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INITIAL:

BEFORE THE UNITED STATES

ATOMIC ENERGY COMMISSION

In the Matter of)
)
Omaha Public Power District) Docket No. 50-285
Fort Calhoun Station
Unit No. 1

Applicant's Environmental Report -

Operating License Stage

March, 1971

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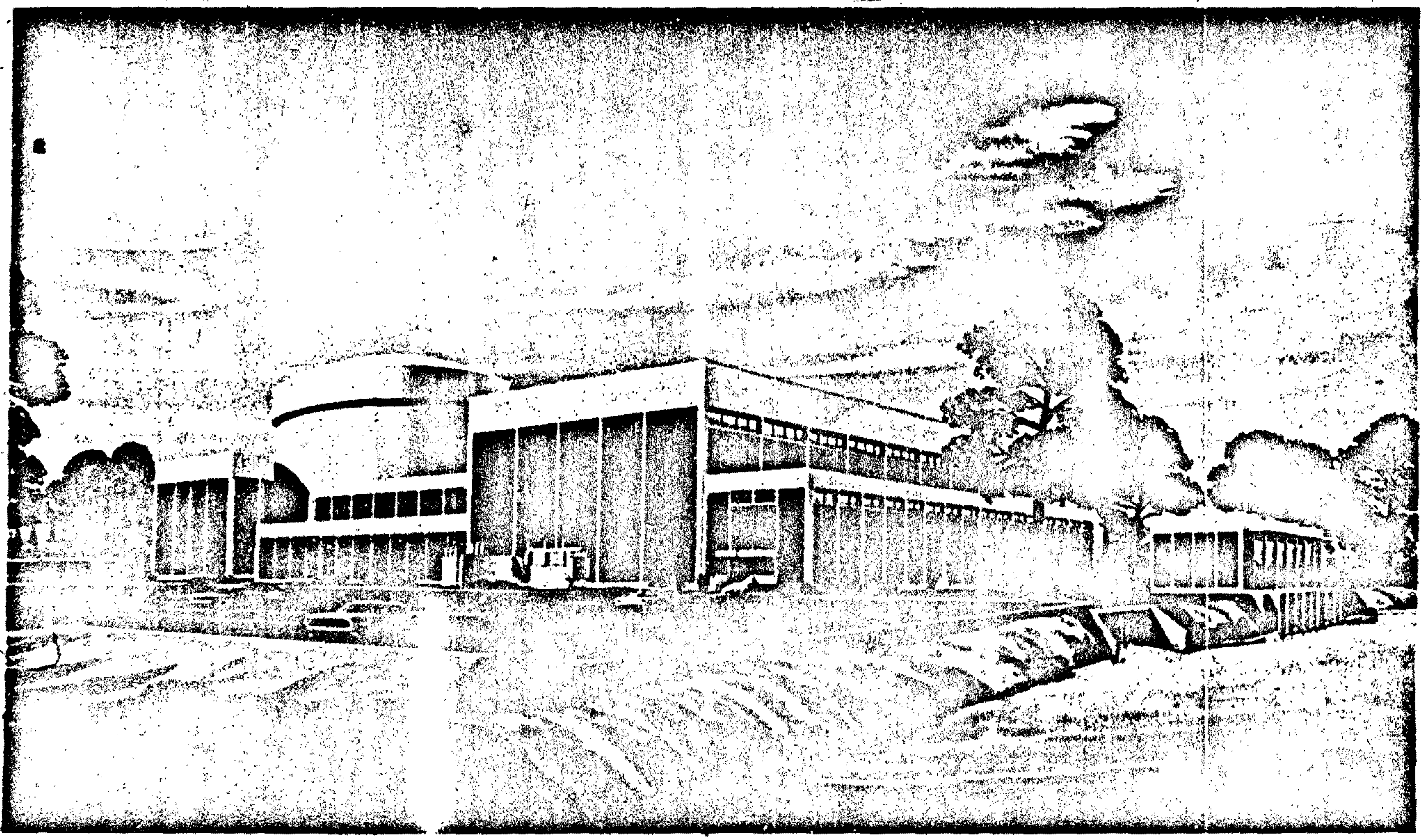
ARTIST'S RENDERING OF FACILITY

OMAHA PUBLIC POWER DISTRICT — FORT CALHOUN STATION — UNIT NO. 1



ENVIRONMENTAL REPORT

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1.0 INTRODUCTION

Construction of Unit No. 1 by Omaha Public Power District (OPPD) at Fort Calhoun, Nebraska, is 78% complete; to date one hundred-fifty million dollars ($150,000,000) have been committed for the completion of this facility at this site.* Roads have been built, transmission towers erected, piles driven, principal structures built, and studies concluded and acted upon.

OPPD's request for an operating license was already under review by the Atomic Energy Commission, when it received a letter from the Director of Reactor Licensing, on June 17, 1970, requesting OPPD to supply certain information on environmental matters. This report is responsive to that letter as well as to Appendix D to 10 CFR Part 50, as amended on December 4, 1970 [35 Fed. Reg. No. 235, 18469-18474, December 4, 1970.].

This response, submitted in connection with operating license review procedures, must necessarily differ in certain ways from that which would be filed at the construction permit stage. The most significant difference is that the alternative section** is in reality historical and not entirely a guide for future decisions. However, even though it is not now possible to reassess in retrospect the basic course of many of OPPD's actions, OPPD has written this report bearing in mind that it is still important that further major incremental acts

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* OPPD filed its Application for Licenses for Unit No. 1 with the AEC in April, 1967, and received a construction permit in June, 1968.

** See Appendix D to 10 CFR 50 of the Atomic Energy Commission's Rules and Regulations.

1.0 INTRODUCTION (continued)

be shaped so as to minimize adverse environmental consequences. [Council on Environmental Quality, Interim Guidelines, 35 Fed. Reg. No. 92 7390, (11 p. 7392) May 12, 1970].

Some of the interpretations chosen in preparing this document (which it is believed are supported by the legislative history of NEPA as well as by the Interim Guidelines issued on May 12, 1970 by the Council on Environmental Quality) are summarized below:

a. The human environment includes that created by man for his subsistence, safety, and comfort as well as that provided by nature.

b. The geographical area considered is roughly the same as the "metropolitan area" of Omaha, which extends from the city itself to those outlying areas which are bound to it by economic and social ties. Thus, the benefits from using a pollution-free source of power and from the utilization of that power (e.g., lighting, heating and cooling the urban environment) to a resident of Omaha as well as to a worker within its geographic confines have been considered appropriate for this report.

c. "Long-term productivity" is presumed to mean productivity over an extended period toward an economic or other purpose generally accepted as a constructive use of some part of the natural environment.

2.0 GENERAL

The Fort Calhoun Station is a nuclear power plant designed to produce electricity at a rated output of 481 electrical megawatts gross. Fort Calhoun Unit No. 1 is scheduled for operation in 1972. The plant consists of five principal structures; the containment building, the auxiliary building, the turbine building, the service building (which are all interconnected) and the separate intake structure. The containment building which houses most of the nuclear components of the facility is one-hundred eighteen feet in diameter and about one-hundred twenty-five feet above ground level. This building, together with the other necessary structures which form the plant complex, occupies approximately twenty acres of the three-hundred eighty-two acre site. The balance of the site not occupied by the plant complex is relatively unchanged from its former state as farmland.

The reactor is of the pressurized water type. Heat from the nuclear fuel is transferred to a closed reactor coolant system utilizing high purity ordinary water. This heated water is circulated through tubing in steam generators whereby the heat from the fissioning process is transferred to a second completely separate water cooling system. The water in the secondary system is allowed to boil in the steam generators producing steam for use in the turbine-generator, which generator in turn produces electricity. An on-site transformer increases the voltage to 345,000 volts for transmission to major load centers of the Omaha Public Power District and its interconnected utility systems.

After the steam passes through the turbine, it is cooled and condensed within the plant condensers and reused in the secondary system. Condenser cooling is provided by water from the Missouri River which is circulated at an expected rate of 360,000 gpm through stainless steel tubes in the condenser.

2.1 Demography and Land Uses in Surrounding Area

The three-hundred eighty-two acre Fort Calhoun Station site is located in Washington County, Nebraska, on the southwest bank of the Missouri River about 19.4 miles north-northwest of downtown Omaha. Figures 2-1 and 2-2 of this report contain a scale plot plan of the site and a map showing the general location of the site in relation to the surrounding area.

As power plants become larger and more numerous, good plant sites become more scarce. In its search for a suitable site, OPPD investigated several potentially desirable locations along the Missouri River. Preliminary site data were collected and each possible site was evaluated in terms of the following criteria:

a. Bed rock near the surface or satisfactory ground conditions to support heavy loads,

b. a location on the outer radius of a bend to ensure an adequate water supply during low river flows,

c. near a good road and a railroad,

d. near the center of the electrical load.

On the basis of all of the information available, the Fort Calhoun site was chosen as the one most nearly fulfilling the above criteria.

Approximately three-quarters of the final site area is on the alluvial flood plain of the Missouri River and the remainder is part of the bluff system on the west side of the river. The Missouri River, which flows generally north to south, forms the northwest to southeast site boundary. The flood plain of the river extends approximately ten miles from the plant site east to the bluff system in the State of Iowa (see Figure 2-3).

In 1980, the population within a fifteen-mile radius of the site

2.1 Demography and Land Uses in Surrounding Area (continued)

is expected to be as follows:

Radial Miles	Population
0-1/2	0
1	450
2	820
3	2030
4	7300
5	12,720
10	24,270
15	52,070

There are no residences within one-half mile of the reactor location. The nearest seven residences are from 3,000 to 4,000 feet distant. These are located generally along Highway 73, the southern boundary of the site. The population within forty miles of the plant site is expected to be approximately 800,000 by 1980 with a major concentration of an estimated 650,000 persons residing in the Omaha metropolitan area. Within a five-mile radius, as shown on Figure 2-4, most of the population is located northwest of the site. Within the larger radius of 40 miles, as shown on Figure 2-5, the majority of the people are located south of the site.

Approximately ninety-five percent of the land in Washington County and in the surrounding counties is used for farming. Douglas County, which includes the city of Omaha and is the most metropolitan of the region's counties, is about seventy percent farmland.

The major industrial centers within forty miles of the plant site are in Omaha and Fremont, Nebraska, and in Council Bluffs, Iowa. Many of the in-

2.1 Demography and Land Uses in Surrounding Area (continued)

dustries are associated with agriculture and food products, but other industries also exist. For example, the largest industries within ten miles of the plant site are the Blair Manufacturing Company (employing 100-199 people in Blair, Nebraska), which manufactures farm machinery, and the Wilkinson Manufacturing Company (employing 200-499 people in Fort Calhoun, Nebraska), which manufactures aluminum products and aluminum foil products.

The city of Omaha has more than thirty industries employing greater than 200 people, the largest being the Western Electric plant which employs more than 5,000.

From the Fort Calhoun Station's inception to date, OPPD has contacted and maintained liason with all known local, county, regional, and State planning authorities. OPPD does not know of any development plans for the area surrounding the Fort Calhoun Station site that the construction and operation of Unit No. 1 would adversely affect.

Prior to the acquisition of the property for the Fort Calhoun Station, OPPD requested that the area of the site be rezoned from a "F" District - Farming to an "I-2" District - Heavy Industry. This request was approved by resolution of the Board of Supervisors of Washington County, dated December 13, 1965.

Subsequent to the acquisition of the property and prior to the construction of the plant, OPPD was issued a Building Permit by the County Building Inspector.

2.1.1 DeSoto National Wildlife Refuge

The DeSoto National Wildlife Refuge is located in a general easterly direction approximately two to five miles from the plant site. The Refuge's headquarters is about three miles northeast of the plant and the major picnic area and boating facilities are about four miles southeast of the plant.

The Refuge contains 7,800 acres of land and 800 acres of water. Approximately sixty-five percent of the area is in Nebraska and the balance in Iowa.

There is an interflow of water between the Missouri River and the Wildlife Refuge by means of a hydraulic connection consisting of 1 - 60" pipe and 1 - 54" pipe, which are gravity flow. During 1969, the inflow to the Refuge was 18,974 acre-feet of water and the outflow was 16,138 acre-feet of water. The capacity of the lake in the Refuge is approximately 8,300 acre-feet.

The Refuge is open to the public from April to September and for ice fishing in January and February.

The total number of people visiting the site in 1970 was 364,215 which included the following:

Boating	40,000
Swimming	80,400
Water Skiing	27,000
Picnic	43,000
Camping	None (camping not allowed)
Fishing	44,000 (Hot Water) (March through December)
	1,000 (Cold Water) (January and February)

2.1.1 DeSoto National Wildlife Refuge (continued)

Hunting	The only hunting in 1970 was bow hunting in the Iowa section. There were 645 visits by approximately 250 bow hunters in a two-month deer season.
Trapping	There is no trapping allowed.

The maximum number of visitors for one day was 8,500. By 1980 the estimated number of visitors to the Refuge area is 1,000,000 people per year.

The steamship, Bertrand, which sank in the Missouri River in 1865, was located in 1968 near the center of the DeSoto National Wildlife Refuge. Excavation of the ship was completed in 1969 with the recovery of almost 2,000,000 items from the ship and its cargo. After removal of the artifacts the ground water was allowed to re-cover the ship.

DeSoto Refuge's primary role in wildlife management is to provide a migratory stopover for geese and ducks. Up to 300,000 snow and blue geese rest and feed at DeSoto during their passages between Artic nesting grounds and Gulf Coast wintering areas. Up to 250,000 ducks, mostly mallards, also congregate at the Refuge during migration. Other wildlife inhabiting the Refuge are listed in Appendix A of this report.

The Refuge is not in the direction of the prevailing winds from the plant site, since the prevailing direction from May to December is from the south-southeast, while north-northwest winds predominate through the remainder of the year.

2.1.1 DeSoto National Wildlife Refuge (continued)

There have been frequent meetings between Refuge officials and the technical and managerial personnel of the Omaha Public Power District. OPPD officials met with Refuge officials on April 1, 1968, prior to completing plans for the environmental monitoring program to receive their comments on what should be included in that program. Since then there have been several other meetings to discuss the status of the plant and the environmental monitoring program.

The Wilson Island Recreation Area (shown on Figure 2-6) is located just a few hundred feet south of the DeSoto Refuge. This area includes car and trailer parking areas, camping sites for forty-six cars and trailers, paved roads, and a boat ramp into the river. The maximum number of visitors to this Recreation Area at one time was approximately 1,000.

2.2 Characteristics of Site Prior to Acquisition by OPPD

When the land was purchased by OPPD in early 1966 for the Fort Calhoun site it was farmland, and even now part of it is used for farming purposes (see Figure 2-7).

The site is traversed along the base of the bluff by a single-line track of the Chicago and Northwestern Railway. An overpass across the railroad tracks has been constructed to permit unimpeded access to the station during construction and operation. A dirt access road on the north property line of the site and another near the center of the site were in existence at the time of site purchase but are not now normally used.

The land starting from the Missouri River at about elevation 997 feet above mean sea level dips to an old channel of the river before rising again to approximately 1,004 feet. Beyond this point, the elevation rises at the railroad to approximately 1,020 feet. From the railroad the land rises approximately 60 feet to a higher plateau at elevation 1,080 feet to Highway 73, which is a site boundary. The site topography is shown on Figure 2-8.

At the lower elevations the land was used for agriculture, primarily corn and other grains. About ten percent of this area was in trees, mainly willows and cottonwoods. These trees were along the river and a drainage ditch. The facility and its auxiliary structures are now being constructed on this portion of the site. Some trees have been removed and the drainage ditch was relocated to allow better use of the land.

A steep wooded hill rises from the railroad to the plateau on the west side of the site. Tree varieties on this slope include elm, ash, and cottonwood. The plateau area is cultivated and is suitable for such crops as

2.2 Characteristics of Site Prior to Acquisition by OPPD (continued)

corn, milo, or alfalfa. About 20 percent of the site land area is in this upper plateau. Several gullies with heavily wooded banks cut through the northern side of the plateau and drain toward the drainage ditch in the central part of the lower elevation land. The drainage ditch, which is normally dry, allows entry into the river upstream of the plant. OPPD does not anticipate that it will make any changes in the appearance or use of this land.

At the site, and typical of Washington County and adjoining counties, wildlife is not abundant. The predominant wildlife in the area consists of pheasant, bobwhite quail, cottontail rabbits, squirrels, deer, and other fur bearing animals. During the initial construction phase of this facility, there was some disturbance of the living patterns of these animals. It is expected that upon completion of the facility, the effect upon the wildlife will be minimal.

The atmosphere at the plant site is clear and generally free from pollutants, as is characteristic of the air in the Midwest outside of the major cities and industrial areas. There are no industries in the area of the plant site which contribute significantly to contamination of the atmosphere. While there have been some pollutants released to the atmosphere as a result of construction as discussed in a succeeding section of this report, these pollutants are temporary in nature and will disappear upon completion of construction.

The climate of Nebraska is characterized by relatively warm summers, cold dry winters, and marked variations in temperature and rainfall from year to year. The average annual precipitation for the town of Blair is 27.10 inches with most of this occurring as showers and thunderstorms

2.2 Characteristics of Site Prior to Acquisition by OPPD (continued)

during April through September. Large annual temperature ranges are normal with a mean annual temperature of 51.1°F for Eppley Airfield in Omaha, located about twenty miles from the site. The monthly averages (from 1931 to 1968) ranged from 22.1°F for January to 77.4°F for July.

Although frequent shifts in wind direction are commonplace during all seasons of the year, two primary wind patterns predominate. Based on thirty-three years of records gathered at Eppley Airfield, the prevailing direction from May through December is from the south-southeast while north-northwest winds predominate throughout the remainder of the year. The mean hourly wind speed for the thirty-three years of record is 11.1 miles per hour.

Noise at the site prior to plant construction was from various farm machinery used for agricultural purposes, vehicle traffic on Highway 73, train traffic on the Chicago and Northwestern railway traversing the site, and engine driven boats on the Missouri River.

2.2.1 Information on Missouri River

The Missouri River is under the control of the Army Corps of Engineers which maintains the channel width at 600 feet by the use of pile dikes and bank protection. The river has reached maximum summer temperatures of 86.3°F as measured by the Omaha Public Power District at its North Omaha Power Station 20 river miles downstream of the site. The maximum suspended solids postulated by the Corps of Engineers is 25,400 ppm which is above the maximum measured value of 20,700 ppm. Maximum, minimum, and average Missouri River water analyses for the period from 1955 to 1968 are given in Table 3-14 (see Section 3.2.6)

2.2.1 Information on Missouri River (continued)

There are six dams upstream of the plant site (see Figure 2-9) that control the river flow. These structures are listed in Table 2-1 in the order from the nearest to the site (Gavins Point) to the most distant (Fort Peck). There are no dams, locks, or similar structures on the Missouri downstream of the plant site.

