50-331 •87

Final

environmental statement

related to operation of

DUANE ARNOLD ENERGY CENTER

IOWA ELECTRIC LIGHT AND POWER COMPANY
CENTRAL IOWA POWER COOPERATIVE
CORN BELT POWER COOPERATIVE

DOCKET NO. 50-331

ATOMIC ENERGY COMMISSION · UNITED STATES OF AMERICA

March 1973

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

SUMMARY AND CONCLUSIONS

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

1. This action is administrative.

2. The proposed actions are the continuation of construction permit CPPR-70 and the issuance of an operating license to Iowa Electric Light and Power Company, Corn Belt Power Cooperative, and Central Iowa Power Cooperative for the Duane Arnold Energy Center located in Fayette Township, Linn County, Iowa (Docket No. 50-331).

The Center will have one boiling water reactor, which will produce 1658 MWt of heat and have a net electrical output of 569 megawatts. Cooling will be provided by a closed-cycle system using forced-draft cooling towers.

3. The environmental impact and adverse effects are summarized as follows:

a. Approximately 500 acres of farmland have been converted from the production of crops to power plant use.

b. Approximatel 155 acres of land are required for the transmission lines, bu only a very small fraction of this land will be preempted from productive use.

c. There have been temporary disturbances of the riverbank and bottom and temporary increases in river turbidity due to construction and dredging activities.

d. There will be temporary discharges of chemicals used for cleaning plant components to the Cedar River, but once they are thoroughly mixed with the riverflow, these discharges will produce no changes exceeding the natural fluctuations in the chemical content of the river water.

e. The discharge of blowdown when chlorine is added to the cooling water may result in high levels of total residual chlorine (up to 0.5 ppm) in the discharge plume. The chlorine levels in local regions may prove to be toxic to biota in the river, particularly to fish attracted to the thermal plume in the winter.

f. The heat in the blowdown water will produce a small thermal plume in the river. But even under the worst of conditions, the temperature of the river will be increased 2°F in a region of less than one acre surface area, and the 2° plume will never extend beyond one quarter of the width of the river. The dissipation of the plume by thorough mixing in the riverflow will increase the temperature of the river 1.1°F at most. This will cause a decrease of not more than 0.5 ppm dissolved oxygen, which is well within normal fluctuations.

g. Up to 15,000 gallons per day of aerated sewage effluent will be discharged to the river without chemical disinfection. Given the present usage of the Cedar River (no swimming, drinking, etc. downstream) no deleterious effects are anticipated. The present Iowa sewage permit will require disinfection of sewage if downstream usage of the Cedar River increases sufficiently.

h. Most biota that pass through the 3/16-in. intake screens in the fraction of the river diverted for cooling (less than 10% during low flows and less than 1% during average flows) will be killed. Fish kills from impingement on screens are expected to be minimal because of the low (<0.75 ft/sec) velocity at the screen.

i. There will be additions of sulfates to the Cedar River in the blowdown water. The additions of sulfates will be limited to 19,500 pounds per day, and the resulting increase in sulfate level within the river should not adversely affect river biota.

j. Consumptive uses of river water will not exceed 7000 gpm (15.6 cfs), or 0.5% of normal riverflow. During low riverflows (less than 500 cfs) water will be released from the Pleasant Creek Reservoir to replace the consumption of river water.

k. Up to 1500 gpm will be pumped from the Silurian-Devonian aquifer. This withdrawal rate may deleteriously affect a large number of wells in the area.

l. Operation of the cooling towers may result in very minor increases in fogging and icing in nearby areas.

m. Operation of the cooling towers will result in a noticeable increase in the noise level at the nearest dwellings which may prove annoying to those involved.

n. The DAEC will discharge gaseous and liquid effluents containing radionuclides that will result in an increased exposure to the local population of less than the normal variation of the natural radioactive background.

o. The risk associated with accidental radiation exposures is very low.

4. The following principal alternatives were considered:

a. Purchase power from outside sources.

b. Construct the plant at an alternative site.

c. Use of fossil fuel in place of nuclear fuel.

d. Use of alternative cooling methods.

e. Use of chlorine control techniques or other biocide control techniques to reduce chlorine discharges.

f. Use of sodium hypochlorite to replace liquid chlorine.

g. Use of refrigeration equipment to reduce the need for well water for plant cooling.

5. The following Federal, State, and local agencies were requested to comment on the Draft Environmental Statement issued in November 1972. Comments that were received from these and other sources are presented in Appendix K, and responses to the comments are given in Section 12.

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare

Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
Iowa Department of Health
Iowa State Conservation Commission
Iowa Environmental Quality Department
Iowa Natural Resources Council
Iowa Air Pollution Control Commission
Iowa Bureau of Labor
Linn County Board of Supervisors

6. This Final Environmental Statement is being made available to the public, to the Council on Environmental Quality, and to the agencies noted above in March 1973.

7. On the basis of the analysis and evaluation set forth in this Statement, after weighing the environmental, economic, technical, and other benefits of the Duane Arnold Energy Center against environmental and other costs and considering the available alternatives, it is concluded that the actions called for under NEPA and Appendix D to 10 CFR Part 50 are the continuation of construction permit CPPR-70 and the issuance of an operating license for the facility subject to the following conditions for the protection of the environment:

a. If the total residual chlorine content in the blowdown effluent exceeds the limits as detailed in the Environmental Technical Specifications for the DAEC, the Applicant shall submit, within 12 months after start of plant operation, a report detailing the steps it intends to take to assure that the total residual chlorine in the blowdown effluent will conform to such limits. In the interim period, when total residual chlorine exceeds these limits the following conditions shall be required:

(i) Development of an aquatic monitoring program to define the area in which total residual chlorine is detectable.

(ii) Development of a program to monitor for effects of chlorine.

(Sections 5.4.3, 6.2.2.a, and 10.5).

b. The Applicant will take appropriate measures through monitoring along with administrative measures and/or design changes to insure that the thyroid dose to critical segments of the general population via the milk pathway does not exceed 5 mrem/year.

c. The Applicant's preoperational radiological monitoring program will be continued into the operational phase, with appropriate modifications acceptable to the Regulatory Staff.

d. The Applicant will define a comprehensive environmental monitoring program for inclusion in the Technical Specifications (for the plant operation) which is acceptable to the Regulatory Staff for determining environmental effects which may occur as a result of the operation of the DAEC.

e. If harmful effects or evidence of irreversible damage are detected by the monitoring programs, the Applicant will provide to the Staff an analysis of the problem and a plan of action to be taken to eliminate or significantly reduce the detrimental effects or damage.

CONTENTS

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

CONTENTS (cont'd)

FIGURES

TABLES

TABLES

TABLES

FOREWORD

This final statement on environmental considerations associated with the proposed continuation of the construction permit and issuance of an operating license for the Duane Arnold Energy Center was prepared by the U.S. Atomic Energy Commission, Directorate of Licensing (Staff) in accordance with the Commission's regulation, 10 CFR Part 50, Appendix D, implementing the requirements of the National Environmental Policy Act of 1969 (NEPA).

The National Environmental Policy Act of 1969 states, among other things, that it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.

- Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.

- Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.

- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice.

- Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.

- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

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

(i) The environmental impact of the proposed action,

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

(iii) alternatives to the proposed action,

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

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

Pursuant to Appendix D of 10 CFR Part 50, the AEC Directorate of Licensing prepares a detailed statement on the foregoing considerations with respect to each application for a construction permit or full-power operating license for a nuclear power reactor.

When application is made for a construction permit or a full-power operating license, the applicant submits an environmental report to the AEC. The Staff evaluates this report and may seek further information from the applicant, as well as other sources, in making an independent assessment of the considerations specified in Section 102 (2)(C) of NEPA and Appendix D of 10 CFR Part 50. This evaluation leads to the publication of a draft environmental statement, prepared by the Directorate of Licensing, which is then circulated to Federal, State and local governmental agencies for comment. Interested persons are also invited to comment on the draft statement.

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

In addition, in a proceeding such as this which is subject to Section B of Appendix D of 10 CFR Part 50, the final detailed statement includes a conclusion as to whether, after weighing the environmental economic, technical and other benefits against environmental costs and considering available alternatives, the action called for as regards the previously issued construction permit is the continuation, modification or termination of the permit or its appropriate conditioning to protect environmental values.

Single copies of this statement may be obtained by writing the Deputy Director for Reactor Projects, Directorate of Licensing, U.S. Atomic Energy Commission, Washington, D.C. 20545. Mr. Francis St. Mary is the AEC Environmental Project Manager for this statement. (301-973-7263)

1. INTRODUCTION

The Duane Arnold Energy Center (DAEC) is a nuclear generating plant which is being built jointly by the Iowa Electric Light and Power Company, the Corn Belt Power Cooperative, and the Central Iowa Power Cooperative. The consortium will hereinafter be referred to as "the Applicant." The plant consists of a single boiling-water reactor and associated steam-electric generating equipment. The design operating level is 1658 MWt, which will yield a net of 569 MWe. The plant is located on a 500-acre site on the west bank of the Cedar River near Palo, Iowa. Forced-draft evaporative cooling towers will be used to remove waste heat.

This Final Environmental Statement takes into account the Applicant's Environmental Report and amendments thereto, and the Final Safety Analysis Report and the amendments thereto. Comments received from federal and state agencies on these documents and the Draft Environmental Statement have also been considered during the preparation of this final statement. The above documents and comments are on file in the AEC Public Document Room at 1717 H Street, N.W., Washington, D.C., and at the Cedar Rapids Public Library, 426 Third Avenue, S.E., Cedar Rapids, Iowa 52401. The Final Environmental Statement includes data and information obtained from a site visit in August 1972 as well as information from other sources referenced in the text. Finally, it relies heavily on professional calculations and appraisals made by the AEC Regulatory Staff (Staff).

As presently proposed, a recreation and storage reservoir is to be built by the Iowa State Conservation Commission, a few miles north of the DAEC with the help of a one-million dollar contribution from the Applicant. It is to be managed by the Iowa State Conservation Commission as a recreational area, with the provision that the Applicant reserves the right to release water to the Cedar River when needed to replace that consumed by the plant during periods of low riverflow. There is to be no physical connection between the reservoir and the DAEC. Construction of the reservoir is not scheduled to begin before March of 1973, and as this is written the construction details and operating plans for the reservoir are not firm. Features of the reservoir will be noted and possible impacts will be mentioned where they are obvious, but this statement does not purport to represent a review of the environmental impact of the reservoir because the reservoir if not considered an integral part of the licensing action of this plant.

1.1 STATUS OF PROJECT

The Applicant announced its intent to build the DAEC in February 1968 and applied to the U.S. Atomic Energy Commission for a construction permit in November 1968. The application and its amendments were evaluated by the AEC Regulatory Staff and by the Advisory Committee on Reactor Safeguards to determine that there was reasonable assurance that the plant could be constructed and operated without undue risk to the health and safety of the public. A construction permit was issued in June 1970 after public hearings were held in Cedar Rapids, Iowa (March 1970) and in Washington D. C. (June 1970).

The Applicant submitted an Environmental Report for the DAEC in April 1971. In October of 1971 the Applicant submitted a statement of reasons why with reference to the criteria in paragraph E(2) of the revised Appendix D of 10 CFR 50 the construction permit should not be suspended pending completion of the NEPA environmental review. In November of 1971 the Division of Reactor Licensing, AEC, after reviewing the available information, determined that the construction permit should not be suspended pending completion of the NEPA environmental review. The Applicant's final Environmental Report was issued in November 1971 and amendments have been submitted in July and October of 1972. The Applicant's Final Safety Analysis Report has also been completed. A notice of consideration of issuance of facility operating license and opportunity for hearing which incorporated a notice of hearing on the environmental aspects of the previously issued construction permit for the DAEC pursuant to 10 CFR Part 50, Appendix D, Section B, was published in the Federal Register on September 30, 1972. Public hearings before Iowa State agencies which have been held and/or permits applied for with regard to site access, building, water use, waste discharge, and related environmental considerations are enumerated in Section 1.3 and in the Applicant's Environmental Report.

Construction on the DAEC was started in June 1970 and the plant on December 31, 1972 was 75 percent complete. Fuel loading is scheduled for Se tember of 1973 and operation at 90% of designed power is scheduled to egin in January of 1974.

1.2 SITE SELECTION

The present trend towards constructing large electricity-generating facilities, with their resultant economies of scale, is consistent with the rapid increase in power demand and is possible because of advances in technology. But large generating units require special sites. Large volumes of water are required to dissipate the waste heat from the steam-electric cycle and, if fossil fuels are used, bulk transportation facilities, such as railroads or navigable waters, must be available. The site must be sufficiently close to power users to keep distribution losses from becoming too large, and sufficiently close to existing transmission facilities to keep the cost of construction and additional impacts of new lines from becoming prohibitive.

All of the above factors were considered in selecting a site for the Duane Arnold Energy Center. Sites for both coal-fueled plants and nuclear-fueled ones were considered. The ones chosen as most suitable for coal-fueled plants were on the Mississippi River because of the proximity to coal fields and the availability of river transportation. However, with the decision to build a nuclear-fueled plant, for economic reasons, fuel transportation costs became no longer an important factor and closeness to load centers made the interior sites on the Cedar River more economical. The particular site on the Cedar River was chosen on the basis of its nearness to existing transmission facilities, remoteness from cities, land cost, and subsoil conditions. The site selected is located on the western side of the Cedar River, approximately 2-1/2 miles north-northeast of Palo, Iowa.

1.3 STATUS OF APPLICATIONS AND APPROVALS

Approvals for the construction and operation of the plant, or parts thereof, are required from numerous federal and state agencies. Tables 1.1 and 1.2 summarize the nature of the permits required and indicate the status of each.

At various stages of the planning and construction of the plant, the Applicant has held discussions with federal, state and local officials as well as educational, public-interest, and other groups.

TABLE 1.1. Status of Permits, Licenses, and Approvals from Federal Agencies

Subject	Application Date	Approval Date
Atomic Energy Commission		
Construction Permit	November 4, 1968 Revised June 2, 1970	June 22, 1970
Operating License	May 8, 1972	

TABLE 1.2. Status of Permits, Licenses, and Approvals from Iowa State Agencies

Iowa Natural Resources Council

A permit from the Natural Resources Council is required for the excavation or construction on any designated flood plain or in any creek or river in the State of Iowa. The Council also appoints a Water Commissioner to consider and approve or disapprove applications for permits to divert, store or use surface or ground water (Code of Iowa, 1971, Chapter 455A).

1. The Council on its own motion, on September 10, 1968, established a protected flow for the Cedar River of 500 cfs for power plant uses.

2. Temporary Permit No. 69-206, approved September 5, 1969, authorized excavating grading at the site.

3. Construction Permit No. 69-206MI, approved March 9, 1970, authorized construction of DAEC nuclear facilities. It replaced Temporary Permit No. 69-206.

4. Permit No. 70-72, approved April 6,]970, authorized construction of a railroad bridge over Opossum Creek in Linn County.

5. Letter of December 3, 1970, granted an administrative waiver for an air-quality monitoring tower.

6. Permit No. 71-192, approved August 3, 1971, authorized construction of a low-head diversion dam on Cedar River in Section]0, T 84 N, R 8 W, Linn County, Iowa.

7. Water Permit No. 2711, issued November 24, 1969, authorized the dredging of sand from the Cedar River.

8. Water Permit No. 2794, issued January 25, 1970, authorized the installation of two 750-gpm wells.

9. Water Permit No. 3046, issued October 12, 1971, authorized the installation of industrial wells at the plant site, and authorized the Applicant to withdraw from the Cedar River, for consumptive use, up to 20 cfs, when the flow of the river exceeds 500 cfs. When the flow falls

TABLE 1.2 - Continued

below 500 cfs, the Applicant may continue to withdraw the authorize
amount if it returns an equal amount to the river above Cedar Rapid
from a supplemental source.

<u>Iowa Conservation Commission</u>

The Conservation Commission is dutybound to protect and preserve th fish and wildlife in Iowa, to promote and establish state parks, recreation areas, game reserves, artificial lakes and such other areas acquired for use by the people of the State of Iowa (Code of Iowa, 1971, Chapter 107). Also, the installation of water intake screens and gates require the approval of the Commission (Code of Iowa, 1971, Section 109.14).

1. Sand Dredging Permits No. 74 and 75 in the Cedar River were iss January, 1970 and expired January 1, 1971.

2. Construction Permit No. 65, issued November 25, 1969, authorize breaking of the bank of Cedar River in Section 10, T 84 N, R 8 W, L County, Iowa.

3. Construction Permit No. 63, issued August 13, 1971, authorized struction of low-head diversion dam in the Cedar River in Section 1 T 84 N, R 8 W, Linn County, Iowa.

<u>Iowa Water Pollution Control Commission</u>

The Water Pollution Control Commission has the responsibility to pr vent, abate, or control the pollution of the waters of the state, and enhance water conditions for public supply, aquatic life and other beneficial uses. (Code of Iowa, 1971, Chapter 455B).

1. Permit No. 71-56-S, approved April 14, 1971, authorized dischar of thermal and radioactive wastes into the Cedar River in Section 1 T 84 N, R 9 W, Linn County, Iowa.

2. Certification of compliance with Iowa Water Quality Standards pursuant to Section 21 (b) of the Federal Pollution Control Act was issued on April 14, 1971.

TABLE 1.2 - Continued

Iowa Department of Health

In addition to the full complex of duties involved in general supervision of the public health, the Department of Health has regulatory jurisdiction over all public sewage waste disposal plants (Code of Iowa, 1971, Chapter 135). It also provides the technical secretaries for both the Iowa Air and the Iowa Water Pollution Control Commissions and assists the other Commissions with such technical and engineering services as are needed.

1. Sewage Waste Permit No. 70-28-S, granted February 20, 1970, authorized the use of extended aeration treatment facilities for the DAEC.

Iowa Commerce Commission

A franchise must be obtained from the Commerce Commission prior to the construction, operation, or maintenance of any transmission line over, across, or along any public highway or grounds outside of cities and towns (Code of Iowa, 1971, Chapter 489). The Commission also regulates the rates and services of public utilities in the state (Code of Iowa, 1971, Chapter 490A.1).

Applications for franchises for construction of transmission lines as a part of the DAEC project will be filed as needed. Applications are generally acted upon within 45 to 90 days.

Iowa Department of Labor - Boiler Inspection Division

The Boiler Inspection Division has the responsibility of inspecting all pressure vessels, boilers, and steam piping of 15 pounds pressure or more (Code of Iowa, 1971, Chapter 91).

The DAEC heating boiler has been installed and has been inspected by an authorized inspector. Permit Number 30952 has been issued to authorize operation of this boiler.

---

2. THE SITE

2.1 SITE LOCATION

The Duane Arnold Energy Center is located on the west bank of the Cedar River, eight miles northwest of Cedar Rapids, Iowa. The site is approximately 2-1/2 miles north-northeast of Palo, Iowa, in Linn County (Township 84N, Range 8W, Sections 9 and 20).

The plant site encompasses approximately 500 acres of relatively flat land, which was primarily farmland (Fig. 2.1). The land to the south and west of the site is also essentially flat agricultural land. To the northwest, it rises and is sparsely wooded farmland. To the east, across the river, the land rises and is heavily wooded, with only an occasional field or pasture. Beyond the rise, it is primarily gently rolling farmland.

The plant site is shown in an aerial photograph in Fig. 2.2. The distance from the reactor to the nearest site boundary is approximately 2000 feet. A topographic map is shown in Fig. 2.3.

Present plans call for a storage and recreation reservoir to be built by the Iowa State Conservation Commission called the Pleasant Creek Reservoir; it will provide makeup water for the river to replace that water consumed by the DAEC during periods of low flow (less than 500 cfs). The reservoir will be managed by the State Conservation Commission but the Applicant will retain rights to release water to the Cedar River equal to the plant's consumptive use during low flow periods. The proposed reservoir is to be situated north of the plant site close to the Cedar River, as shown in Fig. 2.4. The reservoir will require the purchase of more than 1900 acres for its construction and will have a surface area of about 410 acres.

2.2 DEMOGRAPHY AND LAND USE

The DAEC is located in a primarily rural, sparsely populated region, though there are three metropolitan areas within 50 miles of the site: Waterloo, 40 miles to the northwest; Cedar Rapids, 8 miles to the southeast; and Iowa City, about 32 miles to the southeast. The townships immediately surrounding the site, Fayette, Washington, and Monroe, are agricultural regions with over 90 percent of the area being farmland.

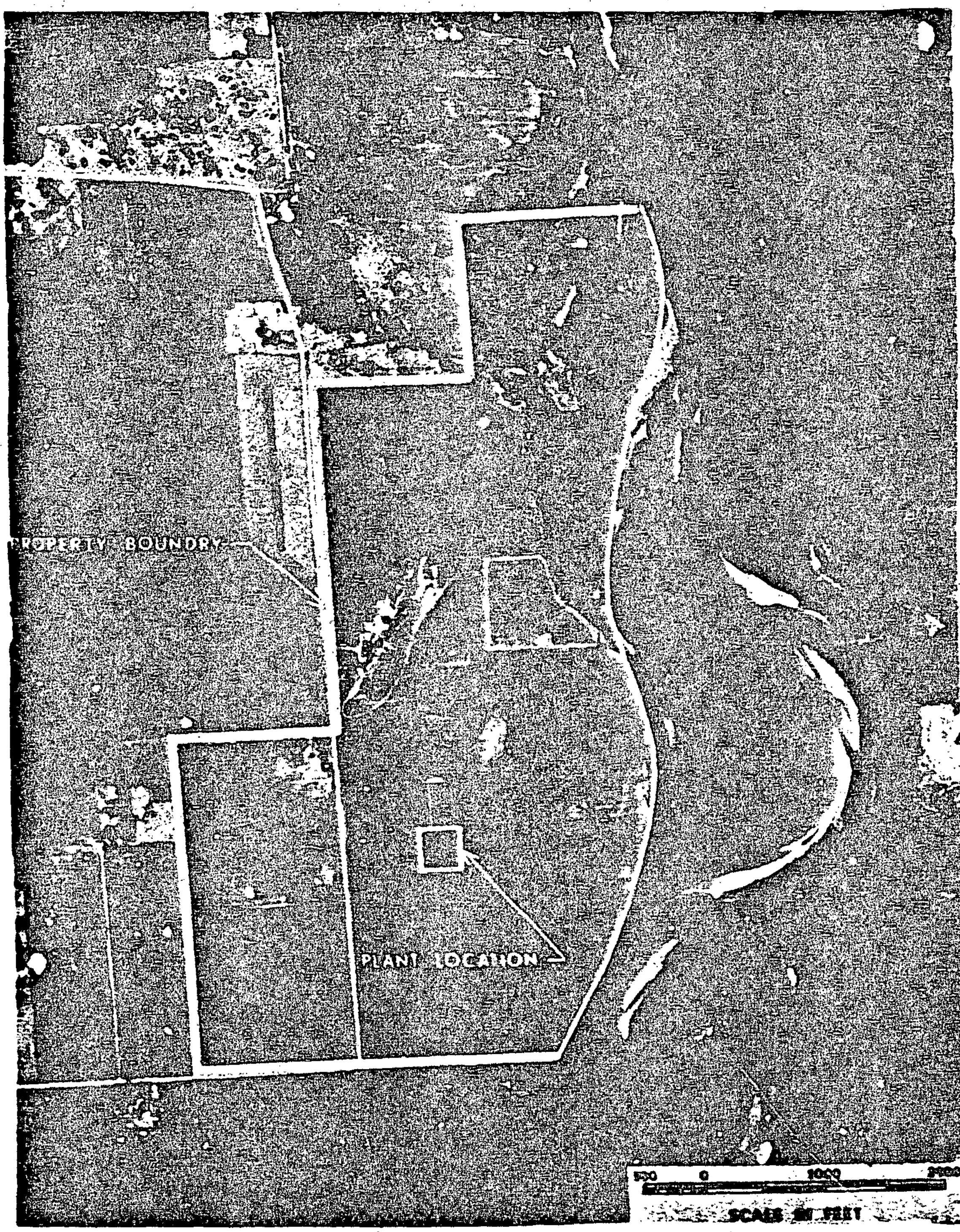

Fig. 2.1. Site of the Duane Arnold Energy Center before Construction Began. From Applicant's Final Safety Analysis Report.

Fig. 2.2. Photo of the Duane Arnold Energy Center under Construction.

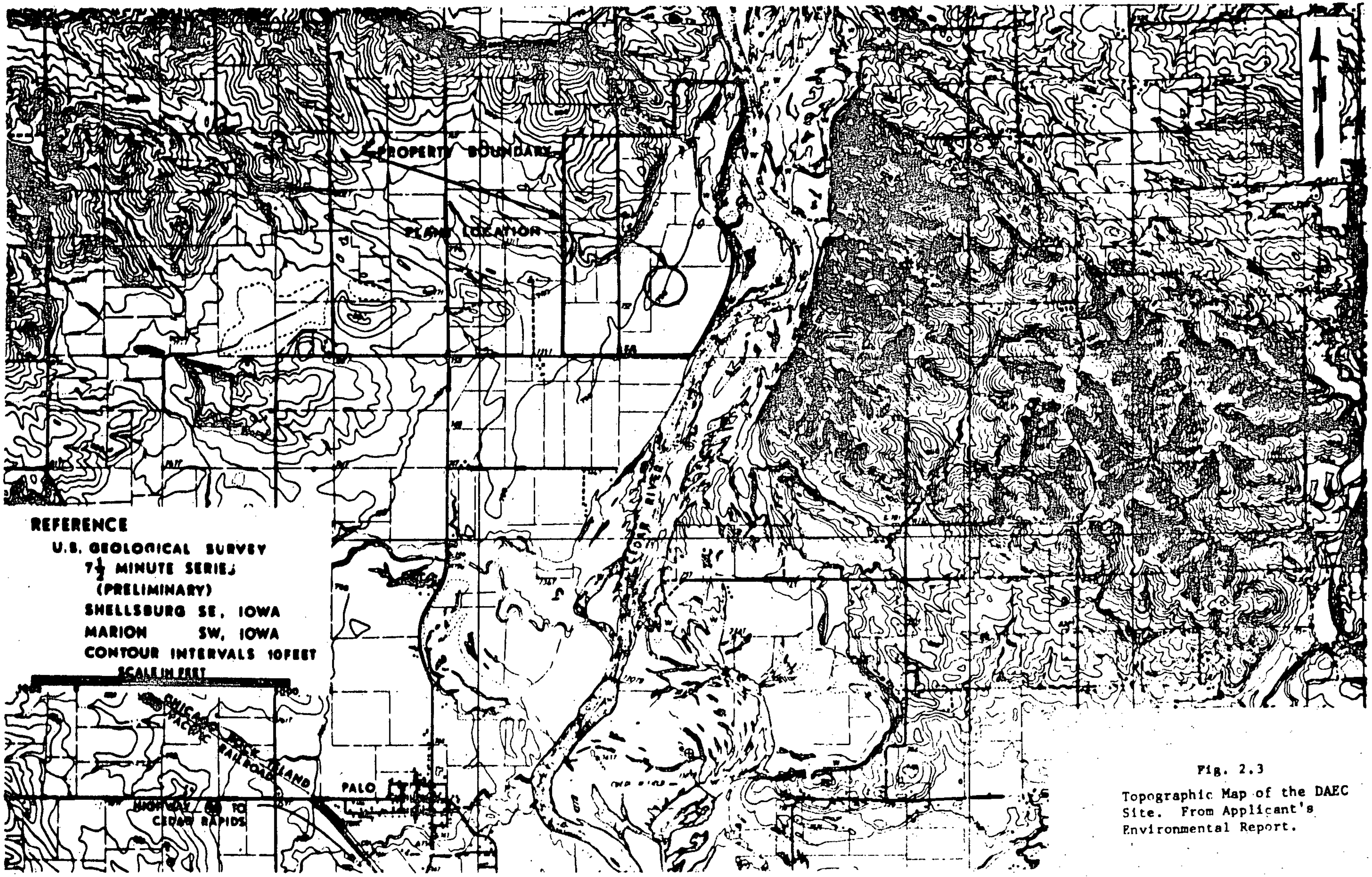

Fig. 2.3

Topographic Map of the DAEC Site. From Applicant's Environmental Report.

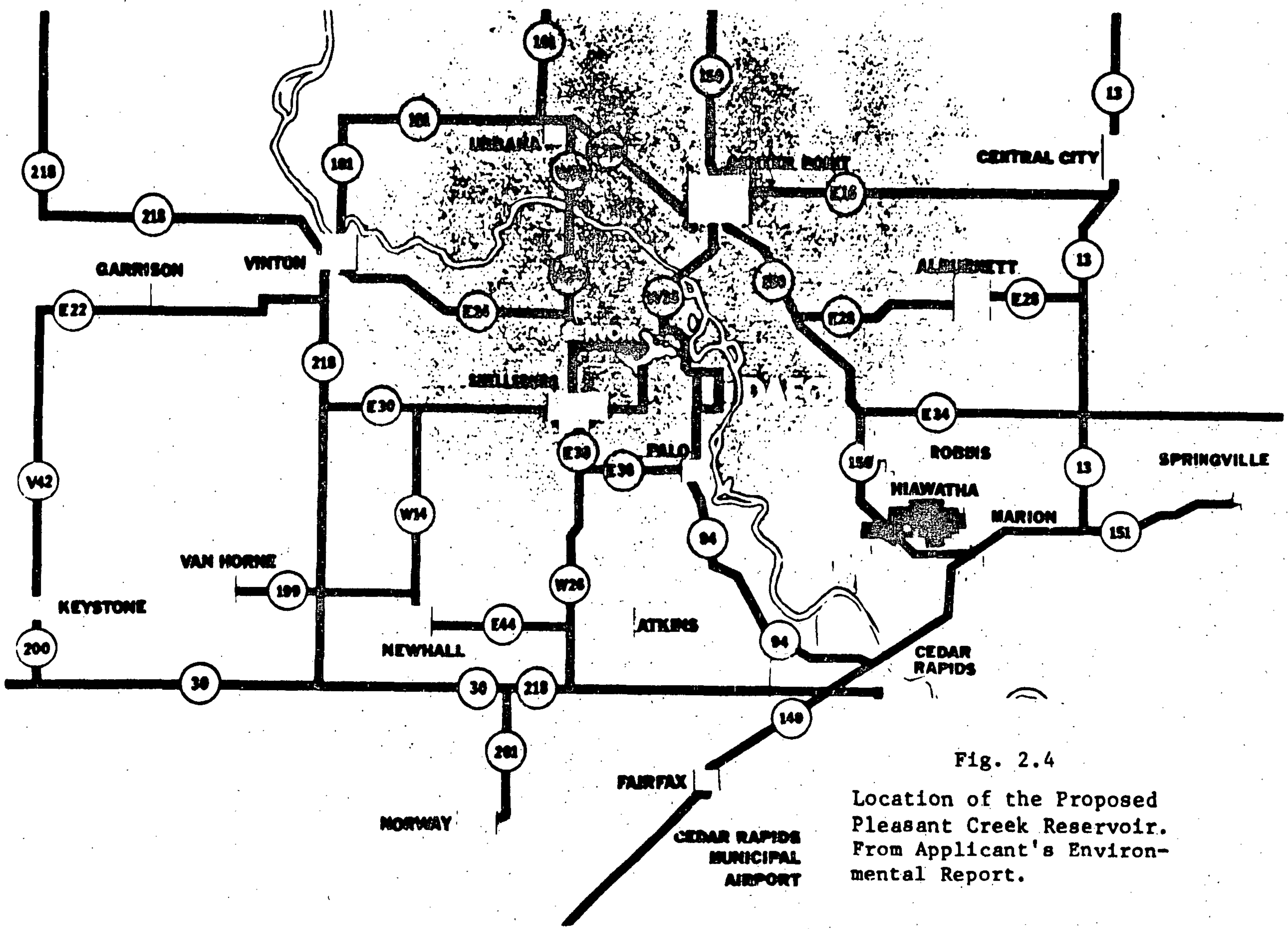

Fig. 2.4

Location of the Proposed Pleasant Creek Reservoir. From Applicant's Environmental Report.

The three principal areas of population concentration within 50 miles of the Duane Arnold Energy Center site are Waterloo 75,533, Cedar Rapids 110,642, and Iowa City 46,850. The total 1970 population within 50 miles of the site was 550,010; the projected 1980 population is 619,778 and the projected 2010 population 952,106. Most of the population increase in the area is expected to develop in the metropolitan areas, the rural areas remaining relatively stable or slowly decreasing.[1]

The area within five miles of the site is primarily farmland or forested land and is very sparsely populated. There are three small communities within five miles of the site - Palo, Toddville, and Shellsburg - with a combined population of about one thousand. Within one mile of the site, there are three occupied farm houses with a total population of 15. The area between five and ten miles of the site is also sparsely populated except to the southeast where the boundary of Cedar Rapids approaches to within eight miles of the site.

The agricultural nature of most of the land within ten miles of the site is not expected to change during the life of the plant. Except for a portion encompassing the city of Cedar Rapids, it is about 90% farmland. About 50% of the farmland is cultivated, principally for corn, oats, and soybeans. Most of the remaining 50% is pastureland supporting about 7000 dairy cows. The land within ten miles of the site which is not farmland is principally covered by woods or buildings and roads. At present, there are no lakes or reservoirs within ten miles of the site, though it is proposed that the 440-acre Pleasant Creek Reservor be built within three miles of the site.

There are several small parks and conservation areas within ten miles of the site, particularly along the Cedar River. Most of them are only slightly developed with low-intensity use, though there are a few highly developed parks. The estimated annual number of people visiting in the public parks within ten miles of the site is one million. Heavily-used park areas such as Lake McBride and Palisades Kepler State Parks are beyond ten miles from the site.

Between 10 and 50 miles of the site the land remains primarily farmland. Coralville Reservoir and Lake McBride, about 20 miles southeast of the site, are the only significant lakes or reservoirs within 50 miles.

The nearest airfield used for commerical traffic is the Cedar Rapids Municipal Airport, located 15 miles south of the site. There is also a small private airport for light planes located approximately four miles southeast of the site.

The Cedar River is not used for commerical river traffic. There is some pleasure boating, but it is principally confined to reaches below the site so the river traffic in the vicinity of the plant is very slight. There are no major highways within a few miles of the site. The nearest present primary state road is Iowa 94, three miles away, which has only light-to-moderate usage. Interstate 380 is, however, proposed to be extended from Iowa City to Waterloo, in which case, it will run within about three miles of the site.

The county of Linn, in which the plant is to be located, has no comprehensive long-range land-use plans, however, it is trying to buy all flood-plain land available along the Cedar River, so future developments along the river near the plant are unlikely. Present county planning maps show the area around the plant site as being in an undeveloped zone.

2.3 HISTORIC AND ARCHAEOLOGICAL LANDMARKS

No historic sites for Linn or Benton Counties are listed in the current National Register of Historic Places.[2] The State of Iowa has just started a listing of state historic sites and has no detailed listing at this time. It is probable that some historic sites will be designated in the future in Cedar Rapids, but these would not be adversely affected by the DAEC.[3]

The Cedar River valley is rich in archaeological sites, but inspections by the State Archaeologist have shown no definite indications of archaeological or historical sites of significance in the area of the plant site.[4] The site of the proposed Pleasant Creek Reservoir has not been surveyed for archaeological interest; however, the Iowa State Conservation Commission has initiated a request to the State Archeologist to undertake a study of the area.

2.4 GEOLOGY AND SEISMOLOGY

The site lies in the northern portion of the Interior Lowland Physiographic Province, within the Central Stable Region of North America, south of the Canadian Shield. The region is characterized by a basement complex of Precambrian crystalline rocks overlain by a varying thickness of Paleozoic sedimentary strata. The sedimentary rocks are of Pennsylvanian age or older. During the Mesozoic and Cenozoic eras, this region generally was above sea level and subject to erosion rather than deposition, which accounts for the absence of younger formations. Minor accumulations of Cretaceous sediments exist in western Iowa and have been reported in portions of western Illinois. These deposits have not been identified in eastern Iowa. During the Pleistocene epoch, the stable interior of the continent was covered by continental glaciers, which scoured the bedrock surface and subsequently covered much of the region with glacial drift. A distribution of the major geologic units in the region is shown in Fig. 2.5.

Postglacial erosion and deposition of alluvial and windblown deposits altered the landscape to its present form. Topography in the region is characterized by smoothly contoured land forms of low to moderate relief. Steep slopes are usually found only in areas where a river or stream has cut into the loess-covered hills.

Pleistocene glaciation, which occurred several hundred million years after deposition of the uppermost bedrock strata, mantled the entire region with unconsolidated sediments of variable thickness and composition. The distribution of surficial unconsolidated materials in the region is shown in Fig. 2.6.

The bedrock strata immediately underlying the site are the Wapsipinicon and Gower Formations, of Middle Devonian and Upper Silurian age, respectively. The bedrock surface at the site ranges in depths from approximately 25 feet to more than 100 feet below the existing ground surface. A bedrock high is centered directly beneath the plant. It is probably due to preglacial erosion modified by interglacial erosion. Weathered bedrock, found in the valleys and hard unweathered rock, encountered on the highs, is attributed to differential glacial scour. In general, the rock encountered at the site is relatively fresh and hard.

A clay till containing some sand and gravel interspersed in the clay matrix directly overlies the bedrock surface. The till has, at various times, been described as both Kansan and Iowan. The till thickness varies from 12 to 80 feet in the site area and averages 20 feet in the plant area.

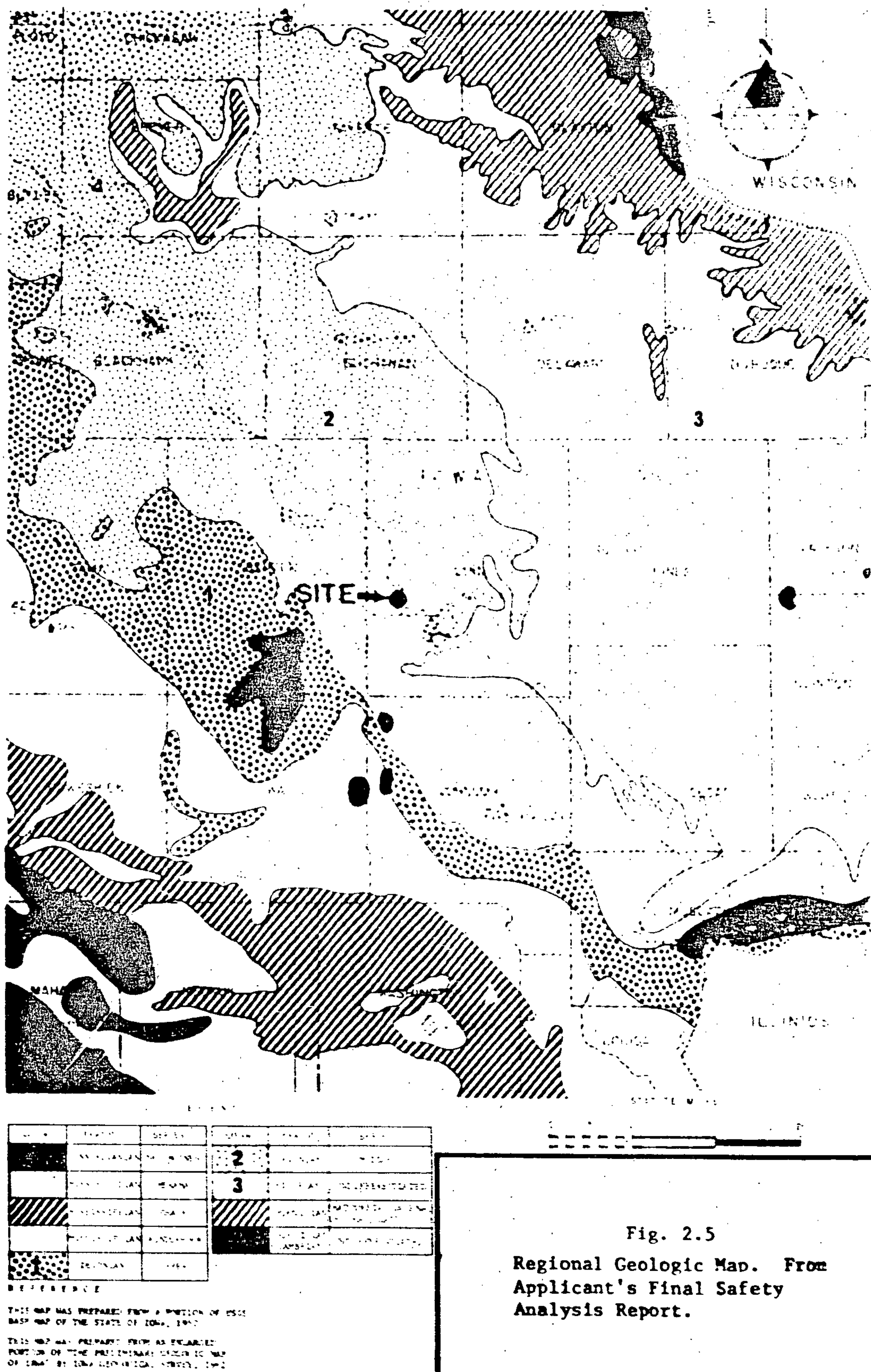

Fig. 2.5
Regional Geologic Map. From Applicant's Final Safety Analysis Report.

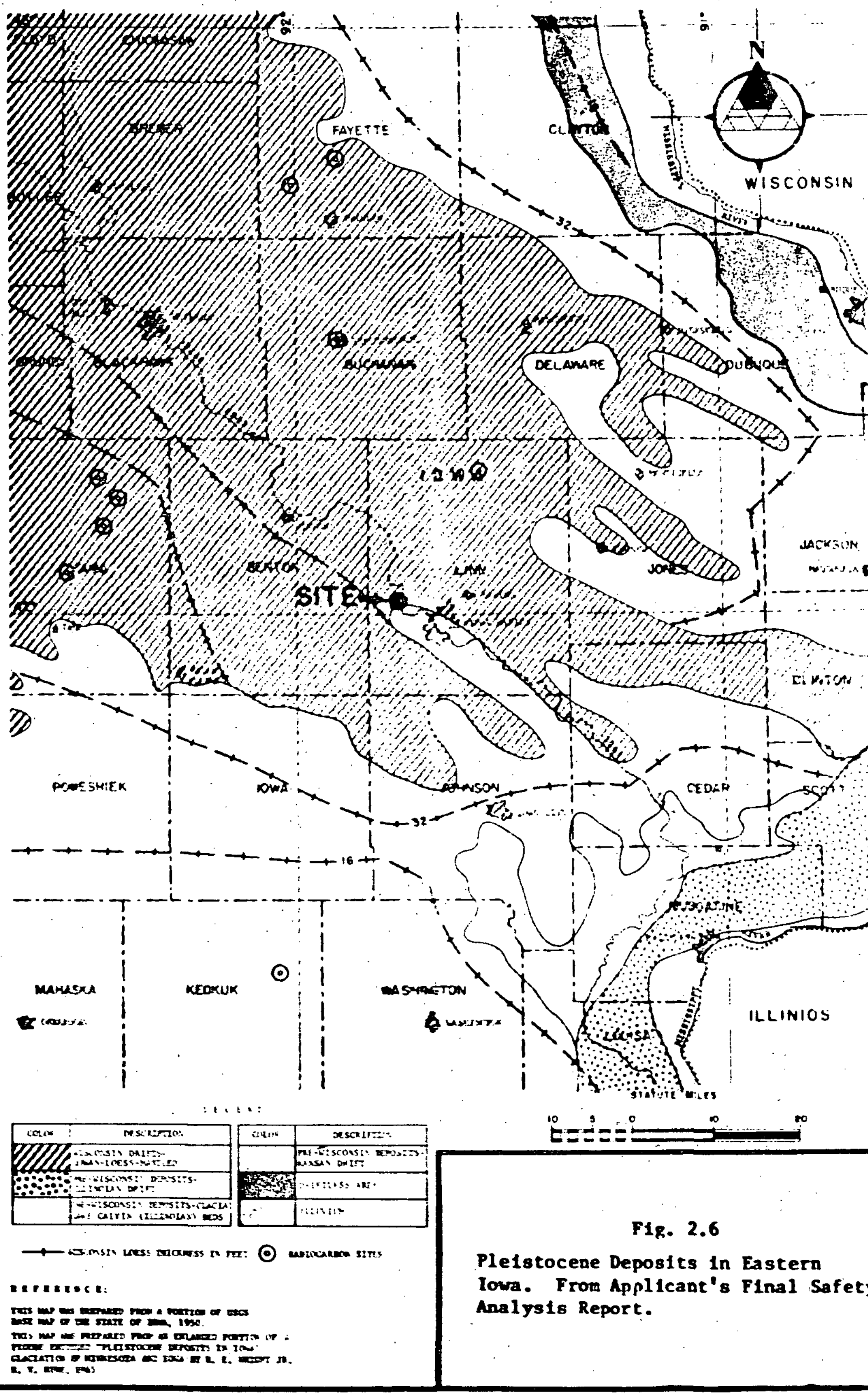

Fig. 2.6

Pleistocene Deposits in Eastern Iowa. From Applicant's Final Safety Analysis Report.

A general description of the soils and rocks encountered at the site is shown in Fig. 2.7.

The site is situated in an area which has experienced very little earthquake activity. No earthquake epicenter has been reported closer than about 75 miles to the site. Since the region has had a permanent population for over 100 years, it is probable that all earthquakes of about Intensity V or greater on the Modified Mercalli Scale would have been reported during this period. Only four earthquakes have been reported within 100 miles of the site and only 15 earthquakes within about 200 miles since the beginning of the 19th Century. None of these shocks was greater than Intensity VII. Few were of high enough intensity to cause structural damage, and only two can be considered more than minor disturbances. These were two Intensity VII earthquakes in northern and central Illinois which occurred in 1909. The epicenter of each shock was about 150 miles from the site. The closest reported earthquake to the site was a 1934 Intensity VI shock near Rock Island, Illinois. Although one or more of these shocks may have been felt in the locality of the site, no damaging effects were experienced (intensities were on the order of III or less). These epicenters as well as those of more distant regional earthquakes are shown in Fig. 2.8.

Further details of the geology, tectonics, and seismology of the region and their relation to plant design and safety may be found in the Applicant's Final Safety Analysis Report.[5]

2.5 HYDROLOGY

2.5.1 Surface Water

Surface water runoff in the State of Iowa averages 6 inches, with the largest amounts in the eastern parts of the state. Principal rivers of Iowa are the Mississippi and the Missouri, on the boundaries of the state; and the Des Moines, Cedar, and Iowa Rivers in the interior of the state. Of the major interior streams, the Cedar River has the least variability inflow and the best sustained low flow.

The Duane Arnold Energy Center is located on the west bank of the Cedar River. At the site location the Cedar River drainage area is 6250 square miles. The flood plain along the Cedar River at the site location is relatively narrow, but upstream of the plant there are spans several miles wide. The site location within the Cedar River basin is shown in Fig. 2.9.

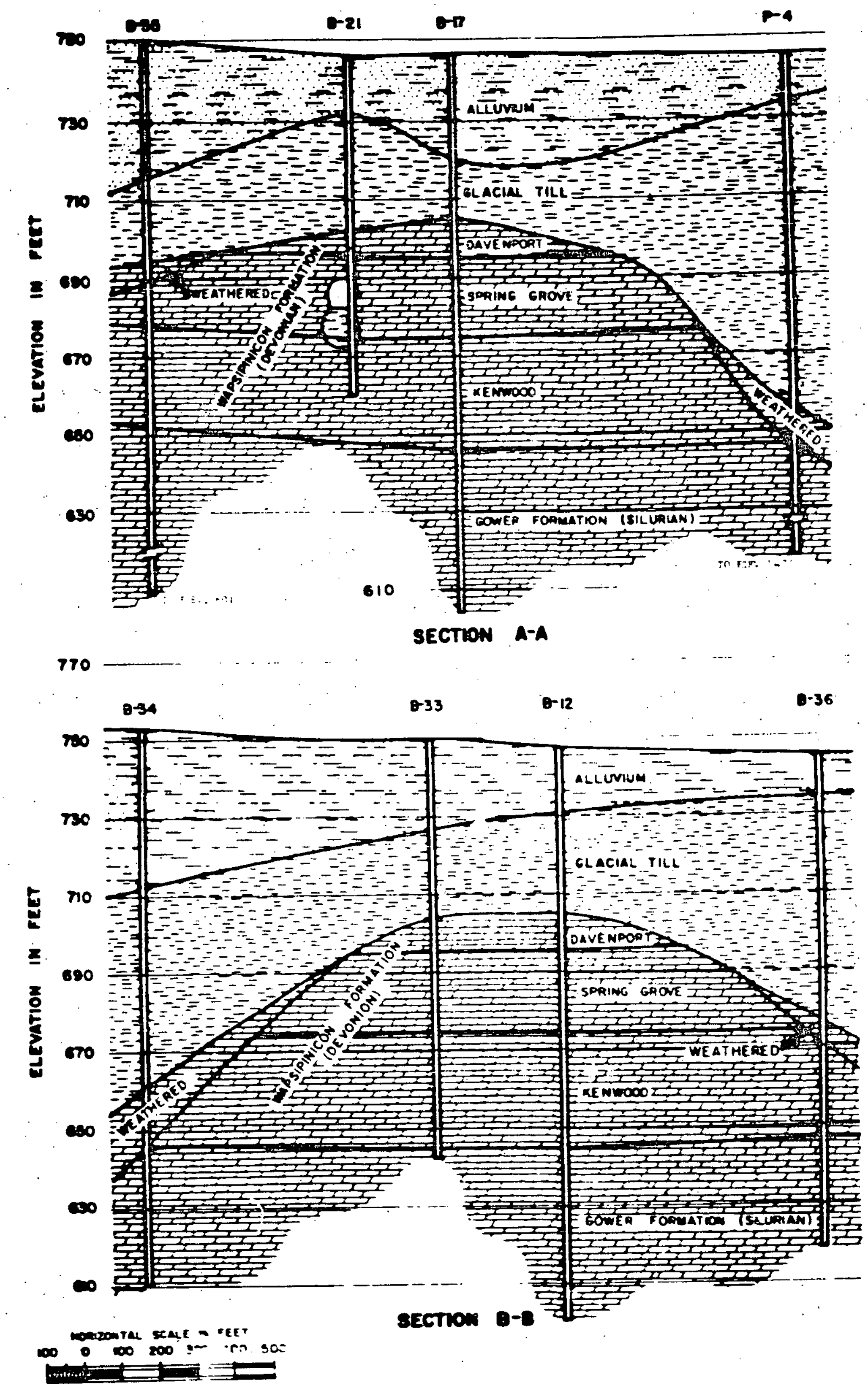

Fig. 2.7. **Geologic Profiles. From Applicant's Final Safety Analysis Report.**

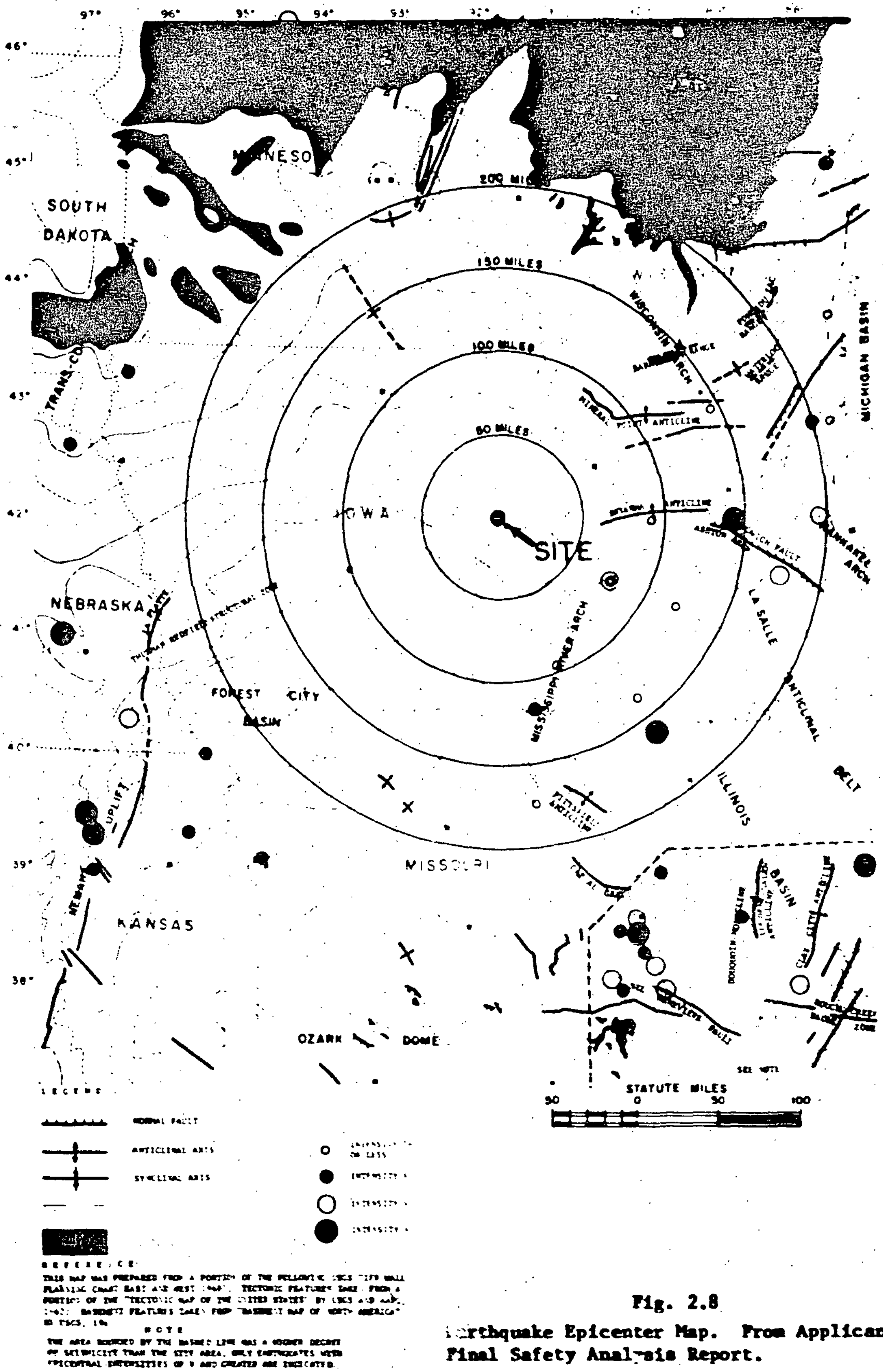

Fig. 2.8

Earthquake Epicenter Map. From Applicant's Final Safety Analysis Report.

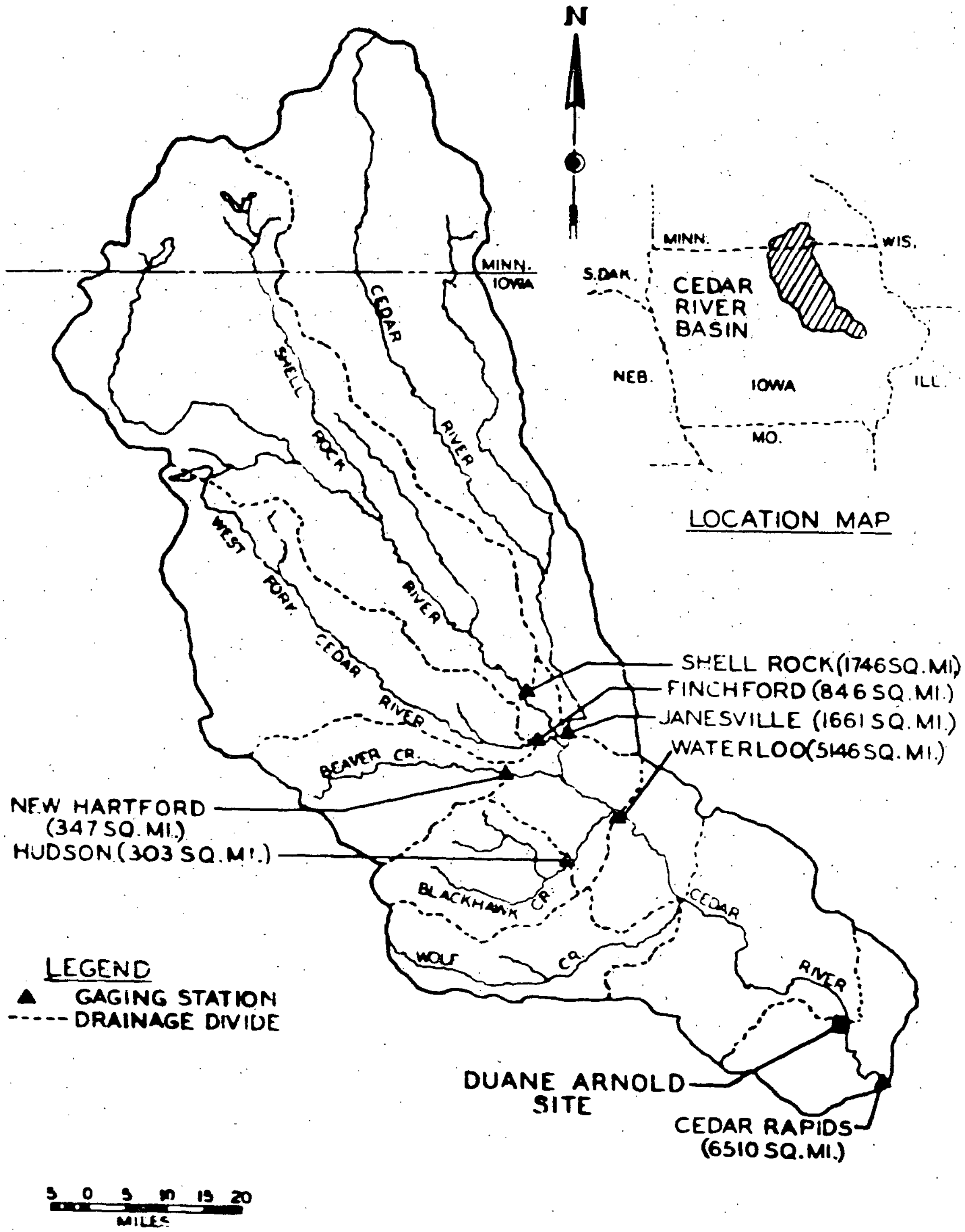

Fig. 2.9. The Cedar River Basin Showing Location of the DAEC Site. From Applicant's Final Safety Analysis Report.

The Cedar River is the largest tributary of the Iowa River and is fed from a well-defined drainage area which at the mouth of the Cedar River is 7819 square miles in area. There are fifteen low-head dams on streams within the Cedar River basin, twelve of which are located upstream of the plant site. Of these twelve, seven are actually on the Cedar River and five are on tributary streams. The dams all have small impoundments and are not used for stream flow regulation. The Cedar River in the area of the site is classified by the Iowa Water Pollution Control Commission as a warm water area and is subject to the Iowa Water Quality Standards for warm waters.

The northeast Iowa basins, including the Cedar River basin, have fairly well-defined sustained low flows in contrast to river basins in the south and west of the state, which have very poor low flow characteristics. Flow data for the Cedar River in the site vicinity are well known, as the longest streamflow records in the state have been taken at Cedar Rapids, just 15 miles downstream from the plant. On the basis of such records from 1902 to 1968 the average flow in the Cedar River is 3065 cfs, corresponding to an annual runoff of 6.39 inches. The average annual runoff and corresponding streamflow is shown in Fig. 2.10. The flow duration curve for the Cedar River at the Cedar Rapids gage is shown in Fig. 2.11. The maximum flood of record reached a peak of 73,000 cfs. The river reached an elevation of 746.5 feet at the plant site during this flood. (The plant site's finished grade will be at 757 feet and all essential structures are designed for flood protection up to at least 769 feet.) The minimum daily recorded flow at Cedar Rapids was 212 cfs.

In connection with the Duane Arnold Energy Center the Iowa State Conservation Commission plans to build the Pleasant Creek Reservoir, which would have a surface area of 440 acres and a storage capacity of 4450 acre feet (1.9×10^8 ft^3). The reservoir would be a pumped storage reservoir approximately 100 feet above the river. Nominal water surface elevation would be 824 ft and the water would be contained behind a 72-ft-high dam. The primary use of the reservoir would be for recreation, and the Iowa State Conservation Commission is to have full responsibility and jurisdiction over its use subject to the restraint that the Applicant would have rights to release water from the reservoir to the river, whenever riverflow falls below 500 cfs, to make up for consumptive use of river water. There is to be no physical interconnection between the cooling system at the power plant site and the water stored in the reservoir.

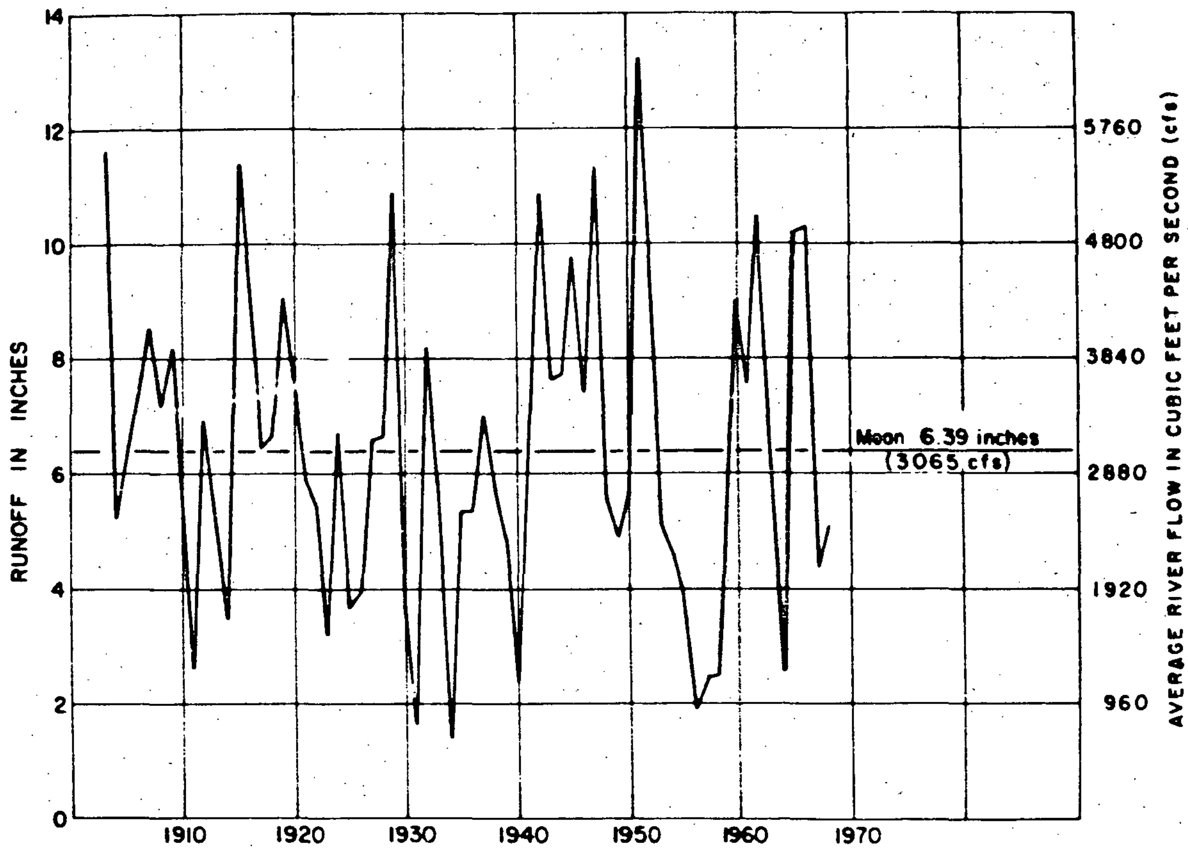

Fig. 2.10. Annual Runoff of Cedar River at Cedar Rapids. From Ref. 6.

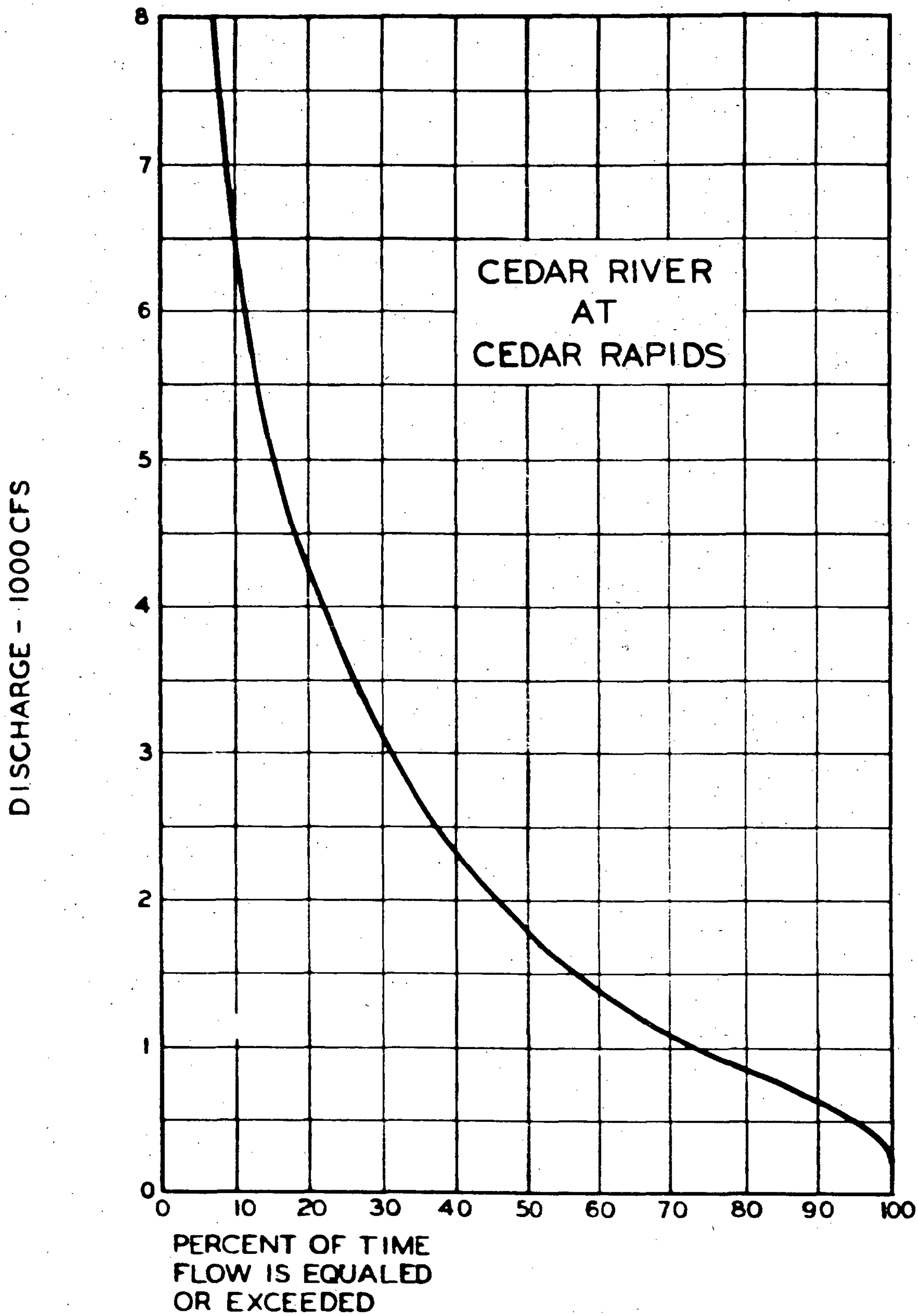

Fig. 2.11. Cedar River Flow Duration Curve. From Applicant's Final Safety Analysis Report.

2.5.2 Ground Water

The site is located in an area of several good sources of ground water. Underlying the Cedar River valley are alluvial aquifers overlying gravel-filled preglacial valleys. These aquifers are very abundant water sources throughout the Cedar River valley down to Cedar Rapids. Individual wells in the alluvial aquifer can supply over 1000 gpm. Underlying the alluvial aquifer, and separated by relatively impervious clayey material, is the Silurian-Devonian aquifer. This aquifer underlies nearly the entire State of Iowa, but is mainly used for water supply in the northeast portions of the state. In the vicinity of the site the Silurian-Devonian aquifer is near the surface, and water can be taken from the Wapsipinicon Formation of limestone at depths of 50 to 100 feet.

The Silurian-Devonian aquifer is largely recharged locally and has a short recharge time.[6] Deep aquifers also exist 1000 to 1700 feet below the surface in the Cambrian-Ordovician aquifer, the most prolific source being the Jordan Sandstone, which is estimated to contain 80 trillion gallons of water[7] (equivalent to 14 years of runoff in the state).

The surficial alluvial aquifers are the primary source of water in the vicinity of the site. They are used to supply Cedar Rapids with an average f 17 million gallons per day. Palo, 2.5 miles southwest of the plant, uses individual wells in the surficial aquifers for water supply. The ground water flow in the alluvial aquifers is generally southeasterly in the vicinity of the site towards the river. No domestic wells in the area are in the line of ground water flow past the plant. The alluvial aquifers are recharged by precipitation, flooding, and by river recharge during periods of high river level.

Well water for the plant will come from the Silurian-Devonian aquifer underlying the alluvial aquifers. Two wells of 750 gpm each will be used. The alluvial aquifers and the deeper artesian aquifers in the Wapsipinicon limestone of the Silurian-Devonian aquifer are isolated by clayey material and should have little interaction. There are no plans to develop the deep Jordan aquifer to supply water to the plant.

