is difficult because impingement problems are often site specific. However, the Dixon intake velocity and flow are about the same as expected at Byron. Throughout most of the year the rate is less than 25 fish per 24-hour period; background impingement of dead and diseased-weakened fish of about this level is to be expected. In early spring the rate goes up to a few hundred fish per 24-hour period for about one month. The applicant has suggested that increased stress from various factors (parasites, insecticide run off, increased stream velocity) may be involved. The staff concurs that the intake is probably not the primary cause of these losses. The staff recommends, however, that operational monitoring include provision to ascertain the condition of impinged fish, when large impingements occur.

5.4.2.2 Effects due to the Discharge of Heated Water

5.4.2.2.1 Applicant's Analysis of the Thermal Discharge. There are no gauging stations at the site, so all flow data used are computed from data collected at the Como gauging station, 45 miles downstream from the site and the Rockton gauging station, 41 miles upstream. The applicant has used the relation $Q_{Site} = 0.306\ Q_{Rockton} + 0.694\ Q_{Como}$ (Ref. 1, p. 6.2-8A). Table 6.2.2 of the applicant's Environmental Report lists the monthly average river temperature, average wet bulb temperature, blowdown temperature, river flow rate, river velocity and average river depth.

Appendix VI of the Environmental Report contains a reprint of the Water Pollution Regulations of Illinois. Excerpts applicable to the Byron Station are set forth in Sec. 5.2. The thermal regulations required for the Rock River are:

1. No single mixing zone shall exceed the area of a circle with a radius of 600 feet (25.96 acres).

2. The mixing zone shall be so designed as to assure a reasonable zone of passage for aquatic life.

3. The maximum temperature rise outside the mixing zone shall not exceed 5°F.

4. The maximum permissible river temperature (Ref. 1, p. 5.1-13) may be exceeded by no more than 3°F no more than 1% of the hours in any 12-month period (see Sec. 5.2).

The applicant has assessed the effect of the blowdown from the cooling towers upon the Rock River using an analytical plume model developed by Sargent and Lundy, Engineers.[55] This analysis was applied to four cases of meteorological and hydrological conditions (one normal and three extreme cases):

1. Average river flow, river temperature and wet-bulb temperature.

2. 7-day bi-monthly minimum flow with average river temperature and wet-bulb temperature.

3. Maximum bi-monthly river water temperature with average river flow and wet-bulb temperature.

4. Minimum river flow and river temperature with maximum wet-bulb temperature.

The results of these calculations, in the form of areas within isotherms are found in Tables 5.1-2, 5.1-3 of the Environmental Report. Under average conditions, the 5° isotherm is maximum in December, and encloses 5.8 acres. The largest plume occurs under condition 4 above for the months of March/April in which the area enclosed is 23 acres.

5.4.2.2.2 Staff's Analysis of the Thermal Discharge. Numerous analytical models have been made in attempts to describe the physical characteristics of thermal discharges. Many of these models are reviewed in the paper by A. J. Policastro and J. V. Tokar.[56] Due primarily to a lack of reliable field data, none of these models have been adequately tested.

The model chosen by the staff was developed by Louis H. Motz and Barry A. Benedict.[57] This model is intended to apply to rivers as well as lakes. Two parameters, which must be determined empirically, are the entrainment coefficient and the drag coefficient. Curves for these parameters were obtained by fitting hydraulic-modeling data and some field data to the analytical model.

In the Motz-Benedict model the area enclosed by a given isotherm is inversely proportional to the entrainment coefficient. For values of $V_a/V_o<.2$ (V_a = ambient river velocity, V_o = discharge velocity) the fitted values of the entrainment coefficient vary between .04 and .4. For $V_a/V_o>.2$, the value of the entrainment coefficient appears to be constant at .4, but the data points are scattered with one point as low as .1.

Paddock et al.,[58] have recently compared field data from plants on Lake Michigan with a variety of models. Under certain conditions, the Motz-Benedict model predicted smaller plumes than observed, when the recommended values of the entrainment coefficient were used. In order to assure that calculations would not underestimate the plume areas of the Byron Station effluent, the staff has chosen an extremely conservative value for the entrainment coefficient, 0.05. Although the minimum value for all cases observed by the authors was 0.04, the entrainment coefficient is usually slightly larger for non-perpendicular discharges.

Table 5.13 lists the applicant's values of the area inclosed by various isotherms for the three extreme cases mentioned previously; also included are the staff's predictions. Figure 5.5 compares several plumes for case 4, March and April (Ref. 1, Fig. 6.2-3).

The table shows that the staff's results generally agree with the applicant's results within a factor of two. The plumes computed by the applicant hug the shore and are typically longer than those predicted by the staff. It appears unreasonable to expect the heated effluent to flow along the shore in this manner except under conditions of a large cross-flow velocity caused by an on-shore wind. In any case, even the staff's estimate of the location of the plume implies that there is a large zone of passage for aquatic life and the state standard will be met.

The staff is not aware of any models that take into account the sinking plume phenomenon, which occurs when the density of the warm effluent is greater than that of the ambient river water (water has a maximum density at about 39°F). Figure 5.5 represents the surface plumes calculated with the sinking phenomena ignored. It is expected that the area encompassed by a given isotherm will increase with depth, but the extent of this increase cannot be quantified.

The calculations of plume areas were made to ascertain that the state standards will be met. Under the best circumstances, thermal plume models are more likely to be qualitatively rather than quantitatively correct in predicting actual lengths, widths and areas of plumes. Thus, one should not assume that if a plume were measured under given meteorological conditions, its parameters would agree closely with the numbers found in Table 5.13 or in Fig. 5.5. One could, however, reasonably assume that the measured values would be less than those predicted by the models of either the staff or the applicant.

The staff will require the applicant to monitor the thermal discharge to assure that the station operates within limits of the State's thermal criteria.

5.4.2.2.3 Effects of the Thermal Discharge on Aquatic Organisms. The most readily observed effect of the discharge will be the congregation of fish in the plume. When ambient river temperatures are below the preferred temperature of a given species, it is likely that fish of that species will congregate in warm water. This type of behavior is a common occurrence at the outfalls of power stations with once-through cooling.[59,60]

It is still debatable whether, in general, such congregation is beneficial, neutral, or deleterious to the fisheries of a system. Fish which are attracted to and reside in heated water would have a higher than normal metabolic rate. If sufficient food were not available, they would lose weight. In some cases it has been shown that some species of fish captured in the discharge region are in a poorer condition than those from unheated regions.[61,62]

TABLE 5.13. Extreme Condition Isotherm Areas

	Month	*Excess Isotherms °F*	*Applicant's Plume Area, Acres*	*Staff's Plume Area, Acres*
Case 2	Jan/Feb	25	.02	.004
		20	.10	.05
		15	.42	.23
		10	1.98	1.0
		5	8.8	7.8
	Mar/Apr	20	.06	.03
		15	.28	.18
		10	1.55	.86
		5	7.2	6.7
	May/Jun	5	.11	.02
		3	1.01	.37
		2	3.81	1.5
	Jul/Aug	5	.91	.33
		3	5.07	2.0
		2	11.0	6.4
	Sep/Oct	10	.22	.04
		5	3.53	.91
		3	10.7	4.5
		2	19.0	13.7
	Nov/Dec	25	.01	-
		20	.06	.03
		15	.28	.17
		10	1.55	.83
		5	7.20	6.5
Case 3	Jan/Feb	20	.02	.06
		15	.11	.26
		10	.72	1.1
		5	4.3	6.8
	Mar/Apr	10	.07	.14
		5	1.4	1.7
		3	4.8	6.5
	May/Jun	3	.07	.07
		2	.45	.46
	Jul/Aug	5	.06	.12
		3	.49	.87
		2	1.66	2.8

TABLE 5.13. (Cont'd)

Case	Month	Excess Isotherms °F	Applicant's Plume Area, Acres	Staff's Plume Area, Acres
Case 3 (cont'd)	Sep/Oct	5	.07	.04
		3	.59	.48
		2	3.14	1.8
	Nov/Dec	15	.07	.04
		10	.44	.34
		5	1.4	3.2
Case 4	Jan/Feb	25	.09	.05
		20	.28	.16
		15	1.08	.53
		10	4.29	2.0
		5	17.5	13.7
	Mar/Apr	25	.34	.24
		20	.96	.56
		15	2.57	1.5
		10	8.00	4.8
		5	23.	29.
	May/Jun	25	.09	.06
		20	.28	.19
		15	1.10	.59
		10	3.78	2.2
		5	12.80	14.5
	Jul/Aug	20	.02	.01
		15	.21	.09
		10	1.3	.52
		5	9.0	4.7
	Sep/Oct	25	.35	.12
		20	1.00	.34
		15	2.52	.96
		10	7.6	3.4
		5	21.2	23.
	Nov/Dec	25	.23	.13
		20	.56	.35
		15	1.90	.98
		10	5.60	3.4
		5	16.50	22.

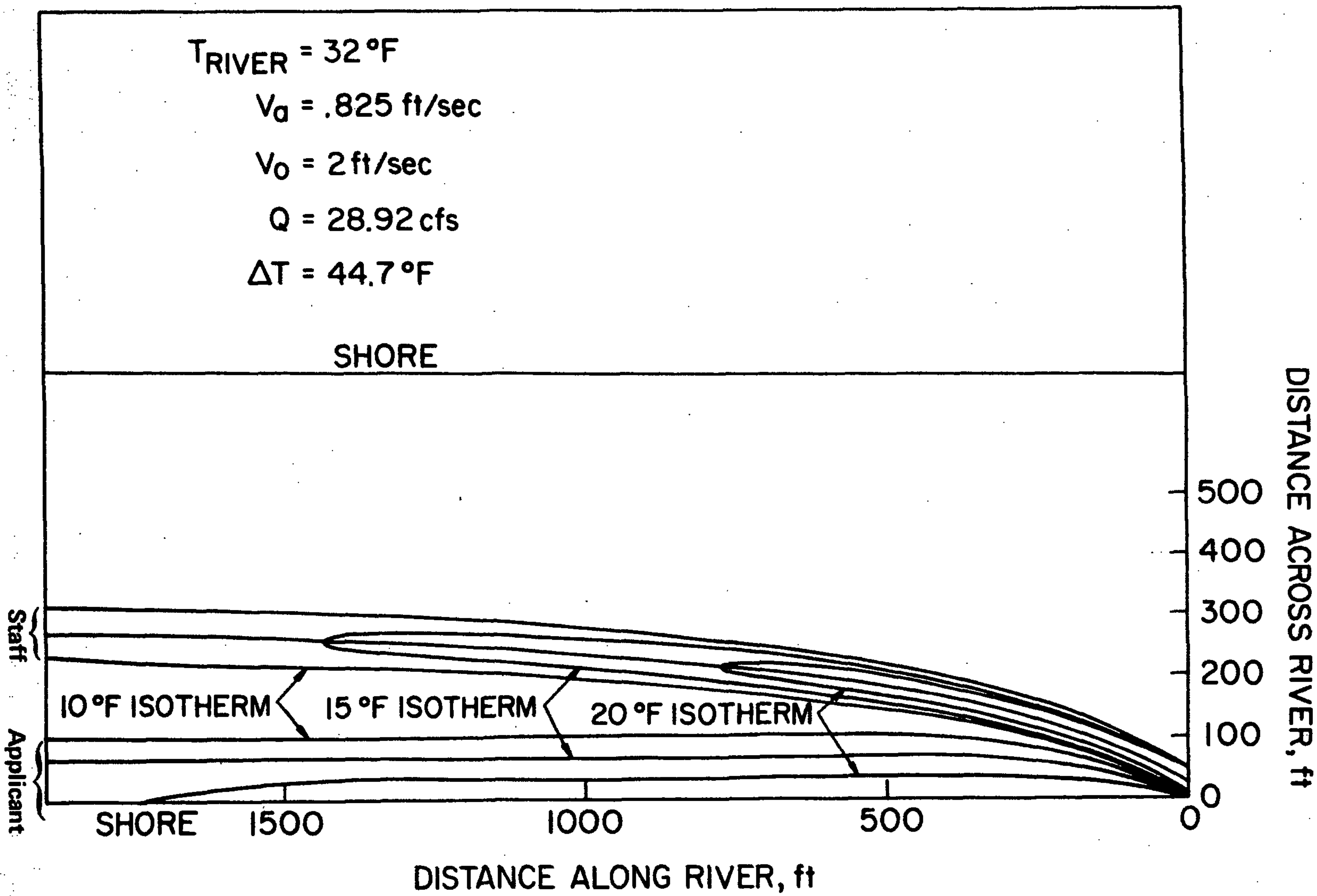

Fig. 5.5 Isotherms from the Byron Station under Extreme Meteorological Conditions.

Loss of condition could result in reduced fecundity with possible reduction in population size or productivity. However, for this impact to materialize, a large portion of the total population would have to frequent the plume. Because of the small size of the plume at Byron, the staff does not expect that, if loss of condition for some fish occurs, it will have a population level impact.

On the other hand, some species may avoid the plume region if it exceeds their preferred temperature. Local reduction in numbers of some fish species below river power plants is known.[59] However, the area from which any species might occasionally be excluded is very small and the effect on the population will be negligable.

The staff does not expect that cold shock kills will be a problem. Because of the large thermal reservoir of the circulating water, the rate of a non-emergency shutdown will not be rapid enough to deliver a cold shock to fish congregated in the plume; and after both units are in operation, it is unlikely that both would be shut down at once.

The upper thermal tolerance of the benthic fauna is about 90°F,[63,64] and since the maximum possible discharge temperature is lower, no reduction in biomass or species composition is expected where the plume contacts the stream bed. It is possible that thermophilic species of midge larvae may colonize the discharge structure, as has been reported an another river power station.[64] In addition, thermophilic algae, which will most likely be attached diatoms,[65] may become established during the summer. The occasional development of thermophilic organisms in the discharge structure is not judged to have a detrimental effect on river productivity or water quality.

The thermal shock to planktonic or drift organisms which become entrained into the discharge will be relatively mild and should seldom be lethal. Only those organisms entrained into the warmest part of the plume might be seriously effected. The number involved will be less than those entrained into the intake flow and will have a negligable impact on total river productivity.

5.4.2.3 Effects due to the Chemical Quality of the Effluent

The chemical nature of the diverted river water is altered to some extent by passage through the plant. The increase in concentration of dissolved solids (about 2 fold) is due to evaporation; chemicals may be lost or gained through contact with the atmosphere in the cooling tower; various microorganisms which can modify water quality may become established in the tower fill (e.g., nitrifying bacteria); chemicals may be added to control scale and corrosion or microorganisms.

With the exception of biocide additions, the staff expects that there will be no adverse impact on the local river biota due to the alteration of water quality in the discharge. Details of biocide usage in the plant are not final. However, the technical specifications for operation will require that plant discharge meet standards adequate to protect most important aquatic organisms. Presently suggested standards for chlorine[66] are quite low and, whether these or standards which supersede them are applied to Byron, some modifications of plant design might be necessary to ensure that the standards are met. The staff is of the opinion that modifications necessary to meet such biocide standards are possible with existing technology. The means available include, but are not limited to, retention ponds, holdup of blowdown, chemical scavengers, and application of biocide to different plant subsystems in such a manner that water with sufficient biocide demand may be mixed with the treated water before discharge.

A further task is to verify that the standards are actually met, because (at least for chlorine) routine analytical devices do not measure accurately below about 0.1 ppm, which is in excess of possible standards. Assessing the effectiveness of the system for reducing biocide levels may necessitate the use of indirect methods. For example, at one power plant which uses a chemical scavenger for chlorine, an amount stoichiometrically in excess of that required to reduce the chlorine is added to the blowdown in a chamber which insures complete mixing.[67] The staff considers that this procedure gives the best guarantee that applicable standards are met. The means developed by the applicant for limiting biocide levels to standards can be designed to be effective even though routine verification by direct measurement is not practical.

Overall, the chemical impacts will be acceptable. Monitoring by the use of artificial substrates (zoobenthos and periphyton), will effectively serve as a bioassay of the influence of the discharge on primary and secondary production in the river.

5.5 SOCIAL AND ECONOMIC EFFECTS

During the 30-year operating life of the station, the applicant estimates that an operating force of about 200 persons will be employed and that an estimated annual payroll of $3 million will result (Ref. 1, p. 8.0-1). The applicant has estimated that 32 of these jobs can be filled locally (Ref. 1, p. 11.1-2); thus, assuming an average of four members per family, a population increase of 672 persons due to new jobs is anticipated by the staff. These 672 persons represent 7% of the combined populations of the towns within 10 miles of the site, and about 0.2% of the combined populations of the towns within 17 miles of the site (includes Rockford, Illinois). Since travel of 20 miles to a place of employment is not unusual in rural areas the staff concludes that this population increase will have an insignificant impact on the area, its schools, housing, hospitals and other public facilities. Traffic congestion upon completion of construction will be greatly reduced over that of the construction period and should cease to pose any unusual safety or noise problems.

The applicant has estimated that the presence of the station will increase the Ogle County tax base by more than 70% (Ref. 1, p. 11.1-2). Since the county, township and local services required by the station, its employees, and their families should not require a proportional increase in effort and materials provided by the local public bodies, the staff concludes that the station will prove to be of economic benefit to the present residents. The applicant has estimated that the present value (1972) of the federal, state and local taxes to be paid during the life of the station is about $330 million while the present value of the increased cost of community service for the same period is about $2.5 million.

The applicant has calculated that local expenditures of the station and its employees will result in 380 additional jobs. If these jobholders earn the mean income of the county, the present value of the jobs is about $34 million. Furthermore, no facet of station operation has been identified which would hamper or discourage the present agricultural activities or existing ways of life.

Except for the occasional noise caused by normal plant activities, no unusually loud or persistant off-site noise levels are anticipated by the staff. The diesel engines which power the emergency electric generators are to be used only during periods when outside power to the station is interrupted or for assurance testing purposes. The applicant is committed to operate these units with mufflers for noise reduction.

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6. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 PRE-OPERATIONAL MONITORING PROGRAMS

6.1.1 Terrestrial Program

A program was undertaken* to establish the main characteristics of the site terrestrial ecology so the impact of plant construction and operation could be evaluated. The "baseline" phase of the program was begun in August 1972 and continued through the summer of 1973. Details of the program are given in the applicant's Environmental Report (Ref. 1, Sec. 6.1) and are summarized below.

6.1.1.1 Vegetation

Following a preliminary survey, four areas were selected as being representative of the vegetation communities on the site, i.e., deciduous forest, grassland, fallow areas, and cropland. Quantitative analysis involving the quadrat method was applied to these four areas. Frequency (the percentage of quadrats in which a species occurred) and abundance (the number of individuals per species) were determined for each species. The mean diameter at breast height (dbh) was calculated for each species of trees with a dbh of over four inches.

6.1.1.2 Animal Life

The animal populations on site were estimated by various methods, i.e., deer by pellet plots and an aerial survey, small mammals (except rabbits and squirrels) by snap-trapping, rabbits by roadside counts, squirrels by time-area counts on chosen plots, and furbearers and large predators by tracks in random quadrats.

Censuses of waterfowl, game and nongame birds were taken by visual and auditory methods. Insects were sampled in four locations by sweep net.

Following the studies outlined above, a pre-operational monitoring program was begun in order to "detect ecological changes during the period of construction activity, and to supplement the data accumulated during the baseline studies." This program is similar to that described for the baseline study. The four onsite vegetation study areas will not be disturbed by construction activities and will be used as vegetation monitoring locations. Censuses of birds and mammals will continue to be taken. Because of the very low densities of amphibians and reptiles observed during the first year of study, these will not be monitored systematically but observations during routine sampling trips will be noted. The program is summarized in Table 6.1.

*The applicant's consultant for its ecological programs is Environmental Analysts, Batavia, Ill.

TABLE 6.1. Summary of Terrestrial Ecology Pre-Operational Monitoring Program

Parameter	*Sampling Frequency*	*Sampling Location*
Vegetation	May and September	Four representative areas
Deer	Quarterly	Ten pellet quadrats, Aerial survey
Mammals	Quarterly	20 track quadrats
Non-game birds	Quarterly	6 bird quadrats
Game birds	Spring	Automobile routes

From applicant's Environmental Report

The staff is of the opinion that the applicant's pre-operational studies will be adequate to establish the general ecology of the site prior to operation. The use of the data as a baseline to measure impacts of normal plant operation will be virtually impossible; except for extreme cases, it will not be possible to separate effects (if any) of operation from natural changes in vegetation and animal populations. The program must be continued through the construction period, nevertheless, since this activity may have detrimental effects. The program shall exclude the use of snap traps since, in the staff's opinion, the value of the data does not justify the killing of animals.

6.1.2 Onsite Meteorological Program

The pre-operational meteorological program, initiated in May 1973, consists of measurements made on a 250-ft tower. Wind speed and direction are measured at 30-ft and 250-ft levels; the vertical temperature gradient is measured between 30-ft and 250-ft levels, and the dewpoint temperature is measured at 30-ft and 250-ft levels. The primary data recording system uses tape cartridges with strip charts forming the secondary system. This program is in accordance with Regulatory Guide 1.23.

No onsite data have been made available to the staff at this time. Joint frequency distributions of wind velocities and atmospheric stability from Rockford, Quad Cities, and Dresden were examined by the staff to determine representative, yet conservative, atmospheric dispersion characteristics for the Byron site. After examining relative concentration values calculated from each set of data, the staff decided upon using 300-ft data from Quad Cities, with a reduction in wind speeds to represent 33-ft data. The staff judges that these data reasonably represent the wind direction frequencies at Byron and provide conservative estimates of-annual average atmospheric dispersion values for the Byron site. Once sufficient onsite data are made available to the staff, these estimates will be revised accordingly and appropriate corrections made. A Gaussian diffusion model, with adjustments for building wake effects, was used to make estimates of relative concentrations at various distances and directions from the site as described in Section 5.

6.1.3 Radiological Monitoring Program

The applicant has proposed an offsite pre-operational radiological monitoring program required by Safety Guide 21 (Regulatory Guide 1.21). Such a monitoring program is required to provide assurance that the contribution of radioactivity to the environment and, hence, the population dose is indeed negligible.

A summary description of-the applicant's pre-operational program is presented in Table 6.2. The description is not intended to be a complete technical specification of the program. Monitoring and analytical techniques are developing and are likely to improve before the program is put into effect. More information on the applicant's program is presented in Section 6.1.5 of Environmental Report (Ref. 1). Guidance provided by the Environmental Protection Agency will be used in the program design.[2]

TABLE 6.2. Pre-operational Radiological Environmental Monitoring Program

Media			
External gamma	Downwind at 6 points of maximum concentrations, one each at Byron and Oregon	a) Quarterly Annually b) Weekly c) Once during program	a) Thermoluminescent dosimetry (TLD) b) Paired 10 mR ion chambers c) Field survey w/pressurized ion chamber & NaI spectrometry
Airborne particulate matter		a) Weekly b) Monthly c) Monthly composite d) Quarterly Composite	a) Gross beta b) Gross alpha c) Gamma spectrum d) Radiostrontium
Milk	Samples from two nearest dairy herds	a) Monthly	a) Gamma spectrum Radiostrontium Radioiodine
Groundwater	Samples from two nearest active wells, down the hydrological gradient	a) Quarterly	a) Gross beta Gamma spectrum Tritium Radiostrontium
Surface water	Five samples (2 above intake, one at and one below intake, and one at Oregon Dam)	a) Monthly b) Quarterly	a) Gross beta & alpha b) Gamma spectrum Radiostrontium
Benthic organisms sediment and aquatic plants	Five samples (2 above intake, one at and one below intake, and one at Oregon Dam)	a) Quarterly	a) Gamma spectrum
Fish	Four samples of various species two upstream and two downstream of intake	a) Semi-annual	a) Gamma spectrum Radiostrontium
Food crops, eggs	Nearby farms. Farm greater than 20 miles distance in least prevalent wind direction	a) Annually (just prior to harvest)	a) Gamma spectrum Radiostrontium
Public water supplies	Byron, Oregon	a) Monthly b) Quarterly composite	a) Gross beta b) Gamma spectrum Tritium Radiostrontium

The staff suggests that the pre-operational program be started at least two years prior to plant operation.

6.1.4 Aquatic Program

6.1.4.1 Rock River

The applicant has carried out an acceptable baseline survey (April 1972 to June 1973) of the aquatic biota in the vicinity of the site (Fig. 6.1). The chemical, physical, and ecological variables which were sampled are as follows:

1. Chemical Variables:

Total suspended solids	Sulfates	Cadmium
Total organic solids	Calcium	Chromium
Total dissolved solids	Magnesium	Cobalt
Biochemical oxygen demand 5-day	Color	Copper
Total organic carbon	Silica	Iron
Dissolved oxygen	Total phosphate	Lead
pH	Orthophosphate	Manganese
Conductivity	Nitrate	Mercury
Hardness	Nitrite	Nickel
Alkalinity	Ammonia	Zinc
Chlorides	Sodium	
Chlorine demand		

2. Physical variables:

Light penetration	Turbidity
Transparency	Current velocity
Temperature	Bottom type
	Mid-channel depth

3. Ecological variables:

Phytoplankton	Fish-Direct sampling
Zooplankton	Fish-Creel census
Benthos	Fish-Bacterial diseases
Periphyton	Fish-Ectoparasites
Bacteria	Fish eggs and larvae
	Emergent aquatic plants

A very brief summary of the data has been given in Section 2.7.2. Further details of methods, frequencies, and locations for the baseline study, as well as the proposed pre-operational monitoring for 1974, and the proposed operational monitoring program are presented in Tables 6.3 to 6.6. A complete compilation of data and methods is presented in the applicant's Environmental Report (Ref. 1, Sec. 2.7.1.2).

For the monitoring to be adequate to determine if first-order biotic changes associated with operation occur, and to provide physical and chemical information to aid in the interpretation of such changes, it

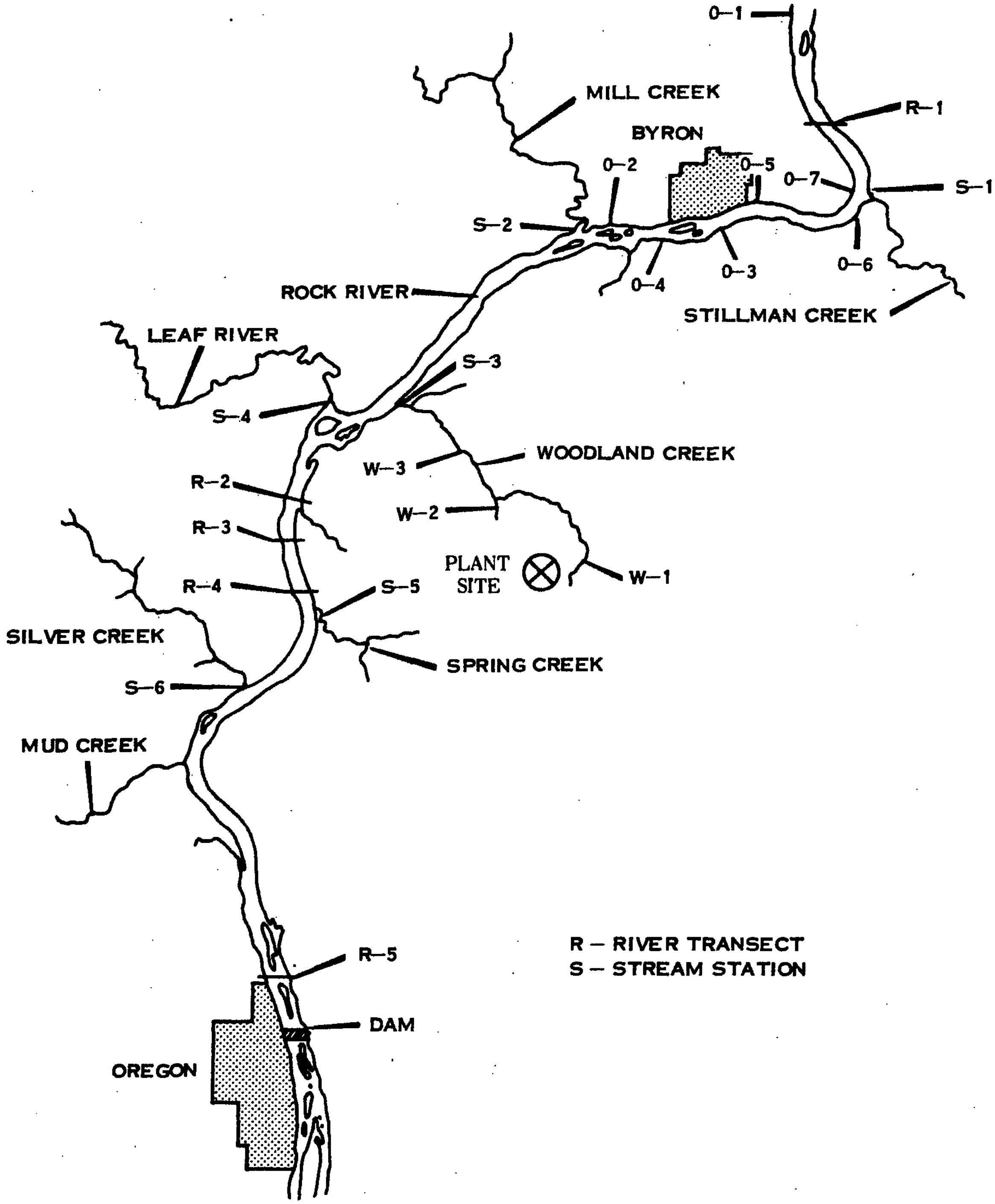

Fig. 6.1. Aquatic Sampling Locations. From the applicant's Environmental Report.

TABLE 6.3. Summary of the Aquatic Ecological Baseline Survey Program

Parameter	*Sampling Frequency*	*Sampling Method*	*Analyses*	*Sampling Location*	*Ancillary Measurements*
Phytoplankton	Twice monthly	Midriver dip sample, 2 liter sample volume	Species composition, relative abundance, biovolume, biomass	Five river transects and near the mouths of 6 streams	Velocity and depths
Zooplankton	Twice monthly	Straining 60 liters through 20 mesh net	Species composition, relative abundance, total counts	Five river transects and near the mouths of 6 streams	Velocity and depths
Benthic Invertebrates	Every other month	Ponar dredge in river, Eckman dredge in streams	Species composition, relative abundance. Diversity indices will be computed, biomass - dry-weight	On each river transect 4 samples 25 yards off each bank. Two samples near each stream mouth	Velocity, depth and bottom type
Periphyton	Twice monthly	Diatometer, Ruth Patrick design, Charles Reimer design drain tiles, substrates	Species composition, relative abundance, biomass, biovolume/unit area. Emphasis will be on diatoms. Biovolume will be converted to biomass	One 10-slide sampler on 2 locations on transects 1, 3, and 5. One 10-slide diatometer near mouth of 6 streams. Three slides per sampler will be examined. Two drain tiles per transect and 1 near 6 stream mouths will be placed in August. Three areas on each substrate equal to areas on slides will be examined	Light penetration, velocity, depth of diatometer
Fish, Direct Sampling	Summer and fall of 1972; 6 electrofishing surveys	Electrofishing, seining	Species composition, length-weights, relative abundance, catch per unit effort. Food habits of the 5 most important species (10 fish per species totaling 50 fish)	Surveys are made along the shoreline of each transect	Temperature, velocity, secchi readings, general habitats described

TABLE 6.3. (Cont'd)

Parameter	*Sampling Frequency*	*Sampling Method*	*Analyses*	*Sampling Location*	*Ancillary Measurements*
Fish Eggs and Larvae	Net tows as of June 13, 1972. Prior to that period 60 liter dip samples collected for zooplankton were examined	15 minute net tows and 60 liter dip samples	Total counts for eggs and larvae-counts per units of volume of water	Midriver tow at midriver on transects 1, 2, 3, 4, and 5	Velocity and depth
Emergent Aquatic Vascular Plants	Throughout study period	Weed beds will be mapped and acreages will be determined. Beds will be photographed	Species composition, relative abundance	Throughout river study area	Depth
Bacteria	Monthly, Fecal strep counts initiated in August 1972; Fecal coliforms initiated December 1972	Standard methods	Coliform counts, total counts, and fecal streptococcus counts	One midriver dip sample on each transect, 1 dip sample near mouth of 6 streams	Standard water chemistry measurement
Fish, Creel Census	Continuous since late August 1972	Fishermen interviews	Species composition, catch per unit rod hour, lengths and weights of fish caught	Throughout study area	None
Fish Diseases, Bacterial Infections	Sampling during fish dieoff	Trypticase soy agar plates	Presence of systemic infections will be assessed by streaking of tissue on TSA	If dieoffs occur or if fish collected during the study appear to be diseased, appropriate tests will be performed	None
Fish Diseases, Ectoparasitic Infections	Sample from fish collected by electrofishing	Examination of gills	Microscopic examination of gills, counts per gill arch. Incidence will be compared to levels associated with disease problems	Adult fish collected by electrofishing on river transects will be examined. For the 5 most important species, 10 fish per species totaling 50 fish will be examined	None

TABLE 6.4. Summary of Aquatic Ecology Pre-Operational Monitoring Program

Parameter	*Sampling Frequency*	*Sampling Location*
Phytoplankton	Quarterly	Mid-channel R-1 through R-5 S-3, S-4, and S-5 + Qualitative Sampling; R-2, R-3, and R-4
Zooplankton	Quarterly	Same as above
Periphyton	Quarterly	Mid-channel R-1 and R-5, S-3, S-4, and S-5 + W-3 and W-1
	Bi-Monthly	R-2, R-3, and R-4
Benthos	Quarterly	Mid-channel R-1 and R-5, S-3, S-4, and S-5 + W-3 and W-1
	Monthly	R-2, R-3, and R-4
Fish	Quarterly	Mid-channel R-1 through R-5 S-3, S-4, and S-5 + W-3 and W-1
Fish Eggs and Larvae	Monthly during April, May, June, and July	Mid-channel R-1 through R-5 S-3, S-4, and S-5
Fish Creel Census	Recreation Season during the Year before Operation	Study Area
Bacteria	Quarterly	Mid-channel R-1 through R-5 S-3, S-4, and S-5
Fish Muscle and Liver	Spring and Autumn	Same as above
Water Chemistry (22 parameters)	Quarterly	Same as above + W-3 and W-1
Trace Metals (Cd, Co, Fe, Cu, Hg, Zn, Pb, Cr)	Quarterly	Same as above + W-3 and W-1

TABLE 6.5. Water Quality Monitoring Program Stations Monitored and Frequency of Tests[a]
(mg/l except pH and bacteria)
(Codes appear at end of table.)