TABLE 2-1

MISSOURI RIVER DAMS

Name	Location	Dist. Upstr. From Plant Site, Miles	Initial Year Of Service
Gavins Point	S. Dak. - Nebr.	165.2	1956
Fort Randall	S. Dak.	234.1	1953
Big Bend	S. Dak.	341.5	1964
Oahe	S. Dak.	426.4	1962
Garrison	N. Dak.	744.0	1956
Fort Peck	Montana	1125.6	1940

These dams are massive earth structures with impervious core walls, ample freeboard (10 to 15 feet) for wave action, and extremely large spillways. The Gavins Point Dam, closest to the site, is some 8,700 feet long, 85 feet wide at the top and up to 859 feet wide at the base. Water flow from the Gavins Point Dam is regulated to provide for barge navigation during all seasons except winter.

There were about 100 commercial fisherman on the Missouri River between Sioux City, Iowa and Plattsmouth, Nebraska, who took in excess of 74,195 pounds of fish from the Missouri River in 1967. The predominant species taken were Catfish, Carp, and Buffalo. The Missouri River is a warm water stream and the prevalent fish species spend their entire life-

times at various locations without migrating for spawning purposes. Missouri River fish are also discussed in Appendix B.

Various permits and approvals are required for the construction and operation of Fort Calhoun Unit No. 1. These are listed as follows:

Atomic Energy Commission - Permits for construction and operation were applied for in April, 1967. The construction permit was issued in June 1968 and the operating license is required prior to fuel loading.

Army Corps of Engineers - Permission to construct the intake and discharge structures has been received.

Army Corps of Engineers - Permit for discharges or deposits into navigable water. The Army Corps of Engineers requires that applications for such permits be submitted prior to July 1, 1971. OPPD will make a timely application for this permit.

Washington County Building Permit - The Washington County building permit was received prior to construction of the facility.

Nebraska Water Pollution Control Council - This permit was applied for and certification is pending.

Nebraska Power Review Board - Approval for the construction of the facility and the transmission line grid system was received.

Federal Aeronautics Administration - Permit for construction of 345,000 volt transmission lines was received prior to construction.

State Railway Commission - Approval for construction of transmission lines has been received.

2.2.1 Information on Missouri River (continued)

The site is underlain by 65 to 75 feet of unconsolidated alluvial and glacial deposits resting on sedimentary bedrock. The bedrock is generally flat with a westward dip. One of the major structural features of the Nebraska-Iowa region is the Thurman-Wilson Fault which extends from south of Lincoln, Nebraska northeast for about 150 miles, almost to Des Moines, Iowa. There is no record of movement of this fault in historic times. Although no significant earthquake ground motion is expected at the site, occasional regional shocks have occurred. For this reason, conservative seismic design criteria have been established for the site as follows:

Design Earthquake: maximum horizontal ground acceleration equal to eight percent of gravity;

Maximum Hypothetical Earthquake: maximum horizontal ground acceleration equal to seventeen percent of gravity.

Ground water is from two sources. The first is the Missouri River Valley, where ample ground water is obtained from alluvial sand and gravels with the water table ranging from two to seventeen feet below the surface. The second source of ground water is the terraces and loess hill upland regions. The elevation of the water table is higher in the upland region than in the adjacent flood plain. The movement of ground water under the uplands is toward and into the Missouri River trench.

2.2.2 Future Power Needs and Interconnections

Power loads in the United States, and in Nebraska in particular, grow at the rate of about 7% to 8% per year. Omaha Public Power District experiences peak loading conditions during the summer months. Consumption reached a record high of 859.8 MWe in June, 1970. Peak loads predicted in

2.2.2 Future Power Needs and Interconnections (continued)

future years are as follows:

Year	Peak Load, MWe
1975	1248
1980	1669
1985	2082
1990	2528

The net generating capability of OPPD generating units is presently 843 MWe which will increase to 943 MWe in 1972 with the installation of two gas turbine generating units and to 1398 MWe with the operation of the Fort Calhoun Station. Power exchanges are scheduled with several neighboring utility organizations over the next several years with long term firm agreements planned with the Bureau of Reclamation, the city of Fremont, Nebraska, and the Nebraska Public Power District. OPPD is a charter member of the Mid-Continent Area Power Planners organization, formed in 1966, which has planned joint expansion of generating and transmission facilities with utilities in the states of Nebraska, Iowa, Minnesota, Missouri, South Dakota, North Dakota, Montana, Wisconsin, Wyoming, and the country of Canada.

3.0 ENVIRONMENTAL IMPACT OF THE PROPOSED FACILITY

3.1 Land Use Compatibility

The Fort Calhoun Station Unit No. 1 site is described in detail in section 2.0. Considerable effort has gone into the design and construction of the station in order to make the most prudent use of the land and its resources. Safety considerations mandated certain land uses such as widening Highway 73 at the point where the exit for the new entrance road to the plant was constructed to provide a means of safe ingress and egress for plant personnel and visitors. A viaduct was constructed over the railroad as a part of the entrance road to provide greater safety for plant personnel and visitors.

A considerable portion of the land acquired for the site was under cultivation at the time the property was acquired, as was much of the adjoining land. Maximum concern has been focused by OPPD on preserving that basically agricultural characteristic. OPPD has continued to farm the portion of tillable land not used for construction and plans to continue to farm the available land after the plant is placed in operation.

The river channel stabilization work by the Army Corps of Engineers over a period of years resulted in the accretion of a large area along the river. As a result of the stabilization work, a great number of willow trees, and some cottonwood trees are growing in this area. These trees contribute to the natural screening of the plant facilities from the river while a portion of this area was used to construct the screenhouse structure and a major portion of the main structure of the plant. This construction did not, nor will not, impair the natural channel stabilization that Corps of Engineers work intended.

Pleasure boating and some sport fishing are two of the most pre-

3.1 Land Use Compatibility (continued)

valent recreational activities in the immediate vicinity of the station. However, both these activities occur considerably downstream from the facility. Therefore, the construction and operation of the facility at this point along the river's course is expected to have no adverse effect on either of these activities.

3.2 Ecological Studies

The studies contained herein are based on information from various agencies, plus studies made by Omaha Public Power District. In many cases the studies are continuing and will continue throughout the life of the Fort Calhoun plant.

The information contained in these studies is believed to be the most reliable, available at the present time, but is subject to change as more information becomes available.

3.2.1 Report of The Nebraska Game and Parks Commission Study "Selected Environmental Effects of Two Nuclear Power Plants on the Missouri River"

The State of Nebraska is conducting a preoperational and a postoperational ecological study of the Missouri River to determine the effects of the thermal discharges from the Fort Calhoun Station and Cooper Nuclear Power Station at Brownville, Nebraska (approximately 80 miles downstream from Fort Calhoun). This study is titled "Selected Environmental Effects of Two Nuclear Power Plants on the Missouri River". The State and Federal agencies participating in this study are as follows:

a. Bureau of Sport Fisheries and Wildlife
b. Federal Water Quality Administration
c. Iowa Conservation Commission
d. Kansas Forestry, Fish and Game Commission
e. Nebraska Department of Health
f. Nebraska Game and Parks Commission (coordinating agency)
g. Nebraska Public Power District
h. Omaha Public Power District
i. Army Corps of Engineers
j. Geological Survey

3.2.1 Report of The Nebraska Game and Parks Commission Study "Selected Environmental Effects of Two Nuclear Power Plants On The Missouri River" (continued)

k. Environmental Protection Agency and Water Quality

l. The University of Nebraska

The primary purpose of the study is to determine some of the effects of the two nuclear power plants on fish and fish-food organisms in the Missouri River. Secondary purposes are to determine the thermal patterns produced by the effluents from these plants and to acquire data to enable an evaluation of the adequacy of the pertinent sections of existing Water Quality Standards.

The study is in three sections: (1) temperature and chemistry, (2) fish, and (3) fish-food organisms. The field work started in July of 1970 and is expected to be completed in November of 1974. The preoperational phase will consist of six sampling periods. These periods are the last week of each of the following months: July, September, and November of 1970, and April through November of 1971. During the April through November 1971 period, fish will be sampled weekly and temperatures and chemistry data will be collected the last week of April, July and September. It is anticipated that both plants will be in operation before July of 1973. The postoperational phase will be similar to the 1971 preoperational program and will begin in the Spring of 1973 and terminate in the Fall of 1974.

The Nebraska Game and Parks Commission has prepared a progress report for the period July 1, 1970 to January 11, 1971 for the study "Selected Environmental Effects of Two Nuclear Power Plants on the Missouri River". This progress report is summarized in Appendix B of this Report.

3.2.1 Report of The Nebraska Game and Parks Commission Study "Selected Environmental Effects of Two Nuclear Power Plants On The Missouri River" (continued)

That portion of the study that pertains to the Fort Calhoun Power Station is briefly outlined below.

Temperatures

The temperature section of the study consists of a number of different types of measurements and stations.

First, there will be several continuous temperature recorders: one upstream of the intake, one at the discharge, and several downstream from the discharge. All continuous temperature recorders are on the same side of the river as the plant, namely, the right bank. Second, temperature and dissolved oxygen readings will be taken one day during each sampling period previously mentioned, to construct vertical and cross-sectional profile temperatures of the river at one station above the plant.and at a number of stations below the plant. These latter stations will extend about 12 miles downstream from the plant. Finally, monthly aerial infrared photographs of the river in the postoperational phase are planned.

Chemistry

Alkalinity and pH values might fluctuate because of increased biological activity in the warm water. In addition to alkalinity and pH, grab samples taken upstream and downstream of the plant will also be analyzed for hardness, calcium, magnesium, sodium, conductivity, total dissolved solids, sodium absorption ratio, potassium, sulfate, turbidity chloride, nitrate, and total phosphate.

3.2.1 Report of The Nebraska Game and Parks Commission Study "Selected Environmental Effects of Two Nuclear Power Plants On The Missouri River" (continued)

Fish

In general, fish sampling will be done on both sides of the river from about 3-1/2 miles upstream of the plant to about 5-1/2 miles downstream in the following manner:

Telephone shocking - At ends of pile dikes both above and below the discharge points. This technique is effective for flathead catfish when water temperature exceeds 60°F.

Seining - To be done with 40-ft. bag seines along the sandbars immediately downstream of the pile dikes. This will be effective for small fish of many species.

Hoop netting - Along the trail dikes above and below the discharge points. This method is effective for large and small fish of many species.

Boat-mounted shocker - Along the trail dikes above and below the discharge points. This will be effective for intermediate and large sizes of many species.

Drift net - Larval fish collections from above and below effluent channel. Postoperational phase only.

It is expected that the fish sampling will give the following information. Comparisons of catch per unit effort for each species before and after operation of the plant will indicate the response of each species to warm water. Marking of fish during preoperational phase will establish "normal" upstream and downstream shuffling. Postoperational marking on

also be used to determine magnitude of movement into or away from warm water. Documentation of fish length will indicate the response of small and large fish to warm water. In the postoperational phase, the condition of gonads may indicate whether fish which inhabit the warm water mature and spawn earlier than those which do not. Also, in the postoperational phase, the stomach contents of fishes inhabiting warm waters may be compared with the stomach contents of those not inhabiting the warm water to indicate differences in food habits, and as an indirect measure of population changes in those aquatic organisms consumed by fish. Age and rate of growth of fish inhabiting warm water will be compared with age and rate of growth of those not inhabiting the warm water. The mortality of larval fish passing through the plant and in the warm water below the plant will be studied.

In addition, several species of fishes will be collected in the preoperational and postoperational phase for analysis of radioactive nuclides. In the postoperational phase, sampling will be done both up-stream and down-stream of the plant site.

Fish-Food Organisms

Fish-food organisms will be studied in two sections: macroinvertebrates and attached algae. The macroinvertebrates and attached algae will be collected from six artificial substrate sampling stations using an exposure time of twenty-one days.

3.2.2 Meteorological Studies

General

As is typical of the inner regions of large continents in the middle latitudes, there are frequent changes in weather from day to day.

3.2.2 Meteorological Studies (continued)

Because of Nebraska's location midway between two distinctive climatic zones, the humid east and the dry west, cyclic weather conditions representative of either zone and combinations of both occur. Changes in weather result from the invasion of large masses of air with dissimilar properties such as warm moist air from the Gulf of Mexico, hot dry air from the southwest, and cold dry air from the northwest. Nebraska is also affected by many storms or "lows" which travel across the country, west to east. Thus, periodic and rapid changes in weather are normal, expecially during the winter months.

Descriptive Meteorology

Climate

Air approaching Nebraska from west of the Rocky Mountains loses much of its moisture on the windward side of the mountains and thus no significant amount of rain or snow reaches the state from the Pacific Ocean. The moisture supply for precipitation comes chiefly from the Gulf of Mexico; the remoteness of this source contributes to the wide variation in rainfall from year to year.

The average annual precipitation for the eastern third of Nebraska is about 27 inches and the 38-year average for 1931-1968 compiled at Eppley Airfield indicates a normal yearly total of 28.46 inches. Additional data furnished by the Omaha Weather Bureau shows that for the period 1931-1968 the yearly averages for the city of Blair (27.10 inches) and North Omaha Airport (27.94 inches) correlate favorably.

The mean total snowfall derived from thirty-eight years of records at Eppley Airfield is 30.9 inches. As is the case for rainfall, there is great variance in the annual total snowfall.

3.2.2 Meteorological Studies (continued)

A number of hailstorms and thunderstorms also occur each year, but their adverse effects are restricted to crop and minor property damage.

Field Meteorological Program

The site climatological station installed in May, 1967, (see Figure 3-1) incorporates instruments capable of minimum Weather Bureau accuracies in every case. The conditions measured are temperature, humidity, barometric pressure, rainfall and wind. The wind data and some of the other more pertinent data for the first and second years have been reduced and evaluated. The wind instrument is mounted on a 40-foot mast and records winds at a location immediately adjacent to the Missouri River and slightly south-southeast of the reactor centerline.

A second permanent weather tower was installed on the Fort Calhoun site during 1970. The tower is approximately 160 feet high and incorporates three aspirated temperature sensors; one is at an elevation ten meters above the plant ventilation discharge duct outlet (117 feet), one is ten meters below this elevation and the third is two meters above the ground. A vector-vane system is also mounted at the discharge duct elevation. Signals from the tower sensors will be processed by the plant computer which will calculate relative concentrations routinely and/or on demand. Temporary recorders are being used to record the meteorological data prior to installation of the plant computer.

This second weather tower is located more than one-half mile northwest of the reactor building, (as shown on Figure 3-1). It is located upriver to measure true wind conditions prior to their passage over the reactor complex towards the greatest concentrations of population in the area. The earlier climatological station will be retained for backup purposes.

3.2.2 Meteorological Studies (continued)

In keeping with the typically continental climate of Nebraska, large annual temperature ranges are normal. A mean annual temperature of 53° F is predicted for the area along the southeastern boundary of the state.

With the present instrument location at Eppley Airfield, the highest temperature recorded was 107° F in August 1964. The record low was -17° F in January 1966. A high temperature of 114° F and a low temperature of -32° F have been recorded at other locations in July 1936 and January 1884.

Records from Blair and North Omaha Airport show close agreement. The mean annual temperature at Blair (1931 to 1968) was 49.6° F while that at North Omaha Airport was 51.3° F.

Winds

Although frequent shifts in wind direction are commonplace during all seasons of the year, two primary wind patterns predominate based on thirty-three years of records gathered at Eppley Airfield.

Storms

Several tornadoes are expected in Nebraska each year. The annual average for the period from 1953 to 1968 was thirty-six. Although these tornadoes are generally very small, both in width and in length of path, damage can be expected where the funnels touch the ground. Two devastating tornadoes have struck Nebraska since 1875. The first one swept across Kansas, Missouri, Nebraska, and Iowa on May 29 and 30, 1879, killing 30 and injuring 50 persons. On March 23, 1913, Omaha was hit by a tornado which claimed 95 lives and caused $3,500,000 property damage.

3.2.2 Meteorological Studies (continued)

A hill-top thermograph was installed during September, 1968 at a higher elevation than the climatological station, in a west-southwest direction from the reactor (as shown in Figure 3-1). The difference in elevation between the two instruments is 310 feet. This hill-top thermograph has provided interim vertical temperature gradiant measurements in conjunction with the thermograph at the climatological station.

Diffusion Climatology

Based on data obtained from the meteorological equipment installed at the Fort Calhoun plant site, diffusion and some potential dose models have been developed for expected routine and hypothetical accidental releases of air borne radioactive substance. Relative concentrations (X/Q) have been developed for each wind direction and classification on an average as well as on a long term weighted average basis. The average annual relative concentrations per sector at the site boundary are delineated in Table 3-1. Thyroid and whole body doses for a maximum hypothetical accident are given in Table 3-2.

Based on the above information, it is concluded that operation of the Fort Calhoun plant does not present any undue hazard either to the general public or to plant personnel.

Cognizance of current and average meteorological conditions will be maintained throughout the plant operating period in order to provide continuing assurance that the health and safety of the general public are not jeopardized.

TABLE 3-1

AVERAGE ANNUAL RELATIVE CONCENTRATIONS (SEC./CUBIC METER) PER SECTOR FOR MINIMUM SITE BOUNDARY (METERS)

Period of Record: September 3, 1968 to May 31, 1970

Direction Affected	Minimum Site Boundary (Meters)	Avg Annual χ/Q (s/m^3)	Avg Dilution Factor	New Site Boundary Relative Concentration
N	538.3	7.790E-06	2.5	3.12×10^{-6}
NNE	478.5	6.234E-06	2.7	2.31×10^{-6}
NE	475.9	8.329E-06	2.7	3.08×10^{-6}
ENE	530.0	8.157E-06	2.6	3.14×10^{-6}
E	447.7	1.567E-05	2.7	5.80×10^{-6}
ESE	381.9	2.961E-05	3.0	9.86×10^{-6}
SE	384.9	2.085E-05	3.0	6.97×10^{-6}
SSE	461.0	1.039E-05	2.75	3.78×10^{-6}
S	712.5	3.060E-06	2.2	1.39×10^{-6}
SSW	971.1	9.534E-07	1.8	5.30×10^{-7}
SW	1109.7	8.034E-07	1.7	4.73×10^{-7}
WSW	1199.5	1.141E-06	1.6	7.14×10^{-7}
W	896.0	3.366E-06	1.9	1.77×10^{-6}
WNW	966.0	6.685E-06	1.8	3.71×10^{-6}
NW	1269.9	5.560E-06	1.5	3.71×10^{-6}
NNW	700.9	8.614E-06	2.2	3.92×10^{-6}

3.2.2 Meteorological Studies (continued)

TABLE 3-2

THYROID AND WHOLE BODY DOSES

		Calculated Dose (rems)	10 CFR 100 Guideline Dose (rems)
Exclusion Boundary	Thyroid	89.0	300
(2 hours)	Whole Body	3.2	25
Low Population Zone	Thyroid	75	300
Radius (30 days)	Whole Body	.036	25
Control Room	Thyroid	7.8	No guideline dose
(24 hours)	Whole Body	1.4	

3.2.3 Radiological Studies

General

The radiological monitoring program is designed to provide data concerning the types and amount of radioactivity present in the environment of the Fort Calhoun Station. The preoperational program is designed to assess environmental conditions before the arrival of the fuel. Subsequent analyses during the operational program will be made to ensure that plant operations do not have a significant effect on the environment.

