Richard J Cole

NUREG-0848

Final Environmental Statement

related to the operation of Byron Station, Units 1 and 2

Docket Nos. STN 50-454 and STN 50-455

Commonwealth Edison Company

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

April 1982

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SUMMARY AND CONCLUSIONS

This Final Environmental Statement, Operating License Stage, was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation (the staff).

1. This action is administrative.

2. The proposed action is the issuance of an operating license to the Commonwealth Edison Company (CECo) for the startup and operation of Units 1 and 2 of Byron station (Docket Nos. STN 50-454, STN 50-455), located near the Rock River in Rockvale Township, Ogle County, Illinois, about 6 km south of Byron and 27 km southwest of Rockford, Illinois.

   The plant 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 maximum design thermal output of the units is 7130 MWt, with a corresponding maximum calculated electrical output of 2330 MWe. The exhaust steam will be condensed by cooling water circulated through two natural-draft cooling towers. Makeup and blowdown water (water to replace that lost by evaporation and water to control the buildup of dissolved solids, respectively) will be taken from, and discharged to, the Rock River.

3. The evaluation in this environmental statement represents the second assessment of the environmental impact associated with the Byron station pursuant to the guidelines of the National Environmental Policy Act of 1969 (NEPA) and 10 CFR Part 51 of the Commission's regulations. After receiving an application in September 1973 to construct Units 1 and 2 of the Byron station, the staff carried out a review of the environmental impact that would occur during construction and operation. This evaluation was issued in July 1974 as a Final Environmental Statement, construction phase (FES-CP). After this environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and public hearings in Rockford, Illinois and Bethesda, Maryland, the U.S. Atomic Energy Commission (now U.S. Nuclear Regulatory Commission) issued Permits Nos. CPPR-130 and CPPR-131 on December 31, 1975 for construction of Units 1 and 2 of the Byron Station. As of November 1, 1981, the construction of Unit 1 was about 78% complete and Unit 2 was about 63% complete. The applicant has applied for a license to operate Units 1 and 2 and submitted, in November 1978, the required safety and environmental reports in support of the application. The applicant estimates fuel-loading dates of April 1983 for Unit 1 and April 1984 for Unit 2.

4. The staff has reviewed the activities associated with the proposed operation of Units 1 and 2. The potential impacts, both beneficial and adverse, can be summarized as follows:

a. The additional generating capacity provided by operation of Units 1 and 2 of the Byron station will result in a significant savings in system production costs and will assist CECo in maintaining a diverse mix of generating resources (Sec. 2).

b. The land use impacts will be small (Sec. 5.2).

c. The Byron station will draw most of the water it consumes in operation from the Rock River; a small portion for the makeup water system will be pumped from wells. The average net use will be about 1.3 m^3/sec (47 cfs), which is about 1% of the average annual flow; therefore, no water-use impacts are expected (Sec. 5.3.1).

d. The chemical, thermal, and other waste discharges into the Rock River will be rapidly assimilated; hence, no adverse impacts on downstream water users or aquatic biota are expected (Secs. 5.3.2 and 5.5.2). The staff expects that applicable standards will be met.

e. The plant area does not alter the flood plain of the Rock River or its tributaries in the vicinity to affect their flood-prone areas (Sec. 5.3.3)

f. There will be a visible plume extending from the cooling tower most of the time; however, the ground-level fogging and icing caused by this plume will be negligible (Sec. 5.4.1).

g. The potential for impacts on the terrestrial ecosystem, which could be caused by operation of the cooling-tower emissions, bird impaction, noise, or transmission-line effects, has been examined and no additional impacts are expected (Sec. 5.5.1).

h. The potential for impacts on the aquatic ecosystem, which could be caused by impingement or entrainment, thermal discharges, or discharges of chemical and sanitary wastes, has been examined and are expected to be small (Sec. 5.5.2).

i. Operation of the plant will not have an adverse effect on any rare, endangered, or threatened species (Sec. 5.6).

j. Operation of the plant will not result in any significant impact on historic and archeological sites in the area nor along the transmission corridors (Sec. 5.7).

k. The staff concludes that the primary socioeconomic impacts of plant operations are tax benefits and employment. Other socioeconomic impacts of operation are expected to be small (Sec. 5.8).

l. No significant environmental impacts are anticipated from normal operational releases of radioactive materials. The estimated maximum individual dose for a member of the public subject to the maximum exposure will be very small compared to natural-background doses. As a result, the staff concludes that there should be no measurable radiological impact on members of the public from routine operation of the plant (Sec. 5.9.3).

m. The staff concludes that the risk to nuclear plant workers from plant operation is comparable to the risks associated with other occupations (Sec. 5.9.3).

n. The staff concludes that the risk associated with radiation exposure due to postulated accidents is very low, and that there are no special or unique features about the Byron site and environs that would warrant special mitigation measures for the Byron Station (Sec. 5.9.4).

o. The environmental impact of the plant on the U.S. population from radioactive gaseous and liquid releases (including radon) due to the uranium fuel is inconsequential when compared to the impact of normal background radiation. In addition, the nonradiological impacts of the uranium fuel cycle are acceptable (Sec. 5.10).

p. Decommissioning of the station can be performed safely and at a reasonable cost (Sec. 5.11).

q. Operation of the station will increase noise levels at some nearby noise-sensitive land use locations. These increases are not expected to raise noise levels at any location above those identified as causing activity interference at any location that did not already experience such levels. The applicant will conduct a confirmatory noise monitoring program during station operation to verify the predictions (Sec. 5.12).

r. The only noteworthy potential source of impacts to the public from emergency planning would be associated with the testing of the early notification system and this is expected to be infrequent and insignificant (Sec. 5.13).

5. The personnel who participated in the preparation of this environmental statement and their area of responsibility are identified in Section 7.

6. The draft environmental statement was made available to the public, to the Environmental Protection Agency, and to other specified agencies in November 1981 (Sec. 8). A list of the Federal, state, and local agencies, groups, and individuals that submitted comments on the draft environmental statement, and copies of their comments, are appended to this statement in Appendix A. The staff considered these comments; the responses are in Section 9.

7. On the basis of the analysis and evaluation set forth in this environmental statement, and after weighing the environmental, economic, technical, and other benefits against environmental, socioeconomic, and economic costs and after considering available alternatives at the operating license stage, the staff concludes that the action called for under NEPA and 10 CFR Part 51 is the issuance of an operating license for Units 1 and 2 of the Byron station, subject to the following conditions recommended by the staff for the protection of the environment:

   a. Before engaging in additional construction or operational activities that 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 of its intentions to engage in such activities to the Director of the Office of Nuclear Reactor Regulation and shall receive written approval before proceeding with such activities.

b. The applicant shall carry out the environmental monitoring programs outlined in this environmental statement as modified and approved by the staff and implemented in the environmental protection plan and the technical specifications incorporated in the operating license for Units 1 and 2 of the Byron station.

c. If harmful effects or evidence of irreversible damage are detected during the operating life of the Byron station, the applicant shall provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

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FOREWORD

This Final Environmental Statement--Operating License Stage was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (the staff), in accordance with the Commission's regulation, 10 CFR 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA). It reviews the impacts of operation of the Byron station, Units 1 and 2. Assessments that are found in this statement augment those described in the Final Environmental Statement - Construction Permit (FES-CP) that was published in July 1974 in support of issuance of construction permits for Byron station, Units 1 and 2.

The information in the various sections of this statement updates the FES-CP in four ways: (1) by evaluating changes in plant design and operation that will result in different environmental effects of operation (including those that would enhance as well as degrade the environment) than those projected during the preconstruction review; (2) by reporting the results of relevant new information that has become available subsequent to issuance of the FES-CP; (3) by factoring into the statement new environmental policies and statutes that have a bearing on the licensing action, and factoring the results of the applicant's preoperational monitoring program into the design of an operational surveillance program and into the development of environmental technical specifications and an environmental protection plan; and (4) by identifying unresolved environmental issues or surveillance needs that are to be resolved by means of license conditions. (No unresolved environmental issues or surveillance needs have been identified in this statement for the case of the Byron station, Units 1 and 2.)

The staff recognizes the difficulty a reader would encounter in trying to establish the conformance of this review with the requirements of NEPA with only updating information. Therefore, introductory resume in appropriate sections summarize both the extent of updating the FES-CP and the degree to which the staff considers the subject to be adequately reviewed.

Copies of this environmental statement are available for inspection at the Commission's Public Document Room, 1717 H Street NW, Washington, DC, and at the Rockford Public Library, Rockford, IL. Single copies may be obtained by writing to:

Division of Technical Information
Document Control Office
U.S. Nuclear Regulatory Commission
Washington, DC 20555

1 INTRODUCTION

The proposed action is the issuance of an operating license to Commonwealth Edison Company (CECo) of Chicago, Illinois, for startup and operation of the Byron Station, Units 1 and 2 on a 710-ha (1754-acre) site in Ogle County 6 km (4 miles) south-southwest of Byron, Illinois, and 3 km (2 miles) east of the Rock River. Each of the two generating units consists of a pressurized-water reactor, four steam generators, one steam turbine generator, a heat-dissipation system, and associated auxiliary and engineered safeguards. Waste heat will be dissipated to the atmosphere from two natural-draft cooling towers. Makeup water will come from the Rock River; blowdown (that is, water released to control the buildup of dissolved solids) will go into the Rock River downstream from the intake. The two units are designed to operate at a nominal/design-maximum thermal level of 6850/7130 MWt and to produce a nominal/design-maximum net electrical output of 2240/2330 MWe (ER-OL,* Section 3.2; FES-CP, Section 1.1). The plant is being constructed for CECo, the applicant, who prepared the ER-OL and will operate the plant.

1.1 Administrative History

On September 20, 1973 CECo (the applicant) filed an application with the Atomic Energy Commission, now Nuclear Regulatory Commission (NRC), for permits to construct the Byron Station, Units 1 and 2. Construction permits Nos. CPPR-130 and CPPR-131 were issued on December 31, 1975 following reviews by the Nuclear Regulatory Commission's staff and its Advisory Committee on Reactor Safeguards, as well as public hearings before an Atomic Safety and Licensing Board in Rockford, Illinois, and Bethesda, Maryland, between September 4, 1974 and November 18, 1975. The conclusions resulting from the staff's environmental review were issued as a final environmental statement for construction permits in July 1974.

As of November 1, 1981, construction of Byron Unit 1 was about 78% complete and Unit 2 was about 63% complete. CECo estimates that Unit 1 will be ready for fuel loading in April 1983 and commercial operation in October 1983; Unit 2 is estimated to be ready for fuel loading in April 1984 and commercial operation in October 1984.

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*"Byron Station Environmental Report, Operating License Stage," Vols. 1 and 2, Commonwealth Edison Company, November 30, 1978. Hereinafter this document is cited in the body of the text as ER-OL, followed by a specific section, page, or figure or table number. The ER-OL Amendments 1 through 3 are cited similarly. Likewise, "Byron Station Environmental Report," Vols. 1 and 2, Commonwealth Edison Company, September 13, 1973, which was prepared for the construction-permit evaluation, is cited as ER-CP. The "Final Environmental Statement Related to the Proposed Byron Station Units 1 and 2," published in July 1974, is referred to as FES-CP.

On June 27, 1978, CECo submitted an application including a Final Safety Analysis Report (FSAR) and Environmental Report (ER-OL) requesting issuance of operating licenses for Byron Station, Units 1 and 2. The FSAR and ER-OL were docketed on November 30, 1978 and operational safety and environmental reviews were then initiated.

1.2 Permits and Licenses

The applicant has provided a status listing, as of July 1981, of environmentally related permits, approvals, licenses, and the like required from Federal, regional, state, and local agencies in connection with the proposed project (Appendix B). The staff has reviewed the listing and is not aware of any potential non-NRC licensing difficulties that would significantly delay or preclude the proposed operation of the Byron Station. The issuance of a water-quality certification pursuant to Section 401 of the Clean Water Act of 1977 by the Illinois Environmental Protection Agency, Division of Water Pollution Control, is a necessary prerequisite for the issuance of an operating license by the Nuclear Regulatory Commission. This certification was received by the applicant on August 18, 1975. The Illinois Environmental Protection Agency issued a National Pollution Discharge Elimination System (NPDES) permit with modification pursuant to Section 402 of the Clean Water Act of 1977 to the applicant on November 7, 1979 (Appendix B). This NPDES permit expired on April 1, 1981, but has been administratively extended by the state, pending promulgation of revised final Effluent Limitations and Performance Standards for the Steam Electric Generating Point Source Category by the U.S. Environmental Protection Agency. In accordance with the provisions of the NPDES permit, the applicant submitted an application on March 31, 1981 to the Illinois Environmental Protection Agency for a permit renewal. Submission of this application will enable the applicant to receive authorization to discharge treated wastes beyond the expiration date of the existing NPDES permit.

The applicant's proposed plan for intake structure performance monitoring pursuant to Section 316(b) of the Clean Water Act of 1977 was found acceptable by the state, subject to comments on the detailed study plan on June 13, 1979 (Appendix B).

2 PURPOSE AND NEED FOR THE ACTION*

2.1 Résumé

When the construction permits for the Byron units were issued in December 1975, the staff concluded that the units should be allowed to operate to ensure, among other things, the reliability of service of the Commonwealth Edison Company's (CECo) system. At that time, Units 1 and 2 were scheduled to begin commercial operation in May 1980 and May 1981, respectively. These online dates were selected as a result of an expected growth in peak demand of 7.5% and an increase in energy requirements of 7.0% per year during the 1973-1982 period (FES-CP).

Actual rates of growth in demand and energy have averaged only 1.97% per year and 1.6% per year, respectively, during the 1973-1980 period. This decline in expected growth is not unique to the CECo service area and is representative of a national trend, attributable, in part, to higher prices for electricity, to conservation, and to an overall slowdown in economic growth. These economic and social disincentives, coupled with generic obstacles that have recently plagued the construction of all generating facilities, have forced adjustments to utilities' generation expansion programs. In this context, the commercial availability of the Byron units has been delayed. Current scheduling calls for Units 1 and 2 to begin operation in February 1984 and February 1985, respectively.

In this section the staff evaluates the need for the Byron station in the context of (1) overall system production costs, (2) availability of alternative fuels, and (3) reliability of the bulk power supply of the CECo service area.

2.2 Production Costs

The Byron station has been constructed to provide an economical source of baseload energy. Because substantial capital and environmental costs associated with construction have already been incurred, the only economic factors that are relevant for analysis, at this stage of review, are those related to the costs of producing electric energy. These "production costs" include fuel expenses and operation and maintenance (O&M) costs.

An analysis was performed by the applicant that compared system production costs with and without the Byron units available. To assess the sensitivity of production costs to varying rates of load growth, the analysis assumed two load-growth scenarios: the applicant's latest forecasted load growth of 2% per year and load held constant at the 1981 level. The analysis was performed for the years 1984 through 1990. Byron Unit 1 will be commercially available in 1984 and Byron Unit 2 in 1985.

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*On March 26, 1982, the Commission published a rule in the Federal Register, effective April 26, 1982, removing need for power considerations from NRC operating license environmental reviews and environmental impact statements (47 FR 12940).

Table 2.1 Incremental system production costs with and without the availability of Byron Units 1 and 2 (all costs are in 1981 $)

Availability of Byron Station[1]	1984	1985	1986	1987	1988	1989	1990
	Production costs with 2% annual load growth ($ thousands)						
Not available	1,431,147	1,381,579	1,272,047	1,350,225	1,270,850	1,415,886	1,468,924
Available	1,274,617	1,123,324	993,365	1,016,970	1,003,066	1,126,965	1,189,182
Annual cost of delay	156,530	258,225	278,682	333,255	267,784	288,921	279,742
Mills/kWh	32.9	26.3	25.6	26.3	23.5	25.5	24.6
	Production costs with no load growth ($ thousands)						
Not available	1,274,045	1,167,575	1,017,651	1,038,519	914,457	971,885	983,395
Available	1,148,120	958,063	798,681	783,208	722,151	770,761	782,145
Annual cost of delay	125,925	209,512	218,970	255,311	192,306	201,124	201,250
Mills/kWh	26.5	21.5	20.4	23.9	17.8	18.9	18.9

[1]Byron Units 1 and 2 are scheduled for commercial operation in February 1984 and February 1985, respectively. Costs are based on the data shown in Table 2.2.

Table 2.2 Basis for incremental costs provided in Table 2.1

	1984	1985	1986	1987	1988	1989	1990
Normal Annual Load Growth at 2%							
Capacity Factors (%)							
Byron Unit 1	48	53	58	74	58	58	58
Byron Unit 2	10	47	53	55	58	58	58
Replacement Power (GWh) (without Byron station)	4,764	9,825	10,900	12,673	11,403	11,316	11,376
Replacement Energy by Fuels (%)							
Coal - High Sulfur	5	7	9	7	8	7	6
Coal - Low Sulfur	57	61	54	52	51	54	55
Oil - #6	17	11	12	13	11	12	12
Oil - Peakers	2	1	1	2	1	2	3
Purchase - Economy	11	8	8	8	7	6	7
Nuclear	8	12	16	18	22	19	17

	1984	1985	1986	1987	1988	1989	1990
No Load Growth							
Capacity Factors (%)							
Byron Unit 1	47	53	58	72	55	54	55
Byron Unit 2	10	46	52	53	55	54	54
Replacement Power (GWh) (without Byron station)	4,752	9,724	10,737	12,202	10,784	10,629	10,665
Replacement Energy by Fuels (%)							
Coal - High Sulfur	6	9	10	8	10	8	8
Coal - Low Sulfur	65	61	53	46	41	46	43
Oil - #6	10	7	7	10	7	8	11
Oil - Peakers	1	0	0	0	0	0	0
Purchase - Economy	8	7	7	8	7	7	8
Nuclear	10	16	23	28	35	31	30

The results of this analysis are shown on Table 2.1. The values reported represent CECo's calculation of the annual savings in fuel costs obtained with and without the Byron units being available during the 1984 to 1990 period. The basis for the Table 2.1 calculations are shown in Table 2.2, assuming a 2.0% load growth and assuming a 0% load growth. The production cost savings resulting from the operation of Byron are sizeable, even with 0% load growth. The average annual savings in 1981 dollars are $266 million and $201 million, respectively, for the two load-growth scenarios. The corresponding average savings in mills per kWh are 26.4 and 20.7.

Nuclear fuel and operation and maintenance costs vary from year to year depending on the capacity factor of the generating units. Nuclear fuel cost is estimated at 11.51 mills/kWh and operation and maintenance cost at 7.27 mills/kWh in 1985, based on a 60% capacity factor.

A decision to operate the Byron units will necessitate a decommissioning expense once the units are retired from service. In Section 10.2.3.3 of the Byron FES-CP, the staff discussed various decommissioning methodologies that were under consideration at that time. In January 1981, the staff published a report titled "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (NUREG-0586)." For large PWR units (such as the Byron facilities), the report estimates that decommissioning costs (in 1978 dollars) will range from $21.0 million (plus $40 thousand per year surveillance cost) per unit for entombment of the facility to $42.8 million per unit for the preparation and maintenance of the facility in a "safe-storage" condition. Immediate decontamination of the facility is projected to cost $33.3 million per unit (in 1978 dollars).

The operation of the Byron station will also result in environmental impacts and increased risks. These have been evaluated by the staff and the findings are presented in Sections 4 and 5 of this report.

2.3 Diversity of Supply

Regardless of the relative production cost advantages of nuclear generation versus generation from other sources, it is beneficial for bulk power systems to have diverse sources of primary power supply. Contingencies may develop that could limit the availability of desired fuels. For example, such contingencies might include

(1) Curtailments in the delivery of fuel oil as a result of revisions in national energy policy

(2) Severe weather conditions causing freezing of coal inventories

(3) Further Federal regulatory limits on use of natural gas as boiler fuel

(4) Shortages in processing and enrichment facilities for nuclear fuels

(5) Prolonged labor strikes involving mining, drilling, and/or transportation of workers

The occurrence of any one or a combination of these contingencies could have a substantial impact on a utility's ability to supply energy for load, particularly if the impacted fuel supply is needed to furnish baseload generation.

Of the total 62,819 GWh generated on the CECo system in 1980, 41% was produced by nuclear facilities and more than 47% by coal-fired plants. The remaining energy was generated by oil- and gas-fueled steam and combustion turbine units, with some minimal input from hydro resources.

The 1981 mix of generating facilities by fuel type in CECo's bulk power system is identified in Table 2.3. Current plans call for the future installation of an additional 6516 MW of generating capacity (summary net) on the CECo system through 1990. Of this new capacity, all (6516 MW) will be generated by nuclear facilities and will increase the amount of installed nuclear capacity (summer net) from 4975 MW in January 1981 to 11,491 MW (including the Byron station) in 1986. This proportion represents approximately 50% of all installed facilities in the CECo system in the year 1986. Conventional generating units will comprise the remaining installed capacity (summer net), with coal units accounting 6937 MW, oil-fueled units for 3848 MW, and natural gas units for 677 MW.

The current and future mix of installed capacity allows CECo to maintain appreciable generating flexibility in the event of possible fuel shortages. The addition of the Byron station will aid in maintaining this flexibility while, concurrently, offering a relatively low-cost source of baseload energy.

2.4 Reliability Analysis

Historical energy production and demand are shown in Table 2.4 for the 1960 through 1980 period. Between 1960 and 1973, CECo's electric energy production and peak demand grew at average annual rates of 7.0% and 8.05%, respectively. During the period 1973 through 1980, energy growth slowed considerably to an average 1.6% annually, and peak demand growth slowed to 1.97% per year. These rates of growth were less than those experienced nationally, with U.S. energy requirements increasing at a rate of 3.1% per year and peak demand at 3.5% per year from 1973 through 1979.

CECo currently projects peak demand to increase at an annual rate of about 2.0% per year during the 1982 through 1990 period. The staff finds these growth rates reasonable in light of the state-level projections developed for the NRC by the Oak Ridge National Laboratory (ORNL) (NUREG/CR 1295). ORNL developed three load growth scenarios based primarily on the sensitivity of consumer demand to the price of electricity. The base-case forecast, which uses fuel-cost projections developed by the Department of Energy, predicts that demand will increase at a rate of 2.9% per year. For the low-cost scenario, demand growth in the State of Illinois is projected to average 4.2% per year. For the high-cost scenario, demand will grow at the rate of 2.4% per year.

The applicant projects peak demand will increase from 14,228 MW in 1980 to 17,400 MW in 1990. Comparable figures for energy growth are 66,946 GWh in 1980 and 81,600 GWh in 1990. CECo plans the installation of 6516 MW of generating capacity through the year 1987 to meet its projected demand. This new capacity, if commercially available as planned, will increase current installed generating capacity to 22,377 MW* (summer rating).

*Applicant proposes to retire the 550 MW Ridgeland oil fueled generating station prior to the summer peak of 1982. (Table 1.1.22 EROL Amendment 3)

Table 2.3 Existing CECo generating units for summer of 1981

Station - Unit	Type of unit[1]	Year of installation	Net capability (MW) Winter	Summer
Bloom T.S.S. 33, 34	D	1971	126	103
Calumet 31-34	D	1969-70	276	220
Collins 1	O	1978	554	554
Collins 2	O	1977	554	554
Collins 3	O	1977	530	530
Collins 4	O	1978	530	530
Collins 5	O	1979	530	530
Crawford 7	C	1958	216	213
Crawford 8	C	1961	326	319
Crawford 31-33	NG	1968	189	149
Dresden 1[2]	N	1960	207	197
Dresden 2	N	1970	794	772
Dresden 3	N	1971	794	773
Electric Junction 31-34	NG	1970-71	243	193
Fisk 19	C	1959	321	316
Fisk 20	D	1966	11	11
Fisk 31-34	D	1968	231	157
Joliet 6	D	1959	308	298
Joliet 7	D	1965	503	499
Joliet 8	D	1966	522	518
Joliet 9	D	1967	11	11
Joliet 31, 32	NG	1969	131	103
Kincaid 1	C	1967	554	554
Kincaid 2	C	1968	554	554
Lombard 31-33	NG	1969	136	108
Powerton 5	C	1972	700	700
Powerton 6	C	1975	700	700
Quad-Cities 1[3]	N	1972	591	576
Quad-Cities 2[3]	N	1972	592	577
Ridgeland 1	O	1951	153	147
Ridgeland 2	O	1950	158	152
Ridgeland 3	O	1953	137	131
Ridgeland 4	O	1955	126	120
Seabrooke 31-34	O	1969-70	135	109
State Line 3	C	1955	213	213
State Line 4	C	1962	318	318
Waukegan 6	C	1952	100	100
Waukegan 7	C	1958	328	328
Waukegan 8	C	1962	297	297
Waukegan 31, 32	O	1968	150	113
Will County 1	C	1955	106	101
Will County 2	C	1955	154	148
Will County 3	C	1957	262	251
Will County 4	C	1963	520	510
Zion 1	N	1973	1040	1040
Zion 2	N	1974	1040	1040

[1]KEY: N = Nuclear, C = Coal, O = Oil, NG = Natural Gas, and D = Diesel
[2]Dresden Unit 1 is taken out of service for chemical cleaning, and expected to return to service June 1986.
[3]The capability figures indicate CECo's 2/3 ownership of Quad Cities Station; Iowa-Ill. E&G's 1/3 interest represents a 29.6 MW and 288 MW capability for winter and summer, respectively.

Table 2.4 System peak loads and energy for load for the years 1960 to 1980

Year	Summer peak load (MW)	Increase over previous year (MW)	Increase over previous year Percent	Output (GWh)	Percent increase over previous year	Annual load factor
1960	4,590	357	8.4	24,822	5.1	59.8
1961	4,840	250	5.4	26,178	5.5	60.1
1962	5,143	303	5.9	28,165	7.6	60.9
1963	5,372	229	4.5	30,037	6.6	62.0
1964	6,102	730	13.6	32,352	7.7	58.5
1965	6,468	366	6.0	34,788	7.5	59.5
1966	7,491	1,023	15.8	38,189	9.8	58.2
1967	7,643	152	2.0	40,018	4.8	59.8
1968	8,950	1,307	17.1	43,457	8.6	55.3
1969	9,265	315	3.5	46,972	8.1	57.9
1970	10,027	762	8.2	49,751	5.9	56.6
1971	10,943	916	9.1	52,144	4.8	54.4
1972	11,750	807	7.4	56,063	7.5	54.3
1973	12,462	712	6.1	60,058	7.1	55.0
1974	12,270	(192)*	(1.5)	59,274	(1.3)	55.1
1975	12,305	35	0.3	60,310	1.7	56.0
1976	12,907	602	4.9	62,567	3.7	55.2
1977	13,932	1,025	7.9	65,110	4.1	53.3
1978	13,720	(212)	(1.5)	67,927	4.3	56.5
1979	13,804	84	0.6	67,650	(0.4)	55.9
1980	14,228	424	3.1	66,946	(1.0)	53.7

Source: ER-OL pp. 1.1-22

*Parentheses indicate negative values.

Table 2.5 CECo system projections of summer peak load capacity and reserves, 1982-1990

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1. Capacity, seasonally adjusted, MW	16909	16909	19077	20197	21090	22377	22377	22377	22377
2. Net of firm purchases and sales, MW	994	682	312	312	87	312			
3. Total resources (1 + 2), MW	17903	17591	19389	20509	21177	22689	22377	22377	22377
4. Unavailable capacity, MW[1]	197	197	197	197	197	197	197	197	197
5. Operable resources (3 + 4), MW	17706	17394	19192	20312	21177	22492	22180	22180	22180
6. Peak-hour demand, MW	14650	15050	15450	15750	16050	16350	16700	17050	17400
7. Reserve margin (5 - 6), MW	3056	2344	3742	4562	5127	6147	5480	5130	4780
8. Reserve margin,[2] % (7 ÷ 6) x 100	20.9	15.6	24.2	29.0	31.9	37.6	32.8	30.1	27.5
9. Reserve margin without Byron units, MW			2622	2322	2887	2902	3240	2890	2540
10. Reserve margin, %			17.0	14.7	18.0	23.9	19.4	17.0	14.6

[1]Dresden Unit 1
[2]With all future capability installed as scheduled.

Table 2.5 depicts the projected capacity and reserve situation during the summer peak periods of 1982 through 1990. This tabulation shows the results of the following two capacity-availability scenarios:

(1) Lines 7 and 8 of Table 2.5 show reserve margins and percent reserve for the CECo system with capacity available as planned.

(2) Lines 9 and 10 show the effect, on reserves and percent reserves, of an indefinite postponement in the availability of the units.

CECo has adopted a minimum installed reserve requirement of 15% of annual peak demand as the capacity margin necessary to maintain acceptable reliability. The staff's assessment uses the applicant's criterion in determining overall reliability of the system during the 1982 to 1990 period. Table 2.5 shows that with the applicant's current estimate of peak demand growth, indefinite postponement of the Byron units will result in reserve deficiencies during two peak periods. For the 1985 peak, the reserve level falls short, by 41 MW, of the 2363 MW needed to satisfy the minimum requirement. During the 1990 peak-demand period, the reserve level is 70 MW short of the 5220 MW needed to meet the minimum requirement. Either scenario shown on Table 2.5 could be adversely altered by delays in installation dates of the two 1120-MW Braidwood units, currently scheduled for commercial operation in 1986 and 1987. Also, should peak demand exceed current projections, reserve margins would be reduced proportionately.

Either one or a combination of unit delay and load-forecast error could reduce the reliability of the CECo system, particularly under scenario 2.

The staff concludes that, under scenario 2, the CECo system would experience some difficulty in reliably supplying its load in 1984 and 1990. Furthermore, this difficulty could be exacerbated by delays in the scheduled installation dates of the Braidwood units and/or increases in peak demand above those currently projected.

2.5 Conclusions

The results of the staff's assessment of purpose and need support a decision to issue an operating license for Byron Station, Units 1 and 2. The concern of overriding importance is that the addition of these units to the CECo system is expected to result in significant savings in system production costs. Furthermore, the availability of the Byron plant will assist in CECo's maintaining a diverse mix of generating resources.

Although the operation of the Byron units will result in increased environmental costs and risks, the staff, in assessing these issues, has found them to be small. If the Byron units are not allowed to operate, environmental costs and risks would still result because of increased use of other generating facilities.

Although decommissioning is identified as an additional cost of operating the Byron units, this cost represents less than 17% of the projected cost savings resulting from the operation of Byron for the year 1987 alone.

3 ALTERNATIVES TO THE PROPOSED ACTION

3.1 Résumé

During the construction permit (CP) stage of the licensing process, the staff analyzed alternative sites, alternative plant designs, and alternative sources of generation, including the alternative of not adding new production capacity. The staff concluded, on the basis of its analysis of these alternatives as well as a cost-benefit analysis, that additional capacity was needed, that nuclear energy would be an environmentally acceptable means of providing the capacity, and that the Byron station, at a specified site and of a specified design, was acceptable from an environmental perspective. Since that time, the Byron station has been substantially constructed. The economic and environmental costs associated with the construction of the Byron station that have been incurred must be viewed as "sunk costs" in any prospective assessment.

3.2 Alternatives

At the operating license (OL) stage it is not rational to consider different sites, extensive plant modifications, or the construction of new and different energy sources* as alternatives to the existing nuclear facility.

The environmental costs associated with any of these alternatives, which were considered and foreclosed at the CP stage, would now be prohibitive when compared to the incremental costs of operating the completed station. These alternatives would require significant environmental and capital commitments, in addition to their costs of operation. Further, the delays caused by any proposed change in plans would necessitate an assessment of the cost of providing the energy that could have been produced by the Byron Station versus the cost of energy from replacement energy sources during the delay period.

Therefore, it is the staff's view that the only alternative to the operation of the Byron station is to deny its operation. The NRC staff has evaluated the cost differential of denying the operation of Byron station in Section 2.2 of this statement and finds that savings of about $200 million per year per unit would be realized during the proposed initial years of operation of the Byron station. Comparable savings would be expected for subsequent years.

Thus, the only feasible alternative to operation has been evaluated, and operation of the Byron station has been determined to be the preferred alternative.

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*On March 26, 1982, the Commission published a rule in the Federal Register, effective April 26, 1982, explicitly removing any need to consider alternative energy sources in an NRC operating license environmental review and environmental impact appraisal (47 FR 12940).

4. PROJECT DESCRIPTION AND AFFECTED ENVIRONMENT

4.1 Résumé

This résumé highlights changes in the design of the facility and new information on the local environment gathered since the FES-CP was issued in 1974.

Minor changes were made in the plant layout, including the construction of a waste treatment building, a waste water settling basin, and the technical support building. Also, the site was enlarged by 159 ha (394 acres). The applicant is developing a land management plan for the site that will be presented to the State Department of Conservation.

Water-use rates from the Rock River have been revised downward while the rate of withdrawal of groundwater for steam cycle makeup and the potable/sanitary system has increased. The amount of biocide in the circulating water system has been reduced by use of a mechanical cleaning system in the station main condenser. The station cooling water intake structure design has been finalized, and the structure constructed since the FES-CP. The station essential cooling system, which was not described in the FES-CP, consists of two mechanical draft cooling towers of four cells each.

Changes in the gaseous, liquid, and solid radwaste systems have occurred since the FES-CP which will result in some changes to the source terms and the volume of solid radwaste for shipment off site assumed in the FES-CP.

Water quality data collection on the Rock River and nearby creeks has continued, with some changes in data since the FES-CP. The applicant discovered that toxic waste had been dumped on the property before they acquired it. This waste has been disposed of in an acceptable manner.

Population growth estimates in the FES-CP have been found to be generally greater than present data would support.

4.2 Facility Description

4.2.1 External Appearance and Plant Layout

While the external appearance of the plant has not had any significant changes, there are changes in the plant layout. These changes are

(1) An enlargement of the main parking area to roughly 107 m by 69 m (350 feet by 225 feet)

(2) An enlargement of the permanent gate house, which is located in the southeast corner of the main parking area

(3) The construction of a waste treatment building and an adjoining waste water settling basin located east of the Unit 2 portion of the turbine room

(4) Minor changes in configuration and size of storage tanks located in the area between the turbine room and the cooling towers.

The above changes are included in Figure 4.1. The applicant plans to construct emergency preparedness facilities to meet the Commission upgraded emergency planning requirements contained in Appendix E to 10 CFR 50. One change is 27-m by 18-m by a (90 feet by 60 feet) technical support building to be attached to the south end of the turbine building, according to a personal communication between the staff and applicant. There will also be an emergency operations facility located at CECo's administrative offices in Dixon, Illinois. The construction of the technical support building is not expected to disturb the area relative to previous disturbances for construction of the facility. The offsite EOF is to be located in an existing building and therefore will have no additional impact.

Finally, the railway spur, which is just under 8 m (5 miles) long, contains about 32 ha (80 acres) of previously farmed land. This contrasts with the 5-km (3-mile) length and 36 ha (90 acres) which the spur was to require, as reported in Section 4.1 of the FES-CP.

4.2.2 Land Use

Since the FES-CP, the site has been enlarged by 159 ha (394 acres), with most of this land currently devoted to agricultural use. Of the 710 ha (1754 acres) 2 ha (4 acres) of woodland and 161 ha (399 acres) of agricultural land were disturbed because of plant building activities. Approximately 61 ha (150 acres) of land encompassing the major plant structures are fenced. A management plan is being developed for the site, and it will be presented to the State Department of Conservation. As currently envisioned, there will be a reduction in the amount of high-quality agricultural land removed from production, and wildlife habitat and natural state areas will be limited to lower quality and high-contour land.

Six soil series occur within the exclusion area (Catlin, Plano, Saybrook, Martinsville, Rockton, and Whalen), all of them prime agricultural land if the slope is less than 5 percent. Changes in land use due to transmission line construction are primarily caused by the clearing of land along the right-of-way. However, only about 10% of the right-of-way occurs in forest land. The terrain crossed by the right-of-way is similar to that on the plant site and is likely to have the same species as were described for similar habitats on site (FES-CP, Section 2.7.1, ER-OL, Section 2.2.2).

4.2.3 Water Use and Treatment

4.2.3.1 General

The overall water-use scheme for the Byron station has not changed since the issuance of the FES-CP. That is, the station is equipped with a closed-cycle cooling system that uses natural-draft cooling towers in the circulating water and nonessential service water cooling loop (that is, condenser cooling water

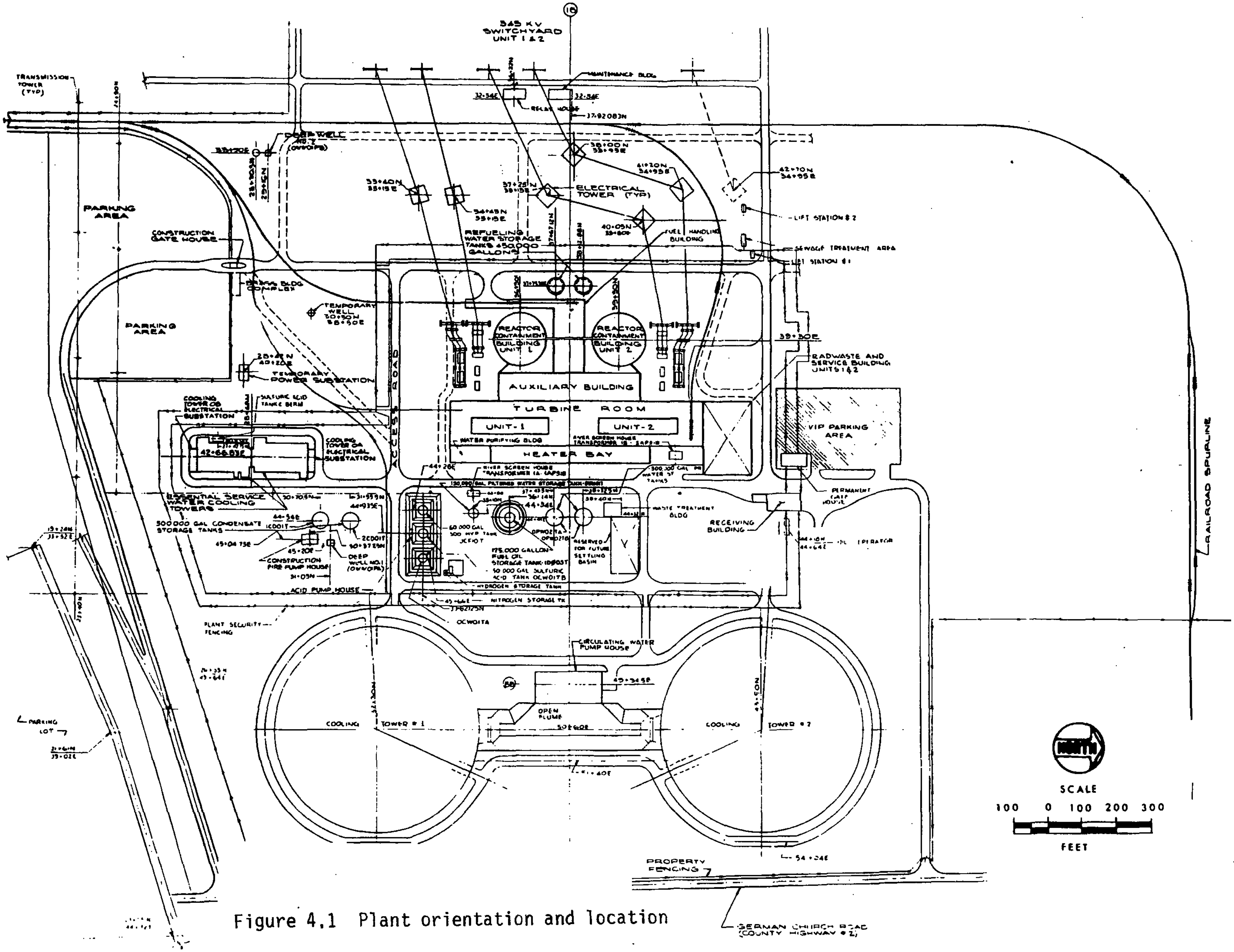


Figure 4.1 Plant orientation and location

and station service water) and mechanical-draft cooling towers for the station essential service water cooling loop. Also, as described in the FES-CP, the Rock River will supply all station circulating and service water systems, while groundwater from onsite wells will supply water for the steam cycle makeup and potable/sanitary supply systems. The Rock River will be the receiving water for all station wastewater.

4.2.3.2 Surface Water Use

The volumetric flow rates for the various water systems of the Byron station have been revised since the issuance of the FES-CP based on (1) a decision to reduce station river water appropriation, (2) a determination that higher total dissolved solids concentrations in the station blowdown could be tolerated without adverse effect, and (3) a revised guarantee on maximum drift loss from the natural-draft cooling towers of 0.002% of the circulating water flow rate, or 1.7 l/sec (0.06 ft^3/sec), down from a predicted value of 25.2 l/sec (0.89 ft^3/sec) in the FES-CP. As a result, the predicted station makeup and blowdown rates from and to the Rock River have been revised downward from the estimated range shown in the FES-CP. These values are now estimated as follows for 100% station load:

	Makeup	Blowdown
Average	2.2 m^3/sec (76.9 ft^3/sec)	0.9 m^3/sec (30.1 ft^3/sec)
Seasonal Averages		
Minimum	1.9 m^3/sec (68.1 ft^3/sec)	0.6 m^3/sec (20.0 ft^3/sec)
Maximum	2.4 m^3/sec (86.3 ft^3/sec)	1.0 m^3/sec (36.9 ft^3/sec)

The station will consume water primarily through evaporation from the circulating and nonessential service water systems. The average evaporative loss is estimated at 1.3 m^3/sec (46.7 ft^3/sec), with a monthly average range of 1.05 m^3/sec (37 ft^3/sec) to 1.5 m^3/sec (54.6 ft^3/sec). Consumptive water use through evaporation from the essential service water system will be small, estimated 0.06 m^3/sec (2 ft^3/sec). Station surface water usage is shown in Table 4.1 and Figure 4.2.

At 100% load, the water-use rates given above represent an average concentration factor of about 2.6, with average seasonal values ranging from about 2.3 to 2.8. The average concentration factor given in the FES-CP was about 2.1.

4.2.3.3 Groundwater Use

The estimated rate of withdrawal of groundwater by the station during operation for steam cycle makeup and potable/sanitary system use has increased from 18.9 l/sec (0.67 ft^3/sec) in the FES-CP to an average of 31.1 l/sec (1.1 ft^3/sec). This water will be supplied by two onsite wells, each with a capacity of 50.4 l/sec (1.78 ft^3/sec). Normally, one well will be pumped, with the other on standby. Water usage by the station systems supplied by groundwater is shown in Table 4.1 and Figure 4.2.

The FES-CP indicated that a potable water supply would be developed for the station with an expected capacity of 75.7 l/min (20 gpm), utilizing an onsite water storage tank. The presently installed system employs a 567,750-l

Table 4.1. Variations in plant water use, ft^3/sec

System	100% operation	50% operation	Hot standby[1]	Cold shutdown
Natural draft cooling tower system				
Makeup	76.9	39.0	15.4	0
Blowdown	30.1	15.5	15.4	0
Evaporation	46.7	23.5	0	0
Drift	0.06	0.06	0.06	0
Sanitary System[2]	0.22	0.22	0.22	0.22
Radwaste System[2]	1.1	1.1	1.1	1.1
Demineralizing system[3]				
Makeup to steam generator	0.33	0.17	0	0
Mechanical-draft cooling tower essential service water system				
Makeup	4 (peak)	4 (peak)	2.5	0
Blowdown	2 (peak)	2 (peak)	2.0	0
Evaporation	2 (peak)	2 (peak)	0.5	0
Drift	0	0	0	0

[1]Subject to operating variables.

[2]Intermittent flow.

[3]The demineralizers are designed to have a greater capacity to supply demineralized water during startup conditions.

Note: All values are in ft^3/sec for two-unit operation. To convert to m^3/sec, multiply values in this table by 0.028.

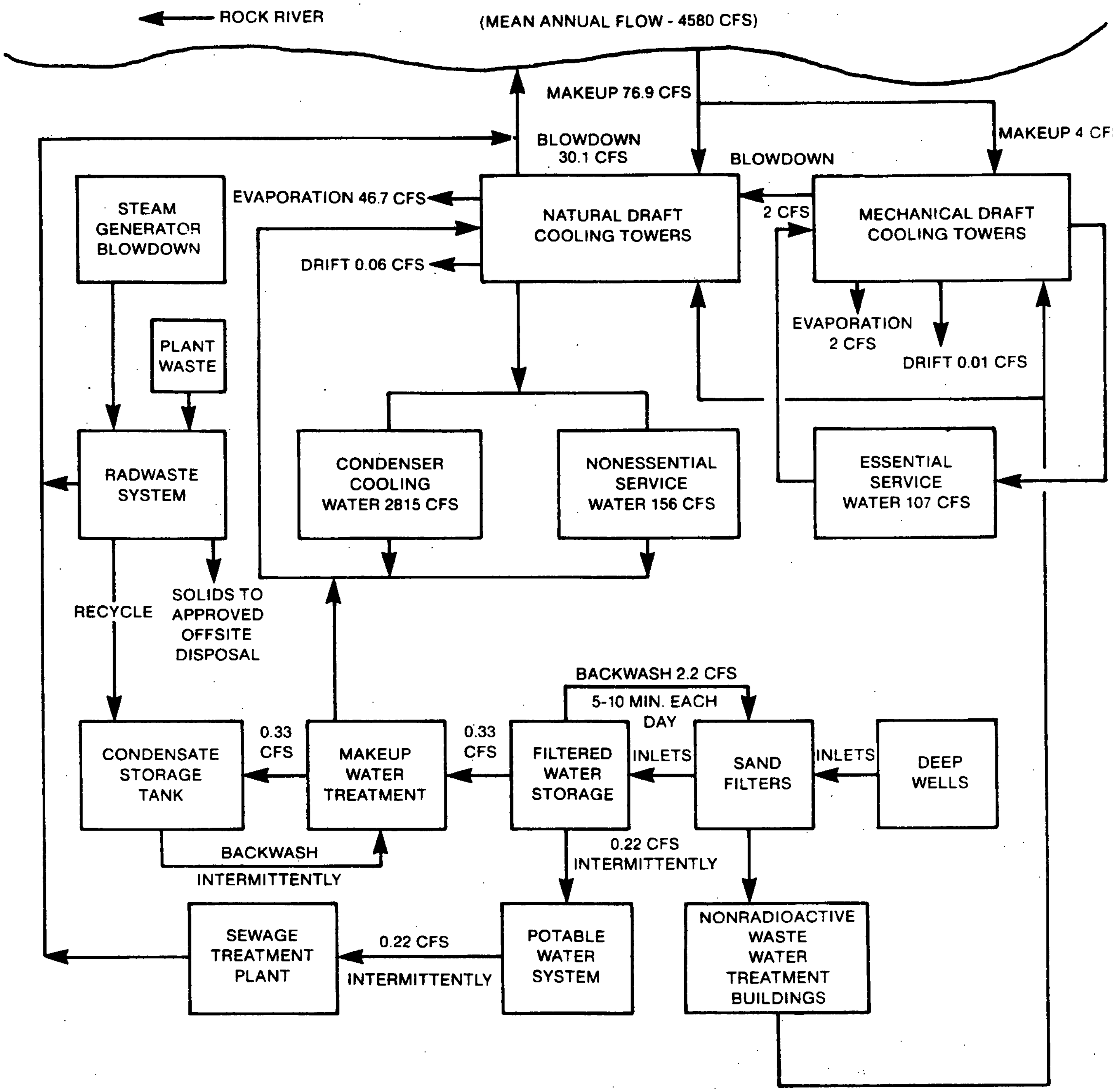


Figure 4.2 Water Usage Flow Diagram

(150,000-gal) filtered water storage tank, which supplies water to the potable water system at a rate of up to 378.5 l/min (100 gpm).

4.2.3.4 Surface Water Treatment

4.2.3.4.1 Circulating Water and Nonessential Service Water Systems

There have been changes in the treatment of the water withdrawn from the Rock River for use in these systems from that described in the FES-CP.

Biofouling control in the circulating water system during operation will now be aided by the use of a mechanical cleaning system in the station main condensers. This system uses sponge rubber balls to wipe the condenser tubes clean of biological growths that could reduce heat transfer across the condenser tube walls. These balls are injected into the cooling water flow at the condenser inlet, automatically strained out at the condenser outlet, and recirculated to the head of the condenser or stored for use at a later time. This system reduces the amount of biocide needed to control biofouling on heat transfer surfaces. Biocide will be used in the remainder of the system where use of a mechanical system is not possible.

As stated in the FES-CP, sodium hypochlorite biocide will be periodically injected into the circulating water system in amounts sufficient to attain a free available chlorine residual of 0.1 mg/l. However, the point at which this residual is to be attained is the outlet of the cooling tower basins, not the outlet of the condenser, as proposed in the FES-CP. This change was made because of the addition of the mechanical condenser cleaning system.

Treatment of the nonessential service water system with sodium hypochlorite for biofouling control will be as described in the FES-CP with an expected free available chlorine residual of 0.1 mg/l to be attained at the discharge of the nonessential service water system into the circulating water system. The applicant has provided the following additional information: the intermittent hypochlorite applications are estimated to consume about 836 kg (1840 lb) of 15% sodium hypochlorite per day; biocide addition is expected to be required three times per day; and biocide addition is expected to last 30 minutes per application.

In addition to the treatment of the makeup water for these cooling water systems with sulfuric acid, as described in the FES-CP, the applicant plans to use Aminomethylene phosphonate (AMP) or 1-Hydroxyethylidene-1, 1-Diphosphonic Acid (HEDP) for scale control and Polyacrylate as a dispersant. Use of AMP or HEDP will reduce the amount of acid needed. The appliant estimates that an average feed rate of 14.8 l/min (3.9 gpm) of 93% sulfuric acid, resulting in a concentration of aout 1.5 mg/l, will be required to maintain system pH between 7.0 and 7.5. The dispersant will be added in an amount sufficient to maintain a 2.0 mg/l concentration in the system (ER-OL Amendment 3).

4.2.3.4.2 Essential Service Water System

The treatment of the essential service water is as stated in the FES-CP, namely chlorination with sodium hypochlorite. The application frequency and duration and target concentration are the same as discussed under the nonessential service water system. The amount of 15% sodium hypochlorite solution estimated to be needed is about 580 kg (1275 lb) per day.

4.2.3.5 Groundwater Treatment

4.2.3.5.1 Makeup Water System

Water for use in this system is withdrawn from onsite wells, sand filtered and stored for use in the station's two 568 l/day (150 gpd) capacity demineralization systems.

4.2.3.5.2 Potable Water System

Water for use in this system is taken from the filtered water storage tank and processed through two zeolite softeners for use in the station. The rate of usage, about 56,775 l/day (15,000 gpd), is expected to be small compared with other station usage.

4.2.4 Cooling System

4.2.4.1 General

The type and arrangement of the components in the Byron station cooling system have not changed since the issuance of the FES-CP. However, there have been changes in the actual component specifications as compared to the estimates presented in the FES-CP. These are described below along with a description of the cooling system for the essential service water system, which was not described in the FES-CP. Location of these structures is shown in Figures 4.1 and 4.3.

4.2.4.2 Intake

The station intake structure design has been finalized and the structure completed since the issuance of the FES-CP. The two-bay shoreline structure is located and equipped as stated in the FES-CP, with the following exceptions: all three circulating water pumps (that is, two for normal operation and one for standby) have the same pumping capacity of about 1.51 m^3/sec (53.5 ft^3/sec); the second bar grill system for removal of waterborne debris that passes through the outside trash rack and the traveling screens is located in the station screen house where the circulating and nonessential cooling water is pumped to the main condenser and service water heat exchanger after leaving the natural-draft cooling tower basins. These grills were described to be in the river intake structure in the FES-CP.

A revised estimate of water velocities in the intake structure is available, based on the design parameters of the intake as constructed. The maximum expected approach velocity in the area between the mouth of the intake at the bar grill to the face of the traveling screens is between 0.13 m/sec (0.43 ft/sec) and 0.17 m/sec (0.55 ft/sec). This value, as estimated in the FES-CP, was about 0.15 m/sec (0.5 ft/sec).

As stated in the FES-CP, debris removed from the traveling screens and bar grills will be disposed of off site by an independent contractor.

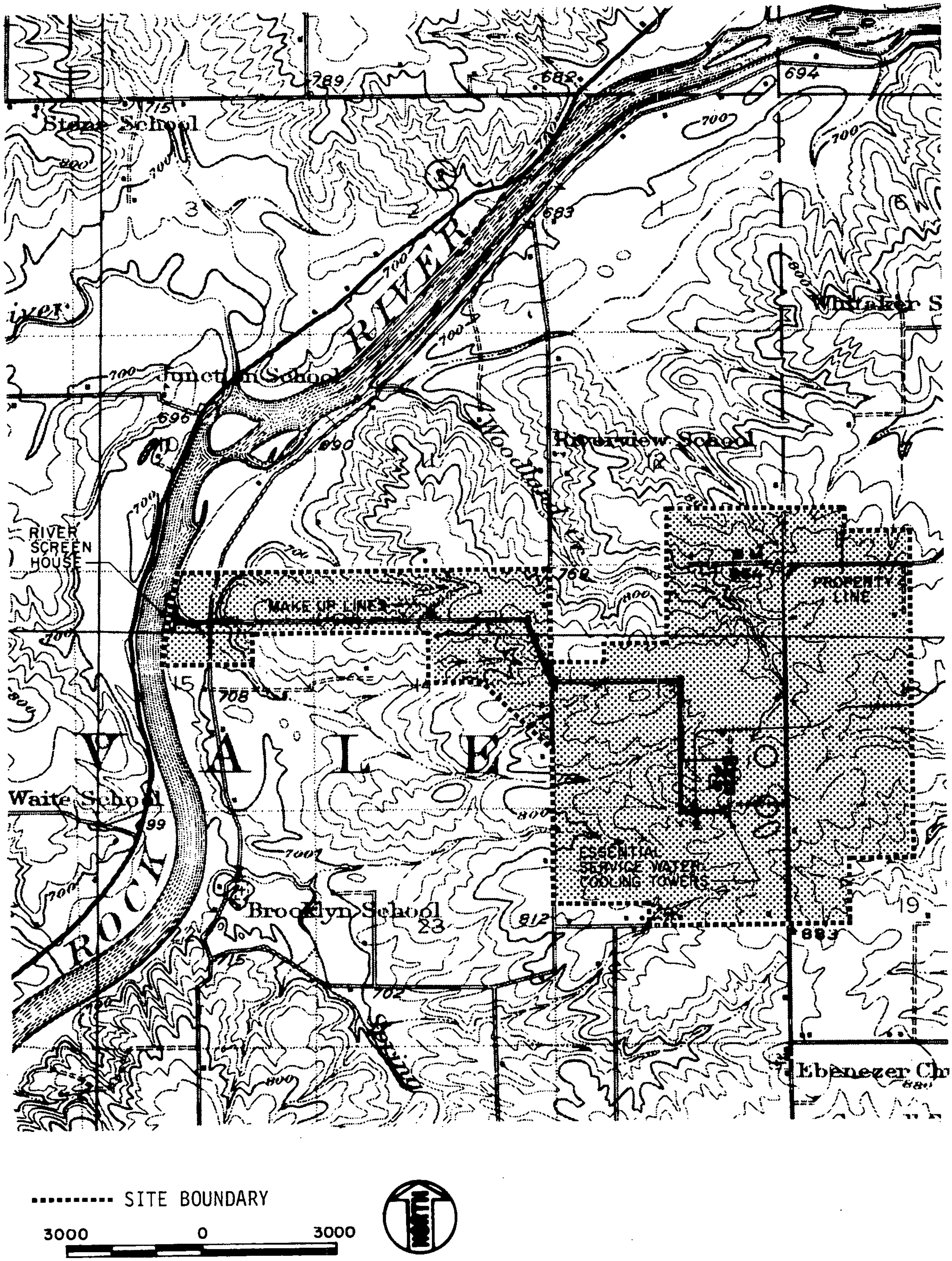


Figure 4.3 Cooling system arrangement

4.2.4.3 Circulating Water Cooling System and Nonessential Water Cooling System

The cross-flow natural-draft cooling towers that will serve these systems have been constructed with the dimensions given below, which show the towers to be larger than projected in the FES-CP. The dimensions are

hyperbolic shell height - 151 m (495 feet)
hyperbolic shell exit diameter - 83 m (272 feet)
water collection basin diameter - 184 m (605 feet)

The heat rejection rate for the towers remains the same as shown in the FES-CP, 1.6 x 10^{13} J/hour (1.52 x 10^{10} Btu/hour). However, the water flow rate through the towers is greater than that shown in the FES-CP, and is now given as 84.2 m^3/sec (2972 ft^3/sec), resulting in a 13.1-second time of passage through the station main condensers, as compared with a 14.2-second time given in the FES-CP. The temperature rise across the condenser remains the same as described in the FES-CP, 13.3°C (24°F) maximum.

4.2.4.4 Station Essential Water Cooling System

The station essential water cooling system was not described in the FES-CP. This system includes two linear mechanical-draft cooling towers of four cells each. Tower dimensions are as follows: 15 m (50 feet) high, 53 m (174 feet) long, and 14 m (45 feet) wide. These towers will operate continuously during station operation with a flow rate through each tower of 3 m^3/sec (107 ft^3/sec). Makeup, blowdown, and evaporation rates for these towers are given in Table 4.1 and Figure 4.2.

4.2.4.5 Discharge

The location of the station discharge structure is as described in the FES-CP. The design of the discharge structure has changed since the issuance of the FES-CP, section and plan views of the discharge structure as built are shown on Figure 4.4. The significant changes from the structure described in the FES-CP are the maximum predicted discharge velocity of 1.3 m/sec (4.3 feet/sec), up from 0.6 m/sec (2 feet/sec) in the FES-CP and the use of two blowdown water pipes from the station to the discharge structure instead of a single pipe, as shown in the FES-CP. These pipes are equipped with valves that will permit stoppage of blowdown from either or both units during shutdown or refueling.

4.2.5 Radioactive-Waste-Management System

Portions of the design of the liquid, gaseous, and solid radwaste systems have been changed since the construction permit (CP) stage. These changes are:

(1) At the CP stage the steam generator blowdown subsystem was to process steam generator blowdown (SGB) through a blowdown evaporator and polishing demineralizer with the water reused in the station. The present scheme treats SGB by demineralization with either reuse or discharge off site.

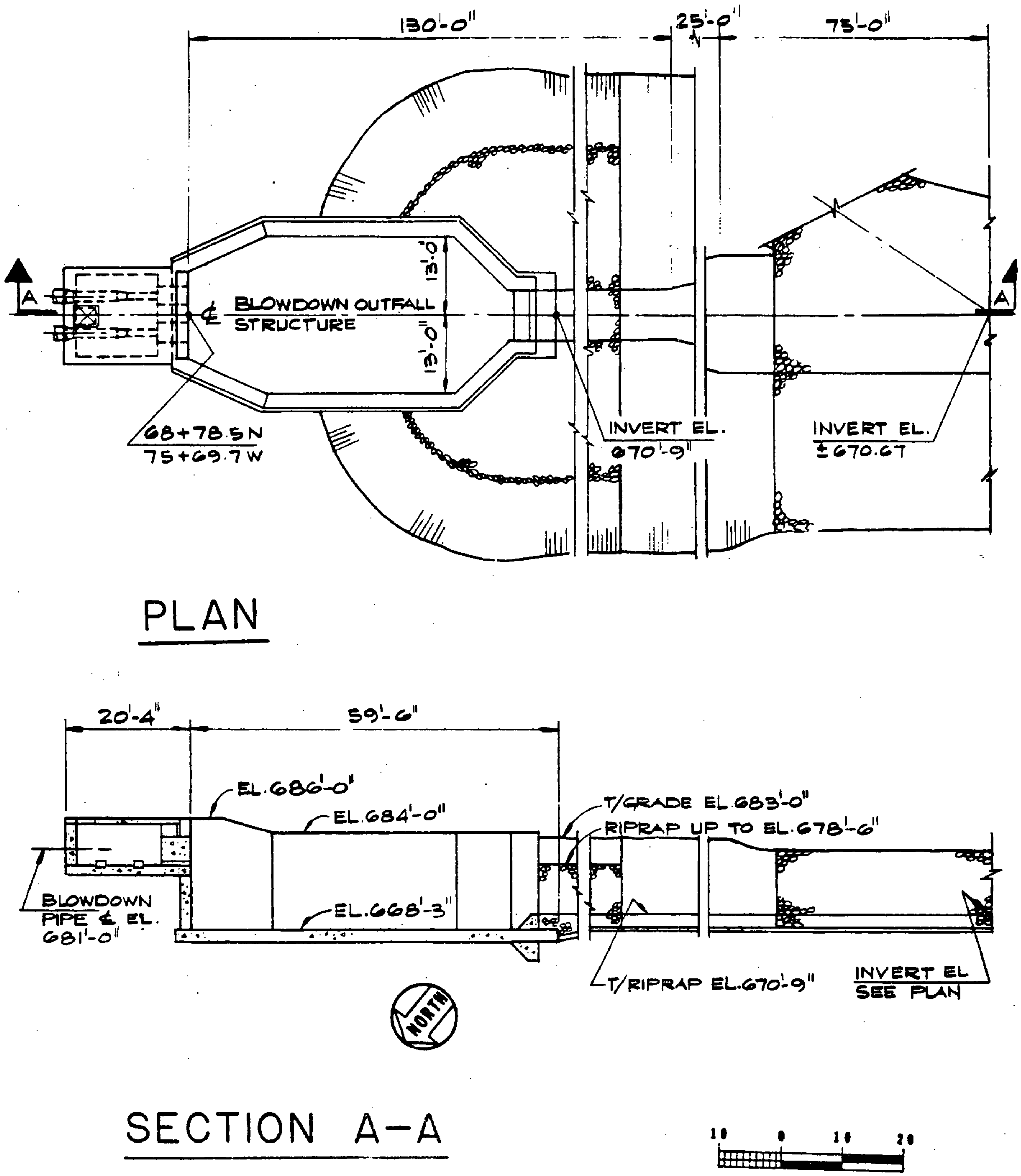


Figure 4.4 Discharge structure

(2) At the CP stage, laundry wastes were to be treated by reverse osmosis and evaporation with the liquid recycled or discharged off site. Currently the intended treatment for the laundry waste is that it will be filtered and then discharged off site. It should be noted that the capability exists within the liquid radwaste treatment system for treating SGB and laundry wastes by evaporation but this is not the intended mode of treatment.