2.6 METEOROLOGY AND CLIMATOLOGY

The Duane Arnold site has a continental climate typical of the Great Plains, with cold, dry winters and hot, humid summers. In winter, the most frequent air mass is Continental Polar; in summer, Maritime Tropical. The passage of warm and cold fronts and high and low pressure centers produces high average wind speeds and frequent changes in wind direction. The wind conditions plus the lack of orographic features produce adequate ventilation. In summer, the frequency of frontal passages is reduced, but convective showers and thunderstorms in tropical air masses are common.

Meteorological observations have been made on a 165-foot tower on the site since January 1971. During the first year of data collection, recovery of data has been 92%. Parameters being measured include wind speed, wind direction, wind direction variability (sigma-Θ), air temperature, and dew point temperature at two heights: 165 and 35 ft above grade. In addition, the temperature difference between the two elevations is measured. The starting speed of the upper wind sensor is 0.8 mps; of the lower one, 0.27 mps. The data are recorded on strip charts; thirty-minute averages of the various weather elements are extracted from the charts each hour. The wind direction variability (sigma-y) data are extracted from the charts using the standard technique over a thirty-minute period. No rainfall data are being collected at the site. Rainfall data for the site is taken from Cedar Rapids Airport data. The meteorology tower is located 1700 ft south-southeast of the reactor. Meteorological data obtained by the Applicant provides an acceptable basis for estimating atmosphere diffusion for gaseous effluent releases from the plant.

The duration of data collection at the site is too short to establish long-term averages so weather data collected by the Federal Aviation Authority at the Cedar Rapids Airport and by a National Weather Service cooperative weather station located 3 miles northeast of the city are also used in this report.

2.6.1 Temperature and Humidity

Table 2.1 gives average monthly temperature data for the Cedar Rapids area for a 29-year period ending in 1960.[8] During this period, the highest and lowest temperatures were 109° (July 1936) and -25°F (January 1936); the average number of days with temperatures 0°F and below was 14. The maximum temperature ever recorded in the Cedar Rapids area was 110°F (July 1911), and the minimum -36°F (January 1883).

TABLE 2.1. Temperature (°F) Data for Cedar Rapids, Iowa (29 Years of Record)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Ann
Average daily max	30.4	33.9	44.7	60.7	72.3	81.4	86.7	84.2	76.5	64.9	46.9	34.2	59.7
Average daily min	13.0	15.8	15.4	38.0	49.1	59.3	63.0	61.4	52.7	41.7	28.2	18.1	38.8
Average monthly	21.7	24.9	35.1	49.4	60.7	70.3	74.9	72.8	64.6	53.3	37.6	26.1	49.0
Extreme max	61	64	85	91	104	103	109	108	99	92	77	65	109
Extreme min	-25	-24	-12	-12	26	36	44	38	23	15	-3	-20	-25
No. days T max $\geq 90^\circ$	0	0	0	*	*	5	8	6	3	*	0	0	22
No. days T min $\leq 32^\circ$	30	26	25	9	1	0	0	0	*	7	20	29	147
No. days $\leq 0^\circ$F	6	4	1	0	0	0	0	0	0	0	*	3	14

From Ref. 8.
*More than 0 but less than 0.5 days.

The thermal performance of cooling towers is controlled partly by the wet-bulb temperature. During the four warmest months of the year (June through September), the following wet-bulb temperatures were equaled or exceeded the indicated percentage of the time:[9]

Wet-bulb temperature	Time equaled or exceeded
80°F	1%
78°F	2.5%
76°F	5%
74°F	10%

2.6.2 Precipitation

Precipitation in the Cedar Rapids area, based on a 79-year record at the National Weather Service station, averages 32.02 in./yr (Table 2.2), with 69% of the total falling in the growing season (April-September).[8] Based on 10 years of record (1951-1960), rainfall amounts > 0.10 inches occur on 62 days/year; amounts $\geq$ 0.50 inches 22 days/year.[8] These heavier rainfall amounts are usually associated with summer showers and thunderstorms. Snowfall at the Cedar Rapids airport averages 28.2 in./yr.

Snowfall amounts vary considerably from one year to the next; it has been as low as 8.1 inches (1921-1922) to as much as 62.4 inches (1959-1960). In most winters, the maximum snow depth on the ground does not exceed 8 inches.

Iowa experiences about 20 tornadoes on 10 tornado days per year. Thom[10] reported 11 tornadoes within the one-degree latitude-longitude square containing the site in the period 1953-1962; the computed recurrence interval for a tornado striking within the 500 acre site area is one tornado every 1171 years.[10]

2.6.3 Wind

One year of onsite meteorological data (January 8, 1971-January 7, 1972) are now available; an extensive analysis of these data is contained in a supplement to the Applicant's Final Safety Analysis Report.[9]

TABLE 2.2. Precipitation Data for Cedar Rapids, Iowa

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Ave Precip in.*	1.28	1.24	2.05	2.94	4.04	4.30	3.66	3.40	3.64	2.45	1.74	1.30	32.02
Days with thunderstorms**	†	†	2	4	7	9	8	7	5	3	1	†	46
Ave Monthly snowfall, in.††	7.3	6.0	7.4	0.3	†	†	†	†	0	†	2.1	5.1	28.2

From Ref. 8.
*Cedar Rapids NWS Station, 70-year period of record.
**Data from FSAR, based on 70 years of data from Dubuque and Davenport, Iowa.
†Less than 0.5 but greater than 0.
††Cedar Rapids Airport, 7-year period of record.

Based on this one year of data, the average wind speed at the 35-ft level is 3.6 m/sec; at the 165 ft level, 5.3 m/sec. Wind roses, based on this one year of data, are shown in Figs. 2.12 and 2.13.

Table 2.3 shows the average windspeed at the top of the DAEC meteorology tower by seasons and by stability classes. Seasonal average windspeeds are highest in spring and lowest in summer.

2.6.4 Atmospheric Stability

The vertical mixing and turbulence of the atmosphere depends on hydrostatic stability as well as on wind velocity and surface topography. Hydrostatic stability is determined by the vertical temperature gradient, which is usually expressed as a lapse rate, the rate of decrease of temperature with height. An important value of this parameter is the rate at which a body of dry air cools adiabatically with increasing height. This adiabatic lapse rate corresponds to a decrease of 1.0°C per 100 meters, or 5.5°F per 1000 feet. When the observed lapse rate is less than this value, the atmosphere is stable and vertical motions are damped, the extreme case being a negative lapse rate which occurs in a temperature inversion. When the lapse rate is greater than 1.0°C per 100 meters, the atmosphere is unstable and vertical mixing is rapid.

As mentioned earlier, wind direction fluctuations can also be used to measure atmospheric stability, and the stability class can be determined from the wind direction trace. Observations of the vertical temperature gradient at the site are made by comparing the temperatures at the 35- and 165-ft levels. These observations are tabulated in the Applicant's Environmental Report and are summarized in Table 2.4. This table also shows the frequency of the various stability classes as indicated by the 165-ft wind vane. The numerical limits of the various classes are also shown in the table.

2.7 ECOLOGY

2.7.1 General

The topography of the Cedar River basin in the plant site region is typical of central Iowa agricultural land. It is moderately rolling except for the flat marsh areas near the river. Trees and bushes are present in small scattered woodlots, usually near farm buildings, in ravines, and along the Cedar River and its creeks.

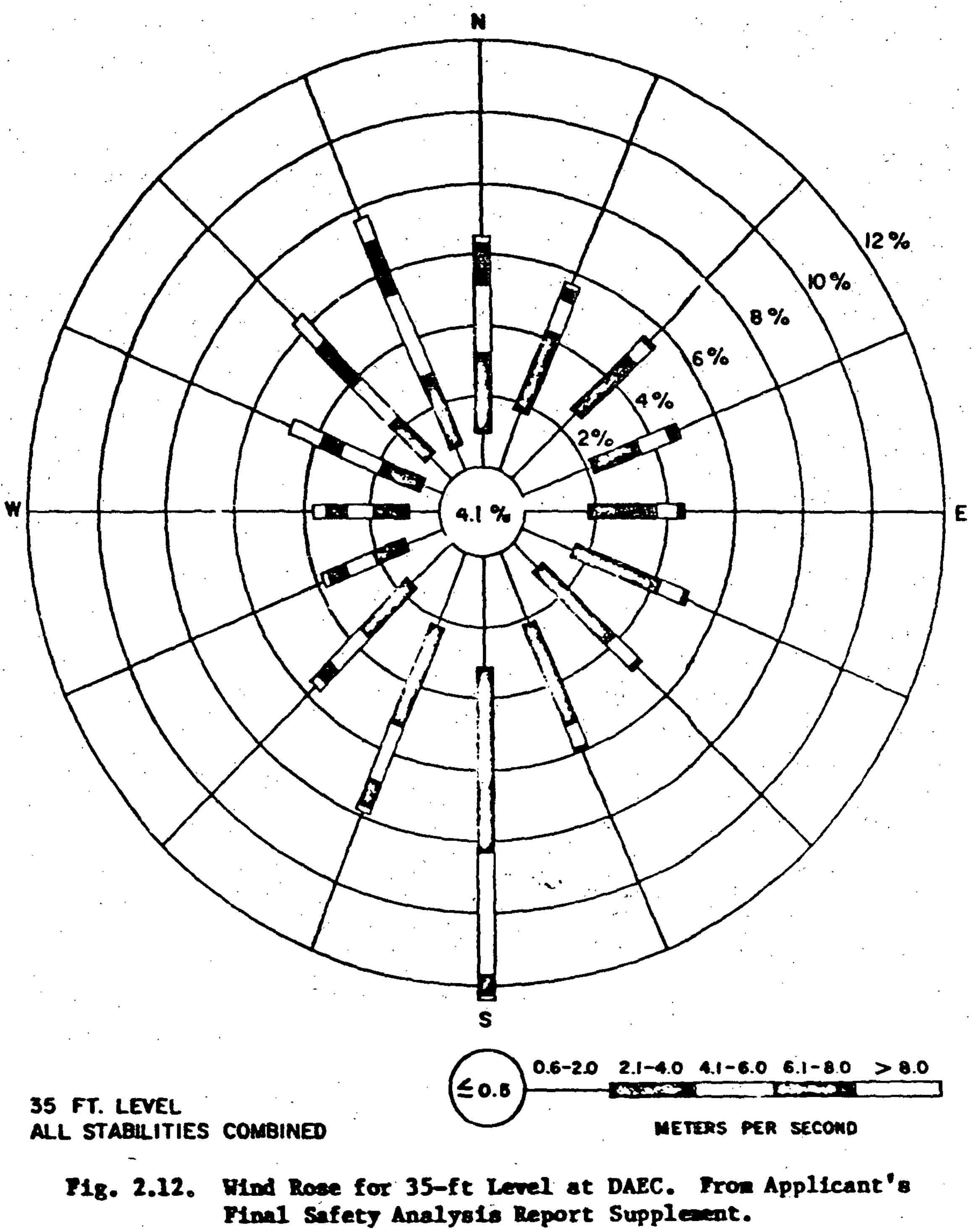

Fig. 2.12. Wind Rose for 35-ft Level at DAEC. From Applicant's Final Safety Analysis Report Supplement.

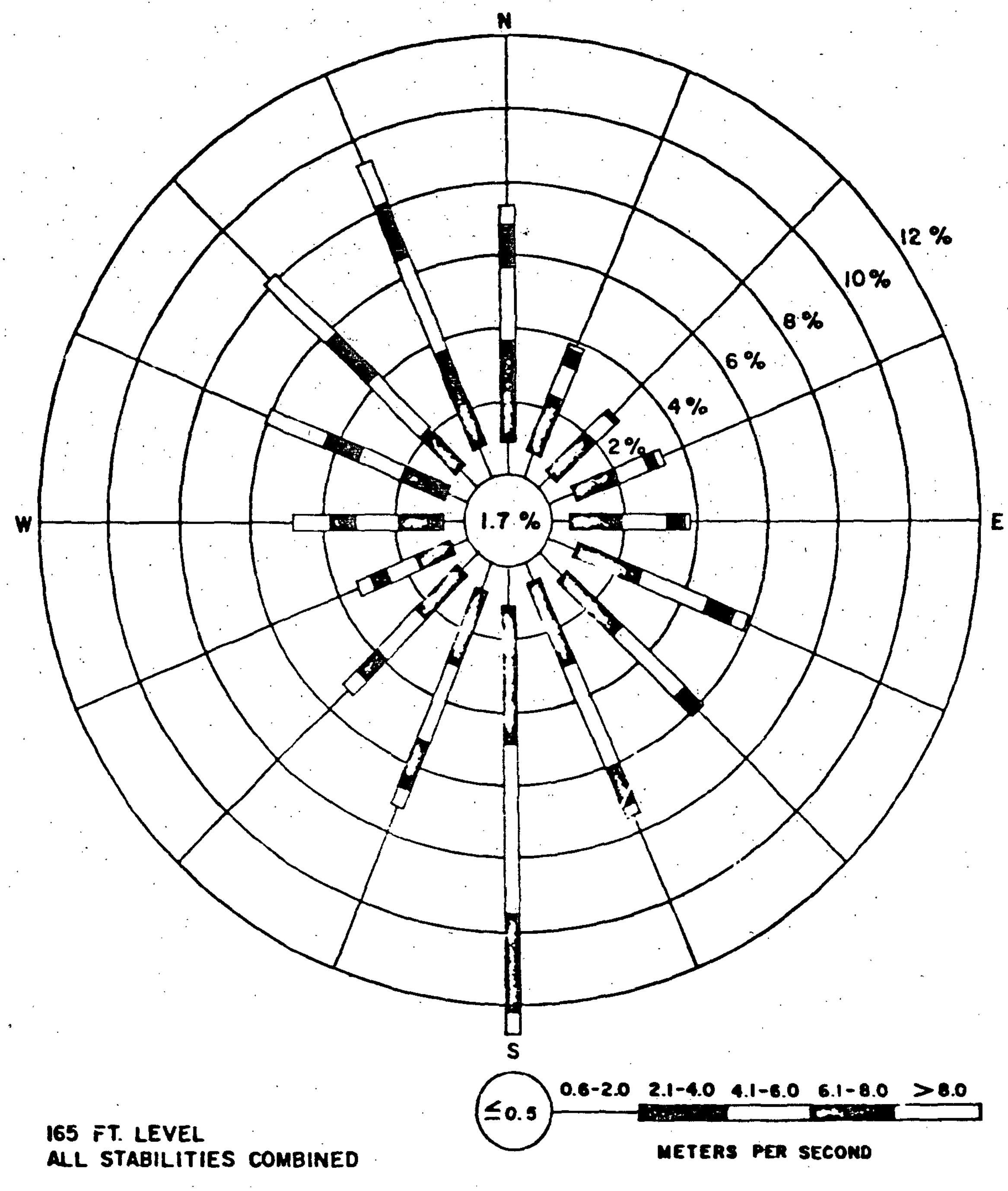

Fig. 2.13. Wind Rose for 165-ft Level at DAEC. From Applicant's Final Safety Analysis Supplement.

TABLE 2.3. Average Wind Speed (m/sec at 165-ft Level) by Stability Category (Determined by ΔT)

Category	Spring	Summer	Fall	Winter	Annual
A	8.7	5.0	5.3	6.4	5.9
B	5.8	4.7	5.3	9.8*	5.2
C	5.4	4.4	5.1	5.4*	4.9
D	5.7	4.1	5.2	5.1	5.5
E	6.5	3.8	4.9	5.4	5.1
F	3.2	3.0	3.4	4.6	3.5
G	2.3	2.1	2.3	3.1	2.3

From Applicant's Environmental Report.
*Less than 30 observations.

TABLE 2.4. Frequency Distribution of Stability Categories, All Wind Directions (January 8, 1971-January 7, 1972)

Stability Class	Frequency % as determined by: ΔT (165 - 35 ft)	σ_θ (165 ft)
A	3.2	2.2
B	2.7	3.4
C	5.1	12.3
D	42.5	31.2
E	29.7	28.4
F	7.2	15.5
G	9.6	7.0

Pasquill Stability Class	ΔT (°C/100 m)	σ_θ
A	$\Delta T \leq -1.9$	$\sigma_\theta \geq 22.$
B	$-1.9 < \Delta T \leq -1.7$	$17.5 \leq \sigma_\theta < 22.$
C	$-1.7 < \Delta T \leq -1.5$	$12.5 \leq \sigma_\theta < 17.$
D	$-1.5 < \Delta T \leq -0.5$	$7.5 \leq \sigma_\theta < 12.$
E	$-0.5 < \Delta T \leq +1.5$	$3.8 \leq \sigma_\theta < 7.$
F	$+1.5 < \Delta T \leq +4.0$	$1.3 \leq \sigma_\theta < 2.$
G	$+4.0 < \Delta T$	$\sigma_\theta < 2.$

From Applicant's Environmental Report.

The region is intensively farmed and the ecology and water quality of the river are largely influenced by runoff from agricultural land. The Cedar River at the plant site has a drainage area of about 6250 square miles, 1024 of which are in Minnesota. Of the 4.3 million acres in the basin, 94% or 4.06 million acres are used for agricultural activities. Municipal and industrial wastes from towns and cities, such as Waterloo and Cedar Rapids, are discharged into the river.[11]

The average flow of the Cedar River at Cedar Rapids is 3065 cfs. It exceeds 620 cfs 90% of the time and 6600 cfs 10% of the time. During periods of increased riverflow, turbidity, BOD, ammonia, nitrate and phosphate values frequently increased markedly. Pesticide concentrations, ranging from about 75 to 700 ppb in fish taken from the Cedar River indicate that these substances are introduced into the river, possibly adsorbed onto sediment particles, and concentrated in fish.

The effects of agricultural chemicals, silt and organic matter on the limnology of the Cedar River in the vicinity of the DAEC are evident. An abundance of nutrients that support algal growth are present in the river, and very high algal concentrations are frequently observed. This was especially evident during periods of low turbidity and high water temperature. Although large blooms of taste- and odor-p ducing algae and high-threshold odor values did not occur during the preoperational study, the natural occurrence of these conditions is a possibility.

2.7.2 Terrestrial Ecology (Botanical)

In order to detect a possible effect of the DAEC on the terrestrial ecology, it is necessary to know the composition, distribution, and density of plant cover which exists in the region before startup. This is particularly true of the general Cedar Rapids-Palo area because of the multitude of public recreational parks and preserves. These support a wide diversity of plant communities in addition to those in the farmed land and other nonrecreational land space.

In efforts to document the present nature of the plant cover in the vicinity of the Center, a multispectral data acquisition flight mission over the Cedar River area was conducted in June 1972 by the Iowa Geological Survey. In addition, ecological studies were carried out by the Applicant in conjunction with the aerial survey to specifically determine plant types and densities in selected areas.[12,13]

The region around the Duane Arnold Energy Center has a humid continental, warm summer climate. This type of climate favors the development of broad-leaved deciduous forest in areas where rainfall is adequate, such as in eastern Iowa. The regional vegetation of this area is described as oak-hickory forest along the major rivers and a mosaic of oak-hickory forest and bluestem prairie on the uplands. Forest originally covered 16% of the land surface in Iowa with the remaining 84% being tall grass prairie.

Forest growth is essentially all that remains of the native vegetation in Iowa, most of the prairie having been plowed and devoted to agriculture. Even though some of the original forest cover has remained in Iowa, it has been greatly altered from its original structure by the activities of man since the settlement of the state. Cutting, grazing, the cessation of prairie fires, and the introduction of the Dutch Elm disease have all had a drastic effect on the forests.

Five study areas were selected by the Applicant in addition to the plant site (Fig. 2.14) in order to determine the structure of the native vegetation.[12] Four of these are relatively natural areas which have been set aside as county parks or conservation areas. They are all within 5 miles of the Energy Center and are composed of: a) the Palo Marsh Wildlife Refuge; b) the Lewis Bottom Access County Park; c) the Lewis Preserve County Park; d) the Wickiup Hill Conservation Area County Park. The fifth area studied (e) was the site of the future Pleasant Creek Reservoir. The plant site is discussed in section (f) below.

a. Palo Marsh Wildlife Refuge

The Palo Marsh is located just north of the town of Palo, and about 2 miles SSW of the DAEC in Section 21, T84N, R8W. The Palo Marsh consists of two general areas. The area to the west is open and grassy. while the one to the east is forested.

The open area in the western portion may be divided into several separate communities, but most of it is dominated almost entirely by the canary grass (Phalaris arundinacea). Near the center of the open area is a north-south sand deposit which is sufficiently high and dry to support a weedy community with hog-weed (Erigeron canadensis) and other weeds (Appendix A, Table 2). Scattered throughout the canary grass community are several depressions which are more moist than the surroundings. These are dominated by arrowhead (Sagittaria latifolia) and mud-plantain (Alisma triviale) except in open water where species of pondweed (Potamogeton) and water-milfoil (Myriophyllum) occur.[13]

It appears that the open area is being invaded by a natural succession of woody plants. A comparison of a 1964 photograph with the present condition of the marsh seems to substantiate this. Unless some practice such as burning is established, shrubs and trees will probably continue to invade the area, ultimately leading to forest conditions. Once woody plants invade, they cast enough shade to prevent the vigorous growth of the canary grass. This same shade and the lack of vigor of canary grass will foster the continued invasion of forest vegetation.

The Palo Marsh woods lies just to the east of the open area. It is a flood-plain forest which is close enough to the Cedar River to flood every year. Such forests frequently have a rather poor representation of herbs. They are often dominated by such tree species as the American elm (Ulmus americana), the box elder (Acer negundo), cottonwood (Populus deltoides), and the soft, or silver maple (Acer saccharinum).

The herbaceous layer is conspicuously represented by the wood-nettle (Laportea canadensis), which occurred in 95% of the plots (Appendix B, Table 1).[12] Many of these plants were seedlings. The same situation is true of the honewort (Crypotoaenia canadensis), which is mainly represented by seedlings.

The arborescent vegetation of the Palo Marsh is characteristic of flood plains in Iowa. The American elm was formerly very important but is now rapidly being replaced by other species. In the Palo Marsh woods the silver maple seemed to be assuming much of the space formerly occupied by the elm. The silver maple is the most frequent species, followed by the box elder, green ash, and hawthorn (Crataegus mollis), with the American elm in fifth place (Appendix B, Table 2). The American elm will decline in the future because of Dutch Elm disease. Of interest also is the presence of the white oak, Quercus alba, not considered a flood plain species. The tree density in the Palo Marsh woods was 232 trees per acre.[12]

A species list for the Palo Marsh woods is given in Appendix B, Table 3.

b. Lewis Bottom Access County Park

Lewis Bottom Access County Park is located about 4 miles upstream of the Duane Arnold Energy Center (Fig. 2.14), adjacent to the Cedar River in

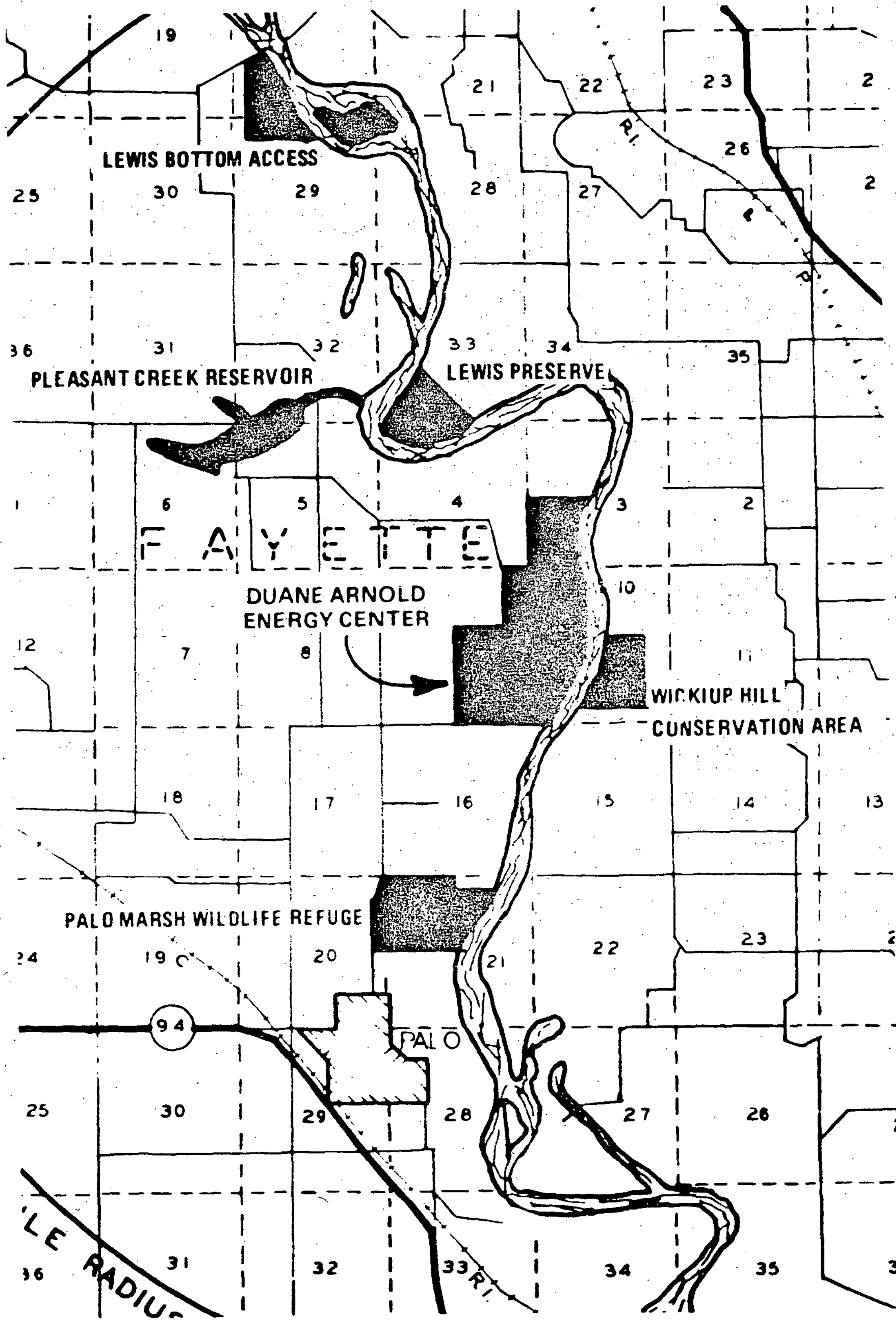

Fig. 2.14. Ecological Study Areas in the Vicinity of the DAEC.

Section 20, T85N, R8W, and contains a flood plain forest as well as some sand deposits which support mainly weeds and a few prairie perennials.[12] The flood plain forest is quite typical except that it occurs on rather sandy soil, so that the forest is not as well developed and not as dense as some flood plain forests.

In the herb layer, the wood-nettle (Laportea canadensis) was again most frequently found, followed by poison ivy (Rhus radicans) (Appendix C, Table 1). As in the Palo Marsh woods, the frequency of the wood-nettle is mainly accounted for by the large number of seedlings. The same is true of violets (Viola sp.) and buttercup plants (Ranunculus abortivus) which were almost entirely represented by seedlings. As in the Palo Marsh woods, this abundance of seedlings may not be present every year. Wood-nettle and poison ivy are almost equally dominant although in specific areas one species may entirely dominate, while in other areas the other species may completely dominate. The tall bell flower, Campanula americana, also shows this type of variation. Although it averaged only 12.2% cover, in places the figure was 100%. A number of other herbs are present (Appendix C, Table 3), but there is very little evidence for tree reproduction. The box elder was the most frequent tree species encountered, followed by the red mulberry (Morus rubra), the silver maple, the American elm, and the green ash (Appendix C, Table 2). The American elm is becoming less important because of the Dutch Elm disease. A species list for the area is given in Appendix C, Table 3.

c. Lewis Preserve County Park

The Lewis Preserve County Park is located adjacent to the Cedar River about 2 miles north of the DAEC in Section 33, T85N, R8W (Fig. 2.14). It consists of flood plain forest, canary grass communities similar to the one in the Palo Marsh open area, weeds of various types, and some cropland.[12]

This flood plain forest is similar to the previous two already described, but there are differences. One is the presence of very large, scattered trees. Also of interest is the fact that some of the very large trees found in this forest are white oak; this is not considered a flood plain species.[12]

A study of the herbaceous species revealed that a few of them occur in high frequency (Appendix D, Table 1). These include the clearweed (Pilea pumila), stinging-nettle (Urtica dioica), wood-nettle (Laportea canadensis), cutgrass (Leersia virginica), and buttercup (Ranunculus abortivus) with a number of other less frequent herbs.

The soils in the forest consist of two types, nearly pure sand and nearly pure clay. On the sandy soil clearweed grows luxuriantly while wood-nettle scarcely can be found. On the clay soils, the opposite relationship holds. It is significant that a number of plants of Cuscuta sp. (dodder) were found. This floral parasite, while not occupying much cover, can completely dominate a small area within one summer season.[12]

There has been a low level of tree reproduction in recent years. The relative frequency of trees of the Lewis Preserve County Park is shown in Appendix D, Table 2. The silver maple was by far the most frequent species. Calculations showed that there were 178 trees per acre, much less than in the previous sites. A list of herb and tree species for the Lewis Preserve County Park is given in Appendix D, Table 3.

d. Wickiup Hill Conservation Area Park

The Wickiup Hill County Park is located less than a mile east of the DEAC across the river in Section 10, T84N, R8W (Fig. 2.14). It consists of rolling hills with steep slopes. The entire area was undoubtedly forested at one time, but some areas in the park have been cut and mowed much like a pasture. The reason for this management practice is unknown.[12]

The plants most frequently found were seedlings of white ash (Appendix E, Table 1). This is probably a temporary occurrence due to especially favorable conditions a few years ago. The Virginia creeper or woodbine (Parthenocissus quinquefolia) and the wood-nettle (Laportea canadensis) also accounted for a relatively large percentage of the cover. The miterwort (Mitella diphylla) is restricted to this site, not being found in any of the other five sites studied. Other species are of frequent occurrence in common with the flood plain forests, such as sedge (Carex sp.), honewort (Cryptotaenia canadensis), and wood-nettle, after which decreasing numbers of subsequent species occurred (Appendix E, Tables 1 and 3). Some other species are restricted to this site, such as enchanters night shade (Circaea quadrisuloata), liverleaf (Hepatica acutiloba), fragile fern (Cystopteris fragilis), and rattlesnake fern (Botrychium virginianum).

The relative dominance of trees is shown in Appendix E, Table 2. Red oak and green ash account for half of the tree specimens. White oak and white ash were next in dominance. Ironwood (Ostrya) is not a dominant tree, but rather an understory tree in moist forests of this type. There were 168 trees per acre in the sample area. A species list for the Wickiup Hill site is given in Appendix E, Table 3.

e. Pleasant Creek Reservoir

The lake site studied was the area of the proposed Pleasant Creek Reservoir. The lake will serve as a recreation area and as a reserve water supply to supplement the flow of the Cedar River during low flow periods. The study area was in Section 5 T84N, R8W, and Section 32 T85N, R8W, due west of the Lewis Preserve (Fig. 2.14).

The lake site is rather interesting in several ways: It possesses remnants of an upland forest which appears to have been rather fertile. Several species of plants were observed in this forest which are uncommon in Iowa. These include papooseroot (Caulophyllum thalictroides), trillium (Trillium flexipes), and showy orchis (Orchis spectabilis).[12]

The most frequent herb in the lake site was black snakeroot (Sanicula marilandica), closely followed by honewort (Cryptotaenia canadensis) and wood-nettle (Appendix F, Table 1). Seedlings of two tree species were encountered, indicating some recent tree reproduction. There is no clear set of dominant herbs, but a very gradual progression from fairly important to insignificant. This is in contrast to the sharp drop in importance observed in the flood plain herbs.[12]

The shrub plots revealed some information at the lake site (Appendix F, Table 2). A number of tree dominants were represented in the shrub layer, indicating reproduction of the forest dominants. A number of shrubs, such as bramble (Rubus sp.), prickly gooseberry (Ribes cynosbati), poison ivy (Rhus radicans), elderberry (Sambucus canadensis), and choke cherry (Prunus virginiana) were also present.

The forest of the lake site was quite different from the flood plain forests of the other sites. The soft or silver maple, a dominant of the flood plain forests, was completely absent at the lake site. Hard, or sugar maple (Acer saccharum) and basswood (Tilia americana), absent in all the flood plain forests, were present at the lake site.

The most frequent tree at the lake site was hackberry (Celtis occidentalis), followed rather closely by box elder (Acer negundo) (Appendix F, Table 3). A few flood plain species such as box elder and black willow (Salix nigra) were present even though generally regarded as flood plain species. The lake site consisted of a mosaic of areas; the eastern part was greatly dominated by hackberry, while red oak (Quercus rubra) became important upstream. The total tree density was 302 trees per acre.

A species list for the lake site is given in Appendix F, Table 4.

f. The Plant Site

A major part of the plant site and surrounding area is agricultural land. Some woodland areas occur close to the Cedar River and its tributary streams and in the two wood lots north of the plant buildings, but none are significantly different than the wooded areas already discussed. The tree cover in these areas is mostly oak and hickory with an occasional walnut tree. The elms are dying out because of Dutch Elm disease. Near the plant site property many of the wooded lands are plantations, windbreaks, or woods so heavily browsed by cattle that they cannot be considered forests. Others are nearly undisturbed flood plains with trees, but such areas are similar to the types already discussed. There are no unique features of the plant site, and the five study areas monitored in the Applicant's ecological monitoring program contain all the essential features of the nonfarmed portions of the land surrounding the plant site.

2.7.3 Terrestial Ecology (Zoological)

a. Birds

Surveys of birds and animals at the DAEC site and in other areas close to the site were carried out, and will serve as a basis for comparison with surveys made after the plant has been in operation.[22]

The following small birds, listed in the order of abundance, were observed at the DAEC: meadowlark, barn swallow, red wing blackbird, flicker, blue jay, and bunting. The larger birds observed on site were pheasants, quail, doves, crows, and several species of hawks. The greatest concentrations of pheasants were found in old, formerly farmed fields. These are the primary game birds in the area, and are heavily hunted. Some quail were seen but their numbers were considerably less than the pheasants. Very few quail occur in forested areas and are subject to little hunting pressure.[14] The lack of nesting areas accounted for the rather limited number of doves on site. The resident species of waterfowl is composed mostly of wood ducks. A number of species of ducks are observed along the river during the spring migration, although few are present during the autumn.[22]

Small bird life at the Pleasant Creek site of the proposed reservoir is more abundant than the the plant site, probably due to the greater diversity of habitat at the Pleasant Creek site. The following birds, listed in order of abundance, were observed in July, 1972, during road and hiking observations:[11,15] meadowlark, red headed woodpecker, robin, doves, sparrow hawk, barn swallow, flicker, redwing blackbird, bunting dickcissel, phoebe, flycatcher, and blue jay. Larger birds consisted of pheasants and quail. Doves were abundant. Starling and English sparrows, associated with human habitation, were not often seen. Various species of migrating shorebirds including wood duck are occasionally seen along the stream and in wet land areas.[15,22]

The Palo Marsh area supports a rather limited duck population and is closed to duck hunting.

b. Mammals

Although whitetail deer are still common in the area, including the wooded bottom areas in and around the Lewis Preserve and Wickiup Hill Area, many have moved out of the DAEC site because of construction activities. Raccoon occur mostly along the river. The ground squirrel population is cyclic, and tree squirrels are scarce because of lack of habitat. Few rabbits live on site.[22]

Muskrats (Ondatra zibethica) are common along the river and slough areas although the habitats are of low quality for them. A few beaver are present. Populations of fox, weasels, mink, badger, skunk, raccoon, and oppossum are not large. Some trapping of these animals, except for badger occurs, particularly during the winter months.[22]

At the Pleasant Creek site, some whitetail deer have been seen. Raccoon are moderately abundant. Occasional gray and some fox squirrels occur, although they are not abundant. Cottontail rabbits are moderately abundant. Badger and jackrabbits have been reported in the area. Skunk and oppossum occur throughout the Pleasant Creek zone and their populations appear to be static. Fox are sparsely distributed. Mink and muskrat frequent the Pleasant Creek stream.

c. Summary

In summary, the birds and other animals studied in the vicinity of the Duane Arnold Energy Center are typical of the forms normally encountered in east Central Iowa. No endangered species were observed or are known to occur in the area. In a comparative overview of the DAEC Plant site, Wickiup Hills, and the Pleasant Creek Reservoir Site, it is concluded that the latter supports the greatest abundance of terrestrial wildlife.

This level of abundance is related to the quantity, quality and spatial diversity of existing vegetative cover. The Plant site reflects the effect of intensive agriculture and changing land use patterns. Habitat conditions within the DAEC site will probably improve with changes in land use patterns.[22]

2.7.4 Aquatic Ecology

Because of the dynamic nature of the river and the necessity of obtaining information on its ecology above and below the site, samples were taken throughout the year at four locations shown in Fig. 2.15. Samples for general chemical and plankton analysis were routinely taken twice per month. Complete chemical analysis, benthic and fishery studies were conducted by the Applicant in June-July and October-November, 1971.[11]

a. General

The Cedar River, in common with the Iowa River and other rivers in the Midwest, is a nutrient-rich stream whose limnology is greatly influenced by agricultural activities and hydrological conditions in the drainage basin, as well as discharges from municipalities and industries.

Shobe and Gakstatter of the Iowa State Hygienic Laboratory[11,16,17] found that there is a borderline situation with respect to water quality (ammonia, fecal coliforms, suppression of the total number of invertebrates coupled with a major shift in species composition) in the Cedar River 3.5 miles below the Cedar Falls-Waterloo area, and that there was an obvious potential for severe damage to aquatic life during low flow periods. Although municipal and industrial wastes from the Waterloo-Cedar Falls area may have some effect on the water quality of the river in the vicinity of the Duane Arnold Energy Center, especially during low flow periods, it appears that these discharges are of secondary importance,[11] compared to agricultural runoff. In his studies of the factors influencing the water quality of the Cedar River, Wagner[18] notes that at average flow, the treated sewage from Waterloo is diluted almost 100 to 1 and that "there should be little, if any, deleterious effect on the water quality of the river attributed to it." The distance between the Waterloo Sewage outfall and the DAEC is about 35 miles.[14] Even without the recommended further improvement in the Cedar Falls-Waterloo sewage treatment plant[16] the distance between it and the DAEC Plant is adequate for the river to recover from its polluted condition except during times of very low flow. Detailed data on the water quality of the Cedar River at the site is given in Reference 11.

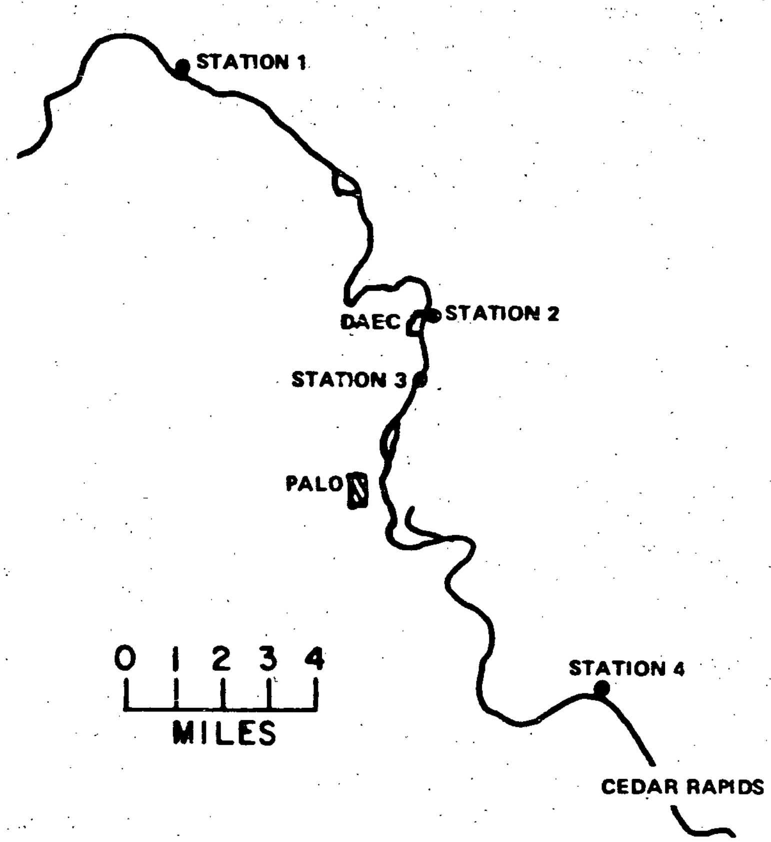

Fig. 2.15. Location of Water-sampling Sites

b. Phytoplankton

Due to the extent of agricultural runoff, the river contains ample quantities of nitrates and phosphates to support phytoplankton growth.[11] Frequently, wide fluctuations in runoff occur. Phytoplankton growth is reduced following heavy rains when dilution occurs and the turbidity is increased. A variety of diatoms, green algae, and blue-green algae have been reported in the river (Tables 2.5 and 2.6); algal counts above 100,000/ml have been recorded[11,14,17]. Large plankton populations were generally present during the spring and summer months, although rapid declines in numbers were occasionally observed. The diatom Cyclotella was the dominant organism observed, although a variety of other diatoms and green algae were also present. Blue-green algae, chiefly Oscillatoria, reached their greatest concentrations in July and August when over 1,300 trichomes/ml were observed in some samples.

Very large algal populations, composed primarily of the diatom Cyclotella, were observed in September, although blue-green algal populations declined Over 183,000 organisms/ml were observed at Station 4 (Mohawk Park) on September 27, 1971. Plankton populations remained high during October, but declined markedly as water temperatures dropped.[11,17]

Minimum plankton populations occurred during the winter months. The smallest population observed during the year occurred on February 28, when less than 900 organisms/ml were observed at all stations. Cyclotella and a variety of unidentified flagellates were the dominant organisms during the winter months.

Plankton populations increased during the spring. On April 10, 1972 over 100,000 organisms/ml, chiefly Cyclotella, were observed at all stations.[11]

c. Zooplankton

Ciliated and flagellated protozoa were found in abundance from time to time in the Cedar River.[11] Rotifers were also repeatedly although not consistently found, but crustacean zooplankton were sparse or absent (Table 2.5). Meroplankton were very sparsely distributed.

d. Benthos (bottom fauna)

The Cedar River in the vicinity of the Duane Arnold Energy Center supports a relatively sparse benthic population. This appears to be largely due to the shifting silt bottom, present in most areas, rather

TABLE 2.5. Plankton Count (per milliliter) at DAEC, Station 2.

	1971 April 28	May 12	May 24
Blue-Green Algae			
Anabaena	13	89	
Diatoms			
Asterionella			64
Cyclotella	37,760	37,312	16,832
Cymatopleura			64
Fragilaria	192	640	
Meridion			64
Navicula	320	704	448
Nitzschia	9,308	4,408	448
Stephanodiscus		64	128
Surirella		64	
Synedra	2,624	1,344	192
Naviculacae	640	128	
Green Algae			
Actinastrum		1,728	576
Ankistrodesmus		64	
Chlorella-like	1,856	1,856	704
Closterium		64	
Coelastrum	256	512	
Oocystis		128	
Pediastrum			64
Scenedesmus	1,024	2,304	832
Selenastrum	128	384	64
Staurastrum		64	
Tetraspora	64		
Tetraedron		128	
Chroococcus	576	1,536	896
Unidentified	384	576	
Flagellates			
Chlamydomonas	640	1,408	640
Euglena		192	64
Pandorina			64
Unidentified	1,472	1,408	896
Miscellaneous			
Ciliate	448	64	128
Rotifer		192	
TOTALS	57,805	57,433	23,168

From Ref. 11.

TABLE 2.6. Summary of Total Plankton Counts

1971 April 28	May 12	May 24
Station 1 - Lewis Access		
50,730	56,200	26,750
Station 2 - DAEC Plant		
57,805	57,430	23,170
Station 3 - John Comp Farm		
61,530	58,160	21,130
Station 4 - Mohawk Park		
82,825	55,620	24,470

From Ref. 11.

than the quality of the water. In rocky areas where siltation is at a minimum, extensive benthic populations composed largely of mayflies, caddis flies and other forms associated with fair to good water quality are present.

Most bottom samples taken from the river channel consisted of sand and silt or gravel and silt. Samples taken in quiet water areas near shore consisted primarily of silt and mud. The only organisms found in those samples were immature tubificid worms and a few chironomid larvae.

Although the bottom faunas obtained from the river channel were sparse in number and generally did not indicate high water quality, the presence of relatively large numbers of mayfly nymphs of the genus Stenonema on submerged rocks in areas not subjected to silting or scouring is indicative of fair to good water quality. Mayfly nymphs were abundant near the plant where rock fill had recently been placed in the river. The mayflies are not generally found in polluted waters. Benthic populations in the river near the plant are thus apparently limited by a scarcity of proper habitat, rather than water quality.

Very little difference was found in the kinds and numbers of bottom organisms sampled within a few miles above and a few miles below the plant site (Appendix G, Fig. 1 and Tables 1 and 2).[11,17]

These benthic data have much in common with those further upstream in the Cedar Falls-Waterloo area and in its tributaries, the Shell Rock River, West Fork of the Cedar, and various small tributaries of these streams.[11,16,17,19]

In this general area (Cedar Falls-Waterloo) the Cedar River has an abundance of larvae of the caddis fly, Cheumatopsyche. Acroneuria appears to be the most common stonefly with Pteronarcys and Taeniopteryx also present. Of the mayflies, Ephoron, Hexagenia, Blasturus, Isonychia and Stenonema have been collected on a number of occasions. Locally and seasonally blackfly larvae (Simulium) have been taken as well as various undetermined members of the family Tendipididae. A few years ago some alderfly larvae (Sialis) were taken but none has been collected recently. Similarly, snipe fly larvae (Atherix) were more common a few years ago. Hellgrammites (Corydalus cornutus) are present but not particularly common. Adults and larvae of the aquatic bettle Stenelmis of the family Elmidae have been taken on several occasions. Fingernail clams are abundant. The most common freshwater mussel in that area is Lampsilis ventricosa. Numerous species of diatoms occur frequently forming a slick covering over rocks. In riffle areas the green alga, Cladophora, often forms rope-like growths.[19]

A separate study was made of the aquatic faunas in the Cedar Falls-Waterloo area of the Cedar River.[16] These data also indicate a reasonably nonpolluted river except for an area about 3.5 miles below the Waterloo Sewage discharge outfall.

e. Fish

The fish in the Cedar River within several miles above and below the plant were studied by personnel from the Iowa State Conservation Commission in cooperation with those from The University of Iowa, Department of Environmental Engineering. Samples were taken during the period June 18-22, 1971, and November 24-28, 1971, by means of electroshocking, two cheese baited nets (1-1/2 and 1-1/4-in. mesh), and one unbaited hoop net.[11]

Channel catfish were the dominant fish taken during the sampling period. Walleye, sauger, and other game fish are not common in the area and were not taken during the course of the study. Fewer channel catfish were collected during the November sampling period than in June, but this was typical of fall sampling. Flathead catfish, carp, carpsuckers, and a variety of minnows were also collected. These fish are all commonly found in the Cedar and other Iowa rivers. These and some other fish caught during June and November are summarized in Appendix H, Table 1.

The Cedar River supports a relatively homogeneous fishery from Vinton, Iowa northwest of the Plant to the Interstate 80 bridge south of Cedar Rapids (Fig. 2.15). Consequently, little difference was observed in the fish species above and below the plant site. This section of the river is noted for good to excellent channel catfishing and also supports a fairly good flathead catfish fishery. Carp are also frequently taken by fishermen, and bullhead, smallmouth bass, walleye and northern pike are occasionally caught. It has been estimated by personnel of the Iowa Conservation Commission that carp compose about 60% by number and 85% by weight of the total catch in the Cedar River in the vicinity of the DAEC.[14]

Preliminary analysis of stomach samples indicates that the aufwuch community (organisms growing attached to submerged rocks, trees, etc.) may provide a significant amount of food for a number of fish species. The Iowa Conservation Commission collected a number of scale samples for age and growth studies, which will be analyzed during the coming year (1972-1973).

Pesticide residues found in a variety of fish collected in the vicinity of the plant have been summarized.[11] Relatively high pesticide concentrations were observed in several of the fish analyzed. This condition is typically observed in midwestern streams, such as the Cedar River, which receives extensive runoff from agricultural land to which pesticides have been applied. Dieldrin and the breakdown products of DDT were found in the greatest concentrations. As might be expected, those species of fish which are bottom feeders contained the largest residues. This is probably due to the adsorption of pesticides onto clay particles, which are subsequently washed into the stream by runoff. Lowest residues were observed in the crappie.

In summary, the nature and composition of the fishery in the DAEC section of the Cedar River appear to be typical of those which normally occur in similar midwestern streams. The dominant fish are warm water forms tolerant of relatively high water temperatures and turbidity.

f. Conclusion

Terrestrial and aquatic surveys conducted in the vicinity of the Duane Arnold Energy Center have not revealed the presence of any unique or endangered species. Several species of plants which are rather uncommon in Iowa were observed in the area of the proposed Pleasant Creek Reservoir. These include (papooseroot), Caulophyllum thalictroides (trillium), Trillium flexipes and (showy orchis) Orchis spectabilis.[14]

2.8 BACKGROUND RADIOLOGICAL CHARACTERISTICS

The radiology of the area surrounding the plant is unremarkable. There are no conspicuous natural sources, and the natural background (135 mrem/yr) is close to the average for the United States (130 mrem/yr).[20]

About 14 state and federal monitoring stations have been operated within 300 km of the plant for the last two decades,[21] so a considerable backlog of data is available. A list of the major stations and their more recent reports is presented in Table 2.7. These stations have monitored not only the Cedar River but also surface, ground, and tapwaters in the area, as well as milk, dietary, and atmospheric concentrations. Thus, any changes introduced by the operation of the plant will have an extensive backlog of information for comparison. Further, the DAEC's own extensive preoperational program in conjunction with recent studies at The University of Iowa at Iowa City (see Section 6.1) is providing additional regional information.

TABLE 2.7. Radiological Monitoring Stations near the Duane Arnold Energy Center, 1969-1972

Station	Distance from Plant	Sample Type*	Sample Years	Analysis	Range*	Mean*
Burlington, Iowa (Mississippi River)	100 miles SW	SW	Jan-Oct 1971	Gross beta, diss.	3-12	8
				Gross beta, susp.	1-21	7
				Gross alpha, diss.	0.2-2	1
				Gross alpha, susp.	0.2-6	1
Chicago, Illinois	240 miles E	DA	Jan-Oct 1971	Sr-90	5-10	8
		PM	July-Jan 1969-1972	Sr-90	5-11	7
Des Moines, Iowa	90 miles SW	PM	July-Jan 1969-1972	Sr-90	5-9	6
Iowa City, Iowa	30 miles S	PM	July-Jan 1969-1972	Sr-90	4-10	8
		SA	July-Feb 1969-1972	Gross beta	0-7	1
		P	" "	Gross beta	0-32,000	2,000
		TW	Jan-Dec 1970-1971	Tritium	500-900	600
Little Cedar, Iowa	100 miles NW	PM	Oct-Jan 1970-1972	Sr-90	6-7	7
Madison, Wisconsin	150 miles NE	SA	July-Feb 1969-1972	Gross beta	0-3	1
		P	" "	Gross beta	1000-24,000	6,000
Mankato, Minnesota	190 miles NW	PM	July-Jan 1969-1972	Sr-90	3-17	6
Minneapolis, Minnesota	215 miles N	SA	July-Feb 1969-1972	Gross beta	0-4	1
		P	" "	Gross beta	1000-52,000	16,000
Moline, Illinois (Mississippi River)	80 miles SE	SW	Oct-Dec 1970-1971	Tritium	0-500	100
		TW	1967 & 1970	Gross beta, diss.	8-9	8
				Gross beta, susp.	0-9	4
				Gross alpha, diss.		0
				Gross alpha, susp.		0

TABLE 2.7 (Contd.)

Station	Distance from Plant	Sample			Range*	Mean*
		Type*	Years	Analysis		
Morris, Illinois	180 miles SE	TW	Oct-Dec 1970-1971	Tritium	0-600	125
Omaha, Nebraska	220 miles SW	DA	July-Oct 1970-1971	Sr-90	5-10	7
				CS-137	0-12	3
		PM	July-Jan 1969-1972	Sr-90	0-10	6
Rochester, Minnesota	120 miles N	PM	July-Jan 1969-1972	Sr-90	4-11	8
Spencer, Iowa	185 miles NW	PM	July-Jan 1970-1972	Sr-90	3-8	6
Springfield, Illinois	190 miles SE	SA	July-Feb 1969-1972	Gross beta	0-5	1
		TW	July-Aug 1968	Gross beta		3
				Gross alpha		0
		TW	Jan-Dec 1970-1971	Tritium	0-700	150

*DA = Diet analysis, pCi/kg
PM = Pasteurized milk, pCi/ℓ
SA = Surface air, pCi/m^3
P = Precipitation, pCi/m^2/month
SW = Surface water, pCi/ℓ
TW = Tap water, pCi/ℓ

References

1. "1970 Census of Population, Number of Inhabitants, Iowa," Department of Commerce, PC(1)-A17, June, 1971.
2. National Register of Historic Places, Nat'l. Park Service, Dept. of Interior, Federal Register 37, No. 51, Mar. 15, 1972 and Supplements through Dec. 5, 1972.
3. Personal Communication, A. D. Anderson, Iowa State Liaison Officer, Aug. 25, 1972.
4. Letter, A. D. Anderson, Iowa State Liaison Officer, Sept. 5, 1972.
5. Final Safety Analysis Report, DAEC, Vol. 1, Iowa Electric Light and Power Co., 1968.
6. R. E. Hansen, "Geology and Ground-water Resources of Linn County, Iowa," Iowa Geological Survey, 1970.
7. Water Resources of Iowa, Iowa Academy of Science, P. J. Horick, Ed., 1969.
8. Climatic Summary of the United States, 1951-1960, Iowa. Climatography of the United States, No. 86-11, U.S. Weather Bureau, 1964.
9. Final Safety Analysis Report, DAEC, Supplement "On-site Meteorological Data," Iowa Electric Light and Power Co.
10. H. C. S. Thom, "Tornado Possibilities," Monthly Weather Review, Oct.-Dec., 1963.
11. D. B. McDonald, "Cedar River Baseline Ecological Study," Annual Report, April 1971-April 1972, Duane Arnold Energy Center, June, 1972.
12. D. Niemann and D. B. McDonald, "An Ecological Study of the Terrestial Plant Communities in the Vicinity of the Duane Arnold Energy Center," Unpublished Report, Iowa Electric Light and Power Company, Aug, 1972.
13. Environmental Report, DAEC, Amendment 2, Oct, 1972.
14. Environmental Report, Revised Nov, 1971, DAEC, Docket 50-331, April, 1971.
15. D. B. McDonald, "Preliminary Report of an Analysis of Wildlife at the DAEC Site," 1972.
16. W. R. Shobe and J. H. Gakstatter, "Cedar River Water Quality Survey, Cedar Falls-Waterloo Area" Iowa State Hygienic Laboratory Report 71-72, 1970.
17. "Water Quality Survey of the Cedar River, Cedar Rapids, Iowa," Iowa State Hygienic Laboratory Report 71-1, 1970.
18. M. D. Wagner, "A Study of the Factors Influencing the Water Quality of the Cedar River," Unpublished Masters Thesis, The University of Iowa, 1972.
19. Letter, V. E. Dowell, Professor of Biology, University of Northern Iowa, July 20, 1972.

20. A. W. Klement, Jr., et al., "Estimates of Ionizing Radiation Doses in the United States 1960-2000," Environmental Protection Agency Report ORP/CSD 72-1, Aug, 1972.
21. Radiation Data and Reports, Vol. 1-13, 1959-1972, Environmental Protection Agency, 1972.
22. F. W. Collins and D. B. McDonald, "Terrestrial Fauna Determination, Duane Arnold Energy Center Site Environs." Unpublished Preliminary Report for Iowa Electric Light and Power Company, Cedar Rapids, Iowa, October 25, 1972.

3. THE CENTER

3.1 EXTERNAL APPEARANCE

The finished external appearance of the plant, as depicted in architectural rendition from a point approximately 1000 feet northwest of the center of the building complex, is shown in Fig. 3.1. On the left is an end view of one of the cooling towers. Land bordering the Cedar River is in the background, and the hills to the west of the river vanish at the horizon. On the right is the road which leads directly south to the site boundary. There it turns west for a distance of 1-1/2 miles before it again turns south toward Palo.

The low-profile switchyard and substation lies to the right of the road to Palo. The fenced area on which the switching, transforming and supporting equipment is located begins approximately 700 ft from the outer edge of the parking lot and about 2000 ft from the turbine-generator building. The center of the plant building complex is about 1700 ft from the western side of the north-south reach of the Cedar River and the center of the switchyard is about 2500 ft from it. An open-channel discharge canal runs approximately 1700 ft from the cooling tower area to a riverbank location (behind the plant as depicted) for channeling the cooling-tower blowdown to the river. The intake and pumphouse structures for draining water from the river to meet makeup requirements are located a short distance north of the point where the blowdown is released to the river.

Buildings which are joined together to form the plant complex are (from left to right) the turbine-generator building, control building, reactor building, administration building (left foreground) and radwaste building (right foreground). The pumphouse for recirculating cooling water from the cooling tower wet well to the turbine condenser is located between the turbine-generator building and the cooling tower. A small sanitary sewage treatment facility is located a few hundred feet north of the complex, and the offgas stack (depicted in the background behind the radwaste building) is located a few hundred feet south of the complex. Nominal dimensions of the station areas on the 500-acre plant site are: power plant, 420 x 475 ft (4.6 acres); cooling towers, 500 x 600 ft (6.9 acres), and switchyard and substation, 600 x 1000 ft (13.7 acres). Except for the offgas stack which rises to a height of 328 ft above ground, the 153-ft reactor building is the tallest onsite structure.

Outer walls for all plant buildings are of light buff-colored exposed-aggregate precast concrete. The upper region of the walls of both the reactor and turbine-generator buildings is highlighted by a covering of

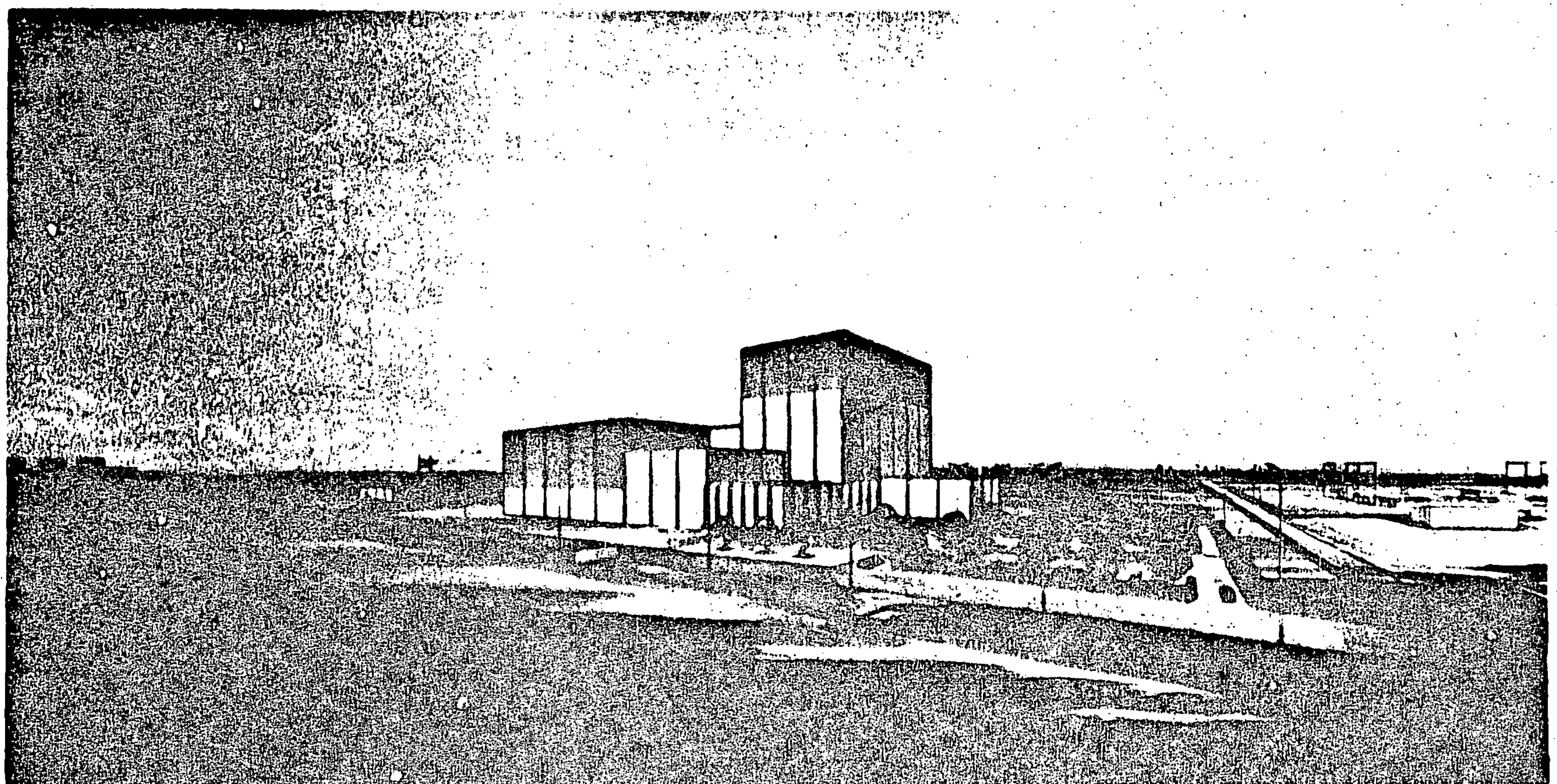

Fig. 3.1. Architect's Drawing of the Duane Arnold Energy Center. From Applicant's Environmental Report.

light gold colored metal siding which is fluted by dark brown vertical feature strips.

Cooling towers are of cedar and fir impregnated with colorless Martreat preservative which does not appreciably alter the natural appearance. All substation and switchyard equipment and supporting structures (with possible exception of the Cyclone fence) are painted light gray, irrespective of whether the metal surfaces are or are not galvanized. Overhead aluminum conductors leading to and away from the plant have a nonspecular (i.e., nonreflecting) "shadowline" finish.

All areas of the site on which no structures are erected but which were disturbed during development and construction are being carefully restored and planted with grasses, shrubs and trees, under the guidance and care of professional landscapers.

3.2 REACTOR AND STEAM-ELECTRIC SYSTEMS

Electric power generated at the DAEC is derived from the controlled release of nuclear energy for formation of steam in the core of a single-cycle forced-circulation boiling-water reactor (BWR). General Electric Company designed, fabricated, and delivered the nuclear steam-supply system and turbine-generator system. During installation, GE worked closely with the Bechtel Corporation, which provided balance-of-plant engineering, procurement, and construction services. General Electric will provide technical direction for checking out and starting up the reactor and steam-electric systems.

The steam, at 965 psia, saturated and of 99.7% quality, is routed to the turbine, where that part of its heat energy, which is thermodynamically available under the temperature conditions at the turbine exhaust, is converted to mechanical energy for driving the generator. The part of the heat energy which is not converted to mechanical energy is removed by total condensation of the steam in the condenser. This heat energy is rejected to the atmosphere by way of the cooling towers. The condensate from the condenser is pumped back to the reactor core for reboiling.

3.2.1 Reactor System

The reactor core is made up of 368 fuel assemblies, each of which contains 49 fuel rods. The rods are fabricated from Zircaloy-2 tubes with highly compacted and sintered uranium dioxide pellets sealed inside. The uranium in this form is enriched slightly to approximately

1.9 wt% U-235. The fuel pellets in selected rods are a uranium dioxide and gadolinium mixture. The gadolinium is provided as a burnable "poison" for reactivity control.

The reactor pressure vessel is of carbon steel internally clad, except for the inner top head, with stainless steel. Weighing about 400 tons, this vessel, which is 66 ft long, slightly over 16 ft OD, and of approximately 5 in. wall thickness, has a design pressure of 1250 psig. The normal operating pressure in the steam space above the reactor core and steam separators is 1005 psig for delivery of the steam to the turbine at 980 psig. Sections of the pressure vessel were formed and heat treated at facilities of the Chicago Bridge and Iron Company, and were weld assembled, checked, and tested in situ at the plant site.

The reactor pressure vessel and auxiliaries which are directly associated with forced-convection flow-through and with control of the reactor are housed within a containment shell. Pipes of major dimensions that "pierce" the containment shell are those which carry the steam to the turbine, and those which carry the condensate from the condenser, as feedwater, back to the pressure vessel. A bypass system is provided in the pipe to the turbine for passing excess steam directly to the condenser whenever the steam-production rate of the reactor exceeds turbine-generator use.

3.2.2 Turbine-Generator System

The turbine is a tandem compound-condensing type with a single high-pressure shell and two double-flow low-pressure shells. Combination moisture-separator and reheater units are employed to dry and reheat the steam between the high- and low-pressure shells. The turbine is rated at 565 MW (gross) when operating with inlet steam conditions of 965 psia and 99.7% quality.

The condenser is a single-pass divided water-box type of dual pressure aerated design. Noncondensibles are removed by two full-capacity steam jet air ejectors.

3.3 WATER USAGE

Sources of water and the uses associated with each are:

1. River water
   a. Circulating water (condenser cooling water)

b. Service water
    i. Residual heat removal (RHR) service water system
    ii. Emergency service water system
    iii. General service water system
    iv. Fire protection water system
2. Well water
    a. Demineralizer makeup water
    b. Potable water
    c. Air-cooling systems

Under design plant operating conditions, water is pumped into the plant from the river at the rate of 11,000 gpm, and from two onsite wells at the rate of 1500 gpm. With exception of water lost to the atmosphere as vapor (including vaporized drift) from the cooling towers, all water used during plant operation is ultimately discharged to the river. Water usage is shown in Table 3.1.

The outlet to the river for sewage effluent is upstream from the intake, and that for the drainage canal for all other water is downstream. The maximum rates of discharge due to plant operation at these upstream and downstream points are 15,000 gpd (about 10 gpm) and 4000 gpm, respectively. Onsite precipitation also drains to the river through the discharge canal.

3.3.1 River Water

River water is used as the dependable supply of water for the center's normal and emergency cooling operations for which the quality and temperature of river water is adequate. A submerged barrier across the Cedar River immediately downstream from the point of river intake assures a dependable pool from which the water is withdrawn.

a. Circulating Water

Water is circulated between the condenser and the cooling towers at the rate of about 290,000 gpm. No consumption or loss of circulating water occurs between the pump house and the cooling towers. Therefore, the above rate of circulation has no direct bearing on the rate of river water consumed for condenser cooling. However, water is continuously added to and subtracted from the stream of water which is circulated for main condenser cooling. That which is subtracted is: a) the water that is lost from the system as vapor and as mist (cooling tower "drift") as the warmed water from the main condenser is evaporatively cooled during exposure to air while flowing through the cooling towers; and b) the water that is removed from the system as cooling tower "blowdown"

TABLE 3.1. Water Usage in the DAEC (Design Values)

Water System	Circulation Rate, gpm	Consumptive Use Rate, gpm
River water		
Circulating water	290,000	7,000
Service water		
Residual heat removal	9,600*	0
Emergency service water	1,500*	0
General service water	9,600	0
Fire protection	-	-
Well water		
Makeup demineralizer	100	100
Potable	<10	<10
Air-cooling systems	1,400	1,400

*Intermittent use only.

(to the river by way of the discharge canal) in order to maintain a desirable dissolved mineral concentration in the circulating water stream. These two subtractions are replaced by the addition of fresh water to the circulating water system. This addition is termed "makeup" water. The quantity of water lost by vaporization varies somewhat with air conditions. Design vapor and drift losses account for 7000 gpm, and "blowdown" for 4000 gpm, so a total of 11,000 gpm of makeup water is required.

b. Service Water

Service water from the Cedar River is used for plant cooling purposes in both normal and emergency operating conditions. Except for fire protection water usage during a fire, there is no net consumptive use of service water. The residual heat removal (RHR) system is used to remove heat from the reactor core during reactor cooldown and may be used for possible postaccident flooding of the reactor core. The emergency service water system supplies cooling water under conditions of loss of offsite power to the center or a loss-of-coolant accident. General service water is used for cooling equipment throughout the center other than equipment cooled by well water (normal conditions) or emergency service water (emergency conditions).

3.3.2 Well Water

Each of the two production wells can provide water from the Silurian-Devonian aquifer at rates up to 750 gpm. This well water, because of its coldness (54°F) and relative cleanness, can satisfy several in-plant uses more readily and more economically than river water. Most of the well water used in the plant will be discharged into the circulating water system. A small amount will, however, be lost by evaporation or used in the sanitary sewer system.

a. Demineralizer Makeup Water

Requirements for makeup demineralized water will vary with plant operation. Up to 100 gpm may be supplied from the well-water system, but average use will be much less. In addition to being used for initial charging of the closed loop reactor system, the demineralized water will be used to make up for all losses of water from the reactor water system. Water from equipment drains is recycled 100 percent and represents no requirement for makeup water. Water lost from the reactor water system to the floor drains is 70 percent recycled, and the rest released to the discharge canal. The average loss of water in this manner is expected to average less than 1 gpm. Demineralized water will also be used consumptively as in the chemistry laboratory for rinsing glasswater and for other housekeeping activities.

b. Potable Water

Well water will be used to supply the drinking and sanitary facilities. Total usage for this purpose will vary but will amount to only a few gpm on the average. This water will be discharged through the sanitary waste facilities with a maximum capacity of 15,000 gpd (about 10 gpm).

c. Air-Cooling Systems

Circulation of well water through air-cooling units will constitute the primary use for well water. These air-cooling units are primarily associated with cooling in the dry well area in deference to instrument and equipment performance requirements. Water requirements for the air-cooling systems may be as high as 1200 to 1400 gpm.

