T.M. Crimmins, Jr

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL
Power & Light
Company

ENVIRONMENTAL REPORT

JERSEY CENTRAL POWER & LIGHT COMPANY

AMENDMENT NO. 2

TO

OYSTER CREEK NUCLEAR GENERATING STATION

ENVIRONMENTAL REPORT

NOVEMBER 17, 1972

INSTRUCTIONS:

1. Remove page xi from the Environmental Report and insert Amendment 2 page xi.

2. Insert entire Appendix C from Amendment 2 into the Environmental Report.

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JERSEY CENTRAL POWER & LIGHT COMPANY

AMENDMENT NO. 1

TO

OYSTER CREEK NUCLEAR GENERATING STATION

ENVIRONMENTAL REPORT

SEPTEMBER 1972

INSTRUCTIONS:

1. Remove pages xi through xx from the Environmental Report and insert Amendment 1 pages xi through xxi.
2. Insert entire Section 11.0 from Amendment 1 into Environmental Report.

1.0

INTRODUCTION

1.1 PURPOSE

The Jersey Central Power & Light Company (JC) has constructed and is operating under a provisional license the nuclear electric generating station known as "Oyster Creek Nuclear Generating Station." JC, along with Pennsylvania Electric Company (Penelec), Metropolitan Edison Company, (Met-Ed), and New Jersey Power and Light Company (NJP&L) are operating subsidiary companies of General Public Utilities Corporation (GPU); together with another subsidiary company, the GPU Service Corporation (GPUSC), they comprise the GPU System. The generating station, owned by JC, is located near Barnegat Bay on a 1,416 acre site in Lacey and Ocean Townships in Ocean County, New Jersey. The coordinates for the site are 39° 48' 44" N by 74° 12' 24" W. The plant itself is located on that portion which lies between U.S. Highway 9 on the east, the Garden State Parkway on the west, the South Branch of Forked River on the north, and Oyster Creek on the south. Physiographically, it is located in the pine barrens of New Jersey, 60 highway-miles south of Newark, 35 miles north of Atlantic City, about 9 miles south of Toms River, and about 60 miles east of Philadelphia, Pennsylvania.

The Oyster Creek facility contains a single boiling water reactor (BWR), turbogenerator, and accessory equipment with an expected ultimate electrical capability of 640 MW net. The once-through method of cooling is used to remove waste heat from the condensers. Water is taken from Barnegat Bay by way of the South Branch of Forked River and a dredged canal. After passing through the condensers the cooling water is discharged into a dredged canal flowing into Oyster Creek, which eventually returns it to Barnegat Bay.

JC received an amendment to Provisional Operation License (DPR-16) from the Atomic Energy Commission (AEC) August 1, 1969 which authorized operation at 1600 MWt. The start-up program and one year operating experience verified the conservatism of the design parameters and consequently the license was amended on December 2, 1970 to permit operation at 1690 MWt. Subsequently, the license was again amended on November 5, 1971 to permit operation to full power of 1930 MWt.

This Environmental Report has been prepared and submitted in accordance with the AEC's "Interim Statement of General Policy and Procedure; Implementation of the National Environmental Policy Act of 1969," 10 CFR Part 50; Appendix D. The report is being submitted in conjunction with an application for a Full Term Operating License.

This report includes descriptions of the plant and its surrounding environment, environmental effects of plant operation and accidents, unavoidable adverse effects of plant construction and operation, alternatives to construction and operation, resources committed in plant construction and operation, and environmental approvals and consultations. The environmental analysis submitted in this report leads to the following conclusions:

1) The Oyster Creek Nuclear Generating Station will not have any significant adverse effect on the environment.

2) To the extent that the project has any adverse environmental impact, JC has exerted and will continue to exert its best efforts to minimize that impact.

3) Any unavoidable adverse environmental impact is outweighed by the social and environmental benefits that will be afforded by the availability of electric power from the project.

4) The Oyster Creek Nuclear Generating Station has the least adverse environmental impact of the available modes of generating the energy required.

1.2 ENVIRONMENTAL POLICY STATEMENT

JC, as a member of the community and a user of natural resources, is deeply concerned with the conservation and improvement of the environment. The Company seeks to meet the electrical power requirements of its customers as economically as possible, consistent with intelligent use of the environment, and with due consideration not only for present power needs but also for the requirements of future generations.

JC intends to do its part to satisfy projected needs; to maintain clean and healthy surroundings; and to support health, education, welfare, cultural and recreational pursuits; and economic opportunity.

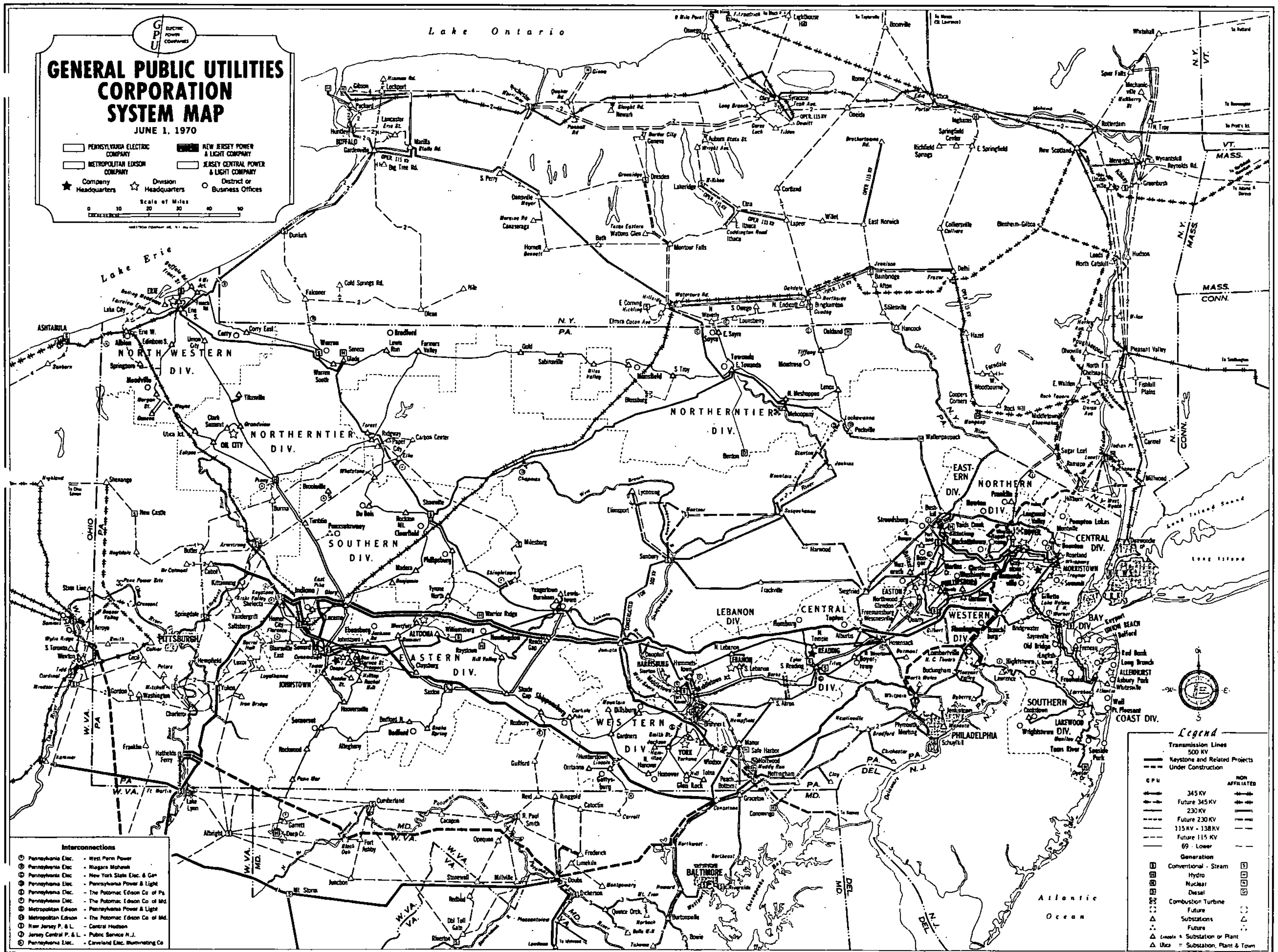
1.3 NEED FOR LOCATING POWER PLANT AT THE SITE

The power needs which have been met by the existing Oyster Creek Project will be discussed in relation to the present generating capacity of the GPU System. The relationship of Oyster Creek to the power supply situation of the Pennsylvania-New Jersey-Maryland Interconnection (PJM) at the intended in-service date, and subsequently to the present time, is also presented.

The requirement for additional generating capacity in the area of Oyster Creek is discussed. Major power uses are identified to the extent possible. The economic and other consequences of the actual delay in its construction are discussed as an evidence of the need for this project.

1.3.1 General Public Utilities System

The GPU System is planned and operated on a fully integrated basis; and since generating capacity and related transmission are planned to meet System needs, the need for Oyster Creek should be examined in relation to GPU System requirements and costs, as well as those of its owner, JC. Figure 1.3-1 is a map of the service areas and transmission lines of the GPU System and of the principal transmission lines of its neighbors. Oyster Creek Nuclear Station is shown on the lower right (southeastern) corner of the GPU service area.


GENERAL PUBLIC UTILITIES CORPORATION SYSTEM MAP
JUNE 1, 1970
Lake Ontario
Lake Erie
Atlantic Ocean
NORTH WESTERN DIV.
NORTHERNTIER DIV.
SOUTHERN DIV.
EASTERN DIV.
LEBANON DIV.
CENTRAL DIV.
WESTERN DIV.
EASTERN DIV.
NORTHERN DIV.
CENTRAL DIV.
BAY DIV.
WESTERN DIV.
SOUTHERN COAST DIV.
LAKEWOOD DIV.
PITTSBURGH
JOHNSTOWN
ALTOONA
HARRISBURG
READING
PHILADELPHIA
BALTIMORE
BUFFALO
Interconnections
Legend
FIGURE 1.3-1

The GPU System extends from Lake Erie in Pennsylvania to the Atlantic Coast of New Jersey. This extent has greatly influenced the development of generating plants for the System. It has heretofore been economic to install large mine-mouth, steam-electric plants in west-central Pennsylvania, in excess of local GPU requirements for power, and to transmit this excess to eastern Pennsylvania and New Jersey. The development of this west-to-east pattern began in the early 50's with a single 230-kv transmission line and a single 115-kv line, since supplemented with additional 230-kv and 345-kv lines. In the mid-60's most of the companies in PJM, including the GPU companies, joined in the further development of mine-mouth generation, which was connected to the eastern load centers by 500-kv transmission. JC shares in the ownership of Keystone Station, the first of three recent mine-mouth stations in PJM.

The availability of low cost coal has therefore resulted in a concentration of relatively modern generation in the Penelec territory, in the general vicinity of Johnstown, Indiana and Clearfield. All of the recent GPU generation has not, however, been installed in the western part of the System, for consideration of both economy and reliability requires that substantial amounts of capacity be located close to eastern load centers. As long as this need for local supplies was met with steam-electric generation and associated transmission, requirements for condenser cooling water dictated that the plants be located on the Susquehanna, Schuylkill, or Delaware Rivers or on tidewater in New Jersey. Subsequent to the construction of Oyster Creek, the GPU System has installed a number of combustion turbines primarily for capacity or peak load period which, because of minimum water requirements, can be located either to save transmission, or to meet local area requirements, or to take advantage of favorable fuel deliveries. Existing GPU generating stations are noted in Table 1.3-1.

1.3.2 Pennsylvania-New Jersey-Maryland Interconnections

The GPU System is part of the Pennsylvania-New Jersey-Maryland Interconnection (PJM)(*). There is a high degree of coordination in the planning of generating capacity among the member companies of PJM, as witnessed by the mine-mouth generation and 500-kv transmission discussed above. Other jointly owned generation and transmission projects, involving from two to four of the member companies, have been and are being developed.

Coordination in PMJ goes far beyond planning, for operation is carried out essentially without reference to ownership of facilities by individual companies. There is an overall economic dispatch of energy generation within PJM and a free flow of interchange power among the member

(*) The PJM Pool consists of the following electric utility systems: Public Service Electric and Gas Company, Philadelphia Electric Company, Atlantic City Electric Company, Delmarva Power & Light Company, Pennsylvania Power & Light Company, UGI Corporation, Baltimore Gas and Electric Company, Jersey Central Power & Light Company, Metropolitan Edison Company, New Jersey Power & Light Company, Pennsylvania Electric Company and Potomac Electric Power Company, The pool serves a population of about 20 million in a 48,000 square mile area including three quarters of Pennsylvania, almost all of New Jersey, more than half of Maryland, all of Delaware and the District of Columbia, and a small part of Virginia. The Pool operates under a written agreement which provides for planning and operating the bulk power supply of each company as an integral part of the total PJM System and for operation as a single control area.

Table 1.3-1. GPU System Installed Capacity as of December 31, 1971.

Coal or Oil Fired	Net Capability, Mw Summer	Net Capability, Mw Winter
Shawville	610	636
Homer City	550	550
Front St.	122	118
Seward	212	222
Warren	80	80
Saxton	48	49
Williamsburg	36	38
Portland	409	410
Crawford	108	116
Titus	234	240
Eyler	54	57
Gilbert	124	128
Werner	105	112
Sayreville	340	356
Keystone	273	273
Conemaugh	280	280
Subtotal	3,585	3,665

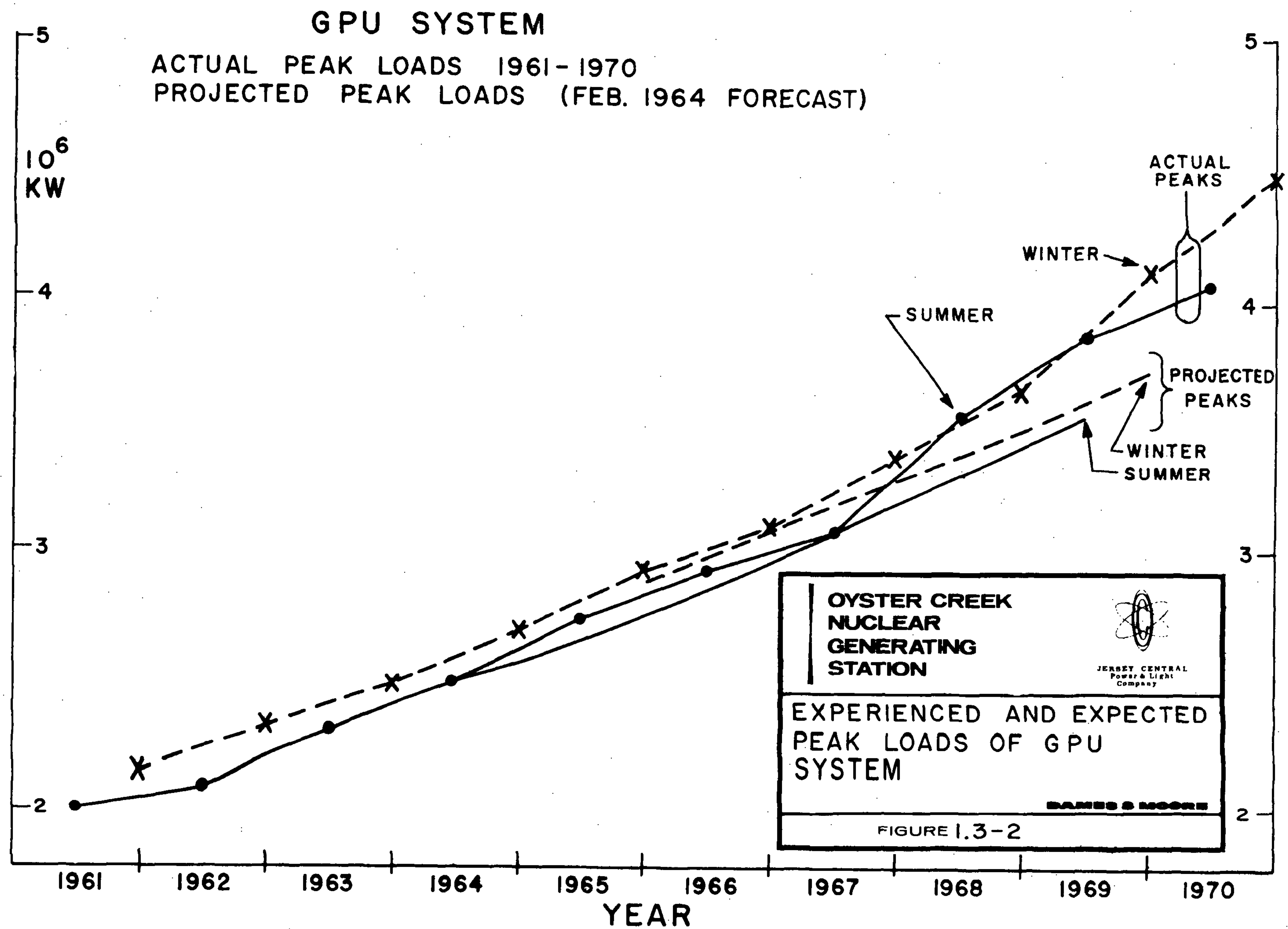
	Net Capability, Mw Summer	Net Capability, Mw Winter
Nuclear		
Oyster Creek	600	625
Hydro		
4 Plants	56	62
Pumped Storage		
Yards Creek	165	165
Seneca	76	76
Diesel		
5 Plants	17	17
Comb. Turbines		
Gilbert	92	132
Glen Gardner	168	216
7 Plants	225	268
Subtotal	1,399	1,561
Total GPU	4,984	5,226
Customer Owned	24	25
TOTAL	5,008	5,251

companies. Interchange is also scheduled by PJM with four neighboring areas. Furthermore, the coordinated operation of the PJM area is such that a deficiency of capacity in any one company is met by purchases from others, to the extent excess is available. If the PJM group as a whole is deficient and is unable to obtain sufficient help from other areas, all member companies share in the voltage reduction, load curtailment, or other measures necessary to maintain service. Although the Oyster Creek plant represented only a small fraction (about two percent as of 1969) of the total PJM installed capacity, the delay from 1967 to 1969 in operation of this unit contributed to the need for voltage reductions and other emergency measures that were required during this period.

1.3.3 System Peak Load and Installed Capacity

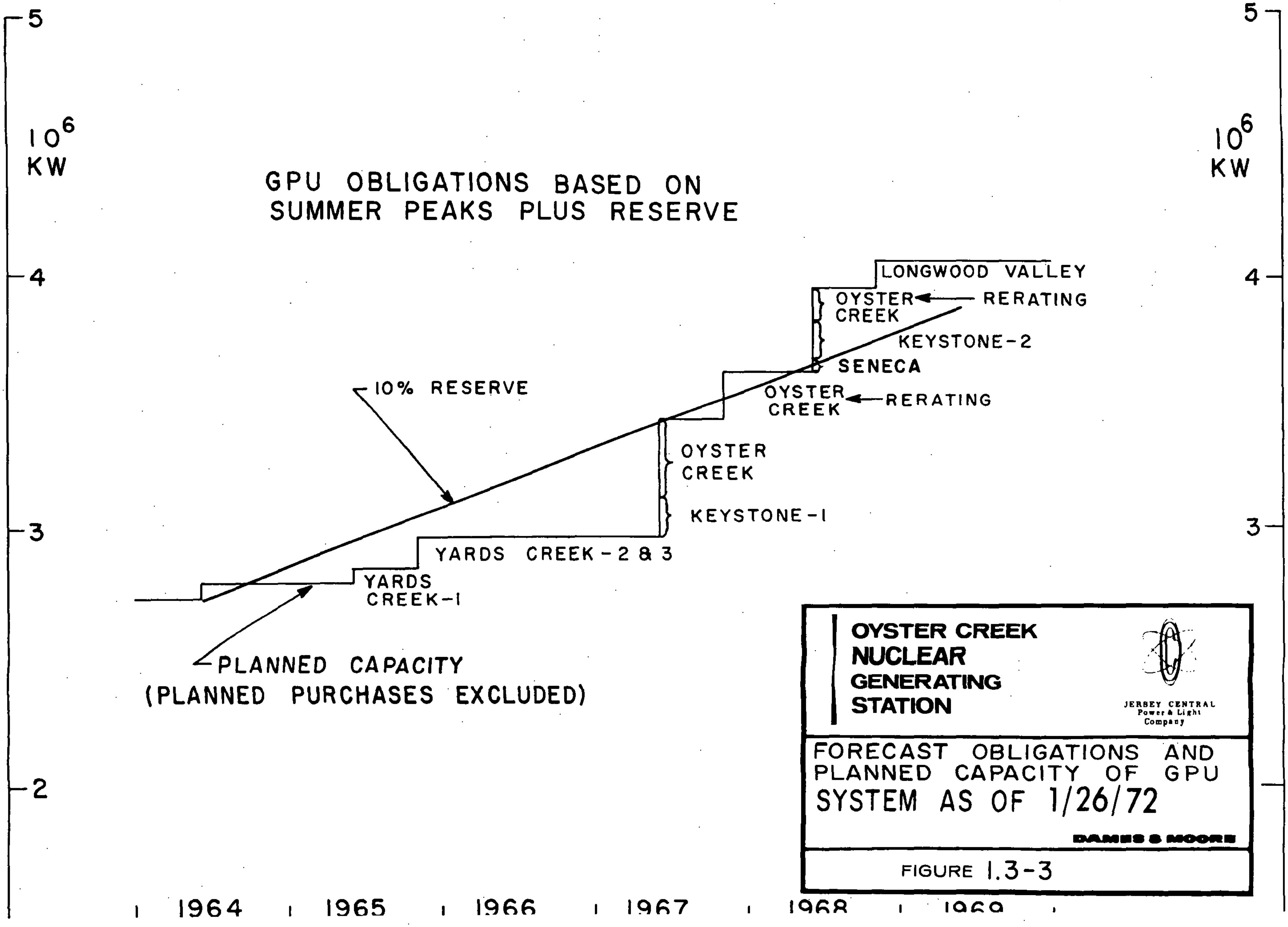
The actual and projected power demands of the GPU System are shown in Figure 1.3-2, the projected demands being those forecast at about the time a decision was made to proceed with Oyster Creek. It is evident that actual loads have exceeded those estimated since 1964 and that the forecast need for Oyster Creek capacity has been confirmed by experience.

Figure 1.3-3 shows the GPU forecast capacity obligations, including reserve and planned capacity additions from 1964 to 1968. Major generating station additions are identified, but planned purchases are omitted in this diagram. Figure 1.3-4 is a similar diagram, but based on actual loads and actual capacity additions, including firm purchases, for 1964 to 1969, the extension being necessary to show the delay operation of



EXPERIENCED AND EXPECTED PEAK LOADS OF GPU SYSTEM

FIGURE 1.3-2



FORECAST OBLIGATIONS AND PLANNED CAPACITY OF GPU SYSTEM AS OF 1/26/72

FIGURE 1.3-3

In the industrial classification, the larger classifications in order of usage are:

	Percent of Revenues From Industrial Customers
Primary Metal Industries	17.4
Machinery, including Electrical	13.9
Paper and Allied Products	8.8
Stone, Clay and Glass Products	7.6
Chemical and Allied Products	6.7
Others (6 percent or less)	45.6
	100.00

1.4 INVESTIGATORS

The principal investigators participating in the preparation of this report, and their particular areas of expertise are listed as follows:

Philip Sherlock	-	Principal-in-Charge and Project Director	(Dames & Moore)
Gerald A. Place	-	Project Manager and Agronomist	(Dames & Moore)
Stanley Kozlowski	-	Meteorologist	(Dames & Moore)
Charles W. Proctor, Jr.	-	Aquatic Biologist	(Dames & Moore)
Alan L. Koechlein	-	Terrestrial Biologist	(Dames & Moore)
Robert C. Erickson	-	Aquatic Biologist	(Dames & Moore)
Fredrick B. Lobbin	-	Nuclear Engineer	(Southern Nuclear Engineering Company)
Eric Geiger	-	Radiochemist	(Eberline Instrument Company)
John Pratt	-	Demographer	(Dames & Moore)
Bernard Archer	-	Geologist	(Dames & Moore)
Gerald M. Budlong	-	Geographer	(Dames & Moore)
Leopold M. Page	-	Hydrologist	(Dames & Moore)
Nancy W. Walls	-	Biologist	(Georgia Tech Universit[illegible]

Resumes of the foregoing individuals are presented in Appendix A.