(3) At the CP stage, the main condenser air ejector exhaust was to be filtered by a HEPA filter with the capability to divert the exhaust to a charcoal adsorber only on a high radiation signal. It is now planned that the exhaust will be filtered by a HEPA filter and a charcoal adsorber only on a high radiation signal and will be unfiltered at all other times. The radwaste building exhaust was to be filtered by a HEPA filter at all time with the capability to divert flow through a charcoal adsorber on a high radiation signal. It is now planned that the exhaust from the radwaste building will be filtered by a HEPA filter at all times, with no provisions for the diversion of flow through a charcoal adsorber.

(4) Wastes were to be solidified by a mixture of cement and vermiculite. Now wastes will be solidified by either cement or a polymer binder.

(5) The amount of evaporator bottoms solidified, contaminated oil and trash compacted will be reduced from that anticipated at the CP stage as a result of the use of volume reduction equipment (fluidized bed dryer and dry waste processor).

Under requirements set by 10 CFR 50.34a an application for a permit to construct a nuclear power reactor must include a preliminary design of equipment to keep levels of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable (ALARA). The term ALARA takes into account the state of technology and the economics of improvements both in relation to benefits to the public health and safety and other societal and socioeconomic considerations and in relation to the utilization of nuclear energy in the public interest. Appendix I to 10 CFR 50 provides numerical guidance on radiation-dose-design objectives for light-water-cooled nuclear power reactors to meet the requirement that radioactive materials in effluents released to unrestricted areas be kept ALARA.

To comply with the requirements of 10 CFR 50.34a, the applicant has provided the final designs of radwaste systems and effluent-control measures for keeping levels of radioactive materials in effluents ALARA within the requirements of Appendix I to 10 CFR 50. In addition, the applicant has provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced during normal operation, including anticipated operational occurrences.

The staff's detailed evaluation of the solid radwaste system and its capability to accommodate the solid wastes expected during normal operations, including anticipated operational occurrences, is in Chapter 11 of the Safety Evaluation Report (NUREG 0876). On the basis of its evaluation and on recent data from operating PWRs, the staff estimates that between 6,600 and 25,644 ft^3 of "wet" solid wastes containing approximately 2000 Ci of radioactivity, mainly the long-lived fission and corrosion products, Cs-134, Cs-137, Co-58, Co-60, and Fe-55, and between 324 and 12,000 ft^3 of "dry" solid wastes containing less than 10 Ci of radioactivity will be shipped offsite annually from the Byron station to a licensed burial site or placed in storage. The range of estimated radwaste volumes shipped offsite or stored reflects the varying degree of use of the volume reduction equipment. Greater use of the volume reduction equipment will result in a smaller volume of waste. The packaging and shipping of all these wastes will be in conformance with the applicable requirements of 10 CFR 20 and 71 and 49 CFR 170-178.

The quantities of radioactive material that are now estimated by the staff to be released from the plant are presented in Appendix C to this statement, along with examples of the calculated doses to individual members of the public and to the general population that result from these effluent quantities.

As part of the operating license for this plant, the staff will require Technical Specifications limiting release rates for radioactive material in liquid and gaseous effluents and requiring routine monitoring and measurement of all principal release points to ensure that the plant operates in conformance with the radiation-dose-design objectives of Appendix I to 10 CFR 50, as amended.

4.2.6 Station Nonradioactive Effluents

4.2.6.1 General

The station nonradioactive effluents will result from operation of the station evaporative cooling systems, station water treatment systems, and station wastewater treatment systems. The systems producing these effluents and the types of effluents produced have not changed significantly since the issuance of the FES-CP. However, the volumes and character of the effluents produced have changed and these changes are discussed below.

Since the issuance of the FES-CP, the applicant has commissioned two simulations of the Byron Station thermal discharge into the Rock River (ER-OL Section 5.1). These simulations compared the predicted sizes of the thermal plume under the conditions of shore attachment of the plume (a condition where maximum temperatures are found along the bank of a stream instead of at some distance offshore) and of fully mixed plume conditions (nonshore attachment). Worst case discharge conditions, including adverse meteorology, low river flow 42.5 m^3/sec (1500 ft^3/sec) and initial excess temperatures up to 24.8°C (44.7°F), were considered. The results of the analyses and a comparison with the analysis results in the FES-CP are in Table 4.2. In all but one case, the applicant's simulations show areas for the 2.7°C (5°F) excess isotherm to be less than those presented in the FES-CP. In all instances, these areas are predicted to be less than the approximate 10.5 ha (26 acres) allowable mixing zone for this and higher excess temperature isotherms. The applicant's simulations also show that for the extreme worst case (March/April) that the 2.7°C (5°F) isotherm would extend about 3.1 km (1.9 miles) downstream, and the 1.1°C (2°F) isotherm would extend about 4.4 km (2.75 miles) downstream. The widths of the thermal plumes are predicted to be about 25% of the river width for this extreme case.

4.2.6.2 Cooling Water Systems

The operation of the closed cycle cooling systems for the station will result in discharge of water of different composition than that withdrawn from the

Table 4.2. Comparison of excess 2.7°C (5°F) plume sizes

River discharge (ft^3/sec)	IIHR (Paily 1975a)[2]	ER-OL[2]	FES-CP
1501	0.3	21.2	23
2178	2.5	17.5	13.7
2200	4.1	16.5	22
2222	1.0	23	29
2254	0.7	12.8	14.5

[1]To convert ft^3/sec to m^3/sec, multiply values shown by 0.028, to convert acres to hectares multiply values shown by 0.405.

[2]Applicant estimates

Source: ER-OL Table 5.1-5.

Rock River. As indicated in Section 4.2.3, the evaporative loss from the natural draft and mechanical draft cooling tower systems will result in a concentration of the physical and chemical constituents in the makeup water. The expected average concentration of these constituents, based on the average Rock River water quality data collected since the issuance of the FES-CP is shown in Table 4.3. Maximum average discharge concentrations could be expected to be about 10% higher than the values shown in that table, based on the operational variability of the station cooling system (station seasonal maximum expected concentration factor is about 2.8). Short-term maximum concentrations, using maximum seasonal values for the major water quality constituents, are shown on Table 4.4. This exact discharge composition would not normally be expected to occur because constituent maxima do not occur simultaneously.

Also affecting the composition of the station blowdown from the cooling water systems are the chemical additions to the makeup water for these systems to control biofouling, scale, and system pH (see Section 4.2.3.4). These additions will noticeably affect the total dissolved solids, sulfate, and alkalinity concentrations and, to a much lesser extent, affect the sodium and chloride concentrations in the blowdown. The expected average and maximum values are shown in Tables 4.3 and 4.4, respectively.

The estimated amount of dissolved solids expected to escape from the station natural-draft cooling towers in the drift has changed from the estimate given in the FES-CP. Based on an estimated maximum drift rate of 0.002% of the circulating water flowrate and a maximum seasonal average total dissolved solids (TDS) concentration of 1823 mg/l (the same as the average winter season circulating water concentration), up to about 265 kg/day (585 lb/day) of solids could be dispersed in the drift. Based on an average TDS concentration of

Table 4.3. Estimated average effluent analysis (All values in mg/liter)

Effluent	Blowdown	Final discharge to river
Calcium	174	174
Magnesium	89	89
Sodium	48	48
Sulfate	602	602
Chloride	74	74
Alkalinity (as $CaCO^3$)	143	143
Nitrate	5	5
Total Dissolved Solids	1555	1555
Silica	8	8

Source: ER-OL Table 3.6-5.

1555 mg/l, up to about 225 kg/day (500 lb/day) of solids could be dispersed in the drift, as compared to about 1659 kg/day (3650 lb/day) under average conditions, as estimated in the FES-CP. Expected average drift composition is shown on Table 4.5.

Sodium hypochlorite additions for biofouling control in the cooling water systems will result in the discharge of combined available chlorine, as indicated in the FES-CP. However, the estimated amount of biocide to be used has decreased since the FES-CP (see Section 4.2.3.4). The discharge concentration of total residual chlorine will likely be restricted to a lower value than the staff estimated in the FES-CP, based on the Proposed Conditions for Future Discharges in the station NPDES permit (Appendix B, NPDES Permit, Part IV). The proposed limit is 0.2 mg/l total residual chlorine; the staff estimated in the FES-CP was that as much as "a few tenths" of a part per million (mg/l) could exist in the cooling tower basins and thus the blowdown. The FES-CP staff conclusion that the free available fraction of the total residual chlorine concentration in the blowdown would likely be not detectable remains the same.

The estimated volume of normally nonradioactive steam generator blowdown from the secondary coolant system has been revised from the estimate presented in the FES-CP from 17 l/min (0.01 ft^3/sec) to 68 to 221 l/min (0.04 to 0.13 ft^3/sec). The blowdown will be recycled to the condensate system after treatment in the blowdown system by demineralization. Wastes from the demineralization system are discharged with the cooling tower blowdown at a variable rate so that the water leaving Byron station will have a radioactivity level less than the applicable maximum possible concentration as stated in 10 CFR 20.

Table 4.4. Estimated maximum effluent analysis (all values in mg/liter as substance)

Effluent	Blowdown[1]	Discharge to river[2]
Calcium	188	188
Magnesium	97	97
Sodium	56	56
Sulfate	745	745
Chloride	92	92
Alkalinity (as $CaCO_3$)	114	114
Nitrate	8	8
Total Dissolved Solids	1854	1854
Silica	14	14

[1]Highest of the four seasonal average river analyses was used.

[2]In this analysis,the radwaste, sanitary waste, and waste treatment building waste discharges to the blowdown were considered negligible.

Source: ER-OL Table 3.6-4.

Table 4.5. Estimated average quantities discharged to the atmosphere from drift of two natural-draft cooling Towers at the Byron Station (lb/day)[1]

Effluent	Quantity
Calcium	56
Magnesium	29
Sodium	16
Sulfate	194
Chloride	24
Nitrate	2
Total Dissolved Solids	502

[1]To convert to kg/day, multiply values shown by 0.45.

Source: ER-OL Table 3.6-3.

4.2.6.3 Water Treatment System Wastes

The treatment systems for makeup and potable water supplies described in Section 4.2.3.3 will produce wastewaters intermittently because of the of exhausted demineralizer resins, and the regeneration of the water softening zeolite and backwashing of sand filters, respectively. The estimated chemical usage during demineralizer resin regeneration has decreased from that presented in the FES-CP, to 1018 kg/day (2240 lbs/day) of 93% sulfuric acid and 360 kg/day (792 lbs/day) of 100% sodium hydroxide. Total waste volume is estimated at 265,310 l/day (70,095 gal/day). Wastewater discharge is directed to the circulating water flow, as stated in the FES-CP. Regeneration of the zeolite softener is accomplished with brine. The waste produced is high in dissolved solids removed from the well water supply and are discharged to the circulating water system. Backwashing the sand filters is expected to occur once per day per filter (for 3 filters). The wastewater contains the suspended solids removed from the well water supply and are conveyed to the waste treatment building. Treatment by flocculation, clarification, oil skimming and filtration is followed by discharge to the circulating water system. Sludge from the clarification process is dried on-site in beds and then removed from the site for disposal in an approved landfill.

4.2.6.4 Wastewater Treatment

Station sanitary waste treatment will be as described in the FES-CP. The estimated volume to receive tertiary treatment and be discharged in the station blowdown is 59,000 l/day (15,525 gal/day).

4.2.7 Power-Transmission Systems

Five new transmission lines in three rights-of-way will be required for the Byron station. All of the right-of-way routes for the Byron station have been approved by the Illinois Commerce Commission. Table 3.9-1 of ER-OL Amendment 1 provides data regarding the actual rights-of-way which will be utilized which differ from the FES-CP Table 3.4. The main difference between the two tables is that wider rights-of-way will be needed; hence, a greater area (41 ha (100 acres)) will be required than is stated in the FES-CP. More specific routing maps for all three corridors are provided in the ER-OL than were available in the FES-CP (Figures 3.9-2 thru 3.9-5). A total of 95 km (59.3 miles) of rights-of-way will be needed to connect the Byron station to the existing transmission grid system.

Although the rights-of-way will be wider, there will be a reduction in the area of farmland taken out of production because tangent and light angle tower structures will be single shaft or narrow base lattice steel instead of conventional lattice steel towers.

4.3 Project-Related Environmental Descriptions

4.3.1 Hydrology

4.3.1.1 Surface Water Hydrology

The Byron station is 4.8 km (3 miles) southwest of the town of Byron in Ogle County in North Central Illinois. The station is 3.2 km (2 miles) east of the Rock River at river mile 115 which is 185 km (115 miles) upstream of the river's confluence with the Mississippi River. The plant site includes a portion of Woodland Creek, which is about 4.8 km (3 miles) long and an intermittent tributary to the Rock River. A portion of the site area drains to Black Walnut Creek which is about 3.2 km (2 miles) east of Byron station. Black Walnut Creek is an ungauged watershed that flows north and enters the Rock River just upstream of the Byron station.

There are no other significant streams within the immediate vicinity of the site. Figure 4.5 is a topographic map of the site and its vicinity.

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 471 km (293-mile) course of the Rock River, approximately 264-km (164 miles) are in Illinois; of the 28,218-km^2 (10,900-mi^2) drainage basin, about 13,721-km^2 (5300-mi^2 are in Illinois. The drainage area upstream of the site is about 20,700 km^2 (8000 mi^2).

There are two U.S. Geological Survey (USGS) river gauging stations on the Rock River near the site. The Rockton gauging station is 66 km (41 miles) upstream of the site and controls a drainage area of 16,473 km^2 (6363 mi^2); the Como gauging station is 72 km (45 miles) downstream and controls a drainage area of 22,665 km^2 (8755 km^2).

The drainage area between the two gauging stations is 6192 km^2 (2392 mi^2). The area between the Byron site and the Rockton gauging station is 4678 km^2 (1807 mi^2) or 75.5% of the drainage area between Rockton and Como gauging stations. The area between the Como gauging station and the site is 1514 km^2 (585 mi^2) or 24.5% of the drainage area between Rockton and Como gauging stations. For low or normal flows, the flow at the Byron site may be expressed as the sum of weighted flows at Rockton and Como. This approach gives

$$Q_{site} = 0.245\ Q_{Rockton} + 0.755\ Q_{Como}$$

For the purposes of predicting extremely high flows, the flow data from the Como gauging station are more reliable and are appropriate. This conclusion is reached because of the longer uninterrupted flood record at Como and because the flood flows at Como are more representative of the flows at the Byron site. Also the drainage area at Byron is 93% of that at Como. The annual maximum flood flow at the Byron site is calculated, using the following equation:

$$Q_{site} = 0.966\ Q_{Como}$$

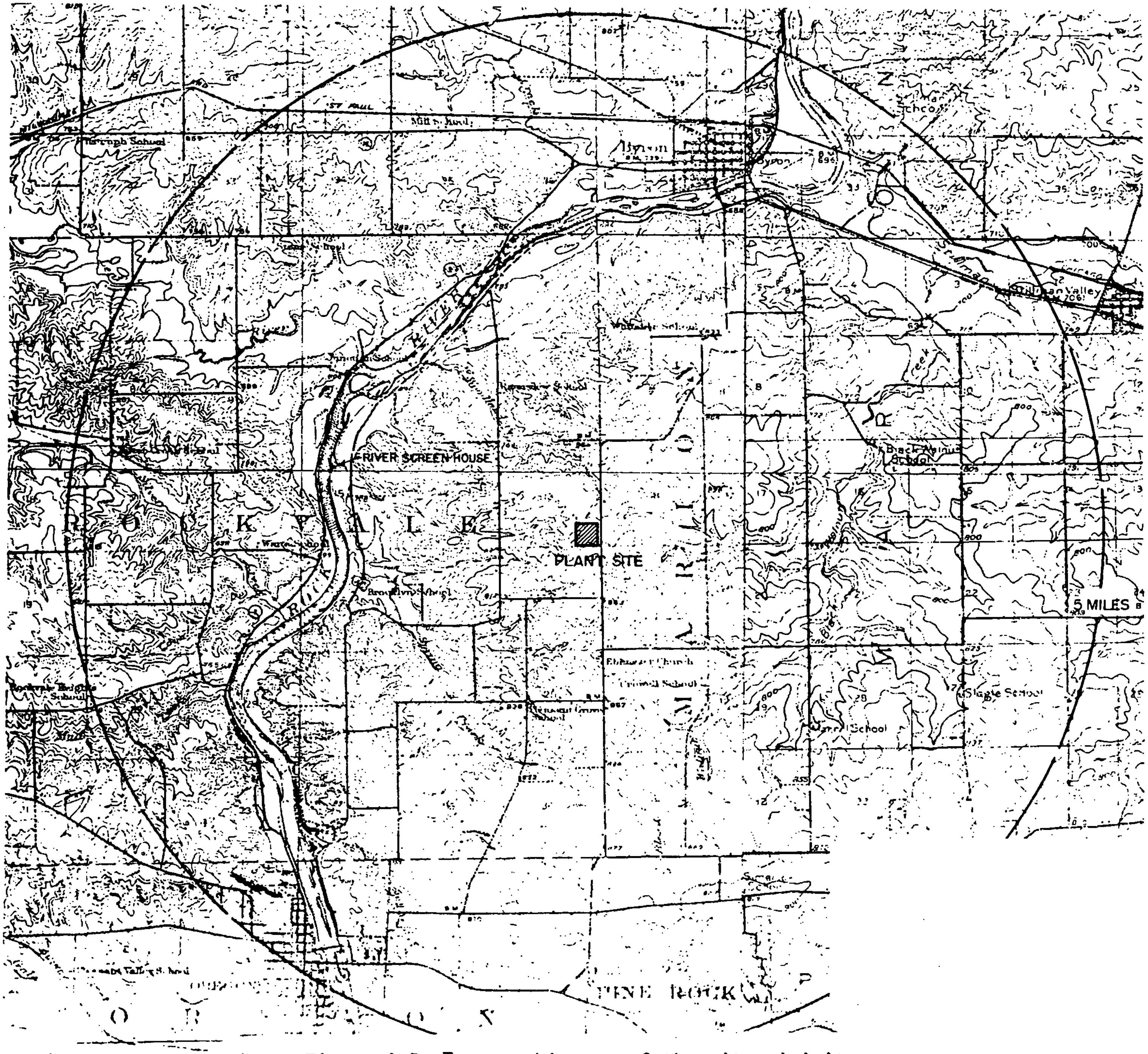


Figure 4.5 Topographic map of the site vicinity

Table 4.6 Rock River average monthly flows near the Byron station area

Month	Flow, cms	Month	Flow, cms
January	110	July	105
February	124	August	79
March	242	September	91
April	269	October	103
May	197	November	113
June	134	December	101

Source: ER-OL

The coefficient of 0.966 is obtained by taking the square root of the ratio of the drainage areas. The drainage area at Como station is 22,665 km^2 (8755 km^2) and at the Byron site is 21,151 km^2 (8170 mi^2).

Based on flow records through 1981, the long-term average flow rate of the Rock River in the vicinity of the proposed intake is 137 m^3 per second (cms) (4856 ft^3 per second (cfs)). Average monthly flow rates are given in Table 4.6. The average water surface elevation is 672 feet mean sea level (msl). The highest recorded discharge of 920 cms (32,500 cfs) at Rockton, Illinois occurred on March 30, 1916. The highest recorded discharge occurring at Rockton in recent times was 849 cms (30,000 cfs) on March 25, 1975. The flood of record at the Como gauging station was 1690 cms (59,700 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 370 cms (13,100 cfs), 215 cms (7,600 cfs), and 159 cms (5,600 cfs), respectively. The estimated flood of record in the Rock River near the site area was 1633 cms (57,700 cfs) on April 22, 1973.

The river screenhouse is the only structure that could be affected by flooding on the Rock River. The operating floor of the river screenhouse is located at an elevation of 687.0 feet msl, 1 meter (3.4 feet) above the flood-of-record elevation of 683.6 feet msl.

The estimated low flow rates for the Rock River at the site are given in Table 4.7. The 7-day 10-year low flow is 26 cms (925 cfs). The 11.3 cms (400 cfs) flow is based on the lowest recorded 1-day flow of 12.5 cms (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 (3.4 meters (11 feet) high), 71 km (44 miles) upstream; Fordham (4 meters (13 feet) high), 35 km (22 miles) upstream; Oregon (3 meters (10 feet) high), 8 km (5 miles) downstream; and Dixon (3.8 meters (12.4 feet) high), 43 km (27 miles) downstream.

The Rock River is relatively shallow (maximum depth between 2.1 and 4.6 meters); moderately fast-moving (average 0.7 meters per second), and completely mixed;

Table 4.7 Low flow data for the Rock River at the Byron station area

Duration-frequency	River flow, cms
1-day lowest	11.3
1-day 10-year low	20
7-day 10-year low	26
30-day 10-year low	30
60-day 10-year low	33
183-day 10-year low	42

Source: ER-OL

summer temperatures range from 21°C to 27°C 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.

4.3.1.2 Groundwater Hydrology

The four most significant hydrogeologic units at the site are the glacial drift, the Galena-Platteville dolomites, the sandstone units of the Cambrian-Ordovician Aquifer (the St. Peter, Ironton, and Galesville sandstones), and the Mt. Simon Aquifer.

A generalized stratigraphic column showing regional hydrogeologic units is presented in Table 4.8 and Figure 4.6.

4.3.1.2.1 Description

Glacial Drift

The site is covered with a mantle of glacial drift consisting mainly of till covered by a few feet of loess (windblown silt). A study of the borehole logs at the site indicates that the thickness of the drift there averages about 5.5 meters (18 feet). Groundwater may occur in the drift perched upon the underlying bedrock. The generally low permeability and thinness of the till preclude the development of the drift by drilled wells. The drift is recharged by precipitation.

Table 4.8 Generalized hydrogeologic column (meters)

Unit	Depth to top	Depth to bottom	Thickness	Hydrogeology
Glacial drift	0	3	3	Not an aquifer
Cambrian-Ordovician Aquifer[1]	3	260	256	Major aquifer
Galena-Platteville	3	60	58	Minor aquifer
St. Peter	67	146	79	Important aquifer
Ironton-Galesville	213	260	46	Most important aquifer
Eau Claire Formation	260	381	122	Not an aquifer
Mt. Simon Sandstone	381	838	457	Aquifer, salty at depth

[1]Only the most important units are listed
Source ER-OL

Galena and Platteville Groups

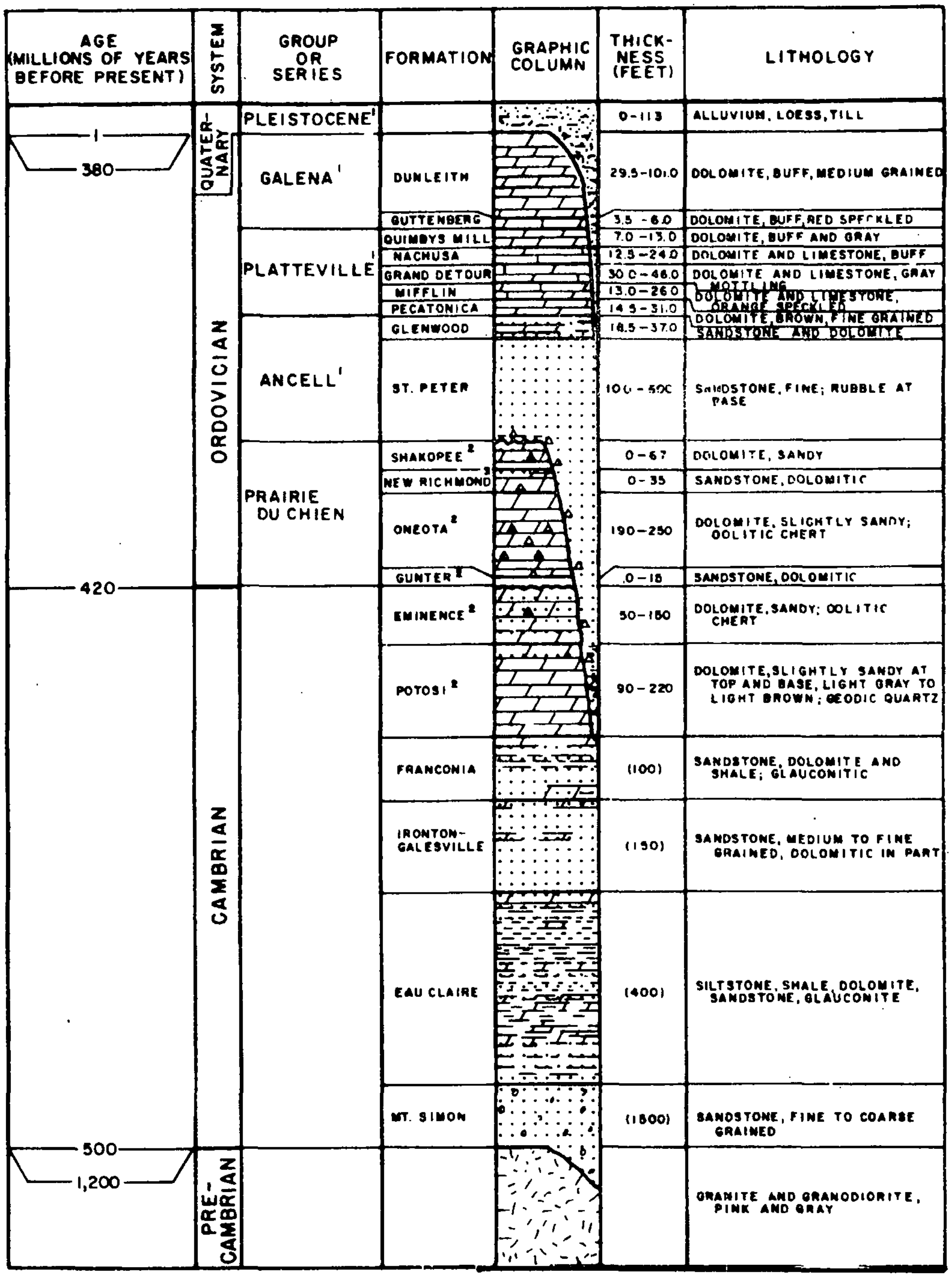
The thin mantle of drift is underlain by dolomites and limestones of the Ordovician-age Galena and Platteville groups. The dolomites are extensively fractured near the top, with solution-enlarged openings in places, but become denser with depth. In areas of thin drift, particularly where the till is absent or sandy, water table conditions may prevail. The study of borehole logs indicates that the Galena-Platteville dolomites range from about 30.5 meters (100 feet) to 68.5 meters (225 feet) thick at the site. The depth to the top of the dolomite equals the thickness of the drift.

A piezometric surface map of the site, constructed from groundwater levels measured before plant construction in onsite observation wells completed in the Galena-Platteville dolomites, is presented in Figure 4.7. This map shows that the Byron station lies on a potentiometric high with groundwater movement radially outward. The piezometric surface generally reflects the surface topography, as expected with a water table aquifer.

In the site area, the Galena-Platteville dolomites are recharged by precipitation through the overlying glacial drift and discharged into the Rock River and its associated tributaries and into shallow domestic wells.

St. Peter Sandstone

The Galena-Platteville dolomites are underlain by thin shales, sandstones, and limestones of the Glenwood Formation. This unit grades down into the thick sandstones of the St. Peter Sandstone. The Ordovician-age St. Peter Sandstone is permeable and has a relatively uniform lithology throughout the area. In



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.

Figure 4.6 Stratigraphic column

the regional area, the St. Peter Sandstone is discharged primarily through wells for small municipalities, subdivisions, parks, and several industries that have water requirements generally less than 757 lpm (26.8 ft^3/min). Numerous domestic wells in the site area obtain water from the St. Peter Sandstone.

The uneroded thickness of the Glenwood Formation in the area ranges from about 5.5 to 9.8 meters (18 to 30.4 feet). The full thickness of the St. Peter Sandstone in the area is about 76 meters (249 feet). Groundwater in the St. Peter Sandstone is confined under artesian conditions.

Ironton and Galesville Sandstones

Deep-well logs in the area suggest that the Prairie du Chien Group is locally missing and that Cambrian-age dolomites of the Eminence Formation, Potosi Dolomite, and Franconia Formation underlie the St. Peter Sandstone. These units have a combined thickness of about 68 meters (223 feet) in the site area.

The Franconia Formation is underlain by the Ironton and Galesville sandstones, which are about 46 meters (151 feet) thick in the site area. In the site area, the Ironton and Galesville sandstones are discharged primarily through industrial and municipal wells. Regionally, the Ironton and Galesville sandstones are considered the best bedrock aquifer in northern Illinois because of their consistent permeability and thickness. Yields on the order of hundreds of liters per minute may be obtained from the Ironton and Galesville sandstones in wells less than 300 meters (984 feet) deep. As reflected by their relatively high specific capacities, the Byron station wells have the Ironton and Galesville sandstones as their major water-producing zones.

Mt. Simon Sandstone

The Ironton and Galesville sandstones are underlain by the Eau Claire Formation, which is about 122 meters (400 feet) thick. The basal part of the Eau Claire Formation and the underlying Mt. Simon Sandstone (which is up to 457 meters (1500 feet) thick) form the Mt. Simon Aquifer. Wells yielding many hundreds of liters per minute have been finished in the Mt. Simon Aquifer, which contains fresh water to depths of about 610 meters (2000 feet)). The aquifer is recharged in outcrop areas in Wisconsin and with vertical leakage from overlying aquifers.

4.3.1.2.2 Onsite Wells

Two groundwater wells have been installed, developed, and tested at the station for potable water supply and demineralized water. The two Byron station water wells were completed through the Ironton and Galesville sandstones of the Cambrian-Ordovician Aquifer. The locations of these wells are shown in Figure 4.7.

The water wells are open from the Ancell Group through the Ironton and Galesville sandstones. As noted in Table 4.8, the Ironton and Galesville sandstones are the major water-producing zones.

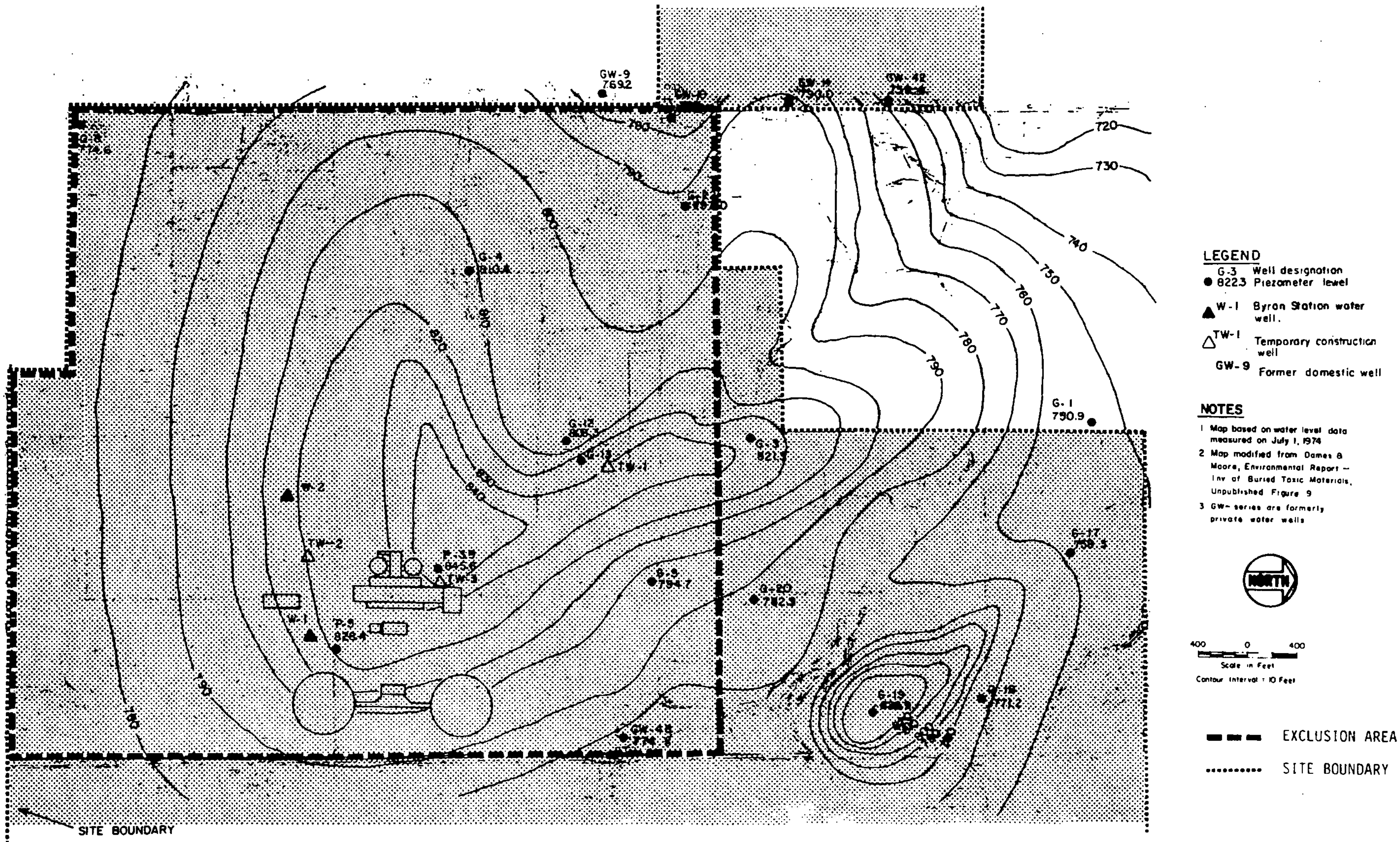


Figure 4.7 Site area piezometric surface map

Available drawdowns in the two water wells are approximately 36 meters (118 feet), based on static water levels of 57 meters (187 feet) in Well 1 and 56 meters (184 feet) in Well 2, and a final pump setting of 93 meters (305 feet) in both wells. The specific capacities obtained during pumping tests were 7.7 lpm/m (9.6 gpm/ft) of drawdown for Well 1 at 4350 lpm (1150 gpm) for 24 hours and 8.3 lpm/m (10.3 gpm/ft) of drawdown for Well 2 at 2350 lpm (620 gpm) for 12 hours. Although each pumping test lasted 24 hours, the pumping rate for Well 2 was relatively constant for the initial 12 hours and then varied between 1640 and 3560 lpm (433 and 939 gpm) during the last 12 hours. Grouting at the Byron Station did not extend into the formations open to the site water wells, so the specific capacities were unaffected by onsite grouting.

In addition to the Byron station water wells, a temporary water well (TW-1) was installed for construction supply. The location of this well is shown on Two water wells were installed to provide water for the grouting operation. These wells are presently capped and are not in use. Both wells produce water from the St. Peter Sandstone.

4.3.1.3 Surface and Groundwater Use

Surface Water

Potential future uses of water upstream of the site will depend primarily on the availability and use of groundwater. In 1971 the total groundwater pumpage in Winnebago County was 197 million liters per day (mld) (52 million gallons per day (mgd)). The predicted water demand for Winnebago County is 333 mld (88 mgd) in 1980 and 655 mld (173 mgd) in 2020. Available resources in Winnebago County are 378 mld (100 mgd) of groundwater and 2347 mld (620 mgd) of surface water (Illinois Dept. of Business and Economic Development, 1967), which indicates total resources in excess of predicted demands.

In 1971 the total groundwater pumpage in Ogle County was 38 mld (10 mgd). The predicted water demand for Ogle County is 42 mld (11 mgd) in 1980 and 76 mld (20 mgd) in 2020. The available resources include 416 mld (110 mgd) groundwater and 2517 mld (665 mgd) surface water which is substantially more than the demand.

Only a small portion of the water used in the Rock River Valley is consumed; the remainder is returned directly or indirectly to the Rock River. Because the Rock River Valley is a major groundwater discharge area, much of the groundwater is intercepted by wells before it is discharged into the river. This water, after use, is piped to sewage treatment plants where it is discharged to the river. Septic tanks also return most of the groundwater to the ground where the water ultimately discharges to the Rock River.

In Winnebago and Ogle Counties, 0.8 mld (0.21 mgd) and 1.4 mld (0.36 mgd) respectively is used for production washing in sand and gravel pits; irrigation use of surface water is negligible. No significant increase in these uses is predicted.

One unmeasured but important indirect use of surface water is the induced infiltration of Rock River water into sand and gravel wells along the river. In 1971, 76 mld (20 mgd) was pumped from the sand and gravel aquifer in Winnebago

County. Over 85% of the pumpage was for the city of Rockford. Some of that 76 mld (20 mgd), probably less than 19 mld (5 mgd), was actually surface water that had been induced to infiltrate through the stream bed into the wells. Since the flow in the Rock River equals or exceeds 1775 mld (469 mgd) 99% of the time and since permeable sand and gravel deposits fill the valley, the induced infiltration of surface water will become an important future source of water in the Rock River valley. As described previously, virtually all of this water will be returned to the river.

Groundwater

There are 15 public water supply systems within 16 km (10 mi) of the Byron site, all of which use groundwater wells for their supplies. Table 4.9 lists each public water supply systems and gives details of each.

A piezometric surface map of the Cambrian-Ordovician Aquifer in northern Illinois, based on piezometric elevations measured in October 1971, is presented in Figure 4.8 (Sasman et al. 1973). In the general region of the Byron site, the Rock River and the city of Rockford are the main groundwater discharge areas that control the slope of the piezometric surface. The Byron site is within a trough in the piezometric surface that is the result of discharge from the aquifer to the Rock River.

Yearly changes in piezometric levels at public groundwater wells in the Cambrian-Ordovician Aquifer are shown in Table 4.9. These data indicate that there was little fluctuation for the period of record in the piezometric surface within a 16-km radius of the Byron site.

According to 1966 projections, public, industrial, and domestic groundwater pumpage in Ogle County was to double in the next 10 to 25 years (Illinois State Water Survey 1966; Sasman and Baker 1966). Groundwater pumpage in Ogle County, however, actually decreased at an average rate of 908,400 lpd (240,000 gpd) per year from 1965 to 1970. The record of groundwater pumpage in Ogle County from 1971 through 1976 is shown in Table 4.10. In this table the total annual groundwater pumpage is broken down into the seven principal users (municipal, subdivision, institutional, industrial, irrigation, domestic, livestock), and the portions of the total pumpage obtained from the gravel, dolomite, and sandstone aquifers are shown. During the period of record, the total annual groundwater pumpage has remained fairly constant, and the total pumpage in 1976 was slightly less than those in 1972, 1973, and 1974. This same trend is seen in the records of pumpage from the sandstone aquifers, one of which, the Cambrian-Ordovician Aquifer, will supply groundwater to the Byron station. Due to the relatively low level of urbanization around the site area and the small amount of onsite groundwater use, it is unlikely that future increases in groundwater withdrawal in the area would have much effect on the groundwater supply at the site.

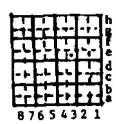
Piezometers and observation wells were installed at the Byron site as part of the groundwater monitoring program. Table 4.11 lists the borings with piezometers, the depth and elevation at which they were installed, and the hydrogeologic unit in which they were installed. Table 4.11 also lists the water level

Table 4.9 Public groundwater supplies within 16 km of Byron station

FIGURE REFERENCE NUMBER[a]	NAME	LOCATION[ab]	FROM SITE (miles)	WELL NUMBER	DATE DRILLED	TOTAL DEPTH (feet/surface elevation, MSL)	LOWEST HYDROSTRATIGRAPHIC UNIT PENETRATED	ELEVATION OF PIEZOMETRIC SURFACE (MSL/date)	1980 AVERAGE DAILY USE (gpd)	REMARKS
1	Leaf River	25N9E-36 25N9E-36.5d	7.5	1 2	1914 1945	125 325/765	Silurian dolomite St. Peter	659/1971, 702/1973	105,000	Abandoned, 1946
2	Lowden Memorial State Park	24N10E-34.6b 24N10E-34.4c	3.7	1 2	1950 1963	415 295	St. Peter St. Peter	NA[d] NA	NA NA	
3	Mt. Morris	24N9E-26.8c1 24N9E-26.8c2 24N9E-27.1f1 24N9E-27.1a	8.4	1 2 3 4	1894 1920 1926 1950	500 1147 1807 1452	St. Peter Ironton-Galesville Mt. Simon Mt. Simon	NA NA 640/1966, 635/1971 648/1966, 627/1971	NA NA 270,000 (Total 3&4)	Abandoned, 1923 Emergency Use Only
4	Northern Illinois University Lorado Taft Campus	24N10E-34.8e 24N10E-34.7d	3.5	1 2	1953 1970	435 580	St. Peter St. Peter	667/1967 665/1970	4,300 (Total 1&2)	
5	Oregon	23N10E-3.6d 23N10E-3.6g 23N10E-3.7g	4.0	1 2 3	1886 1948 1964	1690/672 1200/707 1200/710	Mt. Simon Mt. Simon Mt. Simon	650/1966, 652/1971, 642/1976 661/1966, 657/1971, 660/1976 660/1966, 655/1971, 648/1976	440,000 (Total 1,2,3)	
6	Stillman Valley	24N11E-1.2b 24N11E-1.7a	5.9	1 2	1938 1954	300/725 445/740	St. Peter St. Peter	690/1971 660/1904	124,000 (Total 1&2)	
7	Byron	25N11E-32.8e1 25N11E-32.8e2 25N11E-32.6g	4.2	1 2 3	1900 1929 1969	2000 673/720 715/720	Mt. Simon Galesville Galesville	661/1968 659/1966, 662/1968 660/1969, 672/1975	428,550 (Total 1,2,3)	
8	Lakeview Mobile Home Park	25N11E-29 25N11E-29	5.0	1	1958	90/	NA	NA	7,000	
9	Meridian Manor Mobile Home Park	24N-11E-2	5.0	1 2	NA	193/ 93/	NA NA	48/	6,000	
10	Hillhaven Mobile Home Park	23N10E-4	5.0	1	1957	243	St. Peter	90/	3,500	
11	Mount Morris Estates	24N10E-31	6.0	1	1972	390/	St. Peter	155/	30,000	
12	Harrington Brothers	43N1E-19.3e	10	1	1954	310/740	St. Peter	60/1966	10,000	
13	Rockvale Corporation	24N10E-21	4.0	1 2	1974 1977	429/765 450/790	NA NA	99/1974 160/1977	4,000	
14	Castle Rock State Park	23N10E-17.1e 23N10E-17.2d	8.5	1 2	1975 1975	125/790 170/750	NA NA	90/1975 135/1975	NA NA	
15	Timberlane Mobile Home Park	43N1E-19	10	1	NA	450/	NA	25/	NA	

[a]Locations of pumping centers are shown on Figure 2.4-11, FSAR.

[b]Locations within each section are based on the following system used by the Illinois State Water Survey:

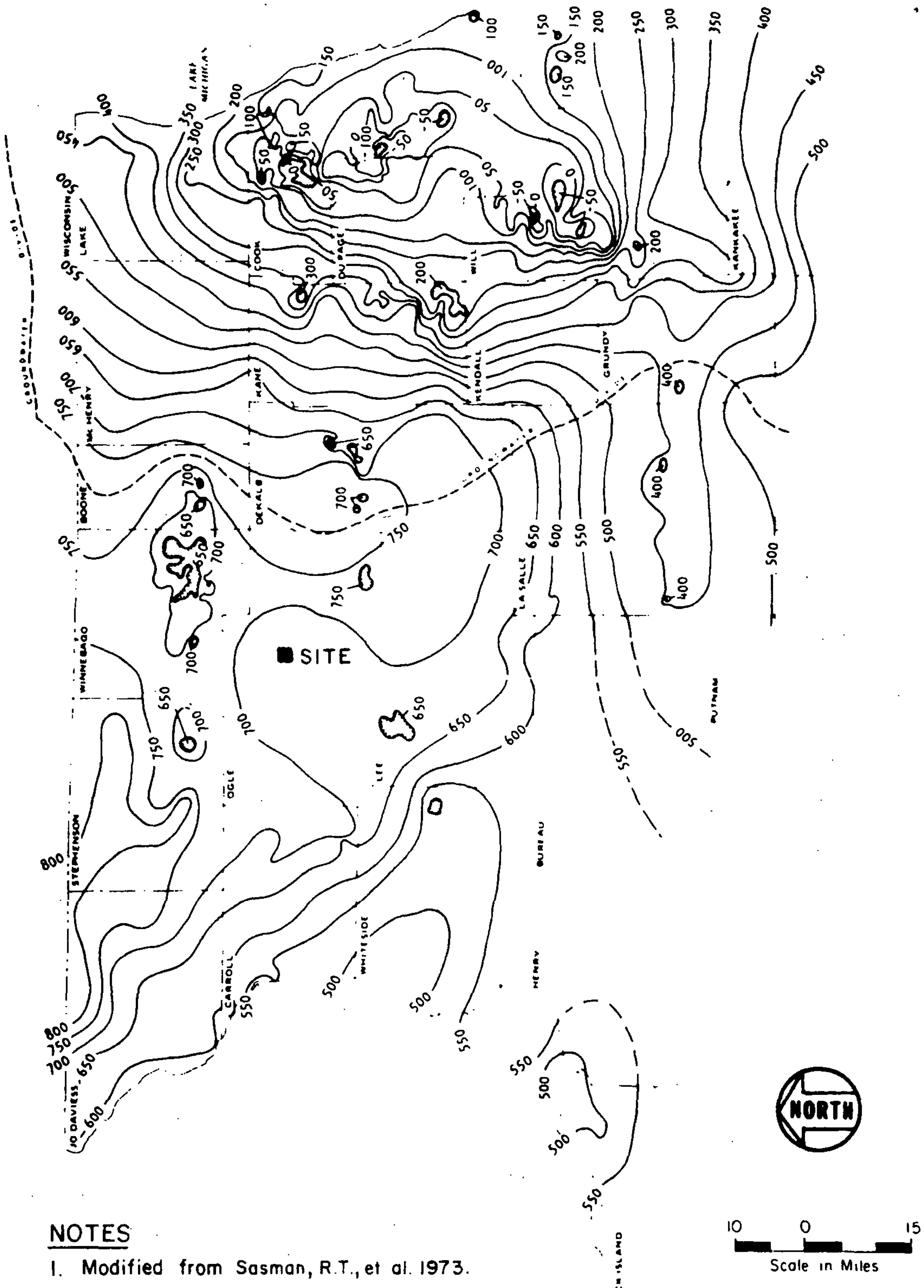


Well location in Section 17.3e

[c]Potentiometric levels were obtained from Illinois EPA (1976)

[d]NA = data not available.

Sources: Illinois State Water Survey (Sasman 1981).
Illinois Environmental Protection Agency (Sands 1981).
Illinois Health Board (Rudin 1981).



NOTES

1. Modified from Sasman, R.T., et al. 1973.
2. Piezometric contour interval is 50 feet.

Figure 4.8 Piezometric surface of the Cambrian-Ordovician aquifer elevations measured in the piezometers and observation wells. The locations of the piezometers and observation wells are shown in Figures 2.4-13, 2.4-14, and 2.4-15 of the ER-OL. Groundwater levels recorded on the boring logs were observed while the borings were being drilled.

On a regional basis, the Galena-Platteville dolomites are hydraulically continuous with the lower sandstone units of the Cambrian-Ordovician Aquifer (Walton and Csallany 1972). In the vicinity of the Byron site, however, groundwater in the Galena-Platteville dolomites is perched on the low-permeability Harmony Hill Shale Member of the Glenwood Formation. A piezometric surface map of the site vicinity, as measured in the Galena-Platteville dolomites, is shown in ER-OL Figure 4.3.3.

Groundwater flows radially from the site, and the principal discharge boundaries are the Rock River to the west and northwest of the site and Black Walnut Creek to the east and southeast of the site.

Table 4.12 lists recorded active, domestic or agricultural groundwater wells east of the Rock River within 3.6 km (2.25 miles) of the site. Most of these wells are completed in the Galena-Platteville dolomites. ER-OL Figure 2.4-16 shows the locations of the wells. Domestic and agricultural wells west of the Rock River are not discussed because the river is a common discharge boundary for wells, east and west of the river, that are completed in the Galena-Platteville dolomites.

Pump tests were performed on June 20 and July 2, 1974, in two domestic water supply wells that are completed in the Galena-Platteville dolomites. These two wells are located at the west edge of the site along Razorville Road. From the pump tests, aquifer parameters were derived based on July 1, 1974 piezometric levels. Based on estimated saturated thicknesses of 34 and 23 meters at the two wells, the hydraulic conductivities of the aquifer measured at the wells are 2.2×10^{-3} meters per day (m/d) (6.3 gpd/ft2) and 7.8×10^{-3}m/d (22.2 gpd/ft^2). The effective porosity of this portion of the aquifer is estimated to range from 0.05 to 0.10.

There are no anticipated changes in the present pattern of groundwater use in the site area.

4.3.2 Water Quality

Data on surface water quality of the Rock River in the vicinity of the Byron station intake were presented in the FES-CP for years 1972 and 1973. These data were based on the applicant's baseline water quality monitoring program. The applicant supplemented this baseline program by continuing it during 1973 and 1974, using the same sample locations in the Rock River and six creeks in the site vicinity (Stillman, Mill, Woodland, Leaf, Spring, and Silver creeks). The applicant's analysis of the data from the completed baseline study indicates (1) river chemistry fluxuations due primarily to seasonal changes in temperature, precipitation and river flow rates; (2) all parameters except phosphorus and, in one instance, copper to be within the Illinois Pollution Control Board 1975 Standards (IPCB) 1975; (3) nutrient levels were generally high; and (4) bacteria numbers were high, with total coliform numbers exceeding the recommended standard in four out of six samples. This section of the Rock River was

Table 4.10 Groundwater pumpage by year in Ogle County* (all values in mgd)

1971

	Sand Gravel	Dolomite	Sandstone	Total
Municipal	-	-	5.324	5.324
Subdivision	-	-	-	-
Institution	-	0.005	0.021	0.026
Industrial	0.205	0.003	1.094	1.302
Irrigation	-	-	0.020	0.020
Domestic	0.384	0.921	0.230	1.535
Livestock	0.497	1.195	0.298	1.990
	1.086	2.124	6.987	10.197

1972

	Sand Gravel	Dolomite	Sandstone	Total
Municipal	-	0.001	6.133	6.134
Subdivision	-	0.010	-	0.010
Institution	-	0.005	0.028	0.033
Industrial	0.047	0.084	1.052	1.183
Irrigation	-	-	0.050	0.050
Domestic	0.384	0.921	0.230	1.535
Livestock	0.497	1.195	0.298	1.990
	0.928	2.216	7.791	10.935

1973

	Sand Gravel	Dolomite	Sandstone	Total
Municipal	-	0.001	6.155	6.156
Subdivision	-	0.028	0.008	0.036
Institution	-	0.005	0.038	0.043
Industrial	0.066	0.003	1.090	1.159
Irrigation	-	-	0.050	0.050
Domestic	0.384	0.921	0.230	1.535
Livestock	0.497	1.195	0.298	1.990
	0.947	2.153	7.869	10.969

1974

	Sand Gravel	Dolomite	Sandstone	Total
Municipal	-	0.001	8.800	8.801
Subdivision	0.002	0.030	0.008	0.040
Institution	-	0.005	0.038	0.043
Industrial	0.020	0.003	1.117	1.140
Irrigation	-	-	0.050	0.050
Domestic	0.384	0.921	0.230	1.535
Livestock	0.497	1.195	0.298	1.990
	0.903	2.155	10.541	13.599

1975

	Sand Gravel	Dolomite	Sandstone	Total
Municipal	-	-	5.943	5.943
Subdivision	0.004	0.032	0.010	0.046
Institution	-	0.005	0.042	0.047
Industrial	0.016	-	0.963	0.979
Irrigation	-	-	0.050	0.050
Domestic	0.384	0.921	0.230	1.535
Livestock	0.497	1.195	0.298	1.990
	0.901	2.153	7.536	10.590

1976

	Sand Gravel	Dolomite	Sandstone	Total
Municipal	-	-	6.051	6.051
Subdivision	0.004	0.032	0.018	0.054
Institution	-	0.005	0.042	0.047
Industrial	-	-	1.098	1.098
Irrigation	-	-	0.050	0.050
Domestic	0.384	0.921	0.230	1.535
Livestock	0.497	1.195	0.298	1.990
	0.885	2.153	7.787	10.825

Source: Sasman (1977).
*From Applicant's ER-OL.

Table 4.11 Site area groundwater levels in Galena-Platteville dolomites as measured during water quality monitoring program

DATE	WELL 1[a] DEPTH[b]	ELEV.[c]	WELL 2 DEPTH	ELEV.	WELL 3 DEPTH	ELEV.	WELL 5 DEPTH	ELEV.	WELL 6 DEPTH	ELEV.
12/9/75	45	741	43	746	83	810	81	769	79	754
1/20/76	60	726	-[d]		40	853	155	695	90	743
2/17/76	50	736	55	734	80	813	100	750	90	743
3/23/76	51	735	40	749	55	838	95	755	70	763
4/13/76	28	758	48	741	38	855	85	765	63	770
5/21/76	28	758	48	741	36	857	78	772	61	772
6/7/76	33	753	48[e]	741	38	855	83	767	68[e]	765
7/5/76	38	748			54	839	96	754		
8/11/76	41	745			56	837	97	753		
9/20/76	40	746			55	838	95	755		
10/19/76	41	745			57	836				
11/8/76	40	746			48	845	96	754		
12/6/76	39	747			57	836	97	753		
1/18/77					56	837	50.5	799.5		
2/22/77	39	747			51	842	91	759		
3/21/77	40	746			50	843	91	759		
5/10/77	45	741			55	838	95	755		
6/13/77	47	739			59	834	103	747		
7/19/77					58	835	103	747		
8/9/77	42	744			50	843	95	755		
9/26/77					59	834	99	751		
11/28/77	33	753			54	839	92	758		
12/19/77	32	754			53	840	95	755		

Note: All depths and elevations are approximate.

[a] Well locations are shown in Figure 2.4-17, and their composite water quality is shown in Table 2.4-16, FSAR.

[b] Depths are measured depths to groundwater in feet.

[c] Elevations are in feet above mean sea level.

[d] Missing data indicate groundwater levels were not measured in that well on that date.

[e] Groundwater level measurements were discontinued in Wells 2 and 6 in June 1976.

Table 4.11 continued

SECTION	WELL NO.	LOCATION[a] DIRECTION	APPROXIMATE DISTANCE (mi)	DEPTH (ft)	APPROX. PUMPAGE (gal/day)	USAGE	OWNER
20	64	SE	2.25	165	500	Domestic Agricultural	T. O'Hara
22	65	SW	2.25	Unknown	Unknown	Domestic	Mueller
22	66	SW	2.25	Unknown	100	Domestic	C. Fant
23	67	SW	1.75	--	--	Domestic	Devries
23	68	SW	2.0	--	--	Domestic	Wolfe
23	69	SW	1.25	Unknown	100	Domestic	Comm. Edison
24	70	S	0.75	200	150	Domestic	J. Devries
24	71	S	1.0	120	100	Domestic	Becker
24	72	S	1.0	--	--	--	--
24	73	S	1.0	95	100	Domestic	Devries
24	74	S	1.0	--	--	--	--
24	75	S	1.25	--	--	Not in use	--
24	76	S	1.25	280	100	Domestic	L. Rapoport
24	77	S	1.25	60	60	Domestic	A. Greenfield
24	78	S	1.25	Unknown	100	Domestic	Sherman
24	79	S	1.0	Unknown	100	Domestic	E. Merrell
24	80	S	1.0	328	100	Domestic	E. Winterton
24	81	S	1.5	Unknown	50	Domestic	I. Maas
24	82A	S	1.5	180	50	Domestic	I. Maas
25	82	S	1.75	Unknown	10	Domestic	Ebenezer Reformed Church
25	83	S	1.75	166	250	Domestic Agricultural	H. Ehmen
25	84	S	1.75	285	100	Domestic	A. Gale
25	85	S	2.0	110	100	Domestic	Jorden
25	86	S	2.0	90	--	Not in use	J. Yosd
26	87	SSW	1.75	220	400	Domestic Agricultural	R. Bettner
26	88	SSW	2.25	Unknown	150	Domestic Agricultural	L. Rushford
30	89	SSE	2.0	Unknown	10	Domestic	Ebenezer Reformed Church
30	90	SSE	2.0	Unknown	300	Domestic Agricultural	Blumever
30	91	SSE	2.25	225	100	Domestic	Sheffler
30	92	SSE	2.25	75	100	Domestic	Sheffler

[a] Locations determined from center of Section 13.

Table 4.11 continued

SECTION	WELL NO.	LOCATION[a] DIRECTION	APPROXIMATE DISTANCE(mi)	DEPTH (ft)	APPROX. PUMPAGE (gal/day)	USAGE	OWNER
12	30	N	0.5	--	--	--	--
12	31	N	1.0	--	--	--	R. Wayne
14	32	W	1.0	--	--	Not in use	--
14	33	W	0.75	135	60	Domestic	Dauenbaugh
14	34	W	0.5	--	--	--	--
14	35	W	0.5	--	--	--	Rapp
14	36	W	0.5	--	--	--	--
15	37	W	2.0	243	100	Domestic	Landis
15	38	W	2.0	--	--	--	--
15	39	W	2.0	--	--	Domestic Agricultural	--
15	40	W	2.0	--	--	Domestic Agricultural	--
15	41	W	2.0	90	--	Not in use	Pulver
15	42	W	2.0	200	100	Domestic	Eklund
15	43	W	2.0	90	200	Domestic Agricultural	Frye
17	44	E	1.5	Unknown	100	Domestic	H. Hillman
17	45	E	1.5	Unknown	100	Domestic	K. Stout
17	46	E	1.75	140	200	Domestic Agricultural	R. Case
17	47	E	1.5	235	50	Domestic	L. Powell
17	48	E	1.5	100	400	Domestic Agricultural	Powell
18	49	E	0.75	310	100	Domestic	F. Seabold
18	50	E	0.5	106	199	Domestic	A. Johnson
18	51	E	1.0	323	200	Domestic Agricultural	R. Seabold
18	52	E	1.5	Unknown	200	Domestic Agricultural	A. Bennett
18	53	E	1.5	Unknown	1000	Domestic Agricultural	J. Anderson
18	54	E	1.5	--	--	--	--
19	55	SE	0.5	Unknown	100	Domestic	K. Greffe
19	56	SE	1.0	Unknown	150	Domestic	D. Hardesty
19	57	SE	1.0	Unknown	10	Domestic	D. Hardesty
19	58	SE	1.0	Unknown	10	Domestic	D. Hardesty
19	59	SE	1.5	--	--	--	--
19	60	SE	1.5	--	--	--	--
19	61	SE	1.75	Unknown	150	Domestic	D. Beemer
19	62	SE	2.25	Unknown	300	Domestic Agricultural	C. Hepfer
20	63	SE	2.0	Unknown	100	Domestic	M. Bennett

[a] Locations determined from center of Section 13.