3.4 HEAT-DISSIPATION SYSTEMS

3.4.1 General

The plant dissipates about 3.6×10^9 Btu/hr at normal full-load operation through a closed-cycle cooling system employing forced-draft evaporative cooling towers. About 95% of this heat is removed in the main condenser, the balance in residual heat-removal systems. A schematic diagram of the cooling systems is shown in Fig. 3.2, indicating the divisions of the systems and their main components. The main condenser is located in the turbine building. The pump house for the main circulating-water pumps is immediately adjacent to the turbine building. The river intake structure is located in a separate building on the riverbank. The two cooling towers are separate structures. The site layout is shown in Fig. 3.3. Discharge of cooling water to the river is indicated as blowdown in Fig. 3.2; this water is conducted to the river via an open canal and a discharge structure immediately downstream of the intake. The design flows are as follows: circulating water 640 cfs (290,000 gpm); blowdown 8.9 cfs (4000 gpm); intake 24.5 cfs (11,000 gpm). Air is drawn through the forced-draft cooling towers at about 500,000 cfs, and this air contains vapor from the evaporation of about 15.6 cfs (7000 gpm) of the circulating water.

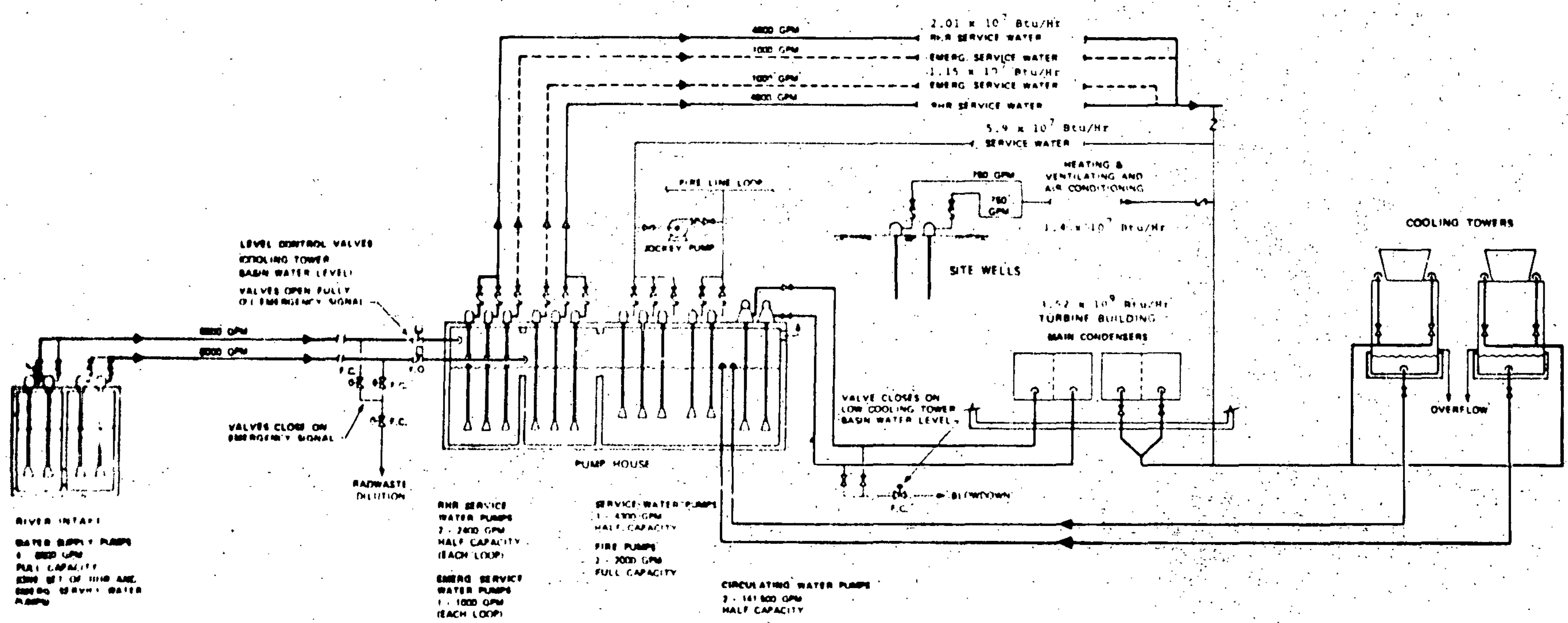

Fig. 3.2. Diagram of Cooling Systems. From Applicant's Environmental Report.

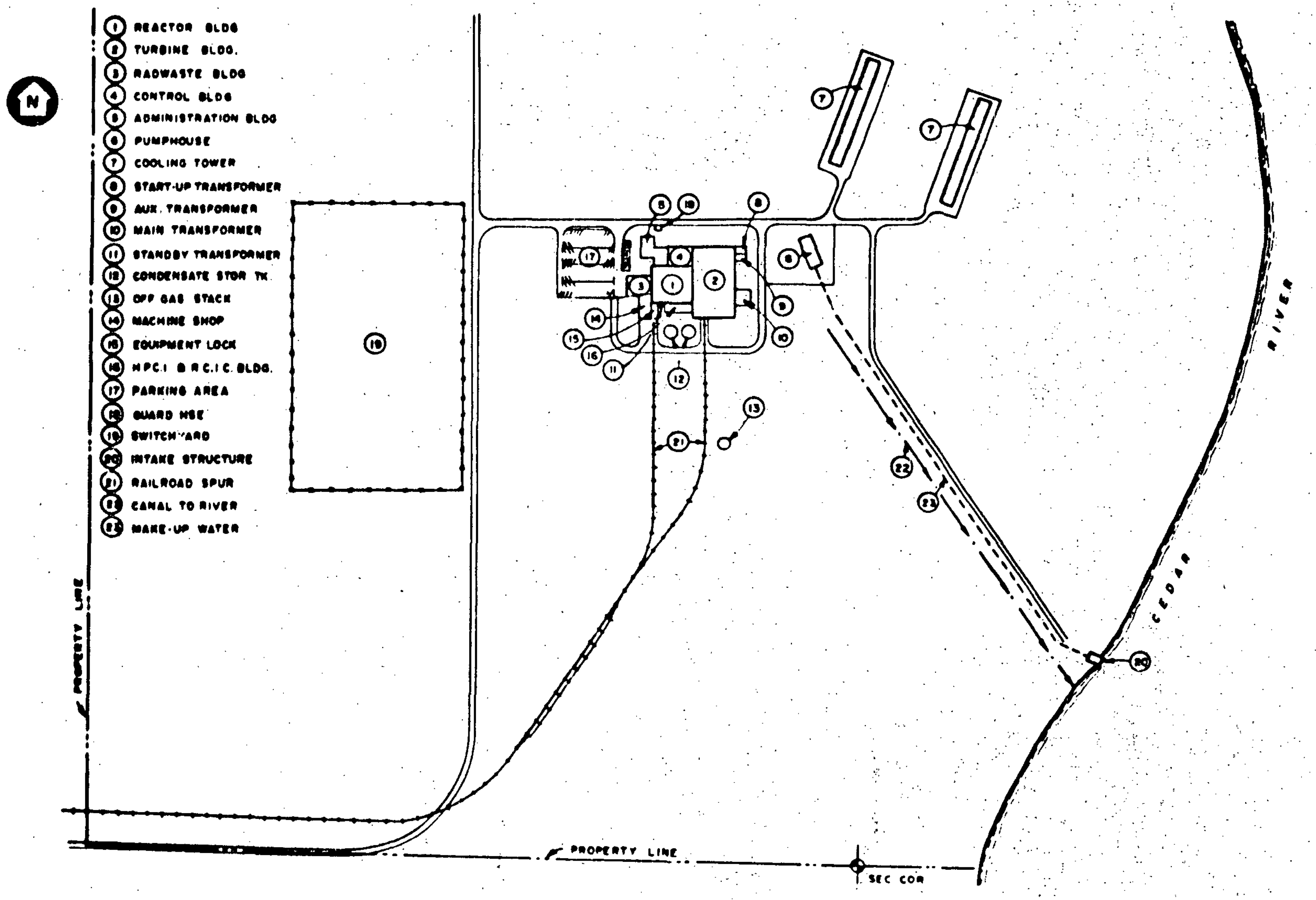

Fig. 3.3. Site Plan of the DAEC. From Applicant's Environmental Report.

3.4.2 Intake Structure

Water is drawn from the river through an intake structure located on the bank of the river at the southeast edge of the site, as shown in Fig. 3.4. A normally submerged barrier wall of sheet piles has been constructed across the full width of the river (approximately 400 ft) with an overflow weir at the right-hand shore (immediately adjacent to the intake structure) in order to assure maximum river-water availability for plant intake in case of abnormally low riverflow. The average river surface elevation is 731 ft; the top of the barrier is 725-1/2 ft; and the top of the weir is 724-1/2 ft. The barrier is shown in Fig. 3.5.

Intake water from the river first passes through a bar grill serving as a trash rack. The grill opening extends from elevation 722 ft to 753 ft. Design maximum and minimum river elevations are 752.5 ft and 725.0 ft, respectively. The grill is mounted with a slight incline to the vertical. The bars are 1/2 in. x 3 in. mounted edgewise to flow, with 2-in. spaces between them. At minimum riverflow (minimum elevation) the intake velocity for the normal 11,000-gpm intake flow is about 0.3 ft/sec at the entrance. At higher river elevations, the intake velocity will be lower, because of the increased area at the intake opening.

Two traveling screens, each with 3/16-in. square mesh openings are used. The maximum velocity (at minimum river elevation) is about 0.75 ft/sec through the screens. The channel velocity approaching the screens is lower, about that of the trash rack. The screens have an automatic wash cycle operating between a pressure drop of 3/4 in. water and 3 in. water. Debris on the screen is sluiced off and collected in a wire basket for inspection and for offsite removal.

Two water-supply pumps are located behind each traveling screen. Exit water from each pair of pumps is conducted separately in a 24-inch diameter pipe connected to the circulating water pump house.

The intake structure is provided with a 24-inch diameter warm-water line from the circulating water system to provide deicing by spraying warm water at the grill inlet. Gates between the trash grill and the traveling screen are also provided to shut off the river inlet during maintenance periods.

3.4.3 Cooling Towers

The two mechanical-draft cooling towers were designed and built by the Marley Corporation and have the guaranteed performance shown in Fig. 3.6. These towers operate similarily to those of the Applicant's Sutherland

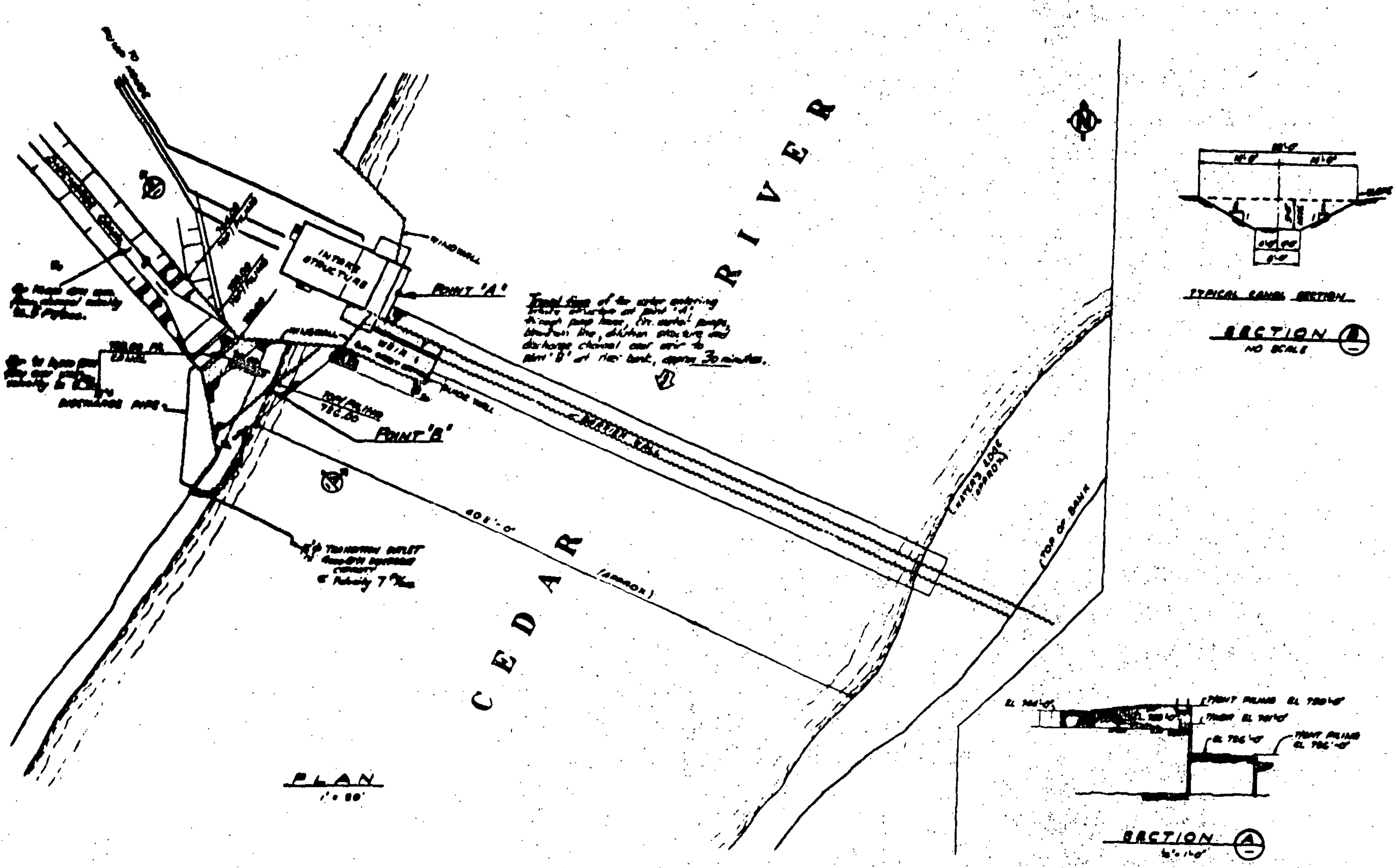

Fig. 3.4. Water Intake and Discharge Structures. From Applicant's Environmental Report, Amendment 2.

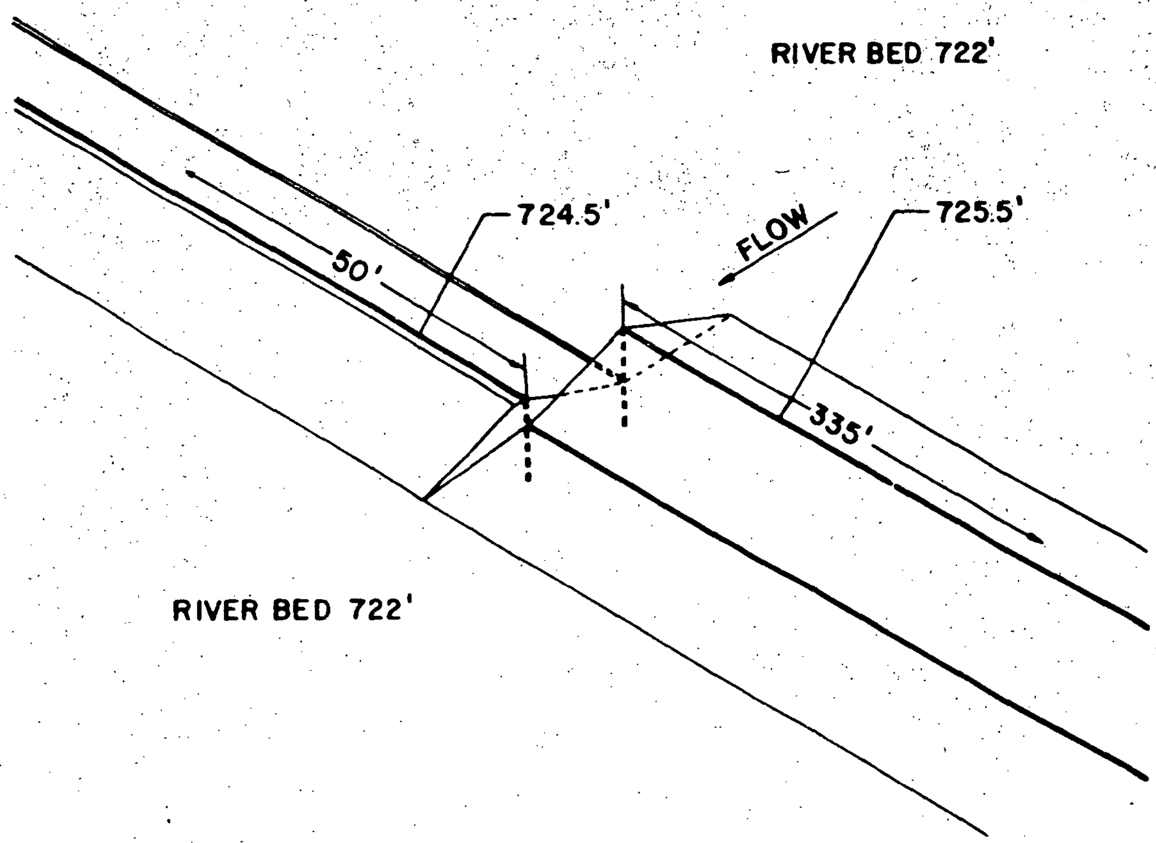

Fig. 3.5. Weir and Barrier Arrangement.

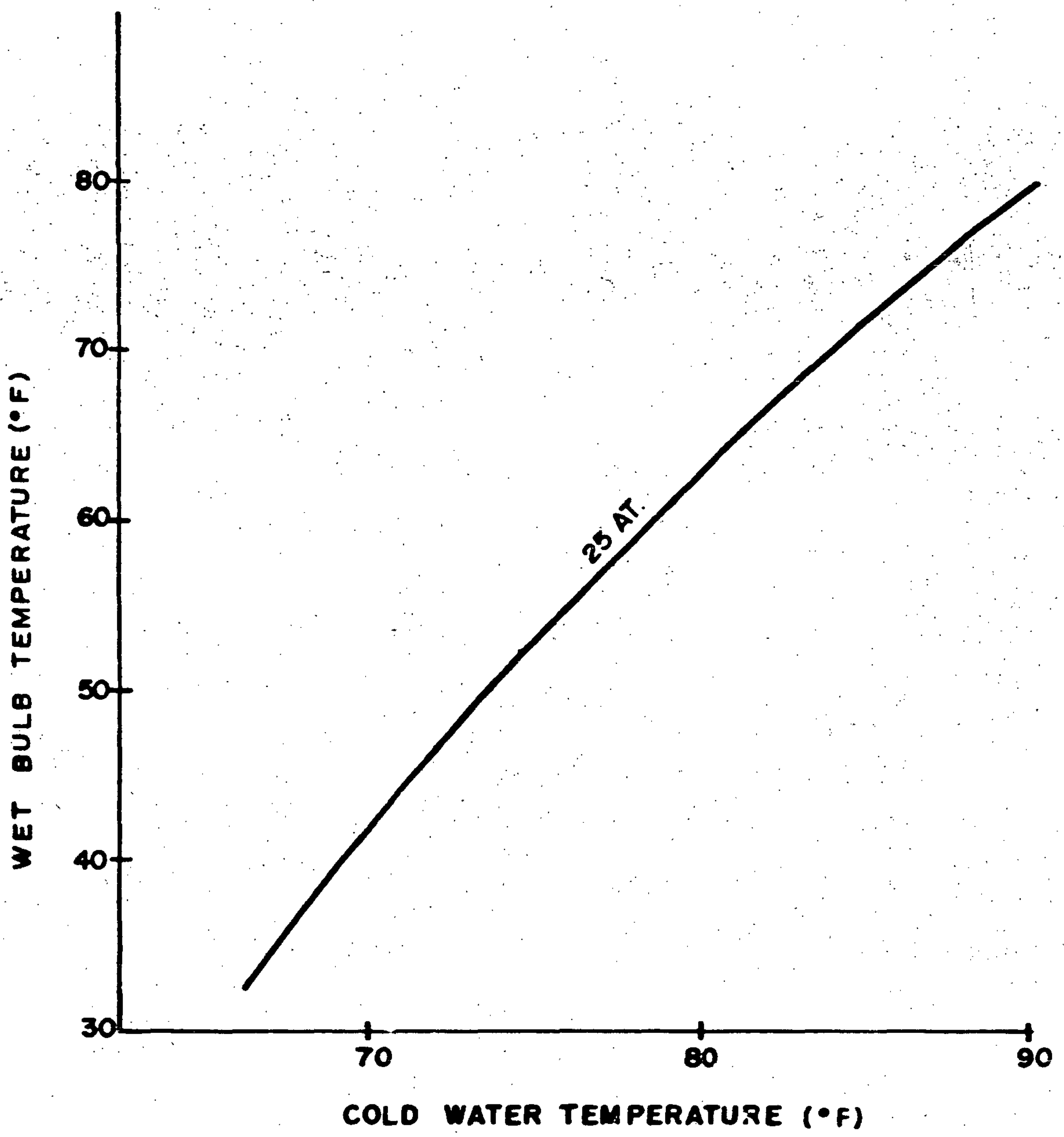

Fig. 3.6. Cooling-tower Performance Curve. From Applicant's Environmental Report, Amendment 2.

Station at Marshalltown, Iowa. The towers are expected to remove nearly the full heat load under all predicted weather conditions. The towers will each be approximately 40 ft wide, 400 ft long, and 60 feet high.

The towers are of the cross-flow type, with air entering the side through louvers and passing horizontally through the zone of water falling over splash bars (the "fill"). The air then passes through baffles serving as "drift" (entrainment) eliminators and enters the central air exhaust plenum. Air leaves the tower by being exhausted vertically by large fans each driven by an electric motor. Each tower is built on a modular basis, consisting of one fan and the associated section of the tower; a unit modulus is termed a "cell." Two separate towers are used, each consisting of 10 cells. Water is circulated to each tower in a 78-in-diameter pipe by a pump rated at 141,500 gpm at 80-ft waterhead. The two pumps are located in the pumphouse adjacent to the turbine building.

The fan in each cell of the towers is powered by a 200 hp motor, and for the 20 cells approximately 500,000 cfs of air are exhausted at a power consumption of about 3 MW. The design cooling performance of the two-tower system is such that inlet water at 112°F will be cooled to 87°F at an ambient air wet-bulb temperature of 76.5°F. This cooling range of 25°F, when applied to the 292,000 gpm (649 cfs) of rated cooling waterflow, amounts to a heat dissipation rate of 3.6 x 10^9 Btu/hr or 1066 MW(t).

As indicated in Section 2.6.1, the design wet-bulb temperature of 76.5 will be exceeded less than 2% of the time, or less than 180 hours per year. This means that the full heat load of the plant at least 98% of the time can be expected to be dissipated by the cooling tower with the blowdown water at a temperature of less than 87°F. At full load, higher wet-bulb temperature will be matched by increased blowdown temperature.

The tower fill or splash plates are made of polyvinyl chloride, and the supports of fiberglass-reinforced plastic. The tower structure itself is made of fir. These materials are standard in cooling-tower practice, and are expected to require no special water treatment for fouling prevention, corrosion, etc.

Noise is generated in the cooling towers by the turbulence of the air passing the fan blades and varies directly with fan power. Also, noise is produced by the water splashing down through the internal fill of the tower and into the water-collection basin at the bottom. Each cooling tower contributes 138 db as the overall noise pressure at the source, and this noise level is calculated to drop to less than 87 db at a distance of 50 ft. For both towers, the calculated combined noise at the nearest plant boundary is a maximum of 68.5 db and the noise at the nearest occupied dwellings is 54.5 db.[1] (For comparison, the noise of a single automobile passing 25 ft away at 65 mph is 77 db; the sound of light auto traffic at 100 ft is 50 db; normal conversation is 60 db and TV audio is 70 db.)[2] Actual sound measurements from very similar mechanical-draft towers associated with the Vermont Yankee Nuclear Plant indicate that the calculated values are conservatively high.[3]

The maximum evaporation of water at full load is 15.5 cfs, or 7000 gpm. The drift or entrainment is estimated by the Applicant to be a maximum of 0.1% of cooling waterflow, or 0.65 cfs (290 gpm). On the basis of experience at other cooling towers, the staff is of the opinion that the drift will actually be much lower (<0.01%).[4]

For operation at low temperature, special procedures are required to prevent ice from forming at the air inlet of the cooling towers. Although the fans are of fixed speed only, they may be reversed in order to melt accumulated ice. Also, individual fans can be shut off to reduce the intake of cold air. The towers allow individual cells to be shut down for maintenance, or one tower at a time may be operated during off-peak periods and during periods of cold weather.

3.4.4 Blowdown Discharge System

The closed-cycle circulating-water cooling system of the plant is supplied with river water to make up for losses to the air which occur at the evaporative cooling towers and to provide a purge to limit accumulation of nonvolatile dissolved solids in the circulating water. This purge discharge is taken from the circulating water system at the exit of the main circulating-water pumps, and thus is at the low temperature of the circulating water and at the full head of the pumps. This discharge, also termed the "blowdown," is piped into an open discharge canal where it flows to the river through the discharge structure. The discharge structure consists of an 18-inch-diameter pipe with a 16-inch reducer at the discharge which results in a 15-inch discharge stream. This conducts all discharge water to the river under the design outfall rate of about 4000 gpm (8.9 cfs). The opening of the discharge pipe is oriented so that the discharge occurs at the bottom of the river (at the right-hand shore) in the downstream direction but pointing upward to the surface at an angle of 20° to the horizontal. This submerged discharge has a design velocity of 6 ft/sec. The temperature of the discharge is reduced by mixing with the river water in concurrent flow. The effect of the blowdown water on the Cedar River after complete mixing is summarized in Table 3.2. In the following subsections, an assessment is made of the extent of the river which is raised 2°F or more above normal ambient river temperature due to the presence of a mixing zone or warm-water "plume."

The discharge structure also includes an overflow weir in addition to the discharge pipe described above. The weir is above the level of the discharge pipe, and when flow in the discharge canal goes above 4000 gpm, the flow will go over the overflow weir. The flow over the weir discharges into an open canal into the river. This provision is made to allow higher flow when required, such as during rains.

a. Reference Conditions for Applicant's Plume Analysis

The reference conditions adopted as a basis of the plume analysis[5] are listed in Table 3.3. Meteorological data were obtained from an earlier Bechtel report.[6] The riverflows were based on historical records at the Cedar Rapids USGS gage station. The Applicant's Environmental Report[1] presented statistics for high flow (flood frequencies, Environmental Report Table 2.4-1) and low flow (drought frequencies, Environmental Report Figure 2.4-2). For the present study, monthly flow averages were determined from the 1902-1967 historical data as shown in Fig. 3.7. Average river temperatures reported[7] for January and July in the period 1944-1954 were used to represent the ambient river temperature at the site for winter and summer, respectively. River water surface elevation at the site was determined using a survey of river cross sections and other available recorded and computed information. Effects of barrier wall installation were estimated.[5]

b. Methods and Results of Applicant's Analysis

Available calculational models[5] were used to estimate the dimensions of isotherms in the plume of the warm-water outfall of the plant. Separate models were used for the near-field analysis (where mixing due to the momentum of the discharge jet is dominant) and for the far-field analysis (where ambient river turbulence dominates the mixing), under conditions selected for appropriateness to the present case.[5]

The results are summarized in Table 3.4 and Figs. 3.8 and 3.9.

TABLE 3.2. Estimated Temperature Effects of 4000 gpm (8.9 cfs) Cooling Tower Blowdown on the Cedar River Based upon Existing Temperatures and Flow Records

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
(River)												
Maximum Temperature	38	38	60	67	77	84	89	87	82	71	62	49
Minimum Temperature	*32	*32	*32	35	48	54	66	65	51	38	32	*32
Average Temperature	34.1	34.6	39.2	50.8	62.9	71.8	77.9	76.6	67.6	56.6	42.1	34.8
Maximum Cooling Tower Temperature	72.2	72.2	82.4	85.4	88.5	91.5	91.5	91.5	88.5	88.5	79.5	74.5
Minimum River Flow (cfs)	300	310	670	1100	520	350	540	380	480	500	500	350
Average River Flow (cfs)	1400	2300	6200	6000	4000	4800	3000	2200	2100	1900	2000	1600
Est. Comb. Temp. at Min. Flow & Max. River Temp.	39.0	39.0	60.3	67.1	77.2	84.2	89.1	87.1	82.1	71.3	62.3	49.6
Est. Comb. Temp. at Ave. Flow & Max. River Temp.	38.2	38.1	60.0	67.0	77.0	84.0	89.0	87.0	82.0	71.1	62.1	49.1
ΔT°F Min. Flow & Max. River Temp.	1.0	1.0	.3	.1	.2	.2	.1	.1	.1	.3	.3	.6
ΔT°F Ave. Flow & Max. River Temp.	.2	.1	<.1	<.1	<.1	<.1	<.1	<.1	<.1	.1	.1	.1
Est. Comb. Temp. at Min. Flow & Min. River Temp.	33.1	33.1	32.7	35.4	48.7	54.9	66.4	65.4	51.7	38.9	32.8	33.1
Est. Comb. Temp. at Ave. Flow & Min. River Temp.	32.3	32.2	32.1	35.1	48.1	54.1	66.1	65.1	51.2	38.2	32.2	32.2
ΔT°F Min. Flow & Min. River Temp.	1.1	1.1	.7	.4	.7	.9	.4	.4	.7	.9	.8	1.1
ΔT°F Ave. Flow & Min. River Temp.	.3	.2	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2
Est. Comb. Temp. at Min. Flow & Ave. River Temp.	35.2	35.6	39.8	51.1	63.3	72.3	78.1	76.9	68.0	57.2	42.8	35.8
Est. Comb. Temp. at Ave. Flow & Ave. River Temp.	34.3	34.7	39.3	50.9	63.0	71.8	77.9	76.7	67.7	56.7	42.3	35.0
ΔT°F Min. Flow & Ave. River Temp.	1.1	1.0	.6	.3	.4	.5	.2	.3	.4	.6	.7	1.0
ΔT°F Ave. Flow & Ave. River Temp.	.2	.1	.1	.1	.1	<.1	<.1	.1	.1	.1	.2	.2

River Temperatures from: Iowa Geological Survey, Water Supply Bulletin No. 5 (1944-1954)
Approximate average and minimum monthly discharges flow records from 1902-1967. Cedar River at Cedar Rapids. (Data from Amendment 16, Graph, Figure 5)
Data assumes complete mixing with river water.
*Minimum temperatures for January, February, and December were indicated in the IGS bulletin to be 31°F. These were increased to 32°F which would seem to be more realistic.
From Applicant's Environmental Report.

TABLE 3.3. Reference Conditions for Plume Analysis

Outfall

a. Outfall 14.8 miles upstream from U.S. Geological Survey gaging station at Cedar Rapids; river width approximately 400 ft.

b. Outfall immediately downstream of intake structure, with normally submerged barrier (full river width) in between, with overflow weir on right-hand shore. Average river surface elevation 731 ft; top of barrier 725 ft 6 in; top of weir 724 ft 6 in.

c. 15 in.-diam stream, directed downstream, 20° upward from horizontal at river bottom at right bank. Overflow weir elevation 741 ft.

d. Design discharge flow 4000 gpm or 8.9 cfs; linear flow 6 fps.

e. Discharge water temperature: Summer 91.5°F; Winter 72.2°F.

River

a. River depth as a function of riverflow: 3.5 ft deep at 300 cfs, 8 ft deep at 1500 cfs, 9 ft deep at 3000 cfs.

	Summer	Winter
b. Flow, cfs	3000 (av.)	3000 (high)
	300 (low)	1500 (av.)
	-	300 (low)
c. Temperature °F	77.9	34.1

d. Linear velocity varies between 0.8 and about 2.3 ft/sec

Air

	Summer	Winter
a. Dry-bulb temperature °F	88	31
b. Relative humidity, %	49	69
c. Average wind speed, mph	4	4
d. Solar radiation, langleys/day	575	150

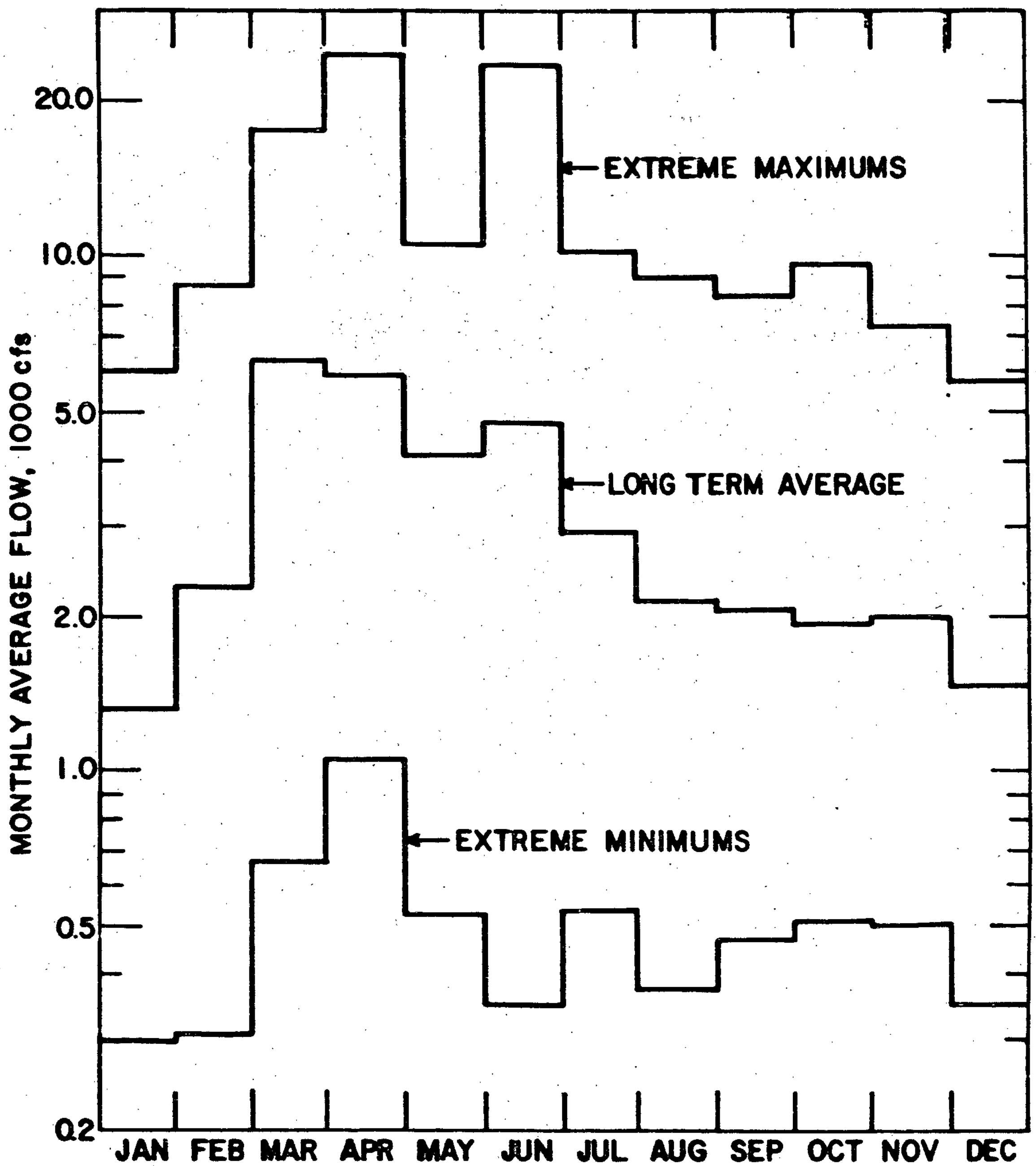

Fig. 3.7. Monthly Average River Flow at Cedar Rapids. From Applicant's Environmental Report.

TABLE 3.4. Summary of Surface Temperature-Rise Isotherms

Season	Riverflow, cfs	2°F Isotherm Length, ft	2°F Isotherm Area, acres	5°F Isotherm Length, ft	5°F Isotherm Area, acres
Summer	3000	40	0.01	-	-
	300	74	0.03	28	0.004
Winter	3000	124	0.08	53	0.015
	1500	176	0.16	73	0.028
	300	246	0.32	84	0.037

From Ref. 5.

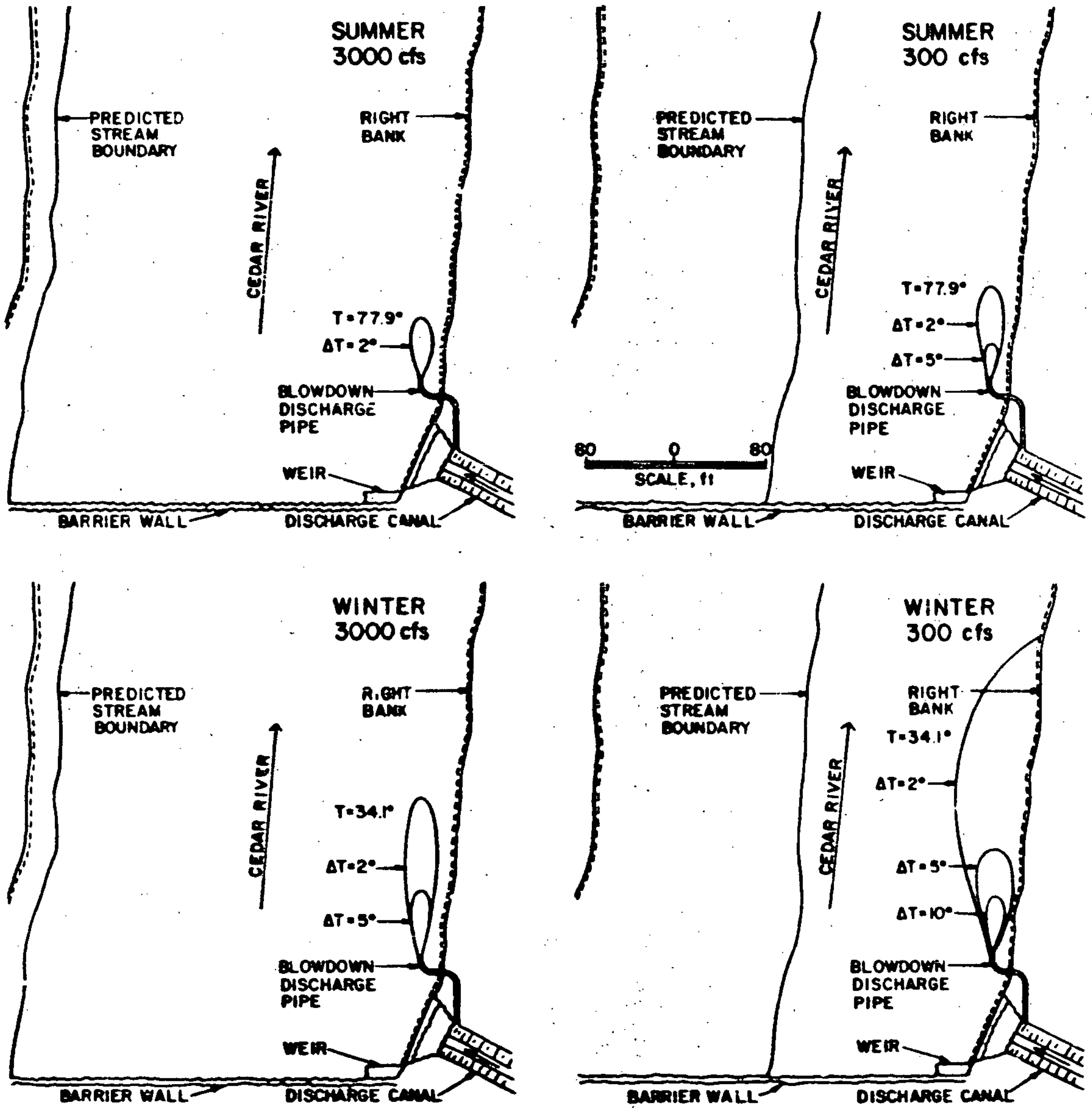

Fig. 3.8. Surface Temperature-Rise Isotherms. From Ref. 5.

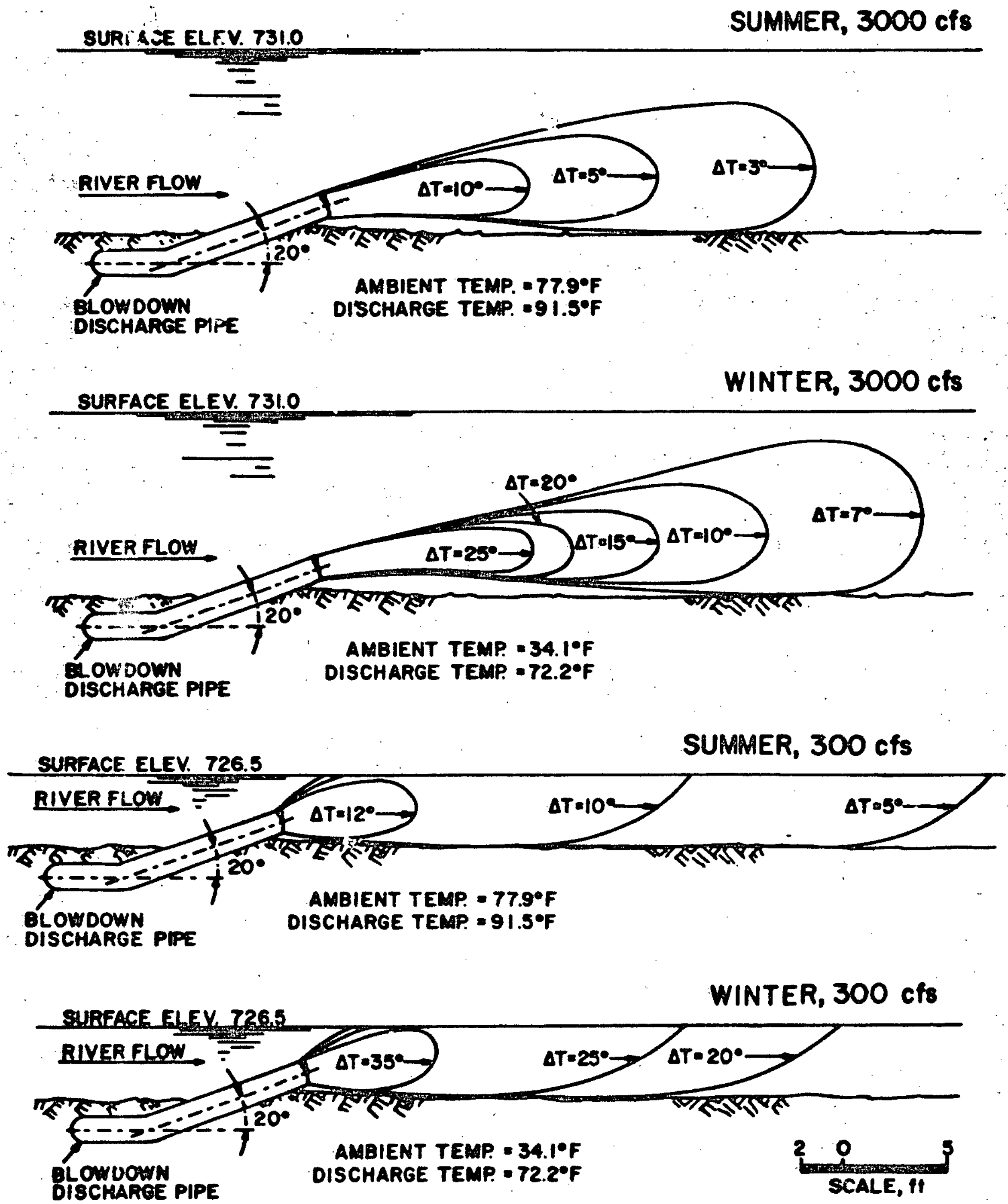

Fig. 3.9. Vertical Temperature-rise Isotherms. From Ref. 5.

c. Evaluation of Plume Analysis by the Staff

A number of factors of judgment enter into the application of calculational models to practical cases. In a review of the models cited as a basis for the Applicant's study, most assumptions appear to be reasonable and the results reported for the 3000 cfs case were confirmed by an independent calculation based on the correlation of Shirazi and Davis.[8] However, the model used for the low flow case (300 cfs) is somewhat more questionable because the reference data does not correspond to the shallow water depth which limits the vertical mixing. In the opinion of the Staff, even though the low flow cases are somewhat speculative, the predicted results are reasonable approximations. The main conclusion that the plumes are small (<1 acre in area and involving less than 25% of the total river width) are expected to be borne out in actual practice.

3.5 RADIOACTIVE WASTE SYSTEMS

During the operation of nuclear power reactors, radioactive material will be produced by fission and by neutron activation reactions in metals and other material in the reactor coolant system. Small amounts of gaseous and liquid radioactive wastes may enter the waste streams, which will be processed and monitored within the plant to minimize the radioactive nuclides that will ultimately be released to the atmosphere and into the Cedar River. Releases of radioactivity during operation of the DAEC will be in accordance with the Commission's regulations, as set forth in 10 CFR Part 20 and 10 CFR Part 50. The Applicant will utilize the equipment described in this section to meet the "as low as practicable" discharge criteria as delineated in the appropriate Technical Specifications.

The waste handling and treatment systems to be installed at the station are discussed in detail in the Final Safety Analysis Report and in the Applicant's Environmental Report. In these documents, the Applicant has provided the results of his analysis of the proposed treatment systems including estimates of the annual effluents.

The following analysis is based on the Staff's model, adjusted to apply to this plant and uses somewhat different operating conditions. The Staff's calculated effluents are therefore different from the Applicant's; however, the model used results from a review of available data from operating power plants.

3.5.1 Liquid Waste System

The liquid radioactive waste treatment system will consist of the process equipment and instrumentation necessary to collect, process, monitor and discharge potentially radioactive liquid wastes from the plant. Prior to release of any treated liquid wastes, samples will be analyzed to determine the type and amount of radioactivity in a batch. Based on the analysis these wastes will either be released under controlled conditions to the Cedar River or retained for further processing. Monitors will give an indication of high radiation levels and liquid waste discharges will be automatically terminated. The Applicant indicates in the FSAR that the liquid waste processing system will be designed to recycle as much reactor grade water entering the system as practicable.

The reactor water purity will be maintained by means of a reactor water cleanup system and a condensate demineralizer system. Both systems will utilize Powdex type filter/demineralizers.

The liquid radwaste system is divided into several subsystems so that the liquid wastes from various sources can be kept segregated and processed separately. Cross-connections between the subsystems provide additional flexibility for processing of the wastes by alternate methods. The liquid radwastes will be classified, collected, and treated as high purity, low purity, chemical, detergent, sludge or spent resins. The terms high purity and low purity refer to the conductivity and not radioactivity. Table 3.5 lists the principal assumptions used in evaluating the waste treatment systems. Figure 3.10 is a simplified liquid radwaste system flow diagram.

High purity (low conductivity) liquid wastes will be collected in the waste collector tank (10,000 gal), principally from the piping and equipment drains but also liquid decanted from the resin backwash phase separators. These wastes will be processed by filtration and ion exchange through the waste filter and waste demineralizer. After processing, the liquid will be received in one of two waste sample tanks (10,000 gal each) where it will be sampled. Then, if it is satisfactory for reuse, it will be transferred to the condensate storage tank as makeup water.

The Staff analysis assumed a daily input into this system of 21,000 gallons of high purity wastes at about 28 percent of primary coolant activity. The Staff further considered that 90% of this water would be recycled and that 10% would be discharged. The annual release from this source was calculated to be 0.5 Ci.

TABLE 3.5. Principal Conditions and Assumptions Used in Estimating Radioactive Releases from Duane Arnold Energy Center

Power	1,658 MWt
Plant capacity factor	0.8
Operating power fission source term	Equivalent to 100,000 μCi/sec with 30-min holdup for a 3,400-MWt reactor
Total steam flow	7,150,000 lb/hr
Weight of liquid in the system	1,538,000 lb
Weight of steam in the system	28,320 lb
Cleanup demineralizer flow	77,000 lb/hr
Containment purges	4 per year
Leaks	
Reactor Bldg.	480 lb/hr
Turbine Bldg.	1,700 lb/hr
Condenser air inleakage	20 cfm
Gland seal flow	7,150 lb/hr
Iodine partition coefficients	
Steam/liquid in reactor	0.012
Reactor Bldg. liquid leak	0.001
Turbine Bldg. steam leak	1
Gland seal	1
Air ejector	0.005
Air-ejector recombiner system	0.01
Condensate demineralizer	0.0016
Cleanup demineralizer	0.1
Gland-seal condenser	0.01
Holdup times	
Gland-seal gas	0.03 hr
Air-ejector gas	0.5 hr
Charcoal delay holdup time for	
Kryptons	0.76 days
Xenons	13.6 days

Decontamination factors

	I	Cs, Rb	Y	Mo, Tc	Others
High-purity waste	10^2	10	10	10^2	10^2
Low-purity waste	10^2	1	10	10^2	10^2
Chemical waste	10^2	10^3	10^4	10^5	10^3

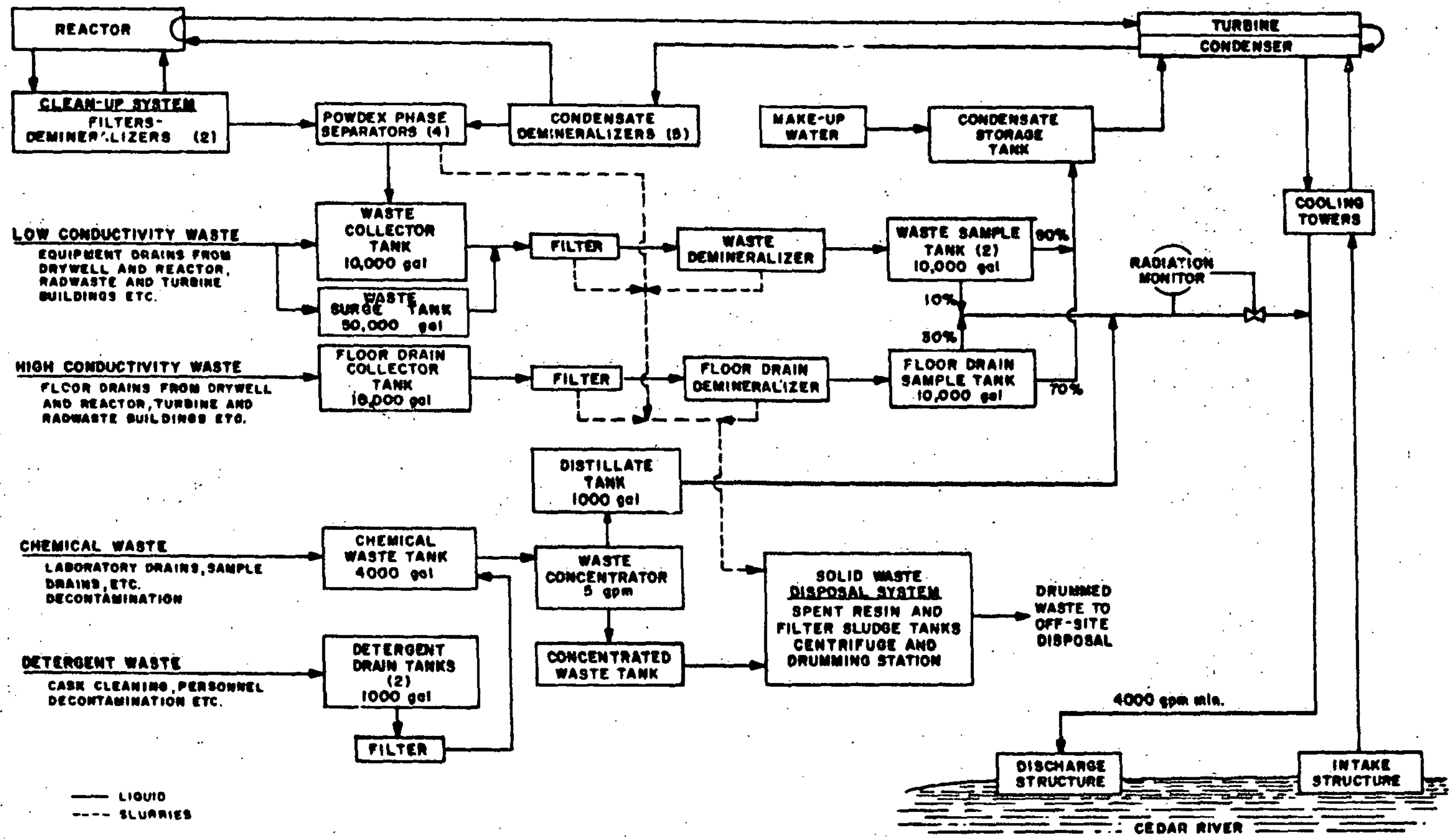

Fig. 3.10. Liquid Radioactive Waste Flow Diagram.

Low purity (moderate conductivity) liquid wastes will be collected in t floor drain collector tank (10,000 gal), principally from the various floor drain sumps. These wastes will generally have low concentrations of radioactive impurities. Processing will consist of filtration, ion exchange, and subsequent transfer to the floor drain sample tank (10,000 gal) for sampling and analysis. Normally, treated low purity wastes will meet the specifications of water quality used in the plant and, if the water inventory of the plant permits, they will be returned to the condensate storage tank for reuse. Infrequently, when the water inventory of the plant does not permit return to condensate storage, treated low purity waste will be sampled and discharged.

The Staff analysis assumed a daily input to this system of 8500 gallons of low purity wastes at about 34 percent of primary coolant activity. About 30% of this water will be discharged after processing. The annual release from this source was calculated to be 1.0 Ci.

Chemical wastes will be collected in the chemical waste tank (4000 gal) principally from decontamination, laboratory drains and cask cleaning drains. These chemical wastes will be of such high conductivity as to preclude treatment by ion exchange. These wastes will be neutralized, if required, and then processed by filtration and by evaporation. Exces waste will be discharged to the cooling tower blowdown stream. Evaporat bottoms (concentrates) will be drummed and disposed of as solid radwaste The distillate from the evaporator will be collected in a sample tank fo sampling and analysis.

The Staff analysis considered a daily input to this system of 500 gallon of chemical wastes at an estimated 10% of primary coolant activity with 100% of the condensate discharged. The annual release from this source was calculated to be less than 0.5 Ci.

Detergent wastes will be collected in one of two detergent drain tanks (1000 gal each). The source of these wastes are shop regulated drain, personnel decontamination, cask cleaning drains, and turbine washdown area drains. Detergent wastes will be of low radioactivity concentration, but they will be treated in the same manner as chemical wastes to the maximum extent practicable, taking into account the tendency of these wastes to adversely affect evaporator performance. Plant laundry will be done offsite by an outside contractor.

The Staff assumed a daily input of 300 gallons of detergent waste at a negligible activity. In their calculations the Staff combined the chemical and detergent wastes.

The Staff estimated annual liquid waste releases are shown in Table 3.6. Based on evaluation of the liquid waste treatment system and the assumptions summarized in Table 3.5, the Staff calculated these releases to be a fraction of the values shown in Table 3.6. However, to compensate for equipment downtime and expected operational occurrences the values have been normalized to 4 curies per year excluding tritium. Based on operating experiece with other BWR's the Staff estimate the annual tritium release to be approximately 20 curies. In comparison the Applicant estimates a yearly liquid waste release of 0.4 curie excluding tritium, based on an off-gas rate of 100,000 microcuries per second, and a yearly tritium release of 20 curies. The liquid effluent will be discharged into the cooling tower blowdown stream.

3.5.2 Gaseous Wastes

During power operation of the plant, radioactive materials released to the atmosphere in gaseous effluents include low concentrations of fission-product noble gases (krypton and xenon), halogens (mostly iodines), tritium contained in water vapor, and particulate material including both fission products and activated corrosion products. A simplified schematic of the various systems for processing of radioactive gaseous waste and ventilation paths is shown in Fig. 3.11.

The primary source of gaseous radioactive waste will be the noncondensable gases removed from the primary coolant through the main condenser by the air ejector. These gases will consist of a small amount of air which has leaked into the condenser (approximately 20 cfm), and approximately 5 times as much hydrogen and oxygen produced by the radiolytic decomposition of water, with very small volumes of radioactive gases, primarily krypton and xenon. Other sources of airborne radioactivity include the noncondensable radioactive gases removed from the turbine gland seal condenser and those from the reactor building, turbine building, and radwaste building ventilation systems. Additional potentially radioactive gases include the off-gas removed from the main condenser during startup by the mechanical vacuum pump, and the off-gas from purging the drywell and suppression chamber during shutdowns.

The gases removed from the main condenser by the air ejectors will be processed in a gas delay system consisting of two redundant catalytic H_2-O_2 recombiners to convert these gases to water in order to reduce the volume of gases to be treated; a condenser to remove the water vapor; a 30-min holdup pipe to permit the decay of short-lived radioactive gases; and 12 beds each containing 3 tons of activated charcoal wherein xenons and kryptons will be adsorbed and delayed selectively, thereby permitting

TABLE 3.6. Estimated Annual Releases of Radioactive Materials in Liquid Effluents

Nuclide	Ci/yr	Nuclide	Ci/yr
Rb-86	0.00096	I-[illegible]	0.027
Sr-89	0.075	I-133	0.318
Sr-90	0.0046	I-135	0.093
Sr-91	0.0765	Cs-134	0.555
Y-90	0.027	Cs-136	0.225
Y-91m	0.050	Cs-137	0.450
Y-91	0.163	Ba-137m	0.43
Y-92	0.142	Ba-140	0.140
Y-93	0.451	La-140	0.062
Zr-95	0.00096	La-141	0.004
Zr-97	0.00096	Ce-141	0.0026
Nb-95	0.00088	Ce-143	0.0027
Nb-97m	0.00088	Ce-144	0.00056
Nb-97	0.00096	Pr-143	0.00096
Mo-99	0.093	Pr-144	0.00056
Tc-99m	0.085	Nd-147	0.00034
Ru-103	0.00074	Pm-147	0.00008
Ru-106	0.00030	Pm-151	0.0001
Rh-103m	0.00074	Sm-153	0.0002
Rh-105	0.001	Cr-51	0.018
Rh-106	0.00030	Mn-54	0.0015
Sb-127	0.000062	Fe-55	0.074
Te-125m	0.000039	Fe-59	0.0030
Te-127m	0.00022	Co-58	0.178
Te-127	0.00022	Co-60	0.018
Te-129m	0.00088	Zn-65	0.000037
Te-129	0.00059	Zn-69	0.00027
Te-131m	0.0025	W-187	0.053
Te-131	0.00049	Na-24	0.0[illegible]8
Te-132	0.022	P-32	0.00074
I-130	0.0020	Np-239	0.0144
I-131	0.132		
		Total (excluding tritium)	4.0 Ci
		Tritium	20 Ci

Note: Isotopes having an estimated release of less than 10^{-5} Ci/yr have not been included.

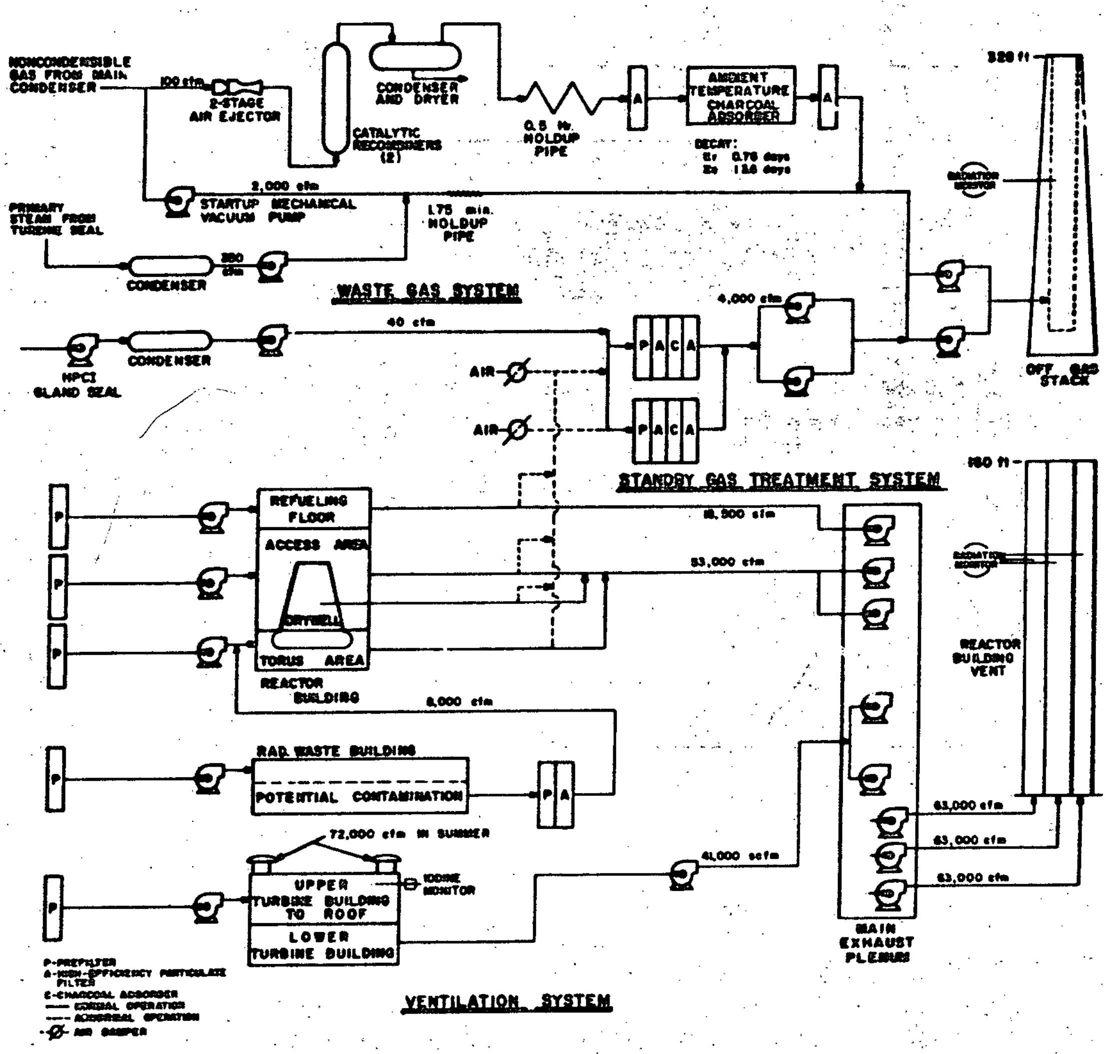

Fig. 3.11. Gaseous Radioactive Waste Flow Diagram

a significant reduction by radioactive decay. The residual gases w be released through a HEPA filter to the environs through the 100-m main off-gas stack.

According to the Staff's calculations, the expected delay for krypt will be 18.2 hours and for xenon 13.6 days. The gases are expected be dried to a 45°F dew point and the beds to be maintained at 77°F. The Applicant has calculated delay periods of 19 hours for krypton 15 days for xenon.

Primary system steam will be used in the turbine gland seal system; hence, the gases released from the turbine gland seal condenser can radioactive. These gases will be held up approximately 1.8 minutes before being exhausted into the off-gas stack without further treatm

During unit startup, air and any radioactive gases present will be removed from the main condenser by a mechanical vacuum pump. It is assumed that the pump will operate about 10 hours per year. These gases will be discharged through the same holdup pipe into which the turbine gland seal condenser exhausts. The gases will be released through the main stack without further treatment.

The ventilation air from the reactor building will normally be disch through the reactor building vent without treatment. The flow will monitored, and the building will be isolated if the activity exceeds preset level. During building isolation, air flow will be reduced t 4000 cfm and directed through the Standby Gas Treatment System (SGTS before release through the main stack. The SGTS will consist of a prefilter, a HEPA filter, a charcoal adsorber, and another HEPA filt in series.

The drywell and suppression chambers will be isolated during normal operation. However, during shutdowns and startups associated with re ing maintenance these areas will be purged, with the gases exhausting through the Standby Gas Treatment System, or directly to the main st if the activity is low. The expected release from this operation is insignificant. A requirement for a quarterly test of the High Press Coolant Injection Pump necessitates the use of primary steam as the turbine power source. As shown on the drawing, this gland seal stea is condensed and the vented gases directed through the SGTS system. As an additional source of radioactivity release, this is considered be negligible.

The ventilation air flow rate through the Turbine Building will vary from approximately 41,000 cfm in the winter to approximately 112,000 cfm in the summer. Approximately 41,000 cfm of potentially contaminated air will be constantly exhausted from the lower areas of the turbine building to the reactor building vent. The balance of the air flow through the upper turbine building for heat removal in summer will be exhausted unfiltered through roof outlets. The exhaust air from the Radwaste Building will pass through prefilters and HEPA filters before discharging to the reactor building torus area where it is exhausted to the reactor building vent. All of the ventilation systems will be designed to operate at negative pressure and air will flow from clean regions to areas of higher contamination potential.

Table 3.7 lists the results of the Staff's calculations of annual gaseous effluents based upon the conditions listed in Table 3.5. This table indicates an expected annual release of noble gases of about 33,000 Ci. Based on use of the charcoal delay system and an off-gas rate of 25,000 microcuries/second, the Applicant has estimated an annual release of about 17,000 Ci of noble gases. In addition we estimate an annual release of 0.6 curie of I-131 coming mainly from expected steam leaks in the turbine building. The Applicant estimates 0.08 curie of I-131.

3.5.3 Solid Radwaste System

The solid waste handling system is designed to collect, monitor, process, package and provide temporary storage for radioactive solid wastes prior to offsite shipment and disposal in accordance with applicable regulations. Solid wastes will be grouped under two categories, wet and dry.

Wet wastes will consist of spent demineralizer resins, filter sludges and evaporator bottoms. Because of differences in radioactivity or contamination levels of the many wastes, various methods will be employed for processing and packaging. The waste from the evaporator bottoms will be solidified and drummed.

Standard 55-gallon steel drums will be used for packaging solid wastes because of their ready availability, ease of handling, and conformance with present shipping practices. Spent resins and filter sludges will be held for radioactive decay in the phase separators or sludge tanks and will then be transferred to one of two centrifuges where the excess water will be removed. The solids will be discharged by gravity to a hopper below each centrifuge. Drums will be filled from the hoppers. The excess backwash water from the phase separators, sludge tanks and centrifuges will be transferred to the liquid radwaste system for processing.

TABLE 3.7. Calculated Annual Release of Radioactive Gaseous Effluents

Nuclide	Curies per year: Mechanical Vacuum Pump	Reactor Building	Turbine Building	Gland Seal	Air Ejector	Total
Kr-83m	-	-	10	41	39	90
Kr-85m	-	-	16	69	3,600	3,600
Kr-85	-	-	-	-	360	360
Kr-87	-	-	49	200	7	260
Kr-88	-	-	53	220	2,200	2,500
Kr-89	-	-	17	490	-	500
Xe-131m	-	-	-	-	140	140
Xe-133m	-	-	1	4	68	70
Xe-133	1,445	-	29	120	20,600	22,000
Xe-135m	-	-	82	320	-	400
Xe-135	215	-	84	350	-	650
Xe-137	-	-	290	900	-	1,200
Xe-138	-	-	260	1,020	-	1,300
Total Noble Gases						33,160
I-131	-	0.012	0.547	0.041	-	0.6
I-133	-	0.041	2.54	0.214	-	2.8

After filling, the drums will be moved to the capping station where lids will be remotely placed on the drums and secured in place under manual control of an operator. After capping, decontamination and monitoring the drums will be moved to the storage area to await shipment by a licensed carrier to a licensed disposal site in accordance with applicable regulations. Loading of drums for offsite shipment will be done within the confines of the radwaste building.

Typical dry solid wastes will include air filters, miscellaneous paper, rags from contaminated areas, contaminated clothing, tools, and equipment parts, and solid laboratory wastes. The disposition of a particular item of waste will be determined by its radiation level, type and the availability of disposal space. Material which can be compressed will be compacted into 55-gallon drums by a hydraulic press. Some solid wastes will be handled manually because of low radioactivity content or minimal contamination levels. Except for used reactor components, generally, solid wastes need to be held on site only until quantities large enough for economical shipment are accumulated.

The Applicant estimates the weight and volume of waste concentrates exclusive of evaporator bottoms, to be respectively about 63,000 pounds and 2200 cubic feet per year. The Applicant expects the total isotopic inventory of these solids to be about 1000 curies per year. The Staff estimate that approximately 500 drums of spent resins, filter sludges and evaporator bottoms and 250 drums of dry and compacted waste will be shipped offsite at a total activity of approximately 1500 curies per year after 180 days of storage.

3.6 CHEMICAL AND BIOCIDE SYSTEMS

Nonradioactive chemicals are used in the plant to regenerate demineralizers for purifying plant water supplies, for prevention of fouling of heat exchangers, for maintenance of water quality, for corrosion inhibition and for cleaning. The sources of these chemicals, their controlled use in the plant, and their management as waste effluent are described below.

3.6.1 Demineralizer Wastes

One source of chemical waste is the liquid effluent from the regeneration of the demineralizers used to purify well water for use as makeup to reactor coolant. Under normal continuous operation, the makeup demineralizer system discharges 12,000 gal/day of waste into the neutralizing tank. Sulfuric acid and caustic solutions are added such that about 500 lb of sodium sulfate are added to the batch. At the above maximum chemical discharge rate from this source, about 10 ppm of sodium sulfate is added to the 4000-gpm blowdown as a daily average. This batch also contains the natural minerals present in the well water. After it is sampled and neutralized, the batch is discharged to the normal waste drain and enters the river via the blowdown discharge canal. Small amounts of miscellaneous nonradioactive laboratory chemicals are also discharged in this manner.