Preoperational Radiological Surveillance Program

The purpose of the Preoperational Surveillance Program is to determine the base level of existing radioactivity to which future analytical results can be compared. The program extends for a minimum of four consecutive calendar quarters. The monitoring program was developed in cooperation with the regulatory agencies of Nebraska and Iowa, and the Fish and Wildlife Service of the United States Government, Department of the Interior.

3.2.3 Radiological Studies (continued)

Specific radionuclide and/or gross radioactivity analyses are performed on selected samples. Table 3-3 summarizes the types of samples and analyses included in the preoperational program.

TABLE 3-3

GROSS AND SPECIFIC RADIONUCLIDE ANALYSES

	Gross α	Gross β-γ	γ Spec.	Sr-90	H-3	K-40	I-131	Cs-137
Surface Water	x	x	x	x	x			
Well Water	x	x	x	x	x			
Mud & Silt	x	x	x					
Aquatic Biota		x	x	x		x		
Milk		x	x	x		x	x	x
Vegetation	x	x	x	x	x	x		
Air Particulate	x	x	x					
Wildlife				x			x	

Surface water samples were collected at six stations: one at the DeSoto National Wildlife Refuge lake area and five from the Missouri River at sampling stations located above and below the plant site, including the municipal water supplies at Omaha, Nebraska, and Council Bluffs, Iowa.

Well waters were sampled at eleven wells within a four-mile radius of the plant.

Mud and silt samples were taken from the Missouri River downstream of the plant.

The basis for sampling aquatic biota was formulated from specific recommendations of the Nebraska Game and Parks Commission. The fish species

selected were chosen because their food habits include organisms with many of the lower trophic levels and because they are important from the standpoint of sport and commercial fishing. The food habits and fish samples taken from the Missouri River are shown in the following table:

TABLE 3-4

FISH SPECIE AND FOOD HABITS

Specie	Food Habits
Flathead Catfish#	Fish
Flathead Catfish*	Insects
Channel Catfish#	Fish
Channel Catfish*	Insects
Carp	Omnivorous
Paddlefish	Plankton
Buffalo	Algae & Insects
Shad	Plankton

over 10 inches long
* less than 10 inches long

The Missouri River has a sand bottom which moves with the water flow, therefore, benthos and other bottom organisms are extremely scarce. Joint efforts with the Nebraska Game Commission to obtain sufficient samples of analysis of periphyton have failed; a cooperative study continues as a separate project.

Milk from large Grade A milk producers in the local milkshed was sampled in cooperation with the Omaha Douglas County Health Department. The dairy herds of these Grade A milk producers are located downwind of the plant site.

3.2.3 Radiological Studies (continued)

Foods normally consumed by the general population constitute the vegetation samples. Six stations with a total of ten varieties of food were sampled during the 1968 growing season.

Airborne particulate matter was collected at the plant site on 0.45 micron pore size filters; the filter was removed from the sampler and counted after the radioactivity had decayed for at least seventy-two hours. The air volume passed through the filter was approximately 1000 cubic feet.

Background radiation readings were measured with a Geiger-Mueller survey meter at sixteen stations. Combination film badge and thermoluminescent dosimeters were placed at eleven stations.

A wild rabbit sample is included to represent wildlife normally consumed in the area. These rabbits are free to wander, but they normally remain in the immediate vicinity.

Operational Radiological Surveillance Program

The Operational Radiological Surveillance Program is to be conducted by OPPD in conjunction with the Eberline Instrument Corporation.

The design requirements are shown in Table 3-5. The program developed must incorporate the requirements delineated in this section of this report. The sampling frequencies are delineated in Table 3-5 and sensitivity requirements for each sample type are in Table 3-6.

Background gamma radiation surveys utilizing ion chambers, film badges, thermoluminescent dosimeters (TLD), or a combination of these devices shall be made as shown in Figures 3-2 and 3-3. A statistical analysis establishing the mean ambient gamma dose rate and the standard deviation will be based on the data so obtained.

TABLE 3-5
FORT CALHOUN STATION - UNIT NO. 1
PROGRAM SUMMARY
OPERATIONAL ENVIRONMENTAL SURVEILLANCE PROGRAM

Samples	Coll. Freq.	Anal. Freq.	Gross α	Gross β	K-40	Sr-90	H-3	γ-Scan	I-131	Cs-137	No. of Samples	Notes
TLD/Film Badge	Q	Q									10	#1
G-M Survey	Q	Q									15	
Air Particulate	W	W-Q	X	X				X	X		4	
Surface Water	W	M	X	X		S	X	S	S	S	5	#2
Well Water	M	Q	X	X		S	S	S	S	S	4	#3
Mud & Silt	A	A	X	X		S		X		S	1	
Fish	A	A		X	X	X		X		S	6	#4
Milk	Q	Q		X	X	X		X	X	X	3	
Vegetation	A	A	X	X	X	S	S	X		S	6	#4
Rabbit	A	A				X			X		1	
												#5

S = Specific Analysis (Above Decision Limits)

A = Annually
Q = Quarterly
M = Monthly
W = Weekly

TABLE 3-5 (con'd)

Note 1 = Film/TLD Background Readings Results in Absolute mrems for Comparison with G-M Survey Readings.

Note 2 = Surface Water Sampling Continued At

1/2 Mile Downstream; Metropolitan Utilities District; Council Bluffs Municipal Water Works; DeSoto Wildlife Refuge Lake and Upstream of Plant Site.

Analysis Made on Entire Water Sample; Not Filtrate and Residue Separates

Note 3 = Well Water Sampling at

DeSoto Wildlife Headquarters
Eugene Smith Farm
Albert Shideler Farm
City of Blair Well

Note 4 = Start On-Site Grain Sampling Station

Note 5 = Iodine 131 and Cesium 137 Data to be Accumulated on Air; Water; Mud and Silt; Fish and Vegetation for Reference to Specific Analyses.

TABLE 3-6

FORT CALHOUN STATION - UNIT NO. 1
OPERATIONAL ENVIRONMENTAL SURVEILLANCE PROGRAM
SENSITIVITY REQUIREMENTS

Sample	Units	Gross βγ	Decision Limit βγ	Sr - 90	H - 3	I - 131	Cs - 137
Surface Water	μCi/ml	$5x10^{-10}$	$6x10^{-8}$	$1x10^{-9}$	$2x10^{-6}$	$2x10^{-9}$	$2x10^{-9}$
Well Water	μCi/ml	$5x10^{-10}$	$3x10^{-8}$	$1x10^{-9}$	$2x10^{-6}$	$2x10^{-9}$	$2x10^{-9}$
Mud and Silt	μCi/gm	$4x10^{-7}$	$8x10^{-5}$	$8x10^{-9}$	- -	- -	$1x10^{-7}$
Fish	μCi/gm	$1x10^{-7}$	$3x10^{-5}$	$2x10^{-8}$	- -	- -	$3.5x10^{-8}$
Milk	μCi/ml	$6x10^{-9}$	- -	$1x10^{-9}$	- -	$1x10^{-9}$	$2x10^{-9}$
Vegetation	μCi/gm	$1.5x10^{-7}$	$7x10^{-5}$	$3x10^{-8}$	$1x10^{-5}$	- -	$2x10^{-7}$
Air	μCi/ml	$2x10^{-14}$	$1x10^{-12}$	- -	- -	$2x10^{-13}$	- -
Wildlife	*μCi/gm		- -	$3x10^{-6}$	- -	$5x10^{-6}$	- -
Film/or TLD	- -	10 mrem/month above ground	- -	- -	- -	- -	- -

*Rabbit - Strontium - 90 = μCi/gm Calcium in Femur

Iodine - 131 = μCi/gm of Thyroid

3.2.3 Radiological Studies (continued)

Composite water samples both in the vicinity and downstream of the plant site shall be analyzed for gross alpha and Beta-Gamma activity. Five sampling stations shall be established including:

a. A site far enough downstream from the plant discharge to ensure some mixing of the plant effluent.

b. The drinking water intake facility for the city of Omaha.

c. The drinking water intake facility for the city of Council Bluffs, Iowa.

d. The lake area of the DeSoto National Wildlife Refuge.

Samples of mud and silt, collected from one station situated at the first suitable location downstream from the site, shall be analyzed for gross alpha and gross Beta-Gamma activities. Gamma spectra shall be performed on all samples.

When a gross Beta-Gamma count reveals radioactivity in excess of preset limits, analyses for specific isotopes as listed will be performed.

Aquatic biota present in the river water shall be subjected to gross Beta-Gamma analyses. Gamma spectra shall be performed on all samples. Special attention shall be given to select fish which are normally consumed as food in the area. A Potassium-40 (K-40) and Strontium 90 (Sr-90) analysis shall be made for each sample.

A gross Beta-Gamma count shall be made of composite samples of milk gathered from three stations. Gamma spectra shall be performed on all samples. In addition, the milk shall be analyzed for its K-40, Sr-90, I-131, and Cs-137 content. During the course of the milk monitoring program, samples of the fodder consumed by the animals shall also be analyzed, should the monitoring program indicate unexplainable high activity levels in the milk.

3.2.3 Radiological Studies (continued)

Specimens of the vegetation in the vicinity of the plant site and the surrounding area shall be examined for gross Beta-Gamma activity and K-40. Gamma spectra shall be performed on all samples. The gross alpha activity shall also be determine for these samples. Six sampling stations have been established.

Particulate contamination of the atmosphere shall be monitored on a continuous or semi-continuous basis and the filters shall be changed weekly. Sampling method to be employed shall be the air suction-filtration technique and shall measure gross alpha and gross Beta-Gamma activities. Gamma spectra shall be performed using the composite of all samples. Four monitoring stations shall be utilized as shown on Figures 3-2 and 3-3. A program shall be included which defines the equipment and analysis requirements to provide radio-iodine measurements of atmospheric samples.

The monitoring program will begin collecting samples as soon as possible, and will continue for the life of the facility with appropriate modifications as required.

3.2.4 Thermal Studies

Introduction

Historically, the power industry has found it economically advantageous to locate their plants near a large cooling water source. Large supplies of cooling water are necessary to condense efficiently steam from the last stage of the turbine. This water usage is usually a once-through process. Cooling water is taken into the plant and pumped through the tubes of the condenser and then discharged.

There are two major factors that currently focus public interest on the temperature aspect of this use of streams and rivers. These factors

are: the growth of the power industry and the growing public and government concern over water quality.

As a result of federal legislator, each state must submit its water quality criteria along with a plan for implementing and enforcing these criteria. As a result of this Federal action, Nebraska passed Legislative Bill 360 in June, 1967 relating to water pollution. Under that authority, Nebraska's Water Pollution Control Council received Federal approval from the Department of the Interior for its "Water Quality Standards Applicable to Nebraska Waters, January, 1969".

These federally approved state standards classify the Missouri River as a Class "A" warm water stream between Sioux City, Iowa, and Omaha, Nebraska. As a Class "A" warm water stream, the following criteria on thermal discharges are applicable to the Missouri River.

> These criteria are applicable at flows greater than the lowest flow for (7) seven consecutive days which can be expected to occur at a frequency of once every ten years. For temperatures: Flows considered are for ice-free conditions.
>
> Warm Water Streams allowable change 5°F May through October; 10°F November through April, maximum limit 90°F, maximum rate of change limited to 2°F per hour.

These standards also state that every effort must be made in the evaluating process to sample the receiving waters after they have had a reasonable opportunity to mix with the waste waters.

Description of Missouri River

In order to predetermine the temperature effects on the Missouri River of future units such as Fort Calhoun Unit No. 1, OPPD decided to study the downstream temperature effects of an operating fossil-fired plant. Omaha Public Power District's North Omaha Power Station

3.2.4 Thermal Studies (continued)

was selected, as it is the largest facility in the Omaha area and is on a section of the river similar to the section of the river at the Fort Calhoun Plant. The river at both these points consists of a 600-foot wide controlled channel with essentially a sand and silt bottom. The Fort Calhoun Plant is located at river mile 646.0; the North Omaha Plant is located at river mile 625.3. Both are on the cutting banks of the river. The river bank at both sites is controlled by stone and stone-filled pile revetments. The November 3, 1964 thermal study by the Army Corps of Engineers on the Missouri River downstream from the North Omaha Power Station as well as those temperature records of various governmental agencies and neighboring utilities, were analyzed by OPPD prior to actual testing as part of this study.

The temperature of the Missouri River fluctuates daily as much as 4.6°F with a normal minimum at about 8:00 AM and a normal maximum at about 6:00 PM. Extreme river temperatures measured vary from a winter low of 32.0°F to a summer high of 86.3°F. Table 3-7 shows that peak temperatures above 82°F occurred infrequently and (see Note to Table) then only twice on consecutive days in a fifteen year period. Table 3-8 indicates the expected average, average maximum and average minimum monthly temperatures from 1952 through 1970.

Tables 3-9, 3-10 and 3-11 show historical flow data of the Missouri River at Omaha. It should be emphasized that the extreme minimum flows shown were all the result of severe icing conditions.

3.2.4 Thermal Studies (continued)

TABLE 3-7

NUMBER OF DAYS IN YEAR 1955 THROUGH 1970

MISSOURI RIVER WATER 8:00 AM TEMPERATURE

WAS 80° TO 84° F

Year / Temp. °F	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
>84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	5	0	1	0	0	0	0	0	0	0	0	1	0	0	2	0
83	6	0	11	4	0	0	0	0	0	0	0	3	0	0	3	0
82	15	2	6	3	2	2	1	1	3	3	0	0	0	0	2	0
81	6	4	6	8	9	5	1	1	8	6	1	3	0	0	1	3
80	17	28	17	0	9	3	7	3	6	3	2	12	3	2	5	1

Note: In 1955 there were 5 days at 84°F, however, only two sets of these days were consecutive. These days were July 31 - August 1, August 5 - August 6.

: Data from Omaha Metropolitan Utilities District.

3.2.4 Thermal Studies (continued)

TABLE 3-8

AVERAGE 8:00 AM TEMPERATURES OF THE MISSOURI RIVER

AT MILE 626.3 (NORTH OMAHA)

1952 THROUGH 1970

	Avg. For Period °F	Max. Mo. Avg. °F	Min. Mo. Avg. °F
Jan.	32.7	34.0	32.0
Feb.	32.8	35.0	32.0
Mar.	36.3	39.0	32.0
Apr.	48.7	55.0	46.0
May	61.0	66.0	56.5
June	71.7	76.0	67.3
July	78.1	83.0	75.0
Aug.	76.8	80.0	73.0
Sep.	68.0	76.4	61.0
Oct.	56.4	64.0	52.4
Nov.	42.3	46.0	36.8
Dec.	33.7	36.0	32.0

Note: Data from Omaha Metropolitan Utilities District.

3.2.4 Thermal Studies (continued)

TABLE 3-9

MISSOURI RIVER FLOW RECORD SUMMARY AT
OMAHA, NEBRASKA OCTOBER, 1960 THROUGH SEPTEMBER, 1969

Month	Avg. No. Flow Rate ft^3/sec.	Avg. No. Maximum Flow Rate ft^3/sec.	Avg. No. Minimum Flow Rate ft^3/sec.
January	11,770	17,280	9,161
February	13,460	25,500	8,162
March	20,930	25,880	13,080
April	36,870	66,320	25,670
May	31,860	44,730	26,450
June	34,350	43,060	26,890
July	34,080	44,950	28,990
August	34,720	53,860	28,060
September	33,980	54,700	29,590
October	29,640	34,510	16,920
November	26,500	32,420	8,324
December	12,810	18,960	8,296

Average for period - 26,750 ft^3/sec.

Average for January through December for period - 19,185 ft^3/sec.

Average for April through September for period - 31,370 ft^3/sec.

Note: Data from U. S. Geological Survey

TABLE 3-10

MEAN MONTHLY VELOCITY AND DISCHARGE OF THE MISSOURI RIVER AT AKSARBEN BRIDGE

OMAHA MILE 615.9

Date	Ft/sec. Mean Velocity	Ft^3/sec. Mean Discharge
Oct., 1969	6.00	46,960
Nov., 1969	5.59	40,760
Dec., 1969	4.73	28,970
Jan., 1970	3.95	18,600
Feb., 1970	4.50	20,725
Mar., 1970	5.18	31,325
Apr., 1970	5.08	34,720
May 1970	4.74	34,240
Jun., 1970	4.73	38,140
Jul., 1970	4.76	40,200
Aug., 1970	5.42	44,000
Sep., 1970	5.32	41,840
Average	5.00	35,040

Note: Data from U. S. Geological Survey

TABLE 3-11

MISSOURI RIVER MAXIMUM AND MINIMUM FLOW
BY YEAR 1961 THROUGH 1969

Year	Ft^3/sec. Maximum	Ft^3/sec. Minimum
1961	41,700	2,440
1962	115,000	3,300
1963	61,700	6,000
1964	68,900	3,200
1965	69,800	-
1966	61,800	11,500
1967	62,200	4,800
1968	46,000	6,000
1969	99,500	10,500

Maximum on record 396,000 ft^3/sec. April 18, 1952

Minimum on record 2,200 ft^3/sec. January, 1937

Note: Data from U. S. Geological Survey

Thermal Testing

In cooperation with the Army Corps of Engineers, the U. S. Geological Survey and neighboring utilities, a number of tests have been run. Table 3-12 gives the dates of these tests and the station's gross megawatts loading at the time the tests were made.