Table 4.12 Wells within 4 km of the Byron station

SECTION	WELL NO.	LOCATION[a] DIRECTION	APPROXIMATE DISTANCE (mi)	DEPTH (ft)	APPROX. PUMPAGE (gal/day)	USAGE	OWNER
1	1	N	2.5	90	100	Domestic	R. Weems
1	2	N	2.5	90	200	Domestic Agricultural	D. McKiskr
1	3	N	2.5	--	--	--	Gutzmer
1	4	N	2.0	Unknown			
6	5	NNE	2.0	284	100	Domestic	D. Green
6	6	NNE	2.0	385	Not in use	Domestic	R. Henricks
6	7	NNE	2.0	Unknown	100	Domestic	G. Ashby
6	8	NNE	2.0	290	100	Domestic	T. Wilson
6	9	NNE	2.0	245	100	Domestic	B. Tubbs
6	10	NNE	2.0	350	200	Domestic Agricultural	T. Zimmerman
6	11	NNE	2.0	--	--	Domestic	
7	12	NNE	1.25	200	300	Domestic Agricultural	Walker
7	13	NNE	1.5	120	250	Domestic Agricultural	G. Reeverts
7	14	NNE	1.5	--	--	--	--
7	15	NNE	1.75	280	100	Domestic	C. Babbitt
7	16	NNE	1.75	100	300	Domestic Agricultural	K. Reeverts
7	17	NNE	1.5	--	--	--	--
7	18	NNE	1.5	Unknown	200	Domestic Agricultural	Oltman
7	19	NNE	1.5	135	200	Domestic Agricultural	Oltman
8	20	NE	2.25	200	2000	Domestic Agricultural	E. Seabold
8	21	NE	2.25	130	600	Domestic Agricultural	R. Stukenberg
8	22	NE	2.25	85	500	Domestic Agricultural	S. Case
11	Total of 110 to 115	NW	1.75	--	--	Domestic	Rock River Terrace Unincorp.
11	23	NW	1.25	109	150	Domestic Agricultural	Kinyon
11	24	NW	1.25	Unknown	100	Domestic Agricultural	R. Stukenberg
11	25	NW	1.0	--	--	Domestic	V. Eakle, Jr.
11	26	NW	1.0	Unknown	200	--	Bonties
12	27	N	1.25	--	--	Not in use	
12	28	N	1.0	--	--	Domestic	Rapp
12	29	N	1.0	84	500	Domestic Agricultural	Palmer

[a] Locations determined from center of Section 13.

Table 4.12 continued

BORING	GROUND SURFACE ELEVATION (ft, MSL)	DEPTH OF PIEZOMETER (ft)	GROUP IN WHICH PIEZOMETER INSTALLED[a]	DATE OF WATER LEVEL MEASUREMENT	WATER LEVEL ELEVATION (ft, MSL)
G-17	840.7	107	P	11/8,9/72	751.8
				1/25/73	752.0
				6/27/74	758.1
				7/1/74	758.3
		249	A	11/8,9/72	686.8
				1/25/73	686.7
				6/27/74	689.3
				7/1/74	689.1
G-18	852.1	120	P	11/8,9/72	760.0
				1/25/73	760.8
				6/27/74	770.6
				7/1/74	771.2
				4/14/75	755.4
		250	A	11/8,9/72	688.4
				1/25/73	688.7
				6/27/74	690.3
				7/1/74	690.8
				4/14/75	688.4
G-19	863.9	111	P	1/25/73	843.6
G-20	861.1	120	P	11/8,9/72	776.4
				1/25/73	777.1
				6/28/74	772.4
		248	A	11/8,9/72	689.8
				1/25/73	690.1
				6/28/74	671.4
				4/14/75	689.3
G-21	869.5	118	P	11/8,9/72	773.1
				1/25/73	773.4
G-22	855.7	120	P	1/25/73	774.7
				6/17/74	787.7
				6/26/74	786.7
				7/1/74	786.9
				4/14/75	765.6
G-23	676.5			11/8,9/72	672.5
G-24	878.4	123	P	11/8,9/72	794.5
				1/25/73	796.8
		295	A	11/8,9/72	692.6
				1/25/73	695.0
G-25	860.1	119	P	11/9,9/72	790.5
				1/25/73	791.2
		275	A	11/8,9/72	691.4
				1/25/73	692.1
				6/27/74	693.9
				7/1/74	693.9
P-4	881.6	100	G	1/25/73	799.6
P-5	872.8	107	P	1/25/73	803.8
				7/1/74	828.3
				4/14/75	787.5
P-8	874.1	260	A	1/25/73	694.3
P-9	861.3	248	A	1/25/73	692.4
P-10	866.1	104	P	1/25/73	793.1
P-11	867.1	88	G	1/25/73	823.8
P-22	877.3	95	G	1/25/73	798.4
P-39	871.9	100	P	11/29/73	824.9
				7/1/74	845.6
				4/14/75	787.5
0-1	872.1	85	G[b]	1/25/73	817.1
0-2	878.9	85	G[b]	1/25/73	815.2
0-3	878.0	85	G[b]	1/25/73	818.4

[a]Key for group is as follows:

G = Galena Group
P = Platteville Group
A = Ancell Group (St. Peter Sandstone)

[b]Observation wells 0-1, 0-2, and 0-3 were drilled to the depths listed and left open.

concluded to be in a state of moderate entrophication (ER-OL Section 2.2.1.4 and 2.2.1.5). The data are in the ER-OL Section 2.2.1. Further discussion is provided in ER-OL Section 4.1.4.2.

Water quality data collection continued in the Rock River and the creeks in the site vicinity on a seasonal basis after the issuance of the FES-CP through the winter of 1980. These data are presented in ER-OL Section 4.1.4.2 and in Espy (1978-1980). A summary seasonal analysis of Rock River water based on these data is presented in Table 4.13. Comparison of the average data for the

The applicant's Construction and Preoperational Aquatic Monitoring Program for Byron station revealed that concentrations of total iron, total copper, phosphorus, and ammonia nitrogen were often above the State of Illinois Water Quality Standards for the Rock River sampling stations during the period of spring 1975 through winter 1976 (ER-OL Section 4.1.4.2). However, an improvement trend in Rock River water quality was noted beginning with the spring 1977 sampling and this trend has continued through the winter 1980 sampling. (ibid). During this time phosphorus and total iron concentrations continued to be above the applicable state water quality standards; however, exceedances decreased in both number of stations and frequency of occurrence (Espy 1980).

It was noted that at no time during the sampling period were effects on Rock River water chemistry observed as a result of Byron station construction or dewatering activities (Espy 1978-1980).

4.3.3 Meteorology and Air Quality

Regional climatic information in Section 2.6.1 of the FES-CP is still applicable.

Meteorological measurements on site serve as the basis for evaluating the conditions observed in the area of the site rather than the previous use of data from other nuclear plant sites approximately 100 km away from the site, as described in Section 2.6.2 of the FES-CP.

Onsite measurements, which were initiated in 1973, are made on a 76-meter tower. Wind speed and direction are measured at the 10- and 76-meter levels. The annual wind roses for the 10- and 76-meter wind measurements are shown in Figures 4.9 and 4.10. Temperature difference for stability determination is determined between the 10- and 76-meter levels. Relative humidity measurements are made at these same levels using dew point sensors while precipitation is measured at ground level. At Byron, precipitation shows great monthly variability in total amounts reflecting the effects of passing weather systems as illustrated in Table 4.14.

Temperatures on site (1974-1976) average from -6°C in January to 23°C in July, which compares favorably with long-term monthly average values at Rockford and Argonne. Extremes of temperature on site ranged from -26°C to 34°C. The stability distributions as shown in Table 4.15 during the 1974-1976 period indicate a preponderance for neutral, D, to stable E, F, Pasquill-Gifford stability classes, with lesser values of A and G classes (Meteor. and Atomic Energy).

Table 4.13 Summary seasonal analysis of Rock River water[1] (all values except pH in mg/l)

	Winter[2]	Spring	Summer	Fall	Average	Maximum
Calcium (as $CaCO^3$)	184	165	174	157	170	233
Magnesium (as $CaCO^3$)	159	131	133	155	145	180
Sodium	22	13	18	21	19	30
Alkalinity (as $CaCO^3$)	286	196	236	261	245	308
Sulfate	49	43	30	42	41	63
Chloride	36	26	26	29	29	43
Nitrate	3	2	2	2	2	4
Silica	5.4	2.0	3.4	1.9	3.2	6.2
Total Dissolved Solids	484	391	362	422	415	658
pH (standard units)					range	6.4-8.7

Source: ER-OL Table 3.6-1; Espy 1978-1980.

[1]Data are for water quality sampling station R-2 (intake) for time period Spring 1975 through Winter 1980.

[2]Seasonal entries represent average values for the indicated season.

4.3.4 Ecology

4.3.4.1 Terrestrial

The terrestrial ecology of the site was adequately described in the CP-ER based on studies performed in 1972 through 1974. Subsequent environmental monitoring studies were performed from 1975 through 1980 and are in the OL-ER.

Since the CP-FES, the applicant has discovered that toxic waste had been dumped on the property before he acquired it for the cooling water pipeline from the power plant to the Rock River. These toxic materials consisted primarily of heavy metals and were disposed of in an acceptable manner (Busch).

4.3.4.2 Aquatic

The aquatic environment potentially affected by the Byron station was described in the FES-CP on the basis of baseline data collected by the applicant from

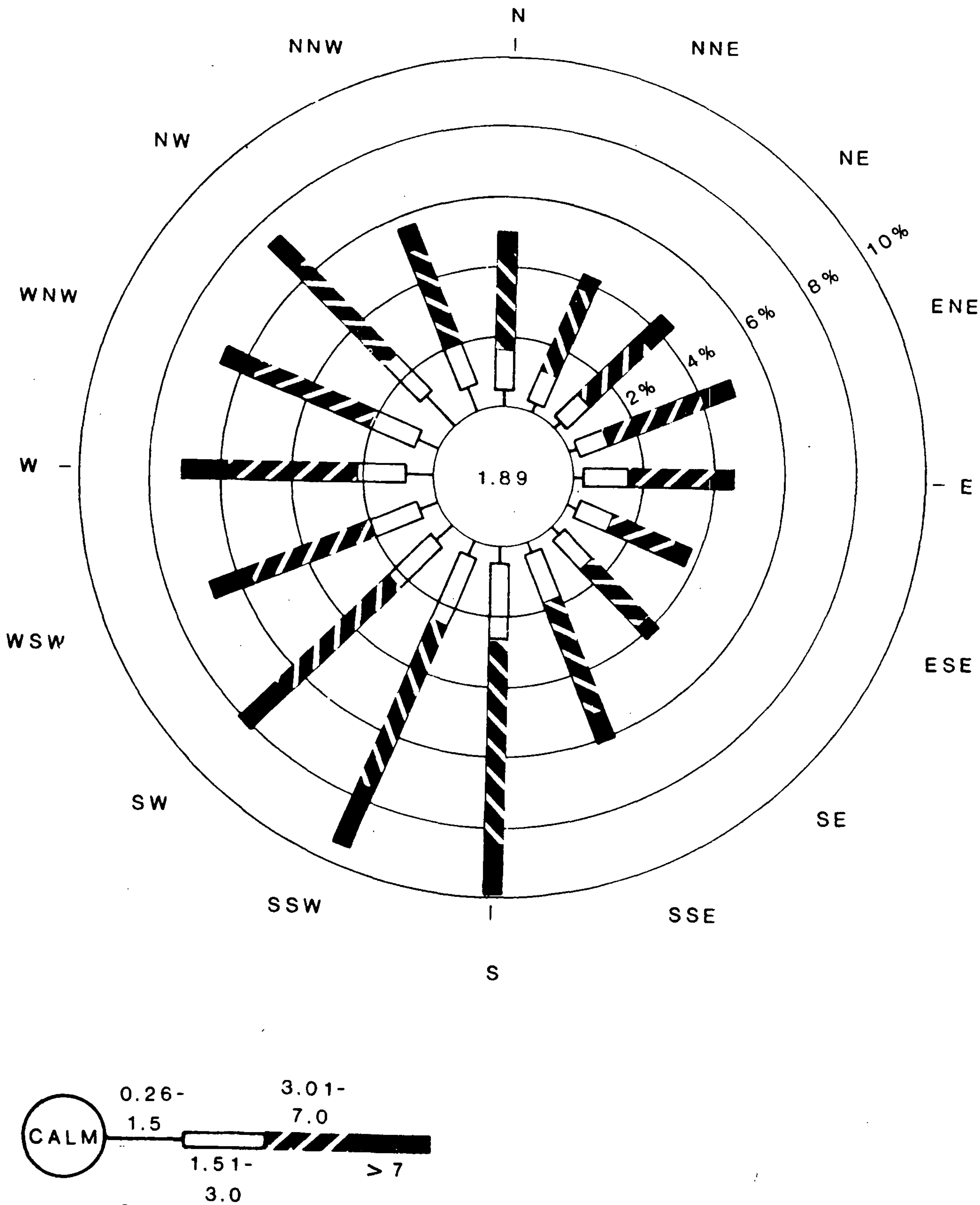


Figure 4.9 Annual wind rose, 10-m level

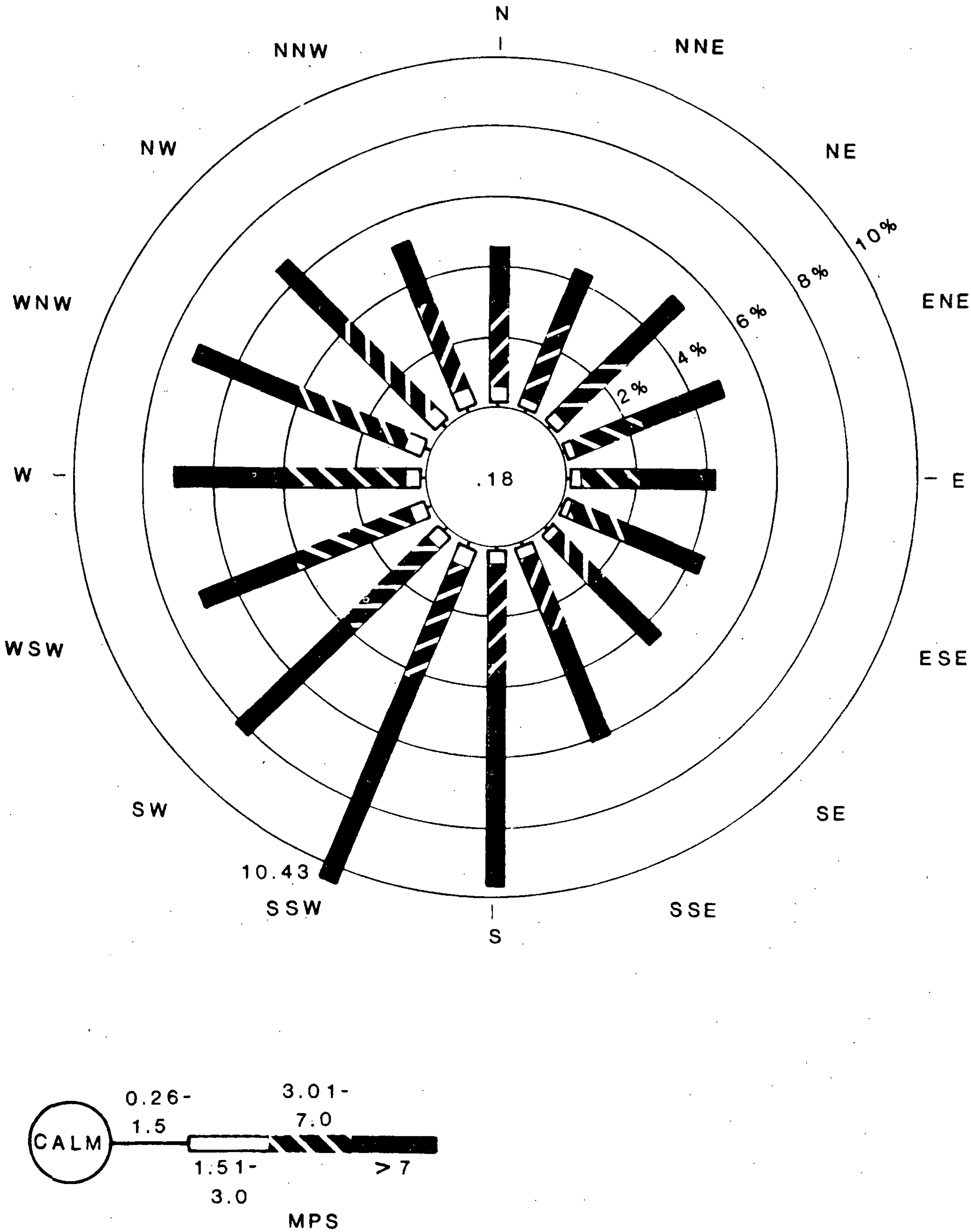


Figure 4.10 Annual wind rose, 76-m level

Table 4.14 Precipitation at Byron station, 1974-1976, by month (inches)

	1974	1975	1976
January	M*	1.19*	0.07*
February	0.74*	0.25	1.32*
March	2.26	1.27	3.82*
April	2.79	0.03	3.15
May	7.39	2.36	2.37
June	6.38	2.77*	2.27
July	1.58	1.70	0.36*
August	1.85	2.57	1.31
September	0.46	1.13	1.10
October	2.58*	0.41	2.44
November	1.49*	3.69*	0.20
December	0.93	0.99*	0.30

* missing or questionable

Table 4.15 Pasquill-Gifford Stability Classes at Byron station, 1974-1976

Class	Frequency, %
A	2.7
B	5.0
C	3.5
D	31.3
E	39.4
F	13.5
G	4.6

April 1972 through July 1973. Since issuance of the FES-CP, 6 years of additional data have been collected by the applicant. Also, the Illinois Department of Conservation has made several surveys of the fish community of the Rock River in the vicinity of the Byron site. This section summarizes the new information on aquatic biota with emphasis on differences from the FES-CP descriptions.

Details of the applicant's field and laboratory methods used in aquatic monitoring programs are presented in Section 6.1.1 of the ER-OL. Results of the second year of baseline monitoring (1973-1974) are summarized in the ER-OL, Section 2.2.1. Starting in 1975, a comprehensive 5-year program of construction and pre-operational monitoring was initated. Results of the aquatic studies are summarized from annual reports in Section 4.1.4.2 of the ER-OL. The following comparisons with FES-CP descriptions are based primarily on information from the fifth (and final) annual monitoring report (Espy 1980).

As noted in the FES-CP (Section 2.7.2), the algal community structure and production parameters show the Rock River to be a nutrient-enriched, moderately eutrophic system. The zooplankton continued to be dominated by rotifers and/or juvenile copepods typical of large flowing water bodies. Dominant taxa of benthic invertebrates on natural substrates were the pollution tolerant tupificids and chironomids. There were no consistent differences between upstream and downstream nor right and left bank locations for these lower taxonomic groups; no changes were attributable to effects of station construction.

In the FES-CP, ichthyoplankton (fish eggs and larvae) densities were noted as being very low (one egg or larvae per 100 m^3). Data for 1974 (ER-OL, Table 2.2-33) indicated a slightly higher density of 9 larvae per 100 m^3 as an average for combined sampling in the Rock River and in the mouths of tributary streams. Average density for the river sampling stations was about 6 larvae per 100 m^3 as compared to an average density for the three streams of 288 larvae per 100 m^3. Egg densities for 1974 could not be calculated because of the failure of the flowmeter during the one sample in which eggs were collected. Predominant larvae collected belonged to the minnow family, with carp accounting for 40% of the total collected.

Data for 1977 and 1978 indicate fish egg densities in the river averaged 5 eggs per 100 m^3 in June 1977 and in May 1978. No eggs were collected in the stream mouths in 1978 and none were found at either the river or tributary streams in 1979. Estimates of larval densities continued high at the stream mouth stations perhaps due to washout of eggs from spawning sites; the high estimates may also be due, in part, to extrapolation from small sample sizes. The common fish families in the larval fish collections, made during the 1975-1979 monitoring program, were the Cyprinidae, Catastomidae, Ictaluridae and Centrarchidae.

Description of the fish community in the FES-CP (Section 11.11.5) was based on the applicant's baseline monitoring in 1972-73. Of the 74 fish species expected to occur in the Rock River; 43 species were collected in the applicant's baseline monitoring program during 1972-74 (CECO, p. 4.27) and 51 species were collected in the 5 years of pre-operational monitoring during 1975-1979 (Espy 1980 p. 6-25). A survey of the fishery in 1965 by the Illinois Department of Conservation had shown the fish community to consist of 57% commercial species, 38% forage species (minnows), and 5% game fish (Dunham, p. 25). The commercial species are those considered as rough fish in other classification schemes (carp, buffalo, carpsuckers, redhorse suckers, and freshwater drum). Dunham described the Rock River as a channel catfish stream, also supporting good populations of other game fish including the black bullhead catfish, rock bass, smallmouth bass, and walleye and limited population of largemouth bass, sauger, bluegill, and crappie.

In the applicant's first year of baseline study, 1972-73, forage fish collected at river stations made up 48% of the fish community. During the second year of baseline, the community consisted of 62% rough fish, 7% forage, and 31% game fish (ER-OL Table 2.2-21). The changes in relative contributions of forage and game between the 2 baseline years was attributed in part to changes in gear type and effort (ER-OL p. 2.2-11). Channel catfish made up 62% of the game fish collected in the 1973-74 sampling year, followed by crappies (24%), and bluegills (5%). Channel catfish continued to be the most abundant game fish collected in pre-operational studies in 1975-76 and 1976-77; bluegill was the most abundant game species collected in the 1977-78 study year and black crappie was most abundant in 1978-79 and 1979-80 collections (Espy 1980, p. 6-25). Rough fish continued to dominate the fish community by both numbers and biomass throughout the 5 years of pre-operational monitoring (ibid, p. 6-20).

4.3.5 Endangered and Threatened Species

No endangered species of aquatic organisms are expected to occur in the vicinity of the Byron site (Saunders). In over the 7 years of baseline, construction, and pre-operational monitoring no endangered species of aquatic biota have been identified in field collections made by the applicant.

The only Federally listed endangered species that potentially could occur onsite are the bald eagle (*Haliaeetus leucocephalus*) and the Indiana bat (*Myotis sodalis*). Neither species has been observed onsite during the past 5 years of environmental monitoring. A single bald eagle was sited 24 km southwest of the site during the 1980-81 winter (ibid).

In addition, two State of Illinois endangered species were observed in the area of the site. These were the common tern (*Sterna hirundo*) and the red-shouldered hawk (*Buteo laneatus*) (Espy 1980).

4.3.6 Historic and Archeological Sites

FES-CP Section 2.3 states that no National Historic Sites or National Landmarks are within 16 km of the Byron site. Since then Pinehill, 400 Mix St., Oregon, Illinois, has been added to the Register. Pinehill is 8 km southwest of the site.

Archeological surveys have been conducted on the transmission corridors since the FES-CP was issued. The surveys have been evaluated by the State Historic Preservation Officer (Appendix H).

4.3.7 Socioeconomic Characteristics

Section 2.2 of the FES-CP describes the socioeconomic characteristics of the area, including demography and land use. The site is located approximately in the center of agriculturally based Ogle County. The 1980 population of the county was 46,338, with 61% of the inhabitants living on farms or in communities of less than 2500 people. The 1970 population of the county was 42,926. However, within 48 km of the plant, the majority of people reside in urban areas such as Rockford and Belvidere.

The population growth projected in the FES-CP has generally been found to be greater than what the data now show. For example, the 0-80 km (0-50 mile) population was estimated to be over one million in 1980, while that population actually was 958,331. The 0-16 km population was estimated to be greater than 21,000 and actual data show it to be 18,269. One exception to this over-estimating was in the 0-8 km area. The estimate for 1980 was 5623, but the actual was 6235. Population growth should remain well within the bounds established in the FES-CP. This is emphasized by Ogle County's having passed a land use plan in 1979 that encourages continued agricultural use of the county's prime farmland. This should result in residential developments being placed in existing towns and on marginal land (ER-OL RQ 310.2). There are no other significant changes which have occurred from the description in the FES-CP.

4.3.8 Noise

Ambient noise level data for locations in the vicinity of the Byron station were not presented in the FES-CP. However, since that time the applicant has measured ambient noise levels in the villages of Byron and Oregon at locations in the villages nearest Byron Station (about 5.6 km and 6.4 km, respectively, from the station cooling towers). Ambient noise level data were also collected in the vicinity of the station's Rock River intake (applicant's sample location number 4), at two locations along the southern site boundary (applicant's sample location numbers 2 and 3), and at a location along the eastern site boundary (applicant's sampling location number 1) (ER-OL Figure 5.6.1). The applicant's sample location number 3 is at the edge of the nearest residential property. The day-night equivalent noise levels* for applicant's sample locations 1 through 4 are as follows:

Sample Location	L_{dn}
1	45 dB
2	45 dB
3	54 dB
4	56 dB

The area surrounding the Byron site is characterized as having a low population density and as being predominantly rural in land use. However, there are several identified noise-sensitive land uses in the site vicinity (ER-OL Sec. 2.1 and response to staff question 290.3). The closest of these include: four residences within 1.6 km (1 mi) of the site; Ebenezer Church, about 1.9 km (1.2 mi) south of the natural draft cooling towers; a campground and marina 3.2 km (2 mi) east of the site; a county park about 4.8 km (3 mi) east-northeast

*The equivalent steady A-weighted noise level during a 24-hour time period that would contain the same noise energy as the time varying noise during this same period but with a 10 decibel weighting applied to the equivalent sound level during the nighttime hours of 10 p.m. to 7 a.m.

of the site; a state park about 5.6 km (3.5 mi) southwest of the site; and two schools, each about 5.9 km (3.6 mi) north-northeast of the site. The applicant's sampling locations 1 and 3 correspond to residential locations near the site. Location 2 is along the road leading from the site past Ebenezer Church about halfway between the station cooling towers and the church.

The estimated ambient noise levels prepared by the applicant appear to be somewhat higher than would normally be expected for rural areas, based on "typical" values for this land use category given in the literature. The applicant reports (C. L. McDonough, CECo, letter to NRC, January 18, 1982) that insects and local traffic were the dominant noise sources during this survey. Construction activity at Byron station was suspended during the survey so that the survey results would not be biased by this noise source.

4.4 References

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5 ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

5.1 Résumé

This résumé highlights changes in the staff's evaluation of the environmental effects of operating the Byron station in the light of information gained since the FES-CP was issued in 1974. No discussion is provided of those impacts for which there has been no new information or change since the construction review.

No significant changes in land-use impacts have been noted since the issuance of the FES-CP. Water-use and hydrological impacts are re-examined and updated to reflect changes in plant design and operation and more recent environmental data. Air-quality impacts are also re-examined. Terrestrial- and aquatic-ecology impacts are reviewed and updated. Historic and archeological sites are reviewed in the light of new information. Socioeconomic impacts are reviewed and updated. Information on radiological impacts of normal operation has been revised to reflect updated knowledge. The material on plant accidents now contains information that has been revised and updated to include Class 9 accidents and the lessons learned from the accident at Three Mile Island, Unit 2 (TMI-2). The latest information on environmental effects of the uranium fuel cycle and decommissioning is provided. The environmental impact of the new emergency planning facilities required as a result of the accident at TMI-2 is provided.

Operational monitoring programs are to be conducted in accordance with the Environmental Protection Plan (EPP) and the Environmental Technical Specifications for radiological monitoring to be issued by the NRC as part of the operating license. The EPP will require the applicant, as licensee, to (1) notify NRC if changes in plant design or operation occur, or if tests or experiments affecting the environment are performed, provided that such changes, tests, or experiments involve an unreviewed environmental question; (2) maintain specific environmentally related records; (3) report violations of conditions stated in the NPDES permit or state certification pursuant to Section 401 of the Clean Water Act; and (4) report unusual or important environmental events.

5.2 Land Use

The main impact on land use from operation of the station will be a continuation of the diversion of former agricultural land to industrial use. This will involve the approximately 61 ha (150 acres) encompassing the major plant structures of the 710-ha (1754-acre) site. The marginal farmland consisting of approximately 132 ha (325 acres) will be developed to provide a permanent low maintenance ground cover that can be useful for wildlife habitat and control soil erosion. This will be done after consultation with the Ogle County Soil Conservation Service and the Illinois Department of Conservation.

5.3 Water

5.3.1 Water Use

5.3.1.1 Surface Water

The Byron station has an average water consumptive use rate of about 1.3 m^3/sec (47 cfs). The lowest historical one day flow at the site was about 11 m^3/sec (400 cfs) and the average annual flow is about 135 m^3/sec (4800 cfs). Backwater analyses by the applicant for low flow conditions in the Rock River indicate that a reduction of 10% in the river discharge would result in only negligible (less than 3 cm (0.1 foot)) changes in water surface at the intake and downstream.

The maximum planned net river water withdrawal is 1.7 m^3/sec (60 cfs). The water surface elevation at the intake corresponding to the historic low flow of 11 m^3/sec (400 cfs) is 670.4 feet msl. The invert elevation of the intake channel is 663.5 feet msl. There are no water use permits that could affect plant operation.

The operation of the Byron station should not have any significant impact on downstream surface water users. Conversely, the projected future water uses in the Rock River Basin should not have any significant impact on plant operation.

5.3.1.2 Groundwater

The projected effects of station groundwater withdrawals of approximately 1780 lpm (470 gpm) were evaluated using the Theis equations (Theis 1935) with assumed values of 19,700 m^2/day (17,000 gpm/ft) and 3.5×10^{-4} as the coefficients of transmissivity and storage (Hackett and Bergstrom 1956). Theoretical distance- and time-drawdown curves were constructed in order to determine the anticipated shape of the cone of depression and the radius of influence of the Byron station wells. These theoretical curves indicate that the Byron station groundwater withdrawals should not impose measurable interference drawdowns on the nearest public water supply wells completed in the Cambrian-Ordovician Aquifer. In fact, the groundwater withdrawals at the Byron station intercept groundwater that otherwise would naturally discharge from the aquifer into the Rock River.

Pumping from the Byron station water wells will cause little effect on domestic wells completed in the Galena-Platteville dolomites. The Galena-Platteville dolomites in the site vicinity are hydraulically separated from the lower portion of the Cambrian-Ordovician Aquifer by the Harmony Hill Shale Member of the Glenwood Formation. In addition, the Byron station water wells are cased through the Galena-Platteville dolomites. Groundwater in the Galena-Platteville dolomites is perched on the Harmony Hill Shale Member, and initially, water levels in this aquifer will not be lowered by the pumping required for daily station use from the lower portion of the Cambrian-Ordovician Aquifer. As pumpage from the station water wells continues, minor vertical leakage may occur through the Harmony Hill Shale Member. If recharge by rainfall infiltration is not considered, water levels in domestic and agricultural wells in the site vicinity may be lowered slightly as a result of long-term pumping of groundwater from the Byron station water wells. The aquifer pumping test of the Byron station water wells will include the monitoring of groundwater levels in nearby wells installed in the Galena-Platteville dolomites. The results of these tests will be included in either the Final Safety Analysis Report or the Environmental Report.

During construction, the bedrock foundations of the seismic Category I structures were grouted. These structures included the power block and the two essential service water cooling towers. Before the consolidation grouting, a grout curtain was placed around the perimeter of each of the foundations. The grout curtains and the consolidation grouting were extended to the top of the Harmony Hill Shale Member of the Glenwood Formation. The foundation grouting, therefore, significantly reduced rock mass permeability in the overlying Galena-Platteville dolomites. The consolidation grouting should not significantly affect perched groundwater levels in the Galena-Platteville dolomites. The site groundwater monitoring program has shown no water-level decline in this aquifer since grouting was completed.

A continuing site groundwater monitoring program began in December 1975. This monitoring program is being performed to define existing conditions as a base for future comparisons; to monitor the effects of construction; to check for changes in water levels, mineralization, and water quality due to either plant operation or groundwater use by others; and to provide ample warning time and a basis for remedial action to protect offsite groundwater users in case of detrimental changes in groundwater quality. The existing site groundwater monitoring program is not a part of any future radiological monitoring program.

Six domestic and agricultural water wells are being monitored for monthly changes in groundwater chemistry, and in three of the wells, monthly changes in piezometric levels are being recorded. Three of the water wells are owned by CECo and are located on the inside perimeter of the Byron site boundaries. The other three wells are on the outside perimeter of the site boundary. Data from the ongoing monitoring program at the site indicate that there have been no changes in groundwater piezometric levels attributable to excavation, grouting, groundwater pumping, or other activities at the Byron station. Groundwater chemistry and water level data gathered through December 1977 provide the bases for comparison with future data collected during the monitoring program. These groundwater water level data are provided in Table 5.1.

5.3.2 Water Quality

5.3.2.1 General

Water quality impacts may be caused by chemical and other wastes in the station effluent discharged to the Rock River. The potential for impacts to receiving water quality were assessed during the construction permit environmental review (FES-CP Sections 5.2.3 and 5.4). There have been changes in the volume and concentration of wastes in the station effluent due to changes in station design, operating procedures, and environmental data (Sections 4.2.6 and 4.3.2). The resulting changes in potential water quality impacts are examined below.

Table 5.1 Summary of piezometer installations and groundwater measurements

BORING	GROUND SURFACE ELEVATION (ft, MSL)	DEPTH OF PIEZOMETER (ft)	GROUP IN WHICH PIEZOMETER INSTALLED[a]	DATE OF WATER LEVEL MEASUREMENT	WATER LEVEL ELEVATION (ft, MSL)
G-1	837.6	105	P	11/8,9/72	747.3
				1/25/73	745.7
		195	A	11/8,9/72	686.2
				1/25/73	686.6
G-2	847.9	118	P	11/8/,9/72	762.6
				1/25/73	760.9
				6/4/74	789.5
				6/17/74	789.5
				6/26/74	789.8
				7/1/74	789.9
				10/16/74	789.4
				10/30/74	790.4
				12/3/74	790.4
				1/6/75	789.9
				4/9/75	789.5
G-3	855.3	63	G	11/8,9/72	802.5
				1/25/73	809.3
				6/27/74	820.6
				7/1/74	821.3
				4/14/75	800.9
		90	P	11/8, 9/72	776.1
				1/25/73	776.3
				6/27/74	788.0
				7/1/74	788.8
				4/14/75	769.7
G-4	828.7	95	G	11/8,9/72	782.8
				1/25/73	782.4
G-5	869.0	113	G	11/8,9/72	775.3
				1/25/73	776.5
				6/27/74	809.8
				7/1/74	810.4
				4/14/75	772.8
G-7	865.9	95	G	11/8,9/72	793.5
				1/25/73	774.8
G-8	831.3	120	P	11/8,9/72	769.0
				1/25/73	767.3
				6/17/74	776.5
				6/26/74	774.5
				7/1/74	774.5
		231	A	11/8,9/72	688.3
				1/25/73	688.4
				6/17/74	691.3
				6/26/74	690.0
				7/1/74	691.1
				4/14/75	688.6
G-10	884.3	110	G	1/25/73	840.8
		279	A	11/8,9/72	691.9
				1/25/73	702.6
				6/26/74	693.0
				7/1/74	693.6
G-12	852.8	120	P	11/8,9/72	781.7
				1/25/73	774.8
				6/27/74	807.0
G-14	796.8	75	P	11/8,9/74	751.5
		181	A	11/8,9/74	686.6
G-15	782.3	116	P	11/8,9/74	719.3
		175	A	11/8,9/74	700.8
G-16	832.2	100	P	11/8,9/74	762.6
		220	A	11/8,9/74	691.9

[a]Key for group is as follows:

G = Galena Group
P = Platteville Group
A = Ancell Group (St. Peter Sandstone)

5.3.2.2 Surface Water

The staff assessment in the FES-CP concerning the size of the Byron station thermal plume relative to the allowable areal river cross-sectional extents was that the actual plume size and configuration would likely be smaller than the staff's modelling predictions. These predictions indicated compliance with applicable state limitations for all but the worst case condition. The staff concluded that the discharge would comply, even under the worst case condition. The information presented by the applicant since the issuance of the FES-CP shows smaller thermal plume areas for the same conditions analyzed in the FES-CP and the applicant, therefore, concludes that the thermal discharge will readily comply with state limitations. The proposed thermal effluent limitations in the NPDES permit would require the applicant to comply with the 2.8°C (5°F) contour during station operation (see Appendix B). Based on these new data and requirements, the staff has not redone its thermal model for Byron station. The staff conclusion that the station will likely meet the state limitations remains valid.

The revised estimates of the average and maximum concentrations of wastes to be discharged to the Rock River by Byron station during operation are given in Tables 4.3 and 4.4, respectively. Nearly all of the changes in the discharge concentrations of the major effluent constituents are increases. These changes are a result of the increase in the level of dissolved substances in the Rock River since the issuance of the FES-CP (see Table 4.13) and the increase in the concentration factor of the station cooling system over that estimated in the FES-CP.

The average dissolved solids concentration is in excess of the average of the river by 1140 mg/l. The quantity of solids returned to the river, in excess of the amount contained in a volume of river water equal to the volume of blowdown discharged in a day, would be equal to about 84,100 kg/day (185,000 lb/day). This quantity, if completely mixed in the average river flow past the site, would increase the total dissolved solids concentration by 1.7% or about 7 mg/l to 422 mg/l. This increase is the result of a net removal by evaporation of water from the river. This increase is not expected to have an observable adverse impact on downstream water quality.

An NPDES permit addressing the operational phase discharges from the Byron station has not been issued by the State of Illinois. However, as indicated in Section 4.2.6, a proposed condition (limitations) for these discharges have been added to the existing NPDES permit for the construction phase (Appendix B). The staff has examined the proposed discharge limitations compared to the proposed operation of the station and concludes that compliance without change to the proposed mode of station operation is likely, with the possible exception of the proposed limitation on daily duration of residual chlorine discharge from the station of 2 hours per day. Compliance with this limitation, if imposed, will depend on the specific cooling system characteristics experienced during operation. However, as indicated in the FES-CP (Section 5.4.2.3), modifications such as holdup of blowdown or dechlorination, are available under existing technology so that compliance with this effluent limit to protect designated uses of the Rock River would be readily achieved.

The staff has examined the specific constituents and the concentrations expected to be in the station effluent. Comparison of these concentrations with the permissible concentrations under the Illinois Pollution Control Board Rules and Regulations 203, 204, and 408 indicate that violations of the standards applicable to the Rock River or the effluent standards are not anticipated. The applicant has indicated that operation of Byron station will be in compliance with all applicable state regulations (ER-OL Section 5.3) with respect to liquid effluents. The staff concurs with this assertion, and concludes, regarding the comparison of ambient river quality, expected discharge quality and quantity, available criteria in the literature, and the analysis presented in the FES-CP, that surface water quality impacts caused by the operation of Byron station will be small.

5.3.2.3 Groundwater

The staff assessment in the FES-CP that the quantity of groundwater to be used by Byron station is small compared to the groundwater available has not changed. In addition, the operation of Byron station will not result in the discharge of any effluents to the groundwater. Therefore, the staff concludes that there will be no adverse impacts on groundwater quality in the vicinity of Byron station.

5.3.3 Floodplain Aspects

The Byron station is located in the Rock River Basin. A detailed description of the Rock River drainage basin and its tributaries is given in Section 4.3.1.

Figure 5.1 shows the preconstruction flood prone area of the Rock River in the vicinity of Byron station. This figure was reproduced from the United States Geological Survey flood prone area map for Oregon, Illinois, Quadrangle, 1975. Figure 5.2 shows the preconstruction flood hazard area of the Rock River and its tributaries in the vicinity of the Byron station due to the 1% chance per year flood. This flood hazard area was delineated by the Federal Emergency Management Agency, Department of Housing and Urban Development in 1978.

The plant area and the river screenhouse which are located in or near the floodplains of the Rock River are also shown in Figures 5.1 and 5.2. It is evident from the figures that the station area does not alter the floodplain of Rock River or its tributaries in the vicinity so as to affect their flood prone areas. The station area is on or near a ridge area.

The river screenhouse, located on the Rock River approximately 8 km upstream of Oregon Dam, encroaches on the Rock River floodplain as shown in Figure 5.2. The effect of the river screenhouse, on the 1% chance flood level in the Rock River at the location of the river screenhouse, was evaluated by backwater analysis. The 1% chance per year discharge at the river screenhouse is 1772 cms (62,600 cfs). The corresponding flood level at the screenhouse under natural conditions was calculated to be 684.2 ft msl. The analysis performed with the river screenhouse in place also resulted in a flood level of 684.2 ft msl. This shows that there is negligible effect from the river screenhouse on the 1% chance flood level in the vicinity of the screenhouse.

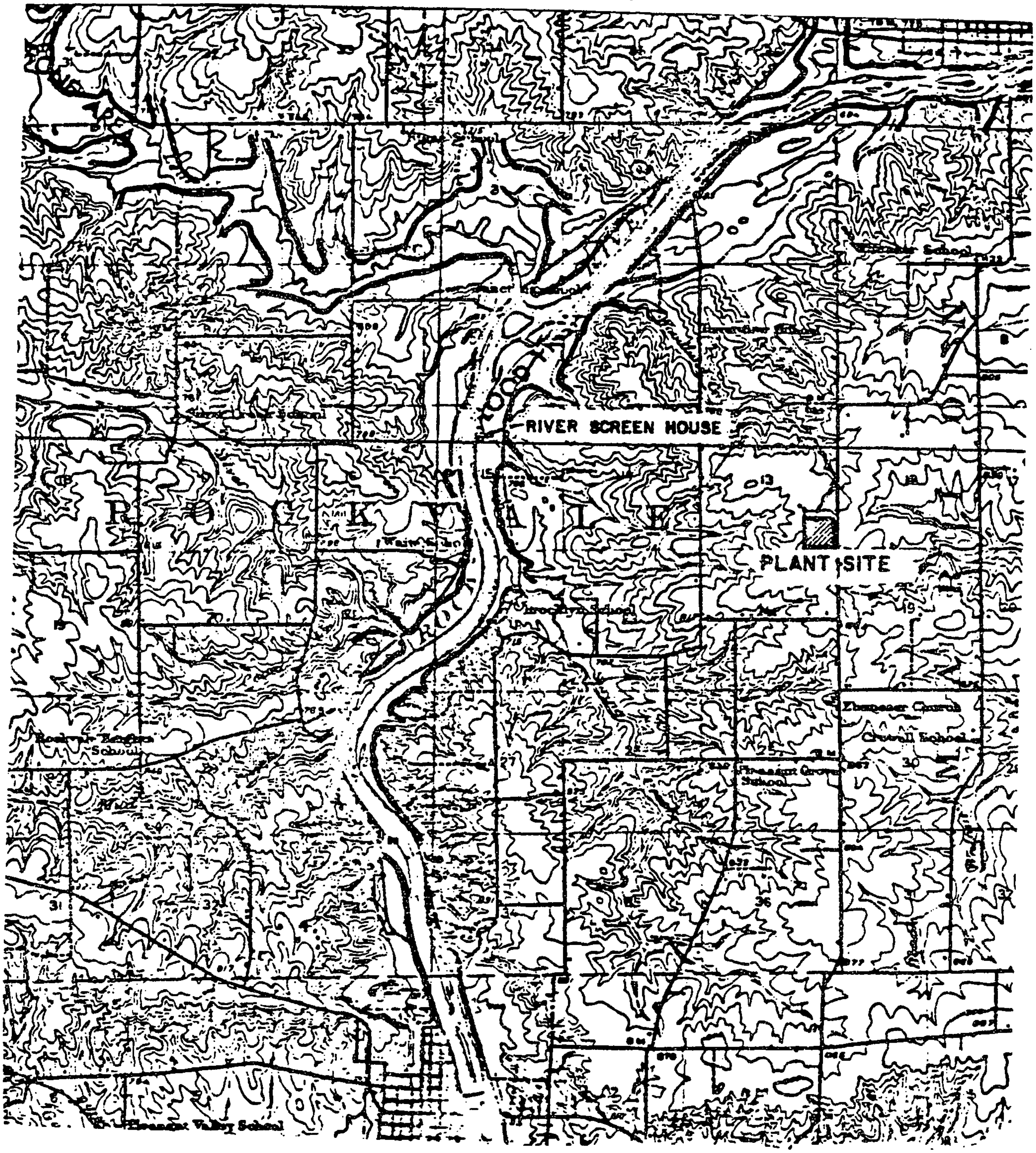

Figure 5.1 Floodplain area of the Rock River

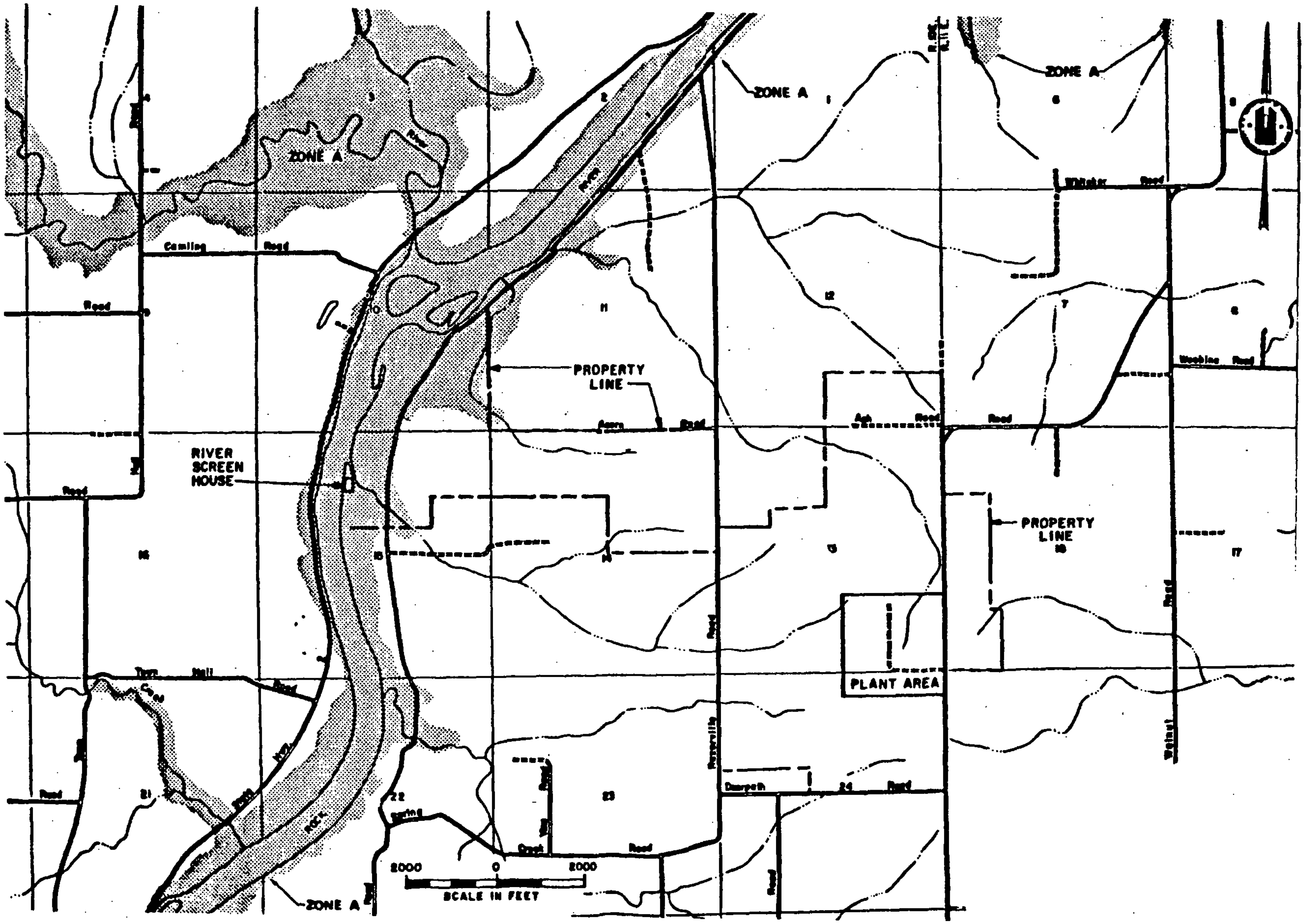

Figure 5.2 Flood hazard area of the Rock River and tributaries

Figure 5.3 shows the river cross-section at the screenhouse with and without the screenhouse. At elevation 684.2 ft msl., the cross-sectional area under natural conditions is 2126 m^2 (22,884 sq ft), and the area with the screenhouse in place is 2066 m^2 (22,248 sq ft). Thus, the river screenhouse reduced the cross-sectional area of the river under 1% chance flood condition by only 2.8%.

It is clear from the above discussion that Byron station and in particular the river screenhouse do not alter either flood flows or flood levels, both upstream and downstream of the screenhouse. No debris is or will be generated and disposed of into the waterways from the Byron station facilities. Debris accumulation at the station structures is not expected and, hence, there would be no potential effect on flood prone areas.

5.4 Air Quality

The Byron site is in a nonindustrial rural area and as such air quality conditions are generally considered good. The CEQ 1980 report does not indicate poor ambient air quality in this portion of Illinois.

5.4.1 Emissions

The principal nonradiological emissions to the atmosphere will be from the operation of the natural-draft and mechanical-draft cooling towers. The existence of a visible vapor plume will provide the most significant impact on the site region. The existence of the plume, its extent, and duration are functions of ambient meteorological conditions of humidity, air temperature, wind speed, and direction. Within the plume, the liquid water and some chemicals used within the cooling system will be transported away from the towers and deposited nearby. This deposited material is termed drift.

The information in Section 2.3.2.2.1 of the Byron FSAR provides a reasonable evaluation of the effects of cooling-tower operation. The existence of the natural-draft cooling-tower plume will produce insignificant shadowing and only very slight chance of augmenting natural precipitation down wind of the tower (Argonne). Similarly, ground-level icing and fogging resulting from the natural draft towers is not expected.

The effect of the mechanical-draft towers should only affect the conditions in close proximity to the tower and not have an impact upon offsite activities.

5.4.2 Monitoring

The operational meteorological measurements program will be the same as the preoperational program described in the FSAR stage, and in Section 4.3.3 of this document. In addition, the needs of emergency preparedness meteorology monitoring as described in NUREG-0654 will be available.

5.5 Ecology

5.5.1 Terrestrial

The terrestrial ecology impacts that were expected to be caused by operation of the plant were assessed during the construction permit review (FES-CP,

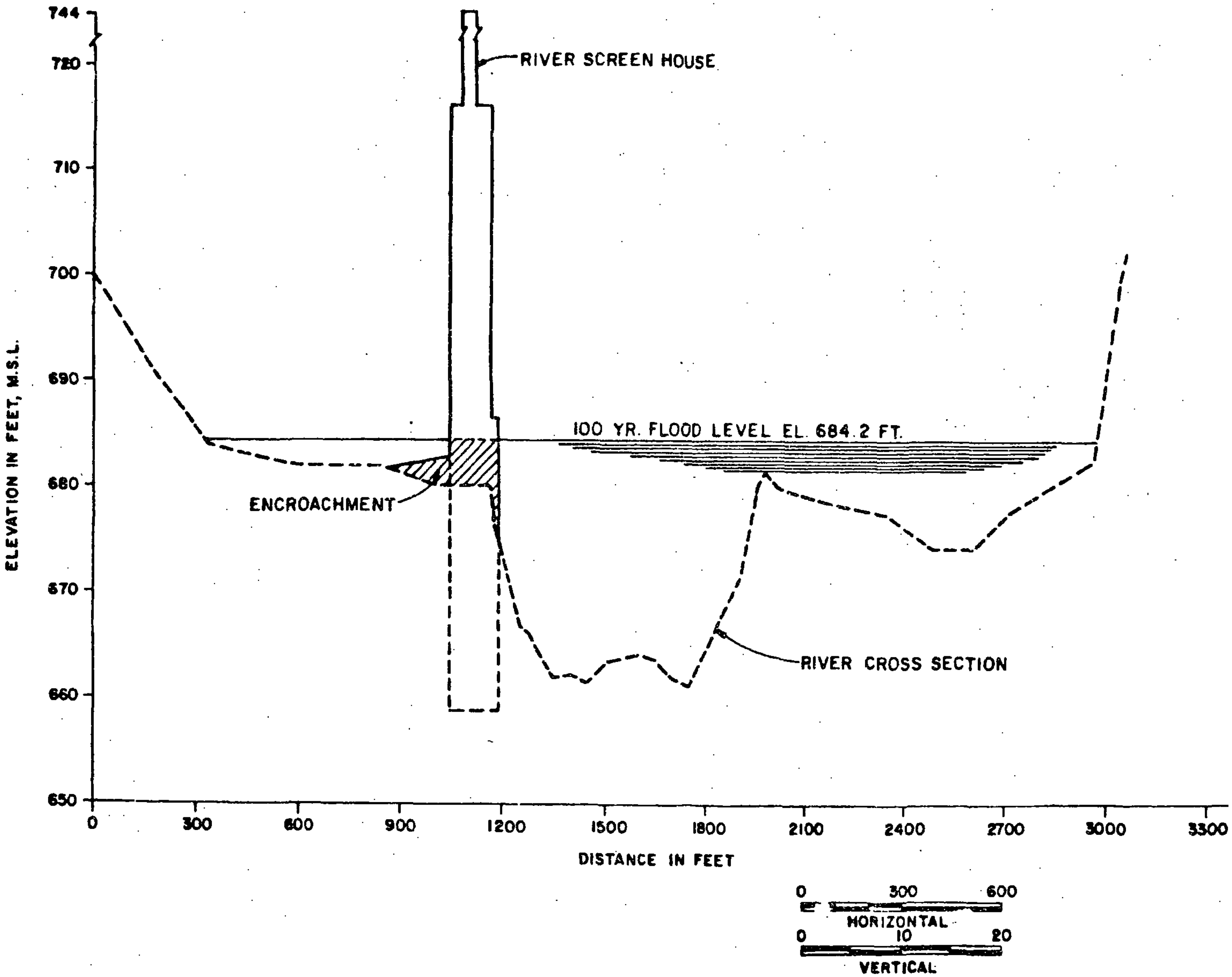

Figure 5.3 Rock River cross section

Section 5.4.1). No additional impacts are expected to occur that were not considered at the CP stage.

5.5.1.1 Cooling-Tower Emissions

The staff considers that the construction and preoperational monitoring efforts by the applicant will provide an adequate information base for detecting and evaluating the impacts of station operation on terrestrial environments. A short-term continuation of the program will be required to detect any possible changes to the terrestrial environment due to operation of the station. The details of the program will be presented in the Environmental Protection Plan which will be included as Appendix B of the operating license.

5.5.1.2 Bird Impaction

Bird kills by collision with cooling towers have been studied and reviews presented (Avery, et al.). There have been no reported major bird kills at cooling towers. The avifaunal survey to document any migratory bird fatalities that may result from direct collision with the meteorological tower, cooling towers, or containment and turbine buildings began in August 1977. During the 1977 to 1979 survey periods, no dead or injured birds were observed. During the 1980 survey, nine dead birds were documented during the fall migratory season (October). There were five golden-crowned kinglets, one long-billed marsh wren, one white-throated sparrow, one Tennessee warbler, and one warbler that could not be more completely identified due to its condition. All of these birds were collected from around the bases of the natural-draft cooling-tower structures. During the 1981 survey period, no impaction mortalities were reported. The results as briefly described here were reported to the U. S. Fish and Wildlife Service and the Illinois Department of Conservation.

5.5.1.3 Transmission Lines

Because only about 10% of the rights-of-way are forested and there are an abundance of county and secondary roads, there will be little need to construct any new access or service roads along the 100 km of transmission lines. Most woodlands are open with low tree density and the applicant has committed to clear only those trees necessary for line security. This method of clearing the right-of-way avoids a notched or tunneled appearance and thus is the least disturbing way of establishing a right-of-way.

The staff has reviewed environmental impacts which could be associated with the operation of transmission lines. These potential sources are (1) ozone production, (2) induced electrical currents, (3) electrical fields, and (4) corridor maintenance and herbicide use. Only very small amounts of ozone are produced by transmission lines so quantity of ozone poses no detrimental environmental effects. Health effects to humans from electric fields associated with transmission lines have been reviewed (Phillips and Kaune, ITT, DOE).

While experimental work is still underway on the biological effects of electrical fields along extra high voltage transmission lines, the staff has found no convincing or compelling arguments to date to prohibit the operation of 345-kV lines, as proposed by the applicant. The applicant has designed the station-related portion of his transmission system in accordance with practices approved by the National Electric Safety Code (1977 edition) to ensure the safeguarding of persons from hazards arising from the operation of overhead lines (Hackett). These practices include the adequate grounding of all steel transmission towers along the right-of-way. Because most of the right-of-way traverses agricultural land, only limited corridor maintenance will be required with possible spot application of herbicides. All herbicides used in the control of vegetation will be applied in accordance with the restrictions stated in the registered container labels.

5.5.2 Aquatic

5.5.2.1 Intake Effects

Entrainment

In the FES-CP, the staff evaluated the potential entrainment impact on the basis of the ratio of intake flow to river flow. With maximum intake flow of 3.0 m^3/sec (107 cfs), the predicted losses of planktonic (drift) organisms during summer was about 2% for average river flow and 7% for the 7-day 10-year low river flow condition (FES-CP Section 5.4.2).

The potential entrainment impact has been reconsidered on the basis of new information and data obtained since issuance of the FES-CP. These include (1) revised makeup water requirements, (2) revised river flow rates at the site, (3) results of the applicant's demonstration study pursuant to Section 316(b) of the Clean Water Act, and (4) ichthyoplankton data from the applicant's construction and preoperational aquatic monitoring program.

The makeup water requirements are now expected to be less than those considered in the FES-CP. The predicted range is from 1.7 m^3/sec (60.7 cfs) to 2.5 m^3/sec (88.7 cfs) with average makeup of 2.2 m^3/sec (76.9 cfs).

River flow characteristics have been updated by the applicant based on USGS flow records through 1976. Monthly average flows for the period of record, 1954-1976, are generally higher than those given in Table 2.1 of the FES-CP; the average flows were less for 2 months, February and March. The annual average flow of 133.9 m^3/sec (4728 cfs) given in the ER-OL, p. 2.4-2, is slightly greater than the value of 129.7 m^3/sec (4580 cfs) given in the FES-CP (p. 2-15). Low flows of specified duration and recurrence interval are also greater as shown by a comparison of Table 2.4-5 of the ER-OL with Table 2.2 of the FES-CP. The 1-day lowest flow of 11.3 m^3/sec (400 cfs) is the same as given in the FES-CP.

A reassessment of potential entrainment, based on the new data for intake flow and river flow, is summarized in Tables 5.2 and 5.3. Under average river flow conditions, the percent withdrawn, at the maximum makeup rate, ranges from 0.9% in April to 3.2% in August; the annual average remains at about 2%, as reported in the FES-CP. Under low flow conditions, the ratios of makeup to river flow increase as shown in Table 5.3. During the 90-day/10-year low flow, the withdrawal is about 7%, as indicated in the FES-CP for the summer value. Thus, to the extent which the FES-CP assessment of entrainment was carried, there are no changes between the current results and FES-CP results. The new information allows further treatment and assessment of potential entrainment impact.

Table 5.2 Average river flows and percentage withdrawn for Byron station

	Average river flow (1954-1976), m^3/sec (cfs)	% river flow withdrawn for makeup*
Jan	109.9 (3878)	2.3
Feb	123.9 (4373)	2.0
Mar	242.6 (8560)	1.0
Apr	269.2 (9499)	0.9
May	197.2 (6960)	1.3
Jun	134.0 (4730)	1.9
Jul	105.1 (3708)	2.4
Aug	79.3 (2799)	3.2
Sep	90.7 (3200)	2.8
Oct	103.5 (3654)	2.4
Nov	113.1 (3991)	2.2
Dec	100.6 (3550)	2.5

*Based on maximum makeup = 2.5 m^3/sec (88.7 cfs)

Table 5.3 Percent of river flow required for Byron station makeup during historical average and low-flow conditions

Duration/Recurrence	River flow m^3/sec (cfs)	% of river flow*
1-day lowest/> 100-year	11.3 (400)	22.1
1-day/100-year	12.9 (454)	19.4
1-day/10-year	20.2 (714)	12.4
7-day/10-year	26.2 (925)	9.5
30-day/10-year	30.2 (1064)	8.3
90-day/10-year	36.2 (1276)	6.9
365-day/10-year	80.7 (2849)	3.1
Average Annual	134.0 (4728)	1.9

*Based on maximum makeup = 2.5 m^3/sec (88.7 cfs)

Values obtained in this analysis were compared with results given in the applicant's demonstration pursuant to Section 316(b) of the Clean Water Act (CECo). Ratios of makeup to river flow reported in the 316(b) demonstration report were found to be greater than those presented here. Investigation of the methods used in the 316(b) study indicated the following reasons for the higher estimates:

(1) the river flows were based on records at the Rockton, Ill. gauge and were not corrected for the additional drainage area between the Rockton gauging station and the Byron site

(2) the expected maximum makeup flow used in the 316(b) entrainment calculations was 2.8 m^3/sec (98 cfs).