3.6.2 Cooling-Water Quality Cont...

The main cooling system for the plant condensers and other heat exchangers uses an automatic acid addition to control pH (the pH is controlled to about 7.1) for the normally alkaline waters. The chief purpose is for scale control. Maximum normal additions from this source add about 400 ppm sulfate to the blowdown to the river, or about 19,000 lb/day. This is the largest chemical effluent. The condenser tubes are type-304 stainless steel, but other condenser steels are also used in the system. Present plans do not call for use of additional chemicals for corrosion inhibitors.

Because about 2.5% of the circulating water flow of the closed-cycle cooling system is lost by evaporation in each pass through the system, a purge is provided to limit the buildup of dissolved solids in the circulating water. A design discharge of 8.9 cfs (blowdown) is used for this purpose. The makeup water required is equal to the sum of evaporation and blowdown, or 24.5 cfs. An additional purge can be provided for dilution of effluents up to the capacity of the makeup pumps, which is about 53 cfs.

The expected analysis of the principal chemicals present in the blowdown discharged to the Cedar River is given in Table 3.8. The values shown include concentration from evaporative losses, and addition of chemicals from the demineralizer and the circulating water systems.

3.6.3 Nonradioactive Cleaners

During plant construction about 414 kg of trisodium phosphate (TSP) and 190 kg of sodium nitrite will be used in a once-only cleaning operation of the plant's condenser and piping systems. Schedules and concentrations for the cleaning operations are given in Table 3.9.

TSP will be released to the river at a rate of approximately 50 gpm after being mixed with approximately 450 gpm of dilution water. This will result in TSP concentrations of about 50 mg/l in the water as it

TABLE 3.8. Calculated Effects of Cooling Tower Blowdown on Some Chemical Concentrations in the Cedar River[f]

	Cedar River Conc.[a]		Cooling Tower	Cedar River Conc. after
	Range	Average	Blowdown[b]	Mixing[c]
pH	7.9–9.5	8.6	7.1[d]	8.2
Total P	0.48–2.41	1.22	3.29	1.38
Orthophosphate	0.09–1.71	0.79	2.05	0.89
Ammonia N	0.02–1.56	0.50	Most will probably be converted to nitrate and chloramines.	
Nitrate N	0.05–3.85	0.65	1.69	0.73
Nitrite N	0.02–0.03	0.02	0.05 or be converted to nitrate.	0.02
Chloride	16.3–19.5	18.1	48.9	20.5
Sulfate	29–43	38	501[e]	63

[a] Unless otherwise indicated, values are those obtained during monthly sampling at 4 stations (see Fig. 2.15) during the period April 1971–April 1972.[9]

[b] Except as indicated, values were calculated based on a concentration factor of makeup/blowdown = 2.7.

[c] Dilution factor based on minimum river flow = 20.

[d] Adjusted to this value by addition of sulfuric acid.

[e] Sum of 99 mg/l due to concentration of Cedar River water and 392 mg/l added as sulfuric acid to control pH, and 10 mg/l due to demineralizer waste.

[f] Except for pH, all values are in mg/liter (ppm).

enters the river and TSP concentrations of 0.02 mg/l in the river after mixing at average riverflows (3000 cfs). Even at low flow (300 cfs) TSP concentrations should not exceed 0.2 mg/l.

The 5000 gallons of 1% sodium nitrite solution used to clean the condenser shell side will be released to the river at about 10 gpm diluted with approximately 500 gpm of well water. This would result in a concentration of 200 mg/l of $NaNO_2$ and $NaNO_3$ in the water as it enters the river. $NaNO_2/NaNO_3$ concentrations in the river after mixing would be about 0.08 mg/l at average flows and 0.8 mg/l at low flow.

3.6.4 Biocides

All power-plant cooling systems require means for preventing formation of bacterial slimes on heat-transfer surfaces. The main condenser is the major equipment item involved, although a similar need applies to the heat exchangers of the plant service-water system. The defouling method designed for the plant specifies the addition of liquid chlorine to the circulating water at the pump house. This use of chlorine as a biocide is a common method of preventing fouling. Present plans by the Applicant call for chlorine additions to the water at the condenser inlet for a limited period (15 to 20 minutes) three or four times a day.[10] This method constitutes a "shock" treatment of adequate biocidal effectiveness, while minimizing the total chlorine added. The effectiveness of chlorine as a biocide depends on the availability of chlorine as an oxidizing agent, that is, with a chemical valence higher than the -1 exhibited by the chloride ion. Treatment will require the addition of chlorine at a concentration of about 5 ppm at the condenser inlet but the Applicant will control the introduction of chlorine such that the concentration of residual available chlorine at the condenser outlet should not rise above about 0.1 ppm. Any positive residual would be effective as a biocide, and high concentration would be unnecessary since efficient defouling is only needed in the condenser itself. The chlorine will be added to the system after the blowdown line in order to maximize reaction time before discharge. In the absence of reacting chemicals, the available chlorine is present mainly as hypoclorous acid (HOCl) in near-neutral water. The residual chlorine tends to be quickly consumed in natural waters due to the presence of various oxidizable materials constituting a high chlorine demand. However, ammonia naturally present in the water reacts chemically with available chlorine at the ppm level to form chloramines which are also toxic to biota and are more persistent in natural waters.

TABLE 3.9. Cleaning Solutions to be Drained after Use in Flushing Equipment and Piping

Description of Equipment	Approx. Qty. of Water (gal)	Quality of Cleaning Water*	Scheduled Date of Dumping
Miscellaneous Discharge	5,000	650 ppm TSP	October 1972
Condenser (shell side)	5,000	1% sodium nitrite	February 1973
Nuclear boiler & reactor recirculation system	110,000	500 ppm TSP	March 1973

*Cleaning water is diluted before being dumped into river.

3.7 SANITARY AND OTHER WASTE SYSTEMS

3.7.1 Sanitary Wastes

Treatment of wastes from sanitary facilities in the plant is provided by an extended-aeration activated-sludge package plant of 15,000 gal/day capacity. This plant, Model FL 118C of the Chicago Pump Company, has been put into operation (Iowa Permit No. 70-28-S) during the construction period, and wastes from approximately 300 men have been handled satisfactorily. At times during construction up to 1500 men are onsite, and most of these men use portable toilet facilities. The wastes from the portable toilets are removed from the site. Under the normal operating load of about 70 persons, a high degree of treatment will be provided by the plant.

Effluent from the sewage plant enters a skimmer pond, which drains into the river via an open ditch. The skimmer pond is provided to receive miscellaneous wastes normally suitable for discharge to the river in order to provide an additional measure of safety in case of accidental spill of oil. Any oil or floating debris will be held up and removed from the skimmer pond.

The Iowa Sanitary Permit issued to the Applicant does not presently require chlorination of the sanitary wastes, and the Applicant's system has no chlorination facilities. Chlorination is not presently considered necessary because of the large dilution provided by the Cedar River and because of the limited downstream uses of the Cedar River. However, in the absence of chlorination, monitoring of the sewage effluent for fecal coliforms is considered necessary, as discussed in Section 6.2. A discussion of the alternatives of disinfection, monitoring, and discharge is presented in Section 10.6.

The sewage plant is north of the turbine building and west of the cooling towers. The skimmer pond is immediately west of the cooling towers and the ditch flows past the north end of the towers to the river.

3.7.2 Other Wastes

Two diesel-powered emergency generators are included in the plant. They are each rated at 2850 kWe (continuous duty) and 3250 kWe (300 hr). The exhaust effluent from their combined operation would be equivalent to that from an 8600-hp internal combustion engine. However, because of the low use factor, the impact is considered negligible.

Miscellaneous nonradioactive solid wastes are transported by truck to a state-licensed sanitary landfill area offsite. Such wastes include material removed from the trash rack and stilling basin of the cooling water intake and any fish or other material sluiced off the traveling screens of the intake and deposited in the collection basket. Routine inspections are made of these waste sources.[10]

3.8 TRANSPORTATION OF NUCLEAR FUEL AND SOLID RADIOACTIVE WASTE

The nuclear fuel for the reactor at the Duane Arnold Energy Center in Palo, Iowa is slightly enriched uranium in the form of sintered uranium oxide pellets encapsulated in zircaloy fuel rods. Each year in normal operation, about 100 fuel elements are replaced.

3.8.1 Transport of New Fuel

The Applicant has indicated that new fuel will be shipped by truck in AEC-DOT approved containers which hold two fuel elements per container. About 4 truckloads will be required each year for replacement fuel and about 12 truckloads for the initial loading. Source of the fuel for initial loading and five reloads is Wilmington, North Carolina.

3.8.2 Transport of Irradiated Fuel

Fuel elements removed from the reactor will be unchanged in appearance and will contain some of the original U-235 (which is recoverable). As a result of the irradiation and fissioning of the uranium, the fuel element will contain large amounts of fission products and some plutonium. As the radioactivity decays, it produces radiation and "decay heat." The amount of radioactivity remaining in the fuel varies according to the length of time after discharge from the reactor. After discharge from a reactor, the fuel elements are placed under water in a storage pool for cooling prior to being loaded into a cask for transport.

The initial process site for irradiated fuel will be Morris, Illinois, approximately 200 rail miles from the site. For calculating purposes, the Staff estimate the shipping distance to be 500 miles to allow for any later change in process site location.

The Applicant states that the irradiated fuel elements will be shipped by rail in approved casks. The loaded casks are expected to weigh about 85 tons. To transport the irradiated fuel, the Applicant estimates 2-3 shipments per year. An equal number of shipments will be required to return the empty casks.

3.8.3 Transport of Solid Radioactive Wastes

The Applicant has not identified where the waste will be shipped for disposal. For calculating purposes, the Staff has assumed a shipping distance of 500 miles.

The Applicant has indicated that spent resins and solidified concentrator bottoms will be shipped in drums and soft, solid wastes will be compacted in drums for shipment and disposal. The Applicant has not estimated the number of drums of waste that will be required to be shipped from the plant each year. The Staff estimates about 25 truckloads of waste in drums will be shipped from the plant each year.

3.9 TRANSMISSION FACILITIES

The plant is located approximately 100 miles northwest of the south-eastern corner of Iowa. Within a 100-mile radius of the plant there are 31 transmission substations. Two of the substations are on a 345-kV grid, the rest are on 100-161 kV grids. Generating units of more than 300 MW, in addition to the DAEC, which are committed through 1977 to be a part of the 345 kV grid are Prairie Island, to the north of the DAEC, Neal and Fort Calhoun to the west, Cooper to the southwest, and Quad Cities to the east. The Prairie Island, Fort Calhoun, and Cooper stations will be nuclear. The commitment date to MARCA* for the DAEC is December 31, 1973. It will deliver power at 345 kV over two single-circuit lines to the existing Hills-Hazelton 345 kV line which runs in a north-south direction approximately 3-1/2 miles west of the plant site. Also, it will deliver power at 161 kV over three single-circuit lines which total 87 miles in length to substations at Washburn (northwest of DAEC, towards Waterloo) Bertram (southeast of DAEC and east of Cedar Rapids), and Hiawatha (east-southeast of DAEC and northeast of Cedar Rapids).

These lines are required not only to disperse power from the site but also to meet the load demand of the growing grid system of the surrounding region in all directions.

For startup and emergency, the plant can receive power from both the Hazelton (345 kV) and Hiawatha (161 kV) substations.

Plans are to install before 1982 a 345-kV line across the State of Iowa to connect Duane Arnold and Fort Calhoun and the Omaha-Council Bluffs stations. During the intervening period, no other construction of 345-kV transmission lines in Iowa is contemplated.

---

* MARCA = Mid-Continent Area Reliability Coordination Agreement. Both MAIN and MARCA are members of the nine-member National Electric Reliability Council.

The Applicant has acquired all of the land required in the 345-161-kV transmission-line corridor which extends 3-1/2 miles west of the site, and for the Hiawatha line which is used to supply startup power. The Applicant estimates that all right-of-way acquisition will be completed by April 1973.

Four transmission-line systems extend westward in a 665-ft corridor from the southwest edge of the plant site for a distance of one mile to a north-south county road. Near this road, one 161-kV line departs and continues within a corridor of 100-ft basic width (generally narrower along railroad and public rights-of-way) in a southerly direction west of Cedar Rapids and then eastward, via Fairfax, to the Bertram substation. The total distance is 28 miles. The other 161-kV line and two 345-kV lines continue in a 500-ft corridor for a distance of 1.7 miles beyond the county road in a westerly direction. There, one 345 line turns south to the Hills substation, another 345 line turns north to the Hazelton substation, and a 161-kV line, for a distance of 16 miles, continues to the Garrison substation and then an additional 30 miles to the Washburn substation.

A fifth transmission line leaves the plant site in a generally easterly direction, crosses the Cedar River, and continues for a distance of 8 miles to the Hiawatha substation. The transmission lines are indicated in Fig. 3.12.

Proposed corridor routings and transmission line designs are being presented to the Iowa State Commerce Commission for review and conduct of public hearings, as required. The franchises for construction, operation, or maintenance of each of the several transmission lines which cross over, or run along public highways or grounds (outside of cities and towns) are being granted one by one as final hearings are completed. The Hiawatha transmission line is complete. Others are in various stages of hearing progress.

A total of 1155 acres (85 miles) of rights-of-way will be required for transmission lines (Table 3.10) of this total, 216 acres (18 miles) are along public roads or railroads. Most of these 18 miles are associated with the rights-of-way between the plant and Bertram, and 16 of the 18 miles of right-of-way are along railroads. Those along roads are along secondary (graveled) rather than primary (hard-surfaced) public roads in incorporated and unincorporated areas. These 18 miles use existing rights-of-way and do not involve a change in land use. The remainder of the total length of right-of-way (67 miles or 939 acres) is over private property. The prior character of lands acquired for transmission line rights-of-way were cultivated (85.9%), pasture (6.5%), wooded (3.6%) and marsh (4.0%).

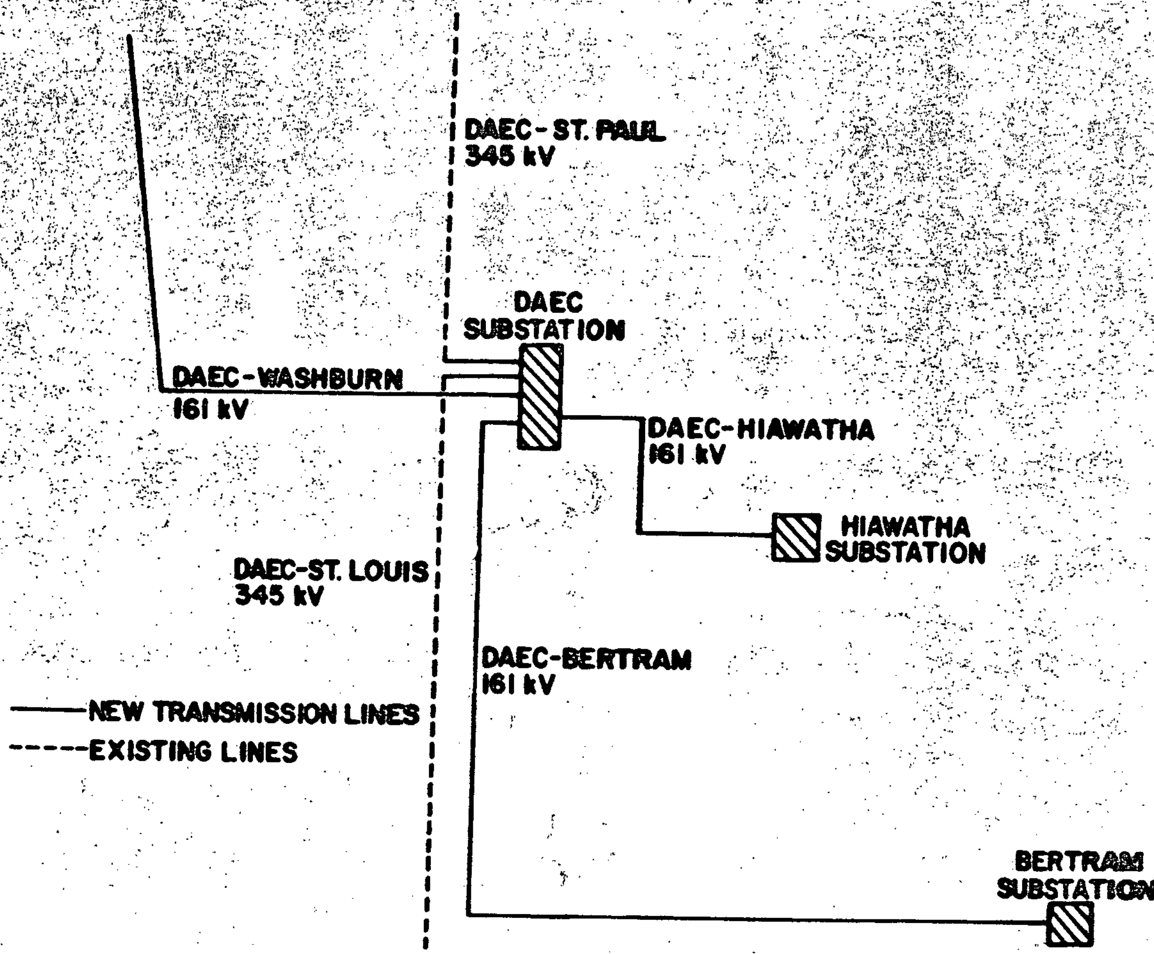

Fig. 3.12. Transmission Lines for DAEC.

TABLE 3.10. Land Use for DAEC Transmission Lines

Description	Line Length, miles	Area Used, acres	Type of R-O-W, miles			Use of Private Land, acres			
			Public Road	Railroad	Private	Crop	Pasture	Wooded	Marsh
DAEC-Bertram 161 kV	28.0	339	0.25	15.6	12.2	128.8	13.3	4.3	-
Washburn 161 kV (IE)	2.7*	162	-	-	2.7	42	3	-	9
Hills 345 kV	2.7*		-	-	2.7	42	3	-	9
Hazelton 345 kV	2.7*		-	-	2.7	42	3	-	9
Hiawatha 161 kV	7.75	91	1.8	0.3	5.65	31	10	26.8	-
Washburn 161 kV (CB)	46.4	563	-	-	46.4	521	28	3	11
	84.9	1155							

*These lines are to be placed in the same corridor.

NOTE: All land is returned to the same use as when acquired.

Highest Structure 100 ft Longest Span 1236 ft

Lowest Structure 57.5 ft Shortest Span 329 ft

Line structures are basically of three types: wood H-frames for open field; steel poles for turning corners, long spans and restricted right-of-way locations; and laminated wood poles for straight runs and certain restricted right-of-way locations. Both the steel pole and laminated wood pole types are self-supporting i.e., they are capable of being used without guy wires and anchors.

Ninety percent of all poles used for the transmission lines are of wood. H-frame poles are of red cedar with fir cross and angle members, preserved and of specified natural light color (color grade 3). Laminated wood poles are clear southern yellow pine or douglas fir, treated with colorless preservatives. They are tapered and of rectangular cross-section, installed with the longest dimension perpendicular to the direction of the supported conductors. Steel poles are painted light gray, are tapered and are of octagonal cross section. Pole lengths range from 65 to 112 ft for aboveground heights of 57 to 100 ft. Minimum conductor distances from the ground between adjacent poles are from 28 to 45 ft.

According to the Applicant, "The design principles and right-of-way selection are based on minimum environmental impact, to the extent practical, in line with the guidelines and criteria established by the State and local agencies, the Department of Interior, Department of Agriculture and the Federal Power Commission ('Environmental Criteria for Electric Transmission Systems' by the Department of Interior, and 'Electric Power Transmission and Environment' by the Federal Power Commission), and consistent with established land use, safety, reliability of service, economic and engineering feasibility."[10]

Gray insulators and nonspecular "shadowline" conductors are used to reduce distracting contrasts and reflections. Guy wires and anchors were eliminated as obstructions to movements within and maintenance of rights-of-way and paths within rights-of-way for line construction and maintenance were kept narrow (20-ft maximum width) to minimize disturbance of all forms of ground covering and wildlife. When clearing was required for opening the paths, only hand and hand-guided power tools were used. No defoliants were used during the construction phase, nor will they be used during line maintenance measures. Moreover, in wooded areas spanned by relatively straight runs of transmission line, tree trimming was performed only where necessary to effect transmission reliability, with removal of trees confined to pathways for the construction and subsequent system maintenance. To avoid a notched appearance in long transmission line corridors through wooded and native brush covered areas, paths were allowed to meander from side to side within the right-of-way boundaries. Ruts from equipment were closed and leveled. The vegetation was immediately restored at locations where washing from rains might occur.

For crossing hills, transmission line structures were located to minimize silhouetting against the sky. Routings were chosen to avoid public lands such as parks, wildlife, recreational, or significantly wooded areas.

The effect to the land involved is held to a minimum by taking into consideration the present and future land use contemplated by the property owners. Fence gates are installed with the permission of property owners to allow easy access. Any damage to the property was either repaired or owners were compensated for repair on a negotiated basis.

Transmission lines at 345-kV and 161-kV voltage levels are maintained annually. Based on past experience, the average frequency of attention in physically maintaining a line is once in 2 to 3 years. Maintenance consists primarily of replacing broken insulators and trimming trees.

In addition to an onsite plant substation, only one new substation had been constructed. This, the Hiawatha substation, is 500 ft by 600 ft (6.9 acres) on marginally-productive farmland.

Both on- and offsite substations are of low profile. The natural "lay" of the land was preserved, and plantings were used for gradient blending of the low profile substation structures with the near and distant surroundings. Exposed steel exteriors of substation components, whether galvanized or not, are made nonreflective and of uniform subdued appearance with light gray paint. Earth surfaces between concrete and equipment are covered with crushed stone to and beyond the fence enclosure to a distance of 1-2 ft. Entrances to substations including the access road and substation environment are maintained for neat appearance at regular intervals of a week or two.

References

1. "Environmental Report on the Duane Arnold Energy Center," Revised November 1971, Iowa Electric Light and Power Co., Docket 50-331.
2. "Noise - Fourth Form of Pollution," Environmental Science and Technology 4, No. 9, p. 720, September 1970.
3. J. E. Kruck, "Acoustical Effects of Cooling Tower Operation," Affidavit in Support of Motion for Temporary Operating License. USAEC Atomic Safety and Licensing Board. Docket 50-271, July 8, 1972.
4. F. M. Shofner and C. O. Thomas, "Development and Demonstration of Low-Level Drift Instrumentation," EPA Report 16130 GNK 10/71 Water Poll. Cont. Research Series, October 1971.
5. Thermal Plume Analysis (DAEC), Bechtel, Inc., July 28, 1972.
6. Thermal Characteristics of Plant Discharge Canal (DAEC), Bechtel, Inc., January 6, 1972.
7. Water-Supply Bulletin No. 5, Iowa Geological Survey.
8. M. A. Shirazi and L. R. Davis, "Workbook of Thermal Plume Prediction," Vol. 1, Submerged Discharge, USEPA, April 1972.
9. D. B. McDonald, "Cedar River Ecology Study, Annual Report," April 1971-April 1972, June 1972.
10. "Environmental Report on the Duane Arnold Energy Center," Amendment 2, Iowa Electric Light and Power Co., Docket 50-331, October 1972.

4. ENVIRONMENTAL EFFECTS OF CONSTRUCTION

4.1 EFFECT ON LAND USE

Construction of the plant has resulted in the withdrawal of about 500 acres of productive farmland from use. This represents less than 0.2% of the farmland of Linn county, and will not have a measurable effect on farm production in Iowa.

The farmland withdrawn from productive use will be landscaped to blend in with the appearance of other natural areas. The small amount of wooded land on the site will be left undisturbed. After construction the site area will have the appearance of natural (i.e. unfarmed) land. The plant buildings are being grouped, designed and colored in such a way as to reduce the visual shock of a man-made facility in rural surroundings. Due to the relative remoteness of the site, it will not need to be seen by a large segment of the public.

Impact factors of plant construction include heavy truck traffic, noise, and dust. As the plant is relatively isolated, construction noises have not created any appreciable disturbances, and watering practices have kept dust levels to minimal values from construction. There were, however, evidently dust problems in areas such as Palo from traffic by construction workers when entering and leaving the plant. This has led to the oiling of existing gravel approach roads. Oiling of the roads has alleviated dust problems from traffic to and from the site.

A permanent storm drainage system has been installed on site for use in controlling runoff and erosion during construction. This factor, combined with the relatively small amount of land disturbed by construction resulted in no significant soil erosion problems during construction.

Construction of the transmission facilities associated with the DAEC will involve 1155 acres of transmission corridors. Of the 1155 acres, 216 will be existing rights-of-way, and 939 will involve the use of other land. About 90% of the 939 acres will be agricultural land. However, the Applicant will allow most of this land to continue to be used for agricultural purposes, so that only a few acres of land will be withdrawn from productive use. Routing, construction, and appearance of the transmission facilities generally conform to current federal recommendations.[1,2] The transmission facilities will have a visible impact, but this impact will be minimal in public areas such as parks, wildlife, recreational, and significantly wooded areas.

Construction of the plant site and transmission lines has not resulted in the displacement of any families. The one farm house which once existed on the plant site was abandoned prior to purchase of the land by the Applicant. If the Pleasant Creek Reservoir is built as proposed, it will result in the displacement of fewer than 10 farm families.

4.2 EFFECT ON WATER USE

Appreciable amounts of water had to be pumped during the dewatering of building sites. However, the alluvial aquifer from which the water was pumped during dewatering is a prolific water source in the Cedar River Valley[3] at the plant site, and flow in the alluvial aquifer is away from the plant site towards the river. Therefore, noticeable effects on the nearby well sites which are in the upstream flow direction of the gorund water are not expected. The Applicant states that there have been no measurable changes in the water table of the alluvial aquifer as a result of dewatering.[4]

One on-site well into the lower Silurian-Devonian aquifer, rated at 400 gpm was used to supply water for drinking, sanitary and construction purposes during the initial construction. Average well water use was 150 gpm. The production wells are now used at an average use rate of 350 gpm. There will be a lowering of the piezometric surface associated with the lower Silurian-Devonian aquifer caused by water use during construction, but withdrawal of water during construction is small in relation to the total water available so that deleterious effects on nearby wells are not anticipated.

The sanitary sewage-disposal system for the construction phase is the same sanitary sewage-disposal system which will be used during operation, supplemented by portable chemical toilets which are used by most of the construction workers. On the basis of the rating of the sanitary waste facility, the capacity of the sanitary waste system, supplemented by the portable chemical toilets, should be adequate. Disposal of the waste from the chemical toilets is made off-site in compliance with state regulations.

Preoperational cleaning and flushing of plant components will involve the dumping of trisodium phosphate (TSP) and sodium nitrite into the

Cedar River as indicated in Table 3.9. Prior to dumping of the wastes into the river, the TSP will be diluted ten-fold so that the maximum concentration is 50 ppm, and the sodium nitrite will be diluted 50 fold to a concentration of 200 milligrams/liter. Chemical concentrations in the vicinity of the DAEC will be slightly increased by dumping of these wastes, but since these are one time dumps and there are no present uses of the water in the plant vicinity, there should be no noticeable effect on uses of the Cedar River water. Further downstream mixing in the river will have diluted the concentrations to the point where they are within normal variations and no adverse effects are anticipated.

Construction activities have caused some changes in the surface runoff from the site, but the land area affected is small, and no measurable effects are likely. No additional adverse effects are anticipated on ground water supplies. Recreational usage of the Cedar River is limited, and dredging and other construction activities within the river are of limited duration so that no effect on recreational use of the river is anticipated.

4.3 EFFECTS ON SITE ECOLOGY

Approximately 100 acres of flat land on the 500-acre site were disrupted due to plant construction, movement of heavy machinery and motor vehicles, and the presence of 300 to 1500 construction workers.

The land in the site area was actively farmed and offered little shelter for small animals and birds. No trees were present in the construction areas of the site, and no trees have been removed during construction.

About 10,000 cubic yards of alluvium from the required excavation for the plant and 119,330 cubic yards of sand dredged from the river were placed on the construction site,[5] eliminating vegetation from the area. No apparent damage to trees resulted from dewatering of the excavation. An additional 12,000 cubic yards of sand will be dredged from the river and spread over the site.

Dredging of the river during construction of the weir and barrier wall (see Sec. 3.4) and discharge structures resulted in temporary disruptions of benthic biota (which are scarce in the Cedar River due to shifting bottom sediments, silt, and sand), temporary increases in turbidity of the river at and below the site, and very likely, releases of organic and inorganic material from the river bed. No adverse effects on fish at the site were observed by the Applicant during the dredging.

Removal of vegetation along the river bank during construction of the intake and discharge structures has resulted in some erosion of the river bank. The Applicant has stated that he will replant those portions of the riverbank disturbed during construction to minimize erosion. (see p. K-51).

In the preparation of transmission right-of-way, selective tree cutting was employed in areas hazardous to the line. Some trimming of trees and brush along stream was carried out at crossing points, but this was limited as much as practicable as described in Section 3.9. No chemicals were used to prohibit growth of vegetation.

After construction is completed, final trimming of a maximum of two to three years growth will be cut back to provide electrical clearance from the conductors. Natural vegetation will be allowed to grow back and trimmed every two to three years at point of trouble. These actions may disturb wildlife along these corridors to some extent, but it is likely that these birds and animals can relocate themselves to undisturbed areas without major loss to any species.

During the construction period trisodium phosphate and sodium nitrite will be used for cleaning components (most of the latter is expected to be oxidized to nitrate in the river). The resulting levels of orthophosphate and nitrate/nitrite will be within normal fluctuations in the nitrate/nitrite concentrations of these ions in the Cedar River (see Tables 3.8 and 3.9 of Section 3.6). The discharge of these chemicals, therefore, is not expected to cause detectable changes in the river's ecosystem.

4.4 RESOURCES COMMITTED

During the construction period, there has been the requirement of a construction labor force of up to 1500 persons. Principally, these workers come from the Marion-Cedar Rapids area. Construction work at the site has come at a time of decreasing employment demand within other sectors of the Cedar Rapids economy, and has helped the employment picture of the area.[6] Some movement of workers to the small village of Palo has occurred, but this is a temporary effect which will not necessitate the building of new community services such as hospitals or schools. No temporary housing facilities have been built in Palo for the construction workers.

Construction of the DAEC will result in the commitment of a large number of different materials. Most of these materials will ultimately be recoverable, but some of them may not be in a recoverable form at the end of plant operation. In all cases, however, the amount of material committed will be very small in terms of the total amount of the material available.

References

1. Federal Power Commission, "Guidelines for the Protection of National, Historic, Scenic, and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities," FPC Order No. 414, Washington, D.C., November 27, 1970.

2. U.S. Departments of the Interior and Agriculture, "Environmental Criteria for Electric Transmission Systems," U.S. Government Printing Office, Washington, D.C., October 1970.

3. "Water Resources of Iowa," Iowa Geological Survey (1969).

4. "Environmental Report on the Duane Arnold Energy Center," Amendment 2, Iowa Electric Light and Power Co., Docket No. 50-331, October 1972.

5. Bechtel Corp. Letter to Iowa Electric and Power Co., December 4, 1970.

6. Letter, R. B. Faxon, Executive Vice President, Cedar Rapids Chamber of Commerce, to J. R. Schlessinger, October 15, 1971. Contained in Appendix F of DAEC Statement in Compliance with Section E, 10 CFR Part 50, Appendix D, Docket No. 50-331, October 16, 1971.

5. ENVIRONMENTAL EFFECTS OF PLANT OPERATION

5.1 EFFECT ON LAND USE

Effects of actual construction on land use are discussed in Section 4.1. As a result of construction of the plant, some 500 acres of land which were previously wooded or farmland have been converted. About 40 acres of this land will be occupied by buildings and roads. The small amount of acreage removed from the regional economy by the plant will not significantly alter land use in the vicinity, and the small reduction in the economy caused by the removal of this amount of productive land will be more than offset by the positive economic stimulus of plant operation. By the time construction is completed, approximately $5,390,000 in property and sales taxes will have been paid by the Applicant. Property taxes per year at the end of construction are estimated at $4,600,000 to be paid within Linn County.[1] The overall effect of the plant will be to increase the tax base for the local communities.

5.1.1 New Residents

The total permanent plant staff will be only 70 persons, or less than 0.1% of the Cedar Rapids population. No appreciable impact on local residential and commercial functions should occur.

5.1.2 Noise Effects

The three most significant noise sources associated with the DAEC are the cooling towers, transformers, and circuit breakers. The sound levels calculated by the Applicant to result from cooling-tower operation are given in Table 5.1. (Actual sound measurements from very similar mechanical-draft towers associated with the Vermont Yankee Nuclear Plant[2] indicate that the Applicant's calculated values are conservative). As shown in Figure 5.1,[3] the calculated outdoor noise levels at the nearest farm house correspond roughly to noise criteria (NC) level 40. The indoor noise levels, assuming typical wall construction with some open windows, correspond roughly to NC level 30. As can be seen from Table 5.2[3] of indoor noise criteria, the occupants of the nearest farm house will be "transferred" from a rural environment to an urban environment. This may prove annoying to the occupants, particularly at night. Another area close to the site which will be affected by cooling tower noise is the Wickiup Conservation Area, less than a mile across the river from the plant. Persons visiting the Wickiup Conservation Area will be subjected to an overall sound pressure level of about 55 db. This may be annoying to persons visiting the

TABLE 5.1 Sound Levels (db) at Various Locations near Cooling Towers

Octave Band		1	2	3	4	5	6	7	8	Over-all SPL*
Frequency (cps) L		37.5	75	150	300	600	1200	2400	4800	
H		75	150	300	600	1200	2400	4800	9600	
Location	Distance From Source, ft									
West bank of Cedar River	1000	64	63	62	58	54	42	48	44	68.5
Nearest farm housing	2900	54.5	53.5	52.5	48.5	44.5	42.5	38.5	34.5	57
Village of Palo	13000	42	41	39	36	32	30	29	22	46.5
Nearest population center	32000	35	34	33	29	25	23	19	15	39.5

*Sound Pressure Level
From Applicant's Environmental Report

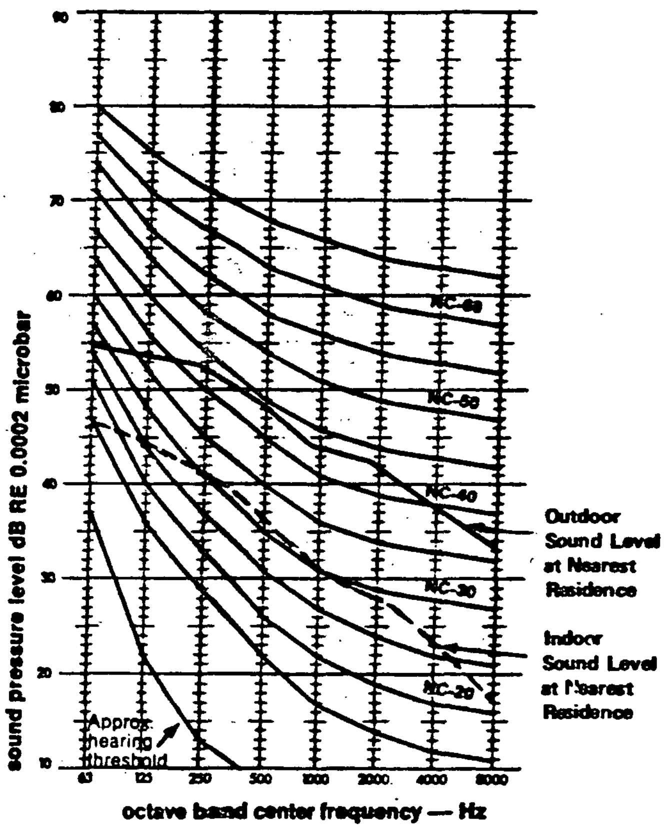

Fig. 5.1. Noise Criterion "NC" Curves. The octave band sound pressure levels associated with the noise criterion conditions of Table 5.2. Modified from Ref. 3.

TABLE 5.2. Noise Criteria for Indoor Activities

Activity	Suggested Range of Noise Criteria
Sleeping, Resting, Relaxing	
Homes, apartments, hotels, hospitals, etc.,	
Suburban and rural	NC-20 to NC-25
Urban	NC-25 to NC-30
Excellent Listening Conditions Required	
Concert halls, recording studios, etc.	NC-15 to NC-20
Very Good Listening Conditions Required	
Auditoriums, theaters	NC-20 to NC-25
Large meeting and conference rooms	NC-25 to NC-30
Good Listening Conditions Required	
Private offices, school classrooms, libraries, small conference rooms, radio and television listening in the home, etc.	NC-30 to NC-35
Fair Listening Conditions Desired	
Large offices, restaurants, retail shops and stores, etc.	NC-35 to NC-40
Moderately Fair Listening Conditions Acceptable	
Business machine areas, lobbies, cafeterias, laboratory work areas, drafting rooms, satisfactory telephone use. etc,	NC-40 to NC-45
Acceptable Working Conditions with Minimum Speech Interference	
Light to heavy machinery spaces, industrial areas, commercial areas such as garages, kitchens, laundries, etc.	NC-45 to NC-55

From Ref. 3.

area in search of tranquility. If the noise level becomes a problem, as evidenced by complaints from the public, the Applicant has stated that it will take action to reduce offsite sound levels.[43] Possible alternatives to reduce sound levels are discussed in Section 10.1.3. The Staff concludes that in no case will offsite sound levels from cooling tower operation be of such a magnitude as to cause actual hearing damage.

There are two large transformers associated with the plant, one at the turbine building and one in the electrical power distribution substation located west of the plant. The Applicant assumes a source noise level of 89 db from each transformer based on NEMA published sound values for transformers. The source noise level assumption is quite reasonable and is much less than the source noise level of the cooling towers. The resulting sound levels at the nearest off-site occupied dwelling from the transformers are probably below the threshold of hearing and are of no importance.

The circuit breakers associated with the plant are air-operated and have a source noise level of 181 db (for comparison, each cooling tower has a 138-db source noise level). At the nearest occupied dwelling, this will result in momentary sound pressure levels of the order of 110 db. (Exposures to ambient levels of 110 db are of sufficient magnitude to cause possible hearing damage if they are constantly repeated for the order of one hour per day). The Applicant estimates that the breakers will operate on the order of once per year. Thus, even though the sound levels associated with circuit breaker operation are high, the circuit breakers should not have a serious noise impact. However, if circuit breaker operation proves to be fairly frequent (several times a month) the resulting noise impact may be annoying enough to require remedial action. The Applicant has stated that it will take remedial action if off-site sound levels become annoying. (See p. K-52)

5.1.3 Road Traffic

Road use in the vicinity of the DAEC is light, additional traffic resulting from the plant operation will not be heavy, and no road traffic problems are anticipated. In the event of improbable accident conditions, rerouting of traffic could be accomplished with little inconvenience to motorists.

5.1.4 Plume Effects

The Center will utilize induced-draft cooling towers on a closed-cycle basis to dissipate waste heat to the atmosphere (see Section 3.4). The use of cooling towers will result in a maximum of 7000 gpm of water being added to the atmosphere in the form of water vapor and droplets. Calculations of the meteorological effects from this addition of moisture to the atmosphere have been made for the Applicant by the NUS Corporation using its LUPM computer program. Limited comparisons between calculated and measured results[4] indicate that the NUS model gives reasonable results. The calculations performed for the Applicant were made using weather data from the Des Moines, Iowa Weather Station. An analysis of one year's data taken at the plant site indicates that the Des Moines data are adequately similar to the on-site data.[5]

The areas of immediate concern in regard to environmental effects of cooling tower operation are populated areas and transport routes. The plant site is located approximately 2 1/2 miles from the nearest villages of Palo and Toddville, Iowa. Route 94 is the closest medium-duty traffic route, approximately 2 1/2 miles southwest from the site, and a light-duty, gravel road connecting Routes 95 and 150 approaches to about one mile of the site to the west.

A plume is most often observed during the cold months of the year, when the mixing of cold ambient air with the cooling tower effluent produces a moisture content above the saturation level. In general, the visible plume exists only for the first few thousand feet. However, during the very cold winter months, December, January, and February, plumes several miles long can occur. The Applicant's calculations indicate that a plume will be observed over the villages of Palo and Toddville less than one-half percent of the time during the winter season. The plume at 2.5 miles from the plant can also be expected to be relatively thin and usually some distance above the ground. Experience at operating towers indicates that fog near towers is often quite dense; dispersion and re-evaporation downwind should reduce the liquid water content of the effluent to acceptable visibility levels off-site.

Beyond the visible portion of the cooling tower plume the evaporated moisture will continue to be dispersed by the turbulent action of the atmosphere. It can be anticipated that some of this moisture will be carried to the ground and increase the relative humidity to an extent which may increase the likelihood of fog or icing conditions. The Applicant's calculations indicate that the hours of fog for the nearby community of Palo would be increased by less than 0.01 percent, or by 0.2 hours, during any season of the year. The cooling tower design proposed by the Applicant incorporates drift eliminators which should reduce drift losses to much less than the 0.1 percent which the Applicant uses as a design value.

In studies of cooling tower plumes, it has been found that fogging problems associated with downwash into the wake of the cooling tower structure are initiated during periods of cold 9weather, when winds are more than ten miles per hour, essentially perpendicular to the long axis of the structure, and the relative humidity is greater than 80%.[6,7] Conditions of this type, directed toward the gravel roadway connecting Routes 94 and 150, are expected to occur for about 0.25 percent of the total hours of the spring season, the season of most frequent occurrence. However, the high wind speeds which cause the downwash also tend to dissipate the plume within the first few thousand feet. This limit to affected distance is consistent with other reports[7] and information obtained from European installations where a separation of cooling tower and traveled areas of 400 meters (1200 feet) is suggested. Accordingly, the Staff concludes that local fogging effects such as occur on the few occasions when the plume is affected by downwash over the cooling tower structures do not present an environmental problem. Operation experience from towers similar to the DAEC towers indicates that icing beyond one mile will not be a problem, so that no adverse effects from icing are anticipated.[3,8]

Aynsley[37] has observed that cooling tower plumes can, if meteorological conditions are proper, create cumulus clouds. He concludes that this is a "rare occurrence", and that these man-made clouds only precede natural cloud formation. There have been some reported occurrences of snow showers or ice crystals being generated by cooling towers,[38,39,40] however, in all cases the amounts of precipitation were very small. The state-of-the-art in cloud physics is such that firm, quantitative estimates of increases in rainfall or snowfall from cooling tower plumes cannot be made. However, all evidence suggests that increases in precipitation will only infrequently occur and will amount to only a small fraction of natural precipitation. The Staff does not anticipate that any deleterious effects due to increased rainfall or snowfall will occur.

5.2 EFFECT ON WATER USE

5.2.1 Ground Water

In the vicinity of the plant site, ground water is commonly taken from shallow alluvial aquifers or from the Silurian-Devonian aquifer underlying the alluvial aquifer. The two aquifers are hydraulically disconnected by a layer of clayey material. The DAEC will withdraw water only from the Silurian-Devonian aquifer. Water withdrawal will be at a maximum rate of 1500 gpm, from two wells.

Test runs of the two production wells to be used during plant operation indicated that use of the wells will create a cone of depression in the piezometric surface of the Silurian-Devonian aquifer extending 85,000 feet from the wells. This, coupled with the fact that the piezometric surface has dropped 105 feet in 70 years in the Cedar Rapids area,[5] indicates that the DAEC withdrawal of 1500 gpm from the lower aquifer may have a significant effect on other wells. Detailed information to predict the exact effect that the plant wells will have on surrounding wells is not available. The Applicant is aware that the plant's use of water may affect surrounding wells, and has stated that it will be their policy to "correct any deleterious local well effects."[1] Possible alternatives which could be used to reduce the DAEC's use of well water are discussed in Section 10.1.

Since the upper alluvial aquifer is hydraulically disconnected from the Silurian-Devonian aquifer, the DAEC use of well water should have no effect on shallow wells or deep-rooted vegetation.

Construction of buildings and roads on the plant site will increase surface runoff slightly, but the amount of land affected (less than 40 acres) is small.

5.2.2 Surface Water

The river in the vicinity of the plant is not used for commercial navigation or for commercial fishing. The river is lightly used for recreational fishing and boating. Operation of the DAEC should have no serious adverse effects on recreational uses of the Cedar River.

Water is withdrawn from the Cedar River at a maximum rate of 11,000 gpm for input to the cooling water system. Of the 11,000 gpm withdrawn from the river, 7000 gpm will be lost by evaporation and drift from the cooling towers and 4000 gpm will be returned as warmed water from the cooling tower blowdown. As a part of the intake structure, a low head diversion dam is being built to assure an adequate water supply in periods of low flow; this dam will block most of the river channel, but in such periods the river is not likely to be used for recreational boating in the site area because of the many sand bars which will be a hazard.

Water will be discharged from the plant at two locations. The sanitary waste discharges will be upstream of the plant and the blowdown water from the circulating cooling water will be discharged downstream. By far, the largest discharge is the blowdown discharge, which will be at a rate of about 4000 gpm. The chemical content of this discharge water is summarized in Table 3.8. During periods of average flow the Cedar River will dilute chemical discharges sufficiently (3065 cfs average river flow in comparison to 8.9 cfs blowdown flow) so that chemical increases will be within normal fluctuations. It should also be noted that the Cedar River is used in only a limited manner at present (downstream from the Plant it is only used as an indirect source of drinking water, i.e., via wells near the riverbank, and recreational uses are limited). The Staff is of the opinion, therefore, that the blowdown effluent from the Plant should have no deleterious effect on water uses. Note also that the quality of the blowdown effluent is directly related to the quality of the river water. If the river water were chemically pure, no sulfuric acid would need to be added for pH control and no solids would be present to be concentrated by evaporation. Thus if the Cedar River is ever cleaned up, the blowdown effluent will be correspondingly cleaner and no deleterious effects on water uses are anticipated even if the Cedar River quality improves. Effects of the blowdown effluent on the aquatic ecosystem are considered in Section 5.4.

The sanitary waste discharges will be limited to 15,000 gpd (about 10 gpm average). The waste treatment system will have more than adequate capacity and the waste effluent should be of adequate quality in regard to chemical contents, solid content, and oxygen demand not to significantly affect water uses. A possible exception is in regard to bacterial content since the sanitary waste is not chlorinated. At present, the Iowa State Department of Health does not believe that downstream uses of the Cedar River are such that chlorination of the sanitary wastes is warranted, though chlorination may be required at a future date. Since chlorine additions can in themselves cause possible ecological problems, and in view of the large dilution factor provided by the Cedar River, the approach of the Iowa State Department of Health seems reasonable. However, if the sanitary wastes are not chlorinated, it seems prudent to require monitoring for bacterial content in the sewage treatment effluent as discussed in Section 6.2. Control measures based on proper effluent monitoring should assure that downstream users of the Cedar River are not adversely affected.

The water loss of 7000 gpm (15.5 cfs) from the river is quite small in comparison with the 3065 cfs average river flow. The Iowa Natural Resources Council has established a protected flow of 500 cfs in the Cedar River at Cedar Rapids. As a consequence, whenever the river flow is below 500 cfs, the DAEC may make no net withdrawals from the river. This will be accomplished by discharging from the proposed Pleasant Creek

Reservoir (see Section 2.1) to the river an amount of water equal to the consumptive use of river water. The maximum fraction of river water consumed, therefore, will occur at 500 cfs and will be 3.1%. The effect of plant operation on the Cedar River level will be minimal.

Filling and discharging of the proposed Pleasant Creek Reservoir may significantly affect the river flow, depending upon the policies followed. Evaporation and seepage from the reservoir will also increase the loss of river water. The reservoir will be built and operated by the Iowa State Conservation Commission to serve primarily as a recreational area and secondarily to provide makeup water for the DAEC during these periods of low river flow (about 5% of the time). However, the Iowa State Conservation Commission has not decided upon any details of operation of the reservoir. Further, formal agreements between the Applicant and the State Conservation Commission have not been made. No definitive statements concerning reservoir management are possible, therefore, at this time.

5.3 EFFECT ON TERRESTRIAL ENVIRONMENT

The greatest impact of plant operation on the terrestrial environment has already taken place, i.e., the construction of the buildings, cooling towers, and auxiliary structures. These occupy about 40 acres of land previously used for agriculture. Natural vegetation on the remainder of the 500 acre site will serve as a wildlife habitat.

Disturbance of the natural soil profiles on the site has resulted from excavation and spreading of sand and alluvium over about 80 acres of the site. After construction is complete, the Applicant will replant unused areas to grass and trees, which will minimize any soil erosion and run-off from the site.

Effluent from the plant during operation is not expected to affect terrestrial vegetation or wildlife, and monitoring of the terrestrial ecosystem (see Section 6.2.3) will be carried out to detect damage if it occurs.

In addition to plumes, the cooling towers will generate noise, as discussed in Section 3.4. In areas such as the Wickiup Hills County Park, the overall sound pressure level will be about 55 db and should not affect wildlife, as far as is known. Studies on effects of sonic booms from aircraft on behavior and capacity of farm animals have indicated little or no effect.[9]

Drift from cooling tower operation, as calculated by the Applicant,[10] will result in the deposition of chloride (the most corrosive salt in the drift) to the extent of about 15 lb/acre/yr a the closest site boundary. The Staff calculates that chloride drift will be a maximum of 5.3 lb/acre/yr at the site boundary and will drop off away from the boundary. The two calculations differ primarily due to differences in the assumed chloride content of the cooling tower water. The Staff's calculation is based on more recent data and is considered to be more realistic. The Staff's calculation used a conservative deposition rate of 0.1 meter/sec and an assumed effective plume height of 100 meters which should also be conservative.[41] Phenomena such as water droplet fallout which would further reduce the calculated salt fallout rate at the site boundary were neglected. The Staff is of the opinion, therefore, that actual chloride salt drift will be 5 lb/acre/yr or less at all offsite locations. Based on the cooling tower blowdown analysis given in Table 3.8, total salts will be deposited at a rate of less than 60 lbs/acre/yr and will consist primarily of sulfates.

Natural chloride deposition in rainfall varies from about 10 lb/acre/yr inland, to several hundred lbs/acre/yr in coastal areas.[42] Chlorides from the cooling tower drift, therefore, will add a small increment to natural deposition at the closest site boundary, and progressively smaller increments further downwind. Such additions are not expected to have any undesirable effects on soils or vegetation. The terrestrial monitoring program will include monitoring for such effects (see Section 6). Sulfate deposition from rainfall in the U.S. varies from about 6 lbs/acre/yr (Nebraska) in rural areas to more than 100 lbs/acre/yr (Gary, Indiana) in industrial areas.[11,42] Total sulfur in surface soils in midwestern areas is on the order of 1000 lbs/acre; additions from irrigation and fertilization are often necessary in rural areas to replenish sulfate losses by crop removal, leaching, and erosion.[42] The deposition of sulfates from the drift, therefore, is expected to cause no undesirable effects on soils or vegetation.

Chemical changes that may occur in cooling tower waters have been investigated.[12] Chlorides, sodium, sulfate, and total dissolved solids do not change chemically upon concentration. The amount of chloride formed due to addition of chlorine as biocide will be very small compared to the chloride concentration in the makeup water (less than 3 ppm compared to 18 ppm). Some of the ammonia existing in the river water may be converted to nitrate in the cooling towers.

When deposited on the soil surface, soluble salts in the drift will be readily leached through the layer of topsoil at the site and environs, which appear to be largely sandy alluvium. Further percolation of these salts into the lower aquifer will be minimized by the presence of a large proportion of montomorillonitic clay in the glacial till underlying the topsoil,[5] and the thick layer of bedrock below the till (see Section 2.4).

Damage to vegetation from salt deposition on foliage or uptake from the soil is not expected; the terrestrial monitoring program described in Section 6.2.3 should detect any such effects if they occur.

A change in the terrestrial environment will result from construction of the Pleasant Creek reservoir. The reservoir will inundate approximately 410 acres of rough grazing and cultivated land. As mentioned previously, an analysis of the environmental impact of the reservoir is beyond the scope of this Statement.

5.4 EFFECT ON AQUATIC ENVIRONMENT

5.4.1 Intake Effects

The design of the intake structure is given in Section 3.4. The design will insure that the flow through the screens will be as uniform as possible and of low velocity ($\leq$ 0.75 fps) in order to minimize the entrainment of fish from the Cedar River. Most adult and juvenile fishes can then avoid being drawn into the traveling screens. As noted in Section 2.7.4, the macro-invertebrates that are living unattached in the open river water are very sparsely distributed. Thus, their possible entrainment and loss are expected to be of little or no importance to fish or man.

The smaller organisms in the water entering the intake will pass through the traveling screen (3/16-in mesh). These organisms predominantly are the bacteria, phytoplankton, and zooplankton described or referenced in Section 2.7.

There is little evidence of more than sparse populations of crustacean zooplankton.[13-15] However, the protozoa are well represented by flagellates and ciliates.[14] The phytoplankton make up the bulk of the planktonic organisms in the river, and these, like the protozoa, will readily pass through the screens and condensers. Since the DAEC is of the closed-cycle type, it can be assumed that most of the entrained plankton regardless of species will be killed. However, the rate of plankton reproduction is relatively fast, and no species' population is likely to be perceptibly depressed as a result of full power operation at the DAEC. Furthermore, at normal river flow, less than 1% of the river water will be used by the plant.

Most of the meroplankton (eggs and embryos of aquatic animals) including the icthyoplankton (fish eggs or embryos) will not be components of these planktonic forms since the great majority will be anchored to substrates or lie on the river bottom.[14,16] A part of the intake system as a whole is the barrier wall described in Section 3.4.2 and shown in Figure 3.5. During normal river flows the barrier wall will be entirely submerged and of such a design (gentle sloping walls) that river water movement should not be hindered. If very low flows were encountered, the river would be diverted to the lower (weir) section of the barrier wall near the intake and discharge structures. This would risk damage to river biota forced to pass the DAEC outfall. However, even with the lowest flow of record (60 years) flow elevations will be above the barrier elevation.

The barrier wall has been designed to minimize build-up of silt on the upstream side of the wall. If heavy siltation does occur, however, the Applicant plans to dredge the area as needed to remove the accumulated silt. The dredging operation will suspend silt and cause increased turbidity in the river at the site and for some distance downstream, depending on the river flow and particle sedimentation rates.

Turbidity has been associated with reduction of phytoplankton photosynthesis and interference with the feeding mechanisms of certain zooplankters such as cladocerans and rotifers. Benthic organisms are also adversely affected. Abnormal silting may cause suffocation of fish fry and, to a lesser extent, of adult fish.[17] Since the increased turbidity due to the dredging will be a more or less localized and temporary condition, any plankton losses are not expected to have a significant effect on the total Cedar River ecosystem either at the site or downstream. Suffocation of fish, however, may be an observable effect of the increased turbidity during the dredging periods, since the fish have no alternative waterway in which to avoid the operation. However, warm water fishes are apparently more tolerant of turbidity and suspended silt than are cold water fishes.[17] Carp, catfish, and suckers, which are the dominant fish in the Cedar River (see Section 2.7), are classified as warm water fishes, and these species may not be significantly affected by the turbidity during dredging.

5.4.2 Blowdown Effects

a. Below Mixing Zone

If complete mixing occurs and if the cooling effect of the canal from the towers to the river is ignored, the blowdown water from the DAEC will normally cause a 0.1 to 0.2°F temperature rise in the Cedar River below the mixing zone. Maximum temperature elevations at historical low flows would not exceed 1.1°F, if complete mixing is assumed (Table 3.2). This temperature rise is well below the 5°F maximum established by the Iowa Water Pollution Control Commission.[13] The Staff does not expect that this increase in water temperature over ambient will have any damaging effect on the river organisms including fish.[18] The decrease in concentration of dissolved oxygen associated with a 1.1°F increase in temperature is small (less than 0.5 ppm) in terms of the total dissolved oxygen in the Cedar River (4.7 to 16.5 ppm).[14] This will have a negligible effect on river biota.

b. Plume Effects

Before complete mixing of the thermal discharge with the river some effects on fish may be observed, depending on the ambient conditions during a particular season and are discussed in the following subsections. The impact of these plume effects will be confined to an area of less than one acre, with no more than 25 percent of the river width affected (Section 3.4).

(1). Winter Conditions.

During the cold season of the year, fish may be attracted to the thermal plume,[18] probably because of preferred temperature conditions and the improved availability of food. The discharge jet (6 ft/sec) will tend to prevent most fish from entering the warmest areas of the plume and they will likely seek a zone of preferred temperature in which they can maintain themselves with a minimum of swimming effort.

The residence of fish in the heated effluent may have the following consequences:

(a) increased metabolic rate, causing loss of condition (weight length ratio). This effect has been described for certain fish species in the Connecticut River, due to residence in the discharge canal of an atomic power plant on the river.[18] Channel catfish in the same study, however, showed no decline in condition. Catfish are abundant in the Cedar River, as shown in Section 2.7.

(b) premature spawning, leading to loss of fry due to lack of proper food. Evidence of early sexual maturity and early spawning by white suckers and sauger (species found to a minor extent in the Cedar River) was obtained in power plant studies on the Delaware River and a Kentucky lake.[18] Loss of some fry of the species during the winter at the DAEC is expected.

(c) increased susceptibility to pesticides. There is some evidence that rainbow trout and bluegills were more susceptible to the lethal effects of certain pesticides at a temperature of 12.7°C (55°F) than at 1.6°C (35°F).[19] These species are not found in the Cedar River, but the possibility exists that the increase in temperature of the plume over ambient may have a similar effect on the species that are present.

(d) cold-kill in case of sudden plant shutdown. During the reactor "scram" condition, or sudden shutdown, a drop in temperature to the ambient will occur over a period of a few hours. Fish resident in the thermal plume and acclimated to that temperature, may be killed due to the drop in temperature. This loss cannot be avoided during an emergency shutdown. However, the likelihood of a scram condition is remote. Cold kills can be prevented in other instances by scheduling shutdowns for other than winter months, or by assuring that shutdowns are carried out slowly (over a period of days).

(e) exposure to chlorine, leading to injury and/or death. No problem is anticipated from chlorine discharges up to 0.2 mg/l for a maximum of two hours per day, since the exposure times will be short and intermittent. Further, carp and catfish appear to be relatively tolerant of chlorine concentrations.[20] Discharges greater than 0.2 mg/l total chlorine, however, may injure or kill the fish attracted to the discharge by the warm water if they choose to remain near the outfall. It is important, therefore, that chlorination during the winter months be limited as much as possible. Due to the colder intake water temperature and lack of agricultural run-off during the winter, the amount of chlorine needed in the intake water should be much less than that required during the rest of the year for slime control. It is suggested that chlorination be performed only when a definite slime-buildup is indicated, and chlorine amounts added should be rigidly controlled to the minimum amount needed for slime control. If total residual chlorine concentrations exceed 0.2 mg/l at the river discharge point, monitoring for symptoms of chlorine and chloramine-related damage to fish (see Section 6.2.3) must be carried out and chlorine additions further limited if signs of chlorine or chloramine damage are detected.

(2). Warm Weather Conditions

The effects of the thermal discharge on fish in the Cedar River during the warmer months are not expected to be as critical as during the winter. The species of fish in the Cedar River are warm water fishes (see Section 2.7) and, if there are no restrictions to their movements, will seek their preferred temperatures. Fish kills due to thermal discharges have resulted when the fish were trapped in the discharge canals of power plants.[18] The design of the discharge canal at the DAEC is such that no fish are expected to reach the discharge canal at all, and will be free to move in and out of the thermal plume at will.

Some adverse effects that may possibly occur are as follows:

(a) increased incidence of fish disease. Studies on incidence of fish diseases have indicated acceleration of certain diseases and the development of fish parasites in heated waters.[21]

(b) exposure to chlorine. It is expected that most fish will avoid the discharge plume when they sense a chlorine gradient, particularly in warm weather when warm water other than that of the discharge plume is available to them. Even at low flow periods, the area covered by the discharge plume is only a small portion of the waterway available to the fish (see Figures 3.8 and 3.9). The orientation of the elongated plume is such that fish need not encounter the plume in their downstream travel. There is documented evidence for avoidance of some concentrations of chlorine by salmonids;[22] the fish in the Cedar River may behave in a similar manner. However, it is possible that some fish, particularly fry, may not avoid the chlorine concentrations; others may be present in the discharge area between chlorination periods and be shocked by a sudden discharge of chlorine. Chlorine discharges less than 0.2 mg/l total chlorine should not be lethal or injurious to adult fish for intermittent exposures, although fry of certain species may be sensitive.

(3). Effect on Biota other than Fish

(a) Benthic Organisms

The blowdown water discharge jet is directed upward and mixing with the river water is so rapid that benthic organisms should experience little of the warmed effluent except at the outfall. Although some local temperature increases will occur, various species of benthic organisms can tolerate considerable change in temperature. The distribution and abundance of 21 species of mayflies (Ephemeroptera) and 13 species of stoneflies (Plecoptera) on the River Severn in England, which is warmed 2° to 4°C (3.6° to 7.2°F) by cooling water from a power station, indicated that each species tolerated these unnatural temperature ranges during different developmental stages and survived.[21]

The benthic population in the Cedar River near the DAEC is sparse because of the shifting bottom sediments.[14] The scouring action and turbulence caused by the discharge jet will probably be the limiting factor in the maintenance of the benthos in that location, rather than the temperature per se. The destructive effects of both these factors (temperature and scouring) will very likely be limited to about one quarter of an acre of the river bottom near the discharge pipe.

(b) Plankton

A portion of the phytoplankton and zooplankton in the river will float into the warmed plume, but their resident time in the plume will be comparatively brief, and the temperature of the plume will rapidly decrease downstream. Because of the small size of the plume, relative to that from a once-through cooling system of a power plant of the same capacity, and the relatively low temperature of the water from the cooling towers, damage to the total phytoplankton and zooplankton populations in the river by heat is not anticipated.

A 15-month study of temperature effects on aquatic life in the Ohio River showed that thermal discharges from four power plants did not shift type of dominant algae from diatoms to green or blue-green groups, nor did the discharges change the algal productivity potential.[21] At the DAEC site in winter, however, an increase over normal levels in periphyton populations attached to rocks and riprap in the discharge zone is expected due to temperatures more favorable for growth in this area than in other areas of the river. This improved growth may attract fish.

5.4.3 Chemical Discharge Effects

The concentration of various compounds in the cooling tower before and after mixing with the Cedar River at minimum dilution have been given in Table 3.8. These chemicals are not expected to cause damage to the river biota, nor to change the ecology of the river.

Not included in the table, but of great importance, is the discharge of residual chlorine. In either its free or combined form, chlorine is toxic to living organisms.[23-25] The concentration of total residual chlorine (composed of both free and combined chlorine) in the blowdown will depend upon the concentration of ammonia, ammonia-containing compounds, and other oxidizable substances in the water, among other factors. Oxidation of organic and nonorganic compounds in the water by free chlorine results in the formation of the chloride ion which is relatively harmless to aquatic biota. Reaction of free chlorine with high molecular weight compounds containing the amino group leads to formation of chloramine compounds that have relatively low toxicity when compared to free chlorine. Reaction of free chlorine with ammonia results in the formation of mono-, di-, and trichloramine, which have high toxicity to aquatic life and which persist in water for longer periods of time than does free chlorine. The State of Iowa has not specified an allowable residual chlorine concentration in discharge waters,[13] but the AEC Staff has established the following guidelines for receiving streams in cases of intermittent chlorine utilization. For a period of two hours per day, the concentration of total residual chlorine may be up to but not exceed 0.1 mg/l. This concentration would not protect trout and salmon but should protect warm water species. This recommendation assumes that no free chlorine is present. For continuous discharge the concentration of total chlorine in the receiving stream must not exceed 0.005 mg/l to protect most warm water species of fish. This concentration would not protect some fish food organisms or sensitive life stages of certain fish species.

Note that these guidelines are for the receiving stream. In view of the fact that concentrations of total chlorine below 0.1 mg/l cannot be reliably measured with present field methods, and in order to protect chlorine-sensitive organisms in the area of the outfall, the Staff is of the opinion that the two hour limit of 0.1 mg/l stated above must be measured in the effluent before discharge to the river. During the remainder of the time the limit for continuous discharge of 0.005 mg/l should be met. Since this concentration of total residual chlorine cannot be reliably measured with present methods, the Applicant will only be required to insure that total residual chlorine in the blowdown is substantially below the limit of reliable analysis as will be detailed in the Technical Specifications.

However, it is not clear whether it will be possible to control residual chlorine in the blowdown at all times to conform to the recommendation stated above without additional treatment of the discharge. No free chlorine is expected to be present in the discharge to the river due to rapid reaction with oxidizable substances in the water. Combined compounds, however, particularly monochloramine, are expected to form in the cooling water due to the presence of ammonia in the Cedar River water of up to about 1.6 ppm (see Table 3.8) which will react with the free chlorine. Concentrations of chloramine up to about 5 ppm as a result of the 1.6 ppm of ammonia, of which about 97% will be monochloramine and about 3% will be dichloramine,[43] are likely. Passage through the cooling tower circuit (8 to 30 minutes travel time) will likely dissipate most of the dichloramine. In turn, this will reduce somewhat a concentration of the less volatile monochloramine due to equilibrium reaction. Mixing of the water in the chlorinated condenser half with water from the unchlorinated condenser half (chlorine will be added to 1/2 of the condenser at a time) will reduce the concentration of chlorine in the water by dilution and reaction with chlorine-demanding substances, but the extent which this will reduce the total chlorine in the blowdown is presently not predictable due to the wide fluctuation in chlorine demand of the water. Chlorine demand may rise to 15 ppm during early spring when runoff from farm land is maximum.[44] If such runoff contains concentations of ammonia higher than given in Table 3.8, concentration of chloramine in the circulating water ahead of the cooling tower will be higher than the 5 ppm maximum stated above.

Experience at other installations is difficult to apply here, particularly because no data are available on chlorination at plants sited on a river similar in chemical characteristics to the Cedar River, and which use cooling towers.

Because of the uncertainty in expected levels of residual chlorine in the blowdown, the Applicant will be allowed an interim period in which to determine whether total chlorine in the discharge to the river will exceed the recommended criteria at any time during the year. If such occurs, the Applicant must, within this interim period, determine the extent of the area in which chlorine in the river is detectable and must adopt an ecological monitoring program which will determine the effects of chlorination on the aquatic ecosystem as discussed in Section 6.2. A limit of 0.5 mg/l total chlorine in the discharge for a period not to exceed two hours per day, is considered a maximum acceptable concentration during this interim period. At all other times, total residual chlorine in the discharge must not exceed 0.1 mg/l during the interim period. These limits are based on the following:

a. Even with the historical 10 year low flow these levels will assure that after mixing (dilution factor of 20) total residual chlorine in the river will be 0.01 mg/l, or less, except for a maximum of two hours per day when it may rach 0.05 mg/l.

b. The area of the river at the immediate outfall, in which the guidelines may be exceeded, will be relatively small in extent (see the thermal plume sizes given in Section 3.4).

c. The species of fish in the Cedar River are more tolerant of chlorine than cold water species such as salmon and trout. Sensitive species of zooplankton and benthos, as well as sensitive stages of a particular fish species' life cycle may be adversely affected by this discharge at the immediate outfall, but such effects are not expected to affect the total river ecology. In the event that deleterious effects are found by the monitoring program, the Applicant must reduce chlorine concentrations in the discharge as needed to protect the river's ecosystem.

In order to assure that plant operation does not result in long term adverse changes in the Cedar River, the Applicant must initiate a study of methods for chlorine control, if concentrations of total residual chlorine in the blowdown exceed the guidelines as stated above. Within twelve months after startup the Applicant will submit to the Staff a report stating that it can or cannot meet the limits established in the Technical Specifications. If it cannot, then a plan will also be submitted stating what modifications the Applicant proposes to enable the DAEC to meet the limits. Stricter limits will be applied if required by Iowa State Standards or other applicable standards at that time. Control methods are discussed in Section 10.

Depression of phytoplankton photosynthesis and respiration in the vicinity of a power plant on the St. Croix River were tied to chlorination.[26] Similar effects may occur locally in the plume area near the DAEC as a result of chlorinated discharges into the Cedar River, but plankton productivity should soon recover downstream from the discharge zone, and not affect the total river ecosystem to any observable extent. The river monitoring program will determine whether there are any observable effects.

Miscellaneous chemicals required in the DAEC Laboratory, some of which are discharged to the river, are present in minor amounts. No measurable adverse effects on either the quality of the water, nor on the biota are expected as a result of the release of these chemicals or their reaction products. Concentrations of toxic chemicals in the river such as Cr, Zn, Hg, Pb, Mn and nitrates will be measured by the Applicant's monitoring program, (see Section 6.2.1). If levels of these chemicals exceed that allowed by the Iowa Pollution Control Commission, and plant operation is a causative factor, it will be required that their discharge into the river be reduced to satisfactory levels or terminated.

5.4.4 Summary

It is anticipated that the operation of the Duane Arnold Energy Center will have no measurable adverse effects on aquatic biota except in a small area (<1 acre) near the outfall. The Cedar River Baseline Ecology Study has and will continue to provide information on the present ecology of the Cedar River. Studies conducted after plant startup adjacent to and downstream of the plant discharge are designed to identify significant environmental changes caused by plant operation and will make it possible to take corrective action should deleterious environmental effects occur.