Analysis	*State Effluent Standard*[b]	*State Water Quality Standard*[c]	*Intake from River to Cooling Tower Make-up*	*Blowdown from Cooling Tower to River*	*River Down-stream*	*Sewage Treat-ment Plant Outlet*
Dissolved	-	>5	-	-	QX	M
Oxygen	-	-	-	-	-	-
pH	5-10	6.5-9.0	MA	C	M	-
Dissolved Solids	3500 max 750 avg above	1000	MA	C	QX	-
	background	-	-	-	-	-
Bacteria	400/100 ml	200/100 ml	MA	-	M	M
Ammonia Nitrogen	-	1.5	MX	-	MX	-
Arsenic	0.25	1.0	QX	-	QX	-
Barium	2.0	5.0	QX	-	QX	-
Cadmium	0.15	0.05	QX	-	QX	-
Chromium (+6)	0.3	0.05	MX	-	MX	-
Chromium (+3)	1.0	1.0	QX	-	QX	-
Copper	1.0	0.02	QX	-	QX	-
Cyanide	0.025	0.025	QX	-	QX	-
Iron (total)	2.0	1.0	QX	-	QX	-
Lead	0.1	0.1	QX	-	QX	-
Nickel	1.0	1.0	QX	-	QX	-
Oil (hexane soluble or equal)	15.0	-	Q	Q	-	-
Phenols	0.3	0.1	Q	Q	-	-
Selenium	1.0	1.0	Q	Q	-	-
Silver	0.1	0.005	Q	Q	-	-
Zinc	1.0	1.0	MX	MX	-	-
Calcium	-	-	Q	Q	-	-

TABLE 6.5. (Cont'd)

Analysis	*State Effluent Standard*[b]	*State Water Quality Standard*[c]	*Intake from River to Cooling Tower Make-up*	*Blowdown from Cooling Tower to River*	*River Down-stream*	*Sewage Treat-ment Plant Outlet*
Mercury	0.0005	0.0005	QX	QX	-	-
Total Suspended Solids	15.0	-	M	M	-	M
BODs	-	-	M	M	-	M
Manganese	1.0	1.0	QX	QX	-	-
Total Phosphate as P	1.0	0.05	QX	QX	-	-
Sulfates	-	500	M	M	-	-

[a]Operating reports must be submitted to the Illinois EPA at a frequency determined by the Illinois EPA. The sampling schedule shown in this table is similar to schedules approved for other plants.

[b]Effluent standards apply to the individual streams discharging from the plant to the river.

[c]Water quality standards apply to the quality of the river water outside of the mixing zone.

<u>Frequency Codes</u>

C - Continuous
M - Monthly
Q - Quarterly
A - or as required based on findings
X - to be run the first year and adjusted thereafter

TABLE 6.6. Summary of Aquatic Ecology Operational Monitoring Program

Parameter	*Sampling Frequency*	*Sampling Location*[a]
Phytoplankton	Quarterly	Mid-channel R-1 through R-5 S-3, S-4, and S-5 Qualitative Sampling; R-2, R-3, and R-4
Zooplankton	Quarterly	Same as above
Periphyton	Quarterly	Mid-channel R-1 and R-5, S-3, S-4, and S-5 + W-3 and W-1
	Bi-monthly	R-2, R-3, and R-4
Benthos	Quarterly	Mid-channel R-1 and R-5, S-3, S-4, and S-5 + W-3 and W-1
	Monthly	R-2, R-3, and R-4
Fish	Quarterly	Mid-channel R-1 through R-5, S-3, S-4, and S-5 + W-3 and W-1
Fish Eggs and Larvae	Monthly during April, May, June, and July	Mid-channel R-1 through R-5 S-3, S-4, and S-5
Fish Creel Census	Recreation Season during Second Year of Operation	Study Area
Bacteria	Quarterly	Mid-channel R-1 through R-5 S-3, S-4, and S-5
Fish Muscle and Liver Trace Metals and Pesticides	Once each during spring and summer	Same as above
Water Chemistry (22 parameters)	Quarterly	Same as above plus W-3 and W-1
Trace Metals (Cd, Co, Fe, Cu, Hg, Zn, Pb, Cr)	Quarterly	Mid-channel R-1 through R-5 S-3, S-4, and S-5 + W-3 and W-1

TABLE 6.6. (Cont'd)

Parameter	*Sampling Frequency*	*Sampling Location*[a]
Physical Parameters (temperature, current velocity, turbidity, depth, light penetration, transparency)	Quarterly	Mid-channel R-1 through R-5 S-2, S-4, and S-5 + W-3 and W-1

[a]See Fig. 6.1.

TABLE 6.7. Summary of Terrestrial Ecology Operational Monitoring

Parameter	*Sampling Frequency*	*Sampling Location*
Vegetation	May and September	2 areas on-site 4 areas off-site
Deer	Quarterly	Same as above
Mammals	Quarterly	Same as above
Nongame birds	Quarterly	Same as above
Game birds	Spring	Automobile routes

From applicant's Environmental Report

is necessary to have sufficiently accurate information about the natural variability of the samples. Because of the strong seasonal influence on the biota, it is necessary to have samples from several years at similar seasonal times. Thus, the staff recommends that the proposed pre-operational monitoring program for 1974 be carried out in substantially the same form for each succeeding year until operation.

The monitoring program should be adequate to demonstrate that operation has not caused significant ecological damage to the river and to detect undue changes in ecological variables, if, contrary to expectation, these should occur.

6.1.4.2 Ground Water

Ground water will be monitored before and during plant operations to: (a) define existing conditions as a base for future comparisons; (b) check for changes in water level, mineralization, and other water quality parameters due either to plant operation or to intensive groundwater use by others; and (c) provide ample warning time and a basis for remedial action to protect offsite groundwater users in case of detrimental changes in groundwater quality (Ref. 1, 6.1-17). Small-diameter observation wells will be drilled, and private wells might be usable for monitoring.

Baseline data should be obtained from the observation wells and nearby private wells (particularly those which do not tap either of the two main aquifers but are into the scattered shallow fractured aquifers) prior to any dewatering activities or to pumping from the station's new wells.

6.2 OPERATIONAL MONITORING PROGRAMS

6.2.1 Terrestrial Program

The terrestrial monitoring program (non-radiological) proposed by the applicant, to be carried out after operation begins, is summarized in Table 6.7. The staff believes the plans are adequate as an inventory of flora and fauna of the survey areas, but as discussed in Section 6.1, will not be sufficient for the difficult task of separating naturally occurring changes from subtle changes caused by normal station operation, should such changes occur. Gross effects, however, such as the sudden disappearance of all deer from the site as soon as the mechanical-draft cooling towers are turned on, should be detected by the applicant's program. Again as stated in Section 6.1, the use of snap trapping must be avoided.

In addition to the applicant's program outlined in Table 6.7, the following must be included in the Station's operational monitoring program (it should be understood that generic data obtained from other facilities may allow the requirements for monitoring to be adjusted prior to plant operation):

a. Salt deposition on foliage of crop plants. Once a month during the growing season (beginning at emergence and continuing to harvest), visual inspection of crop plants shall be carried out in the areas northeast, east, and southeast of the natural-draft towers across German Church Road. The inspection must be done by persons qualified in plant physiology and plant pathology so that distinctions can be made between necrotic areas on foliage caused by salt deposition from drift and those caused by insects and/or nutritional deficiencies or toxicities. If necessary to confirm a diagnosis, samples of the foliage should be taken for analysis (total salts) and compared with analysis of unaffected leaves. This procedure shall be carried out for the first two years of continuous cooling tower operation. Continuation of this monitoring will depend on the results of the first two years, i.e., this part of the monitoring subsequently may be discontinued if no drift salt effects are detected during the first two years.

b. Bird-kill surveys. The areas surrounding cooling towers, taller station buildings, and meteorological tower should be monitored intensively during the spring (approximately April to May) and fall (August to October) song bird migrations. This should involve daily inspection and pick-up of birds. In addition, on those nights when predictions favor particularly adverse weather conditions, night pick-ups should be noted. This monitoring should take place during construction as well as during operation.

6.2.2 Onsite Meteorological Program

The applicant has not identified modifications to the pre-operational program that will be made for the operational program. However, in the Environmental Report (Ref. 1, p. 6.2-11), the applicant has stated that the meteorological monitoring system will continue after the beginning of plant operation. Staff evaluation of the operational program will be made prior to plant operation.

6.2.3 Radiological Monitoring

The applicant plans to continue the proposed pre-operational radiological monitoring program during the operating period. The operational monitoring program will assist in verifying projected or anticipated environmental radioactivity concentrations and related public exposures. More detailed information on this program is presented in Sec. 6.2 of the applicant's Environmental Report.

6.2.4 Aquatic

The operational aquatic monitoring program is basically the same as the pre-operational program and base-line studies. The applicant has not specified any modifications to the program. Staff evaluation of the program will be made prior to plant operation.

6.2.5 Conclusions

The operational radiological, chemical effluent, thermal effluent, meteorological, hydrological and ecological monitoring programs will evolve from the pre-operational monitoring programs described in the applicant's Environmental Report. Since the present action pertains to issuance of a construction permit, detailed staff evaluation of the operational program will be done at the time of application for an Operating License, and monitoring requirements will be included in the Environmental Technical Specifications of the Operating License.

6.3 RELATED ENVIRONMENTAL PROGRAMS AND STUDIES

In addition to the non-radiological monitoring programs carried out by the applicant, water quality of the Rock River is determined by the Illinois EPA on samples routinely taken at Oregon (Route 64 town bridge) about five miles downstream of the Station discharge, and at Byron (Route 72 bridge) about five miles upstream of the Station intake.[3] River flow data are obtained at gaging stations located at Rockton on the Rock River and near Perryville on the Kishwaukee River (the two closest upstream stations) and at Como on the Rock River (the closest downstream station). The State Water Survey also carries out sampling for non-biological water quality parameters. The Argonne National Laboratory conducted a one-year pilot project study of the Rock River basin in 1970;[4] further study is not planned at this time.

Radiological monitoring, independent of the applicant's program, is conducted routinely by the Division of Radiological Health of the Illinois Department of Public Health. Pre-operational sampling for background characteristics begins about two years before Station operation. Operational monitoring conducted by this agency usually includes thermoluminescence dosimetry (TLD), air sampling (particulates), milk sampling, and water (surface and ground) sampling.

References

1. Commonwealth Edison Co., "Byron Station Environmental Report," including insertions, Vols. 1 and 2, Docket Nos. STN 50-454 and 50-455.

2. "Environmental Radioactivity Surveillance Guide," U. S. Environmental Protection Agency, Report ORP/SID-72-2, 1972.

3. "Summary of Data," State of Illinois EPA Water Quality Network, Vol. 1, 1971.

4. H. L. Dyer and T. A. Tamblyn, "Illinois River - Basin Pilot Project," (pertains to Rock River), Center for Environmental Studies, (ANL, (Draft) March 1973.

7. ENVIRONMENTAL IMPACT OF POSTULATED ACCIDENTS

A high degree of protection against the occurrence of postulated accidents is provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system of the Byron Station 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 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 Byron Station Environmental Report, dated August 1973.

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 exposure that might be delivered to the population within 50 miles of the site are also presented in Table 7.2. The man-rem estimate was based on the projected population within 50 miles of the site for the year 2010.

To rigorously establish a realistic annual risk, the calculated doses in Table 7.2 would have to be multipled 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 they are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in Table 7.2 are weighted by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low. Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain a high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

The AEC is currently performing a study to assess these risks more quantitatively. The initial results of these efforts are expected to be available in 1974. This study is called the Reactor Safety Study and is an effort to develop realistic data on the probabilities and sequences of accidents in water-cooled power reactors, in order to improve the quantification of available knowledge related to nuclear reactor accident probabilities. The Commission has 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 is described in correspondence with EPA, which has been placed in the AEC Public Document Room (letter, Doub to Dominick, dated June 5, 1973).

As with all newly developed information which might have an effect on the health and safety of the public, the results of the study 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 one year 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 a small fraction of the annual 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.

TABLE 7.1. Classification of Postulated Accidents and Occurrences

Class	AEC Description	Applicant's Examples
1	Trivial incidents	Included in the evaluation of routine releases.
2	Small releases outside containment	Included in the evaluation of routine releases.
3	Radioactive waste system failure	Waste gas and liquid decay tank failures. Equipment leakage or malfunctions.
4	Fission products to primary system (BWR)	Not applicable.
5	Fission products to primary and secondary systems (PWR)	Fuel cladding defects and steam-generator tube leak; steam-generator tube rupture.
6	Refueling accident	Fuel bundle drop and heavy object drop onto fuel in core.
7	Spent fuel handling accident	Fuel assembly drop in fuel storage pool. Heavy object drop onto fuel rack.
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Loss of coolant accident, steam line break, and rod ejection accidents.
9	Hypothetical sequence of failures more severe than Class 8	Not considered.

TABLE 7.2. Summary of Radiological Consequences of Postulated Accidents[1]

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[2]	Estimated Dose to Population in 50-mile Radius, man-rem
1.0	Trivial incidents	3/	3/
2.0	Small releases outside containment	3/	3/
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.098	3.4
3.2	Release of waste gas storage tank contents	0.39	14
3.3	Release of liquid waste storage tank contents	0.011	0.38
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	3/	3/
5.2	Off-design transients that induce fuel failure above those expected and steam-generator leak	0.002	<0.1
5.3	Steam-generator tube rupture	0.13	4.5
6.0	Refueling accidents		
6.1	Fuel bundle drop	0.020	0.72
6.2	Heavy object drop onto fuel in core	0.35	12
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel rack	0.013	0.45
7.2	Heavy object drop onto fuel rack	0.051	1.8
7.3	Fuel cask drop	N.A.	N.A.

TABLE 7.2 (Cont'd)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary[2]	Estimated Dose to Population in 50-mile Radius, man-rem
8.0	Accident initiation events considered in design basis evaluation in the SAR		
8.1	Loss-of-coolant accident		
	Small break	0.21	14
	Large break	2.1	450
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)	0.21	45
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	<0.1
8.3 (b)	Steamline break (BWR)	N.A.	N.A.

[1]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.

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

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

8. THE NEED FOR POWER

This section of the Environmental Statement contains an evaluation of the applicant's need to have additional generating capability in the period of 1979 through 1981. The applicant's projected need for both the Byron Station and the Braidwood Station is evaluated herein because the stations were proposed for licensing in a single application. The summer capability of the four units in these plants is 4420 MW. Included in the analysis are: demands for both peak power and total energy, characteristics of the applicant's system, reserve margins needed for reliable generation, and relationships of the applicant with the other regional utilities.

8.1 DESCRIPTION

8.1.1 Applicant's Service Area

The applicant's service area covers about 13,000 square miles, primarily in the northern third of Illinois (Ref. 1, Fig. 9.2-1). Included are the northern Illinois area with metropolitan Chicago and three separate, smaller, and less densely populated areas in central Illinois. Figure 8.1 is a geographical map showing the service areas.[2] At the present time, the three small areas are served by generating capacity outside the applicant's system. The applicant intends to sell his facilities and franchise for these three areas.[3]

In the service area, which contains approximately eight million people, residential, commercial, and industrial customers, have about equal electrical energy consumption. The following list gives the percentage breakdown of the 53 billion kWh sales for 1972:

Residential	28.2%
Commercial	30.6
Industrial	29.9
Other (Public Authority, Electric Railroads, Sales for Resale)	11.4
Total	100%

On a per capita basis, the average use was slightly less than 7000 kWh/yr.

For comparison, the U. S. with over 200 million people in 1972 had total sales of about 1600 billion kWh with a somewhat comparable breakdown into categories.[4] Expressed in percent the values are:

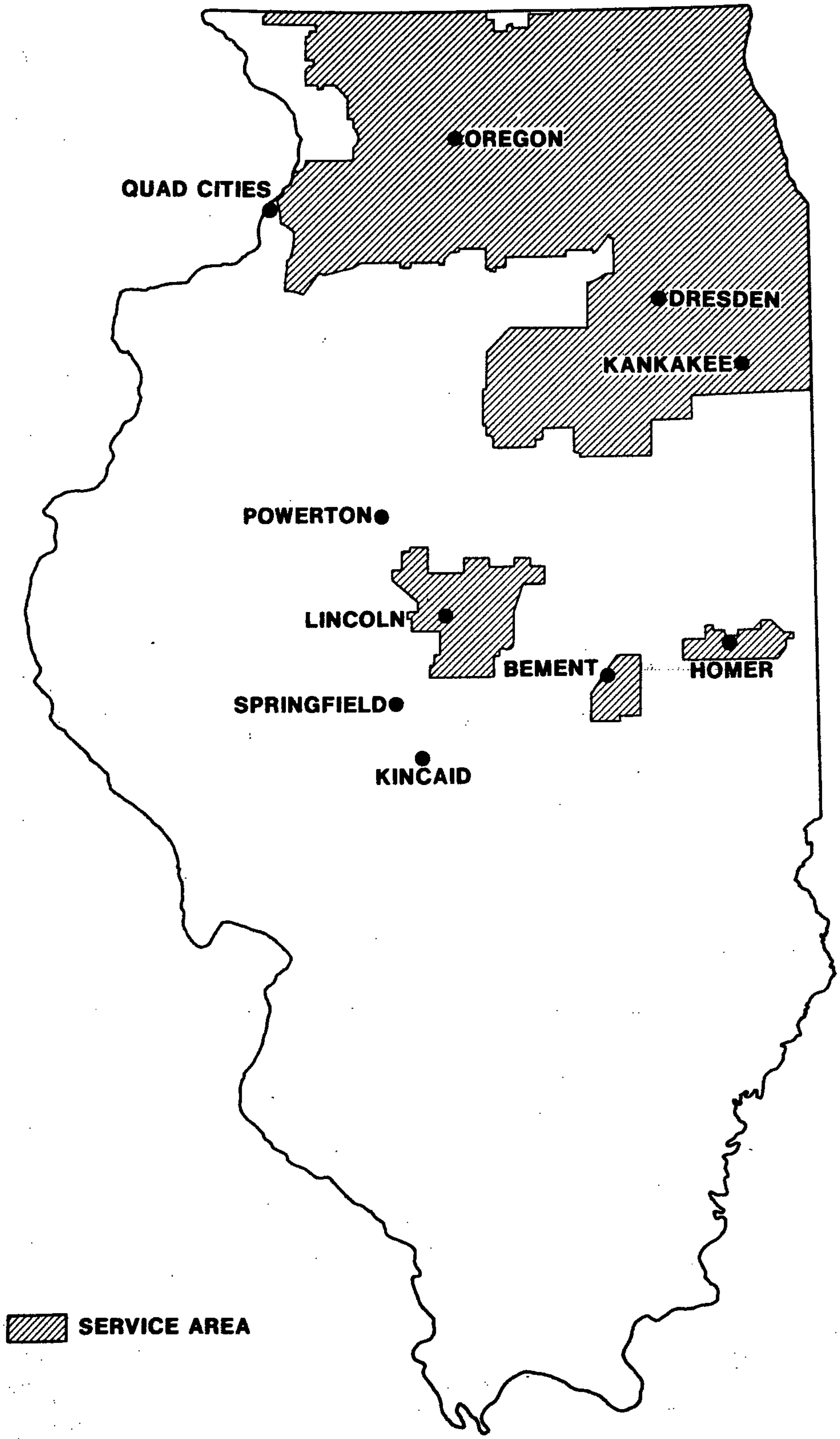

Fig. 8.1. Commonwealth Edison's Service Areas

Residential	32%
Commercial	23
Industrial	40
Other (Streets, Highway and Public Authority, Railways, etc.	5
Total	100%

Although there are uncertainties in defining the bounds for the various categories, the percentage of the kWh sales to the residential customers for the applicant's system and for the total U. S. are very similar. Because of the large commercial activities of metropolitan Chicago, the percentage sales in this category is greater than for the U. S. The average per capita sales for the applicant's area is about 15% below that for the U. S.

8.1.2 Applicant's Power System

Commonwealth Edison is one of the largest utilities in the U. S. with an installed capacity of about 14,000 MWe in 1973. Both fossil and nuclear units supply the base load; the intermediate range load is supplied by fossil-fueled units. Gas turbines and the older, smaller fossil units are used to meet the remaining portion of the demand. The generating stations, together with the fuel used and capacity, are listed in Table 8.1. The applicant's power generating system is almost entirely within the State of Illinois; the only exception is the State Line Station, which is located near Hammond, Indiana.

Coal, oil, gas, and nuclear fuels are currently used; however, the ponderance of the electrical energy is obtained from coal and uranium. In 1973 about 61% of the energy generated was from coal and 29% from nuclear fuel. At present, the annual system peak demand occurs in the summer; the winter peak is about 80% of the summer peak. The annual load factor for the system is about 53%.

Commonwealth Edison has an extensive transmission system to deliver bulk power to load centers. The Kincaid, Powerton, and Dresden generating stations are located to the south of the main load centers. The Zion and Waukegan stations are located to the north of the load centers. Quad Cities station, which is a joint venture with the Iowa-Illinois Gas and Electric Company, is on the western border of the applicant's territory. With the planned retirement and reduced usage of many of the generating units within the matrix of the load centers as well as for increased demand, the applicant has built up an extensive

TABLE 8.1 Commonwealth Edison's Generating Units and Their Approximate Capability for Summer Peak Service (1973)

			Steam Electric Summer Capability, MW			
Name	No. of Units	Location	Coal	Gas Coal[d]	Oil	Nuclear[e]
Calumet	(1)	Chicago		120		
Crawford	(3)	Chicago		650		
Dixon	(2)	Dixon		120		
Dresden	(3)[a]	Morris				1760
Fisk	(2)[b]	Chicago		480		
Joliet	(4)[b]	Joliet	1680			
Kincaid	(2)	Kincaid	1230			
Powerton	(5)	Pekin	1170			
Quad Cities	(2)[c]	Cordova				1170
Ridgeland	(4)	Stickney			570	
Sabrooke	(4)	Rockford		150		
State Line	(3)	Hammond, Ind.		940		
Waukegan	(4)	Waukegan		950		
Will County	(3)	Lockport	1050			
			5130	3410	570	2930
		Total Steam Electric				12040
Gas turbines (oil & gas fueled at many locations)						1600
Diesel (oil fueled)						20
		Total for applicant				13660
Ludington pumped hydro[f]						520
		Total				14180

[a] Two units are not fully operational.

[b] An 11-MWe diesel is also located at this site.

[c] Applicant's portion of the two units.

[d] Two units (Calumet #7 and Crawford #6) can only burn gas.

[e] In 1973 a portion of the nuclear capacity was under trial operation; for various reasons 500 MW was unavailable for the summer peak.

[f] Part of output from the Ludington pumped hydro facilities is available to the applicant under a 15-year agreement. (An additional 104 MW became available after the summer peak.)

transmission system to carry power from the outlying stations to the load centers of the Chicago metropolitan area. This is shown in part in Fig. 8.2. Another function of the transmission system is to provide the capability to carry bulk power to and from surrounding utilities in order to provide for interchanges of low cost power and to increase the reliability of the applicant's and the adjoining utilities' systems.

8.1.3 Regional Relationships

The applicant is a member of the Mid American Interpool Network (MAIN), which is one of the nine Regional Reliability Councils of the National Electric Reliability Council. MAIN's purpose is to promote regional coordination of the planning, construction and operation of the members' generating and transmission facilities;[5] emphasis is on reliability and economy. The following is a list of the groups, including their associate members, of the MAIN council and their installed capacity as of January 1974:[6]

Commonwealth Edison	15,900 MWe
Illinois Group	6,300 MWe
Missouri Group	7,200 MWe
Wisconsin-Upper Michigan Systems Group	6,400 MWe
Total	35,800 MWe

The MAIN Council region is contiguous with four other council regions. Coordinated planning is carried out among these councils; in addition, purchases and sales of electricity take place between certain of the utilities in these other councils and some utilities in the MAIN council.

The applicant's electrical system is connected with its neighboring utilities and depends upon these interconnections in planning the required generating capacity. Although the total interconnection capability is large, only about 3000 MW could be transferred simultaneously. The dependable amount of this transfer capability in time of emergency is usually much less, due to generating conditions and loads in neighboring utilities. At the present time MAIN has no reserve margin requirement for its members, but a criterion is being developed. However, as reported by MAIN, load flow and stability studies of the council's network are made to test the performance of the projected interconnected transmission system when subjected to extreme disturbances.[7]

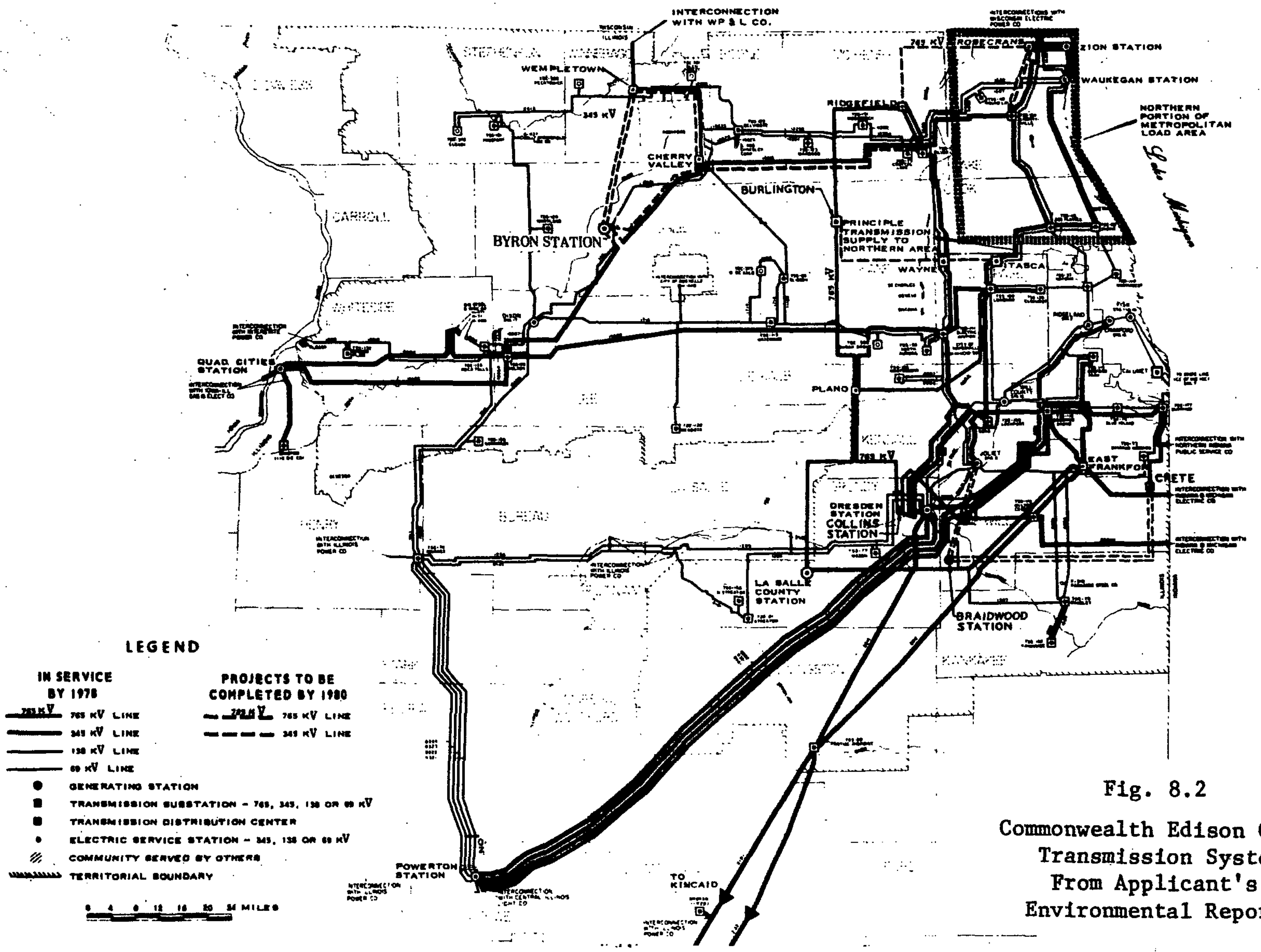

Fig. 8.2

Commonwealth Edison Outer Transmission System. From Applicant's Environmental Report.

8.2 HISTORIC DEMANDS AND CAPABILITY

8.2.1 Peak Power Demand and Generating Capability

8.2.1.1 Peak Power Demand

The annual peak power demand on the applicant's system occurred during the summer in recent years; however, prior to 1964 the peak occurred during the winter. The relative demands by various classes of the consumer at the time of peak demand is not well known because daily power demand is only recorded for a few large industrial customers, although some sampling of power demand is conducted among other classes of consumers. The summer peak demand since 1959 is plotted in Fig. 8.3. The slope of the line representing the past peak loads in this figure corresponds to a growth rate of slightly over 8% per year. For comparison the U. S. had a growth rate of the noncoincident peak of slightly less than 8% per year from 1962 through 1972. For the 1968 through 1973 interval, the applicant's annual growth rate (including demand not met due to disconnection of some interruptible load and to a voltage reduction) was slightly less than 8%, whereas for the U. S. the growth rate for the noncoincident peak was slightly greater than 8%. In general, the annual growth rate of the summer peak for the Commonwealth Edison system is very similar to that for the United States.

8.2.1.2 Generating Capability

The generating capability in the past has been based on coal-fired units. The use of gas-fired units increased during the 1960's. Environmental pressures promoted the use of oil-fired facilities starting in 1969; however, for the last two years nuclear plants have been the main generating additions. Gas-turbine units, which have a low capital cost and can be installed quickly, were about 12% of the 1973 summer peak capability. The magnitude of the generating capability for any year is based on peak power demand plus a reserve margin.

8.2.1.3 Reserve Margin

The applicant's policy on reserve capability is that the required reserve margin be 14% of the total of the peak load minus firm purchases, diversity interchanges, and Ludington purchase.[6] The Federal Power Commission (FPC) considers a reserve margin in the range 15-25% of the anticipated peak load to be adequate.[8] The purpose of the reserve margin is to assure a reliable generation system by allowing for forced outage of units, and uncertainty in load forecasts. It is the applicant's practice not to schedule plant maintenance and reactor refueling during the season when the peak load occurs. The magnitude of the reserve margin depends upon the interconnections with other utilities and their projected ability to supply power in emergencies.

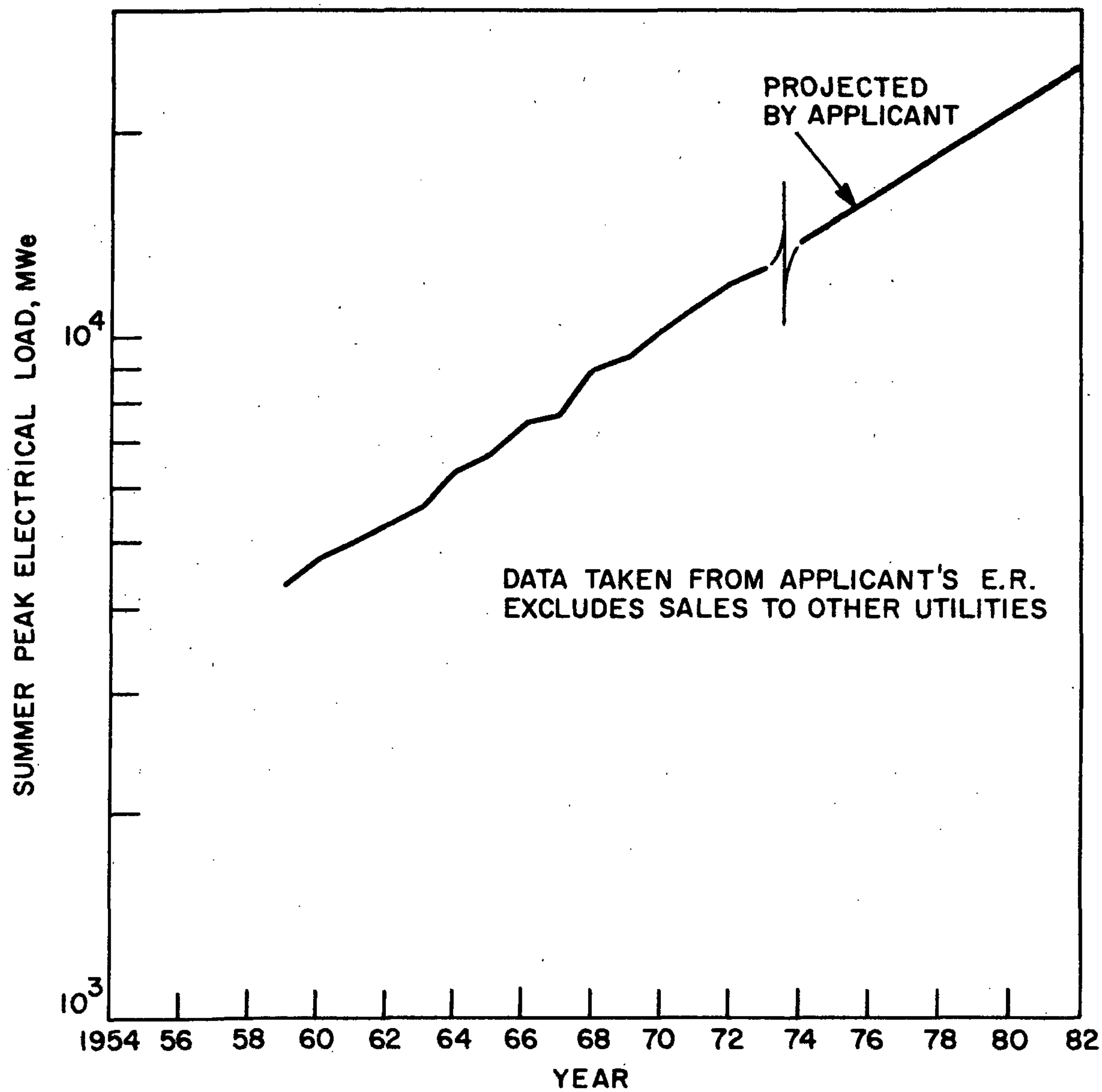

Fig. 8.3. Historic Summer Peak Power Demand.

Based on data given in the applicant's Environmental Report, calculations show that during the last six years the reserve margin varied from 7 to 24%. The average was 14.5%. During this period there were no blackouts in the system; however, voltage reduction, disconnection of interruptible load, and special purchases at the time of the system peak did occur.

The needed generating reserve for a given reliability criterion is determined in part by anticipated equipment forced outage rates (product of outage frequency and downtime during the outage). In the past, projected forced outage rate estimates used in reliability calculations were based on reasonably firm data, although uncertainties in the data for new large fossil units became more prominent in the last few years. Estimates of forced outage rates for the large nuclear units coming on line in 1972 and 1973 are also tenuous because of the lack of operating experience.

8.2.1.4 Operating Reserve

Due to equipment outages and variable weather and business conditions (which strongly influence demand), the actual operating reserve (that is, the available capability on the system) at the time of peak gives an indication of the effectiveness of utility's planning methods. At the request of the staff the applicant estimated the following operating reserve:

Year	Total Peak, MW	Operating Reserve, MW	Operating Reserve, % of Peak
1969	9,419	447	4.7
1970	10,049	75	0.7
1971	10,973	449	4.1
1972	11,991	973	8.2
1973	12,703	264	2.1

In 1970 and 1973 the applicant reduced the voltage during the time of the peak. Also in 1973 customers having contracts that allowed interruption of power were disconnected to reduce the load; net purchases of capacity by the applicant were 1173 MW at the time of peak. The applicant has been able to sustain required loads, but the operational reserves were rather small.