3.2.4 Thermal Studies (continued)

TABLE 3-12

THERMAL TEST

Test By	Test Date	North Omaha Power Station MWe Plant Load
USACE	11-3-64	300 to 324
OPPD, USACE & USGS	7-6-67	367
OPPD, USACE & USGS	8-31-68	340
OPPD, USACE & USGS	8-29-68	430
OPPD, USACE & USGS	8-30-68	605
OPPD, USACE & USGS	9-1-70	615 to 650

Note: USACE - Army Corps of Engineers
USGS - Geological Survey
OPPD - Omaha Public Power District

All tests showed the following general results:

a. Maximum temperatures occurred immediately downstream of the discharge in a small area close to the river bank prior to complete mixing of the receiving water and the discharged water. In this area, less than 200 feet wide and 2500 feet long, temperatures fluctuated rapidly indicating incomplete mixing in the vertical section.

b. The influenece of the thermal discharge stayed along the same bank as the discharge, tending to spread out on the inside of a river bend and contract on the outside. The area of influenece in general increased in width and decreased in magnitude as the mixing zone progressed downstream from the point of discharge.

c. Heat discharged to the river is rapidly lost by dissipating to the air and to the environment. Dependent upon the heat load imposed, weather conditions, and other revelant factors the tests showed that the river will return to its natural temperatures in about ten to fourteen

miles. Approximately ten miles are also required to mix the discharged waters completely with the receiving waters.

d. After about five-tenths miles downstream, where there is complete mixing in the vertical section, temperatures in the vertical section are extremely uniform and will generally not vary more than one or two tenths of 1°F from top to bottom.

Each test run has become more sophisticated. The November 3, 1964 tests involved fewer readings than the July 6, 1967 test. The 1968 tests employed more accurate temperature reading devices (Whitney Underwater Thermometers), instrument location of temperature readings, measured velocities, and depth gauges. The later tests also considered mode of heat transfer and energy balances.

The September test in 1970 was conducted in the same manner as the August 1968 test; however, it was limited to the area immediately below the discharge point, and included dissolved oxygen analysis. It is of interest to note that dissolved oxygen readings upstream in the circulating water stream and downstream from the point of discharge were all within a few tenths of one part per million. In fact, some measured readings downstream were higher than those upstream.

Results from the 605 MWe test made in 1968 are of the most interest as they represent the largest measured thermal loading of the Missouri over a 10 mile length of the river. The results are summarized in figures 3-4 and 3-5.

Figure 3-5 illustrates the rapidity with which heat discharged

3.2.4 Thermal Studies (continued)

to the river is dissipated to air and the environment. For large heat loads the left side of the graph would be expanded and for lesser heat loads it would be contracted. Thus, it can be reasoned that for very large differences in heat input the total distance required in the river to exchange this heat to the air and outer space would not vary greatly due to the extremely large initial heat losses occurring in the first few miles downstream.

Figure 3-4 is a isotherm plot at 605 MWe load downstream from the North Omaha Power Station discharge and illustrates areas of temperature increases due to the discharge.

Figures 3-6 and 3-7 are isotherm plots from the September 1, 1970, test at 615 to 650 MWe load and are similar to the plot at the 605 MWe load.

3.2.5 Hydrological Studies

The plant site is bounded on the northeast by a portion of the Missouri River referred to as the Blair DeSoto Bend by the Army Corps of Engineers. The Corps maintains the river bounds to prevent further meandering of the channel within the alluvial flood plain; the protection takes the form of pile dikes and bank protection. As stated previously in this report, there are six dams upstream of the plant site (see Figure 2-9) that control the river flow.

Figures 3-8 and 3-9 show the Missouri River stage and flow duration curves at the plant site.

With reference to flooding, the water level that will be equalled or exceeded 0.1 percent of the time is 998 feet - this is a stage-duration

value, not a flood peak. The 0.1 percent probability flood peak stage is 1001.3 feet. This is a momentary peak that has a 0.1 percent chance of occurrence in any year. The 0.1 percent probability flood peak stage is not determinable by statistical analysis with sufficient precision for planning use. However, the design flood peak stage of 1004.2 feet is the proper order of magnitude for a 0.1 percent probability flood. As a matter of fact, extrapolation of the probability curve would yield a value slightly less than 1004.2 feet for the 0.1 percent probability flood. Therefore, 1004.2 feet is conservative and is proper for use.

The release from Gavins Point is maintained at 11,000 cfs as a normal minimum depending largely on availability of water. Flows during the winter non-navigational season are normally in the range of 6,500 to 16,500 cfs. In years when an extended period of drought has depleted storage reservoirs, flows may run as low as 5,000 cfs, and after additional irrigation development, 3,000 cfs. Ice formation can temporarily reduce these quantities but the flow is soon restored after the initial ice formation. The irrigation development takes place in the area upstream of the main stem dams. There are no irrigation developments between the plant site and the municipal water intake for the city of Omaha, approximately twenty miles downstream.

Table 3-9 shows on a monthly basis average, maximum, and minimum flows in the Missouri River from October, 1960 through September, 1969, at Omaha, Nebraska. Table 3-10 shows mean river velocities and discharges in the Missouri River from October, 1969 through September, 1970, at Omaha, Nebraska. Table 3-11 shows maximum and minimum discharges of the Missouri River from 1961 through 1969 at Omaha, Nebraska. Figure 3-10 shows expected

3.2.5 Hydrological Studies (continued)

future flow durations of the Missouri River for 1970, 1980, 2000, and 2020 at Sioux City, Iowa.

Based on the above and on the natural storage of the reaches below a momentary and partial ice dam, adequate cooling water to meet plant requirements will always be available.

Calculations have been made to determine the downstream concentrations of radionuclides to be discharged into the Missouri River from the Fort Calhoun Station. These calculations were based on a model developed and experimentally verified by Yotsukura, Fisher and Sayre in Measurements of Mixing Characteristics of the Missouri River Between Sioux City, Iowa and Plattsmouth, Nebraska (Geological Survey Water Supply paper 1899-G, Government Printing Office, Washington: 1970). The computer code described in this publication was obtained by OPPD and applied to the configuration of the river both at and downstream from the site.

The calculated maximum concentration of wastes all the way to the water intake point for the City of Omaha, 19.5 miles downstream, for both high and low river discharge conditions are shown in Figure 3-11.

Work has been done for high and low flow rates. Additional work on the same topic will be done in the future with efforts to correlate calcualted and experimental data.

3.2.6 Chemical Studies

Several organizations in the Omaha area make periodic chemical analyses of the Missouri River and ground waters in the Omaha area.

3.2.6 Chemical Studies (continued)

The primary source for chemical analysis data for the Missouri River is Metropolitan Utilities District. Metropolitan Utilities District analyzes Missouri River water taken from their intake structure located at North Omaha (river mile 626.3) once a week. In addition, the Army Corps of Engineers analyzes once a week this river water sampled at Bellevue, Nebraska, approximately 44.5 miles downstream from the plant site for suspended solids. The Metropolitan Utilities District performs complete river analyses weekly; some analyses are even performed daily.

The Omaha Public Power District also analyzes the Missouri River water at its North Omaha Power Station (river mile 625.3) on a weekly basis. In addition, OPPD makes occasional well water analyses at the Fort Calhoun site.

Summaries of these analyses plus some additional analyses are shown in Tables 3-13 and 3-14.

Theoretical average chemical quantities that will be discharged from the Fort Calhoun plant have been determined and are summarized in Tables 3-15, 3-16, and 3-17.

3.2.6 Chemical Studies (continued)

TABLE 3-13

TEST WELL WATER ANALYSIS

Analysis	Maximum Anion	Minimum Anion	Average Anion
Iron Fe, ppm	15.9	14.5	15.5
Manganese Mn, ppm	3.1	0.6	2.4
Sodium Na, ppm	34.3	42.1	47.1
Potassium K, ppm	4.0	3.2	3.5
Calcium Ca, ppm	168.0	157.6	161.6
Magnesium Mg, ppm	65.7	48.7	55.2
Total Cations, ppm	293.7	275.0	283.3
Sulfate SO_4,ppm	174.0	141.9	157.6
Chloride Cl, ppm	130.6	4.0	24.4
Bicarbonate HCO_3, ppm	772.1	553.9	702.0
Nitrate NO_3, ppm	0.1	0.5	0.3
Total Anions, ppm	933.8	830.3	884.3
Silica SiC_2, ppm	27.3	20.6	23.3
Total Dissolved Solids, ppm	1,247.1	1,146.0	1,191.4
Total Hardness, $CaCO_3$, ppm	668.0	604.0	633.8
Alkalinity $CaCO_3$, ppm	632.9	454.0	575.4
pH	7.4	7.0	7.3
Conductivity, μ mho	1,400	1,200	1,261

3.2.6 Chemical Studies (continued)

TABLE 3-14

ANALYSIS OF MISSOURI RIVER WATER AT
OMAHA, NEBRASKA

AUGUST, 1955 - DECEMBER, 1968

Analysis	Maximum	Minimum	Average
Calcium, ppm Ca	88	29	63.1
Magnesium, ppm Mg	28	8	20.1
Sodium, ppm Na	83	16	57.9
Sulphate, ppm SO_4	255	51	193.7
Chloride, ppm Cl	22	5	13.1
Nitrate, ppm NO_3	7.5	0.2	1.8
Phosphate, ppm PO_4	3.8	0.0	0.3
Silica, ppm SiO_2	12.6	3.3	7.06
Total Iron, ppm Fe	17.5	0.0	1.74
Total Manganese, ppm Mn	0.86	0.0	0.28
Total Dissolved Solids @ 103°C, ppm	595	264	486
Total Organic Free Suspended Solids @ 105°C, ppm	20,700	70	1,148
Free Carbon Dioxide, ppm, CO_2	Trace	0.0	0.0
Chlorine Demand for 1 hour, ppm Cl_2	12.0	0.9	2.68
Chlorine Demand for 24 hours, ppm Cl_2	28.5	2.9	6.21
Chloroform-Extractable Matter, ppm	0.252	0.078	0.139
Total Hardness, ppm $CaCO_3$			
Methyl Orange Alkalinity, ppm $CaCO_3$	201	90	160.7
Phenolpthalein Alkalinity, ppm $CaCO_3$	Trace	0.0	0.0
pH	8.5	7.7	8.18
Conductivity @ 25°C, µ mho	900	400	733
Color Units, Platinum-Cobalt Scale	36.0	2.0	8.3
Turbidity, Jackson Candle Scale	850	5	166

3.2.6 Chemical Studies (continued)

TABLE 3-15

WASTE MATERIALS TO AND FROM LAGOONS

Source	Substances	Lbs/Day Waste to Lagoon	Lbs/Day Solids That Remain in Lagoon	Lbs/Day Soluble Salts That Overflow Lagoon
Presedimentation and Cold Lime	Sodium Aluminate, $NaAlO_2$	26.5	26.5	
	Calcium Carbonate, $CaCO_3$	654.4	204.0	
	Magnesium Hydroxide, $Mg(OH)_2$			
	Sand and Silt	3,051.6	3,051.6	
Demineralize	Calcium Sulfate, $CaSO_4$	94.2	708.0	
	Magnesium Sulfate, $MgSO_4$	176.1		201.6
	Sodium Sulfate, Na_2SO_4	897.4		1,538.4
	Sulfuric Acid, H_2SO_4	910.0		
	Sodium Chloride, NaCl	40.8		40.8
	Sodium Carborate, Na_2CO_3	71.4		
	Sodium Silicate, Na_2SiO_3	12.4	12.4	
	Sodium Hydroxide, NaOH	309.9		
	TOTAL	6,257.5	4,002.5	1,780.8

3.2.6 Chemical Studies (continued)

TABLE 3-16

FORT CALHOUN STATION CHEMICAL DISCHARGE AVERAGE FLOWS AND AVERAGE QUANTITIES

Analysis	To Discharge lbs/hr max.	To Discharge lbs/hr avg.	Circulation Water Flow Rate of 248,000 gpm To River ppm max.	Circulation Water Flow Rate of 248,000 gpm To River ppm avg.	Circulation Water Flow Rate of 365,000 gpm To River ppm max.	Circulation Water Flow Rate of 365,000 gpm To River ppm avg.
Secondary System						
Chlorides, Cl	11.6	0.0	0.98	0.0	0.063	0.0
Silica, SiO_2	4.7	0.14	0.039	0.0012	0.026	0.0008
Orthophosphate as PO_4	3.9	1.4	0.031	0.0117	0.021	0.0077
Ammonium Hydroxide NH_4OH	3.9	1.06	0.031	0.0089	0.021	0.0120
Hydrazine, N_2H_4	0.0078	0.0014	T	T	T	T
Sodium, Na	2.79	0.76	0.023	0.0063	0.0153	0.0042

T = trace or negligible quantity

3.2.6 Chemical Studies (continued)

TABLE 3-17

FORT CALHOUN STATION CHEMICAL DISCHARGE
AVERAGE FLOWS AND AVERAGE QUANTITIES

	To Discharge		Circulation Water Flow Rate of 248,000 gpm To River		Circulation Water Flow Rate of 365,000 gpm To River	
Analysis	lbs/hr max.	lbs/hr avg.	ppm max.	ppm avg.	ppm max.	ppm avg.
Reactor Coolant System						
Fluoride, F	0.0033	T	T	T	T	T
Boron, B	68.3	3.7	0.57	0.031	0.020	0.020
Ammonium Hydroxide, NH_4OH	1.67	0.28	0.014	0.002	0.0015	0.0015
Hydrazine, N_2H_4	1.53	0.26	0.013	$<$0.002	$<$0.002	$<$0.002
Lithium, Li	0.0081	0.0005	T	T	T	T
Chlorides, Cl	0.0049	0.0014	T	T	T	T
Sodium, Na	50.0	14.0	0.42	0.117	0.27	0.077

T = trace or negligible quantity

3.3 Thermal Discharges

3.3.1 Introduction

Fort Calhoun Unit No. 1 will use considerable quantities of Missouri River water for cooling purposes. Also, small amounts of certain chemicals used for cleaning and water purification will be released to the river during operation. These discharges will be made in accordance with the most recent state standards adopted by the Nebraska Water Pollution Control Council, and are also subject to the certification requirement of Section 21(b) of the Federal Water Pollution Control Act, as amended. Omaha Public Power District has made application to the Nebraska Water Pollution Control Council for such certification and will take all necessary steps to obtain certification on a timely basis. Omaha Public Power District has a construction and maintenance permit number 68-13 for Fort Calhoun Unit No. 1 obtained from the Army Corps of Engineers. Upon receipt of the water quality certification from the State of Nebraska, a request for a new Army Corps of Engineers permit will be made in accordance with the December 23, 1970, Executive Order 11574 and the revised 33 CFR Part 209.131.

3.3.2 Description of Facilities

The Fort Calhoun circulating water system provides cooling water from the Missouri River for Unit No. 1 turbine generator condensers in addition to the cooling water for a pair of heat exchangers. Flow is provided by three 120,000 gpm circulating water pumps. Operation of two pumps is sufficient when the river temperature is below 60° F. Provision is made to control surface and frazil ice by recirculating the discharge water.

3.3.2 Description of Facilities (continued)

Motor driven traveling water screens are installed ahead of the pump suction to remove the debris and refuse from the river water.

At a maximum output of 1420 MW thermal from the nuclear steam supply system which corresponds to a 481 gross megawatts electric plant output, the thermal heat introduced into the Missouri River will result in a cooling water temperature rise of about 17.9° F with a cooling water circulation rate of about 360,000 gpm.

3.3.3 Thermal Studies and Expected Operational Results

Section 3.2.4 discussed some thermal studies both at the North Omaha plant and downstream from it. Figures 3-4 and 3-5 summarized the 605 MWe test run with a heat rejection of 2.6×10^9 BTU/hr to the Missouri River. Figures 3-6 and 3-7 summarize a 615 to 650 MWe test run with a maximum heat rejection of 3.1×10^9 BTU/hr to the river. The North Omaha plant at full load during the summer months will reject as much as 3.2×10^9 BTU/hr. It is expected that the Fort Calhoun facility will reject approximately 3.3×10^9 BTU/hr to the river at full load. Therefore, the summarized test data represents heat rejections of 79% to 94% of the maximum heat rejection expected from Fort Calhoun.

It would, therefore, be anticipated that at maximum loads from Fort Calhoun (or from the North Omaha plant) the downstream temperatures would be only slightly higher than those illustrated in Figures 3-4 through 3-7. It is also reasonable to assume that at maximum loads, the downstream temperature effects at the Fort Calhoun Plant and North Omaha plant would be

comparable. There have been no known long or short term adverse effects resulting from the thermal discharges from the North Omaha Power Station.

As stated in the section of this report discussing thermal studies, it is expected in the operation of the Fort Calhoun facility that:

a. Thermal discharges will result in a thermal plume that slowly widens with distance downstream. Maximum temperatures in any cross section, after complete mixing in the vertical, will be at the bank and will rapidly decrease to the edge of the plume. The maximum temperature in any cross section will decrease rapidly with distance downstream from point of discharge.

b. Thermal plumes will have a tendency to widen on inside bends of the river and will contract on outside bends.

c. There will be a small area of incomplete mixing immediately downstream from the point of discharge. In this area temperatures will fluctuate rapidly, since there is incomplete mixing in the vertical section. Stable temperatures and complete mixing in the vertical section of the thermal plume can be expected to occur at about 1/2 mile from the discharge. At this point the thermal plume is expected to be about 150 feet wide.

3.3.3 Thermal Studies and Expected Operational Results (continued)

d. Heat rejected to the river from the station will be rapidly exchanged from the river to the atmosphere. It is expected that in about 10 to 14 miles downstream from the discharge, there will be no detectable remaining thermal plume. Test results show that it requires about 6 river miles for the thermal plume to reach the opposite bank and about another 3 to 4 miles for the river to become thermally homogeneous.

3.4 Heat Removal Facilities

All cooling requirements for Fort Calhoun Unit No. 1 are accomplished by a once-through cooling water system using Missouri River water. There are no special techniques or equipment such as dilution with additional water or diffusers, employed to reduce the temperature of the cooling water discharged to the river.

It is believed that there will be no measurable detrimental ecological effects as a result of thermal discharges from the Fort Calhoun Plant. The discharge will mix rapidly with large amounts of river water flowing by the discharge structure. Temperature increase in the Missouri River below the power plant circulating water discharges are discussed in greater detail in Section 3.3 of this report.

3.5 Fish Diversion

The Missouri River supports over fifty species of fish. The design of Unit No. 1 requires that water from the Missouri be drawn through the intake screen structures directly in front of the unit and after condensing the steam from the turbine return to the river at a point approximately 72 feet downstream from the intake screen structure.

Intake screens serve the necessary function of "screening" the cooling water of anything large enough to plug the water passages in the plant equipment. At the entrance is a trash rack -- heavy bar members on wide spacing -- designed to restrain logs and other large debris as well as floating ice in wintertime. Behind this are traveling screens of relatively fine mesh (two openings per linear inch) to prevent entry of smaller material. The traveling screens are made up of a number of screen sections, fastened top to bottom, to form an endless belt of screens.