5.5 RADIOLOGICAL EFFECTS ON BIOTA OTHER THAN MAN

During normal operation of the DAEC, small quantities of radioactive materials will be released to the environment. The releases that will probably be permitted under the provisions of 10 CFR 50, proposed

Appendix I, have been covered in Section 3.5. Using these releases, a fault-tree and systems analysis of the DAEC and its environment was performed using the ARIP program package.[27] The results of this analysi are shown, in part, in Table 5.3 where dose rates are listed for the biota in the vicinity of the DAEC. These include phytoplankton, zooplankton, benthic organisms, terrestrial and aquatic plants, and local and migrating birds and mammals. Other terrestrial organisms will receive doses intermediate between those of terrestrial plants and birds. Doses at the effluent outlet, or in the Cedar River, are applicable only to aquatic forms. The river littoral down river of the DAEC has been chosen to represent the maximum doses to be expected on land, or at the aquatic-terrestrial interface. Doses in all other terrestrial areas will be lower than those given for the littoral. In each case, the doses given are those for the limiting species, i.e., the species that are critical for this particular area by reason of showing the maximum bioaccumulation effects. Inspection of the table shows that these doses are, in fact, quite low for all of the biota in the area. At these dose levels, no deleterious effects are anticipated for any of the biota in the area.[28,29] Even at the effluent outfall the high river and high effluent discharge velocities precluded more than momentary residence of mobile species. Thus, their annual dose commitments would be much less than that given in Table 5.3. For sessile organisms, e.g., benthos, radiosensitivity is less than for mobile organisms by several orders of magnitude. Thus, deleterious effects are not to be anticipated even for benthos in the immediate effluent. In any case, steady-state radioactive concentrations will drop several orders of magnitude within a few tenths of a mile of the effluent discharge,[30] so that the benthos in only a very limited area will be exposed.

A diagrammatic representation of some of the pathways utilized in the evaluation is included in Figure 5.2. In addition, equilibration between geosphere, hydrosphere, and atmosphere was assumed, as well of the various trophic levels to and from birds, mammals, etc., in the biosphere.

5.6 RADIOLOGICAL EFFECTS ON MAN

5.6.1 Plant Operation Effects

The methodology above was then extended to man. Direct doses to the human population via atmospheric dispersion of plant releases are given in Table 5.4. Detailed doses for the population within the 16 sectors extending to 50 miles are given in Appendix J. These are subdivided into the critical organ doses attendant on releases of

TABLE 5.3 Doses (mrem/yr) to Biota in the Vicinity of the DAEC

Organisms	Effluent	Cedar River	Littoral
Aquatic plants	3441	10	10
Aquatic invertebrates	1500	4.5	4.5
Aquatic vertebrates	1200	3.4	3.4
Terrestrial plants	—	-	5.1
Terrestrial invertebrates	—	-	2.3
Birds	—	-	4.5
Mammals	—	-	8.8

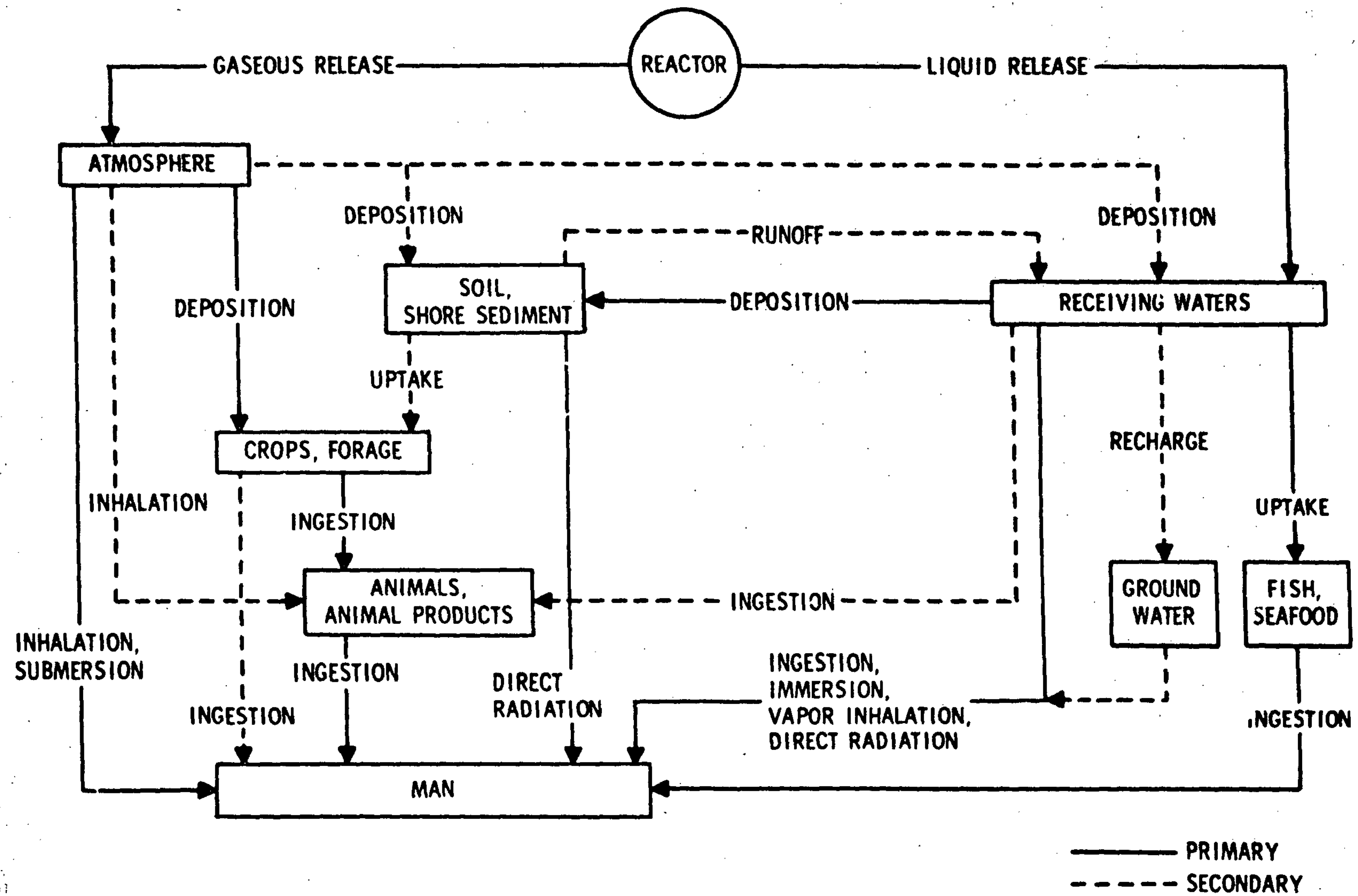

Fig. 5.2. Pathways to Man.

TABLE 5.4 Cumulative Annual Population Dose and Average Dose From Gaseous Effluents

Radial Distance from Plant, miles	Cumulative Population	Cumulative Population Dose, man-rem/yr	Average Individual Dose, mrem/yr
1	15	0.0069	0.46
2	275	0.14	0.50
3	1,005	0.34	0.34
4	1,720	0.43	0.28
5	2,735	0.60	0.22
10	79,320	8.0	0.10
20	176,300	11.0	0.065
30	231,100	12.0	0.054
40	365,800	14.0	0.038
50	550,800	15.0	0.028

halogens and particulates (e.g., I-131), and of noble gases (e.g., Kr-85). These are given because they represent the limiting cases of human hazard (e.g., carcinogenesis).

The maximum airborne doses are found in the north sector at, or near, the boundary. This sector is also habitable so that the maximum value, 1.4 mrem/year, represents a potential dose commitment. Direct doses in all sectors are completely dominated by the noble gas component. Hunters, anglers, and other occasional occupants of the area will receive doses at this rate or less, with an annual dose markedly less than 1.4 mrem. The annual population-integrated commitment over the 50-mile radius will be 15 man-rem (the natural population-integrated commitment is about 74,000 man-rem).

The nearest identifiable dairy herd is pastured about 1.6 miles to the west-northwest of the site. Annual doses to a child's thyroid via the air-cow-milk iodine pathway will be less than 6.5 mrem. The nearest land suitable for pasture lies about 0.7 miles north of the site. Pasture uses of such land represents a potential dose to a child's thyroid less than 20 mrem/year. Monitoring, administrative measures and/or design changes will be required to insure that the actual dose does not exceed 5 mrem/year.

If in the future a cow is located closer to the DAEC than at present (1.6 miles from the site), the Applicant will be required to evaluate the thyroid radiation doses likely to result from consumption of milk produced at the new location, and to take whatever steps are necessary to assure that these doses will be compatible with the then-existing limits for human exposure.

Direct and indirect doses to man via waterborne radionuclides are given in Table 5.5. These include doses to permanent residents, of the area, to temporary residents, anglers, boaters, swimmers, etc., and to consumers of foods produced in the area. The maximum, cumulative, annual dose received by any member of the population via normal liquid releases from the DAEC would be less than 0.38 mrem. The corresponding population doses would be 12 man-rem/year.

Direct dose rates from radioactive fuel and/or radionuclides produced at and/or stored at the DAEC will be less than one mrem/year at the closest approach to the DAEC. This dose drops off very rapidly with distance, however, so that the total annual population dose from this source will be less than one man-rem. This source is independent of plant releases.

In summary, the Staff concludes that the radiological characteristics of the DAEC and its environs are such as to limit human doses and dose rates to a very small fraction of the natural background (about 135 mrem/year).[31]

TABLE 5.5 Individual and Population Doses due to Liquid Releases from the DAEC

Pathway	Populations at Risk, man years/yr.	Dose Rate, mrem/yr ($x10^3$)				
		Bone	Thyroid	GI Tract	Whole Body	Critical Organ
Tap Water, Cedar Rapids	110,000	2.3	6.0	0.71	1.2	7.5
Dietary, Commercial	550,000	5.9	15.0	1.9	3.1	20.0
Dietary, Sport	270	240.0	11.0	240.0	150.0	260.0
Direct, Recreation	270	88.0	88.0	88.0	88.0	88.0
Immersion, Recreation	270	0.17	0.17	0.17	0.17	0.17
Inhalation, Recreation	270	0.005	0.005	0.005	0.005	0.005
Private Wells	1,000	2.3	6.0	0.71	1.2	7.5
Total Risk, manrem/yr		3.6	8.9	1.2	1.9	12

The fraction is less than 2% in nearby sectors, and much less than that at a distance. Deleterious effects on the human population would not be anticipated since much higher dose rates, extended over the lifetime of significant segments of the U. S. population, have failed to show any evidence of human hazard.[32]

5.6.2 Transportation Effects

a. Principles of Safety in Transport

The transportation of radioactive material is regulated by the Department of Transportation and the Atomic Energy Commission. The regulations provide protection of the public and transport workers from radiation. This protection is achieved by a combination of standards and requirements applicable to packaging, limitations on the contents of packages and radiation levels from packages, and procedures to limit the exposure of persons under normal and accident conditions.

Primary reliance for safety in transport of radioactive material is placed on the packaging. The packaging must meet regulatory standards[33] established according to the type and form of material for containment, shielding, nuclear criticality safety, and heat dissipation. The standards provide that the packaging shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety, and provide adequate heat dissipation under normal conditions of transport and under specified accident damage test conditions. The contents of packages not designed to withstand accidents are limited, thereby limiting the risk from releases which could occur in an accident. The contents of the package also must be limited so that the standards for external radiation levels, temperature, pressure, and containment are met.

Procedures applicable to the shipment of packages of radioactive material require that the package be labeled with a unique radioactive materials label. In transport the carrier is required to exercise control over radioactive material packages including loading and storage in areas separated from persons and limitations on aggregations of packages to limit the exposure of persons under normal conditions. The procedures carriers must follow in case of accident include segregation of damaged and leaking packages from people and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipment and trained personnel, if necessary, in such emergencies.

Within the regulatory standards, radioactive materials may be safely transported in routine commerce using conventional transportation equipment with no special restrictions on speed of vehicle, routing, or ambient transport conditions. According to the Department of Transportation (DOT), the record of safety in the transportation of radioactive materials exceeds that for any other type of hazardous commodity. DOT estimates approximately 800,000 packages of radioactive materials are currently being shipped in the United States each year. Thus far, based on the best available information, there have been no known deaths or serious injuries to the public or to transport workers due to radiation from a radioactiver material shipment.

Safety in transportation is provided by the package design and limitations on the contents and external radiation levels and does not depend on controls over routing. Although the regulations require all carriers of hazardous materials to avoid congested areas[34] wherever practical to do so, in general carriers choose the most direct and fastest route. Routing restrictions which require use of secondary highways or other than the most direct route may increase the overall environmental impact of transportation as a result of increased accident frequency or severity. Any attempt to specify routing would involve continued analysis of routes in view of the changing local conditions as well as changing of sources of material and delivery points.

b. Transport of New Fuel

Since the nuclear radiations and heat emitted by new fuel are small, there will be essentially no effect on the environment during transport under normal conditions. Exposure of individual transport workers is estimated to be less than 1 millirem (mrem) per shipment. For the 4 shipments, with two drivers for each vehicle, the total dose would be about 0.008 man-rem per year. The radiation level associated with each truckload of cold fuel will be less than 0.1 mrem/hr at 6 feet from the truck. A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of about 0.005 mrem per shipment. The dose to other persons along the shipping route would be extremely small.

c. Transport of Irradiated Fuel

Based on actual radiation levels associated with shipments of irradiated fuel elements, the Staff estimates the radiation level at 3 feet from the rail car will be about 25 mrem/hr.

Train brakemen are likely to remain a few minutes in the vicinity of the rail car for an average exposure of about 0.5 millirem per shipment. With 10 different brakemen involved along the route, the annual cumulative dose for 6 shipments during the year is estimated to be about 0.03 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the rail car, might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose for the 6 shipments would be about 0.1 man-rem. Approximately 150,000 persons who reside along the 500-mile route over which the irradiated fuel is transported might receive an annual cumulative dose of about 0.08 man-rem. The regulatory radiation level limit of 10 mrem/hr at a distance of 6 feet from the vehicle was used to calculate the integrated dose to persons in an area between 100 feet and 1/2 mile on both sides of the shipping route. It was assumed that the shipment would travel 200 miles per day and the population density would average 330 persons per square mile along the route.

The rate of heat release to the air from each cask will be about 70 kw for a rail cask. This might be compared to about 50 kw of waste heat which is released from a 100 horsepower truck-engine. Although the temperature of the air which contacts the loaded cask may be increased a few degrees, because the amount of heat is small and is being released over the entire transportation route, no appreciable thermal effects on the environment will result.

d. Transport of Solid Radioactive Wastes

Under normal conditions, the average radiation dose to the individual truck driver during a 500-mile shipment of solid radioactive waste is estimated to be about 15 mrem. If the same driver were to drive 25 truckloads in a year, he could receive an estimated dose of about 400 mrem during the year. The annual cumulative dose to all drivers for 25 shipments during the year, assuming 2 drivers per vehicle, would be about 0.8 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 feet from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the annual cumulative dose would be about 0.3 man-rem. Approximately 150,000 persons who reside along the 500-mile route over which the solid radioactive waste is transported might receive an annual cumulative dose of about 0.2 man-rem. These doses were calculated for persons in an area between 100 feet and 1/2 mile on either side of the shipping route, assuming 330 persons per square mile, 10 mrem/hr at 6 feet from the vehicle, and the shipment traveling 200 miles per day.

5.7 RESOURCES COMMITTED

Resources committed in the construction of the DAEC are given in Section 4.4. The principal resources which will be used during operation of the plant are human and fuel (uranium). A few thousand man-years of effort will be involved in operating the Plant during its lifetime.

In the process of producing power the DAEC will use a natural resource of fuel-Uranium-235. Part of the enriched uranium fuel loading for the reactors is periodically reprocessed for removal of fission products and, after adjustment of the enrichment, refabricated for return to the reactor. During a 40-year lifetime, about 900 metric tons of uranium as UO_2 will pass through the reactor, with 78 metric tons being in the reactor at any one time.

A total of about 22 metric tons of fuel will be actually fissioned and lost as a natural resource. Plutonium production in the plant reactor will partially offset the loss of fissionable uranium (approximately 25 percent). A listing of some of the chemicals which will be used during a 40-year lifetime of the DAEC are given in Table 5.6. Nonfuel resources used are small in terms of total resources available, especially when viewed in terms of the total production of some 160×10^9 kWh of electricity which will be produced by the DAEC. Many other materials are involved in the Plant construction and operation, but most of these will be recoverable upon termination of plant operation. The Staff concludes that in no case will the amount of material committed during the construction and operation of the DAEC be appreciable in terms of the supply of the material available.

5.8 EFFECTS OF THE TRANSMISSION SYSTEM

Effects of construction of the transmission system have been considered in Section 4.1. The primary effects of the transmission system are involved in the original construction of the system. Operational effects will be primarily confined to periodic maintenance of the transmission system. No defoliants will be used during line maintenance, and trimming of growth near the lines will be limited to that needed for protection of the lines.[1] Effects of continued operation of the transmission system are, therefore, expected to be minimal.

TABLE 5.6 Chemicals Used in 40 Years of Plant Operation

Material	Amount Used
Sulfuric acid	210×10^6 lb
Sodium hydroxide	1.1×10^6 lb
Chlorine	10×10^6 lb

The generation of ozone as a result of corona generated by transmission lines has recently been experimentally investigated in the laboratory and field.[35,36] These investigations indicate that for transmission lines up to 765 kV the maximum ground-level ozone concentration will be well below federal standards.[35] The National Primary Air Quality Standard for photochemical oxidants as issued by the Environmental Protection Agency is 0.08 ppm by volume maximum arithmetic means for a one-hour concentration not to be exceeded once per year. Laboratory studies have indicated that 0.0193 ppm by volume of total oxidants might be expected at ground level. Field studies with equipment sensitive to 0.002 ppm by volume indicated no measurable oxidants at either ground or transmission line wire level.

References

1. "Environmental Report on the Duane Arnold Energy Center" Amendment 1, Iowa Electric Light and Power Co., July 1972.

2. J. E. Krick, "Accoustical Effects of Cooling Tower Operation," Affidavit in Support of Motion for Temporary Operating License. USAEC Atomic Safety and Licensing Board, July 8, 1972, Docket 50-271.

3. E. Aynsley, "Environmental Effects of Water Cooling Techniques - A Status Report" Draft dated August 1972. To be published as an ANL report by Argonne National Laboratory.

4. "Evaluation of Environmental Effects of Cooling Tower Operation at the Trojan Site," NUS Corp., May, 1972.

5. "Environmental Report on the Duane Arnold Energy Center," Amendment 2, Iowa Electric Light and Power Co., October, 1972.

6. T. J. Overcamp and D. P. Hoult, "Precipitation in the Wake of Cooling Towers," Atmospheric Environment, Vol. 5, p. 175, 1971.

7. L. Veldvizen and J. Ledbetter, "Cooling Tower Fog: Control and Abatement," J. Air Pollution Control Ass'n., 21 (1) Jan. 1971.

8. W. Bowman and W. Biggs, "Meteorological Aspects of Large Cooling Towers," Dames and Moore, 72-128, Presented at Air Pollution Control Association Meeting, June 1972.

9. J. Bond, "Noise: Its Effect on the Physiology and Behavior of Animals," Agr. Science Rev. 9 (4): 1-10.

10. Letter, E. L. Davis, Environmental Services Div., Research Corp. of New England, June 23, 1972.

11. M. Fried and H. Broeshart, "The Soil-Plant System in Relation to to Inorganic Nutrition," Academic Press, 1967.

12. I. Davies, "Chemical Changes in Cooling Water Towers," Air and Water Pollution Int. J., 10: 853-863.

13. "Water Quality Criteria and Plan for Implementation and Enforcement for the Surface Waters of Iowa," Iowa Water Pollution Control Commission, State Dept. of Health, Des Moines, Iowa, 1970.

14. D. B. McDonald, "Cedar River Baseline Ecological Study," Annual Report, April 1971-1972, Iowa Electrical Light and Power Co., 1972.

15. "Environmental Report on the Duane Arnold Energy Center," Revised Edition, Iowa Electric Light and Power Co., Nov. 1971, Docket 50-331.

16. R. W. Pennak, "Freshwater Invertebrates of the United States," Ronald Press, N. Y.

17. H. B. Hynes, "The Ecology of Running Waters," Univ. of Toronto Press, 1970.

18. C. C. Coutant and A. V. Brook, "Biological Aspects of Thermal Pollution. I. Entrainment and Discharge and Discharge Canal Effects," CRC Critical Reviews in Environmental Control, pp. 341-381, Nov. 1970.

19. K. J. Macek, et al., "The Effects of Temperature on the Susceptibility of Bluegills and Rainbow Trout to Selected Pesticides," Bul. Envir. Contamination and Toxicology 4 (3): 174-183, 1969.

20. Personal communication, J. Truchan, Michigan Water Quality Control Dept., Sept. 1972.

21. C. C. Coutant and C. P. Goodyear, "Thermal Effects," J. Water Pollution Control Fed. 44: 1250-1294, 1972.

22. J. B. Sprague and D. E. Drury, "Avoidance Reactions of Salmonid Fish to Representative Pollutants," Adv. in Water Pollution Research, Proc. of the Fourth Int'l. Conf., Prague, 1969.

24. J. A. Zillich, "Toxicity of Combined Chlorine Residuals to Freshwater Fish," J. Water Pollution Control Fed., 44: 213-220.

25. J. W. Arthur and J. G. Eaton, "Chloramine Toxicity to the Amphipod Gommarus pseudolimneaus and the Fathead Minnow (Pimephales promelas), J. Fisheries Res. Bd. of Canada, 28:1841-1845, 1971.

26. A. Brook and A. Baker, "Chlorination of Power Plants: Impact on Phytoplankton Productivity" Science 176 :1414-1415, 1972.

27. N. A. Frigerio, "The Argonne Radiological Impact Programs," Argonne National Laboratory, in preparation, 1972.

28. A. H. Sparrow, et al., "Chromosomes and Cellular Radiosensitivity," Radiation Res. 32, 915, 1967.

29. S. I. Aurbach, "Ecological Considerations in Siting Nuclear Power Plants: the Long-Term Biotic Effects Problem," Nuclear Safety, 12 (1), 1971.

30. D. M. Nelson, et al., "Radionuclide Concentrations near the Big Rock Point Nuclear Power Station," in ANL-7760 Part III Annual Report of the Radiological Physics Division, Argonne National Laboratory, "Environmental Studies," July 1969 - December 1970, p. 18.

31. A. W. Klement, Jr., et al., "Estimates of Ionizing Radiation Doses in the United States 1960-2000," U. S. Environmental Protection Agency, Office of Radiation Programs Publication ORP/CSD 72-1, 1972.

32. N. A. Frigerio, "Cancer Epidemiology and the Radiation Background," submitted to Nature, 1972.

33. 10 CFR Part 71; 49 CFR Parts 173 and 178.

34. 49 CFR Sections 397.1 (d).

35. H. N. Scherer, et al., "Gaseous Effluents due to EHV Transmission Line Corona," Preprint of paper presented at IEEE PES Summer Meeting, San Francisco, July 9-14, 1972.

36. M. Frydman, et al., "Oxidant Measurements in the Vicinity of Energized 765-KV Lines," Preprint of paper presented at the IEEE PES Summer Meeting, San Francisco, July 9-14, 1972.

37. E. Aynsley, "Cooling-Tower effects: Studies abound." Electrical World, 42-43, May 11, 1970.

38. W. C. Colbaugh, J. P. Blackwell, and J. M. Leavitt, "Interim Report on Investigation of Cooling Tower Plume Behavior, TVA Muscle Sheals," Paper presented at the A.I.CH.E. Cooling Tower Symp., Houston, Texas, March 3, 1971.

39. W. M. Culbowski, "An Anomalous Snow at Oak Ridge, Tennessee," Monthly Weather Rev. 90, 194-196, 1962.

40. Federal Water Quality Administration, "Feasibility of Alternative Means of Cooling for Thermal Power Plants near Lake Michigan," Prepared by National Thermal Pollution Research Program, Pacific Northwest Water Laboratory and Great Lakes Regional Office, U.S. Department of Interior, 1970.

41. A. Roffman, et al., "The State of the Art of Salt Water Cooling Towers Applicable to Nuclear Electric Power Generating Plants," Prepared for U.S.A.E.C., Contract No. AT(11-1)-2221, Oct., 1972.

42. U. S. Dept. of Agriculture, 1957, Soil, The Yearbook of Agriculture.

43. Draley, J. E., "The Treatment of Cooling Waters with Chlorine," ANL/ES-12, Argonne National Laboratory, February 1972.

44. Memo to DAEC File reference "Chlorine Problem," February 14, 1973.

6. EFFLUENT AND ENVIRONMENTAL MONITORING PROGRAMS

The programs discussed in this section will form the basis for the monitoring requirements included in the Staff's Technical Specifications if an operating license is issued to the Applicant. The Technical Specifications will be attached to, and become part of, the operating license.

6.1 RADIOLOGICAL PROGRAMS

6.1.1 Preoperational Radiological Monitoring

The preoperational environmental monitoring program began in 1971. It was designed to document existing radioactivity levels and fluctuations in various environmental media, including air, water, soil, vegetation, foodstuffs, sediments and biota. The program was designed by the Applicant in conjunction with the NUS Corporation, and samples collected during the period between April and December of 1971 were analyzed by NUS. Samples collected subsequent to that time were analyzed by the Eberline Company of Santa Fe, New Mexico. This program is described in greater detail in Section 2 and Appendix B (Technical Specifications) of the Applicant's Final Safety Analysis Report (FSAR).[1]

Samples are collected by employees of the Applicant, or by its ecological consultant, and sent to Santa Fe. The single exception is that thermoluminescence dosimeters (TLD) used for the monthly determination of the ambient radiation background are now read by the Applicant because doses incurred in air shipment to Santa Fe were found to exceed the doses otherwise accumulated. A parallel set of badges, which are left in the field for one year, are still sent to Santa Fe for reading. Altogether about 2400 samples of various types are collected from almost 80 sampling locations each year.

The samples are analyzed by the established procedures of the Environmental Protection Agency (EPA) Laboratories or the Health and Safety Laboratory (HASL) of the AEC. Quality assurance is maintained in part by interlaboratory comparisons on samples furnished by the analytical control service of the EPA and by the International Atomic Energy Agency (IAEA).

The types of samples collected, locations and frequency of collection, and the analyses performed are given in Tables 6.1 and 6.2. Sampling locations are shown in Fig. 6.1. Additional details regarding sample analysis along with the results of the first year of monitoring are to

TABLE 6.1. Sampling System for the Environmental Monitoring Program

...ample Type	Location	Sampling Frequency Preoperational	Operational	Analysis	Remarks
...articulate	1-16	W	W	α, β-γ, γ spec.	Continuous filter
...odine	4, 5, 7, 8, 11, 12, 14, 15	W	W	γ spectrum	Weekly composite
...nt radiation	1-48	M	M	γ dose	TLD
...ce water	49-52, 73, 75	M	M	α, β-γ, Sr-90, γ spec. Tritium(a) Ra-226	If β >10 pC/ℓ Composited If α >3 pC/ℓ
...d (well) water	53-60	M	M	As for surface water	
...m sediments	49-51, 61	M	SA	α, β-K40, γ spec. Sr-90	
	15, 16, 62-74	Q	SA	As for bottom sediments	
...ation	62-74	At harvest	SA	As for soil	Edible portion
...and poultry		As available	SA	α, β-K-40, I-131 thyroid, Cs-137 muscle	Various farms within 10 miles.
	62	M(b)	TM(c)	Sr-89, -90, I-131, Cs-137, Ba-La-140, Elemental Ca	Control farm near Brandon
	63-72	M(b)	TM(c)		Dairies w/i 10 mi.
	73	M(b)	TM(c)		Control farm at Amana
	Cedar River	Q	Q	α, β-K-40, γ spec., Sr-90 bone	All avail. species
...ic biota	Cedar River	Q	Q	α, β-K-40, γ spec.	As available
...ife	Palo Marsh	SA	SA	α, β-K-40, I-131 thyroid, Cs-137 muscle	Also from other areas

W(weekly), TM(twice-monthly), M(monthly), Q(quarterly), SA(semi-annually), α(gross α), β-γ(gross βγ), γ spec.(γ spectrum analysis), TLD(Thermoluminescent dosimetry)

...or tritium analysis (electrolytic enrichment) composited quarterly 1st year and annually thereafter.

...ore frequently if I-131 is suspected (or detected).

...eekly if I-131 detected in plant effluents.

TABLE 6.2 Monitoring Locations

Location	Approximate Distance, Miles	Samples Obtained
1. Cedar Rapids	11	air, TLD
2. Marion	10	air, TLD
3. Hiawatha	6	air, TLD
4. Morris	2	air, TLD, iodine
5. Palo	3	air, TLD, iodine
6. Center Point	6	air, TLD
7. Shellsburg	5	air, TLD, iodine
8. Urbana	10	air, TLD, iodine
9. Route W26	7	air, TLD
10. Atkins	8	air, TLD
11. Toddville	2	air, TLD, iodine
12. Iowa City	30	air, TLD, iodine
13. Alburnett	8	air, TLD
14. Alice	8	air, TLD, iodine
15. On site	-	air, TLD, iodine, soil
16. On site	-	air, TLD, soil
17-32 Sixteen cardinal compass directions	Site boundary	TLD
33-48 Sixteen cardinal compass directions	1-3	TLD
49. Lewis Access	4.5	Surface water, BS
50. Plant intake	-	Surface water, BS
51. Plant discharge	-	Surface water, BS
52. Cedar Rapids City Park	7	Surface water
53. Cedar Rapids water treatment (treated)	7	Well water
54. Cedar Rapids water treatment (untreated)	7	Well water
55-56 On-site wells	-	Well water
57-60 Wells near site	<1	Well water
61. Cedar River below plant discharge	0.5	BS
62. Control farm near Brandon	18	Soil, vegetation, milk*
63-72 Dairy farms	$\leq$10	Soil, vegetation, milk
73. Control farm near Amana	20	Soil, vegetation, milk, Surface water
74. Irrigated farm downriver	1.5	Soil, vegetation
75. Farm pond near Toddville	2	Surface water

key: air(particulates filtered), TLD(ambient γ radiation), BS(bottom sediments)

*Except locations 69,70.

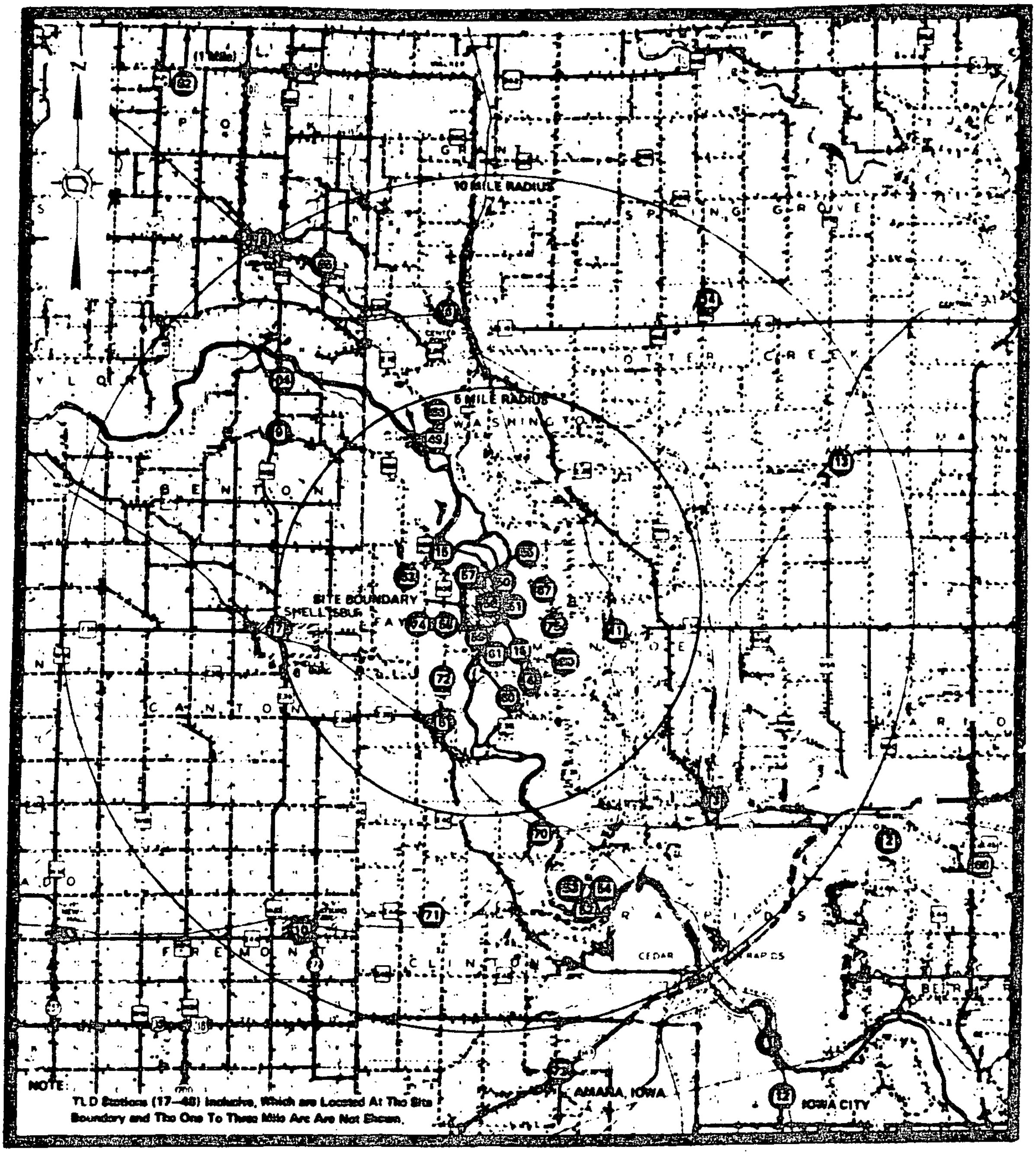

Fig. 6.1. Environmental Monitoring Program Sampling Stations.

be found in the Applicant's document, "Report of Environmental Monitoring Program, April 1971-March 1972."

The program is basically a good one, thoroughly described and documented, properly redundant in critical areas, well-focused on important human and biotrophic pathways, yet sufficiently inclusive to ensure adequate monitoring of minor pathways as well. The Staff regards the Applicant's program as adequate to provide a baseline for the assessment of radiological changes in the environment which might be caused by the operation of this plant.

6.1.2 Operational Effluent Monitoring

Possible release paths for gaseous radioactivity (Section 3.5.2) include the air-ejector offgas train, the offgas stack which carries both the air-ejector offgas and the gland seal exhaust, and the reactor building ventilation system. Radioactivity released via each path will be measured and reported in accordance with AEC Safety Guide 21. This guide specifies minimum requirements for measurement and reporting of radioactivity in gas and liquid releases and specifies such details as the need for isotopic identification, and sensitivity of analyses.

The DAEC process monitoring is described in Section 7.12 and Amendment 1 of the FSAR.[1] Monitor readings will be continuously recorded and alarms will be signaled if radioactivity levels exceed preset trip levels. An alarm in a reactor system ventilation monitor will cause that system to shut down and the standby gas-treatment system to be started up.

Liquid process monitors will be installed on the reactor building closed cooling water system, the plant service water system and the pumpout line from the liquid radwaste system. The last named monitor serves as a backup since the radioactivity content of any tank to be released must be first ascertained by sampling and analysis, again in accordance with AEC Guide 21. Monitor readings will be continuously recorded and alarms will be signaled if preset levels are exceeded.

At this time, specific trip levels have not been set. Appropriate levels will be required for inclusion in the Technical Specifications prior to operation of the plant. Since the limits will be related to the long-term release limits which are given in the Technical Specifications and will ensure conformity with the as low as practicable provisions of 10 CFR 20 and 10 CFR 50, this aspect of plant operation is considered to be satisfactory.

6.1.3 Operational Environmental Monitoring

The operational radiological monitoring program for the environment will be essentially the same as the preoperational one. It will use the same sampling locations, techniques, analyses, and approximately the same sampling frequency. Changes will be made in the program as indicated by operating experience. It will be further defined in the Technical Specifications for the plant. Basically, the program is a good one and, together with the preoperational program, is adequate for the assessment of radiological changes in the environment that may be caused by plant operation.

6.2 ECOLOGICAL PROGRAMS

6.2.1 Preoperational Environmental Monitoring

a. Aquatic

The Applicant initiated a baseline ecological study of the Cedar River in April 1971, which will continue until plant startup.[2] The study is under the supervision of Dr. Donald B. McDonald, Limnologist and Associate Professor of Civil Engineering at The University of Iowa, Iowa City.

The river sampling techniques used are based largely on eight years' experience on the Iowa River, which is similar in its drainage basin and limnology to the Cedar River. At the beginning of the Cedar River study, a number of samples were taken across the river at various stations to determine the degree of homogeneity in the water. It was found that, with the exception of the shallow water areas near shore, the river was relatively homogeneous at any one time, although considerable water quality changes occurred throughout the year. For this reason, two samples were taken with the Kemmerer sampler from the channel edge or main channel of the river and mixed prior to analysis. It was found that this procedure gave an accurate picture of the water quality of the Cedar River at a given time. Since the water quality of the river is subject to considerable seasonal changes, samples for chemical and plankton analysis are taken twice monthly rather than quarterly. Studies on the Iowa River showed that this is necessary if a true picture of the seasonal water quality is to be obtained. In order to determine diurnal variations in alkalinity, D.O., temperature, and pH, samples are collected at three- to four-hour intervals on a quarterly basis.[3]

Samples are taken from the river throughout the year at four locations: 1) about five miles upstream of the plant at the Lewis Access Bridge;

2) directly above the intake structure for the cooling tower makeup water; 3) at the John Comp farm, about one mile below the site; and 4) at Mohawk Park, just above the city of Cedar Rapids' water treatment plant. Sampling sites are shown in Fig. 2.15. Samples for general chemical and plankton analysis were routinely taken twice per month while complete chemical analysis, benthic and fishery studies were conducted in June-July and October-November, 1971. The following specific studies were conducted:

I. General Water Quality Analysis:
   A. Frequency: twice per month, routinely.
   B. At all four sites.
   C. Parameters measured:

D.O.	Total PO_4	COD
pH	Ortho PO_4	Taste and odor
CO_2	NO_3^-	Temperature
Total alkalinity	NH_3	Turbidity
CO_3 alkalinity	Fe	Color
Total hardness	Lignins & tannins	Solids
Ca hardness	BOD	

II. Additional Water Quality Analysis:
   A. Frequency: quarterly.
   B. At all four locations.
   C. Parameters measured: All general water quality parameters plus:

Cu	Mn
Zn	Cl^-
Hg	SO_4^-
Pb	NO_2^-
Cr^{+6}	Pesticides in fish

In addition, D.O., pH, and alkalinity were determined at each site every four hours over a 24-hour period.

III. Plankton Studies
   A. Frequency: twice per month, routinely.
   B. At all four locations.
   C. Analyses for: numbers and kinds (to genus whenever possible) of organisms present.

Studies to determine periphyton using artificial substrates were undertaken at the beginning of the study but were abandoned because of the fluctuation in riverflow and the effects of siltation, which made any interpretation meaningless. No studies of higher aquatic plants were undertaken as these organisms are almost never found in the river because of the nature of the channel and the bottom.[3]

IV. Bacteriological Studies
- A. Frequency: twice per month.
- B. At all four locations.
- C. Analyses made:

Total plate count (20°C)	Fecal coliform (MF)
Total coliform (MF)	Fecal streptococci

V. Benthic (bottom organisms) Studies
- A. Frequency: quarterly.
- B. Analysis: kinds (to genus whenever possible) and numbers of organisms present.

Benthic samples were taken by means of a Ponar dredge or by simply scraping rocks at certain areas. It is difficult to make quantitative estimates of the benthic production in the Cedar River because of the fact that much of the bottom consists of shifting sand and silt which support relatively few benthic organisms. Where exposed rock substrate is available, relatively large populations of mayflies and other forms characteristic of fair to good water quality are present. Thus, it appears that substrate rather than water quality is the limiting factor in benthic populations in the area.[3]

VI. Fishery Studies

Fishery studies were conducted in cooperation with the Iowa Conservation Commission using electroshocking and baited nets. These are the methods routinely employed by the Iowa Conservation Commission throughout the State of Iowa and will be employed by the Conservation Commission in any postoperational studies conducted.

Age and growth studies are also being conducted by the Iowa Conservation Commission.

METHODS

Analyses for alkalinity, pH, dissolved oxygen and temperature are performed in the field at the time of sampling. Other analyses are performed in the laboratory. With the exception of heavy metal determinations, which are done by the Iowa State Hygienic Laboratory at Des Moines, all laboratory work is performed in the water laboratory of the Department of Civil Engineering, located at The University of Iowa in Iowa City. Most of the chemical tests are made in accordance with "Standard Methods,"[4] with a few minor variations that involve the use of reagents prepared by the Hach Chemical Company. Bacterial counts are made by use of the Millipore filter procedure. Plankton counts are made on centrifuged samples by use of the Whipple micrometer disc and the Sedgwick-Rafter slide. Both of these procedures are described in "Standard Methods." A sample of uncentrifuged water from each site is also examined in order to include those blue-green algae that are lighter than water and are eliminated by the centrifuging process. Determinations of pesticide residues in fish are made with a MicroTech MT220 gas chromatograph on samples extracted by means of the techniques given in the "Pesticide Analytical Manual."[5]

b. Terrestrial

Since the brief description of wildlife and vegetation existing in the vicinity of the plant, as presented in the Environmental Report, was inadequate as a preoperational ecological study, the Applicant has made a more systematic survey of the area with regard to terrestrial plants and animals.[6,7,17]

Most of the field work was conducted by Mr. Frank W. Collins, M.S. in Wildlife Biology, and Chief of the Environmental Resources Division, Rock Island District, U.S. Army Corps of Engineers; David Niemann, M.S.; and Donald B. McDonald, Ph.D., Limnologist, The University of Iowa, Iowa City.

Information to be obtained includes compiled data on soil types, land use, and the studies conducted in the area by the Iowa Conservation Commission. Field studies consist of determination of presence and abundance of game birds and animals, and a species inventory of mammals, birds, reptiles, and amphibians. Techniques utilized include actual observations, animal signs, reports, road counts, random line transects, and trapping, if necessary.

During June, 1972, the Iowa Geological Survey conducted a multispectral data acquisition mission over the Cedar River. Five rolls of imagery were obtained, two at an altitude of 4000 feet, three at 8000. The Applicant states that the data are being processed and will be available to IELPCo and its consultants.[6]

In conjunction with the aerial surveys, studies of the terrestrial vegetation were conducted in the vicinity of DAEC and the Pleasant Creek Reservoir. These studies included general vegetation surveys to determine the types and distribution of vegetation in the area, as well as transects of selected areas (Palo Marsh, Lewis Preserve, Wickiup Hills, and Lewis Preserve Access).

These field studies of plant communities were conducted during June and July 1972, using the following methods:[7]

- All of the study areas were initially examined in order to obtain preliminary data on the type of vegetation present and the species composition. Transects were established in each study area for the purpose of obtaining quantitative data.

- Herbaceous species were sampled using a 20 x 50-cm plot. All herbaceous species as well as shrubs and tree seedlings less than 1 meter tall were sampled with the 20 x 50-cm plot. Forty plots were taken along the transect in each sample area. The plots were 1.5 meters apart along the transect. Each species occurring within the plot was recorded along with rooted density and percentage foliage cover.

- Shrubs were sampled in a similar manner using a 1 x 1-meter plot. Forty plots were located one meter apart along the transect. Each species occurring within a plot was recorded as well as the rooted density and the percentage foliage cover. All shrubs and tree seedlings over one meter tall but less than 2.5 cm in diameter at breast height (1.5 meters above the ground) were sampled with these plots.

- Trees were sampled by the quarter system method as discussed by Curtis.[8] Briefly, this method consists of setting up a transect and locating points at intervals along the transect. At each point, usually 20 paces apart in this study, four quadrats are established using the line of the transect and a line at right angles to it. In each quadrat, the distance to the nearest tree is measured as well as the diameter of the tree and the species is determined. All trees over 2.5 cm in diameter are measured. As many as 40 points (160 trees) were sampled in each site where this method was used. In one study area this method was not practical because of the small area to be sampled, so a rectangular plot was used for sampling. Where the quarter system was used, the original transect which was used for herb and shrub sampling was also used for the tree sampling, but because of greater area required for sampling trees, several parallel transects were required, but they were all relatively close to the herb and shrub transect.

Treatment and analysis of the data collected are described in Ref. 7. The Staff concludes that the program outlined above is adequate.

6.2.2 Operational Effluent Monitoring

With some exceptions, the Applicant's Environmental Report gives no details of its nonradiological effluent monitoring program. The following sections, therefore, describe monitoring which should be included in any program carried out by the Applicant.

a. Chlorine

Of particular importance is the monitoring of residual chlorine in the cooling tower blowdown. The amperometric method is among the most accurate for the determination of free and/or combined available chlorine, and is not subject to the errors of the more common orthotolidine method.[9] Dr. W. A. Brungs, of the U.S. Environmental Protection Agency, has stated that one of the most common causes of environmental problems due to chlorine results from a much greater use of chlorine than was intended because of imprecise analytical results.[10] Portable field equipment is available for this method, and should be used by the Applicant in the monitoring program, unless the Applicant can show that an alternate method is as accurate and as sensitive.

Because of the harmful effects of free and combined chlorine on aquatic biota[10,11,12] monitoring of residual chlorine should be carried out before effluents are mixed with the Cedar River. The Applicant will ~~be~~ required to monitor total residual and free residual chlorine at the end of the discharge canal, immediately before outfall into the Cedar River, which will indicate the concentrations actually being discharged to the river.

Ideally, the concentration of total (free and combined) residual chlorine at the point of discharge to the river, should not exceed 0.1 ppm. However, given the characteristics of the Cedar River (specifically the ammonia levels which may exist) and the uncertainty of chlorine control techniques, it is anticipated that control of the blowdown effluent to less than 0.1 mg/l total residual chlorine may not be possible during the initial phases of plant operation. Total residual chlorine concentrations in the blowdown greater than 0.1 mg/l for two hours per day but limited to a maximum of 0.5 mg/l will be permitted, providing the Applicant meets the following requirements:

(a) defines the area of the river in which residual chlorine is detectable.

(b) develops a program to monitor for effects of chlorine on fish and other aquatic organisms. Such a program should include methods (e.g., live basket techniques) for detection of gross injury to fish, such as mortality, erratic movements, loss of protective slime covering, and bleeding from the base of pectoral fins.[11] Studies to detecc subtle effects such as elimination or reduction of number of eggs produced per spawning, and increased susceptibility of fry predation are more difficult to carry out, but are necessary for a thorough study. Effects on benthos, zooplankton, and photoplankton productivity should also be included.

b. Chemicals other than Chlorine

The Iowa Water Pollution Control Commission has established criteria for specific chemical constitutents in Iowa surface waters.[13] The Applicant's preoperational Cedar River water analysis program (see Section 6.1), if continued throughout the plant's operational period, should provide adequate chemical effluent monitoring.

c. Cooling Tower Drift

The Applicant states that salt deposition from cooling towers on the land, ground water, vegetation, animals and property, will be measured by the terrestrial monitoring program, and that action will be taken "before any effects are significant."[14] Further details on monitoring for cooling tower drift effects are discussed in Section 6.2.3.b.

The Applicant has established a weather station at the plant site, but plans no monitoring of moisture from cooling tower plumes. Adverse effects from icing are not expected so that no monitoring appears to be necessary.

d. Thermal Effluent

The Applicant's Cedar River monitoring program calls for temperature measurements at four sampling sites (Fig. 2.15) at a frequency of twice per month. Continuous automatic recording of temperature will be made on a strip chart recorder located in the intake structure, and hourly, daily, and monthly records will be available on computer printout of both the intake and blowdown water temperature. During the first year the Applicant will make in-river temperature measurements, during representative flow conditions, to verify the thermal plume calculations. The results will be made available to the Staff for analysis. Additional measurements may be required by the Staff during later years to encompass the full range of flow conditions expected to be encountered.

e. Sanitary Waste Effluent

Since the Iowa Department of Health is not requiring routine chlorination of the sanitary waste effluent from the DAEC, the Applicant will include monitoring for fecal coliform in the present sewage effluent monitoring program. The Applicant's river sampling program does test for fecal coliform counts (twice monthly) downstream of the plant, but the river water is apt to be polluted from other sources which would mask the plant effluent. Fecal coliforms will be monitored in the sewage effluent on the same bimonthly frequency as they are monitored in the river.

6.2.3 Operational Environmental Monitoring

a. Aquatic

The Applicant plans to continue the preoperational monitoring program (see Section 6.2.1) of the Cedar River after plant startup.[15] Sampling sites, parameters, and methods used in the operational monitoring program may be modified as experience and data indicates.

The following additional procedures should be included in the operational monitoring program:

i. Determination (once a day) of the number of fish found in the trash collection basket, and the data sent monthly to the Applicant's consultant for its Cedar River Ecological Monitoring Program. In addition, quarterly inventory of species and number of all zoological specimens in the collection basket on a given day. For fish species, measurements of length should be taken.

ii. Determination (once a month) of species and biomass of biota entrained in the intake water after passing the traveling screens and before entering the pump house. This determination can be dispensed with after 2 years of operation if the results show that the routine Cedar River sampling program gives similar results.

iii. More intensive and systematic observations of fish behavior and condition than is stated in the preoperational program, both upstream and downstream from the plant to a distance of 8 miles (i.e., immediately upstream of Cedar Rapids). In addition to numbers of dead fish other evidence of injury to fish should be noted, as well as evidence of normal behavior and condition.[11]

iv. Establishment of "control" areas in the Cedar River, upstream from the plant, in addition to sampling Site 1, (Fig. 2.15). It will often be difficult, if not impossible, to detect subtle changes in Cedar River biota attributable to plant operation, i.e., to separate plant-effected changes from "normal" biological changes. Because of this, it is often meaningless to treat a "before" and "after" set of data from a particular sampling site as evidence of effects of plant operation. It will be necessary, therefore, to establish "control" areas upstream of the plant along with areas downstream from the plant (Sites 3 and 4, Fig. 6.2). Changes in the biota of the "control" areas can then be compared with changes in biota downstream of the plant, provided that similar river environments (riffle, pool, or run) are used in both cases.[16]

b. Terrestrial

The Applicant's preoperational terrestrial ecology program (see Section 6.2.1) will be repeated two years after plant startup. Depending upon the findings it may be desirable to repeat the study periodically. Spring and late summer surveys of herbaceous vegetation should be included during each study. The Applicant also states that salt deposition from cooling tower drift will be measured by the terrestrial monitoring program,[14] but does not describe the methods to be used. It is therefore recommended that monthly visual inspections be made of vegetation on and around the site, in the directions of the prevailing winds, and at the three closest park areas (Wickiup, Palo Marsh, Lewis Preserve). If symptoms of salt damage are apparent, samples of affected and unaffected individuals of the same plant species should be photographed, sampled, and the unwashed samples analyzed chemically for total salts. A high salt content of affected vegetation samples compared to unaffected samples would indicate salt damage. (Necrotic areas on foliage are sometimes difficult to diagnose simply by visual inspection as to whether the damage was caused by salt burn, some mineral deficiency or toxicity, or certain plant pathogens.) If salt damage is indicated, efforts to reduce cooling tower drift should be initiated.

Although salt deposition on soil will undoubtedly occur, it will be difficult to distinguish between salt deposition from cooling tower drift and that from other sources such as rainfall, irrigation, fertilization, windblown deposits, etc. For this reason, soil sampling for the purpose of monitoring salt deposition from cooling tower drift will very likely be meaningless except in extreme cases.

Changes in the species composition of the vegetative community after an extended period of time, if detected by the operational monitoring program, should be interpreted with the possibility in mind that micronutrients added to the soil in drift may be a causative factor.

References

1. Duane Arnold Energy Center, Final Safety Analysis Report, Docket 50-331.

2. "Cedar River Baseline Ecological Study, Annual Report, April 1971-April 1972," Iowa Electric Light and Power Company.

3. Letter from Dr. D. B. McDonald, Limnologist, The University of Iowa, Iowa City, July 12, 1972.

4. APHA, AWWA, WPCF, "Standard Methods for the Examination of Water and Wastewater," 13th Ed., 1971.

5. "Pesticide Analytical Manual," Vol. I, U.S. Department of Health, Education and Welfare, Food and Drug Administration, 1968.

6. "Terrestrial Fauna and Terrestrial Vegetation Analysis Study Plans, DAEC Environs." Supplied by K. A. Meyer, Iowa Electric Light and Power Company, July 24, 1972.

7. D. Niemann and D. B. McDonald, "An Ecological Study of the Terrestrial Plant Communities in the Vicinity of the DAEC," Iowa Electric Light and Power Co., 1972.

8. J. T. Curtis, "The Vegetation of Wisconsin," Univ. of Wisconsin Press, Madison, Wis., 1959.

9. H. C. Marks, "Residual Chlorine Analysis in Water and Waste Water," Chapter 22 in Water and Water Pollution Handbook, Volume 3, L. L. Ciaccio, Ed., Marcel Dekker, Inc. New York, 1972.

10. W. A. Brungs, "Literature Review of the Effects of Residual Chlorine on Aquatic Life," U.S. Environmental Protection Agency, National Water Quality Laboratory (Draft), 1972.

11. J. A. Zillich, "Toxicity of Combined Chlorine Residuals to Fresh-water Fish," J. Water Pollution Control Fed. 44(2):212-220.

12. J. Truchan, Personal communications (printed reports of experiments carried out by the Water Quality Appraisal Section) Michigan Water Resources Commission, 1972.

13. "Water Quality Criteria and Plan for Implementation and Enforcement for the Surface Waters of Iowa," Iowa Water Pollution Control Commission, State Dept. of Health, Des Moines, Iowa, 1970.

14. "Environmental Report on the Duane Arnold Energy Center," Amendment 1, Iowa Electric Light and Power Co., 1972.

15. "Environmental Report of the Duane Arnold Energy Center," Iowa Electric Light and Power Co., Nov. 1971.

16. D. King, "Sampling in Natural Waters and Water Effluent," in Water and Water Pollution Handbook, Vol. 2, L. L. Ciaccio, Ed., Marcel Dekker Inc., N.Y., 1971.

17. F. N. Collins and D. B. McDonald, "Terrestrial Fauna Determination, Duane Arnold Energy Center, Site Environs", unpublished preliminary report for Iowa Electric Light and Power Co., October 25, 1972.

7. ENVIRONMENTAL EFFECT OF ACCIDENTS

7.1 PLANT ACCIDENTS

Protection against the occurrence of postulated design basis accidents in the Duane Arnold Energy Center is provided through correct design, manufacture, operation and testing, and the continued quality assurance program used to establish the necessary high degree of integrity of the reactor primary system. These aspects were considered in the Commission's Safety Evaluation dated February 13, 1970 on the issuance of a construction permit and will be further considered in the Commission's Safety Evaluation on the issuance of an operating license. Off-design conditions that may occur are limited by protection systems which place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, even though unlikely; and engineered safety features are installed to mitigate the consequences of these postulated events.

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

The Commission issued guidance[1] to the Applicants requiring the consideration of a spectrum of accidents with assumptions as realistic as the state of knowledge permits. The Applicant's response was contained in the revised "Environmental Report" submitted by the Iowa Electric Light and Power Company dated November 1971.

The Applicant's analysis has been evaluated using the standard accidents described in the proposed annex[2] to Appendix D to 10 CFR Part 50. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious have been identified by the Commission. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate, and those on the low potential consequence end have a higher occurrence rate. The examples shown in Table 7.1 are selected by the Applicant for these accidents and are reasonably

TABLE 7.1 CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	AEC Description	Applicant's Examples
1	Trivial incidents	Not considered
2	Small releases outside containment	Reactor coolant leaks outside Primary Containment or Reactor Building
3	Radwaste system failures	Any single equipment failure or any single operator error
4	Fission products released to primary system (BWR)	Fuel failures during transients outside the normal range of plant variables but within expected range of protective equipment and other parameter operation
5	Fission products released to primary and secondary systems (PWR)	Primary coolant loop to auxiliary cooling system secondary side of heat exchanger leak
6	Refueling accident	Dropping of fuel assembly on reactor core, spent fuel rack or against pool boundary
7	Spent fuel handling accident	Dropping of spent fuel shipping cask in pool or outside pool Transportation incident involving spent and new fuel Shipment on site but outside PC or RB
8	Accident initiation events considered in design basis evaluation in the SAR	a. Reactivity transient. b. Loss of reactor coolant inside or outside primary containment.
9	Hypothetical sequence of failures more severe than Class 8	Not considered

homogeneous in terms of probability within each class. Certain assumptions made by the Applicant, such as the assumption of an iodine partition factor in the suppression pool during a loss-of-coolant accident, in the Staff's view are optimistic; but the use of alternative assumptions does not significantly affect the overall environmental risks.

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

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

The information given in Table 7.2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an individual assumed to be standing at the site boundary to concentrations of radioactive materials which were

TABLE 7.2 Summary of Radiological Consequences of Postulated Accidents*

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary**	Estimated Dose to Population within 50-mile Radius, man-rem
1.0	Trivial incidents	†	†
2.0	Small releases outside containment	†	†
3.0	Radwaste system failures		
3.1	Equipment leakage or malfunction	0.22	6.6
3.2	Release of waste gas storage tank contents	0.86	26
3.3	Release of liquid waste storage tank contents	<0.001	<0.1
4.0	Fission products to primary system (BWR)		
4.1	Fuel cladding defects	†	†
4.2	Off-design transients that induce fuel failure above those expected	0.009	0.68
5.0	Fission products to primary and secondary systems (PWR)	N.A.	N.A.
6.0	Refueling accidents		
6.1	Fuel assembly drop into core	<0.001	<0.1
6.2	Heavy object drop onto fuel in core	0.002	0.41
7.0	Spent fuel handling accident		
7.1	Fuel assembly drop in fuel storage pool	<0.001	<0.1
7.2	Heavy object drop onto fuel rack	<0.001	0.17
7.3	Fuel cask drop	0.32	10

Continued

TABLE 7.2 (continued)

Class	Event	Estimated Fraction of 10 CFR Part 20 Limit at Site Boundary**	Estimated Dose to Population within 50-mile radius, man-rem
8.0	Accident initiation events considered in design basis evaluation in the safety analysis report		
8.1	Loss-of-coolant accidents inside containment		
	Small break	<0.001	<0.1
	Large break	0.001	3.7
8.1(a)	Break in instrument line from primary system that penetrates the containment	<0.001	<0.1
8.2(a)	Rod ejection accident (PWR)	N.A.	N.A.
8.2(b)	Rod drop accident (BWR)	0.01	0.81
8.3(a)	Steamline break PWR's outside containment)	N.A.	N.A.
8.3(b)	Steamline breaks (BWR)		
	Small break	0.008	0.24
	Large break	0.038	1.2

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

**Represents the calculated whole body dose as a fraction of 500 mrem (or the equivalent dose to an organ).

†These releases will be comparable to the design objective indicated in the proposed Appendix I to 10 CFR Part 50 for routine effluents (i.e., 5 mrem/yr to an individual from either gaseous or liquid effluents).

within the Maximum Permissible Concentrations (MPC) listed in Table II of 10 CFR Part 20. Table 7.2 also shows that the estimated exposure of the population within 50 miles of the plant from each postulated accident would be much smaller than that received from naturally occurring radioactivity. The exposure from naturally occurring radioactivity corresponds to approximately 960 man-rem/year within five miles and approximately 128,000 man-rem/year within 50 miles of the plant. These estimates are based on a natural background level of 0.135 rem/year. When considered with the probability of occurrence, the annual potential radiation exposure of the population from all the postulated accidents is an even smaller fraction of naturally occurring background and, in fact, is well within naturally occurring variations in the natural background. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents at the Duane Arnold Energy Center are exceedingly small and need not be considered further.

7.2 TRANSPORTATION ACCIDENTS

Exposures Resulting from Postulated Accidents

Based on recent accident statistics,[3] a shipment of fuel or waste may be expected to be involved in an accident about once in a total of 750,000 shipment-miles. The staff has estimated that only about 1 in 10 of those accidents which involve Type A packages or 1 in 100 of those involving Type B packages might result in any leakage of radioactive material. In case of an accident, procedures which carriers are required[4] to follow will reduce the consequences of an accident in many cases. The procedures include segregation of damaged and leaking packages from people, and notification of the shipper and the Department of Transportation. Radiological assistance teams are available through an inter-Governmental program to provide equipped and trained personnel. These teams, dispatched in response to calls for emergency assistance, can mitigate the consequences of an accident.

7.2.1 New Fuel

Under accident conditions other than accidental criticality, the pelletized form of the nuclear fuel, its encapsulation, and the low specific activity of the fuel, limit the radiological impact on the environment to negligible levels.

The packaging is designed to prevent criticality under normal and severe accident conditions. To release a number of fuel assemblies under conditions that could lead to accidental criticality would require severe damage or destruction of more than one package, which is unlikely to happen in other than an extremely severe accident.

The probability that an accident could occur under conditions that could result in accidental criticality is extremely remote. If criticality were to occur in transport, persons within a radius of about 100 feet from the accident might receive a serious exposure but beyond that distance, no detectable radiation effects would be likely. Persons within a few feet of the accident could receive fatal or near-fatal exposures unless shielded by intervening material. Although there would be no nuclear explosion, heat generated in the reaction would probably separate the fuel elements so that the reaction would stop. The reaction would not be expected to continue for more than a few seconds and normally would not recur. Residual radiation levels due to induced radioactivity in the fuel elements might reach a few roentgens per hour at 3 feet. There would be very little dispersion of radioactive material.

7.2.2 Irradiated Fuel

Effects on the environment from accidental releases of radioactive materials during shipment of irradiated fuel have been estimated for the situation where contaminated coolant is released and the situation where gases and coolant are released.

(a) Leakage of contaminated coolant resulting from improper closing of the cask is possible as a result of human error, even though the shipper is required to follow specific procedures which include tests and examination of the closed container prior to each shipment. Such an accident is highly unlikely during the 40-year life of the plant.

Leakage of liquid at a rate of 0.001 cc per second or about 80 drops/hour is about the smallest amount of leakage that can be detected by visual observation of a large container. If undetected leakage of contaminated liquid coolant were to occur, the amount would be so small that the individual exposure would not exceed a few mrem and only a very few people would receive such exposures.

(b) Release of gases and coolant is an extremely remote possibility. In the improbable event that a cask is involved in an extremely severe accident such that the cask containment is breached and the cladding of the fuel assemblies penetrated, some of the coolant and some of the noble gases might be released from the cask.

In such an accident, the amount of radioactive material released would be limited to the available fraction of the noble gases in the void spaces in the fuel pins and some fraction of the low level contamination in the coolant. Persons would not be expected to remain near the accident due to the severe conditions which would be involved, including a major fire. If releases occurred, they would be expected to take place in a short period of time. Only a limited area would be affected. Persons in the downwind region and within 100 feet or so of the accident might receive doses as high as a few hundred millirem. Under average weather conditions, a few hundred square feet might be contaminated to the extent that it would require decontamination (that is, Range I contamination levels) according to the standards[5] of the Environmental Protection Agency.

7.2.3 Solid Radioactive Wastes

Provisions in transportation regulations are designed to assure maximum containment of wastes and minimum contamination from wastes in accidents. Shipments of wastes are likely to be made by exclusive-use truck, which means that the vehicle is loaded by the consignor and unloaded by the consignee. In most cases the shipments are made in closed vehicles. Since the shipment is exclusive use, the shipper can provide specific instructions to carrier personnel regarding procedures in case of accidents.

Commission and Department of Transportation regulations provide specific instructions to carriers for segregating damaged and leaking packages, keeping people away from the scene of an accident, and notification of the shipper and the Department of Transportation.

Each package containing radioactive material is labeled with the radioactive material label, a distinctive label which identifies the material and provides a visual warning. The regulations specify placarding on the outside of the truck for identifying the presence of shipments of large quantities of radioactive materials. An extensive program has been carried out over the past several years by which emergency personnel, including police departments, fire departments, and civil defense offices, have been advised of procedures to follow in accidents involving radioactive materials and other hazardous materials. Specific instructions with regard to radioactive materials have been provided through the AEC's efforts as well as those of carrier organizations such as the Bureau of Explosives of the Association of American Railroads, the American Trucking Association, and the Air Transport Association. An intergovernmental program to provide personnel and equipment is available at the request of persons (truck drivers, police, bystanders or other persons) at the scene of such accidents.

The waste itself is confined either in the form of solidified materials, such as concrete, or compacted solids. The low-level of radioactivity in the waste together with the form of the waste, serves to minimize the contamination in the unlikely event that there is a spill in an accident.

The procedures prescribed by existing applicable regulations, together with the other precautions discussed above are considered by the Commission to be adequate to mitigate the effects of infrequent accidents which might occur involving shipments of wastes from the Station.

7.2.4 Severity of Postulated Transportation Accidents

The events postulated in this analysis are unlikely but possible. More severe accidents than those analyzed can be postulated and their consequences could be severe. Quality assurance for design, manufacture, and use of the packages, continued surveillance and testing of packages and transport conditions, and conservative design of packages ensure that the probability of accidents of this latter potential is sufficiently small that the environmental risk is extremely low. For those reasons, more severe accidents have not been included in the analysis.

References

1. "Scope of Applicants' Environmental Reports with Respect to Transportation, Transmission Lines, and Accidents," U. S. Atomic Energy Commission, September 1, 1971.

2. Federal Register, Vol. 36, No. 231-December 1, 1971-Annex to Appendix D, 10 CFR Part 50, "Discussion of Accidents in Applicants' Environmental Reports: Assumptions."

3. "1969 Accidents of Large Motor Carriers of Property," Federal Highway Administration, Dec. 1970; "Summary and Analysis of Accidents on Railroads in the U. S." Federal Railroad Administration Bulletin No. 138, 1969; "Statistical Summary of Casualties to Commercial Vessels," U. S. Coast Guard, Dec. 1970.

4. 49 CFR Sections 171.15, 174.566 and 177.861.

5. "Background Material for the Development of Radiation Protectio Standards; Protective Action Guides for Strontium 89, Strontium and Cesium 137," Federal Radiation Council Report No. 7, May 1965.

8. EVALUATION OF PROPOSED ACTION

8.1 NEED FOR POWER

The Duane Arnold Energy Center is being built by the Iowa Electric Light and Power Company (IELP), the Central Iowa Power Cooperative (CIPCO), and the Cornbelt Power Cooperative (Cornbelt), jointly referred to as the Applicant. IELP and CIPCO have summer peak loads while Cornbelt has a winter peak load. The total demand of the three utilities is summer peaked. All three of these utilities are members of the Iowa Power Pool, which is a part of the Mid-America Power Planners (MAPP) region.

The DAEC is being built as a cooperative project to realize the economy inherent in a large plant. Even as a joint effort, the plant is quite large in comparison to the power demands of the three cooperating utilities. As shown in Table 8.1, the plant will supply more than 50% of the Applicant's anticipated peak summer load in 1974.

The addition of a plant of this size to the relatively small system represented by the Applicant's power Pool necessarily will result in a sharp increase in the total power reserve when the plant goes on-line, resulting in a reserve capacity of 37% in the summer of 1974 (Table 8.1). The Mid-Continent Area Reliability Coordination Agreement (MARCA), to which the Applicant companies belong, recommends a reserve capacity of 12% at present, increasing to 14-15% in 1974.[1] However, if the plant is not operating in the summer of 1974, there will be a projected power deficiency of 19%, as shown in Table 8.1. The short-term need for additional power by the Applicant is evident from the power deficiencies shown in Table 8.1 without the DAEC installed.

The power to be made available by the installation of the DAEC is also considered by the reliability planning group, MARCA, to be a necessary part of the generating capacity of the larger Iowa Pool to which the Applicant belongs. The power requirements and generating capabilities of the Iowa Pool are shown in Table 8.2, with and without the DAEC installed. With the DAEC installed the projected power reserve in the near future (1974-1976) is in an appropriate range in regard to the MARCA recommendations for reserves. Without the DAEC installed the projected reserves are very low or nonexistent for the entire Iowa Pool. It is evident from the data shown in Tables 8.1 and 8.2 that if the DAEC is not installed by the summer of 1974 that the Applicant will have an appreciable power deficit and that the Iowa Pool will have very little reserve margin. Given the increasing power demands of other power Pools

TABLE 8.1. Applicant's Power Requirements, Capacity (Summer Data, MW)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
					With DAEC Installed					
Net generating capacity	721	721	720	750	1281	1298	1297	1296	1295	1294
Capacity additions	0	0	30	531	17	-1	-1	-1	-1	0
Total capacity	721	721	750	1281	1298	1297	1296	1295	1294	1294
Net purchases	106	211	230	10	10	10	10	10	10	10
Total capacity	827	932	980	1291	1308	1307	1306	1305	1304	1304
Peak demand	679	791	852	943	1021	1100	1189	1281	1386	1495
Reserve	148	141	128	348	287	207	117	24	-82	-191
Reserve margin, %	22	18	15	37	28	19	10	2	-6	-13
					Without DAEC Installed					
Total capacity	827	932	980	760	758	757	756	755	754	754
Peak demand	679	791	852	943	1021	1100	1189	1281	1386	1495
Reserve	148	141	128	-183	-263	-343	-433	-526	-632	-741
Reserve margin, %	22	18	15	-19	-26	-31	-36	-41	-46	-50

TABLE 8.2. Iowa Power Pool Requirements and Capacity (Summer Data, MW)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
With DAEC Installed										
Net generating capacity	2638	2638	3347	3376	3906	3924	4443	4442	4391	4390
Capacity additions	0	709	29	530	18	519	-1	-51	-1	0
Total capacity	2638	3347	3376	3906	3924	4443	4442	4391	4390	4390
Net purchases	605	382	904	436	531	427	423	420	416	416
Total capacity	3243	3729	4280	4342	4455	4870	4865	4811	4806	4806
Peak demand	2754	3070	3320	3610	3896	4186	4501	4841	5208	5599
Reserve	489	659	960	732	559	684	364	-30	-402	-793
Reserve margin, %	18	21	29	20	14	16	8	-0.6	-8	-14
Without DAEC Installed										
Total capacity	3243	3729	4280	3811	3905	4320	4315	4261	4256	4256
Peak demand	2754	3070	3320	3610	3896	4186	4501	4841	5208	5599
Reserve	489	659	960	201	9	134	-186	-580	-952	-1343
Reserve margin, %	18	21	29	6	0	3	-4	-12	-18	-24

Derived from data in Ref. 1.

around the Iowa Pool (see Section 9.1), it is possible that there would be no means of purchasing significant amounts of power on a short-term basis during the summer of 1974. The short-term need for power appears to the Staff to be well documented.