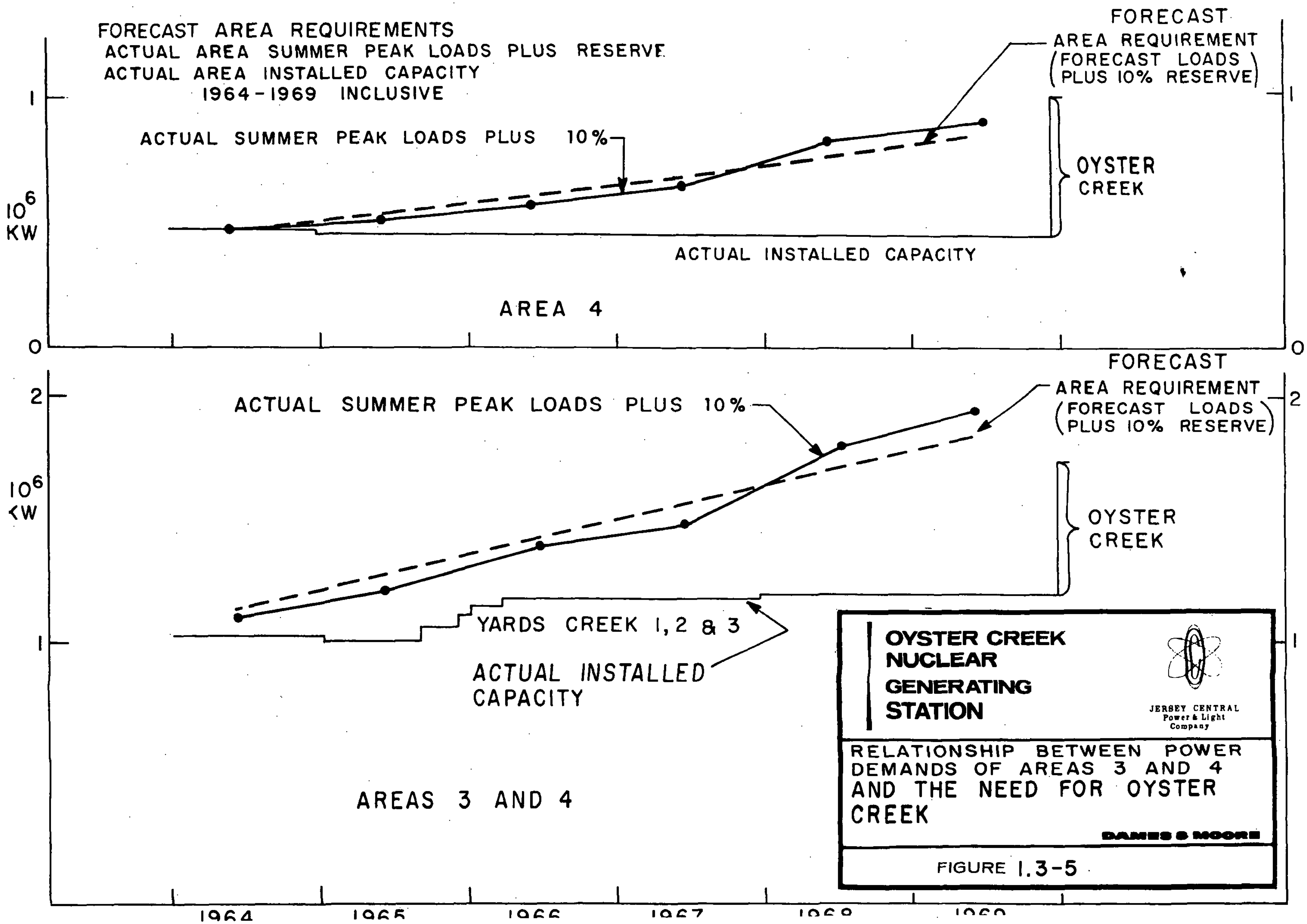
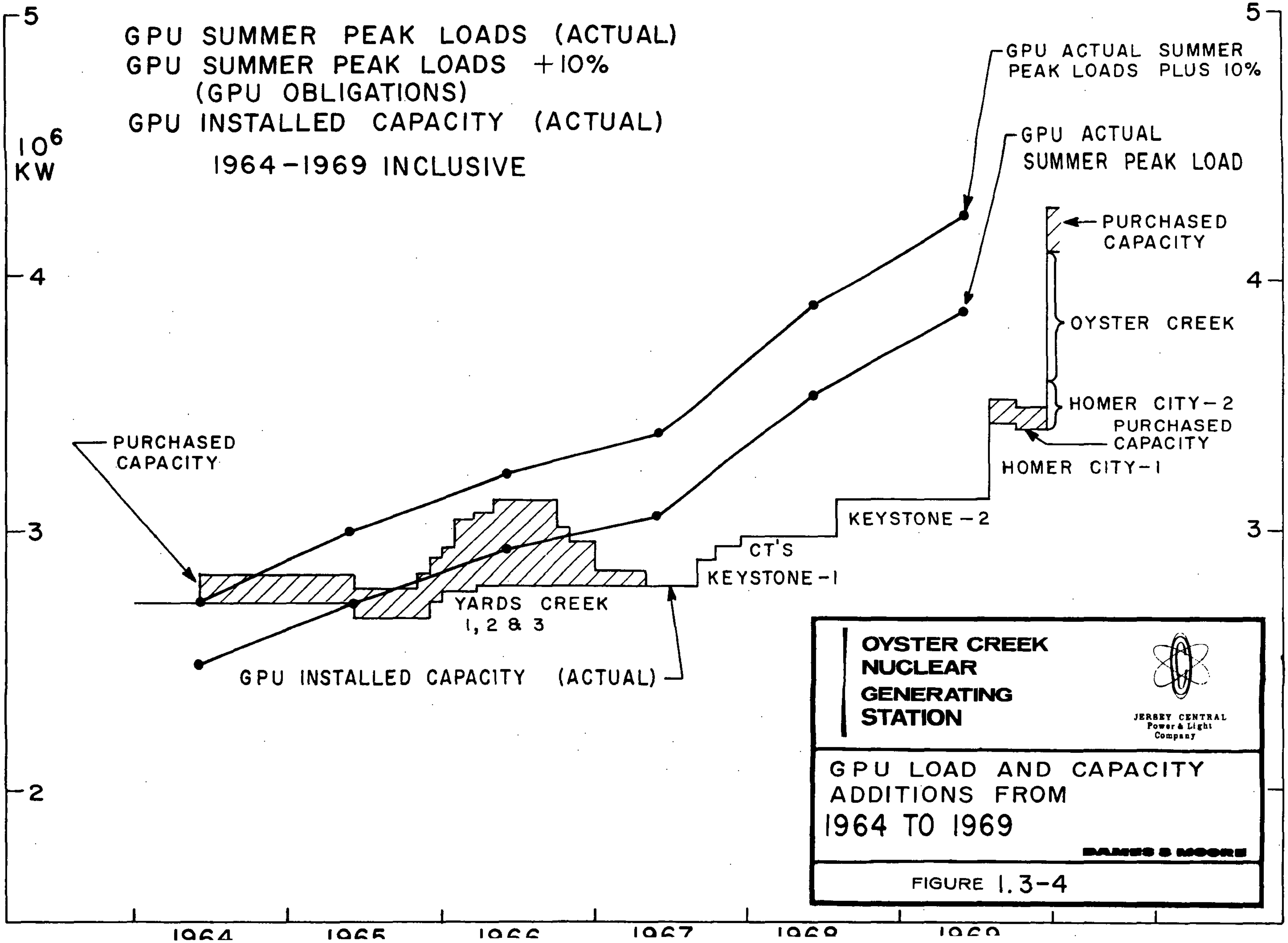


FIGURE 1.3-5

RELATIONSHIP BETWEEN POWER DEMANDS OF AREAS 3 AND 4 AND THE NEED FOR OYSTER CREEK



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

GPU LOAD AND CAPACITY ADDITIONS FROM 1964 TO 1969

DAMES & MOORE

FIGURE 1.3-4

Oyster Creek. The capacity obligations for GPU are here based on summer peak loads, which is the present base for planning within PJM. Although GPU has a winter peak, forecast reserve margins are lower in the summer than in winter, because of increased generating efficiency during cold weather. GPU capacity obligations are shown for 10 percent reserves, which is the contractual requirement in PJM. However, since August 14, 1969 a 20 percent reserve has been used as the basis of PJM planning in order to meet reliability requirements. This reserve level for planning has been endorsed by regulatory authorities(*). Both Figures 1.3-3 and 1.3-4 show graphically the need for the Oyster Creek capacity, as well as other units installed by GPU in recent years. With all these additions, including Oyster Creek, GPU did not meet its reserve obligation in 1969 (or even in 1970 and 1971).

The need for Oyster Creek capacity and output is also demonstrated by the following facts:

1. Since the beginning of operation in late 1969, the plant has been operated at the maximum level of output permitted by its license and by its physical condition. In 1970, the net generation of Oyster Creek was 3454 x 10^6kwh, and in 1971, 3825 x 10^6 kwh. This output represented 48 percent and 47 percent of the total power produced in JC and 15 percent and 16 percent of the total produced by GPU in these two years.

(*) The Federal Power Commission in its Summary Report on 1971 Summer Electric Load Supply Outlook (May 6, 1971) stated "Average reserve margins of about 20 percent of expected peak load demands generally are considered necessary to compensate for forced outages, required maintenance, uncertainties in load forecasting, and other reasonable contingencies." The Public Utility Commissions of the PJM member states have established the 20 percent reserve capacity as an objective.

2. Operation of Oyster Creek was delayed from the fall of 1967 to December 1969, and this delay adversely affected installed capacity reserves, as shown by the following comparisons for GPU and PJM summer peak conditions, with and without Oyster Creek in service.

	% GPU Reserves		% PJM Reserves	
	1968	1969	1968	1969
Without Oyster Creek (actual)	-16.0	-19.2	5.4	2.4
With Oyster Creek	- 1.0	- 5.5	7.9	4.6

The low levels of reserves were caused by delays in other units in PJM as well as by delay in Oyster Creek. If Oyster Creek had been in service, many of the occasions for voltage reduction in PJM, calls for emergency assistance from other areas, etc. would not have been required (the peaks on which the PJM reserves are based are adjusted for curtailment of PJM load effective at the time of peak).

3. The delay in operation of Oyster Creek required GPU and PJM to operate other capacity more extensively; and since this was necessarily the older and less efficient fossil-fired generation, the result was a substantial discharge of various pollutants to the atmosphere and a greatly increased cost of fuel consumed. These increased costs were not passed on to customers, because of the absence in those years of automatic

rate adjustments based on fuel costs and the absence of regulatory decisions resulting in rate changes for the GPU companies.

1.3.4 Local Area Need for the Oyster Creek Capacity

Although generating capacity is not matched exactly with demands to each geographic area, reliability and stability of the System cannot be maintained if the mismatch is too great. Consequently, there was a need for capacity in the coastal area of New Jersey to balance the mine-mouth generation that had been and was concurrently being installed in western Pennsylvania.

Demands for power are, of course, not uniformly distributed throughout the System; and if demands are to be related to sources of supply, it is necessary to measure these demands over some geographic area. For this purpose, the GPU System has been divided into the four areas, which can be described by reference to the map, Figure 1.3-1. These areas are:

1. All of Penelec (the division of this large area into smaller segments is not required here).
2. Met-Ed, except the Eastern Division along the Delaware River.
3. Northwest New Jersey, comprising parts of Met-Ed and the two companies in New Jersey.

4. Coastal portion of JC area, consisting of the Bay, Coast and Southern Divisions.

Oyster Creek is in area 4; but for planning purposes (particularly as of the early 1960's) areas 3 and 4 were considered as a single area. Consequently, the need for Oyster Creek is examined, Figure 1.3-5, in relation to the power demands of areas 3 and 4 combined as well as of area 4 alone. In this diagram, capacity obligations are shown in two ways: (1) forecast demands plus 10 percent reserve (PJM contractual requirement), and (2) actual demands plus 10 percent reserve. Since the time period (1964 to 1969) discussed here, PJM has accepted, based on reliability studies, a 20 percent reserve for planning purposes. The 10 percent reserve is used here since it was applicable during the period discussed. The capacities available to meet the demands during this period are shown in-service as of the actual date, rather than the planned date of commercial operation. That Oyster Creek was needed, even before its actual operation, is made evident by the excess of obligations over the installed capacities prior to 1969.

1.3.5 Users of Power

The energy sales of the GPU System in 1970, by major classifications, were as follows:

	Million kwh	Percent of Total
Residential	7,314	32.8
Commercial	4,392	19.7
Industrial	9,363	41.9
Street Lighting and Public Authorities	309	1.4
Sales for Resale	942	4.2
Total	22,320	100.0

2.0

THE SITE

2.1 LOCATION OF PLANT

An aerial view of the 1,416 acre site which is owned by JC is given in Figure 2.1-1. The site is located in the coastal pine barrens of New Jersey about nine miles south of Toms River. U.S. Highway 9 divides the property, with 755 acres lying west of the Highway and 661 acres lying to the east. The Oyster Creek Station is located approximately 1,400 feet west of the Highway. The western portion of the site is bounded on the north and south by undeveloped land, on the west by the Garden State Parkway and on the east by U.S. Highway 9. The eastern half of the site has residential developments on its north and south boundaries. These residential developments have both land and water access easements.

The Central Railroad of New Jersey and U.S. Highway 9 provide the only access routes to the site by land. Water access to the site can be obtained via the Intracoastal Waterway which runs through Barnegat Bay. Hence barges and boats can approach the plant as close as the U.S. Highway 9 bridge by way of the South Branch of Forked River and Oyster Creek.

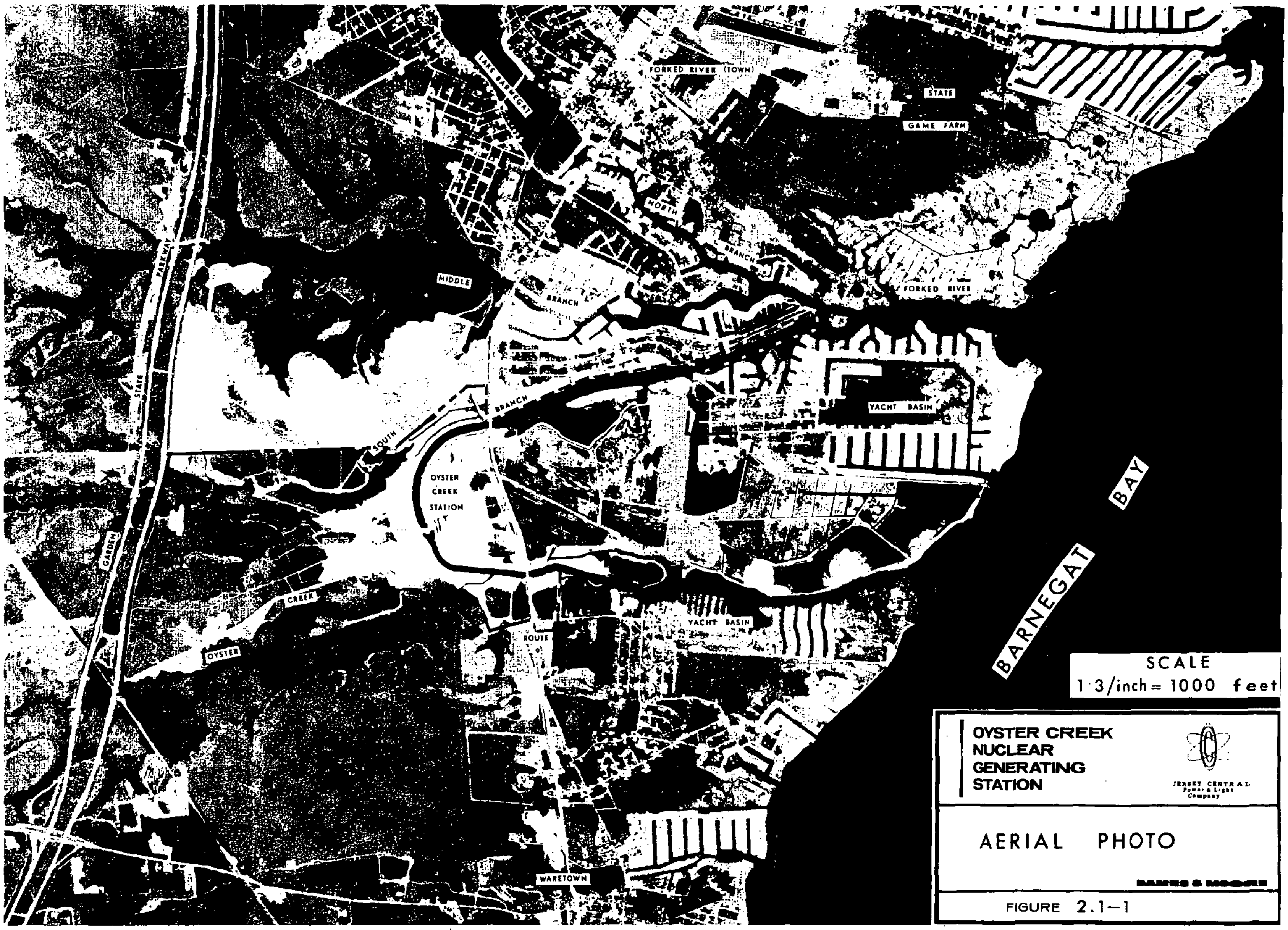

FORKED RIVER (TOWN)
STATE
GAME FARM
LAKE BARNEGAT
NORTH
BRANCH
FORKED RIVER
MIDDLE
BRANCH
YACHT BASIN
SOUTH
BRANCH
OYSTER
CREEK
STATION
GARDEN
STATE
PARKWAY
OYSTER
CREEK
ROUTE
YACHT BASIN
WARETOWN
BARNEGAT BAY
N
SCALE
1·3/inch = 1000 feet
OYSTER CREEK
NUCLEAR
GENERATING
STATION
JERSEY CENTRAL
Power & Light
Company
AERIAL PHOTO

FIGURE 2.1–1

2.2 HUMAN ACTIVITIES IN THE ENVIRONS

2.2.1 Population

2.2.1.1 General

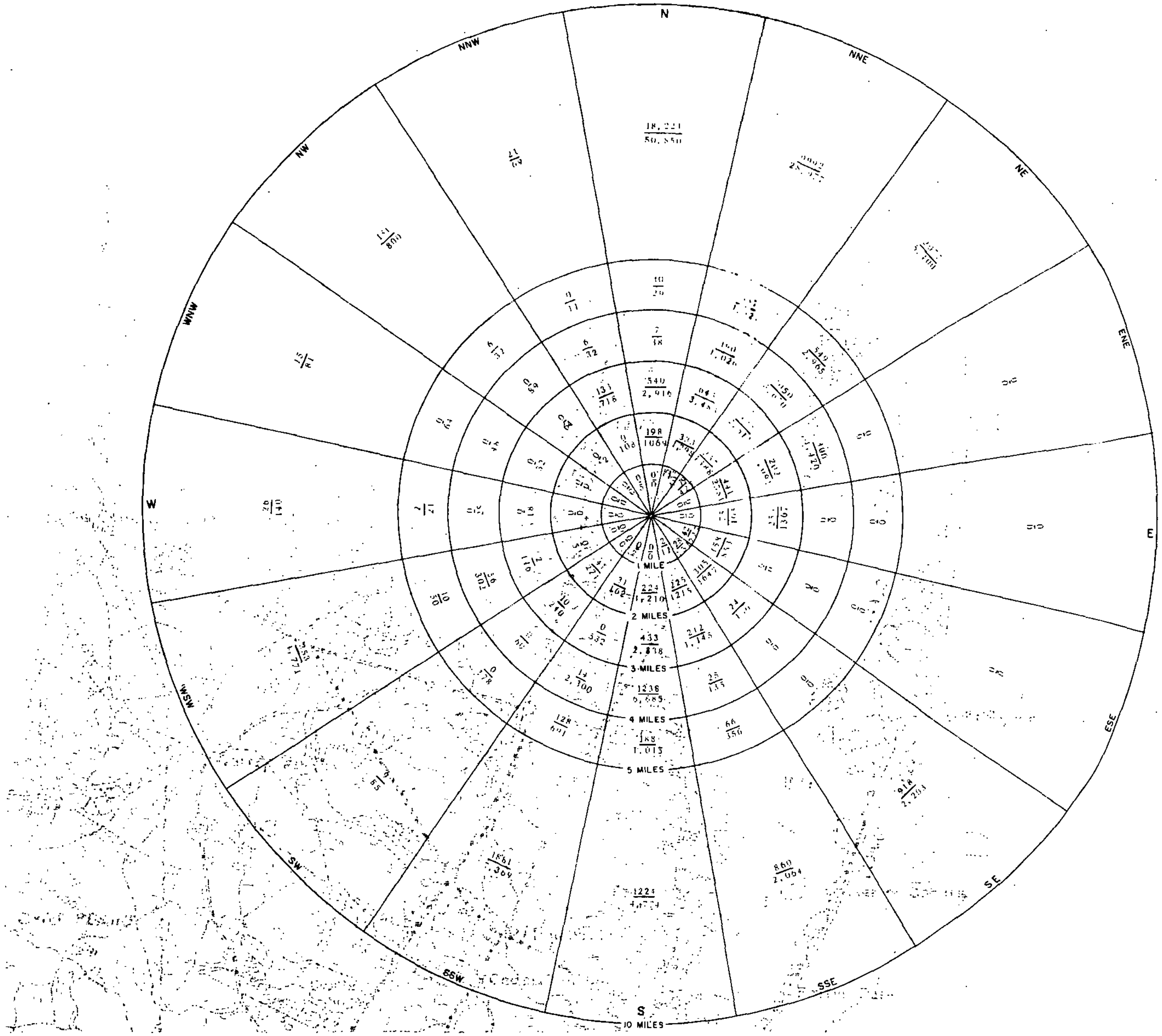
This portion of the report presents results of a population study based on 1970 information for the area within a 50-mile radius of the site. The sources used in compiling this information include the U.S. Bureau of the Census (Ref. 2.2-1 through 6), various county planning commission reports (Ref. 2.2-7), and numerous maps (Ref. 2.2-8 through 10) and aerial photographs (Ref. 2.2-11) of the site and surrounding area.

2.2.1.2 Present Population

The Oyster Creek Nuclear Generating Station is located in the fastest growing county in New Jersey. Ocean County's population rose more than 92 percent from 1960 to 1970, and over 91 percent the previous decade. The State population rose less than 19 percent between 1960 and 1970.

A resort area, the eastern coast of the State, is densely populated with an additional influx between June and September. This seasonal increment is concentrated on the barrier beaches, and on the mainland within five miles of the Bay. The area immediately west of this five mile strip is sparsely populated pine barrens.

Present population distributions and densities within ten miles of the site are shown in Figures 2.2-1 through 2.2-4. Due to the concentration



KEY

41 / 223	ESTIMATED 1970 POPULATION / ESTIMATED 2010 POPULATION

NOTE:

RADIUS IN MILES		1	2	3
ACCUMULATIVE TOTAL	1970	226	2,514	5,433
	2010	1,228	13,702	29,433

RADIUS IN MILES		4	5	10
ACCUMULATIVE TOTAL	1970	8,319	9,835	45,366
	2010	45,266	51,988	156,571

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF A U.S.G.S. QUADRANGLE WILMINGTON, DEL.-PA.-N.J.-MD. DATED 1945.