The cooling water intake of Fort Calhoun Unit No. 1 is not expected to experience problems with fish being impinged on the screens. The intake structure and screening of Fort Calhoun Unit No. 1 are similar to intake structures at Omaha Public Power District's North Omaha and Jones Street Stations. The North Omaha Station started operation in 1954 and no problems have been experienced with fish being harmed by the screens. The Jones Street Power Station has had similar screens in operation since 1920 and, as in the case of the North Omaha Power Station, no problems have been experienced with fish impinging on screens. The structure is designed to provide an intake water flow velocity approaching all of the screens of less than one and one fourth foot per second with all main circulating pumps operating.

3.6 Chemical Discharges

3.6.1 Introduction

In view of the current concerns over chemical discharges to the environment, this section describes in detail the efforts in design and proposed operation which Omaha Public Power District has taken to assure that such discharges will be minimal.

Chemical discharges due to construction and operations of the Fort Calhoun Unit No. 1 will be small. There are no planned routine discharges of harmful corrosion inhibitors such as chromates. Some chromates may be used in a closed cooling water loop. Should this system ever require draining, special treatment will be used so that appropriate state and federal regulations will be adhered to.

The subject of chemical discharges shall be considered as those discharged into the Missouri River and those discharged into the air.

3.6.2 Liquid Chemical Discharges

During operation of Fort Calhoun Unit No. 1, a number of chemical waste systems will discharge liquids to the Missouri River. These discharges will meet state and federal requirements. The chemical liquid waste discharges are the wastes from the water treatment plant, the sanitary wastes, the blowdown from the steam generators and the waste from the waste disposal system.

Water Plant Waste Waters

Fort Calhoun Unit No. 1 is equipped with a water plant that produces service water, potable water and high purity water. The water

plant consists of a (525 gpm) presedimentation unit, a (525 gpm) cold lime softener, three (500 gpm) sand filters, a pair of (500 gpm) carbon filters, a pair of (300 gpm) cation ion exchangers, a pair of (300 gpm) anion ion exchangers and a pair of (300 gpm) mixed bed ion exchangers.

Missouri River water is first fed to the presedimentation unit along with a floculating agent and a small amount of calcium hypochlorite. Clarified effluent from the presedimentation unit is fed to the cold lime softener along with floculating agents, hypochlorite and hydrated lime. Softened water from the cold lime unit is recarbonated and filtered through sand filters. At this stage of treatment, some water is chlorinated for the potable water supply, some is used for the service water supply and the remainder is fed through the carbon filters and then converted to high purity water by demineralization.

The suspended solids in the river water feed to the presedimentation unit, the precipitants in the cold lime unit, backwash waters from filters, spent acid and salts along with spent caustic from the demineralization system are discharged to one of two lagoons which then discharges into the other lagoon which in turn overflows to the river.

For short periods of time (ten minutes) waste discharges could be as high as 1,235 gpm, assuming the simultaneous backwashing of a sand filter (ten minutes at 900 gpm) and the backwashing of a cation unit (15 minutes at 335 gpm). On the average it is expected that 51,393

3.6.2 Liquid Chemical Discharges (continued)

gallons per day of waste waters containing some 6,257 lbs. of suspended or dissolved materials will be discharged to the lagoons. Also, on the average, the overflow from the lagoons will contain 1,780 lbs. of dissolved nontoxic salts. These average expected waste materials to and from the lagoons are shown in Table 3-15 and Table 3-18.

TABLE 3-18

WASTE WATER TO AND FROM LAGOONS

Source	Gallons per Day
Demineralizer	32,236
Carbon filter backwash	3,500
Sand filter backwash	9,000
Cold lime & presedimentation blowdown	6,657
Total Water to Lagoons	51,393

If the water plant were operated at maximum capacity for a day, the waste discharges to the lagoons would be about 2.8 times larger than those shown on Table 3-15 and Table 3-18. As should be noted from Table 3-15, acid and caustic are discharged to the lagoons where they react with each other producing sodium sulfate. Excess acid reacts with other salts such as calcium carbonate to produce carbon dioxide and water. The overflow from the lagoons will contain nontoxic salts and be slightly basic (pH ≈ 9.0).

The lagoons are in reality chemical equalization and decantation holding basins that process the waste discharges from the water plant. Each lagoon has a capacity of approximately 15,000 cubic feet at three feet of water depth and approximately 20,000 cubic feet at five feet

3.6.2 Liquid Chemical Discharges (continued)

of water depth (maximum). It is expected that a lagoon will require cleaning every 280 days. The solids cleaned from the lagoons will be about 76% sand and silt, 18% calcium sulfate or gypsum and 5% calcium carbonate. The waste products, calcium sulfate and calcium carbonate, are found in nature, thus solids cleaned from the lagoons will be used for land fill either on or off the plant site.

It should also be emphasized that the cations and anions of the waste salts dissolved in the overflow from the lagoons also occur naturally in the river water and will not cause any short or long term ecological problems.

Sanitary Waste Waters

All of the sanitary waste at the Fort Calhoun Plant drain south from the plant to a Smith and Loveless, "Mon-o-ject" 30 gpm, 20 ft. total dynamic head, sewage lift station equipped with a 6 inch inlet and discharge line. The lift station discharges to a Smith and Loveless cylindrical "Oxigest" Model No. 8CY7 aerobic digestion unit that is defined as "a complete mixing extended-aeration, activated-sludge process".

The "Oxigest" system is designed to process 7000 gallons per day of raw sanitary sewage or waste with an organic loading of 12.75 pounds of 5-day B.O.D. The treated effluent from the "Oxigest" unit is discharged to the Missouri River. The lift station and aerobic digestion system are located near the lagoons that receive the water plant waste. In case the aerobic digestion unit has to be shut down for maintenance, the discharge from the lift station could be routed to the

3.6.2 Liquid Chemical Discharges (continued)

lagoons. It is expected that this bypass operation to the lagoons will occur rarely and then for only short periods of time.

Chemical Waste Waters Injected into Circulating Water Discharge

There are two waste waters that are injected into the circulating water discharge duct, namely waste waters from the nuclear plant systems that have been processed in the liquid waste disposal system and blowdown waters from the secondary side of the steam generators.

Both of these waste discharges can contain some radioactive isotopes. A steam generator blowdown could contain some radioactive isotopes in the unlikely event there was a leak in one or more tubes in the unit. The blowdown from each steam generator is monitored. In the event activity is detected, the blowdown is diverted to the liquid waste disposal system where caustic neutralization, holdup decay tanks, filtering, degassing, evaporation and mixed-bed demineralization processes are available for treatment before being discharged to the circulating water effluent conduit. Caustic neutralization is used to neutralize reactor coolant waste waters that contain boric acid. The radioactive discharges are discussed in detail in Section 3.7.

Due to equipment design limits, the maximum steam generator blowdown for both steam generators is 120,000 pounds per hour. It is expected that very little blowdown (only a few hundred pounds per hour) will be required. However, if the average blowdown is conservatively considered 35,116 pounds per hour, and the maximum steam generator water analysis shown on Table 3-19 is used at maximum blowdown and the average analysis is used with the average blowdown, the resulting increase in

3.6.2 Liquid Chemical Discharges (continued)

chemical content of the circulating water discharge will be negligible. Maximum and average discharge of steam generator blowdown chemicals are delineated in Table 3-16.

TABLE 3-19

STEAM GENERATOR WATER CHEMICAL CONCENTRATIONS

Analysis	Maximum ppm	Average ppm
Chloride Cl	75	2
Silica, SiO_2	30	2
Orthophosphate, PO_4	25	20
Ammonium Hydroxide, NH_4OH	25	15
Hydrazine, N_2H_4		

It is expected that the normal processing of the reactor coolant, which will contain some radioactive isotopes and boric acid, will consist of neutralization, decay in waste holdup tanks, degassing, filtering, and evaporation with occasional demineralization. Maximum and average reactor coolant chemical concentrations are shown in Table 3-20.

TABLE 3-20

REACTOR COOLANT CHEMICAL CONCENTRATIONS

Analysis	Maximum ppm	Average ppm
Total Solids	0.50	0.30
Fluoride, F	0.10	0.00
Chloride, Cl	0.15	T
Boric Acid, H_3BO_3	12,000	2,288
Ammonium Hydroxide, NH_4OH	25.0	15.0
Hydrazine, N_2H_4	25.0	
Lithium, Li	2.5	0.5

3.6.2 Liquid Chemical Discharges (continued)

If it is now considered that reactor coolant system waste waters are decayed in waste holdup tanks and that all of these wastes are discharged to the circulating water discharge duct, the increase in chemical concentration in the circulating water discharge over that already existing would be negligible. This is illustrated by considering both a maximum and an average condition. A maximum condition is defined as maximum boric acid concentration in the reactor coolant at maximum discharge ability of waste treatment pump capacity, and average conditions are defined as average boric acid concentrations at average annual average deborating rates. The chemical increases due to the above described maximum and average conditions are shown in Table 3-17.

<u>Waste Water Discharges During Construction</u>

During construction some waste waters have been discharged to the Missouri River. As construction proceeds, it is anticipated that additional waste discharges will be made. Past and expected future discharges have been or are anticipated to be in conformance with the current Nebraska Water Quality Standards.

During the early excavation phase of construction, it was necessary to keep excavated portions of the plant dry by employing a grid of sand points and wells to draw down the ground water in the area. This process is called dewatering. This well water was discharged directly to the Missouri River and consisted of ground water and recharge water from the Missouri River. This phase of construction is now completed and did not cause any appreciable impact on the environs. Dewatering was done at about a 800 gpm rate from January 1, 1968, to December 3, 1969.

3.6.2 Liquid Chemical Discharges (continued)

the average Missouri River water analysis. This is illustrated by comparison of Table 3-14 which is an analysis of Missouri River water, with Table 3-13 an analysis of well water at Fort Calhoun. It should be emphasized that the discharged well water was potable, and drawdowns did not affect existing well levels off the OPPD site. Presently the water table at the site has been re-established as a result of ground water replacement and recharge from the river.

As construction progresses, it is aniticipated that considerable volumes of flushing waters will be required to clean up systems prior to placing them in service. In general, these waters will be almost zero solids water and will, after flushing, only contain small amounts of pipe scale, dust and dirt.

There will be a phosphate flush of the secondary condensate and feedwater system. After flushing, this material will be slowly discharged to the river to avoid any harmful chemical shock or other adverse effects.

The steam lines at the plant are being dry cleaned and no liquid waste discharges from this source are anticipated.

The reactor coolant system consists primarily of stainless steel Zircaloy and Inconel. It is anticipated that this system will be cleaned with pure water and a biodegradable detergent (maximum total 50 gal.).

3.6.3 Air Chemical Discharges

Fort Calhoun Unit No. 1, like other nuclear power plants, will release no combustion products to the atmosphere as a result of reactor operation. It will, however, have a package boiler and two diesel gen-

3.6.3 Air Chemical Discharges (continued)

erators, fueled by #2 fuel oil (0.5% maximum sulfur), which produce auxiliary service steam and emergency electrical power. The exhaust from the boiler and diesel generators will be discharged through stacks directly to the atmosphere. The amount of combustion products released per year from the boiler and diesel generators will be insignificant.

The District does not now anticipate that emissions from its diesel fuel facilities will exceed those normal primary or secondary ambient air quality standards to be established by the administration under the Clear Air Amendments of 1970, nor any other standards which may be promulgated at a national, state or local level. At the time of writing this Report, to OPPD's knowledge, Nebraska has not yet been declared an air quality control region with resultant promulgation of standards.

3.7 Radioactive Discharges

Great attention has been devoted in the design and construction of Unit No. 1 by OPPD to prevent the accidental release of radioactive materials to the environment. Much of the cost of the unit was expended on both equipment and structures to avoid accidents and limit their consequences should one occur. Numerous postulated equipment failures, abnormal operating conditions, and operator errors have been analyzed to assure that the health and safety of the public as well as the plant personnel will be protected. A comprehensive quality assurance program has been carried out during design and construction to assure that the unit as built will meet these safety objectives. On-going operator training, detailed operating and emergency procedures, and periodic tests as well as inspection over the lifetime of the unit will assure the safe operation of the facility.

3.7.1 Radiological Effects of Operation

Under normal operating conditions of Unit No. 1, small amounts of radioactive wastes will be released into the atmosphere and into the Missouri River. These releases will comply with 10 CFR 20. The following sections discuss the quantities of liquid and gaseous effluents which are expected as a result of facility operation.

Based on the estimates presented, the radiation levels to which a person within the site's boundary would be exposed as a result of the operation of Unit No. 1 are only a fraction of that which he normally receives from background radiation. These subjects are covered in detail in the Final Safety Analysis Report for Unit No. 1, filed by OPPD with the Atomic Energy Commission.

Equipment is provided for processing radioactive wastes to

3.7.1 Radiological Effects of Operation (continued)

reduce to a minimum the amount released to the environment.

Administrative procedures will control the manner in which gaseous and liquid effluents are released. As required by current AEC regulations, OPPD will keep such releases as far below regulatory limits as practicable.

Solid radioactive wastes will be packaged and transported to an authorized disposal area in accordance with applicable governmental regulations.

3.7.2 Radioactive Waste Disposal Facilities

Fort Calhoun Station Unit No. 1 contains a number of facilities for disposal of liquid, gaseous, and solid radioactive wastes. These facilities are designed to ensure that the discharge of effluents and off-site shipments are in accordance with relevent governmental regulations.

The bulk of the radioactive liquids discharged from the Reactor Coolant System are processed by demineralization and filtration inside the plant by the Chemical and Volume Control System. The processed water is then reused in the Reactor Coolant System, thus minimizing liquid input to the waste disposal system, which latter system processes relatively small quantities of generally low-activity level wastes. For information on the specific radionuclides expected to be discharged from the facility, see Table 3-21.

Radioactive liquids entering the waste disposal system are collected in sumps and tanks and then transferred for holding to liquid waste storage tanks for determination of subsequent treatment. They are sampled

TABLE 3-21

TYPICAL CONCENTRATIONS OF RADIONUCLIDES IN THE DISCHARGE TUNNEL

	Expected Upper Limit (Annual Average) µCi/cc	Fraction of 10 CFR 20 App. B, Table II
Sr-89	5.0×10^{-14}	1.7×10^{-8}
Sr-90	2.7×10^{-15}	9.0×10^{-9}
Y-90	1.4×10^{-14}	7.0×10^{-10}
Y-91	1.1×10^{-11}	3.4×10^{-7}
Mo-99	1.6×10^{-11}	8.0×10^{-8}
Ru-103	3.9×10^{-14}	4.9×10^{-10}
Te-129	2.0×10^{-13}	2.5×10^{-10}
I-131	2.5×10^{-11}	8.3×10^{-5}
Te-132	7.4×10^{-13}	2.5×10^{-8}
I-133	3.1×10^{-13}	3.1×10^{-7}
Cs-134	1.6×10^{-10}	1.8×10^{-5}
Cs-136	4.2×10^{-12}	4.7×10^{-8}
Cs-137	7.7×10^{-10}	1.3×10^{-5}
Ba-140	4.6×10^{-14}	1.5×10^{-9}
Co-60	2.4×10^{-13}	4.8×10^{-9}
Fe-59	1.2×10^{-15}	2.0×10^{-11}
Co-58	1.3×10^{-12}	1.3×10^{-8}
Mn-54	3.5×10^{-15}	3.5×10^{-11}
Cr-51	4.6×10^{-13}	2.3×10^{-10}
Zr-95	2.9×10^{-15}	4.8×10^{-11}
H-3	2.0×10^{-6}	6.6×10^{-4}

3.7.2 Radioactive Waste Disposal Facilities (continued)

and analyzed to determine the quantity of radioactivity, with an isotopic breakdown, if necessary. They are then processed before release to the condenser cooling water. There is also an automatic cutoff on this system to prevent inadvertent releases as well as an alarm in the control room.

Radioactive gases from various sources are collected and compressed in gas decay tanks where they are held until their activity is low enough for release. (Table 3-22 shows the principal waste gas activities expected during operation of this facility) The degree of activity is determined by sampling the tanks. Discharge to the atmosphere is made through the plant discharge duct. The discharge duct is continuously monitored for radioactive gases, and an additional system for monitoring particulate and gaseous activity can be used, if desired. There is an automatic cutoff on this system to prevent inadvertent releases through the discharge duct as well as an alarm in the control room.

Although the amounts of radioactivity expected in discharges from Fort Calhoun Station are extremely small, even compared with normal radioactivity exposures due to natural causes, cognizance of the pathways of exposure to man has been a vital part of plant design and of the radioactivity surveillance program. Direct exposure at off-site locations are expected normally to be below the limit of detection; exposures via liquid and gaseous releases will not add significantly to those exposures due to naturally occurring radioactivity and will be measured in the surveillance program (see Section 3.2.3).

TABLE 3-22

WASTE GAS ACTIVITIES

Isotope	Activities (µCi/cc) in Waste Gas at Times (t) After Removal from Reactor: t=0 (As Received)	t=1 day	t=7 days	t=30 days	10 CFR 20 Limit Unrestricted Area (µCi/cc)	Fraction of 10 CFR 20 Limit at Exclusion Boundary for Controlled Release from RWD at Times (t) After Removal from Reactor: t=0	t=1 day	t=7 days	t=30 days
Kr 85m	1.73	3.96×10^{-2}	*	*	1.0×10^{-7}	0.008	0.0003	+	+
Kr 85	3.88	4.25	4.25	4.25	3.0×10^{-7}	0.007	0.0075	0.0075	0.0075
Kr 87	0.925	2.77×10^{-6}	*	*	2.0×10^{-8}	0.025	+	+	+
Kr 88	3.00	7.80×10^{-3}	*	*	2.0×10^{-8}	0.070	0.0003	+	+
Xe 131m	2.50	2.36	1.66	0.447	4.0×10^{-7}	0.003	0.0032	0.0022	0.0006
Xe 133	252.0	221	101	4.96	3.0×10^{-7}	0.443	0.393	0.179	0.0082
Xe 135	8.75	1.50	2.51×10^{-5}	*	1.0×10^{-7}	0.046	0.0080	+	+
Xe 138	0.414	*	*	*	(not listed)	—	—	—	—

* Less than 10^{-8}

\+ Less than 10^{-4}

Activities taken are those for time, t=0. Gaseous waste activity values are based on the following:

a. Reactor operation at 1,500 MWt, three equilibrium core cycles, and 1 percent failed fuel.

b. Liquid collected in the waste disposal system at 70 F displaces an equivalent volume of nitrogen cover gas. Average activity of volatiles at 70 F and at 1 atm pressure are considered to be present in the same activity to volume ratio whether in the liquid or gas phases. Total gas volume increase attributed to hydrogen release or miscellaneous gas purge which would reduce the above values has not been considered.

c. Boundary fraction is based on a dispersion factor of 1.11×10^{-5} sec/m^3.