The long-range power needs in the Iowa area can best be seen in Table 8.3, which shows the projected power requirements and power generating capacity of the Iowa Pool to 1980. Table 8.3 differs from Table 8.2 in that generator additions planned for the Iowa Pool are included. In Table 8.2 only those power additions, such as the DAEC, which are firmly committed as of April 1972 are given. The MARCA figures for future power needs assume an approximate 7.5% yearly increase in power demand. The Applicant assumes an 8% yearly increase in power demand for that portion of the Iowa Pool which it serves. These figures are in line with estimates of increases in power demand made by other Applicants and other power planning groups. They do appear somewhat high given the slow increase in overall population of Iowa (2.4% increase from 1960 to 1970);[2] however, Iowa is experiencing a relatively fast increase in urbanization and industrialization (10.5% increase in urban population 1960 to 1970)[2] which will result in increasing power demand per capita. To meet the projected power demands the Iowa Pool plans to install an additional 3248 MWe between 1974 and 1980. Even if the power demand increases at a somewhat slower rate than projected, the projected power demand increases are of such a magnitude to indicate that the 550 MWe from the DAEC will be needed in the longer range, even during nonpeak-demand periods. Thus, the Staff considers that the power the DAEC will generate is needed.

8.2 ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION

Construction and operation of the DAEC will result in the withdrawal of about 500 acres of farmland from productive use. This is, however, a small fraction of the total farmland in Linn County (<0.2%) and will not result in a significant drop in crop yield from the area. The negative effect on the economy from the loss of productive farmland will be more than compensated for by the positive economic stimulus provided by the plant.

Construction of transmission lines associated with the DAEC will require the use of 939 acres of private land, about 90% of which is cultivated or pasture land. The Applicant, however, will permit agricultural uses of the land to continue so that only a very small fraction of the 939 acres will be excluded from productive use.[3]

TABLE 8.3. Iowa Power Pool Requirements and Capacity (Summer Data, MW) Projected Generator Additions Included, DAEC Installed

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Net generating capacity	2638	2638	3347	3376	4006	4024	4573	4772	5196	5645
Capacity additions	0	709	29	630	18	549	199	424	449	826
Total capacity	2638	3347	3376	4006	4024	4573	4772	5196	5645	6471
Net purchases	605	382	904	436	531	427	423	420	416	416
Total capacity	3243	3729	4280	4442	4555	5000	5195	5616	6061	6887
Peak demand	2754	3070	3320	3610	3896	4186	4501	4841	5208	5599
Reserve	489	659	960	832	659	814	694	775	853	1288
Reserve margin, %	18	21	29	23	17	19	15	16	16	23

Derived from data of Ref. 1.

During construction a work force of up to 1500 persons has been required. Employment of these persons has come at a time of increasing unemployment in other segments of the economy[3] in the area and has helped maintain economic growth. The construction workers have been largely from the area so the plant construction has not resulted in a large influx of people. The total work force is only about 1% of the population in the Cedar-Rapids, Marion area and should not have an appreciable effect on community services required.

A total work force of about 70 persons will be employed during plant operation. This is a very small number in comparison to the area work force and will have only a small effect on the economics of the area. Likewise, plant operation will not result in an appreciable increase in community services needed. Property taxes during the plant lifetime will, however, increase the tax base for the local communities (see Section 5.1).

Operation of the cooling towers will result in a noticeable increase of the noise level at the nearest dwellings. At the nearest farm house the occupants will be "transferred" from a rural environment to an urban one. This may prove to be annoying to those involved and require remedial action to be taken (Section 10.1.3).

8.3 ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

8.3.1 Land Use

The land being used for the construction and operation of the DAEC was primarily agricultural land, and impact on wildlife habitat will be small. In those limited areas where transmission lines will be built on nonagricultural land, care is being exercised to minimize disturbance of the land. No major changes in the terrestrial ecosystem are expected to result from the use of land for plant operation.

8.3.2 Air Use

During normal operation of the DAEC, water vapor will be the only non-radioactive gaseous emission of sufficient magnitude to cause detectable effects. During certain emergency periods there will be a release of some combustion products from the emergency diesel units, but these will be small in quantity and low in frequency of emittance. (Section 3.7.2)

Operation of the cooling towers will result in the addition of water vapor and water droplets to the atmosphere. Salt deposition from the tower drift (Section 5.3) at the site boundary will be equal to or less than that from natural precipitation and will drop off rapidly with distance from the plant. Addition of water vapor to the atmosphere may result in a very minor increase in fogging in the nearest community and on the nearest roads. No other deleterious effects are anticipated from the cooling tower plume.

8.3.3 Water Use

Plant operation will involve the use of both river water and ground water. Several factors will be involved in the plant's use of water which may have adverse environmental effects. These factors and possible adverse effects are discussed below.

a. Construction Changes

There will be a temporary disturbance of the Cedar River bank and bottom during construction of the DAEC water intake and discharge structures and the barrier wall. There will be localized temporary increases in river turbidity due to dredging activities. The disturbances will be temporary and the river and river ecosystems are expected to restabilize with no lasting adverse changes.

b. Discharges of Chemicals during Construction

There will be temporary discharges of chemicals used for cleaning plant components (Section 4.3) during plant construction. The resulting chemical increases in the Cedar River after mixing due to these discharges will be within normal fluctuations, and are not expected to result in any detectable long-range change in the river ecosystem.

c. Discharge of Sewage during Construction and Operation

There will be sanitary waste discharges to the Cedar River during construction and operation of the Plant. The sewage will be of adequate quality in regards to chemical content, solid content, and oxygen demand not to adversely affect water uses. The sewage will not be chlorinated, but dilution provided by the Cedar River will be adequate to prevent bacterial content from adversely affecting present downstream users.

d. Discharge of Chemicals during Operation

Chlorine and sulfuric acid will be added to the cooling water to control slime and scale in the condensers. The addition of sulfuric acid will result in the addition of sulfates to the Cedar River (Section 3.6).

The sulfates will be in a soluble form with a very low toxicity. No detectable changes in the river ecosystem are anticipated from the addition of sulfuric acid to the cooling tower water.

Chlorine additions may result in locally high levels of total residual chlorine (up to 0.5 ppm before mixing) discharged to the Cedar River. Due to the high concentrations of ammonia-containing compounds in the Cedar River, the residual chlorine will be largely in the form of chloramines. The levels of total residual chlorine to be discharged may prove toxic to biota in the river in the vicinity of the discharge. In winter particularly, fish attracted to the warm waters of the plume area will be subjected to chlorine exposure.

e. Discharge of Heat

Heat added to the river in cooling tower blowdown will result in a maximum elevation of river temperature at the outfall of 40°F, during worst-case conditions (minimum river flow, minimum river temperature). During winter, the river temperature will be raised 2°F over a surface area of less than 1 acre. After mixing, the maximum temperature increase will be 1.1°F, resulting in a decrease of not more than 0.5 ppm dissolved oxygen. Premature spawning of white suckers and sauger due to the warm waters of the discharge area may result in loss of some fry. However, these fish are very scarce in this region (Section 2.7).

f. Water Withdrawal from the Cedar River

The maximum withdrawal rate from the Cedar River will be 11,000 gpm (24.5 cfs), 4,000 gpm of which will be returned to the river in the blowdown, resulting in a net loss of river water of 7,000 gpm (15.6 cfs). During normal river flows, this will be about 0.5% of the river flow. For river flows of less than 500 cfs water will be added to the river from the Pleasant Creek Reservoir equal to the total consumptive use. Consumptive uses of river water, therefore, will not exceed about 3.1% of total river flow (Section 5.2).

Withdrawal of river water will be accompanied by some entrainment of organisms into the cooling system. The closed-cycle operation will probably result in almost complete mortality of plankton and fry entrained in the cooling water, due to mechanical, thermal, and chemical stress. However, during normal river flow less than 1% of the total river water will be diverted and in low flow periods less than 10% of the river flow will be diverted.

Fish kills from impingement on the intake screens are expected to be minimal because of the low (<0.75 fps) intake velocity.

g. Well Water Withdrawal

During Plant operation up to 1500 gpm of well water will be withdrawn from the Silurian-Devonian aquifer. This water withdrawal rate could affect a large number of wells in the surrounding area.

8.3.4 Radioactive Releases and Radiological Impact

Radioactive releases from the plant will be less than the normal variation of the natural radioactive background. The whole-body dose to nearby residents will be less than two percent of natural background. The cumulative population dose within 50 miles of the plant will be 27 man-rem per year. Deleterious effects in humans or other biota are not anticipated.

8.4 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The local short-term uses of the environment include those required to construct and operate the facility (during which the DAEC will therefore "use" the local environment).

Various environmental and radiological monitoring programs will be used to detect and evaluate environmental impacts that might lead to long-term effects so that timely corrective action can be taken. The monitoring programs should ensure that the local short-term uses of the plant will not jeopardize the long-term productivity of the environment.

Prior to construction of the DAEC, most of the site was used for agriculture. Except for the plant buildings and grounds, much of this land could be returned to agriculture soon after startup, if there were a sufficient need. The land bordering the river had little recreational use before construction of the plant, and this aspect has not been changed. When the DAEC is shut down it will be feasible to return the land to its former use, though it is doubtful if complete restoration of the land will be considered to represent the best economic and environmental balance.

No specific plan for the decommissioning of the DAEC has been developed. This is consistent with the Commission's current regulations which contemplate detailed consideration of decommissioning near the end of a reactor's useful life. The licensee initiates such consideration by preparing a proposed decommissioning plan which is submitted to the AEC for review. The licensee will be required to comply with Commission regulations then in effect and decommissioning of the facility may not commence without authorization from the AEC.

To date, experience with decommissioning of civilian nuclear power reactors is limited to six facilities which have been shut down or dismantled: Hallam Nuclear Power Facility, Carolina Virginia Tube Reactor (CVTR), Boi g Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor, and the Elk River Reactor.

There are several alternatives which can be and have been used in the decommissioning of reactors: (1) Remove the fuel (possibly followed by decontamination procedures); seal and cap the pipes; and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. (2) In addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. (3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill all cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor. Alternative decommissioning procedures (1) and (2) would require long-term surveillance of the reactor site. After a final check to assure that all reactor-produced radioactivity has been removed, alternative (3) would not require any subsequent surveillance. Possible effects of erosion or flooding will be included in these considerations.

The Staff concludes that the benefits derived from the DAEC in serving the electrical needs of the area outweigh the short-term uses of the environment in its vicinity.

8.5 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Numerous resources are involved in construction and operation of a major facility such as the DAEC. These resources include the land upon which the facility is located, the materials and chemicals used to construct and maintain the plant, fuel used to operate the plant, capital and human talent, skill and labor.

Major resources to be committed irreversibly and irretrievably due to the operation of the DAEC are essentially the land (during the life of the plant) and the uranium consumed by the reactor. Only that portion of the nuclear fuel which is burned up or not recovered in reprocessing is irretrievably lost to other uses. This will amount to approximately 22 metric tons of uranium-235 assuming a 40-year life-time for the plant. Most other resources are either left undisturbed, or committed only temporarily as during construction or during the life of the DAEC, and are not irreversibly or irretrievably lost.

Of the land used for plant buildings, it would appear that only a small portion beneath the reactor, control room, radwaste and the turbine-generator buildings would be irreversibly committed. Also, some components of the facility such as large underground concrete foundations and certain equipment are, in essence, irretrievable due to practical aspects of reclamation and/or radioactive decontamination. The degree of dismantlement of the plant, as previously noted, will be determined by the intended future use of the site, which will involve a balance of health and safety considerations, salvage values, and environmental effects.

The use of the environment (air, water, land) by the DAEC does not represent significant irreversible or irretrievable resource commitments, but rather a relatively short-term investment. The biota of the region have been studied, and the probable impact of the plant is presented in Sections 4 and 5. In essence, no significant short- or long-term damage or loss to the biota of the region has occurred or is anticipated.

Should an unanticipated significant detrimental effect to any of the biotic communities appear, the monitoring programs are designed to detect it, and corrective measures would then be taken by the Applicant.

The Staff concludes that the irreversible and irretrievable commitments are appropriate for the benefits gained.

References

1. A Report by MARCA to the Federal Power Commission Pursuant to FPC Docket R-362 Appendix A, April 1, 1972.

2. "1970 Census of Population, Number of Inhabitants, Iowa," U.S. Dept. of Commerce, PC(1)-A17, June, 1971.

3. Letter; R. B. Faxon, Executive Vice President, Cedar Rapids Chamber of Commerce, to J. R. Schlessinger, Oct. 15, 1971. Contained in Appendix F of DAEC Statement in Compliance with Section E, 10 CFR Part 50, Appendix D, Oct. 16, 1971, Docket No. 50-331.

9. ALTERNATIVE ENERGY SOURCES AND SITES

The need for additional power within the service areas of the Applicant and the Iowa Power Pool is discussed in Section 8.1. It is shown there that additional power equal to the 550 MWe expected from the DAEC will be needed to maintain adequate generating reserve from 1974 on. Three alternative sources of power are considered in this section:

1. The purchase of power from other companies.

2. The construction of a nuclear generating plant at a different site.

3. The construction of a nonnuclear plant at the DAEC site.

Full acceptance of any one of these alternatives would imply that the proposed plant should be abandoned. In that event, little of the sunk economic costs (money already spent or irrevocably committed) could be salvaged. The estimated loss if the DAEC were abandoned at year-end 1972 is about $120 million. Similarly, most of the environmental impacts associated with construction (but not operation) of the DAEC are "sunk" because they have already occurred.

9.1 PURCHASE OF POWER

The purchase of power by the Applicant and/or other Iowa Pool members from other power companies would be a reasonable alternative to completion and operation of the DAEC only if (1) sufficiently firm long-term commitments for power could be achieved to allow adequate system reliability and if (2) the vendor companies had no need to construct additional generating plants, since such construction would merely transfer environmental impacts to other localities.

As shown in Section 8.1 (see Tables 8.2 and 8.3) the Iowa Pool, to which the Applicant belongs, has an increasing power demand, requiring the Iowa Pool to purchase large amounts of power and requiring substantial amounts of new power generating capacity to be built in the coming years. The Iowa Pool, therefore, does not represent a source of power for the Applicant which would not require additional generating plants to be built.

The major producers of power within the mid-Continent region are members of either the Mid-Continent Area Reliability Coordination Agreement (MARCA) or the Mid-America Interpool Network (MAIN), fact-gathering and coordinating organizations. As shown in Tables 9.1 and 9.2,[1,2] both MARCA and MAIN members as a group face a continuing need for additional generating capacity comparable to that faced by the Applicant and the Iowa Pool. The projected annual peak-load increa exceed 6.5 percent for both MAIN and MARCA. The individual members of both MARCA and MAIN face the same increasing demand for power. The conclusion is that if the expected generating capacity of the DAEC were replaced by purchases from other power companies within t MARCA or MAIN region, the consequence would be augmented constructi elsewhere or delay of the retirement of obsolete coal-fired plants within the region. Since the environmental impact of either consequence compares with that expected from the DAEC, we conclude that the purchase of power is not a reasonable alternative to the comple and operation of the center.

9.2 ALTERNATIVE SITES

The Applicant's consideration of possible sites, described in Secti of this statement and in Sections 4.2, 8.1, and 8.2 the Applicant's Environmental Report[3] was made in the region served by the Applican system, which covers mainly the central and eastern portion of the with extensions to the northwest and southeast. The load center is the vicinity of Cedar Rapids and the eastern boundary is a major se of the Mississippi River. Detailed evaluation of candidate sites a plants was begun in 1967 by the Applicant with the assistance of Commonwealth Associates, Inc., (CAI), a utility consulting firm base Jackson, Michigan. Environmental factors, alternative fuels, and al native cooling methods were considered, and state agencies were con

Two basic requirements of a site for generating plants are (1) adeq water resources for cooling, and (2) suitable conditions for provis of new transmission lines. Comparison of sites also considered oth environmental and economic factors, including availability. Availa water determined possible cooling means; for example, once-through c ing was considered feasible only on the Mississippi River. The mak water for closed-cycle cooling could be taken from deep wells, but i was considered prudent to locate candidate plants on rivers with a minimum flow adequate to provide makeup.

Consideration of water resources (Section 2.5) led to selection of 24 candidate sites and plants: 15 on the Mississippi River, 8 on th Cedar River, and 1 on the Coralville Reservoir on the Iowa River. These sites are shown on a map (Fig. 9.1). The Mississippi River, because of its large flow and its capacity for heavy barge traffic, offered sites more favorable for transport of Illinois coal and for

TABLE 9.1. Projected MARCA Load and Generating Capacity

Year	Summer Peak Load,* MWe	Increase, %	Generating Capacity, MWe	Increase, %
1972	12,222	-	14,406	-
1973	13,231	8.3	16,864	17.0
1974	14,272	7.9	18,395	9.1
1975	15,364	7.7	18,871	2.6
1976	16,520	7.5	20,581	9.1
1977	17,745	7.4	22,725	10.4
1978	18,980	7.0	24,039	5.8
1979	20,264	6.8	26,038	8.3
1980	21,609	6.6	27,864	7.0
1981	23,040	6.6	30,114	8.1

Derived from Ref. 1.

*Total coincident demand. Derived by reducing peak summer demands of participating power pools within MARCA by 6% to account for diversity.

TABLE 9.2. Projected MAIN Load and Generating Capacity

Year	Summer Peak Load, MWe	Increase, %	Generating Capacity, MWe	Incr
1972	27,535	-	32,712	
1973	29,543	7.3	36,901	12
1974	32,023	8.3	37,151	0
1975	34,514	7.8	39,174	5
1976	37,073	7.3	42,171	7
1977	39,897	7.6	45,723	8
1978	43,449	8.9	49,055	7
1979	46,485	7.0	52,244	6
1980	49,754	7.0	57,584	10
1981	53,209	7.0	59,619	3

Derived from Ref. 2.

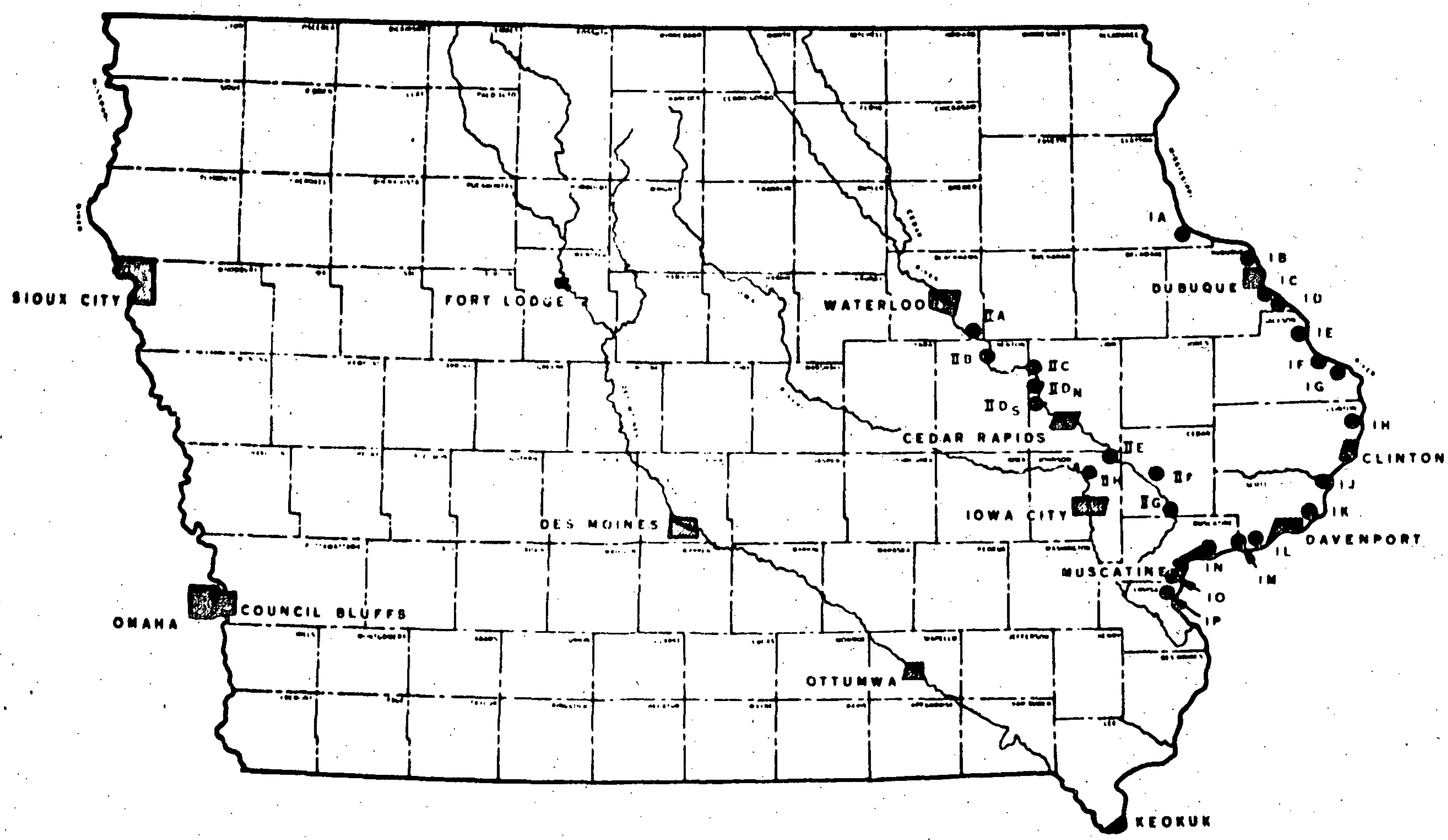

Fig. 9.1. Locations of Sites Surveyed by the Applicant. From Applicant's Environmental Report.

once-through cooling, as compared to the sites on the smaller rivers. Apart from river size, the Applicant's study indicated no environmental features indicating relative disadvantages to any particular site. There is relative uniformity of terrain and meteorology in Iowa, as discussed in previous sections.

Once the Applicant had decided upon a nuclear plant, sites in the Cedar River basin were favored over those on the Mississippi because of the nearness to the load center (close to Cedar Rapids) and the minimum requirement of additional transmission lines. From among these Cedar River sites, the Palo site was selected by the Applicant at the beginning of 1968 because of overall low environmental impact and low costs. In particular, the Palo site was judged favorable by the Applicant for nuclear power-plant construction and operation because of its low transmission-line impact and cost, its low population density, and low land costs.[3]

The Applicant's evaluation of alternative sites did not make as detailed an environmental comparison as it did economic comparisons. However, the Staff judges that the site is suitable and that any further environmental advantages that might have been gained by a more detailed environmental evaluation is now outweighed by the economic penalty and delay which would be involved in reopening the study at the present stage of construction.

9.3 ALTERNATIVE MEANS OF POWER GENERATION

Potential hydroelectric capacity approaching 550 MWe does not exist within the MARCA service area. Natural gas is not available in the area in adequate quantity for large generating stations. For baseload (24 hours per day) operation fuel costs for an oil-fired steam plant would be about double those for a coal-fired plant. The remaining commercially practicable alternative to the proposed nuclear steam-turbine plant is a coal-fired steam-turbine plant. Most present generating plants in the West Central area are of this type.

Two environmental impacts associated with nuclear plants are reduced for coal-fired plants. Because of higher thermodynamic efficiency and because some of the heat passes up the stack with other combustion products, fossil-fuel plants release only about 65 percent as much waste heat to the plant condenser cooling water as do nuclear plants of the same electrical output capacity. Also, although the release of radioactivity from current nuclear plants leads only to minor increments to the natural radiation levels, coal-fired plants release even less and oil-fired plants release virtually none.

Coal-fired plants, however, produce combustion products including dust, sulfur dioxide, and oxides of nitrogen in substantial amounts and these are a significant source of air pollution. The comparative environmental impacts expected for the reference plant and for a coal-fired plant of the same generating capacity are given in Table 9.3. Combustion products are estimated on the basis that the coal-fired plant just meets the Environmental Protection Agency standards for new plants.[4]

The Applicant made the decision in 1968 to build a nuclear rather than a coal plant for this increment of additional generation capacity to meet the growing demand of its Iowa customers. This decision was based principally on economic grounds, especially on the inability to negotiate at that time a long-term contract for coal at a price competitive with the nuclear plant.

If at the approximate time of the final hearings for the DAEC (June 30, 1973) the decision were to be made to abandon the nuclear plant and build a coal-fired one at the same site, nearly the full cost of construction of the nuclear plant would have been incurred, \$209 million,[7] which includes interest during construction, but not core costs nor associated transmission cost. Even if a substantial salvage credit, say \$48 million, were applied to the alternative plant, a penalty of about \$161 million or about 77% of the total capital cost of the reference plant would be associated with the alternative. In addition, higher costs would be incurred for provision of power for the time until the alternative plant is operating. At another site, where the salvage would not be as available, the economic penalty would be even higher.

In order to assess the comparative costs of completing the reference plant or constructing the alternative coal-fired plant, only the costs incurred after the assumed time of decision (June 30, 1973) should be considered. Additional costs that would be incurred after the assumed decision point are labeled incremental costs in Table 9.4.

An alternative (coal) plant could not be operational until about January 1, 1979, assuming a lead time of six years for a fossil plant. Since the DAEC is scheduled to begin commercial operation January 1, 1974, the cost of providing power for five years from other sources should be charged against this alternative. An estimated rate of 8 mills per kilowatt hour is used. However, the postulated combination of five years purchase and 30 years plant life provides power for the 35 years, and credit is given for sale of power for five years after 30 years of reference plant life; this net present worth allowance for loss of generation is entered in Table 9.4.

The estimated economic costs associated with the reference plant and with an alternative coal-fired plant of the same capacity are presented in Table 9.4. Capital costs of coal-fired capacity is estimated at \$240

TABLE 9.3. Comparative Environmental Impacts for Reference and Coal-Fired Plants

Category	Reference: 550-MWe Nuclear Plant	550-MWe Coal-Fired Plant with Cooling Tower
Land use:		
Plant (including cooling towers)	40 acres	Similar to reference
Fuel storage	minor	10 acres
Total plant	100 acres (without exclusion area)	100 acres
Total heat discharged	76×10^9 Btu/day	54×10^9 Btu/day
Releases to air:[a]		
Radioactivity	91 curies/day	small[d]
Dust	none	4.6 tons/day[d]
Sulphur dioxide	none	55 tons/day[d]
Nitrogen oxides	none	32 tons/day[d]
Water evaporated	7.3 million gal/day	4.8 million gal/day[d]
Releases to water:		
Radioactivity		
Tritium	0.05 curies/day	none
Other	0.01 curies/day	none
Chemical		
Chlorine[b]	5 lb/day	3 lb/day
Salts	19,500 lb/day	13,000 lb/day[c]
Fuel:		
Consumed	21 tons/year	1.6 million tons/year
Transported	4 truckloads/year	220 trainloads/year
Wastes	9 truckloads/year	160,000 tons/year
Aesthetic	Inoffensive	Similar to reference plus 10-acre coal pile

[a] Assumes 80% load factor.

[b] Assumes 0.1 mg/liter residual chlorine in blowdown.

[c] Does not include discharge of ash-sluicing effluent.

[d] Based on EPA standards for new plants.[4]

TABLE 9.4. Comparative Economic Costs for Reference and Alternative Plants
(in millions of dollars)

	555-MWe Reference (Nuclear) Plant. First Operation January 1, 1974		555-MWe Coal-Fired Plant. First Operation January 1, 1979	
Construction cost:				
Total		$209		$133
Expenditures as of Jun. 30, 1973 (est.)	$190		0	
Additional expenditures	19		$133	
Salvage allowance	0		48	
Net incremental cost after Jun. 30, 1973	19		85	
Present worth of net incremental cost		19.0		56
Allowance for loss of power, present worth				121
Annual operating cost:				
Fuel	6.5		15.0	
Other	2.7		1.5	
Total	9.2		16.5	
Present worth of capitalized operating cost		96.5		104
Decommissioning allowance	11.75		3	
Present worth, decommissioning		1.0		0.2
Present worth of incremental life-of-plant cost		116.5		291.2

TABLE 9.4 (Contd.)

	555-MWe Reference (Nuclear) Plant. First Operation January 1, 1974	555-MWe Coal-Fired Plant. First Operation January 1, 1979
Annualized equivalent of life-of-plant cost		
Incremental	11.1	27.7

Note: Present worth based on 8.75% interest rate. Life of plant taken at 30 yr at average 80% factor.

per kWe and coal costs at \$0.45 per 10^6 Btu. In order to achieve comparability among costs which would be incurred at different times, all costs are reduced to present worth at the assumed time of first operation, January 1, 1974. The present worth of a future payment is equal to the sum which, drawing interest from the given (present) time at a stated interest rate, would just suffice to meet the payment when due at the future time. The discount rate used is 8.75 percent which is representative of the overall before-Federal-income-tax rate required for payment of interest on bonds and stock dividends by investor-owned power companies. Estimated construction costs for the reference plant are those provided by the Applicant. These figures include interest during construction and no present-worth adjustment need be made. To compute the present worth of the stream of payments for fuel and other operating costs, a life of 30 years is postulated.

The estimated coal costs used in Table 9.4 appear reasonable in relation to estimates published by the Federal Power Commission[5] when inflation and the rapid increase in minehead coal prices during recent years are taken into account. If anything, for the Iowa area the coal costs used are low.[6] The nuclear capital costs are based on current estimates as reported by the Applicant to the AEC. Nuclear fuel costs are close to the estimates made by the Applicant in 1968.

The data in Table 9.4 show <u>incremental costs</u>, present-worth and annualized, more than doubled by abandoning the nuclear plant at this stage and building a coal plant at the same site.

The coal-fired plant would discharge less heat to the Cedar River and less radioactivity to the atmosphere than the reference plant. However, as assessed in Sections 5 and 8, the impacts of these discharges are very small for the reference plant. The Staff judges their effect to be clearly outweighed by the air pollution intrinsic to the coal-fired plant and therefore consider the reference plant to be, on balance, the better with respect to environmental impact. Considering the loss of reliability to the Iowa pool during the five-year delay and the large economic penalty to the Applicant, which is ultimately paid by the public, the reference plant is the preferred alternative.

9.4 SUMMARY

Three alternatives to the completion and operation of the proposed DAEC have been considered. Purchase of power is not a reasonable alternative action because all of the possible vendors of power face the same need for new generating capacity as the Applicant and the Iowa Power Pool and

MARCA. The construction of an equivalent plant at a different site offers no promise of significant environmental gains to balance either the large economic penalty or the threatened delay to a reliable supply of electric power. The most reasonable alternative means of power genera tion, a coal-fired steam plant, would impose more serious environmental costs than the proposed plant as well as a severe economic penalty and a loss of reliability within the Applicant's reliability pools. Therefore, completion and operation of the plant is the recommended action.

References

1. "A Report by MARCA to the Federal Power Commission Pursuant to FPC Docket R-362, Appendix A," April 1, 1972.

2. "MAIN's 1972 Reply to Appendix A of Order No. 383," April 1, 1972.

3. "Environmental Report on the Duane Arnold Energy Center." Revised Edition, Iowa Electric Light and Power Co., Nov. 1971, Docket No. 50-331.

4. Environmental Protection Agency Regulation on Standards of Performance for New Stationary Sources, 40 CFR 60; 36 FR 24876, December 23, 1971.

5. "The 1970 National Power Survey." Federal Power Commission. See Table 19.3, p. I-19-4 for plant costs; Table 4.2, p. I-4-3, and Fig. 4.9, p. I-4-28 for coal costs.

6. Comments of the Federal Power Commission. In the Appendix to the AEC Environmental Statement on the Fort Calhoun Plant, Docket No. 50-285.

7. U.S. Atomic Energy Commission, Quarterly Progress Report on Reactor Construction (Duane Arnold), October 13, 1972.

10. PLANT DESIGN ALTERNATIVES

Alternative plant designs were considered by the Applicant before selecting the design of the proposed plant. The comparative evaluation of these alternatives was made with respect to (1) plant cost in terms of the present state-of-the-art for reliable utility operation, (2) use of land, water, and air resources, (3) changes of the quality of the environment surrounding the plant site as it affects uses, activities, and interests of the public at large, (4) conformance to applicable policies, laws, and standards. In this section, possible modifications to the reference design which the Staff considered are given. The alternatives considered are those which might significantly affect the balance between economic and environmental costs.

10.1 COOLING SYSTEMS

10.1.1 Cooling Towers

Because of the absence of large bodies of water capable of satisfactory dissipation of the heat discharged by once-through cooling, only closed-cycle cooling systems were considered. Dry cooling towers require no consumptive uses of water except the minor quantities used in filling and occasional external washing. However, dry cooling towers are physically larger than wet towers of the same cooling capacity, and their capital costs are estimated to be about three times that of wet towers.[1] Dry towers also cause significant power loss from increased turbine back pressure. The increased cost and power loss would add an estimated one mill per kWh to the bus-bar energy cost.[2] In view of the small environmental impact of evaporative cooling towers, the increased cost of dry cooling towers does not appear justified for the DAEC.

The use of a cooling lake is a possible alternative to the reference plant design, but cooling lakes require large areas. For a plant the size of the DAEC, a lake surface of about 1.6 square miles (1000 acres) is required and an assured continuous supply of water at a rate of at least 8000 gpm is needed for evaporation and blowdown losses.[11] The Applicant's cost estimate for a cooling lake in terms of present worth incremented generating costs is \$6.9 million in comparison to the reference plant design cost of \$7.0 million.[12] There appears to be no environmental savings associated with a cooling lake which could justify both the use of an additional 1000 acres of land and a change in plant design given the commitment to the reference design.

Spray canals are another possible alternative cooling scheme. Spray canals employ pumps to spray water into the air, thereby enhancing evaporation and obtaining more cooling per unit of area than a cooling lake. A spray canal for a plant the size of the DAEC would require about 100 four-spray modules and a canal length of more than one mile. Although less land is required than for a cooling lake, this alternative uses electric power for the pumps and is not nearly as compact as the cooling towers chosen for the DAEC. The performance of spray units is also not nearly so well known under various atmospheric conditions as for modern cooling towers. Spray canals would not reduce water consumption in comparison to cooling towers. Spray canals are also apt to produce locally heavy fogging though the fogging would not be as widespread as that from a cooling tower. The use of spray canals does not appear justified given the uncertainties in the use of spray canals and the high cost in changing design at this time.

Although the Applicant's initial plant description showed natural-draft cooling, further economic evaluation led to the selection of forced-draft towers. Natural draft cooling towers are more costly in terms of initial cost than the reference forced-draft towers, are much larger and taller, and have a substantially higher appearance impact. They are, however, cheaper to operate, produce less noise, and cause less fogging and icing.

The effects of the effluent of forced-draft cooling towers are different from those of natural-draft towers in that the latter are released at higher altitudes (400 ft vs. 80 ft) which reduces fogging and icing problems. Due to the relative isolation of the plant site, however, fogging and icing are not significant problems even with the forced-draft cooling towers (see Section 5.1). Forced-draft cooling towers are much noisier than natural-draft towers and this noise will have a noticeable effect on the few nearest neighbors to the plant site. All cooling towers are subject to tornado damage, but reliability here is provided by low frequency of tornadoes at the plant site and available pooling of power from neighboring utilities on an emergency basis.

The forced-draft and natural draft towers seem to be fairly balanced in terms of both economic and environmental cost. The high cost of the total plant in relation to the Applicant's financial resources led to a priority to reduce initial costs, resulting in the choice of forced-draft towers over natural-draft ones. In terms of environmental cost the increased visual impact of natural-draft towers must be weighed against the increased noise output of forced-draft towers. Given the resources already committed to the building of forced-draft towers there appears to be no justification for choosing natural-draft towers at this time.

10.1.2 Supplementary Water Supplies

The alternative supplementary water supplies for periods of low river flow are wells (of various depths) and reservoirs (at various locations). The alternative chosen, that of a reservoir to be built by the Iowa State Conservation Commission, was justified in terms of its recreational uses as well as its use for supplementary water supply. The cost of the reservoir is the same as that of deep wells, since the Applicant is giving a sum equal to the cost of deep wells to the State Conservation Commission. Given the small number of times that supplementary water will be required (less than 5% of the time), it would appear that, in terms strictly of supplemental water supply, wells would be environmentally less costly. However, the Iowa State Conservation Commission justifies the reservoir primarily in terms of its recreational uses, for which the wells would be of no value.

10.1.3 Cooling Tower Sound Reduction

A possible alternative to reduce the noise level of the cooling towers would be to interpose a zone of trees or other structures in the path of sound travel to attenuate the noise. Because the quantitative estimate of the acceptability of the noise is so uncertain, a definite recommendation for the alternative cannot be made. However, the Applicant should undertake to ascertain the effect of the noise on those persons involved, and should undertake remedial action, if needed, to make cooling tower noise levels acceptable to the public.

10.1.4 Cooling of Dry-Well Air Space

Cooling of the airspace in the reactor dry well is required to facilitate equipment and instrument operation and personnel access. This heat load has been estimated as 1.4×10^7 Btu/hr maximum (Fig. 3.2) and it is expected to be removed by cool water (about 54°F) obtained from the two 750-gpm production wells in the Silurian-Devonian aquifer.

Probably the most straightforward alternative would be to provide a waterchiller, i.e., an electric-powered refrigerator which would chill water to about 50°F and discharge the heat to the water of the closed-cycle cooling system. A refrigeration unit or units totalling about 1000 tons (1 ton = 12,000 Btu/hr) of reliable refrigeration duty would be required. (While a price estimate was not obtained, it would be expected to have an initial cost less than $50,000.)

Another possible alternative would be to return the well water to the aquifer after use. However, to avoid recirculating warm water the reinjection point would need to be remote from the withdrawal point. Any possible reinjection scheme would need to be carefully worked out to avoid adversely affecting the Silurian-Devonian aquifer.

If the number of wells affected is small, the environmental benefits of using one of the alternatives mentioned above is not considered by the Staff to be sufficient to warrant the economic cost. The Silurian-Devonian aquifer is a shallow aquifer locally recharged so that the use of well water will not constitute a long-term commitment of a natural resource. However, if the number of wells affected is large the economic cost of one of the above alternatives will be offset by the cost of correcting deleterious well effects on a well-by-well basis. An alternative to the consumptive use of well water should be adopted if the number of wells affected is such as to make the alternative economically competitive.

10.2 INTAKE SYSTEMS

The intake structure at the shore of the Cedar River provides makeup water to the closed-cycle cooling system, and is of a generally standard design. The approach velocity at the outlet up to the screen is a maximum of 0.75 ft/sec at the screen face at minimum river level. In light of the populations of biota in the Cedar River, the present design minimizes adverse effects sufficiently to make a consideration of alternative designs unnecessary.

10.3 DISCHARGE SYSTEMS

The single-jet discharge of the blowdown effluent has the advantage of providing fairly rapid mixing with the river water for very little cost. Only a small fraction of the total river width is affected (<25% for the 2-degree isotherm) (Section 3.4). More elaborate mixing or diluting systems would be more costly and would require more water appropriation and/or more of the river width. Lower velocity discharge would require a larger mixing zone in the river. It is not anticipated that alternative designs would result in detectably less environmental impact.

10.4 CHEMICAL SYSTEMS

The systems producing the principal nonradioactive liquid effluents bearing chemical wastes are (1) the reactor-coolant makeup water demineralizer and (2) the pH adjustment to makeup water for the closed-cycle circulating-water system to prevent carbonate scale formation. Alternative means to reduce these chemical effluents are discussed below.

10.4.1 Demineralizer Waste

The purification of well water for supply of makeup water to the reactor coolant system uses demineralizer resin beds with an automatic cycle such that 24,000 gal of regeneration waste is produced every 24 hours, an average rate of about 84 gpm. The chemical content of these wastes includes the dissolved minerals removed from the river water and the chemicals added to the system (about 75% of the total). About 500 pounds per day of sulfates are added to the Cedar River from the demineralizer system.

a. Evaporation

One alternative capable of reducing this chemical waste entering the river is to evaporate the waste stream, return the water condensate to the system, and store the concentrated brine on land, either on site or at another location. An evaporation scheme of this type was described in the environmental report for another reactor, a 1150-MWe boiling water reactor.[3] In spite of the larger reactor size, the volumetric capacity of this combination demineralizer-evaporator system has about the same processing rate. The total construction cost of the combination system was 50% higher than that of the demineralizer alone. The added cost was about $1,300,000. No chemicals would be returned to the natural body of water in this operation, though disposal of the brines would also have an environmental cost.

b. Combination of Reverse Osmosis, Demineralization, and Evaporation

Another scheme is a combination of reverse osmosis and demineralizing action for the purification of makeup water with evaporation in a falling-film evaporation to eliminate liquid release of regeneration chemicals.

A schematic is shown in Fig. 10.1. This scheme was described as an alternative system for an 850-MWe boiling water reactor.[4] The reverse osmosis as a head-end water purification substantially reduces the loading on the demineralizer and on the subsequent evaporation of regeneration wastes. Energy requirements and magnitude of brine disposal are similarly reduced. A cost estimate for the incremental equipment cost of this system over a demineralizer alone was stated as $300,000. Although this is probably an incomplete cost estimate, this scheme could have cost advantages over the use of an evaporator alone to reduce chemical waste discharges.

c. Evaluation of Alternatives

Considering that the demineralizer system has already been purchased, it would not be possible to take economic advantage of the advanced technology of the combination system using reverse osmosis. Applying the

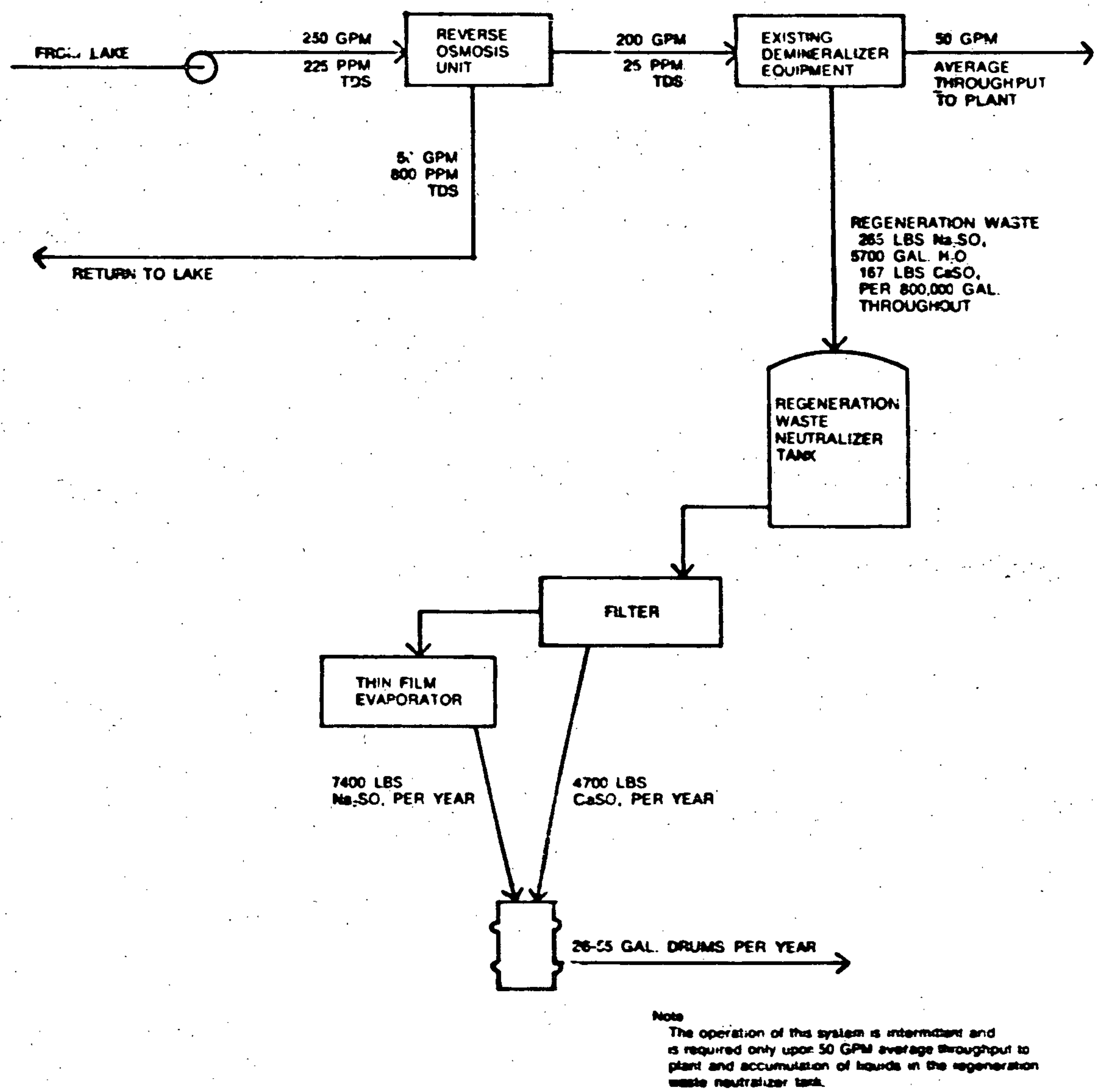

Fig. 10.1. Alternate Water-treatment Scheme Involving Reverse Osmosis and Evaporation of Regenerative Wastes.

evaporator system as an add-on would appear to add about $1 million of cost with little compensation derived from increased benefits of higher water quality of the Cedar River. Therefore, it is concluded that adoption of the alternative system is not warranted.

10.4.2 Circulating-Water pH Adjustment

There is no doubt of the practical importance of avoiding the formation of mineral scale on equipment components exposed to the high-carbonate waters of the Cedar River, especially as concentrated in the operation of a closed-cycle cooling system. The addition of sulfuric acid to adjust the pH to about 7 is standard practice. No other acid or other means of pH adjustment is known to be more favorable as far as reducing the chemical content. Other descaling chemicals would also add to the dissolved-solid waste burden and could well be less favorable than sulfate, the one involved in the reference proposal. Since no alternative scheme has been identified as more favorable, no alternative is recommended.

10.5 BIOCIDE SYSTEM

10.5.1 Chlorine Control or Elimination

If the Applicant's present system results in the discharge of total residual chlorine in conformance with the proposed criteria of the National Water Quality Laboratory as detailed in the Technical Specifications, no alternatives need to be considered. If the total residual chlorine concentration exceeds these limits in the blowdown, the Applicant will be required to consider alternative chlorine control techniques. Possible chlorine control methods include the following methods.

(a) Holdup blowdown during periods of chlorination. The residual chlorine concentration in the circulating water system will decline from its maximum value as soon as injection stops, due to chemical reaction and evaporation of chloramine. If blowdown is stopped during periods of maximum concentration, less residual chlorine will be released to the river. The normal holdup volume of the circulating water system is about 1800 cu ft and the circulating time is about 2.8 minutes and the purge time about 3.3 hours. If the blowdown is stopped during the chlorine addition, the blowdown rate could be increased about 5% during the periods of noninjection to obtain purging effect equivalent to a constant 8.9 cfs blowdown. The optimum period for stopping blowdown would take account of other aspects of the operation also, and is a matter of further study.

(b) Dilute the blowdown. Adding river water to the blowdown channel will not only reduce the chlorine levels through dilution, but chlorine demand of the river water will help to use up both free and combined forms of residual chlorine.

(c) Dechlorinate the blowdown effluent by adding chemicals such as sodium bisulfite. Present information suggests that sodium bisulfite has a much lower toxicity (~1/1000) than chlorine or chloramines.[6]

Thought should also be given to injecting the chlorine at the optimum location upstream of the condensers so as to minimize the chlorine additions needed to obtain the necessary de-sliming effect.

If no chlorine control technique can be found, an alternative to the use of chlorine will be required. Possible alternatives to consider are given below.

(a) Periodic passage of heated water. Passage of heated water through the condensers at regular intervals to control slime growth requires little or no use of chemicals, and provides a use for some of the "waste" hot water. This technique has been used successfully for many years in controlling growth of marine organisms in the intake and discharge pipes of a steam-electric plant at a cost 1/7 that calculated for chlorine.[7,8] This technique, however, has not been developed for condensers under the conditions at the DAEC, and its effectiveness in this instance is open to question. Factors involved in the problem, such as characteristics of the slime-forming organisms present in the water, attainment of effective temperatures for cleaning, and interference with normal plant output, have not been studied.

(b) Use of mechanical methods. Automatic mechanical cleaning systems are offered by AMERTAP Corporation and American M.A.N. Corporation. Type 304 nickel stainless steel condenser tubes (the type used at DAEC) are "easy to keep free of foreign matter" with either of these systems.[9]

The AMERTAP system circulates sponge-rubber balls through the condenser tubes to provide a scrubbing action that maintains the metal surfaces free of scum and fouling. A disadvantage of this system is the need for periodic replacement of the sponge-rubber balls, and the addition of particles to the receiving water caused by fragmentation of the balls.

The M.A.N. system employs nonmetallic brushes that are restrained in the tubes by plastic baskets attached to the ends of each tube. By reversing the flow of the cooling water, the operator can automatically "shoot" the tubes with the brushes.[9] An advantage of this system is that a visual inspection of the condenser outlet tube sheet immediately reveals any tubes with internal obstructions, since the brushes in a blocked tube will not be visible in the end basket. The use of this method at DAEC would be possible only if there were means of reversing the flow of cooling water in the condensers. At present, there is no means of such reversal at DAEC.

(c) Use of Ozone. The use of ozone (O_3) as biocide has some advantages over use of chlorine: action of ozone is immediate and forms no persistent toxic compounds such as chloramines; it is a stronger oxidizing agent than chlorine, thus requiring a shorter reaction time; it can be generated from air at the plant site and its supply is less subject to outside interruptions such as shipment delays; its maximum allowable concentration (MAC) as established by the American Council of Governmental Industrial Hygienists is 0.1 ppm by volume for continuous exposure, which is 10 to 15 times higher than the threshold odor level, so that a worker could detect the presence of ozone at concentrations far below the MAC.[10] A major disadvantage of ozone use at present, is its high cost compared to chlorine. For example, the estimated cost for secondary effluent disinfection was x for liquid chlorine, about 2x for sodium hypochlorite, and about 2.5x for ozone.[10] Since the method is virtually undeveloped for power plant use, little is known of the effects on biota in the condenser and receiving waters.

(d) No addition of biocide. In some cases, the addition of biocides to a condenser system may not be necessary. At the Oswego Steam Station in upstate New York, for example, the low level of nutrients in the intake water and the abrasive effect of fine suspended particles of glacial till in the water made the use of algicides unnecessary.[5] The water of the Cedar River, however, is relatively high in nutrients due to agricultural run-off, and the buildup of slime is expected if no condenser cleaning is carried out. Monitoring of the heat-transfer coefficient should indicate when the addition of a biocide is necessary.

10.5.2 Alternative Chlorine Source

The use of sodium hypochlorite solution rather than liquid chlorine as a source of available chlorine is an alternative meriting consideration

—not for differences in biocidal effect, since they are chemically equivalent—but for possible differences in case of an accidental release from their primary containers (Section 7.3). Although liquid chlorine is routinely used in industrial practice, the possibility of accidental release of gaseous chlorine from large cylinders containing the highly volatile liquid makes the consequences of such an accident potentially more severe than the case of the hypochlorite solution (about 15% in water). On the other hand, the cost of liquid chlorine use is less. It has been estimated for a chlorination disinfection plant using 1.5 million pounds of chlorine per year that the comparative costs are as follows:[10]

Alternative Chlorinating Agents

Item	Liquid chlorine	Sodium hypochlorite
Equipment, 15-yr amort.	\$ 6,400	\$ 3,300
Building, 40-yr amort.	6,600	7,500
Chemical	82,000	186,000
Power	6,800	700
Labor and maintenance	12,200	12,500
TOTAL	\$114,000	\$210,000
Cost, ¢/1000 gal	0.49	0.90

In the present plant, the applicant has estimated chlorine use at 600,000 lb/yr. This may be high by as much as a factor of two if a stringent chlorine control is established. However, the above cost data indicate that the cost of the sodium hypochlorite alternative could be as much as \$100,000 per year more than liquid chlorine, or as much as \$1,000,000 more as equivalent investment cost over the plant lifetime.

The cost of converting to the use of sodium hypochlorite may be substantial, and whereas the benefits in terms of reduced consequences of an accidental release are uncertain at this time, the use of sodium hypochlorite is not specifically recommended.

10.6 SANITARY WASTE SYSTEMS

The extended aeration system provides secondary sewage treatment of high capacity and nearly complete digestion. Septic tanks provide less complete treatment and are not a preferable alternative. Chlorination in addition to the present treatment is a possible alternative. However, if monitoring of the sewage effluent is provided as described in

Section 6.2, chlorination is not considered sufficiently justified at present to offset the increased cost.

If chlorination facilities are added, provisions must be made to control total residual chlorine discharges to the Cedar River. This could be accomplished through the use of holdup tanks or ponds or by dilution of the sewage effluent. Limiting the total residual chlorine concentration in the sewage effluent to less than 0.1 ppm should assure that there will be no resultant significant changes in the aquatic ecosystem.

10.7 LIQUID RADWASTE SYSTEM

The estimated liquid radioactive discharges are sufficiently small that no detectable deleterious effects are anticipated. Therefore, no alternatives to the present system are considered justified. The radiological monitoring program will provide a check on actual system performance.

10.8 GASEOUS RADWASTE SYSTEM

The dose to a child's thyroid via the milk pathway based on the calculated I^{131} release from the Center exceeds the limits considered acceptable by the Staff. The Applicant will be required to take appropriate measures through monitoring, administrative measures and/or design changes to insure that the thyroid dose to critical segments of the general population via the milk pathway does not exceed 5 mrem/year.

In all other respects the estimated gaseous radioactive discharges are sufficiently small that no detectable deleterious effects are anticipated. Therefore, no alternatives to the present system are considered justified. The radiological monitoring program will provide a check on actual system performance.

10.9 TRANSMISSION SYSTEM

It is not practicable in the present state of technology to transmit power on the required scale through underground cables. Overhead transmission lines are therefore an inevitable adjunct of large generating stations. The Applicant's choice of 345-kV and 161-kV follows accepted practice for the load capacity required and no alternative is suggested.

The Applicant has taken account of aesthetic, social, and environmental values in the placement of the transmission lines. However, the Applicant's wish to use "voluntary" right-of-way acquisition has resulted in extending certain lines and placement of some lines on public rights-of-way. Aesthetic impacts could have been reduced by other placements, but at the cost of disregarding the wishes of some landowners. No feasible alternatives would produce sufficient benefit to outweigh the costs already expended or committed.

10.10 ALTERNATIVES TO NORMAL TRANSPORTATION PROCEDURES

Alternatives, such as special routing of shipments, providing escorts in separate vehicles, adding shielding to the containers, and constructing a fuel recovery and fabrication plant on the site rather than shipping fuel to and from the station, have been examined by the Staff for the general case. The impact on the environment of transportation under normal or postulated accident conditions is not considered to be sufficient to justify the additional effort required to implement any of the alternatives.

References

1. F. L. Parker and P. A. Krenkel, "Thermal Pollution: Status of the Art," Vanderbilt University, School of Engineering, Nashville, Tenn., December 1969.

2. R. W. Beck and Associates, "Cost Comparison of Dry-Type and Conventional Cooling Systems for Representative Nuclear Generating Plants," TID-26007, March 1972.

3. "Environmental Report, Nine Mile Point Nuclear Station, Unit 2," Docket No. 50-410, June 1972, Sections 3.7 and 8.6.

4. Environmental Report on the James A. FitzPatrick Nuclear Power Plant, Supplement No. 2, "Benefit/Cost Analysis," Power Authority of the State of New York, Docket No. 50-333, May 1972, Section 8.12.

5. "Environmental Statement, Oswego Steam Station Unit 5," U.S. Army Engineer District, Buffalo, N.Y., Oct. 1971.

6. "Water Quality Criteria," California Water Pollution Control Board, Publ. 3A, 1971.

7. D. L. Fox and E. F. Corcoran, "Thermal and Osmotic Countermeasures against some Typical Marine Fouling Organisms," Corrosion 14:31, 1958.

8. W. L. Chadwick, et al., "Thermal Control of Marine Fouling at Redondo Steam Station of the Southern California Edison Company."

9. J. W. Carey, Ed., "Experiences with Stainless Steel Tubes in Utility Condensers," Nickel Topics 24(5):5-7, 1971.

10. K. M. Yao, "Is Chlorine the Only Answer," Water and Wastes Engineering, January 1972, pp. 30-31.

11. National Academy of Engineering, "Engineering for the Resolution of the Energy - Environmental Dilemma," 1972.

12. Environmental Report, DAEC, Amendment 1, July, 1972.

11. COST-BENEFIT SUMMARY

11.1 BENEFITS

The primary benefits from completion and operation of the DAEC will be the generation of about 3.8 billion kilowatt hours per year of electrical energy and increased reliability within the Iowa pool because of 550 MWe additional generating capacity. About 35 percent of the power will be sold to industrial users, 25 percent to commercial users, and 40 percent to residential and rural users.

Indirect local and regional benefits will include a revenue of about $4 million per year in taxes to Linn County. Some 70 persons will be employed in the operation of the plant. The environmental and radiological monitoring programs will provide data of general interest to the scientific community, particularly in regard to the ecology of the Cedar River, provided that results from the studies are made generally available.

11.2 ENVIRONMENTAL COSTS

11.2.1 Land Use

About 500 acres of farm land have been removed from use by construction of the DAEC, although only about 40 acres are occupied by buildings, roads, substation, etc. Access to the river at the site was restricted by private ownership in the past and will remain so. Construction of the plant intake and discharge facilities and the river channel barrier wall has disturbed the river shore and bottom; however, natural water flow and silt movement will restore the shore and bottom grade, so that detectable long-term effects are unlikely. Although about 1180 acres of off-site land, mainly farm land, will be used for new transmission lines, only that required for the towers themselves will necessarily be removed from previous use, and since the towers over farm land are mostly of the single-pole or H-frame types, the tower areas are very small.

The forced-draft cooling towers are only 60 feet high and will not be conspicuous on the landscape, although the vapor plumes will be visible for some distance, especially in winter. A small increase in fog on the site or immediately adjacent may occur; it is estimated that fog at the nearest town, Palo, would be increased by less than 0.2 hr in winter. Icing will be confined to the site. Downwash of the vapor plume to the nearest road is estimated at 1/2 hour (in spring). The cooling towers will contribute noticeable noise levels at the nearest residences and in the Wickiup Hill Conservation Area. The noise levels will be the equivalent of that found in urban areas and may be annoying to some.

11.2.2 Water Use

The net consumption of river water by the DAEC (as evaporation from the cooling tower) will be about 2.7 billion gallons per year. Average river flow is about 260-fold greater so that no detectable change in the river will result from this consumption of water. Water will be withdrawn from the Silurian-Devonian aquifer at a rate not to exceed 1500 gpm. This water withdrawal may deleteriously affect neighboring wells.

Use of cooling towers in a closed-cycle system will greatly reduce discharges of heat to the Cedar River. The total river area warmed by 2°F will be limited to less than 1 acre. After complete mixing of the blowdown effluent in the Cedar River, the river will be warmed less than 1.2°F even at low flow conditions; under average summer conditions, the river will be warmed less than 0.1°F. Chemical additions, with the exception of chlorine, are not expected to be toxic to river biota. Chlorine additions may result in locally high levels of total residual chlorine (up to 0.5 ppm) being discharged to the Cedar River.

11.2.3 Biological Effects

Virtually all of the organisms drawn into the plant intake will be killed. These will include plankton, fish eggs, and very small fish, but almost no healthy adult fish. The rate of river flow is variable by a factor of about 100: at the average river flow of 3000 cfs, only about 0.8 percent of the river flow will enter the cooling system. Although this proportion of entry may increase about 10-fold at low flow conditions, principally in winter, no detectable effect on aquatic populations or species balance is expected. Any detectable effect on birdlife or terrestrial wildlife is highly improbable. Close control and monitoring of chemical (including chlorine) and sanitary discharges will provide assurance that adverse effects on river biota and public health are minimized.

11.2.4 Radiological Effects

The total dose from operation of the DAEC to the entire population within 50 miles is estimated to be 27 man-rem per year, distributed among about 0.55 million people who live within this area. The dose to individuals in areas near the plant will be less than 2 percent of that due to natural background; in more distant areas it will be much less.

11.3 COST-BENEFIT BALANCE

The DAEC as designed and subject to controls of the Technical Specifications is expected to have only a small impact on the environment. The identified benefits and costs are listed in Table 11.1.

The Staff has considered these benefits and costs in some detail as outlined above. The Staff concludes that on balance benefits from completion and operation of the DAEC will exceed the environmental and economic costs. Aside from the possible need to (a) modify the chlorination system, (b) reduce the consumptive use of well water, and (c) adopt noise attenuation methods depending upon experience and data gained during initial plant operation, the costs of the available alternatives are not justified when balanced with the potential benefits to be gained.

TABLE 11.1 Cost-Benefit Summary for the DAEC*

Benefits	
Primary benefits:	
Electrical energy to be generated	3.8 billion kWh/yr
Generating capacity contributing to reliability of electrical power in the Iowa Pool service area	550,000 kilowatts
Secondary local benefits:	
Employment of operating staff	70 persons
State and local taxes paid	$4 million per year
Environmental Costs	
Land use:	
Farm land for station	500 acres
Transmission line right-of-way	1155 acres; 85 miles
Cooling tower operation	Noticeable noise at nearest residences
Water use:	
Water evaporated	7.3 x 10^6 gallons per day
River surface area within 2°F excess isotherm of thermal plume	<1 acre
Chemicals discharged to river	5 lb/day of total residual chlorine, 20,000 lb/day of sulfates
Well water use	1500 gal/min (maximum)
Radiological impact:	
Normal operation:	
Cumulative population dose (50-mile radius)	27 man-rem per year
Whole-body dose to nearby residents	Less than 2 percent of natural background
Biological impact:	Small destruction of aquat[illegible] life, no detectable change[illegible] in terrestrial life

* Except as noted, values are average values.

12. DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to paragraph A.6 of Appendix D to 10 CFR 50, the Draft Environmental Statement of November 1972 was transmitted, with a request for comment, to:

Advisory Council on Historic Preservation
Department of Agriculture
Department of the Army, Corps of Engineers
Department of Commerce
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
Iowa Department of Health
Iowa State Conservation Commission
Iowa Environmental Quality Department
Iowa Natural Resources Council
Iowa Air Pollution Control Commission
Iowa Bureau of Labor
Linn County Board of Supervisors

In addition, the AEC requested comments on the Draft Environmental Statement from interested persons by a notice published in the <u>Federal Register</u> on November 22, 1972 (37 FR 20096).

Comments in response to the requests referred to above were received from:

Advisory Council on Historic Preservation
Department of Agriculture
Department of Commerce
Department of the Interior
Department of Transportation
Environmental Protection Agency
Federal Power Commission
Iowa State Conservation Commission
Iowa Natural Resources Council
Linn County Board of Supervisors
Governor, State of Iowa
Iowa Civil Defense Division
Iowa Geological Survey

State Historical Society of Iowa
Department of Conservation, Linn County
Linn County Health Department
Mayor, City of Cedar Rapids

Our consideration of comments received and the disposition of the issues involved are reflected in part by revised text in other sections of this Final Environmental Statement and in part by the following discussion. The comments are included in this statement as Appendix K.

12.1 PLEASANT CREEK RESERVOIR

12.1.1 Complete Environmental Review (Interior, p. K-13)

The Department of the Interior has commented that the proposed Pleasant Creek Reservoir should be further described in the Environmental Statement. As stated in the Draft Environmental Stat ment, the Staff does not consider the proposed reservoir an integra part of the DAEC and has, therefore, not attempted to make a full environmental review of the reservoir. The reservoir is to be buil and managed by the Iowa State Conservation Commission and is justif primarily as a recreation resource. The Iowa State Conservation Commission has commented, by letter dated December 22, 1972, that " is understood that the Pleasant Creek Project will be covered by a separate Environmental Impact Statement to be prepared by the feder agency providing cost sharing for the recreation development. This agency is the Bureau of Outdoor Recreation in the Department of the Interior."

12.1.2 Drawdown (Interior, p. K-13)

Department of the Interior commented regarding the Applicant's righ to drawdown the Pleasant Creek Reservoir during the recreation seas and to construct a 345 kV overhead transmission line which would cr one arm of the reservoir.

The 345 kV overhead transmission line in question has existed since 1966. This is part of the Twin Cities-Iowa-St. Louis 345 Interconnection Transmission System. The existing towers are located in areas proposed to be set aside for wildlife and will not hamper the development of the reservoir as a recreation area. The Applicant would retain the right to drawdown the reservoir during the recreation season. The probability of drawdown during the recreation season is very low. Records dating back to 1903 indicate that flows below 500 cfs occur approximately 5% of the time and that these low flows are usually in the winter months when the recreational use of the facility would be at a minimum. Preliminary studies indicate that the withdrawal of 15.5 cfs, required to make up the consumptive use of river water by the DAEC, would result in decreasing the water level by only one foot after 14 days.

The following data provides additional details concerning potential drawdown requirements on the reservoir by the DAEC. It was submitted to the Iowa Conservation Commission in connection with their application to the Bureau of Outdoor Recreation.

CEDAR RIVER FLOWS

United States Geological Survey river flow records for the Cedar River at Cedar Rapids 8th Avenue gaging station were reviewed for the period 1903 thru 1969.

Based upon those recorded flows, flows below 500 cfs occurred approximately 5% of the time. Thus the DAEC would have required water from the lake a very small percentage of the time, or 1,264 days during the 67 years.

Flows of 500 cfs or lower have been experienced, on an average over the 67-year period of 1903 thru 1969, about twice per year (143 occurrences). One-half of the 143 occurrences (75) were for periods of 3 days or less:

1 day: 40 occurrences - 16 in Dec.-Feb.; 27 in Nov.-Mar.
2 days: 20 occurrences - 8 in Dec.-Feb.; 15 in Nov.-Mar.
3 days: 15 occurrences - 8 in Dec.-Feb.; 11 in Nov.-Mar.

Twenty-eight years (such as 1969) experienced no such low flows. On the other hand, of nine periods lasting for a month or longer, all but one occurred during the winter months when icing of the gaging station produced doubtful readings or required supplying estimated values. These nine periods of 30 consecutive days or more were as follows:

3[illegible] days	[illegible]	1934 -	June 1934
39 days	Dec.	1930 -	Jan. 1931
43 days	Jan.	1951 -	Feb. 1951

57 days	Dec.	1904 - Feb.	1905
67 days	Dec.	1939 - Mar.	1940
70 days	Dec.	1910 - Feb.	1911
77 days	Dec.	1916 - Feb.	1917
80 days	Dec.	1958 - Feb.	1959
95 days	Nov.	1955 - Mar.	1956

Thus only once during the summer recreation period over the entire 67 year span, would the recreation facilities of the lake have been impaired.

Based upon the data cited above the impact of DAEC withdrawal is expected to be negligible, thereby making this dual purpose recreation project feasible.

12.2 GEOLOGY AND SEISMOLOGY (Interior, p. K-11)

The comment was made that the brief description of geology and seismology presented is inadequate for an independent assessment of the geologic environment relevant to the proposed construction of the plant. The function of this statement is to evaluate the effects of the Duane Arnold Energy Center on the environment, and the material on geology and seismology in the statement is intended only to serve as a part of the general description of the site. The geologic and seismologic considerations used for design criteria were evaluated by the staff and were published in the Safety Evaluation Report issued by the AEC on January 23, 1973.

12.3 TRANSMISSION LINES

12.3.1 Wooded Areas Along Rights-of-Way (Agriculture, p. K-7)

The comment was made that there is an apparent discrepancy of 8.3 acres of wooded rights-of-way for transmission lines. It should be noted that the 3.6% wooded land refers only to the private land portion in Table 3.10 and not to the total length of rights-of-way.

12.3.2 Railroad Right-of-Way (Transportation, p. K-15)

The Federal Railroad Administration notes that 5.05 miles of right-of-way will be utilized for DAEC 161 kV transmission lines. The final right-of-way arrangements have resulted in a total of 15.9 miles of railroad right-of-way which will be utilized for DAEC transmission lines.

12.3.3 Inductive Coupling (Transportation, pp. K-15, K-16)

The operation of high voltage lines in close proximity to railroad rights-of-way may produce interference with railroad communications and signal systems. The Applicant has stated that it is aware of these potential problems and is working with the Chicago and North Western Railway to assure that there will be no interference with railroad communications and signal systems. A formal agreement concerning this matter is expected to be signed in the near future.

12.3.4 Effect on Navigable Airspace (Transportation, p. K-15)

The Applicant is aware of FAA requirements and has submitted final design plans for the DAEC-Bertram transmission line to the Kansas City office of the FAA for approval.