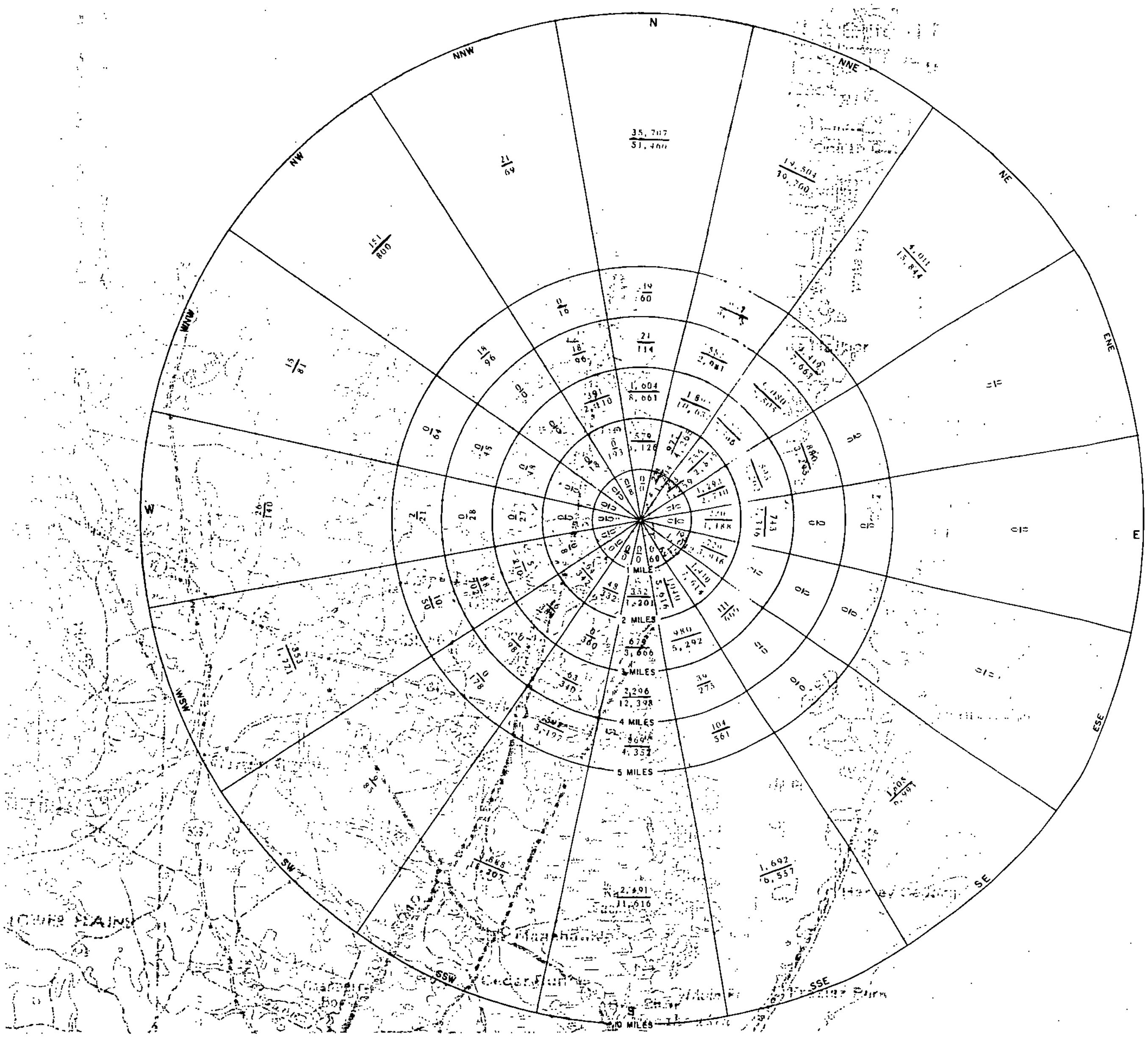
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

SITE VICINITY MAP
Showing Present and Future,
Resident Population Distribution,
0 to 10 Miles

DAMES & MOORE

FIGURE 2.2-1



KEY:

$\frac{64}{460}$ $\frac{\text{ESTIMATED 1970 POPULATION}}{\text{ESTIMATED 2010 POPULATION}}$

NOTE:

RADIUS IN MILES		1	2	3
ACCUMULATIVE	1970	789	8,257	16,635
TOTAL	2010	4,264	34,564	76,554

RADIUS IN MILES		4	5	10
ACCUMULATIVE	1970	23,672	27,642	97,315
TOTAL	2010	104,523	124,554	277,877

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF A U.S.G.S. QUADRANGLE WILMINGTON, DEL.-PA.-N.J.-MD. DATED 1966.

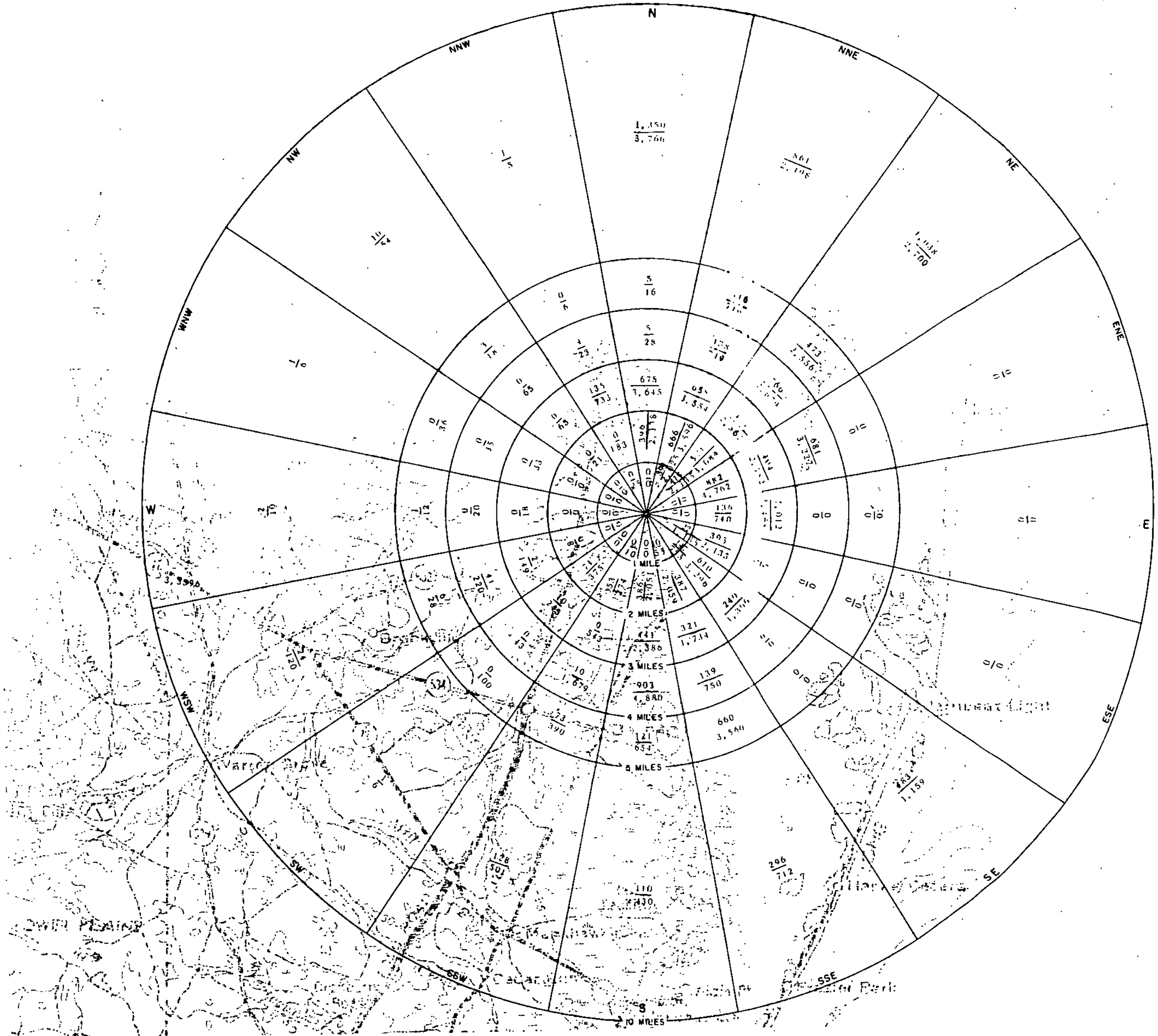
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

SITE VICINITY MAP
Showing Present and Future, Resident and Seasonal Population Distribution, 0 to 10 Miles

DAMES & MOORE

FIGURE 2.2-2



KEY:

$\frac{20}{40}$ = ESTIMATED 1970 RESIDENT POPULATION PER SQUARE MILE / ESTIMATED 2010 RESIDENT POPULATION PER SQUARE MILE

NOTE: DENSITY BASED ON LAND AREA ONLY

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF A U.S.G.S. QUADRANGLE WILMINGTON, DEL.-PA.-N.J.-MD. DATED 1966.

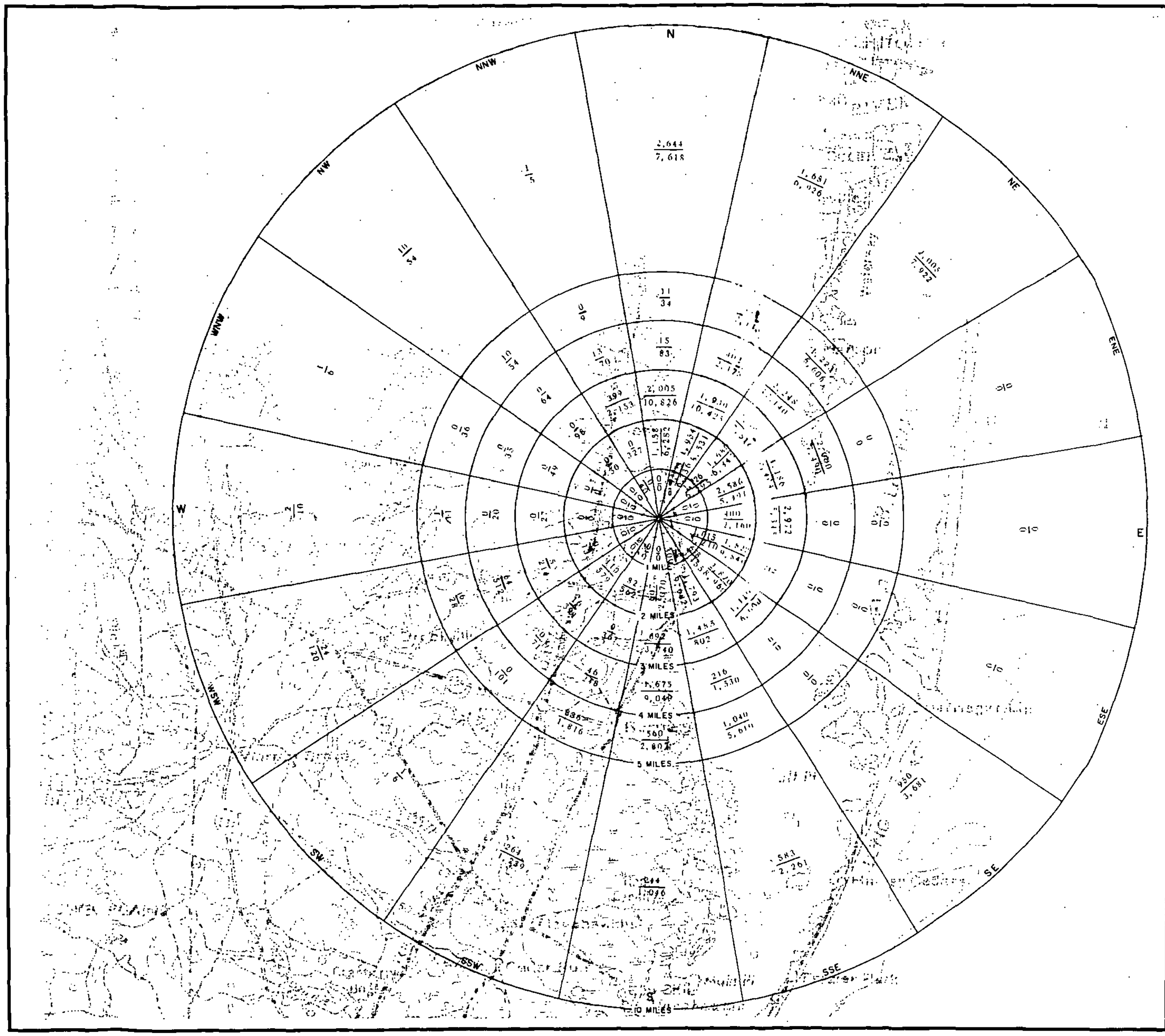
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

SITE VICINTY MAP
Showing Present and Future, Resident Population Density, 0 to 10 Miles

DAMES & MOORE

FIGURE 2.2-3



KEY

$\frac{20}{40}$ = ESTIMATED 1970 RESIDENT AND SEASONAL POPULATION PER SQUARE MILE / ESTIMATED 2010 RESIDENT AND SEASONAL POPULATION PER SQUARE MILE

NOTE: DENSITY BASED ON LAND AREA ONLY

REFERENCE:

OYSTER CREEK NUCLEAR GENERATING STATION

SITE VICINTY MAP
Showing Present and Future, Resident and Seasonal Population Density, 0 to 10 Miles

DAMES & MOORE

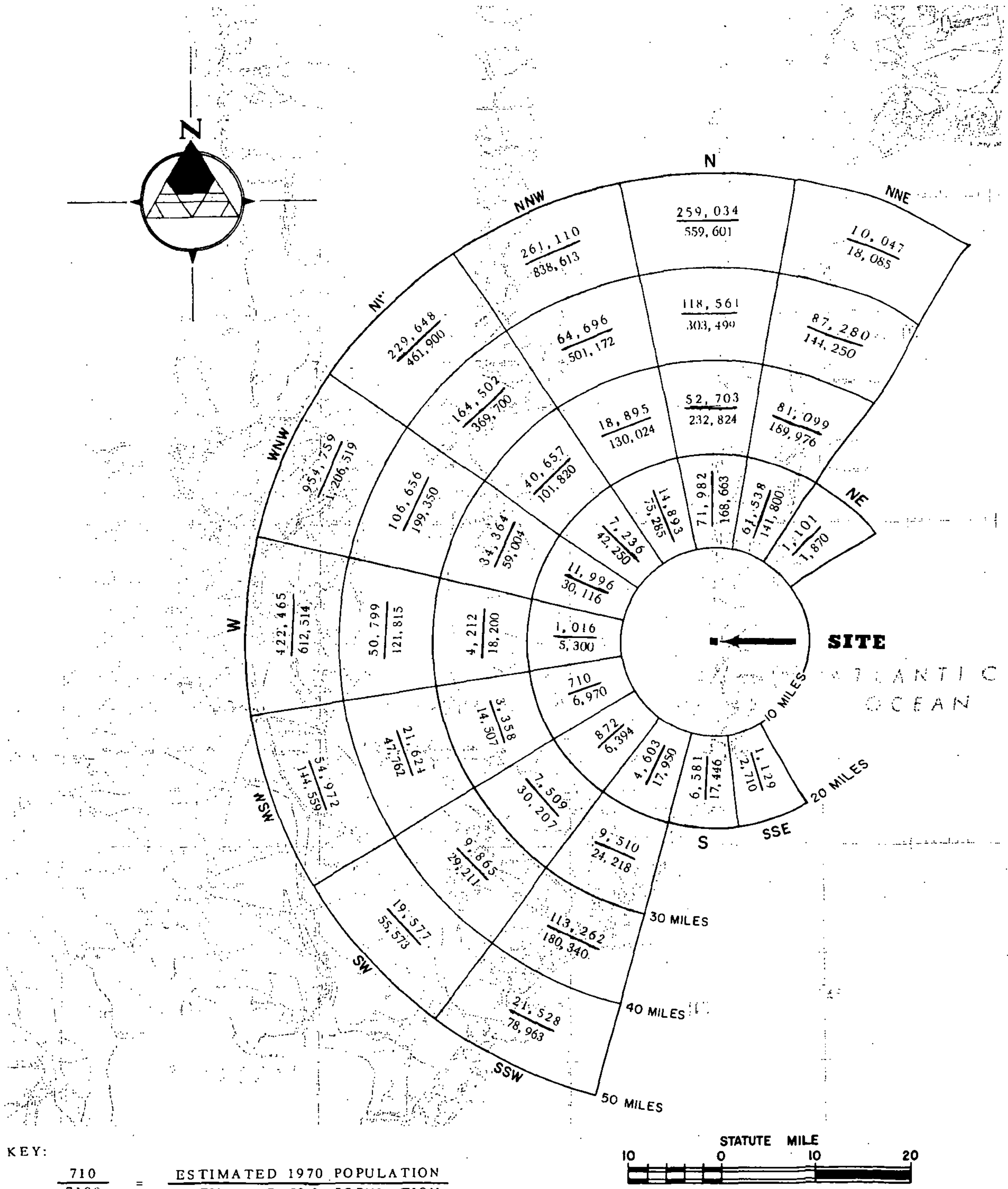
FIGURE 2.2-4

of population bordering Barnegat Bay, the 1970 resident population figures are based on house counts determined from 1968 aerial photographs, recent topographic maps, and information from local housing development agencies. A factor of persons per housing unit was derived from each township's 1970 census population and its total house count. This factor was then applied to the homes located in each segment of the distribution wheel to yield the resident population. This method best encompasses the uneven population distribution within the site vicinity.

The seasonal population figures are based on county estimates of summer residents as shown in Table 2.2-1. This additional population was added to the total resident population located within the five mile seasonal strip. The persons per housing unit factor was derived using the seasonal population, and the procedure to determine distribution was repeated.

Densities shown in Figure 2.2-3 and 2.2-4 are based on land area only.

Resident population distributions and densities for the outlying areas up to 50 miles from the site are shown in Figures 2.2-5 through 2.2-8. They are based on 1970 census data for the population of minor civil divisions (cities or townships). The population was assumed to be uniformly distributed within each city or township.



KEY:

$\frac{710}{7100}$ = $\frac{\text{ESTIMATED 1970 POPULATION}}{\text{ESTIMATED 2010 POPULATION}}$

RADIUS IN MILES		10	20	30
ACCUMULATIVE	1970	45,586	229,243	513,510
TOTAL	2010	156,571	673,325	1,474,105

RADIUS IN MILES		40	50	
ACCUMULATIVE	1970	1,250,755	3,483,895	
TOTAL	2010	3,371,204	7,347,531	

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS, WASHINGTON AND NEW YORK.

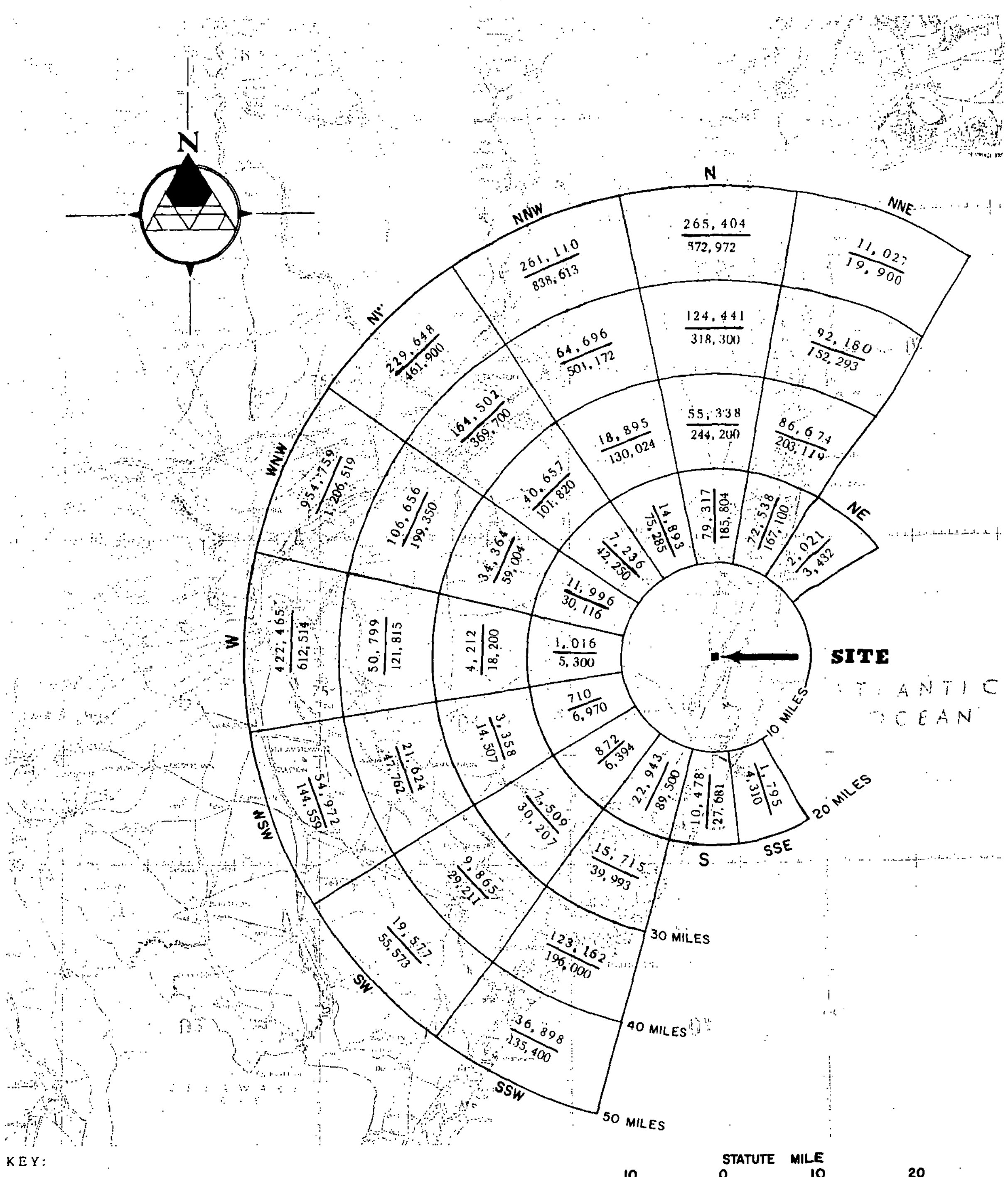
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

REGIONAL MAP
Showing Present and Future Resident Population Distribution, 0 to 50 Miles

DAMES & MOORE

FIGURE 2.2-5



KEY:

710 / 7, 100 = ESTIMATED 1970 POPULATION / ESTIMATED 2010 POPULATION

NOTE:

RADIUS IN MILES		10	20	30
ACCUMULATIVE	1970	97, 315	323, 152	621, 834
TOTAL	2010	277, 877	886, 653	1, 727, 727

RADIUS IN MILES		40	50	
ACCUMULATIVE	1970	1, 379, 759	3, 635, 619	
TOTAL	2010	3, 663, 330	7, 711, 280	

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS, WASHINGTON AND NEW YORK.