3.8 Construction Effects

As stated in the Introduction to this Report, the facility is 78 percent completed. Confining concern over construction to environmental factors, that portion of construction having an effect on the environment is 90 percent complete. The major portion of the overall work to be finished involves interior work, such as installation of the reactor vessel and steam generators, and other components specified in the design of the facility.

Site preparation and construction activities have been conducted in such a manner as to minimize the effects upon the natural environment. Prior to purchasing the land, preliminary borings for the purpose of locating bedrock were made in 1965. Additional borings were made in 1966 to study and map the subsoil and bedrock conditions. These borings were essentially all made where the permanent structures have been built.

The site was cleared of dead timber and underbrush to assure proper drainage as well as to maximize the amount of suitable farming acreage.

Three roads have been used for access to the site during construction. As previously described in Section 2.2, the roads on the north and south site boundaries were existing farm roads, which OPPD improved by grading and covering with crushed rock. The main access road was built up from existing site soil, and hard-surfaced with concrete, in 1970. A viaduct over the railroad tracks was completed in 1967, as were the acceleration and deacceleration lanes where the main access road intersects Highway 73. A limited amount of traffic congestion has occurred from time to time during construction, since there have been as many as

several hundred persons working on-site at a given time. However, this sparadic congestion has been temporary and will not recur after construction is finished. A railroad spur to the plant was built in 1968. All filling necessary to construct the roads and the bridge was covered with topsoil, contoured and landscaped to minimize erosion and scars. Grasses were planted along the substation slopes, railroad spur, access road, borrow pit, and drainage ditch to prevent erosion as well as to improve the appearance of these areas.

In the spring of 1968, several wells were drilled for the purpose of dewatering. The dewatering operation at the construction area produced no significant change in the water table surrounding the site. Pile driving operations began in April 1968, and were completed ten months later. Of all the construction activities, the driving of piles was the only one which produced noticeable noise. Due to the remoteness of the site, however, the impact upon the surrounding area was insignificant.

The fill from excavating operations was deposited in existing sloughs in the construction parking lot and in the substation area. After the ground was leveled for the substation, a crushed rock surface was applied. The heavy earth hauling operations were essentially completed in April, 1968.

Dredging and filling may have resulted in the destruction of benthic organisms. Relatively little disturbance of the Missouri occurred from the construction of intake and discharge structures, except for a cofferdam constructed in 1968. However, this dam produced no noticeable effect on the river. It will be removed in its entirety in 1971. The

necessary authorization for this work had been obtained by OPPD from the Army Corps of Engineers.

During the summer of 1968 the soil surrounding the pipe pilings was densified using a vibroflotation method. The purpose of the densification program was to arrest liquefaction which might occur during seismic disturbances.

Numerous temporary buildings have been moved onto the site or built for construction activities. A concrete batching plant was erected to facilitate and expedite the making of concrete for constructing the plant. Water has been supplied to the batching plant from a test well originally used for site hydrological studies. Upon completion of construction, the batching plant and all other temporary buildings will be removed from the site.

Two small holding lagoons for chemical effluents from plant systems will be excavated south of the plant in 1971. These ponds will be landscaped to blend with their natural surroundings.

A one hundred sixty foot permanent weather tower was erected northwest of the plant structures in 1970. A smaller weather station forty feet in height had been erected in the same general area in 1967. A permanent security fence around the immediate plant area was put up in 1970.

Temporary power, consisting of a 13,800 volt primary line and six transformers, was installed in 1968. This equipment will be removed upon completion of construction.

Some combustion products from operation of diesel-powered mach-

inery were released to the atmosphere during construction. This is no different from any other large construction project and has had no significant effect upon the environment.

There have been discharges to the river of small amounts of chemicals used for cleaning construction equipment, and there will be some further chemical discharges prior to completion of construction. There have been no adverse effects, nor is any expected from these discharges. There has been compliance at all times with the Federal Water Pollution Control Act, as amended. The specifics of these and other chemical discharges are covered in greater detail in Section 3.6 of this Report.

All construction activities will essentially be concluded in 1973. At that time, construction personnel and equipment will have left the site, temporary buildings will have been removed, landscaping will have been completed, and that small portion of the site necessarily involved in the construction of the facility will have been restored as nearly as practicable to its preconstruction natural environment.

3.9 Transmission Lines, Switchyards and Substations

3.9.1 Transmission Lines

Route Selection

The criteria used for selection of transmission line routes were developed by OPPD's Engineering Department. The guidelines used in the development of these criteria were basically technical, financial, and environmental.

The routes were located wherever conditions permitted on existing rights-of-way, and made as straight and short as possible to avoid unnecessary mileage between the terminal points. Wherever possible, topographical features were used either to conceal or otherwise visually subdue the line. It has been OPPD's policy to avoid such areas as Federal lands, parks and other recreational areas, wildlife sanctuaries, historical sites and monuments, marshlands and bodies of water frequented by migrating water fowl, nesting areas, military installations, cemetaries, residential subdivisions, orchards, dams, bridges, television and radio antenna farms, micro-wave facilities, extensive parallels to open wire telephone and railroad signal systems. It has also been OPPD's policy to use wastelands which are unsuitable for agricultural use. This includes land seasonally inundated by flood water, grazing land, and land zoned for industrial use. Figure 3-12 shows the transmission line routes.

Route Location

The Transmission System expansion associated with the construction of OPPD's Fort Calhoun Station consists of 195.12 miles of 345 kV transmission lines, and 6.98 miles of 161 kV transmission line. The transmission lines were constructed during the period beginning in mid year of 1969 and ending

3.9.1 Transmission Lines (continued)

early in 1971. OPPD's Fort Calhoun Station and its associated EHV transmission lines are included in a major transmission network designed to connect large Midwestern population centers with electric generating plants.

The OPPD 345 kV transmission system is located in the eastern part of the state of Nebraska. The lines route generally parallels the Missouri River and stays entirely within Nebraska. The line passes through 8 of the 13 counties served by OPPD and also crosses two counties outside the District's service area.

Design of Equipment and Towers

Both steel and wood towers are used in the OPPD transmission system. The lines carrying power south of the Fort Calhoun plant are of a lattice and tubular steel type. Examples of these towers are shown in Figure 3-13. Elsewhere wooden towers of the type shown on Figure 3-14 are used.

The following descriptions represent the five types of structures used in the wood pole portion of OPPD's 345 kV transmission system, linking Iowa Public Service near Sioux City, Iowa, in the north, to St. Joseph Light & Power Company near Rulo, Nebraska, in the south, and Nebraska Public Power District, in the west.

a. The tangent structure is a typical H-frame structure with one cross brace, two vee braces, and a laminated crossarm.

b. The "AT" or shieldwire transposition structure uses the same basic construction and hardware as the tangent structure, except that guying materials are required, and the suspension shieldwire assembly is brought into the structure as a deadend, transposed

3.9.1 Transmission Lines (continued)

by means of 2 cross ties between poles with necessary jumpers, and then sent out on the opposite side of the structure.

c. The type "C" suspension angle structure changes to a 3 pole structured configuration with pole spacing being 27'-6". Three strain V braces are attached to the laminated double crossarm, from which 3 insulator V strings are secured at one point by an anchor shackle and ball clevis extension link, and to another point by a pole band on each of the 3 poles.

d. The angle deadend structure type "D" is again a 3 pole structure with varying pole spacing. The middle pole extends to just 1'6" above the 2-piece laminated crossarm. The only knee brace existing is on the inside pole of the angle.

e. The final structure type "E" is a 2-phase deadend conductor transposition. The "E" structure consists of 3 poles tied together by two double-adjustable crossarms, one at the top and the other 27'-2" down, and 2 sets of cross braces.

The poles used throughout the wood pole section of line are class 1 and 2, penta treated Douglas Fir and range in lengths from 70' to 130'. Pole holes were drilled with a minimum of 3' diameter and were dug 12" deeper than the setting depth requirement. With the exception of the strain brace attachments to the pole and the bottom cross brace attachments, all framing holes were filled prior to pole treatment. After erection of the structures, strain and cross braces were attached, and the strain braces were adjusted to provide a 2" upsweep at the ends of the arm.

3.9.1 Transmission Lines (continued)

Route Clearing

Each tree and brush within the limits of the right-of-way was cut and disposed of, unless contrary written instructions were issued by the District requiring individual trees to be trimmed, topped, or left intact. Trees on the right-of-way were cut as close to the ground as possible with stump height limited to 6 inches above ground-level. Splinters or sprigs which might endanger animals or hinder future reclearing were removed. All brush, small trees and snags not impeding the movement of vehicles along the right-of-way, and which normally would not grow taller than ten (10) feet, were left standing approximately two feet in height.

All trees and brush were cut using saws, chainsaws or bulldozers with cutting edge blades. However, bulldozers were soon abandoned as a method of clearing, because they caused too much scaring of the land. After the brush and trees were cut, the stumps were burned or otherwise removed from the right-of-way. Those stumps not burned were treated chemically by a basal spray application, done carefully to prevent drift and resulting damage to crops, fruit trees, or other desirable plants and trees growing on or adjacent to the right-of-way.

The movement of crews and equipment was curtailed to minimize damage to property, and to avoid marring the land. If work crews had to move from one clearing location to another, they used roads rather than damage a crop by moving within the right-of-way. Ruts and scars were obliterated by land fill and reseeding. Damage to ditches, terraces, waterways, roads and other features of the land resulting from tree removal operations was corrected, and the land restored as nearly as possible to

its original condition.

Impact of Construction on Environment

Construction of a transmission line like any other construction project requires the mobilization of equipment and experienced manpower. The main difference between a transmission line project and other construction projects is that the equipment is constantly on the move. Consequently, the personnel on a transmission line project must be somewhat nomadic in nature.

Like any construction project, careful planning of equipment and manpower requirements is of the utmost importance. The equipment must be of adequate size and in sufficient quantity to balance the planned work force. The equipment must be flexible to the extent that it can be adapted to several uses with a minimum of down time. The use of rubber tired vehicles or track mounted equipment depends upon the terrain and soil conditions along the route traversed by the transmission line. The maintenance of equipment must be done in the field.

Storage of the equipment is of no particular problem in transmission line construction because it is left in the field when work stops for the day. Arrangements for this type of right-of-way use were worked out in advance of construction. Field offices, material storage yards, and work force show-up halls are the only items that require location for extended periods.

The selection of manpower to staff the required work-force is a rather complicated problem in the sense that many variables control and influence the final decision. The main variable is the workman himself.

3.9.1 Transmission Lines (continued)

In addition to housing needs, adequate schools and shopping facilities are important to the migrating workman. Because of the mobile nature of a transmission line construction project, the total impact it has on the environment cannot be fully realized until after the project is completed.

Impact of Maintenance

The maintenance of transmission lines involves periodic aerial, truck and foot patrol of the transmission lines. The period of time between patrols depends upon the importance of the line, its location with respect to accessibility, climatic conditions, and the incidence of trouble during storms and over measured periods of time. Normal procedures call for aerial patrols on a monthly basis and after all major storms. All of our transmission lines are inspected by walking patrols once a year. Truck patrols are used where the transmission lines parallel existing roads.

The aerial, truck, or walking patrols are mobile operations which do not mar the landscape or employ equipment or procedures which deviate from those used by the total environment.

The actual maintenance of the line falls into two categories: preventative and repair of storm damage. Routine maintenance of OPPD's EHV structure is expected to commence approximately five years after the line was built, and repeat on 10-year intervals throughout the life of the line. Maintenance of the line to repair storm damage probably has the greatest impact upon the environment because it requires the mobilization of heavy equipment, which usually has to traverse water soaked terrain leaving deep ruts. The terrain cannot be restored until the soil has dried to the extent it can be worked and reseeded.

3.9.1 Transmission Lines (continued)

Underground System

Due to the high cost and technical problems associated with underground EHV Transmission, it was considered to be a measure of final resort. The District concluded that the problems of capacity, reliability, and security in an underground system could not be solved economically with the available technology on the subject. Therefore, OPPD elected to invest money in improvement of its overhead plant to enhance its appearance and make it aesthetically blend into the environment.

Measures Taken to Reduce Environmental Impact

An investigation of radio-interference profiles and clearance requirements for vertical, horizontal and triangular double-circuit conductor configurations was made before selection of tower design was finalized. The study proved that the triangular configuration had a low radio-interference profile, and offered a reduction in height over the vertical configuration. In areas of high density population, the tubular structure was used in combination with V-string insulators to reduce the right-of-way width requirements to 160 feet, 40 feet less than that required for a typical line of equal capacity. The tubular structures were also located in the flood plain of a highly populated creek valley necessitating the installation of a streamlined structure to reduce the obstruction to the flow of flood currents.

Applications: Federal, State and Local

Since all of the EHV lines constructed in connection with the Fort Calhoun facility are either in service or under construction at this time, all required permits and applications have been acquired and acknowledged by all parties involved.

3.9.1 Transmission Lines (continued)

The Federal permits and applications required for the construction of OPPD's 345,000 volt transmission line involve the crossing of navigable rivers and the construction of towers near airports that will be higher than the allowable limits set forth by the FAA. The required applications and permits for the Missouri River crossings near Sioux City, Iowa and Rulo, Nebraska, were acquired by the utility responsible for constructing the river crossing. The applications to the FAA were approved at least six months prior to the construction of the 345 kV transmission line.

Applications and permits required by the Nebraska Power Review Board and the State Railway Commission have been filed and approved by all parties concerned.

Applications and permits to local authorities are covered on a blanket agreement included in our franchise with the city of Omaha and other municipalities in our service area.

3.9.2 Switchyard and Substation Facilities

There is a 345 kV switchyard located approximately 2,500 feet from the nuclear reactor in the immediate area below the Bluffs and on the river side of the Chicago and Northwestern Railroad. The area, measuring 695 feet by 960 feet is surrounded by an eight-foot wire mesh fence and is covered with a layer of crushed light grey limestone rock. The fence provides maximum security from unauthorized personnel for the electrical apparatus.

Four 345 kV power circuit breakers for four outgoing circuits are arranged in a ring bus arrangement. All outgoing circuits are ter-

3.9.2 Switchyard and Substation Facilities (continued)

minated at full line tension on latticed steel galvanized structures. The bundled phase conductors, two per phase, are teminated at an elevation of 66 feet above crushed rock. Twenty feet above this, two shield wires are terminated. Bringing the transmission lines directly into the station at full line tension eliminates guyed structures immediately adjacent to the switchyard or within the fenced area.

The dead-end towers and heavy equipment foundations are placed on cast-in-place concrete piling which extend approximately 75 feet to bedrock. All equipment (circuit breakers, reactors, coupling capacitors, etc.) are painted a teal green color, which is compatible with the surroundings in OPPD's service area.

The control building is located near the equipment to give the station an appearance of compactness. This building is metal painted desert tan trimmed in white and with a white roof. This tan color blends very well with the teal green equipment.

A rigid tubular aluminum bus was used to reduce the number of tall structures and the unsightly appearance of the strain bus conductors. The support insulators and equipment bushings are all blue-gray color, which in turn blend with the other metalic structures, crushed rock yard surface and the sky itself. The choice of colors and design represents an attempt to blend the yard into one natural color mass except for obvious pieces of equipment, which are painted in a manner to be as aesthetically pleasing as possible.

3.10 **Aesthetics**

As shown in the artist's rendering of the facility at the beginning of this report, the structures for this Unit have been designed and constructed to provide an attractive appearance both from the river and from the highway. The architect gave special attention to the form, color, and texture of the plant buildings so that they might blend more naturally into the adjoining surroundings at the site. For example, OPPD at considerable extra expense substituted resin panels and rubbed concrete for the exterior structures rather than the less expensive aluminum or galvanized iron siding.

In the original design of the plant complex, the 345KV/161KV substation was to have been located on a plateau adjacent to highway 73. Since the erection of this substation would have been an intrusion upon the landscape and would have been alien to the surrounding farm land, the substation was moved into the valley where it was less noticeable.

Upon completion of the facility, the site will be landscaped with trees, shrubs, bushes and grass native to the area. The exact manner in which this restoration will be accomplished is discussed in Section 3.8.

As described in detail in Section 2.0 of this report, the DeSoto National Wildlife Refuge and the Wilson Island Recreation Area are in the immediate vicinity of the site. On February 20, 1971, the steamship Bertrand was declared a National Historic Landmark (see 36 Fed. Reg. 3326). Since the Bertrand is now under water again, there appears to be no problem concerning it from an aesthetic point of view.

3.10 Aesthetics (continued)

On the same date, Fort Atkinson was also declared an Historic Landmark. From this latter landmark, the Fort Calhoun nuclear facility cannot be seen. There are, therefore, no plans at this time to dedicate any portion of the site for the recreational purposes such as picnic areas and nature trails, as they would be redundant with these excellent facilities.

New rights-of-way are necessary for transmission to OPPD's load centers of the energy produced at this facility for the OPPD system and its interconnection. The transmission lines and towers which will send this energy are both modern steel and wooden towers, designed and placed to minimize their intrusive effect upon the environment. For a further description of these towers, see Section 3.9 of this report.

3.11 Cumulative Effects

Cumulative or synergistic effects from activities in the surrounding area are virtually non-existent.

The nearest large facility using the Missouri River for cooling purposes is OPPD's fossil fired plant (North Omaha Station). It is approximately twenty miles downstream from the Fort Calhoun site. Studies made by OPPD, previously detailed in Section 3.3, show that thermal effects from the Fort Calhoun unit will be dissipated ten to fourteen miles downstream from the site. Therefore, there will be no cumulative thermal effect from the operation of these two plants.

Chemical discharges from the facility will be held to a minimum by the use of holding ponds. Although these minimal additions will be cumulative with wastes discharged to the river from the cities of Sioux City (approximately one hundred miles upstream from the site) and Omaha (approximately twenty miles downstream from the site), the effects of contributions from the Fort Calhoun facility itself are considered negligible.

One other nuclear plant is being constructed at Brownville, Nebraska (approximately eighty miles downstream from the site). Although OPPD knows of no specific studies which have been conducted on the synergistic effects of the operation of these two plants, each facility's operational restrictions are such that cumulative effects of radioactive discharges are not considered hazardous.

The possibility of the construction of a second nuclear unit at the Fort Calhoun site for operation in 1980 is now being considered by OPPD. If a decision is made to construct this unit, a complete revaluation of environmental factors will be made at that time.