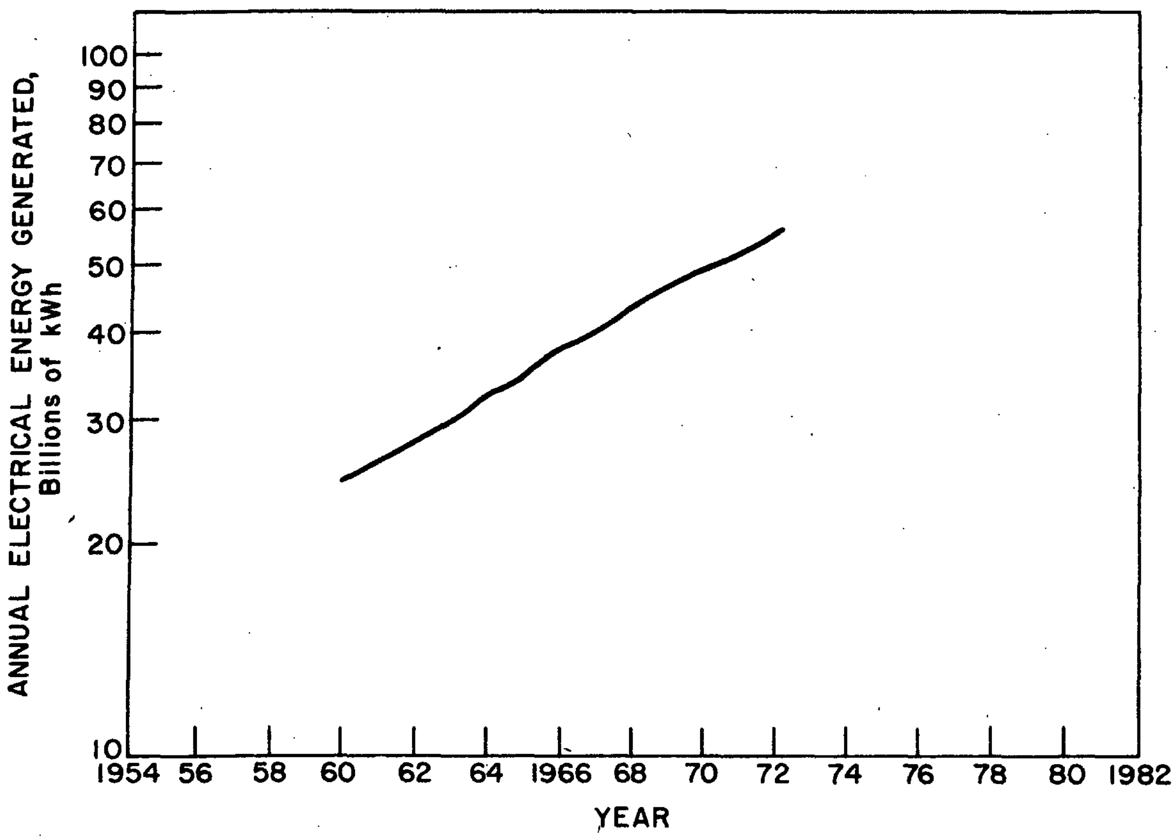

Fig. 8.4. Applicant's Annual Electrical Generation.

8.2.2 Energy Demand

8.2.2.1 Electrical Energy Generation

The annual generation of electrical energy has not grown as rapidly as the annual peak power demand in recent years. Figure 8.4 shows annual generation from 1960 through 1972 as given by the applicant. Over this period the growth rate was about 7% per year; for the U. S. the growth rate was slightly higher. The trend and magnitude of the applicant's growth appears reasonably consistent over the 12-year period. Since 1964, when the annual power peak started to occur in the summer, the energy growth rate has been 7.1% per year, whereas the peak load growth rate (excluding sales) was 8.1% per year.

8.2.2.2 Load Characteristics

The applicant's Environmental Report (Ref. 1, Fig. 1.1-1) displays annual load duration curves for 1968 through 1971. These curves are very similar in shape with no apparent trend with time; in fact the applicant states that the annual system load factor, which may be determined from the curves, will be about constant in the near future. In the past the annual load factor has decreased and now is in the 52-54% range. In the applicant's display, the annual base load is 57% of the annual peak load.

8.2.2.3 Fuel Sources

Historically, coal has been the applicant's main fuel. Natural gas was also used but this was mainly during the summer. Because of the natural gas shortage, this use is severely curtailed. Fuel oil was practically never used, but conversion of some of the coal units to fuel oil started to occur in 1969 because of environmental pressures. The following table displays the applicant's trend in fuel use, expressed as percent:

	Coal	Gas	Oil	Nuclear
1968	86	12	0*	2
1969	83	14	1	2
1970	65	23	6	6
1971	60	19	12	9
1972	57	10	11	22
1973	61	3	7	29

*Negligible

With the present oil shortage and the proposed Federal directive for utilities to convert from oil to coal where possible[9] and with the rulings in the priorities of natural gas use not favoring electrical utilities,[10] the applicant's use of coal and uranium for fuel can be expected to increase.

8.3 PROJECTED DEMANDS

8.3.1 Introduction

The projected need for new generating capacity rests largely on the prediction of future demands. In this section, not only will future electrical power demand be discussed, but also future electrical energy demand. Energy demand estimates are, of course, needed for proper selection of the type of generating capacity to be added. How best to meet these demands depends on the economic and environmental costs of alternatives. The consideration of alternatives for this station is given in Section 9.

There are many forecasting methods in use in electrical planning. The methodology of load forecasting, as of 1969, has been described in "The 1970 National Power Survey".[11] This work has been updated[12] and in addition there are other reports on the subject.[13] Under a National Science Foundation program an econometric analysis has been used to study electricity demand.[14,15]

The staff has not used any particular methodology to project demands but rather has reviewed the applicant's projections for aptness of method considering the current state of the art for making projections and for suitability of information used.

8.3.2 Energy

The applicant did not directly project the future electrical energy demand using any complex methodology; however, he did state that the annual load factor in 1979 should be nearly equal to that in 1971.

Econometric modeling of electrical energy supply and demand is an active investigative field. A recently published study by Asbury of ANL reviews past studies and presents an independent analysis.[16] Econometric modeling has been based mainly on energy rather than on power demand relationships with the variables. Some of the explanatory variables, or econometric factors, in these studies are: electricity price, natural gas price, heating oil price, consumer income and electrical appliance prices. The impact on demand caused by changes in the values of the econometric factors takes time to be fully reflected in consumption.[14] Thus, past and possible future price increases by the applicant can influence demand at the time of startup of these units. There appears to be little doubt that on a national basis electricity price is a very important econometric factor. These models predict that increases in electricity price will decrease demand. Counter-factors are the increasing income of consumers and the increasing prices of fuel oil and natural gas. These tend to increase demand for electricity; however, their elasticities are probably less than the electricity price elasticity.[15]

Basically, energy and power demands may follow the same trends, but the magnitudes of the trends may be different. If good energy demand models with suitable data existed, these could be used to gain better insights into the power demand trends than is available from present projection models and data. It should be noted, however, that some of the econometric factors in present projections by utilities are expressed explicitly while others are used in implicit form.

The current state of the art of econometric analysis is summarized in the following extracts from the Asbury report.

"A number of investigators have recently reported results of econometric studies of the market for electrical energy.[17-24] The studies have attempted to explain temporal and inter-market variations in electricity consumption in terms of variables which, on a priori grounds, might be expected to affect electricity demand. Using multiple regression techniques, the investigators have examined the dependence of electricity consumption on such variables as: electricity price, population, personal income, climate variables, degree of urbanization, the price of electric appliance, and the price of natural gas. Although most of the studies have concentrated on the residential market for electricity, results have been reported for the commercial and industrial markets as well.

"Selected results from several previous studies of electricity demand are presented in Table 8.2. The table lists estimated demand elasticities for three explanatory variables: electricity price, income, and natural-gas price.

"Despite differences in underlying assumptions, methodology, and data base, the studies all indicate that electricity price is the most important determinant of electricity demand. The results of Wilson, Halvorsen, and Chapman, Tyrrell, and Mount for the residential market indicate a price elasticity of demand of about -1.25. Stull and MacAvoy find a similar elasticity value for the whole U. S. electricity market, and Anderson's result for the residential market is not in too serious disagreement.

"Although the econometric approach to the analysis of the market for electrical energy has provided considerable insight into the causal factors underlying electricity supply and demand, none of the models developed to date provides a reliable method for estimating future consumption. The existing dynamic models fail to incorporate the supply relation, while the static supply-demand models are ill suited to situations involving changes in long run supply and demand trends."

Thus, based on Asbury's analysis, the staff finds that it is premature to make analyses using any of these correlations. It should be noted that elasticity coefficients for the models as they apply to the applicant's

Table 8.2

Elasticity Estimates from Previous Studies of Electricity Demand

Study (Reference)	Model	Market	Elasticities*		
			Electricity Price	Income	Gas Price
Mount, Chapman, Tyrrell[17,19]	Dynamic, Single Equation	Residential Commercial Industrial	-1.3+ -1.5+ -1.7+	+0.3+ +0.9+ +0.5+	+0.15+ +0.15+ +0.15+
Anderson[18]	Static, Single Equation	Residential	-0.85	+0.94	+0.21
Halvorsen[20]	Static (+ Time Trend), Supply-Demand	Residential	-1.2	+ .61	+ .036
Wilson[21]	Static, Single Equation	Residential	-1.33	- .46	+ .31
Stull, MacAvoy[22§]	Static Single Equation	Combined	-1.24	+0.86	-

+Elasticities estimates for constant elasticity model (Reference 19). See Reference 17 for variable elasticity estimates.

§Capacity demand model.

*The three elasticities are defined as the relative change of demand with the relative change of electricity price ($\Delta D/D \div \Delta E/E$), of income ($\Delta D/D \div \Delta I/I$) and of gas price ($\Delta D/D \div \Delta G/G$).

would have to be developed, if a correlation were to be used. In addition, the projection of the existing econometric data is necessary in order to use these correlations.

The staff has reviewed the applicant's statement that the load factor in 1979 would be about the same as now, and the projection of electrical energy inherent in that statement. In addition, the staff has reviewed the applicant's projected energy growth as it appears in Appendix A of the MAIN report to the FPC.[6] As explained below, these considerations lead the staff to believe that the applicant's projections of energy demand are too high.

As given in Reference 6, the applicant's 1982 peak power demand is 24,350 MWe and the net output to the load is 116 billion kilowatt hours. This corresponds to an annual load factor of about 54.6%. In the same reference, the 1974 projections were 13,760 MWe peak power and 64.4 billion kilowatt hours net output, which corresponds to a load factor of 53.4%. The energy growth rate during this period is calculated to be 7.7% per year. During the 1962-1972 period, the applicant's energy growth rate was 7.0%/yr. This was a high growth period for the applicant both in energy and power. Considering that the peak power growth rate from 1973 to 1982 will probably not match the rate from 1960 to 1972 of about 8%/yr, and considering the consumer's response to the energy shortage in recent months, the staff believes that the energy growth rate will average no higher than 7%/yr between 1973 and 1982. On this basis, the energy demand will be less than 95% of that projected by the applicant.

8.3.3 Power

The electrical power users in the applicant's area largely determine the demand placed on the generating units; to a small extent power use outside of the applicant's system also contributes to the demand. The applicant is required to estimate consumer demand. In these days of expensive and scarce capital for electrical utilities, high estimates of demand can be costly not only to the consumer, who of course must ultimately pay the tariffs, but also to the utility, which must bear the burden of reduced earnings prior to rate adjustments. Under the present social pressure to consume energy, the utility can do little to increase demands. A low estimate of power demand also places a burden on the utilities by requiring short-term purchases (or in some cases power and energy exchanges) of often expensive electricity from other utilities.

The applicant's method to forecast peak load is based on two factors, business conditions and weather. The relationship and selection of the specific variables were obtained by reviewing and correlating past statistical data for his system. The applicant uses an analytical model incorporating these variables to make projections for up to ten years into the future. Projected loads are based on a 24-year average of peak-making summer weather conditions. It is thus apparent that, in addition to the uncertainties in the model, uncertainties in the weather and future business conditions also contribute to the inaccuracy of the forecast.

The projection of the 1973 peak (made prior to the actual peak, and given in the Environmental Report) was checked against the actual peak given in the FPC News.[25] The agreement was very good: 12,750 MWe projected demand vs. 12,834 MWe actual demand including estimates of load not met.

The power projections given by the applicant correspond to an annual growth of 7.5% from 1973 through 1982. As stated previously, the actual annual growth of the applicant's summer peak from 1964 through 1973 was about 8.1%. For comparison the estimated annual growth for the U. S. from 1973 through 1980 is 7.5%.[4] Thus the applicant with general electrical conditions representative of the U. S. projects a growth rate representative of the national average rate. The 1982 peak demand projected by the applicant is 24,350 MWe.

Energy availability and price have undergone some significant changes in the last year due to many factors. In the future, energy will be more expensive than in the recent past. After a long period of a downward movement in the real price of electricity, its price has started to increase. Although in this "need for power" section the main concern is with power not energy, estimates of future demand for most consumers is invariably linked to the cost of energy; however, there does not need to be a one-to-one correspondence between power and energy. Indeed, air conditioners, which are a principal cause for the summer peak, may be used in the very hot weather even though their annual energy consumption may be reduced. Thus the consumer stock plus the future availability of electrical appliances can contribute to peak demand even though their annual usage may decrease. Increased manufacturers' shipments of electrical ranges, dryers, and water heaters occurred in 1973; shipments of corresponding gas-fired units remained the same or decreased during the same period when compared with the previous year.[26]

In the staff view, the downward electrical energy and power use in the U.S. is more than a passing phenomenon. Projections of power demand for 1982 are very uncertain. The applicant in a recent letter to the AEC has stated in the period of December 1973 through April 1974 there has been a 6% decrease in the expected demand for power.[27] In the U.S. the cumulative energy output from January 1, 1974 to May 18, 1974 was only 0.1% higher than last year during the same period.[28] As discussed in Section 8.3.4, there are a number of reasons for this decrease in demand.

The staff believes that the applicant's estimate of about 7.5% per year growth from a base of 12,703 MW in 1973 to 24,350 MW in 1982 is an upper level of the projection for peak summer power demand. Until more certainty exists and trends are better indicated, it appears prudent to view the 24,350 MWe projection (and the corresponding values for 1980 and 1981) as an upper value for planning.

8.3.4 The Impact of Energy Conservation and Substitution Measures on Need for Power

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.[29] In the following sections, the staff considers conservation of energy as related to the need for the electricity to be produced by the Byron and Braidwood plants.

8.3.4.1 Recent Experience

Implementation of energy conservation measures by households, business, and government has already contributed to less growth than projected in the consumption of electricity nationally since the third quarter of 1973. For the applicant, lack of growth also could be attributed to economic slowdown, self-imposed voltage reductions, and a somewhat milder winter than anticipated. Consumption of electricity in the applicant's service area has been less than the forecasted consumption by an average of about six percent during the period December 1973 to April 1974. Monthly peak load demand also was less than the forecast by an average of about six percent during the same period. Milder than anticipated weather accounts for an insignificant percent of the deviation from the monthly peak load demand forecast. Some deviation is attributed to the economic slowdown. A rough approximation indicates that 80% of the deviation is attributed to energy conservation and changes in econometric factors such as price.

The interpretation of the significance of such limited data on energy conservation impacts on the forecasted need for power in the applicant's general service area over the next six to ten years is uncertain. For instance, although conservation effects on peak load demand have been observed during the winter months, it is not known if such effects will continue during the hot summer months when the applicant's system peak load occurs. Much will depend, of course, of the future decisions of consumers and governmental agencies in responding to the energy crisis and potential developments in energy supply and demand factors which might ease the energy crisis or cause it to worsen. Only actual data on power demand in the applicant's general service area will provide a reasonable basis for demand projections which include conservation decisions.

8.3.4.2 Promotional Advertisement and Conservation Information Services

In the past, Commonwealth Edison Company has attempted, through advertising, to increase the demand for certain uses of electricity in its service area. A major thrust of advertising was to promote demand during off-peak periods, for electritity uses such as water heating and space heating.

The applicant terminated promotional advertising and began advertising the efficient use and conservation of electricity in 1973. Monthly reports to the Federal Power Commission indicate that Commonwealth Edison Company is sponsoring T.V., radio and newspaper advertising, publishing booklets and sponsoring industry programs aimed at conserving electricity.

On a national basis, an estimated $450 million was spent on promotional advertising in 1972 by manufacturers of electrical applicances and equipment;[30] this advertising has not been curtailed. The manufacturer and utility programs tend to offset each other and the net effect on future demand is uncertain.

8.3.4.3 Change in Utility Rate Structure

The Federal Power Commission regulated the rates for interstate wholesale electric energy, while the Illinois Commerce Commission regulates the rates utilities charge the ultimate consumer in the applicant's service area. There are different rates for each class of consumer (resident, commercial, and industrial) as well as a rate structure for each class.

Historically, utility rate structures were designed to encourage consumption of electricity by using 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 electricity instead of other energy sources.

There recently appears to be increasing support for a more nearly level set of rates. In an Oak Ridge National Laboratory study of the effect of rates on electrical energy consumption, it was concluded (for the U.S.), however, that equal average rates for all consumers of all classes would not materially change the aggregate electrical energy demand.[31]

8.3.4.4 Load-Shedding, Load Staggering and Interruptible Load Contracts to Reduce Peak Demand

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.[7] 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, this involves customer and worker preferences external to the utility industry and is beyond the bounds of utility industry action.

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 three of Commonwealth Edison's industrial customers are supplied a portion of their services under Ridge 17, Electric Furnace Interruptible Service. Power interruptions are being practiced by the utility at times of peak demand. The amount of power involved is small (<100 MWe).

8.3.4.5 Energy Use Efficiencies

Due to energy shortages and higher energy costs in the U.S. economy, an emphasis recently has been placed on increasing the efficiency of energy use. In the past, the selection of efficiencies by utilities was normally carried out on a cost effectiveness basis, i.e., the operations to produce electrical energy should result in the lowest cost product. A brief review of efficiencies involved in the use of coal and nuclear fuel is appropriate.

Two efficiencies of interest are the generating plant efficiency and the fuel system efficiency. For the generating plant, the overall net heat rate expresses the efficiency of fuel conversion to electrical energy. With present design practices, coal-fired plants have higher efficiencies than the LWR nuclear plants. Per kilowatt hour electrical output, the coal-fired plant needs only 4/5 the thermal input that a nuclear plant does. The fuel system efficiency includes not only the energy used to convert fuel in the generating plant but also the energy for mining, preparation, and transportation of fuel. In addition the transmission losses to the customer are included. Neglecting the unrecovered coal and uranium in mining and material losses in processing, it has been estimated that the coal system only needs 3/4 of the heat input that a nuclear system does per kWh of electrical energy to the consumer.[32]

Although important in assessments, energy use efficiencies based on thermal input requirements are not the only criteria in judging the effectiveness of man's use of resources. The efficiency of labor and capital to construct facilities must also be considered and this is generally done in the context of dollars. Environmental costs throughout the energy system must also be included when considering alternative fuels. With the increase in fossil fuel prices, which are expected to exceed the increase in capital costs on a percentage basis, future designs of power plants can be expected to incorporate the latest technology that gives increases in efficiency.

8.3.4.6 Factors Affecting the Efficient Utilization of Electrical Energy

During the past two years, much of industry, the Federal Government and many State and local governments have made the promotion of energy conservation a priority program. The Department of Commerce has developed a departmentwide effort to: (1) encourage business firms to conserve energy in the operation of their own processes and building; (2) encourage the manufacture and marketing of more energy-efficient products; and (3) encourage businessmen to disseminate information on energy conservation. The National Bureau of Standards has been given a leading role in promoting the development and implementation of energy saving standards. Programs include: voluntary labeling of household appliances; research, development and education relative to energy conservation in building; efficient use of energy in industrial processes; and improved energy efficiency in environmental control processes. While considerable efficiencies in electricity usage have already been gained, and while further efficiencies will be realized, any present estimates of the magnitude of electricity savings to be realized over time must be treated as tentative and subject to continual reassessment.

Considerable efficiency can be achieved in space conditioning by improved insulation and the use of building materials with better insulation properties as well as by using equipment which transfers or stores excess heat or cold. For example, the seven story Federal Office Building to be built in Manchester, N. H. illustrates the potential for energy conservation in future commercial buildings using existing technology. For this particular building, energy savings are anticipated to be a minimum of 20 to 25 percent over a conventionally designed building in the same location. Heat savings alone are expected to be 44 percent because of better insulated walls, less window area, use of efficient heating and heat storage equipment, and the use of solar collectors on the roof.

In 1971, FHA established new insulation standards which were to reduce average residential heating losses by one-third. Studies have shown that it is possible to gain even greater reductions in heat loss through improved insulation at costs which are economical over a period of years. Improved insulation conserves not only in winter but also reduces the air conditioning burden in the summer.

Lighting, which has accounted for about 24 percent of all electricity sold nationally, is another area where savings are being realized. Many experts believe recommended lighting levels in typical commercial buildings have been excessive. It has been calculated that adequate illumination in commercial buildings can be achieved at 50 percent of current levels through various design and operational changes.

Another study indicated that if all households in 1970 had changed to fluorescent from incandescent lighting, the residential use of electricity for lighting would have been reduced approximately 75 percent and total electrical sales would be reduced approximately 2.5 percent.[33] However, since the majority of residential lighting occurs in off peak hours, the reduction on peak demand would be less than one percent.

The potential for greater energy efficiency in household appliances is well recognized. The National Bureau of Standards is working with an Industrial Task Force, from the Association of Home Appliance Manufacturers, in a voluntary labeling program which would provide consumers with energy consumption and efficiency values for each appliance and educate tham as to how to use this information. Room air conditioners are the first to be labeled. The next two categories of house appliances which are to be labeled are refrigerators and refrigerator/freezers and hot water heaters.

The importance of energy efficiency labeling of appliances is that it will allow the consumer to select the most energy efficient appliance. A recent study titled, "The Room Air Conditioner as an Energy Consumer," has estimated that an improvement in average efficiency from six to 10 Btu/Watt-hr could hypothetically save electric utilities almost 58,000 MW in 1980.[33] Air conditioners which are more energy efficient require a combination of increased heat exchanger size and higher efficiency compressors resulting in higher initial cost. The consumer must be convinced that is is profitable for him in the long run to purchase the more expensive machine. Today, however, there is a high degree of uncertainty in predicting to what extent consumers will actually purchase these more expensive appliances. In addition, selection of central air conditioning by developers and many home owners has historically been based on minimizing front end costs consistent with meeting local building zoning requirements.

The realization of these potential energy savings depends upon many unpredictable economic, political and technological factors. Dependable forecasts of the efficacy of energy conservation measures require the accumulation of much more experiential information. Also, some programs beneficial to overall productivity require the expenditure of additional energy. For example, the National Institute of Occupational Safety and Health has recommended heat stress standards which would require a significant number of employers to air-condition their plants.[34] The combination of forces tending to increase energy use with the unpredictability of the factors which would help save energy makes any significant reduction in electrical demand due to more efficient use highly uncertain at this time.

8.3.4.7 Consumer Substitution of Electricity for Scarce Fuels

While conservation measures are rather quickly adopted in a "crisis" situation, the consumer's substitution of electrical energy for fuels such as oil or gas takes several years to result in a substantial upward impact on the need for power. The staff expects that substitution of electricity for scarce energy sources will increase in the applicant's service area because of the uncertainty of oil and gas supplies and the outlook for higher prices relative to the price of electricity produced from coal-fired or nuclear plants. In the applicant's service area, 3.9 percent of living units were electrically heated in 1970 and the applicant projected 7.8 percent will be electrically heated by 1980. Similarly from 1970 to 1980, the use of electric water heaters is projected to increase from 9.0 to 10.8%, and that of electric ranges from 23.6 to 25.6%.

8.3.4.8 Summary on Conservation

The peak load in the applicant's area has decreased about six percent during the period December 1973 to April 1974. This is mainly due to weather factors, lower economic activity in the service area, changes caused by economic factors such as electricity price, and to energy conservation practices. It is believed that energy conservation has caused the largest part of the change in the demand.

A recent study of the potential reduction in overall U. S. fuel consumption led to the estimate that projected 1980 consumption of 96 quadrillion Btu (quads) could be reduced to 82 quads if all reasonable measures were instituted as rapidly as possible. It is far from clear that consumption of electric energy would be reduced to the same degree since many energy-efficient changes, such as increased provision and use of mass-transit facilities in urban areas, would actually increase consumption of electric energy. However, if the 1980 and later projections of the power demands as well as electrical energy were adjusted downward by 15 percent, the need for the station would be delayed by two years.

Economic growth in the United States may be slowed by the shortage of petroleum products and the resulting dislocations of the economy. The increased emphasis on the more efficient use of energy may lead to reduced consumption of electric energy for present uses, providing some margin for new uses without the construction of generating plants. However, the persistent shortage of petroleum fuels would also tend to induce additional use of electric energy as a substitute.

The conservation measures as well as other factors discussed in Sections 8.3.1, 8.3.2, and 8.3.3 show the uncertainties in the projections. These will be discussed in context with facilities to provide the needed capability in the next section.

8.4 NEEDED CAPABILITY

The applicant has changed his plans on the scheduling of two Byron and two Braidwood generating units. Now the first Byron unit and the first Braidwood unit are scheduled in May 1980 to provide power to meet the summer peak demand. The Byron Unit No. 2 will enter service in May of 1981 and be available for the summer peak of that year. The Braidwood Unit No. 2 will not enter service until October 1981, and thus will be available for the 1982 peak. The applicant has also changed his original schedule for the retirement of old units. Previously he had planned to retire 10 fossil-fired generating units that had a total summer capability of 980 MWe. Now he plans to only retire 4 units having a summer capability of 330 MWe prior to the service dates of Bryon and Braidwood units. In addition the applicant has cancelled some tentative plans to sell power during the summer peaks of 1981 and 1982. The staff views these changes as reasonable planning perturbations. Table 8.3 shows the applicant's projection of capability, demand, and reserves.

There are two main parts in the analytical development of estimated required capacity in future years for a utility: the power demand and reserve margin. The projected demand as well as the uncertainties in demand have been discussed. Future reserve margins necessary for reliable systems will undoubtedly change. At the present time, the MAIN Reliability Council is attempting to develop criteria for reserves and for the assignments of reserves responsibility to its members. Transmission interconnections among utilities and generating unit forced-outage rates will be factors in this assignment.

The forced outage rates that will be experienced by large nuclear plants are uncertain at this time. Prior experience would indicate a need to increase the reserve margin; counteracting this is the fact that as a system grows

Table 8.3. Commonwealth Edison's Capability, Demand, and Reserve Data[6A]

Year	1979		1980		1981		1982		1983	
S=Summer, W=Winter	S	W	S	W	S	W	S	W	S	W
A. CAPABILITY, MW										
(a) Owned capability	21,953	22,328	24,163	24,568	25,283	26,808	27,473	28,655	29,290	30,522
(b) Non-firm purchases (sales)	624	624	624	624	624	624	624	624	312	312
ADJUSTED CAPABILITY (a+b)	22,577	22,952	24,787	25,192	25,907	27,432	28,097	29,279	29,602	30,834
B. DEMAND, MW										
(a) Native	19,760	13,530	21,210	14,450	22,730	15,320	24,350	16,230	26,050	17,200
(b) Firm sales (purchases)	0	0	0	0	0	0	0	0	0	0
(c) Interruptible	-	-	-	-	-	-	-	-	-	-
ADJUSTMENT DEMAND (a+b+c)	19,760	13,530	21,210	14,450	22,730	15,320	24,350	16,230	26,050	17,200
C. RESERVE										
(a) MW (A-B)	2,817	9,422	3,577	10,742	3,177	12,112	3,747	13,049	3,552	13,634
(b) Percent $\left(\frac{A-B}{B} \times 100\right)$	14.3	69.6	16.9	74.3	14.0	79.1	15.4	80.4	13.6	79.3

in size the needed reserve margin should decrease with the addition of constant size generating units. The applicant currently uses one of the lowest reserve margins in the utility industry. Part of the justification for this low margin is the number and strength of the interties with other utilities. Extensive interties increase the probability of obtaining outside help in emergencies. The reserve margin of 14% appears justified, based on the flexibility and experience of the applicant.

The major uncertainty in the need for power is the uncertainty in the projection of the peak power demand for 1980, 1981, and 1982. As previously stated, the staff believes that the applicant's demand projection forms an upper bound.

From the staff's viewpoint it is reasonable for the applicant to defer the construction of the unnamed fossil unit for April 1982 should demand not materialize; this would reduce the capacity by 1100 MW. Another possible adjustment that the applicant could make, if the demand did not materialize, would be to delay the construction schedule so that one unit would be completed one year later. The combined effect of these two procedures would reduce capacity by about 2200 MW. This corresponds to 9% of the applicant's projected summer peak (24,350 MW) in 1982. In addition, the economic and environmental incentives to retire some additional older units, such as those indicated in the applicant's original retirement schedule, can be reviewed.

The reserves indicated by the applicant for 1980, 1981, and 1982 are 16.9, 14.0, and 15.4 percent. The staff finds that the critical item is the demand projections. We believe that future information, especially the magnitude of the summer peak in this and next year, will allow timely adjustments to the applicant's plans for power facilities. The sociological, economical, and environmental concerns can best be accounted for with such timely adjustments.

In view of the uncertainties in the demand projections, the staff concludes that the applicant's program to add capacity to its power system is a prudent one.

SUMMARY AND CONCLUSIONS

1. The applicant's historical growth (last 10 years) and the per capita use of electrical energy are very similar to those of the United States. The applicant's estimate of the future growth rate (percent power increase per year) of power demand, which was made after the national energy difficulties in late 1973 and early 1974, is about the same as estimates for the U.S., which were made prior to the energy shortage.

2. The applicant changed the proposed operational dates for the Byron and Braidwood units from the period of May 1979 through October 1980 in their initial Environmental Report, to May 1980 through October 1981 in an amendment. The applicant did not, however, change his estimate of peak power demands, but only stretched out the retirement schedule of the older facilities to meet these demands.

3. The applicant forecasts the peak power demand based on an economic and a weather component. Using expected values for the economic and weather variables, the applicant has had good success with this method of forecasting in the past. The staff has reviewed the econometric energy-forecasting method, which may be more suitable in these times of changing energy conditions because the explanatory variables may be adjusted for changing conditions, but the staff cannot confidently use such an approach because the elasticity information required for use of the method is not available for the applicant's service area; in addition, the projections of the economic variables themselves are uncertain.

Nevertheless, the staff wishes to emphasize that econometric studies to date have shown that electricity price is one parameter that strongly influences electrical energy demand. If this effect were not compensated by other variables that increase demand, after suitable time lags, a decrease in electrical energy consumption due to the real price increases in electrical energy would result.

4. The staff finds that the applicant's estimate of facilities to meet his projected power demand is a prudent estimate because the long lead time nuclear facilities must be scheduled before "the results are in" from our energy shortage. This estimate forms an upper bound. If the demand is less than anticipated, the unnamed 1100 MW fossil unit (for 1982) can be deferred, and the nuclear plant construction possibly slowed by one year. The action would reduce the summer peak capacity for 1982 by approximately 2200 MW, which is 9% of the presently projected peak demand for that year.

5. The staff finds that the annual electrical energy consumption projected by the applicant is high. The staff believes that from 1973 until 1982 the average annual growth rate of energy consumption will be no higher than it was in the period from 1960 through 1972; this corresponds to about 7%/yr. The 1982 energy consumption will be about 95% of the applicant's projections in its Environmental Report and in the MAIN Report to the FPC.

6. The staff concludes that in order to meet prudent estimates of power demand in the summers of 1981 and 1982, there is a need for the 4420 MWe of additional power capability represented by the Braidwood and Byron Stations.

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9. BENEFIT-COST ANALYSIS OF ALTERNATIVES

In this section the potential sources of energy to produce electricity, possible alternative sites to locate the generating station, and alternative designs of the power station will be evaluated for the Byron Station (2240 MWe) alone.

9.1 ALTERNATIVE ENERGY SOURCES AND SITES

9.1.1 Energy Sources

There exist many alternative energy sources for use in the generation of electric power. Some of these are the fossil fuels (coal, oil, and natural gas), nuclear fuel, hydro- and geothermal energy. An alternative source of energy for the applicant is the purchase of electrical power from other utility systems.

9.1.1.1 Power Purchases

In order for the applicant to realistically consider the purchase of 2240 MWe from neighboring utilities, it would be necessary that the purchased power be a firm commitment for at least 5 years beginning in 1980. A firm purchase for less than five years would only permit a delay in scheduling and constructing of generating capacity. An examination of the neighboring utility systems indicates that excess generating capacity of the magnitude required for Edison's needs will not be available in 1980 or immediately thereafter.[1] For many of the neighbors, 2240 MWe would represent a sizeable portion of their capacity; for others, this requirement would be a large fraction of their reserve margin. For example, one of the larger neighbors, the Illinois-Missouri Pool of MAIN has a planned reserve of about 3000 MWe for the summer of 1980; a sale of 2240 MWe would leave this pool with a totally inadequate reserve.[2] The staff concludes that power purchases of sufficient magnitude are not available to provide a viable alternative energy source.

9.1.1.2 Geothermal Power Generation

Electric power is being generated by geothermal steam at the Geysers, California. Currently the Geysers plant has a capacity of 290 MWe with additional generating capacity planned or being installed to bring the capacity to 1300 MWe by the end of 1980. Generation of power from geothermal resources is being studied for other favorable sites.[3] Inasmuch as no sites with potential geothermal power have, as yet, been identified in the applicant's service area, the staff does not consider geothermal energy to be a viable energy source for the applicant's system.

9.1.1.3 Hydroelectric Power Generation

Hydroelectric power is not considered by the staff to be a practical alternative, as natural sites for any significant amounts of power do not exist within the applicant's service area. The nearest hydroelectric type facility known to the staff is the Ludington Pumped Storage Plant near Ludington, Michigan. This facility, jointly owned by Consumer Power (51%) and Detroit Edison (49%), began operation in early October, 1973. Commonwealth Edison, as a result of its financial support of the plant, has a commitment for the purchase of 624 MWe of the 1896 MWe output. Pumped storage units do not increase the total capacity of a system, since the water must be first raised against the force of gravity by electrically powered pumps; but they tend to increase the average capacity factor and peak power capacity.

9.1.1.4 Natural Gas

Natural gas, in the quantities required to generate 2240 MWe of power, is not considered to be a feasible energy source for the applicant's system. Recent shortages of natural gas have caused the FPC to issue Order No. 467,[4] which sets forth initial priorities, based on end-use of gas, to be followed by pipeline companies. The lowest priority is given to "Interruptible requirements of more than 10,000 Mcf per day, where alternate fuel capabilities can meet such requirements." The natural gas requirements of a 2240-MWe plant would average nearly 500,000 Mcf per day and is clearly subject to the FPC order. Because of the present shortages, curtailments, and end-use priorities of natural gas, the staff does not now consider this fuel to be a reasonable alternative energy source.

9.1.1.5 Oil

Historically, the applicant has been a coal-burning utility and coal still accounts for more than 8000 MWe of its 13,600 MWe generating capacity. Commonwealth Edison has been a pioneer in the use of nuclear power with a capacity of 3865 MWe in the summer of 1973. The applicant has converted one large station, Ridgeland (597 MWe), to oil, and commitments have been made to convert four older units at Sabrooke (146 MWe) to oil.* In addition, the applicant is building an oil-fired station, Collins (near the Dresden Station), consisting of five 500-MWe units to be put into service during the 1976-1978 period. Difficulty has been experienced, however, in obtaining guaranteed supplies of oil for these units (Ref. 1, p. 9.2-6).

In view of the above discussion and considering the continuing problem of foreign oil supply, the staff concludes that oil is not a realistic

*On Nov. 27, 1973 the Federal Energy Policy Office published a regulation (38 Fed. Reg. 32577), effective Dec. 7, 1973, which appears to prevent the planned conversion.

alternative energy source at this time. In addition, even if low-sulfur fuel oil were available to meet emission standards, the present trend in prices indicates that an oil-fired plant would be much more expensive than a nuclear plant, and thus impose unnecessary long-term economic penalties on the applicant's customers.

9.1.1.6 Coal

Coal is the most abundant of domestic fossil fuel resources. Estimates place U. S. coal reserves at 3200 billion tons, of which 390 billion tons are recoverable under current technological and economic conditions.[5] The extent of these reserves can be put into perspective by considering the current domestic consumption rate of about 0.6 billion tons/yr.[5] Because of this abundance the staff considers coal to be a realistic and viable alternative energy source. This alternative is compared with a nuclear power plant in Section 9.1.2 .