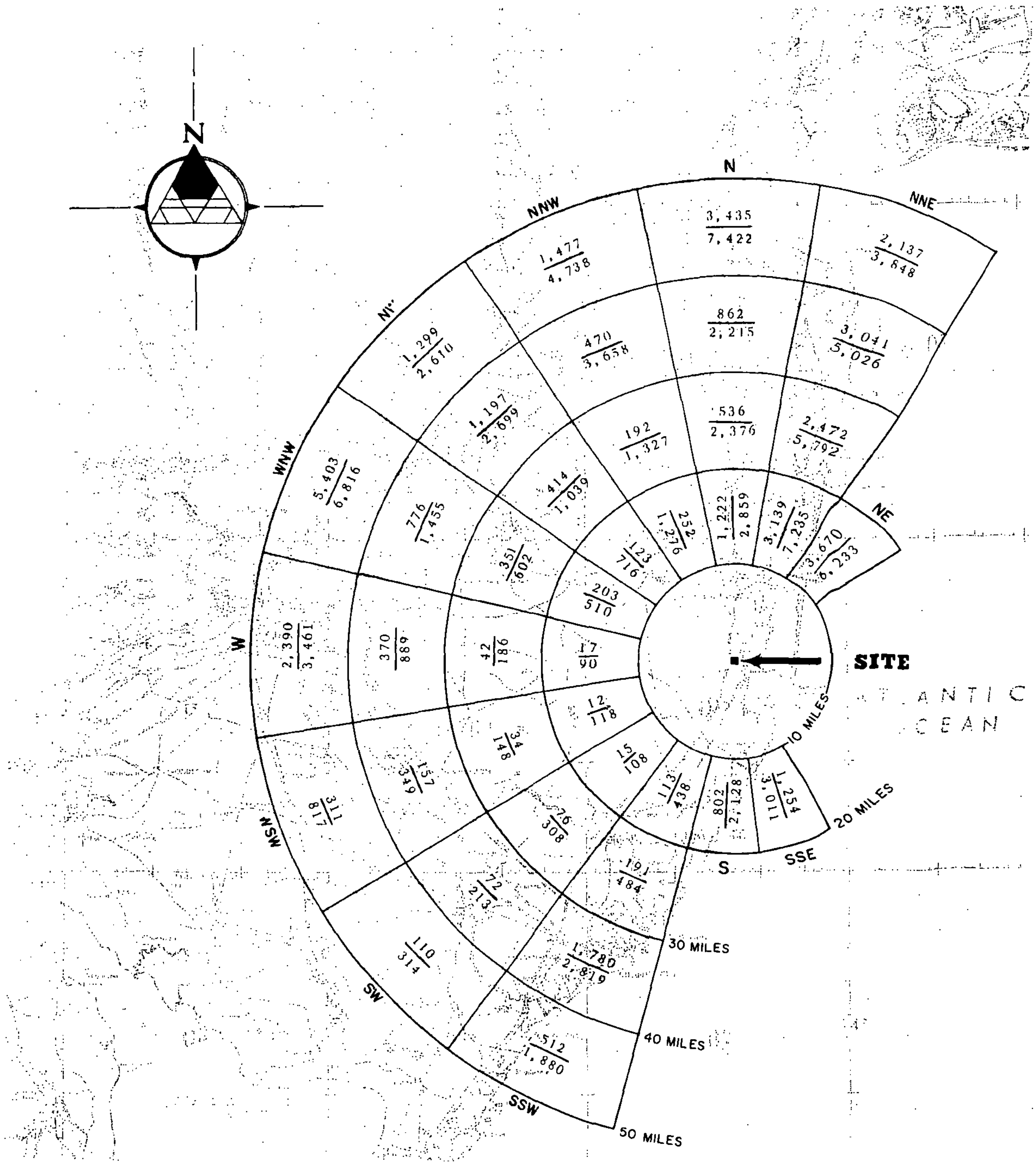
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

REGIONAL MAP
Showing Present and Future, Resident and Seasonal Population Distribution, 0 to 50 Miles

DAMES & MOORE

FIGURE 2.2-6



KEY:

$\frac{20}{40}$ = ESTIMATED 1970 RESIDENT POPULATION PER SQUARE MILE / ESTIMATED 2010 RESIDENT POPULATION PER SQUARE MILE

NOTE: DENSITY BASED ON LAND AREA ONLY

STATUTE MILE

10 0 10 20

R E F E R E N C E:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS, WASHINGTON AND NEW YORK.

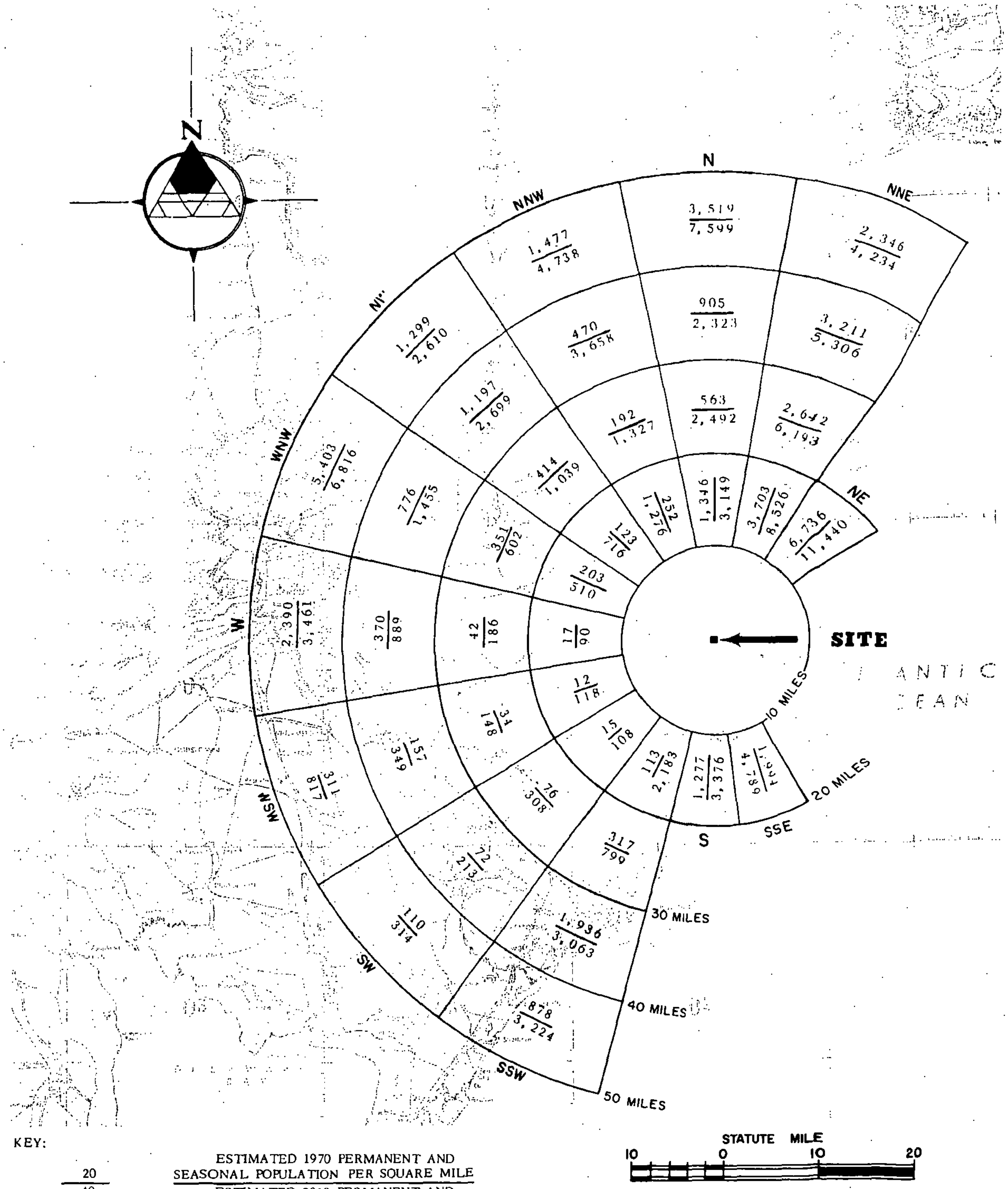
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

REGIONAL MAP
Showing Present and Future, Resident Population Density, 0 to 50 Miles

DAMES & MOORE

FIGURE 2.2-7



KEY:

20 / 40	ESTIMATED 1970 PERMANENT AND SEASONAL POPULATION PER SQUARE MILE / ESTIMATED 2010 PERMANENT AND SEASONAL POPULATION PER SQUARE MILE

NOTE: DENSITY BASED ON LAND AREA ONLY

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS, WASHINGTON AND NEW YORK.

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

REGIONAL MAP
Showing Present and Future, Resident and Seasonal Population Density, 0 to 50 Miles

DAMES & MOORE

FIGURE 2.2-8

To determine the population distribution for each sector within the 50 mile radius, the percentage of each township within the sector was noted. This percentage was applied to the township population to derive the number of persons living in the sector. The procedure was repeated until all land area within a sector had a corresponding population. The total of these figures yielded the 1970 resident population.

The seasonal distribution was determined in the same manner, using the additional population shown in Table 2.2-1. Again it was assumed that the additions would occur within five miles of the Atlantic Coast.

Fort Dix, the nearest community with a resident population of over 25,000 is approximately 28 miles WNW of the site. Ten miles north of the site, the Toms River area, including the communities of Toms River, South Toms River, Beachwood, Pine Beach, Ocean Gate, Island Heights, and Gilford Park, has a combined resident population of 23,554 (Ref. 2.2-1). The seasonal population influx in this area would bring the total aggregate population to a level greater than 25,000, qualifying it as a "concentrated population center" during the summer months.

Public marinas are the chief recreational facilities in the immediate site area. They are the main source of a daily transient population in the area and are clustered in the natural inlets and man-made harbors facing Barnegat Bay, a large sheltered body of water that attracts boats for pleasure and fishing activities. The estimated public mooring capacity of each inlet or harbor within five miles of the site is shown on Table 2.2-2. The Atlantic Intracoastal Waterway follows a channel in Barnegat Bay approximately two and one-half miles east of the site.

There are a number of public beaches on the shores of Barnegat Bay. The major ones are located on the Atlantic Ocean side of the barrier bar forming the eastern boundary of the Bay. Island Beach State Park is located on the barrier directly across from the site, six miles to the east. A total of 540,175 persons visited the park during 1971. On July 4, 1971, one of the park's most active days, attendance was 7,549. Barnegat Light State Park, located on a barrier bar some six miles southeast of the site, recorded 100,039 visitors during 1970. (Personal communications with the New Jersey State Parks Office.)

Industrial activities within ten miles of the site, along with the number of employees engaged at each location are shown on Table 2.2-3. (Ref. 2.2-12)

The location and daily attendance of all schools within ten miles of the site are given in Table 2.2-4 (Ref. 2.2-13).

Community Memorial Hospital, at Toms River, ten miles north of the site, is presently the only hospital within a ten mile radius of the site. The hospital has a 240-bed capacity and a staff of 580. As a result of recent population expansion, a hospital is being constructed in Manahawkin, ten miles south. Due for completion in 1972, it will be a satellite hospital under the direction of the Burlington County Hospital.

Table 2.2-2. Public Marina Facilities Within Five Miles of the Plant Site.

Location	From the Site Distance (Miles)	From the Site Direction	Approximate Boat Mooring Capacity*
Oyster Creek	3/4	ESE	450
Forked River	1 1/2	NE	455
Fresh Creek	1 1/2	SE	60
Waretown Harbor	1 1/2	SSE	50
South Harbor	2	SSE	130
Liberty Harbor	2 1/4	SSE	70
Barnegat Beach	2 1/4	SSE	80
Double Creek	4 1/2	S	160
Cedar Creek	4 1/2	NE	165

* Capacities estimated from aerial photographs.

Table 2.2-3. Industrial Locations Within Ten Miles of the Plant Site.

Community	Distance From The Site(Mi.)	Direction From The Site	Name of Company	Industry	Number of Employees
Barnegat	4	South	Research Products Corp.	Dental Supplies	10
			Weatherproof Aluminum Inc.	Storm Windows	6
Bayville	7	NNE	Berkeley Machine Shop, Inc.	Machine Shop	12
			Denzer-Schafer X-Ray Co.,Inc.	Silver Recovery	9
			New Jersey Pulverizing Co.	Sand Products	66
			Rainbow Sportswear Corp.	Sportswear	10
			Woodland Manufacturing Co.	Wrought Iron	30
Pine Beach	8	North	Castle Woodcraft	Kitchen Cabinets	8
Toms River	8	North	Best Block of Toms River	Concrete Blocks	15
	9	North	Observer Couier-Sun	Newspaper	80
			Trilco Terminal	Building Materials	37
	10	North	Acme Cabinet Corp.	Cabinets	77
			Delta Lumber Co., Inc.	Lumber	15
			Fischer's Machine Works	Machinists	6
			Glover, H. Clay Co., Inc.	Pet Shop	21
			Marban Construction Co.	Partition Walls	6
			Towne Fabrics, Inc.	Fabrics	23
			Quality Aluminum Products Co.	Aluminum Products	10
			Reardon Company	Paints	22
			Rochelle Novelty Co.	Shoe Bags	10
			Toms River Boat Works	Ship Construction	20
			Toms River Chemical Corp.	Dyes	1400

Source: 1971 New Jersey State Industrial Directory

Table 2.2-4. Schools Within Ten Miles of the Plant Site.

	Distance (Miles)	Direction From The Site	School Name	Daily Attendance
Waretown	1½	SSE	Waretown Elementary	238
Forked River	2	NNE	Forked River School	356
Lanoka Harbor	3½	NNE	Lanoka Harbor School	399
Barnegat	4	S	Barnegat Elementary	161
Bayville	7	N	Central Regional High School	2139
Bayville	8	NNE	Bayville School	671
			Clara B. Worth	630
Island Heights	9	NNE	Island Heights	165
Ocean Gate	9	NNE	Ocean Gate Elementary	159
Pine Beach	9	N	Pine Beach	670
Seaside Park	9½	NE	Seaside Park Elementary	137
Manahawkin	9½	SSW	Southern Regional High	1330
			Southern Regional Middle	763
			Stafford Elementary	594
Toms River	10	N	Toms River High School North	2099
			Toms River High School South	1786
			Intermediate	2332
			East Dover	1329
			Hooper Avenue Elementary	1327
			North Dover	634
			Toms River Elementary	876
			Cedar Grove Elementary	1184
			Walnut Street Elementary	1392
			Washington Street	557
			West Dover	620

Source: Public School Directory of Ocean County, New Jersey 1971-1972

The low population zone surrounding the site has a radius of approximately three-quarters of a mile. There are no nursing homes, mental institutions, prisons or military bases within this zone.

2.2.1.3 Future Population

The projected future population distributions and densities for the year 2010 are shown on Figure 2.2-1 through 2.2-8. The projections were based on individual county planning board predictions. The predictions varied in scope from a county-wide basis in some cases to the township level in others. The maximum prediction year varied from the year 1980 to the year 2020.

The Planning Board figures were plotted with 1970 census data and extrapolated to 2010. Where township projections were available, the future population was read directly. If data were available only on county or county sub-division level, then a percentage growth factor was derived from the graphed curve and applied to each township's 1970 census population. The distribution procedure used in determining the 1970 sector population was repeated.

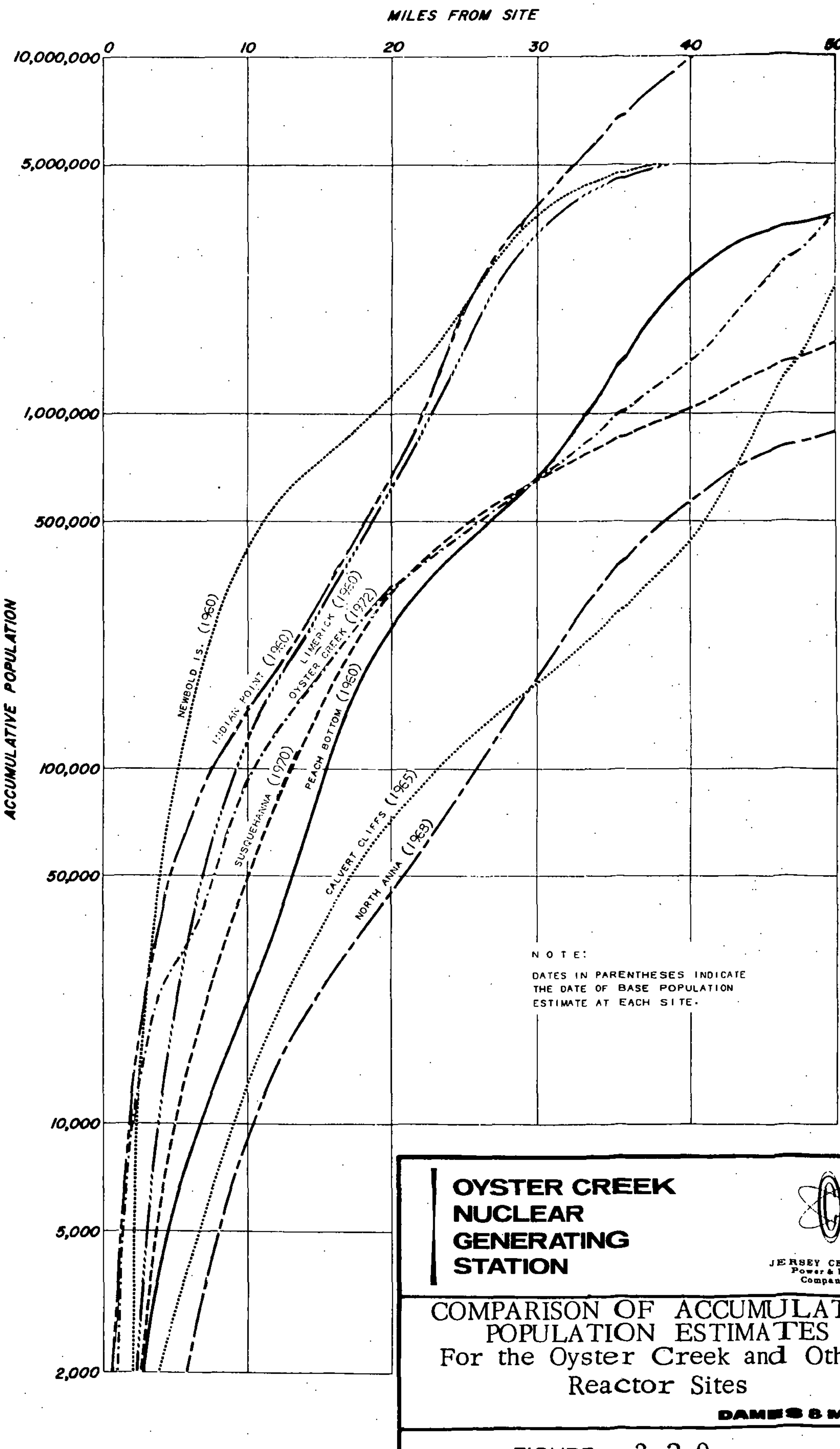
The projections of seasonal population for 2010 fluctuate in the same proportion as the 1970 resident and seasonal figures.

A large portion of the projected growth within Ocean County is due to an incease in senior citizens and metropolitan growth. Retirement villages are becoming more popular. For example, 31,000 elderly people moved to the county between 1960 and 1970. With improvements in rapid transit, the suburbs of both New York City and Philadelphia can be expected to grow toward Ocean County.

2.2.1.4 Conclusions

The Oyster Creek Generating Station in central Ocean County is in an area of rapid population growth. By 2010 the population within a ten mile radius will triple. The area surrounding Barnegat Bay will become more densely populated, with residential and local commercial development in the pine barrens to the west.

Figure 2.2-9 illustrates the accumulative 1970 resident and seasonal population within any given distance up to 50 miles from the generating station. Curves representing similar data developed for other representative nuclear power generating facilities are shown for comparison with the Oyster Creek site. Figure 2.2-10 represents the 2010 resident and seasonal population within any distance up to 50 miles from the site. Comparison is made with projected population developed for other representative facilities. The results show the residential and seasonal populations within ten miles of the site are similar to those nuclear facilities. However, the populations between 10 and 50 miles from the plant are lower in comparison with the other sites. This has occurred because there is a great deal of underdeveloped land west of the plant and the Atlantic Ocean lies east of the plant.



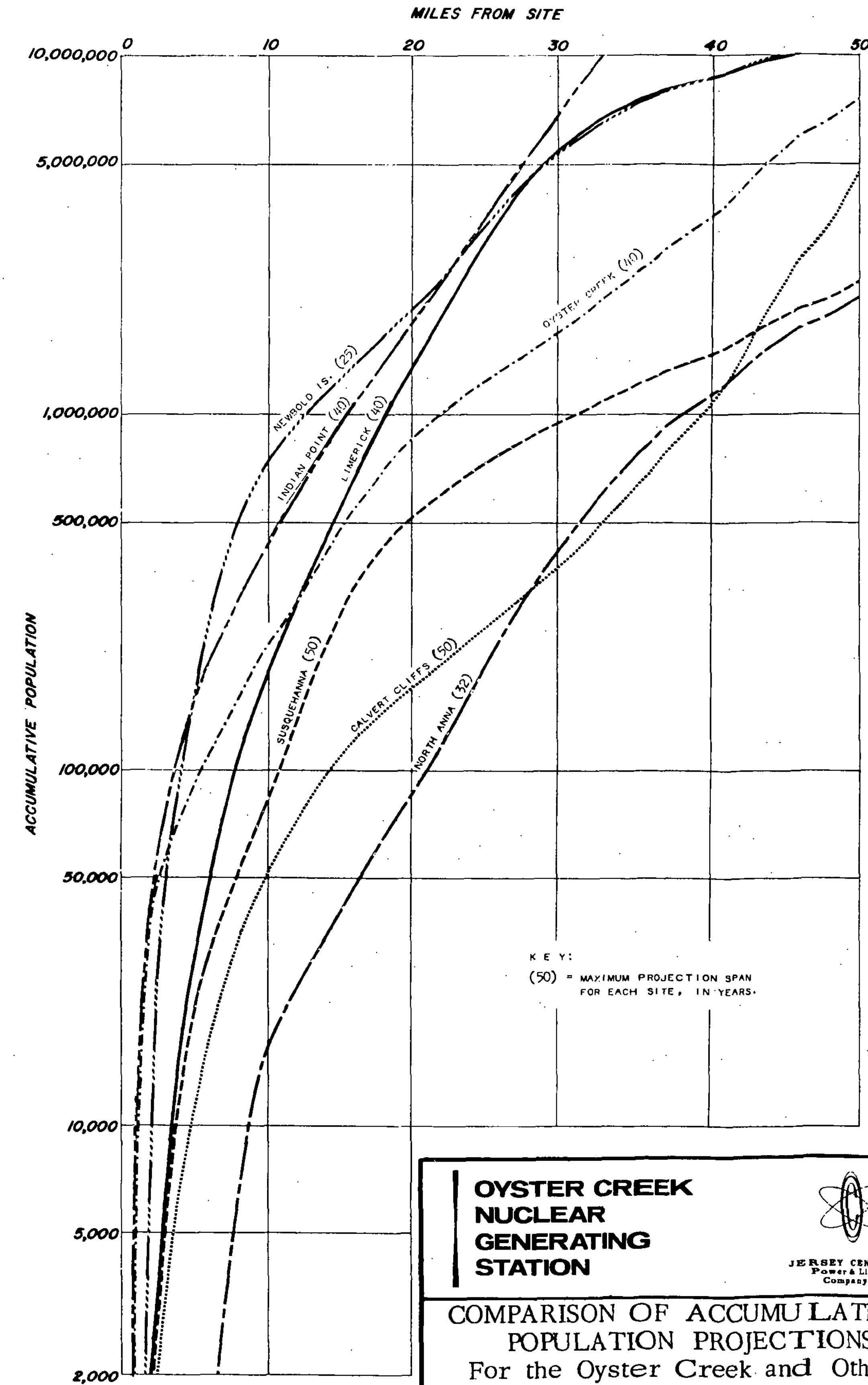
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

COMPARISON OF ACCUMULATIVE POPULATION ESTIMATES
For the Oyster Creek and Other Reactor Sites

DAMES & MOORE

FIGURE 2.2-9



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

COMPARISON OF ACCUMULATIVE POPULATION PROJECTIONS For the Oyster Creek and Other Reactor Sites

DAMES & MOORE

FIGURE 2.2-10

2.2.2 Land Use

2.2.2.1 Within Plant Environs

Most of the area within a 60-mile radius of the plant is covered with vegetation common to the pine barrens of New Jersey. Approximately 70 percent of the land is forest, vacant, or farm land with little industrial development. Heavy industrial development is present, from 40 to 60 miles from the plant, near the metropolitan areas of New York and Philadelphia. Table 2.2-5 summarizes the land use in those counties falling within a 60-mile radius of the plant. Two nuclear generating facilities, Forked River and Newbold Island, have been proposed for construction within a 50-mile radius of the Oyster Creek Plant. The Forked River facility will be located approximately 3,400 feet west of the Oyster Creek plant and the Newbold Island facility will be located 39 miles NW.