Both lower river flows and higher makeup flow contribute to higher estimated entrainment ratios than those developed in the staff's analysis.

A potentially significant piece of new information regarding the entrainment assessment was presented in the 316(b) demonstration report. This concerns the morphometry of the river cross-section at the intake location and the river width potentially affected by intake withdrawal. The intake withdraws river water from the east bank region of the river where the depths are much less than the mean depth of the river cross-section. Thus, the percent of river width affected by intake withdrawal is higher than the percent of river flow entrained. In Table 5.4, these two parameters are compared for several river flows representative of low and average flows at the site. By linear interpolation of the tabular values, it is indicated that about 5% of the river width is affected by intake withdrawal during mean annual river flow and about 16% during the 7-day/10-year low flow. Thus, the potential entrainment impact could be greater based on this alternative assessment approach, particularly if the drift organisms (such as fish eggs and larvae) are concentrated along the shallower overbank region near the intake.

The applicant's sampling program for drift organisms was not designed to document the relative distribution over the river cross-section. However, results of phytoplankton and zooplankton studies indicate homogeneous distribution of planktonic organisms (see Section 4.3.4.2). If fish eggs and larvae are homogeneously distributed like the lower trophic level organisms, then the ratio of intake flow to river flow is an appropriate measure of the potential entrainment impact.

For the more probable river flows expected at the site, intake entrainment is predicted to be less than 10%. For extreme low river flows of short duration and infrequent recurrence, entrainment would be greater than 10%. Extreme low flows do not typically correspond to the months of peak spawning activity. However, when the cooling tower consumptive demand exceeds 10% of the river flow, the applicant has committed to maintain a net withdrawal at a level acceptable to the Illinois Department of Conservation. The established level is no more than 9% of the Rock River flow when the flow is at or below 19.2 m^3/sec (679 cfs), the approximate 1-day/10-year low flow (Rogers). The mitigative action to be taken in this instance would be a reduction in plant power level until the river flow increases sufficiently to allow the withdrawal rate necessary for full power operation (ER-OLS, Section 3.3.1). Such mitigative

Table 5.4 Percentages of river flow withdrawn and river width affected by Byron station intake for selected river flows

River flow m^3/sec (cfs)	% of flow withdrawn*	Width affected m (ft)	% of river width**
17.0 (600)	14.8	42.7 (140)	22.5
28.3 (1000)	8.9	27.4 (90)	14.4
42.5 (1500)	5.9	21.3 (70)	11.2
56.6 (2000)	4.4	18.3 (60)	9.6
85.0 (3000)	3.0	15.2 (50)	8.0
113.3 (400)	2.2	12.2 (40)	6.4
141.6 (5000)	1.8	9.1 (30)	4.8
184.0 (6500)	1.4	6.1 (20)	3.2

*Intake flow = 2.5 m^3/sec (88.7 cfs) maximum
**River width at intake = 189.9 m (623 ft)

Source: CECo (River widths affected by intake flow of 2.5 m^3/sec determined graphically from Figures 5.14 through 5.19 of CECo 316(b) demonstration report)

action should ensure that intake entrainment and discharge effects (discussed in the following section) do not result in significant adverse impacts during the extreme low river flow conditions.

Impingement

In the FES-CP, the staff evaluated the potential impingement impact on the basis of characteristics of the Byron station intake structure and impingement experience at the Dixon Generation Station located downstream of the Byron site. Impingement was not anticipated to be of significance because of the design and orientation of the structure and low impingement experienced at the Dixon Generation Station.

New information obtained since the FES-CP supports the staff's previous conclusion regarding low potential for impingement impact. This new information concerns the revised makeup water requirements and impingement data from studies conducted at the Sabrooke Generation Station, prior to retirement of the Sabrooke station in September 1976 (CECo, p. 5.50).

The makeup water requirements are now less than those considered in the FES-CP. Therefore, the intake approach velocities will be slightly less based on intake design considerations. Correspondingly, impingement potential would be slightly reduced.

The Sabrooke station is located upstream of the Byron site, and its cooling water source was from the same pool of the Rock River as for the Byron station. Although impingement may vary between plants even on the same source water body, results of the Sabrooke impingement study are expected to be most indicative of the potential impingement at the Byron station. The following is based on the Sabrooke study results, as presented in the applicant's Section 316(b) demonstration (ibid).

Over a 1-year period of study, an average of about seven fish, weighing 148 grams, were impinged per 24-hour sample period. The rate varied from 1.2 fish/24 hours during the third quarter of the year to 13.8 fish/24 hours during the second quarter. Catfish, mostly channel catfish, accounted for 45% of the total number, followed by bluegills (10%), yellow bass (10%) and black crappie (7%). Catfish also dominated the impingement collection on the basis of weight; channel catfish accounted for 19% followed by shorthead redhorse (16%), black bullhead (13%) and black crappie (10%).

The applicant has compared the impingement rate at Sabrooke station as equivalent to the one-day catch of 1.5 sport fishermen. The fish impinged average only 21.2 g compared to 367.1 g per fish in the creel; thus, in terms of weight, a 1-day catch by the sport fishermen is about 12 times the average impingement experienced at the Sabrooke station. Assuming that similar impingement will be experienced at the Byron station, the staff concludes that impingement impact will be insignificant.

The operational 316(b) demonstration, required by the NPDES permit (see Appendix B), will include monitoring of fish impingement at the Byron intake.

5.5.2.2 Discharge Effects

The staff's assessment of the effects of chemical and thermal discharges on aquatic biota remains valid as presented in the FES-CP. Monitoring will be conducted by the applicant in accordance with the requirements specified in the Byron NPDES permit and in accordance with the applicant's agreement with the Illinois Department of Conservation (Rogers).

5.5.2.3 Concerns of Illinois Department of Conservation

A monitoring program will be conducted in accordance with the applicant's agreement with the Illinois Department of Conservation. This program will be based upon examination, by an acceptable third party, of "...both the validity and reliability of the existing and planned monitoring program for adequacy to detect gradual changes (both declines and improvements) which could have an effect on fish disease, or the river's general ecology" (ibid).

5.6 <u>Endangered and Threatened Species</u>

The Byron site is not critical habitat for any of the listed species. Habitat loss is small and has already occurred. Further impacts due to plant operation, if any, will be very small; traffic and the number of workers will be less than during construction, and operational impacts due to cooling tower operation have been examined and found to be negligible or small. Therefore, the staff concludes that operation of the Byron station will not have an adverse impact on any of the endangered species.

5.7 Historic and Archeological Sites

Operation of the station will not result in any significant impact on historic and archeological sites in the area (FES-CP Section 5.1) nor along the transmission corridors (ER-OL, RQ 310.4). However, as directed in a letter from the State Historic Preservation Officer to the applicant (See Appendix H), care must be taken to avoid the known archeological sites in the transmission corridors during maintenance activities, and in the event that a future major ground disturbance related to the operation and maintenance of the transmission lines is anticipated at the sites, the applicant is required to consult the SHPO before taking action. The applicant shall provide copies of this correspondence to NRC.

5.8 Socioeconomics

The socioeconomic impacts of station operation are analyzed in Section 5.5 of the FES-CP with visual impacts covered in Section 5.1.2. The primary impacts of plant operation are tax benefits and employment. The tax benefits are estimated to be approximately $11 million (1981 dollars) in 1985 when the station is scheduled to be completed. These annual revenues will be paid to nine local jurisdictions ranging in amount from $4.9 million to $10,900 (1981 dollars) as shown in Table 5.5. The plant will employ about 400 personnel when operating, with an annual payroll of $10.9 million (1981 dollars). Approximately 25% of these will be local hires. There will also be 100 security force employees with an annual payroll of $1,450,000 (1981 dollars). It is estimated that all of the security staff will be hired locally. (ER-OL, RQ 310.7.) The inflow of operating personnel will not significantly affect local services especially when compared to the number of workers required for the construction phase of the station.

Table 5.5 Byron station property taxes

Taxing Jurisdiction	1985 Estimated*
Ogle County	$ 2,022,800
Rockvale Township	1,322,600
School District U-226	4,944,300
Byron Fire District	1,516,000
Junior College District 511	629,200
Oregon Park District	313,300
Byron Library District	45,900
School District U-220	199,200
Junior College District 523	10,900
	$11,004,200

*1981 dollars.
Source: ER-OL, Amendment No. 1, Table 8.2-1.

Other socioeconomic impacts of operation such as local purchases and traffic congestion are expected to be small. The applicant has a competitive bid system for procuring goods and services for the operation of its nuclear power plants and was not able to arrive at an estimate of local purchases to be made by the operation of Byron (ER-OL, RQ 310.6). The staff feels these purchases would be minimal due to the largely agricultural economy of the county. Lastly, there should be no significant traffic problems due to the commuting of plant operating personnel. This is because of shift work, staggered work hours, car pooling, and different commuting routes (ER-OL, RQ 310.3). The staff anticipates no other significant socioeconomic differences from those listed in the FES-CP.

5.9 Radiological

5.9.1 Regulatory Requirements

Nuclear power reactors in the U.S. must comply with certain regulatory requirements and guidance in order to operate. The permissible levels of radiation in unrestricted areas and the radioactivity in effluents to unrestricted areas are spelled out in 10 CFR 20, "Standards for Protection Against Radiation". These regulations specify limits on levels of radiation and limits on concentration in effluent releases of radionuclides in air and water (above natural background) under which the reactor must operate. These regulations state that no member of the general public in unrestricted areas shall receive a radiation dose of more than 0.5 rem per year (or 2 millirems per hour or 100 millirems per 7 days) to the total body. These radiation-dose limits are established to be consistent with considerations of the health and safety of the public.

In addition to the radiation-protection standards of 10 CFR 20, license requirements are spelled out in 10 CFR 50.36a that are to be imposed on licensees in the form of technical specifications on effluents from nuclear power reactors to keep releases of radioactive materials to unrestricted areas during normal reactor operations, including expected operational occurrences, as low as is reasonably achievable (ALARA). Appendix I to 10 CFR 50 provides numerical guidance on design objectives and limiting conditions for operation for light water reactors to meet this ALARA requirement. Applicants for permits to construct and licenses to operate a light water reactor shall provide reasonable assurance that the following dose-design objectives will be met: 3 millirems per year to the total body or 10 millirems per year to any organ from liquid effluents; 10 millirads per year gamma radiation or 20 millirads per year beta radiation from gaseous effluents--and/or 5 millirems per year to the total body or 15 millirems per year to the skin from gaseous effluents; and 15 millirems per year to any organ from the airborne effluents that include the radioiodines, carbon-14, tritium, and particulates.

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

In addition to the impact created by radioactive effluents from light water reactors discussed above there are, within the NRC policy and procedures for environmental protection spelled out in 10 CFR 51, generic treatments of environmental effects of all aspects of the uranium fuel cycle. These environmental data are discussed and tabulated in Section 5.10. In the same manner, data regarding the environmental impact of transportation of fuel and waste to and from a light water reactor are discussed and tabulated in Section 5.9.3.

Recently, an additional operational requirement for uranium-fuel-cycle facilities including nuclear power plants has been established by the EPA in 40 CFR 190. This standard specifies annual dose limits (excluding radon and daughters) for members of the public of 25 millirems total body, 75 millirems thyroid, and 25 millirems other organs from all fuel-cycle-facility contributions that may impact a specific individual in the public.

5.9.2 Operational Overview

During normal operations of the Byron station, small quantities of fission products and induced radioactivity will be released to the environment. In partial fulfillment of NEPA requirements, the staff has determined the estimated dose to members of the public outside the plant boundary due to the radiation from these radioisotope releases and relative to natural-background-radiation dose levels.

These very small environmental doses are the result of a series of successive, conscious efforts to contain and control all radioactive emissions and effluents from the plant. As mentioned above, highly efficient radioactive-waste-management systems are incorporated in the nuclear plant design and are specified in detail in the operating technical specifications for the plant. The effectiveness of these systems is measured by process and effluent radiological-monitoring systems that permanently record the amounts of radioactive constituents remaining in the various airborne and waterborne process and effluent streams. The amounts of radioactivity released through vents and discharge points to be further dispersed and diluted to points outside the plant boundary are recorded and published semiannually in the Radioactive-Effluent-Release Reports of each facility.

The small amounts of airborne effluents that are released diffuse in the atmosphere in a fashion determined by the prevalent meteorological conditions and, thus, are much dispersed and diluted by the time they reach unrestricted areas that are open to the public. Similarly, the small amounts of waterborne effluents that are released are diluted with plant wastewater and then are further diluted as they are discharged into the Rock River beyond the plant boundary.

Any radioisotopes originating in the Byron station that finally enter unrestricted areas will produce dose effects through their radiations on members of the general public similar to the effects from background radiations (cosmic/

terrestrial and internal radiations), which also include radiation from nuclear-weapons fallout. These radiation-dose effects can be calculated for the many potential radiological-exposure pathways specific to the environment outside the plant boundary such as direct-radiation doses from airborne or waterborne effluent streams or internal radiation-dose commitments from radioactive contaminants deposited on vegetation, in meat and fish products, in drinking water, or in cows' milk.

These doses, calculated for the "maximally exposed" individual (that is, the hypothetical individual potentially subject to maximum exposure), form the basis of staff evaluation of impacts. Actually, these estimates are for a fictitious person because assumptions are made that tend to overestimate the dose that would actually accrue to members of the public outside the plant boundary. For example, the maximally exposed individual would have to remain physically at the plant boundary for 70% of the year to receive the dose calculated at that boundary, an unlikely occurrence.

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

A periodic land census, required by the radiological technical specifications, will be made. As use of the land surrounding the site boundary changes, revised calculations will be made to ensure that the dose estimate for gaseous effluents always represents the highest dose for any individual member of the public for each applicable pathway. For example, the estimate considers where people live, vegetable gardens are located, cows are pastured, and the like.

For the Byron station, in addition to the direct effluent monitoring, measurements will be made on a number of types of samples from the surrounding area to determine the possible presence of radioactive contaminants that, for example, might have been deposited on vegetation, be present in drinking water outside the plant, or be incorporated in cows' milk at nearby farms.

5.9.3 Routine Operation

5.9.3.1 Exposure Pathways: Dose Commitments

There are many environmental pathways through which persons may be exposed to radiation originating in a nuclear power reactor. All of the potentially meaningful exposure pathways are shown schematically in Figure 5.4. When an individual is exposed through one of these pathways, the dose is determined, in part, by the amount of time the individual is in the vicinity of the source or the amount of time the radioactivity is retained in the body. The actual effect of the radiation or radioactivity is determined by calculating the dose commitment. This dose commitment represents the total dose that would be received over a 50-year period following the intake of radioactivity for 1 year under the conditions existing 15 years after the plant begins operation (the midpoint of plant operation).

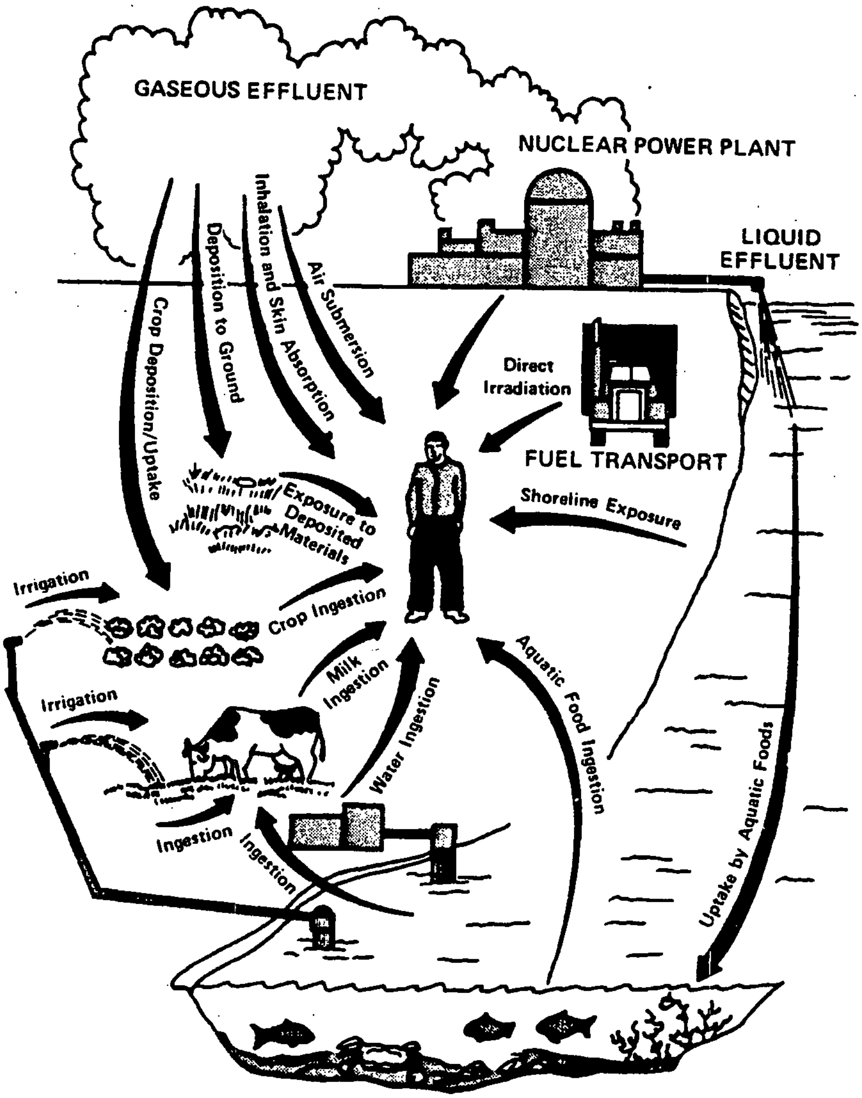

Figure 5.4 Exposure pathways to man

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

Other less significant pathways include: external irradiation from radionuclides deposited on the ground surface, eating animals and food crops raised near the site, using irrigation water that may contain liquid effluents, shoreline activities near lakes or streams that may be contaminated by effluents, drinking potentially contaminated water, and direct radiation from within the plant itself. Calculations of the effects for most pathways are limited to a radius of 80 km (50 mi). This limitation is based on several factors. Experience has shown that all significant dose commitments (greater than 0.1 millirem per year) for radioactive effluents are accounted for within an 80-km radius of the plant. Beyond that radius the doses are smaller than 0.1 millirem per year, which is far below natural-background doses, and are subject to substantial uncertainty because of limitations of predictive mathematical models.

The staff has made a detailed study of all the significant pathways and has evaluated the radiation-dose commitments both to the plant workers and the general public for these pathways resulting from routine operation of the Byron station. Discussions of these evaluations follow.

Occupational Radiation Exposure

The dose to nuclear plant workers varies from reactor to reactor and can be projected for environmental-impact purposes by using the experience to date with modern PWRs. Most of the dose to nuclear plant workers is due to external exposure to radiation from radioactive materials outside the body rather than internal exposure from inhaled or ingested radioactive materials. Recently licensed 1000-MWe PWRs are designed and operated in a manner consistent with new (post-1975) regulatory requirements and guidelines. These new requirements and guidelines place increased emphasis on maintaining occupational exposure at nuclear power plants ALARA, and are outlined in 10 CFR 20; the Standard Review Plan, Chapter 12 (NUREG-0800); and Regulatory Guide 8.8. The applicant's proposed implementation of these requirements and guidelines is reviewed by the staff at the CP stage, the OL stage, and during actual operation. Approval is granted only after the review indicates that an ALARA program can actually be implemented.

Based on actual operating experience, it has been observed that occupational dose has varied considerably from plant to plant, and from year to year. Average collective occupational-dose information from 239 PWR-years of operation is available for those plants operating between 1974 and 1980. (The year 1974 was chosen as a starting date for these data because the total average rated capacity for reactors for years prior to 1974 was below 500 MWe.) These data indicate that the average reactor annual dose at PWRs has been about 440 person-rems, with particular plants experiencing an average lifetime annual dose to date as high as 1300 person-rems (NUREG-0713). These dose averages are based on widely varying yearly doses at PWRs. For example, annual collective doses for PWRs have ranged from 18 to 5262 person-rems per reactor, and the average annual dose per nuclear-plant worker has been about 0.8 rem (ibid, NUREG-0692).

The wide range of annual doses (18 to 5262 person-rems) experienced at PWRs in the U.S. is dependent on a number of factors such as the amount of required routine and special maintenance and the degree of reactor operations and in-plant surveillance. Because these factors can vary in an unpredictable manner, it is impossible to determine in advance a specific year-to-year or average annual occupational radiation dose for a particular plant over its operating lifetime. The need to accept high doses can occur, even at plants with radiation-protection programs that have been developed to ensure that occupational radiation doses will be kept at levels that are ALARA.

In recognition of the factors mentioned above, staff occupational-dose estimates for environmental-impact purposes for Byron station are based on the assumption that the plant will experience the annual average occupational dose for PWRs to date. Thus, the staff has projected that the occupational dose for each unit at the Byron station will be 440 person-rems per year, but could average as much as three to four times this value over the life of the plant.

In addition to the occupational radiation exposures discussed above, during the period between the initial power operation of Unit 1 and the similar startup of Unit 2, construction personnel working on Unit 2 will potentially be exposed to sources of radiation from the operation of Unit 1. The applicant has estimated that the integrated dose to construction personnel, over a period of 1 year, will be about 83 person-rems. This radiation exposure will result predominantly from Unit 1 radioactive components and gaseous effluents from Unit 1. Based on experience with other PWRs, the staff finds that the applicant's estimate is reasonable. A breakdown of the integrated dose to the construction workers is given in Table 4.4-1 of the ER.

The average annual dose of about 0.8 rem per nuclear plant worker at operating BWRs and PWRs has been well within the limits of 10 CFR 20. However, for impact evaluation, the staff has estimated the risk to nuclear power plant workers and compared it in Table 5.6 to risks that are published for other occupations. Based on these comparisons, the staff concludes that the risk to nuclear plant workers from plant operation is comparable to the risks associated with other occupations.

The risk estimates used in this section are derived from the recommendations of the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation Committee (BEIR I). The estimates of the risks to workers and the general public are based on conservative assumptions (the estimates are probably higher than the actual number). The following risk estimators were used to estimate potential health effects: 135 potential deaths from cancer per million person-rems and 258 potential cases of all forms of genetic disorders per million person-rems. The cancer mortality risk estimates are based on the "absolute risk" model described in BEIR I. Higher estimates can be developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. This would produce risk values up to four times greater than those used in this report. The staff regards this as a reasonable upper limit of the range of uncertainty. The lower limit of the range would be zero. The range of uncertainty in the genetic risk estimates extends a factor of about 6 above and about 4 below the value of 258 potential cases of all forms of genetic disorder per million person-rems. The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential fatal cancers. The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation protection organizations, such as the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP), the National Academy of Sciences BEIR III Report, and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).

Table 5.6 Incidence of job-related fatalities

Occupational group	Fatality incidence rates (premature deaths per 10^5 person-years)
Underground metal miners[1]	1275
Uranium miners[1]	422
Smelter workers[1]	194
Mining[2]	61
Agriculture, forestry, and fisheries[2]	35
Contract construction[2]	33
Transportation and public utilities	24
Nuclear-plant workers[3]	23
Manufacturing[2]	7
Wholesale and retail trade[2]	6
Finance, insurance, and real estate[2]	3
Services[2]	3
Total, private sector[2]	10

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

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

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

The risk of potential fatal cancers in the exposed workforce population at Byron station, and the risk of potential genetic disorders in all future generations of this workforce population, is estimated as follows. Multiplying the annual plant worker population dose (about 440 person-rems) by the risk estimators, the staff estimates that about 0.06 cancer deaths may occur in the total exposed population and about 0.11 genetic disorders may occur in all future generations of the same exposed population. The value of 0.06 cancer deaths means that the probability of one cancer death over the lifetime of the entire workforce due to 1 year of operations at Byron station is about 6 chances in 100. The value of 0.11 genetic disorders means that the probability of 1 genetic disorder in all future generations due to one year of operations at Byron station is about 11 chances in 100. These health impacts will not be measurable.

Public Radiation Exposure

Transportation of Radioactive Materials. The transportation of "cold" nuclear fuel to the reactor, of irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to waste burial grounds is considered in 10 CFR 51.20g. The contribution of the environmental effects of such transportation to the environmental costs of licensing the nuclear power reactor is set forth in Summary Table S-4 from 10 CFR 51.20, reproduced herein as Table 5.7. The cumulative dose to the exposed population as summarized in Table S-4 is very small population or 26,000,000 person-rems to the U.S. population from background radiation.

Direct Radiation. Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, as well as of radioactive-effluent releases. Because the primary coolant of a PWR is contained in a heavily shielded area, dose rates in the vicinity of PWRs are generally undetectable (less than 5 millirems per year).

Low-level radioactivity storage containers outside the plant are estimated to make a dose contribution at the site boundary of less than 1% of that due to the direct radiation from the plant.

Radioactive Effluent Releases: Air and Water. As pointed out earlier, all effluents from the Byron station will be subject to extensive decontamination, but small controlled quantities of radioactive effluents will be released to the atmosphere and to the hydrosphere during normal operations. Estimates of site-specific radioisotope-release values have been developed on the basis of estimates of fuel performance and the descriptions of operational and radwaste systems in the applicant's ER and FSAR and by using the calculational model and parameters developed in NUREG-0017. NUREG-0017 does not provide the calculative methodology for determining releases of radioactive materials from the solid radwaste system's volume reduction (VR) equipment. Therefore, releases from this system were calculated based upon the staff's estimate of wastes to be treated by the VR system and information contained in Aerojet Energy Conversion Company's topical reports AECC-1-A, "Fluid Bed Dryer," and AECC-2-P, "Radioactive Waste Volume Reduction System," which describe the VR system. This has been supplemented by extensive use of the applicant's site and environmental data in the ER-OL, and in subsequent answers to staff questions, to obtain a complete picture of airborne and waterborne releases from Byron station.

Table 5.7 (Summary Table S-4) Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor[1]

NORMAL CONDITIONS OF TRANSPORT

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

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

ACCIDENTS IN TRANSPORT

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

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

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

[3] Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

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

These small amounts of effluents are then highly diluted by the air and water into which they are released before they reach areas in which they interact with activities of the general public.

Radioactive effluents can be divided into several groups. Among the airborne effluents, the radioisotopes of the noble gases--krypton, xenon, and argon--do not deposit on the ground or interact with living organisms; therefore, the noble-gas effluents act primarily as a source of external radiation emanating directly from the effluent plume. Dose calculations are performed for the site boundary where the highest external-radiation doses to a member of the public as a result of gaseous effluents have been estimated to occur; these include the annual beta and gamma air doses as well as the total-body and skin doses from the plume at that boundary location.

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

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

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

The release values for each group of effluents, along with site-specific meteorological and hydrological data, serve as input to computerized radiation-dose models that estimate the maximum radiation dose that would be received outside the facility via a number of pathways for individual members of the public and for the general public as a whole. These models and the radiation dose calculations are discussed in Regulatory Guide 1.109 and in Appendix D of this statement.

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

5.9.3.2 Radiological Impact on Humans

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

Plant operation will be governed by radiological-effluent technical specifications that will be based on the dose-design objectives of Appendix I. Because these design-objective values were chosen to permit flexibility of operation while still assuring that plant operations are ALARA, the actual radiological impact of plant operation may result in doses close to the dose-design objectives. Even if this situation exists, the individual doses for the member of the public subject to maximum exposure will still be very small when compared to natural-background doses (about 100 millirems per year) or the dose limits specified in 10 CFR 20 (500 millirems per year, whole body). As a result, the staff concludes that there will be no measurable radiological impact on members of the public from routine operation of the plant.

Since December 1, 1979, licensees have also been regulated according to 40 CFR 190, the Environmental Protection Agency's "Environmental Radiation Protection Standards for Nuclear Power Operations." These operating standards specify that the annual dose equivalent must not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials (radon and its daughters excepted) to the general environment from all uranium-fuel-cycle operations and radiation from these operations that can be expected to affect a given individual. The staff further concludes that, under normal operations, Byron station is capable of operating within these guidelines.

Multiplying the risk estimators in the preceding section by the 10 CFR 50, Appendix I, annual dose design objectives for the maximally exposed individual, the risk of potential premature death from cancer to that individual from exposure to radioactive gaseous or liquid effluents from one year of reactor operations is less than one chance in a million. The risk of potential premature death from cancer to the average individual within 80 km of the reactors from exposure to radioactive effluents from the reactors is much less than the risk to the maximally exposed individual.

Multiplying the annual U.S. general public population dose from exposure to radioactive effluents and transportation of fuel and waste from the operation of Byron station (about 70 person-rems) by the preceding risk estimators, the staff estimates that about 0.009 cancer deaths may occur in the exposed population and about 0.02 genetic disorders may occur in all future generations of the exposed population. The probability of one cancer death over the lifetimes of the entire U.S. general public due to exposure to radioactive effluents and transportation of fuel and waste from normal annual operation is less than one chance in 100. The probability of one genetic disorder in future generations of the U.S. general public due to exposure to radioactive effluents and transportation of fuel and waste from normal annual operation of Byron station is less than 1 chance in 50. For comparative purposes, the staff has estimated the risk of potential premature death from cancer to the general public from exposure to natural background radiation. Multiplying the U.S. population dose from 1 year's exposure to background radiation by the preceding risk estimators, the staff estimates that about 3600 cancer deaths may occur in the exposed population and about 7000 genetic disorders may occur in the future generations of the U.S. population due to exposure to 1 year of background radiation. The risks to the population from exposure to radioactive effluents and transportation of fuel and waste from each year of operation of the Byron station are a very small fraction (less than 0.0003%) of the risks to the U.S. population from each year of exposure to natural background radiation.

Another way to put the risk to the general public from exposure to radioactive effluents and transportation of fuel and waste from the annual operation of Byron station in perspective is to compare the preceding risks (0.009 potential cancer deaths and 0.02 potential genetic disorders) with the risk to the year 2000 population using the current incidence of actual cancer fatalities and actual genetic disorders. Multiplying the estimated U.S. population for the year 2000 (i.e., ∿260 million persons) by the current incidence of actual cancer fatalities (i.e., ∿20%) and the current incidence of actual genetic diseases (i.e., ∿6%), about 52 million cancer deaths and about 16 million genetic abnormalities are expected. The risk to the general public from exposure to radiaoctive effluents and transportation of fuel and wastes from the annual operation of Byron station are very small fractions (about 1 part in a billion or less) of the estimated normal incidence of cancer fatalities and genetic abnormalities in the year 2000 population.

On the basis of the preceding comparisons (comparing the risk from exposure to radioactive effluents and transportation of fuel and waste from the annual operation of Byron station with the risk from exposure to other sources of radiation, and the risk from the estimated incidence of cancer fatalities and genetic abnormalities in the year 2000 population), the staff concludes that the risk to the public health and safety from exposure to radioactive effluents and the transportation of fuel and wastes from normal operation of Byron station will be very small.

5.9.3.3 Radiological Impact on Biota Other than Man

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

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

5.9.3.4 Radiological Monitoring

Radiological environmental monitoring programs are established to provide data on measurable levels of radiation and radioactive materials in the site environs. Such monitoring programs are conducted to verify the effectiveness of inplant systems used to control the release of radioactive materials and to assure that unanticipated buildups of radioactivity will not occur in the environment. Secondly, the monitoring programs could identify the highly unlikely existence of unmonitored releases of radioactivity. A surveillance (land census) program is established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs.

These programs are discussed in greater detail in Regulatory Guide 4.1, Revision 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and the staff's Radiological Assessment Branch Technical Position, Revision 1, "An Acceptable Radiological Environmental Monitoring Program" (in NUREG-75/087).

<u>Preoperational</u>

The preoperational phase of the monitoring program should provide for the measurement of background levels of radioactivity and radiation and their variations along the anticipated important pathways in the areas surrounding the plant, the training of personnel, and the evaluation of procedures, equipment, and techniques. In the ER-CP, the applicant proposed a radiological environmental-monitoring program to meet these objectives, and it was discussed in the FES-CP. This early program has been updated and expanded; it is presented in the ER-OL (Section 6.1.5) and is summarized here in Table 5.8.

The applicant states that the preoperational program will be implemented at least 18 months before initial criticality of Unit 1 to document background levels of direct radiation and concentrations of radionuclides that exist in the environment. The preoperational program will continue for 2 years following criticality of Unit 1, at which time the operational radiological monitoring program will commence.

The staff has reviewed the preoperational environmental monitoring plan of the applicant and finds that it is generally acceptable as presented. However, the current staff position is that a total of about 40 dosimetry stations (or

Table 5.8 Preoperational radiological-monitoring program[1]

Sample Media	Collection Sites	Type and Frequency of Analysis[1,2]	Frequency of Collection
Airborne Particulate Filter	Byron, Stillman Valley Nearsite-E, Paines Point, Nearsite-S, Oregon Mt. Morris, and Leaf River	Gross Beta - W SR-89, SR-90 - Q Comp. Gamma Spec. - Q Comp.	Weekly
Charcoal Cartridge	Same as for particulate filter collection sites	I-131	Every 2 weeks beginning 3 months before fuel loading
Gamma Radiation	Same as for particulate filter collection sites	TLD	Quarterly
Surface Water[3]	Downstream at Location By-12, Upstream at Location By-13, Woodland Creek at Location By-9	SR-89, SR-90 - Q. Comp. Gamma Spec. - M Comp. Gross Beta - W Tritium - Q Comp.	Weekly
Intake/Discharge Pipes	I/D pipes if pumping; if not pumping, at Locations By-10 and By-11	Gross beta - W SR-89, SR-90 - M. Comp. Tritium - M Comp. Gamma Spec. - M Comp.	Weekly
Precipitation	Two nearby dairies	Gamma Spec. - Q Comp. Sr-89, Sr-90 - Q. Comp. Gross Beta - M Tritium - Q Comp.	Monthly
Well Water (offsite)	Nearest well	Gamma Spec. SR-89, Sr-90 Gross Beta Tritium	Quarterly
Well Water (onsite)	One onsite well (the one chosen for providing drinking water	Gamma Spec. - Q Comp. Sr-89, Sr-90 - Q. Comp Gross Beta - M Tritium - Q Comp.	Monthly
Vegetables	Farms within 16 km	Gross Beta Sr-89, Sr-90 Gamma Spec. I-131	As available at harvest time
Cattle Feed and Grass	Two nearby dairies	Gross Beta Sr-89, Sr-90 Gamma Spec.	Quarterly Grass: Summer Feed: Winter
Milk	Two nearby dairies	Gamma Spec. Sr-89, Sr-90 - M I-131 (Pasture Season)	Monthly
Sediment Aquatic Plants[3]	Downstream at Location By-12, Upstream at Location By-13	Gross Beta Gamma Spec.	3 times a year if available
Fish[3]	Oregon Pool (Location By-12)	Gross Beta Sr-89, Sr-90 Gamma Spec.	3 times a year

[1]If frequency of analysis is not given, it is the same as the frequency of collection.
[2]Frequency of analysis key: W = Weekly; M = Monthly; Q = Quarterly; Comp. = Composite.
[3]See Figure 6.1.10 of the ER-OL for sampling locations.

continuously recording dose-rate instruments) should be placed as follows: an inner ring of stations in the general area of the site boundary and an outer ring in the 6-8 km (4-to-5 mi) range from the site with a station in each sector of each ring (16 sectors x 2 rings = 32 stations). The remaining eight stations should be placed in special interest areas such as population centers, nearby residences and schools, and in two or three areas to serve as control stations.

Operational

The operational offsite radiological monitoring program is conducted to measure radiation levels and radioactivity in plant environs. It assists and provides backup support to the effluent-monitoring program as recommended in Regulatory Guide 1.21, "Measuring, Evaluating, and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants".

The applicant states that the operational program will in essence be a continuation of the preoperational program described above, for 2 years after commercial operation of the Byron station begins. When the final operational monitoring program goes into effect, it will involve some adjustment of sampling frequencies and deletion of some types of samples. For example, milk sampling frequency is increased while vegetable sampling is discontinued. Adequate sampling of specific indicator organisms and selected media will be provided to confirm that levels of radioactivity in the environment stemming from Byron station remain ALARA. The proposed operational program will be reviewed prior to plant operation. Modification will be based on anomalies and/or exposure-pathway variations observed during the preoperational program.

The final operational monitoring program proposed by the applicant will be reviewed in detail by the staff, and the specifics of the required monitoring program will be incorporated into the radiological technical specifications for the operating license.

5.9.4 Environmental Impact of Postulated Accidents

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

5.9.4.1 Plant Accidents

The staff has considered the potential radiological impacts on the environment of possible accidents at the Byron Station in accordance with a Statement of Interim Policy published by the Nuclear Regulatory Commission in the Federal Register on June 13, 1980. The following discussion reflects these considerations and conclusions.

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

Next, actual experience with nuclear power plant accidents and their observed health effects and other societal impacts are described. This is followed by a summary review of safety features of the Byron station and of the site that act to mitigate the consequences of accidents.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given. Also described are the results of calculations for the Byron site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence.

5.9.4.2 General Characteristics of Accidents

There are several features that combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation comprising the first line of defense are to a very large extent devoted to the prevention of the release of these radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defense that are designed to mitigate the consequences of failures in the first line. Descriptions of these features for a Byron unit may be found in the applicant's Final Safety Analysis Report, and are included in the staff's Safety Evaluation Report. The most important mitigative features are described in Section 5.9.4.4(1) of this statement.

These safety features are designed taking into consideration the specific locations of radioactive materials within the plant, their amounts, their nuclear, physical, and chemical properties, and their relative tendency to be transported into and for creating biological hazards in the environment.

(1) Fission Product Characteristics

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

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

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

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and in some chemical forms may be quite volatile. For these reasons, they have traditionally been regarded as having a relatively high potential for release from the fuel. If released to the environment, the principal radiological hazard associated with the radioiodines is ingestion into the human body and subsequent concentration in the thyroid gland. Because of this, its potential for release to the atmosphere is reduced by the use of special systems designed to retain the iodine.

The chemical forms in which the fission product radioiodines are found are generally solid materials at room temperatures, however, so that they have a strong tendency to condense (or "plate out") upon cooler surfaces. In addition, most of the iodine compounds are quite soluble in, or chemically reactive with, water. Although these properties do not inhibit the release of radioiodines from degraded fuel, they do act to mitigate the release from containment structures that have large internal surface areas and that contain large quantities of water as a result of an accident. The same properties affect the behavior of radioiodines that may "escape" into the atmosphere. Thus, if rainfall occurs during a release, or if there is moisture on exposed surfaces, (such as dew), the radioiodines will show a strong tendency to be absorbed by the moisture.

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

All of these radioactive materials exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 5.9). Many of them decay through a sequence or chain of decay processes and all eventually become stable (nonradioactive) materials.

? one plant @ equilibrium ??

Table 5.9 Activity of radionuclides in a Byron station reactor core at 3565 MWt

Group/Radionuclide	Radioactive Inventory in Millions of Curies	Half-Life (Days)
A. NOBLE GASES		
Krypton-85	0.62	3,950
Krypton-85m	27	0.183
Krypton-87	52	0.0528
Krypton-88	76	0.117
Xenon-133	190	5.28
Xenon-135	38	0.384
B. IODINES		
Iodine-131	95	8.05
Iodine-132	130	0.0958
Iodine-133	190	0.875
Iodine-134	210	0.0366
Iodine-135	170	0.280
C. ALKALI METALS		
Rubidium-86	0.029	18.7
Cesium-134	8.4	750
Cesium-136	3.3	13.0
Cesium-137	5.2	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	6.6	0.391
Tellurium-127m	1.2	109
Tellurium-129	35	0.048
Tellurium-129m	5.9	34.0
Tellurium-131m	14	1.25
Tellurium-132	130	3.25
Antimony-127	6.8	3.88
Antimony-129	37	0.179
E. AKALINE EARTHS		
Strontium-89	100	52.1
Strontium-90	4.1	11,030
Strontium-91	120	0.403
Barium-140	180	12.8
F. COBALT AND NOBLE METALS		
Cobalt-58	0.87	71.0
Cobalt-60	0.32	1,920
Molybdenum-99	180	2.8
Technetium-99m	160	0.25
Ruthenium-103	120	39.5
Ruthenium-105	80	0.185
Ruthenium-106	28	366
Rhodium-105	55	1.50
G. RARE EARTHS, REFRACTORY OXIDES AND TRANSURANICS		
Yttrium-90	4.3	2.67
Yttrium-91	130	59.0
Zirconium-95	170	65.2
Zirconium-97	170	0.71
Niobium-95	170	35.0
Lanthanum-140	180	1.67
Cerium-141	170	32.3
Cerium-143	140	1.38
Cerium-144	95	284
Praseodymium-143	140	13.7
Neodymium-147	67	11.1
Neptunium-239	1800	2.35
Plutonium-238	0.063	32,500
Plutonium-239	0.023	8.9×10^6
Plutonium-240	0.023	2.4×10^6
Plutonium-241	3.8	5,350
Americium-241	0.0019	1.5×10^5
Curium-242	0.56	163
Curium-244	0.026	6,630

Note: The above grouping of radionuclides corresponds to that in Table 5.11.

The radiation emitted during these decay processes is the reason that they are hazardous materials.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given. Also described are the results of calculations for the Byron site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence.

(2) Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive material, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways for the transport of radiation and radioactive materials that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are depicted in Section 5.9.3, Figure 5.4. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure 5.4. One of these is the fallout onto open bodies of water of radioactivity initially carried in the air. The second would be unique to an accident that results in temperatures inside the reactor core sufficiently high to cause melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This creates the potential for the release of radioactive material into the hydrosphere through contact with ground water. These pathways may lead to external exposure to radiation and to internal exposures if radioactive material is inhaled or ingested from contaminated food or water.

It is characteristic of these pathways that during the transport of radioactive material by wind or by water the material tends to spread and disperse, like a plume of smoke from a smokestack, becoming less concentrated in larger volumes of air or water. The result of these natural processes is to lessen the intensity of exposure to individuals downwind or downstream of the point of release, but they also tend to increase the number who may be exposed. For a release into the atmosphere, the degree to which dispersion reduces the concentration in the plume at any downwind point is governed by the turbulence characteristics of the atmosphere which vary considerably with time and from place to place.

This fact, taken in conjunction with the variability of wind direction and the presence or absence of precipitation, means that accident consequences are very much dependent upon the weather conditions existing at the time.

(3) Health Effects

The cause-and-effect relationships between radiation exposure and adverse health effects are quite complex (Common Nuclear and Alternative Energy Systems (CONAES), Land), but they have been more exhaustively studied than any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 10 rems for a few persons and about 25 rems for nearly all people over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about 10 to 20 times larger than the latter dose, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe, but extremely low probability end of the accident spectrum, exposures of these magnitudes are theoretically possible for persons close to the site of such accidents if measures are not or cannot be taken to provide protection, (such as by sheltering or evacuation).

Lower levels of exposures may also constitute a health risk but the ability to define a direct cause-and-effect relationship between any given health effect and a known exposure to radiation is difficult given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necessary to assess such effects on a statistical basis. Such effects include randomly occurring cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. Occurences of cancer in the exposed population may begin to develop only after a lapse of 2 to 15 years (latent period) from the time of exposure and then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (in utero), occurrences of cancer may begin to develop at birth (no latent period) and end at age 10 (the plateau period is 10 years). The health consequences model currently being used is based on the 1972 BEIR Report of the National Academy of Sciences (BEIR I). The occurence of cancer itself is not necessarily indicative of fatality.

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

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

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

5.9.4.3 Accident Experience and Observed Impacts

The evidence of accident frequency and impacts in the past is a useful indicator of future probabilities and impacts. As of mid-1981, there were 71 commercial nuclear power reactor units licensed for operation in the United States at 50 sites with power-generating capacities ranging from 50 to 1130 MWe. (The Byron units are each designed for 1175 MWe.) The combined experience with these units represents approximately 500 reactor years of operation over an elapsed time of about 20 years. Accidents have occurred at several of these facilities (Bertini, NUREG-0651). Some of these have resulted in releases of radioactive material to the environment, ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any member of the public, or any significant individual or collective public radiation exposure, or any significant contamination of the environment. This experience base is not large enough to permit a reliable quantitative statistical inference. It does, however, suggest that significant environmental impacts caused by accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these units, during the accident at Three Mile Island Unit 2 (TMI-2) on March 28, 1979. In addition to the release of a few million curies of xenon-133, it has been estimated that approximately 15 Ci of radioiodine were also released to the environment at TMI-2 (Rogovin). This amount represents an extremely minute fraction of the total radioiodine inventory present in the reactor at the time of the accident. No other radioactive fission products were released in a measurable quantity.

It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 millirems (Rogovin, President's Commission). The total population exposure has been estimated to be in the range from about 1000 to 3000 person-rems. This exposure could produce between none and one additional fatal cancer over the lifetime of the population. The same population receives each year from natural background radiation about 240,000 person-rems and approximately a half-million cancers are expected to develop in this group over its lifetime (ibid), primarily from causes other than radiation. Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were impacted.

Accidents at nuclear power plants have also caused occupational injuries and a few fatalities but none attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rems as a direct consequence of accidents, but the collective worker exposure levels (person-rems) are a small fraction of the exposures experienced during normal routine operations that average about 440 to 1300 person-rems in a PWR and 740 to 1650 person-rems in a BWR per reactor-year.

Accidents have also occurred at other nuclear reactor facilities in the United States and in other countries (Bertini, NUREG-0651). Because of inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the one in 1966 at the Enrico Fermi Atomic Power Plant Unit 1. This was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. The damages were repaired and the reactor reached full power in 4 years following the accident. It operated successfully and completed its mission in 1973. This accident did not result in the release of any radioactivity to the environment.

A reactor accident in 1957 at Windscale, England, released a significant quantity of radioiodine, approximately 20,000 Ci, to the environment. This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor, the fuel overheated and radioiodine and noble gases were released directly to the atmosphere from a 405-ft stack. Milk produced in a 518-km^2 (200-mi^2) area around the facility was impounded for up to 44 days. This kind of accident cannot occur in a water-cooled reactor like those at Byron, however.

5.9.4.4 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, as amended, the NRC is conducting a safety evaluation of the application to operate the Byron Station, Units 1 and 2. Although this safety evaluation will contain more detailed information on plant design, the principal design features are presented in the following section.

(1) Design Features

The Byron station contains features designed to prevent accidental release of radioactive fission products from the fuel and to lessen the consequences should such a release occur. Many of the design and operating specifications of these features are derived from the analysis of postulated events known as design basis accidents. These accident preventive and mitigative features are collectively referred to as engineered safety features (ESF). The possibilities or probabilities of failure of these systems is incorporated in the assessments discussed in Section 5.9.4.5.

The steel-lined concrete containment building is a passive mitigating system which is designed to minimize accidental radioactivity releases to the environment. Safety injection systems are incorporated to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage. Cooling fans provide heat removal capability inside the containment following steam release in accidents and help to prevent containment failure due to overpressure. Similarly, the containment spray system is designed to spray cool water into the containment atmosphere. The spray water also contains an additive (sodium hydroxide) which will chemically react with any airborne radioiodine to remove it from the containment atmosphere and prevent its release to the environment.

All the mechanical systems mentioned above are supplied with emergency power from onsite diesel generators in the event that normal offsite station power is interrupted.

The fuel-handling building also has accident-mitigating systems. The safety-grade ventilation system contains both charcoal and high efficiency particulate filters. This ventilation system is also designed to keep the area around the spent-fuel pool below the prevailing barometric pressure during fuel-handling operations so that outleakage will not occur through building openings. If radioactivity were to be released into the building, it would be drawn through the ventilation system and any radioactive iodine and particulate fission products would be removed from the flow stream before exhausting to the outdoor atmosphere.

There are features of the plant that are necessary for its power-generation function that can also play a role in mitigating certain accident consequences. For example, the main condenser, although not classified as an ESF, can act to mitigate the consequences of accidents involving leakage from the primary to the secondary side of the steam generators (such as steam generator tube ruptures). If normal offsite power is maintained, the ability of the plant to send contaminated steam to the condenser instead of releasing it through the safety valves or atmospheric dump valves can significantly reduce the amount of radioactivity released to the environment. In this case, the fission-product-removal capability of the normally operating offgas treatment system would come into play.

Much more extensive discussions of the safety features and characteristics of the Byron station may be found in the FSAR. The staff evaluation of these features is in the Byron SER. In addition, the implementation of the lessons learned from the TMI-2 accident--in the form of improvements in design, procedures, and operator training--will significantly reduce the likelihood of a degraded core accident which could result in large releases of fission products to the containment. Specifically, the applicant will be required to meet those TMI- related requirements specified in NUREG-0737. As noted in Section 5.4.4.5, no credit has been taken for these actions and improvements in discussing the radiological risk of accidents.

(2) Site Features

The NRC's reactor site criteria, 10 CFR 100, require that the site for every power reactor have certain characteristics that tend to reduce the risk and potential impact of accidents. The discussion that follows briefly describes the Byron site characteristics and how they meet these requirements.

First, the site has an exclusion area, as required by 10 CFR 100. The total site area is about 538 ha (1330) acres. The exclusion area, located within the site boundary, is a rectangular area with a minimum distance of 445 meters (1460 feet) from the outer edge of the containment wall to the exclusion area boundary. There are no residents within the exclusion area. The applicant owns all surface and mineral rights in the exclusion area, and has the authority, required by 10 CFR 100, to determine all activities in this area. No public highways, railroads, or waterways traverse the exclusion area. There are no other activities unrelated to plant operation within the exclusion area.

Second, beyond and surrounding the exclusion area is a low population zone (LPZ), also required by 10 CFR 100. The LPZ for the Byron site is a circular area with a 4.8-km (3-mile) radius. Within this zone, the applicant must ensure that there is a reasonable probability that appropriate protective measures could be taken on behalf of the residents in the event of a serious accident. The applicant has indicated that 1010 person lived within a 4.8-km radius in 1977 and projects that the population will increase to 1403 in the year 2000. The peak population for 0-4.8 km, miles including transients at local recreational areas in 1977, was stated to be 13,470 persons. In case of a radiological emergency, the applicant has made arrangements to carry out protective actions, including evacuation of personnel in the vicinity of the nuclear plant. (See also the following section on emergency preparedness.)

Third, 10 CFR 100 also requires that the distance from the reactor to the nearest boundary of a densely populated area containing more than about 25,000 residents be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ. Because accidents of greater potential hazards than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to add the population center distance requirement in 10 CFR 100 to provide for protection against excessive doses to people in large centers. The city of Rockford, Illinois, with a 1980 population of 139,211 located 27 km northeast of the site, is the nearest population center. The population center distance is at least one and one-third times the LPZ distance. The population density within a 16-km radius of the site was 66 people/mi^2 in 1977 and is projected to increase to 101 people/mi^2 by the year 2020.

The safety evaluation of the Byron site has also included a review of potential external hazards, that is, activities offsite that might adversely affect the operation of the nuclear plant and cause an accident. The review encompassed nearby industrial and transportation facilities that might create explosive, fire, missile or toxic gas hazards.

The risk to the Byron station from such hazards has been found to be negligible. A more detailed discussion of the compliance with the Commission's siting criteria and the consideration of external hazards is in the SER.

(3) Emergency Preparedness

Emergency preparedness plans including protective action measures for the Byron station and environs are in an advanced, but not yet fully completed stage. In accordance with the provisions of 10 CFR 50.47, effective November 3, 1980, no operating licenses will be issued to the applicant unless a finding is made by the NRC that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Among the standards that must be met by these plans are provisions for two emergency planning zones (EPZs). A plume exposure pathway EPZ of about 16 km in radius and an ingestion exposure pathway EPZ of about 80 km in radius are required. Other standards include appropriate ranges of protective actions for each of these zones, provisions for dissemination to the public of basic emergency planning information, provisions for rapid notification of the public during a serious reactor emergency, and methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences in the EPZs of a radiological emergency condition.

NRC findings will be based upon a review of the Federal Emergency Management Agency (FEMA) findings and determinations as to whether State and local government emergency plans are adequate and capable of being implemented, and on the NRC assessment as to whether the applicant's onsite plans are adequate and capable of being implemented. NRC staff findings are included in the SER. The staff's overall conclusions on the state of emergency preparedness for Byron station and its associated emergency planning zones will be reported in an SER supplement. Although the presence of adequate and tested emergency plans cannot prevent the occurrence of an accident, it is the judgement of the staff that such plans can and will substantially mitigate the consequences to the public if one should occur.

5.9.4.5 Accident Risk and Impact Assessment

(1) Design-Basis Accidents

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

In the safety analysis and evaluation of the Byron station, three categories of accidents have been considered. These categories are based upon their probability of occurrence and include (1) incidents of moderate frequency (events that can reasonably be expected to occur during any year of operation), (2) infrequent accidents (events that might occur once during the lifetime of the plant), and (3) limiting faults (accidents not expected to occur but that have the potential for significant releases of radioactivity). The radiological consequences of incidents in the first category, also called anticipated operational occurences, are discussed in Section 5.9.3. Some of the initiating events postulated in the second and third categories for the Byron plant are shown in Table 5.10. These events are designated design-basis accidents in that specific design and operating features as described above in Section 5.9.4.4(1) are provided to limit their potential radiological consequences. Approximate radiation doses that might be received by a person at the nearest boundary of the plant exclusion area, which is about 445 meters (0.26 mi) distant from the reactor, during the first 2 hours of the accident are also shown in the table. The results shown in the table reflect the expectation that engineered safety and operating features designed to mitigate the consequences of the postulated accidents would function as intended. An important implication of this expectation is that the releases considered are limited to noble gases and radioiodines and that any other radioactive materials, (for example, in particulate form) are not expected to be released. The results are also quasi-probabilistic in nature in the sense that the meteorological dispersion conditions are taken to be neither the best nor the worst for the site, but rather at an average value determined by actual site measurements. To contrast the results of these calculations with those using more pessimistic, or conservative, assumptions described below, the doses shown in Table 5.10 are sometimes referred to as "realistic" doses.

Calculated population exposures for these events range from a small fraction of a person-rem to about 450 person-rems for the population within 80 km (50 mi) of the Byron station. These calculations for both individual and population exposures indicate that the risk of incurring any adverse health effects as a consequence of these events is exceedingly small. By comparison with the estimates of radiological impact for normal operations shown in Section 5.9.3, the staff also concludes that radiation exposures from design-basis accidents are roughly comparable to the exposures to individuals and the population from normal station operations over the expected lifetime of the plant.

The staff has also carried out calculations to estimate the potential upper bounds for individual exposures from the same initiating accidents in Table 5.10 for the purpose of implementing the provisions of 10 CFR 100, at the CP stage. For these calculations, much more pessimistic (conservative or worst case) assumptions are made as to the course taken by the accident and the prevailing conditions. These assumptions include much larger amounts of radioactive material released by the initiating events, additional single failures in equipment, operation of ESFs in a degraded mode,* and very poor meteorological dispersion conditions. The results of these calculations taken from the CP stage SER show that for these events the limiting whole-body exposures are not expected to exceed 9 rems and most would not exceed 1 rem to any individual at the site boundary. They also show that radioiodine releases have the potential for offsite exposures ranging up to about 148 rems to the thyroid. For such an exposure to occur, an individual would have to be located at a point on the site boundary where the radioiodine concentration in the plume has its highest value and inhale at a breathing rate characteristic of a person jogging for a period of 2 hours. The health risk to an individual receiving

Table 5.10 Approximate 2-hour radiation doses from design basis accidents at exclusion area boundary

	Dose (rems) at 445 meters[1]
	Whole Body
Infrequent Accident:	
Steam generator tube rupture[2]	0.07
Fuel-handling accident	0.01
Limiting Faults:	
Main Steamline break	0.0005
Control rod ejection	0.11
Large-break LOCA	1.1

[1]Plant exclusion area boundary distance.
[2]See NUREG-0651 for descriptions of three steam generator tube rupture accidents that have occurred in the United States.

*The containment structure, however, is assumed to prevent leakage in excess of that which can be demonstrated by testing, as provided in 10 CFR 100.11(a).

such an exposure to the thyroid is the potential appearence of benign or malignant thyroid nodules in about 5 out of 100 cases, and the development of a fatal thyroid cancer in about 2 out of 1,000 cases.

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

(2) <u>Probabilistic Assessment of Severe Accidents</u>

In this and the following three sections, there is a discussion of the probabilities and consequences of accidents of greater severity than the design-basis accidents discussed in the previous section. As a class, they are considered less likely to occur, but their consequences could be more severe, both for the plant itself and for the environment. These severe accidents, heretofore frequently called Class 9 accidents, can be distinguished from design-basis accidents in two primary respects: they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and they involve deterioration of the capability of the containment structure to perform its intended function of limiting the release of radioactive materials to the environment.

The assessment methodology employed is that described in the Reactor Safety Study (RSS) which was published in 1975 (NUREG-75/014).* However, the sets of accident sequences that were found in the RSS to be the dominant contributors to the risk in the prototype PWR (Westinghouse-designed Surry Unit 1) have recently been updated ("rebaselined") (NUREG-0715). The rebaselining has been done largely to incorporate peer group comments (NUREG/CR-0400), and better data and analytical techniques resulting from research and development after the publication of the RSS. Entailed in the rebaselining effort was the evaluation of the individual dominant accident sequences, as they are understood to evolve. The earlier technique of grouping a number of accident sequences into the encompassing "Release Categories" as was done in the RSS has been largely (but not completely) eliminated.

The Byron station, Units 1 and 2 are Westinghouse-designed PWRs having similar design and operating characteristics to the RSS prototype PWR. Therefore, the present assessment for the Byron units has used as its starting point the rebaselined accident sequences and release categories referred to above, and more fully described in Appendix E. Characteristics of the sequences and release categories used (all of which involve partial to complete melting of the reactor core) are shown in Table 5.11. Sequences initiated by natural phenomena such as tornadoes, floods, or seismic events and those that could be initiated by deliberate acts of sabotage are not included in these event sequences. The radiological consequences of such events would not be different

*Because this report has been the subject of considerable controversy, a discussion of the uncertainties surrounding it is provided in Section 5.9.4.5(7).

Table 5.11 Summary of atmospheric releases in hypothetical accident sequences in a PWR (rebaselined)

Accident sequence or sequence group[2]	Probability (per reactor yr)	Fraction of core inventory released[1]						
		Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru[3]	La[4]
Event V	2.0×10^{-6}	1.0	0.64	0.82	0.41	0.1	0.04	0.006
TMLB'	3.0×10^{-6}	1.0	0.31	0.39	0.15	0.044	0.018	0.002
PWR3	3.0×10^{-6}	0.8	0.2	0.2	0.3	0.02	0.03	0.003
PWR7	4.0×10^{-5}	6×10^{-3}	2×10^{-5}	1×10^{-5}	2×10^{-5}	1×10^{-6}	1×10^{-6}	2×10^{-7}

[1]Background on the isotope groups and release mechanisms is presented in Appendix VII, WASH 1400.

[2]See Appendix E for description of the accident sequences and Release Categories.

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

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

Note: Refer to Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates.

in kind from those which have been treated. Morever, there are design requirements in 10 CFR 50, Appendix A, relating to effects of natural phenomena, and safeguards requirements in 10 CFR 73, assuring that these potential initiators are in large measure taken into account in the design and operation of the plant. The data base for assessing the probabilities of events more severe than the design bases for natural phenomena or sabotage is small. Hence, inclusion of accident sequences initiated by natural phenomena and sabotage events is beyond the state-of-the art of probabilistic risk assessment. In addition, the staff judges that the additional risk for severe accidents initiated by natural events or sabotage is within the uncertainty of risks presented for the sequences considered here.

The calculated probability per reactor-year associated with each accident sequence or release category used is shown in the second column in Table 5.11. As in the RSS, there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in the data base on failure rates of individual plant components that were used to calculate the probabilities (NUREG/CR-0400). The probability of accident sequences from the Surry plant were used to give a perspective of the societal risk at Byron because, although the probabilities of particular accident sequences may be substantially different and even improved for Byron, the overall effect of all sequences taken together is likely to be within the uncertainties (see Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates).