9.1.1.7 Other Energy Sources

There is a continuing effort to utilize other sources of energy which might have minimal impact on the environment. Some of these sources are solar, nuclear fusion, wind, and tidal energies. In addition, new energy conversion methods, such as breeder reactors, magnetohydrodynamics, electrogasdynamics, fuel cells, and binary cycles, are being explored. All of these advanced methods of power generation or conversion offer certain potential benefits when compared with conventional methods; however, a review of the current literature[6] leads the staff to conclude that none of these are or will be sufficiently developed to allow commercial power production of the magnitude required by the applicant in the time period of the 1980's.

9.1.2 Comparison of Energy Alternatives

The staff concluded in Section 9.1.1 that the most realistic alternative energy sources for baseload electric power generation by the applicant are coal and nuclear fuel. This section will assess the relative merits of a coal-fired plant and a nuclear-fueled power plant. In the analysis, the staff assumed that each station consists of two 1120-MWe units, with natural-draft cooling towers, ready for commercial operation in May 1980 and May 1981 in the general vicinity of the proposed site.

9.1.2.1 Economic Costs

Two types of coal-fired plants were compared with a nuclear plant: firstly, one which would burn-low-sulfur coal; secondly, one which would burn high-sulfur coal with stack-gas cleaning systems to sufficiently reduce the sulfur content of the effluent. The results given in Table 9.1 show that a nuclear plant has a definite economic advantage over both types of coal-fired plants. The staff's estimates of capital costs are based on a model similar to those used in the industry.[7] The fuel costs are recent estimates made for comparable systems. The staff's estimates agree only approximately with those presented by the applicant

TABLE 9.1. Estimated Economic Costs of Coal and Nuclear Plants for Natural Draft Tower Cooling

	Coal[1]		Nuclear[2]		
	Low Sulfur	High Sulfur	60%	70%	80%
Construction cost	821	996 (801)	1213	1213	1212 (902)
Fuel costs[3]	1825	1460 (1223)	352	410	469 (620)
Operation and maintenance[3]	207	576 (131)	185	198	211 (238)
Total generating costs[3,4]	2853	3032 (2155)	1750	1821	1893 (1760)

[1]Load factor of 80%.
[2]Load factors of 60, 70, and 80%
[3]Present value at time of first commercial operation.
[4]Generating costs do not include capability loss of natural draft cooling towers.

Notes: All estimates in units of millions of dollars. Numbers in parentheses are applicant's estimates adjusted to same assumptions as staff estimates.

Assumptions:

Discount rate	10%
Escalation rate	0%
Operating life	30 years

(shown in parentheses in Table 9.1); however, the conclusions reached by the staff and the applicant are the same. Nuclear power is a more economic energy source than is coal at this general location and during this time period.

The major economic disadvantage of coal is its rapidly rising costs. The figures given in Table 9.1 are based on the assumption that the costs of both nuclear fuel and coal will remain constant throughout the thirty-year operating lifetime of the plant. The staff realizes that this is unrealistic; it is almost certain that fuel costs will increase in the years ahead. Cost increases will, in all likelihood, further enhance the competitive advantage of nuclear fuel, since estimates of future costs show the cost of fossil fuel increasing faster than that of nuclear fuel.[6]

If high-sulfur coal were to be used, the applicant would be required to install equipment for the removal of sulfur. At present, the costs, as well as the reliability, of sulfur removal equipment are largely unknown. The staff has assumed a capital cost for the sulfur removal equipment of $46 per kilowatt and an increased operation and maintenance cost of 1 mill per kilowatt-hour, which are consistent with other estimates.[8]

9.1.2.2 Environmental Costs

The major environmental impacts of a coal-fired plant and a nuclear plant, both with a capacity of 2240 MWe, are compared in Table 9.2. From an environmenal viewpoint, the most significant advantage of the coal-fired plant, relative to the proposed light-water reactor nuclear plant, is the higher thermal efficiency. The assumed efficiency of the coal-fired plant is 38%, as opposed to 34% for the nuclear plant; these efficiencies are representative of the current experience. Since about 10% of the heat input to a coal-fired plant is rejected through the stack, the thermal discharge to the cooling water is approximately 40% greater from a nuclear plant than that from a coal-fired plant of the same electrical capacity. It should be noted for closed-cycle cooling systems that most of the waste heat from either a fossil fuel or nuclear plant is released to the atmosphere.

The major disadvantage of a coal-fired plant is the amount of pollutants which would be released to the air. The staff has estimated, based on EPA standards,[9] that a coal-fired plant would emit 5300 tons of particulates per year, 65,000 tons of sulfur dioxide per year, and 37,000 tons of nitrogen oxides per year. In addition, storage, transportation, and disposal facilities would be required for the residual fly-ash. If low-sulfur (1-2%) coal were used, the ash content of about 20% would produce about 900,000 tons of ash per year; if high-sulfur (3-5%) coal were used, the ash content of about 10% would produce about 450,000 tons of ash per year and, in addition, the wastes from the sulfur removal system must be handled, and stored, or disposed of in some acceptable manner. A 90-day supply of coal at the plant site would require approximately 70 acres of land, assuming a density of 80 lb/per cu ft and a 10-foot high pile. The amount of

TABLE 9.2. Comparison of Environmental Costs of Alternative Energy Sources

Impact	*Coal*	*Nuclear*
Land Use		
Plant proper, acres	ca. 200	125
Fuel Storage, acres	70	small
Waste Storage, acres	ca. 600	ca. 500
Releases to Air		
Particulates, tons per year	5,300	60
Sulfur dioxide, tons per year	65,000	60
Nitrogen oxides, tons per year	37,000	250
Radioactivity, man-rem per year	0[a]	14.8[b]
Fogging, days per year	ca. 1	ca. 1
Icing, days per year	none	none
Releases to Water		
Heat, Btu per hour	1.3×10^8	1.8×10^8
Radioactivity, man-rem per year	none	5.7[b]
Chemicals, tons per year	10,000	13,500
Consumptive Use of Water		
Evaporation, maximum, cfs	42	60
Drift, cfs	1	1
Fuel		
Consumed, tons per year	4,500,000	250[c]
Transported, tons per year	4,500,000	80[d]
Ash (high sulfur coal), tons per year	450,000	80
Esthetics	Would require tall stacks, coal yard, frequently used railroad. Would create a visible smoke plume.	Relatively inoffensive

[a]Radionuclides of naturally occurring radium, thorium, and uranium are emitted with the fly ash.

[b]See Table 5.9. The radioactive releases to the air include 14 man-rem per year from the transportation of fuel and radioactive wastes.

[c]Natural uranium U_3O_8.

[d]Slightly enriched uranium dioxide pellets.

coal consumed each year would be about 4,500,000 tons. Assuming delivery by unit trains of 120 cars of 100 tons capacity each, a train load of fuel would be required every 23 hours for a 2240-MWe coal-fired plant.

The staff concludes that, with closed-cycle cooling, consideration of currently allowed releases of fossil-fueled and nuclear-fueled plant effluents, nuclear-fueled plants degrade the environment less than fossil-fueled alternatives. In addition, the lower power generating costs of a nuclear plant favor its selection as the preferred energy source.

9.1.3 Alternative Sites

The applicant has performed studies to identify potential sites for new electric generating facilities. In conducting these studies, the applicant included engineering, economic, and environmental parameters in determining feasible alternative sites. Specific siting parameters included: cooling water availability, proximity to transmission facilities, reliability, topography, demography, site accessibility, navigability of waterway, land use, flooding, proximity to recreation and wildlife areas, foundation conditions, archeological studies, meteorological and hydrological studies.

Consideration of these criteria indicated to the applicant that since a new generating plant was needed to supply electrical energy to the northern metropolitan area of Illinois, it should be located near the Rock River. It is the applicant's policy to place at least two large generating units and their associated facilities on each site. Such a policy lessens the number of sites which will be required, and tends to minimize overall land use. It also provides construction convenience as well as operational and economic benefits. In narrowing the search to the Rock River area, the applicant investigated eight potential sites; of these, four were considered practical alternatives.

The eight sites originally considered in the Byron area are shown in Fig. 9.1. Sites A1, A2, A3, and A4 were eliminated from further consideration by the applicant because they lacked the required structural support for a generating station. The founding rock is excessively deep and underlying alluvial soils are insufficient to support the heavy plant loading at these sites. Site A6 encompasses a land area of about 7450 acres; about 3600 acres would be diverted from present usage for plant facilities and a 3400-acre cooling lake. Site A6A consists of about 1000 acres of Site A6; this size site is sufficient for a cooling tower system, etc., but not a cooling lake. Site A7 consists of about 10,500 acres including a 4700-acre cooling lake with two half-mile long arms extending northward into Winnebago County. The applicant's preferred site, A5, has been discussed in detail in Section 2.

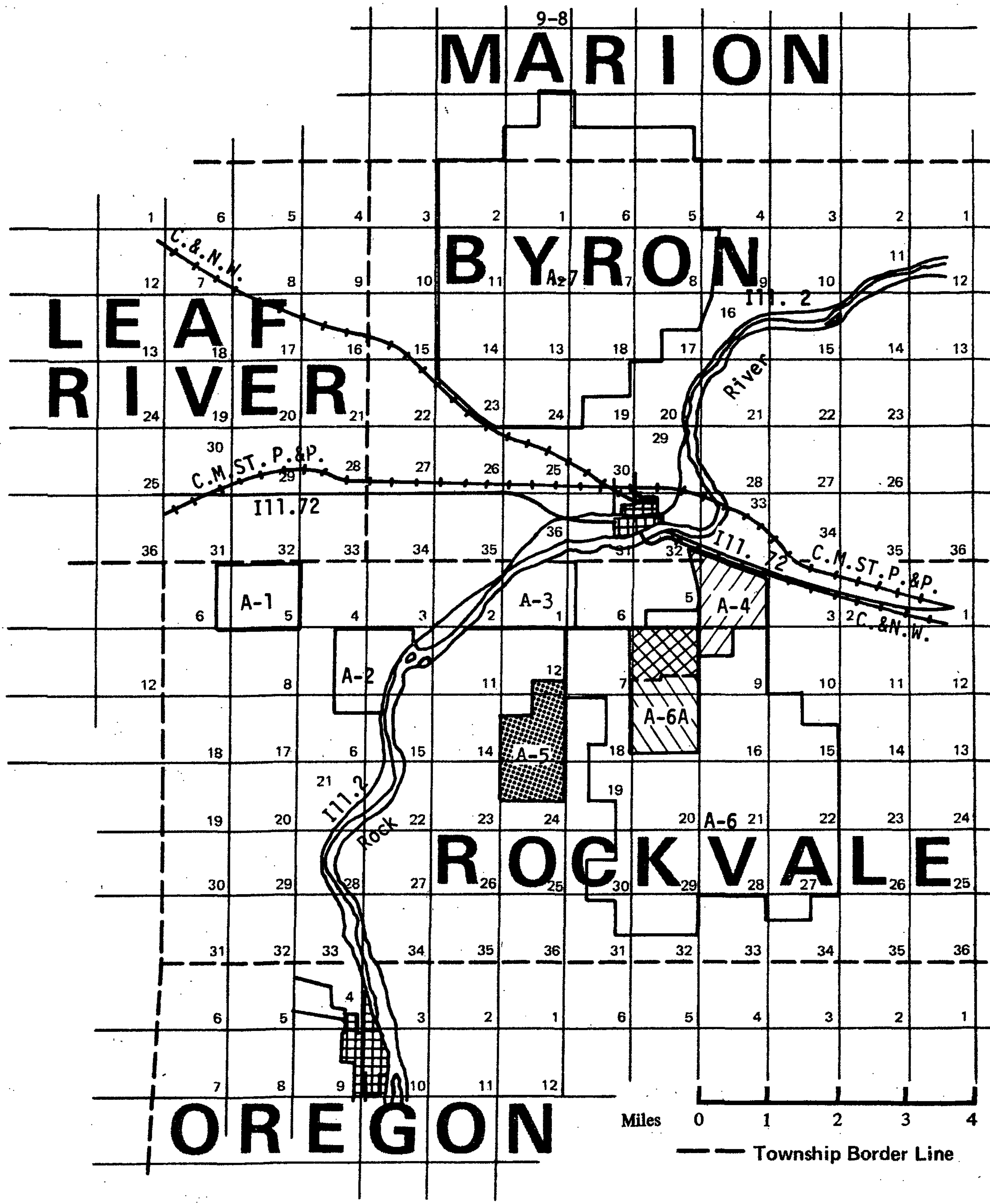

Fig. 9.1. Location of Alternate Sites. From applicant's Environmental Report.

A detailed comparison of the four remaining alternative sites is given in Table 9.3. The staff's evaluation of these sites concluded that the two cooling tower sites were roughly comparable as were the two cooling lake sites. The costs of site land, development, and cooling facilities are approximately the same for all four sites, as are the total generating costs. Makeup water would be pumped comparable distances fron the Rock River and the environmental impacts from station operations such as effluents discharged to the environment would also be expected to be the same for these sites.

In view of the fact that land in the Byron area is of generally good agricultural quality, the two cooling tower sites are more attractive than the cooling lake sites in that less land and agricultural productivity would be preempted. The larger consumptive use of water for the cooling lake sites would also favor the cooling tower sites. In addition, there is the societal impact of greater displacement of residences for the lake sites than the tower sites. The staff concludes from all of the above economic, environmental, and social considerations, that either of the two cooling tower sites is preferable to either of the two cooling lake sites.

Comparison of the two cooling tower sites leads the staff to conclude that they are closely equivalent; distinctions between the sites are small. The site sizes are about the same with the agricultural productivity of site A6A somewhat better than site A5. The use of natural draft towers at site A5 would have some advantage over site A6A; both sites would be equally suited for mechanical draft towers. The visual impact of mechanical draft towers would be about the same at either site whereas that from natural draft towers would probably be greater for site A5. The staff finds that the selection of site A5 will not result in impacts to the environment that are any less favorable than those at the alternative site and concludes that the applicant's proposed site is acceptable.

9.2 PLANT DESIGN ALTERNATIVES

One of the most important design parameters considered for a nuclear power station is the type of cooling system. No cooling system required for a modern generating station is devoid of environmental impacts. Thus, an evaluation of the impacts, costs, etc., of each type of system leads to the selection of that one which provides the best balance of economy, reliability and environmental safety.

9.2.1 Cooling System Alternatives

The alternative cooling systems considered by the applicant are as follows:

TABLE 9.3

COMPARISON OF FOUR ALTERNATIVE SITES IN AREA OF BYRON, ILLINOIS

	Byron Site (A-5) (Natural Draft Cooling Towers)	Alternative A-6A (Natural Draft Cooling Towers)	Alternative A-6 (Cooling Lake)	Alternative A-7 (Cooling Lake)
1. Cost of Site				
Development, cooling facilities and land	$53,200,000.	$53,700,000.	$60,300,000.	$56,500,000.
2. Generating Costs				
Capital Cost	$902,000,000.	$902,000,000.	$909,000,000.	$905,000,000.
Operating and Maintenance	238,000,000.	238,000,000.	236,000,000.	236,000,000.
Fuel Cost[1]	620,000,000.	620,000,000.	610,000,000.	610,000,000.
Incremental Capability Loss	17,000,000.	17,000,000.	---	---
Total Generating Cost	1,777,000,000.	1,777,000,000.	1,755,000,000.	1,750,000,000.
3. Use of Natural Resources				
Site Size	900 acres	1,000 acres	7,450 acres	10,500 acres
Type of Land	45% cropland, 15% wooded, 40% fallow	90% cropland, ~10% fallow	82% cropland, 9% pasture, 8% wooded	89% cropland, 10% wooded
Agric. Productivity	Below average	Nearly average	Nearly average	Average
Lake Size	---	---	3400 acres	4700 acres
Average Water Evaporatively Consumed	47 cfs	47 cfs	66 cfs	67 cfs
Fuel (t=tons)	218t + 73t/yr	218t + 73t/yr	218t + 73t/yr	218t + 73t/yr
4. Discharges to Atmosphere				
Radiation Dose from Gaseous Discharge	0.83 man-rem/yr (Base)	~ Base	~ Base	~ 1.2 man-rem/yr
Salt Deposition from Drift[2]	~ 4.2 lbs/acre-yr (Base)	~ Base	0	0
Impact on Vegetation	Negligible	Negligible	0	0
5. Discharges to River				
Radiation Dose From Liquid Discharges via Fish Ingestion	5.7 man-rem/yr (Base)	~ Base	~ Base	~ Base
Chemical Discharges Dissolved Salts[3]	Acceptable (No Anticipated Adverse Impact)	Acceptable	Acceptable	Acceptable

Table 9.3 (continued)

Chlorine[3]	Negligible (No Adverse Impact)	Negligible	Negligible	Negligible
Effects on Fishing in Area of Thermal Plume				
Effect on Yield	Negligible	Negligible	Negligible	Negligible
Effect from Thermal Shock[4]	Acceptable	Acceptable	Acceptable	Acceptable
6. <u>Effects on River Aquatic Life</u>[5]				
Impingement	Minimal	Minimal	Minimal	Minimal
Entrainment	Negligible (Base)	Negligible	Less than Base	Less than Base
7. <u>Site Features</u>				
Distance to River	∿ 2.5 miles	∿ 3 miles	∿ 3 miles	∿ 5 miles
Elevation of Plant	873 ft MSL	825 ft MSL	825 ft MSL	830 ft MSL
8. <u>Societal Considerations</u>				
Displaced Residences	7	16	92	83
Demography	Population Distribution 0-1m 78 1-5 5,047 5-10 13,611 0-10 18,736	Population Distribution 0-1m 51 1-5 4,752 5-10 13,859 0-10 18,662	Population Distribution 0-1m 0 1-5 4,501 5-10 13,913 0-10 18,414	Population Distribution 0-1m 0 1-5 3,741 5-10 65,031 0-10 68,722
9. <u>Icing and Fogging</u>				
Fogging	Negligible	Negligible	Minimal	Minimal
Icing	Negligible	Negligible	Negligible	Negligible
10. <u>Transmission Lines</u>	Base	∿ Base	∿ Base	∿ Base

[1]Based upon a Station load factor of 80%. Present worth at time of first commercial operation for 30 years of operation.

[2]Average salt deposition for distances between 0.4 to 4.2 miles from natural draft towers.

[3]The concentrations of dissolved salt and chlorine in liquid discharges must meet EPA approved State Standards pursuant to FWPCA (1972).

[4]Water Pollution Regulations of Illinois: Rule 201 - <u>Mixing Zones</u>

a. ". . . no single mixing zone shall exceed the area of a circle with a radius of 600 feet . . . ."

b. In addition to the above, the mixing zone shall be so designed as to assure a reasonable zone of passage for aquatic life in which the water quality standards are met. The mixing zones shall not intersect any area of any such waters in such a manner that the maintenance of aquatic life in the body of water as a whole would be adversely affected, <u>nor shall any mixing zone contain more than 25% of the cross-sectional area or volume of flow of a stream except for those streams where the dilution ratio is less than 3:1</u>.

[5]Section 316(b) Federal Water Pollution Control Act Amendments of 1972.

"(b) Any standard established pursuant to Section 301 or Section 306 of this Act and applicable to a point source shall require that the location, design, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."

Open cycle
Closed cycle
1. Quiescent cooling lake
2. Spray cooling
    a. Spray pond
    b. Spray canal
3. Cooling towers
    a. Evaporative (wet) mechanical-draft cooling towers
    b. Evaporative (wet) natural-draft cooling towers
    c. Dry cooling towers

9.2.1.1 Open Cycle Cooling

An open-cycle cooling system involves the withdrawal, heating, and return of water obtained from a large natural body of water. To maintain a ΔT of 24°F across the condensers of the Byron turbines a cooling system of 1422 cfs is required (Ref. 1, p. 3.3-1). Since this flow exceeds the 7-day 10-year low flow of the Rock River[10] the staff concludes that once-through cooling is impracticable from both a physical and environmental standpoint.

9.2.1.2 Closed Cycle Cooling

A closed-cycle cooling system recirculates all or at least a significant portion of the cooling water back through the system rather than directly discharging it to the source after one heating cycle. The required cooling is accomplished by adding to the system a second heat exchange device which transfers the waste heat to a second medium (usually the atmosphere) prior to recirculation of the coolant water through the station's condensers. Each of the systems discussed below employs and is identified by the secondary heat exchanger considered.

9.2.1.2.1 <u>Quiescent Cooling Lake.</u> A quiescent cooling lake is simply a body of water without any mixing or cooling devices. In such lakes cooling is accomplished primarily by surface evaporation and radiant heat transfer to the atmosphere.

The advantages of a quiescent cooling lake are:

1. Generally smallest initial cost of all closed-cycle systems.

2. Operation and maintenance costs are lowest of all closed-cycle systems.

3. Loss of capability is smallest of all closed-cycle systems.

4. Visual impact is usually considered appealing.

5. Ambient relative humidity and air temperature have minimal restrictive effect.

6. Little susceptibility to damaging winds and tornadoes.

7. Provides maximum temporary overload capability.

The disadvantages are:

1. Requires large amounts of land (1-2 acres/MWe).

2. Blowdown is needed to control concentration of total dissolved solids.

3. Careful planning and management is important.

4. Can cause fogging in the immediate vicinity.

9.2.1.2.2 Spray Cooling. Spray ponds and/or spray canals increase the rate of heat transfer from the water to the air over that achieved by a quiescent lake. This is accomplished by spraying the water through nozzles into the air where the resulting small droplets expose a large total surface area to the air and produce an increased rate of evaporation. Spray systems thus transfer more heat to the atmosphere per unit water area than does a quiescent lake. Potential environmental problems related to spray systems include: drift of water droplets and vapor, fog formation, and icing. Localized fogging and drift from spray cooling devices have created some problems on a roadway near the spray canal of the Dresden Nuclear Station.[11]

a. Spray Pond. Spray ponds operate on the same principle as a cooling lake except that surface evaporation is enhanced by spraying the warm water into the air over the pond. The performance of the spray pond is a function of the design of the spray nozzles and their placement.

Advantages of spray ponds are:

1. Require much less land area than a cooling lake.

2. Lower pumping costs than for cooling towers.

3. Usually require less maintenance than mechanical towers.

4. Not susceptible to damaging winds or tornadoes.

The disadvantages are:

1. Greater likelihood of mechanical and electrical failure than a quiescent cooling lake.

2. Could cause localized fogging and icing.

3. Usually costs more than a cooling lake.

4. Blowdown is necessary to prevent excessive concentration of dissolved salts.

5. Uses more land area than cooling towers.

b. Spray Canal. A spray canal is an elongated pond and in the case of the Byron Station would be several miles in length. In contrast with cooling towers and ponds which have been used for decades, there has been little operating experience with large spray cooling systems, especially in winter, the season of greatest interest. Experience at a power plant with a spray cooling canal in northern Illinois indicated no serious environmental or fogging problem after two seasons of operation.[11-13]

Experience with spray canals in Michigan[14] and New Hampshire[13] are similar. As with cooling ponds, the fogging and icing effects decrease with distance; Hoffman[14] indicates that a distance of 600 feet from the canal to public roads and switchyards was sufficient to preclude any hazardous conditions arising.

From the limited experience to date, it is reasonable to expect that spray cooling systems will create more severe icing conditions near the spray canal during winter than mechanical-draft cooling towers and cooling ponds, with drift being the primary cause of the difference.

Quantitative estimates of fog and icing potential from spray canals are not possible, in part because the properties of the air downwind of spray units (temperature, liquid water content, drop size distribution, etc.) are unknown functions of ambient weather conditions (wind speed, air temperature, humidity, stability), water temperature, and characteristics of the spray heads (nozzle opening, number of sprays and their location with respect to the wind direction, etc.). For most wind conditions, the air will be in contact with the water from the spray for a shorter period than it would be in a cooling tower. Thus, the heat and moisture transferred to the air will be slower, and more air will be modified to cool a given plant load. As might be expected, sprays are slightly noisier than cooling ponds, due to the pumps and falling water.

9.2.1.2.3 Cooling Towers. Cooling towers are described and identified on the basis of design as "mechanical-draft" or "natural-draft" and operating characteristics as "dry" or "wet". A dry-type cooling system operates on the same principle as an automobile radiator, i.e., the cooling water never comes in direct contact with the air and all of the heat is rejected through fin tube exchangers. There are thus no evaporative losses, which require makeup water.

A wet cooling tower operates by rejection of heat through direct contact of the cooling water with the air. The water is pumped through the cooling tower where it is broken up into small drops by splashing down through the "packing" or "fill" of the tower. More than 75 percent of the heat is dissipated by the evaporation of a portion of the circulating water, while the remaining heat is lost as sensible heat transfer to the air.

If the cooling process is assisted by motor-driven fans that move air past cooling fins or through the splashing water, the system is referred to as a mechanical-draft tower. A natural-draft tower requires no fans, but uses the greater tower height to produce a "chimney effect" to move the air.

a. Wet Mechanical-Draft Towers. Evaporation is induced in wet mechanical-draft towers by forcing the air through the heated condenser discharge water with large fans. The return temperature of the water approaches the wet-bulb temperature (the lowest temperature to which water can be cooled by evaporation into the ambient air), which is less than, or at most equal to, the dry-bulb temperature (the actual temperature of the ambient air). About 1% of the circulating water is lost due to evaporation and drift. Another one percent is lost due to blowdown (required to prevent buildup of dissolved solids in the recirculating water). This amount of makeup water can be substantial in large towers.

The advantages of mechanical-draft wet towers are:

1. Positive control over air supply.

2. Close control of return cold water temperature.

3. Generally low pumping head.

4. Ambient relative humidity has a minimal effect on tower performance.

5. Require less land than a spray canal or a quiescent cooling lake.

The disadvantages are:

1. Towers are subject to mechanical failure.

2. Operation and maintenance costs are higher than for natural-draft towers or quiescent cooling lakes.

3. Often cause localized icing and fogging.

4. Require blowdown to control concentration of dissolved solids.

5. May cause deposition of salts on surrounding land from drift.

6. Susceptible to damaging winds and tornadoes.

Of the various evaporative cooling systems discussed in this section, this type of tower has the highest potential for creating significant amounts of low-level fogging and icing. Mechanical-draft towers release large amounts of heat and water vapor over relatively small areas at low levels where wind speeds are lower and the saturation deficit is less than at the higher level at which natural-draft towers release heat and water vapor. Drift losses are also higher with mechanical towers. The high turbulence levels (due to the fans), high entrainment rates, and larger surface/volume ratios in mechanical-draft towers result in plume rises lower than those of natural-draft towers.

b. Wet Natural-Draft Towers. In this type of tower air moves upward as a result of the chimney effect (natural draft) created by the difference in density between the warm moist air inside the tower and the colder, denser air outside.

The advantages of wet natural-draft towers are:

1. Fewer mechanical and electrical components than for mechanical-draft towers.

2. Maintenance costs are lower than for mechanical-draft towers.

3. Require less land area than most other closed-cycle cooling systems.

4. Rarely, if ever, cause fogging and icing at ground level in moderately level terrain.

The disadvantages are:

1. Great tower height necessary to produce draft. This results in huge structures and higher construction costs.

2. Precise control of recirculated water temperature is more difficult than with mechanical-draft towers.

3. May cause deposition of salts on surrounding land due to drift.

4. Can generate large airborne vapor plumes which may occasionally extend for 10-20 miles in the downwind direction.

5. Require blowdown to control concentration of dissolved solids.

6. Are susceptible to damaging winds and tornadoes.

c. Dry Cooling Towers. The heat rejection performance of the tower and the thermodynamic performance of the turbine are the two most significant interdependent factors in the operation of a dry-type condensing system. The return temperature of the coolant can, at best, approach the dry-bulb air temperature. Thus, the coolant returning to the condenser from a dry tower is hotter than it would be if any other method of cooling were used. This in turn results in increased turbine exhaust pressure and consequently lower overall efficiency.

Dry cooling towers have been used in Europe for fossil-fueled plants and chemical processing plants but have not gained widespread acceptance in the United States for large installations. In Europe or the United States, no dry cooling tower has ever been operated on a power plant of more than 250 MWe. The principal manufacturers of large-capacity dry cooling towers are located in Europe. Nucleonics Week[15] recently mentioned a study on the use of dry cooling that concluded that dry cooling technology can be considered "mature" for fossil-fueled plants up to 250 MWebut is less suitable for light-water reactors, with their lower steam temperatures and thermal efficiencies.

The great advantage of dry cooling towers is that there is no consumptive use of water. It follows, since there are no liquid or vapor effluents, that there are no fogging, icing, or chemical deposition problems. A serious limitation of dry-type towers is that all of the thermal energy is transferred to the moving air stream as sensible heat. Since heat transfer to air is so much poorer than to water, the dry tower designs are generally based on barometric condensers in order to eliminate the temperature differences of the conventional tube-and-shell designs. Rather than the 1 to 2.5 in. Hg absolute back pressures of water-cooled plants, the dry towers will give a turbine back pressure of 5 to 10 in. Hg absolute. An increase of back pressure from 2 in. Hg absolute to 10 in. Hg absolute will decrease electrical output by almost 10% for fossil-fueled plants and even more for nuclear plants. Therefore, the use of dry towers will result in an increased capital cost of the plant, with a reduction in plant efficiency due to the higher back pressure and high auxiliary power requirements.

9.2.2 Conclusions

It is concluded from the above discussion that from the viewpoint of minimum water consumption and heat discharge to the Rock River, the most attractive closed-cycle cooling system is the dry cooling

9.3 TRANSMISSION SYSTEM ALTERNATIVES

The selection of a particular transmission system by a utility is based on providing optimum voltage and line capacity from the generating station while meeting certain stability and reliability criteria. These, of course, must be in conformance with all applicable Federal, State and local rules and regulations. In addition, it can be assumed that every effort is made to minimize the cost of the transmission system consistent with the above and environmental considerations.

Transmission system alternatives can be divided into two general categories: overhead and underground. For a typical 345 KV single circuit line, the right-of-way width for an overhead would be 130-150 feet compared to 50-60 feet for an underground. A 150 foot width right-of-way requires about 18 acres per mile which, at a land value of $2,000 per acre, would cost $36,000 per mile. Right-of-way costs are generally a small part of total transmission line costs. The costs of materials ad installation of a 345 KV single circuit overhead would be about $130,000 per mile while the equivalent underground line would be 10-20 times higher.[20,21] Unless land values are extremely high or overhead construction is impossible, such as in congested metropolitan areas, the restricted use of underground lines for the transmission of bulk power is obvious.

There are important technological advantages of overhead compared to equivalent underground systems for the transmission of high voltage bulk power. Some of the obvious disadvantages of such underground systems are the requirements for expensive insulation and cooling whereas overhead systems utilize the surrounding air for insulation and heat dissipation. Because high capacity underground cables are immersed in a cooling fluid inside pipes, this results in a charging current restraint which requires compensating stations at least every 20-25 miles (for alternating current systems) in addition to heat-dissipation pumping stations every 5-10 miles.

There are some high voltage direct current (dc) transmission systems in use throughout the world instead of the conventional alternating current (ac) systems. Although the cost of an overhead dc line is less than an ac line having the same power transfer capability, the reducd line cost is offset by higher terminal costs. The breakeven length for overhead ac to dc lines is on the order of 400 miles. Similar consideration of high voltage ac to dc underground lines indicates a breakeven length of about 20-30 miles.

There is scarcely an aesthetic comparison possible of overhead with underground lines. The smaller right-of-way width required for underground lines is to some extent offset by the areal needs of pumping and compensation stations. There are, however, the substantial impacts associated with the excavation of the approximately 6 foot wide by 6 foot deep trench for placement of each pair of pipes with cables which would correspond to the three cables of a single-circuit overhead line. The land use and productivity of portions of the underground cable right-of-way may be somewhat restricted in both rural and urban areas. In addition to the reduced visual impact of underground transmission systems, there will also be a reduced electrical interference to nearby radios, television, etc.

In summary, the use of underground cable for bulk power transmission appears to be generally limited to highly congested metropolitan areas where overhead construction is impractical or impossible. The staff concludes that the aesthetic impact of overhead transmission lines from the Byron Station is essentially unavoidable in that the undergrounding alternative to improve aesthetic values in the rural areas like that surrounding the Byron Station is not practical.

9.4 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 for the general case. It was concluded that the environmental impact of transportation under normal or postulated accident conditions is not considered sufficient to justify the additional effort required to implement any of these alternatives.

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10. CONCLUSIONS

10.1 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

10.1.1 Abiotic Effects

10.1.1.1 Land

Construction and operation of the Byron Station will result in the 30-40 year diversion of approximately 1340 acres of rural land to an industrial use. Of this acreage, however, only about 100 acres (including 4 acres of woodland) will be required for the station's operational activities. The remaining land, after construction has ceased, will be allowed to revert to a natural state. Approximately 440 acres of land between the main site and the Rock River will be temporarily disturbed during the construction and installation of the intake and blowdown lines. Temporary, but minimal erosion of the land as a result of construction activities is expected. Some chemical deposition may occur within about 1000 feet of the cooling towers. An additional land diversion of about 100 acres with attendant lost productivity will result from the construction of transmission towers and the railroad siding.

10.1.1.2 Water

A maximum consumptive loss of Rock River water of about 63 cfs due to evaporation and drift from the natural and mechanical draft cooling towers is expected for full power operation. Approximately 1 cfs of ground water will be used to supply the water required for the potable water system and the makeup demineralizer.

Small amounts of chmicals will be released to the Rock River in the blowdown from the cooling towers. Trace quantities of radioactive substances which the staff concludes are as low as practicable in accordance with 10 CFR 50.34(a) will also be discharged via the blowdown. Approximately 2.8×10^8 BTU/hr of heat will be discharged to the Rock River during full power operation. The environmental effect of these discharges is expected to be insignificant.

10.1.1.3 Air

Sources of contamination will include: dust and other particulate matter generated during construction; low level fog from the mechanical-draft cooling towers; high level plumes from the natural-draft cooling towers; SO_2, particulates, and NO_x from the operation of the starting boilers and emergency diesel electric generators, and traces of radioactive substances. In addition amounts of heat will be liberated to the atmosphere by the operation of the cooling towers. These emissions into the atmosphere will have negligible effects upon its quality.

10.1.1.4 Noise

A detectable increase in the noise levels of the area will occur particularly during construction. No unacceptable noise levels, however, are foreseen by the staff.

10.1.1.5 Esthetics

Obvious esthetic changes will be occasioned by the presence of the natural-draft cooling towers, and their plumes, and approximately 80 miles of transmission lines. Many persons will consider the changes to be esthetically displeasing, but some will consider the towers to be impressive. The visible plumes, expected to be evident frequently in the winter, may be regarded as low-lying clouds.

10.1.2 Biotic Effects

Potential impacts to the terrestrial environment that may occur due to station construction and operation are as follows:

a. Reduction in sunlight intensity reaching the ground cover.

b. Bird kills from collisions with the cooling towers and other large structures.

c. Dispersal of pathogenic organisms into the local environs of the cooling towers (via drift).

These potential effects are considered to be insignificant by the staff with the possible exception of the dispersion of pathogenic organisms under extremely rare circumstance.

Unavoidable effects on aquatic life of the Rock River can arise from:

a. Entrainment of small organisms in the station's cooling water.

b. Impingement of fish on the traveling screens.

c. Attraction of fish to the warm discharge.

The staff does not expect any of these to be of serious concern. Any occasion where the magnitude of fish impingement results in a major impact, would be detected by the applicant's monitoring program, and action would be taken to correct the problem.