Ocean County covers 641 square miles of land and 113 square miles of water. The resort industry, based largely on water recreation, is the largest business in Ocean County with the annual income estimated at over $700 million.

Ocean County's industrial base is small, but diversified. Boat building and marine equipment manufacturing were once the dominant industrial activities, but today, industrial activity also includes chemical manufacturing, mining of ilmenite (a titanium ore found in sand), quarrying of industrial sands, garment manufacturing, food processing and concrete production. These industries have not been affected by construction and operation of the Oyster Creek plant.

Table 2.2-5. Land Use

County	Total Area Sq. Miles	Area Within 60 Miles Sq. Miles	Forest %	Farm %	Industry %	Public Lands %	Roads %	Railroads %	Residential and Other %
Atlantic Co., N.J.	565.55	565.55	60.6	12.7	0.1	10.7	4.1	0.2	11.6
Burlington Co., N.J.	819.3	819.3	26.5	35.2	0.3	23.6	3.1	0.2	11.1
Camden Co., N.J.	222.16	222.16	34.1	13.2	1.9	14.3	7.9	0.8	27.3
Mercer Co., N.J.	226.00	226.00	5.5	43.6	2.2	4.3	6.0	0.7	37.7
Middlesex Co., N.J.	308.79	308.79	24.1	21.7	6.9	6.0	7.0	1.4	32.9
Monmouth Co., N.J.	477.01	477.01	19.1	34.6	0.4	6.4	5.1	0.4	34.0
Ocean Co., N.J.	641.00	641.00	59.0	6.9	Nil	15.2	4.6	0.2	14.1
Bucks Co., Pa.	616.64	274.18	28.3	47.8	←------	------	23.9	------	------→ *
Philadelphia Co., Pa.	129.0	129.0	Nil	Nil	←------	------	100%	------	------→
Richmond Co., N.Y.	57.0	57.0	9.0	15.0	2.5	10.0	6.0	0.5	57.0
Somerset Co., N.J.	305.10	215.94	15.6	42.6	5.0	6.2	8.3	0.9	21.4
Gloucester Co., N.J.	328.60	300.48	29.2	36.5	0.3	9.8	7.1	0.6	16.5
Union Co., N.J.	103.39	68.96	Nil	2.2	←------	------	97.8	------	------→
Cape May Co., N.J.	265.34	166.23	62.0	12.5	Nil	10.8	4.5	0.2	10.0
Hudson Co., N.J.	44.10	4.97	Nil	Nil	←------	------	100%	------	------→
Cumberland Co., N.J.	502.40	274.94	26.4	37.5	0.5	20.8	3.2	0.2	11.4
Salem Co., N.J.	343.02	83.05	31.6	50.5	←------	------	17.9	------	------→
Montgomery Co., Pa.	491.08	112.12	19.88	37.6	←------	------	42.7	------	------→

Table 2.2-5. (Cont'd.)

County	Total Area Sq. Miles	Area Within 60 Miles Sq. Miles	Forest %	Farm %	Industry %	Public Lands %	Roads %	Railroads %	Residential and Other %
Delaware Co., Pa.	184.43	8.13	7.95	17.3	←------	------	74.8	------	------→
Hunterdon Co., N.J.	437.00	113.30	30.3	47.3	←------	------	22.4	------	------→
Nassau Co., N.Y.	289.0	9.0	←------	------	100%	------	------	------	------→
Kings Co., N.Y.	81.05	48.50	Nil	Nil	←------	------	100%	------	------→
Queens Co., N.Y.	118.6	9.50	Nil	Nil	←------	------	100%	------	------→

* Only a composite percentage is given for those columns spanned by an arrow.

The Toms River Chemical Corporation (a division of Cincinnati Chemical Corporation) is located at Toms River and is the largest industrial employer in the county. The plant employs over 1,400 persons (Ref. 2.2-12).

Land use near the plant is devoted primarily to summer, permanent, and retirement residential subdivisions. Development has been concentrated in the shoreline areas of Barnegat Bay thus far, but must be expected to grow inland because of the limited supply of waterfront property and lower land prices inland.

A portion of the land of the Fort Dix military reservation and Lakehurst Naval Air Station occupy about 23,000 acres, or about six percent of the total land area of Ocean County. These bases in Ocean County are situated in Plumsted, Jackson and Manchester Townships in the northwestern part of the county (Ref. 2.2-14).

State owned public recreational fish and game lands account for over 42,000 acres, or about ten percent of the total land area of the county. The federal government, too, has located three wildlife refuges in the county which utilize over 70,000 acres.

Transportation networks in Ocean County consist of surface roads, a railroad and nine airports. The main surface arteries are aligned north-south and include the Garden State Parkway and U.S. Highway 9. A network of state, county, and local roads also criss-cross the county. The railroad serving the area is the Central Railroad of New Jersey, but it only provides freight service. The airports include two military, one county and six private strips within 25 miles of the plant (see Section 2.2.4).

Results in Tables 2.2-6, 2.2-7 and 2.2-8 (Ref. 2.2-16) give the distribution of farms and agricultural production (crops and livestock), by townships, in Ocean County within a ten mile radius of the plant. Totals for Plumsted Township (Ocean County) which is not located within ten miles of the plant and Ocean County were included to show that agriculture is of little importance in the vicinity of the plant.

The 1970 New Jersey Agricultural Census (Ref. 2.2-15) shows that Ocean County (250 poultry farms) is rated fifth in New Jersey egg production, primarily in Plumsted and Union Townships. In 1970, the 250 poultry farms in Ocean County produced 7,123,000 dozen chicken eggs valued at approximately $3.06 million wholesale. Union Township is the only township in the county that produces eggs and this is only two percent of the total chicken laying population in Ocean County.

The annual income from milk production in Ocean County was $112,000 (Ref. 2.2-15), however, there is no dairy production within ten miles of the plant. Plumsted Township is the largest milk producer in the county with 135 cows. Other townships in the county that produce milk are Jackson Township with 29 dairy cows, located 21 miles NNW of the plant, Little Egg Harbor Township with three dairy cows, located 17 miles SSW, and Brick Township with one cow, located 17.5 miles north of the plant.

Table 2.2-6. Distribution of Agricultural Land Within a Ten Mile Radius of the Oyster Creek Nuclear Generating Station.

Township *	No. of Farms	All Farm Acres	Average Farm Acres	Average Acres Cropped	Acres of Cropland Pastures	Pasture Acres	Woodland Acres	Waste And Wetland Acres	Irrigated Acres
Berkeley	2	64	32	16	0	0	39	6	12
Lacey	4	656	164.1	120	200	202	32	100	0
Union	9	315	35.0	198	7	33	62	4	12
Plumsted**	27	3,778	139.9	1,859	80	237	519	117	615
Ocean County***	159	10,731	69.7	4,625	383	771	3,390	319	824

* Ocean Township is included within the ten-mile radius, but data were not included in Ref. 2.2-16

** Totals for Plumsted Township are included to give a comparison between the township in Ocean County that has the greatest agricultural program to those townships within 10 miles of the plant.

*** Totals for Ocean County are also included for comparative purposes.

Table 2.2-7. Crop Acreage Within a Ten Mile Radius of the Oyster Creek Nuclear Generating Station.

Township*	Alfalfa	Soybeans	Blueberries	Corn Sweet	Cranberries	Nursery	Fresh Tomatoes	Other Crops**
Berkeley	0	0	0	0	0	0	0	0
Lacey	100	5	0	0	0	0	1	17
Union	0	0	4	1	0	40	4	135
Plumsted**	0	317	24	195	60	0	54	876
Ocean County**	201	357	45	293	481	51	105	1,367

* See footnotes (*), (**) and (***) in Table 2.2-6.

**Note: Apples, asparagus (fresh and canhouse), barley, lima beans, snap beans, broccoli, cabbage, cantaloupe, carrots, celery, chicory, clover, corn (gain, silage), cucumbers, eggplant, endive, escarole, flowers, horseradish, lettuce, oats, okra, onions, peaches, peas, peppers, white potatoes, sweet potatoes, pumpkins, sod (cultivated), spinach, squash, strawberries, tomatoes (canhouse), turnips, watermelon, wheat are not grown commercially in Berkeley, Lacey, Ocean and Union Townships and therefore aren't listed in this Table even though they are listed in the agriculture report. These crops are not the "Other Crops" category.

Table 2.2-8. Number of Livestock Within a Ten Mile Radius of the Oyster Creek Nuclear Generating Station.

Township*	Beef	Dairy	Ducks	Fur Animals	Geese	Horses and Ponies	Layers Poultry	Rabbits
Berkeley	0	0	0	0	0	0	0	0
Lacey	0	0	0	0	0	1	0	1
Union	2	0	10	12	10	24	5,000	0
Plumsted	40	135	0	0	0	66	43,000	0
Ocean County	99	168	108	69	22	468	206,000	87

* See footnotes (*), (**) and (***) in Table 2.2-6

Dover Township, 12 miles north of the plant, has the largest concentration of goats in the county, with 11 and Lakewood Township, 18 miles north of the plant, has eight goats.

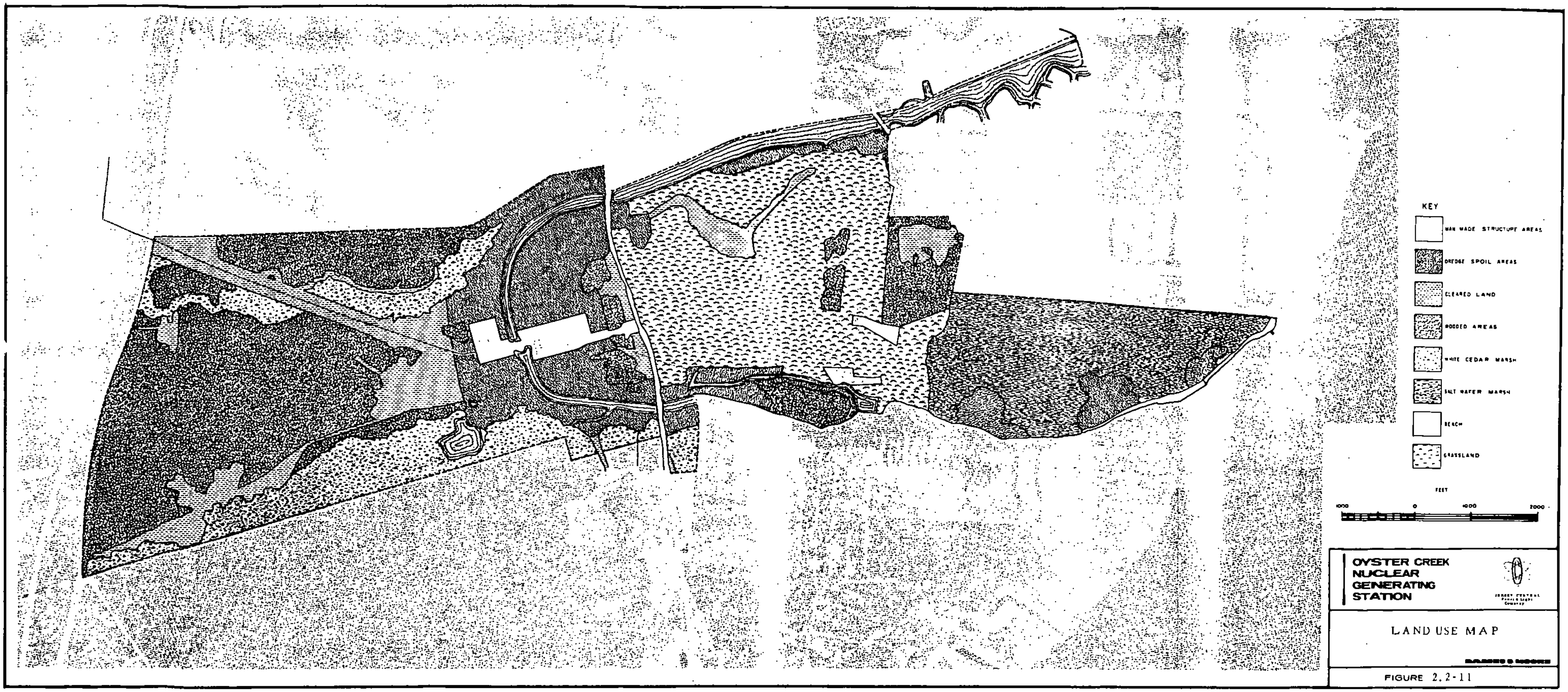
There are also ten beehives, located 12 miles north of the plant. This is the only known location of beehives in Ocean County (Ref. 2.2-16).

2.2.2.2 Within Plant Site

Land use patterns within the plant site fall into either of two broad classifications: some land has been altered or developed by man for his use, and the remainder of the site has been left in its natural state. Location and acreage of the land devoted to each of these uses are shown in Figure 2.2-11. Land developed by man includes that occupied by the generating station and grounds, the switch yard, transmission right-of-way, several spoil areas, cleared land, the transportation right-of-way, and areas designated for industrial or recreational land use, residences, and farm structures. Natural areas are identified as forested or wooded land, salt water marsh, white cedar swamps, and land previously used for pasture and cultivation.

Developed Land

There were 352 acres of land within the plant site utilized during construction of the plant and transmission right-of-way: 288 acres of spoil and cleared area; 33.5 acres of right-of-way for railroads and transmission



LAND USE MAP

FIGURE 2.2-11

lines; 22 acres occupied by the generating plant and switch yard; and 8.5 acres set aside for an emergency fire pond on Oyster Creek.

Some of these areas have multiple uses but were only counted once herein. For example, some spoil and cleared areas also exist in the transmission right-of-way.

The spoil within the plant site was deposited during dredging the South Branch of Forked River and Oyster Creek. The cleared areas include the transmission right-of-way, areas adjacent to U.S. Highway 9, and the Garden State Parkway.

Approximately a 33 acre area near the Garden State Parkway was cleared of vegetation by the former owner before JC acquired the land. Vegetation is slowly being reestablished in all of these areas. Regrowth ranges from very sparse areas to areas with thick ground cover and some trees, such as white cedar. Soil in these areas is sandy and relatively infertile, therefore, regrowth of vegetation has been slow.

Surface routes in the vicinity of the plant includes a railroad, two highways, service roads, and farm access roads. One road goes to the emergency fire system pond on Oyster Creek and another service road serves the transmission corridor. Also, several dirt and paved roads within the site serve as access roads to the pasture, cultivated land, and forested areas. About nine acres of land are devoted to roads within the site. No industries or recreational facilities were displaced by the plant. In

1964 the Lacey Township governing body zoned the land commercial that is bounded on the north by the Middle Fork of Forked River, on the east by U.S. Highway 9, on the south by Oyster Creek, and on the west by the Garden State Parkway. The Oyster Creek Nuclear Generating Station is the only industry that has located on the commercially zoned area.

Two families reside on the JC land between the Bay and Highway 9. One family lives in a tenant house and the other lives in a well landscaped farm which includes a house and several adjoining farm buildings.

Natural Areas

Wooded and forested areas consist of pitch pine and some mixed hardwoods. The largest of these areas within the site is loted west of the plant, but there are also smaller scattered stands to the east. The forests provide wildlife habitat, control erosion, and partially screen the plant and transmission lines from the Garden State Parkway and U.S. Highway 9.

There are 218 acres of marshlands on the site which are habitats for terrestrial and aquatic life. In addition to the marshlands, 358 acres of white cedar swamp adjoin the streams.

The land had originally consisted of pine vegetation and fresh and salt water marshes. The pine and mixed hardwood were cleared east of U.S. Highway 9 and the marsh was drained and plowed for crops and pasture by the former owner. Since JC purchased the land, the cleared cropland and pasture has reverted to a savannah (grassland with scattered trees). The cultivated land has now reverted to the original marsh habitat for wildlife.

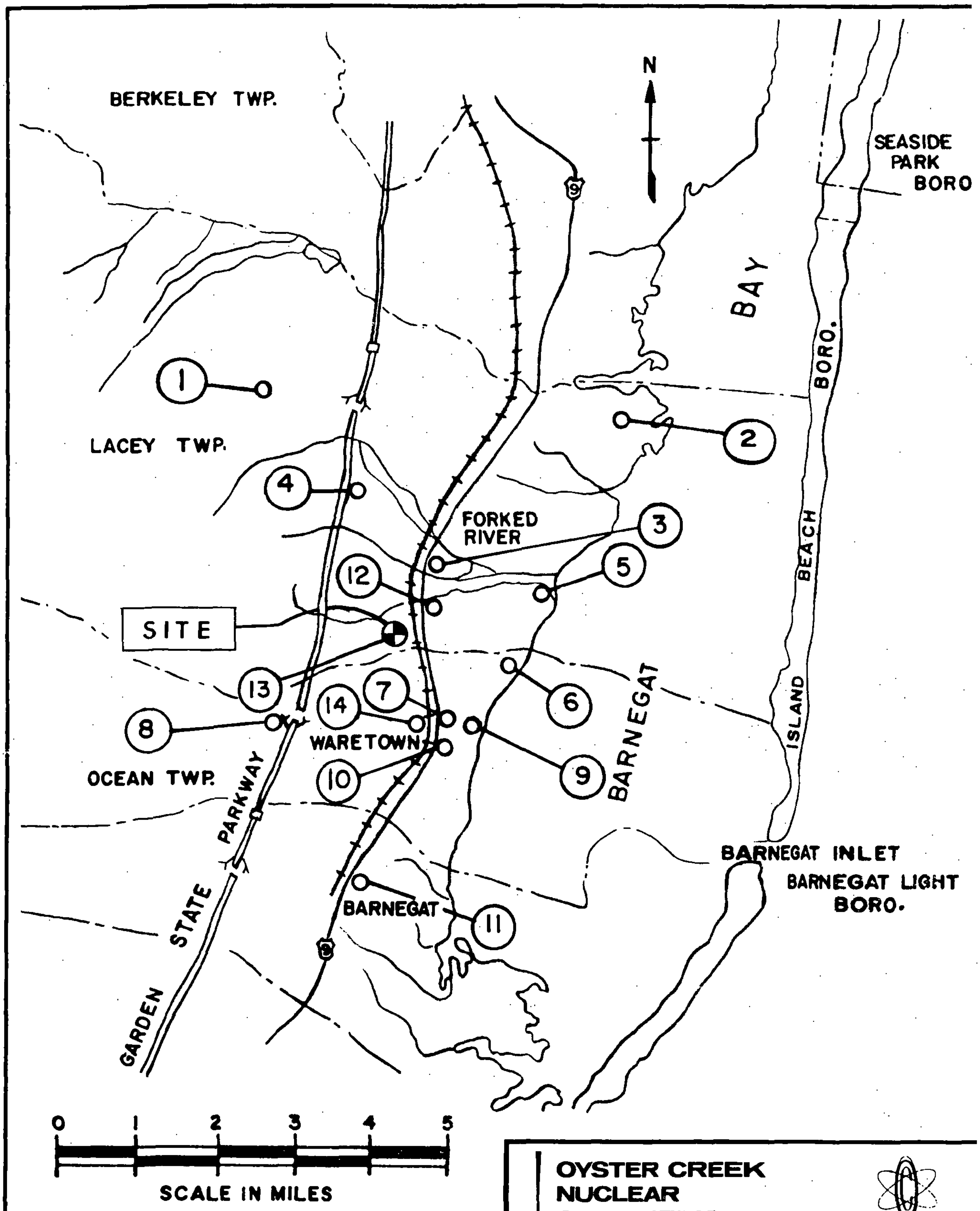
2.2.3 Water Use

2.2.3.1 Within Plant Environs

All domestic and public water supplies in the area surrounding the plant site are drawn from wells whose minimum depth is generally 50 feet. Figure 2.2-12 shows major public water supplies within five miles of the site, as listed in Table 2.2-9.

According to the College of Agriculture and Environmental Science Department at Rutgers University (Ref. 2.2-16), Berkeley Township, which is at least five miles from the plant, has 12 acres under irrigation. The report also states that no other irrigated lands are located within a ten mile radius of the plant.

Water recreation is important to Ocean County business, as much of the county's trade is associated with the water recreation industry. Salt water fishing, boating, water skiing, and bathing are the main activities. The 56-mile coastline (Manasquan Inlet on the north to Beach Haven Inlet on the south, and around the shorelines of Barnegat Bay, Little Egg Harbor, and Manahawkin Bay) is visited by thousands of visitors each summer (Ref. 2.2-18).



OYSTER CREEK
NUCLEAR
GENERATING
STATION

JERSEY CENTRAL Power & Light Company

LOCATION OF PUBLIC WELLS

DAMES & MOORE

FIGURE 2.2-12

Table 2.2-9. Data For Wells In Oyster Creek Generating Station Area.

NO.	Owner	Depth Ft.	Yield GPM	Use
1.	Lacey Materials	120	325	Industrial
2.	Throg's Boat Works	52	12	Domestic
3.	Adolph Essing	34½	10	Garden Irrigation
4.	Joseph DeCheser	52	10	Domestic
5.	C. Pearl - Developer	56*	20	Several hundred shallow wells for summer homes
6.	P. Mamone - Developer	<70	--	Summer homes
7.	Mid-Jersey Water Company	160	--	Community water supply
8.	U.S.G.S. Test Well	306	--	Testing Site
9.	Board of Education Waretown	---	--	School
10.	O.M. Conner	118	12	Summer Home
11.	Barnegat Water Company	148	--	Community Water Supply
12.	Abner Keck	130	40	Summer Home
13.	Oyster Creek Plant	350	400	Industrial
14.	Eastern Shore Transit Mix	160	600	Industrial

* Typical

The Intracoastal Waterway (Ref. 2.2-19) is the only inland waterway used for shipping in the area, however, it is not heavily used. It is approximately two and one-half miles east of the plant at its closest point. The bays and estuaries of Ocean County also provide a network of waterways for commercial and recreational watercraft.

2.2.3.2 Within Plant Site

A well 350 feet deep, with a yield of 400 gallons per minute (gpm), supplies potable water to the Oyster Creek Nuclear Generating Station.

Water recreation in the form of fishing and boating exists near the plant, in the South Branch of Forked River. The main recreation though, is shoreline fishing. The widened channels of Oyster Creek and the South Branch of Forked River enable fishermen to navigate upstream as far as U.S. Highway 9, but boaters generally use the channels for access to Barnegat Bay from the marina located on Oyster Creek.