4.0 ALTERNATIVES TO THE PROPOSED ACTION

As stated in the Introduction to this Report, construction of the Fort Calhoun facility is 78% complete and one hundred fifty million dollars ($150,000,000.00) have been committed to the completion of this project. Subject to obtaining the necessary regulatory approvals, this facility will probably go into operation in 1972. To abandon this project at this stage would not only be economically disastrous to the District but would also cause severe disruption of service both to OPPD's customers and its interconnecting utilities.

4.0 Alternative of not meeting power demand.

Power loads in the State of Nebraska are growing at a rate of approximately 8% a year. OPPD's present net generating capacity is 405 MWe below that which will be necessary to meet peak loads predicted in 1975. (See Section 2.2.2 of this Report) The Fort Calhoun plant Additional power is needed to meet these increasing demands as well as to maintain an adequate system of reserves through 1980 when additional capacity will be required.

OPPD is mandated by law to meet this expanding energy requirement. It cannot ignore increased demands for electricity but must plan its activities in such a manner that it is able to provide power as needed. If OPPD should fail to fulfill this responsibility, the resulting shortages would most surely have pronounced adverse social and environmental effects. Severe shortages of electrical power would not only increase the consumption of fossil fuels throughout OPPD's service area, at a time when every effort is being made to improve the air quality in the Omaha area, but it would also leave many industries without any source of power to operate needed machinery and appliances. Thus, the only alternative to construction and operation of a 481 MWe generating facility, such as that being constructed

Also, many air and water pollution control devices are themselves large users of electric power. This alternative therefore is unrealistic.

at Fort Calhoun, would have been to purchase power from other utilities.

Six years ago when the decision was made to build a nuclear facility several other alternatives were considered. The alternatives to a nuclear plant which were considered were: A conventionally-fueled power plant of approximately the same power capability as the Fort Calhoun nuclear project; a hydroelectric project; gas turbines; a pumped storage project; or the purchase of power from other sources. The feasibility of each of these alternatives as well as the present alternatives are discussed in the following subsections.

4.1 Conventionally-fueled Plants

The so-called conventionally-fueled plants use either coal, oil or gas or a combination of these fossil fuels. Oil is expensive and would not have been - and still would not be - economically feasible. In addition to oil being expensive, oil and gas are both rapidly depleting natural resources in this country. Even had the plant been built for the use of gas, its future use as boiler fuel is highly questionable. Of particular interest is the case now pending before the Federal Power Commission where Northern Natural Gas Company, the transmission pipline company serving the Omaha area, has sought to reduce drastically the sale of natural gas for industrial purposes. See In The Matter of Northern Natural Gas Company, FPC Docket No. RP-71-89.

Coal with a low sulfur content is more expensive than the cost of nuclear fuel. For example, the operation of a coal-fired plant producing electrical energy in the same approximate amount as the Fort Calhoun facility would consume approximately 5,000 tons of coal a day. Thus, the storing of adequate reserves of coal and disposing of fly ash would have meant the withdrawing of a sizeable portion of the Fort Calhoun site from its present use as farm land. The coal would have had to been continuously replenished. This increased activity at the site would probably have resulted in a permanent rather than a temporary relocation of wildlife. In addition, another even more significant environmental concern associated with any fossil-fired plant is air pollutants. While extensive research is currently underway to determine practicable means of removing sulfur oxides from stack gas, most of the processes under development are expected to be only 70% efficient. Thus, even with the employment of such processes, significant quantities of sulfur dioxide would still have been emitted from

4.1 <u>Conventionally-fueled Plants</u> (continued)

a fossil-fired power plant such as one which might have been constructed at the Fort Calhoun site.

4.2 Hydroelectric Project

In selecting other natural resources to be utilized in the production of electric energy OPPD also considered the construction of a hydroelectric dam complex on the Missouri River. This river, incidentally, is the only river in the OPPD service area which has sufficient volume and flow to provide adequate cooling water. In order for a hydroelectric plant to be feasible, the "fall" of the river must be more than one foot per mile. The Missouri River has in the vicinity of Omaha a fall of only about one foot per mile thus making it technically unfeasible to have a hydroelectric plant on that river in or near the OPPD service area. In addition to this technical deficiency, there are two other substantial factors which deterred OPPD from pursuing the construction and operation of a hydro plant. The first of these is that any such dam could interfere with navigation on the Missouri River and would thus have presented a serious obstacle in any plans for such a plant. Moreover, as stated in prior sections of this Report, the channel and flood control of the Missouri River are governed by several dams which are upstream from the site. Construction of an additional dam could have significantly affected the careful and long-range plans of the United States Army Corps of Engineers for flood control and irrigation in the Missouri Valley. It is doubtful that permission could have been obtained for the construction and operation of a hydroelectric plant.

4.3 Gas Turbines

The use of gas turbines, fueled either by high-grade oil (the supply of which is especially uncertain now since most of it has to be imported from the Middle East) or gas (the uncertainty of which we have discussed previously in this Section of the Report) dictate against utilizing gas turbines. In addition, many gas turbines would have to be used to produce the equivalent electric output of the Fort Calhoun facility. Furthermore, they would be expensive and technically they are peaking plants and not base load sources of power.

#2 diesel oil, or gas

6110

60 MW range need

emissions are minimal

closed cycle, little need for cooling, since there is no condensing cooling need

4.4 Pumped Storage Project

This alternative was briefly explored by the officials of OPPD and determined not to be a realistic alternative to the nuclear plant. The topography along the Missouri does not lend itself to the construction and operation of a pumped storage project. Furthermore, like the gas turbines a pumped storage project is more a source of peaking power rather than a base load plant.

4.5 Purchase of Power from Other Sources

OPPD did not believe purchasing power to be a feasible alternative. While it was possible that OPPD could purchase 405 MWe to meet increased demands in 1975, it would be extremely doubtful if it could purchase the amount necessary to meet that predicted for 1980, and impossible to do so on a long-term basis. In fact, the systems interconnected with OPPD, as discussed in Section 2.2.2 of this Report, which are perforce expanding their own capacity to meet their customers' increased requirements, can be expected from time to time after the Fort Calhoun plant becomes operational to purchase power from the OPPD system in order to maintain reliable service in their systems. Further, it should be emphasized that purchasing power from other utilities was not considered by OPPD to be an alternative which would eliminate any of the adverse environmental effects associated with producing that power, since such an act would merely have transferred those effects from one locality to another.

In addition to investigating other alternatives for the production of power, OPPD in 1965-66 investigated other possible sites for a nuclear plant. It and its consultants conducted an extensive study for suitable sites along the Missouri. Preliminary site surveys were made of three of four other potential sites in addition to the Fort Calhoun site. In assessing these potential sites the following factors led OPPD to choose the Fort Calhoun location over others it might have acquired:

a. Satisfactory ground conditions to support heavy loads.
b. A location on the outer radius of a river bend to ensure an adequate water supply during low river flows.
c. Near a good road and railroad.
d. Near the center of an electrical load.

4.5 Purchase of Power from Other Sources (continued)

e. Relatively isolated from large concentrations of people and industrial activities.

For the above reasons, and also because preliminary studies of the environment at the Fort Calhoun site, as discussed in Section 3.2 through 3.2.6, showed that the construction of a nuclear power plant in that location would not be incompatible with environmental values, OPPD decided to acquire the Fort Calhoun site.

4.6 Present Alternatives

Due to the nearness of completion of Unit No. 1, the only question which can be realistically asked at this time about the type of facility to be located at the Fort Calhoun site is whether there are now reasonable alternatives to the completion and operation of that facility in 1972.

As stated in the Introduction to this Section, a new electrical generating unit was considered necessary by OPPD to meet the ever-expanding energy requirements of its service area. Even though the installation of two new gas turbine generating units in 1972 will reduce OPPD's load deficit to 305 MWe by 1975, the adequacy of the system's reserves would certainly be a major problem in 1980. Therefore, it seems reasonable to discuss the present alternatives in relation to 1975, putting aside for such purpose the very large investment already made in Unit No. 1 which is nonrecoverable and mostly non-reuseable at some other site, as well as the related problem of financing the very large cost of any alternative. These alternatives would have been: a nuclear unit at another site, or a unit employing another type of power source, such as coal or oil.

Since it requires five to ten years to build a nuclear power plant, a nuclear unit could not possibly have been designed and constructed for operation at another site by 1975, even if, which is improbable in the extreme, another site could have been found in the OPPD service area which would have been as appealing from the dual standpoint of preservation of environmental values and maximization of economic considerations.

Fossil-fired units require an estimated four years to complete, even on an existing site, and so they would not have been an unreasonable alternative for the year 1975. However, operation of an oil or coal-fired

plant for base load power would result in environmental problems which are not present with a nuclear facility.

Thus, from the standpoint of land use, air quality, fuel resource use, and efficient supply of electric power, OPPD believed that its decision to build a nuclear generating facility at the Fort Calhoun site to supply base load power minimized to the fullest extent possible any adverse environmental effects associated with producing electricity to satisfy the needs of its customers.

5.0 ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

OPPD believes that no adverse environmental effects will result from the construction and operation of the Fort Calhoun Station Unit No. 1. It is an inescapable fact that the construction and operation of Unit No. 1 will somewhat alter the environment and these aspects may be categorized into the following:

a. Physical Presence - aesthetic effects, traffic.

b. Air Quality - Gaseous releases - radioactive, other.

c. Water Quality - Liquid releases - chemical, waste, radioactive, thermal, other.

d. Land Use - Recreation, Historical.

e. Safety

Except for the release of very small quantities of radioactive effluents, all of the above effects are common in varying degrees to any large thermal power generating facility, any large manufacturing plant, large commercial building, and even a large apartment building or complex. Identification of the adverse effects is of great concern, since many of the environmental problems have only recently been clearly identified.

The public attention on the operation of generating plants with respect to the effect on the total environment has increased. There is, therefore, considerable public interest in the location of facilities and their effect on the physical environment. Two of the greatest concerns are waste heat rejection and air pollution.

As previously indicated, the thermal effects of the cooling water returned to the river will be comparable to that of OPPD's North Omaha Station where no adverse effects have been observed during nearly seventeen years of operation. Air pollution in the "chemical sense" will not exist

5.0 ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED (continued)

in the nuclear portion of Unit No. 1. The exhaust discharge of the two stand-by diesel generators and the stack discharge of the oil-fueled heating boiler will be insignificant compared to boiler stack discharges from a plant of comparable size. Both of these concerns are discussed in detail in previous sections. The liquid and gaseous releases from Unit No. 1 have been discussed in detail in previous sections, and will be well below the permissible levels.

6.0 SHORT-TERM USES VERSUS LONG TERM PRODUCTIVITY

The OPPD peak load is estimated to triple by the year 1990. In order to meet this long term electric demand as well as long-term environmental goals, nuclear power plants must be a part of a power company's long range area service plan.

The need for increased use of electric energy has recently become a subject of considerable discussion. A rapidly expanding population will require more goods and services in order to maintain the standard of living enjoyed by most Americans today. New sources of electric energy will be required to supply these goods and services. Electrical energy, moreover, can improve the quality of the environment by reducing and controlling industrial, commercial, and residential pollution. Some examples of how this can be done are:

a. Electric powered devices to process or re-cycle many types of solid waste

b. Use of electro-dialysis in waste treatment facilities

c. Sulfur oxides removal from flue gases

d. Use of electric auto, bus, or truck

In reviewing the environmental impact of Unit No. 1, certain beneficial effects on the human environment should not be overlooked. The unit will supply a substantial part of the energy needs of over a half-million people. Many of the uses of electric energy such as heating, lighting, and cooling homes and places of work take the form of improving a part of the environment where people spend a large portion of their time. Other uses of electric energy such as cooking, street lighting, elevators, communications, and refrigeration are essential, if life in urban areas is to be socially productive or even tolerable. A feature of electric energy important in terms of this report is that it is pollution-free at the point of use.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Unit No. 1 will consume a certain amount of nuclear fuel in the form of uranium 235 in the process of generating electricity. The amount so consumed does not represent a threat to the supply of uranium in this country and will not foreclose military and other uses of nuclear materials. Unit No. 1 will also occupy a portion of the 381 acre plant site and temporarily utilize water resources during its lifetime.

The commitment of the land and water resources are justifiable when compared with the overall advantages gained from the long-term productivity of the OPPD service area. The commitments of resources referred to above are reasonable, both in the absolute sense and in comparison with the commitments of resources which would be involved in the generation of an equivalent amount of electric energy by other means. They do not represent an expedient use of resources at the expense of some more important long-range benefit which could be otherwise obtained.

8.0 CONTINUED STUDIES

As previously mentioned, several studies being conducted by the Omaha Public Power District and other agencies have not been completed. Some of these have a scheduled time for completion and others are of a continuing nature.

a. Selected Environmental Effects of Two Nuclear Power Plants on the Missouri River - by eleven agencies scheduled for completion in 1974. This study is organized to determine the effects on fish and fish-food organisms and to determine the thermal patterns produced by the effluents from these plants (see Section 3.2.1).

b. Meteorological studies - by OPPD will continue throughout the lifetime of the plant. An extensive program is in progress to define the meteorological conditions at the plant site prior to plant operation; certain parameters will be measured and recorded during plant operation for cognizance of existing weather conditions and to allow additional meteorological correlations if necessary.

c. Radiological studies - by OPPD will continue throughout the lifetime of the plant. The operational Environmental Radioactivity Surveillance Program will provide a continuing evaluation of the background and radioactivity at both the plant site and the environs.

d. Thermal studies - by OPPD and others will continue as required.

e. Chemical studies - by OPPD will continue as required.

f. Hydrological studies - by OPPD will continue as required.

APPENDICES

APPENDIX A

A.0 WILDLIFE INHABITING THE "DESOTO NATIONAL WILDLIFE REFUGE"

A.1 Abundant Species of Birds

1. Canada Goose
2. Snow Goose
3. Mallard*
4. Blue Winged Teal*
5. American Widgeon
6. Bald Eagle
7. Bobwhite*
8. Ring-Necked Pheasant*
9. Mourning Dove*
10. Red-Headed Woodpecker*
11. Eastern Kingbird*
12. Bank Swallow*
13. Blue Jay*
14. House Wren*
15. Warbling Vireo*
16. Yellow Warbler*
17. Myrtle Warbler
18. Yellowthroat*
19. American Redstart*
20. Western Meadowlark*
21. Red-Winged Blackbird*
22. Baltimore Oriole*
23. Brown-Headed Cowbird*
24. Rose-Breasted Grosbeak*
25. Dickcissel*
26. American Goldfinch*
27. Rufous-Sided Towhee*
28. Field Sparrow
29. Pintail

* These species nest on the refuge.

A.2 Common Species of Birds

1. Double-Crested Cormorant
2. Great Blue Heron
3. White-Fronted Goose
4. Black Duck
5. Gadwall
6. Green-Winged Teal
7. Shoveler
8. Wood Duck*
9. Ring-Necked Duck
10. Lesser Scaup
11. Bufflehead
12. Common Merganser
13. Red-Tailed Hawk*
14. American Coot
15. Piping Plover*
16. Killdeer*
17. Common Snipe
18. Spotted Sandpiper*
19. Greater Yellowlegs
20. Sanderling
21. Wilson's Phalarope
22. Ring-Billed Gull
23. Least Tern*
24. Yellow-Billed Cuckoo*
25. Black-Billed Cuckoo*
26. Great Horned Owl*
27. Barred Owl*
28. Yellow-Shafted Flicker*
29. Hairy Woodpecker*
30. Downy Woodpecker*
31. Traill's Flycatcher*
32. Least Flycatcher*
33. Eastern Wood Pewee*
34. Horned Lark*
35. Barn Swallow
36. Cliff Swallow
37. Black-Capped Chickadee*
38. Catbird*
39. Brown Thrasher*
40. Robin*
41. Wood Thrush*
42. Ruby-Crowned Kinglet
43. Starling*
44. Bell's Vireo*
45. Black-Throated Green Warbler
46. Blackpoll Warbler
47. Palm Warbler
48. Wilson's Warbler
49. House Sparrow*
50. Eastern Meadowlark*
51. Orchard Oriole*
52. Common Grackle*
53. Cardinal*
54. Indigo Bunting*
55. Slate-Colored Junco
56. Tree Sparrow
57. Harris Sparrow
58. Song Sparrow

* These species nest on the refuge.

A.3 Uncommon Species of Birds

1. Pied-Billed Grebe
2. White Pelican
3. Green Heron
4. Common Goldeneye
5. Hooded Merganser
6. Turkey Vulture
7. Cooper's Hawk
8. Marsh Hawk
9. Osprey
10. Ruddy Twinstone
11. American Woodcock
12. Solitary Sandpiper
13. Willet
14. Lesser Yellowlegs
15. White-Rumped Sandpiper
16. Baird's Sandpiper
17. Least Sandpiper
18. Dunlin
19. Short-Billed Dowitcher
20. Northern Phalarope
21. Herring Gull
22. Common Tern
23. Black Tern
24. Screech Owl*
25. Common Nighthawk
26. Red-Bellied Woodpecker*
27. Great Crested Flycatcher*
28. Acadian Flycatcher*
29. Tree Swallow*
30. Rough-Winged Swallow
31. Purple Martin*
32. Common Crow*
33. Brown Creeper
34. Swainson's Thrush
35. Gray-Cheeked Thrush
36. Eastern Bluebird*
37. Cedar Waxwing*
38. Loggerhead Shrike
39. Black-and-White Warbler*
40. Chestnut-Sided Warbler*
41. Bay-Brested Warbler
42. Grasshopper Sparrow*
43. Vesper Sparrow*
44. Lark Sparrow*
45. White-Crowned Sparrow
46. White-Throated Sparrow

* These species nest on the refuge.

A.4 **Occasional Species of Birds**

1. Common Loon
2. Eared Grebe
3. Common Egret
4. American Bittern
5. Redhead
6. Canvasback
7. Ruddy Duck
8. Sharp-Shinned Hawk
9. Red-Shouldered Hawk
10. Rough-Legged Hawk
11. Sparrow Hawk
12. Sora
13. Semipalmated Plover
14. Upland Plover
15. Knot
16. Stilt Sandpiper
17. Western Sandpiper
18. Franklin's Gull
19. Forster's Tern
20. Short-Eared Owl
21. Saw-Whet Owl*
22. Whippoorwill*
23. Chimney Swift
24. Belted Kingfisher*
25. Yellow-Bellied Sapsucker
26. Western Kingbird*
27. Eastern Phoebe*
28. Long-Billed Marsh Wren
29. Short-Billed Marsh Wren*
30. Red-Eyed Vireo*
31. Tennessee Warbler
32. Nashville Warbler
33. Ovenbird*
34. Bobolink*
35. Yellow-Headed Blackbird*
36. Rusty Blackbird
37. Purple Finch
38. Henslow's Sparrow*
39. Fox Sparrow

* These species nest on the refuge.