The staff does not believe that any adverse radiological effects will occur since the radioactive effluents are reduced to as-low-as-practicable. The 900 man-rem/year received as occupational on site exposure is 0.7 percent of the annual total to the projected 1980 population within a 50 mile radius and the risk associated with the exposure is considered no greater than those risks normally accepted by workers in other present day industries.

10.2 RELATION BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

10.2.1 Summary

In fulfilling its responsibility under the National Environmental Policy Act the staff has attempted in the previous sections of this document to analyze the proposed actions and discover both quantitatively and qualitatively the environmental effects of the proposed action and alternatives. The purpose of this section is to set forth the relationship between the proposed 30-40 year use of the environment associated with the construction and operation being planned and the actions that could be taken to maintain and enhance the long-term productivity of the stations environs.

10.2.2 Enhancement of Productivity

As previously noted, operation of the Byron Station will result primarily in the production of a large block of power needed to meet the demands of the region's society. Availability of this power will have a sustaining beneficial effect on the societal activities, improve the economy of the locale and allow for continued industrial growth and improvement in the material and social life of the service area. Because of the importance of this area to the nation's productive capacity these improvements can be considered to be a national benefit.

10.2.3 Uses Unfavorable to Productivity

10.2.3.1 Land Usage

The land involved in this proposal has been used primarily as agricultural land. Although no short term (30-40 year) productive use of the land (aside from that derived from plant operation) is planned, cooperation of the applicant with the Ogle County Soil and Conservation District should result in the continuance of the productive capability of the land in the long term. Since most of the soil on the site is in the steady albeit slow, process of depletion from an agricultural standpoint, short term diversion to a natural state is considered by the staff to be a beneficial rather than an adverse land use change, provided reasonable efforts are made by the applicant to assure its future improvement by suitable conservation practices.

The environmental effects of the construction and operation of the railroad spur are not expected to be unusual or unacceptable. However, since construction plans are not available at this time, no definitive evaluation can be made.

Construction of the tower bases for the transmission lines will remove five to eight small (2000 to 8000 sq ft) areas per mile from productive use over most of the ∿51 miles of right-of-way that are required. Although most of the land transected is agricultural land, a continuation of present company policy of locating rights-of-way along section and half section lines should minimize the actual productive loss due to these towers. Nevertheless, some small loss of agricultural productivity will result. In addition to the tower base effects, the estimated 1100 acres of right-of-way area will require both initial vegetation removal and continuous management for line security. Clearing and trimming operations are expected to have very little adverse effect on the areas through which the rights-of-way pass. The staff anticipates that construction impacts will be effectively minimized.

10.2.3.2 Water Usage

No adverse consumption of water interference with waterway traffic or other significant loss of productivity due to water usage by the station has been found by the staff.

10.2.3.3 Decommissioning

No specific plan for the decommissioning of the Byron Station has been developed.[1] This is consistent with the Commission's current regulations which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a decommissioning plan which is submitted to the AEC for review. The licensee will be required to comply with Commission regulations then in effect and decommissioning of the facility may not commence without authorization from the AEC.

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

There are several alternatives which can be and have been used in the decommissioning of reactors: (1) Remove the fuel (possibly followed by decontamination procedures); seal and cap the pipes; and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. (2) In addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. (3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill in 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 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.

Estimated costs of decommissioning at the lowest level are about $1 million plus an annual maintenance charge in the order of $100,000.[2] Estimates vary from case to case, a large variation arising from differing assumptions as to the level of restoration. For example, complete restoration, including regrading, has been estimated to cost $70 million.[3] 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.

The degree of dismantlement would be determined by an economic and environmental study involving the value of the land and scrap values versus the complete demolition and removal of the complex. In any event, the operation will be controlled by rules and regulations to protect the health and safety of the public that are in effect at the time.

10.3 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

10.3.1 Introduction

Due to the magnitude of the proposal under consideration, certain irretrievable commitments are postulated. These will result from the consumption or the utilization of resources, which are neither renewable, not economically recoverable. These inherent environmental impacts are identified in this section.

10.3.2 Commitments Considered

The types of resources of concern can be separated into two categories: (1) material resources (e.g., the irretrievable materials of construction and operation); and (2) nonmaterial resources (e.g., any future restrictions to the beneficial use of the environment, reduction of any physical or biological resources of the area, adverse safety or health effects, etc.).

10.3.3 Material Resources

10.3.3.1 Construction of Materials

Materials of construction are almost entirely depletable resources. Concrete and steel constitute the bulk of these materials, but there are numerous other material resources incorporated in the physical plant. No decisions have been made by the applicant on whether these materials will be recycled when their present use terminates.

Some materials are of such value that economics clearly dictate recycling. Plant operation will contaminate only a very small portion of the plant to such a degree that radioactive decontamination would be needed in order to reclaim and recycle the constituents. Some parts of the plant will become radioactive by neutron activation (radiation shielding around each reactor and other components inside the dry-well portion of each containment structure constitute the major materials in this category for which it is not feasible to separate the activation products from the base materials). Components that come in contact with reactor coolant or with radioactive wastes will sustain varying degrees of surface contamination, some of which would be removed if recycling is desired. The quantities of materials that could not be recycled probably represent very small fractions of these resources available in kind and in broad use in industry. Quantities of materials used in other nuclear plants of about the same power output as the Byron Station but not necessarily of the same typical design are shown in Table 10.1. World production, U. S. consumption, and U. S. reserves are also given.

Construction materials are generally expected to remain in use for the full life of the plant, in contrast to fuel and other replaceable components discussed below. There will be a long period of time before terminal disposition must be decided. At that time, quantities of materials, or resources having small natural reserves must be considered individually, and plans to recover and recycle these depletable resources will depend upon need.

10.3.3.2 Replaceable Components and Consumable Materials

Uranium is the principal natural resource material irretrievably consumed in plant operation. Other materials consumed, for practical purposes, are fuel cladding materials, reactor control elements, other replaceable reactor core components, chemicals used in processes such as water treatment, ion exchange resins, and minor quantities of materials used in maintenance and operation. Except for the uranium isotopes 235 and 238, the consumed resource materials have widespread usage; therefore, their use in the proposed operation is reasonable with respect to needs in other industries. The major use of uranium is for production of useful energy.[4]

The two reactors in the plant will be fueled with uranium enriched in the isotope 235. After use in the plant, the fuel elements will still contain uranium-235 slightly above the natural fraction. This slightly enriched uranium, upon separation from plutonium and other radioactive materials (separation takes place in a fuel reprocessing plant), is available for recycling through the gaseous diffusion plant. Fissionable plutonium recovered in the reprocessing of spent fuel is valuable for fuel in power reactors.

If the two units of this plant operate at 70% of capacity, about 8350 metric tons of contained natural uranium in the form of U_3O_8 must be produced to feed the plant for 30 years. The assured U.S. reserves of natural uranium recoverable at (1) a cost of $8 or less per pound of U_3O_8 are 277,000 metric tons of uranium and (2) a cost of $10 or less per pound of U_3O_8 are 340,000 metric tons of uranium.[5] In addition to the assured reserves, the potential uranium resources in conventional deposits recoverable at (1) $8 or less per pound of U_3O_8 are estimated to be 450,000 metric tons of uranium and (2) $10 or less per pound of U_3O_8 are estimated to be 700,000 metric tons of uranium, but this increment will require a major effort in exploration and development to bring it into production.[5] The long-term uranium resource situation in the U.S. will be dependent upon the larger expected reserves of ore recoverable at greater cost and upon utilization of breeder reactors. Plutonium produced in light water reactors, if recycled as fuel to these same reactors, will reduce the requirements for uranium by 15 to 20 percent.

The 8350 metric tons of mined natural uranium required to feed the fuel cycle for this two-reactor plant consists of 59 metric tons of uranium-235, with the balance uranium-238. In the power plant itself, 43 metric tons of uranium-235 will be consumed by fission. Uranium consumption in the proposed operation is considered by the staff to be a reasonable productive use of this resource.

Reactor core materials consumed in a station similar to Byron are listed in Table 10.2. In view of the quantities of materials in natural reserves, resources, and stockpile and the quantities produced yearly, the expenditure of such material is justified by the benefits of the electrical energy produced.

TABLE 10.1. Estimated quantities of materials of construction of water-cooled nuclear power plants

Material	Approximate quantity used in plant[a] (metric tons)	World production[b] (metric tons)	U.S. consumption[b] (metric tons)	U.S. reserves[b] (metric tons)	Strategic and critical material[c]
Aluminum	41	9,089,000	4,227,000	8,165,000	Yes
Asbestos	90	2,985,000	712,000	1,800,000	Yes
Beryllium	0.6	288	308	72,700	Yes
Cadmium	0.005	17,000	6,800	86,000	Yes
Chromium	954	1,590,000	398,000	2,000,000	Yes
Copper	1,670	6,616,000	1,905,000	77,564,000	Yes
Gold	0.001	1,444	221	9,238	No
Lead	108	3,329,000	1,261,000	32,024,000	Yes
Manganese	1,074	7,711,000	1,043,000	907,000	Yes
Mercury	0.03	9,837	2,727	703	Yes
Molybdenum	377	64,770	23,420	2,858,000	No
Nickel	1,110	480,000	129,000	181,000	Yes
Platinum	0.002	46.5	16.0	93.3	Yes
Silver	2	8,989	5,005	41,057	Yes
Steel	80,000	574,000,000	128,000,000	2,000,000,000	No
Tin	5	454,200	82,100	47	Yes
Tungsten	0.01	35,000	7,300	79,000	Yes
Zinc	5	5,001,000	1,630,000	30,600,000	Yes

[a]Quantities used are compiled from various sources for two-unit plants of about the same power rating as Byron Station.

[b]Production, consumption, and reserves were compiled, except as noted, from the U.S. Bureau of Mines publications *Mineral Facts and Problems* (1970 ed., Bur. Mines Bull. 650) and the *1969 Minerals Yearbook*. They are expressed in terms of contained element, regardless of the form. "Production" usually includes material recovered from both primary ores and secondary sources such as scrap recovery. Production and consumption figures are for 1969 unless otherwise noted. Estimates of reserves were published in 1969 but are based on data compiled over a number of years. The reserves stated are the quantities extractable at currently competitive prices; they include inferred as well as measured and indicated ores, when such information was available. Usually, resources recoverable with advanced methods or at greater cost are much greater than the reserves listed.

[c]Designated by G. A. Lincoln, "List of Strategic and Critical Materials," Office of Emergency Preparedness; *Fed. Regist.* 37(39): 4123 (Feb. 26, 1972).

TABLE 10.2 Consumption of Reactor Care Materials Used In a 2300-MWe PWR (40 years)

Material	Quantity used in fuel and control rods (metric tons)
Cadmium	1.1
Indium	2.9
Silver	22
Tin	9.2
Uranium	
U-235	65
U-238	180
Zirconium	605

10.3.4 Non-material Resources

10.3.4.1 Biotic Resources

Loss of about 2% of the plankton passing the intake of the station at average low flow can be considered an irreversible loss of individual plankton; however, since generation time of most plankters is short, recovery of plankton populations is expected to be rapid and no adverse impact on the river ecosystem is anticipated.

Small losses of individual birds by collisions with the cooling towers may occur, but in terms of the overall bird populations, this will not have adverse effects unless such kills occur at a large number of places along the migration routes.

Loss of individual fish due to impingement on the traveling screens will occur, but the numbers killed are not expected to have an adverse effect on the fish population.

10.3.4.2 Water and Air Resources

No irreversible or irretrievable commitments of water and air resources has been found by the staff. Retrieval of resources will occur normally once the materials are released back to the environment for assimilation into the natural hydrologic and chemical cycles.

10.3.4.3 Land Resources

Except for the possible commitment of a small area (less than 10 acres) of land for storage of the station's radioactive components at the end of its service life, no irreversible or irretrievable commitment of the land resources have been found by the staff.

10.3.4.4 Societal Commitments

No irreversible long term societal commitments, including continued use of the site after decommissioning for the purpose of generating power, are expected by the staff. Some of the highly radioactive wastes of the station will, however, be added to the existing and future wastes of other nuclear programs and as such will constitute a long-term commitment on future societies. This aspect of nuclear activities is the subject of separate Commission regulations and controls and is, therefore, considered outside the scope of this statement.

10.4 BENEFIT-COST BALANCE

The staff estimates of the environmental and economic benefits and costs, to be expected from construction and operation of the proposed nuclear power station, have been developed in earlier sections of the statement. These estimates are reviewed and classified in Section 10.4.1 below. The staff assessment of the balance between benefits and costs is developed in Section 10.4.2. It supports the conclusion that construction and operation of the proposed station are desirable.

10.4.1 Benefits, Costs, and Transfers

Benefits, costs, and transfers (e.g., tax payments) are summarized in the Tables 10.3 through 10.6. Each entry is accompanied by a reference to the section where it is discussed in detail. Certain matters of explanation and interpretation are treated for each table in the subsections below.

10.4.1.1 Primary Benefits (Table 10.3)

The direct objectives of the applicant are to produce relatively low-cost electrical energy and to provide additional generating capacity to meet peak demand with adequate reserves. The benefit/cost analysis should consider also the effect of an increased energy supply on economic growth. The historical correlation between electrical energy consumption and gross national product (GNP), shown in Fig. 10.1 implies that continued economic growth requires an increasing supply of electrical energy. Of course, many other inputs such as raw materials, labor, etc., are needed as well. Despite the substantial uncertainty of the evaluation, the staff believes that a rough assessment is preferable to ignoring the need of increased electrical energy supplies for continued economic growth.

The desirability of further economic growth and the value of GNP as an indicator of national well-being are themselves under some public challenge at present. However, the staff has found no reason to doubt the continued acceptance by the public of reasonably full employment and (at least) the maintenance of the present "standard of living" as appropriate national goals. That these goals are achievable without average increases of a few percent per year (in constant dollars) of GNP is not readily evident.

10.4.1.2 Environmental Costs (Table 10.4)

a. Costs Related to Production of Energy. The environmental costs associated with the nuclear fuel cycle have been treated generically.[6] Since these costs are largely independent of the design and

TABLE 10.3. Primary Benefits from Station Construction and Operation

Description	*Reference Section*
Literal statement:	
Annual production of about 12.5 billion kWh of electric energy	8
Contribution to system reliability of 2240 MWe generating capacity	8
Alternative interpretative statement:	
Economic activity associated with \$4 to \$6 billion GNP (1958 dollars) for the life of plant	10.4.1.1

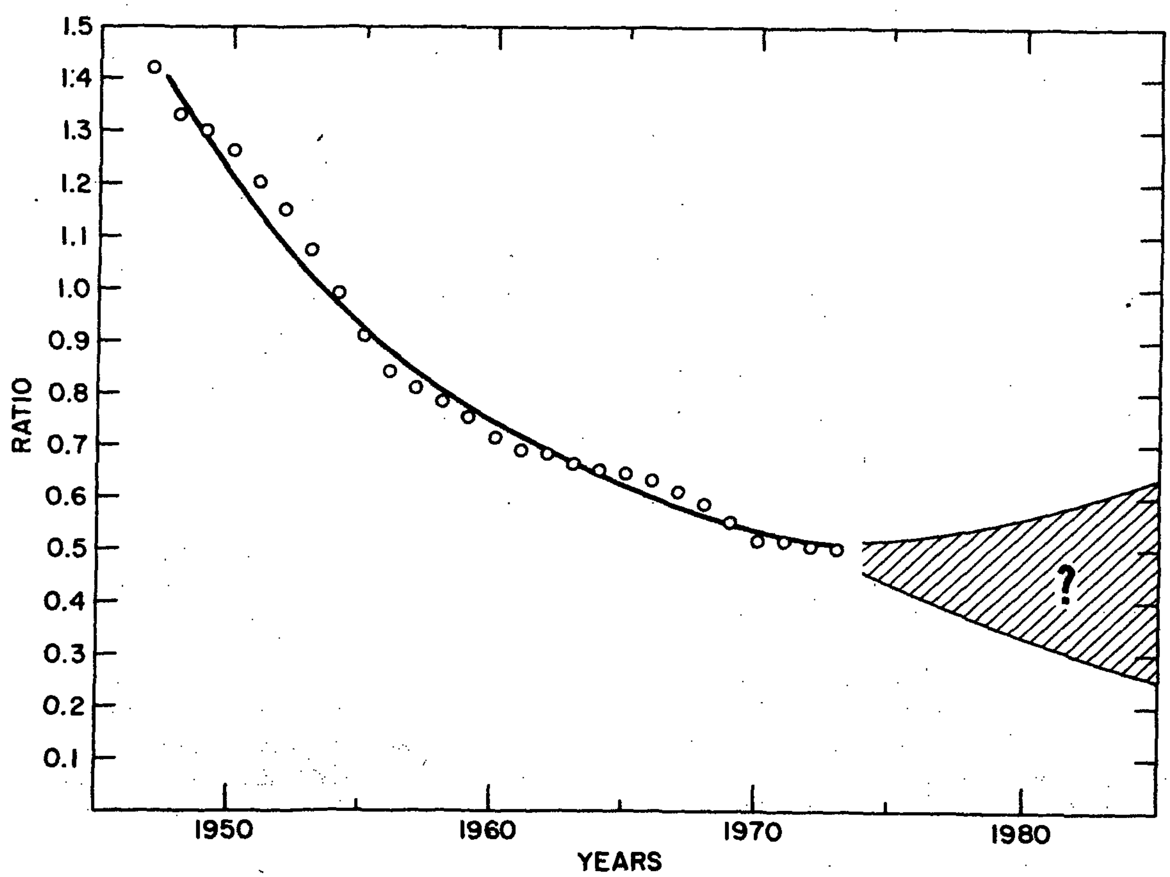

Fig. 10.1. Ratio of GNP to Electric Energy Sales (1958 dollars/kWh).

location of any particular nuclear generating plant, they are not considered here and do not appear in Table 10.4.

b. Costs Related to Consumption of Energy. Environmental costs associated with the consumption of electrical energy are not considered elsewhere in this statement because they are in no sense specific to the proposed station. Since these costs do tend to balance the benefits shown in Table 10.3, however, they are listed in Table 10.4 on the basis of the following discussion.

Major direct uses of electric energy are lighting, the production of mechanical work via electric motors, energizing of control and communications equipment ("electronics"), electrochemical processing, and heating. Except for electrochemical processes (a small fraction of the applicant's load), the only significant waste product due to these direct uses is heat. However, the transformation of electric energy into light, mechanical work, signal amplification, and localized heating is generally more efficient than alternative means, where these exist. Also, most practicable alternative lights, motors, and heaters involve combustion processes, and yield combustion waste products locally as well as waste heat. Therefore, for the same end results (production of light, mechanical work, desired heating, etc.) the consumption of electric energy (distinguished from generation) gives rise to reduced environmental effects relative to available alternatives.

In absolute terms, the only significant environmental effect to be expected directly from the use of the electricity produced by a generating station will be the increased discharge of waste heat to the environment. Probably the only environmental impact will be a relatively modest enhancement of the micrometeorological effects associated with urban "heat islands".

10.4.1.3 Economic Costs (Table 10.5)

The estimated costs of station construction and operation for 30 years are presented in the table in two alternative forms: as "present value" at the estimated date of first commercial operation, and in "annualized" form, giving the annual payment required during each year of plant operation to cover costs of operation and to repay an appropriate fraction of the cost of construction (with interest).

The "present value" of a future payment is the discounted value of the payment, i.e., the sum which deposited at interest at time "present" will with accumulated interest just cover the payment when due. The present value of a sequence of future payments is just the sum of the present values of the individual payments. Similarly, the "annualized"

TABLE 10.4. Environmental Costs

Effect	Reference Section	Summary Description
Land use:		
Erosion	4.1.1, 4.3.1	Minor erosion during construction, will be minimized by construction practices.
Loss of agricultural production	4.1.1	Station proper, 121 acres (doubtful reversibility); exclusion area, 1150 acres (reversible); transmission lines, order of 3 acres (reversible).
Visual	5.1.2	Station proper consists of large industrial-type structures discordant with rural surroundings; natural-draft towers are monumental and will tend to dominate landscape; about 51 miles of transmission line generally regarded as visually unappealing.
Water use:		
Evaporative consumption	5.2.2	About 47 cfs, 1% of normal Rock River flow, 5.4% of (10-year) low flow.
Salts discharged to Rock River	3.6, 5.2.3	94,400 lb/day in excess of normal river concentration in blowdown — leads to 5-25 ppm increase in river TDS.
Thermal plume in Rock River	5.4.1.3, 5.4.1.4	Area order of 10 acres (5° isotherm).
Cooling-tower plumes	5.4.1.1	High, cloud-like plumes, typically 100-1000 ft long, will be visible for many miles -- produce ground shadow but on scale too small to affect crops or other vegetation.
Radiological impact:		
Cumulative population cost (50-mile radius)	5.3	21 man-rem/yr (unrestricted area) and 900 man-rem/yr (restricted area).
Whole-body dose to nearby residents	5.3	Less than 1% of natural background.
Ecological impacts:		
On aquatic life	5.4.3.1	Destruction of order of 1% of plankton in river cross section at intake -- rapid downstream recovery.
	5.4.3.1	Some destruction of (chiefly) weakened fish at intake.
	5.4.3.2	Possible attraction of fish to discharge plume -- affect on fish populations probably undetectable.
	5.4.3.3	Possible effects due to biocide discharge — uncertain now but controllable to low levels.
On terrestrial life	4.3.1	*De facto* establishment of unmanaged wildlife sanctuary in exclusion area.*
Social and economic effects:		
During construction	4.4	Greatly increased traffic on certain roads, possible social problems in nearby towns connected with short-term population increase.
During operation	5.5	Slight population increase in nearby towns because of plant employment (order of 170 new families).
Consumption of electric energy produced by system	10.4.1.2	Heat equivalent to most of energy produced is transferred to atmosphere -- micrometeorological effects due to urban "heat islands" may be enhanced.

*This item may well be a "benefit" rather than a "cost". As a significant ecological impact, it is included for completeness.

TABLE 10.5. Byron Station Economic Costs[a]

Description	*1980-1981 Present Value*	*Annualized (30 years) (millions of dollars)*	*Mills/kWh*
Plant construction	902	85.9	6.74[b]
Fuel consumption	354[c]	33.7	2.64
Plant operation and maintenance	243[c]	23.2[d]	1.82[b]
Decommissioning	22[e]	2.1	0.16[b]
Total	1521	144.9	11.4

[a]Based on applicant's estimates (Byron Environmental Report, Tables 10.1-2 and 11.1-1A), adjusted to exclude taxes and using a different interest-rate assumption as discussed in Section 10.4.1.3.

[b]Assumes annual output of 12.75 billion kWh (65% load factor).

[c]Assumes 30-year life.

[d]Levelized value reflecting 6% per year assumed escalation. 1980-1981 estimate is $11.684 million.

[e]Assumes 1980-81 estimate of $50 million (staff estimate), escalated at 6% per year but discounted at 8-3/4% per year for net discount rate of 2-3/4% per year.

TABLE 10.6. Byron Station Estimated Tax Payments[a]

	1980-1981 Present Value (millions of dollars)	*Annualized (millions of dollars)*	*Mills/kWh*
Corporate income tax[b]	448	42.7[c]	3.35[d]
Real property taxes	24.6	2.35	0.18[d]

[a]Based on applicant's estimates (Byron Environmental Report, Tables 10.1-2 and 11.1-1A), adjusted for 8.75% discount rate in present value computation and for 30-year straight-line depreciation.

[b]Assumes combined state and federal rate of 50% on corporate profits, 46.5% equity financing and 30-year straight-line depreciation.

[c]Levelized value.

[d]Assumes annual output of 12.75 billion kWh (65% load factor).

payment for each of 30 years (say) equivalent to a specific amount at "present" is that payment such that the present value of the 30-year sequence is equal to the specific amount.

The numerical values of the entries in Table 10.5 depend on the interest rate and plant life assumed. To ensure uniformity, the staff assumes an interest rate of 8.75% per year for all investor-owned utility companies. Although this figure is reasonably typical of the industry as a whole during recent years, the effective "cost of money" estimated by a particular utility may be somewhat different because of variations in money-market rates and in debt/equity ratios. [Equity (common-stock) financing normally requires a higher rate of return than debt (bond and preferred-stock) financing because of the larger risks assumed by owners.] The staff also assumes uniformly that the economic life of proposed plants will include 30 years of operation, although the operating license, if issued, will be for 40 years beginning with the date of issuance of the construction permit. Actual economic life is determined by the balance between the higher operating and maintenance costs of older plants, and the capital cost of a replacement plant. These costs are not predictable with any great confidence several decades in the future, however, the estimate of 30 years is reasonably consistent with past experience for fossil-fired generating plants.

Taxes paid directly by the applicant are excluded from the cost estimates of Table 10.5, giving rise to rather large discrepancies between the applicant's estimates (Ref. 1, Table 9.3-1) and those given here. Although taxes are a very real cost for the applicant, in the national sense they are merely transfer payments inasmuch as they do not involve any consumption of human or other natural resources. Taxes are included in Table 10.6 discussed below.

10.4.1.4 Economic Transfers (Table 10.6)

As noted above, tax payments do not enter into a national benefit-cost analysis since they neither create nor consume resources. The monies received by governmental bodies from the applicant are recovered in the form of higher rates from consumers of electric energy. The spending ability gained by the governments is lost by the consumers and the net national spending power is unchanged.

The amounts involved, however, are large and of some natural interest, moreover, the taxes paid to local governments would enter into a local benefit-cost analysis, tending to balance the environmental costs which accrue mainly to the local area. For these reasons, the estimated tax payments which would result from construction and operation of the proposed station are given in Table 10.6.

10.4.2 Benefit-Cost Balance

The basis on which the balance is made is described briefly in Section 10.4.2.1 while the actual balance for the proposed station is developed in Section 10.4.2.2.

10.4.2.1 Basis for Balance

In Appendix D of 10 CFR 50, the AEC has required that a benefit cost analysis (BCA) be prepared for each nuclear plant considered for licensing. A benefit cost analysis involves two major phases. First, all of the significant* benefits and costs to be expected from the proposal must be identified and assessed. Second, the favorable consequences (benefits) must be compared with those unfavorable (costs). If the benefits clearly exceed the costs, to a degree greater than the likely uncertainty in the estimates of each, the proposed course of action is desirable. The reverse case, of course, leads to the opposite conclusion. Indeterminate cases must be resolved by sharper analysis, or by other means.

Prior to the promulgation of Appendix D, the use of BCA was largely confined to cases where it was considered appropriate to assign dollar values to every benefit and cost item. In such cases, the comparison phase involved only the use of arithmetic. Virtually all of the effort addressed to BCA went to the assessment phase** and differences of opinion concerning the adequacy of analysis centered on assessment, with the comparison phase largely taken for granted.

Appendix D, however, (and the spirit and language of NEPA which it implements) requires consideration of virtually all effects on the broadly-defined environment. [For a detailed list of effects, see the Table of Contents of this Statement.] No method for assigning dollar values to such diverse considerations now commands general acceptance, therefore, the required benefit cost balance may not rest on simple and indisputable arithmetic. Ideally, the balance struck should be that which the American public, or an appropriate body representing the public, would reach after study of the assessment presented in this statement and after appropriate discussion and deliberation. In an effort to attain this ideal, the staff's determination of the benefit cost balance is based on the NEPA, legislated by Congress, as implemented in Appendix D of 10 CFR 50.

10.4.2.2 Balance for Byron Station

The environmental and economic effects to be expected from the station if built and operated are given summarily in Tables 10.3 through 10.6.

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* "Significant" here means large enough to possibly influence the final decision.

** Most of the preparation effort for (and pages in) this statement explain the assessments.

The major benefit expected will be the production of about 12.75 billion kWh of electrical energy each year over the anticipated 30-year operating life of the station and the maintenance of an adequate reserve margin of generating capacity (see Section 8.2.1.3). On the basis of the historical correlation between GNP and electric energy production discussed in Section 10.4.1.1, the staff expects that the station will support (along with necessary inputs of labor, raw materials, etc.,) the economic activity associated with about \$4 to \$6 billion (1958 dollars) per year of GNP.

The date of need for the generating capacity which the station would provide must be considered somewhat uncertain because of factors brought to the fore by the current "energy crisis." On the one hand, economic growth in the U. S. may be slowed by the shortage of petroleum products and the resulting dislocations of the economy, and increased emphasis on the more efficient use of energy may lead to reduced consumption of electric energy for present uses, providing some margin for new uses without the construction of generating plants. On the other hand, the persistent shortage of petroleum fuels would tend to induce additional use of electric energy as a substitute while inhibiting the operation of oil-fired generating capacity. The staff has found no marked environmental or economic disadvantage would result from advanced completion of the station and that prudence would favor acceleration rather than delay of the construction schedule.

The economic cost of the proposed station is large, about \$1 billion capital investment and about \$200 million per year for fuel, operation and maintenance, taxes, interest, and depreciation. These large sums are, however, associated with the production of correspondingly large amounts of electric energy, some 12 to 13 billion kWh per year. The "busbar" cost (i.e., not including transmission and distribution costs) of the station output will be about 2 cents per kWh. The conclusion of Section 8 is that a market for the output will exist over the life of the plant; thus the large cost of the plant will be balanced by the large value of the output.

The material resource costs of the station have been considered in Section 10.3.4. Plant construction will require the partly irretrievable commitment of substantial quantities of metals and materials of construction. However, relative to capital investment and contribution to GNP, this commitment appears to be typical of capital intensive basic industries. Plant operation will irreversibly consume substantial quantities of uranium, particularly of the relatively rare mass-235 isotope. However, U. S. uranium reserves appear adequate to support nuclear power at least through the life of plants coming into operation before the middle or late 1980's and for very much longer (centuries) if timely introduction of commercially successful breeder reactors is achieved.

The environmental costs of the proposed station are typical of a large, but carefully planned industrial enterprise located in a hitherto rural area with certain specific exceptions. Some 100 acres, now used as farmland but of modest productivity, will be converted to industrial use. An additional 690 acres, mainly now used as farmland, will serve as "exclusion area" for the plant and probably will lie fallow,* reverting to natural conditions and providing wildlife habitat. Various effects of construction activity during a 5-year period are foreseeable (see Section 4), but none that would not normally accompany large-scale construction and none with unacceptable environmental impact. Operation of the plant will add a few hundred residents to the population within 20 miles (now 260,000).

Environmental effects specific to the proposed type of plant (nuclear power station with natural-draft cooling towers) include consumptive use of water from the Rock River, release of small amounts of radioactivity and direct radiation to the environment, esthetic and meteorological effects of the natural-draft cooling towers and esthetic and land-use effects of the associated new transmission lines. The evaluation of these effects in Sections 4 and 5 indicates that only the esthetic effects appear likely to be more than marginally perceptible against the normal fluctuations of the environment. Assignment of public importance to these esthetic effects is very uncertain because of the very subjective nature of the individual reaction and because of the absence of generally accepted methodology. However, the staff believes that, of residents of the nearby area and travelers through it, only a small fraction will react unfavorably to an occasional sight of cooling towers or transmission lines.

10.4.2.3 Conclusion

As stated in Section 9 the staff believes that there would be no reduction in overall costs by the use of an alternative site, the use of an alternative generating system, the use of alternative plant designs, or the use of any combination of these. The staff evaluation of alternative cooling systems indicated that the use of cooling towers is as environmentally acceptable as any of the alternatives and minimizes the diversion of productive land. The staff concludes that the proposed Byron Station is a system with a benefit to cost ratio at least as high as that of any alternative system.

In the staff's opinion, the benefits of increased availability of electrical energy and improved system reliability in the applicant's service area outweighs the economic and environmental costs caused by the station when it is constructed and operated in accordance with the conditions listed in the Summary and Conclusions.

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*The exclusion area could be returned to agricultural production, however, if national needs so required.

References

1. Commonwealth Edison Co., "Byron Station Environmental Report," including insertions, Vols. 1 and 2, Docket Nos. STN 50-454 and STN 50-455.

2. Atomic Energy Clearing House, Congressional Information Bureau, 17(6), p. 42; 17(10), p. 4; 17(18), p. 7; 16(35), p. 12.

3. "Environmental Report, Diablo Canyon Station, Units 1 and 2," Supplement No. 2., Pacific Gas and Electric Co., July 28, 1972.

4. "Mineral Facts and Problems," Bureau of Mines, U. S. Dept. of the Interior, p. 230, 1970.

5. U. S. Atomic Energy Commission Press Release T-133, dated March 27, 1974.

11. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

11.1 INTRODUCTION

Pursuant to Appendix D of 10 CFR 50, the Draft Environmental Statement (DES) was transmitted in February 1974 with a request for comment to the Federal, State, and local agencies listed in the Summary at the beginning of this statement. In addition, the AEC requested comments from interested persons by a notice published in the Federal Register on February 27, 1974.

Letters in response to these requests were received from the following:

Upper Mississippi River Basin Commission (UMRBC)
Department of Housing and Urban Development (HUD)
Department of Agriculture, Forest Service (FS)
Department of Agriculture, Agricultural Research Service (ARS)
Department of Agriculture, Soil Conservation Service (SCS)
Department of Health, Education, and Welfare (HEW)
Department of Commerce (DOC)
Department of Transportation (DOT)
Advisory Council on Historic Preservation (ACHP)
State of Illinois (ILL)
Federal Power Commission (FPC)
Department of Interior (DOI)
Environmental Protection Agency (EPA)

The letters are reproduced in Appendix A of this Statement. The staff's consideration of the issues raised in these letters are reflected in this Section and by changes in the text. The abbreviations and associated Appendix A page numbers refer to the specific comments received from the various agencies and sources.

11.2 UPPER MISSISSIPPI RIVER BASIN COMMISSION

No comments at this time.

11.3 DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

11.3.1 Disposal of Radioactive Solid Waste (HUD, A-1)

Wet solid wastes will consist mainly of spent demineralizer resins, filter sludges and evaporator bottoms. The staff considers that all wet solid waste will be stored onsite for approximately 180 days prior to shipment which allows shortlived radionuclides time for decay. Dry solid wastes will consist of ventilation air filters, contaminated clothing, paper and miscellaneous items such as tools and laboratory glassware. Since these wastes normally contain less radioactivity than wet solid wastes, the staff assumes that these wastes are shipped as soon as they are packaged and not held for decay.

Based on the staff's evaluation of similar type reactors and data from operating reactors, it is estimated that approximately 7200 Ci/yr or wet solid wastes will be shipped from the site in drums or shipping casks. The staff estimates that less than 5 Ci/yr of dry and compacted solid wastes will be shipped from the station, for each reactor. Greater than 90% of the radioactivity associated with the wastes will be long-lived fission and corrosion products, principally Cs-137, Co-58, Co-60, and Fe-55. (Sect. 3.5.3)

The concerns expressed in this comment are appropriately addressed in the AEC document "Environmental Survey of the Nuclear Fuel Cycle." As noted in that document, the environmental effects of the entire uranium fuel cycle with regard to an individual reactor are small. Further, the potential for any significant effect from the disposal of solid radioactive wastes from a reactor is extremely limited due to (1) the small quantity of radioactivity contained in the wastes, and (2) the care taken in establishing and monitoring commercial land burial facilities as noted below. Commercial land burial facilities must be located on land which is owned by a State of the Federal government, and after radioactive wastes are buried at a site, that site must not be used for any other purpose. Authorization to operate a commercial land burial facility is based on an analysis of the nature and location of potentially affected facilities and of the site topographic, geographic, meteorological, and hydrological characteristics; which must demonstrate that buried radioactive waste will not migrate from the site. Environmental monitoring includes sampling of air, water and vegetation to determine migration, if any, of radioactive material from the actual location of burial. To date, there have been no reports of migration of radioactivity from commercial burial sites. In the event that migration were to occur, plans for arresting any detected migration have been developed. On the basis of the general environmental considerations of burial sites now developed, the wide range of wastes that can be buried, and the observation that an applicant is not restricted to a specific burial site, the staff believes that a more detailed discussion of solid radioactive waste disposal sites is inappropriate to an environmental statement for any one nuclear power plant facility.