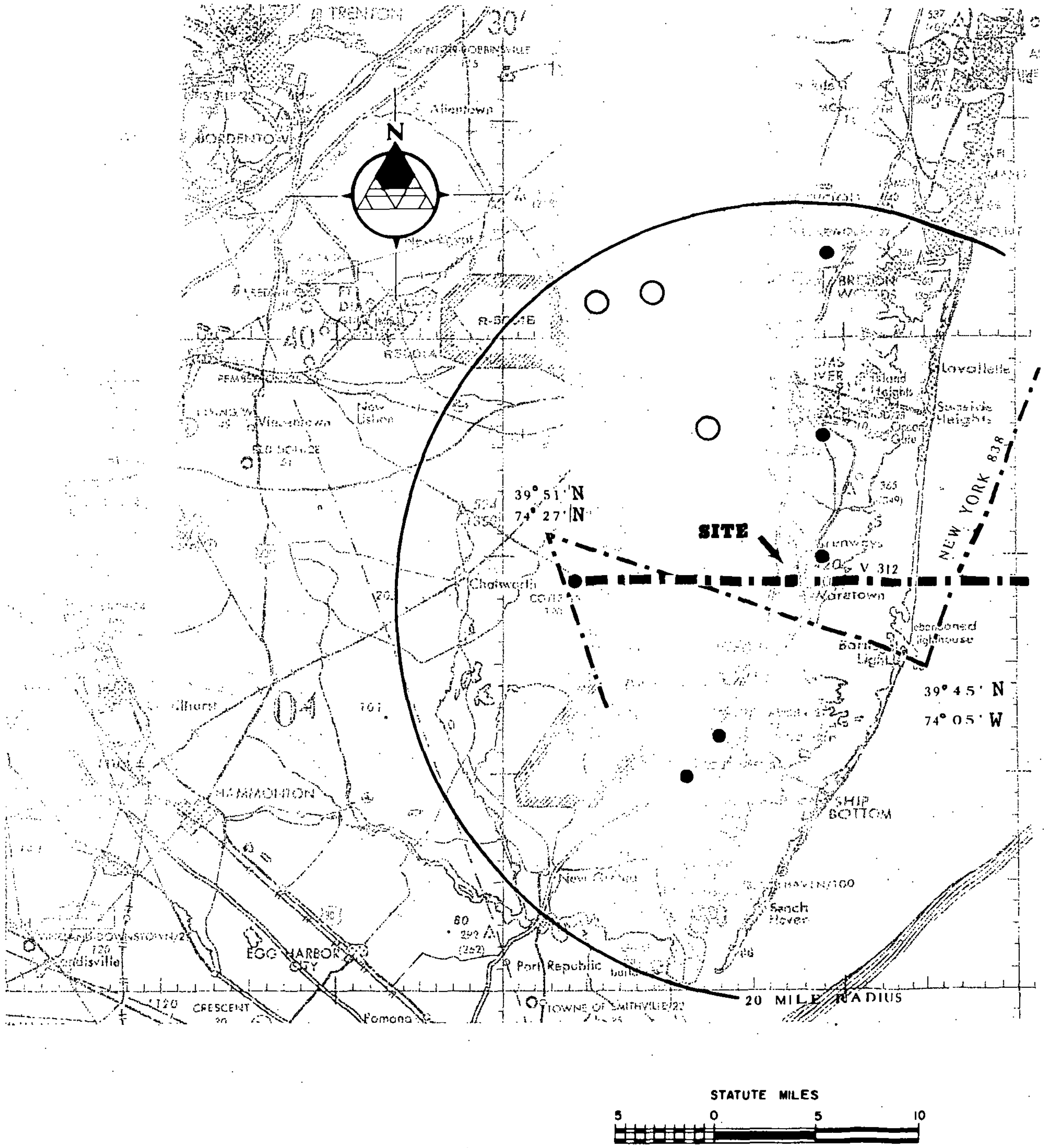
Several small dams have been constructed within the site: an earth-fill dam, a wooden dam, and an earth-filled dam reinforced with sheet piling. The earth-filled dam that has been constructed on Oyster Creek southwest of the plant is approximately 300 feet long and 12 feet high. It stores water that is used as an emergency fire supply for the plant. The wooden dam was originally used to form an irrigation pond. It is approximately 300 feet long and five feet high. The earth-filled dam reinforced with sheet piling is approximately 250 feet long and 20 feet high. It separates the intake and discharge water and the breast of the dam is used as a road.

The only shore protection structures present within the site are located along the shoreline of Barnegat Bay at the eastern end of the site. They consist of a 900 foot long wooden bulkhead at the mouth of Oyster Creek and two wooden barges serving as groins at the northeastern section of the site. These structures were built and placed by the former owner of the property.

2.2.4 Air Use

Nine airfields are located within 20 miles of the plant as shown in Figure 2.2-13 (Ref. 2.2-21). Two of the airfields are military installations: McGuire Air Force Base, also used by the U.S. Air Force, U.S. Air National Guard, and the Military Air Transport Service (MATS) 25 miles to the NW, and Lakehurst Naval Air Station 20 miles NNW. Other airports listed by the Federal Aviation Administration (FAA) are Breton Woods, 17 miles north; Eagle's Nest, 12 miles SSW; Coyle Tower, 10 miles west; Ocean County, nine miles NNW; Manahawkin, 9 miles SSW; and Beechwood, 8 miles NNE. In addition, there is a sod strip two miles NE at Forked River.

The FAA lists three restricted areas in the vicinity of the plant. Two of these areas, R5001A and R5001B are contiguous near Fort Dix, 15 miles to the NNW. These restricted areas are used mainly as firing ranges for small arms, artillery, and mortars. The third area, R5002, at Warren Grove is a low-level aerial target range used by the Air National Guard. Its



KEY:

AIRPORTS

RECTRICTED AREAS

LOW LEVEL AIR ROUTES

VICTOR AIR LANE 312

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS, WASHINGTION AND NEW YORK.

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

LOCATION OF AIRPORTS, RESTRICTED AREAS, AND AIR ROUTES

DAMES & MOORE

FIGURE 2.2-13

closest boundary to the plant is 7.5 miles. Bombs, rockets, and 20 mm gun fire are used in the target range. The bombs are dummies that give off a flash, but no explosive charge. The rockets do not have explosive charges, only a propellant to deliver the rocket on target and the 20 mm shells have solid heads without explosives.

Two air corridors pass in the vicinity of the plant. One is used by the Air National Guard and is known as "New York 838" which is a low-level, high-speed military training route (Ref. 2.1-20) and goes to the Warren Grove Aerial Target Range (R5002). The route is used only to make approaches to the range. After the practice run over the target has been completed the planes climb to higher altitudes to return to their bases by routes other than "New York 838."

The other is a civilian corridor marked "Victor Air Lane 312," shown in Figure 2.2-13 (Ref. 2.2-21) which is aligned east-west and passes over the site. The airlane can be used by all types of aircraft, but the FAA - which controls all civilian aviation - specifies minimum safe altitudes at which planes can be flown in the corridor.

REFERENCES - SECTION 2.2

2.2-1 U.S. Bureau of Census, U.S. Census of Population: 1970, Number of Inhabitants. Final Report PC (1) - A32, New Jersey.

2.2-2 U.S. Bureau of Census, U.S. Census of Population: 1970, Number of Inhabitants. Final Report PC (1) - A34, New York.

2.2-3 U.S. Bureau of Census, U.S. Census of Population: 1970, Number of Inhabitants. Final Report PC (1) - A40, Pennsylvania.

2.2-4 U.S. Census of Housing: 1970, General Housing Characteristics. Final Report HC (1) - A32, New Jersey.

2.2-5 U.S. Census of Housing: 1970, General Housing Characteristics. Final Report HC (1) - A34, New York.

2.2-6 U.S. Census of Housing: 1970, General Housing Characteristics. Final Report HC (1) - A40, Pennsylvania.

2.2-7 County Planning Commission Reports for the Following New Jersey Counties with Dates of Issue Where Known: Atlantic, 1969; Burlington; Camden, 1971; Cape May; Cumberland, 1963; Mercer; Middlesex, 1970; Monmouth, 1969; Ocean, 1972; Somerset, 1971.

2.2-8 Department of Commerce, Bureau of the Census, Minor Civil Division Map, New Jersey and Pennsylvania.

2.2-9 U.S. Department of Interior, Geological Survey, 7.5 minute series topographic maps.

2.2-10 Hagstrom Map, Ocean County, New Jersey.

2.2-11 Abrams Aerial Survey Corporation, Lansing, Michigan, Aerial Photographs of Ocean County, New Jersey taken April 14, 1968, Scale: one inch equals 400 feet.

2.2-12 1971 New Jersey State Industrial Directory.

2.2-13 Public School Directory of Ocean County, New Jersey, 1971-1972.

2.2-14 Ocean County Master Plan, Ocean County Planning Board, Toms River, New Jersey.

2.2-15 New Jersey Crop Reporting Service, New Jersey Department of Agriculture - U.S. Department of Agriculture, New Jersey Agricultural Statistics, Trenton, New Jersey, 1970.

2.2-16 Farm Vehicle Application Summary, Ocean County, New Jersey, New Brunswick, New Jersey, 1971. Cooperative Extension Service, College of Agriculture and Environmental Science, Rutgers.

2.2-17 Aerial Photographs of the Oyster Creek Nuclear Generating Plant Site, #1486-9-432 Aero Service Corporation, Philadelphia, April 3, 1965.

2.2-18 Hagstrom Ocean County Atlas. Hagstrom Company, Inc., 1969.

2.2-19 Intracoastal Waterway Charts 824-A, 824-B. U.S. Coast and Geodetic Survey, Washington, D.C.

2.2-20 December 9, 1971. Flight Information Publication Planning Military Training Routes United States. The Aeronautical Chart and Information Center. U.S. Air Force, St. Louis, Missouri 63118.

2.2-21 Washington Aeronautical Chart, Scale 1:500,000. September 16, 1971. U.S. Department of Commerce, Washington, D.C.

2.3 HISTORIC SIGNIFICANCE

2.3.1 Within Plant Environs

The Jersey shore, and particularly the pine barrens, is little mentioned in histories of the pre-Revolutionary War period, but has a long and colorful history since that time.

Ocean County was separated from Monmouth County on February 18, 1850. It is second in area size among the 21 counties of New Jersey, and is the fastest growing county in New Jersey, with an almost doubling of its population each decade from 1950 to 1970.

The early history of the area contains many interesting incidents and facts, beginning with the first recorded visitor, Captain Cornelius Jacobsen Mey in 1614, and the first settler, Henry Jacobs Falkinbury, who bought 800 acres in 1698 near what is now Tuckerton. In 1704 Edward Andrews built the first gristmill on the Jersey Coast.

Not more than 2,000 people lived in the present Ocean County by 1780 (the present population is 208,470).

Sawmills stood along many creeks before 1790, and dozens of sailing ships put out to sea from Toms River or Tuckerton. Fish-laden wagons labored through the pine barrens from Toms River to Philadelphia.

During the Revolutionary War, Toms River and Tuckerton became important privateering ports after the British blockaded larger coastal cities, and Tuckerton became an official coastal port of entry. The Continental Congress and the Commonwealth of Pennsylvania established a salt works at Toms River. Shipbuilders at Waretown, Toms River, Barnegat and Forked River turned out whale boats, oyster boats and various small craft, and even today the boating industry is a large source of employment and revenue.

The coast of Ocean County was a dreaded ship wrecker, leading in 1834 to Congressional authorization of the Barnegat Lighthouse. Today, Barnegat Light is maintained as a State historic site.

David Wright started the first iron furnace near Lakehurst in 1789, and by 1812 forges were in several other communities. At first they depended on local bog iron, but later iron ore was shipped in from the Fishkill region on the Hudson River and the products supplied to New York City and Philadelphia. William Torrey, Sr., bought 27,500 acres around Wright Forge in 1841 to make charcoal, and his railroad to Toms River in 1860 helped to open up the pine barrens to outside interests. Joseph Brick rebuilt the old Washington furnace in 1833 and founded Bricksburg, now Lakewood.

Most of Ocean County's ironworks had disappeared by the Civil War and the area subsided into a quiet fishing and resort community for the latter half of the 19th century. The county has had one of the lowest industrial employment figures in the state, but a growing population now demands additional employment opportunities. The Toms River Chemical Corporation has approximately 1,400 employees, and many small plants have located or are planning to locate in the area. Many muncipalities are setting up industrial parks in an effort to attract light, clean, small industry.

Ocean County had little agriculture until well into this century. John Webb drained a swamp near Cassville in 1845 and cultivated cranberries. In Civil War years, a cranberry craze swept the county, but soon subsided. During World War II, several hundred new poultry farms came into the area, but the collapse of egg prices in the 1950's was disastrous, although the area still produces "New Jersey eggs" for the metropolitan markets.

Ocean County has 47 known historical sites (Table 2.3-1). Four of them have been recognized by the National Register of Historic Places and the Cultural Center of the State of New Jersey:

1) Hangar Number 1 at Lakehurst Naval Air Station - 20 miles north-northwest of the site;

2) Barnegat Lighthouse - 6 miles southeast of the site;

3) Charcoal Pits near Lakehurst - 16 miles northwest of the site; and

4) Cedar Bridge Tavern - 9 miles west of the site.

The Potter Church at Lanoka Harbor (four miles north) is presently being considered for addition to this list.

Table 2.3-1. List of Historical Sites in Ocean County, New Jersey.

1. Barnegat Lighthouse, Barnegat
2. Old Barnegat School House, Barnegat
3. Burying Ground, Toms River
4. Carlton House, Tuckerton Boro
5. Cedar Bridge Tavern, Union Twp.
6. Charcoal Pits, Lakehurst Vicinity
7. Cranberry Inlet, Dover Twp.
8. Dillion House, Island Heights Boro
9. Dover Forge, Berkeley Twp.
10. Eli Collins Inn, Barnegat
11. Admiral Farragut Academy, Pine Beach
12. Federal Furnace Site, Lakehurst
13. Ferrage-Bamber Forge, Lacey Twp.
14. Francis House, Toms River
15. Gov. Fort Homested, New Egypt
16. Barnegate Friends Meeting House, Barnegat
17. Friends Meeting House, Beach Haven
18. Tuckerton Friends Meeting House, Tuckerton Boro
19. Gilford Park Burial Ground, Gilford Park
20. Gruler Place, Toms River
21. Hilliard House, Manshawing
22. Mott Place, Toms River
23. Mule Railroad, Lakehurst
24. New Jersey Courier Building, Dover Twp.
25. Ocean County Court House, Dover Twp.
26. Old Ocean House Tavern Beacon Hotel, Point Pleasant
27. Site of Ocean House, Toms River
28. Pennsylvania Salt Works, Dover Twp.
29. Old Post Office, Waretown
30. Potter Church, Lanoka Harbour
31. Presbyterian Church, Toms River
32. First Presbyterian Church, Tuckerton
33. Pulaski Monument, Tuckerton
34. Little Red School House, Waretown
35. Stanton House South, Toms River
36. Toms River Block House, Toms River
37. Ebenezer Tucker's Grave, Tuckerton
38. Tuckerton Library, Tuckerton
39. Tustin House, Tuckerton
40. U.S. Naval Air Station, Lakehurst
41. Veterans All Wars Memorial, Lakehurst
42. Walker House, Waretown
43. Zion Methodist Church, Plumstead Twp.
44. Massacre, Barnegat Light Boro
45. Capt. Joshua Huddy, Toms River
46. Mormon Church, Toms River
47. Tuckerton, Tuckerton

The remaining 42 historic sites in the county have been recognized by the State of New Jersey.

Lacey Township was formed in 1871 and the first town meeting was held in April of that year. Forked River was home port for many ships. As early as 1754, a major salt works operated and the lumber industry was active. The township is named after General John Lacey, founder of a major iron works at what is now Bamber Lake. General Lacey's 1810 road from Forked River to his iron works is still known as Lacey Road, a main traffic artery.

The community of Forked River is the governmental center of Lacey Township and the home of many commercial fishing party boats and private craft. Also located here is the Forked River Game Farm, a State pheasant-rearing station.

The main early industries in Ocean Township were lumbering, making charcoal and gathering swamp moss for sale to florists. In summers, gathering wild huckleberries was an active occupation, and in the fall cranberry picking.

Ocean Township now boasts a fine fishing and pleasure-craft fleet with ample docking facilities at the many marinas around the major village, Waretown. A large summer population enjoys the recreational facilities.

The historic sites included in Table 2.3-1 are not affected in any way either by the Oyster Creek Nuclear Generating Station, or by its attendant transmission lines. The historical sites are located far enough away that the plant or transmission lines cannot be seen.

2.3.2 Within Plant Site

The National Register of Historic Places lists no historic sites within the JC property. County and State historical societies, too, have no record of any historical sites at the Oyster Creek facility (Ref. 2.3-1).

The curator of cultural history of the New Jersey State Museum investigated the possible presence of archaeological sites within the plant property. No record was found of any such sites in the area bounded by Oyster Creek, the South Branch of the Forked River, the Garden State Parkway and Barnegat Bay (Ref. 2.3-2).

REFERENCES - SECTION 2.3

2.3-1 New Jersey Historical Sites Inventory. Inventory located in Historic Sites Office Department of Environmental Protection, Trenton, New Jersey.

2.3-2 December 20, 1971. Letter on Possibility of Indian Sites at Oyster Creek Site. Suzanne Corlette, Curator Cultural History, State of New Jersey, Department of Education, New Jersey State Museum, Cultural Center, Trenton, New Jersey.

2.4 REGIONAL GEOLOGY

2.4.1 Physiography

The site is located on the eastern margin of the Atlantic Coastal Plain Physiographic Province as shown on Figure 2.4-1. This province extends southeastward from the Fall Zone, a topographic break that marks the boundary between the Atlantic Coastal Plain and the more rugged topography of the Piedmont Province. The Fall Zone also marks the geologic contact between the crystalline and sedimentary rocks of the Piedmont and the unconsolidated coastal plain sediments. The site is approximately 40 miles southeast of the Fall Zone.

Characteristic topography of the Atlantic Coastal Plain includes gentle rolling plains and flat lowlands at a general elevation of from 0 to 120 feet above mean sea level, although elevations exceed +250 feet locally. The regional dip is to the southeast. Dendritic and modified trellis drainage patterns have eroded and dissected the coastal plain to its current topography. General relief in the coastal plain ranges from 20 to 100 feet.

Local topographic features surrounding the site of the Oyster Creek Nuclear Generating Station are part of a broad (two to three miles wide) lowland (0 to 25 feet elevation) and tidal marsh area flanked on the east by Barnegat Bay and a sand dune barrier beach. These features typify the eastern margin of the New Jersey Coastal Plain from the vicinity of Manasquan to Cape May and reflect emergence of the New Jersey coastline (Ref. 2.4-1).

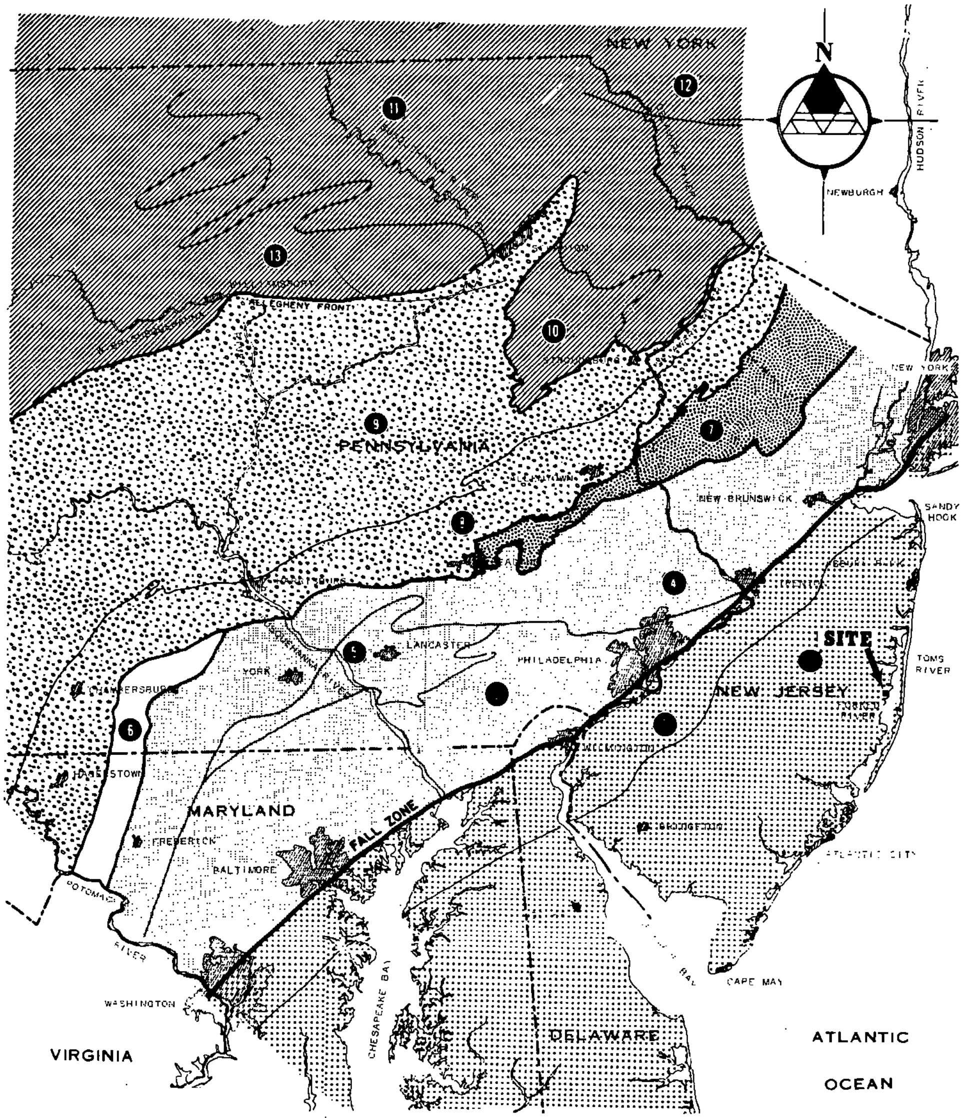
A submerged portion of the coastal plain extends 85 to 100 miles seaward from the present New Jersey shoreline and forms the continental shelf.

2.4.2 Stratigraphy

The New Jersey Coastal Plain is underlain by a sequence of unconsolidated to semi-consolidated deposits of Quaternary, Tertiary and Cretaceous age. These sediments lie unconformably on a basement complex consisting of crystalline Precambrian, early Paleozoic rock, and Triassic rocks (Ref. 2.4-2). The stratigraphic sequence, lithologic descriptions, and general thickness of formations in the New Jersey Coastal Plain are shown on Figure 2.4-2 and 2.4-3.

Coastal plain sediments were deposited in a northwest trending coastal plain "basement depression" which extends from the vicinity of Raritan Bay, New Jersey, to Virginia and westward to the Fall Zone. The center of the broad depression is located in the vicinity of Chesapeake Bay. In the New Jersey Coastal Plain, sediments thicken seaward of the Fall Zone, and southward along the coastline increase from 800 feet at Sandy Hook, to 6,000 feet at Cape May. In the vicinity of the site, sediment thickness is approximately 3,700 feet (Ref. 2.4-4).

The surficial geology of New Jersey is shown on Figure 2.4-4. Eastward across the coastal plain successively younger Cretaceous and Tertiary sediments outcrop in northeast trending bands. Over large areas the exposures are mantled by a relatively thin veneer of Pleistocene and/or



CLASSIFICATION OF UNITS

MAJOR DIVISION	PROVINCE	SECTION OR SUB-PROVINCE	
ATLANTIC COASTAL PLAIN	COASTAL PLAIN	1	OUTER
		2	INNER
APPALACHIAN HIGHLANDS	PIEDMONT	3	PIEDMONT UPLAND
		4	TRIASSIC LOWLAND
		5	CONESTOGA VALLEY
	BLUE RIDGE	6	SOUTH MOUNTAIN

MAJOR DIVISION	PROVINCE	SECTION OR SUB-PROVINCE	
APPALACHIAN HIGHLANDS	NEW ENGLAND	7	NEW ENGLAND UPLAND (READING PRONG)
	VALLEY AND RIDGE	8	GREAT VALLEY
		9	FOLDED APPALACHIANS
	APPALACHIAN PLATEAUS	10	POCONO PLATEAU
		11	SOUTHERN NEW YORK OR GLACIATED LOW PLATEAUS
		12	CATSKILL MOUNTAINS
		13	ALLEGHENY HIGH PLATEAUS

MILES
10 0 10 20 30 40

REFERENCES:

U.S. GEOLOGICAL SURVEY BY F.H. OLMSTEAD, 1952, MAP OF REGION INCLUDING THE DELAWARE RIVER BASIN SHOWING PHYSIOGRAPHIC UNITS.

THIS MAP WAS PREPARED FROM THE FOLLOWING WORLD AERONAUTICAL CHARTS 357, 300 AND 310.