A.5 Rare Species of Birds

1. Horned Grebe
2. Western Grebe
3. Black-Crowned Night Heron
4. Whistling Swan
5. Brant
6. Ross's Goose
7. Greater Scaup
8. Oldsquaw
9. White-Winged Scoter
10. Goshawk
11. Golden Eagle
12. Peregrine Falcon
13. Sandhill Crane
14. Virginia Rail
15. American Avocet
16. Caspian Tern
17. Snowy Owl
18. Ruby-Throated Hummingbird
19. Black-Billed Magpie
20. Tufted Titmouse
21. White-Breasted Nuthatch
22. Mockingbird
23. Snow Bunting

A.6 <u>Mammals of DeSoto National Wildlife Refuge</u>

Following is a list of mammals which have been recorded as of July 25, 1968:

1. Virginia Opossum
2. Shorttail Shrew
3. Raccoon
4. Longtail Weasel
5. Least Weasel
6. Mink
7. Striped Skunk
8. Badger
9. Red Fox
10. Coyote
11. Woodchuck
12. Thirteen-Lined Ground Squirrel
13. Franklin Ground Squirrel
14. Eastern Fox Squirrel
15. Plains Pocket Gopher
16. Beaver
17. Western Harvest Mouse
18. Deer Mouse
19. White-Footed Mouse
20. Muskrat
21. Norway Rat
22. House Mouse
23. Eastern Cottontail
24. Mule Deer
25. Whitetail Deer

A.7 Reptiles of DeSoto National Wildlife Refuge

Following is a list of reptiles which have been recorded as of July 25, 1968:

1. Snapping Turtle
2. Ornate Box Turtle
3. False Map Turtle
4. Painted Turtle
5. Smooth Softshell
6. Spiny Softshell
7. Brown Snake
8. Garter Snake
9. Plains Garter Snake
10. Eastern Hognose Snake
11. Fox Snake
12. Bullsnake

A.8 Fish of DeSoto National Wildlife Refuge

Following is a list of fish taken in a sampling in May of 1970. Due to the size of the nets used in the sampling, there may be some small species which were not identified.

1. Channel Catfish
2. Black Bullheads
3. Largemouth Bass
4. Bluegill
5. Green Sunfish
6. Walleye
7. Yellow Perch
8. White Bass
9. White Crappie
10. Black Crappie
11. Drum
12. Carp
13. Carp Sucker
14. Blue Sucker
15. Smallmouth Buffalo
16. Gizzard Shad
17. Goldeye
18. Longnose Gar
19. Shortnose Gar

APPENDIX B

B.0 SUMMARY OF NEBRASKA GAME AND PARKS COMMISSION STUDY "SELECTED ENVIRONMENTAL EFFECTS OF TWO NUCLEAR POWER PLANTS ON THE MISSOURI RIVER"

B.1 Introduction

The study entitled "Selected Environmental Effects of Two Nuclear Power Plants on the Missouri River" had its conception in a meeting attended by representatives of various federal, state and local agencies interested in the water quality of the Missouri River in January, 1970. The study was prompted by concern over potential changes in the aquatic environment which could result from the thermal discharges emanating from two nuclear power plants under construction near the towns of Fort Calhoun and Brownville, Nebraska. Both sites are on the right bank of the Missouri River. These two plants were selected for the study because they are the only major generating facilities under construction in this area of the Missouri River. During the January meeting the Nebraska Game and Parks Commission was designated as the coordinating agency.

A Design Committee, composed of six representatives of the agencies which were expected to participate in the study, was convened in February of 1970. These cooperating agencies are as follows:

a. Bureau of Sport Fisheries and Wildlife,
b. Iowa Conservation Commission,
c. Kansas Forestry, Fish and Game Commission,
d. Nebraska Department of Health,
e. Nebraska Game and Parks Commission,
f. Nebraska Public Power District,

B.1 Introduction (continued)

g. Omaha Public Power District,

h. Army Corps of Engineers,

i. Environmental Protection Agency - Water Quality,

j. Geological Survey,

k. University of Nebraska

In April of 1970 the study design was finalized and submitted to all interested agencies for their comments. The study was initiated in July of 1970. The primary purpose of the study is to determine some of the effects of two nuclear power plants on fish and fish-food organisms in the Missouri River. Secondary purposes are to determine the thermal patterns produced by the effluents from these plants and to acquire data to enable an evaluation of the adequacy of existing water quality standards. The study has been broken down into three sections, i.e., fishery, temperature and chemistry, and invertebrates.

B.2 Fishery Section

Three periods of field work in the fisheries portion of the thermal study were scheduled for 1970. These encompassed summer, fall and winter seasons and were completed during the five-day periods of July 27-31, September 21-25 and November 16-20. As anticipated, some alterations in field procedures were made at the conclusion of each of the first two sampling periods. These changes were designed to increase the total catches at the sampling stations and to provide for better statistical analysis of the data. However, similar general procedures were followed throughout the year. These are summarized as follows: The river adjacent to the Fort Calhoun nuclear site was divided into upstream and downstream stations each of which encompassed a specific number of pile dikes or length of trail dike. Sampling was confined to the pile dike and trail dike stabilization structures because they comprise most of the shore line and to ensure a constant unit of effort.

During the three sampling periods, several collecting devices were used at the pile dike and trail dike stations with the hope that one or more would be sufficiently effective for the purposes of this study. At the trail dike stations, fish collections were by boat shocking, hoop netting and hook and line fishing. The telephone shocker, seines, boat shocker and hoop nets were used in collecting fish at the pile dike stations. At each station those fish seven inches and longer in total length were measured, marked by fin clipping and returned to the water. Small fish taken by seining were preserved for transport to the laboratory and subsequent identification.

B.2 Fishery Section (continued)

Information to be gained included species composition at each station and patterns of movement between the stations. It was intended that this information would be compared with that gained in the post-operational phase as a method of measuring changes. Stations A through J were selected as follows: Station A is upstream of the discharge on the right bank; Station F is upstream on the left bank; Stations B, C, D and E are downstream on the right bank; and Stations G, H, I, and J are downstream on the left bank.

B.2.1 Sampling Procedures and Results

Hook and Line Fishing

Fishing with baited hooks was to be used in monitoring channel catfish abundance along the trail dikes. Varying numbers of hooks were set at selected trail dike stations in July and September. In July, beef melt, minnows and shrimp were used as baits while in September only the beef melt was used. Each hook was checked and rebaited daily.

Because only 19 fish were caught in 2000 hook nights of effort, hook and line fishing was discontinued prior to the sampling period in November. Channel catfish comprised 95% of the total catch.

Telephone Shocking

The telephone shocker was used to measure abundance of flathead catfish at the pile dike stations. During July, collections were made once at each pile dike in each station while in September telephone shocking was accomplished only once because the water temperature was below the effective range of this tool.

The telephone shocker is ineffective at water temperatures near or below 60° F. For this reason the tool was not used during the November sampling period.

Seining

Bag seines (40' x 6' x 1/4" mesh) were used in collecting the small forage fishes (minnows and young of other species) which congregate along the sand bar on the downstream side of each pile dike. The standard unit of effort was one haul around the point of each sand bar. At the Omaha Public Power District site, a large mean catch at Station C in July was due to a school of silvery minnows which was captured at one pile dike. A comparatively large catch at Station J, Omaha Public Power District site in September, was dominated by red shiners and gizzard shad. Silver chubs occurred at more stations than any other species as they were collected at over 90% of the stations.

Hoop Netting

Hoop nets (30" diameter, 1" mesh) were set at selected trail dike stations near each nuclear plant primarily in order to monitor abundance of channel catfish. In July and September either 5 or 10 nets were set at the selected trail dike stations. All nets were baited with tankage in September. In November the hoop nets (unbaited) were set at both trail dike and pile dike stations but only at those stations on the Nebraska side of the river.

During the sampling periods in July and September, each net was raised and reset daily. These operations proved to be so time consuming; however, that during the sampling period in November the nets were handled every other day.

B.2 Fishery Section (continued)

Mean catches at the trail dike stations at both nuclear sites were small during all sampling periods, ranging from 0.02 to 1.39 fish per net night. Channel catfish, flathead catfish and drum were the most abundant species. The channel catfish and drum also dominated the hoop net catches at the pile dike stations in November. Catches at the pile dike stations were also small with the exception of one net at the Omaha Public Power District site which caught 22 fish.

Boat Shocking

The boat-mounted shocker was the most effective tool used to collect intermediate and large-sized fish of many different species. During the sampling periods in July and September, this tool was used at selected trail dike stations adjacent to both nuclear sites. In November its use was expanded to include some of the pile dike stations as well. Each station was shocked once in July and twice in September and November.

Mean catches of the intermediate and large-sized fish per shocking run along the trail dikes ranged from 1.3 to 32.5 fish. As with the other tools, lowest mean catches were recorded in November. Mean catches at the pile dike stations in November ranged from 5.5 to 129.0. The great number of fish (159) at Station 2, Omaha Public Power District site, resulted from a large catch of carp and drum at one of the five pile dikes during the first run.

Along the trail dikes at both nuclear sites carp, river carpsucker, gizzard shad and freshwater drum were the species which dominated the

catches. These same species also occurred at more stations than did any of the others. In the combined catch from the pile dikes at the Omaha Public Power District site, carp dominated.

B.2.2 Conclusions to Date and Future Plans

The original experimental design called for a week-long sampling period during each of the four seasons of the year. Three sampling periods (summer, fall and winter) were completed in 1970 and the data from these periods have been analyzed to determine the adequacy of this sampling design. The conclusions after consultation with statisticians are as follows:

a. With the present effort, the catches by all methods for all species are too small to claim statistical significance in any changes which may occur after operation of the power plants.

b. The experimental design must be changed so that more fish during each season can be captured. Greater catches will enable statistical detection of smaller changes in gross numbers and a better chance in detecting statistically significant changes in species numbers.

Therefore, the sampling procedures will be altered as follows:

a. Weekly visits to each nuclear site during the ice-free seasons.

b. Boat shocking to be done weekly at the existing six one-half mile long trail dike stations at each site. On each side of the river, one station to be above and two to be below the entrance of the effluent.

B.2 Fishery Section (continued)

c. Hoop netting to be done behind 10 pile dikes at each site on the Nebraska side of the river. Five stations to be above and 5 below the entrance of the warm water. Hoop nets will be checked weekly. Hoop netting to be discontinued along the trail dike stations.

d. Seining to be done weekly at the same 10 pile dikes used for hoop netting.

e. Telephone shocking to be done weekly during the period the ambient water temperature is above 70° F. Telephone shocking will be done at the same 10 pile dikes used for hoop netting and seining.

f. Hook and line fishing to be discontinued.

B.3 Temperature and Chemistry Section

Temperature and dissolved oxygen readings were taken at various widths across the river and at or near the surface, the 5-foot depth, the 10-foot depth and the 15-foot depth at each of six stations during each sampling period. There were some differences in water temperature and dissolved oxygen between stations at each site, but this can be attributed to the time of day when the station was sampled and the prevailing air temperature. Within stations at the Fort Calhoun site, the greatest variations in water temperature between depths and also across the width was 0.1° C. whereas variation in dissolved oxygen was up to 0.1 ppm between depths and 0.3 ppm across the river's width.

Fort Calhoun Unit No. 1 Station locations are as follows:

	River Mile
Station 1	645.9
Station 2	645.55
Station 3	644.0
Station 4	641.4
Station 5	637.0
Station 6	633.7

Chemistry analysis was conducted on water collected from Stations 1, 2, 4 and 6 during each sampling period. Very similar results were obtained for each parameter at all stations during each sampling period. Differences in dissolved oxygen and pH between the three sampling periods can be noted. These would be expected based on prevailing temperatures and photoperiods.

B.3 Temperature and Chemistry Section (continued)

Three Honeywell automatic temperature recorders were installed at each of the two sampling sites during November, 1970. The three recorders installed at the Fort Calhoun site were placed at Station 1, Station 2 and Station 4.

The temperature data collected from the automatic temperature recorders frequently varied by as much as 2° F. between Stations 1 and 4 for a particular time of day. For example, on December 4 at 1 o'clock PM the temperature at Fort Calhoun (Stations 1 and 2) was 34° F. and at Station 4 it was 36° F. This amount of variation from station to station was not noted in the July, September and November field surveys.

To date many problems have been experienced with the operation and maintenance of the constant recording thermometers which has ranged from mice chewing the chart and ink capillary tube to the loss of temperature probes. Ice conditions on the river has caused many problems. Two probes have been lost at Fort Calhoun (Stations 1 and 4); at Station 2, an ice jam caused the probe to be removed from the water. To get the probe back into the water would require cutting through about 10 feet of ice, then it would be highly probable that as the ice moves it would sever the line.

It appears unlikely that a temperature recorder will be placed back into operation at Fort Calhoun until the ice leaves the river. In the future as soon as icing conditions develop the temperature recorders should be removed until spring.

B.4 Macroinvertebrates and Periphyton

Sampling was carried out during three periods. The first sampling period was 6/25/70 to 7/30/70; the second sampling period was 9/1/70 to 10/1/70; and the third sampling period was 11/4/70 to 12/4/70.

During the three study periods (July, September and November) 18 artificial substrate samplers (rock baskets) were exposed at 6 stations at the Fort Calhoun, Nebraska survey site. For comparative purposes, modified multi-plate samplers of the Hester-Dendy design were exposed along with the rock baskets during two study periods to evaluate the colonization rates for each type. Preliminary results indicated that the rock baskets were superior to multi-plate samplers as the rock-filled baskets were colonized by greater numbers of organisms representing a greater species diversity.

At the Fort Calhoun site, recovery was excellent losing only 2 from the original 18 samplers. Table B-1 presents the numbers and types of organisms collected during each study period.

In addition to the fish-food organisms collections, a composite sample of invertebrates from rock basket samplers was obtained during July and November, 1970. The samples with the detritus removed were shipped frozen to the Environmental Protection Agency's NFIC Laboratory in Cincinnati, Ohio, for radiological analysis. The results are pending at this time.

The sampling for periphyton using artificial substrate samplers was hindered by several unforeseen factors during the survey periods.

TABLE B-1

MACROINVERTEBRATES COLLECTED FROM ARTIFICIAL SUBSTRATE SAMPLERS, MISSOURI RIVER, JULY, SEPTEMBER AND NOVEMBER 1970

ORGANISM	FORT CALHOUN -1 R.M. 647.0			FORT CALHOUN -2 R.M. 646.0			FORT CALHOUN -3 R.M. 644.6			FORT CALHOUN -4 R.M. 644.0			FORT CALHOUN -5 R.M. 641.5			FORT CALHOUN -6 R.M. 636.2		
	7-70	9-70	11-70	7-70	9-70	11-70	7-70	9-70	11-70	7-70	9-70	11-70	7-70	9-70	11-70	7-70	9-70	11-70
CRUSTACEA																		
Asellus sp.	4		2			1												
Hyalella Azteca								2										
DIPTERA																		
Ablabesmyia sp.			2					4									8	
Chironomus (Cryptochironomus sp.)	4																	
Cricotopus sp.														4				
Polypedilum sp.	116	2		52			30	8		226				8		28	12	2
Procladius sp.	12																	
Simulium sp.	4											4						
Tanypus sp.	4			4														
Tanytarsus sp.		14						20				4		4		4	4	2
EPHEMEROPTERA																		
Ameletus sp.		6		12			80	8		128			148	16		48		
Baetis sp.	28																	
Caenis sp.	516	16		356			804	24		492			1,732	12		860	24	
Heptagenia sp.	36			28			32					8	48		6			
Isonychia sp.	100			16			124			48			120	16		76		
Paraleptophlebia sp.				4			16						60			32		
Stenonema sp.		36	2			6		56			4	28		12	14		4	2
PLECOPTERA																		
Hastaperla sp.												8						1
Perlesta sp.	8						8			4			4					
TRICHOPTERA																		
Cheumatopsyche sp.	4,488	384	9	2,136		4	2,000	732		740	76	220	1,844	904	72	1,940	900	19
Hydropsyche sp.	1,876	1,104	16	828		27	796	282		260	12	232	972	184	40	228	112	27
Hydropsychidae	4																	
Neureclipsis sp.	44	120	4	204		5	180	126		44	28	32	196	120	24	76	124	11
TURBELLARIA																		
Planaria sp.	12	66	3	164			52	166		48	48	4	136	52	2	36	24	
TOTAL NUMBER	7,224	1,738	36	3,204		33	4,536	1,338		1,988	160	540	4,720	1,332	157	2,708	1,212	98
TOTAL NUMBER TYPES	16	9	7	11		5	11	11		9	5	9	10	11	6	10	9	7

Because the samplers must remain approximately 4 inches below the water surface, any drop in the river stage would strand the fixed samplers. The fragile construction of these devices prohibited the use of a longer line to compensate for river stage fluctuation. If the samplers were allowed to float with a long line, the river traffic and subsequent wave action would either demolish or strand the periphyton floats.

At the Fort Calhoun site, 18 samplers were exposed and 7 were recovered. Table B-2 lists the abundance of periphyton at the Fort Calhoun site.

Sampling Program for 1971

There is no anticipated change in station locations or analyses for the 1971 sampling period. The rock baskets have proved to be satisfactory for invertebrate collections and their use will be continued. There will be an additional spring and fall collection of invertebrates for radiological analysis.

The development of a more suitable periphyton sampler is nearly complete and a trial exposure period is scheduled for mid-March, 1971.

TABLE B-2

MISSOURI RIVER PERIPHYTON ABUNDANCE PER SQUARE MILLIMETER

FORT CALHOUN, NEBRASKA

Stations	River Mile	Centric Diatoms	Pennate Diatoms	Greens	Blue Greens	Flagellates	Total	Predominate Genera
			(6/24/70 - 7/29/70)					
FC-2	646.0	231	6,567	99	0	0	6,897	Gomphonema
FC-4*	644.0	990	29,700	990	0	330	32,010	Gomphonema
FC-6*	636.0	330	48,510	1,320	0	330	49,896	Gomphonema
			(8/31/70 - 9/30/70)					
FC-5	641.5	0	1,947	231	0	33	4,158	Gomphonema
			(11/3/70 - 12/3/70)					
FC-3	644.6	66	8,118	132	0	0	8,316	Gomphonema
FC-4	644.0	426	10,098	132	0	0	10,656	Gomphonema

* Dilution 1:5

FIGURES