11.4 DEPARTMENT OF AGRICULTURE

11.4.1 Forest Service

(1) Summary of Site Land Use (FS, A-2)

Forest service comments indicate that no summary of the use of forest land for transmission, pipeline, and railroad corridors appears in the draft statement. The staff concurs with this comment but points out that the requested data appear in the DES in Table 3.4 and Sections 4.1.1 and 4.3.1. Impacts of pipeline construction and railroad spur construction are not fundamentally different from those of transmission corridors. The principal impact on forests from this type of construction appears to be due to aesthetic effects, possibilities for soil erosion, and alteration of wildlife habitat since these forests are not managed for production purposes. The staff has concluded that adverse aesthetic effects cannot be practically minimized further because of the existing terrain and predominant agricultural land use (Sect. 4.1.2). The staff has further concluded that soil erosion is not a serious hazard (Sect. 4.1.2); it does not appear to be taking place in existing corridors of the area, and it is controllable by established techniques if localized problems should arise. The impact of forest clearing on wildlife should be undetectable since the habitat lost is a small part of that available and the existing wildlife is demonstrably compatible with living in existing habitats which because of extensive agricultural activity can be considered managed (Sect. 4.1.2).

Staff investigations have not revealed any biologically unique features of the proposed pipeline, railroad or transmission corridors. Since forests occupy a small part of the total landscape (Table 3.4), there is no reasonable likelihood that further detailed land use analysis could alter the conclusion that forest clearing for corridors will have an acceptably small impact on aesthetic, physical, and biological features of the region.

(2) Stablilization of Dredged Materials (FS, A-2)

The staff concurs with Forest Service comment that dredged material deposited on site from the intake and discharge structures should be stablized by vegetation or other suitable means. It is the staff's opinion that this point is adequately covered in Sections 7a and 7e of the summary and conclusions of the Byron DES and that the required actions will be taken.

(3) Effects of Transmission Lines (FS, A-2)

The matter of ecological impacts of transmission line construction has been treated in Section 4.1.2 where it is concluded that there will be no detectable effects on wildlife of the region.

The clearing of transmission corridors does inevitably result in some lost productivity of forests, however, the staff concludes that the extent of forests in the region and the lack of harvest of forest product results in an acceptably low adverse impact from transmission line construction. The lost productivity normally utilized by wildlife will be compensated for by the productivity of successional vegetation which will invade the corridors in forested areas.

11.4.2 Agricultural Research Service

No comments at this time.

11.4.3 Soil Conservation Service

(1) Land Use of Unused Portions of Site (SCS, A-4)

The applicant has indicated that he will consult with the United States Department of Agriculture - Soil Conservation Service and the Illinois Department of Conservation Wildlife Management and Forestry Sections in planning for the best use of any unused portion of the plant site.

(2) Return of Unused Land to Natural State (SCS, A-4)

See Response (1) above (Sect. 11.4.3)

(3) Withdrawal of Land From Cultivation (SCS, A-4)

The suggested deletion has been made in the text (Sect. 4.3.2)

(4) Conservation Plan with Ogle County Soil and Water Conservation District (SCS, A-4)

See Response (1) above. (Sect. 11.4.3)

(5) Lost Productivity From Construction of Transmission Towers and Railroad Spur (SCS, A-4)

The suggested addition has been made in the text (Sect. 10.1.1.1),

(6) Acreage Lost to the Railroad Spur (SCS, A-4)

The suggested additon has been made in the text (Sect. 10.2.3.1).

(7) Acreage Lost to Transmission Tower Bases (SCS, A-4)

The suggested deletion has been made in the text (Sect. 10.2.3.1).

(8) Conservation Plan (SCS, A-4)

See Response (1) above (Sect. 11.4.3)

(9) Land Drainage During Construction (SCS, A-4)

The staff's assessment of adverse effects to the land drainage of area and to the adjacent land is given in Section 4.5.1.

11.5 DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

11.5.1 Radiation Doses (HEW, A-5)

The staff evaluation of radiological impacts is given in Sections 5.3 and 7. The staff's assessment is in agreement with the judgement of HEW.

11.5.2 Sewage Discharge from Station (HEW, A-5)

The applicant will obtain a construction permit from the Illinois EPA for all sewage treatment facilities. Conditions to this permit will be observed by the applicant.

11.5.3 Groundwater Effects and Monitoring (HEW, A-5)

The staff's assessment of impacts on groundwater from construction activities is given in Section 4.2.2. Groundwater monitoring of quantity and quality both before and during plant operations is given in Section 6.1.4.2.

11.5.4 Road Maintenance and Traffic Safety (HEW, A-5)

The staff's position regarding increased traffic in the vicinity of the station site during the period of construction is given in Section 4.1.1. The applicant is aware of its responsibilies to maintain roads in the area of the Byron Station in a safe condition and to inform contractors of the necessity to train their employees in all safety related manners.

11.6 DEPARTMENT OF COMMERCE

11.6.1 Noble Gas Releases From Decay Tanks (DOC, A-6)

The release rate of radioactive gaseous waste to the atmosphere will be governed by the limits specified in the Technical Specifications of the Operating License for this station. The staff assumed the release of gaseous effluents from decay tanks will occur over a period of days. Therefore, the staff use of the annual average dispersion factor to calculate annual total body and skin doses is deemed to be appropriate.

11.7 DEPARTMENT OF TRANSPORTATION

11.7.1 Road Maintenance and Traffic Safety (DOT, A-6)

See response to Department of Health, Eduction, and Welfare comments Sect. 11.4.4.

11.8 ADVISORY COUNCIL ON HISTORIC PRESERVATION

11.8.1 Historic and Archeological Sites (ACHP, A-7)

The applicant has stated that excavation of the eight archeological sites at Byron will be conducted by Dr. M. L. Fowler of the Archeology Department of the University of Wisconsin. The State Historic Preservation Office will be notified of the results of excavation.

11.8.2 State Historic Preservation Officer (ACHP, A-7)

Contact with the Illinois State Historic Preservation Officer is evidenced by February 1974 letter to Daniel R. Muller which is given in Appendix B.

11.9 STATE OF ILLINOIS

11.9.1 Department of Conservation

(1) Summary of Site Land Use (DC, A-8)

See response to Department of Agriculture comments Sect. 11.4.1.

(2) Removal of Timber and Retention of Brush (DC, A-8)

The applicant has indicated that the areas where small amounts of timber are removed will be seeded and revegetated after consultation with USDA - Soil Conservation Service and Illinois Department of Conservation.

11.9.2 Department of Public Health

(1) On-Site Meteorological Data (DPH, A-9)

The staff agrees that at least one year of actual on-site meteorological data correlated with nearby meterological stations which have an established climatological data base are required. The meteorological program for the Byron Station is in accordance with Regulatory Guide 1.23. (See Sect. 6.1.2)

(2) Radiological Monitoring Program (DPH, A-9)

The applicant's environmental radiological monitoring program as currently proposed has been evaluated by the staff and is judged to be acceptable. The staff conducts another evaluation of the monitoring program in its review and approval of environmental technical specification at the operating license stage. This review is not completed until just prior to issuance of operating licenses and allows the staff to assure that updated monitoring techniques and hardware are stipulated by the technical specifications which become an integral part of the operating licenses.

11.10 FEDERAL POWER COMMISSION

11.10.1 Need for Power (EPC, A-9 to A-11)

The Federal Power Commission comments substantiate the need for power in the CECO system equivalent to that represented by the proposed Byron Units 1 and 2. Some numerical errors occurred in the comments on the Byron DES, but subsequent comments on Braidwood DES with regard to reserve margin and commencement of unit operation were correct.

11.11 DEPARTMENT OF INTERIOR

11.11.1 Summary and Conclusion (DOI, A-12)

Changes have been made in the text (Sect. 5.4.2.1) to account for the maximum loss of about 2% and 7% of the plankton passing the station intake at average and 7 day, 10 year low flows, respectively.

11.11.2 Location of the Station (DOI, A-12)

Security at the Byron Station will be maintained in accordance with AEC Guidelines and access to the exclusion area will be strictly limited. The applicant believes that the Byron site has no characteristics which would be appropriate for recreational use. However, the applicant will determine the best use of unused portions of the site with consultation and help of the U. S., Department of Agriculture - Soil Conservation Service and Illinois Department of Conservation - Wildlife Management and Forestry Section. (See response to Department of Agriculture Sect. 11.4.3)

11.11.3 Historic and Natural Landmarks (DOI, A-12)

See response to Advisory Council on Historic Preservation Sect. 11.8.1.

The suggested change has also been made in the text (Sect. 2.3) to remove the erroneous identification of the John Deere Shop and Home at Grand Detour as a national historic site.

11.11.4 Geology (DOI, A-13)

The information on geology in the environmental statement is not intended to be sufficient for an independent assessment of the adequacy of the facility design with respect to the geologic environment. Such adequacy is determined by the AEC in its safety evaluation of the proposed station, which, as presumed in the comment, does include consideration of seismology and is in accordance with Appendix A, 10 CFR 100. Therefore, the staff believes the descriptions of geology and seismology in the statement are sufficient.

The basis for the exemption to allow rock grouting of a 3.7 acre area is given in this Statement in Appendix D, "Discussion and Findings by the Directorate of Licensing, U. S. Atomic Energy Commission", relating to an application for an exemption from Licensing for certain site preparation activities at the Byron Station, Units 1 and 2, prior to the completion of the NEPA Environmental Review, AEC Docket Nos. STN 50-454 and STN 50-455. January 11, 1974".

11.11.5 Aquatic Ecology (DOI, A-14)

The staff found the applicant's baseline survey of the aquatic biota in the vicinity of the site to be acceptable. Details of methods, frequencies, and locations for the baseline study, as well as the proposed pre-operational and operational monitoring programs are presented in Tables 6.3 through 6.6 of the text (See Sect. 2.7 of applicants ER for further details).

A sampling program, which included electrofishing and seining among other methods, during April 1972 through July 1973 yielded 43 species of fish from the Rock River and six of its tributaries in the Byron area. The most common species collected by electrofishing were the carpsuckers (carpoides sp.) and carp (cyprinus carpio). (These species are important components of the commercial fishery) The next most common species were river shiners (notropis blennius) and shiners (N. straminous) which were collected mostly by seine. Game fish accounted for 8.0 percent of the total numbers collected from the river, commercial fish 44.2 percent, and forage fish 47.8 percent. The most important game fish are large and smallmouth bass, channel catfish, bluegill, black and white crappie, walleye, northern pike, black bullhead and rock bass.

There is commercial fishing on the Rock River by individuals who are under special contract with the Illinois Department of Conservation. There is only one active commercial fishing operation in Ogle County. This operation utilizes hoop nets, trammel nets and seines. For all methods of commercial collection, carpsuckers are the most abundant, followed by buffalo, carp, and drum.

Stomach content analysis indicated that bottom fauna (e.g., insect larvae, oligochaetes and crayfish) were important food items. Additional collections at the mouths of and in tributary streams yielded mostly minnows, although there was some use of tributary streams by other fish.

Fish egg and larvae drift sampling showed peak fish egg frequencies occuring in June of both 1972 and 1973. Carp accounted for 51.1 percent of the larval fish while minnows and suckers made up 32.9 percent.

As relates to stresses on fish, microscopic examinations and field observations of six species did not indicate epidemics of any ectoparasitic organisms. However, some mortality of channel catfish and gizzard shad in the Rock River was attributable to the bacterial infection Aeromonas liguefaciens. Cyanide pollution was also observed during the baseline study.

Weedbeds are important in providing food and cover for fish and fish spawning areas. However, sand and small gravel comprise a major part of the bottom substrate in the Rock River. Because of the shifting of the substrate by currents, the substrate does not support high benthic production or provide attractive spawning areas. Additional information on fish spawning for some Rock River species may be found in Appendix VII of the applicant's Environmental report.

11.11.6 Chemical and Biocide Releases (DOI, A-14)

The effects of chemical and biocide releases are discussed in Sections 5.2.3 and 5.4.2.3. The staff's discussion in Section 5.2.3 concluded that the chemical impacts will be acceptable. The comments by the Department of Interior concur with the staff conclusion. Furthermore, discharges from Byron Station must meet the provisions of National Pollutant Discharge Elimination System permits issued by the United States Environmental Protection Agency (or State of Illinois as authorized) pursuant to the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500).

11.11.7 On-Site Construction (DOI, A-14)

Plans for the "best use" of unused portions of the station site will be developed by the applicant in consultation with the U. S. Department of Conservation Wildlife Management and Forestry Sections. See responses to Department of Agriculture comments Sect. 11.4.

11.11.8 Transmission Line Constructions (DOI, A-14)

The applicant has stated that a determination will be made as to the best method of clearing vegetation in the corridors during construction of transmission lines. Areas of tower bases will be mechanically cleared. Appropriate herbicides may be used where environmentally safe. Approved herbicides will be principally used to prevent regrowth of trees.

11.11.9 Impacts on Water Use (DOI, A-14)

The applicant is aware that the design of the intake structure must be acceptable under Section 316(b) of the Federal Water Pollution Control Act Amendments of 1972. A National Pollutant Discharge Elimination System (NPDES) permit must be obtained for the intake structure.

11.11.10 Effects Due to Withdrawal of Water for Cooling (DOI, A-14)

The staff has clarified the percent loss of plankton due to water intake from the Rock River. (Sect. 5.4.2.1)

11.11.11 Thermal Discharges (DOI, A-15)

The staff tabulations of heated plume areas have been appropriately rounded off per this comment. (Sect. 5.4.2.2.2)

11.11.12 Effects of the Thermal Discharge on Aquatic Organisms (DOI, A-15)

The staff evaluation of the effects on aquatic organisms from thermal discharge is given in Section 5.4.2.2.3. The staff evaluation indicates that the thermal standards given in the Water Pollution Regulations of Illinois will be met. Furthermore, the staff does not expect any appreciable adverse impact to the aquatic biota to result from the thermal discharge.

11.11.13 Aquatic Program (DOI, A-15)

The staff has evaluated the applicant's aquatic base-line survey and concluded that the survey was acceptable (Sect. 6.1.4.1). However, the staff recommended that the pre-operational monitoring program for 1974 be carried out in substantially the same form for each succeeding year until operation begins. Sufficiently accurate information about the natural variability of the samples should then have been accumulated in order to determine whether first order biotic changes occur with station operation. Further information on all collection techniques and information on meroplankton studies can be found in Section 2.7 of the applicant's Environmental Report. (See also response to Department of Interior comments Sect. 11.11.5)

11.11.14 Operational Monitoring Programs (DOI, A-15)

The operational aquatic monitoring program will be based upon the information obtained and techniques used in the pre-operational program. Detailed evaluation of the operational monitoring program will be done at the time of application for an operating license.

11.11.15 Radiological Accidents (DOI, A-15)

As stated on page 7-2 initial results of the Reactor Safety Study are expected to be available in 1974. The staff position regarding Class 9 accidents is given in Section 7.

11.11.16 Radioactive Wastes (DOI, A-15)

See response to Department of Housing and Urban Development comments Sect. 11.3.1.

11.12 ENVIRONMENTAL PROTECTION AGENCY

11.12.1 Radioactive Waste Treatment (EPA, A-18)

The staff's analysis of turbine building vent releases is given in Section 3.5.2.4. Based on evaluation of the gaseous waste treatment systems, the staff concluded that the proposed systems, as evaluated, will reduce radioactive effluents to as low as practicable levels in accordance with 10 CFR Part 50.34(a) and , therefore, are acceptable.

11.12.2 Thyroid Dose Assessment (EPA, A-17 & 18)

The AEC's dose calculations are repeated below so that the EPA analysis may be checked. The formulae used are from Regulatory Guide 1.42, June 1973, p. 1.42-C5.

$$D_{131}(\text{mrem/yr}) = 1.1\text{x}10^{8}(X/Q)_j\ Q_{131}$$

$$D_{133}(\text{mrem/yr}) = 4.52\text{x}10^{6}(X/Q)_j\ Q_{133}$$

$Q_{131} = .10$ Ci/yr (See page 3-17)

$Q_{133} = .08$ Ci/yr

$X/Q = 1.6\text{x}10^{-6}$ (See Table 5.6 on p. 5-15)

$$D_{131} = 1.1 \times 10^{8} \times 1.6 \times 10^{-6} \times .10 = 17.6 \text{ mrem/yr}$$

$$D_{133} = 4.52 \times 10^{6} \times 1.6 \times 10^{-6} \times .08 = 0.6 \text{ mrem/yr}$$

Total 18.2 mrem/yr

Allowing for a 6 month grazing season (see p. 5-16)

$$18.2 \div 2 = 9.1 \text{ mrem/yr}$$

Allowing for depletion of 0.94 (p. 6B-33, Vol. I, WASH-1258)

$$9.1 \times .94 = 8.6 \text{ mrem/yr}$$

The child-cow-milk-pathway dose of 8.6 mrem/yr at the nearest farm was correctly reported on p. 5-15 of the text.

The dose constants used in the above were changed in the March 1974 revision of Guide 1.42. The calculated child-cow-milk pathway dose at the nearest farm is then 8.7 mrem/yr with this revision.

11.12.3 Radioiodine Monitoring Program (EPA, A-17 & 18)

The applicant's proposed monitoring program will be analyzed in detail at the time the environmental technical specifications to the operating license are determined. This will be 4-6 years hence if a construction permit is granted. The technical specifications will reflect the latest philosophies on monitoring and will incorporate guides in existence at that time.

11.12.4 HERMES Code Iodine Pathway Analysis (EPA, A-17)

The calculational models used represent the current AEC guides. (See Sect. 11.12.2) The reference in the text has been corrected to reflect the actual models used. (Reference 7 page 5-44)

11.12.5 Estimates of Radiation Dose to Individuals (EPA, A-21)

EPA stated that the most critical individual should be considered when making dose estimates. A discussion of the assumptions used in staff calculations of dose is given in Section 5.3.2.1. The calculations are based on conservative assumptions regarding the dilutions of effluent gases and radionuclides in the liquid discharge, and use by man of the station surroundings. This is evidenced for liquid effluent pathways by assuming no dilution by the Rock River (p. 5-13) and that the recreation and fishing activities occur only in the coolant discharge region. The total body and skin doses given in Table 5.6 for gaseous effluent assume an 8760 hour per year outdoor exposure. The infant thyroid dose is calculated at the location of the first dairy animal. Gaseous effluent release limitations are based on calculations at the site boundary and at the first real dairy animal. Using these assumptions and calculational locations, it is highly unlikely that any individual will receive a dose that exceeds the standards or guides.

11.12.6 Treatment of Off-gases from the Main Condenser Vacuum Pump (EPA, A-22)

The off-gases from the main condenser vacuum pump are processed through HEPA filters and charcoal traps if necessary. The text and Figure 3.7 were corrected to eliminate the discrepancy. (See Sect. 3.5.2)

11.12.7 Steam Generator Blowdown Degassing (EPA, A-22)

The off-gas from the blowdown condensate collected in the condenser hotwell is treated in the main condenser air ejector system. The contribution to the gaseous radioactive source terms from degassing of steam generators blowdown is included in the air ejector off-gas column of table 3.3, page 3-22.

11.12.8 Size of Discharge Plume (EPA, A-20)

The staff has evaluated size of the thermal discharge plume in Section 5.4.2.2.2. This evaluation indicates that under worst conditions the revised State of Illinois water quality standards should be met.

11.12.9 Dissolved Solids Concentration (EPA, A-20)

The staff evaluation of dissolved and suspended solids is given in Sections 3.6 and 5.2.3. The staff analysis indicates that the dissolved and suspended solids standards of the State of Illinois should not be violated.

11.12.10 EPA Permits (EPA, A-20)

The staff and applicant recognize applicable water quality standards pursuant to the Federal Water Pollution Control Act amendments of 1972 (FWPCA, P.L. 92-500). Furthermore, certification pursuant to Sec. 401 of FWPCA shall set forth any effluent limitations and other limitations, and monitoring requirements necessary to assure compliance with applicable effluent limitations which shall become a condition on any Federal license or permit. (See also response to Department of Interior comments Sect. 11.11.6)

11.12.11 Biological an Chemical Effects (EPA, A-21)

The staff concurs that compliance with Section 316(b) of the FWPCA concerning water intake structure will minimize adverse environemntal impact.

11.12.12 Plankton Losses due to Entrainment (EPA, A-21)

See response to Department of Interior comments Sect. 11.11.10.

11.12.13 Residual Chlorine Discharge (EPA, A-21)

The staff agrees that in order to minimize the effects of residual chlorine discharges, each cooling water flow (i.e., condenser cooling water, essential service water, and non-essential service water) should be chlorinated at different times to obtain the maximum benefit of the dilution of other flows. All applicable water quality standards will be complied with. (See EPA permits Sect. 11.12.9)

11.12.14 Herbicide Use in Transmission Line Corridors (EPA, A-21)

The staff evaluation of herbicides in transmission line corridors is given in Sections 4.1.2. and 5.4.1.7. The staff recommended that if 2, 4, 5-T is the selected herbicide used to spray vegetation it should contain less than 0.1 pp, of dioxin (2, 3, 7, 8-tetrachlorodibienzo-1, 4-dioxin) in the undiluted herbicide. (Sect. 4.5.2). The staff concurs that an experienced licensed commercial pesticide applicator in Illinois should apply the herbicide.

11.12.15 Chemical Wastes (EPA, A-21)

Appropriate monitoring requirements of chemical wastes will be incorporated in the technical specifications as a part of any operating licenses issued for the Byron Station.

11.12.16 Generating Unit Retirement Schedule (EPA, A-21)

The applicant submitted a revised schedule for generating unit retirements in Supplement IV to the Byron Environmental Report, June 4, 1974. The units, locations, capacity, and dates of retirement are given below.

Generating Unit Retirements

Station	Location	Capacity (MW) Summer	Capacity (MW) Winter	Retirement Date
Powerton #1	Pekin, Ill.	60	63	Oct., 1974
Powerton #2	Pekin, Ill.	60	63	Oct., 1974
Powerton #3	Pekin, Ill.	99	105	Oct., 1974
Powerton #4	Pekin, Ill.	113	119	Oct., 1974

11.12.17 Construction Runoff (EPA, A-22)

The staff has reviewed the method and commitments of the applicant to limit adverse effects during construction. The applicant's commitments in this regard are given in Section 4.5.1. After reviewing the anticipated constructi activities and the expected environmental effects therefrom, the staff concluded that the measure and control commitments of the applicant along with the additional precautions of the staff (Sect. 4.5.2) are adequate to ensure that the adverse environmental effects of construction will be at the minimum practicable level.

11.12.18 Sanitary System Discharges (EPA, A-22)

The applicant will obtain a construction permit from Illinois EPA for sewage treatment facilities (See response to Department of Health, Education and Welfare Sect. 11.5.2). The disposal of solid wastes can be made at sites which meet the requirements of Title 5 of the State of Illinois Environmental Protection Act or through a licensed sanitary land-fill operator. (Sect. 3.7)

11.12.19 State Standards for BOD and Suspended Solids (EPA, A-22)

The state standards presented in Table 5.3 were taken from the Water Pollution Regulations of Illinois as amended through January 31, 1974 by the Illinois Pollution control Board. Rule 404(a) give "...no effluent shall exceed 30 mg/l of five-day biochemical oxygen demand (BOD_5) ..." for all effluents containing deoxygenating wastes. Rule 408(a): "The following levels of contaminants shall not be exceeded by any effluent: Total suspended solids (from sources other than those covered by Rule 404) - 15.0 mg/l."

latory Docket File

STN-50-454
50-455

UPPER MISSISSIPPI RIVER BASIN COMMISSION

FEDERAL BUILDING, ROOM 510, FORT SNELLING, TWIN CITIES, MINNESOTA 55111, PHONE: 612-725-4690
REG OFFICE, ROOM 228 FEDERAL BLDG. COURTHOUSE, FARGO, N.D. 58102, PHONE: 701-237-5771 EXT. 5355

March 1, 1974

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

Dear Mr. Muller:

The Draft Environmental Impact Statement on the Byron Station has been received and filed by this office.

At present, the Upper Mississippi River Basin Commission has not established a review procedure for such documents. Therefore, at this time, we have no comments on the Statement.

The material you provided does contain useful information for the Commission, and we request you continue to send us information and copies of similar material for our future use and consideration.

Thank you for the opportunity to comment.

Sincerely,

George W. Griebenow, Jr.

George W. Griebenow
Chairman

GWG:dm

1860

File Cy.

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
CHICAGO AREA OFFICE
17 NORTH DEARBORN STREET
CHICAGO, ILLINOIS 60602

REGION V
300 South Wacker Drive
Chicago, Illinois 60606

IN REPLY REFER TO:
5.2PM:Koziol

MAR 1 5 1974

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
United States Atomic Energy Commission
Washington, D. C. 20545

50-454
50-455

Dear Mr. Muller:

Subject: Draft Environmental Statement
Byron Station, Units 1 and 2
Commonwealth Edison Company

We have reviewed the Draft Environmental Statement for the Byron Station, Units 1 and 2, of the Commonwealth Edison Company. We have no specific technical comments on the project.

We expect that the design capacity of the Byron Station will be such as to produce no more than the conservatively estimated electrical power needs over the life of the project. An excessive capacity would be an uneconomical use of resources and would unnecessarily increase adverse effects on the environment.

We also expect that the design characteristics of the project will be such as to minimize to the maximum extent feasible adverse impacts on the environment, including thermal pollution of the Rock River, discharge of radioactive materials into the environment, effects of radiation, discharge of non-radioactive pollutants into the environment, etc.

We question the disposition of radioactive solid wastes which will be shipped offsite. Where is the disposal site located; what criteria are used in the choice of location; what disposal techniques are used to minimize adverse effects on the environment and on people; what is the safest method of disposing of radioactive wastes.

Thank you for submitting the Draft Environmental Statement to us for our review.

Sincerely,

John L. Waner

John L. Waner
Director

2255

Regulatory File Cy.

RECEIVED APR 5 1974 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

DOCKETED USAEC APR 5 1974 REGULATORY MAIL SECTION DOCKET CLERK

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA. 19082
TELEPHONE (215) 597-3772

8400
April 2, 1974

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

Re: STN 50-454, STN 50-455 - Draft Environmental Statement for Commonwealth Edison Co., Byron Station, Units 1 and 2, Ogle Co., Ill.

Dear Mr. Muller:

The above Draft Environmental Statement, sent to National Forest System office in Milwaukee, has been forwarded to us for comment because no national forests are involved.

Our main interest is in the effects which the proposal will have on forested areas.

Our comments are based upon a review of the DES only, since we do not have a copy of the environmental report.

There is no one place in the draft that presents a unified picture of how much land is involved in the plant site including the pipeline corridor, the railroad spur, and the transmission lines, nor of the land use or vegetative cover. The following picture is pieced together from the Summary, Table 3.4, and Sections 4.1.1 and 4.3.1

	All land	Forest land
	(acres)	
Plant site incl. pipeline	1360	143
Railroad spur	90	?
Transmission lines	2000	112.7 plus 139 of "mixed forest-field" (Table 3.4)

Of the above forest land, four acres will be cleared at the plant site and at least 112.7 under the transmission lines. We have no way of knowing how much will be cleared for the railroad spur and pipeline, nor how much of the 139 acres of "mixed forest-field" under the transmission lines is forest land which will be cleared. The final statement should clarify this, if possible.

2037

Material to be dredged for the intake and discharge structures will be deposited on the site. While we find no specific mention of revegetation of this material, we assume this will be undertaken.

The discussion of Ecological Effects, 4.3.1 Terrestrial, appears to be limited to the plant site, to the exclusion of the transmission lines. Similarly, the discussion of lost productivity as a result of the transmission lines, under Unavoidable Adverse Environmental Effects, 10.1.1.1 Land, is restricted to the "construction of transmission towers," and ignores the forest land under the lines which will be cleared.

We appreciate the opportunity to review and comment upon the draft.

Sincerely,

Philip L. Archibald
for ROBERT R. RAISCH
Director

Regulatory File Cy.

STN 50-454
STN 50-455

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

April 16, 1974

RECEIVED APR 17 1974

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

Dear Mr. Muller:

The Agricultural Research Service has reviewed the Draft Environmental Statement related to the proposed Byron Station, Units 1 and 2 of the Commonwealth Edison Company, Docket Nos. STN 50-454 and STN 50-455.

We have no comments to make at this time.

Sincerely,

H. L. Barrows

H. L. Barrows
Acting Assistant Administrator
National Program Staff

DOCKETED USAEC APR 17 1974 REGULATORY MAIL SECTION DOCKET CLERK

REGULATORY DOCKET FILE COPY

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P.O. Box 678, Champaign, Illinois 61820

April 18, 1974

RECEIVED APR 23 1974

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

Dear Mr. Muller:

The draft environmental statement for construction of the Byron Station, Units 1 and 2 (Docket Nos. STN 50-454 and 50-455), dated February 1974, located near the Rock River in Rockvale Township, Ogle County, Illinois has been reviewed by the Soil Conservation Service.

Our comments are attached.

Sincerely,

Howard W. Busch

Howard W. Busch
State Conservationist

Attachment

DOCKETED USAEC APR 23 1974 REGULATORY MAIL SECTION DOCKET CLERK

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(

USDA-SOIL CONSERVATION SERVICE April 18, 1974
COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT FOR CONSTRUCTION OF THE BYRON STATION, UNITS 1 AND 2 (DOCKET NOS. STN 50-454 AND 50-455), DATED FEBRUARY 1974, LOCATED NEAR THE ROCK RIVER IN ROCKVALE TOWNSHIP, OGLE COUNTY, ILLINOIS.

Page 4-1, lines 11, 12, 13 indicate the unused portions of the site will be allowed to revert to natural conditions. This may not be the best use of this land. Consideration should be given to using adapted herbaceous and woody plantings. This decision could be made at the time the sponsors of the application develops their conservation plan with the Ogle County Soil and Water Conservation District.

Page 4-1, last two lines refer to returning unused land to a natural state - the above suggestion applies again. The same is true of Page 4-6, item 4.3.1 Terrestrial - second paragraph which suggests the land be allowed to return to native vegetation.

Page 4-7, item 4.3.1 Aquatic, line 11 - suggests deleting the word "native."

Page 10-1, 10.1.1.1 Land, line 6 - suggest it read "be planted to adapted herbaceous and woody plants." Again, if a conservation plan is developed with the Ogle County Soil and Water Conservation District then such decisions will be made when plan is prepared.

Page 10-1, 10.1.1.1, lines 11 and 12 - If estimated acreage could be included this would be convenient in evaluating the impact.

Page 10-3, 10.2.3.1, second paragraph - Suggest including an estimated acreage figure lost to the railroad spur.

Page 10-3, 10.2.3.1, third paragraph, line 7 - suggest deleting the words "but probably insignificant."

Page 10-18, last paragraph - Again a conservation plan would include the land use and recommended land cover.

Care should be taken during construction to avoid any adverse effects to the land drainage of the area and to the adjacent land.

We appreciated the opportunity for our District Conservationist and Soil Scientist to work with a representative from Argonne National Laboratory prior to drafting the environmental statement.

If you have questions relating to the soils, soil interpretations, revegetating the area, woody plantings, drainage, conservation planning assistance, or any soil and water conservation practice, don't hesitate to get in touch with Mr. John J. Conroy, District Conservationist, Soil Conservation Service, Ogle County Resource Center, P. O. Box 183, Oregon, Illinois 61061, telephone 815-732-2931.

We appreciate the opportunity to review and comment on this proposed project.

Regulatory

50-454
50-455

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

APR 10 1974

DOCKETED USAEC APR 11 1974 REGULATORY MAIL SECTION DOCKET CLERK

RECEIVED APR 11 1974 U.S. ATOMIC ENERGY COMMISSION

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

Dear Mr. Muller:

Pursuant to your request of February 27, this Department has reviewed the draft Environmental Impact Statement for Byron Station, Units 1 and 2.

On the basis of information contained in this draft statement, the estimated radiation doses to individuals and to populations as a result of the operation of this station are well within the low as practicable guidelines of the Atomic Energy Commission. The maximum dose to an individual at the site boundary from an accident would be that resulting from a large break in the primary coolant system. This dose would be 1050 millirem. The dose to the population within a 50 mile radius of the site from this same accident would be 450 rads. Considering the postulated frequency of this type of accident, this dose estimate appears to be acceptable.

Other considerations of interest to this Department are the treatment and discharge of sewage from the plant, both during the construction and operational phases. During the construction phase it is planned that the sewage will be treated by the contact stabilization process and initially the effluent will be discharged into a creek having a very low and sometimes intermittent flow. After completion of the cooling tower blow-down piping, the effluent will be discharged directly to Rock River. There is some question as to whether or not the sewage effluent can be discharged into a small creek, namely Woodland Creek, during the initial phases of construction of the plant. If this proves not to be satisfactory after checking more completely with the Illinois authorities, portable toilets will be provided and the sanitary waste will be disposed of off-site through licensed contractors.

3182

Page 2 - Mr. Muller

The draft report discusses possible effect on ground water, both during the construction and operation of the plant. Observation wells will be used to demonstrate that the watering operations during the construction will not cause a significant lowering of the existing ground water level. This precaution is to assure that wells and vegetation in the vicinity will not be effected. Ground water in the observation wells will be monitored for quality as well as the level of ground water. Remedial action will be taken to protect off-site ground water uses should detrimental changes be detected.

The major adverse social and economic effects could occur during the construction phase of the project. Based on the probable source of labor for the construction force there will not likely be a significant influx and temporary relocation of workers with their families into the area during the construction phase. However, it is anticipated that increased traffic plus loads transported to the site will increase the rate of deterioration of paved secondary highways and thus require increased time, effort, and money for road repairs. The licensee is advised to have the contractor maintain close communication with the local highway departments and provide cooperative assistance with maintenance programs to assure that maintenance is properly planned, so that transportation routes in the area will not be seriously degraded. The report also discusses the increased hazards from traffic during this construction period and enjoins the licensee to have the contractor provide appropriate traffic safety training and awareness programs among personnel who will be causing the increases in traffic during this construction period.

Thank you for the opportunity to comment on this statement.

Sincerely,

Charles Custard
Charles Custard
Director
Office of Environmental Affairs

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

April 11, 1974

50-454
50-455

RECEIVED APR 12 1974

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

Dear Mr. Muller:

The draft environmental impact statement for Byron Station, Units 1 and 2, Commonwealth Edison Company, which accompanied your letter of February 27, 1974, has been reviewed and the following comments are offered for your consideration.