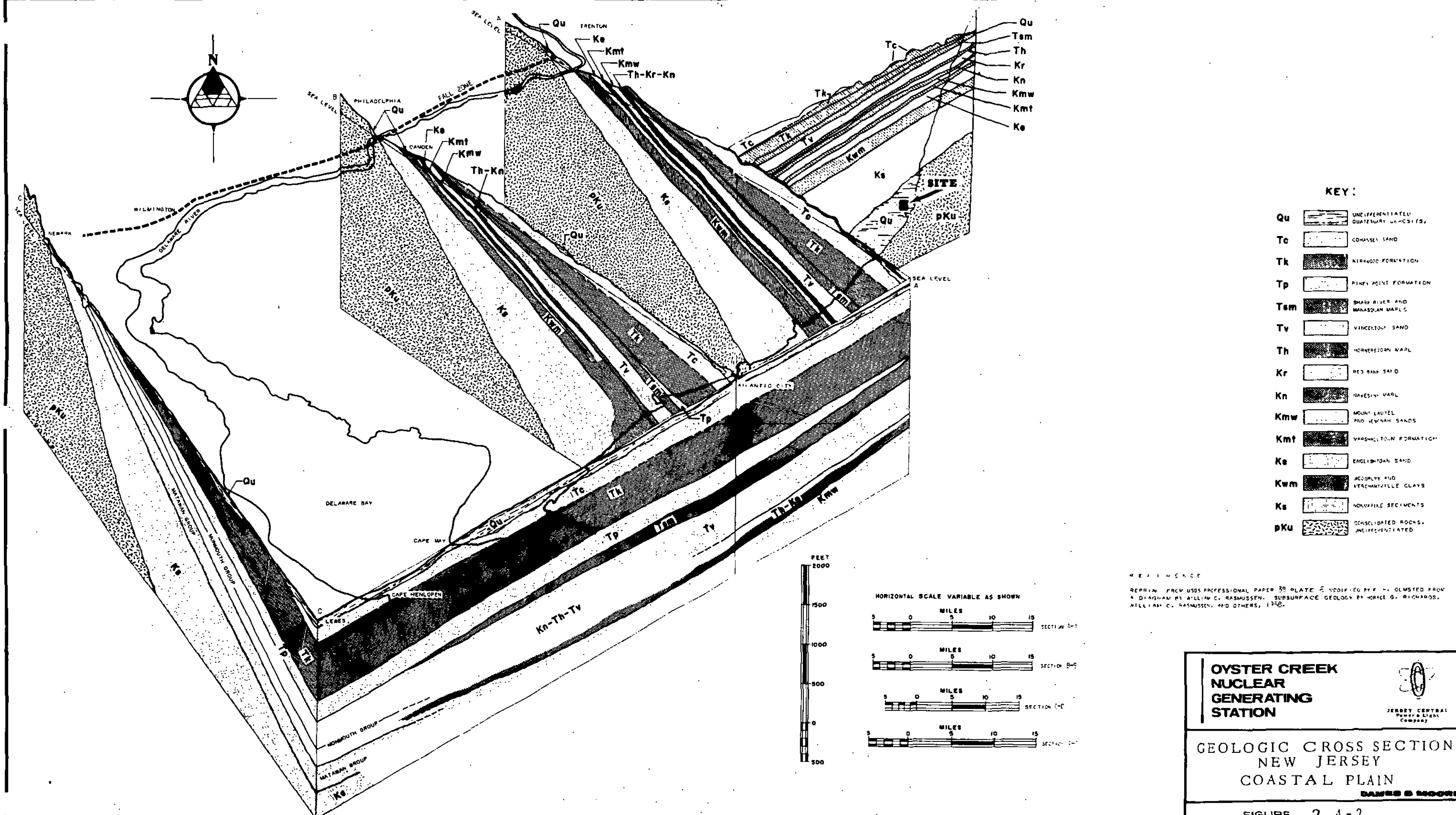
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

REGIONAL PHYSIOGRAPHIC MAP

DAMES & MOORE

FIGURE 2.4-1



REFERENCE

REPRINT FROM USGS PROFESSIONAL PAPER 38 PLATE ... MODIFIED BY ... OLMSTED FROM A DIAGRAM BY WILLIAM C. RASMUSSEN. SUBSURFACE GEOLOGY BY HORACE G. RICHARDS, WILLIAM C. RASMUSSEN, AND OTHERS, 1958.

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

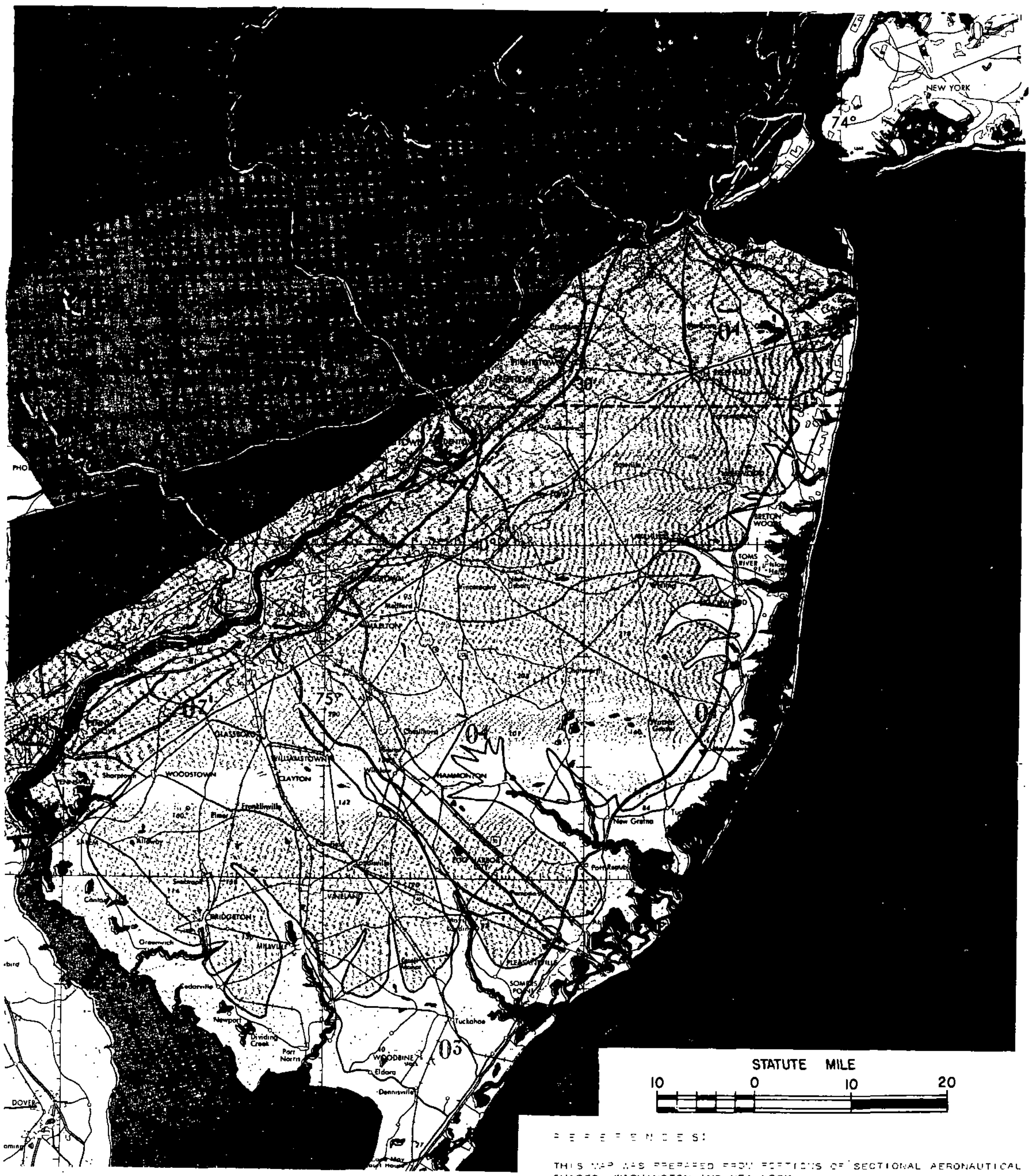
GEOLOGIC CROSS SECTION
NEW JERSEY
COASTAL PLAIN

DAMES & MOORE

FIGURE 2.4-2

Figure 2.4-3 New Jersey Coastal Plain Geologic Column

Geologic units									Hydrologic units	
					In outcrop near Trenton		Island Beach State Park			
System	Series	Group	Formation	Previous maximum reported thickness (feet)	Lithology	Average thickness (feet)	Lithology	Thickness (feet)	Coastal Plain	Island Beach State Park
Quaternary	Recent			80	Fine sand, silt, and mud.	0-10	Medium to coarse-grained quartz sand.	74	Water-table aquifer throughout the Coastal Plain. Generally yields small to moderate quantities of water, but the thicker sands are capable of yielding large quantities of water. Generally, where adjacent to saline surface water bodies, contains brackish or saline water with a thin fresh-water lens on top. Locally artesian. Locally aquiclude	
	Pleistocene		Cape May Formation	200	Heterogeneous mixture of gravel, sand, silt and clay.	less than 50	Very fine to medium-grained quartz sand, and clay.	46		
			Pennsauken Formation				Absent	0		
			Bridgeton Formation							
Tertiary	Pliocene (?)		Beacon Hill Gravel	20	Quartz, gravel, and sand.					
	Miocene (?) and Pliocene (?)		Cohansey Sand	270	Medium to coarse-grained quartz sand. Locally clayey.	200 ±	Silty clay.	30	A widespread aquifer Contains an aquiclude	Aquiclude–aquifer
	Miocene		Kirkwood Formation	750	Very fine to medium-grained. Locally clayey, quartz sand, and silt.	60 ±	Very fine to fine-grained quartz sand, and clay.	250	An aquifer that is a reliable source of moderate to large quantities of water, especially in the southern Coastal Plain. Contains two widespread aquicludes.	An aquifer capable of yielding moderate quantities of water
	Eocene	Rancocas	Manasquan Formation	200	Medium to coarse-grained clayey quartz and glauconite sand, and sandy silt and clay.	40	Very fine to medium-grained clayey glauconite and quartz sand dominant at top, and silt and clay dominant at base.	762	An aquifer that yields small to moderate quantities of water. Locally yields large quantities of water.	An aquifer capable of yielding small quantities of water at the top, grading to an aquiclude at the base.
	Paleocene		Vincentown Formation	460	Fine to coarse-grained clayey quartz sand, and fine-grained clayey quartz and glauconite calcarenite.	55				
			Hornerstown Sand	100	Medium to coarse-grained clayey glauconite sand.	30				
Cretaceous	Upper Cretaceous	Monmouth	Red Bank Formation	185	Fine to coarse-grained clayey quartz and glauconite sand.	0-50	Very fine to fine-grained clayey quartz sand, and silt.	28	An aquitard. Contains several thin water-bearing units capable of yielding small quantities of water.	
			Navesink Formation	70	Medium to coarse-grained clayey glauconite and quartz sand.	20	Clay.	36		
			Mount Laurel Sand	120	Fine to coarse-grained clayey quartz sand.	20	Medium-grained clayey quartz sand.	12	An aquifer that is a widespread reliable source of small to moderate quantities of water. Locally yields large quantities of water.	
		Matawan	Wenonah Formation		Very fine to fine-grained silty quartz sand.	20	Very fine to fine-grained clayey quartz sand, and clayey silt.	116		
			Marshalltown Formation	125	Very fine to medium-grained clayey glauconite and quartz sand.	35	Very fine to medium-grained clayey glauconite and quartz sand, and clayey silt.	244		
			Englishtown Formation	160	Fine to medium-grained quartz sand, Clay-seamed.	45	Absent	0	An aquifer that is a reliable source of moderate to large quantities of water, especially in the northeastern Coastal Plain.	
			Woodbury Clay	255	Clay.	50	Clay and silt.	212	Aquiclude	
			Merchantville Formation		Very fine grained, very clayey quartz sand.	60				
			Magothy Formation	95	Fine-grained quartz sand, and clay.	30	Very fine to medium-grained clayey quartz and glauconite sand, and clay and silt.	260	An aquitard. Contains several thin water-bearing units capable of yielding small to moderate quantities of water. Locally functions as an aquifer in conjunction with the underlying Raritan.	
			Raritan Formation	1,500+	Fine to very coarse-grained quartz sand, and clay	300?	Very fine to coarse-grained quartz sand, and clay.	1,720	An aquifer that is a widespread reliable source of large quantities of water. The water becomes increasingly brackish with downdip position and depth.	
Pre-Cretaceous	Precambrian and early Paleozoic crystalline rocks – metamorphic schist and gneiss and igneous pegmatite and gabbro, and Triassic sands, sandstone, and shale.						Weathered gneiss (saprolite).	64	Aquiclude	
							Biotite gneiss with pegmatite veins.	---		



REFERENCES:

THIS MAP WAS PREPARED FROM PORTIONS OF SECTIONAL AERONAUTICAL CHARTS. WASHINGTON AND NEW YORK.

ADAPTED FROM GEOLOGIC MAP OF PENNA. 1960, GEOLOGIC MAP OF N.J. 1950, AND GEOLOGY AND MINERAL RESOURCES OF BUCKS COUNTY, PA., 1959, BULLETIN C9, TOPOGRAPHIC AND GEOLOGIC SURVEY, COMMONWEALTH OF PA., P. 19, 20, 21.

LEGEND

	GEOLOGIC AGE	DESCRIPTION
	QUATERNARY	Recent and Pleistocene Lowland and beach deposits, sand, gravel and/or clay including Cape May, Pennsauken, and Bridgeton Formations.
	TERTIARY	Unconsolidated sand, silt, and clay including Cohansey and Kirkwood Formations occasionally overlain by Quaternary deposits
	CRETACEOUS	Unconsolidated to semiconsolidated sand, silt, gravel and clay including the Raritan and Magothy Formations
	TRIASSIC	Sedimentary rocks, siltstone, sandstone, shale and igneous intrusives of the Newark Group
	PRECAMBRIAN OR LOWER PALEOZOIC	Crystalline rocks, schist, gneiss, granite, serpentine or sedimentary rocks, limestone, shale

FAULT
INFERRED FAULT
THRUST FAULT

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

NEW JERSEY GEOLOGIC MAP

DAMES & MOORE

FIGURE 2.4-4

Recent sediments. At the site, surficial deposits have been correlated with the Pleistocene Cape May formation (Ref. 2.4-5). These sediments unconformably overlie the Tertiary Cohansey sands.

2.4.3 Geologic History

The basement complex beneath the coastal plain originated as Precambrian sedimentary and crystalline rocks which were folded and metamorphosed into schist and gneiss during early Paleozoic geologic time. Regional subsidence and sedimentation associated with regional tectonic activity occurred through the Paleozoic Era, forming first the Appalachian Geosyncline then the folded and faulted Appalachian Mountains. The tectonic activity was accompanied by regional intrusion by igneous rocks and metamorphism of sedimentary rocks into gneiss and schist.

During the Triassic period (180 to 220 million years ago), graben structures along the eastern margin of eroded Appalachian orogenic belt were filled with clastic sediments and later intruded by basic igneous dikes and sills (Ref. 2.4-6). These Triassic events mark the last major tectonic activity along the North American eastern continental margin. Subsequent regional uplift, weathering, and erosion produced a relatively level plain.

In early Cretaceous time, this erosional surface subsided along a hinge line located approximately along the present Fall Zone. This surface forms the basement of the coastal plain. The area to the west was uplifted and eroded, and stream deposits were laid down over the coastal plain.

From late Cretaceous to Miocene or Pliocene, the New Jersey Coastal Plain was inundated by the sea resulting in a thick sequence of marine sediments. The Kirkwood Formation was the last marine deposit of this sequence. During late Tertiary time, sea level regression exposed the contemporary coastal plain area to subaerial erosion and fluvial and deltaic sedimentation. The upper Tertiary Formation, the Cohansey sand, was deposited during this regression and as a result has both a marine and non-marine phase represented respectively by its clay and sand facies.

Further sea level decline to a base level several hundred feet lower than the present sea stand occurred from late Tertiary to early Pleistocene time. This lowering of sea level increased stream gradients and exposed Mesozoic and Tertiary deposits to accelerate stream erosion. The Bridgeton and Pennsauken complex was deposited locally on Mesozoic and Tertiary strata in upland streams and in estuarine deltas along the regressing Pleistocene marine shoreline. These deposits consisted of sand and gravel with clay. Later in the Pleistocene epoch, sea levels fluctuated from the initial low stand to several tens of feet above present base level, depositing sands, gravels, silts and clay. This transgression and regression occurred at least twice and was contemporary with periods of continental glaciation and deposition of glacial outwash. The Cape May Formation was deposited during this time and consists of alternating beds of marine and non-marine sand, gravel, silt and clay indicative of the varying Pleistocene sedimentary environments existing on the coastal plain.

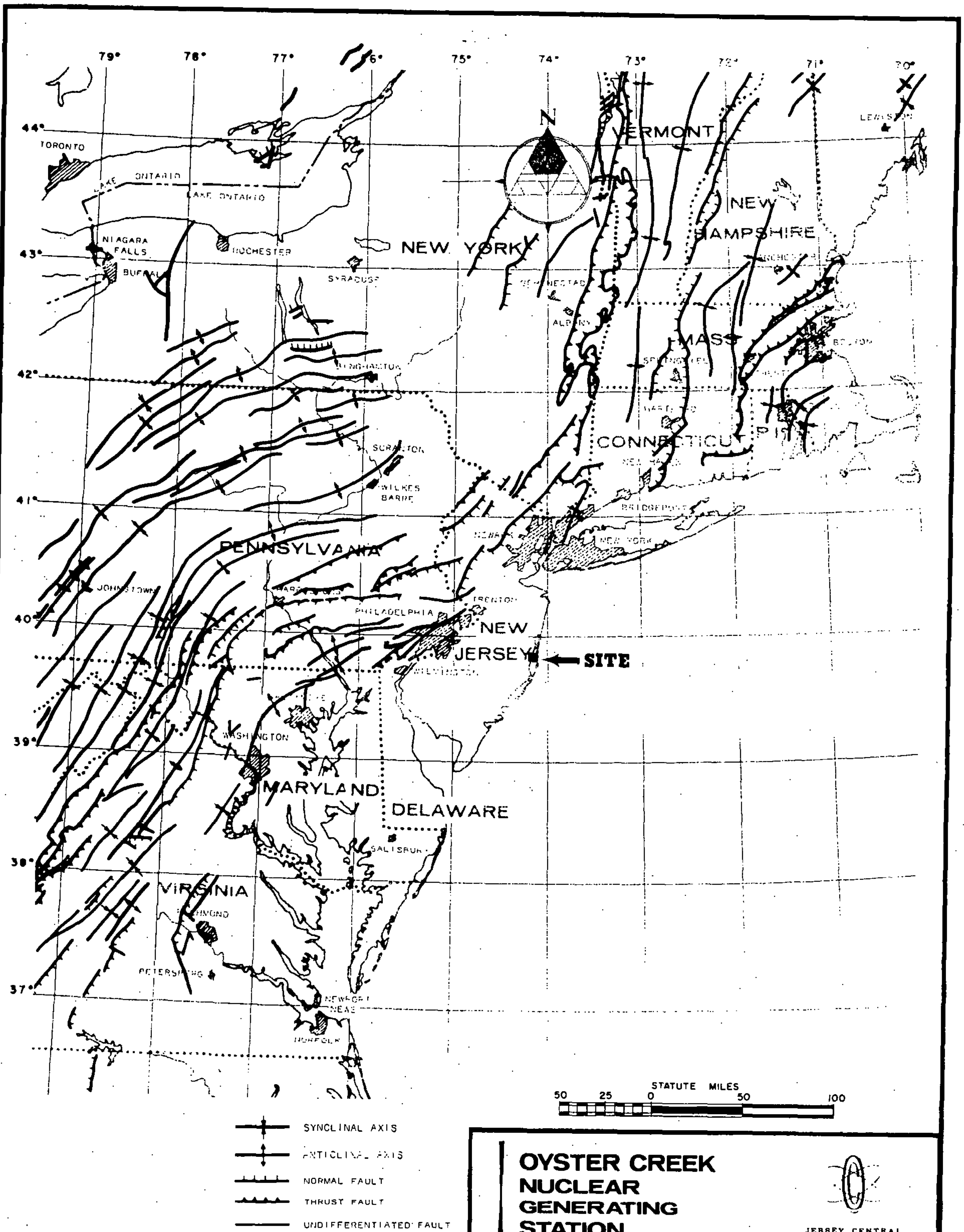
Facies changes within the individual units of the Cape May are common.

Local recent beach, tidal marsh, swamp, and lowland alluvial deposits unconformably overlie the earlier deposits and reflect the Holocene transgression to contemporary sea level (Ref. 2.4-7).

2.4.4 Structure

The dominant regional structural feature is the Appalachian Orogenic Belt. This Belt is marked by the regional northeast-southwest orientation of tectonic axes, lineations of structural features, (Figure 2.4-5), and stratigraphic contacts. Faults within this Belt are relatively shallow, low angle thrust faults associated with late Paleozoic Appalachian Orogenies. In addition, high angle normal faults border Triassic sedimentary basins in the region. Geophysical data and limited drill hole information suggest that Appalachian Orogenic Belt structures continue eastward beneath the New Jersey Coastal Plain sediments. Thus, several authors have suggested that faulting and Triassic basins characteristic of the Appalachian Orogenic Belt exist also in the basement complex beneath the coastal plain (Ref. 2.4-8 and 2.4-9).

The lineations of the Appalachian Belt have a distinct lateral offset near latitude 40°N. This offset marks the location of a postulated east-west trending wrench fault (Ref. 2.4-10). On the basis of geophysical data and interpretations of structural lineations on both the continent and in the Atlantic Ocean Basin this fault has been inferred to follow a line



MAJOR TECTONIC FEATURES WERE TAKEN FROM A PORTION OF THE "TECTONIC MAP OF THE UNITED STATES" BY U.S.G.S. AND A.A.P.G., 1962. (SEE TEXT FOR SEISMOLOGY REFERENCES)

OYSTER CREEK NUCLEAR GENERATING STATION

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REGIONAL TECTONIC MAP

DAMES & MOORE

FIGURE 2.4-5

extending from the Kelvin Sea Mountains westward across the ocean basin to central New Jersey and on into southeastern Pennsylvania (Figure 2.4-4). This postulated fault is approximately 36 miles north of the site. Analysis of sediments from oceanographic core indicate the Cornwall-Kelvin structure may have formed during the early Mesozoic Era (Ref. 2.4-11). Recent (1971) aeromagnetic surveys of the New Jersey Coastal Plain detected magnetic anomalies in the general vicinity of the postulated Cornwall—Kelvin structure. These anomalies have been interpreted as evidence of basement complex deformation and could be related to a wrench fault.

Taylor and Zietz (Ref. 2.4-9) postulated a northeast trending fault which traverses the Atlantic Coastal Plain from Virginia to New Jersey. This structure has been inferred from regional aeromagnetic data collected along widely spaced lines. An aeromagnetic survey was recently (1971) conducted over a portion of the proposed fault where it crosses Delaware Bay and Cape May. This survey was performed over closely spaced north-south trending lines. No magnetic anomaly or evidence of faulting was detected.

The major basement structure of the New Jersey Coastal Plain is the Salisbury Embayment defined by Richards (Ref. 2.4-3). This feature is a northwest-southeast trending trough in the basement complex which extends from the Fall Zone seaward in the vicinity of New Jersey, Maryland, Delaware and Virginia. Its axis trends through the Chesapeake Bay. As much as 10,000 feet of coastal plain sediments occupy this basin at its center.

A minor fault has been reported in the coastal plain near Gibbstown, New Jersey, approximately 60 miles west of the site (Ref. 2.4-14). This fault trends northeastward and occurs in the basement complex beneath several hundred feet of unconsolidated sediments.

Known faults within the region are confined to the Piedmont and Valley and Ridge Provinces of the Appalachian Highlands west of the coastal plain (Figure 2.4-5). The closest faulting to the site is some 40 miles northwest of the site (Figure 2.4-4). This Piedmont structure is the Cream Valley-Huntington Valley Fault which extends from Westchester, Pennsylvania, to the vicinity of Trenton, New Jersey. This fault is late Paleozoic in age and is related to faulting during the Appalachian Orogenies (Ref. 2.4-12).