The magnitudes (Ci) of radioactivity released for each accident sequence or release category are obtained by multiplying the release fractions shown in Table 5.11 by the amounts that would be present in the core at the time of the hypothetical accident. These are shown in Table 5.9 for a Byron unit at the core thermal power level of 3565 MWt, the power level used in the safety evaluation.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS (NUREG-0340), adapted and modified as described below to apply to a specific site. The essential elements are shown in schematic form in Figure 5.5. Environmental parameters specific to the Byron site have been used and include the following:

- meteorological data for the site representing a full year of consecutive hourly measurements and seasonal variations

- projected population for the year 2000 extending throughout regions of 80-km and 563-km radius from the site

- the habitable land fraction within the 563-km (350-mi) radius,

- land-use statistics, on a statewide basis and province-wide basis (by comparison with nearby states), including farm land values, farm product values including dairy production, and growing season information, for the U.S. and Canada within the 563-km (350-mi) region.

To obtain a probability distribution of consequences, the calculations are performed assuming the occurrence of each accident-release sequence at each of 91 different "start" times throughout a 1-year period. Each calculation utilizes the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence reduction benefits of evacuation, relocation, and other protective actions. Early evacuation of people would considerably reduce the exposure from the radioactive cloud and the contaminated ground in the wake of the cloud passage. The evacuation model used (see Appendix F) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the Byron site are estimates made by the staff and are partly based upon evacuation time estimates prepared by the applicant. There normally would be special facilities near a plant such as schools or hospitals, where special equipment or personnel may be required to effect evacuation. Several such facilities have been identified near the Byron site, such as Oregon High School and Leaf River Community School. Further, there may be people who either do not receive notification to evacuate or who choose not to evacuate. Therefore, actual evacuation effectiveness could be greater or less than that characterized but would not be expected to be very much less.

The other protective actions include: (1) either complete denial of use (interdiction), or permitting use only at a sufficiently later time after appropriate decontamination of foodstuffs such as crops and milk;
(2) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of

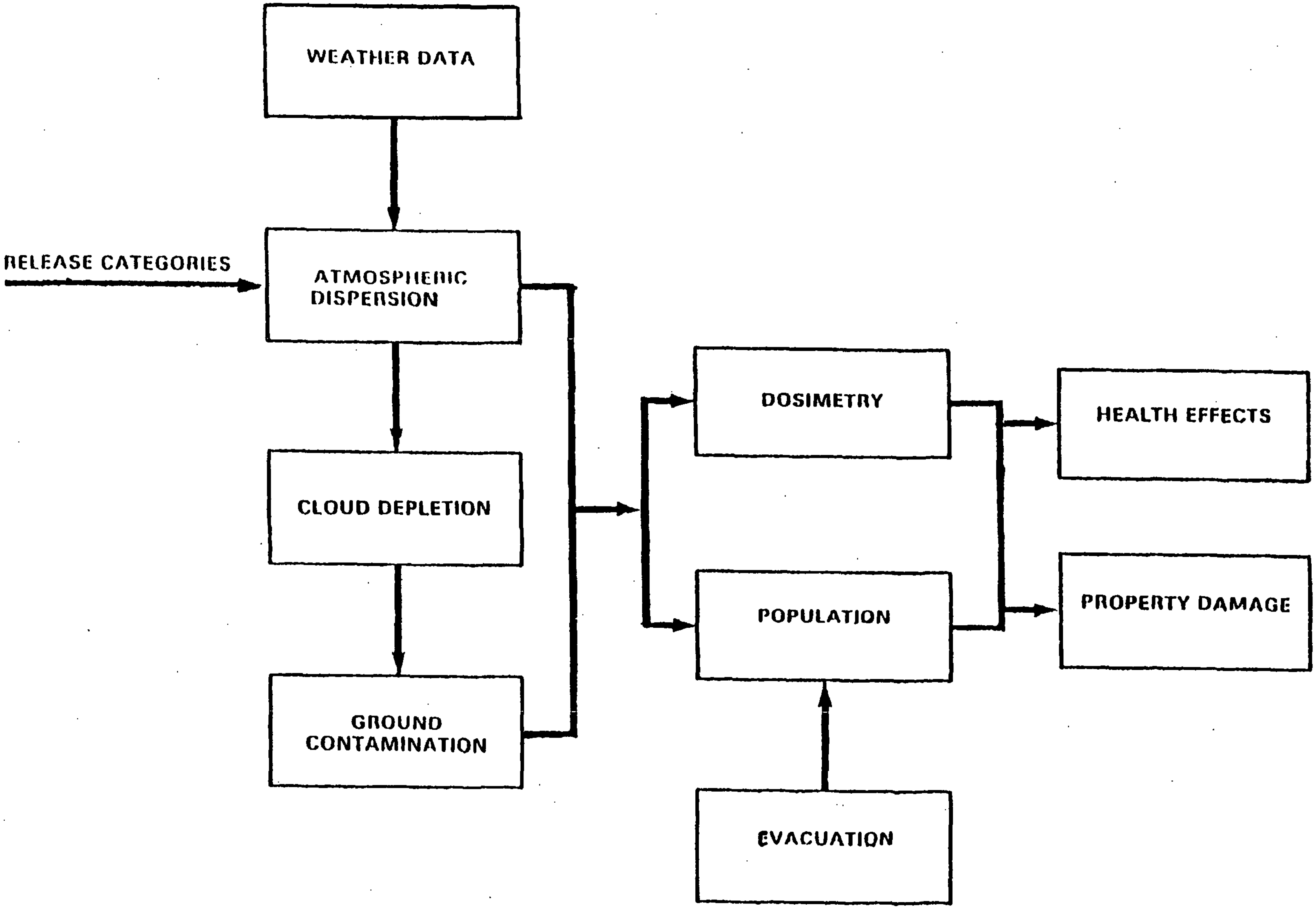

Figure 5.5 Schematic outline of atmospheric pathway consequence model

contamination to protective action guide (PAG) levels; and (3) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels reduce to such values by radioactive decay and weathering so that land and property can be economically decontaminated as in (2) above. These actions would reduce the radiological exposure to the people from immediate and/or subsequent use of or living in the contaminated environment.

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

There are also uncertainties in each facet of the estimates of consequences, and the error bounds may be as large as they are for the probabilities intrinsic in the release categories (see Figure 5.5).

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

(3) <u>Dose and Health Impacts of Atmospheric Releases</u>

The results of the calculations of dose and health impacts performed for a Byron unit and the site are presented in the form of probability distributions in Figures 5.6 through 5.9 and are included in the impact Summary Table 5.12. All of the accident sequences and release categories shown in Table 5.11 contribute to the results, the consequences of each are weighted by the associated probability.

Figure 5.6 shows the probability distribution for the number of persons who might receive whole-body doses equal to or greater than 200 rems and 25 rems, and thyroid doses equal to or greater than 300 rems from early exposure,* all on a per-reactor-year basis. The 200-rem whole-body dose figure corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole-body (which has been identified earlier as the lower limit for a clinically observable physiological effect in nearly all people) and 300-rem thyroid figures correspond to the NRC guideline values for reactor siting in 10 CFR 100.

Figure 5.6 shows in the left-hand portion that there are approximately 8 chances in 1,000,000 (8×10^{-6}) per reactor-year that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that the three curves run almost parallel in horizontal lines initially shows that if one person were to receive such doses, the chances are about the same that

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

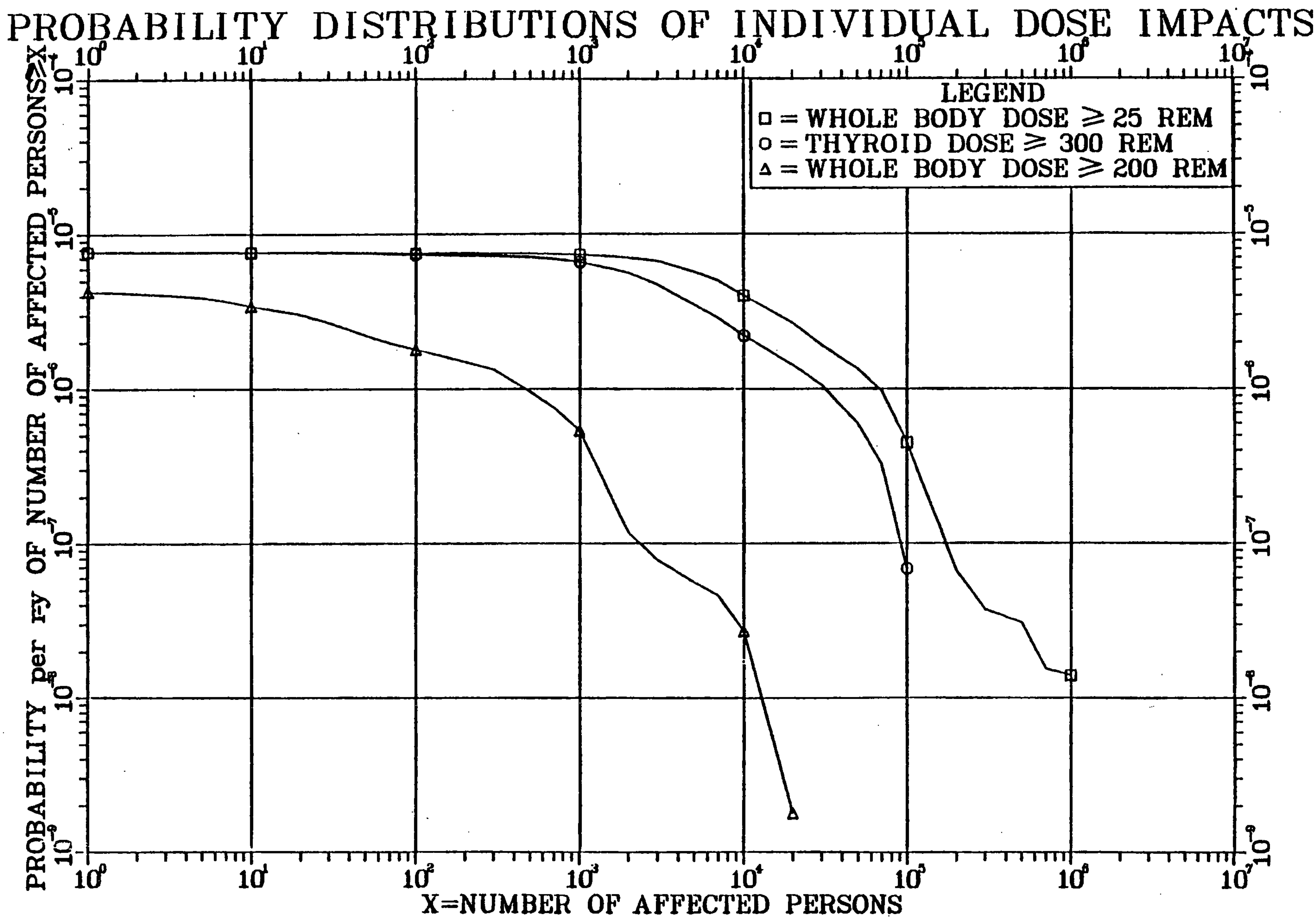

Figure 5.6 Probability distributions of individual dose impacts

NOTE: Please see Section 5.9.4.5(7) for discussion of uncertainties in risk estimates.

several tens to hundreds would be so exposed. The chances of larger numbers of persons being exposed at those levels are seen to be considerably smaller. For example, the chances are about 3 in 100,000,000 (3×10^{-8}) that 10,000 or more people might receive doses of 200 rems or greater. A majority of the exposures the exposures reflected in this figure would be expected to occur to persons within a 40-km (25-mi) radius of the station. Virtually all would occur within a 160-km (100-mi) radius.

Figure 5.7 shows the probability distribution for the total population exposure in person-rem, (the probability per reactor-year that the total population exposure) will equal or exceed the values given. Most of the population exposure up to 1 million person-rems would occur within 80 km but the more severe releases (as in the first two accident sequences in Table 5.11) would result in exposure to persons beyond the 80-km range as shown.

For perspective, population doses shown in Figure 5.7 may be compared with the annual average dose to the population within 80 km of the Byron site due to natural background radiation of 128,000 person-rems, and to the anticipated annual population dose to the general public from normal station operation of 60 person-rems (excluding plant workers).

Figure 5.8 shows the probability distributions for early fatalities, representing radiation injuries that would produce fatalities within about 1 year after exposure. Virtually all of the early fatalities would be expected to occur within the 16 km (10 mi) radius. The results of the calculations shown in this figure and in Table 5.12 reflect the effect of evacuation within the 16-km plume exposure pathway EPZ.

Figure 5.9 represents the statistical relationship between population exposure and the induction of fatal cancers that might appear over a period of many years following exposure. The impacts on the total population and the population within 80 km (50 mi) are shown separately. Further, the fatal, latent cancers have been subdivided into those attributable to exposures of the thyroid and all other organs.

(4) Economic and Societal Impacts

As noted in Section 5.9.4.2, the various measures for avoidance of adverse health effects including those due to residual radioactive contamination in the environment are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for the Byron station and environs have also been made. Unlike the radiation exposure and health effect impacts discussed above, impacts associated with adverse health effects avoidance are more readily transformed into economic impacts.

The results are shown as the probability distribution for cost of offsite mitigating actions in Figure 5.10 and are included in the impact Summary Table 5.12. The factors contributing to these estimated costs include the following:

- evacuation costs
- value of crops contaminated and condemned
- value of milk contaminated and condemned

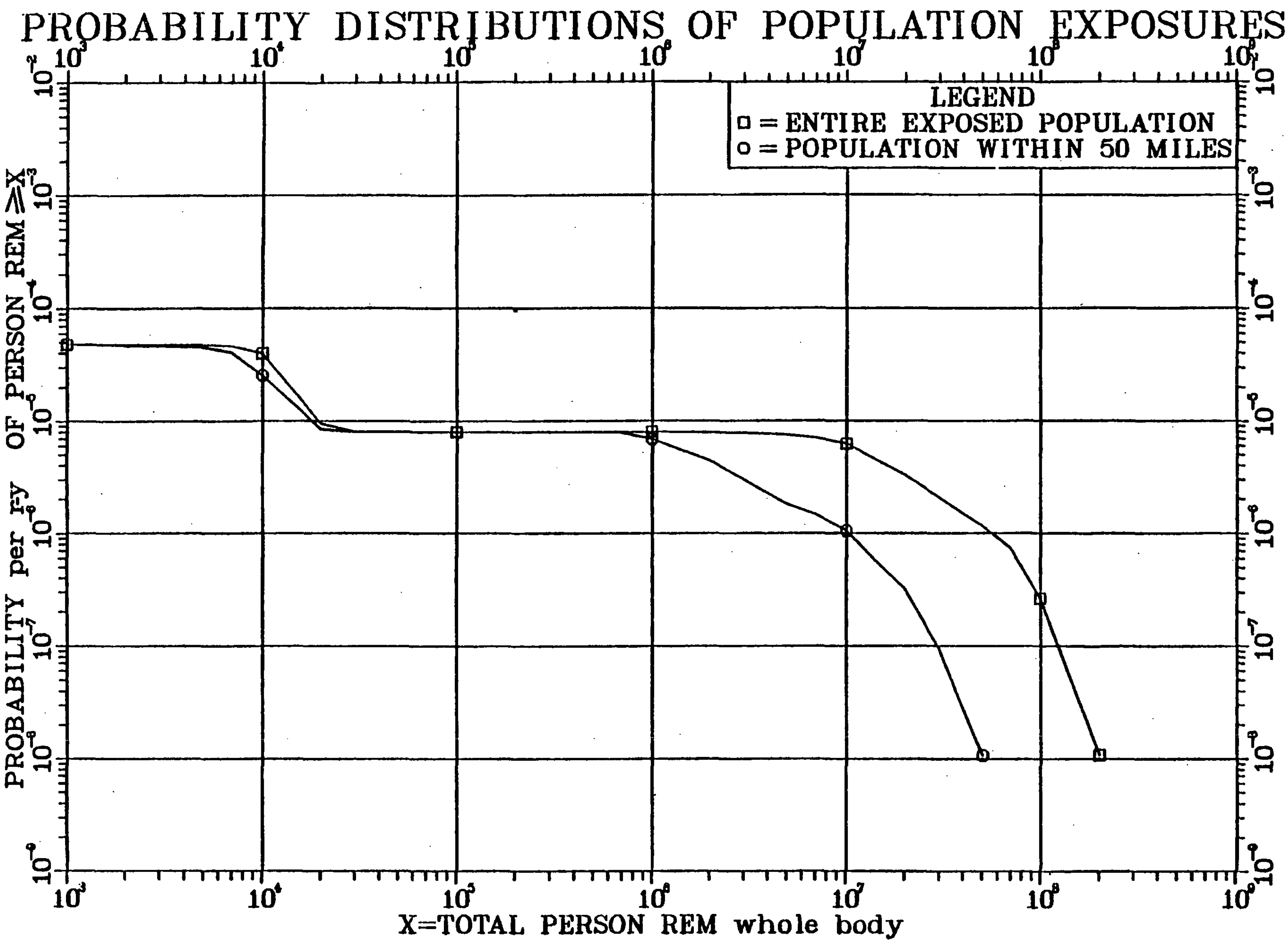

Figure 5.7 Probability distributions of population exposures

NOTE: Please see Section 5.9.4.5(7) for discussion of uncertainties in risk estimates.

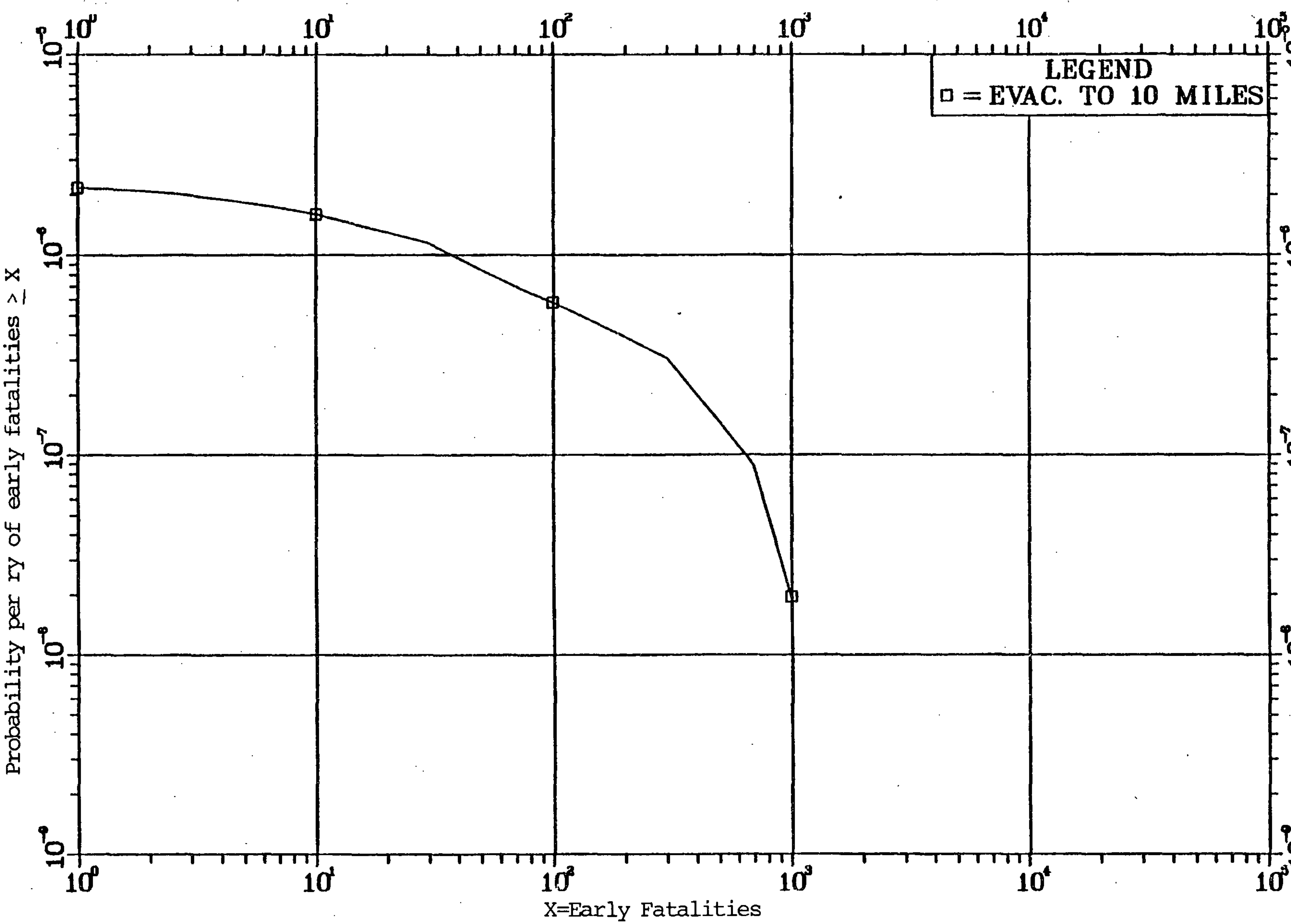

Figure 5.8 Probability distribution of early fatalities

NOTE: Please see Section 5.9.4.5(7) for discussion of uncertainties in risk estimates.

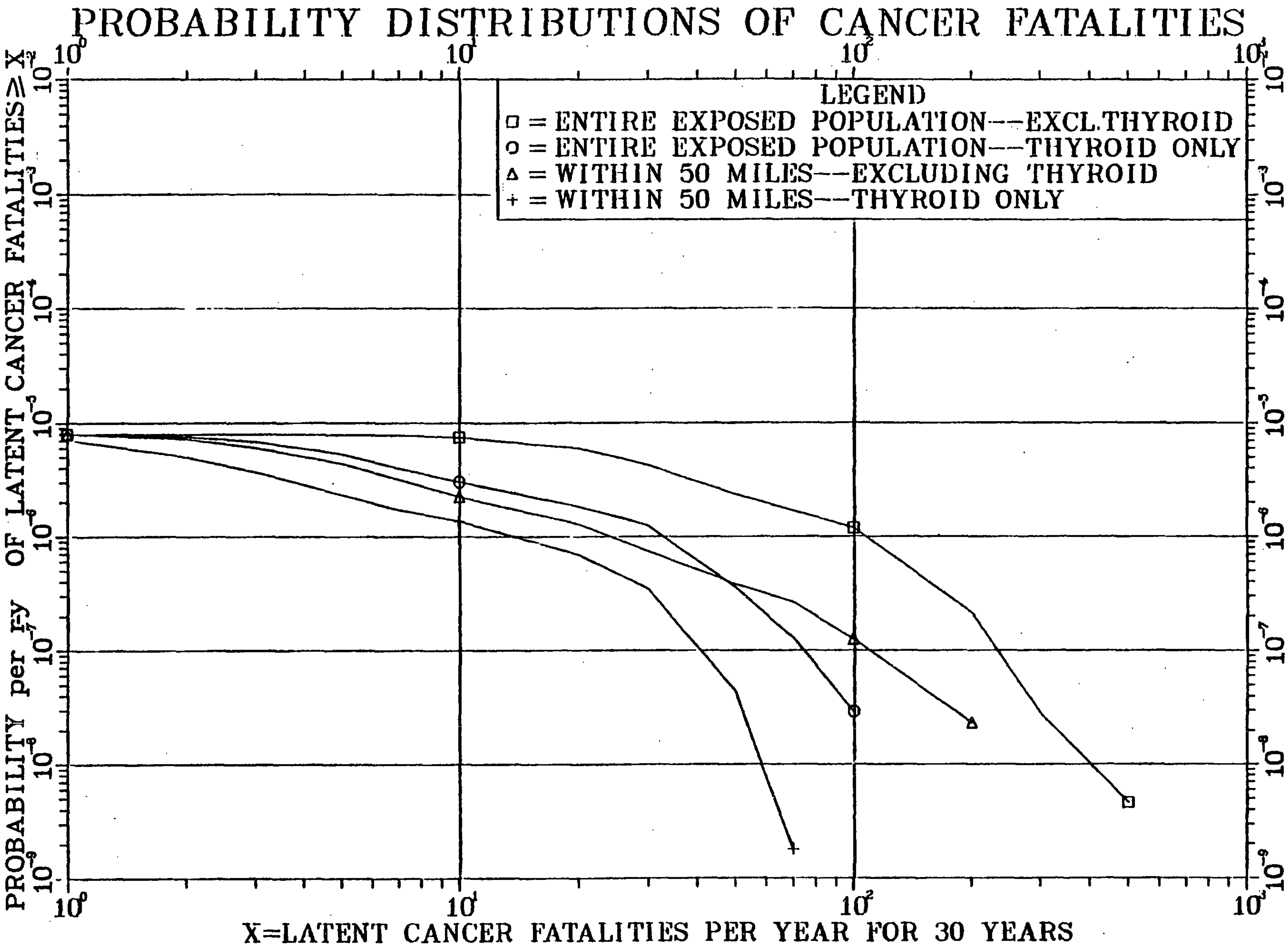

Figure 5.9 Probability distribution of cancer fatalities

NOTE: Please see Section 5.9.4.5(7) for discussion of uncertainties in risk estimates.

Table 5.12 Summary of environmental impacts and probabilities

Probability of impact per reactor-year	Persons exposed over 200 rems	Persons exposed over 25 rems	Early fatalities	Population exposure millions of person-rems, 80 km/total	Latent[1] Cancers 80 km/ total	Cost of off-site mitigating actions millions of dollars
10^{-4}	0	0	0	0/0	0/0	0
10^{-5}	0	0	0	0.017/0.019	0/0	4
5×10^{-6}	0	7,000	0	1.5/12	180/840	430
10^{-6}	480	70,000	37	10/55	1,080/3,990	2,000
10^{-7}	2,200	150,000	680	30/120	4,520/9,090	4,900
10^{-8}	12,000	1,750,000	1,140	51/200	9,630/16,620	10,000
Related Figure	5.6	5.6	5.8	5.7	5.9	5.10

[1]Includes cancers of all organs. Thirty times the values shown in the Figure 5.12 are shown in this column reflecting the 30-year period over which cancers might occur. Genetic effects would be approximately twice the number of latent cancers.

Note: Refer to Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates.

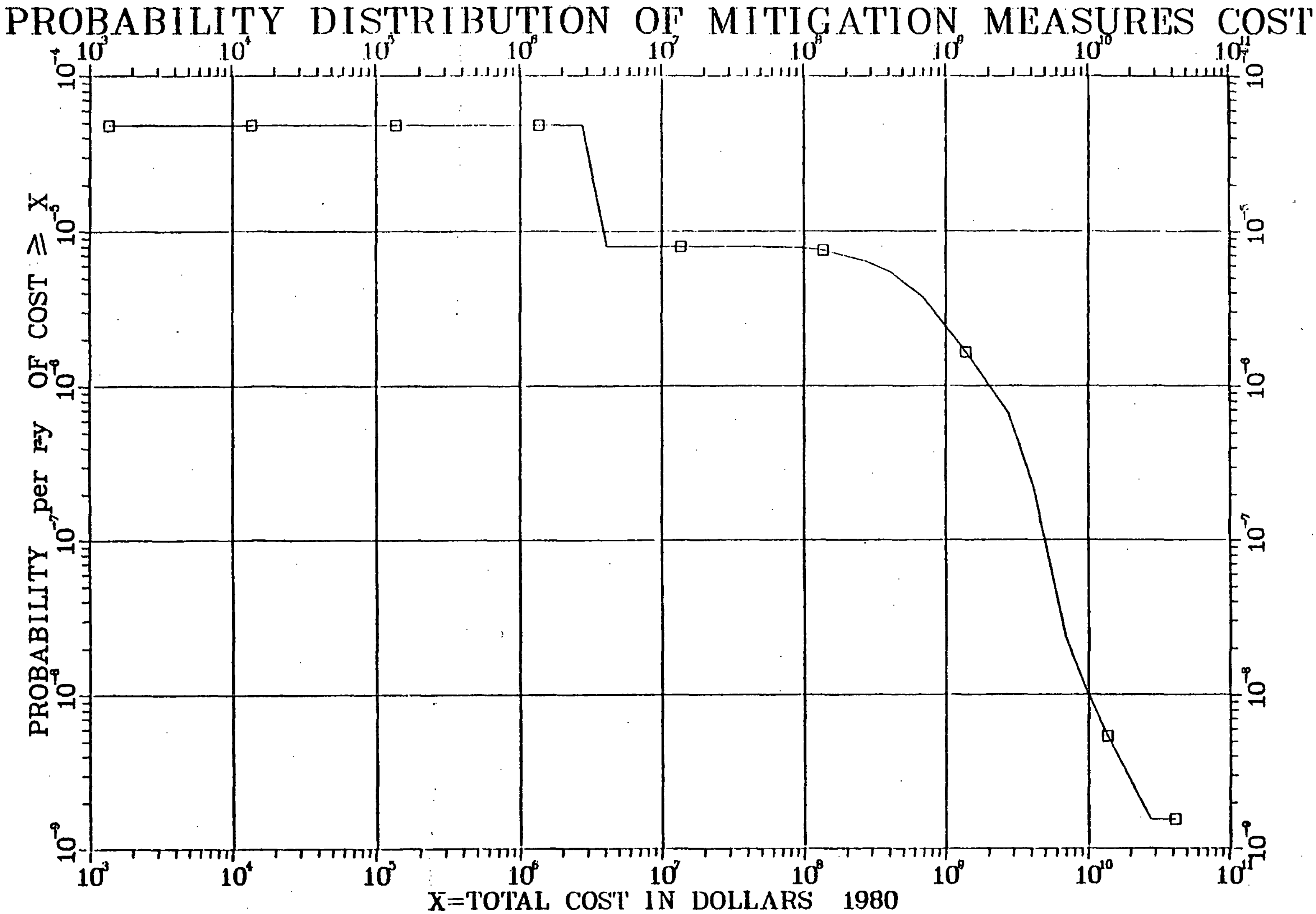

Figure 5.10 Probability distribution of mitigation measures cost

NOTE: Please see Section 5.9.4.5(7) for discussion of uncertainties in risk estimates.

- costs of decontamination of property where practical
- indirect costs due to loss of use of property and incomes derived therefrom.

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

Figure 5.10 shows that at the extreme end of the accident spectrum these costs could exceed several billion dollars but that the probability that this would occur is exceedingly small, less than one chance in a million per reactor-year.

Additional economic impacts that can be monetized include costs of decontamination of the facility itself and the costs of replacement power. Probability distributions for these impacts have not been calculated but they are included in the discussion of risk considerations in Section 5.9.4.5(6).

(5) Releases to Groundwater

A pathway via accidental releases of radioactivity to groundwater for public radiation exposure and environmental contamination that would be unique for severe reactor accidents was identified above. Consideration has been given to the potential environmental impacts of this pathway for the Byron station. The principal contributors to the risk are the core melt accidents shown in Table 5.11. The penetration of the basemat of the containment building can release molten core debris to the strata beneath the plant. The soluble radionuclides in this debris can be leached and transported with groundwater to downgradient domestic wells used for drinking water or to surface water bodies used for drinking water, aquatic food, and recreation. Releases of radioactivity to the groundwater underlying the site could also occur via depressurization of the containment atmosphere or radioactive ECCS and sump water discharged through the failed containment.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the "Liquid Pathway Generic Study" (NUREG-0440). The LPGS compares the risk of accidents involving the liquid pathway (drinking water, aquatic food, swimming, and shoreline usage) for four conventional, generic land-based nuclear plants and a floating nuclear plant (for which the nuclear reactors would be mounted on a barge and moored in a water body). Parameters for the land-based sites were chosen to represent averages for a wide range of real sites and were thus "typical," but represented no real site in particular. The study concluded that the individual and population doses for the liquid pathway through groundwater contamination range from small fractions to very small fractions of those that can arise from the atmospheric pathways.

The discussion in this section is a summary of an analysis to determine whether or not the liquid pathway consequences of a postulated accident at the Byron site, initiated by a release to groundwater beneath a reactor, would be unique when compared to the generic small river land-based site considered in the LPGS. The comparison is made on the basis of population doses from contaminated water and contaminated fish and direct shore line exposure. The parameters which were evaluated include the amounts and rate of release of radioactive materials to the ground, ground water travel time, sorption on geological media, surface water transport, drinking water usage, aquatic food consumption and usage of the shorelines of the involved rivers. Parameters were estimated from site-specific data wherever possible. Shoreline usage was taken as being equal per unit length of shoreline to that used in the LPGS.

All of the reactors considered in the LPGS were Westinghouse PWRs with ice condenser containments. There are likely to be different mechanisms and probabilities of releases of radioactivity for the Byron reactor. It is unlikely, however, that the liquid release for a Byron reactor would be any larger than that conservatively estimated for similarly sized reactors in the LPGS. The source term used for Byron in this comparison therefore is assumed to be equal to that used in the LPGS.

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

The Byron site is located along the Rock River near the town of Byron, Illinois. Groundwater at the site exists in several hydrologic units and is a widely used natural resource of the region. The site is founded on dolomites and limestones of Cambrian and Ordovician age. Groundwater exists in the fractured Galena-Plattesville dolomite under water table conditions. This hydrologic unit is separated from the St. Peter sandstone aquifer at the site by a shale layer. The St. Peter aquifer is locally artesian and is not hydraulically connected to the overlying dolomite in the site vicinity although regionally they are connected. Contamination of the dolomite aquifer would probably not immediately contaminate other aquifers. Groundwater in the dolomite aquifer will discharge to local wells, springs, and the Rock River, which is the local sink for groundwater in the vicinity of the site.

Contaminants released in a postulated core melt accident would be initially deposited to the dolomite and limestone under the site. Groundwater flow would be initially to the southeast, east, or northeast along the gradient of the water table. This flow would take contaminants initially away from the Rock River, but it is likely that the groundwater contamination would be intercepted by small streams such as Black Walnut Creek, Spring Creek, and several unnamed drainage features and be routed to the Rock River. The nearest identified spring is approximately 1100 (3600 feet) from the reactors. For the purpose of this analysis, it is conservatively assumed that all contaminated groundwater flowing under the site would drain into this spring and be routed to the Rock River.

The groundwater travel time from the nearer reactor to the spring is estimated to be about 24 years. For groundwater travel times of this magnitude, the most important contributors to dose are Sr-90 and Cs-137. These radionuclides would be adsorbed to an extent by the geologic media through which they are flowing and therefore would be transported more slowly than the groundwater. Because the groundwater exists primarily in fractures and because dolomite has a low potential for sorption, it was conservatively assumed that the contaminants move at the same speed as the groundwater. The fractions of contaminants released from the plant that would reach surface water are conservatively estimated to be 56% for Sr-90 and 57% for Cs-137.

Contaminated groundwater entering local streams would be transported to the Rock River and eventually travel to the Mississippi River and the Gulf of Mexico. The nearest surface water users are on the Mississippi River, but it is possible that major groundwater users with wells close to the Rock River could be affected by local recharge from the river. The staff conservatively assumed that 25% of recharge to such wells came from the Rock River. Approximately 38,000 surface water and groundwater users could be affected within 80 km of the site. An estimated 25,000 additional users could be affected between the 80 km distance and the Mississippi River. An additional 2.05 x 10^6 people could be affected on the Mississippi River. This compares to the approximately 610,000 drinking water users affected in the LPGS small-river case. Values of population, flow rates and radionuclide releases were used to calculate a relative drinking water population dose for the Byron site of about 130% of that for the LPGS small river site.

No estimates of shoreline usage were available for the Rock River or the Mississippi River. Therefore, average values of user hours per kilometer of shoreline used in the LPGS were employed to calculate the shoreline exposure dose. The staff estimated that the shoreline exposure dose for the Byron site is about a factor of 3 higher than the LPGS small river site.

Quantities of all recreational and sports fish catch were estimated to be about 9.7 x 10^6 kg/yr for all affected water between the Byron site and the Gulf of Mexico. This compares to the approximately 1.2 x 10^6 kg/yr catch used in the LPGS. About half of the fish ingestion dose in the Byron case, however, comes from the Rock River with an estimated catch of only 0.15 x 10^6 kg/yr, because the dilution flow in the Rock River is so much smaller than that of the Mississippi River. Population doses for the Byron site fish ingestion pathway were conservatively determined to be a factor of 24 times greater than the fish ingestion dose for the LPGS small river site. This estimate conservatively neglected the effects sedimentation would have in reducing the concentration of cesium in surface water.

The combined drinking water, fish ingestion and shoreline exposure dose would conservatively be a factor of about three higher then those of the LPGS small river site. The staff considers this estimate to be conservative for the following reasons:

- It is assumed that all contaminated groundwater flowing away from the site would enter the Rock River in the travel time from the reactor to the nearest spring. While the Rock River is ultimately the sink for the local groundwater, the travel time for most of the affected groundwater would probably be much greater than that for the spring.

- No credit was taken for retardation in the dolomite aquifer, although there probably would be a measurable retardation, especially for cesium.

- The estimates of dose to water users affected by recharge of the Rock River into municipal wells is probably too great, because some wells are screened into aquifers not closely connected to the water table aquifer. Furthermore, no effect of retardation in the river alluvium or sandstone was included.

- The removal of cesium from the water column of the Rock River and Mississippi River by sedimentation was not taken into account.

- The plant foundations have been extensively grouted to fill in voids and cracks in the dolomite. This procedure would have reduced the permeability of the dolomite, thereby restricting the movement of groundwater under the site.

The Byron site liquid pathway contribution to population dose, therefore, has been demonstrated to be of the same order of magnitude as that predicted for the LPGS small river site. Thus the Byron site is not unique in its liquid pathway contribution to risk.

Finally, there are measures which would be taken to minimize the impact of the liquid pathway. The staff estimated that the minimum groundwater travel time from the Byron site to the nearest surface water would be about 24 years. This would allow ample time for engineering measures such as additional grouting and well point dewatering to isolate the radioactive contamination near the source.

(6) Risk Considerations

The foregoing discussions have dealt with both the frequency (or likelihood of occurrence) of accidents and their impacts (or consequences). Because the ranges of both factors are quite broad, it is also useful to combine them to obtain average measures of environmental risk. Such averages can be particularly instructive as an aid to the comparison of radiological risks associated with accident releases and with normal operational releases.

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

In Table 5.13 shows average values of risk associated with population dose, acute fatalities, latent fatalities, and costs for evacuation and other protective actions. These average values are obtained by summing the probabilities multiplied by the consequences over the entire range of distributions. Because the probabilities are on a per-reactor-year basis, the averages shown are also on a per-reactor-year basis.

The population exposures and latent cancer fatality risks may be compared with those for normal operation shown in Appendix C. The comparison (excluding

Table 5.13 Average values of environmental risks due to accidents per reactor-year

Environmental risk	Average value
Population exposure	
Person-rems within80 km	37
Total person-rems	218
Early fatalities	0.00026
Latent cancer fatalities	
All organs excluding thyroid	0.0125
Thyroid only	0.0035
Cost of protective actions and decontamination	$8,400*

*1980 dollars

Note: See Section 5.9.4.5(7) for discussions of uncertainties in risk estimates.

exposure to the plant personnel) shows that the accident risks are comparable to those for normal operation.

There are no early fatality or economic risks associated with protective actions and decontamination for normal releases; therefore, these risks are unique for accidents. For perspective and understanding of the meaning of the acute fatality risk of 0.0003/yr, however, it should be noted that, to a good approximation the population at risk is that within about 16 km of the plant, about 26,000 persons in the year 2000. Accidental fatalities per year for a population of this size, based upon overall averages for the United States, are approximately 5.7 from motor vehicle accidents, 2 from falls, 0.8 from drowning, 0.8 from burns, 0.3 from firearms (CONAES, p. 577). The early fatality risk of 0.0026 per reactor year is thus an extremely small fraction of the total risk embodied in the above combined accident modes.

0.00026

Figure 5.11 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the downwind distance from the plant within the plume exposure pathway EPZ. The values are on a per-reactor-year basis and all accident sequences and release categories in Table 5.11 contributed to the dose, weighted by their associated probabilities.

Evacuation and other protective actions can reduce the risk to an individual of acute fatality or of latent cancer fatality. Figure 5.12 shows curves of constant risk per reactor-year to an individual, living within the plume exposure pathway EPZ of the Byron site, of acute fatality as functions of distance due to potential accidents in the reactor. Figure 5.13 shows the same type of curves for risk latent cancer fatality. Section 5.9.4.4 (2), "Site "Features,"

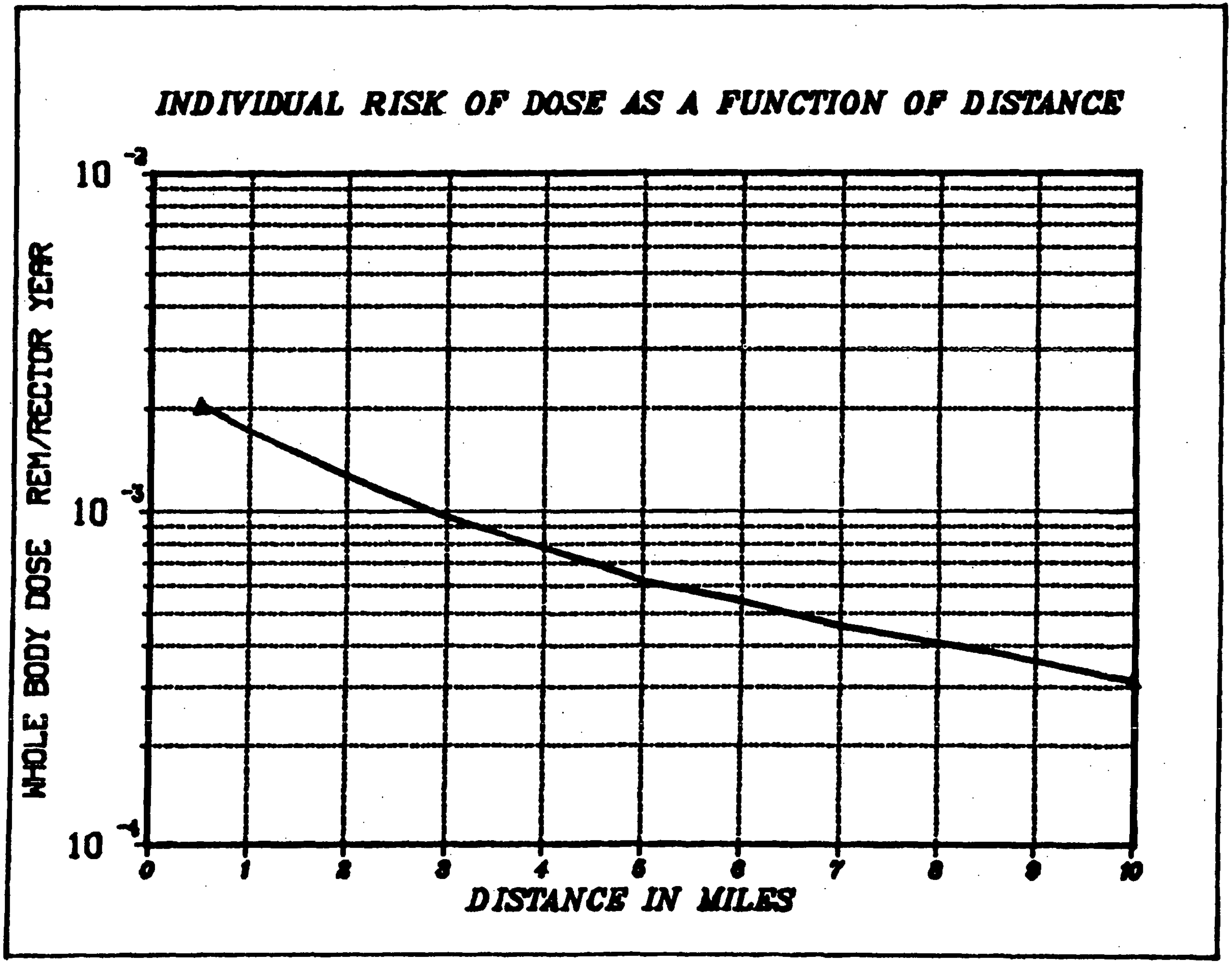

Figure 5.11 Sensitivity of individual risk of dose as a function of distance

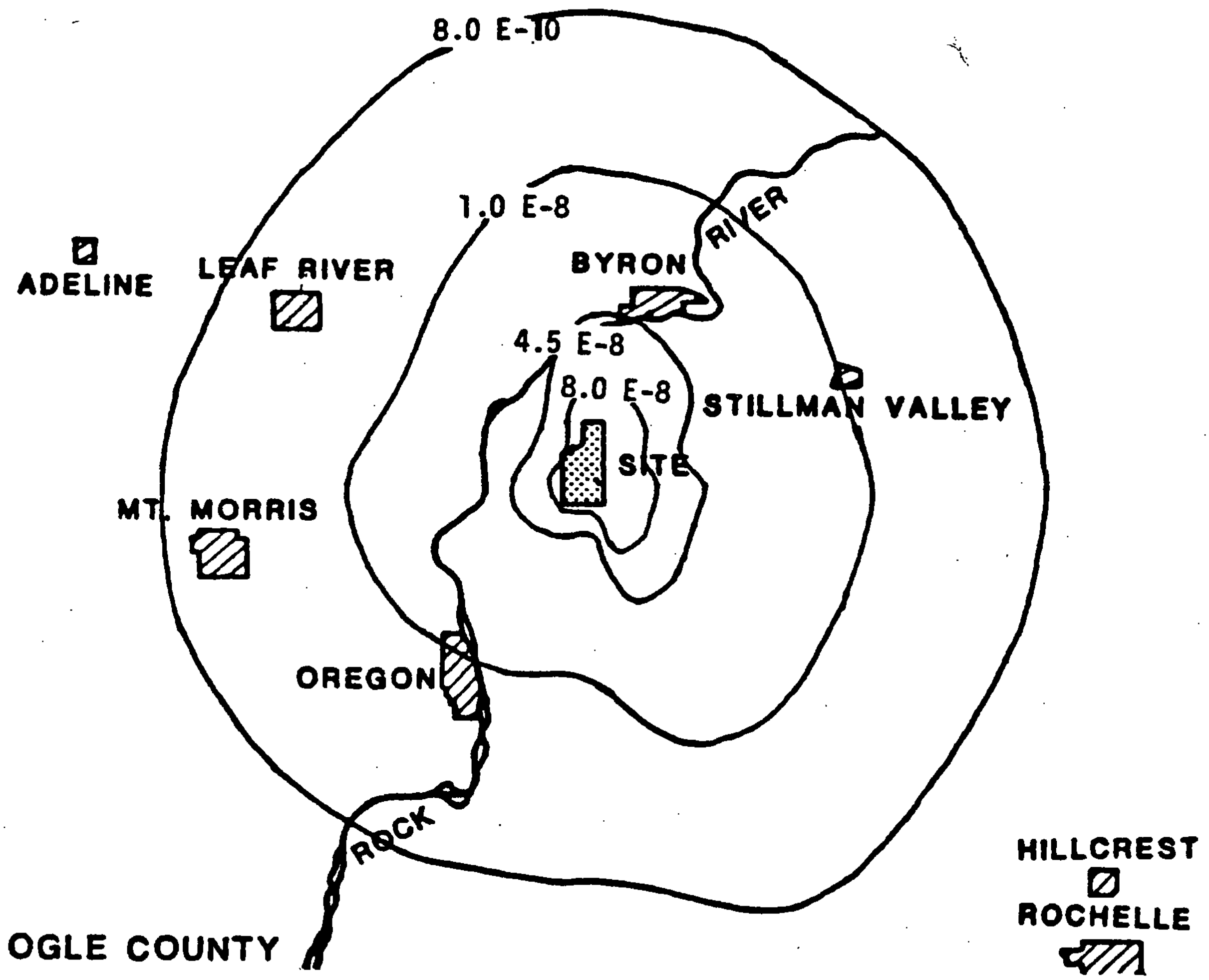

Figure 5.12 Isopleths of risk of early fatality per reactor year to an individual

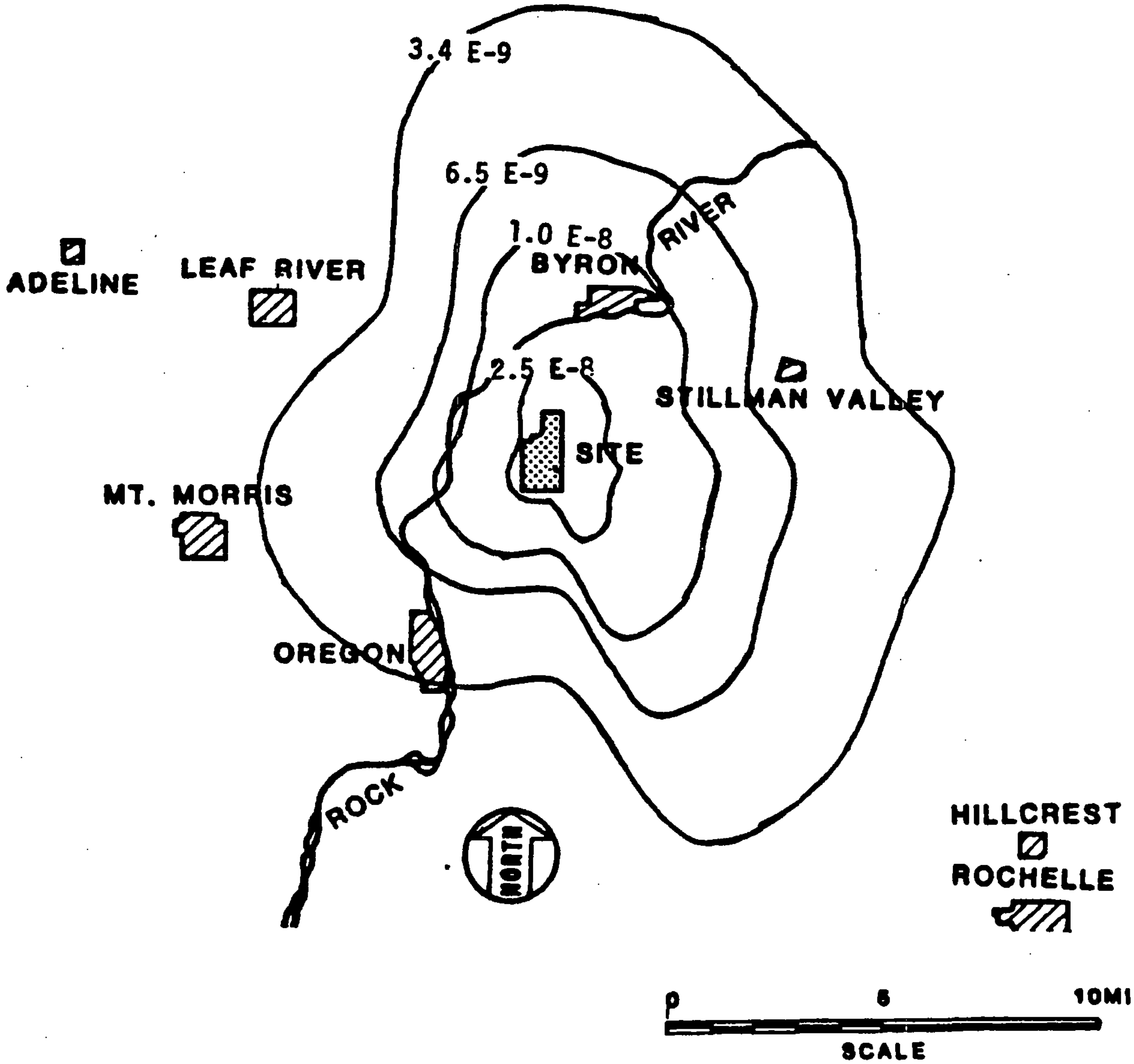

Figure 5.13 Isopleths of risk of latent cancer fatality per reactor year to an individual

discusses the relationship of the exclusion area and low population zone to the features of Figure 5.13. A discussion of the emergency planning zone with respect to other features of Figure 5.13 is in Section 5.9.4.5(6). Directional variation of these curves reflect the variation in the average fraction of the year the wind would be blowing into different directions from the plant. For comparison the following risks of fatality per year to an individual living in the United States may be noted (CONAES, p. 577): automobile accident 2.2×10^{-4}, falls 7.7×10^{-5}, drowning 3.1×10^{-5}, burning 2.9×10^{-5}, and firearms 1.2×10^{-5}.

The relative consequences and risks due to contamination of Lake Michigan as a result of atmospheric fallout from severe accidents in a Byron station reactor would be similar to those determined for contamination of Lake Erie and the other Great Lakes via the severe accident atmospheric fallout route for a Perry Nuclear Power Plant (NUREG-0884) reactor which was, in turn, based on calculations performed for the Fermi 2 plant (NUREG-0769). Byron station is, however, more than 112 km from Lake Michigan, whereas Perry is on the Lake Erie shore. Thus the atmospheric concentrations of airborne radionuclides over Lake Michigan as the result of a severe accident at Byron would be substantially less than similar concentrations over Lake Erie as a result of a severe accident at Perry.

The consequences and risks to society and an individual of delayed cancer fatalities from unrestricted (without any decontamination or interdiction of exposure pathways) use of Lake Michigan and the other Great Lakes contaminated by fallout from atmospheric releases from each Byron reactor would be of similar orders of magnitude as those resulting from the exposure pathways from air and ground contamination following these releases, as shown in Tables 5.12 and 5.13 and Figure 5.13. These consequences and risks were calculated only after exposure pathways interdiction or decontamination was assumed. If similar interdiction of or decontamination in exposure pathways arising from Lake Michigan and the other Great Lakes were assumed, then the consequences and risks from fallout on the Great Lakes would be small compared to those from air and ground contamination, and would not alter conclusions with respect to accident risks compared to risks of normal operation, or with respect to Byron accident risks compared to other accident risks to which the general population is exposed.

The economic risk associated with evacuation and other protective actions could be compared with property damage costs associated with alternative energy generation technologies. The use of fossil fuels, coal, or oil, for example, would result on the emission of substantial quantities of sulfur dioxide and nitrogen oxides into the atmosphere, and, among other things, lead to environmental and ecological damage through the phenomenon of acid rain (CONAES, pp.559-560). This effect has not, however, been sufficiently quantified for a useful comparison to be drawn at this time.

There are other economic impacts and risks that can be monetized that are not included in the cost calculations discussed in Section 5.9.4.5(4). These are accident impacts on the facility itself that result in added costs to the public, (ratepayers, taxpayers, and/or shareholders). These are costs associated with decontamination of the facility itself and costs for replacement power during the time the facility is inoperative. Experience with such costs is currently being accumulated as a result of the TMI-2 accident. If an accident occurs during the first year of operation of Byron Unit 1 (1984), the economic penalty associated with the initial year of the unit's operation is estimated at $1.0 billion for decontamination and $600 million for restoration, including replacement of the damaged nuclear fuel. The staff considers the estimate as conservative (high) in that the total costs are assumed to occur during the first year of the accident, whereas in reality the costs would be spread over several years thereafter. Although insurance would cover $300 million of the $1600 million, the insurance is not credited against the $1600 million because the $300 million times the risk probability should theoretically balance the insurance premium. In addition, the staff estimates additional fuel costs of $210 million (in 1984 dollars) for replacement power during each year the plant is being restored. This estimate assumes that the energy that would have been forthcoming from the Byron Unit 1 (assuming a 60% capacity factor) will be replaced primarily by coal-fired generation. Assuming inoperation of the nuclear unit for 8 years, the total additional replacement power costs would be approximately $1.7 billion in 1984 dollars.

If the probability of sustaining a total loss of the original facility is taken as the sum of the occurrence of a core melt accident (the sum of the probabilities for the categories in Table 5.12) then the probability of a disabling accident happening during each year of the unit's service life is 4.8×10^{-5}. Multiplying the previously estimated cost of $3.3 billion for an accident to Byron Unit 1 during the initial year of its operation by the above 4.8×10^{-5} probability results in an economic risk of approximately $158,000 applicable to Byron Unit 1 during its first year of operation. This is equivalent to approximately $100,000 in 1980 dollars, assuming a 12 percent discount rate. This is also approximately the economic risk to Byron Unit 2 during its first year of operation and to each unit during the second and each subsequent year of their operation. Although nuclear units depreciate in value and may operate at reduced capacity factors so that the economic consequences due to an accident become less as the units become older, this is considered to be offset by higher costs of decontamination and restoration of the units in the later years due to inflation.

(7) Uncertainties

The foregoing probabilistic and risk assessment discussion has been based upon the methodology presented in the RSS, which was published in 1975 (NUREG-75/023).

In July 1977, the NRC organized an Independent Risk Assessment Review Group to (1) clarify the achievements and limitations of the Reactor Safety Study, (2) assess the peer comments thereon and the responses to the comments, (3) study the current state of such risk assessment methodology, and (4) recommend to the Commission how and whether such methodology can be used in the regulatory and licensing process. The results of this study were issued September 1978 (NUREG/CR-0400). This report, called the Lewis Report, contains several findings and recommendations concerning the RSS. Some of the more significant findings are summarized as follows:

- A number of sources of, both conservatism and nonconservatism were found in the probability and consequence calculations in RSS, which were very difficult to balance. The Review Group was unable to determine whether the overall probability of a core-melt given in the RSS was high or low, but they did conclude that the error bands were understated.

- The methodology, which was an important advance over earlier methodologies that had been applied to reactor risk, was sound.

- It is very difficult to follow the detailed thread of calculations through the RSS. In particular, the Executive Summary is a poor description of the contents of the report, should not be used as such, and has lent itself to misuse in the discussion of reactor risk.

On January 19, 1979 the Commission issued a statement of policy concerning the RSS and the Review Group Report. The Commission accepted the findings of the Review Group.

The accident at Three Mile Island occurred in March 1979 at a time when the accumulated experience record was about 400 reactor-years. It is of interest to note that this was within the range of frequencies estimated by the RSS for an accident of this severity (CONAES, p. 553). It should also be noted that the Three Mile Island accident has resulted in a very comprehensive evaluation of reactor accidents like that one by a significant number of investigative groups both within NRC and outside of it. Actions to improve the safety of nuclear power plants have come out of these investigations, including those from the President's Commission on the Accident at Three Mile Island, and NRC staff investigations and task forces. A comprehensive "NRC Action Plan Developed as a Result of the TMI-2 Accident (NUREG-0660, Vol. I, May 1980) collects the various recommendations of these groups and describes them under the subject areas of: Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Practices and Procedures; and NRC Policy, Organization, and Management. The action plan presents a sequence of actions, some already taken, that will result in a gradually increasing improvement in safety as individual actions are completed. The Byron units are receiving and will receive the benefit of these actions on the schedule indicated in NUREG-0660. The improvement in safety from these actions has not been quantified, however, and the radiological risk of accidents discussed in this chapter does not reflect these improvements.

5.9.4.6 Conclusions

The foregoing sections consider the potential environmental impacts from accidents at the Byron Station, Units 1 and 2. These have covered a broad spectrum of possible accidental releases of radioactive materials into the environment by atmospheric and groundwater pathways. Included in the considerations are postulated design-basis accidents and more severe accident sequences that lead to a severely damaged reactor core or core melt.

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe but the likelihood of their occurrence is judged to be small. This conclusion is based on (1) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment, (2) that, in order to obtain licenses to operate the Byron station, it must comply with the applicable NRC regulations and requirements, and (3) a probabilistic assessment of the risk based upon the methodology developed in the Reactor Safety Study. The overall assessment of environmental risk of accidents, assuming protective action, shows that it is roughly comparable to the risk from normal operation although accidents have a potential for acute fatalities and economic costs that cannot arise from normal operations. The risks of acute fatality from potential accidents at the site are small in comparison with risks of acute fatality from other human activities in a comparatively sized population.

The staff has concluded that there are no special or unique circumstances about the Byron site and environs that would warrant special mitigation features for the Byron station.

5.10 The Uranium Fuel Cycle

The uranium-fuel-cycle rule, 10 CFR 51.20 (44 FR 45362), reflects the latest information relative to reprocessing of spent fuel and to radioactive-waste management as discussed in NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle", and NUREG-0216, which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the AEC report WASH-1248, "Environmental Survey of the Uranium Fuel Cycle." The Commission also directed that an explanatory narrative be developed that would convey in understandable terms the significance of releases tabulated in the final rule. The narrative was also to address such important fuel-cycle impacts as environmental dose commitments and health effects, socioeconomic impacts, and cumulative impacts, where these are appropriate for generic treatment. This explanatory narrative was published in the Federal Register on March 4, 1981 (46 FR 15154-15175). Appendix G addresses those impacts of the fuel cycle that reasonably appear to have significance for individual reactor licensing sufficient to warrant attention for NEPA purposes.