The major noble gas sources released to the atmosphere as listed in table 3.3 are from the decay tanks, the auxiliary fuel handling building and the air ejector off gas at rates of 1080, 1100 and 1111 Ci/yr/unit, respectively. The latter two types of releases appear to be continuous throughout the entire year. The period and frequency of the release from the decay tanks is not specified. If, as could possibly be the case, the gases are released over a very short time period (1 hour) from each tank and 10 such releases are made per year, the chi/Q values listed in table 5.6 are inapplicable to this portion of the release.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

DOCKETED USAEC APR 12 1974 REGULATORY MAIL SECTION DOCKET CLERK

3236

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WS/73)
400 SEVENTH STREET SW.
WASHINGTON, D.C.
PHONE: (202) 426-2262

12 APR 1974

50-454
50-455

RECEIVED APR 17 1974

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

DOCKETED USAEC APR 17 1974

Dear Mr. Muller:

This is in response to your letter of 27 February 1974 addressed to Mr. B. O. Davis concerning the draft environmental impact statement for Byron Nuclear Power Station, Units 1 and 2, Ogle County, Illinois.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted. The Federal Highway Administration commented as follows:

"The statement indicates that some local fogging may occur as a result of operation of the proposed cooling towers. However, there are no major highways, existing or proposed, in the proximity of the power station; and we therefore believe that fogging should not adversely affect major highways.

"The construction of an extensive system of power transmission lines and the induced traffic in the vicinity of the plant during construction of the facilities are impacts which can affect transportation programs. A generating station of the size that is proposed will need good access roads to carry construction traffic. It is not clear whether local and State transportation officials are to participate in highway relocation, or whether they were contacted for input into the plan development. Our primary concern is that the plan be coordinated with the local and State transportation officials."

We have no other comments to offer nor do we have any objection to this impact statement. However, the concern of the Federal Highway Administration should be addressed in the final statement.

The opportunity to review this draft statement is appreciated.

Sincerely,

R. I. PRICE
Captain, U. S. Coast Guard
Deputy Chief, Office of Marine
Environment and Systems
By direction of the Commandant

Regulatory File Cy. STN-50-454/455

Advisory Council
On Historic Preservation
1522 K Street N.W. Suite 430
Washington D.C. 20005

April 24, 1974

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 request of February 27, 1974, for comments on the environmental statement for Byron Station, Units 1 and 2, located in Ogle County, Illinois. Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that while you have discussed the historical, architectural, and archeological aspects related to the undertaking, the Advisory Council needs additional information to adequately evaluate the effects on these cultural resources. Please furnish additional data indicating:

a. Compliance with Executive Order 11593 "Protection and Enhancement of the Cultural Environment" of May 13, 1971.

1. Under Section 2(a) of the Executive Order, Federal agencies are required to locate, inventory and nominate eligible properties under their control or jurisdiction to the National Register of Historic Places. The Advisory Council requests that the Commission apply the "National Register Criteria," set forth in Section 800.10 of the Advisory Council's "Procedures for the Protection of Historic and Cultural Properties" (a copy of which is enclosed), to the eight archeological sites referred to on page 2-11 of the environmental statement, and supply us with a determination as to each sites eligibility for inclusion in the National Register.

2. Under Section 1(3) of the Executive Order, Federal agencies are required to institute procedures to assure that Federal plans and programs contribute to the preservation and enhancement of non-federally owned sites. The Advisory Council requests that the Commission supply it with a determination as to whether or not the construction and operation of the Byron Station will contribute to the preservation and enhancement of non-federally owned districts, sites, buildings, structures and objects of historical, archeological or architectural significance.

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

3653

To insure a comprehensive review of historical, cultural, archeological, and architectural resources, the Advisory Council suggests that the environmental statement contain evidence of contact with the appropriate State Historic Preservation Officer and that a copy of his comments concerning the effects of the undertaking upon these resources be included in the environmental statement. The State Historic Preservation Officer for Illinois is Mr. Anthony T. Dean, Director, Department of Conservation, 102 State Office Building, 400 South Spring Street, Springfield, Illinois 62706.

Should you have any questions on these comments or require any additional assistance, please contact Jordan Tannenbaum at 202-254-3974 of the Advisory Council staff.

Sincerely yours,

Ann Webster Smith

Ann Webster Smith
Director, Office of Compliance

STATE OF ILLINOIS

PROJECTS TASK FORCE

DEPARTMENT OF CONSERVATION
605 STATE OFFICE BUILDING
SPRINGFIELD 62706

RECEIVED APR 26 1974 U.S. ATOMIC ENERGY COMMISSION

April 24, 1974

50-454/455

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

Dear Mr. Muller:

The Projects Task Force has reviewed the draft environmental impact statement on Byron Station, Units 1 and 2. We wish to submit the attached comments from two of the member departments.

We appreciate being given the opportunity to review the draft environmental impact statement.

Sincerely yours

Ralph O. Fisher
Chairman

ROF/cff
Attachment
cc: Projects Task Force

DOCKETED USAEC APR 26 1974 REGULATORY MAIL SECTION DOCKET CLERK

371

MEMBER DEPARTMENTS

Agriculture, Business and Economic Development, Conservation, Environmental Protection Agency, Health, Institute for Environmental Quality, Local Governmental Affairs, Mines and Minerals, [illegible], Registration and Education, Transportation, Governor's Task Force for Flood Control, Bureau of the Budget

STATE OF ILLINOIS

DEPARTMENT OF CONSERVATION

OFFICE MEMORANDUM

To: Ralph Fisher
From: Tom Evans TRE
Date: April 11, 1974
SUBJECT: Byron Station Units 1 and 2 - Draft EIS

The Department of Conservation approves, in general, of the above Environmental Impact Statement. All the data and information utilized in decision-making is well documented. With regard to the actual acreages of woodland impacted we do, however, agree with the U.S. Forest Service report that the Statement is not specific in some respects. The acreages impacted by the railroad spur, transmission lines and water intake and blowdown canals is not clear.

We present one recommendation with respect to treatment of the transmission line right-of-way after construction. It is recommended that where timber is removed the right-of-way be seeded to a good sod forming grass. This would serve two purposes; (1) provide a greater diversity of wildlife habitat and, (2) slow the encroachment of tall growing vegetation.

Where possible it would also be desirable to leave brush patches to further add to the diversity of cover.

TRE/kmc

cc: Fred Siemert
Jim Lockart

STATE OF ILLINOIS

DEPARTMENT OF PUBLIC HEALTH

SPRINGFIELD, ILLINOIS 62761

JOYCE C. LASHOF, M.D.
DIRECTOR

CONSUMER HEALTH PROTECTION
VERDUN RANDOLPH, M.P.H., ASSOCIATE DIRECTOR
(AREA CODE 217) [illegible]

IN REPLY REFER TO:

April 22, 1974

Mr. Ralph O. Fisher
Projects Task Force
Department of Conservation
605 State Office Building
Springfield, IL 62706

Dear Mr. Fisher:

RE: Byron Nuclear Power Station

The Department of Public Health has evaluated the radiological impact of the proposed Byron Nuclear Power Station as presented in the United States Atomic Energy Commission <u>Draft Environmental Statement</u> dated February, 1974. The following actions are requested:

1. Obtain at least one year of actual on-site meteorological data, and if found to be significantly different from the Rockford Airport and Quad Cities Station data, which was used, revise the calculated doses from the dispersion of radioactive gases accordingly. Since Rockford Airport is located in the Rock River Valley, the wind patterns measured at that location are not considered representative of the Byron Site. The Quad Cities Station is some 70 miles to the southwest of the Byron Site, and also may not be representative. Although the dose estimates presented may actually be conservative, at least a year of actual on-site data is considered essential.

2. Assure precise operational in-plant monitoring of all radioactive material discharges to permit accurate calculations of radiation dose to the public. The calculated whole body radiation dose to an individual at the site boundary in the direction of the prevailing wind during normal plant operation is 0.7 milliRem, approximately 1% of the natural background dose. Dosages of such low magnitude are quite difficult to measure with normal monitoring equipment. Therefore, we must rely on calculations, based on accurate radioactive material discharge and meteorological data, to determine the radiation dose to the public.

The preliminary data and calculations for the Byron Nuclear Power Station indicate that all radiation doses to the public will be well below all State and Federal Regulations.

Very truly yours,

Leroy E. Stratton

Leroy E. Stratton
Asst. State Sanitary Engineer
Dept. Member-Projects Task Force

Regulatory Docket File

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

MAY 3 1974

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

Dear Mr. Muller:

This is in response to your letter dated February 27, 1974, requesting comments on the AEC Draft Environmental Statement related to the proposed issuance of construction permits to the Commonwealth Edison Company (Applicant) for the construction of the Byron Station, Units 1 and 2 (Docket Nos. STN 50-454 and STN 50-455). The proposed 1,120-megawatt Units 1 and 2 are scheduled for commercial service in June 1979 and March 1980, respectively. The proposed 900-acre site is in a rural area near Byron, in Rockvale Township, Ogle County, Illinois.

These comments by the Federal Power Commission's Bureau of Power staff are made in compliance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality, and are directed to the need for the capacity represented by the Byron Station, and to related bulk power supply matters.

In preparing these comments, the Bureau of Power staff has considered the AEC Draft Environmental Statement; the Applicant's Environmental Report and supplements thereto; related reports made in accordance with the Commission's Statement of Reliability and Adequacy of Electric Service (Docket No. R-362); and the staff's analysis of these documents, together with related information from other FPC reports. The staff generally bases its evaluation of the need for a specific bulk power facility upon long-term considerations as well as upon the load-supply situation for the peak load period immediately following the availability of the new facility. The useful life of each of the Byron Station generating units is expected to be 30 years or more; and during that period, each unit will make a significant contribution to the reliability and adequacy of electric power supply in the Applicant's service area.

4097

Mr. Daniel R. Muller

The Applicant is a member of the Mid-America Interpool Network (MAIN). MAIN coordinates the planning of the members' bulk power facilities serving the area which includes portions of Wisconsin, Upper Michigan, Illinois and Missouri. The Applicant's system is interconnected with adjoining utility systems of the MAIN region and adjoining regions, thereby providing for intra- and inter-regional power exchanges and operating contingency support.

The MAIN systems, including the Applicant, generally include in their consideration of the projected load-supply scheme several factors used by electric utility system planners, such as the probability of loss of load because of the unavailability of generation. The physical characteristics of the subject systems for the time period involved have generally produced calculated projected reserve generating margins of a magnitude toward the lower portion of the 15 to 25 percent range observed by the staff as prevailing throughout a major portion of the industry.

The following tabulations show the projected capabilities, loads and reserve margins for the summer-peaking Applicant's and MAIN systems for the 1979 and 1980 summer peak periods and the effect of the capacity of the proposed Byron units on the reserve margins of these systems.

Mr. Daniel R. Muller

1979 SUMMER PEAK LOAD-SUPPLY SITUATION[1/]

	Applicant's System	MAIN Systems
With Byron Unit 1 (1,120 megawatts)		
Total Capability-Megawatts	22,577	52,001
Load Responsibility-Megawatts	19,760	44,961
Reserve Margin-Megawatts	2,817	7,040
Reserve Margin-Percent of Peak Load	14.3	15.7
Applicant's Desired Reserve Margin (Based on 14 Percent of Peak Load)-Megawatts	2,766	6,295
Reserve Deficiency-Megawatts	-	-
Without Byron Unit 1		
Reserve Margin-Megawatts	1,697	5,920
Reserve Margin-Percent of Peak Load	8.6	13.2
Applicant's Desired Reserve Margin (Based on 14 Percent of Peak Load)-Megawatts	2,766	6,295
Reserve Deficiency-Megawatts	1,069	375

1/ Data source: MAIN report submitted in response to FPC Docket No. R-362 dated April 1, 1974.

Mr. Daniel R. Muller

1980 SUMMER PEAK LOAD-SUPPLY SITUATION[1/]

	Applicant's System	MAIN Systems
With Byron Units 1 and 2 (2,240 megawatts)		
Total Capability-Megawatts	24,787	57,939
Load Responsibility-Megawatts	21,210	48,110
Reserve Margin-Megawatts	3,577	9,829
Reserve Margin-Percent of Peak Load	16.9	20.4
Applicant's Desired Reserve Margin (Based on 14 Percent of Peak Load)-Megawatts	2,969	6,735
Reserve Deficiency-Megawatts	-	-
Without Byron Units 1 and 2		
Reserve Margin-Megawatts	1,337	7,589
Reserve Margin-Percent of Peak Load	6.3	15.8
Applicant's Desired Reserve Margin (Based on 14 Percent of Peak Load)-Megawatts	2,969	6,735
Reserve Deficiency-Megawatts	1,632	-

1/ Data Source: MAIN report submitted in response to FPC Docket No. R-362 dated April 1, 1974.

Mr. Daniel R. Muller

Based on above data, it is noted that if the 1,120-megawatt Byron Units 1 and 2 were not available on schedule, the Applicant's reserve margin would be reduced from the planned 14.3 percent to 8.6 percent of the 1979 summer peak load, and from the planned 16.9 percent to 6.3 percent of the 1980 summer peak load. Hence, reserve margins on the Applicant's system would not meet its stated criterion of 14 percent of the 1979 and 1980 summer peak loads. If the units should not be available on schedule, the reserve margins for the MAIN systems would be reduced from the planned 15.7 percent to 13.2 percent of the 1979 summer peak load and from the planned 20.4 percent to 15.8 percent of the 1980 summer peak load. Delay in the commercial operation of other new capacity could reduce the Applicant's and MAIN's projected margins below levels sufficient to withstand contingencies that experience has shown to occur on interconnected electric bulk power systems.

The Bureau of Power staff concludes that additional capacity equivalent to that represented by the proposed Byron Units 1 and 2 is necessary to provide the level of reserve capacity the Applicant's criterion requires to meet normally encountered contingencies.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

RECEIVED MAY 14 1974

MAY 13 1974

In reply refer to:
PEP ER 74/298

50-454/455
50-456/457

Dear Mr. Muller:

Thank you for your letter of February 27, 1974, transmitting copies of the Atomic Energy Commission's draft environmental statement for Byron Station, Units 1 and 2, Ogle County; and Supplement III to the applicant's environmental report for Units 1 and 2, Byron and Braidwood Stations, Ogle and Will Counties, Illinois.

Our comments are presented according to the format of the statement or according to subject.

BYRON STATION

Summary and Conclusions

Paragraph i states that the maximum loss of aquatic organisms due to entrainment in the circulating water system is expected to be 2 percent. According to the low-flow data presented in the statement, the "one-day low-flow of record for the Rock River is 400 cfs. Assuming that the loss of planktonic organisms is proportional to the ratio of intake flow (92 cfs) to river flow, we suggest the maximum loss would be closer to 20 percent.

We suggest that review of the draft and final statements by the Illinois Department of Conservation would be appropriate.

Location of the Station

On page 2-1, the draft statement indicates, "There are no plans for development of the site for recreational or other public usage, as most of the site will be required for the exclusion area." This statement implies that public recreation use of lands within the exclusion area is prohibited by AEC regulation or other form of guidance. We do not believe this to be AEC's position. The AEC definition of exclusion area (10 CFR 100.3(a)) leads us to the view that compatible land usage at nuclear power plant sites, for example, outdoor recreation, is not precluded, provided the applicant has an

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approved plan for, and method of, controlling use and expeditiously evacuating users in the event of an emergency. In fact, the definition states, in part, "Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result." Thus, it appears to us that this applicant's decision to not allow public recreation, but rather to encourage unused portions of its total landholding to revert "to a natural state" is one of expediency and convenience. This should be clarified in the final statement.

While we do not challenge the landowner's basic right to exclude public use, we would point out that the voluntary provision of outdoor recreation opportunities by the applicant possibly under a partnership arrangement with a unit of local or State government could be to the applicant's benefit in terms of its relationships with the public-at-large, especially at the local level.

Historic and Natural Landmarks

The proposal does not appear to have potential for adverse effect upon any established or studied unit of the National Park System, nor upon any national landmark,

The discussion in the draft statement on pages 2-7 and 2-11 suggests consideration of National Register properties. However, the extent of the investigation of possible impact is not clear. The final statement should contain evidence of examination of the National Register of Historic Places and consultation with the State Historic Preservation Officer, Director, Department of Conservation, 102 State Office Building, 400 South Spring Street, Springfield, Illinois 62706, with respect to sites on or eligible for nomination to the National Register of Historic Places.

The discussion on page 2-11 reflects adequate archeological survey of the project area; however, the final statement should reflect more specifically how the recommendations are to be implemented.

Much of the valuable data essential to interpretation of the recommended test excavations must be recorded in the field by a trained individual. The draft statement could imply that only artifacts recovered by untrained excavators will be presented to an expert consultant for evaluation. The final statement should reflect the arrangements made for a level of professional assistance in the testing, comparable to that secured for the survey. Also, should such consultation and testing define adverse impact on cultural resources, the final statement should detail plans for (1) preservation through redesign of the project or (2) mitigation through professional salvage excavation. All sources for historic and archéological information should be thoroughly referenced in the final statement.

The reference at the top of page 2-11 in the draft statement erroneously identifies the John Deere Shop and Home at Grand Detour as a national historic site. The site is, in fact, listed on the National Register of Historic Places, but it is not a unit of the National Park System as the title in the text suggests.

Geology

The sections on geology in the draft statement and Supplement 3, are not wholly adequate for an independent assessment of the geologic environment relevant to the design, construction, and operation of Units 1 and 2. For example, it is stated that the applicant was allowed to complete rock grouting of a 3.7-acre area but the relation of this work to the geologic conditions has not been discussed in the draft statement.

The presence of solution cavities in the Ordovician rocks beneath the plant site has not been mentioned in the draft statement, but it is stated in Supplement No. 3 that "the formations within the Galena and Platteville Groups have been subjected to solution activity which has occurred both along bedding planes and along major joints." These are the uppermost rocks at the site and the major structures would evidently be founded on them. It seems probable that the rock grouting is largely for the purpose of filling solution cavities and enlarged joints beneath the site and that this work is intended to mitigate any environmental impact related to these features. However, we believe that the environmental statement should provide a description of the scope and purpose of the proposed work, its status or success at the present time, and its relation to potential environmental impacts of the construction and operation of Units 1 and 2.

It is also stated in Supplement 3 on page 2.4-9 that "occasional small sinkholes are developed" in the Dunleith formation of the Ordovician Galena Group and figure 2.8 in the draft statement indicates that this is the uppermost rock formation at the site. It is also stated "that the Galena-Platteville aquifer is not interconnected with the Ancell aquifer and no solution activity should therefore be expected below the top of the Glenwood Formation."

The relation of the sinkholes to the intake and discharge pipelines should be explained, but we can find no mention of sinkholes in the draft statement. Information should be provided for the location of the sinkholes, as the existing topographic maps, figs. 2.3 and 2.7, appear to be of a scale too small to reveal these features. Information should also be provided on the way in which the plant and its facilities, including intake and discharge pipelines, have been designed to accommodate the geologic environment, including any sinkholes, solution cavities, and other natural features.

The staff philosophy, as expressed on page 1-2 of the draft statement, appears to be that natural conditions having a potential effect on the plant have been adequately analyzed in the safety evaluation and have been considered fully in other documents, whereas the environmental statement should be concerned with the effect of the plant on the environment. Apparently in accord with this philosophy, the environmental statement for the Byron Station contains no discussion of seismology of the site, the words "earthquake" and "ground acceleration" are apparently not mentioned in the statement, and no information is provided on ways in which the plant and its facilities have been designed to accommodate geologic and seismic environments. However, the "effects of the environment on the plant" could include plant accidents resulting from a failure of foundations or from the earth movement or shaking induced by an earthquake. Because of the potential direct effects of an accident on the human environment, we believe discussion of these matters is essential in an environmental statement. In addition, assurances should be provided that geology and seismology of the Byron Station have been taken into account, as prescribed in AEC's "Seismic and Geologic Siting Criteria for Nuclear Power Plants" (10 CFR 100, Appendix A, Federal Register, Vol. 36, no. 228, Nov. 25, 1971).

Aquatic Ecology

This section has no information about fishery resources of the Rock River. Since the Environmental Report contains the results of the applicant's fisheries surveys, this information should appropriately be discussed and summarized in the draft statement. A discussion of river bottom types in relation to fish spawning habitat should also be included in the discussion.

Chemical and Biocide Releases

In view of the recognized detrimental environmental impacts of chlorine on the aquatic environment, its use should be minimized. We support the staff recommendation that mechanical cleaning of condenser tubes should be used. Overall discharge of chlorine should be held to a minimum by utilizing available technology such as retention ponds, storage of blowdown, chemical scavengers and varied treatment for different plant subsystems in such a manner that water with sufficient biocide demand may be mixed with the treated water before discharge.

On-Site Construction

At the bottom of page 4-1, it is stated, "The applicant states that upon completion of construction the unused land will be returned to a natural state. The applicant should take whatever steps are necessary to assure the best use of the spare land during the existence of the Byron plant." We suggest it is appropriate to raise the question of what is the "best use" at this site. The applicant has apparently made a determination that no use is best use. We believe no use may not be the best use. Admittedly, there are not enough facts presented in the draft statement to fully support either conclusion. In any event, "best use" can be determined only after careful study and planning. To that end, we urge that the applicant initiate a land use planning effort for its entire site. In consultation with the Illinois Department of Conservation, the plan should address, among other things, all land uses compatible with the site's primary purpose including outdoor recreation, and vegetative planting or management programs for wildlife. This matter should also be addressed in the final statement.

This section also states that present methods of farming are not conducive to the maintenance of wildlife populations. We disagree. Croplands provide cover and food for wildlife and should be classified as wildlife habitat. Important game species such as bobwhite quail and ring-necked pheasant would be adversely affected by the loss of cropland habitat. Without

proper wildlife management practices, including hunting, the unused portions of the site will not necessarily support increased populations of some game species.

Transmission Line Construction

It is stated that the applicant intends to use herbicides to aid in clearing operations. As the staff properly cites, the Department of the Interior has prohibited the use of 2,4,5-T on lands under its control and has also prohibited its use in any program it funds since 1970. Although hand or mechanical clearing methods cost more, impacts on the environment are less severe. Therefore, we recommend the applicant use mechanical clearing methods which would eliminate the need for herbicides.

Impacts on Water Use

Under provisions of the Fish and Wildlife Coordination Act (48 Stat., 401, as amended; 16 U.S.C. 661 et seq.), the applicant is also required to consider recommendations of the Bureau of Sport Fisheries and Wildlife during construction of facilities for intake and discharge structures. The intake structure should therefore be constructed to minimize any adverse environmental impacts as required by Section 316(b) of the Federal Water Pollution Control Act Amendments of 1972.

Ecological Effects

We concur with the staff determination that Woodland Creek be classified as General Use Waters and discharges to it be limited accordingly.

Effects due to Withdrawal of Water for Cooling

This section states that the maximum loss of planktonic organisms will be 2 percent. This should be changed to 20 percent.

With regard to impingement of fishes, the fish collection program for travelling screens should be described either in this section or in Section 6. We recommend that the sampling program include daily collection of data on the number, length (to 1/2 inch), weight to 0.1 pound for each species impinged on the travelling screens. These data should be forwarded monthly to the Illinois Department of Conservation.

Thermal Discharges

The presentation by the staff of heated plume areas to the nearest thousandth of an acre raises a question as to the credibility of this assessment, and should be changed.

Effects of the Thermal Discharge on Aquatic Organisms

The environmental report implies that early gonadal development induced by water temperatures over 60 F is possible but spawning will not occur because fish will have to leave the outfall area to find suitable spawning habitat, thus bringing them into cooler water which inhibits spawning. We agree this could be a problem, and as such, should be pointed out in the draft statement. Data supporting the applicant's contention that spawning habitat does not occur in the vicinity of the outfall and on fish spawning behavior should be presented in the final statement.

Aquatic Program

The exclusive use of shoreline seining and electro-fishing would tend to bias fish collections in favor of certain species. A discussion of sampling bias on the "relative abundance" of fish near the station would be desirable. We recommend expanding the pre-operational fish sampling program to include a greater variety of fishing gear types. In view of the above and the inadequate larval fish studies mentioned earlier, we cannot support the staff view that an adequate base-line survey has been carried out.

Operational Monitoring Programs

The operational monitoring programs for larval fish entrainment, fish impingement and general larval-adult fish surveys should be expanded to provide more intensive monitoring studies.

Radiological Accidents

Discussion of accident probabilities is purely qualitative, but a quantitative assessment of risks is now under study. We recommend that the environmental effects of the most serious accident, class 9, should be evaluated, despite its low probability. The results of the study should be summarized in the environmental statement.

Radioactive Wastes

The staff estimates that solid radioactive wastes from each reactor would include annually about 1,050 drums having a total activity of about 7,200 Ci, to be shipped offsite to an unspecified licensed burial site. These wastes are described as spent demineralizer resins, filter sludges, evaporator bottoms, reverse osmosis concentrates, chemical drain tank effluents, ventilation air filters, contaminated clothing and paper, and miscellaneous items such as tools and laboratory glassware. It is stated that "more than 90 percent of the radioactivity associated with the solid waste will be long-lived fission and corrosion products, principally Cs-134, Cs-137, Co-58, Co-60, and Fe-55" (p. 3-23). It would be advisable to identify the planned burial site and to discuss licensing provisions that relate to: (1) its hydrogeologic suitability to isolate wastes of the Byron Station from the biosphere; (2) surveillance and monitoring of the site; and (3) any remedial or regulatory actions needed while the wastes remain hazardous.

BRAIDWOOD STATION - Supplement III

Supplement No. 3 partially addresses only one of the questions raised in December 10, 1973 review. The applicant mentions seepage computations for the dike and slurry system but supplies no results, models or data from such efforts. This information should be provided.

We hope these comments will be helpful to you.

Sincerely yours,

Royston C. Hughes

[redacted] Secretary of the Interior

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

STN-50-454
STN-50-455

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Regulatory Docket File

5 JUN 1974

RECEIVED JUN 5 1974 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 completed the review of the Draft Environmental Impact Statement (EIS) for the proposed Byron Nuclear Power Station and our detailed comments are enclosed.

Our major concerns after reviewing the EIS are the hazards of the thyroid dose rate exceeding the guides in the proposed Appendix I, Docket RM 50-2, the need to develop a radioiodine monitoring program consistent with Regulatory Guide 1.42 and impacts upon the Rock River from blowdown discharges during certain times of the year.

In light of our review of this draft EIS and in accordance with EPA procedure, we have classified our comments on this project as "ER" (Environmental Reservations) and rated the draft statement as Category 2. If you or your staff have any questions concerning our classification or comments, we will be pleased to discuss them with you.

Sincerely yours,

Rebecca W. Hanmer

for Sheldon Meyers
Director
Office of Federal Activities

DOCKETED USAEC JUN 5 1974 REGULATORY MAIL SECTION DOCKET CLERK

5001

EIS# D-AEC-06127-IL

ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

JUNE 1974

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Byron Station, Units 1 and 2

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency has reviewed the Draft Environmental Impact Statement prepared by the U.S. Atomic Energy Commission in conjunction with the application by the Commonwealth Edison Company for a construction permit for the Byron Nuclear Power Station Units 1 and 2. Units 1 and 2 will employ identical pressurized water reactors, each rated at 3425 megawatts thermal with a net output of 1120 megawatts thermal. Condenser cooling will be accomplished using natural draft cooling towers in a closed-cycle system with make-up water being obtained from the Rock River. Our major concerns for this plant located in Ogle County, Illinois, on the Rock River follow:

1. With the exception of gaseous radioiodine releases, the proposed gaseous and liquid waste treatment systems are expected to be capable of limiting radionuclide releases and, therefore, the related offsite doses, to levels within the guidance of the proposed Appendix I to CFR Part 50.

2. Based on EPA's independent analysis, the thyroid dose of 21 mrem/yr from radioiodine via the cow-milk-child pathway at the nearest farm (first real cow) exceeds the guides in the proposed Appendix I, as given in the concluding statement for Regulatory Docket RM-50-2. (Ref.1)

3. The applicant should develop a radioiodine monitoring program consistent with Regulatory Guide 1.42, which should also include periodic checks as to the location of the nearest cow, in order to assure that the real doses are maintained within the provisions of applicable regulatory limits and guides throughout the lifetime of the plant.

4. The applicant will have to meet the effluent limitations proposed in the March 4, 1974, Federal Register for steam-electric generating plants for power plants where construction is completed after July 1, 1977.

5. Because of the recorded high concentrations of dissolved and suspended solids and the large difference between the ambient river temperature and blowdown discharge temperature, we believe there is a potential for violation of water quality standards.

RADIOLOGICAL ASPECTS

Radioactive Waste Treatment

The proposed gaseous and liquid waste systems are representative of "state-of-the-art" effluent control technology. As a consequence, the quantities and concentrations of radionuclides expected to be released from Byron Station will meet the "as low as practicable" design objectives as defined by the proposed Appendix I to 10 CFR Part 50 except for doses to a child's thyroid, which may exceed the guide values. This is discussed in more detail below.

Sixty percent of the radioiodine estimated to be released from the plant is calculated to be from the turbine building ventilation system. This release pathway is not specifically treated for radioiodine removal, but could be reduced, if the measured thyroid doses exceed the Regulatory Guide 1.42 level. This could be accomplished by plugging steam generator tube leaks, locating and reducing turbine building steam leakage, increasing steam generator blowdown rate, or replacing defective fuel.

Dose Assessment

The calculated doses to individual receptors from radionuclides assumed to be discharged from Byron Station are within the Regulatory design basis objectives given in the proposed Appendix I, except for the potential thyroid dose. The estimated thyroid dose equivalent rate (21 mrem/yr due to milk ingestion) to the most critical individual (an infant) due to the emission of radioiodine and subsequent transport to man through an existing pathway (nearest farm--1040m ENE) indicates that the guidance in the proposed Appendix I may be exceeded. Furthermore, larger thyroid doses than at the nearest farm may be expected at several potential pastures nearer the plant than the nearest farm. The AEC, in its analysis of the plant, calculated a dose of 8.6 mrem/yr. The method of analysis used was the HERMES code (Ref. 2) and not the method described in the interim Regulatory Guide 1.42 or the proposed Regulatory Guide 1.AA, recently commented on by the EPA (Ref. 3). The pertinent pathway transport parameters and internal dose parameters from the HERMES code that were utilized

for the iodine pathway analysis should be presented in the final statement so that an independent evaluation of the iodine pathway dose model can be made. It should be noted that the HERMES code computes a milk ingestion dose to a four year old child rather than to a one year old infant, who is the critical receptor for the milk ingestion pathway. The HERMES internal dose factor (mrem/yr per pCi/yr ingested) for a four year old is approximately 2.3 times lower than that for the critical receptor. Other pathway transport parameters, such as the vegetation specific (or surface specific) deposition velocity and the transfer coefficient for ratio of milk concentration to aerial (or grass) concentration, should be presented so an assessment can be made of the overall dose conversion factor (mrem/yr per Ci/cc in air) in the HERMES code.

In order to provide some verification that the thyroid doses are maintained within the provisions of the proposed Appendix I during plant operation, the applicant should be required to develop an environmental monitoring program for radioiodine which will be capable of demonstrating compliance with the 15 mrem/yr design objective. Furthermore, the applicant should include a periodic audit of the location of the nearest lactating cow so that the critical pathway will be known throughout the plant lifetime.

The EPA expects that the results from current and planned joint EPA-AEC and industry cooperative field studies in the environs of operating nuclear power facilities will greatly increase knowledge of the processes and mechanisms involved in the exposure of man to radiation produced through the use of nuclear power. We believe that, overall, the cumulative assumptions utilized to estimate various human doses are conservative. As more information is developed, the models used to estimate human exposures will be modified to reflect the best data and most realistic situations possible. Based on the results of these cooperative studies, it is possible that the scope and extent of present environmental monitoring programs may be relaxed.

TRANSPORTATION

EPA, in its earlier reviews of the environmental impact of transportation of radioactive material, agreed with the AEC that many aspects of this program could best be treated on a generic basis. The generic approach has reached the point where on February 5, 1973, the AEC published for comment in the Federal Register a rulemaking proposal concerning the "Environmental Effects of Transportation of Fuel and Waste from Nuclear Power Reactors." EPA commented on the proposed rulemaking by a letter to the AEC, dated March 22, 1973, and by an appearance at the public hearing on April 2, 1973.

Until such time as a generic rule is established, EPA is continuing to assess the adequacy of the quantitative estimates of environmental radiation impact resulting from transportation of radioactive materials provided in environmental statements. The estimates provided for this station are deemed adequate on currently available information.

Reactor Accidents

EPA has examined the AEC analysis of accidents and their potential risks which the AEC has developed in the course of its engineering evaluation of reactor safety in the design of nuclear plants. Since these accident issues are common to all nuclear power plants of a given type, EPA concurs with the AEC's approach to evaluate the environmental risk for each accident class on a generic basis. The AEC has in the past and still continues to devote extensive efforts to assure safety through plant design and accident analyses in the licensing process on a case-by-case basis. EPA, however, favors the additional step now being undertaken by the AEC of a thorough analysis on a more quantitative basis of the risk of potential accidents in all ranges. We continue to encourage this effort and urge the AEC to press forward to its timely completion and publication. EPA believes this will result in a better understanding of the possible risks to the environment.

We are pleased to note in the draft statement the discussion of the Reactor Safety Study and the commitment for timely public presentation of its results. If the AEC's efforts indicate that unwarranted risks are being taken at the Byron Station, we are confident that the AEC will assume appropriate corrective action. Similarly, if EPA efforts related to the accident area uncover any environmentally unacceptable conditions related to the safety of the Byron Station, we will make our views known.

NON-RADIOLOGICAL ASPECTS

The proposed Byron Station Units 1 and 2 will utilize two identical pressurized-water reactors, each rated at 3425 megawatts thermal (MWt). Waste heat will be removed by a closed-cycle cooling system incorporating two natural-draft cooling towers. Make-up water will be obtained from the Rock River at a rate varying between 78 and 117 cubic feet per second (cfs).

Thermal Aspects and Cooling-System Design

Section 301 of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA) stipulates that effluent limitations for various point sources discharging into navigable waters shall require the application of "Best Practicable Control Technology Currently Available" no later than July 1, 1977, and "Best Available Technology Economically Achievable" no later than July 1, 1983. The levels of technology corresponding to these terms were defined in EPA's proposed effluent limitations guidelines and standards for the steam electric power plant category of point source. These were published on March 4, 1974, and, with respect to thermal releases, call for "...no discharge of heat from... large base load unit[s]...except that heat may be discharged in [cold-side] blowdown from recirculating cooling water systems...." The proposed cooling system for the Byron Station appears to be in compliance with these requirements.

It should be noted, however, that under Section 303(a) of the FWPCA, portions of the federally approved water quality standards for the State of Illinois were revised. For example, the standards were amended on January 31, 1974, to include a requirement that mixing zones be limited in size to 25% of the cross-sectional area or volume of flow of the receiving streams. In this regard, the final statement should indicate the size of the discharge plume expected under varying conditions of flow in Rock River and indicate the means by which the revised thermal standards will be met.

With regard to the above, of particular concern to EPA are those periods when Rock River exhibits high concentrations of dissolved and suspended solids in conjunction with low ambient water temperatures. During

high concentration periods, which have been recorded in the river near the plant site, it appears it may be necessary to discharge increased amounts of blowdown in order to keep solids concentrations within the cooling system at acceptable levels. If this occurs when there is a large difference between the temperature of the recirculating cooling water and the temperature of the water in the Rock River, there is, in our opinion, a potential for violation of the Illinois thermal standards. Comparing information contained in the draft statement and the known temperature regime of the river indicates that blowdown temperatures could exceed the ambeint river temperatures by as much as 48°F. This would be equivalent in thermal effect to operating a typical 200 megawatt plant with a once-through cooling system at the Byron site. Such factors will be considered by EPA prior to issuance of a permit under the National Pollutant Discharge Elimination System (Section 402 of the FWPCA). Compliance with applicable water quality standards will be a requirement of the permit for the Byron Station Units 1 and 2 and, should the plant systems and projected operating procedures not be sufficient to assure that thermal standards will be met, additional cooling may be required. For example, small induced-draft towers such as those utilized at the Three Mile Island nuclear plant or a blowdown receiving pond are possibilities.