12.3.5 Effect on Land Use (Interior, p. K-12)

The Department of the Interior has commented that the impact of transmission lines on land use was not adequately assessed. The effect of transmission lines was carefully assessed by the Staff, but detailed information as to the exact routing of each transmission line with regard to parks, wildlife and recreation areas was not included in the Draft Environmental Statement. No transmission line to be erected in conjunction with the DAEC will cross any designated park, wildlife, or recreation area. The exact relation of each transmission line to parks, wildlife and recreation areas is shown in Figs. 2-4.1-4 through 2-4.1-8 of Amendment 2 of the Applicant's Environmental Report.

12.3.6 Location of Washburn Substation (FPC, p. K-34)

The Washburn Substation is located 49.1 miles from the DAEC. Thus there are five (vs. six) overhead transmission lines required to integrate the DAEC with the existing transmission system.

12.4 WELL WATER USE (EPA, p. K-28)

EPA has suggested alternatives which could be employed if well water withdrawal by the DAEC adversely affects large numbers of private wells. These alternatives were discussed in section 10.1.4 of the Draft Environmental Statement. In the Draft Statement it was stated that as one of the conditions for issuance of an operating license the applicant must bear the responsibility for detection and correction of any deleterious effects on neighboring wells resulting from plant operation. The Applicant, in its comments on the Draft Statement (Appendix K 18), stated its commitment to correct any deleterious local well effects. The use of well water for drinking and demineralizer makeup is not considered of sufficient magnitude to have any deleterious effects.

12.5 CEDAR RIVER

12.5.1 Water Temperature Data (EPA, p. K-28)

The EPA has commented that more recent water temperature data for the Cedar River should be used, if available. No USGS data for the Cedar River is available for a later time period than the 1944 to 1954 period referenced in the Environmental Statement. Since thermal discharges from the DAEC are quite small, the Staff does not believe that the unavailability of more recent data is of significant importance.

12.5.2 Chemical or Thermal Blockage (Iowa Conservation Comm., p. K-36)

The Iowa Conservation Commission has expressed a concern that chemical discharge or heated water discharge could possibly block the Cedar River. As indicated in the Draft Environmental Statement, the Staff believes that such an occurrence is highly unlikely. However, if the monitoring program does detect evidence of blockage of fish passage in the Cedar River, the Applicant will be required to take corrective action to eliminate or substantially reduce any such blockage.

12.6 SURFACE OR GROUNDWATER DEVELOPMENTS (Interior, p. K-12)

The Department of the Interior has commented that the monitoring systems should be updated if future surface or groundwater developments occur downgradient from the plant. All monitoring programs are subject to revision on the basis of data collected or occurrence of changes in the environment. Plant operation and monitoring programs will be reviewed by the AEC throughout the plant lifetime to assure that changes are made whenever necessary. However, it should be noted that water gradients run from the plant towards the river, and all land between the plant buildings and the river is part of the plant site. Thus, future developments of the type mentioned are not likely.

12.7 CHLORINE RELEASES (EPA, pp. K-19, K-26; Interior, p. K-12)

The Environmental Protection Agency has commented that better assurance that chlorine concentrations in the blowdown water will be at levels consistent with the preservation of area biota are needed. The Statement has been revised to better define allowable concentrations of total residual chlorine in the blowdown and states the requirement that within 30 months discharges will be within the latest proposed criteria of the National Water Quality Laboratory for intermittent chlorine discharges. The EPA has also commented that the Applicant should consider continuous chlorine addition as an alternative to intermittent chlorination. Due to the high chlorine demand of the Cedar River, fairly large amounts of chlorine must be added to the cooling water if any free chlorine is to be available at the outlet end of the condenser. Some free chlorine must exist at the outlet of the condenser if biocide control is to be achieved. Continuous addition of chlorine would not reduce the quantity of chlorine needed at any given time but would merely result in more total chlorine being added to the Cedar River. The comment has been made that consideration should be given to completely eliminate chlorine and other discharges to the Cedar River. Since the Staff does not expect that proposed chemical discharges within the limits discussed in the Environmental Statement will adversely affect river biota, a requirement for further reductions in chemical discharges is not considered justified when weighed against the increased costs associated with the necessary alternatives.

12.8 RADIOLOGICAL EFFECTS

12.8.1 Indirect Use of River Water (EPA, p. K-21)

The comment was made that the details of indirect use of the Cedar River water for human consumption should be included in the Statement. It should be noted that during most of the year the Cedar Rapids wells are not recharged from the river but from the rainfall watershed above the river level. However, in evaluating the dose resulting from use of Cedar River tap water, a recharge rate of 50% was assumed for twelve months. Based on recharge and diffusion rates obtained from the Cedar Rapids Water Department, an annual average effective transient time from reactor to consumer of 30 days was used.

12.8.2 Inhalation Doses (EPA, pp. K-20, K-27; Commerce, p. K-9)

Comments were made that the gaseous radioactive emissions and inhalation doses may be in error and requesting more details on the calculation models used. It is the Staff's position that the calculated doses presented in the Environmental Statement are correct. The radioactive gaseous dispersion calculations used the heights of the 100 meter off-gas stack and the turbine building vents as appropriate for each portion of the radioactive emissions. The meteorological data base used was that collected by the Applicant and summarized in the Environmental Report. The detailed meteorological data used is given in Section 2.4 of the DAEC FSAR and in the Meteorological Supplement to the DAEC FSAR. The inhalation doses were calculated using the ARIP (reference 27, Section 5) dispersion models and the ICRP #2 submersion model.

12.8.3 Limiting Radioiodine Concentrations (EPA, p. K-20)

The comment was made that the statement should include the steps the Applicant will be required to take if cows are ever pastured nearer the DAEC than at present. The Applicant will take an annual survey each spring in the vicinity of the plant site to determine any change in the location of dairy herds. The Applicant has also made a commitment to submit to the Staff proposed design modifications for incorporation in the plant if gaseous effluent discharges exceed limits contained in proposed Appendix I to 10 CFR Part 50.[1]

12.8.4 Direct Shine (EPA, p. K-21)

The statement that the direct dose from onsite sources will be less than 1 millirem per year is based on measurements made at operating power plants. These boiling water plants use turbines and steam systems essentially identical to that to be utilized at the DAEC.

12.8.5 Radioactive Plant Laundry (EPA, p. K-27)

The Environmental Protection Agency has commented that radioactive plant releases from laundry done offsite should be estimated and monitoring and surveillance activities defined to quantify any releases. The Applicant will follow applicable DOT regulations for transporting radioactive wastes. The Applicant has stated that it cannot establish the release paths and rates resulting from offsite laundry operations since the Applicant has no control over the laundry procedures to be followed. The laundry contractor, however, must be licensed by the AEC and appropriate controls will be required so as to assure that there will be no significant hazard to the public from these operations. The Staff has calculated the potential releases of radioactivity from laundry processing to be approximately 0.05 Ci/yr, a quantity which can be considered negligible.

12.9 ACCIDENTS - RADIOACTIVE RELEASES TO WATER (Interior, p. K-13)

The comment was made that environmental effects of releases to water resulting from plant accidents is lacking. The potential for exposure from other pathways was discussed in the footnote in Table 7.2 of the Draft Environmental Statement.

12.10 PLANT HEATING BOILER EMISSIONS (EPA, p. K-29)

The Environmental Protection Agency commented that not enough detail was given on emissions from the plant boiler unit. The DAEC will use a small, auxiliary heating boiler which will be used only during downtime of the plant during winter months. Maximum use will not exceed two months per year. Detailed information on the plant boiler is given below:

Fuel type:	#2 low sulphur fuel oil
Sulphur Content:	0.25%
Fuel BTU Rating:	19,777 BTU/lb
Fuel Use Rate:	3,540 lb/hr
Number of hours use per year	Maximum expected 1,500 hr
Emission Rates	
Particulate:	0.092 gm/sec at rated power
SO_2:	2.3 gm/sec at rated power

Applicable air quality standards for the State of Iowa are on file and have been approved by the EPA.

12.11 ENVIRONMENTAL MONITORING

12.11.1 River Sampling (Commerce, p. K-9)

A comment was made that the river sampling sites indicated in Table 6.1 were not adequately defined, nor were the species to be monitored mentioned. The river sampling sites for the radiological monitoring program will be immediately downstream of the blowdown outfall and at the Lewis Access Site. Biota to be sampled will include periphyton attached to substrates, rooted aquatic plants (as available), and benthic organisms (as available). Further details of the river monitoring program are under development and will be specified in the Technical Specifications for the DAEC.

12.11.2 Creel Surveys (Iowa Conservation Comm., p. K-36)

The Iowa Conservation Commission has suggested that creel surveys be undertaken by the Applicant as part of an expanded surveillance program. While the Staff recognizes that creel surveys might be useful as part of an intensive fisheries study of the Cedar River, they are not considered to be a necessary component of the environmental monitoring program conducted by the Applicant. The Staff is of the opinion that the aquatic monitoring program as discussed in this Statement is adequate for determining environmental effects resulting from operation of the DAEC. The Staff also feels that the present aquatic monitoring plans will provide more quantitative and scientific data than would be derived from creel surveys.

12.12 EMISSIONS OF ALTERNATIVE COAL-FIRED PLANT (Interior, p. K-14)

The emissions of an alternative coal-fired power plant as given in the Draft Environmental Statement were based on the EPA Regulation on Standards of Performance for New Stationary Sources, 1971. The Department of the Interior has commented that state or local emission control standards should have been given if they are more limiting. Proposed 1975 Iowa Source Standards are:

0.7 lb particulate mater per 10^6 BTU
5.0 lbs sulfur dioxide per 10^6 BTU
0.2 lb NO_x per 10^6 BTU

The EPA standards used were:

0.1 lb particulate matter per 10^6 BTU
1.2 lb sulfur dioxide per 10^6 BTU
0.7 lb NO_x per 10^6 BTU

In general the EPA source standards represent the more limiting values.

12.13 LOCATION OF PRINCIPAL REVISIONS OF TEXT IN RESPONSE TO COMMENTS

Topics Commented Upon	Section Where Topics Are Addressed
Area of Proposed Reservoir (Iowa Conservation Comm., p. K-37)	2.1
Historical and Archeological Landmarks (Advisory Council on Historic Preservation, pp. K-4, K-5)	2.3
Doses from Tap Water (EPA, p. K-21)	5.2
Chlorine Releases (EPA, pp. K-19, K-26; Interior, p. K-12)	5.4, 6.2, 8.3
Radioactive Releases (EPA, p. K-20)	5.6

Reference

1. Environmental Report, DAEC, Amendment 5, February, 1973.

APPENDIXES

Appendix Key. Scientific and Common Names of Vascular Plants in the Study Sites around the Duane Arnold Energy Center

Scientific Name	Common Names
Acer negundo	box-elder, ash-leaved maple
Acer saccharinum	silver maple, white maple, soft maple, river maple
Acer saccharum	rock maple, sugar maple
Achillea lanulosa	yarrow
Acorus calamus	sweetflag, flagroot, calamus
Adiantum pedatum	maidenhair fern
Agropyron repens	witch grass, couch, quitch, quick grass
Alisma triviale	water- or mud-plantain
Amaranthus retroflexus	green amaranth, pigweed, wild beet
Ambrosia artenisiifolia	common ragweed, Roman wormwood, hog-weed, bitter-weed
Ambrosia trifida	great ragweed, buffalo-weed
Amorpha fruticosa	false or bastard indigo, indigo-bush
Amphicarpa brecteata	hog-peanut
Anemone canadensis	Canadian anemone
Anemonella thalictriodes	rue-anemone
Apios americana	groundnut, wild bean, potato bean
Apocynum sp.	dogbane, Indian-hemp
Artemisia ludoviciana	western mugwort, white sage
Asarum canadense	wild ginger
Asclepias incarnata	swamp milkweed
Asclepias syriaca	common milkweed, silkweed
Asclepias verticillata	whorled milkweed
Aster cordifolius	heart-leaved aster
Aster sp.	aster, starwort, frost-flower
Avena fatua	oat
Betula nigra	river birch, black birch
Bidens sp.	bur-marigold, cuckold
Botrychium virginianum	rattlesnake-fern
Bromus inermis	awnless or Hungarian brome-grass, smooth brome
Caltha palustris	cowslip, kings-cup, May-blob
Campanula americana	tall bellflower
Cannabis sativa	hemp, marijuana
Capsella bersa-pastoris	shepard's-purse, shovelweed, pickpocket
Carex albursina	sedge
Carex sp.	sedge
Carpinus caroliniana	American hornbeam, blue or water beech
Carya cordiformis	pitnut, bitternut, swamp hickory
Catalpa speciosa	catawba-tree, cigar-tree, catalpa
Caulophyllum thalictroides	blue cohosh, papoose-root

Scientific Name	Common Names
Celtis occidentalis	nettletree, hackberry, sugarberry
Cephalanthus occidentalis	buttonbush
Chenopodium album	pigweed, lambs-quarters
Circaea quadrisulcata	enchanter's nightshade
Cirsium arvense	Canada-thistle
Clematis pitcheri	Pitcher's clematis
Convolvulus sepium	bindweed
Convolvulus sp.	bindweed
Cornus drummondi	Drummond's dogwood
Crataegus mollis	soft or downy hawthorn
Cryptotaenia canadensis	honewort, wild chervil
Cuscuta sp.	dodder
Cystopteris fragilis	fragile fern
Echinocystis lobata	wild or prickly cucumber
Eleocharis sp.	spike-rush
Ellisia nyctellea	nocturnal ellisia
Elymus virginicus	terrell grass, wild rye
Equisetum arvense	common or field horsetail
Equisetum kansanum	Kansan horsetail
Erigeron annuus	daisy-fleabane, sweet-scabious
Erigeron canadensis	horse-weed, hog-weed, butter-weed
Erigeron sp.	fleabane
Euonymus atropurpureus	burning-bush, wahoo
Eupatorium rugosum	white snakeroot
Fraxinus americana	white ash
Fraxinus pennsylvanica	green ash
Galium aparine	cleavers, spring-cleavers, goosegrass, bedstraw
Galium concinnum	bedstraw, cleavers
Galium sp.	bedstraw, cleavers
Geranium carolinianum	Carolina cranesbill
Geranium maculatum	wild or spotted cranesbill
Geum canadense	Canadian avens
Gleditsia triacanthos	honey-locust, honey-shuck
Gymnocladus dioica	Kentucky coffee-tree
Helianthus strumosus	sunflower
Hepatica acutiloba	liverleaf, hepatica, noble liverwort
Hordeum jubatum	squirrel-tail grass
Hydrophyllum virginianum	John's cabbage, waterleaf
Impatiens pallida	pale touch-me-not, snapweed
Iodanthus pinnatifidus	purple rocket
Iris versicolor	blue flag, poison flag
Juglans cinerea	butternut, white walnut
Juglans nigra	black walnut
Juniperus virginiana	red cedar

Scientific Name	Common Names
Lactuca sp.	lettuce
Laportea canadensis	wood-nettle
Leersia oryzoides	rice-cutgrass
Leersia virginica	Virginia cutgrass
Lemna minor	smaller duckweed
Lepidium densiflorum	pepperwort, peppergrass, tonguegrass
Lysimachia nummularia	moneywort
Medicago lupulina	black medick, nonesuch
Melilotus sp.	melilot, sweet clover
Menispermum canadense	yellow parilla, moonseed
Mirabilis nyctaganea	four-O'clock
Mitella diphylla	miterwort, Bishop's-cap, coolwort
Monarda fistulosa	wild bergamot
Morus rubra	red mulberry
Muhlenbergia sp.	muhly
Myriophyllum sp.	water-milfoil
Orchis spectabilis	showy orchis
Osmorhiza claytoni	sweet jarvil
Ostrya virginiana	American hop-hornbeam, leverwood, ironwood
Oxalis stricta	wood sorrel
Panicum virgatum	switchgrass
Parthenocissus quinquefolia	Virginia creeper, woodbine
Pastinaca sativa	parsnip
Phalaris arundinacea	canary-grass
Phleum pratense	common timothy, Herds' grass
Phlox divaricata	blue phlox
Phryma leptostachya	lopseed
Pilea pumila	richweed, clearweed, coolwort
Plantago sp.	plantain
Poa pratense	Junegrass, speargrass, Kentucky bluegrass
Podophyllum peltatum	May-apple, mandrake, wild jalap
Polygonatum biflorum	Solomon's-seal
Polygonum sp.	knotweed, smartweed
Polemonium reptans	Greek valarian, Jacob's-ladder
Populus deltoides	cottonwood, necklace-poplar
Populus tremuloides	quaking aspen, trembling aspen, quiver-leaf
Portulaca oleracea	common purslane
Potamogeton sp.	pondweed
Potentilla sp.	cinquefoil, five-finger
Prenanthes alba	white lettuce, rattlesnake-root
Prunus serotina	black or rum cherry
Prunus virginiana	choke cherry
Quercus alba	white oak
Quercus rubra	red oak
Quercus velutina	black oak, yellow-barked oak, quercitron

Scientific Name	Common Names
Ranunculus abortivus	kidneyleaf, buttercup
Ranunculus pensylvanicus	bristly crowfoot
Rhus aromatica	fragrant sumac, lemon sumac, polecat-bush
Rhus glabra	smooth sumac
Rhus radicans	poison ivy, mercury or markry, cowitch
Ribes cynosbati	prickly gooseberry, digberry
Rorippa islandica	Iceland yellow cress
Rosa blanda	rose
Rubus sp.	bramble
Rudbeckia hirta	black-eyed susan
Rudbeckia laciniata	cut-leaved coneflower
Rumex altissimus	pale dock
Sagittaria latifolia	wapato, duck-potato, arrowhead, swamp potato
Salix interior	sandbar willow
Salix nigra	black willow
Sambucus canadensis	common elder, elderberry
Sanguinaria canadensis	bloodroot, red puccoon
Sanicula marilandica	black snakeroot, sanicle
Scirpus atrovirens	bulrush
Setaria virdis	green foxtail, bottle-grass
Sicyos angulatus	bur-cucumber
Silphium perfoliatum	cup-plant
Smilacina racemosa	false Solomon's-seal, false spikenard
Smilax herbacea	carrion-flower, Jacob's-ladder
Smilax sp.	greenbriar, catbriar
Solidago sp.	goldenrod
Specularia perfoliata	Venus's looking-glass
Stellaria graminea	common stitchwort
Taraxicum officinale	common dandelion
Thalictrum dasycarpum	purple-meadowrue
Tilia americana	linden, basswood, whitewood
Tradescantia ohiensis	spiderwort
Trifolium pratense	red clover
Trifolium repens	white clover
Trillium flexipes	trillium
Typha latifolia	common cat-tail
Ulmus americana	American or white elm
Ulmus rubra	slippery or red elm
Urtica dioica	stinging nettle
Verbascum thapsus	common mullein, flannel-plant
Verbena stricta	hoary verbena
Viola sp.	violet
Vitis riparia	riverbank- or frost grape
Xanthium sp.	cocklebur
Xanthoxylum americanum	northern prickly ash, toothache-tree

Nomenclature follows M. L. Fernald, "Gray's Manual of Botany," 8th Ed., American Book Co., New York, N. Y., 1950.

APPENDIX A. HERBS OF THE PALO MARSH WILDLIFE REFUGE OPEN AREA

TABLE A.1. Relative Frequency of Herbs in the Open Area of Palo Marsh, 1972

Phalaris arundinacea, canary grass	75.0%
Carex sp., sedge	11.5%
Solidago sp., goldenrod	3.9%
Impatiens pallida, snapweed	3.9%
Acorus calamus, flagroot	3.9%
Leersia oryzoides, rice cutgrass	1.8%

TABLE A.2. Species List for the Open Area of Palo Marsh, 1972

Acer negundo
Acer saccharinum
Achillea lanulosa
Acorus calamus
Alisma triviale
Ambrosia artemisiifolia
Ambrosia trifida
Amorpha fruticosa
Anemone canadense
Artemisia ludoviciana
Asclepias incarnata
Asclepias syriaca
Asclepias verticillata

Betula nigra
Bromus inermis

Carex sp.
Chenopodium album
Circium arvense
Clematis pitcheri
Convolvulus sepium
Cornus drummondi
Crateagus mollis
Cuscuta sp.

Eleocharis sp.
Equisetum arvense
Equisetum kansanum
Erigeron canadensis
Erigeron sp.

Fraxinus pennsylvanica

Geum canadense
Gleditsia triacanthos

Hordeum jubatum

Impatiens pallida
Iris versicolor

Leersia oryzoides
Lemna minor
Lepidium densiflorum

Medicago lupulina

Oenothera biennis

Pastinaca sativa
Phalaris arundinacea
Poa pratensis
Polygonum sp.
Populus deltoides
Potentilla sp.
Potomogeton sp.

Rorippa islandica

Sagittaria latifolia
Salix interior
Sambucus canadensis
Scirpus atrovirens
Setaria viridis
Solidago sp.
Specularia perfoliata
Stellaria graminea

Tradescantia ohiensis
Trifolium pratense
Trifolium repens
Typha latifolia

Ulmus rubra
Urtica dioica

Verbascum thapsis
Verbena stricta
Vitis riparia

APPENDIX B. HERBS AND TREES OF THE PALO MARSH WILDLIFE REFUGE WOODS

TABLE B.1. Relative Frequency of Herbs in the Woods of Palo Marsh, 1972

Laportea canadensis, wood-nettle	30.6%
Cryptotaenia canadensis, honewort	17.7%
Impatiens pallida, snapweed	13.5%
Ranunculus pennsylvanicus, bristly crowfoot	11.3%
Rudbeckia laciniata, coneflower	9.7%
Ranunculus abortivus, buttercup	4.8%
Pilea pumila, clearweed	2.4%
Acer negundo, box-elder	2.4%
Polygonum sp., smartweed	2.4%
Galium sp., bedstraw	1.6%
Viola sp., violet	1.6%
Elymus virginicus, wild rye	0.7%
Aster sp., starwort	0.7%
Smilax sp., greenbriar	0.7%

TABLE B.2. Relative Frequency of Trees in the Woods of Palo Marsh, 1972

Acer saccharinum, soft or silver maple	19.0%
Acer negundo, box-elder	17.2%
Fraxinus pennsylvanica, green ash	14.7%
Crataegus mollis, hawthorn	13.8%
Ulmus americana, American elm	11.2%
Salix nigra, black willow	6.9%
Populus deltoides, cottonwood	4.3%
Juglans nigra, black walnut	3.4%
Gleditsia triacanthos, honey-locust	2.6%
Cornus drummondi, dogwood	1.7%
Quercus alba, white oak	1.7%
Betula nigra, black birch	0.9%
Juglans cinerea, butternut	0.9%
Xanthoxylum americanum, toothache-tree	0.9%
Celtis occidentalis, hackberry	0.9%

TABLE B.3. Species List for the Woods of Palo Marsh, 1972

Acer negundo
Acer saccharinum
Amphicarpa bracteata
Aster sp.

Betula nigra
Bidens sp.

Celtis occidentalis
Cephalanthus occidentalis
Cornus drummondi
Crataegus mollis
Cryptotaenia canadensis

Elymus virginicus
Euonymus atropurpureus

Fraxinus pennsylvanica

Galium aparine
Gleditsia triacanthos

Hydrophyllum virginianum

Impatiens pallida
Iodanthus pinnatifidus

Juglans cinerea
Juglans nigra

Laportea canadensis
Lysimachia nummularia

Menispermum canadense

Parthenocissus quinquefolia
Phlox divaricata
Pilea pumila
Polygonum sp.
Populus deltoides

Quercus alba

Ranunculus abortivus
Ranunculus pennsylvanicus
Rhus radicans
Rudbeckia laciniata

Salix nigra
Smilax sp.

Thalictrum dasycarpum

Ulmus americana

Viola sp.

Xanthoxylum americanum

APPENDIX C. HERBS AND TREES OF THE LEWIS BOTTOM ACCESS COUNTY PARK

TABLE C.1. Relative Frequency of Herbs in the Lewis Bottom Access County Park, 1972

Laportea canadensis, wood nettle	23.9%
Rhus radicans, poison ivy	17.0%
Aster sp., starwort	10.9%
Viola sp., violet	9.7%
Campanula americana, tall bellflower	7.9%
Ranunculus abortivus, buttercup	7.3%
Parthenocissus quinquefolia, Virginia creeper	7.3%
Impatiens pallida, snapweed	4.3%
Galium aparine, cleavers	4.2%
Elymus virginicus, wild rye	3.0%
Rudbeckia laciniata, coneflower	2.4%
Carex sp., sedge	2.4%
Pilea pumila, clearweed	1.2%
Vitis riparia, frost grape	0.6%
Acer negundo, box-elder	0.6%
Convolvulus sepium, bindweed	0.6%
Sambucus canadensis, common elder	0.6%
Sanucula marilandica, black snakeroot	0.6%
Lysimachia nummularia, money wort	0.6%
Galium sp., bedstraw	0.6%

TABLE C.2. Relative Frequency of Trees in the Lewis Bottom Access County Park, 1972

Acer negundo, box-elder	25.4%
Morus rubra, red mulberry	20.9%
Acer saccharinum, silver maple	19.4%
Ulmus americana, American elm	14.9%
Fraxinus pennsylvanica, green ash	10.4%
Populus deltoides, cottonwood	3.0%
Celtis occidentalis, hackberry	3.0%
Crataegus mollis, hawthorn	1.5%
Salix nigra, black willow	1.5%

TABLE C.3. Species List of Herbs and Trees in the Lewis Bottom Access County Park, 1972

Acer negundo
Acer saccharinum
Ambrosia artemisiifolia
Ambrosia trifida
Artemisia sp.
Asclepias verticillata
Aster sp.
Avena fatua

Betula nigra
Bromus inermis

Campanula americana
Carex sp.
Celtis occidentalis
Convolvulus sepium
Crataegus mollis

Echinocystis lobata
Elymus virginicus
Ellisia nyctellea
Erigeron sp.

Fraxinus pennsylvanica

Galium aparine
Galium sp.
Geranium carolinianum
Gleditsia triacanthos

Impatiens pallida

Lactuca sp.
Laportea canadensis
Lysimachia nummularia

Melilotus sp.
Mirabilis nyctaganea
Morus rubra

Oenothera biennis
Oxalis stricta

Panicum virgatum
Parthenocissus quinquefolia
Pilea pumila
Plantago sp.
Poa pratensis
Populus deltoides
Portulaca oleracea

Ranunculus abortivus
Rhus aromatica
Rhus radicans
Rosa blanda
Rudbeckia laciniata

Salix interior
Salix nigra
Sambucus canadensis
Sanicula marilandica
Specularia perfoliata
Stellaria graminea

Thalictrum dasycarpum

Ulmus americana

APPENDIX D. HERBS AND TREES OF THE LEWIS PRESERVE COUNTY PARK

TABLE D.1. Relative Frequency of Herbs in the Lewis Preserve County Park, 1972

Pilea pumila, clearweed	23.1%
Urtica dioica, stinging nettle	13.5%
Laportea canadensis, wood nettle	12.1%
Leersia virginica, Virginia cutgrass	11.5%
Ranunculus abortivus, buttercup	5.1%
Bidens sp., bur-marigold	4.5%
Viola sp., violet	3.8%
Polygonum sp., smartweed	3.8%
Cryptotaenia canadensis, honewort	2.6%
Elymus virginicus, wild rye	1.9%
Sicyos angulatus, bur-cucumber	1.9%
Impatiens pallida, snapweed	1.9%
Rhus radicans, poison ivy	1.9%
Aster sp., starwort	1.9%
Amaranthus retroflexus, pigweed	1.3%
Carex sp., sedge	1.3%
Solanum americanum	1.3%
Celtis occidentalis, hackberry	0.6%
Lysimachia nummularia, moneywort	0.6%
Sanicula marilandica, black snakeroot	0.6%
Plantago sp., plantain	0.6%
Iodanthus pinnatifidus, purple rocket	0.6%
Rudbeckia laciniata, cut-leaved coneflower	0.6%
Ulmus americana, American elm	0.6%
Vitis riparia, frost grape	0.6%
Oxalis stricta, wood sorrel	0.6%
Eupatorium rugosum, white snakeroot	0.6%

TABLE D.2. Relative Frequency of Trees in the Lewis Preserve County Park, 1972

Acer saccharinum, silver maple	34.0%
Ulmus americana, American elm	15.4%
Acer negundo, box-elder	13.1%
Crataegus mollis, soft hawthorn	12.1%
Fraxinus pennsylvanica, green ash	11.1%
Populus deltoides, cottonwood	5.5%
Gleditsia triacanthos, honey-locust	3.3%
Quercus alba, white oak	2.2%
Salix nigra, black willow	1.1%
Celtis occidentalis, hackberry	1.1%
Betula nigra, black birch	1.1%

TABLE D.3. Species List of Herbs and Trees in the Lewis Preserve County Park, 1972

Acer negundo
Acer saccharinum
Agropyron repens
Amaranthus retroflexus
Ambrosia artemisiifolia
Ambrosia trifida
Apocynum sp.
Asclepias syriaca
Asclepias verticillata
Avena fatua

Bidens sp.
Bromus inermis

Carex sp.
Celtis occidentalis
Convolvulus sepium
Crataegus mollis
Cryptotaenia canadensis
Cuscuta sp.

Echinocystis lobata
Elymus virginicus
Erigeron sp.
Eupatorium rugosum

Fraxinus pennsylvanica

Galium aparine
Geum canadense
Gleditsia triacanthos
Gymnocladus dioica

Hordeum jubatum

Impatiens pallida
Iodanthus pinnatifidus

Juglans nigra

Lactuca sp.
Laportea canadensis
Leersia virginica
Lepidium densiflorum
Lysimachia nummularia

Mirabilis nyctaginea

Oenothera biennis
Oxalis stricta

Phalaris arundinacea
Phleum pratense
Phlox divaricata
Pilea pumila
Plantago sp.
Poa pratensis
Polygonum sp.
Populus deltoides
Potentilla sp.

Quercus alba
Quercus rubra
Quercus velutina

Ranunculus abortivus
Rhus radicans
Rudbeckia hirta
Rudbeckia laciniata
Rumex altissima

Sambucus canadensis
Sanicula marilandica
Setaria viridis
Smilax sp.
Solanum americanum
Solidago sp.
Sicyos angulatus
Specularia perfoliata
Stellaria graminea

Thalictrum dasycarpum
Tilia americana

Ulmus americana
Urtica dioica

Verbascum thapsis
Viola sp.
Vitis riparia

Xanthium sp.

APPENDIX E. HERBS AND TREES OF THE WICKIUP HILL CONSERVATION AREA

TABLE E.1. Relative Frequency of Herbs in the Wickiup Hill Conservation Area, 1972

Fraxinus americana, white ash	10.2%
Parthenocissus quinque, Virginia creeper or woodbine	8.8%
Carex sp., sedge	8.3%
Cryptotaenia canadensis, honewort or wild chervil	7.9%
Laportea canadensis, wood-nettle	7.4%
Mitella diphylla, miterwort or Bishop's-cap	6.9%
Hepatica acutiloba, liverleaf	5.6%
Osmorhiza claytoni, sweet jarvil	5.6%
Circaea quadrisulcata, nightshade	5.1%
Phryma leptostachya, lopseed	4.2%
Phlox divaricata, blue phlox	4.2%
Carex albursina, sedge	3.2%
Cystopteris fragilis, fragile fern	3.2%
Sanicula marilandica, black snakeroot	2.8%
Ranunculus abortivus, buttercup	2.3%
Impatiens pallida, snapweed	2.3%
Viola sp., violet	1.9%
Galium sp., bedstraw	1.4%
Hydrophyllum virginianum, waterleaf	1.4%
Fraxinus pennsylvanica, green ash	0.9%
Rhus radicans, poison ivy	0.9%
Ulmus americana, American elm	0.9%
Tilia americana, linden or basswood	0.9%
Sanguinaria canadensis, bloodroot	0.4%
Oxalis stricta, wood sorrel	0.4%
Poa pratensis, Kentucky bluegrass	0.4%
Botrychium virginianum, rattlesnake-fern	0.4%
Ribes cynosbati, prickly gooseberry	0.4%
Geum canadense, Canadian avens	0.4%
Amphicarpa bracteata, hog-peanut	0.4%
Acer saccharum, hard maple, sugar maple	0.4%

TABLE E.2. Relative Dominance* of Trees in the Wickiup Hill Conservation Area, 1972

Quercus rubra, red oak	27.3%
Fraxinus pennsylvanica, green ash	23.8%
Quercus alba, white oak	14.5%
Fraxinus americana, white ash	11.0%
Tilia americana, basswood	10.7%
Juglans cinerea, butternut	7.0%
Ostrya virginiana, ironwood	4.5%
Acer saccharum, sugar maple	0.9%
Ulmus americana, American elm	0.5%

*Figures for relative frequency were not available.

$$\text{Relative frequency} = \frac{\text{frequency of species x}}{\text{sum of frequency values for all species}} \times 100$$

Where frequency is the probability of finding the species in any one quadrat.

$$\text{Relative dominance} = \frac{\text{basal area of species x}}{\text{total basal area of all species}} \times 100$$

Where basal area is the cross-sectional area of a tree 4.5 ft above ground.

TABLE E.3. Species List of Herbs and Trees in the Wickiup Hill Conservation Area, 1972

Acer negundo
Acer saccharum
Adiantum pedatum
Ambrosia trifida
Amphicarpa bracteata
Anemonella thalictroides
Asarum canadense
Asclepias syriacus
Avena fatua

Botrychium virginianum

Caltha palustris
Cannabis sativa
Carex albursina
Carex sp.
Carpinus caroliniana
Carya cordiformis
Celtis occidentalis
Chenopodium album
Circaea quadrisulcata
Cirsium arvense
Convolvulus sp.
Cornus drummondi
Crataegus mollis
Cryptotaenia canadensis
Cystopteris fragilis

Elymus virginicus
Erigeron sp.

Fraxinus americana
Fraxinus pennsylvanica

Galium aparine
Galium concinum
Geum canadense
Gleditsia triacanthos

Helianthus strumosus
Hepatica acutiloba
Hordeum jubatum
Hydrophyllum virginianum

Impatiens pallida

Juglans cinerea
Juglans nigra

Laportea canadensis
Lepidium densiflorum

Melilotus sp.
Menispermum canadense
Mitella diphylla
Monarda fistulosa

Orchis spectabilis
Osmorhiza claytoni
Ostrya virginiana
Oxalis stricta

Parthenocissus quinquefolia
Pilea pumila
Phlox divaricata
Phryma leptostachya
Plantago sp.
Poa pratensis
Podophyllum peltatum
Polygonum sp.
Polemonium reptans
Populus deltoides
Populus tremuloides
Prenanthes alba
Prunus virginiana

Quercus alba
Quercus rubra

Ranunculus abortivus
Rhus glabra
Rhus radicans
Ribes cynosbati
Rubus sp.
Rudbeckia laciniata
Rumex altissimus

Salix interior
Sanguniaria canadensis
Sanicula marilandica
Smilacina racemosa
Smilax herbacea

Taraxicum officinale
Tilia americana
Trifolium pratense
Trifolium repens

Ulmus americana
Urtica dioica

Vitis riparia

Xanthoxylum americanum

APPENDIX F. HERBS AND TREES AT THE PLEASANT CREEK RESERVOIR SITE

TABLE F.1. Relative Frequency of Herbs at the Pleasant Creek Reservoir Site, 1972

Sanicula marilandica, black snakeroot	11.1%
Cryptotaenia canadensis, honewort	10.5%
Laportea canadensis, wood nettle	9.4%
Solidago sp., goldenrod	6.7%
Parthenocissus quinquefolia, Virginia creeper	6.7%
Impatiens pallida, snapweed	5.5%
Phlox divaricata, blue phlox	3.9%
Menispermum canadense, moonseed	3.9%
Geum canadense, Canadian avens	3.3%
Smilax sp., greenbriar	2.8%
Carex sp., sedge	2.8%
Pilea pumila, clearweed	2.8%
Hydrophyllum virginianum, waterleaf	2.8%
Muhlenbergia sp., muhly	2.8%
Acer saccharum, sugar maple	2.2%
Vitis riparia, frost grape	2.2%
Sicyos angulatus, bur-cucumber	2.2%
Rhus radicans, poison ivy	1.7%
Urtica dioica, stinging nettle	1.7%
Viola sp., violet	1.7%
Oxalis stricta, wood sorrel	1.7%
Apios americana, wild bean	1.1%
Fraxinus pennsylvanica, green ash	1.1%
Prunus virginiana, choke cherry	1.1%
Helianthus strumosus, sunflower	1.1%
Phalaris arundinacea, canary grass	1.1%
Elymus virginicus, wild rye	0.7%
Aster cordifolia, heart-leaved aster	0.6%
Galium aparine, cleavers	0.6%
Ulmus americana, American elm	0.6%
Eupatorium sp., white snakeroot	0.6%
Erigeron annuus, daisy-fleabane	0.6%
Rorippa islandica, Iceland yellow cress	0.6%
Potentilla sp., cinquefoil	0.6%
Convolvulus sepium, bindweed	0.6%
Erigeron sp., fleabane	0.6%

TABLE F.2. Relative Frequency of Shrubs at the Pleasant Creek Reservoir Site, 1972

Acer negundo, box-elder	7.5%
Carya cordiformis, swamp hickory	5.0%
Celtis occidentalis, hackberry	12.5%
Fraxinus pennsylvanica, green ash	10.0%
Prunus virginiana, choke cherry	2.5%
Ribes cynosbati, gooseberry	15.0%
Rhus radicans, poison ivy	2.5%
Rubus sp., bramble	12.5%
Sambucus canadensis, common elder	2.5%
Ulmus americana, American elm	2.5%

TABLE F.3. Relative Frequency of Trees at the Pleasant Creek Reservoir Site, 1972

Celtis occidentalis, hackberry	26.5%
Acer negundo, box-elder	23.6%
Ulmus americana, American elm	13.2%
Fraxinus pennsylvanica, green ash	8.8%
Quercus rubra, red oak	8.8%
Juglans cinerea, white walnut	5.9%
Tilia americana, linden	5.9%
Acer saccharum, sugar maple	2.9%
Prunus serotina, black cherry	1.5%
Salix nigra, black willow	1.5%
Fraxinus americana, white ash	1.5%

TABLE F.4. Species List of Herbs, Shrubs and Trees at the Pleasant Creek Reservoir Site, 1972

Acer negundo
Acer saccharum
Ambrosia artemisiifolia
Ambrosia trifida
Amphicarpa bracteata
Apios americana
Aster cordifolius

Bidens sp.

Capsella bersa-pastoris
Carex sp.
Carya cordiformis
Catalpa speciosa
Caulophyllum thalictroides
Celtis occidentalis
Chenopodium album
Convolvulus sepium
Cornus drummondi
Cryptotaenia canadensis

Elymus virginicus
Equisetum arvense
Erigeron annus

Fraxinus americana
Fraxinus pennsylvanica

Galium aparine
Geum canadense

Helianthus strumosus
Hydrophyllum virginianum

Impatiens pallida

Juglans cinerea
Juniperus virginiana

Laportea canadensis

Menispermum canadense
Morus rubra
Muhlenbergia sp.

Orchis spectabilis
Osmorhiza claytoni
Oxalis stricta

Parthenocissus quinquefolia
Phalaris arundinacea
Phlox divaricata
Phryma leptostachya
Pilea pumila
Polygonatum biflorum
Polygonum sp.
Prunus serotina
Prunus virginiana

Quercus alba
Quercus rubra

Ranunculus abortivus
Rhus radicans
Ribes cynosbati
Rorippa islandica
Rubus sp.

Salix interior
Salix nigra
Sambucus canadensis
Sanicula marilandica
Silphium perfoliatum
Smilax sp.
Solidago sp.
Sicyos angulatus

Taraxicum officinale
Tilia americana
Trifolium repens
Trillium flexipes

Ulmus americana
Urtica dioica

Viola sp.
Vitis riparia

Xanthium sp.

APPENDIX G. BENTHIC ORGANISMS OF THE CEDAR RIVER IN THE DAEC AND CEDAR RAPIDS AREA

Biological Site 1: This site was located along the east bank of the Cedar River approximately ½ mile upstream from the CRI&P Railroad trestle (Fig. G.1, Point #2). The habitat was tangled and submerged twigs. The population was normal for this type of habitat and showed a high degree of biological diversity. Collection date, July 9, 1970.

Biological Site 2: The location of this site was near the west bank across the river from Biological Site 1. The habitat was the same, and the biological conditions were similar. Collection date, July 9, 1970.

Biological Site 3: This station was near the east bank, approximately 1½ miles above the Edgewood Road bridge (Fig. G.1, Point #3). Although there were not quite the numbers of organisms, the situation here was fairly normal for a submerged twig habitat. Collection date, June 26, 1970.

Biological Site 4: This site was on the west bank opposite Biological Site 3. The habitat in this case was small cobbles. This situation here was fairly normal. Collection date, June 26, 1970.

Biological Site 5: This site was located along the east bank about 250 yards above the Edgewood Road bridge (Fig. G.1, Point #3). There seemed to be some effect because the numbers of organisms were reduced. The populations were mostly mayflies. Habitat, rocks. Collection date, June 26, 1970.

Biological Site 6: The location was about 100 yards below the Vinton Ditch discharge along the west bank 200 yards below the upstream power dam (Fig. G.1, Point #4). This station was essentially devoid of aquatic life and would have to be considered polluted. The most probable pollution source at this location would be the discharge entering the river from the Vinton Ditch, which carries the effluent of the Dearborn Brass Company. Habitat, rocks. Collection date, June 26, 1970.

Biological Site 7: This site was by the railroad bridge just upstream from the Penick and Ford Co. (Fig. G.1, Point #5). The habitat was the midchannel part of a shallow rock and cobble area. The situation here was fairly normal with respect to the kinds of organisms found, although there was some depression in numbers of individuals. Collection date, June 26, 1970.

Biological Site 8: The site was ½ mile upstream from the Indian Creek sewage outfall (Fig. G.1, Point #10). The substrate was rock near the west bend of the river. Some recovery was indicated at this station by the increase in numbers and diversity of the pollution-sensitive organisms. Collection date, July 1, 1970.

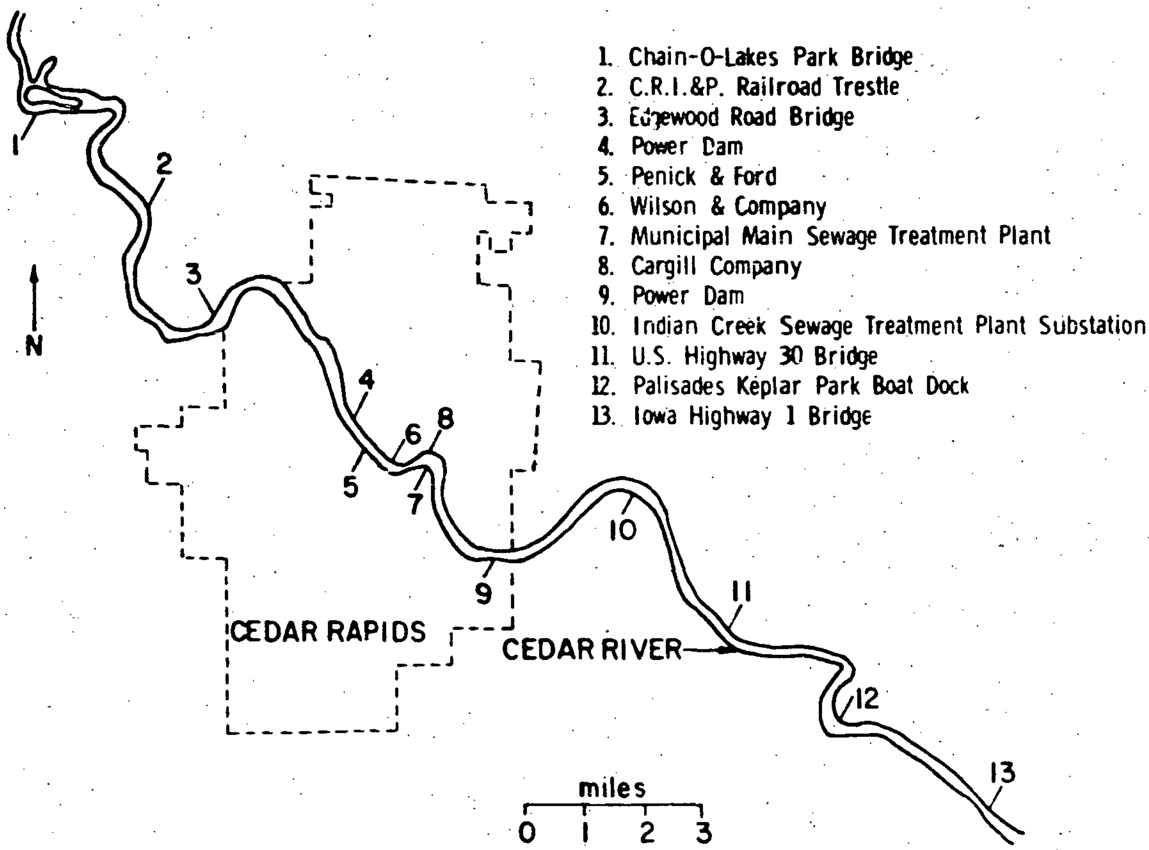

Fig. G.1. Map of Cedar River Benthic Study Area. From Report 71-1, Ref. 2.

Biological Site 9: This site was near the east bank ½ mile above the Indian Creek sewage outfall (Fig. G.1, Point #10). Similar to the above site, recovery from pollution was indicated by the increase in numbers and diversity of pollution-sensitive organisms. Habitat, rocks. Collection date, July 1, 1970.

Biological Site 10: This site was located near the west bank 3/4 mile below the Indian Creek outfall (Fig. G.1, Point #10). Some pollution was indicated by the lack of diversity of mayfly nymphs; however, caddis larvae were present in fairly large numbers. Habitat, twigs. Collection date, July 1, 1970.

Biological Site 11: This site was near the east bank 1-3/4 mile below the Indian Creek outfall (Fig. G.1, Point #10). Biological conditions were approaching normal. Habitat, twigs. Collection date, July 1, 1970.

Biological Site 12: This site was located near the west bank 1-3/4 mile below the Indian Creek outfall (Fig. G.1, Point #10). Although large numbers of *Stenonema* and *Cheumatopsyche* were present, the lack of diversity of pollution-sensitive forms indicated some adverse effects of the upstream wastes. Habitat, rocks. Collection date, July 1, 1970.

Biological Site 13: This site was on the west bank 1½ miles above the Palisades Park boat ramp (Fig. G.1, Point #12). This station was devoid of fish food organisms, indicating a polluted condition. Habitat, rocks. Collection date, August 6, 1970.

Biological Site 14: The location of this site was near the east bank 1½ miles upstream from the Palisades Park boat ramp (Fig. G.1, Point #12). The lack of caddis larvae indicate some effects of pollution in this area. Habitat, rocks. Collection date, August 6, 1970.

Biological Site 15: This site was near the west bank 3/4 mile above the Palisades Park (Fig. G.1, Point #12). This area was essentially devoid of fish food organisms except for two pollution-tolerant *Chironomus* sp. Habitat, rocks. Collection date, August 6, 1970.

Biological Site 16: This site was also 3/4 mile above Palisades Park, but along the east bank. A lack of any pollution-sensitive forms and the predominance of *Chironomus* indicated a polluted condition. Habitat, twigs. Collection date, August 6, 1970.

On July 25-26, 1970, a massive fish-kill including both game and rough fish occurred in the Cedar River at the lower end of the study area. The cause of the kill was attributed to low levels of dissolved oxygen. Initially it was postulated that the low oxygen was due to a heavy algae bloom in the kill zone of the river. However, the study showed that the primary cause of the oxygen depletion in the lower end of the area investigated was the oxygen demand of organic wastes discharged by the

TABLE G.1. Major Potential Sources of Pollution Entering the Cedar River in the Cedar Rapids Area

Effluent Source	Location (See Map, Fig. G.1)	Potential Pollutant
CRI&P train wreck	Point #2	Organic waste
Cedar Lake discharge	3/4 mile above point #4	Metals, R.R. car washings
Quaker Oats discharge	25 yd above point #4	Thermal
Vinton Ditch storm sewer	100 yd below point #4	Metals
Penick & Ford	Point #5	Organic waste
Riverside Park storm sewer	200 yd below point #5	Metals
Wilson & Company	Point #6	Organic waste
Cargill Company	Point #8	Organic waste
Municipal Water Pollution Control Plant	Point #7	Organic waste
Sewage treatment plant lagoon seepage	Just below #7	Organic waste
Prairie Creek	1/2 mile above point #9	Metals, organic waste
Indian Creek Sewage Treatment Plant	Point #10	Organic waste

TABLE G.2. Major Benthic Organisms Found in the Cedar River

Organism	Sensitivity Rating[a]	Number Found by Ten-Minute Hand Count at Each Biological Site[b] 1(2)[c]	2(2)	3(3)	4(3)	5(3)	6(4)	7(5)	8(10)	9(10)	10(10)	11(10)	12(10)	13(12)	14(12)	15(12)	16(12)
Hydropsyche sp. (caddis fly)	C	82	36	12	2			1	3	25	26	61		0		0	0
Cheumatopsyche sp. (caddis fly)	C	19	11	4				8	25	9	22	11	41	0	1	0	0
Baetis sp. (mayfly)	C	18	26	15				2	3	7				0	28	0	0
Heptagenia sp. (mayfly)	C	13	18		6	2		19	12	2	8	27		0	10	0	0
Isonychia sp. (mayfly)	C	2						8	4	23		3		0		0	0
Stenonema sp. (mayfly)	C	12	36		23	14		8	49	14		8	97	0	3	0	0
Ischnura sp. (dameslfly)	F														1	0	7
Stenelmis sp. (elmid beetle)	F														8	0	0
Simulium sp. (black fly)	F	31	16	44				1		13	1			0		0	0
Pentaneura sp. (midge)	F	11		12						1	4			0	7	0	10
Hirudinea sp. (leech)	F												3	0	4	0	11
Chironomus sp. (bloodworm & midge)	P															2	160

[a] Clean water = C
Facultative = F
Pollutional = P

[b] For description of sampling sites, see preceding pages

[c] Numbers in parentheses refer to map numbers (Fig. G.1)

Cedar Rapids Municipal Water Pollution Control Plant. While oxygen consumption by the algae at night would certainly be a contribution factor to the lowering of dissolved oxygen levels, the algae contribution to the kill can only be considered as slight when compared to the waste discharges of the Cedar Rapids area. In fact, algae cell concentrations above the city of Cedar Rapids (Edgewood Road bridge) and from the major kill zone (Palisades Park) were virtually an identical 30,000 cells/ml. On the other hand, it is an accepted fact that when an organic effluent, such as that from the Cedar Rapids Water Pollution Control Plant, is discharged into a stream, the oxygen demand of that effluent will cause a sag in the level of dissolved oxygen somewhere below the point of discharge. This sag will be followed by a natural recovery due to physical and biological processes in the river as the water moves downstream. The depth of the oxygen sag and the length of the river over which recovery occurs is, of course, a function of the strength of the discharge.

References

1. D. B. McDonald, "Annual Report on the Cedar River Baseline Ecological Study for the Duane Arnold Energy Center in Iowa," 1972.
2. W. R. Shobe and J. H. Gakstatter, "Water Quality Survey of the Cedar River, Cedar Rapids, Iowa Area," State Hygienic Laboratory, Report 71-7, 1970.
3. M. D. Wagner, "A Study of Factors Influencing the Water Quality of the Cedar River," Master Thesis, University of Iowa, 1972.

APPENDIX H. FISHERIES STUDIES IN THE CEDAR RIVER NEAR THE DAEC

TABLE H.1. Fisheries Studies with Shocking and Bait Nets

Species	Nets (10 net days)		Shocking (15 min)	
	Number	Weight, lb	Number	Weight, lb
		Above DAEC, June 18-22, 1971		
Channel catfish	210	262	0	0
Flathead catfish	8	28	0	0
Carpsucker	1	1	8	11.0
Carp	11	32	2	5.0
White crappie	0	0	1	0.1
Northern redhorse	0	0	1	0.3
Gizzard Shad	0	0	3	0.3
	Nets (9 net days)		Shocking (20 min)	
		Below DAEC, June 18-22, 1971		
Channel catfish	232	52	4	1.0
Flathead catfish	5	47	1	0.6
Carpsucker	2	2	30	23.0
Carp	9	30	17	28.0
Bigmouth buffalo	7	24	0	0
Black crappie	0	0	1	0.4
Northern redhorse	0	0	7	11.0
Gizzard shad	0	0	1	0.1

Continued

TABLE H.1. Fisheries Studies with Shocking and Bait Nets (cont.)

Species	Net (12 net days) Number	Net (12 net days) Weight, lb	Shocking Number	Shocking Weight, lb	Seine Number
		Above DAEC, November 24-28, 1972			
Channel catfish	47	14			57
Carp	3	4			0
Carpsucker	1	1			0
River carpsucker	0	0			64
Highfin carpsucker	0	0			3
Fathead minnow	0	0			2
Bullhead minnow	0	0			23
Bluntnose minnow	0	0			28
Northern common shiner	0	0			1
Emerald shiner	0	0			3
Spotfin shiner	0	0			3
Bigmouth shiner	0	0			3
Sand shiner	0	0			143

	Net (9 net days)		Shocking (15 min)		Seine
		Below DAEC, Nov. 24-28, 1972			
Channel catfish	113	26	5	1	0
Flathead catfish	4	4	0	0	0
Carp	0	0	9	13	0
Carpsucker	5	4	22	12	0
White crappie	1	1	2	1	0
Northern redhorse	0	0	3	5	1
Golden redhorse	0	0	7	6	0
Gizzard shad	0	0	5	1	0
River carpsucker	0	0	0	0	7
Bullhead minnow	0	0	0	0	21
Bluntnose minnow	0	0	0	0	8
Northern common shiner	0	0	0	0	4
Spotfin shiner	0	0	0	0	295
Bigmouth shiner	0	0	0	0	17
Sand shiner	0	0	0	0	21

TABLE J.1. Population Doses from Airborne Releases

Direction		Boundary	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
		Distance (Miles)										
N	a	20	18	14	8.4	5.6	4.0	2.0	.82	.42	.27	.19
	b	14	13	10	6.1	4.0	2.9	1.5	.60	.31	.20	.13
	c	0	0	5.1	21	22	15	278	80	180	62	126
	d	21	19	15	8.9	5.9	4.2	2.1	.87	.45	.30	.21
	e	0	0	.05	.35	.55	.50	19	13	56	31	86
NNE	a	11	10	7.9	4.8	3.2	2.3	1.1	.46	.24	.15	.095
	b	8.1	7.3	5.7	3.4	2.3	1.6	.83	.34	.18	.11	.083
	c	0	0	8.6	10	10	6.6	25	47	88	34	66
	d	12	11	8.3	5.0	3.3	2.4	1.2	.49	.26	.17	.12
	e	0	0	.15	.30	.45	.40	3.0	14	50	30	80
NE	a	8.1	7.4	5.8	3.5	2.3	1.6	.83	.34	.17	.11	.080
	b	5.9	5.3	4.2	2.5	1.7	1.2	.61	.25	.13	.085	.061
	c	0	0	6.3	7.5	6.7	4.8	18	52	30	51	45
	d	8.6	7.8	6.1	3.7	2.4	1.8	.88	.36	.19	.12	.09
	e	0	0	.15	.30	.40	.40	2.9	21	24	61	75
ENE	a	5.5	5.0	3.9	2.4	1.6	1.1	.57	.23	.12	.076	.054
	b	4.0	3.6	2.8	1.7	1.1	.82	.41	.17	.088	.057	.041
	c	0	0	4.3	6.0	5.7	4.1	28	34	8.8	34	25
	d	5.8	5.3	4.1	2.5	1.7	1.2	.60	.24	.13	.08	.06
	e	0	0	.15	.35	.50	.50	6.7	20	10	60	60
E	a	7.8	7.1	5.5	3.3	2.2	1.6	.80	.32	.16	.11	.076
	b	5.6	5.1	4.0	2.4	1.6	1.2	.58	.24	.12	.080	.058
	c	0	0	8.0	16	6.4	6.9	24	109	55	32	32
	d	8.2	7.4	5.8	3.5	2.3	1.7	.85	.35	.18	.12	.08
	e	0	0	.20	.65	.40	.60	4.1	46	44	41	56
ESE	a	9.5	8.6	6.8	4.1	2.7	1.9	.98	.39	.20	.13	.093
	b	6.9	6.2	4.9	2.9	2.0	1.4	.71	.29	.15	.098	.071
	c	0	0	7.3	5.9	7.8	9.2	468	145	60	49	28
	d	10	9.1	7.1	4.3	2.8	2.0	1.0	.42	.22	.14	.10
	e	0	0	.15	.20	.40	.65	.66	50	40	50	40
SE	a	13	12	9.0	5.4	3.6	2.6	1.3	.53	.27	.17	.12
	b	9.2	8.3	6.5	3.9	2.6	1.9	.95	.38	.20	.13	.095
	c	0	0	33	20	13	17	3500	1280	118	292	61
	d	13	12	9.5	5.7	3.8	2.7	1.4	.56	.29	.19	.14
	e	0	0	.50	.50	.50	.90	370	330	59	220	64
SSE	a	14	13	10	6.2	4.1	3.0	1.5	.60	.30	.20	.14
	b	10	9.5	7.5	4.5	3.0	2.2	1.1	.44	.23	.15	.11
	c	0	0	19	38	6.0	13	2760	1330	92	328	65
	d	15	14	11	6.5	4.3	3.1	1.6	.64	.33	.22	.16
	e	0	0	.25	.85	.20	.60	250	300	40	220	60

TOTAL = 15 manrem/year
a Dose from halogens + particulates, mrem/year x 10^3
b Dose from noble gases, mrem/year x 10
c Manrem/year x 10^3
d Dispersion factor x 10^8
e Sector population, in hundreds (1970)

TABLE J.1. (cont'd)

Direction		Boundary	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
		Distance (Miles)										
S	a	11	10	8.1	4.8	3.2	2.3	1.2	.47	.24	.16	.11
	b	8.3	7.5	5.9	3.5	2.3	1.7	.85	.35	.18	.12	.085
	c	0	0	12	7.1	8.2	2.5	57	99	59	140	52
	d	12	11	8.6	5.1	3.4	2.5	1.2	.51	.26	.17	.12
	e	0	0	.20	.20	.35	.15	6.7	28	32	120	61
SSW	a	6.2	5.6	4.4	2.6	1.8	1.3	.63	.26	.13	.084	.060
	b	4.5	4.0	3.2	1.9	1.3	.91	.46	.18	.098	.063	.046
	c	0	0	3.2	46	23	1.8	42	38	29	70	23
	d	6.5	5.9	4.6	2.8	1.8	1.3	.67	.27	.14	.09	.07
	e	0	0	.10	2.4	1.9	.20	9.2	20	30	111	50
SW	a	4.9	4.4	3.4	2.1	1.4	1.0	.50	.20	.10	.067	.048
	b	3.5	3.2	2.5	1.5	1.0	.72	.36	.15	.077	.050	.036
	c	0	.96	2.5	3.0	2.5	1.8	12	29	28	15	11
	d	5.1	4.7	3.7	2.2	1.5	1.1	.53	.21	.11	.07	.05
	e	0	.03	.10	.20	.25	.25	3.2	20	37	30	31
WSW	a	5.1	4.6	3.6	2.2	1.4	1.0	.53	.21	.11	.070	.050
	b	3.7	3.4	2.6	1.6	1.0	.76	.38	.16	.081	.053	.038
	c	0	1.3	4.0	2.4	2.1	6.8	11	16	24	16	11
	d	5.4	4.9	3.8	2.3	1.5	1.1	.56	.23	.12	.08	.06
	e	0	.04	.15	.15	.20	.90	2.9	10	30	30	30
W	a	6.0	5.4	4.2	2.5	1.7	1.2	.61	.25	.13	.081	.058
	b	4.3	3.9	3.1	1.8	1.2	.88	.44	.18	.093	.061	.044
	c	0	.78	6.1	5.5	4.9	29	21	67	19	20	29
	d	6.3	5.7	4.5	2.7	1.8	1.3	.65	.26	.14	.09	.06
	e	0	.02	.20	.30	.40	3.3	4.8	37	20	32	65
WNW	a	9.1	8.2	6.5	3.9	2.6	1.8	.93	.37	.19	.12	.089
	b	6.6	6.0	4.7	2.8	1.9	1.3	.68	.28	.14	.093	.068
	c	0	0	9.4	5.6	4.7	4.7	20	55	29	19	47
	d	9.6	8.7	6.8	4.1	2.7	2.0	.99	.40	.21	.14	.10
	e	0	0	.20	.20	.25	.35	2.9	2.9	20	20	70
NW	a	9.4	8.5	6.7	4.0	2.6	1.9	.96	.39	.20	.13	.092
	b	6.8	6.1	4.8	2.9	1.9	1.4	.70	.28	.15	.096	.070
	c	0	3.1	2.4	10	4.8	2.8	21	56	42	144	366
	d	9.9	8.9	7.0	4.2	2.8	2.0	1.0	.42	.22	.14	.10
	e	0	0.5	0.5	.35	.25	.20	.30	20	28	150	520
NNW	a	12	11	8.3	5.0	3.3	2.4	1.2	.48	.25	.16	.11
	b	8.4	7.7	6.0	3.6	2.4	1.7	.87	.36	.18	.12	.087
	c	0	.77	0	0	4.8	4.3	78	68	52	168	436
	d	12	11	8.8	5.3	3.5	2.5	1.3	.52	.27	.17	.13
	e	0	.01	0	0	.20	.25	9.0	19	28	140	500

TOTAL = 15 manrem/year

a Dose from halogens + particulates, mrem/year x 10^3

b Dose from noble gases, mrem/year x 10

c Manrem/year x 10^3

d Dispersion factor x 10^8

e Sector population, in hundreds (1970)

APPENDIX K

TEXT OF COMMENTS RECEIVED

ON

DRAFT ENVIRONMENTAL STATEMENT

FOR

DUANE ARNOLD ENERGY CENTER

DOCKET NO. 50-331

ADVISORY COUNCIL
ON
HISTORIC PRESERVATION

WASHINGTON, D.C. 20240

January 5, 1973

Mr. Francis A. St. Mary
Project Manager
Environmental Projects Branch No. 4
Directorate of Licensing

Dear Mr. St. Mary:

Thank you very much for your prompt response to our comments concerning the Duane Arnold Energy Center.

Having reviewed the document submitted, the Advisory Council on Historic Preservation has determined that your draft environmental statement is adequate regarding our area of expertise and we have no further comment to make.

Sincerely yours,

John D. McDermott
John D. McDermott
Acting Executive Secretary

THE COUNCIL, an independent agency of the Executive Branch of the Federal Government, is charged by the Act of October 15, 1966, with advising the President and Congress in the field of Historic Preservation, commenting on Federal, federally assisted, and federally licensed undertakings having an effect upon properties listed in the National Register of Historic Places, recommending measures to coordinate governmental with private activities, advising on the dissemination of information, encouraging public interest and participation, recommending the conduct of special studies, advising in the preparation of legislation, and encouraging specialized training and education, and guiding the United States membership in the International Centre for the Study of the Preservation and the Restoration of Cultural Property in Rome, Italy.

DEC 29 1972

Advisory Council on Historic
Preservation
ATTN: Mr. Jordan Tannenbaum
1522 K Street, N. W.
Suite 430
Washington, D. C. 20005

Dear Mr. Tannenbaum:

Enclosed as per our telecon on December 27, 1972, is a copy of a letter from Mr. Adrian D. Anderson, State Liaison Officer (Iowa) to Dr. Kerry Dance (Team Leader, Argonne National Laboratory) dated September 5, 1972.

Don't hesitate to call if I can be of further assistance.

Sincerely,

Original signed by
F. A. St. Mary

Francis A. St. Mary, Project Manager
Environmental Projects Branch No. 4
Directorate of Licensing

Enclosure:
As stated

50-331

ADVISORY COUNCIL
ON
HISTORIC PRESERVATION
WASHINGTON, D.C. 20240

RECEIVED

December 26, 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

In response to your request of November 20, 1972 for comments on the environmental statement for the Duane Arnold Energy Center, and pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969, the Advisory Council on Historic Preservation has determined that your draft environmental statement is inadequate regarding our area of expertise as it does not contain sufficient information to enable the Advisory Council to comment. Therefore, the Council considers your draft environmental statement incomplete and cannot comment until sufficient information is supplied by your agency indicating:

a. That the most recent listing of the National Register of Historic Places has been consulted and that no National Register properties are affected by the proposed project.

   Although your environmental statement contains evidence of having consulted the National Register of Historic Places, the inventory utilized by your agency (Federal Register 36, No. 35, February 2, 1971) is not the most current listing. Determinations should be based on the Federal Register of March 15, 1972. Volume 37, No. 51 and the monthly supplements which appear in the Federal Register on the first Tuesday of each month and contain the latest additions to the National Register.

b. Compliance with Executive Order 11593 of May 13, 1971.

   In addition to those sections detailing Federal responsibilities, particular attention should be payed to Section 1(3) of the Executive Order which requires that in the case of lands not under the control or jurisdiction of the Federal Government a determination be made as to whether or not the proposed undertaking will contribute to the preservation and enhancement of non-federally owned districts, sites, buildings,

structures and objects of historical, archeological, architectural or cultural significance.

c. That a comprehensive interdisciplinary study has been made of al archeological, historical, architectural and cultural resources extant in the proposed project area; the effects, if any, on the resources; and an account of steps taken to assure their preservation and enhancement.

In order to expedite our review of the draft environmental statement, ple furnish the Advisory Council with the necessary information at your earli convenience. Should you have any questions on these comments or require any additional assistance, please contact Mr. Jordan Tannenbaum of the Advisory Council staff.

Sincerely yours,

John D. McDermott
Acting Executive Secretary

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

50-331

January 9, 1973

Mr. Daniel R. Muller
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

We have had the draft environmental statement for the Duane Arnold Energy Center, Iowa Electric Light and Power Company, reviewed in the relevant agencies of the Department of Agriculture and comments from Soil Conservation Service and Forest Service, both agencies of the Department, are enclosed.

Sincerely,

T C Byerly

T. C. BYERLY
Assistant Director
Science and Education

Enclosures

United States Department of Agriculture
Forest Service

RE: Duane Arnold Energy Center, Iowa Electric Light and Power Company

The project is largely in place. The draft states that no trees were removed in construction of the power plant site, and that of the 1,182 acres (87 miles) of rights-of-way for the transmission lines, 3.6% are wooded. (Table 2-4.1-1 of Amendment 2 of Iowa Electric Light and Power Co.'s Environment Report indicates 34.2 acres, but the apparent discrepancy of 8.3 acres is probably explained someplace and we missed it; in any event, it is not significant.) From the description of the location and clearing of the right-of-way, it would appear that adequate consideration has been given wooded areas both in the draft, and on-the-ground.

Soil Conservation Service, USDA
Comments on Draft Environmental Statement
prepared by the Iowa Electric Light and
Power Company for the Duane Arnold Energy
Center

We have reviewed the draft statement and believe that the project will not adversely affect any Soil Conservation Service program in Linn County, Iowa.

The Soil Conservation Service, through the Linn County Soil Conservation District, would be glad to provide further assistance concerning problems related to soils, drainage or general land use.

We appreciate the opportunity to review and comment on this project.

K-9

THE ASSISTANT SECRETARY OF COMMERCE
Washington, D.C. 20230

January 5, 1973

50-331

RECEIVED
JAN 5 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Mr. Daniel R. Muller, Assistant Director
for Environmental Projects
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

The draft environmental impact statement for the Duane Arnold Energy Center which accompanied your letter of November 20, 1972, has been received by the Department of Commerce for review and comment.

The Department of Commerce has reviewed the draft environmental statement and has the following comments to offer for your consideration.

We have assumed from table 3.7 and the preceding text that the bulk of the radioactive routine release is from the gland seal and the air ejector by way of the 100-m main off-gas stack. Our estimate for the maximum annual average relative concentration is 8×10^{-8} sec m^{-3} towards the north of the site and at a distance of 2500 m. This is in comparison to the applicant's value of 6×10^{-8} sec m^{-3} as found in the Final Safety Analysis Report. If our interpretation of the AEC staff's table 5.4 is correct, their maximum value is 2.1×10^{-7} sec m^{-3}. However, no units are indicated nor is the assumed stack height and the meteorological data base presented.

We have reviewed the sections of the draft environmental impact statement pertaining to the impact of operation of the Duane Arnold Energy Center, Linn County, Iowa, on the aquatic environment, and we noted several deficiencies in the information provided in the radiological portions of the statement. Table 5.3, "Doses to Biota in the Vicinity of the DAEC," does not specify the units for the radiation doses listed; however, we assume that the dose rates given in the table are in mrems/year. Table 6.1, "Sampling System for the Environmental Monitoring Programs," lists Cedar River as a sampling location for aquatic biota but does not specify either the distance from the effluent outfall or the species to be sampled. Aquatic plants are not included in the list of samples to be analyzed. We suggest that the information in these tables be revised and expanded.

We hope these comments will be of assistance to you in the preparation of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 72/1342

RECEIVED FEB 6 1973

FEB 5 1973

50-331

Dear Mr. Muller:

This is in response to your letter of November 20, 1972, requesting our comments on the Atomic Energy Commission's draft statement, dated November 1972, on environmental considerations for Duane Arnold Energy Center, Linn County, Iowa.

Our comments are presented according to the format of the statement or according to specific subjects.

Historic and Archeological Landmarks

Since the power plant is more than 60 percent complete, most of the environmental effects resulting from plant construction have been experienced. Further construction and operation of the nuclear power plant will not affect any existing or proposed units of the National Park System nor any site eligible for registration as National Historic, Natural or Environmental Education Landmarks.