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

Appendix G contains a description of the environmental impact assessment of the uranium fuel cycle as related to the operation of Byron station. The environmental impacts are based on the values given in Table S-3 and on an analysis of the radiological impact from radon releases. The staff finds that the environmental impact of Byron station on the U.S. population from radioactive gaseous and liquid releases (including radon) due to the uranium fuel cycle is inconsequential when compared to the impact of natural-background radiation. In addition, the nonradiological impacts of the uranium fuel cycle are found to be acceptable.

Table 5.14 (Table S-3) Uranium-fuel-cycle environmental data[1]

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

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
NATURAL RESOURCES USE		
Land (acres):		
Temporarily committed [2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
EFFLUENTS—CHEMICAL (MT)		
Gases (including entrainment): [3]		
SO_x	4,400	
NO_x [4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F	.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HC1	.014	
Liquids:		From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3—600 cfs. NO_3—20 cfs. Fluoride—70 cfs.
SO_4^-	9.9	
NO_3^-	25.8	
Fluoride	12.9	
Ca^{++}	5.4	
C1	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.

Table 5.14 (Table S-3) (Continued)

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

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

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

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

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

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

5.11 Decommissioning

Decommissioning of a nuclear power reactor does not usually involve environmental impacts that are unique to a specific project. The technology for decommissioning nuclear facilities is well in hand and, although technical improvements in decommissioning techniques are to be expected, at the present time decommissioning can be performed safely and at reasonable cost. Radiation doses to the public as a result of decommissioning activities should be very small and would come primarily from the transportation of decommissioning waste to waste-burial grounds. Radiation doses to decommissioning workers should be a small fraction of the worker exposure over the operating lifetime of the facility; these doses usually will be well within the occupational-exposure limits imposed by regulatory requirements. Decommissioning costs for reactors are a small fraction of the present-worth commissioning costs. A full analysis of decommissioning is available in NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities."

5.12 Noise

Offsite noise during the operation of Byron station will result from the continuous operation of the natural-draft and the mechanical-draft cooling towers, station ventilation fans, transformers and their cooling fans, and the station water pumps. Noise will also result from the use of the station power-operated relief valves, although this is expected to be an infrequent occurrence (about once per year per valve (response to staff question 290.6)) and of relatively short duration when it does occur. Offsite noise character and level are expected to be dominated by the station cooling towers. However, the station switchyard/transformer area and the Rock River intake pumps and associated equipment could be expected to predominate for offsite locations near this equipment. In addition, the noise of the relief valves, when they are in use, is likely to override other station noise generators.

The staff considered the nearby noise sensitive land uses as well as station property boundaries in its assessment of likely impacts of Byron station noise levels. These uses and their locations are given in Section 4.3.8. The applicant considered locations around the station property boundaries and nearby offsite residential areas in the noise assessment. One of the station boundary noise assessment/prediction locations was used to approximate one of the residential areas (OL-ER Section 5.6). The applicant considered all of the major noise sources for this type of generating station in the analysis, using manufacturer's data or published estimation techniques. The staff has reviewed the scope of the applicant's analysis and prediction techniques used and finds them acceptable.

The staff does not have detailed lists of all station noise sources, their exact locations, the manufacturer's source noise data, and other inputs used by the applicant to estimate offsite noise levels. However, the staff checked the offsite noise level estimates of the applicant for locations expected to be dominated by cooling tower noise by using the Capano and Bradley field-verified technique and concludes that the applicant's estimates are reasonable for these sites. The applicant's extrapolation of the source noise data to the other prediction locations (see Section 4.3.8) used estimates of noise attenuation via barrier effects, directivity of sources (except for the mechanical-draft cooling towers, which had already incorporated directivity in the estimation technique) and atmospheric adsorption (ER-OL Section 5.6 and response to staff question 290.5). These attenuation factors cannot account for all conditions at the site (such as wind and other atmospheric conditions, reflectance of sound wave by station structures) and therefore, the applicant's predicted noise levels may not be the maximum expected at the locations shown. The estimated noise levels, shown in Table 5.15, can be considered reasonable, if not necessarily conservatively high.

Table 5.15 Estimated noise levels at Byron station

Location	Predicted station noise level during normal operation	
	$L_d = L_n$	L_{dn}
1	42dBA	49dBA
2	47dBA	53dBA
3	48dBA	55dBA
4	29dBA	36dBA

Note: Values rounded to nearest whole dB

Because the predominant noise sources at Byron station normally operate in a constant and continuous manner, the predicted values are the same for daytime or nighttime and can be considered equivalent to the 24-hour equivalent noise level. Under these assumptions, the values can be readily converted to the day-night equivalent noise levels (L_{dn}) shown (EPA 550-9-74-004).

The applicant provided octave band analyses for the estimated operational noise levels at nearby locations and compared them with the permissible octave band limits of the Illinois Pollution Control Board Noise Regulations (Illinois Pollution Control Board). The comparison was made using the most restrictive adjacent land use type (residential) for the most restrictive time period, nighttime. The data presented in ER-OL Table 5.6-1 and Figures 5.6-2 through 5.6-5 indicate that the regulations will be met for all locations examined. Compliance in the 250-Hz through 1000-Hz for octave bands for locations 2 and 3 is, however, minimal and actual compliance under operating conditions as compared to the predictions will depend on the magnitude of station noise sources and the action of the various attenuating mechanisms at the site relative to their values as assumed in the predictions.

The U.S. EPA has proposed an "identified level" for the protection of public welfare with respect to outdoor activity interference, of 55dBA (2×10^{-5} N/m^2) measured as a day/night equivalent sound level (L_{dn}). The predictive information indicates that plant contributions to ambient noise levels will not likely result in any of the examined location exceeding this "identified level" that did not already exceed it. At location 3 (nearby residential area), the station contribution would exacerbate the ambient L_{dn}, calculated to be 57dBA. The L_{dn} for the predictive locations, considering both the ambient and station contributions, are shown in Table 5.16.

Table 5.16 L_{dn} for predictive locations

Location	Predicted noise level during operation, L_{dn}
1	50dBa
2	54dBa
3	57dBa
4	56dBa

The predictive levels also indicate that, for locations 1 and 2, the change in noise levels could be 5 dB or more. A change of this magnitude in community noise levels is sufficient to cause a change in the general reaction pattern to such noise at these locations (Stephens, et al.). An increase in annoyance to residents may result. The difference in pre- and post-operational noise levels may also cause annoyance or activity interference in the vicinity of location 3, as well as locations 1 and 2 during nighttime hours, because these preoperational noise levels would be expected to be lower than the stated L_{dn} values. This effect is expected to be seasonal, as non station ambient noise sources (such as insects) and outdoor activity would be seasonally influenced.

The applicant has committed to conducting a confirmatory monitoring program in the vicinity of Byron station (ER-OL Section 6.2.2 and response to staff questions 290.6 and 290.7). This program will quantify operational phase noise levels at locations 1 through 4 and at the villages of Byron and Oregon. The program will be conducted for both one-unit and two-unit operation at the site. The staff concurs that this program should be performed. The details of this program will be included in the environmental protection plan for the station.

Based primarily on the magnitude of the station contribution to noise levels using station cooling tower noise estimates, the staff believes that operation of Byron station will not result in significant activity interference or annoyance at such nearby identified noise sensitive land uses as Ebenezer Church, the cemetery on River Road, or the county and state parks and schools identified in Section 4.3.8. Activity interference is also not expected in the villages of Byron and Oregon nor on or along the Rock River near the station intake.

5.13 Emergency Planning Impacts

Construction of the facilities is discussed in Section 4.2.1. The staff believes the only noteworthy potential source of impacts to the public from emergency planning would be associated with the testing of the early notification system. The test requirements and noise levels will be consistent with those used for existing alert systems; therefore, the staff concludes that the noise impacts from the system will be infrequent and insignificant.

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6 EVALUATION OF THE PROPOSED ACTION

6.1 Unavoidable Adverse Impacts

The NRC staff has reassessed the physical, social, biological, and economic impacts that can be attributed to the operation of the Byron station, Units 1 and 2. For the most part, these impacts are as stated in Section 5 of the FES-CP. Actions taken by the applicant since the FES-CP stage have resulted in adequately mitigating the operating impacts. The residual impacts are summarized in Table 6.1.

6.2 Irreversible and Irretrievable Commitments of Resources

All of the significant resource commitments were identified at the time of the construction permit review.

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

There have been no significant changes in the staff's evaluation for the Byron station since the CP environmental review.

6.4 Benefit-Cost Summary

6.4.1 Summary

Sections below summarize the economic, environmental, and socioeconomic benefits and cost which are associated with the operation of Units 1 and 2 of the Byron station. The benefits and costs of are shown in Table 6.1.

6.4.2 Benefits

The direct benefits to be derived from the operation of the Byron station include the approximately 12 billion kWh of baseload electrical energy that the station will be able to produce annually (this projection assumes that both units will operate at an average 60% capacity factor). The benefits also include a savings of over $200 million in production costs per year (1987 dollars) and improved reliability of the CECo system brought about by the addition of 2240 MWe of generating capacity to the system.

6.4.3 Economic Costs

The economic costs associated with station operation include fuel costs and operation and maintenance costs which will amount to 11.51 mills/kWh and 7.27 mills/kWh, respectively (in 1985 dollars). The cost of decommissioning is a small additional cost of plant operation. The staff's estimate for decommissioning each Byron unit ranges from about $21 million to $42.8 million in 1978 dollars.

Table 6.1 Benefit-cost summary

Primary impact and effect on population or resources[1]	Quantity[2] or section	Impact[3]
Direct Benefits		
Energy (2.2)	12,000 kWh/yr x 10^6	
Capacity (2.4)	2,240 kW x 10^3	
Reduced generating costs (2.2)	$201 to 266 million/yr (1981 dollars)	Large
Improved diversity of supply (2.3)		Moderate
Improved system reliability (2.4)		Small
Indirect Benefits		
Local taxes (ad valorem) (5.8)	$11 million	Large
Annual employment (5.8)	500 employees	Small
Annual payroll (5.8)	$12 million	Moderate
Economic Costs of Operating		
Fuel (2.2)	11.5 mills/kWh (1985 dollars) first year	
O&M (2.2)	7.27 mills/kWh (1985 dollars) first year	
Decommissioning (2.2 and 5.11)	21-42.8 million (1978 $/unit)	
Environmental Costs		
Resources committed		
Land (CP-FES 4.1)	710 hectares (1754 acres)	Small
Water (4.2.2)		
Damages suffered by other water users because of		
Surface water consumption (5.3.1)		None
Surface water contamination (5.3.2)		Small
Groundwater consumption (5.3.1)		Small
Groundwater contamination (5.3.2)		None
Damage to aquatic biota due to		
Intake losses (5.5.2)		Small
Surface water discharges - heat (5.5.2)		Small
Surface water discharges - chemical (5.5.3)		Small

Table 6.1 (continued)

Primary impact and effect on population or resources[1]	Quantity[2] or Section	Impact[3]
Damage to terrestrial resources due to		
Fog (5.4.1)		Small
Drift (5.4.1)		Small
Bird impaction (5.5.1)		Small
Human health effects (radiological) due to		
Effects of reactor operation on general population (5.9.3)	Small	
Effects of reactor operation on workers at site (5.9.4)	Small	
Effects of balance of fuel cycle (5.10)		Small
Accident risk (5.9.4)		Small
Societal costs in terms of		
Historic and archeological resources (5.7)		Small
Visual intrusion (5.8)		Small
Noise (5.12)		Small
Increased traffic (5.8)		Small
Increased demands on public facilities and services (5.8)		Small
Increased demands on private facilities and services (5.8)		Small
Accident risk (5.9.4)		Small

[1]References in parentheses indicate section of this report where evaluation appears.

[2]For those factors which are not quantifiable, see text section.

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

6.4.4 Socioeconomic Costs

No significant socioeconomic costs are expected from the normal operation of the station or from the number of Byron station personnel and their families living in the area. The socioeconomic impact of possible accidents are described in Section 5.9.4.5. The socioeconomic impacts of a severe accident could be large; however, the probability of such an accident is small.

6.4.5 Environmental Costs

The environmental costs were previously evaluated in the FES-CP and have not adversely changed.

No significant environmental costs are expected from the normal operation of the plant, including considerations of the uranium fuel cycle and plant accidents. The economic impact of possible accidents are described in Section 5.9.4.5.

6.4.6 Conclusions

As a result of the analysis and review of potential environmental, technical, economic, and social impacts, the staff has prepared an updated forecast of the effects of operation of the Byron station. The staff has determined that the Byron station can be operated with minimal environmental impact. No new information has been obtained that alters the overall favorable balancing of the benefits of station operation versus the environmental costs struck at the CP stage.

7 LIST OF CONTRIBUTORS

The following NRC personnel participated in the preparation of this environmental statement:

S. Chesnut	Licensing Project Manager
W. Kane	Licensing Project Manager
K. Kiper	Licensing Project Manager
G. LaRoche	Terrestrial Resources
C. Billups	Aquatic Resources
J. Lehr	Water Quality; Noise
B. Richter	Regional Impact Analysis
C. Ferrell	Siting Analysis
M. Wohl	Accident Evaluation
F. Akstulewicz	Accident Evaluation
J. Mitchell	Accident Evaluation
D. Loveless	Accident Evaluation
S. Baker	Accident Evaluation
R. Houston	Accident Evaluation
J. Levine	Meteorology
J. Hawxhurst	Meteorology
J. Hayes	Effluent Treatment Systems
R. Struckmeyer	Radiological Assessment
R. Houston	Accident Evaluation
E. Fields	Cost-benefit
A. Toalston	Cost Impact of Accidents
G. Staley	Hydraulic Engineering
R. Codell	Hydraulic Engineering
W. Axelson	Emergency Planning
S. Acharya	Accident Evaluation
M. Taylor	Accident Source Terms

8 LIST OF AGENCIES AND ORGANIZATIONS REQUESTED TO COMMENT ON THE DRAFT ENVIRONMENTAL STATEMENT

The following Federal, state, and local agencies were asked to comment on the draft environmental statement:

Advisory Council on Historic Preservation
Department of Agriculture, Natural Resources and Economics Division
Department of Agriculture, Rural Electrification Administration
Department of Agriculture, Agricultural Research Service
Department of Agriculture, Forest Service
Department of Agriculture, Soil Conservation Service
Department of the Army, Corps of Engineers
Atomic Industrial Forum
Brookhaven National Laboratory
Department of Commerce
Department of Commerce, Environmental Assessment Division
Department of Commerce, National Oceanographic Data Center
Department of Energy
Environmental Protection Agency
Environmental Protection Agency, Office of Radiation Programs
Environmental Protection Agency, EIS Review Coordinator, Region V
Federal Emergency Management Administration
Federal Energy Regulatory Commission
Department of Health and Human Services
Department of Health and Human Services, Food and Drug Administration
Department of Housing and Urban Development
Department of the Interior, Office of Environmental Projects Review
Department of Transportation
Attorney General, State of Illinois
Illinois Institute of Natural Resources
Illinois State Clearinghouse
Ogle County Board of Supervisors, State of Illinois

9 RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR 51, the "Draft Environmental Statement Related to Operation of Byron Station, Units 1 and 2" was transmitted, with a request for comments, to the agencies and organizations listed in Section 8 of this report.

In addition, the NRC requested comments on the DES from interested persons by a notice published in the Federal Register on December 4, 1981 (46 FR 59350).

In response to these requests, comments were received from the following:

U. S. Department of Agriculture, Soil Conservation Service (DASCS)
U. S. Department of Agriculture, Economics and Statistics Service (DAESS)
U. S. Department of Agriculture, Forest Service (DAFS)
U. S. Department of Health and Human Services (DHHS)
U. S. Department of Energy (DOE)
U. S. Department of the Army, Corps of Engineers (DACE)
U. S. Department of the Interior (DI)
U. S. Environmental Protection Agency (EPA)
Federal Energy Regulatory Commission (FERC)
Illinois State Clearinghouse (ISC)
Illinois Department of Nuclear Safety (IDNS)
Patrick Carnaham (PC)
Commonwealth Edison Company (CECo)
John Doherty (JD)

The comment letters are reproduced in this statement in Appendix A. The comments received from DAESS, FERC, and the ISC did not require a staff response either because they offered no comments or because their comments indicated agreement with the DES.

The remaining comment letters did require responses and/or revisions to the text of the environmental statement. The staff's consideration of these comments and its disposition of the issues involved are reflected in part by revised text in the pertinent sections of this report and in part by the discussion in this section. Individual comments are designated by number in the margin of the letters in Appendix A. The comments are categorized by subject and are referenced by the use of abbreviations shown in the list above.

9.1 Introduction (CECo-1)

The footnote on page 1-1 has been revised to include reference to ER-OL, Amendment 2.

9.2 Purpose and Need for the Action (CECo-2, CECo-15, DOE)

Commonwealth Edison submitted more recent data for the reserve and production cost analyses in Section 2 of the DES. The FES has been updated to reflect this information.

Additionally DOE submitted, by marginal notations in the DES, a number of questions regarding the reserve and production cost analyses. Several of those notations refer to tables or data that have been revised or deleted to reflect the comments and more recent data provided by the applicant. Several of the editorial comments noted by DOE have been incorporated into the updated portions of Section 2.

Several DOE comments dealt with the existing capacity mix and questioned what is a desirable mix. In response to those concerns, Table 2.3 shows the capacity mix for the CECo system during the summer of 1982. The staff does not propose to indicate or suggest a "desirable mix" of generating facilities. The staff's intention is only to indicate, as stated in Section 2.3, that it is beneficial for bulk power systems to have diverse sources of primary power. The staff feels that the text provided in this section provides adequate support for these statements. Further, as indicated in the footnote on page 2-1, the Commission has removed need for power matters in operating license environmental reviews and in environmental impact appraisals.

9.3 Alternatives to the Proposed Action (PC-2)

Unless there are unusual circumstances, the staff has found that alternative energy sources or sites are not feasible alternatives to be considered at the operating license stage because, by the OL stage, extensive costs have been put into the construction of the facility and must be recovered whether the plant operates or not. The Commission has explicitly removed alternative energy sources from consideration at the OL stage as indicated in the footnote on page 3-1.

9.4 Project Description and Affected Environment

9.4.1 Water Use and Treatment (IDNS-1)

The staff has not performed an analysis of the retention integrity of the mechanical condenser tube cleaning system proposed for use at the Byron station, nor on the effects on the introduction of the sponge rubber balls used by the system on other station systems or on the environment. The staff is aware of instances where these cleaning balls have escaped through strainers used for their retention and have entered cooling towers and the environment. Staff experience and review of operating nuclear power plant environmental data indicate that these escaped balls have neither interfered with the proper operation of other plant systems, such as cooling towers, nor caused harm in the aquatic environment. Based on this experience, the staff believes that a detailed site-specific analysis for the Byron station is not necessary.

Information from the applicant (responses to DES comments dated March 8, 1982) indicates that the system proposed for use at Byron station is expected to have better performance in ball recovery and retention than the system in use at the Zion Nuclear Power Station. The applicant also indicates there have been no operating or environmental problems associated with the mechanical condenser tube cleaning system at Zion.

9.4.2 Surface Water Treatment (CECo-17)

Section 4.2.3.4.1, which describes the treatment of the circulating water and nonessential service water systems, has been changed to reflect the new information on use of a scale inhibitor and dispersant.

9.4.3 Radioactive Waste Management System (IDNS-2)

Section 4.2.5 has been modified to reflect the design changes to the building ventilation system. The changes to filtration paths of the main condenser air ejector exhaust and the radwaste building ventilation system are changes involving nonsafety-related systems. Therefore, changes to their design does not invalidate the assumptions that were made in DES Section 5.9.4.4, "Mitigation of Accident Consequences, "because only ESF filters are considered in the accident evaluation of Section 5.9.4.4. For ESF air filter systems such as the fuel-handling building and nonaccessible area exhaust from the auxiliary building, the flow will be diverted to a charcoal adsorber and a downstream HEPA filter on a high radiation signal or by manual initiation by the control room operator. The applicant has proposed Technical Specifications that detail tests to demonstrate the operability of the systems on a periodic basis and following certain events that could impact the removal capability of the filters. Controls and equipment qualification were addressed by the applicant in FSAR Appendix A, under A1.52, which details the station's conformance to the various positions of Regulatory Guide 1.52, "Design, Testing and Maintenance Criteria for Post-Accident Engineered Safety Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants."

9.4.4 Cooling System (CECo-18)

Section 4.2.4.2 has incorporated the suggested revision.

9.4.5 Station Nonradioactive Effluents (CECo-19)

The maximum total dissolved solids (TDS) concentration used by the staff as basis in the draft estimate is the highest average seasonal predicted TDS concentration in the circulating water system; that is, 1823 mg/l for average winter conditions (concentration factor equal to 2.3). The maximum TDS concentration value of 1854 mg/l in the circulating water is based on maximum values of water quality constituents in the makeup water. This value is overly conservative in that it represents an extreme case that would not likely occur, because the makeup water constituent maxima would not be expected to occur simultaneously. The estimate of TDS in the cooling tower draft cited from the FES-CP was based on the then-expected average cooling water TDS concentration and the drift loss rate estimate at that time. The text of the FES has been changed to show the quantity of TDS lost in cooling tower drift under both the maximum seasonal average condition and the average condition.

9.4.6 Power Transmission Systems (CECo-20)

Section 4.2.7 has been revised to reflect the right-of-way data.

9.4.7 Surface Water and Groundwater Use (CECo-21, DI-1)

In response to the CECo comments, Section 4.3.1.3 and Figure 4.8 have been revised using data from Amendment 2 to the ER-OL.

In response to comments from DI, the units for hydraulic conductivity have been changed from liters per day per meter squared (1 pd/m^2) to meters per day (m/d). The FES has been revised accordingly.

The units for transmissivity have been changed from liters per minute per meter (1 pm/m) to square meters per day (m^2/d). The FES has been revised accordingly.

9.4.8 Noise (CECo-23, CECo-24)

The new information and corrected data, as provided by the comment and amendment to the ER-OL, have been accounted for in the revised text of Section 4.3.8. Based on the clarification provided in the comment that available data are from actual measurements of noise levels at the site boundaries and that construction activities did not bias the survey results, the staff agrees that a new ambient sound level survey is not necessary. This recommendation has been deleted from Section 4.3.8.

9.5 Evironmental Consequences and Mitigating Actions

9.5.1 Land Use (DAFS, DACES)

In response to DAFS, the marginal farmland consisting of approximately 132 ha (325 acres) will be developed to provide a permanent low maintenance ground cover that can be useful for wildlife habitat and can control soil erosion. This will be done after consultation with the Ogle County Soil Conservation Service and the Illinois Department of Conservation.

In response to DACES, the correct soil classifications have been indicated in section 4.2.2.

9.5.2 Surface Water (CECo-25)

The sentence in the DES text reading "However, the applicant has committed to conducting a monitoring program during operation to confirm these predictions (Sec. 5.5.2.2)" has been deleted from the first paragraph of Section 5.3.2.2. The required monitoring is specified in the NPDES permit for the Byron station.

9.5.3 Ecology (CECo-27, CECo-28, PC-1, JD-1)

In response to CECo-27, Section 5.5.1.2 has been revised to reflect more recent bird impaction data. In response to CECo-28, the transmission line voltage has been revised in Section 5.5.1.3.

In response to PC-1, Section 5.5.1.3 has been modified to reflect restrictions associated with herbicides used to control vegetation.

In response to JD-1, the concerns regarding a toxic waste dump on the Byron property were addressed in the DES (Section 4.3.4.1). The toxic wastes found on the Byron station property had been buried by others prior to the acquisition of the property by Commonwealth Edison and has been reported to be cleaned up in a satisfactory manner by the Illinois EPA. Additional monitoring of ground-water wells will be conducted by the Illinois EPA to monitor the effects of dumping on adjacent property.

9.5.3.1 Aquatic (DI-2, CECo-29, CECo-32)

DI commented on Section 5.5.2.1. This section has been revised based on comments received from the applicant (see Appendix A). The applicant points out that neither the operational Section 316(b) demonstration study nor the concerns of the IDOC to be studied include entrainment. The applicant has committed to keep the Rock Island Field Office of the Fish and Wildlife Service informed of the findings from both the NPDES monitoring program and the special study addressing the IDOC concerns (according to a letter from C. L. McDonough, Commonwealth Edison Director of Environmental Assessment, to S. Chesnut, NRC Licensing Project Manager, March 9, 1982).

In response to the applicant's comments, the first sentence on page 5-16 has been deleted. Corrected information is in Section 5.5.2.2.

Section 5.5.2.2 has been revised to reflect the monitoring requirements specified by the NPDES permit and the applicant's agreement with the IDOC.

However, while Section 5.5.2.2 has been revised, the title has not been altered as suggested because the applicability of the information is stated in the first sentence of the revised text.

A new Section 5.5.2.3 has been added to clarify the separate monitoring program being conducted under the agreement between the applicant and the IDOC.

9.5.4 Historic and Archeological Sites (CECo-33)

It was not the staff's intent to eliminate CECo's communication with the SHPO but that SHPO and NRC be informed if archeological sites in the transmission corridors are to be affected by future activities. See revised Section 5.7.

9.5.5 Radiological (CECo-35; HHS-1, -2; EPA-1, -2, -5; IDNS-3, -4, -5)

In response to CECo and IDNS, the staff's judgment that the calculated results of the consequences are more likely overestimates is based upon the following:

(1) The release fractions of fission products, shown in Table 5.11, are believed to be conservatively high for those radionuclides that are dominant risk contributors. This is due to the complexities of modelling more accurately natural plate-out and aerosol agglomeration and settling tendencies within containment.

(2) The meteorological dispersion model employed is believed to be conservative.

(3) The staff's estimates of the effectiveness of protective actions, particularly evacuation times, are believed to be conservative.

Because the judgment is difficult to quantify, the statement has been removed from the FES.

Regarding comments from HHS, the evacuation model used in the CRAC computer code calulations performed in generating many of the analytic results presented in the DES is based upon a Sandia National Laboratory Study discussed in "A Model of Public Evacuation for Atmospheric Radiological Releases" (SAND 78-0092, June 1978), which is referenced in the FES. Parameters utilized in implementing the model for the Byron plant are taken, in part, from information provided in an August 29, 1980 letter from the applicant.

Table 5.8 indicates that TLDs will be used at designated sites for detecting airborne gamma radiation and that a charcoal cartridge will be used at these sites for collection of I-131. The use of these separate methods allows for the determination of radiohalogens in the presence of radionoble gases under normal operating conditions. Instrument systems for radioiodine monitoring, as well as other types of environmental monitoring, are evaluated before and during use to ensure that they perform according to Technical Specifications. Licensees are required to participate in an Interlaboratory Comparison Program, which provides independent checks on the precision and accuracy of the measurements of radioactive material in environmental monitoring.

EPA commented on the drinking water pathway for routine releases. This pathway was not evaluated because there are no public water supplies taken directly from the Rock River, and because of the very large dilution and travel time for river water, which contributes to recharge of the ground-water supply. However, to be consistent with the assessment provided in Section 5.9.4.5(5) regarding accidental releases, the appropriate section of the FES regarding ingestion of drinking water from routine releases have been revised to reflect the possibility of radioactive contaminants reaching the public water supplies via recharge of groundwater from the Rock River.

EPA also commented on impact from other nuclear stations. The DES, on page 5-29, stated that the Byron station will be capable of operating within the requirements of 40 CFR 190 under normal operating conditions. The DES for the Byron station focused on impacts from Byron and not other stations, but such information is readily available. The Radiological Effluent Technical Specifications for operating nuclear power plants, which are required by 10 CFR 50.36a, specify that an annual radiological environmental operating report and a semiannual radioactive effluent release report must be submitted by each operating facility. These reports are available in the NRC Public Document Room in Washington, DC, and provide information regarding compliance with regulations by nuclear power stations. Experience with other stations indicates that, under normal operating conditions, compliance with the regulations will be achieved.

The FES indicated the levels of radiation that an individual could expect to receive from the Byron station. These levels are given in Tables C.6, C.7, and C.8. Note that these doses tend to be overestimated, for reasons stated in Section C.2.1.

Section 6.2.3 of the ER-OL states that the preoperational monitoring program will continue for 2 years following the start of commercial operation of the Byron station, after which the operational program will go into effect. As stated in the DES, when the operational monitoring program begins, vegetable sampling will be discontinued. According to the Radiological Assessment Branch Technical Position, the operational monitoring program requires monitoring of vegetation that is used as a food product only if: (1) the vegetation is irrigated by water in which liquid plant wastes have been discharged, or (2) milk sampling is not performed. In the case of the Byron station, milk sampling will be performed as part of the operational monitoring program; therefore, on that basis, monitoring of vegetation is not required. This leaves open the question as to whether vegetation monitoring should be required on the basis of irrigation. Two irrigated fields are located downstream of the Byron station. According to the ER, the corn grown in these fields is used as feed grain. Human exposure would occur by way of ingestion of meat animals that were fed this corn. The ER states that this corn goes into grain markets and is mixed with corn from other farms, and that the diet of livestock fed this corn is likely comprised of additional feed; therefore, any radiation dose to persons from ingestion of cornfed meat products from this area is considered insignificant. In the staff's analysis of doses performed for the DES, it was conservatively assumed that meat animals receive all of their feed from irrigated fields, as well as all of their drinking water from the irrigation system. It was found that maximum individual doses due to ingestion of meat were less than 0.01 mrem to the total body or any organ, and that population doses were less than 0.05 person-rem to the total body and less than 0.05 organ-rem to any organ. Given the extremely small impact of the irrigation pathway, it is not necessary to require monitoring of vegetation. Any increases in radioactivity in liquid effluents will be detected by one or more of the several other monitoring programs. If crop irrigation is increased to any significant extent, monitoring of vegetation could be required.

Regarding the question of the IDNS as to the staff's assessments utilizing proposed revisions to 10 CFR 20, no consideration was given to the proposed revision, because the NRC is required to regulate nuclear power facilities under existing regulations. If and when these regulations are revised, the NRC will revise its assessment procedure as necessary.

The NRC continually assesses the operating experience of each licensed nuclear power facility. This experience is taken into account in updating existing regulations and, where necessary, developing new regulations. The evaluation of the radiological impacts of normal operation is carried out using conservative assumptions regarding releases of radioactive materials, dispersal in the environs, and potential doses to individuals and populations via the various exposure pathways. As a result, these doses tend to be overestimated to a degree which makes the small variations in releases during normal plant operations inconsequential in comparison to the magnitude of the calculated doses. Furthermore, the consequences of events resulting in unanticipated releases are covered by the design-basis accidents discussion (Section 5.9.4.5) or are of smaller magnitude than those covered in this discussion.

9.5.6 Environmental Impact of Postulated Accidents (EPA-3, -4; IDNS-5, -6, -7)

EPA commented regarding the exclusion area. The exclusion area is a rectangular area within the site boundary (shown on Figure 5.13), with a minimum distance of 445 meters (1460 feet) from the outer edge of the containment wall to the exclusion area boundary. There are no permanent residents within the exclusion area.

Beyond and surrounding the exclusion area is a circular low population zone (LPZ) with a 4.8-kilometer (3-mile) radius (discussed also in the "Site Features" section of NUREG-0848). This is readily discernible on Figure 5.13 also, which has a scale. Populated localities of interest to the general public are also shown on this figure. Additionally, the emergency planning zone (EPZ) can be visualized as a circular zone of 16-kilometer (10-mile) radius concentric with the LPZ boundary. A discussion of these features has been added to the FES in Section 5.9.4.5(6).

The direct addition of the dose factors for drinking water, fish ingestion, and shoreline usage to give an overall dose factor for the Byron site of 30 times greater than the LPGS small-river site misrepresents the dose comparison. The staff estimates that drinking water at the Byron site accounts for 34% of the total dose, fish consumption 61% of the total dose, and shoreline exposure 5% of the total dose. The fractions of the total population dose in the LPGS small-river case were 86%, 8%, and 6% for drinking water, fish consumption and shoreline usage, respectively. The comparative total dose should be weighted by these fractions to give an overall ratio of the Byron to LPGS population dose of about 3.3. The staff's reasons for concluding that this estimate of relative dose is in fact conservative is stated in Section 5.9.4.5(5).

Regarding comments from IDNS, since the issuance of the DES, the staff published NUREG-0876, "Safety Evaluation Report related to the operation of Byron station, Units 1 and 2" (SER). The staff's evaluation of the TMI-related requirements is included in that document. A cross-reference of the requirements that are applicable to the Byron station is in Table 1.1 of the SER.

The discipline of probabilistic risk assessment (PRA) is a developing art. WASH-1400 represented a PRA for two specific plants, and PRA studies have been completed by licensees for a few plants in relatively high population areas. For these latter studies, the review process is not complete, and the staff has drawn no definite conclusions. Relative to natural phenomena and sabotage as potential initiators of accidents, the staff notes that such events are, in large measure, taken into account in the design and operation of nuclear power plants. However, the data base for the occurrence of events of these types, which are more severe than the design bases, is small. Therefore, inclusion of accident sequences initiated by natural phenomena and sabotage is beyond the present state-of-the-art of PRA. The staff judges, based on assessments done for WASH-1400 and a preliminary assessment of other PRA studies, that the additional risk from severe accidents initiated by natural phenomena and sabotage is within the uncertainty of risks presented in this statement for the accident sequences initiated by internal system failures. The text has been changed in Section 5.9.4.5 to reflect these statements.

9.5.7 Noise (CECo-36, -37)

The portion of the FES text that shows the predicted noise levels in the site vicinity during station operation has been changed, based on the corrected data supplied by the applicant (ambient Ldn noise level at sampling location number 3 is equal to 54 dBa). Combining this corrected ambient data and the applicant's estimated station operational noise level yields a predicted noise level (Ldn) at location 3 (nearby residential area) of 57 dBa. This value has been incorporated into the FES text.

Consistent with the staff's changes to Section 4.3.8, the requirement to measure ambient noise level in the site vicinity has been deleted from this section (see also response to CECo-24 in Section 9.4.7).

9.6 Evaluation of the Proposed Action

9.6.1 Decommissioning (EPA-6)

The staff has prepared an environmental analysis on decommissioning, NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning Nuclear Facilities." That document states:

> Since 1960, five licensed power reactors, four demonstration reactors, six licensed test reactors, one licensed ship reactor, and 52 licensed research reactor and critical facilities have been or are being decommissioned by the methods discussed in this EIS. Forty-two research reactors and critical facilities have been dismantled. Only one power reactor, the Elk River Demonstration reactor, has been completely dismantled. Three other demonstration power reactors of small size have been entombed.
>
> Decommissioning experience with some of the specific types of facilities is limited, but a broad base of experience with various facilities exists which is generally relevant to the decommissioning of any type of nuclear facility.

Based on the evaluation above, the staff feels that although commercial reactors tend to be larger than reactors that have already been decommissioned, the techology exists to decommission a commercial power reactor. The staff does not expect that there will be any unusual technical problems associated with the decommissioning of a commercial reactor.

9.7 Appendices

9.7.1 Permits (CECo-38, -39; DACE-1)

Changes suggested by these comments have been incorporated in Appendix B.

APPENDIX A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

United States Department of Agriculture
Soil Conservation Service

Springer Federal Building
301 North Randolph Street
Champaign, IL 61820

January 13, 1982

ATTN: Director, Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Your requests to the Soil Conservation Service regarding the draft environmental impact statement relating to the operation of Byron Station, Units 1 and 2, Docket Nos. STN 50-454 and STN 50-455, Ogle County, Illinois, have been reviewed by our field office.

Of the approximately 260 acres involved with the construction and operation of the Byron Station, the majority of the soils are prime. These soils include 175B, 175C--Lamont sandy loam; 73--Ross loam; 221B--Parr loam; 243B--St. Charles silt loam; 363B--Griswold loam; 410B--Woodbine silt loam; 416B--Durand silt loam; 440B--Jasper loam; 490--Odell silt loam; and 570A, 570B--Martinsville silt loam.

The cropland not involved directly with the construction is being leased by farmers and intensively farmed to corn and soybeans. Erosion is well above soil loss tolerances "T". The Commonwealth Edison Company is interested in conservation, has signed a cooperative agreement with the Ogle County Soil and Water Conservation District, and has started establishment of terrace systems on some of the acreage. With annual expenditures restricted to take full advantage of Agricultural Conservation Program cost-sharing, it will be many years before adequate conservation is installed. An initial start of a contour farming operation with some form of conservation tillage would be desirable.

Please correct our address on your records from: State of Illinois, Soil Conservation Service, ATTN: Mr. Daniel E. Holmes, Federal Building, 200 W. Church Street, P. O. Box 678, Champaign, Illinois 61820 to: USDA, Soil Conservation Service, ATTN: State Conservationist, Springer Federal Building, 301 North Randolph Street, Champaign, Illinois 61820.

We have no other comments at this time.

Sincerely,

August J. Dornbusch Jr.

AUGUST J. DORNBUSCH, JR.
Acting State Conservationist

EBCAMPBELL:sbs:3/12

cc: Roger Rowe, AISWCD, Marseilles, IL
John Rowley, IDOA, Springfield, IL
Ron Darden, IDOA, Springfield, IL
Don Manecke, Orion, IL
G. Paulsgrove, AC, Sterling, IL, Al
W. Fisher, DC, Oregon, IL, Al
N. Berg, Chief, SCS, Washington, D.C.
E. Pope, Director, MTSC, Lincoln, NE

United States Department of Agriculture

Economics and Statistics Service

Washington, D.C. 20250

November 30, 1981

Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Youngblood:

Thank you for forwarding the material relating to the startup and operation of Byron Station, Units 1 and 2, Rockvale Township, Ogle County, Illinois, which is part of the Commonwealth Edison Company (CECo).

We have reviewed Docket Nos. STN 50-454 and STN 50-455 and have no comments.

Sincerely,

Velmar W. Davis

VELMAR W. DAVIS
Associate Director
Natural Resource Economics Division

United States Department of Agriculture
Forest Service
Northeastern Area State & Private Forestry
370 Reed Road
Broomall, PA 19008

Reply to: 1950

Date: January 11, 1982

JAN 1 3 1982

Chief, Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Refer to: NUREG-0848
Draft Environmental Statement
Byron Station, Units 1 and 2

Dear Mr. Youngblood:

After review of the subject DES, it appears that this project will have a minimal impact on the woodland environment, since only about 40 acres of forested land has or will be impacted by power plant or transmission line construction.

One item of particular interest is the development of a land management plan for the site and we feel such a plan should provide a good means for documenting actions to mitigate any adverse impacts and to enhance the environment. We are confident that the various Divisions of the Illinois Department of Conservation will be able to make substantive comments on this plan.

#1 On page 5-1, in the last paragraph, the last sentence states, "..., some low quality agricultural land will be removed from production and allowed to revert to a natural state." We would recommend that some estimate be included on the amount of land that is involved and that the statement, "allowed to revert to a natural state," be modified to indicate some form of management will be applied to this land, i.e. wildlife habitat, woodland.

We appreciate the opportunity to review this document and hope our comments will prove helpful in developing the Final Environmental Statement.

Sincerely,

KARL A. DAVIDSON
Staff Director, Planning and Program Development

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PDR ADOCK 05000454
A PDR

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Food and Drug Administration
Rockville MD 20857

JAN 12 1982

Mr. B. J. Youngblood
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

The Bureau of Radiological Health staff have reviewed the Draft Environmental Statement (DES) for the Byron Station, Units 1 and 2, NUREG-0848, November 1981. We note that (1) the application for construction of this station was received by the NRC in September 1973, (2) the NRC staff evaluation was issued as a Final Environmental Statement - Construction Phase (FES-CP) in July 1974, and (3) as of November 1, 1981, the construction of Unit 1 was about 78 percent complete, and Unit 2 was 63 percent complete. While the FES - CP is not included in this DES, the DES does include adequate introductory resumes in appropriate sections which summarize the extent of updating the FES-CP. The Bureau of Radiological Health staff have evaluated the public health and safety aspects associated with the proposed operation of the plant, and have the following comments to offer:

1. It appears that the design objectives of 10 CFR 50, Appendix I, the operating standards of EPA's 40 CFR 190, and the proposed operations plan of the Byron Station, Units 1 and 2, provide adequate assurance that the potential individual and population radiation doses meet current radiation protection standards.

2. The environmental pathways identified in Section 5.9.3.1 and shown schematically in Figure 5.4 cover all possible emission pathways that could impact on the population in the environs of the facility. The dose computational methodology and models used in the estimation of radiation dose to individuals near the plant and to populations within 80 km. of the plant have provided reasonable estimates of the doses resulting from normal operations and accident situations. Results of the environmental pathway dose calculations are shown in Appendix C, Tables C-6, C-7, C-8 and C-9, and confirm that the potential doses meet the design objectives.

#1

3. The discussion in Section 5.9.4 on the environmental impact of potential radiological accidents is considered to be an adequate assessment of the radiation exposure pathways and dose and health impacts of atmospheric releases. The evacuation model presented in Appendix F.1 is based on assumed conditions and capabilities to evacuate people to specified downwind directions. Since evacuation involves early and expeditious movement of people to avoid exposure of the passing cloud and acute ground contamination following cloud passage, it would be helpful to include references to show that studies either have or have not been made to verify the model and to demonstrate that evacuation is feasible for the specific facility covered by the EIS.

In our view Section 5.9.4.4(3) on emergency preparedness is not adequate to meet planning needs. However, we will forego further comments on this aspect, realizing that the process of granting an operating license to the facility will include an adequate review of emergency preparedness (FEMA-NRC Memorandum of Understanding, Regional RAC's, criteria in NUREG-0654). We have representatives on the RAC's whose evaluation relative to Byron Station will speak for this Agency.

The accident risk and impact assessment presented in Section 5.9.4.5 is considered to be an adequate analysis of potential accidents in relation to the dose and health impact on the population from atmospheric releases. It is important that such an assessment provide the public with an understanding of risks involved and the measures the NRC is taking to mitigate the consequences of potential accidents.

#2

4. The radiological monitoring program, as presented in Section 5.9.3.4 and summarized in Table 5.8, appears to provide an adequate sampling frequency in expected critical exposure pathways. The analyses for specific radionuclides are considered sufficiently inclusive to (1) measure the extent of emissions from the facility, and (2) verify that such emissions meet applicable radiation protection standards.

In view of the monitoring problems that were identified during the Three Mile Island - Unit 2 accident, we suggest that the plan be modified to address the particular problems of monitoring radiohalogens (especially radioiodine) in the presence of radionoble gases. This could be accomplished by reference to FEMA REP-2, a document on instrumentation systems prepared with considerable input from NRC. Furthermore, it would be helpful to cite specific studies at operating plants that would verify that the instrument systems for making such measurements actually perform as expected and meet the technical requirements.

5. Section 5.10 and Appendix G contain a description of the environmental impact assessment of the uranium fuel cycle. The environmental effects presented are a reasonable assessment of the population dose commitments and the health effects associated with the releases of radon-222 from the Uranium Fuel Cycle.

Thank you for the opportunity to review and comment on this draft document.

Sincerely yours,

John C. Villforth
Director
Bureau of Radiological Health

DOE F 1325.8
(7-79)

U.S. DEPARTMENT OF ENERGY

memorandum

DATE: December 3, 1981

REPLY TO ATTN OF: EP-422

SUBJECT: Comments on Byron Station Draft Environmental Statement relating to Plant Operation

TO: B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
Nuclear Regulatory Commission

My comments on the Draft Environmental Statement related to operation of Byron Station Units 1 and 2 are marked on pp. 2-1 through 2-11 of the attached copy.

In addition, I have attached copies of Tables 4A.7.1 and 4A.7.2 which appear in the July 1981 DOE report on Electric Power Supply and Demand for the Contiguous United States 1981-1990 (DOE/EP-0022). These tables project reserve margins for Commonwealth Edison, for the years 1982-1990, that lend support to Table 2.6 in the Byron DES.

Norton Savage

Norton Savage
General Engineer
Office of Energy Emergency Operations
Assistant Secretary for Environmental
Protection, Safety, and Emergency
Preparedness
Department of Energy

Attachments

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U.S. NUCLEAR REGULATORY COMMISSION

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2 PURPOSE AND NEED FOR THE ACTION

annual

2.1 Résumé

When the construction permits for the Byron units were issued in December 1975, the staff concluded that the units should be allowed to operate to assure, among other things, the reliability of service of the Commonwealth Edison Company's (CECo) System. At that time, Units 1 and 2 were scheduled to begin commercial operation in May 1980 and May 1981, respectively. These on-line dates were selected as a result of an expected growth in peak demand of 7.5 percent and an increase in energy requirements of 7.0 percent per year during the 1973-1982 period. Should this be 1975?

Actual rates of growth in demand and energy have averaged only 2.0 percent per year and 1.6 percent per year, respectively, during the 1973-1980 period. This decline in expected growth is not unique to the CECo service area, ~~This~~ but ~~decline~~ is representative of a national trend, attributable, in part, to higher prices for electricity, to conservation, and to an overall slowdown in economic growth. These economic and social disincentives, coupled with generic obstacles which have recently plagued the construction of all generating facilities, have forced adjustments to utilities' generation expansion programs. what is In this context, the commercial availability of the Byron units has been delayed. Current scheduling calls for Units 1 and 2 to begin operation in October 1983 and October 1984, respectively.

In this section the staff evaluates the need for the Byron Station in the context of (1) overall system production costs, (2) availability of alternative types capacity ~~fuels~~; and (3) reliability of the bulk power supply of the CECo service area.

2.2 Production Costs

The Byron Station has been constructed to provide an economical source of baseload energy. Since substantial capital and environmental costs associated with construction have already been incurred, the only economic factors that are relevant for analysis, at this stage of review, are those related to the costs of producing electric energy. These "production costs" include fuel expenses and operation and maintenance (O&M) costs.

The 1980 average production costs for electric energy generated on the CECo system is shown, by type of fuel, in Table 2.1. The breakdown of electric energy generated in 1980, by type of fuel, is shown in Table 2.2.

Assuming that production costs increase at an average annual rate of 10 percent from 1980 through 1984, 1984 production costs on the CECo system, by fuel type, are projected to be:*

is the reader supposed to skip from here to the top of page 2-4? This is awkward.

*Including O & M costs.

Table 2.1* Average 1980 Production Cost for Electric Energy Generated by Fuel ~~Types~~ ON THE CECO SYSTEM ?

Fuel Type	Average Production Cost** (mills/kWh)
Nuclear	8
Coal	
High Sulfur	17
Low Sulfur	26
Oil	
Steam Cycle	64
Combustion Turbines	127
Gas-Combustion Turbines	80

How does this grouping relate to the grouping in Table 2.2 ?

what % of energy came from hi and lo sulfur?

— what percent of energy came from these sources

*From Amendment No. 1, Byron Environmental Statement, response to staff question Q320.3, July 1981.

**Production cost includes fuel, operation and maintenance.

Where is cost of purchased energy ?

This implies that gas was not used in steam plants in 1980. Is the implication true ?

Table 2.2* A Breakdown of Electric Energy Generated in 1980 by Fuel Types

Fuel Type	Energy Generated (GWh)
Nuclear	25,970
Hydro	15
Pumped Storage	
Load (input)	-1,553
Output	1,068
Geothermal	--
Fossil Fuels-Steam Cycle	
Coal – what % is High Sulfur, Low Sulfur?	29,559
Oil – what % in steam, C.T.?	6,808
Gas	491
Fossil Fuels-Combustion Turbines	
Oil (includes diesels)	153
Gas	303
Total Energy Generated	62,819
Net Energy Purchased and Interchanged	4,127
Total Energy for Load	66,946

*From Amendment No. 1, Byron Environmental Statement, response to staff question Q320.3, July 1981.

how was this table computed?

WHERE IS SOURCE OF DATA?

Nuclear	11.7 mills/kWh
Coal	30.8 mills/kWh
Oil	117.1 mills/kWh
Purchased Power	46.9 mills/kWh

Table 2.3 shows the estimated average savings in 1984 dollars associated with the operation of the Byron Station during the seven year period from 1984 through 1990 assuming that fuel escalation and discount rates remain essentially equal during this period. This analysis is based on an average 60 percent capacity factor for both units during the study period and replacement sources of energy supply are assumed to be approximately in proportion to the actual mix of supply during 1980.*

Should this word be "constant"? or is it intended to say that the escalation rate is equal to the discount rate?

The results of our analysis show strong justification for issuing operating licenses for the Byron units.

A decision to operate the Byron units will necessitate a decommissioning expense once the units are retired from service. In section 10.2.3.3 of the Byron CP-FES, the staff discussed various decommissioning methodologies which were, at that time, under consideration. In January 1981, the staff published a report titled "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities (NUREG-0586)." For large PWR units (such as the Byron facilities), the report estimates that decommissioning costs (in 1978 dollars) will range from $21.0 million (plus $40 thousand per year surveillance cost) per unit for entombment of the facility to $42.8 million per unit for the preparation and maintenance of the facility in a "safe storage" condition. Immediate decontamination of the facility is projected to cost $33.3 million per unit. Immediately on retirement?

1978 dollars?

The operation of the Byron Station will also result in environmental impacts and increased risks. These have been evaluated by the staff and our findings are presented in Sections 4 and 5 of this report.

2.3 Diversity of Supply

Regardless of the relative production cost advantages of nuclear generation versus generation from other sources, it is beneficial for bulk power systems to have diverse sources of primary power supply. Contingencies may develop which could limit the availability of desired fuels. For example, such contingencies might include:

1. Curtailments in the delivery of fuel oil as a result of revisions in national energy policy;

2. Severe weather conditions causing freezing of coal inventories;

3. Further Federal regulatory limits on use of natural gas as boiler fuel;

4. Shortages in processing and enrichment facilities for nuclear fuels;

*See footnote on Table 2.3.

Table 2.3 Estimated Savings in Production Costs Associated with Operation of Byron Station (1984-1990)

		1984-1990
1.	Energy Generated by Byron Station	78,009 GWh
2.	Fuel and O&M Cost of Byron Station - 1984 Dollars	11.7 mills/kWh
3.	Total Cost of Producing Energy with Byron Station Available (Line 1 times Line 2) - 1984 Dollars	$913.0 x 10^6$
4.	Fuel and O&M Cost for Replacement Energy - 1984 Dollars	49.7 mills/kWh
5.	Total Cost of Providing Replacement* Energy in Lieu of Byron Station Generation (Line 2 times Line 4) - 1984 Dollars	$3877.0 x 10^6$
6.	Savings Associated with Byron Station Operation (Line 5 Minus Line 3) - 1984 Dollars	$2964.0 x 10^6$

*Weighted average cost of replacement sources - 70% coal @ 30.8 mills/kWh, 20% oil @ 117.1 mills/kWh and 10% purchases @ 46.9 mills/kWh.

How was this Table obtained from the source material in the preceding tables? The procedure is not apparent.

5. Prolonged labor strikes involving mining, drilling and/or transportation of workers.

The occurrence of any one or a combination of, these contingencies could have a substantial impact on a utility's ability to supply energy for load, particularly if the impacted fuel supply is needed to furnish baseload generation.

Of the total 66,946 GWh generated in 1980, 41 percent was produced by nuclear facilities and over 47 percent from coal fired plants. The remaining energy was generated by oil and gas fueled steam and combustion turbine units, with some minimal input from hydro resources.

The 1981 mix of generating facilities by fuel type in CECo's bulk power system is identified in Table 2.4.[1] ~~Future~~ Present plans call for the future installation of an additional 7,066 MW of generating capacity on the CECo system through 1990. Of this new capacity, 6,516 MW will be ~~generated by~~ nuclear ~~facilities~~ and will increase the amount of installed nuclear capacity from 4,975 MW in January 1981 to 11,491 MW (including the Byron Station) in 1986. This proportion represents approximately 50 percent of all installed facilities in the CECo system in the year 1986. Conventional generating units will comprise the remaining installed capacity, with coal units totaling 6,937 MW, oil fueled units amounting to 3,848 MW, and natural gas units accounting for 677 MW.

The current and future mix of installed capacity allows CECo to maintain appreciable generating flexibility in the event of an impending fuel shortage. The addition of the Byron Station will aid in maintaining this flexibility while, concurrently, offering a relatively low cost source of base load energy.

2.4 Reliability Analysis

Historical energy production and demand are shown on Table 2.5 for the 1960 through 1980 period. Between 1960 and 1973, CECo's electric energy production and peak demand grew at average annual rates of 7.0 percent and 8.1 percent, respectively. During the period 1973 through 1980, energy growth slowed considerably to an average 1.6 percent annually, while peak demand growth slowed to 2.0 percent per year. These rates of growth were less than those experienced nationally, with U.S. energy requirements increasing at a rate of 3.1 percent per year and peak demand at 3.5 percent per year from 1973 through 1979.

CECo currently projects demand to increase at no less than 2.5 percent per year but no more than 3.5 percent per year during the 1981 through 1990 period.[2] We find these growth rates reasonable in light of the state level projections developed for the NRC by the Oak Ridge National Laboratory (ORNL).[3] ORNL developed three load growth scenarios based primarily on the sensitivity of consumer demand to the price of electricity. The base case forecast, which uses fuel cost projections developed by the Department of Energy, predicts demand will increase at a rate of 2.9 percent per year. For the low cost scenario, demand growth in the State of Illinois is projected to average 4.2 percent per year. For the high cost scenario, demand will grow at the rate of 2.4 percent per year.

Table 2.4 Existing CECo Generating Units for the Summer of 1981

Station - Unit	Type of Unit[a]	Year of Installation	Net Capability (MW) Winter	Summer
Bloom T.S.S. 33, 34	D	1971	126	103
Calumet 31-34	D	1969-70	276	220
Collins 1	O	1978	554	554
Collins 2	O	1977	554	554
Collins 3	O	1977	530	530
Collins 4	O	1978	530	530
Collins 5	O	1979	530	530
Crawford 7	C	1958	216	213
Crawford 8	C	1961	326	319
Crawford 31-33	NG	1968	189	149
Dresden 1[b]	N	1960	207	197
Dresden 2	N	1970	794	772
Dresden 3	N	1971	794	773
Electric Junction 31-34	NG	1970-71	243	193
Fisk 19	C	1959	321	316
Fisk 20	D	1966	11	11
Fisk 31-34	D	1968	231	157
Joliet 6	C	1959	308	298
Joliet 7	C	1965	503	499
Joliet 8	C	1966	522	518
Joliet 9	C	1967	11	11
Joliet 31, 32	NG	1969	131	103
Kincaid 1	C	1967	554	554
Kincaid 2	C	1968	554	554
Lombard 31-33	NG	1969	136	108
Powerton 5	C	1972	700	700
Powerton 6	C	1975	700	700
Quad-Cities 1[b]	N	1972	591	576
Quad-Cities 2[b]	N	1972	592	577
Ridgeland 1	O	1951	153	147
Ridgeland 2	O	1950	158	152
Ridgeland 3	O	1953	137	131
Ridgeland 4	O	1955	126	120
Seabrooke 31-34	O	1969-70	135	109
State Line 3	C	1955	213	213
State Line 4	C	1962	318	318
Waukegan 6	C	1952	100	100
Waukegan 7	C	1958	328	328
Waukegan 8	C	1962	297	297
Waukegan 31, 32	O	1968	150	113
Will County 1	C	1955	106	101
Will County 2	C	1955	154	148
Will County 3	C	1957	262	251
Will County 4	C	1963	520	510
Zion 1	N	1973	1040	1040
Zion 2	N	1974	1040	1040

[a]KEY: N = Nuclear, C = Coal, O = Oil, NG = Natural Gas, and D = Diesel

[b]Dresden Unit 1 is taken out of service for chemical cleaning, and expected to return to service June 1986.

[c]The capability figures indicate CECo's 2/3 ownership of Quad Cities Station; Iowa-Ill. E&G's 1/3 interest represents a 29.6 MW and 288 MW capability for winter and summer, respectively.

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Should this be "Energy Generated" or "Energy For Load"?

Table 2.5* System Peak Loads and Energy Output for the Years 1960 to 1980

Year	Summer Peak Load (MW)	Increase Over Previous Year (MW)	Increase Over Previous Year Percent	Output (GWh)	Percent Increase Over Previous Year	Annual Load Facto
1960	4,590	357	8.4	24,822	5.1	59.8
1961	4,840	250	5.4	26,178	5.5	60.1
1962	5,143	303	5.9	28,165	7.6	60.9
1963	5,372	229	4.5	30,037	6.6	62.0
1964	6,102	730	13.6	32,352	7.7	58.5
1965	6,468	366	6.0	34,788	7.5	59.5
1966	7,491	1,023	15.8	38,189	9.8	58.2
1967	7,643	152	2.0	40,018	4.8	59.8
1968	8,950	1,307	17.1	43,457	8.6	55.3
1969	9,265	315	3.5	46,972	8.1	57.9
1970	10,027	762	8.2	49,751	5.9	56.6
1971	10,943	916	9.1	52,144	4.8	54.4
1972	11,750	807	7.4	56,063	7.5	54.3
1973	12,462	712	6.1	60,058	7.1	55.0
1974	12,270	(192)**	(1.5)	59,274	(1.3)	55.1
1975	12,305	35	0.3	60,310	1.7	56.0
1976	12,907	602	4.9	62,567	3.7	55.2
1977	13,932	1,025	7.9	65,110	4.1	53.3
1978	13,720	(212)	(1.5)	67,927	4.3	56.5
1979	13,804	84	0.6	67,650	(0.4)	55.9
1980	14,228	424	3.1	66,946	(1.0)	53.7

*From Amendment No. 1, Byron Environmental Statement, p. 1.1-22
**Parentheses indicate negative values.

according to Table 2.2, energy for load was 66946 Gwh and energy generated was 62,819.

The applicant projects peak demand will increase from 14,228 MW in 1981 to 19,800 MW in 1990. Comparable figures for energy growth are 66,946 GWh in 1981 and 91,700 GWh in 1990. CECo plans the installation of 6,516 MW of generating capacity through the year 1986 to meet its projected demand. This new capacity, if commercially available as planned, will increase current installed generating capacity to 22,953 MW.

Table 2.6 depicts CECo's projected capacity and reserve situation during the summer peak periods of 1982 through 1990. This tabulation shows the results of four capacity availability scenarios:

1. Lines 9 and 10 show reserve margin and percent reserve for the CECo system with capacity available as planned.

2. Lines 11 and 12 show reserve margin and percent reserve with one Byron unit postponed (slipped) one full year.

3. Lines 13 and 14 show reserve margin and percent reserve with both Byron units slipped 2 full years.

4. Lines 15 and 16 show the effect, on reserves and percent reserves, of an indefinite postponement in the availability of Units 1 and 2.

Based on CECo's minimum installed reserve criterion of 15 percent, system reserve margins under capacity Scenario No. 1 are adequate throughout the study period with the exception of the 1982 summer peak. However, CECo states that "appropriate steps will be taken to eliminate..." this deficiency.[4]

With the Byron units postponed one year (Scenario No. 2), reserve deficiency occurs during the 1984 summer peak period - about 431 MW short of the 2483 MW necessary to satisfy the minimum installed reserve criterion. This deficiency could conceivably be mitigated through some of the same procedures CECo intends to implement during the 1982 peak period. However, the magnitude of the deficit is such that considerably more capacity must be available for these procedures to be effective.

The 1985 reserve level exceeds the minimum requirement (with Unit 1 available) and the 1986 reserve is nearly double the requirement (with both units available). With a two-year slippage of both units (Scenario No. 3) reserve capacity falls to 9.1 percent of demand in 1985 and recovers to 18.7 percent in 1986 (the year in which Unit 1 becomes commercially available). During the 1987 summer peak period, the period in which both units are available, the system reserve margin increases to 28.5 percent of anticipated peak demand.

The 1985 deficit is sufficiently critical to support the contention that slippage of more than one year in the availability of Unit 1 will cause an appreciable decline in the reliability of the CECo System. However, based on the amount of reserve available to the system in 1986 (Scenario No. 2) and in 1987 (Scenario No. 3), it is reasonable to assume that no appreciable reliability problem would result if the time between installation dates of Units 1 and 2 were extended from one to two years. This estimate is contingent upon Unit 1 being available no later than the summer peak period of 1985 and all other projected capacity additions being available as scheduled.

Can any of the reserve margins shown here be properly compared with the CECO 15% installed reserve margin?