It should be noted that Section 316(a) of the FWPCA can provide relief to the applicant from the thermal effluent limitations that could be imposed under Section 301 (e.g., an NPDES permit condition for supplemental cooling if, in fact, required). However, such relief can be granted only if the applicant can demonstrate to the satisfaction of the Administrator of EPA (or, if appropriate, the State) that the imposed limitations are "...more stringent than necessary to assure the pro[t]ection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife in and on the body of water into which the discharge is to be made...."

Biological and Chemical Effects

The AEC staff indicates that the expected background (normal) impingement rate of dead and diseased fish at the makeup water intake is at least 25 fish per 24 hours. This projection is not supported in the draft statement. In addition, no mention is made regarding the possibility of returning viable organisms (primarily fish) collected on the intake screens to the Rock River at a point away from the intake. All such factors will be considered by EPA in determining compliance with Section 316(b) of the FWPCA. This section stipulates that the "...location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact." This requirement applies to all plants regardless of cooling system design.

The AEC staff has predicted some plankton losses due to entrainment in the cooling water intake and from direct interaction with the thermal plume during low flow conditions. Under 7-day once-in-ten-year low flow conditions we anticipate greater losses of plankton and recommend that impacts on aquatic biota during such periods be discussed in the final statement.

On page 3-24 of the draft statement the chlorination of various cooling water flows is discussed. In our opinion, in order to minimize the effects of residual chlorine discharges, each cooling water flow (i.e., condenser cooling water, essential service water, and non-essential service water) should be chlorinated at different times to get the maximum benefit of the dilution of other flows. We recommend that the plant systems be designed to accommodate this type of chlorination procedure and that proposed design and operational changes be discussed in the final statement.

ADDITIONAL COMMENTS

During the review, we noted in certain instances that the draft statement does not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Byron Station. The cumulative importance, 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. On page 5-13 of the draft statement, the AEC states that "Radiation doses calculated by the staff are intended to apply to an average adult." The EPA believes that the most critical individual should be considered when making dose estimates. If this approach is not taken, applicable standards or guides may be exceeded.

2. The draft statement indicates (page 4-3) that the applicant planned to use herbicides 2, 4, 5-T; 2-4-D; Dibar; and Ural to aid in the clearing operations for transmission lines. We concur with the AEC staff recommendations for the use of these herbicides; however, to fully assess the impact of this program, an estimate of the total land area and some details involved in clearing, reseeding, and herbicide control should be provided in the final statement. Current registered uses of 2,4,5-T (especially spot hand spraying and application) do not appear to present environmental problems. However, an experienced licensed commercial pesticide applicator in Illinois should apply the herbicide.

3. With regard to chemical wastes, the design should include provisions for sampling of each stream identified in Figure 3-2, including: radwaste system discharge, sanitary system discharge, neutralizing tank discharge, and cooling tower blowdowns. The details of such design provisions should be included in the final statement.

4. On page 8-14, the draft statement mentions there will be ten fossil-fired units retired with the completion of this project. The units, locations and dates of retirement should be included in the final environmental statement.

5. A discussion of the methods to be used to prevent all construction runoff and miscellaneous discharges from entering Woodland Creek should be included in the final statement.

6. The final statement should include a discussion of the handling and disposal of sludges resulting from the treatment of sanitary sewage.

7. In Table 5.5, the State standards for BOD and suspended solids are represented as maximums. These are average values. The final statement should rectify this discrepancy.

8. On page 5-16 of the draft statement, the AEC staff states that there will be no treatment of the off-gases from the main condenser vacuum pump. This statement is confirmed by Figure 3.7 on page 3-18 and applicant's Environmental Report. But on page 3-20, a DF of 10 for charcoal adsorbers is assumed for air ejector offgases. This discrepancy should be explained in the final statement.

9. The draft statement mentions on page 3-16 that the steam generator blowdown treatment system heat exchangers are degassed. This source term should be included in Table 3.3 on page 3-22 when put in the final statement.

References

1. Concluding Statement of Position of the Regulatory Staff, U.S. Atomic Energy Commission Docket No. RM-50-2, February 20, 1974.

2. J. F. Fletcher and W. L. Dofson "HERMES--a Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry," Hanford Engineering Development Laboratory, Report HEDL-TME-71-168, December 1971.

3. Letter from Dr. William A. Mills, Acting Deputy Assistant Administrator for Radiation Programs, to Mr. L. Manning Muntzing, Director of Regulations, U.S. Atomic Energy Commission, dated March 21, 1974.

APPENDIX B.

Regulatory File Cy.

STATE OF ILLINOIS
DEPARTMENT OF CONSERVATION
SPRINGFIELD 62706

RECEIVED FEB 15 1974 U.S. ATOMIC ENERGY COMMISSION Mail Section

DOCKETED USAEC FEB 15 1974 REGULATORY MAIL SECTION DOCKET CLERK

Docket Nos.: STN 50-454, STN 50-455
STN 50-456, STN 50-457
STN 50-461, STN 50-462

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

Dear Mr. Muller:

The environmental reports prepared by Commonwealth Edison on Braidwood Station (Units 1 and 2, Will County) and Byron Station (Units 1 and 2, Ogle County) and Illinois Power Company's environmental report on the Clinton Power Station (Units 1 and 2, De Witt County) have been reviewed. This review was made to determine what effect, if any, undertaking the Byron, Braidwood, or Clinton projects would have on cultural and historical sites of significance within or adjacent to project work boundaries.

Archaeological studies conducted on the project sites by members of the Illinois Archaeological Survey for Illinois Power and Commonwealth Edison indicate the existence of archaeological sites within the boundaries of each of the three projects. Results of the archaeological surveys for each site should be included in the final environmental statements. The final statements should also indicate Commonwealth Edison's and Illinois Power's plans for archaeological salvage of the located sites and their plans for recording and salvage of archaeological sites which may be discovered during project construction.

It has been determined that, with the exception of the aforementioned archaeological sites, no cultural or historical sites of significance are located within the projects' boundaries. No National Register of

RECYCLED PAPER

Historic Places sites are found within the project boundaries of the Braidwood, Byron, or Clinton Power Stations.

Sincerely,

Anthony T. Dean
Director
State Historic Preservation Officer

ATD:gjf

cc. Mr. George Montet, Building 11A, Environmental Statement Projects, Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439

Mr. Charles Bareis, Illinois Archaeological Survey, 109 Davenport Hall, University of Illinois, Urbana, Illinois 61801

Mrs. Ann Webster Smith, Director, Office of Compliance, Advisory Council on Historic Preservation, Washington, D. C. 20240

APPENDIX C.

COST ESTIMATES FOR ALTERNATIVE BASE-LOAD GENERATION SYSTEMS

The staff elected to use a recently developed computer program to rough check the applicant's capital cost estimate for the Byron Nuclear Station and to estimate the costs for coal-fired and oil-fired alternative generation systems. This computer program, called CONCEPT[1-3] was developed as part of the program analysis activities of the AEC Division of Reactor Research and Development, and the work was performed in the Studies and Evaluations Program at the Oak Ridge National Laboratory. The code was designed primarily for use in examining average trends in costs, identifying important elements in the cost structure, determining sensitivity to technical and economic factors, and providing reasonable long-range projections of costs. Although cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates for specific projects, the code has been organized to facilitate modifications to the cost models so that costs may be tailored to a particular project. Use of the computer provides a rapid means of calculating future capital costs of a project with various assumed sets of economic and technical ground rules.

DESCRIPTION OF THE CONCEPT CODE

The procedures used in the CONCEPT code are based on the premise that any central station power plant involves approximately the same major cost components, regardless of location or date of initial operation. Therefore, if the trends of these major cost components can be established as a function of plant type and size, location, and interest and escalation rates, then a cost estimate for a reference case can be adjusted to fit the case of interest. The application of this approach requires a detailed "cost model" for each plant type at a reference condition and the determination of the cost trend relationships. The generation of these data has comprised a large effort in the development of the CONCEPT code. Detailed investment cost studies by an architect-engineering firm have provided basic cost model data for pressurized water reactor nuclear plants,[4] coal-fired plants,[5] and oil-fired plants.[6] These cost data have been revised to reflect plant design changes since the 1971 reference date of the initial estimates.

The cost model is based on a detailed cost estimate for a reference plant at a designated location and a specified date. This estimate includes a detailed breakdown of each cost account into costs for factory equipment, site materials, and site labor. A typical cost model consists of over a hundred individual cost accounts, each of which can be altered by input at the user's option. The AEC system of cost accounts[7] is used in CONCEPT.

To generate a cost estimate under specific conditions, the user specifies the following input: plant type and location, net capacity, beginning date for design and construction, date of commercial operation, length of construction workweek, and rate of interest during construction. If the specified plant size is different from the reference plant size, the direct cost for each two-digit account is adjusted by using scaling functions which define the cost as a function of plant size. This initial step gives an estimate of the direct costs for a plant of the specified type and size at the base date and location.

The code has access to cost index data files for 20 key cities in the United States. The data for Chicago were used for the Byron cost estimates. These files contain data on cost of materials and wage rates for 13 construction crafts as reported by trade publications over the past twelve years. These data are used to determine historical trends in escalation of site labor wages and material costs. If desired, the escalation trends can be based on only a selected portion of the available historical data. These trends may be projected into the future as an exponential function of time. The code also will allow adjustments of site labor productivity and escalation of manufactured equipment costs, but the trend data must be provided by the user.

This technique of separating the plant cost into individual components, applying appropriate scaling functions and location-dependent cost adjustments, and escalating to different dates is the heart of the computerized approach used in CONCEPT. The procedure is illustrated schematically in Fig. 1.

ESTIMATED CAPITAL COSTS

The assumptions used in the CONCEPT calculations are listed in Table 1. Tables 2 and 3 summarize the total plant capital investment estimates for the Byron Nuclear Station. As shown, calculations were made with different condenser cooling systems. The cost differentials with evaporative cooling towers are lower than some which have been quoted in the literature, but are thought to be realistic for new plant installations. Reduction in intake velocities from 2.0 feet per second to 0.5 fps has caused a large increase in cost of cooling water intake structures for once-through cooling. Also, reductions in allowable temperature rise through the condenser has increased the size and cost of condensers in once-through systems. Systems using closed-cycle cooling towers are not influenced significantly by the above ecological considerations. In closed-cycle systems, the temperature rise across the condenser is not limited. Also, the quantity of makeup water is small compared to once-through flows, so the intake structures have a lower cost. Thus, the reductions in intake structure and condenser cost partially offset the cost of the cooling towers.

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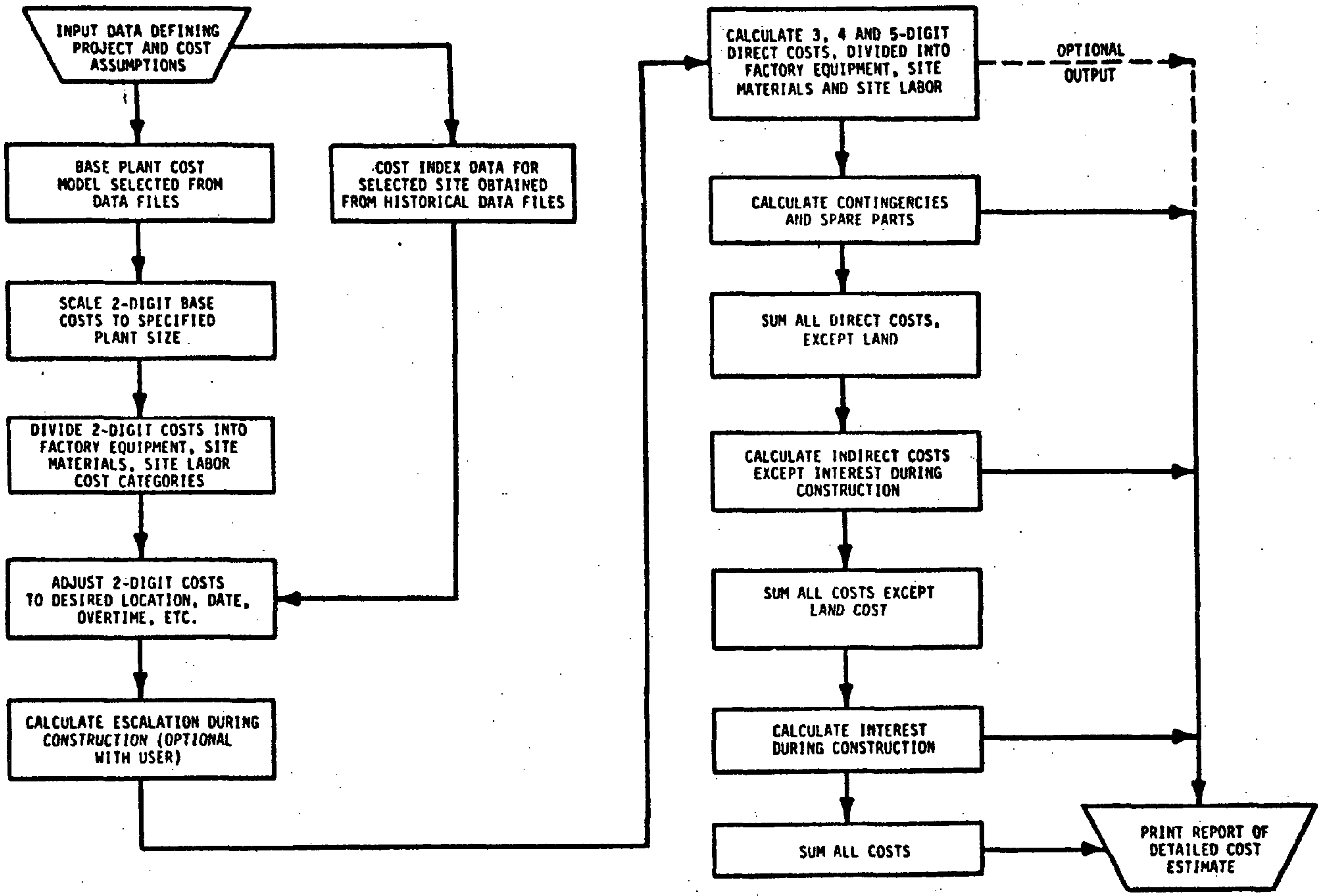

General Flow of Calculations in the CONCEPT Code

Fig. 1. Use of the CONCEPT Program for Estimating Capital Costs

Table 1. Assumptions Used in CONCEPT Calculations for the Byron Power Plant

Plant type	Two-unit PWR
Alternate plant types	Two-unit coal-fired and oil-fir
Unit size	1,120 MW(e)-net, each unit
Plant location	Chicago, Illinois area
Start of Construction date	
PWR NSSS ordered	April 1971
Fossil alternatives	May 1973
Commercial operation date	
Unit 1	May 1979
Unit 2	March 1980
Length of workweek	40 hours
Interest during construction	10%/year, compound
Escalation rates	
Site labor	12.5%/year
Site materials	6.0%/year
Purchased equipment	5.0%/year

Table 2. Plant Capital Investment Summary for a 2,240-MW(e) Pressurized Water Reactor Nuclear Power Plant Using Natural Draft Evaporative Cooling Towers (Commonwealth Edison Company, Byron Station)

	Unit 1	Unit 2	Total
Direct Costs (Millions of Dollars)			
Land and land rights	1.0	0	1.0
Physical plant			
Structures and site facilities	43.5	35.4	78.9
Reactor plant equipment	74.6	72.8	147.4
Turbine plant equipment	79.1	76.9	156.0
Electric plant equipment	26.0	22.4	48.4
Miscellaneous plant equipment	4.8	2.8	7.6
Subtotal (physical plant)	228.0	210.3	438.3
Spare parts allowance	1.5	1.4	2.9
Contingency allowance	15.5	13.9	29.4
Subtotal (total physical plant)	245.0	225.6	470.6
Indirect Costs (Millions of Dollars)			
Construction facilities, equipment and services	16.3	10.4	26.7
Engineering and construction management services	39.7	28.6	68.3
Other costs	12.7	8.8	21.5
Interest during construction	135.4	129.8	265.2
Total Costs			
Total plant capital cost at start of project			
Millions of dollars	450	403	853
Dollars per kilowatt	402	360	381
Escalation during construction	176	184	360
Total plant capital cost at commercial operation			
Millions of dollars	626	587	1213
Dollars per kilowatt	559	524	542

Table 3. Plant Capital Investment Summary for the Byron Nuclear Station, with Alternative Heat Rejection Systems

Heat Rejection System and Plant Net Capability, MW(e)	Nat. Draft Evap. Towers 2,240	Mech. Draft Evap. Towers 2,240	Once Through 2,286
Direct Costs (Millions of Dollars)			
Land and land rights	1	1	1
Physical plant			
Structures and site facilities	79	79	89
Reactor plant equipment	147	147	147
Turbine plant equipment	156	147	145
Electric plant equipment	48	49	48
Miscellaneous plant equipment	8	8	8
Subtotal (physical plant)	438	430	437
Spare parts allowance	3	3	3
Contingency allowance	29	29	29
Subtotal (total physical plant)	470	462	469
Indirect Costs (Millions of Dollars)			
Construction facilities, equipment and services	27	26	27
Engineering and construction management services	68	67	68
Other costs	22	21	21
Interest during construction	265	261	265
Total Costs			
Total plant capital cost at start of project			
Millions of dollars	853	838	851
Dollars per kilowatt	381	374	372
Escalation during construction	360	351	359
Total plant capital cost at commercial operation			
Millions of dollars	1,213	1,189	1,210
Dollars per kilowatt	542	531	529

Estimated costs for alternative fossil-fired plants are presented in Tables 4 and 5. The estimated costs for SO_2 removal equipment are based on a study performed by Oak Ridge National Laboratory.[8] The assumptions used in that study are summarized in Table 6.

As stated previously, the above cost estimates produced by the CONCEPT code are not intended as substitutes for detailed engineering cost estimates, but were prepared as a check on the applicant's estimate and to provide consistent estimates for the nuclear plant and fossil-fired alternatives.

Table 4. Total Plant Capital Investment Cost Estimated for a 2,240-MW(e) Coal-Fired Plant as an Alternative to the Byron Nuclear Station

	Without SO_2 Abatement System			With SO_2 Abatement System		
	Once Through Cooling	Natural Draft Towers	Mechanical Draft Towers	Once Through Cooling	Natural Draft Towers	Mechanical Draft Towers
Direct Costs (Millions of Dollars)						
Land and land rights						
Physical plant	1	1	1	1	1	1
Structures and site facilities	58	52	52	68	62	62
Boiler plant equipment	147	149	149	189	193	193
Turbine plant equipment	121	139	129	124	142	131
Electric plant equipment	28	28	29	39	40	41
Miscellaneous plant equipment	6	6	6	6	6	6
Subtotal (physical plant)	360	374	365	426	443	433
Spare parts allowance	2	2	2	3	3	3
Contingency allowance	25	26	25	29	30	30
Subtotal (total physical plant)	387	402	392	458	476	466
Indirect Costs (Millions of Dollars						
Construction facilities, equipment and services	20	21	20	35	36	35
Engineering and construction management services	32	33	33	38	39	38
Other costs	12	13	12	16	16	16
Interest during construction	174	179	176	214	220	216
Total Costs						
Total plant capital cost at start of project						
Millions of dollars	626	649	634	762	788	772
Dollars per kilowatt	279	290	283	340	352	345
Escalation during construction	164	172	166	199	208	202
Total plant capital cost at commercial operation						
Millions of dollars	790	821	800	961	996	974
Dollars per kilowatt	353	367	357	429	445	435

Table 5. Total Plant Capital Investment Cost Estimated for a 2,240-MW(e) Oil-Fired Plant as an Alternative to the Byron Nuclear Station

	Without SO_2 Abatement System			With SO_2 Abatement System		
	Once Through Cooling	Natural Draft Towers	Mechanical Draft Towers	Once Through Cooling	Natural Draft Towers	Mechanical Draft Towers
Direct Costs (Millions of Dollars)						
Land and land rights	1	1	1	1	1	1
Physical plant						
Structures and site facilities	52	46	46	63	56	56
Boiler plant equipment	129	131	131	155	158	158
Turbine plant equipment	121	138	128	123	141	131
Electric plant equipment	25	26	26	36	37	37
Miscellaneous plant equipment	6	6	6	6	6	6
Subtotal (physical plant)	333	347	337	383	398	388
Spare parts allowance	2	2	2	2	2	2
Contingency allowance	23	24	23	26	27	27
Subtotal (total physical plant)	358	373	362	411	427	417
Indirect Costs (Millions of Dollars						
Construction facilities, equipment and services	19	20	19	32	33	32
Engineering and construction management services	30	31	31	34	35	35
Other costs	11	12	12	14	15	15
Interest during construction	161	166	162	191	197	193
Total Costs						
Total plant capital cost at start of project						
Millions of dollars	580	603	587	683	708	693
Dollars per kilowatt	259	269	262	305	316	309
Escalation during construction	154	161	155	181	190	183
Total plant capital cost at commercial operation						
Millions of dollars	734	764	742	864	898	876
Dollars per kilowatt	328	341	331	386	401	391

Table 6. Basis for SO_2-Removal Equipment

Cost Estimate

Type of process	Wet scrubbing of flue gas by a limestone slurry	
Cost basis	Integrated installation in a new plant (no backfitting required)	
Fuel Composition (Design Values)	Coal-Fired	Oil-Fired
Sulfur content, % by weight	5	3
Ash content, % by weight	25	0.3
Energy value	10,000 BTU/lb	150,000 Btu/gal
Abatement level, % SO_2 removal (minimum)	76	80
Plant Operating Data		
Plant net output,* MW(e)		
Without SO_2 control	1,150	1,150
With SO_2 control	1,120	1,120
Assumed plant load factor	0.80	0.80
Annual fuel consumption	3,600,000 tons	11,730,000 barrels
Limestone used, tons/year	885,000	885,000
Sulfur removed, tons/year	138,000	82,000
Waste products, tons/year		
Slurry	1,000,000	1,000,000
Fly ash	800,000	0

*With once-through cooling

REFERENCES

1. *CONCEPT: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Status Report,* USAEC Report WASH-1180 (April 1971)

2. R. C. DeLozier, L. D. Reynolds, and H. I. Bowers, *CONCEPT: Computerized Conceptual Cost Estimates for Steam-Electric Power Plants — Phase I User's Manual,* USAEC Report ORNL-TM-3276, Oak Ridge National Laboratory, October 1971.

3. H. I. Bowers, R. C. DeLozier, L. D. Reynolds, and B. E. Srite, *CONCEPT-II: A Computer Code for Conceptual Cost Estimates of Steam-Electric Power Plants — Phase II User's Manual,* USAEC Report ORNL-4809, Oak Ridge National Laboratory, April 1973.

4. *1000-MWE Central Station Power Plant Investment Cost Study, Volume I, Pressurized Water Reactor Plant,* USAEC Report WASH-1230 (Vol. I), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

5. *1000-MWE Central Station Power Plant Investment Cost Study, Volume III, Coal-Fired Fossil Plant,* USAEC Report WASH-1230 (Vol. III), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

6. *1000-MWE Central Station Power Plant Investment Cost Study, Volume IV, Oil-Fired Fossil Plant,* USAEC Report WASH-1230 (Vol. IV), United Engineers and Constructors, Inc., Philadelphia, Pa., June 1972.

7. *Guide for Economic Evaluation of Nuclear Reactor Plant Designs,* USAEC Report NUS-531, NUS Corporation, January 1969.

8. M. L. Myers, *Cost Estimate for the Limestone—Wet Scrubbing Sulfur Oxide Control Process,* USAEC Report ORNL-TM-4142, Oak Ridge National Laboratory, July 1973.

APPENDIX D.

DISCUSSION AND FINDINGS BY THE DIRECTORATE OF LICENSING U. S. ATOMIC ENERGY COMMISSION RELATING TO AN APPLICATION FOR AN EXEMPTION FROM LICENSING FOR CERTAIN SITE PREPARATION ACTIVITIES AT THE BYRON STATION, UNITS 1 AND 2 PRIOR TO THE COMPLETION OF THE NEPA ENVIRONMENTAL REVIEW

AEC DOCKET NOS. STN 50-454 AND STN 50-455

JANUARY 11, 1974

1.0 INTRODUCTION

By letter dated December 17, 1973 the Commonwealth Edison Company (the applicant) made Application for Exemption to Allow Grouting Activities at Byron Station Prior to Issuance of Construction Permits, AEC Docket Nos. STN 50-454 and STN 50-455. The Environmental Report In Support of Exemption From Construction Permit attached to this letter provides the details of the work to be performed and provides analyses of the environmental factors required by 10 CFR 50.12(b).

The purpose of this report is to summarize the regulatory staff's determination and findings on the environmental impact of certain preconstruction permit activities at the Byron Station. We have based our study on the documents identified above and elsewhere in this report. Our study is limited to the environmental impact of the proposed exempted work and does not consider the long term environmental impact of the nuclear plant and the power it generates. Thus, we have not included an evaluation of possible alternatives for limiting the environmental impact of the Byron Station construction and operation, or the associated power transmission lines. This evaluation will be developed during the full National Environmental Policy Act (NEPA) review now in progress and presently scheduled for completion in March 1975. The purpose of the present study has been to balance the environmental impact of the proposed preconstruction activities against the monetary saving and other benefits which would be lost if initiation of the proposed work is delayed until the construction permit is issued.

For this period our evaluation considered the environmental impact of preconstruction activities, the foreclosure of alternatives of the type that might be required as a result of the full NEPA review, the redress of any adverse environmental effects and the possible foreclosure of the option of abandonment.

2.0 COMPLETION OF NEPA REVIEW

The ongoing NEPA environmental review for the Byron Station nuclear plant including all actions leading to issuance of a construction permit is estimated to be completed by March 1975. Should the environmental review not be completed by March 1975 and should the exemption not be granted, total plant construction costs for the facility would be increased.

We have taken these considerations into account in balancing the applicable environmental factors. We have concluded that, if a significantly longer time period were required to complete the NEPA review, it would not affect our determination that the limited site preparation activities associated with rock grouting, as stated in Section 1.0 and set forth in Section 4.0 of this Discussion and Findings, may be authorized pending completion of the NEPA environmental review specified in Appendix D of 10 CFR Part 50.

3.0 SITE AND ENVIRONS

The Byron Station Site is located about 17 miles southwest of Rockford and 4 miles south of Byron in Rockvale township, Ogle County, Illinois. The proposed site consists of approximately 1000 acres of gently rolling terrain 2 miles east of the Rock River.

The principal land use in the region of the site is agriculture. Ogle County and the neighboring counties, Winnebago and Stephenson, have approximately 61%, 48% and 65% of their land in agricultural production. Corn is the principal crop grown in all three counties on the basis of both acreage planted and dollar value. Cattle, hogs, and milk cows are the predominant livestock. At the proposed site, about 45% of the 1000 acres is cropland, while the remainder is woodland or fallow land, some of which is used as pasture.

The site lies in a relatively sparsely populated area. The major center of population nearby is Rockford, Illinois (1970 population: 147,370), 17 miles northeast. All other cities within 50 miles of the site have populations of less than 50,000. The area within 10 miles of the site has a population density of 62.6 persons per square mile. The area within 50 miles has a population density of 112 persons per square mile; this is expected to grow to 175 persons per square mile by the year 2010.

The only major industrial activities in the region of the site are those associated with principal populations centers. Of these, only Rockford, Illinois is within 20 miles of the site. Other major centers, Freeport and Belvidere, Illinois and Beloit and Janesville, Wisconsin, are from 20 to 50 miles from the site. There are no nuclear power plants or nuclear reprocessing works within 50 miles of the site; the nearest nuclear facility is Commonwealth Edison's Quad-Cities Nuclear Power Station, 60 miles southwest.

4.0 ENVIRONMENTAL IMPACT DURING THE PROSPECTIVE REVIEW PERIOD

Site preparation activities concerning rock grouting that would be permitted by the exemption and expected to be accomplished during the prospective NEPA review period are those set forth below:

(a) The requested grouting activities are limited to a 3.7 acre area underlying portions of the proposed plant structures. The auxiliary building and two reactor containments are the Category I structures for which this exemption applies. The grouting program consists of a grout curtain around the perimeter of the Category I structures and primary grout holes within the area. The grout curtain holes will be spaced on 4 to 10 foot centers and will be completed prior to commencement of the primary grouting program. The primary grout holes will be spaced on 20 foot centers. The injected grout will not lie closer to the existing ground surface than the underlying rock surfaces approximately 5 to 15 feet below the natural grade. This will ensure that potential return of the 3.7 acres to farmland could be easily achieved with no significant environmental impact.

(b) It is planned that the water used during drilling, washing, pressure testing, and grouting will be obtained from a well having a capacity of 100 - 250 gpm. This well will be drilled prior to the grouting program, but will not be a part of the permanent well system. The Staff concludes that the withdrawal of water from this well will not significantly affect the nearest existing well approximately 2000 feet from the grouting area or other nearby domestic wells using the shallow glacial drift or shallow dolomite aquifers.

(c) The water used for washing the drilled grout holes will be placed in a settling pond after use and will both evaporate to the atmosphere and gradually seep back into the ground. The settling pond will have a 65' x 75' area and will be located to the north and west of the work area. The seepage of this water will not be a potential source of contamination to the aquifer.

(d) The groundwater used for pressure testing the boreholes will reenter the aquifer during the testing process. This water will not constitute a potential source for contamination of ground or surface water.

(e) The area to be grouted, about 3.7 acres, will be covered with gravel to provide a stable working base for the drilling rigs and movement of heavy equipment. The access road will similarily be improved with gravel. The gravel will also serve to help control erosion and sediment runoff from the grouting area during periods of rainfall. Construction of low earth dikes are planned at the heads of nearby drainage channels to contain sediment in the area and prevent their discharge to the surface water streams. Should the site be abandoned, the Staff concludes that the dikes and gravel can be readily removed and redress of environmental effects easily achieved.

(f) The grouting program will be managed to insure that no deterimental impact occurs to the groundwater regime. The Staff concludes that the loss of recharge to the water table from grouting of 3.7 acres should have no significant effect on nearby groundwater levels or well discharges.

The environmental impacts resulting from this exempted work are those normally expected to be associated with any construction project of this type, including those related to vehicular traffic and the noise, dust, and wastes generated by site preparation activities. If it is found necessary to redress the site, the applicant will remove the gravel placed to improve the trafficability and all ruts and variations in the natural topography caused by the grouting operation will be graded and filled with topsoil. All debris will be removed from the site and disposed of accordingly.

In summary, the exempted work is not expected to result in a significant adverse effect on the environment. The proposed site could be returned to its original productive state if necessary. The total cost of redress for all the exempted work is estimated to be about $100,000. This cost includes: removal of dikes, drilling spoils and gravel base; regrading; filling with topsoils; and seeding.

5.0 FORECLOSURE OF ALTERNATIVES

Because of the limited nature of the activities authorized by the exemption, we believe that reasonable alternatives would not be foreclosed by the exempted activities during the ongoing NEPA environmental review period.

6.0 EFFECT OF DELAY ON THE PUBLIC INTEREST

Should the exemption requested by the applicant in its December 17, 1973 letter not be granted the delay of preconstruction activities will, in the applicant's opinion, result in a 10 month delay in its overall schedule. The commercial operation date of June 1979 would thus be delayed and such a delay would result in increased costs.

The Staff has reviewed the Requirement for Power given in Section 1.1 of the applicant's Byron Station Environmental Report. The Staff believes that there is an uncertainty in future energy demand, but that the methods of predicting demand used by the applicant were reasonable. Therefore, the capacity of Byron Station Unit 1 is needed for the 1979 summer peak as predicted.

The applicant has stated in its exemption application that none of the possible alternative energy sources, within its own system or from other regional systems, is considered feasible to supply a reliable source of reserve capacity which could provide electricity in the absence of the Byron Station not meeting its scheduled commercial operation dates. The Staff concurs in this evaluation.

After reviewing the construction schedule for this facility, we have determined that the granting of the exemption as described herein will greatly reduce the potential delay period.

We conclude that should the power from the Byron Station plant not be available on schedule or soon thereafter, the public's interest in the availability of adequate, economical electric power would not be served, since (1) power might not be available when needed, and (2) when power is available the additional costs of such power would be passed on to the customer.

7.0 COSTS OF DELAY

The applicant stated in its December 17, 1973 letter that a 10 month delay in commercial operation would occur if site preparation work would not be performed prior to the decision concerning the issuance of a construction permit. The applicant has estimated the following costs that would result from a delay of 10 months:

(a) The increased cost of plant construction due to escalation is estimated at $29 million.

(b) The differential cost of fuel to purchase replacement power for 10 months of Byron Unit 1 (1120MWe) service is estimated at $25 million.

(c) The electrical generating reserve margin would drop from 14% to 9% which is less than the reserve which Edison considers to be adequate to assure reliable system operation.

The Staff agress that the above estimates are realistic in view of the long term projections required.

8.0 BALANCING OF FACTORS AND DETERMINATION

We have taken into consideration and balanced the following factors set forth in Section 50.12 of 10 CFR Part 50 in making a determination whether or not to grant an exemption for the discussed site preparation activities at the Byron Station site pending completion of the NEPA environmental review.

(1) The scope of the work to be performed is such that it is not likely that such activities will have a significant adverse environmental impact. The work performed will not include any major excavation activities and will not result in any permanent construction above grade.

(2) Redress of such environmental impact as might result from the preliminary site preparation activities to be performed could easily be achieved.

(3) The site preparation activities that would be authorized by the granting of an exemption pending completion of the NEPA review would not foreclose subsequent adoption of alternatives.

(4) The effects on the public interest of delay in the completion of the Byron Station nuclear plant could be substantial. The public demand for adequate, economical electric power would likely not be met without significant economic penalty and or adverse environmental impact. Increased construction, interest and other costs would result from such a delay. The increased cost of plant construction due to escalation during the delay is estimated to be $29 million and the differential fuel costs alone to purchase replacement power for the 1C months of Byron Unit 1 (1120 MWe) service would be approximately $25 million. The Staff's evaluation of existing plants scheduled for retirement before 1979 indicates that these cannot be depended upon for adequate reliability of system reserves for the summer peak of 1979. In addition, increased power costs would undoubtedly be passed on to the consumers.

(5) In the context of balancing environmental harm and economic cost of abandonment, the commitment of funds that would result if the exemption were granted is not likely to affect the eventual decision that will be reached upon completion of the NEPA review. The cost associated with the site preparation activities permitted by the exemption ($10,000,000.) is a small percent (1%) of the total cost of the project ($988,000,000.).

9.0 UNIQUE CONSIDERATIONS

The granting of the requested exemption for grouting activities for the proposed Byron Station nuclear plant is considered a unique exemption in that: (1) the grouting program will take place on cleared land that has been farmed and no impact will occur to natural vegetation, (2) the requirement for grouting was not anticipated at the time the applicant scheduled additional capacity, and (3) the resultant impact to the 3.7 acres of farmland if construction were not to proceed, would not be significantly greater than core drilling which is currently allowed without an exemption.

10.0 DETERMINATION

We have determined that the granting of an exemption for the work described is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. After balancing the factors described above, we have further determined that the exemption requested in the applicant's December 17, 1973 letter should be granted prior to a decision regarding the issuance of a construction permit.

Pending completion of the full NEPA environmental review, Commonwealth Edison Company proceeds with site preparation of the Byron Station site at its own risk. The discussion and findings herein do not preclude the AEC, as a result of the ongoing NEPA environmental review, from continuing, modifying, or terminating the site preparation activities permitted by the exemption or from appropriately conditioning the exemption to protect environmental values.

02-0408/33