Geology and Seismology

The brief description of the geology and seismology presented in the draft statement is inadequate for an independent assessment of the geologic environment relevant to the proposed construction of the plant. We think that the physical properties of the geologic materials on which the plant and its appurtenant structures will be founded should be described along with an indication of how a knowledge of the physical properties were used in the design of the facility. The seismic-design criteria and the methods of their derivation should also be included.

The draft statement refers to the applicant's Safety Analysis Report to the AEC that treats the details of the geologic and seismologic investigations and analyses that have been performed for the plant. We suggest that, as a minimum, a more comprehensive summary of the geologic and seismologic analysis sections of the Safety Analysis Report be included in the final environmental statement with adequate cross references to appropriate parts of the environmental statement to indicate how the data and analyses have been utilized for purposes of design and construction.

As a result of procedures established between the Geological Survey and the AEC, we have previously reviewed the geologic aspects of the site that are included in the Safety Analysis Report. The Geological Survey's comments were transmitted to the AEC Director of Regulation on October 8, 1969, and was made part of the public record in the AEC licensing procedures.

Hydrology

The applicant and AEC should remain cognizant of any future surface or ground-water developments located downgradient from the plant and update appropriate monitoring systems as needed.

Chemical and Biocide Systems

The defouling method described on page 3-35 specifies a liquid chlorine treatment dose of 5 ppm at the condenser inlet with a chlorine residual at the outlet of 0.1 ppm. Since chlorine is extremely toxic to aquatic organisms consideration should be given to completely eliminating it from the discharge. Therefore we think that consideration should be given to constructing an impoundment or other devices that would result in the elimination of chlorine, other biocides and residual chemical salts in the plant effluent.

Effect on Land Use

The impacts of the transmission facilities on public areas such as parks, wildlife, recreation and wooded areas are described on page 4-1 as minimal. We do not consider this an adequate description of the environmental impacts and suggest that a more adequate assessment of these impacts be given in the final environmental statement.

Present Land Use plans for the 500-acre project site will involve about 40 acres for plant facilities and the remaining 460 acres will be allowed to revert to natural vegetation. We believe that a land use plan which would enhance the indigenous wildlife populations and the aesthetic appeal of the site should be considered. Also, controlled public hunting should be considered where this activity is compatible with the safety limitations of the plant. We suggest that the applicant contact State and local planning authorities to determine the type of facilities that could be developed to serve the recreational needs of the area.

Since the Pleasant Creek Reservoir will become an integral part of the plant operation, it should be described beyond that given on page 2.1 of the draft environmental statement. The reservoir site, water supply, water level regulation, other physical and operational details and the beneficial and adverse environmental impacts of construction and operation of the reservoir should be included in the statement. Its recreational development should be meshed with those of the plant site and the surrounding recreational areas.

This Department through the Bureau of Outdoor Recreation has received correspondence from the State regarding funding assistance for the proposed reservoir and is withholding a decision pending receipt of a description of the proposal. We have reservations for funding a project where the applicant would have a right to drawdown the reservoir during the recreation season and to construct a 345 kv overhead transmission line which would cross one arm of the reservoir.

Effluent and Environmental Monitoring Programs

We are pleased that the postoperational radiological and ecological monitoring and biological surveys will be conducted at the same intensity and thoroughness as the preoperational studies; however, we think that the applicant should also have contingency plans for increasing the number of sampling stations or intensity of sampling at the present stations if unexpected adverse effects are experienced. These plans should be described in the final statement.

Plant Accidents

This section contains an adequate evaluation of impcats resulting from plant accidents through Class 8 for airborne emissions. However, the environmental effects of releases to water is lacking. Many of these postulated accidents listed in table 7.2 could result in releases to the Cedar River and should be evaluated.

We also think that Class 9 accidents resulting in both air and water releases should be described and the impacts on human life and the remaining environment discussed as long as there is any possibility of occurrence. The consequences of an accident of this severity could have far-reaching effects on land and in the Cedar, Iowa and Mississippi Rivers systems which could persist for centuries.

Alternative Means of Power Generation

The emissions of an alternative coal-fired powerplant which are based on the EPA new source performance standards promulgated in December 1971 are included on page 9-7. We suggest that the specific limiting values for emission control be given in this section, perhaps a footnote to table 9.3 would be appropriate.

If State and local emission control regulations are stricter than the EPA regulations these limiting values should also be given. If there are no State or local regulations or if they are less limiting than the EPA regulations, the statement should so indicate.

We hope these comments will be helpful to you in the preparation of the final environmental statement.

Sincerely yours,

Deputy Assistant Secretary of the Interior

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS
U.S. COAST GUARD (GWS/83)
400 SEVENTH STREET S.W.
WASHINGTON, D.C. 20590
PHONE: 426-2262

50-331

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of 20 November 1972 addressed to Mr. John E. Hirten, Assistant Secretary for Environment and Urban Systems, concerning the draft environmental impact statement, environmental report and other pertinent material on the Duane Arnold Energy Center, Linn County, Iowa.

The concerned operating administrations and staffs of the Department of Transportation have reviewed the material submitted.

The Federal Railroad Administration noted:

"In its review of the draft environmental impact statement, the Federal Railroad Administration notes that 5.05 miles of railroad right-of-way will be utilized for DAEC 161 KV transmission lines. We endorse this joint use of right-of-way and assume that satisfactory arrangements have been made with the involved railroad.

"The discussion in the draft environmental impact statement concerning transmission lines is considered by us to be one of the most comprehensive that we have reviewed. However, it is suggested that there be included a brief acknowledgement that the inductive coupling problem with railroad signal and communication lines has been addressed."

In its review of the project, the Federal Aviation Administration commented as follows:

"We have reviewed the draft environmental impact statement concerning the Duane Arnold Energy Center, Cedar River, Linn County, Iowa. While the nuclear station plant does not appear to present any conflict with the programs or plans of the FAA, the transmission lines could adversely affect navigable air-space if any of the lines are erected in close proximity to existing airports.

"The cover sheet of the enclosed form (Notice of Proposed Construction or Alteration) defines the requirements for "notification" of proposed construction near airports.

"It is requested that we be advised by completion of the form of any proposed construction near airports that would be within the parameters defined by the enclosure. Should the sponsor desire to discuss any aspect of the notification procedures, Mr. Howard Tisdale (phone 816 374-3408) is familiar with the Duane Arnold Energy Center project."

The Department of Transportation has no further comments to offer on the draft statement. This Department concurs with the comment of the Federal Railroad Administration that the discussion in the draft statement on the transmission lines is indeed most comprehensive. The final statement should reflect the fact that "right-of-way" arrangements are satisfactory to the involved railroads and also that an acknowledgement be included that the inductive coupling problem with railroad and communication lines was addressed.

FAA Form 7460-1, which they note in their comments, is attached. It is requested that it be forwarded to the applicant for execution.

The opportunity for the Department of Transportation to review and comment on the draft environmental impact statement for the Duane Arnold Energy Center is appreciated.

Sincerely,

J. D. Mc[illegible]
Captain, U. S. Coast Guard
Acting Chief, Office of Marine
Environment and Systems

Encl: (1) FAA Form 7460-1

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

50-331

25 JAN 1973

OFFICE OF T
ADMINISTRAT

Mr. L. Manning Muntzing
Director of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Muntzing:

The Environmental Protection Agency has reviewed the draft environmental statement for the Duane Arnold Energy Center and our detailed comments are enclosed.

Our review indicates that except for radioiodine releases from the turbine building, the center's radioactive waste treatment system is capable of limiting discharges to "as low as practicable" levels. Our assessment indicates that, in the event land in the vicinity of the site boundary is used for pasturing of dairy cows, treatment of turbine building ventilation effluent may be required in order to meet the guidelines of proposed Appendix I to 10 CFR Part 50.

We believe that the construction and operation of the plant, as proposed, will not have a significant impact on the aquatic environment.

We will be pleased to discuss our comments with you or members of your staff.

Sincerely,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities

Enclosure

D-AEC-06073-37

ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C. 20450

JANUARY 1973

ENVIRONMENTAL IMPACT STATEMENT COMMENTS

Duane Arnold Energy Center

TABLE OF CONTENTS

INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has reviewed the draft environmental statement for the Duane Arnold Energy Center prepared by the U.S. Atomic Energy Commission (AEC) and issued on November 20, Following are our major conclusions:

1. Except for radioiodine releases from the turbine building, the capabilities provided by the waste management equipment appea to be consistent with the concept of "as low as practicable." Th estimated quantity of radioiodine released via component leakage and subsequently released through the turbine building ventilatic system leads to predicted concentrations and thyroid doses which exceed the guidelines of proposed Appendix I to 10 CFR Part 50. In the event dairy cows become pastured nearer the site boundary, potential thyroid doses via the air-cow-milk pathway may be such that additional effluent control measures will be required to lin radioiodine releases from this source.

2. The EPA expects that the construction and operation of this plant, as proposed, will not result in a significant adverse impact upon the aquatic environment and that the proposed discha will meet the present water quality standards. However, the fin statement should provide additional assurance that chlorine concentrations in the blowdown water will be maintained at levels consistent with the preservation of area biota.

RADIOLOGICAL ASPECTS

Radioactive Waste Management

Except for potential radioiodine releases, the radioactive waste treatment systems provided for the Duane Arnold Energy Center appear to be capable of limiting releases of radioactive wastes to within the guidelines of the proposed Appendix I to 10 CFR Part 50. Our analysis indicates that the radioiodine effluent from the turbine building ventilation system may exceed the proposed guidelines.

Dose Assessment

Our calculations indicate that the maximum concentration of iodine-131 at the site boundary will be two orders of magnitude above the $10^{-15}\mu Ci/ml$ guideline given in the proposed Appendix I to 10 CFR Part 50. If dairy cows were to be pastured where such radioiodine concentrations prevail, annual child thyroid doses of hundreds of millirems could potentially result through the air-cow-milk pathway. The draft statement indicates that the nearest "... identifiable dairy herd is pastured about 1.6 miles to the west-northwest... " and that the annual child thyroid dose will be less than 6.5 millirems from the consumption of milk from this source. Therefore, it appears that radioiodine effluents will exceed the guidelines of proposed Appendix I. Further, we note that land suitable for pasture lies nearer the site than 1.6 miles, and there are three occupied farm houses within 1 mile of the site, and approximately 7,000 dairy cows are pastured within 10 miles. The final statement should identify the location of the nearest cow, and include an estimate of the potential thyroid dose from this cow. The statement should also describe: (1) how the applicant will assure that dairy cows are not pastured near the site boundary where radioiodine concentrations are high and (2) what steps the applicant wi take in the event dairy cows become pastured in the vicinity of the site boundary.

The draft statement indicates that the direct dose from on-site sources will be less than 1 millirem per year. Our analysis, however, based on a nominal 2-ft of ordinary concrete shielding, indicates that direct dose from nitrogen-16 in the turbine alone can be expected to be 20 to 30 millirems per year at the site boundary of the Duane Arnold En Center. We are pleased to note that the applicant has recently committ himself to the installation of additional shielding in the turbine buil to reduce direct dose. Even with the additional shielding, the applica calculated annual doses are 20 to 30 millirems. The final statement should include the bases and assumptions used to arrive at the estimate of "...less than one mrem/yr at the closest approach...." Also, a determination should be made as to what levels of turbine shine doses w require corrective action and what corrective action will be taken if needed. Interpretation by the AEC on allowable direct shine doses is necessary since the proposed Appendix I to 10 CFR Part 50 does not addr direct radiation doses.

The draft statement indicates that water "... downstream from the plant ... is no longer used for drinking water...." However, Table 5.5 presents estimates of individual and population doses from Cedar Rapids tap water during normal operations, but does not give the bases and assumptions used in making these estimates. The applicant's environmental report indicates that the City of Cedar Rapids draws wate from wells near the river bank, and some of the recharge for these wells comes from the Cedar River as water is withdrawn to supply the municipal system. The final statement should describe the details of this indirect use of river water for human consumption purposes, including pertinent details such as settling, filtration, decay time, and dilution factors.

Transportation and Reactor Accidents

In its review of nuclear power plants, EPA has identified a need for additional information on two types of accidents which could result in radiation exposure to the public: (1) those involving transportation of spent fuel and radioactive wastes and (2) in-plant accidents. Since these accidents are common to all nuclear power plants, the environmental risk for each type of accident is amenable to a general analysis. Although the AEC has done considerable work for a number of years on the safety aspects of such accidents, we believe that a thorough analysis of the probabilities of occurrence and the expected consequences of such accidents would result in a better understanding of the environmental risks than a less-detailed examination of the questions on a case-by-case basis. For this reason we have reached an understanding with the AEC that they will conduct such analyses with EPA participation concurrent with review of impact statements for individual facilities and will make the results available in the near future. We are taking this approach primarily because we believe that any changes in equipment or operating procedures for individual plants required as a result of the investigations could be included without appreciable change in the overall plant design. If major redesign of the plants to include engineering changes were expected or if an immediate public or environmental risk were being taken while these two issues were being resolved, we would, of course, make our concerns known.

The statement concludes "... that the environmental risks due to postulated radiological accidents are exceedingly small." This conclusion is based on the standard accident assumptions and guidance issued by the AEC for light-water-cooled reactors as a proposed amendment to Appendix D of 10 CFR Part 50 on December 1, 1971. EPA commented on this proposed amendment in a letter to the Commission on January 13, 1972. These comments essentially raised the necessity for a detailed discussion of the technical bases of the assumptions involved in determining the various classes of accidents and expected consequences. We believe that the general analysis mentioned above will be adequate to resolve these points and that the AEC will apply the results to all licensed facilities.

NON-RADIOLOGICAL ASPECTS

Thermal and Biological Effects

The Duane Arnold Energy Center has one boiling-water reactor which produces a gross electrical output of 550 MW. Condenser cooling will be accomplished by evaporative, forced-draft cooling towers within a closed-cycle cooling system. Makeup water for the cooling system will be drawn from Cedar River at the rate of 11,000 gallons per minute (gpm) and at an intake velocity not to exceed 0.75 feet per second. Cooling-tower blowdown will be discharged downstream from the intake at the design rate of 4,000 gpm.

Iowa water quality standards, applicable to the Cedar River, limit stream temperature to a maximum of 90°F and a maximum rise over ambient river temperature of 5°F. Water sampling to determine conformance with these thermal requirements is to be done at a sufficient distance downstream from the discharge to allow adequate mixing.

The highest discharge temperature is expected to be 91.5°F, and the highest discharge temperature increase above ambient is expected to be 40.5°F. The surface area encompassed by the 2°F isotherm is expected to be less than one acre, under the worst conditions of river flow and temperature. Since the thermal plume is unusually small, and the applicable water quality standards allow a mixing zone, it appears likely that the applicant will be in compliance with the applicable thermal standards.

The applicant should be aware that the 1972 Amendments to the Federal Water Pollution Control Act (Public Law 92-500) define the thermal component of any discharge as a pollutant. EPA is required by this law to set effluent guidelines, by the fall of 1973, for pollutants discharged from steam electric power plants. Effluent discharges from the Duane Arnold Energy Center will have to be in accordance with the requirements of Public Law 92-500.

The proposed monitoring plans of the applicant appear to be adequate to determine the thermal impact of the plant on the aquatic biota.

Chemical Impact on Biota

Chlorine, for which standards are not presently established, will be used for defouling of the condenser cooling system. The draft statement presents an extensive discussion of (1) the potential impact of residual chlorine on the aquatic environment, (2) a thorough chlorine monitoring system, and (3) numerous alternatives to the use of chlorine for defouling the condenser cooling system. The applicant's present plans call for intermittent application of chlorine, during the initial stage of plant operation, which may result in high residual chlorine levels in the blowdown. We propose that the applicant consider, as an additional alternative, a continuous application of chlorine on the following schedule:

TYPE OF CRITERION	RECOMMENDATION FOR TOTAL RESIDUAL CHLORINE	DEGREE OF PROTECTION
Continuous	A. Not to exceed 0.01 mg/l	This concentration would probably not protect fish reproduction, some important fish food organisms, and could be lethal to sensitive life stages of sensitive fish species.
	B. Not to exceed 0.002 mg/l	This concentration should protect most aquatic organisms.

ADDITIONAL COMMENTS

During the review we noted in certain instances that the draft statement did not present sufficient information to substantiate the conclusions presented. We recognize that much of this information is not of major importance in evaluating the environmental impact of the Duane Arnold Energy Center. The cumulative effects, however, could be significant. It would, therefore, be helpful in determining the impact of the plant if the following topics were addressed in the final statement:

1. The inhalation dose estimates given in Table 5.4 of the draft statement are one to two orders of magnitude lower than indicated by our calculations. Even so, the inhalation dose does not appear to be a significant component of the individual or population dose commitment. However, the final statement should include revised estimates of inhalation doses, or should state the bases and assumptions used in the calculations which lead to the lower estimates.

2. The draft statement indicates that plant laundry will be done off-site by an outside contractor, and potential releases of radioactivity from laundry processing are not included in the statement. Such releases are a part of the total impact of the center, and should be considered. The final statement should include estimates of the annual amounts of radioactivity leaving the site with the laundry and the amount entering the biosphere through this pathway. The final statement should also discuss the monitoring and surveillance activities which will be employed by the applicant to quantify the radioactivity entering the biosphere through this source,

3. The applicant plans to use 1,500 gpm of well water for demineralizer makeup, drinking water, and the dry-well area air-cooling system. This large drawdown of ground water may reduce or eliminate flow to privately owned wells in the area. If this occurs, and a large number of wells are affected, the applicant should consider the following alternatives:

(a) Installation of a closed-cycle water system with a water-cooler unit. In this way, the portion of the water used for dry-well area cooling could be maintained at the required 50°F. The draft statement makes no comment on the source of the 110 gpm of water required for drinking and demineralizer makeup if this alternative is used.

(b) Return the well water to the aquifer, after use, by injection back into the ground.

If only a few private wells are adversely affected, the benefits of using one of the above-mentioned alternatives would probably not be considered sufficient to warrant the cost. The final Statement should discuss the remedial action to be taken if this is the case.

4. Contingency plans and measures to control accidental spillage of liquids such as oil, liquid chlorine, acid, and caustic are mention in the applicant's Environmental Report and should be referenced in the final statement.

5. Temperature data for the Cedar River for the period 1944 to 1954 are summarized in Table 3.2. Similar treatment of 1960 to 1970 temperature data, if available, should be presented in the final statement in order to supply a more accurate picture of present

6. The effects of the plant heating boiler system on air quality should be discussed including:

(a) fuel type and specifications, including sulfur content and BTU rating,

(b) fuel use rate and expected number of hours of use annually,

(c) emission rates for particulates, SO_2, and NO_2, and

(d) maximum ground level concentrations of boiler emissions and where they occur.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426
February 7, 1973

IN REPLY REFER TO:
50-331

RECEIVED
FEB 8 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory
Mail Section

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter dated November 20, 1972, requesting comments on the AEC Draft Environmental Statement related to the proposed continuation of the Construction Permit No. CPPR-70 and issuance of an operating license to the Iowa Electric Light and Power Company, the Corn Belt Power Cooperative and the Central Iowa Power Cooperative for the Duane Arnold Energy Center (Docket No. 50-331).

Pursuant to the National Environmental Policy Act of 1969 and the April 23, 1971, Guidelines of the Council on Environmental Quality, these comments review the need for the facilities as concerns the adequacy and reliability of the affected bulk power systems and related matters. In preparing these comments, the Federal Power Commission's Bureau of Power staff has considered the AEC Draft Environmental Statement; the Applicant's Revised Environmental Report and amendments thereto; related reports made in response to the Commission's Statement of Policy on Reliability and Adequacy of Electric Service (Order No. 383-2); and the staff's analysis of these documents together with related information from other reports submitted to this Commission by the Applicants. The staff generally bases its evaluation on the need for a specific bulk power facility upon long term considerations as well as the load-supply situation for the peak load period immediately following the availability of the facility on the Applicant's system and that of the pool or regional coordinating area with which the Applicant is associated.

Mr. Daniel R. Muller

Need for the Facility

The 550-megawatt nuclear Duane Arnold Energy Center is located on the Cedar River approximately two and one-half miles north-northeast of Palo, Iowa in Linn County. The facility is owned jointly by a consortium of the Iowa Electric Light and Power Company, the Corn Belt Power Cooperative, Inc. and the Central Iowa Power Cooperative, Inc., which will hereinafter be referred to as "the Applicant." The generating plant, which is now more than 60 percent complete, is scheduled for commercial service in December 1973 and should be available to assist in meeting the 1974 summer peak load.

The following tabulation shows the electric system loads to be served by the Applicant's system, by the Iowa Power Pool [1/] of which the Applicant was a part at the time the Arnold Energy Center was planned, and by the Mid-Continent Area Power Pool (MAPP), and the relationship of the electric power output of the Duane Arnold Energy Center to the projected available reserve capacities on the summer-peaking Applicant's, Iowa Power Pool and MAPP systems at the time of the 1974 summer peak load.

In January 1973 the members of the Iowa Power Pool, including the Applicant, became part of MAPP and filed with the Federal Power Commission to suspend the Iowa Power Pool agreement. Currently, the MAPP agreement is under study by this Commission and may or may not be in force at the time the Duane Arnold Energy Center is placed into commercial service. Therefore, both the data for the Iowa Power Pool and for MAPP are shown. Further, even under the MAPP agreement the Duane Arnold Energy Center will have a significant effect upon the Iowa Power Pool members because of its geographical location. The 1974 summer peak period is the anticipated initial service period of the new unit, and it is expected to constitute a significant part of the Applicant's total generating capacity throughout its lifetime. Therefore, the unit will be depended upon to supply power to meet future demands over a period of many years beyond the initial service needs discussed in this report.

1/ The members of the Iowa Power Pool other than the Applicant are:
Iowa-Illinois Gas & Electric Co.
Iowa Power & Light Co.
Iowa Public Service Co.
Iowa Southern Utilities Co.

Mr. Daniel R. Muller

1974 SUMMER PEAK LOAD - SUPPLY SITUATION 1/

	Applicants Combined Systems	Iowa Power Pool	MA[illegible]
Conditions With Duane Arnold Energy Center (550 Megawatts) 2/			
Net Total Capability - Megawatts	1,280	3,906	17,24[illegible]
Net Load Responsibility - Megawatts	932 3/	3,174 4/	14,61[illegible]
Reserve Margin - Megawatts	348	732	2,63[illegible]
Reserve Margin - Percent of Peak Load	37.3	23.1	1[illegible]
Minimum Reserve needed based on 15 percent of Peak Load - Megawatts	139	476	2,19[illegible]
Conditions Without Duane Arnold Energy Center			
Net Total Capability - Megawatts	730	3,356	16,69[illegible]
Net Load Responsibility - Megawatts	932 3/	3,174 4/	14,61[illegible]
Reserve Margin - Megawatts	-202	182	2,08[illegible]
Reserve Margin - Percent of Peak Load	-	5.7	1[illegible]
Reserve Deficiency - Megawatts	341	297	10[illegible]

1/ Source - MARCA Report 383-2, dated 4-1-72.

2/ The 500 megawatt capacity of the Duane Arnold unit will be shared 90 percent or 476 megawatts to the Iowa Electric Light and Power Company and the Central Iowa Power Cooperative and 10 percent or 55 megawatts to the Corn Belt Power Cooperative.

3/ Net Load Responsibility reduced for Net Purchase of 10 megawatts and total USBR allocations of 32 megawatts.

4/ Net Load Responsibility reduced for Net Purchase of 463 megawatts and USBR allocation of 32 megawatts.

The Applicants are m[illegible]bers of the Mid-Continent Area Reliability Coordination Agreement (MARCA) as well as participants in the Iowa Power Pool and in MAPP. MARCA is the regional coordinating organization for the planning of bulk power generating and transmission facilities, operation of these facilities and provision for short term emergency relief in the event of contingencies normally experienced on interconnected power systems. Although the reliability standards for the MARCA region have been met by a minimum system reserve margin of 12 percent, this minimum reserve margin will be increased to 15 percent in 1974 to meet the reliability standard of loss-of-load probability of one occurrence in ten years. The increased reserve margin is made necessary by the large capacity of new thermal generating units coming in service in MARCA members' systems. These reserve margins are gross; in addition to providing for scheduled outages for maintenance, the reserve margin must provide an excess of generating capacity over the peak system demands to provide for errors in load forecasts, forced outages of generating equipment, slippage of scheduled availability of new units and spinning reserves. For this report, minimum reserve margins of 15 percent have been used.

The availability of the Duane Arnold Energy Center for 1974 summer peak load period would provide a reserve margin of 348 megawatts or 37.3 percent of the peak load responsibility on the Applicant's system. If delays for any reason should make this unit unavailable for this peak period, the reserve margin on the Applicant's system would be reduced to a negative 202 megawatts and a deficiency of 341 megawatts from the MARCA criterion would occur on the Applicant's system. Based on the Applicant's 1974 peak load responsibility of 932 megawatts a minimum reserve margin of 139 megawatts is needed to meet the 15 percent reserve criterion. Similarly, the Iowa Power Pool will have a reserve margin of 732 megawatts, or 23.1 percent of the peak load responsibility with the unit available; without the unit the reserve margin is reduced to 182 megawatts or 5.7 percent of the 1974 peak load responsibility of 3,174 megawatts. The deficiency of 294 megawatts on the Iowa Power Pool's system would require the Applicant to purchase power from other sources in order to maintain their needed reserve position. MAPP would have an 18 percent margin with the Arnold unit in service and 14.3 percent without it and thus would not meet its criterion of 15 percent installed reserve.

Review of the planned new capacity additions for the participating systems in the Iowa Power Pool during the period 1973 to 1981 reveals that only 1,180 megawatts of new capacity are planned. The 550-megawatt Duane Arnold unit will provide the bulk of reserve capacity available for these systems until 1976 when the 520-megawatt Neal Unit No. 3 comes into commercial operation. Hence, the reliability and adequacy of the generating capacity for these systems is dependent at least until 1981 upon the timely commercial operation of the Duane Arnold and Neal units.

Although some 5,932 megawatts of new capacity in large fossil a nuclear steam units are planned for commercial operation by 1981 wit the MARCA region, the importance of adequate capacity resources to s the projected demands and provide the needed reserves within the Iov Power Pool must be given adequate consideration. The availability c adequate local generating capacity, without dependence upon large bl of capacity from distant sources, is fundamental to system reliabili

Transmission Facilities

Six overhead transmission lines will be required to integrate t Duane Arnold Energy Center into the existing transmission system. T 345-kilovolt lines will be located on a 500-foot right-of-way originating at the plant switchyard and extending westerly for a distance 2.7 miles; both lines will then tie into the existing 345-kilovolt Hills-Adams line. One 161-kilovolt line will be located on the righ of-way and extend westerly for a distance of 2.7 miles terminating a the Washburn Substation. A second 161-kilovolt line located on a separate right-of-way extends southerly for a distance of 30.25 mile to terminate at the Bertram Substation. A 161-kilovolt extension of 46.4 circuit miles is planned by the Corn Belt Power Cooperative to deliver energy from the Washburn Substation to their system. A four 161-kilovolt line will extend from the plant site generally eastward for a distance of 7.8 miles to the Hiawatha Substation.

The design, routing and construction of the transmission lines planned in accordance with the guidelines issued by the U. S. Departı of the Interior and Agriculture in their joint publication, "Environ Criteria for Electric Transmission Lines" and the Federal Power Commi publication "Electric Power Transmission and the Environment." The will pass through cropland, pasture and woodland on routes selected minimum environmental impact.

Alternatives and Costs

The Applicant, in determining the need for additional generation meet its projected system needs, considered in addition to firm power purchases a number of practical alternatives including locations, pla type, fuels, environmental effects and economics. The Palo site was selected after consideration of 24 sites. The available undeveloped hydroelectric capacity in the State of Iowa was estimated in 1972 to 346.4 megawatts of conventional hydroelectric capacity, with an assoc annual energy potential of 1,637,400 megawatt-hours. Pumped-storage hydroelectric capacity is no alternative to baseload nuclear capacity; however, even if it could be considered a partial alternative, the total hydroelectric generated energy would not meet the energy production capability of the nuclear plant which is estimated to be some 3,923,000 megawatt-hours. Combustion turbine peaking units were considered; however, the high operating and maintenance costs of such units render them unsuitable for baseload operation.

Natural gas and fuel oil were not considered available in adequate quantities to meet the projected needs for a generating plant of comparable capacity, and the only alternative fuel available was considered to be coal. The choice of the nuclear-fueled plant was made after consideration of the fuel economics of coal-fueled and nuclear-fueled plants. The Applicant considered estimated capital costs of $194 million or $353 per kilowatt of capacity for the nuclear-fueled plant and $111 million or $202 per kilowatt of capacity for the coal-fueled plant. Annual fuel costs were estimated for the nuclear-fueled plant at $6.5 million or 1.6 mills per kilowatt-hour, and for the coal-fueled plant at $15 million or 4.0 mills per kilowatt-hour. The staff of the Bureau of Power finds the capital costs to be within the range of capital costs reported by the industry, however, the fuel costs are lower than most fuel costs currently reported by the industry.

Conclusions

The staff of the Bureau of Power concludes that the electric power output of the Duane Arnold Energy Center will be needed to meet the Applicant's, Iowa Power Pool's and MAPP's systems projected loads and to provide them with reserve margins in accordance with the regional coordination council's stated system reliability objective.

Very truly yours,

T. A. Phillips
Chief, Bureau of Power

FRED A. PRIEWERT, DIRECTOR
300 FOURTH STREET, DES MOINES, IOWA 50319
515/281-5145

50-331

RECEIVED
DEC 29 1972

December 22, 1972

Deputy Director for Reactor
Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Sir:

The Iowa Conservation Commission appreciates the opportunity to review the Atomic Energy Commission's Draft Environmental Statement related to the proposed operation of the Duane Arnold Energy Center, Linn County, Iowa. In general, the Draft Environmental Statement does an adequate job of assessing the effect of the operation of the plant on the areas of concern under the Commission's jurisdiction.

It is understood that the Pleasant Creek Project will be covered by a separate Environmental Impact Statement to be prepared by the federal agency providing cost sharing for its recreation development. This agency is the Bureau of Outdoor Recreation in the Department of the Interior. The Bureau is aware that the Commission will be making a project request for financial assistance on the Pleasant Creek Area and understands the responsibilities associated with such a request.

The following are specific comments with regard to the concerns of the Commission as related to the operation and development of the Duane Arnold Energy Center.

The first items of concern are water oriented: 1. There is a concern by the Commission's biologists that the chemical discharge or heated water discharge could possibly block the stream. It is indicated in the report that this situation will not occur, however, a cautious approach should be taken with regard to the possibility of a complete blockage of the stream. 2. Personnel from the Conservation Commission cannot undertake more intensive fisheries studies, due to current work loads however, it would seem adviseable that an expanded surveilance program would include creel surveys. The Commission staff would assist in planning for an expanded program encompassing creel surveys.

Deputy Director for Reactor Projects
December 22, 1972
Page 2

3. The area near the low-head dam will undoubtedly develop a high sport fisheries potential and public access to the site should be encouraged either on Power Company land or on land owned by the County Conservation across the river from the plant site.

The following are general comments relating to land oriented concerns of the Commission: 1. It is understood that there is a great deal of land involved not only in the plant site but in ownership of the Power Company. In this regard, the Iowa Conservation Commission has offered the services of its wildlife managers to initiate farm management programs and a leasing system that would maximize the benefits to wildlife and provide farming opportunities for the local area. In this way, the concerns over the reduction of farm acreage could be greatly alleviated. The farming of the land within the plant site proper could be undertaken in such a manner that public utilization in terms of hunting would not be allowed but the area could serve as a refuge for wildlife. Erosion control practices would become an integral part of the farm management plans.

The following are specific comments relative to the report: 1. Page 2, item 2.1, (Site Location). In the fourth paragraph, reference is made to the statement that reservoir will require the purchase of more than 600 acres for its construction. It will have a surface area of about 440 acres. This statement should be changed to read that approximately 1,900 acres will be acquired for the lake and associated recreational development at Pleasant Creek Reservoir and that it will have a surface area of approximately 410 acres. 2. Page 2 - 6, item 2.2, second paragraph, (Demography and Land Use). This paragraph seems anomaly in that reference is made that park areas are slightly developed and low in intensive use. The next statement refers to an estimated number of people visiting the parks within ten miles of the site as one million. These two statements are not consistent, as the figure of the usage of one million is a relatively high figure. The third paragraph makes reference to the fact that the Coralville Reservoir, about twenty miles southeast, site is the only significant lake or reservoir within fifty miles, however this should be corrected to include Lake MacBride as it is a significant recreation lake. 3. Page 2 - 7, item 2.3, (Historic and Archeological Landmarks). Although the proposed Pleasant Creek Reservoir site has not been surveyed for archeological interest, the Conservation Commission has initiated a request to the State Archeologist to undertake a study of the area.

Deputy Director for Reactor Projects
December 22, 1972
Page 3

We trust our comments will be given consideration.

Sincerely,

Fred A. Priewert, Director
Iowa Conservation Commission

FAP:GS:cd

cc: Mr. Francis St. Mary
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Mr. Charles W. Sandford
Vice President
Iowa Electric Light and Power Company
P. O. Box 351
Cedar Rapids, Iowa 52406

Commissioners
Chiefs

Natural Resources Council

Grimes State Office Building
East 14th and Grand
Des Moines, Iowa 50319

OTHIE R. McMURRY, Director
R. G. BULLARD, Water Commissioner

Iowa
a place to grow

December 18, 1972

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Docket No. 50-331

Dear Mr. Muller:

We have reviewed the Draft Environmental Statement prepared by your office related to the proposed operation of the Duane Arnold Energy Center being built by Iowa Electric Light and Power Company, Corn Belt Power Cooperative, and Central Iowa Power Cooperative near Palo, Iowa. We have particularly analyzed the environmental impact and adverse effects as summarized in the Summary and Conclusions included in that Statement and submit the following comments:

1. Impacts 3a through 3p are very satisfactorily answered in the text of the Statement. We would like to add to the items concerning our specific fields of authority the following:

    3c. Dredging from the river bed, filling of the area and location of the buildings was authorized by the Iowa Natural Resources Council after review of the applications and plans submitted. Adverse effects were considered minimal.

    3j. Riverwater consumption was fully considered when the permit for the requested use was granted by the Iowa Natural Resources Council. There were no objectors at the public hearing on the requested use held at Cedar Rapids prior to granting the permit. The conditions contained in that permit are designed to protect all public and private interests.

Daniel R. Muller
U. S. Atomic Energy Commission

Page - 2 -

3k. The Silurian-Devonian aquifer withdrawal effects are perhaps overrtated. It is largely recharged locally and has a short recharge time. The widespread or long term effects of withdrawals from this formation are therefore minimal. The permit for these withdrawals was granted by the Iowa Natural Resources Council following the same procedures and with the same conditions as outlined in 3j. above.

2. Principle alternatives 4a through 4g are very satisfactoril answered in the test of the Statement.

3. Conditions for operation 7a through 7h appear to contain ample safeguards for alleviation or compensation for any adverse effects.

This office and to our knowledge other affected state and local agencies and the public at large have been kept fully advised very early in each study phase on a continuing basis of the plans concerning this installation. These agencies and the public have been encouraged by applicant to make suggestions, and all suggestions have been duly considered and often incorporated in the plans as they were developed.

We believe that Iowa Electric Light and Power Company, as the principal applicant, on the basis of its activities to date, can be relied upon to meet all reasonable environmental requirements associated with the installation and operation of the proposed Duane Arnold Energy Center. We encourage approval of this installation and operation in order that additional electric energy for present and future needs in this area may be met.

Very truly yours,

Othie R. McMurry
Othie R. McMurry
Director

R. G. Bullard

ORM/RGB/mh

R. G. Bullard
Water Commissioner

K-41

BOARD OF SUPERVISORS

LINN COUNTY, IOWA

Cedar Rapids

GEO. W. CLIFFORD

COURT HOUSE

RECEIVED JAN 2 1973 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

December 21, 1972

50-331

Deputy Director for Reactor Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D.C. 20545

Dear Sir;

This is in response to your request for comments (Federal Register, November 22, 1972) on the draft environmental statement for the Duane Arnold Energy Center.

Iowa Electric Light and Power Company has maintained close communication with this office as well as other local and state agencies throughout the planning and construction of the DAEC. We have been impressed by the obvious concern and care taken by the Company to assure that the plant is both safe and desirable from an environmental standpoint.

We are now equally impressed by the care and obvious dedication of the AEC regulatory staff in preparing a draft environmental statement which meticulously evaluates the environmental impact of the DAEC and carefully evaluates its costs and benefits. The draft statement lends strong, independent confirmation to our view that the Duane Arnold Energy Center will be a good and useful neighbor to the people of Cedar Rapids and the State of Iowa.

We strongly endorse the statement in section 9.4 of the draft environmental statement that the continued construction and operation of the Duane Arnold Energy Center is proper course of action.

Very truly yours,

Linn County Board of Supervisors

Geo. W. Clifford

George Clifford, Chairman

Floyd Emmons

Floyd Emmons

William D Martin

William D. Martin

GC:myk
cc: Francis St. Mary
Charles W. Sandford

Robert D. Ray
Governor

Office of the Governor

STATE CAPITOL
DES MOINES, IOWA 50319

50-331

January 12, 1973

RECEIVED
JAN 19 1973
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Deputy Director of Reactor Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D.C. 20545

Dear Sir:

Our heads of Departments charged with environmental protection and my staff have reviewed the Environmental Report for the Duane Arnold Energy Center of Iowa Electric Light and Power Company of Cedar Rapids and advise me that this Report covers the predicted impact of this installation to their satisfaction.

I am convinced that Iowa Electric has conducted its development operation related to this nuclear generator in an exemplary manner. They have earnestly solicited the advise of our appropriate state agencies as well as other knowledgable and concerned people in the state and elsewhere.

Therefore, I respectfully recommend for your consideration the Environmental Report for the Duane Arnold Energy Center of Iowa Electric Light and Power Company.

Thank you.

Sincerely,

Robert D. Ray

Robert D. Ray
Governor

RDR/bab
cc: Mr. Francis St. Mary
Directorate of Licensing
United States Atomic Energy Commission
Washington, D.C. 20545

Mr. Charles W. Sandford
Vice-President
Iowa Electric Light and Power Company
P.O. Box 351
Cedar Rapids, Iowa 52406

IOWA CIVIL DEFENSE DIVISION

Iowa
a place to grow

LUCAS STATE OFFICE BUILDING
ROOM B-33
DES MOINES, IOWA 50319
PHONE: 281-3231
AREA CODE 515

ROBERT D. RA
GOVERNOR

ALBERT R. MAR
DIRECTOR

December 18, 1972

Deputy Director for Reactor Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D.C. 20545

Dear Sir:

This office has recently completed its review of the Duane Arnold Energy Center Draft Environmental Statement. The Statement represents a very thorough investigation of all the environmental consequences normally attributed to a nuclear power plant.

This office and the staff of the DAEC have thoroughly coordinated every aspect of emergency planning relevant to the operation of the plant. Those requirement for emergency planning delegated to this office by the Code of Iowa have been satisfied by planning and coordination which preceded the publication of the Draft Environmental Statement.

This office prefers not to recommend any deletions or additions to the Statement as presently proposed.

Sincerely,

Albert R. Mariele

Albert R. Mariele
Director

ARM:cvt
cc: Mr. Francis St. Mary
Mr. Charles W. Sanford

STATE OF IOWA
IOWA GEOLOGICAL SURVEY
16 WEST JEFFERSON STREET
IOWA CITY, IOWA 52240
Phone: (319) 338-1173

Iowa
a place to grow

Samuel J. Tuthill
Director and State Geologist
Orville J. Van Eck
Assistant State Geologist

December 29, 1972

50-331

JAN 3 1973

Deputy Director for Reactor Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Sir,

My staff and I have reviewed the Draft Environmental Statement of the Duane Arnold Energy Center (Iowa Electric Light and Power Company, Cedar Rapids, Iowa) and recommend it to your favorable consideration.

This agency is a non-regulatory, research and consulting agency having special competence in water resources, mineral resources, remote sensing, and systemic and intersystemic environmental relationships.

I have been impressed with the manner in which this company has solicited the advice and criticism from the start of their operation, of all of the knowledgeable agencies and persons they could identify.

Sincerely,

Samuel J. Tuthill

Samuel J. Tuthill

SJT:wg
cc: F. St. Mary
C. W. Sandford

K-46

STATE HISTORICAL SOCIETY OF IOWA

Peter T. Harstad, Director

Iowa City, Iowa 522

December 20, 1972

Daniel R. Muller, Assistant Director
for Environmental Projects
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Re: Docket No. 50-331

Dear Mr. Muller:

By letter of November 20, 1972, you requested this agency to review the A. E. C. Draft Environmental Statement related to the Duane Arnold Energy Center currently in the process of construction in this part of Iowa. You also sent to us the three volume Environmental Report prepared by Iowa Electric Light and Power Company.

Evaluating the scientific merit of the above materials is quite out of the realm of our experience here at the State Historical Society.

Nevertheless, an able University of Iowa graduate student in History, Richard Lawton, has read and studied this material and also attended a question and answer session with Iowa Electric officials at Cedar Rapids a few days ago. He offers the following comment: "Both the Draft and the Iowa-Electric reports seem to exhibit the research of highly trained specialists animated by the recent goal of pollution-free environments."

This state agency will continue to follow the progress at the Duane Arnold Energy Center, but it is questionable whether this institution can make useful responses to requests such as yours of November 20, 1972. Had we been called upon at an early stage in developments to evaluate what impact this installation might have upon the life patterns of Iowans living in proximity to the site we might have geen able to provide some meaningful data. It is quite clear that you are not concerned with such matters.

Unless informed otherwise, we see it as our responsibility to make the Draft and Environmental Report available for public use and study.

Sincerely yours,
Peter T. Harstad
Peter T. Harstad
Director

Administration Division
DEPARTMENT OF CONSERVATION
Linn County, Iowa

BOX NO. 160-4
CENTRAL CITY, IOWA 52214
TELEPHONE

December 20, 1972

50-331

Deputy Director for Reactor Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Sir:

It is the purpose of this letter to advise you in regards to the position of the Linn County, Iowa, Conservation Board with respect to the Draft Environmental Statement of the Iowa Electric Light and Power Company in regards to the Duane Arnold Energy Center.

The Conservation office has received a copy of the environmental statement and has attended numerous meetings relating to the effort of the power company to minimize the impact on the environment from the operation of the nuclear energy center. We are also well advised on the environmental monitoring program and we have had ample opportunity to exchange views with company officials relating to the adequacy of this part of their effort.

We believe the power company has made a strenuous effort to protect the environment and provide us with an early warning of any difficulties that may arise.

In the absence of any technological failures we would like to reiterate our view expressed earlier that nuclear fuel with proper safeguards is superior to fossil fuel from an environmental impact view. We would like to see this plant completed and in operation at the earliest possible date.

Very truly yours,

George D. Hamilton
Executive Director

GDH/ejn

K-43

LINN COUNTY HEALTH DEPARTMEN

751 CENTER POINT RD. N. E.
CEDAR RAPIDS, IOWA 52402
PHONE (319) 398-3551

December 19, 1972

Deputy Director for Reactor Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D.C. 20545

Gentlemen:

The following comments are made concerning the Duane Arnold Energy Plant located within Linn County, Iowa:

The personnel of the IE Company has, since the conception of this power source, kept this office informed as to construction and proposed operation programs and procedures. Communication has been at a maximum and any potential problems have been resolved to the satisfaction of each party.

This office finds no conflict with the information in the draft of Environmental Statement by the United States Atomic Energy Commission's Director of Licensing, which have not been resolved by mutual agreement.

This office has committed it's support to the company within it's areas of capabilities.

We anticipate this type of continuing cooperation between IE Company and this agency.

Sincerely,

Alfred M. Ahern

AMA/hk

cc: Mr. Francis St. Mary
Mr. Charles W. Sandford

CITY OF CEDAR RAPIDS, IOWA

Commission Form of Government

50-331

RECEIVED DEC 21 1972

OFFICE OF THE MAYOR

December 20, 1972

Deputy Director for Reactor Projects
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Sir:

I would like to take this opportunity to offer my comments on the draft environmental statement for the Duane Arnold Energy Center, pursuant to your request in the Federal Register, November 22, 1972.

Throughout the planning and construction of the Duane Arnold Energy Center, the Iowa Electric Light and Power Company has maintained close communication with the City of Cedar Rapids as well as other local and State agencies. It is apparent that the Company is very concerned that all steps are taken to assure that the plant is both safe and desirable from an environmental standpoint.

The Duane Arnold Energy Center regulatory staff has demonstrated extreme care in the preparation of an environmental statement which evaluates the environmental impact of the Duane Arnold Energy Center, in addition to evaluating the costs and benefits of the Center. The draft environmental statement reaffirms our belief that the Duane Arnold Energy Center will be a good and useful neighbor to the citizens of Cedar Rapids.

I would endorse the statement in section 9.4 of the draft environmental statement that the continued construction and operation of the Duane Arnold Energy Center is the proper course of action.

Sincerely,

Donald J. Canney
Mayor

DJC:sp

cc: Frances St. Mary, AEC
Charles Sandford, IE

DUANE ARNOLD ENERGY CENTER

DOCKET 50-331

Applicant's Comments on the Draft Environmental Statement

In accordance with the notice in the Federal Register dated November 22, 1972, the following comments on the Draft Environmental Statement for the Duane Arnold Energy Center are submitted by the applicant.

Applicant, Iowa Electric Light and Power Company and Co-Applicants, Central Iowa Power Cooperative (CIPCO) and Cornbelt Power Cooperative (Cornbelt) submit the following comments on the Draft Environmental Statement (DES) for the Duane Arnold Energy Center (DAEC). Applicant and Co-Applicants are hereinafter referred to as "applicant".

I. Comments on Proposed Conditions for Operation

As noted below, applicant concurs in the staff's proposed conditions for operation as set forth in paragraph 7 (pp S-4 to S-5) of the DES, subject to the modifications hereinafter discussed with respect to paragraphs 7a and 7g. A discussion of each of the proposed conditions, identified by reference to the specific subparagraphs of paragraph 7 follows:

7a. If the total residual chlorine content in the blowdown effluent exceeds 0.1 ppm, Iowa Electric will adopt chlorine control measures with the objective in mind of reducing such residual chlorine to less than 0.1 ppm within 30 months of the start of plant operation. During the initial 30 month period if residual chlorine exceeds 0.1 ppm, applicant will implement the program set forth in paragraphs 7a (i) and (ii) on page S-4 of the Draft Environmental Statement.

The desirability of the restriction on total residual chlorine concentrations to 0.5 ppm "at any time" is questionable at this time in light of the current state of knowledge. Little information is available now on the effects of chloramines (particularly as regards the aquatic life present in the Cedar River) and means to reduce their impact. This is especially true for cooling tower circuits and rivers, such as the Cedar River, with high agricultural runoff and a high consequent chlorine demand. In light of these uncertainties, it is suggested that in lieu of an immediate and perhaps arbitrary, limit of 0.5 ppm, the applicant undertake an intensified monitoring program to determine residual chlorine concentrations and their effects and report on the results thereof to the AEC staff. Using these data, it should be possible to arrive at limitations which are realistic and take into account the real ecosystem effect by the DAEC. In the interim, applicant will also employ control measures, including such measures which are practicable as outlined on pages 10-6 to 10-9 of the Draft Environmental Statement, in an effort to minimize such discharges.

7b. The applicant will replant those portions of the riverbank disturbed during construction to minimize further erosion. Erosion to date has been minimal.

7c. As stated in Amendment 1 to the Environmental Report subsection B.2.1 and Amendment 2 response 5.2.4 the applicant has notified all local well owners of possible well interference and has taken the commitment to correct any deleterious effects.

It should be noted that per 1964 water usage figures for Linn County, the anticipated 1,500 gpm usage (pg. 5-7 DES) will be a net increase of 3% or less of the usage in this aquifer. As the trend within Linn County has been an increasing usage of this aquifer, these 1964 figures should be low and the percentage less.

7d. The applicant will take appropriate action to reduce offsite sound levels if the breaker operation and cooling tower noise become annoying. This commitment is made in subsection 3.8.2.3 of the Environmental Report. Alternatives that would be considered if the noise were annoying, would include, among others, those discussed in section 10.1.3 of the Draft Environmental Statement.

7e(I) The applicant will handle chlorine in conformity with the recommendations of recognized organizations concerned with its safe use.

(II) The site emergency plan will be expanded to include the evacuation of nearby downwind neighbors in the event of an accidental chlorine release which is detectable offsite.

7f. The applicant would be pleased to discuss changes to the operational phase of the radiological monitoring program. The applicant recognizes that the radiological monitoring program must be responsive to changed circumstances and modified accordingly. The DES, however, does not appear to contain any specific suggestions for modifications of the program.

7g. The applicant will define a comprehensive environmental monitoring program for inclusion in the Technical Specifications. The items contained in subsection 6.2.3 of the Draft Environmental Statement will be fully implemented with exception of the item in section 6.2.3.a.iii. Applicant suggests the following in lieu of the present language of subsection 6.2.3:

> "More intensive and systematic observations of fish behavior and condition than is stated in the preoperational program both upstream and downstream from the plant to a distance of one mile. Live baskets will be used as it is difficult, if not impossible to determine sub-lethal effects or minor fish kills by field studies alone. Live baskets containing native fish will be placed upstream of the plant, in the discharge and at intervals downstream of the discharge to determine the effects of chloramines and other plant effluents on fish."

This position has been discussed with the State Conservation Commission and is felt to be adequate by the Conservation Commission.

7h. If harmful effects or evidence of irreversible damage are detected by the monitoring program, the applicant will provide to the staff an analysis of the problem and a plan of action to be taken to eliminate or significantly reduce the detrimental effect or damage.

II. Other Comments

In addition to the foregoing comments on proposed operationg conditions, applicant also offers the following specific comments for the Commission's consideration:

Cover page, 5th line should read: "Related to the Continued Construction and Proposed Operation of the Duane Arnold Energy Center"

Page 1-1

The wording in the first paragraph on this page should be modified to reflect the fact that outdoor construction is essentially complete. Essentially all land to be withdrawn or otherwise disturbed for the construction of the facility has already been so affected and no further withdrawal or disturbance is contemplated. As stated on page 4-3 of the DES, only about 100 acres of land have been disturbed. This comment should also be reflected where appropriate throughout the Draft Environmental Statement.

Page 1-2

The sentence in the third paragraph that a notice of intent to hold public hearing in regard to the issuing of an operating license for the DAEC was published in the Federal Register on September 30, 1972 is not accurate. The sentence should read "A notice of consideration of issuance of facility operating license and opportunity for hearing which incorporated a notice of hearing on the environmental aspects of the previously issued construction permit for the DAEC pursuant to 10CFR Part 50, Appendix D, Section B, was published in the Federal Register on September 30, 1972."

Page 1-6

Under Iowa Water Pollution Control Commission, it should be noted that a Certificate of Compliance pursuant to Section 21(b) of the Federal Pollution Control Act was issued on April 14, 1971.

Page 1-7

The statement "No such facilities have yet been installed", is not current. The plant heating boiler has been installed and has been inspected by an authorized inspector and authority to operate this boiler has been received from the state.

Page 2-6

Fifth paragraph. The airport in Shellsburg is no longer operational. An updated description of airport facilities in the vicinity of the DAEC is contained in the response to AEC question 2.31 in Amendment 10 to the DAEC FSAR.

Page 2-17

Fifth paragraph. Wind direction variability is Sigma-θ rather than Sigma-Y.

Page 2-17

Fifth paragraph. The starting speed of the lower wind sensor is 0.27 mps rather than 0.6 mps as stated in this paragraph.

Page 2-17

Fifth paragraph. The Draft Environmental Statement states "No rainfall data are being collected at the site." It should be noted that rainfall data is being collected at the Cedar Rapids Airport which is representative of the area.

Page 2-33

Fourth paragraph. The Draft Environmental Statement states "Data on reptiles, amphibians, insects and other inverte rates characteristic of the site and nearby areas are being collected and have not yet been submitted by the Applicant". The applicant has not committed to collect this type of information. nor are there any plans for this purpose. It should be noted that a flora and faur study will be submitted in December 1972 as stated in response to comment on page 6.8 of the DES.

Page 2-40

Third paragraph. The Draft Environmental Statement states that the natural background at the site is 135 mrems per year. The Duane Arnold Energy Center report of Environmental Monitoring Program, April 1971 to March 1972 states, "All but one of the 48 stations are lower than the 110 mrems per year estimated by the United States Environmental Protection Agency" on page 33.

Page 3.1

The description of the metal siding on the DAEC buildings which appears in the next-to-last paragraph, is incorrect. An accurate description appears in subsection 3.9 of the Environmental Report on page 3.9-1.

Page 3-15

Second paragraph. The discharge structure pipe is an 18-inch diameter pipe with a 16-inch reducer at the discharge, which results in a 15-inch discharge stream.

Page 3-17

Table 3.3 Item c. See comment on page 3-15 referring to discharge pipe.

Page 3-19

In the middle of the page, the Draft Environmental Statement states, "The data does not apply appropriately to a surface jet. Further details were not given for the interfacing of the near- and far-field models and this aspect could not be evaluated." The following comment applies:

> For the low flow case (300 cfs) the surface jet model (Ref. 1) was used for the near-field only to the point where the vertical mixing becomes restricted due to the bottom topography. The resulting temperature and flow distributions were then used to determine the average "cell" temperatures and flows for input into the far-field model (Ref. 2). For the interfacing of the two models conservation of heat and mass were observed.
>
> Since the far-field model gives slower dispersion through ambient river turbulence, the adoption of the far-field model at this transition point is considered conservative because there was still jet momentum available for dilution. The far-field model used takes into account boundary effects from the bottom and sides of the river.

References

1. Jem, Y., Wiegel, R. L., Mobarek, I. "Surface Discharge of Horizontal Warm Water Jet", Hydraulic Engineering Laboratory Wave Research Projects, University of California, Berkeley, December 1964.
2. Elwin, H. E., "Uniform Flow Dispersion Model For a Thermal Source", presented at the ASGE National Environmental Engineering Meeting, St. Louis, Missouri, October 18-22, 1971.

Page 3-25

Figure 3-10. The figure does not show bypass of the radwaste evaporator for chemical waste and detergent drains. Bypass of the radwaste evaporator is addressed in Amendment 10, question 9.24 of the DAEC FSAR.

Page 3-30

Last paragraph. The DES states that no estimate for iodine 131 from the turbine building has been made. Table 9.5-4 in Amendment 2 to the FSAR does contain iodine 131 release data for the reactor and turbine building combined.

Page 3-30

Fourth paragraph. The DES states that exhaust air from the radwaste building is discharged to the reactor building drywell. This is incorrect. The wording should be corrected to read "reactor building torus area" in lieu of "reactor building drywell".

Page 3-38

Section 3.8.1. The source of fuel for initial loading and five reloads is General Electric, Wilmington, North Carolina.

Page 3-38

Section 3.8.2. The initial process site for irradiated fuel will be General Electric, Morris, Illinois, which is approximately 200 rail miles from the site.

Page 3-38

Section 3.8.2. The applicant feels that the staff's estimate of 25 truck loads of radwaste per year is reasonable.

Page 3-39

Fifth paragraph. Virtually all right-of-way acquisition has been completed. It is anticipated that acquisition will be complete within 90 days without complication.

Page 3-39

The last paragraph should be corrected to read as follows: Four transmission-line systems extend westward in a 665 foot corridor from the southwest edge of the plant site for a distance of one mile to a north-south county road. Near this road, one 161 KV line departs and continues within a corridor of 100 foot basic width (generally narrower along railroad and public rights-of-way) in a southerly direction west of Cedar Rapids and then eastward, via Fairfax, to the Bertram substation. The total distance is 29 miles. The other 161 KV line and two 345 KV lines continue in a 500 foot corridor for a distance of 1.7 miles beyond the county road in a westerly direction. There, one 345 line turns south to the Hills substation, another 345 KV line turns north to the Hazelton substation, and a 161 KV line for a distance of 16 miles, continues to the Garrison substation and then an additional 30 miles to the Washburn substation.

Page 3-39

Second paragraph. The wording should be corrected to state "disperse" power, rather than "dispose power".

Page 3-40

First paragraph. Should be corrected to strike "10 miles" and insert "8 miles".

Page 3-40

Third paragraph. "1,182" should be replaced by "1,167", to reflect rights-of-way as acquired. Also, the statement should state this land is required for transmission lines and not the plant.

Page 3-41

Figure 3.12. The Beverly substation will not be a part of the DAEC transmission lines at the time of energizing DAEC. The Beverly substation should be omitted from this figure and the title of the line changed to "DAEC - Bertram 161 KV". The Beverly substation will be used to support and enhance the reliability of the southwest quadrant of the Cedar Rapids metropolitan area and rural towns and farms. This substation will serve Iowa Electric and Rural Electric Cooperative sub-transmission substations. The Beverly sub is part of the integrated transmission network of Iowa Electric and other Iowa utilities. The substation is required to distribute power from the existing 345 KV line and is not dependent upon the DAEC generation.

Page 3-42

Table 3.10. This table should be amended as follows to account for actual acquisition of rights-of-way for the DAEC - Bertram 161 KV line.

Line length	29	miles
Area used	351	acres
Public road	0.25	miles
Railroad	17.75	miles
Private	11.0	miles
Crop	125.5	acres
Pasture	12.9	acres
Wooded	4.2	acres
Total Line Length	85.9	miles
Total Area Used	1,167	acres

Page 3-44

Next to the last sentence. Insert the word "and" between "concrete" and "equipment".

Page 4-1

The discussion of "Effect on Land Use" should be changed to indicate the fact that the DAEC outdoor construction is presently essentially complete. This same comment was made on page 1-1.

Page 4-1

Fourth paragraph. With almost all outdoor construction completed, it can be stated that no significant soil erosion problems during construction have been noted.

Page 4-1

Fifth paragraph. This 1,182 should be changed to 1,167 per comment on page 3-42.

Page 4-2

Second paragraph. Up to the middle of 1972 the construction well was in use with an average usage of about 150 gpm. Since the middle of 1972, the production wells have been in use with an average usage of about 350 gpm total.

Page 4-3

Fourth paragraph. The DES states "damage to benthic organisms and fish downstream was not investigated". It should be noted that no fish kills have been noted downstream during any dredging operation.

Page 5-1

Under the discussion of noise affects, it states that a minimum of 10 db attenuation can be assumed to be provided by the walls of the typical house. It is felt that to correctly illustrate these noise levels, Figure 5.1 on page 5-3 should include this 10 db attenuation for the plotting of noise levels indoors.

Page 5-5

Second paragraph. As stated in response to condition 7d (Part I of these comments) the applicant will take appropriate action to reduce offsite sound levels if these sound levels become annoying.

Page 5-6

Second paragraph. The correct value for hours of fog per year is 0.2 hours. This is stated in Amendment 2 to the Environmental Report Table 2.6-7. A page change to the Environmental Report has also corrected this number within the fogging discussion.

Page 5-7

In the discussion of ground water, it should be noted that the withdrawal of 1,500 gpm from the Silurian-Devonian aquifer will be an increase of 3% or less of the usage of this aquifer within Linn County per 1964 usage figures. This item also discussed in response to condition 7c.

Page 5-12

Item c. Evidence (collected by Dr. D. B. McDonald, the applicant's limnologist) indicates that the pesticide levels in the river are too low to be toxic even with elevated temperatures.

Page 5-16

Third paragraph, last sentence. It is the applicant's intent to conform with the standards of Iowa Pollution Control Commission for discharge of all chemicals.

Page 5-17

Table 5.3. No units are given for this table.

Page 5-18

Section 5.6.1, third paragraph. "160 sectors" extending to 50 miles should be changed to "16 sectors".

Page 6-5

Fourth paragraph. All effluent monitoring equipment has been purchased at this time. Appropriate trip levels will be included in the plant Technical Specifications.

Page 6-8

Paragraph b. The terrestrial flora and fauna studies are presently being printed and will be formally submitted in December 1972.

Page 6-11

Second paragraph. Onsite meteorological station records upper (165 ft) and lower (35 ft) dewpoint data of the FSAR Onsite Meteorological Data Supplement includes frequency distribution of moisture deficit. This moisture deficit data serves as a baseline index of onsite moisture conditions. Dewpoint measurements will be continued during plant operation. There has apparently been some misunderstanding with respect to the expectation that reports of icing conditions will be received from the County Sheriff. There are no present arrangements for this purpose, although the matter can be pursued.

Page 6-11

Paragraph d. Thermal effluent. The applicant will include a temperature monitor for the river downstream of the mixing zone, but not beyond sampling station 3 as per staff recommendation.

Page 6-11

Paragraph e. Sanitary waste effluent. The applicant will include the monitoring of the sanitary discharge for fecal coliform as per staff recommendations.

Page 6-11

Paragraph 6.2.3. Operational Environmental Monitoring. This subject is discussed in response to condition 7g (Part I of these comments)

Page 7-8

Paragraph 7.3. Other Accidents-Chlorine. This item is addressed in response to condition 7e. (Part I of these comments)

Page 8-1

First paragraph. The correct abbreviation for Central Iowa Power Cooperative is "CIPCO". The correct short name for Cornbelt Power Cooperative is "Cornbelt".

Page 8-1

Statement on withdrawal of land should read such that it recognizes the fact that land has already been withdrawn. This is same as comment on page 1-1.

Page 8-2, 8-3 and 8-4

Table 8.1, 8.2, and 8.3. The attached sheets are corrected to correspond with the data submitted in Reference 1 to Section 8 of the DES.

Page 8-5

Section 8.2, second paragraph. This item is addressed in response to condition 7d. (Part I of these comments)

Page 9-4

Last paragraph. The DES states, "The applicant's evaluation of alternative sites did not make as detailed an environmental comparison as it did economic comparison." At the time the site selection studies were made, there were no requirements to study formally the environmental alternatives. However, environmental factors were given consideration by the applicant. Sites which appeared to be acceptable, but were located in conservation areas, were dismissed in the early stages of site selection. Other items considered in the study were suitability of farm land, amount of land disturbance, locations of a cemetary, location of game breeding, and shooting preserves, other heavily wooded land, locations of summer cottages, locations near state parks. Various agencies were contacted including the State Natural Resources Council, the Conservation Commission and the U. S. Geological Survey (hydraulics lab and groundwater division) in the process of site selection. The hydrological aspects were thoroughly examined to determine which site would be most acceptable from the standpoint of surface and ground water usage.

Later, after the site had been selected, the alternative of cooling towers and cooling ponds was considered and as stated in subsection 4.3 of the Environmental Report, the primary consideration was the withdrawal of further land rather than economic considerations in deciding in favor of cooling towers.

A detailed Environmental Study of the alternative sites at this time would probably not show another site more favorable as there is no unique environmental condition at the DAEC site.

Page 9-7

Table 9.3 under aesthetic category, the 300 foot stack should not be pointed out for the coal fired plant as it is not unique to the coal fired plant.

Page 10-1

Section 10.1.1. The discussion of once-through cooling should recognize that minimum low flows on interior Iowa rivers required the use of cooling tower/pond concepts for units of the capacity of DAEC. The Cedar River does not have the necessary flow or heat dissipation capability to permit use of once-through cooling at the DAEC and discharges from such a system could not meet Iowa water quality requirements.

Page 10-2

Section 10.1.2. The statement concerning the Pleasant Creek Reservoir does not give sufficient credit to the reservoir as an environmental asset. In view of the uses of the lake for boating, swimming, fishing and associated activities and the fact that it will be built and operated by the State Conservation Commission, the applicant feels that the reservoir will furnish a major and unique recreational facility for eastern Iowa and that it will be constructed and operated in accordance with policies, regulations, and criteria employed by the Iowa Conservation Commission for comparable projects.

Page 10-2

Section 10.1.3. As stated in response to condition 7d (Part I of these comments) the applicant will consider alternatives such as presented in this section.

Page 11-1

Last paragraph. As stated in comment on page 5-6, the correct number for hours of fog per year is 0.2.

TABLE 8.1. Applicant's Power Requirements, Capacity (Summer Data, MW)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
				With DAEC Installed						
Net generating capacity	721	721	720 ~~701~~	750 ~~702~~	1281 ~~1302~~	1298 ~~1301~~	1297 ~~1301~~	1296 ~~1301~~	1295 ~~1301~~	1294 ~~1301~~
Capacity additions	0	0	30	531	17 ~~19~~	-1 ~~0~~	-1 ~~0~~	-1 ~~0~~	-1 ~~0~~	0
Total capacity	721	721	750 ~~731~~	1281 ~~1297~~	1298 ~~1301~~	1297 ~~1301~~	1296 ~~1301~~	1295 ~~1301~~	1294 ~~1301~~	1294 ~~1301~~
Net purchases	106	211	230	10	10	10	10	10	10	10
Total capacity	827	932	980 ~~961~~	1291 ~~1292~~	1308 ~~1311~~	1307 ~~1311~~	1306 ~~1311~~	1305 ~~1311~~	1304 ~~1311~~	1304 ~~1311~~
Peak demand	679	791	852	943	1021	1100	1189	1281	1386	1495
Reserve	148	141	128 ~~109~~	348 ~~349~~	287 ~~290~~	207 ~~211~~	117 ~~122~~	24 ~~30~~	-82 ~~-75~~	-191 ~~-184~~
Reserve margin, %	22	18	15	37	28	19	10	2	-6 ~~-5~~	-13 ~~-12~~
				Without DAEC Installed						
Total capacity	827	932	980 ~~961~~	760 ~~762~~	788 ~~762~~	787 ~~761~~	786 ~~762~~	785 ~~761~~	784 ~~761~~	784 ~~761~~
Peak demand	679	791	852	943	1021	1100	1189	1281	1386	1495
Reserve	148	141	128 ~~109~~	-183 ~~-181~~	-263 ~~-260~~	-343 ~~-339~~	-473 ~~-428~~	-486 ~~-520~~	-678 ~~-625~~	-741 ~~-734~~
Reserve margin, %	22	18	15	-19	~~-22~~ -26	-31	-36	-41	~~-42~~ -46	~~-49~~ -50

Derived from data in Ref. 1.

TABLE 8.2. Iowa Power Pool Requirements and Capacity (Summer Data, MW)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
With DAEC Installed										
Net generating capacity	2638	2638	3347	3376	3906	3924	4443	~~4443~~ 4442	~~4390~~ 4391	4390
Capacity additions	0	709	29	~~600~~ 530	18	519	~~0~~ -1	~~-52~~ -51	~~0~~ -1	0
Total capacity	2638	3347	3376	3906	3924	4443	~~4443~~ 4442	4391	4390	4390
Net purchases	605	382	904	436	531	427	423	420	416	416
Total capacity	3243	3729	4280	4342	4455	4870	~~4866~~ 4865	4811	4806	4806
Peak demand	2754	3070	3320	3610	3896	4186	4501	4841	5208	5599
Reserve	489	659	960	732	559	684	~~365~~ 364	-30	-402	-793
Reserve margin, %	18	21	29	20	14	16	8	-0.6	-8	-14
Without DAEC Installed										
Total capacity	3243	3729	4280	3811	3905	4320	~~4316~~ 4315	4261	4256	4256
Peak demand	2754	3070	3320	3610	3896	4186	4501	4841	5208	5599
Reserve	489	659	960	201	9	134	~~-185~~ -186	-580	-952	-1343
Reserve margin, %	18	21	29	6	0	3	-4	-12	-13	-24

Derived from data in Ref. 1.

TABLE 8.3. Iowa Power Pool Requirements and Capacity (Summer Data, MW)
Projected Generator Additions Included, DAEC Installed

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Net generating capacity	2638	2638	3347	3376	4006 ~~4106~~	4024 ~~4124~~	4573 ~~4673~~	4772 ~~4879~~	5196 ~~5348~~	5645 ~~5798~~
Capacity additions	0	709	29	630 ~~730~~	18	549	199 ~~200~~	424 ~~475~~	449 ~~450~~	826
Total capacity	2638	3347	3376	4006 ~~4106~~	4024 ~~4124~~	4573 ~~4673~~	4772 ~~4879~~	5196 ~~5348~~	5645 ~~5798~~	6471 ~~6624~~
Net purchases	605	382	904	436	531	427	423	420	416	416
Total capacity	3243	3729	4280	4442 ~~4542~~	4555 ~~4655~~	5000 ~~5100~~	5195 ~~5296~~	5616 ~~5768~~	6061 ~~6214~~	6887 ~~7040~~
Peak demand	2754	3070	3320	3610	3896	4186	4501	4841	5208	5599
Reserve	489	659	960	832 ~~932~~	659 ~~759~~	814 ~~914~~	694 ~~795~~	775 ~~927~~	853 ~~1006~~	1288 ~~1441~~
Reserve margin, %	18	21	29	23 ~~26~~	17 ~~19~~	19 ~~22~~	15 ~~18~~	16 ~~19~~	16 ~~20~~	23 ~~26~~

Derived from data of Ref. 1.

K-65

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

50-331

OFFICE OF THE SECRETARY

WASHINGTON, D.C. 20201

FEB 22 1973

RECEIVED FEB 26 1973 ATOMIC ENERGY COMMISSION Regulatory Mail Section

Mr. Daniel R. Muller
Assistant Director for
Environmental Projects
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Muller:

This is in response to your letter of November 20, 1972, wherein you requested comments on the draft environmental impact statement for the Duane Arnold Energy Center, Iowa Electric Light and Power Company, Docket Number 50-331.

The Department of Health, Education, and Welfare has reviewed the health aspects of the above project as presented in the documents submitted. This project does not appear to represent a hazard to public health and safety.

The opportunity to review the draft environmental impact statement is appreciated.

Sincerely yours,

Richard L. Seggel

Richard L. Seggel
Acting Assistant Secretary
for Health

END

FILMED

MAY

25,1982