Table 2.6 CECo System Projections of Summer Peak Load Capacity, and Reserves 1982-1990

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1. Installed Capacity - seasonally adjusted-	17485	18533	19653	20773	21863	22953	22953	22953	22953
2. Net of Firm Purchases and Sales	624	312	312	312	87	312	0	0	0
3. Total Resources (1 + 2)	18109	18845	19965	21085	21950	23265	22953	22953	22953
4. Unavailable Capacity	197	197	197	197	0	0	0	0	0
5. Operable Resources (3-4)	17912	18648	19768	20888	21950	23265	22953	22953	22953
6. Peak Hour Demand	15600	16050	16550	17050	17550	18100	18650	19200	19800
7. Reserve Margin (5-6)	2312	2598	3218	3838	4400	5165	4303	3753	3153
8. Scheduled Outage	40	40	40	40	0	0	0	0	0
9. Adjusted Margin (7-8)	2272	2558	3178	3798	4400	5165	4303	3753	3153
10. Percent Reserve (9 ÷ 6) (X100.0)	14.6	15.9	19.2	22.3	25.1	28.5	23.1	19.5	15.9
11. Reserve Margin with One Byron Unit Postponed One Year	2272	2558	2050	2678	4400	5165	4303	3753	3153
12. Percent Reserve	14.6	15.9	12.4	15.7	25.1	28.5	23.1	19.5	15.9
13. Reserve Margin with Byron Units Postponed Two Years	2272	2558	2050	1558	3280	5165	4303	3753	3153
14. Percent Reserve	14.6	15.9	12.4	9.1	18.7	28.5	23.1	19.5	15.9
15. Reserve margin without Byron Units	2272	2558	2050	1558	2160	2925	2063	1513	913
16. Percent Reserve	14.6	15.9	12.21	9.1	12.3	16.2	11.1	7.9	4.6

These margins are AFTER scheduled outages. Is the CECO 15% margin also after scheduled outages?

With the exception of the summer peak period of 1987 (the period in which the Braidwood No. 2 facility is scheduled), reserve margins under Scenario No. 4 remain well below CECo's 15% minimum requirement. If the Byron units were not allowed to operate, severe reliability consequences could result during the 1985-1990 period.

2.5 Conclusions

The results of the staff's assessment of purpose and need support a decision to issue operating licenses for Byron Station, Units 1 and 2. The concern of overriding importance is that the addition of these units to the CECo system is expected to result in significant savings in system production costs. Furthermore, the availability of Byron Station will assist in CECo's maintaining a diverse mix of generating resources.

Although the operation of the Byron Station will result in increased environmental costs and risks, the staff has found them to be small. If the Byron units are not allowed to operate, environmental costs and risks would, nevertheless, result due to increased use of other generating facilities.
some

Although decommissioning is identified as an additional cost of operating the Byron Station, it should be noted that this cost represents less than 3% of the projected cost savings resulting from the operation of Byron Station for the seven-year period 1984-1990.

References

1. Amendment 1, Byron Station Units 1 and 2, Environmental Report July 1981, response to staff question Q320.3 page Q320.3-2.

2. Ibid, page 1.1-22.

3. The ORNL State Level Electricity Demand Forecasting Model, W. S. Chern NUREG/CR-1295, July 1980.

4. MAIN ~~Main~~ Regional Reliability Council Coordinated Bulk Power Supply Program, April 1, 1981 Report to the Department of Energy, p. 3B-5

You have not shown
1) what the capacity mix is, in terms of percentages (coal, oil, gas, nuclear, other
2) what is considered a desireable mix and why

DEPARTMENT OF THE ARMY
ROCK ISLAND DISTRICT. CORPS OF ENGINEERS
CLOCK TOWER BUILDING
ROCK ISLAND. ILLINOIS 61201

REPLY TO
ATTENTION OF:

NCRED-PB

04 JAN 1982

JAN 8 1982

Director, Division of Licensing
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Sir:

The Rock Island District has completed the review of the draft EIS for the operation of Byron Station, Units 1 and 2.

Please add 33 U.S.C. 1344 to both entries for permits required from the US Army Corps of Engineers (Table B.1, page B-2). This is the statute authority for the Department of Army Section 404 Permits which were issued, in conjunction with the permits listed, on the stated dates.

Thank you for the opportunity to comment on the draft EIS. If you have any questions, please call Mary Ann Boyer at 309/788-6361, Ext. 6308.

Sincerely,

, P.E.

for DOYLE W. McCULLY, P.E.
Chief, Engineering Division

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United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 81/2502

JAN 18 1982

B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Youngblood:

Thank you for your letter of November 25, 1981, transmitting copies of the draft environmental impact statement related to the operating license stage of Byron Station, Units 1 and 2, Ogle County, Illinois. Our comments are presented according to the format of the statement or by subject.

Surface and Groundwater

#1 The hydraulic conductivities determined by tests in two domestic supply wells that tap the Galena-Platteville dolomites are 2.2 lpd/m^2 and 7.8 lpd/m^2. These units (lpd/m^2) are customarily used for the expression of the field coefficient of permeability, whereas hydraulic conductivity is expressed in meters per day (m/d). (See Lohman, S. W., 1972, Ground-water hydraulics: U.S. Geological Survey Professional Paper 708, p. 5). Because the ratio of hydraulic conductivity to the field coefficient of permeability is 1 to 7.48, the two characteristics differ considerably in numerical magnitude. Classification is needed as to which characteristic, hydraulic conductivity or field coefficient of permeability, is meant on page 4-35.

Similarly, we believe that the units given for transmissivity in Section 5.3.1.2 may also be in error. The transmissivity is given as 13,650 liters per minute per meter (lpm/m) whereas the customary units are square meters per day (m^2/d). In this case the use of the units given on page 5-2 would indicate an unbelievable high transmissivity. These discrepancies should be clarified in the final statement.

Intake effects

#2 We note in the section on Entrainment, "...when cooling tower consumptive demand exceeds 10% of the river flow, the applicant has committed to maintain a net withdrawal at a level acceptable to the Illinois Department of Conservation." Further that, "any additional mitigation will be determined by the applicant's operational monitoring programs, which include...(2) a special study to address the concerns of the Illinois Department of Conservation." These efforts should minimize adverse effects on the fish resources. We would appreciate the applicant keeping the Rock Island Field Office of the U.S. Fish and Wildlife Service informed of the monitoring activities and findings.

We hope these comments will be helpful to you in the preparation of a final statement.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

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A PDR

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO ATTENTION OF:

RECEIVED
JAN 22 1982
US NUCLEAR REGULATORY COMMISSION
DOCUMENT MANAGEMENT BR.
TIDC

18 JAN 1982

Mr. B. J. Youndblood, Chief
Licensing Branch
Division of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20555

RE: NEPA-D-NRC-F06011-IL
(81150)

Dear Mr. Youndblood:

We have completed our review of the Draft Environmental Impact Statement (EIS) related to the Operation of the Byron Station Units 1 and 2 near Byron, in Olge County, Illinois. Construction of Unit 1 is approximately 80% complete and fuel loading will begin in April 1983, and construction of Unit 2 is approximately 60% and fuel loading will begin in April 1984.

Impacts related to construction of the station have already been addressed in the past draft and final environmental impact statements related to the construction permit. Our attached comments on this environmental impact statement concern the radiological impacts to man and his environment due to operation of the facility and our major concern is related to the need to complete the Radiation Emergency Response Plan.

We appreciate the opportunity to review this environmental impact statement. In accordance with our responsibility to inform the public of our views on other agencies projects, the date and classification of our comments will be published in the Federal Register. We have rated our attached comments related to the facility as ER (Environmental Reservations) and classified the environmental impact statement as Category 2 (Additional Information Necessary). We will continue to have environmental reservations on the issuance of an operating permit for this station until the Radiation Emergency Response Plan has been completed. When the Final Environmental Impact Statement and the Safety Evaluation Report are published, please forward three copies to us.

Sincerely yours,

Barbara Taylor Backley

Barbara Taylor Backley, Acting Chief
Environmental Review Branch
Planning and Management Division

Attachment

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Environmental Protection Agency, Region V Comments on the Draft Environmental Impact Statement Related to the Operatioin of the Byron Station, Units 1 and 2

Radiological Impacts

Exposure Pathways:

#1 The environmental impact statement indicated there were seven public water supplies, within ten miles of the Byron Station, which use groundwater sources. However, it is also indicated it was not necessary to evaluate the drinking water pathway to the determine the exposure of persons outside the site boundries. It is unclear how there can be seven public water supplies within ten miles of the station, and no consideration of the drinking water pathway. The final environmental impact statement should discuss the reasoning for not assessing the drinking water pathway.

Radiological Impacts on Man:

#2 This station will have to limit radioactive releases to the environment to those specified in 40 CFR 190. Since this station is not an operating station, information on how other similar stations operated by the Commonwealth Edison Company have complied with these regulations should be provided. The final environmental impact statement should indicate under what, if any, circumstances compliance with the regulations will not be achieved.

The environmental impact statement indicated the natural background radiation levels are approximately 100 millirems per year and releases from the Byron Station will be so minute in comparison as to have no measurable radiological impact on members of the public. The final environmental impact statement should indicate the levels of radiation which an individual could expect to receive from the Byron Station to substantiate negligible impact.

General Characteristic of Accidents:

#3 We suggest that the environmental impact statement include a map which shows the Exclusion Area, Low Population Zone, Emergency Planning Zones, etc. This would provide an indication to the general public where these areas are in relation to their town, homes, schools, etc.

A full review of the Radiation Emergency Response Plan for the Byron Station has not been completed, tested or reviewed by the Federal Emergency Management Agency (FEMA) and the Regional Advisory Committee. We note that a thorough evaluation of the ability of all parties to handle accidents is not possible at this time, and will have to await future actions by FEMA.

Accident Risk and Impact Assessment:

#4 Section 5.9.4.5, part 5 discusses the potential releases to the groundwater if an accident occurred at the Byron Station. This section compares the explosure doses from the Byron Station to the Liquid Pathway Generic Study (LPGS) for floating nuclear power stations. Comparison of exposure doses for drinking water pathway, shoreline exposure and fish ingestion were made between the Byron Station and the LPGS small river site; i.e., (1) the drinking water population dose would be about 130 percent of the LPGS small river site, (2) the shoreline exposure dose would be a factor of three higher than the LPGS small river site, and (3) the fish ingestion pathway would be a

#4 factor of 24 times greater than that of the LPGS small river site. The direct addition of these three pathways for the Byron Station, provides a factor which is almost 30 times greater than the LPGS small river site. The Final Environmental Impact Statement should discuss why the staff believes "a factor of about three times higher than those of the LPGS small river site", in light of the above figures, was selected and determined to be conservative.

Radiological Monitoring:

#5 The environmental impact statement indicated that once the final monitoring programs go into effect, some adjustments of sampling frequences and the deletion of some types of samples will occur. One of the programs to be discontinued is vegetable sampling. We assume the reason for stopping this monitoring program is because there are no vegetable farms near the Byron Station,but the final environmental impact should indicate the reason why vegetable monitoring will cease.

Decommissioning:

#6 A statement should be made here that decommissioning of a commercial nuclear power plant has not yet occurred in this country, even though the technology may be available to handle it. Therefore, this section should reflect this as a judgement of the Nuclear Regulatory Commission staff, not as an accomplished event.

K. Kiper
S. Chesnut

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON 20426

IN REPLY REFER TO:

January 13, 1982

U. S. Nuclear Regulatory Commission
Washington, D. C. 20555
ATTN: Director, Division of Licensing

Dear Sir:

I am replying to your request of November 25, 1981, to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement for Operation of Bryon Station, Units 1 and 2. This Draft Supplement has been reviewed by appropriate FERC staff components upon whose evaluation this response is based.

This staff concentrates its review of other agencies' environmental impact statements basically on those areas of the electric power, natural gas, and oil pipeline industries for which the Commission has jurisdiction by law, or where staff has special expertise in evaluating environmental impacts involved with the proposed action. It does not appear that there would be any signifciant impacts in these areas of concern nor serious conflicts with this agency's responsibilities should this action be undertaken.

Thank you for the opportunity to review this statement.

Sincerely,

JM Heinemann

Jack M. Heinemann
Advisor on Environmental Quality

STATE OF ILLINOIS
EXECUTIVE OFFICE OF THE GOVERNOR
BUREAU OF THE BUDGET
SPRINGFIELD 62706

RECEIVED
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US NUCLEAR REGULATORY COMMISSION
DOCUMENT MANAGEMENT BR
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SUBJECT: ENVIRONMENTAL IMPACT STATEMENT
DEIS: Byron Station, Units 1 & 2
SAI #81 11 30 60

50-454

TO: U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Director, Division of Licensing

The Illinois State Clearinghouse has reviewed the referenced subject pursuant to the National Environmental Policy Act of 1969, OMB Circular A-95, Revised and the administrative policy of the State. State agencies which are authorized to develop and enforce environmental standards have been given the opportunity to comment on this subject. At this time no comments have been received.

Edward J. Welk, Jr.
Illinois State Clearinghouse

12/28/81
Date

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Illinois Department of Nuclear Safety

1035 Outer Park Drive   Springfield, Illinois 62704   (217) 546-8100

Philip F. Gustafson
Director

Jane A. Bolin
Deputy Director

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US NUCLEAR REGULATORY COMMISSION
DOCUMENT MANAGEMENT BR
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January 22, 1982

Director, Division of Licensing
Office of Nuclear Reactor Regulations
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Draft Environmental Statement Related to the Operation of, Byron Station, Units 1 & 2 (NUREG-0848), Operating License Stage. (Docket No.s STN 50-454 and STN 50-455)

Dear Sir:

After review of the subject document, the following comments and questions are directed to your attention:

A. Circulating Water and Non-Essential Service Water Systems - Section 4 - 2.3.4.1

1 This section indicates that sponge rubber balls will be used to wipe the condenser tubes clean of biological growths as an aid to biofouling control. What analysis has been performed examining the affects of the introduction of these sponge rubber balls into both the Rock River via normal blowdown and into the pumping and internal system of the natural draft cooling tower? How does this system compare to that system already in use at the Zion Nuclear Power Station?

B. Radioactive-Waste Management System - Section 4.2.5

2 Item 3 in this section indicates a change in the design of the ventilation system filtration path for the main condenser air ejector and auxiliary fuel and waste buildings' discharge exhausts. This design change, since the construction stage permit, utilizes only a HEPA filter. The new design does allow the discharge paths to be diverted, presumably by operator action, to a path containing a HEPA filter, charcoal adsorber and another HEPA filter, all in series, if a high radiation signal is present. In Section 5.9.4.4, "Mitigation of Accident Consequences", it appears that credit is taken for the use of the former design ventilation pathway of a direct filter-adsorber-filter series. What controls, commitments, equipment qualification or technical specification requirements

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will be imposed to assure that the rediverting actions are taken for mitigation of accident consequences?

C. Radiological - Section 5.9

3 (1) Section 5.9.1 discusses the Regulatory requirements used in the assessments for protection against radiation. The present version of 10CFR20 is cited, but what consideration or assessments have been made for this evaluation in light of the proposed revision of 10CFR20?

(2) This section discusses the radiological aspects of normal operation and accident conditions, risks, impacts and probabilistic assessments. Commonwealth Edison Company operates Zion Nuclear Power Station, another very similar PWR, as well as other nuclear plants. How have the operating experiences, including accidental radioactive releases, safety systems out of service, licensee event reports and abnormal occurrences been included in the development of the assessments made in this section? What emphasis has been placed on this more realistic information versus other older theoretical references utilized within the section?

4 (3) In some of the cases analyzed in Section 5.9.4.5, "Accident Risk and Impact Assessment", the staff judges that some of the calculated results are over estimates of the consequences related to nuclear accidents, rather than under estimates. The staff also indicates that the uncertainties and error bounds may be as large as the probabilities themselves. Clarification of these combined positions is needed if realistic values for the impacts given are to be considered acceptable.

5 (4) Sections 5.9.4.4, "Mitigation of Accident Consequences", and 5.9.4.5., "Accident Risk and Impact Assessment" indicate that this report does not take credit for the TMI-2 related requirements specified in NUREG-0737 and NUREG 0660, which apply to the Byron Station. Please provide a brief synopsis of the applicable requirements and a schedule for completion.

6 (5) Section 5.9.4.5, "Accident Risk and Impact Assessment", indicates that sequences initiated by natural phenomena, such as a seismic event, are not included in the event sequences being evaluated. The staff also indicates this, as well as other natural phenomena effects, would not contribute sigificantly to risk. The Safe Shutdown Earthquake is normally considered to be a design basis event, for which a great deal of design analysis, qualification, and other special concerns at lease equivalent to the pipe break analyses, has been performed. Further discussion should be included in this section to support the judgement of the staff for at least the seismic events.

Thank you for the opportunity to review the Byron Station Draft Environmental Statement - Operating License Stage. Your consideration of the above comments is appreciated.

Sincerely,

Philip F. Gustafson, Director
Illinois Dept. of Nuclear Safety

PFG:RWD:jt

FROM: PATRICK CARNAHAN
92 LAWRENCE DR
LONGMEADOW MASS
01106

DEAR SIRS,

THIS LETTER IS IN COMMENT ON THE DRAFT ENVIRONMENTAL STATEMENT RELATED TO THE OPERATION OF BYRON STATION, UNITS 1 & 2.

COMMENTS ON SECTION:

E1 5.5.1.3 TRANSMISSION LINES - THIS IS IN REFERENCE TO THE CORRIDOR MAINTENANCE AND HERBICIDE USE. I WOULD LIKE TO KNOW JUST WHAT KIND OF HERBICIDE IS TO BE, OR PLANNED TO BE, USED, AND, HOW MUCH AND HOW OFTEN IT WILL BE USED. I WOULD LIKE TO POINT OUT THAT THE HERBICIDE 2,4,D, AN HERBICIDE COMMONLY USED BY POWER COMPANIES, IS A HARMFUL CHEMICAL AGENT THAT AFFECTS NOT ONLY ANIMALS, BIRDS, AND PLANTS BUT ALSO HUMANS AS WELL.

5.9.4.6 CONCLUSIONS - YOU SAY, AND I QUOTE "These IMPACTS COULD BE SEVERE BUT THE LIKELIHOOD OF THEIR OCCURENCE IS JUDGED TO BE SMALL." YOU MAY BE WILLING TO RISK THE LIVES OF MANY PEOPLE AND THE LOCAL ENVIRONMENT, BUT I CERTAINLY AM NOT. I THINK THAT TO TAKE A CHANCE, AND TO ME IT SEEMS AS though THAT IS WHAT YOU ARE DOING, WITH A LARGE RADIOACTIVE RELEASE IS UNTHINKABLE.

TABLE 6.1 [redacted]EFIT-COST SUMMARY - throughout THIS TABLE YOU LIST THE IMPACT AS BEING "SMALL", JUST WHAT IS SMALL. WHAT IS SMALL TO ONE MAY BE HUGE TO ANOTHER.

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#2 I ALSO DISAGREE WITH YOUR STATEMENT IN SECTION 3.1, ON ALTERNATIVES. YOU SAY, "AT THE OPERATING LICENSE STAGE IT IS NOT RATIONAL TO CONSIDER DIFFERENT SITES, EXTENSIVE PLANT MODIFICATIONS, OR THE CONSTRUCTION OF NEW AND DIFFERENT ENERGY SOURCES AS ALTERNATIVES TO THE EXISTING NUCLEAR FACILITY."

IN MY OPINION IT IS NOT RATIONAL TO POUR VAST AMOUNTS OF MONEY AND ENERGY INTO WHAT IS NOTHING MORE THAN A DINOSAUR. I THINK THAT IT IS TIME FOR THE FEDERAL GOVERNMENT TO STOP SUBSIDIZING THE NUCLEAR INDUSTRY AND LET IT STAND ON IT'S OWN. I WOULD LIKE TO SEE THE BYRON STATION COMPLEX NOT EVEN OPEN OR BEGIN OPERATIONS. I THINK IT IS MORE RATIONAL TO DO THIS THAN COMMIT, WHAT COULD BE, NUCLEAR MADNESS.

THANK YOU FOR YOUR TIME

PATRICK [illegible]

Commonwealth Edison
72 West Adams Street, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

January 18, 1982

Director
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Byron Station Units 1 and 2
Docket Nos. STN 50-454-OL and STN 50-455-OL

Dear Sir:

Enclosed are Commonwealth Edison Company's comments pertaining to the Byron Station Units 1 and 2 Draft Environmental Statement (NUREG-0848). These comments are being submitted for consideration by the Commission in accordance with 10 CFR Part 51.

Sincerely,

C. L. McDonough

C. L. McDonough
Director of Environmental Assessment

CLMc:vs

Enclosure

Commonwealth Edison Company's Comments
Pertaining to the Byron
Station Units 1 and 2 Draft Environmental Statement

Since publication of this DES, certain events have occurred which may have a bearing on the matters contained in Chapter 2 of the DES. First, Commonwealth Edison Company has revised downward the projected annual summer peak load growth estimates to about 2% per year from its previous projection of 3%.

In addition, the proposed service dates for capacity additions have been changed as follows:

Unit	Capacity MW	Service Dates Previous	Service Dates Proposed
LaSalle County #1	1078	April, 1982	June, 1982
LaSalle County #2	1078	June, 1983	October, 1983
Byron #1	1120	October, 1983	February, 1984
Byron #2	1120	October, 1984	February, 1985

Capacity reductions include a proposal to retire the Ridgeland Station (550 MW oil fired) which proposal is currently the subject of a proceeding before the Illinois Commerce Commission, a decrease in net capacity of State Line #3 of 26 MW and an indefinite delay in return to service of Dresden #1 (207MW).

The resulting estimates for capacity, (assuming Ridgeland retirement) summer peak loads and percent reserve margins expressed as percentages of peak loads are as follows:

		Capacity and Reserve Margins					
		w/Byron Units 1&2			w/o Byron Units 1&2		
Year	Peak Load MW	Capacity MW	Reserve MW	Reserve %	Capacity MW	Reserve MW	Reserve %
1982	14,650	17,706	3055	20.9	17,706	3055	20.9
1983	15,050	17,394	2344	15.6	17,394	2344	15.6
1984	15,450	19,192	3742	24.2	18,072	2622	17.0
1985	15,750	20,312	4562	29.0	18,072	2322	14.7
1986	16,050	21,177	5127	31.9	18,937	2887	18.0
1987	16,350	22,492	6142	37.6	20,252	3902	23.9
1988	16,700	22,180	5480	32.8	19,940	3240	19.4
1989	17,050	22,180	5130	30.1	19,940	2890	17.0
1990	17,400	22,180	4780	27.5	19,940	2540	14.6

In the event the Byron Units 1 and 2 are placed into service as currently planned, CECo. does not anticipate experiencing percent reserve margins below its minimum installed reserve margin criterion of 15 percent. If, however, the Byron units were delayed beyond 1990, the reserve margins would be below the 15% criterion in 1985 and 1990.

	Page/Section	Comments
6	2-4/2.2 (Par. 1)	The word "average" should be deleted from the first sentence and the last sentence should be changed to read as follows: "This analysis is based on an average 60 percent capacity factor for both units during the study period and replacement sources of energy supply are based on projections of the type of capacity that would supplant Byron Station's generation*."
7	2-5/Table 2.3	Item 1 - 78,009 GWh should be changed to 78,000 GWh Item 4 - 49.7 mills/kWh should be changed to 58.7 mills/kwh Item 5 - "(line 2 times line 4)" should be changed to (line 1 times line 4)" and $3877.0 x 10^6 should be changed to $4579.0 x 10^6 Item 6 - $2964.0 x 10^6 should be changed to $3666.0 x 10^6 Footnote should read: *Weighted average cost of replacement sources - 44% L.S. coal at 38.1 mills/kWh 9% H.S. coal at 24.9 mills/kWh, 28% steam oil at 93.7 mills/kWh, 5% C.T. oil and gas at 137.7 mills/kWh and 14% purchases at 46.9 mills/kWh.
8	2-6/2.3 (Par. 2)	66,946 should be changed to 62,819.
	(Par. 3)	Starting with the second sentence the text should read as follows: "Future plans call for the installation of an additional 6,516 MW of generating capacity (summer net) on the CECo system through 1990. Of this new capacity, all 6516 MW will be nuclear facilities and will increase the amount of installed nuclear capacity, (summer net) from 4975 MW in January 1981 to 11,491 MW (including Byron Station) in 1986." In the last sentence of the this paragraph, "(summer net)" should be inserted after the words "installed capacity".
9	2-6/2.4 (Par. 1)	The first sentence should read: "Historical energy production and summer peak load demand . . . ." In the second sentence "8.1 percent" should be changed to "8.0 percent". In the third sentence "2.0 percent" should be changed to "1.9 percent".

Page/Section — **Comment**

10 2-7/Table 2.4

The following changes should be made to more accurately describe the generating facilities listed in the table:

Bloom T.S.S.	Type of Unit "P"		
Calumet	Type of Unit "P"	- winter net	70
		- summer net	57
	Type of Unit NG	- winter net	206
		- summer net	163
Electric Junction			
	Type of Unit NG	- winter net	191
		- summer net	154
	Type of Unit P	- winter net	52
		- summer net	39
Fisk 31-34	Type of Unit "P"		
Joliet 9	Type of Unit "D"		

Quad Cities 1 - change footnote designation to "c"
Quad Cities 2 - change footnote designation to "c"
Seabrooke-Correct spelling is "Sabrooke"
Type of Unit "P"
Waukegan 31,32 - Type of Unit "P"
Footnote a - change: NG = Natural Gas to NG = Peaker Natural Gas and add P = Peaker Oil.
Footnote "c" - change 29.6 MW to 296 MW

11 2-9/2.4 (Par. 1)

The paragraph should be revised to read: "The applicant projects peak demand will increase from 14,228 MW in 1980 to 19,800 MW in 1990. Comparable figures for energy growth are 66,946 gwh in 1980 and 91,700 gwh in 1990. CECo plans the installation of 6,516 MW of generating capacity (summer net) through the year 1987 to meet its projected demand. This new capacity, if commercially available as planned, will increase current installed generating capacity (summer net) to 22,953 MW."

12 2-9/2.4 (Par. 2)

Item 2 should read . . . "both Byron units postponed . . . ."

13 2-9/2.4 (Par. 3)

Due to recalculated reserve percentages (see Table 2.6) the reserve margins are adequate under Scenario No. 1 and the sentence should end after the word "period". The balance of the paragraph and the reference should be deleted.

Page/Section	Comment
14 2-9/2.4 (Par. 4)	The article "a" should be inserted before the word "reserve" in the first sentence and 431 MW should be changed to 425 MW. The second sentence should read "This deficiency could conceivably be mitigated through some of the same procedures CECo intends to implement for the 1982 peak period (purchasing the necessary capacity)."
(Par. 5)	First sentence "nearly double" should be changed to "1.7 times".
(Par. 6)	First sentence should read "The 1985 deficit (Scenario 3) is sufficiently . . . ."
15 2-10/Table 2.6	The following changes should be made: Item 2 - under 1982 change 624 to 994 and under 1983 change 312 to 682. Item 3 - under 1982 change 18,109 to 18,479 and under 1983 change 18,845 to 19,215. Item 5 - under 1982 change 17,912 to 18,282 and under 1983 change 18,648 to 19,081. Item 7 - under 1982 change 2312 to 2682 and under 1983 change 2598 to 2968. Item 9 - under 1982 change 2272 to 2642 and under 1983 change 2558 to 2928. Item 10 - under 1982 change 14.6 to 16.9 and under 1983 change 15.9 to 18.2. Item 11 - change subject to "Reserve Margin With Both Byron Units Postponed One Year", and under 1982 change 2272 to 2642, under 1983 change 2558 to 2928 and under 1984 change 2050 to 2058. Item 12 - under 1982 change 14.6 to 16.9 and under 1983 change 15.9 to 18.2 Item 13 - under 1982 change 2272 to 2642 and under 1983 change 2558 to 2928. Item 14 - under 1982 change 14.6 to 16.9 and under 1983 change 15.9 to 18.2. Item 15 - under 1982 change 2272 to 2642, under 1983 change 2558 to 2928 and under 1984 change 2050 to 2058. Item 16 - change 1982 under 14.6 to 16.9, under 1983 change 15.9 to 18.2 and under 1984 change 12.21 to 12.4.
16 3-1/3/2 (Par. 1)	We believe this sentence should be clarified by inserting "which would not significantly reduce environmental impacts of operation," after the word "modification".

	Page/Section	Comment
17	4-7/4.2.3.4.1 (Par. 4)	This paragraph should be revised to read as follows: "Treatment of the make-up water for these cooling water systems will consist of the addition of sulfuric acid for the control of pH of the cooling water. Aminomethylene phosphonate (AMP) or 1-Hydroxyethylidene-1, 1-Diphosphonic acid (HEDP) is planned to be used for scale control and to minimize the use of sulfuric acid. A low molecular weight polyacrylate-type polymer is planned for use as a dispersant. Industry experience has shown that the use of either (AMP) or (HEDP) allows the system pH to be as high as 8.0 which reduces the quantity of sulfuric acid required."
18	4-8/4.2.4.2 (Par. 2)	In the first sentence, the word "channel" should be changed to "structure."
19	4-15/4.2.6.2 (Par. 3)	The 590 lbs/day dispersal of dissolved solids in the cooling tower drift refers to the seasonal maximum (winter) of 1823 mg/l. This estimate should refer to the 1854 mg/l maximum concentration (Table 4.3) which would yield 600 lbs/day maximum.
20	4-17/4.2.7 (Par. 1)	All of the right-of-way routes for the Byron Station transmission lines have been approved by the Illinois Commerce Commission and Table 3.9-1 of the ER-OLS, Amendment 1, reflects data regarding the actual rights-of-way which will be utilized. The total acreage difference between that shown in Table 3.4 of the CP-FES (1107.1 acres) and Table 3.9-1, ER-OLS, Amendment 1 (1207.5 acres) is 100 acres rather than 320 acres.
21	4-26/4.3.1.3 (Par. 1) (groundwater)	There are 15 public water supply systems using groundwater wells within 10 miles of the Byron site. Table 2.4-11 of the ER-OLS Amendment 2 shows the details of these systems including average daily use for the year 1980. With one exception, Castle Rock State Park, the eight additional public water supply systems serve subdivisions and mobile home parks.

	Page/Section	Comment
22	4-39/4.3.3 (Par. 4)	The average temperature figure for January should be -6^{o}C.
23	4-45 and 4-46/4.3.8	Contrary to the impression created, CECo has collected reliable data on which to predict noise impacts associated with Byron Station. The ambient noise level measurements for locations 1, 2, 3 and 4 were taken during the summer months of 1976 and 1977. The measurements for locations 1, 2 and 3 were taken on the site during periods when there was no construction activity and, therefore, are representative of the area and not biased by construction noise. The following methodology was used to determine ambient noise levels: 1) all ambient noise levels were recorded from the AC output of a General Radio 1933 sound level meter onto a Nagra tape recorder; 2) a 20 mminute tape sample was recorded at each location for both day and nighttime periods; 3) this field data was analyzed using the original tape recorder output into a sound level meter; and 4) the DC output from the sound level meter was in turn fed into a DC volt meter whose output feeds a minicomputer utilizing a satistical routine sampling 10 times per second. A review of the data on the tapes used to record the sound levels at location 3 has revealed an analysis error of 10dB in the daytime L_{eq} level which is used to determine the L_{dn} and $L_{33.3}$ values. The corrected values for the L_{dn} is 54 dBA (rather than 57 dBA) and $L_{33.3}$ is 46.5 dBA (rather than 56.4 dBA). See Table 5.6-4 ER-OLS. In view of this, the following changes should be made in the DES:
	(Par. 1)	The last sentence should read: "Ambient noise level data were also collected on the site (for applicant's sample locations 1, 2 and 3) and across the river from the station's Rock River intake (sample location number 4).

Page/Section — Comment

24 4-45 and 46/4.3.8 (Par. 2)

This paragraph should read as follows: "The on site ambient noise level collection locations were a point west of German Church Road immediately south of the location of the Unit 1 natural draft cooling tower which was used to represent locations 1 and 2; and at a point southwest of the construction parking lot which was used to represent location 3. Location 1 is at the southeast corner of the site (2900 feet east of German Church Road), location 2 is at the corner of German Church Road and Deerpath Road and location 3 is at the southwest corner of the site at the edge of the nearest residential property (see Figure 5.6-1 ER-OLS Amendment 1). Location 4 is located directly across the river from the Rock River intake about 50 feet east of Illinois Route 2. The day-night equivalent noise levels* for the applicant's sample locations 1 through 4 are as follows:

Sample Location	Ldn
1	45 dBA
2	45 dBA
3	54 dBA
4	56 dBA"

(Par. 4)

The only apparent noises appearing on the tapes used to characterize locations 1, 2 and 3 are dominant insect noise with some occasional local traffic passby. Location 4 is composed mostly of traffic noise with a residual of insect noise during the quiet periods. In view of the information presented in these comments, we believe that CECo should not be required to perform additional ambient noise monitoring as suggested in the DES. Therefore, we request that the language establishing such a requirement be deleted. The confirmatory monitoring program (Section 6.2.2 ER-OLS Amendment 1) will be conducted when Unit 1 and again when both Units 1 and 2 are operational.

25 5-5/5.3.2.2 (Par. 1)

Sentence 5 should be deleted in view of Section 6.2.1 of the ER-OLS Amendment 1 which states that the aquatic operational monitoring program will be conducted in accordance with

	Page/Section	Comment
26	5-5/5.3.2.2 (Par. 1) (Cont.)	the requirements specified in Byron Station NPDES Permit Number IL 0048313. Sentence 6 should be revised to read "The Proposed Thermal Effluent Limitations in the NPDES permit (Appendix B) would require the applicant to comply with the 2.7°C (5°F) contour during station operation."
27	5-11/5.5.1.2	The section indicates that since the avifaunal survey began in August, 1977, no dead or injured birds have been observed during either spring or fall migratory periods. This section should be revised to include the following results since the survey began. During the 1977-1979 survey periods no dead or injured birds were observed. During the 1980 survey, nine dead birds were documented during the fall migratory season (October). There were five golden crowned kinglets, one long-billed marsh wren, one white throated sparrow, one tennessee warbler and one warbler which could not be more completely identified due to its condition. All of these birds were collected from around the bases of the natural draft cooling tower structures. During the 1981 survey period, no impaction mortalities were reported. The results as briefly described above, were reported to the U.S. Fish and Wildlife Service and the Illinois Department of Conservation.
28	5-11/5.5.1.3 (Par. 3)	The transmission voltage should be 345 kv rather than 500 kv.
29	5-16/5.5.2.1 (Par. 1)	We would suggest that this paragraph be deleted from this section concerning entrainment, since item (1) the 316(b) Demonstration will not include entrainment and, therefore, will not address the need for additional mitigation. In addition, with respect to item (2) the concerns of the Illinois Department of Conservation to be studied do not include entrainment. We would recommend that the information in item (2) be addressed in an additional subsection 5.5.2.3 "Concerns of IDOC".

	Page/Section	Comment
30	5-17/5.5.2.2 (1)	This paragraph should be revised, to be consistent with Section 6.2 of the ER-OLS, Amendment 1, to state "The applicant will conduct monitoring in accordance with the requirements specified in Byron Station NPDES Permit Number IL 0048313 and its agreement with the Illinois Department of Conservation." Everything else should be deleted.
31	5-17/5.5.2.2 (2)	This paragraph should be deleted and be incorporated into paragraph (1). The title of paragraph (1), should read: "Chemical and Thermal."
32	5-17/5.5.2.3	As stated above, we believe that a new subsection 5.5.2.3 entitled "Concerns of IDOC" should be created. This section should read as follows: "5.5.2.3 Concerns of IDOC. A monitoring program will be conducted in accordance with CECo's agreement with the Illinois Department of Conservation. This program will be based upon evaluation, by an acceptable third party, of past and proposed aquatic monitoring programs for validity and reliability to detect gradual changes that could have an effect on the general ecology of the Rock River."
33	5-17/5.7	It is recommended that the requirement to contact the NRC if any known archeological sites along the transmission corridors are to be affected by future activities in order to evaluate for possible nomination to the National Register of Historic Places be changed to require that CECo notify the State Historic Preservation Officer (SHPO) and inform the NRC by copies of correspondence concerning proposed affects. In this way CECo would continue to coordinate its archeological activities for all projects through the SHPO as has been done to this point and, at the same time, the NRC's responsibility to insure the protection of those archeological sites meriting nomination to the Federal Register of Historic Places would be fulfilled.
34	5-31/Table 5.8	The last entry concerning the frequency of fish collection should read: "3 times a year."

	Page/Section	Comment
35	5-32 to 5-67/5.9.4	The consequences of severe accidents analysis contained in the DES is based upon the updated Reactor Safety Study. We fully agree with the Staff's conclusions that the level of risk associated with operation of Byron is very small and thus acceptable. However, we would point out that recent industry efforts to define and quantify accident risks demonstrate that use of the Reactor Safety Study may well be somewhat overly conservative. Therefore, we believe that it would be appropriate for the Staff to recognize that the risks associated with potential accidents at Byron are most likely even smaller than those identified in the DES.
36	5-72/5.12 (Par. 3)	Due to the error in analysis discussed in the comments on Section 4.3.8, the predicted noise level during operation, L_{dn} for Location 3 should be changed from 59dBA to 55 dBA.
37	5-72&5-73/5.12 (Par. 5)	We request the deletion of the requirement to include additional measurement of ambient noise levels since, as shown in the comments on Section 4.3.8, we have indicated that the original measurements of ambient noise levels were made on site and are representative of the Byron site area.
38	B-2/Table B.1	The fourth entry, concerning the By-Product License, under Purpose should properly read: "Possess by-product materials prior to operating license."
39	B-4/Table B.1	The fourth entry, concerning Registration, under Status of Permit should read "Granted 5-6-81."

January 20, 1981

RECEIVED JAN 23 1982 US NUCLEAR REGULATORY COMMISSION

4327 Alconbury Lane #3
Houston, Texas 77021

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington D. C. 20555

RE: COMMENT ON NUREG-0848, DRAFT ENVIRONMENTAL IMPACT STATEMENT WITH REGARD TO OPERATION OF THE BYRON STATION, Units 1 and 2, Docket Nos. STN-50-454 and STN 50-455 (Commonwealth Edison Company)

To whom it may concern:

John F. Doherty, J. D., of Houston, Texas, offers the below comment on the above titled commission publication:

The DEIS is incomplete, because it does not mention any impact of the cyanide dumping at the cite which was evidently discovered in May of 1974, and later. (See attachment)

JD #1

That is, the omission of mention of the evident discovery of large numbers of discarded waste barrels at the cite, is not thorough enough in view of the fact that wells are drilled for use of the cite, and that large amounts of water will be evaporated for cooling. The Commission has a duty to the public to at least notify the public that it has inquired (if indeed it has) of what the effect would be of quantities of undiscovered hazardous waste of the type previously discovered in the environs were to inadvertantly interact with the various plant water systems. This would include both the general public and plant employees. In addition, this would include an assessment of the need for other than normal monitoring of water quality in the area of the plant due to the possible presence of hazardous materials yet undiscovered.

Where there is no mention of the "Dirk's Farm"dumping it appears the public is not being fully served.

See attached: "Laying Waste" by Michael Brown, Pantheon Books, 1981 edition, Page 115. *

Thank you.

C002
B
1/1

Sincerely,

John F. Doherty, J.D.

John F. Doherty, J. D.

*Copyrighted attachment not reprinted herein.

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PDR ADOCK 05000454
D PDR

APPENDIX B

PERMITS

TABLE B.1

AUTHORIZATIONS REQUIRED FOR CONSTRUCTION AND OPERATION OF THE BYRON STATION

AGENCY	PERMIT REQUIRED DESCRIPTION	PERMIT REQUIRED STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (JULY 1981)	CATEGORY OF ENV. IMPACT[a]
U.S. Nuclear Regulatory Commission	Construction Permit	Atomic Energy Act of 1954 and Regulation 10 CFR 50	Construct Units 1 & 2	Granted 12-31-75	Air, Land, Water - CE
U.S. Nuclear Regulatory Commission	Operating Permit	Atomic Energy Act of 1954 and Regulation 10 CFR 50	Operate Units 1 & 2	Submitted 12-1-78	Air, Land, Water - OE
U.S. Nuclear Regulatory Commission	Materials License	10 CFR 70	Possess special nuclear materials prior to operating license	Granted in part - 7-2-79 Other part to be applied for 12/81	Radiological - OE
U.S. Nuclear Regulatory Commission	By-Product License	10 CFR 30	Possess special nuclear materials prior to operating license	Granted 10-30-80	Radiological - OE
U.S. Army Corps of Engineers	Construction Permit	33 USC § 403, 404, 565	Construct intake and discharge structures	Granted 5-18-77	Water - CE
U.S. Army Corps of Engineers	Construction Permit	33 USC § 403, 404, 565	Construct barge unloading dock	Granted 6-25-75	Water - CE
Federal Aviation Administration	Approval	Civil Aeronautics Act of 1938 as amended Sections 205 and 1101	Approval of 370-foot meteorological tower	Granted 2-22-73	Land - Planning
Federal Aviation Administration	Approval	Civil Aeronautics Act of 1938 as amended Sections 205 and 1101	Approval of cooling towers	Granted 5-7-7[illegible]	Land - Planning
Federal Aviation Administration	Approval	Civil Aeronautics Act of 1938 as amended Sections 205 and 1101	Notice of proposed use of construction crane	Granted 10-20-79	Land - Planning

[a]CE = Construction Effect; OE = Operational Effect.

TABLE B.1 (Cont'd)

AGENCY	PERMIT REQUIRED DESCRIPTION	PERMIT REQUIRED STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (JULY 1981)	CATEGORY OF ENV. IMPACT[a]
U.S. Environmental Protection Agency	NPDES Permit	FWPCA Section 402	Discharge treated plant waste	Granted 5-19-76	Water - CE and OE
Illinois Commerce Commission	Cert. of Convenience & Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 § 50 et seq.	Construct and operate Units 1 & 2	Granted 7-11-73	Land - Planning
Illinois Commerce Commission	Cert. of Convenience & Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 § 50 et seq.	Byron East transmission line right-of-way	Granted 3-10-76 Section 50 Cert. issued 7-28-76 Section 55 Cert. issued 3-10-76	Land - Planning
Illinois Commerce Commission	Cert. of Convenience & Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 § 50 et seq.	Byron South transmission line right-of-way	Granted 3-15-78 Section 55 Cert. issued 3-15-78 Section 50 Cert. issued 4-12-78	Land - Planning
Illinois Commerce Commission	Cert. of Convenience & Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 § 50 et seq.	Byron - Wempletown transmission line right-of-way	Granted 2-14-79 Cert. issued	Land - Planning
Illinois Commerce Commission	Cert. of Convenience & Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 § 50 et seq.	Requisition of parcels for spur-track right-of-way	Granted 8-14-74	Land - Planning
Illinois Commerce Commission	Cert. of Convenience & Necessity	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 § 50 et seq.	Widening Nelson Cherry Valley right-of-way	Granted 7-12-78 Section 55 Cert. issued 7-12-78 Section 50 Cert. issued 10-25-78	Land - Planning

[a]CE = Construction Effect; OE = Operational Effect.

TABLE B.1 (Cont'd)

AGENCY	PERMIT REQUIRED: DESCRIPTION	PERMIT REQUIRED: STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (JULY 1981)	CATEGORY OF ENV. IMPACT[a]
Illinois Commerce Commission	Supplemental Order	Ill. Public Utilities Act, Ill. Rev. Stat. 1971, Ch. 111-213 § 50 et seq.	Construct spur-track across five roadways	Granted 9-24-75	Land - Planning
Illinois Dept. of Transportation, Div. of Waterways	Construction Permit	Ill. Commerce Act June 10, 1911; (Ill. Rev. Stat. 1969, Ch. 19, 52 et seq.)	Construct intake and discharge structures	Granted 4-7-77	Water - CE
Illinois Dept. of Transportation, Div. of Waterways	Construction Permit	Ill. Commerce Act June 10, 1911; (Ill. Rev. Stat. 1969, Ch. 19, 52 et seq.)	Construct barge unloading dock	Granted 3-20-75	Water - CE
Illinois Dept. of Nuclear Safety	Registration	Ill. Public Health & Safety Radiation Installation Registration Law, July 5, 1957 (Ill. Rev. Stat. 1979, Ch. 111½ § 194-200)	Registration of nuclear materials	Granted 5-6-81	Radiological - OE
Illinois Dept. of Mines & Minerals	Permit	Ill. Act of 1941, (Ill. Rev. Stat. 1969, Ch. 104, 62 et seq.)	Drill wells at site for potable water	2 permits, both granted 9-19-74	Water - CE
Illinois Dept. of Transportation, Div. of Aeronautics	Permit	Ill. Rev. Stat. 1971; Ch. 127 et seq.	To construct 370-foot meteorological tower	Granted 3-6-73	Land - Planning
Illinois Dept. of Transportation, Div. of Aeronautics	Permit	Ill. Rev. Stat. 1971, Ch. 127 et seq.	To construct cooling towers	Granted 5-16-73	Land - Planning

[a]CE = Construction Effect; OE = Operational Effect.

TABLE B.1 (Cont'd)

AGENCY	PERMIT REQUIRED: DESCRIPTION	PERMIT REQUIRED: STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (JULY 1981)	CATEGORY OF ENV. IMPACT[a]
Illinois EPA, Div. of Water Pollution Control	Construction and Operating Permit	Environmental Prot. Act. (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	To construct and operate the sewage treatment works for 1 year	Granted 4-2-75	Water - CE and OE
Illinois EPA, Div. of Water Pollution Control	Renew Operating Permit	Environmental Prot. Act. (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	Renew operating permit for the sewage treatment works	Granted 5-3-76	Water - OE
Illinois EPA, Div. of Water Pollution Control	401 Cert.	FWPCA Sec. 401	To construct the intake and discharge structures (needed for Corps of Engineers permit)	Granted 4-12-74	Water - CE
Illinois EPA, Div. of Water Pollution Control	401 Cert.	FWPCA Sec. 401	To discharge into the Rock River (needed for NRC construction permit)	Granted 10-31-74	Water - CE
Illinois EPA, Div. of Water Pollution Control	401 Cert.	FWPCA Sec. 401	To discharge into the Rock River (needed for NRC operating permit)	To be applied for	Water - OE
Illinois EPA, Div. of Water Pollution Control	401 Cert.	FWPCA Sec. 401	To discharge into the Rock River (needed for NPDES permit)	Granted 8-18-75	Water - OE
Illinois EPA, Div. of Water Pollution Control	NPDES Permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	Discharge Permit - Operational Phase (renew existing permit)	Submitted 4-1-81	Water - OE

[a]CE = Construction Effect; OE = Operational Effect.

TABLE B.1 (Cont'd)

AGENCY	PERMIT REQUIRED: DESCRIPTION	PERMIT REQUIRED: STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (JULY 1981)	CATEGORY OF REV. IMPACT[a]	1
Illinois EPA, Div. of Water Pollution Control	401 Cert.	FWPCA Sec. 401	To construct barge unloading dock (needed for Corps of Engineers permit)	Granted 1-3-75	Water - CE	
Illinois EPA, Div. of Water Pollution Control	Construction Permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	To construct wastewater pollution treatment facilities (cooling towers)	Granted 1-20-75	Water - CE	
Illinois State Fire Marshal	Construction Permit	Ill. Act of June 28, 1919, Sect. 2, (Ill. Rev. Stat. 1971; Ch. 127½, Sect. 154)	To construct diesel fuel tanks and turbine oil tanks	Granted 7/78	CE and OE	1
Illinois EPA, Div. of Air Pollution Control	Construction Permit	Environmental Prot. Act. (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	To construct diesel generators	Granted 4-25-77	Air - CE	
Illinois EPA, Div. of Air Pollution Control	Operating Permit	Environmental Prot. Act. (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	To operate diesel generators	Granted 10-4-78	Air - OE	1
Illinois EPA, Div. of Air Pollution Control	Construction Permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	To construct diesel fuel tanks and turbine oil tanks	Granted 4-25-77	Air - CE	

[a]CE = Construction Effect; OE = Operational Effect.

TABLE B.1 (Cont'd)

AGENCY	PERMIT REQUIRED: DESCRIPTION	PERMIT REQUIRED: STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (JULY 1981)	CATEGORY OF ENV. IMPACT[a]
Illinois EPA, Div. of Air Pollution Control	Operating Permit	Environmental Prot. Act (Ill. Rev. Stat. 1971; Ch. 111½ 1001 et seq.)	To operate diesel fuel tanks	Granted 10-4-78	Air - OE
Illinois Dept. of Public Safety, Board of Boiler Rules	Registration	Boiler and Pressure Vessel Safety Act and Rules and Regulations (1976 edition), Part III, Section 1, Part II, Pub. 24	Register boiler and pressure vessels with the Board	To be applied for	OE
Illinois Dept. of Public Safety, Board of Boiler Rules	Inspection Certificate	Boiler and Pressure Vessel Safety Act and Rules and Regulations (1976 edition), Part II, Section 1, Part II, Pub. 11	Certify that boiler and pressure vessels comply with regulations	To be applied for	OE
Illinois Dept. of Public Safety, Board of Boiler Rules	ASME, NA and NPT Stamps	Boiler and Pressure Vessel Safety Act and Rules and Regulations (1976 edition), Part III, Section 1, Part III, Section VIII	Required to conduct maintenance	To be applied for	OE
Ogle County Superintendent of Highways	Permit		To do county road work	Granted 4-23-74	Land - Planning
Rockvale Township Highway Commission	Permit		To do township road work	Granted 4-26-74	Land - Planning

[a]CE = Construction Effect; OE = Operational Effect.

TABLE B.1 (Cont'd)

AGENCY	PERMIT REQUIRED DESCRIPTION	STATUTE AUTHORITY	PURPOSE	STATUS OF PERMIT (JULY 1981)	CATEGORY OF ENV. IMPACT[a]
Chicago and North Western Transportation Company	Agreement		To connect CECo's spur line with the Chicago and North Western Transportation Company Railroad	Agreement reached 6-24-77	Land - Planning
Ogle County	Zoning Certificate		To erect the river screen house	Granted 7-22-77	Land - Planning
Ogle County Superintendent of Highways	Permit		Road posting release	Granted 1-31-77	Land - Planning
Rockvale Township Highway Commission	Permit		Road posting release	Granted 2-14-77	Land - Planning
Ogle County	Building and Use Permit		To construct Byron Station	Granted 6-19-75	Land - Planning
Ogle County	Building and Use Permit		To construct intake structure	Granted 7-22-77	Land - Planning

[a]CE = Construction Effect; OE = Operational Effect.

217/782-0610

Commonwealth Edison Company
Byron Generating Station
NPDES Permit No. IL0048313
Modification of NPDES Permit (After Public Notice)

NOV 07 1979

Commonwealth Edison Company
Post Office Box 767 - Room 1700E
Chicago, Illinois 60690

Attention: John H. Hughes

Gentlemen:

The Illinois Environmental Protection Agency has reviewed the request for modification dated July 3, 1979 and issued a public notice based on that request. The final decision of the Agency is to modify the Permit as follows:

Addition of outfall 001(a) which authorizes the discharge of demineralizer regenerate waste.

Enclosed is a copy of the modified Permit.

Should you have any question or comments regarding the above, please contact Don Richardson of my staff.

Very truly yours,

Thomas G. McSwiggin, P.E.
Manager, Permit Section
Division of Water Pollution Control

TGM:DR:jb/sp0884b

cc: USEPA/With Enclosure
Region 1/With Enclosure
Permit Section
Records Unit
Consulting Engineer

Enclosure

NPDES Permit No. IL0048313

Illinois Environmental Protection Agency

Division of Water Pollution Control

2200 Churchill Road

Springfield, Illinois 62706

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Modified (NPDES) Permit

Expiration Date: April 1, 1981
Modification Issue Date: Nov. 7, 1979
Modification Effective Date: Nov. 7, 1979

Issue Date: December 30, 1976
Effective Date: December 30, 1976

Permittee: Commonwealth Edison Company

Facility Name and Address: Commonwealth Edison Co., Byron Generating Station, Byron, Illinois 61010

Receiving Waters: Woodland Creek and Rock River

In compliance with the provisions of the Illinois Environmental Protection Act, the Chapter 3 Rules and Regulations of the Illinois Pollution Control Board, and the FWPCA, the above-named permittee is hereby authorized to discharge at the above location to the above-named receiving stream in accordance with the standard conditions and attachments herein.

Permittee is not authorized to discharge after the above expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit the proper application as required by the Illinois Environmental Protection Agency (IEPA) not later than 180 days prior to the expiration date.

Thomas G. McSwiggin, P.E.
Manager, Permit Section
Division of Water Pollution Control

TGM:DR:jb/sp0884b

Permit No. IL0048313
AS MODIFIED Nov. 7, 1979

PART I
jb/sp0884b

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the effective date of this permit and lasting until* the expiration date, the permittee is authorized to discharge from outfall(s) serial number(s) 001 sanitary waste.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Weekly	Daily Average Flow Estimate
Suspended Solids	-	-	5 mg/l	25 mg/l	Monthly	Grab
BOD_5	-	-	4 mg/l	20 mg/l	Monthly	Grab
Fecal Coliform	-		200counts/100 ml	400counts/100 ml	Monthly	Grab

*The commencement of discharge to blowdown tunnel.

The pH shall not be less than 6.0 nor greater than 9.0 and shall be monitored by monthly grab samples.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the discharge from the treatment system.

Permit No. IL0048313
AS MODIFIED Nov. 7, 1979

PART I
jb/spp884b

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

2. During the period beginning on the effective date of discharge to the blowdown tunnel and lasting until April 1, 1981, the permittee is authorized to discharge from outfall(s) serial number(s) 001 sanitary waste.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Weekly	Daily Average Flow Estimate
Suspended Solids	-	-	30 mg/l	45 mg/l	Monthly	Grab
BOD_5	-	-	30 mg/l	45 mg/l	Monthly	Grab
Fecal Coliform	-		200counts/100 ml	400counts/100 ml	Monthly	Grab

The pH shall not be less than 6.0 nor greater than 9.0 and shall be monitored by monthly grab samples.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the discharge from the treatment system prior to dilution with other waste streams.

Permit No. IL0048313
AS MODIFIED Nov. 7, 1979

PART I
jb/sp0884b

B-12

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

3. During the period beginning on the effective date of this permit and lasting until April 1, 1981 the permittee is authorized to discharge from outfall(s) serial number(s) 002 construction runoff.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS*	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Weekly	Daily Average Flow Estimate
Suspended Solids	-	-	-	50 mg/l	Weekly	Grab
Oil and Grease	-	-	-	15 mg/l	Monthly	Grab

*During periods of discharge.

The pH shall not be less than 6.0 nor greater than 9.0 and shall be monitored by monthly grab samples.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the discharge from the treatment system.

Permit No. IL0048313
AS MODIFIED Nov. 7, 1979

PART I
sh/sp/9656a

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on the modification date of this permit and lasting until April 1, 1981, the permittee is authorized to discharge from outfall(s) serial number(s) 001(a) - Demineralizer Regenerate Waste.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Monthly During Discharge	Single Reading
Total Suspended Solids				15 mg/l	Monthly	Composite

The pH shall not be less than 6.0 nor greater than 9.0 and shall be monitored monthly on a grab.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the discharge but prior to mixing with the cooling system blowdown line, except pH shall be sampled prior to entry into the receiving stream.

PART I

MONITORING AND REPORTING

1. Representative Sampling - Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. Reporting - The permittee shall record monitoring results on Discharge Monitoring Report forms, using one such form for each discharge each month. The completed monthly forms shall be retained by permittee for a period of three months beginning with each calendar quarter, and the forms from those three months shall be mailed to USEPA no later than the 28th day of the following month; i.e. (a) January, February, March (submit April 28); (b) April, May, June (submit July 28); (c) July, August, September (submit October 28); October, November, December (submit January 28).

The permittee shall retain a copy of all reports submitted. All reports shall be submitted to:

U. S. Environmental Protection Agency
Attention: Chief, Compliance Unit
230 South Dearborn Street
Chicago, Illinois 60604

The permittee shall submit these monitoring reports each month to the appropriate District Office of the Illinois Environmental Protection Agency by the 15th day of the following month unless otherwise directed by the Illinois Environmental Protection Agency.

3. Noncompliance Notification - If, for any reason, the permittee does not comply with or will be unable to comply with any daily maximum effluent limitation specified in this permit, the permittee shall provide the Regional Administrator and the State with the following information, in writing, within five (5) days of becoming aware of such condition: (a) a description of the discharge; (b) cause of noncompliance; (c) the period of noncompliance, including exact dates and times; (d) if not corrected, the anticipated time the noncompliance is expected to continue, and (e) steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

4. Definitions

a. "Daily Average" Discharge
1. Weight Basis - The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

2. Concentration Basis - The "daily average" concentration means the arithmetic average (weighted by flow value) of all the daily determinations of concentration made during a calendar month. Daily determination of concentration made using a composite sample shall be the concentration of the composite sample. When grab samples are used, the daily determination of concentration shall be the arithmetic average (weighted by flow value) of all the samples collected during the calendar day.

b. "Daily Maximum" Discharge
1. Weight Basis - The "daily maximum" discharge means the maximum total discharge by weight permitted during any calendar day.

2. Concentration Basis - The "daily maximum" concentration means the maximum value in terms of concentration permitted in the discharge during any calendar day.

5. Test Procedures - Test procedures for the analysis of pollutants shall conform to regulations published pursuant to Section 304(g) of the Act, under which such procedures may be required.

6. Recording of Results - For each measurement or sample taken pursuant to the requirements of this permit the permittee shall record the following information: (a) the exact place, date, and time of sampling; (b) the dates the analyses were performed; (c) the person(s) who performed the analyses; (d) the analytical techniques or methods used; and (e) the results of all required analyses.

7. Additional Monitoring by Permittee - If the permittee monitors any pollutant at the location(s) designated herein more frequently than required by this permit, using approved analytical methods as specified above, the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (EPA No. 3320-1). Such increased frequency shall also be indicated

8. Records Retention - All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a minimum of three (3) years, or longer if requested by the Regional Administrator or the State Water Pollution Control Agency.

PART II - A. MANAGEMENT REQUIREMENTS

1. Change in Discharge - All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Facilities Operation - The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

3. Adverse Impact - The permittee shall take all reasonable steps to minimize any adverse impact to navigable waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

4. Bypassing - Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this permit is prohibited, except (i) where unavoidable to prevent loss of life or severe property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall promptly notify the Regional Administrator and the State in writing of each such diversion or bypass.

5. Removed Substances - Solids, sludges, filter backwash, or other pollutants removed from or resulting from treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

6. Power Failures - In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either: (a) in accordance with the Schedule of Compliance contained in Part I, provide an alternative power source sufficient to operate the wastewater control facilities; or, if no date implementation appears in Part I, (b) halt, reduce or otherwise control production and/or all discharges upon the reduction, loss, or failure of one or more of the primary sources of power to the wastewater control facilities.

B. RESPONSIBILITIES

1. Right of Entry - The permittee shall allow the head of the State Water Pollution Control Agency, the Regional Administrator, and/or their authorized representatives, upon the presentative of credentials: (a) to enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and (b) at reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. Transfer of Ownership or Control - In the event of any changes in control or ownership of facilities from which the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Regional Administrator and the State Water Pollution Control Agency.

3. Availability of Reports - Except for data determined to be confidential under Section 308 of the Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the State Water Pollution Control Agency and the Regional Administrator. As required by the Act, effluent data shall not be considered confidential. Knowingly making any false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

4. Permit Modification - After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to, the following: (a) violation of any terms or conditions of this permit; (b) obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or (c) a change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

5. Toxic Pollutants - Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. Civil and Criminal Liability - Except as provided in permit conditions on "Bypassing" (Part II, A-4) and "Power Failure" (Part II, A-6), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

7. Oil and Hazardous Substance Liability - Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

8. State Law - Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

9. Property Rights - The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. Severability - The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PART III

A. OTHER REQUIREMENTS

1. Additional Reporting of Monitoring to Illinois Environmental Protection Agency

   Monitoring results obtained during the previous one month shall be summarized and reported on a Discharge Monitoring Report Form (EPA No. 3320-1), postmarked no later than the 15th day of the month following the completed reporting period. The first monthly report is due on June 15, 1976. The signed reports required herein, shall be submitted monthly to the State at the following address:

   Environmental Protection Agency
   State of Illinois
   Division of Water Pollution Control
   2200 Churchill Road
   Springfield, Illinois 62706

2. This Permit incorporates all applicable provisions of the Illinois Environmental Protection Act and of the Rules and Regulations of the Illinois Pollution Control Board, as if they were set forth herein. All such provisions shall become conditions of this Federal NPDES permit granted to you as provided by Section 401(d) of the Federal Water Pollution Control Act Amendments of 1972.

3. This permit is specifically for the listed pollutants to be discharged from the designated outfalls only. Discharge of pollutants added in other than trace amounts or discharged from an undesignated outfall is not permitted.

B. Rainfall Runoff

1. Rainfall runoff from construction activity at the generating facility site and from material storage areas shall be controlled to meet all effluent restrictions specified in Part I A(3) of this permit.

2. Any untreated overflow from facilities designed, constructed and operated to treat the volume of material storage runoff and construction runoff which is associated with a 10 year, 24 hour rainfall event shall not be subject to the limitations for Suspended Solids and pH specified in Part I A(3) of this permit.

C. Erosion Control

The permittee shall utilize EPA Publication No. 430/9-73-007 "Process, Procedures, and Methods to Control Pollution Resulting from Construction Activity," October 1973, in developing and implementing procedures and methods for controlling erosion and sediment deposition.

As a minimum, the following practices shall be instituted:

1. Minimization of the duration of excavation and grading activities.

2. Control of the speed and volume of stormwater runoff, as necessary, by:

   a. Proper sizing of drainage ditches;
   b. Use of energy dissipative devices such as check dams and pooling area.

3. Construction of sediment traps and settling areas as necessary to prevent sediment from leaving the site.

4. Soil stabilization by minimizing slopes, revegetating spoil banks and cleared surfaces by seeding or sodding and through the proper and timely surfacing of parking lots, roads and laydown areas with crushed rock or gravel.

5. Taking all necessary precautions to minimize erosion through proper timing and installation of necessary erosion control devices, by avoiding land clearing in fall (insofar as feasible) and prior to installation of sediment traps, runoff drainage system or any necessary impoundments for sediment control.

D. Control of Other Construction - Related Activity

1. The company will dike and berm such areas as necessary to prevent accidental spills and leakage of fuel and oil.

2. Proper receptables will be provided for collection of oil soaked rags and papers to prevent contact with area runoff.

3. In the event that drainage from equipment maintenance area results in discharges of oil to the receiving waters, such discharges will meet the following effluent quality and will be monitored during periods of discharge at a representative point prior to discharge into receiving waters:

Parameter	Limits Monthly Average	Limits Daily Maximum	Frequency	Sample Type
Flow			Monthly	Daily Maximum Flow Estimate
Oil and Grease	15 mg/l	20 mg/l	Monthly	Grab

E. Intake Structure Requirements

Within 180 days of the issuance of this permit, the permittee shall submit to the Regional Administrator and the Illinois Environmental Protection Agency a demonstration detailing the ability of the intake system to meet the requirements of Section 316(b) of the Act. The report shall be based on presently available information regarding receiving water hydrology, intake siting and design, proposed intake operation and the biological population. Development of the report shall be guided by the "Development Document for Minimizing Adverse Environmental Impact for Cooling Water Intake Structures," as proposed by the U.S. EPA, and any other publications relating to intake impacts.

This report will be evaluated with regard to Section 316(b) of the Act. As a result of this evaluation, the Regional Administrator may modify the permit in accordance with Part II B.4 to establish an implementation schedule to insure compliance with Section 316(b).

F. "This permit may be modified or revised, or, alternatively revoked and reissued, to comply with an applicable effluent limitation issued purusant to the order of the United States District Court for the District of Columbia issued on June 8, 1976, in Natural Resources Defense Council, Inc. et. al. v. Russell E. Train, 8 ERC 2120 (D.D.C. 1976), in the effluent limitation so issued:

1. is different in conditions or more stringent than any effluent limitation in the permit; or

2. controls any pollutant not limited in the permit."

This permit may be revised, following notice by the Agency that applicable effluent limitations covered by the Natural Resources Defense Council, Inc. et. al. v. Train, 8 E.R.C. 2120 (D.D.C. 1976) will not be promulgated, to incorporate any applicable effluent limitations determined under Section 402(a)(1) of the Federal Water Pollution Control Act. (FWPCA) Amendments of 1972 as necessary to carry out the provisions of Section 301(b)(2)(a) of the FWPCA, if the effluent limitations so determined;

a. Is more stringent than any effluent limitation in the permit; or

b. Controls any pollutant not limited in the permit.

PART IV

Proposed Conditions for Future Discharges

The following are proposed conditions for a permit to be issued to the Company upon the expiration of this permit on April 1, 1981. These proposed conditions reflect the present assessment of U.S. EPA and the Illinois Environmental Protection Agency and are for informational purposes only. The limitations apply to discharges or waste sources not in existence during the construction phase of the Byron Nuclear Power Generating Station.

Permit No. IL0048313
AS MODIFIED Nov. 7, 1979

PART IV
jb/sp0844b

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning on Apri. 2, 1981 and lasting until April 2, 1986, the permittee is authorized to discharge from outfall(s) serial number(s) Intake Screen Backwash.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Monthly	Daily Average Flow Estimate

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): N/A.

PART IV
jb/sp0884b

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

2. During the period beginning on April 2, 1981 and lasting until April 2, 1986, the permittee is authorized to discharge from outfall(s) serial number(s) Boiler Blowdown, Demineralizer Wastes, Radiation Waste Treatment System, Filter Backwash.

   Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Weekly	Daily Average Flow Estimate
Suspended Solids	-	-	-	15 mg/l	Weekly	8-hr. Composite
Total Copper	-	-	-	1.0 mg/l	Weekly	8-hr. Composite
Total Iron	-	-	-	1.0 mg/l	Weekly	8-hr. Composite

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the treatment system discharge prior to dilution with condenser cooling water.

Permit No. IL0048313
AS MODIFIED Nov. 7, 1979

PART IV
jb/sp0884b

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

3. During the period beginning on April 2, 1981 and lasting until April 2, 1986, the permittee is authorized to discharge from outfall(s) serial number(s) cooling system blowdown.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Continuous	Continuous
Total Chlorine Residual**	-	-	-	0.2 mg/l*	Continuous	During Chlorination
Discharge Temperature	-	-	-	-	Continuous	Continuous
Plant Load Factor	-	-	-	-	Monthly Average	

*Limited to cold-side blowdown.
**The release of total chlorine residual into the Rock River will be limited to two hours per day for the facility.

The pH shall not be less than 6.0 nor greater than 9.0 and shall be monitored on a continuous basis at the discharge to the discharge canal.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the discharge.

A.4. THERMAL EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

Discharge of wastewater from this facility must not alone or in combination with other sources cause the receiving stream to violate the following thermal limitations:

a. Maximum temperature rise above natural temperature must not exceed 5°F.

b. Water temperature at representative locations in the main river shall not exceed the maximum limits in the following table during more than one (1) 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 limits in the following table by more than 3°F. (Main river temperatures are temperatures of those portions of the river essentially similar to and following the same thermal as the temperatures of the main flow of the river.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
°F	60	60	60	90	90	90	90	90	90	90	90	60
°C	15.6	15.6	15.6	32.2	32.2	32.2	32.2	32.2	32.2	32.2	32.2	15.6

c. The mixing zone shall not extend over more than 25% of the cross-sectional area of the river.

d. In addition, the permittee shall perform the following thermal monitoring:

The permittee shall determine the 2.8°C(5°F) contour, the contour of the applicable monthly maximum and the areas within these contours at three (3) month intervals for a period of one year after the effective date of this permit. After the initial year of measurements, the permittee shall continue to determine these areas and contours every three months but may use estimating procedures based on the first years data. The results of these determinations shall be reported to the Regional Administrator and the Illinois EPA on a quarterly basis.

Permit No. IL0048313
AS MODIFIED Nov. 7, 1979

PART IV
jb/sp0884b

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

5. During the period beginning on April 2, 1981 and lasting until April 2, 1986, the permittee is authorized to discharge from outfall(s) serial number(s) 001 sanitary waste discharge.

Such discharges shall be limited and monitored by the permittee as specified below:

EFFLUENT CHARACTERISTIC	DISCHARGE LIMITATIONS kg/day (lbs/day)		Other Units (Specify)		MONITORING REQUIREMENTS	
	Daily Avg	Daily Max	Daily Avg	Daily Max	Measurement Frequency	Sample Type
Flow-M^3/Day (MGD)	-	-	-	-	Weekly	Daily Average Flow Estimate
BOD_5	-	-	30 mg/l*	45 mg/l	Monthly	Grab
Suspended Solids	-	-	30 mg/l*	45 mg/l	Monthly	Grab
Fecal Coliform	-	-	200counts/100 ml	400counts/100 ml	Weekly	Grab

*Or 85% removal, whichever is less.

The pH shall not be less than 6.0 nor greater than 9.0 and shall be monitored by weekly grab samples.

There shall be no discharge of floating solids or visible foam in other than trace amounts.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): At a point representative of the discharge from the treatment plant.

ILLINOIS EPA
Environmental Protection Agency
2200 Churchill Road, Springfield, Illinois 62706

217/782-1696

316(b) Demonstration, Commonwealth Edison Company
NPDES Permit No. - Byron Station

June 13, 1979

Mr. John Hughes
Director of Water Quality
Commonwealth Edison Company
Box 767
Chicago, Illinois 60690

Dear Mr. Hughes:

This letter is in response to your letter of March 12, 1979 in regard to the impingement study to be conducted at the Byron Station. We find your general proposal acceptable. As proposed monitoring should cover a contiguous twelve month period beginning in October of 1981 (based on the service date of Unit #1). A sampling frequency of twice a week is acceptable. The final report is to be submitted 120 days after the 12-month study (February, 1983).

We request the submittal of the detailed study plan by October 1, 1980.

Very truly yours,

WHBusch

William H. Busch, Manager
Field Operations Section
Division of Water Pollution Control

WHB:KRR:bld/8882a/22

cc: Richard Monzingo, Commonwealth Edison
Al Manzardo, USEPA

APPENDIX C

EXAMPLES OF SITE-SPECIFIC DOSE-ASSESSMENT CALCULATIONS

C.1 CALCULATIONAL APPROACH

As mentioned in the text, the quantities of radioactive material that may be released annually from Byron Station are estimated on the basis of the description of the radwaste systems in the applicant's ER and FSAR and by using the calculational model and parameters described in NUREG-0017 (Ref. 1). These estimated effluent-release values, along with the applicant's site and environmental data in the ER and in subsequent answers to staff questions, are used in the calculation of radiation doses and dose commitments.

The models and considerations for environmental pathways that lead to estimates of radiation doses and dose commitments to individual members of the public near the plant, and of cumulative doses and dose commitments to the entire population within an 80-km (50-mi) radius of the plant as a result of plant operation, are discussed in detail in Regulatory Guide 1.109 (Ref. 2). Use of these models with additional assumptions for environmental pathways that lead to exposure to the general population outside the 80-km radius are described in Appendix D of this environmental statement.

The calculations performed by the staff for the potentially contaminated atmosphere and hydrosphere provide total integrated-dose commitments to the entire population within 80 km (50 mi) of the plant based on the projected population distribution in the year 2000. The dose commitments represent the total dose that would be received over a 50-year period following the intake of radioactivity for one year under the conditions existing 15 years after the plant begins operation (the midpoint of plant operation). For younger persons, changes in organ mass and metabolic parameters with age after the initial intake of radioactivity are accounted for.

C.2 DOSE COMMITMENTS FROM RADIOACTIVE-EFFLUENT RELEASES

Radioactive effluents released to the atmosphere and to the hydrosphere from Byron Station will result in very small radiation-dose commitments to individual members of the public and to the general population. Staff estimates of expected gaseous and particulate releases (Table C.1) and expected liquid releases (Table C.2), along with site meteorological and hydrological considerations (Tables C.3 and C.4, respectively), were used to estimate radiation doses and dose commitments.

Annual average relative-concentration (χ/Q) and relative-deposition (D/Q) values were calculated using the straight-line Gaussian model described in Regulatory Guide 1.111 (Ref. 3). A 3-year period of record (from January 1, 1974 to December 31, 1976) of meteorological data collected at the site was used. Wind-speed and -direction data were based on measurements at the 10-m level and atmospheric stability was defined by the vertical temperature gradient measured between the 10-m and 76-m levels. All releases through the unit vent were considered to be mixed mode (partially elevated and partially ground level). The results of the straight-line model were not adjusted to consider spatial and temporal variations in airflow due to the uniformity of the terrain in the region.

C.2.1 Radiation-Dose Commitments to Individual Members of the Public

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

Individual receptor locations and pathway locations considered for the maximally exposed individual are listed in Table C.5. The estimated dose commitments to the individual who is subject to maximum exposure at selected offsite locations from airborne releases of radioiodine and particulates, and from waterborne releases, are listed in Tables C.6, C.7, and C.8, as are the maximum annual gamma and beta air doses and the maximum total-body and skin doses to an individual at the site boundary.

The maximally exposed individual is assumed to consume well-above-average quantities of the potentially affected foods and to spend more time at potentially affected locations than the average person, as indicated in Tables E-4 and E-5 of Regulatory Guide 1.109 (Ref. 2).

C.2.2 Cumulative Dose Commitments to the General Population

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

References

1. "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)." NUREG-0017, U.S. Nuclear Regulatory Commission, April 1976.

2. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I." Regulatory Guide 1.109, Rev. 1, U.S. Nuclear Regulatory Commission, October 1977.

3. "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Reactors." Regulatory Guide 1.111, Rev. 1, U.S. Nuclear Regulatory Commission, July 1977.

Table C.1 Calculated Releases of Radioactive Materials in Gaseous Effluents from Byron (Ci/yr/reactor)

	Gas Stripping		Building Ventilation			Air-Ejector Exhaust	
Nuclide	Periodic	Continuous	Reactor	Auxiliary	Turbine	Continuous	Total
Ar-41	a	a	25	a	a	a	25
Kr-83m	a	a	a	a	a	a	a
Kr-85m	a	a	a	3	a	2	5
Kr-85	45	280	65	2	a	a	390
Kr-87	a	a	a	2	a	a	2
Kr-88	a	a	a	5	a	3	8
Kr-89	a	a	a	a	a	a	a
Xe-131m	6	15	23	2	a	2	48
Xe-133m	a	a	11	5	a	3	19
Xe-133	71	94	1900	420	a	260	2700
Xe-135m	a	a	a	a	a	a	a
Xe-135	a	a	3	9	a	6	18
Xe-137	a	a	a	a	a	a	a
Xe-138	a	a	a	1	a	a	1
Total, noble gases							3200
Mn-54	b	0.0045	b	0.00018	b	b	0.0047
Fe-59	b	0.0015	b	0.00006	b	b	0.0016
Co-58	b	0.015	b	0.00060	b	b	0.016
Co-60	b	0.007	b	0.00027	b	b	0.0073
Sr-89	b	0.00033	b	0.000013	b	b	0.00034
Sr-90	b	0.00006	b	0.0000024	b	b	0.00006
Cs-134	b	0.0045	b	0.00018	b	b	0.0047
Cs-137	b	0.0075	b	0.00030	b	b	0.0078
Total, particulates							0.043
I-131	c	c	0.002	0.081	0.001	0.028	0.112
I-133	c	c	0.001	0.066	0.001	0.041	0.110
C-14	a	7	1	a	a	a	8
H-3	-	-	140	790	-	-	930

a Less than 1 Ci/yr for noble gases and carbon-14.

b Less than 1% of total for nuclide.

c Less than 0.0001 Ci/yr.

Table C.2 Calculated Releases of Radioactive Materials in Liquid Effluents from Byron Station

Nuclide	Ci/yr/reactor
Corrosion and Activation Products	
Cr-51	0.00047
Mn-54	0.00110
Fe-55	0.00040
Fe-59	0.00028
Co-58	0.008
Co-60	0.0092
Zr-95	0.0014
Nb-95	0.002
Np-239	0.00025
Fission Products	
Br-83	0.00054
Rb-86	0.00021
Rb-88	0.034
Sr-89	0.00011
Sr-91	0.00011
Y-91m	0.00012
Mo-99	0.023
Tc-99m	0.065
Ru-103	0.00015
Ru-106	0.0024
Ag-110m	0.00044
Te-127	0.00035
Te-129m	0.00035
Te-129	0.0022
I-130	0.00069
Te-131m	0.00053
Te-131	0.0021
I-131	0.1522
Te-132	0.0061
I-132	0.039
I-133	0.15
I-134	0.0022
Cs-134	0.073
I-135	0.045
Cs-136	0.027
Cs-137	0.064
Ba-137m	0.038
Ce-144	0.0052
All others[a]	0.00059
Total, except tritium	0.73
Tritium	710

[a] Nuclides with release rates less than 10 μCi/yr/reactor are not individually listed, but are included in this category.

Table C.3 Summary of Atmospheric Dispersion Factors and Relative Deposition Values for Maximum Site Boundary and Receptor Locations Near the Byron Nuclear Station[1]

Location	χ/Q (sec/m^3)	Relative deposition(m^{-2})
Site boundary (ESE 1.0 km)	5.9×10^{-8}	1.6×10^{-9}
Nearest[2] residence and garden (N 1.8 km)	5.7×10^{-8}	8.4×10^{-10}
Nearest milk cow (ENE 2.4 km)	4.0×10^{-8}	4.9×10^{-10}
Nearest meat animal (NE 1.6 km)	5.0×10^{-8}	1.0×10^{-9}

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

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

Table C.4 Summary of Hydrologic Transport and Dispersion for Liquid Releases from the Byron Station

Location	Transit time (hours)	Dilution factor
<u>ALARA Calculations</u>		
Drinking Water	1.6×10^6	1000
Fish ingestion	0	50
Shoreline exposure	0	50
<u>Population-Dose Calculations</u>		
Drinking Water	1.6×10^6	1000
Commercial fishing	13	
(Rock River)		316
Sport fishing	13	316

Table C.5 Nearest Pathway Locations Used for Maximum Individual Dose Commitments for the Byron Station

Location	Sector	Distance (km)
Site boundary[1]	ESE	1.0
Residence[2] and garden	N	1.8
Milk cow	ENE	2.4
Meat animal	NE	1.6

[1]Beta and gamma air doses, total body doses, and skin doses from noble gases are determined at site boundaries in the sector where the maximum potential value is likely to occur.

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

Table C.6 Annual Dose Commitments to a Maximally Exposed Individual Near the Byron Station

Location	Pathway	Doses (mrems/yr per unit)			
		Noble Gases in Gaseous Effluents			
		Total	Body Skin	Gamma Air Dose (mrads/yr per unit)	Beta Air Dose (mrads/yr per unit)
Nearest site boundary[1] (ESE 1.0 km)	Direct radiation from plume	0.005	0.014	0.008	0.024
		Iodine and Particulates in Gaseous Effluents[2]			
		Total Body		Organ	
Nearest[3] site boundary (ESE 1.0 km)	Ground deposit	0.015 (T)		0.015 (C) thyroid	
	Inhalation	0.002 (T)		0.006 (C) thyroid	
Nearest residence & garden (N 1.8 km)	Ground deposit	0.008 (C)		0.008 (C) bone	
	Inhalation	0.002 (C)		<0.001 (C) bone	
	Vegetable consumption	0.019 (C)		0.059 (C) bone	
Nearest milk cow (ENE 2.4 km)	Ground deposit	0.004 (C)		0.004 (I) thyroid	
	Inhalation	0.001 (C)		0.003 (I) thyroid	
	Vegetable consumption	0.013 (C)		- -	
	Cow milk consumption	0.006 (C)		0.61 (I) thyroid	
Nearest meat animal (NE 1.6 km)	Meat consumption	0.002 (C)		0.007 (C) bone	
		Liquid Effluents (Adults)			
		Total Body		Organ	
Nearest drinking water (well, 5.6 km SW, 30 m from shore)	Water ingestion	<0.001		<0.001 thyroid	
Nearest shore access (0.4 km downstream)	Shoreline exposure	<0.001		<0.001 thyroid	
Nearest fishing (0.4 km downstream)	Fish ingestion	0.87		1.16 liver	

[1]"Nearest" refers to that site boundary location where the highest radiation doses as a result of gaseous effluents have been estimated to occur.
[2]Doses are for the age group that results in the highest dose. T=teen, C=child, I=infant.
[3]"Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

Table C.7 Calculated Appendix I Dose Commitments to a Maximally Exposed Individual and to the Population from Operation of Byron Station, Annual Doses per Reactor Unit

Maximally Exposed Individual

	Appendix I Design Objectives[1]	Calculated Doses
Liquid effluents		
Dose to total body from all pathways (millirems)	3	0.9
Dose to any organ from all pathways (millirems)	10	1.2
Noble gas effluents (at site boundary)		
Dose in air		
Gamma (millirads)	10	0.008
Beta (millirads)	20	0.024
Dose to an individual		
Total body (millirems)	5	0.005
Skin (millirems)	15	0.014
Radioiodines and particulates[2]		
Dose to any organ from all pathways (millirems)	15	0.61

Population Within 80 km

	Total Body	Thyroid
Natural-background radiation[3] (person rems)	128,000	
Liquid effluents (person-rems)	0.36	0.32
Noble-gas effluents (person-rems)	0.1	0.1
Radioiodine and particulates (person-rems)	1.0	2.9

[1]Design objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR 50 consider doses to maximum individual and population per reactor unit.

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

[3]"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average background dose for Illinois of about 103 millirems per year, and year 2000 projected population of 1,244,000.

Table C.8 Calculated RM-50-2 Dose Commitments to a Maximally Exposed Individual from Operation of Byron Station[1], Annual Dose per Site

Source	RM-50-2 Design Objectives[2]	Calculated Doses
Liquid effluents		
Dose to total body or any organ from all pathways (millirems)	5	2.4
Activity-release estimate, excluding tritium (Ci/yr)	10	1.4
Noble-gas effluents (at site boundary)		
Dose in air		
Gamma (millirads)	10	0.016
Beta (millirads)	20	0.048
Dose to total body of an individual (millirems)	5	0.01
Radioiodine and particulates[3]		
Dose to any organ from all pathways (millirems)	15	1.2
I-131 activity release (Ci/yr)	2	0.3

[1]An optional method of demonstrating compliance with the benefit-cost section (Sec. II.D) of Appendix I to 10 CFR Part 50.
[2]Annex to Appendix I to 10 CFR Part 50.
[3]Carbon-14 and tritium have been added to this category.

Table C.9. Annual Total-Body Population-Dose Commitments in the Year 2000 (both units)

Category	U.S. Population-Dose Commitment (person-rems per year)
Natural-background radiation[1]	26,000,000
Byron Station operation	
Plant workers	880
General public	
Radioiodine and particulates	60
Liquid effluents[2]	0.7
Noble-gas effluents	1.0
Transportation of fuel and waste	7

[1]Using the average U.S. background dose (100 millirems per year) and year-2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 541, February 1975.

[2]80-km (50-mi) population dose.

APPENDIX D

NEPA POPULATION-DOSE ASSESSMENT

APPENDIX D

NEPA POPULATION-DOSE ASSESSMENT

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

D.1 IODINES AND PARTICULATES RELEASED TO THE ATMOSPHERE

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind; thus, the concentration of these nuclides remaining in the plume is continuously being reduced. Within 80 km (50 mi) of the station, the deposition model in Regulatory Guide 1.111, Rev. 1 (Ref. 3) is used in conjunction with the dose models in Regulatory Guide 1.109, Rev. 1. Site-specific data concerning production and consumption of foods within 80 km of the station are used. For estimates of population doses beyond 80 km it is assumed that excess food not consumed within the 80-km distance would be consumed by the population beyond 80 km. It is further assumed that none, or very few, of the particulates released from the station will be transported beyond the 80-km distance; thus, they will make no contribution to the population dose outside the 80-km region.

D.2 NOBLE GASES, CARBON-14, AND TRITIUM RELEASED TO THE ATMOSPHERE

For locations within 80 km (50 mi) of Byron station, exposures to these effluents are calculated with a constant mean wind-direction model according to the guidance provided in Regulatory Guide 1.111, Rev. 1, and the dose models described in Regulatory Guide 1.109, Rev. 1. For estimating the dose commitment from these radionuclides to the U.S. population residing beyond 80 km, two dispersion regimes are considered, which are referred to as first-pass dispersion and world-wide dispersion. The model for the first-pass-dispersion regime estimates the dose commitment to the population from the radioactive plume as it leaves the station and drifts to the northeastern corner of the United States. The model for the world-wide-dispersion regime estimates the dose commitment to the U.S. population after the released radionuclides mix uniformly in the world's atmosphere or oceans.

D.2.1 First-Pass Dispersion

For estimating the dose commitment to the U.S. population residing beyond 80 km (50 mi) due to the first pass of radioactive pollutants, it is assumed that the pollutants disperse laterally and vertically along the plume path. The direction of movement of the plume is assumed to be from the station toward the northeastern corner of the United States. The extent of vertical dispersion is assumed to be limited by the ground plane and the stable atmospheric layer aloft, the height of which determines the mixing depth. The shape of such a plume geometry can be visualized as a right-cylindrical wedge whose height is equal to the mixing depth. Under the assumption of constant population density, the population dose associated with such a plume geometry is independent of the extent of lateral dispersion, and dependent only on the mixing depth and other related nongeometrical factors (Ref. 4). The mixing depth is estimated to be 1000 m (3300 ft); a uniform population density of 62 people/km^2 (24 people/mi^2) along the plume path and an average plume-transport velocity of 2 m/s (4.5 mph) are assumed.

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

D.2.2 World-Wide Dispersion

For estimating the dose commitment to the U.S. population after the first pass, world-wide dispersion is assumed. Nondepositing radionuclides with half-lives greater than one year are considered. Noble gases and carbon-14 are assumed to mix uniformly in the atmosphere (3.8×10^{18} m^3), and radioactive decay is taken into consideration. The world-wide-dispersion model estimates the activity of each nuclide at the end of a 15-year release period (midpoint of reactor life) and estimates the annual population-dose commitment at that time, taking into consideration radioactive decay. The total-body population-dose commitment from the noble gases is due mainly to external exposure from gamma-emitting nuclides, whereas from carbon-14 it is due mainly to internal exposure from ingestion of food containing carbon-14.

The population-dose commitment due to tritium releases is estimated in a manner similar to that for carbon-14 except that, after the first pass, all the tritium is assumed to be absorbed by the world's oceans (2.7×10^{16} m^3). The concentration of tritium in the oceans is estimated at the time after which releases have occurred for 15 years, taking into consideration radioactive decay; the population-dose-commitment estimates are based on the incremental concentration at that time. The total-body population-dose commitment from tritium is due mainly to internal exposure from the consumption of food grown with irrigation water.

D.3 LIQUID EFFLUENTS

Population-dose commitments due to effluents in the receiving water within 80 km (50 mi) of the station are calculated as described in Regulatory Guide 1.109. It is assumed that no depletion by sedimentation of the nuclides present in the receiving water occurs within 80 km. It is also assumed that aquatic biota concentrate radioactivity in the same manner as was assumed in the ALARA evaluation for the maximally exposed individual. However, food-consumption values appropriate for the average, rather than the maximum, individual are used. It is further assumed that all the sport and commercial fish and shellfish caught within 80 km are eaten by the U.S. population. For the region beyond 80 km, it is assumed that all the liquid-effluent nuclides except tritium have deposited on the sediments so that they make no further contribution to population exposures. The tritium is assumed to mix uniformly in the hydrosphere and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

References

1. "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I." Regulatory Guide 1.109, Rev. 1, U.S. Nuclear Regulatory Commission, October 1977.

2. "Domestic Licensing of Production and Utilization Facilities." Title 10 Code of Federal Regulations, Part 50, January 1981.

3. "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Reactors." Regulatory Guide 1.111, Rev. 1, U.S. Nuclear Regulatory Commission, July 1977.

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

APPENDIX E

REBASELINING OF THE RSS RESULTS FOR PWRs

APPENDIX E

REBASELINING OF THE RSS RESULTS FOR PWRs

The results of the Reactor Safety Study (RSS) have been updated. The update was done largely to incorporate results of research and development conducted after the October 1975 publication of the RSS and to provide a baseline against which the risk associated with various light-water reactors (LWRs) could be consistently compared.

Primarily, the rebaselined RSS results (NUREG/CR-1659) reflect use of advanced modeling of the processes involved in and meltdown accidents, that is, the MARCH computer code modeling for transient- and loss-of-coolant accident (LOCA)-initiated sequences and the CORRAL code used for calculat-ing magnitudes of release accompanying various accident sequences. These codes* have led to a capability to predict the transient and small LOCA-initiated sequences that is considerably advanced beyond what existed at the time the Reactor Safety Study was completed. The advanced accident process models (MARCH and CORRAL) produced some changes in estimates of the release magnitudes from various accident sequences in WASH-1400. These changes primarily involved release magnitudes for the iodine, cesium, and tellurium families of isotopes. In general, a decrease in the iodines was predicted for many of the dominant accident sequences while some increases in the release magnitudes for the cesium and tellurium isotopes were predicted.

Entailed in this rebaselining effort was the evaluation of individual dominant accident sequences as they are understood to evolve rather than the technique of grouping large numbers of accident sequences into encompassing, but synthetic, release categories as was done in WASH-1400. The rebaselining of the RSS also eliminated the "smoothing technique" that was criticized in the report by the Risk Assessment Review Group (sometimes known as the Lewis Report; NUREG/CR-0400). In both of the RSS designs (pressurized water reactor and boiling water reactor, PWR and BWR), the likelihood of an accident sequence leading to the occurrence of a steam explosion (a) in the reactor vessel was decreased. This was done to reflect both experimental and calculational indications that such explosions are unlikely to occur in those sequences involving small-size LOCAs and transients because of the high pressures and temperatures expected to exist within the reactor coolant system during these scenarios. Furthermore, if such an explosion were to occur, there are indications that it would be unlikely to produce as much energy and the massive missile-caused breach of containment as was postulated in WASH-1400.

For rebaselining of the RSS PWR design, the release magnitudes for the risk dominating sequences (Event V, TMLB' σ, γ, and $S_2C\sigma$ (described later)) were

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*It should be noted that the MARCH code was used on a number of scenarios in connection with the TMI-2 recovery efforts and for post-TMI-2 investigations to explore possible alternative scenarios that TMI-2 could have experienced.

explicitly calculated and used in the consequence modelling rather than being lumped into release categories as was done in WASH-1400. The rebaselining led to a small decrease in the predicted risk to an individual of early fatality or latent cancer fatality relative to the original RSS-PWR predictions. This result is believed to be largely attributable to the decreased likelihood of occurrence for sequences involving severe steam explosions (α) that breached containment. (In WASH-1400, the sequences involving severe steam explosions (α) were artificially elevated in their risk significance (that is, made more likely) by use of the "smoothing technique".)

In summary, the rebaselining of the RSS results led to small overall differences from the predictions in WASH-1400. It should be recognized that these small differences due to the rebaselining efforts are likely to be far outweighed by the uncertainties associated with such analyses.

The accident sequences which are expected to dominate risk from the RSS-PWR design are described below. Accident sequences are designated by strings of identification characters in the same manner as in the RSS (see Table E.1). Each of the characters represents a failure in one or more of the important plant systems or features that ultimately would result in melting of the reactor core and a significant release of radioactive materials from containment.*

Event V (Interfacing System LOCA)

During the RSS a potentially large risk contributor was identified due to the configuration of the multiple check valve barriers used to separate the high pressure reactor coolant system from the low design pressure portions of the emergency core cooling system (ECCS) (that is, the low pressure injection subsystem, LPIS). If these valve barriers were to fail in various modes, such as a leak in one valve and rupture of the other or rupture of both valves, and suddenly exposed the LPIS to high overpressures and dynamic loadings, the RSS judged that a high probability of LPIS rupture would exist. Because the LPIS is largely located outside of containment, the Event V scenario would be a LOCA that bypassed containment and those mitigating features (such as sprays) within containment. The RSS assumed that if the rupture of LPIS did not entirely fail the LPIS makeup function (which would ultimately be needed to prevent core damage), the LOCA environment (flooding, steam) would. Predictions of the release magnitude and consequences associated with Event V have indicated that this scenario represents one of the largest risk contributors from the RSS-PWR design. The NRC has recognized this RSS finding, and has taken steps to reduce the probability of occurrence of Event V scenarios in both exist-ing and future LWR designs by requiring periodic surveillance testing of the interfacing valves to assure that these valves are properly functioning as pres-sure boundary isolation barriers during plant operations. Accordingly, Event V predictions for the RSS-PWR are likely to be conservative relative to the design and operation of the Byron Station, Units 1 and 2.

*For additional information, see the Reactor Safety Study (WASH-1400), Appendix V.

TMLB'-δ, γ

This sequence essentially considers the loss and nonrestoration of all ac power sources available to the plant along with an independent failure of the steam turbine driven auxiliary feedwater train which would be required to operate to remove shutdown heat from the reactor core. The transient event is initiated by loss of offsite ac power sources which would result in plant trip (scram) and the loss of the normal way that the plant removes heat from the reactor core (that is, via the power conversion system consisting of the turbine, condenser, the condenser cooling system, and the main feedwater and condensate delivery system that supplies water to the steam generators). This initiating event would then demand operation of the standby onsite emergency ac power supplies (two diesel generators) and the standby auxiliary feedwater system, two trains of which are electrically driven by either onsite or offsite ac power. With failure and nonrestoration of ac and the failure of the steam turbine driven auxiliary feedwater train to remove shutdown heat, the core would ultimately uncover and melt. If restoration of alternating current were not successful during (or following) melt, the containment heat removal and fission product mitigating systems would not be operational to prevent the ultimate overpressure (δ, γ) failure of containment and a rather large, energetic release of activity from the containment. Next to the Event V sequence, TMLB'δ, γ is predicted to dominate the overall accident risks in the RSS-PWR design.

S_2C-δ (PWR 3)

In the RSS the S_2C-δ sequence was placed into PWR release Category 3 and it actually dominated all other sequences in Category 3 in terms of probability and release magnitudes. The rebaselining entailed explicit calculations of the consequences from S_2C-δ and the results indicated that it was next in overall risk importance following Event V and TMLB'δ, γ.

The S_2C-δ sequence included a rather complex series of dependencies and interactions that are believed to be somewhat unique to the containment systems (subatmospheric) employed in the RSS PWR design.

In essence, the S_2C-δ sequence included a small LOCA occurring in a specific region of the plant (reactor vessel cavity); failure of the recirculating containment heat removal systems (CSRS-F) because of a dependence on water draining to the recirculation sump from the LOCA; and a resulting depend-ence imposed on the quench spray injection system (CSIS-C) to provide water to the sump. The failure of the CSIS-C resulted in eventual overpressure failure of containment (δ) due to the loss of CSRS-F. Given the overpressure failure of containment the RSS assumed that the ECCS functions would be lost either due to the cavitation of ECCS pumps or from the rather severe mechanical loads that could result from the overpressure failure of containment. The core was then assumed to melt in a breached containment leading to a significant release of radioactive materials. Approximately 20% of the iodines and 20% of the alkali metals present in the core at the time of release would be released to the atmosphere. Most of the release would occur over a period of about 1.5 hours. The release of radioactive material from containment would be caused by the sweeping action of gases gener-ated by the reaction of the molten fuel with concrete. Because these gases would be initially heated by contact with the melt, the rate of sensible energy release to the atmosphere would be moderately high.

PWR 7

This is the same as the PWR release Category 7 of the original RSS, which was made up of several sequences such as S_2D-ε (the dominant contributor to the risk in this category), S_1D-ε, S_2H-ε, S_1H-ε, AD-ε, AH-ε, TML-ε, and TKQ-ε. All of these sequences involved a containment base mat melt-through as the containment failure mode. With exception of TML-ε and TKQ-ε, all involve the potential failure of the emergency core cooling system following occurrence of a LOCA with the containment engineered safety features continuing to operate as designed until the base mat was penetrated. Containment sprays would operate to reduce the containment temperature and pressure as well as the amount of airborne radioactivity. The containment barrier would retain its integrity until the molten core proceeded to melt through the concrete containment base mat. The radioactive materials would be released into the ground, with some leakage to the atmosphere occurring upward through the ground. Most of the release would occur continuously over a period of about 10 hours. The release would include approximately 0.002% of the iodines and 0.001% of alkali metals present in the core at the time of release. Because leakage from containment to the atmosphere would be low and gases escaping through the ground would be cooled by contact with the soil, the energy release rate would be very low.

References

U.S. Nuclear Regulatory Commission, NUREG-75/014, "Reactor Safety Study, An Assessment," WASH-1400, October 1975.

---, NUREG/CR-0400, H. W. Lewis, et al., "Risk Assessment Review Group Report to the Nuclear Regulatory Commission," September 1978.

---, NUREG/CR-1659, "Reactor Safety Study Methodology Applications Program," Vol. 1, April 1981.

TABLE E.1 Key to PWR Accident Sequence Symbols

A	-	Intermediate to large LOCA.
B'	-	Failure to recover either onsite or offsite electric power within about 1 to 3 hours following an initiating transient which is a loss of offsite AC power.
C	-	Failure of the containment spray injection system.
D	-	Failure of the emergency core cooling injection system.
H	-	Failure of the emergency core cooling recirculation system.
K	-	Failure of the reactor protection system.
L	-	Failure of the secondary system steam relief valves and the auxiliary feedwater system.
M	-	Failure of the secondary system steam relief valves and the power conversion system.
Q	-	Failure of the primary system safety relief valves to reclose after opening.
S_1	-	A small LOCA with an equivalent diameter of about 2 to 6 inches.
S_2	-	A small LOCA with an equivalent diameter of about 1/2 to 2 inches.
T	-	Transient event.
V	-	LPIS check valve failure.
α	-	Containment rupture due to a reactor vessel steam explosion.
γ	-	Containment failure due to hydrogen burning.
δ	-	Containment failure due to overpressure.
ε	-	Containment vessel melt-through.

APPENDIX F

CONSEQUENCE MODELING CONSIDERATIONS

APPENDIX F

CONSEQUENCE MODELING CONSIDERATIONS

F.1 EVACUATION MODEL

"Evacuation," used in the context of offsite emergency response in the event of a substantial amount of radioactivity released to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation" which denotes a post-accident response to reduce exposure from long term ground contamination. The Reactor Safety Study (RSS) (WASH-1400) consequence model contains provision for incorporating radiological consequence reduction benefits of public evacuation. The benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in reduction of early health effects associated with early exposure; namely, in the number of cases of early fatality (see Section F.2) and acute radiation sickness which would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400 as well as in NUREG-0340. However, the evacuation model which has been used herein is a modified version (SAND 78-0092) of the RSS model and is, to a certain extent, site emergency planning oriented. The modified version is briefly outlined below.

The model utilizes a circular area with a specified radius (such as a 16-km (10-mile) plume exposure pathway Emergency Planning Zone (EPZ)), with the reactor at the center. It is assumed that people living within portions of this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactivity to the atmosphere.

Significant atmospheric releases of radioactivity would in general be preceded by one or more hours of warning time (postulated as the time interval between the awareness of impending core melt and the beginning of the release of radioactivity from the containment building). For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor), within the circular zone with the down-wind direction as its median (that is, those people who would potentially be under the radioactive cloud that would develop following the release) would leave their residences after lapse of a specified amount of delay time* and then evacuate. The delay time is reckoned from the beginning of the warning time and is recognized as the sum of the time required by the reactor operators to notify the responsible authorities; the time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate; and time required for the people to mobilize and get underway.

*Assumed to be of a constant value which would be the same for all evacuees.

The model assumes that each evacuee would move radially out in the downwind direction* with an average effective speed** (obtained by dividing the zone radius by the average time taken to clear the zone after the delay time) over a fixed distance** from the evacuee's starting point.

This distance is selected to be 24 km (15 miles) (which is 8 km (5 miles) more than the 16-km (10-mile) plume exposure pathway EPZ radius). After reaching the end of the travel distance the evacuee is assumed to receive no further radiation exposure.

The model incorporates a finite length of the radioactive cloud in the downwind direction, which would be determined by the product of the duration over which the atmospheric release would take place and the average windspeed during the release. It is assumed that the front and the back of the cloud formed would move with an equal speed which would be the same as the prevailing windspeed; therefore, its length would remain constant at its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time were be less than the warning time, then all evacuees would have a head start; that is, the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time were more than the warning time, then depending on initial locations of the evacuees there are possibilities that (1) an evacuee will still have a head start, or (2) the cloud would be already overhead when an evacuee starts to leave, or (3) an evacuee would be initially trailing behind the cloud. However, this initial picture of cloud-people disposition would change as the evacuees travel, depending on the relative speed and positions between the cloud and people. The cloud and an evacuee might overtake one another one or more number of times before the evacuee would reach his or her destination. In the model, the radial position of an evacuating person, either stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclides would be deposited continually from the cloud as it passed a given location, a person who is under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the revised model assumes that persons are (1) exposed to the total ground contamination concentration which is calculated to exist after complete passage of the cloud after they are completely passed by the cloud, (2) exposed to one half the calculated concentration when they are anywhere under the cloud, and (3) not exposed when they are in front of the cloud. Different values of the shielding protection factors for exposures from airborne radioactive and ground contamination have been used.

Results shown in Section 5.9.4.5 for accidents involving significant release of radioactivity to the atmosphere were based upon the assumption that all people within the 16-km plume exposure pathway EPZ would evacuate as per the evacuation scenario described above. It is not expected that detailed inclusion of any special facility near a specific plant site, where not all

*In the RSS consequence model the radioactive cloud is assumed to travel radially outward only.

**Assumed to be of a constant value which would be the same for all evacuees.

persons would be quickly evacuated, would significantly alter the conclusions. Sheltering in such cases can provide significant mitigation of consequences in most cases. For the delay time before evacuation, a generic value of one hour, considered to be achievable by appropriate planning, was used. The staff estimated the effective evacuation speed to be 0.6 meters per second (1.34 mph) based on the applicant's estimate of the time necessary to clear the 16-km zone. As an additional emergency measure for the site, it was also assumed that all people beyond the evacuation distance who would be exposed to the contaminated ground would be relocated after passage of the plume. For the people outside the evacuation zone and within 40 km, a reasonable relocation time span of 8 hours has been assumed, during which each person is assumed to receive additional exposure to the ground contami-nation. Beyond the 40-km distance the usual assumption of the RSS consequence model regarding the period of ground exposure was used--which is that if the calculated ground dose to the total marrow over a 7-day period would exceed 200 rems, then this high dose rate would be detected by actual field measure-ments following the plume passage, and people from those regions would then be relocated immediately. For this situation the model limits the period of ground dose calculation to 24 hours; otherwise, the period of ground exposure is limited to 7 days for calculation of early dose.

Figure F.1 shows a pessimistic case for which no early evacuation is assumed and all persons are assumed to be exposed for the first 24 hours following an accident and are then relocated.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as in the orginal RSS model. For this purpose, the model assumes that for atmospheric releases of durations three hours or less, all people living within a circular area of 8-km radius centered at the reactor plus all people within a 45° angular sector within the plume exposure pathway EPZ and centered on the downwind direction will be evacuated and tempo-rarily relocated. However, for releases exceeding three hours, the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would be evacuated and temporarily relocated. For either of these situations, the cost of evacuation and relocation is assumed to be $125 (1980 dollars) per person, which includes cost of food and temporary sheltering for a period of 1 week.

F.2 EARLY HEALTH EFFECTS MODEL

The medical advisors to the Reactor Safety Study proposed three alternative dose-mortality relationships that can be used to estimate the number of acute or early fatalities that might result in an exposed population. These alternatives characterize different degrees of post exposure medical treatment from "minimal" to "supportive," to "heroic," and more fully described in NUREG-0340.

The calculational estimates of the early fatality risks presented in the texts of Section 5.9.4.5 and Section F.1 of this appendix used the dose-mortality relationship that is based upon the supportive treatment alternative. This implies the availability of medical care facilities and services for those exposed in excess of about 200 rem. At the extreme low probability end of the spectrum (at the one chance in one hundred million per reactor-year level), the number of persons involved might exceed the capacity of facilities for such services in which case the number of early fatalities might have been somewhat underestimated. To gain perspective on this element of uncertainty, the staff

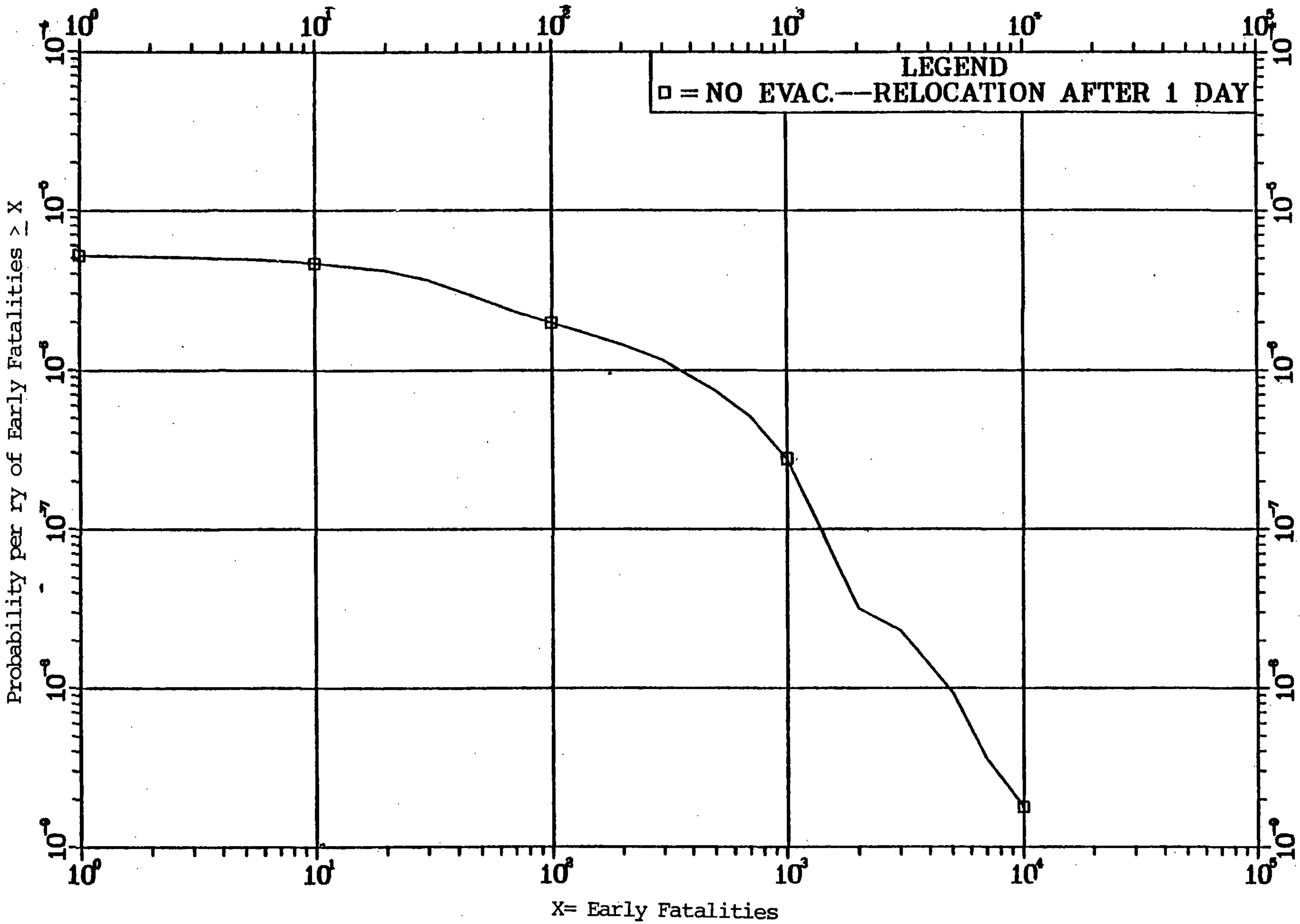

Figure F.1 Probability Distribution of Early Fatality for No Evacuation

NOTE: Please see Section 5.9.4.5(7) for discussion of uncertainties in risk estimates.

has also performed calculations using the most pessimistic dose-mortality relationship based upon minimal medical treatment and using identical assumptions regarding early evacuation and early relocation as made in Section 5.9.4.5. This shows an increase in early fatalities from 37 to 110 at the one chance in one million per reactor-year level and an increase from 1140 to about 5000 early fatalities at the one chance in one hundred million per reactor-year level (see Table 5.12). There is an overall doubling of the annual risk of early fatalities (see Table 5.13).

The major fraction of the increased risk of early fatality in the absence of supportive medical treatment would occur within 10 km and virtually all would be contained within 64 km of the Byron site.

References

Sandia National Laboratories, SAND 78-0092, "A Model of Public Evacuation for Atmospheric Radiological Releases," June 1978.

U.S. Nuclear Regulatory Commission, NUREG-075/014, "Reactor Safety Study," WASH-1400, October 1975.

---, NUREG-0340, "Overview of the Reactor Safety Study Consequences Model," October 1977.

APPENDIX G

IMPACTS OF THE URANIUM FUEL CYCLE

APPENDIX G

IMPACTS OF THE URANIUM FUEL CYCLE

The following assessment of the environmental impacts of the fuel cycle as related to the operation of Byron Station, Units 1 and 2 is based on the values given in Table S-3 (Table 5.10 in Section 5.10) and the staff's analysis of the radiological impact from radon releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80%. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of Byron station.

G.1 LAND USE

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 46 ha (113 acres); about 5 ha (13 acres) are permanently committed and 41 ha (100 acres) are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant; such as, mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 41 ha temporarily committed annually, 32 ha (79 acres) are undisturbed and 9 ha (22 acres) are disturbed. Considering common classes of land use in the United States,* fuel-cycle land-use requirements to support the model 1000-MWe LWR do not represent a significant impact.

G.2 WATER USE

The principal water-use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required for removal of waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43 x 10^6 m^3 (11.4 x 10^9 gal), about 42 x 10^6 m^3 (11.1 x 10^9 gal) are required for this purpose, assuming that these plants use once-through cooling. Other annual water uses involve the discharge to air (e.g., evaporation losses in process cooling) of about 0.6 x 10^6 m^3 (160 x 10^6 gal) and water discharged to ground (e.g., mine drainage) of about 0.5 x 10^6 m^3 (130 x 10^6 gal).

On a thermal-effluent basis, annual discharges from the nuclear fuel cycle are about 4% of those from the model 1000-MWe LWR using once-through cooling. The

*A coal-fired power plant of 1000-MWe capacity using strip-mined coal requires the disturbance annually of about 81 ha (200 acres) for fuel alone.

consumptive water use of 0.6×10^6 m^3/yr is about 2% of that from the model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel cycle use cooling towers) would be about 6% of that of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption acceptable relative to the water use and thermal discharges of the Byron station.

G.3 FOSSIL-FUEL CONSUMPTION

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

G.4 CHEMICAL EFFLUENTS

The quantities of chemical, gaseous, and particulate effluents associated with fuel-cycle-processes are given in Table S-3. The principal species are sulfur oxides, nitrogen oxides, and particulates. Judging from data in a Council on Environmental Quality report (Ref. 1), the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with these same emissions from the stationary fuel-combustion and transportation sectors in the United States; that is, about 0.02% of the annual national releases for each of these species. The staff believes that such small increases in releases of these pollutants are acceptable.

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

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

G.5 RADIOACTIVE EFFLUENTS

Radioactive effluents estimated to be released to the environment from reprocessing and waste-management activities and certain other phases of the fuel-cycle process are listed in Table S-3. Using these data, the staff has calculated the 100-year involuntary environmental dose commitment* to the U.S. population. It is estimated from these calculations that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222) would be about 400 person-rems for each year of operation of the model 1000-MWe LWR (reference reactor year, or, RRY). Based on Table S-3 values, the additional involuntary total-body dose commitment to the U.S. population from radioactive liquid effluents due to all fuel-cycle operations other than reactor operation would be about 100 person-rems for each year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is about 500 person-rems (whole body) per RRY.

At this time, the radiological impacts associated with radon-222 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings. The staff has determined that releases per RRY from these operations are as given in Table G.1. The staff has calculated population-dose commitments for these sources of radon-222 using the RABGAD computer code described in NUREG-0002, Appendix A, Section IV.J (Ref. 2). The results of these calculations for mining and milling activities prior to reclamation of open-pit uranium mines and tailings stabilization are given in Table G.2.

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

The staff has considered health effects associated with the releases of radon-222, including both the short-term effects of mining, milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that underground mines will be sealed after completion of active mining, with the result that releases of radon-222 from them will return to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that if all ore were produced from open-pit mines, releases from them would be 110 Ci/yr per RRY. However, because the distribution of uranium-ore reserves available using conventional mining methods is 66% underground and 34% open-pit (Ref. 3), the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 37 Ci/yr (0.34 x 110) per RRY.

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*The environmental dose commitment (EDC) is the integrated population dose for 100 years; that is, it represents the sum of the annual population doses for a total of 100 years. The population dose varies with time, and it is not practical to calculate this dose for every year.

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

Table G.1 Radon Releases from Mining and Milling Operations and Mill Tailings for Each Year of Operation of the Model 1000-MWe LWR*

Source	Radon-222 Release
Mining[1]	4060 Ci
Milling and tailings[2] (during active milling)	780 Ci
Inactive tailings[2] (prior to stabilization)	350 Ci
Stabilized tailings[2] (for several hundred years)	1 to 10 Ci/yr
Stabilized tailings[2] (after several hundred years)	110 Ci/yr

[1]Testimony of R. Wilde from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed 17 April 1978.

[2]Testimony of P. Magno from: "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed 17 April 1978.

*After three days of hearings before the Atomic Safety and Licensing Appeal Board (ASLAB) using the Perkins record in a "lead case" approach, the ASLAB issued a decision on May 13, 1981 (ALAB-640) on the radon-222 release source term for the Uranium Fuel Cycle. The decision, among other matters, produced new source term numbers based on the record developed at the hearings. These new numbers did not differ significantly from those in the Perkins record which are the values set forth in this Table. Any health effects relative to radon-222 are still under consideration before the ASLAB. Since the source term numbers in ALAB-640 do not differ significantly from those in the Perkins record, the staff continues to conclude that "both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural background sources." (see page C-6)

Table G.2 Estimated 100-Year Environmental Dose Commitment for Each Year of Operation of the Model 1000-MWe LWR

Source	Radon-222 Release (Ci)	Population-Dose Commitment (person-rems) Total Body	Bone	Lung (bronchial) epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1000	29	750	620
Total		140	3600	2900

Table G.3. Population-Dose Commitments from Unreclaimed Open-Pit Mines for Each Year of Operation of the Model 1000-MWe LWR

Time Period (yr)	Radon-222 Release (Ci)	Population-Dose Commitment (person-rems) Total Body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

Based on these assumptions, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37,000 Ci per RRY, respectively. The total dose commitments for periods of 100, 500, and 1000 years would be as shown in Table G.3. These commitments represent a worst-case situation because no mitigating circumstances are assumed. However, state and Federal laws currently require reclamation of strip and open-pit coal mines, and it is very probable that similar reclamation will be required for open-pit uranium mines. If so, long-term releases from such mines should approach background levels.

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

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

> 0.11-0.19 fatality for a 100-year period,
> 0.19-0.57 fatality for a 500-year period, and
> 1.2-2.0 fatalities for a 1000-year period.

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

These doses and predicted health effects have been composed with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP) (Ref. 5), the average radon-222 concentration in air in the contiguous United States is about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 millirems. For a stabilized future U.S. population of 300 million, this represents a total lung-dose commitment of 135 million persons-rems per year. Using the same risk estimator of 22 lung-cancer fatalities per million person-rems (lung) used to predict cancer fatalities for the model 1000-MWe LWR, estimated lung-cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year, or 300,000 to 3,000,000 lung-cancer deaths over periods of 100 and 1000 years, respectively.

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

These exposures also can be compared with those from naturally-occurring terrestrial and cosmic-ray sources, which average about 100 millirems. Therefore, for a stable future population of 300 million persons, the whole-body

Table G.4 Population-Dose Commitments from Stabilized-Tailings Piles for Each Year of Operation of the Model 1000-MWe LWR

Time Period (yr)	Radon-222 Release (Ci)	Population-Dose Commitment (person-rems)		
		Total Body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

dose commitment would be about 30 million person-rems per year, or three billion person-rems and 30 billion person-rems for periods of 100 and 1000 years, respectively. These dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis the staff concludes that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared with dose commitments and potential health effects to the U.S. population resulting from all natural-background sources.

G.6 RADIOACTIVE WASTE

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) are specified in Table S-3. For low-level waste disposal at land-burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. For high-level and transuranic wastes, the Commission notes that these are to be buried at a Federal repository, and that no release to the environment is associated with such disposal. It is indicated in NUREG-0116 (Ref. 6), in which are provided background and context for the high-level and transuranic Table S-3 values established by the Commission, that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is expected from such disposal.

G.7 OCCUPATIONAL DOSE

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rems. The staff concludes that this occupational dose will not have a significant environmental impact.

G.8 TRANSPORTATION

The transportation dose to workers and the public is specified in Table S-3. This dose is small and is not considered significant in comparison with the natural-background dose.

G.9 FUEL CYCLE

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

References

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

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

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

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

5. National Council on Radiation Protection and Measurements, "Natural Background Radiation in the United States," Publication No. 45, November 1975.

6. U.S. Nuclear Regulatory Commission, NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," Supplement 1 to WASH-1248, October 1976.

APPENDIX H

HISTORIC AND ARCHEOLOGICAL SITES

CONTENTS

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DEPARTMENT OF CONSERVATION
SPRINGFIELD 62706

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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

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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

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ENVIRONMENTAL AFFAIRS DEPARTMENT

STATE OF ILLINOIS

DEPARTMENT OF CONSERVATION

605 STATE OFFICE BUILDING
400 SOUTH SPRING ST.
SPRINGFIELD 62706

CHICAGO OFFICE—1227 S. MICHIGAN AVE. 60605

September 18, 1974

Mr. J. P. McCluskey
Director of Environmental Affairs
Commonwealth Edison
Post Office Box 767
Chicago, Illinois 60690

Dear Mr. McCluskey:

On August 22, this office received the Phase II Archaeological Report for the Byron Station site. The Report has been reviewed and the Department is satisfied that no archaeological sites will be disturbed by construction activities detailed in your transmittal letter and surveyor's map. It is noted that safeguards are being taken to protect the known archaeological sites and that construction crews will be instructed to remain a minimum of 50 feet from them. Thank you for this opportunity of review and comment.

Sincerely,

Tony Dean

Anthony T. Dean
Director
State Historic Preservation Officer

ATD:tmm

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Illinois Department of Conservation
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CHICAGO OFFICE – ROOM 100, 160 NO. LASALLE 60601
David Kenney, Director • James C. Helfrich, Assistant Director

May 12, 1981

Mr. Ben Berrickman
Environmental Affairs
Commonwealth Edison
P.O. Box 767
Chicago, IL 60690

RE: Commonwealth Edison's
Byron South Transmission
Corridor near Oregon, IL
Ogle County

Dear Mr. Berrickman:

The Department of Conservation staff archaeologist has reviewed the report submitted on the survey conducted for the above referenced project.

The survey and assessment of the archaeological resources appear to be adequate and, based on this report, it has been determined that the project will have no effect on archaeological resources.

Sincerely,

David Kenney
State Historic Preservation
Officer

DK/MKB/lsa
cc: Elizabeth Benchley

Illinois Department of Conservation
life and land together

605 WM. G. STRATTON BUILDING • 400 SOUTH SPRING STREET • SPRINGFIELD 62706
CHICAGO OFFICE – ROOM 100, 160 NO. LASALLE 60601
David Kenney, Director • James C. Helfrich, Assistant Director

July 16, 1981

Mr. C. L. McDonough
Director of Environmental
Assessment
Commonwealth Edison
P. O. Box 767
Chicago, Illinois 60690

Dear Mr. McDonough:

We have received your letter of July 7, 1981 concerning the archaeological surveys on the transmission corridors. Avoidance of the sites in the Byron-Wempletown corridor and those in the Byron-East corridor will result in no effect on those sites. Care should be taken that maintenance activities avoid these locations. If future work is proposed that might impact these sites, evaluation of them for eligibility for the National Register of Historic Places should be done.

The assessment of the archaeological resources within the various Byron Station corridors appears to have been adequately completed and the project as described will have no effect on archaeological sites.

Sincerely,

David Kenney
State Historic Preservation
Officer

DK/MKB/bk

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16. ABSTRACT *(200 words or less)*

The information in this Final Environmental Statement is the second assessment of the environmental impact associated with the construction and operation of the Byron Station, Units 1 and 2, located in Rockvale Township, Ogle County, Illinois, approximately seventeen miles southwest of Rockford, Illinois. The first assessment was the Final Environmental Statement related to construction issued in July 1974 prior to issuance of the Byron Construction Permits. The present assessment is the result of the NRC staff review of the activities associated with the proposed operation of the plant, and includes the staff response to comments on the Draft Environmental Statement.

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