Farther (60 to 100 miles) northwest of the site are three Triassic-aged normal faults. These faults are located in or border the Triassic rocks of the Piedmont Lowland. All of these features cross the Delaware River northwest of Trenton, New Jersey (Figure 2.4-4). The southernmost fault is the Chalfont-Hopewell Fault. Several miles north of the Chalfont-Hopewell Fault is the Flemington Fault which trends northeastward from the Doylestown, Pennsylvania vicinity to Lambertville and Flemington, New Jersey. The Northern Border Fault lies from 10 to 20 miles north of the Flemington Fault and forms the northern boundary of the Triassic rocks in eastern Pennsylvania and western New Jersey (Ref. 2.4-13).

2.4.5 Seismology

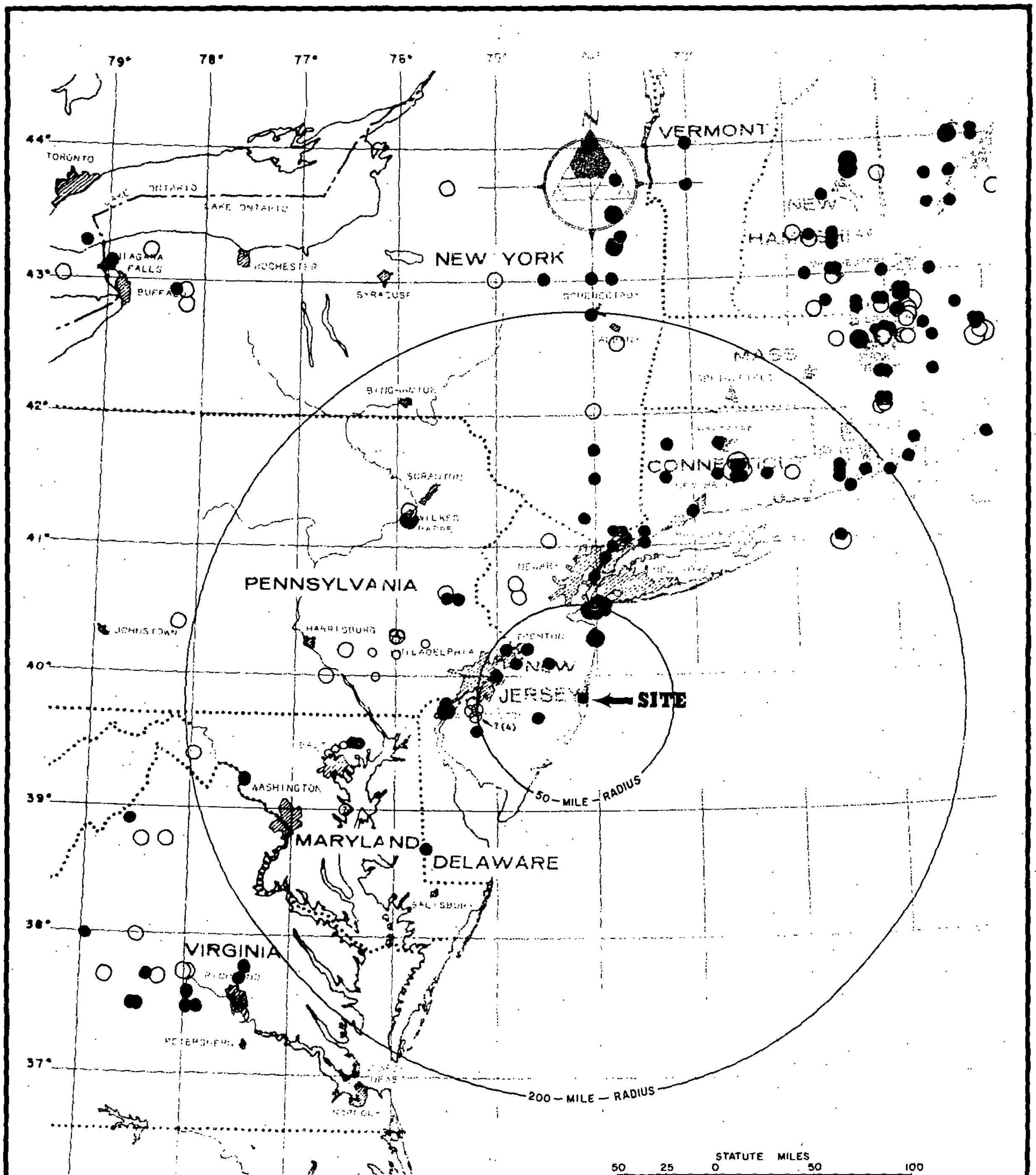
The plant site is situated in an area which has experienced minor earthquake activity. Most of the earthquakes of the region originated within the Piedmont Province, which is characterized by moderate to strong folding and faulting. A number of shocks have been reported in the coastal plain. The distribution of known earthquake epicenters surrounding the site are shown on Figure 2.4-6.

The most significant earthquake within the region is a Modified Mercalli* Intensity VII earthquake, reported June 1, 1927 in the vicinity of Asbury Park and Long Branch, New Jersey, some 40 miles north of the site. The shock was the largest recorded in the region and was felt from Sandy Hook to Toms River and as far inland as Freehold. Damage from the earthquake, however, was small.

Other Intensity VII earthquakes not as strong as the 1927 shock were reported in 1871 at Wilmington, Delaware, and near New York City in 1737 and 1884. Numerous minor shocks have been reported in the region surrounding the site.

In some cases, earthquakes of the region have been related to known geologic structures of the Piedmont. The Long Branch-Asbury Park shocks to date have not been related to known geologic structures; however,

*Modified Mercalli Intensity (Damage) Scale of 1931, Table 2.4-1.



LEGEND:

- ○ INTENSITY IV OR LESS
- ● INTENSITY V
- ○ INTENSITY VI
- ● INTENSITY VII
- ○ INTENSITY VIII
- ? INTENSITY UNKNOWN

OYSTER CREEK NUCLEAR GENERATING STATION

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REGIONAL EPICENTER MAP

DAMES & MOORE

FIGURE 2.4-6

Table 2.4-1. Modified Mercalli Intensity (Damage) Scale of 1931*

I.	Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel Scale.)
II.	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing. (I to II Rossi-Forel Scale.)
III.	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel Scale.)
IV.	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale.)
V.	Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale.)
VI.	Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale.)
VII.	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars. (VIII Rossi-Forel Scale.)
VIII.	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII+ to IX- Rossi-Forel Scale.)
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel Scale.)
X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale.)
XI.	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII.	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air.

*Abridged

the postulated Cornwall-Kelvin Wrench Fault intersects the New Jersey coast near its epicenter.

Based on the geology and seismic history of the region, it appears unlikely that the site will experience significant ground motion during the economic life of the plant. The maximum horizontal ground acceleration anticipated, if any historical earthquake should recur, would be only a few percent of gravity (Ref. 2.4-15).

2.4.6 Site Geologic Conditions

Results of geologic borings made at the site showed the following formations were present (Ref. 2.4-16):

AGE	FORMATION	LITHOLOGY	THICKNESS (feet)	GENERAL ELEVATION (MSL)
Pleistocene	Cape May Formation	Sand and clay layers	20-30	135 to -11
Upper Tertiary	Cohansey Sand	Dense medium to coarse sand	50-65	-11 to -76
Miocene	Kirkland	Layers of clay, silt, dark grey, fine sand	--	Below -76

Clay-silt strata were penetrated at the base of the Cape May Formation and at the top of the Kirkwood Formation. These layers act as aquicludes and separate the granular soils at the site into three coastal plain aquifers, one located in each formation. Locally, these clay strata may be missing in a sequence allowing interconnection of these aquifers. The coolant canals for the plant were excavated in the clay layer at the base of the Cape May Formation.

Building foundations are situated on generally the dense Tertiary Cohansey sand described above (Ref. 2.4-16) and it is unlikely that these soils will experience any loss of strength during earthquake loading.

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REFERENCES - SECTION 2.4 (CONTINUED)

2.4-11 Offshore Nuclear Generating Station, Preliminary Concept and Site Description (1971), Public Service Electric and Gas Company, Newark, New Jersey, Vol. 1, p. 7-1, 7-4.

2.4-12 Report, Site Environmental Studies, Limerick Generating Station, Limerick Township, Pennsylvania 1970, Dames & Moore, Fig. 2.5.8.

2.4-13 McLoughlin, D. B., 1942, The Distribution of Minor Faults in the Triassic of Pennsylvania, Michigan Acad. of Sci. Papers, Vol. 27, p. 465-479.

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2.5 HYDROLOGY

2.5.1 Barnegat Bay

Barnegat Bay is a shallow, irregular tidal basin enclosed by the mainland on the west and separated from the Atlantic Ocean on the east by a barrier beach extending some 30 miles from Point Pleasant on the north to Manahawkin Causeway on the south. The only break in the barrier beach in this stretch is at Barnegat Inlet, opposite Waretown, about 20 miles south of Point Pleasant. Although the barrier beach extends another nine miles south to Beach Haven Inlet, the basin south of Manahawkin Causeway is considered to be the northward extension of Little Egg Harbor. The Causeway therefore marks the approximate southern limit of influence of Barnegat Inlet.

The maximum width of Barnegat Bay, thus defined, is about four miles and the maximum depth is about 20 feet at local mean low tide. This depth is found at only one locality, and the thalweg (line joining points of greatest depth in successive cross sections) generally has a depth of less than ten feet. The average depth of the Bay is under five feet, and there are large areas that are one foot or less in depth at local mean low tide. The surface area of the Bay is conservatively estimated at over 1,800,000,000 square feet and the volume of 8,500,000,000 cubic feet.

Water levels in Barnegat Bay are influenced primarily by wind and tidal action. Effluents discharged into Barnegat Bay are mixed ultimately with ocean water, although the amount of mixing depends upon tidal forces, local winds, runoff of rainfall, and gradients of salinity and temperature.

The barrier beach and the shallowness of the Bay minimize tidal fluctuations.

The tidal establishment of Barnegat Bay is as follows (Ref. 2.5-1):

Place	Time Differences (On Sandy Hook) High Water h.m	Low Water h.m.	Mean Ranges Feet
Mantoloking	+5:34	+5:34	0.5
Coates Point	+4:19	+4:28	0.5
Toms River (town)	+4:37	+4:47	0.6
Waretown	+2:33	+2:49	0.6
Oyster Creek Channel (off Sedge Island)	+2:16	+2:17	0.6
Barnegat Inlet	-0:20	-0:21	3.1
Harvey Cedars	+3:15	+4:02	0.8

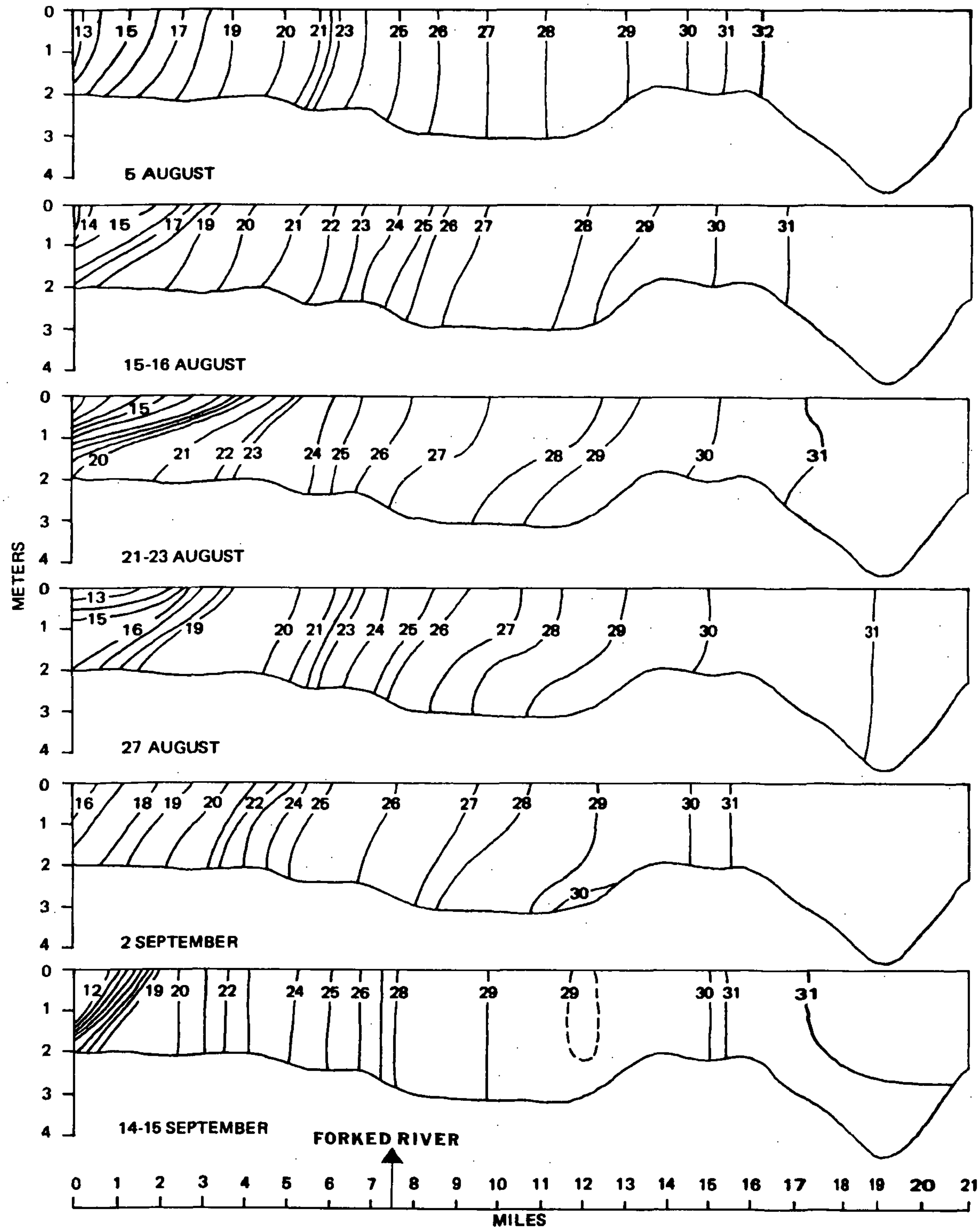
These data show that tide magnitude diminishes progressively north and south from Barnegat Inlet. The inter-tidal volume, or tidal prism, has been calculated (Ref. 2.5-2) from these data to be 790,000,000 cubic feet, most of which enters and leaves the Bay via Barnegat Inlet. The tidal currents in the Bay thus are weak and the inflow of fresh water from coastal streams and storms further complicates the weak current system. Tidal changes during storms may be greater than 3.1 feet.

Measurements of salinity were taken in Barnegat Bay for studies made during the period of August 4 to September 15, 1963 under the direction of Dr. J. H. Carpenter, Johns Hopkins University. Six surveys were made along a section starting in Toms River and extending south in the Barnegat Bay channel to Manahawkin Bay. The variations of bay salinity with respect to depth and time are shown in Figure 2.5-1. These channel vertical distributions suggest that, while periods of complete vertical mixing occur, a significant tendency toward two-layered circulation exists in the areas deeper than five feet. This pattern in which a downstream (seaward) drift in the upper layer and an upstream drift in the lower layer occur, is common in deeper estuaries.

Inspection of the tide record shows that for the period 18 through 26 August 1963, the conditions were typical for those of that month. The wind was 25 to 30 miles per hour for the previous 48 hours.

Table 2.5-1 highlights salinity data collected in Barnegat Bay prior to the startup of the Oyster Creek plant. Figure 2.5-2 gives the locations where the salinity samples were collected.

Because Barnegat Bay is so shallow and because of the relatively low turbulence that is experienced, the water temperature is likely to be somewhat more responsive to air temperatures than a deep and more turbulent water body (Ref. 2.5-3). Water temperature data observed at a point 800 feet offshore, midway between the mouths of Forked River and Oyster Creek, are summarized below:



SALINITY (TIMES 1000 PPM) WITH DEPTH. TOMS RIVER TO MANAHAWKIN BAY.

OYSTER CREEK NUCLEAR GENERATING STATION

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SALINITY PROFILE 1963

DAMES & MOORE

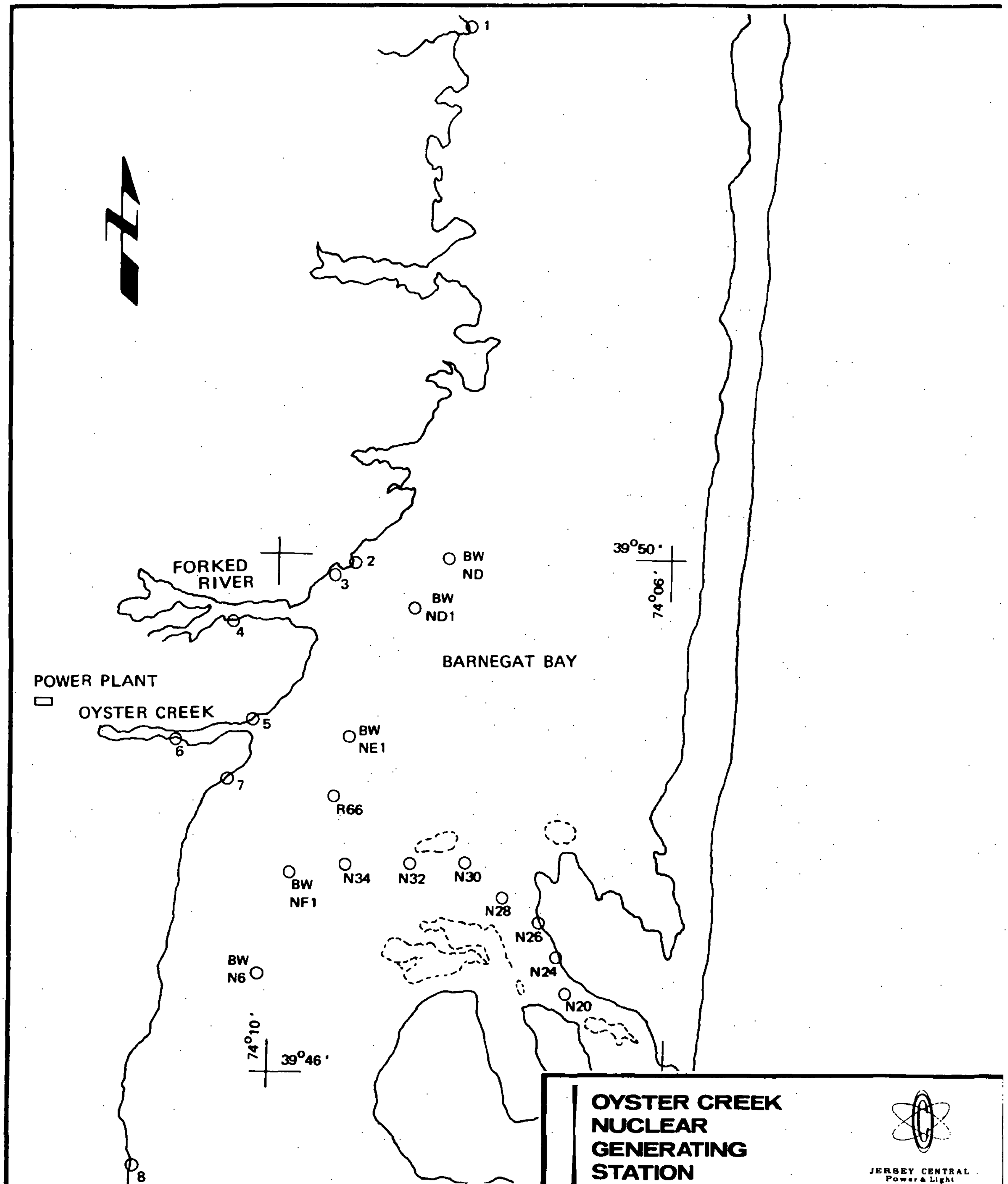
FIGURE 2.5-1

Table 2.5-1. Salinity Collected in 1968 from Barnegat Bay.

Location*	Depth (feet)	Salinity (ppm) April 19 S	B	May 18 S	B
N 20	25	26,780	27,150	26,920	27,100
N 24	13	26,300	26,550	27,100	27,200
N 26	18	26,100	26,650	26,580	26,800
N 28	15	25,800	25,850	26,480	26,680
N 30	16	25,720	25,870	25,950	26,150
N 32				26,100	26,100
N 34	7	25,800	25,800	26,120	26,180
BW NG	9	25,950	25,850	26,150	26,090
BW NF 1	9	25,300	25,400	26,220	26,220
R 66				25,380	28,200
BW NE 1	12	24,580	28,350	25,650	25,590
BW ND 1	10	23,920	24,050	26,510	26,890
BW ND	10	23,760	24,120	24,100	24,350

*See Figure 2.5-2

S = Surface
B = Bottom



OYSTER CREEK NUCLEAR GENERATING STATION

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SALINITY AND FISH SAMPLING LOCATIONS

DAMES & MOORE

FIGURE 2.5-2

TEMPERATURE DATA FROM BUOY IN BARNEGAT BAY

Period (Calendar Year)	Temperature Degrees F.	Hours	% of Period Temperature is Equalled or Exceeded
1964	Over 80	98	4.3
1963	Over 80	26	1.1
1964	Over 75	704	31.2
1963	Over 75	571	25.3
1964	Over 70	2,012	89.0
1963	Over 70	1,583	70.2

With respect to water temperatures, it can be seen from the above data that Barnegat Bay has an average temperature of well above 70°F during the summer months. It is probable that the motions due to meteorological factors constitute the most important component of the motions of the waters in Barnegat Bay, but these in turn depend on the variation of the weather systems. Thus, in an extended period having a below normal incidence of winds of strength that are of significance in affecting the regimen of Barnegat Bay, it may be expected that the circulation of waters of the Bay will be below normal. This would cause higher temperatures of the water to occur than would be the case in a similar period having the same air temperature but more frequent winds of significant velocity.

The inflow of fresh water has an important effect on the thermal regime of the water in Barnegat Bay. The surface inflow is about two percent of the tidal flow during a tidal cycle (Ref. 2.5-3, page 5). The component of ground water seepage has not been determined but based on salinity measurements of the water in Barnegat Bay (the average salinity in the Bay is about 25,000 parts per million (ppm) which is 30 percent less than normal sea water) it appears that it is a significant part of total fresh water inflow.

The ground water component of fresh water inflow to Barnegat Bay occurs at relatively constant temperature (55^{o} to $65^{o}F$) throughout the year. At the present time the ground water discharge to the Bay is nearly maximum due to the high elevation and pressure heads on most of the aquifers adjacent to the Bay. As the development of ground water supplies increases in the future the elevation and pressure heads of these aquifers will be decreased significantly along with ground water discharge to the Bay and there will be an accompanying increase of temperatures and salinities of Bay waters.

2.5.2 Characteristics of Streams in Area

The plant site is between two small fresh water streams, Oyster Creek on the south and the South Branch of Forked River on the north. The streams have these characteristics:

1) Oyster Creek: Drainage area approximately 7.5 square miles, primarily pine barrens. The United States Geological Survey flow records for 1966-1969 reflects a mean daily flow of approximately 25 cfs (11,200 gpm) with a maximum discharge of 122 cfs and a minimum of 12 cfs. Flows are relatively uniform throughout the year.

2) South Branch of Forked River: Drainage area approximately two square miles, primarily pine barrens. Definitive flow records are not available, but a brief sample series by the USGS indicated an average discharge of three cfs (1,350 gpm).

Water quality characteristics of Oyster Creek and South Branch of Forked River near the site are shown on Table 2.5-2. These analyses were made prior to the construction of the Oyster Creek intake-discharge canals.

Table 2.5-2. Chemical Analyses of Water from Oyster Creek and the South Branch of Forked River.

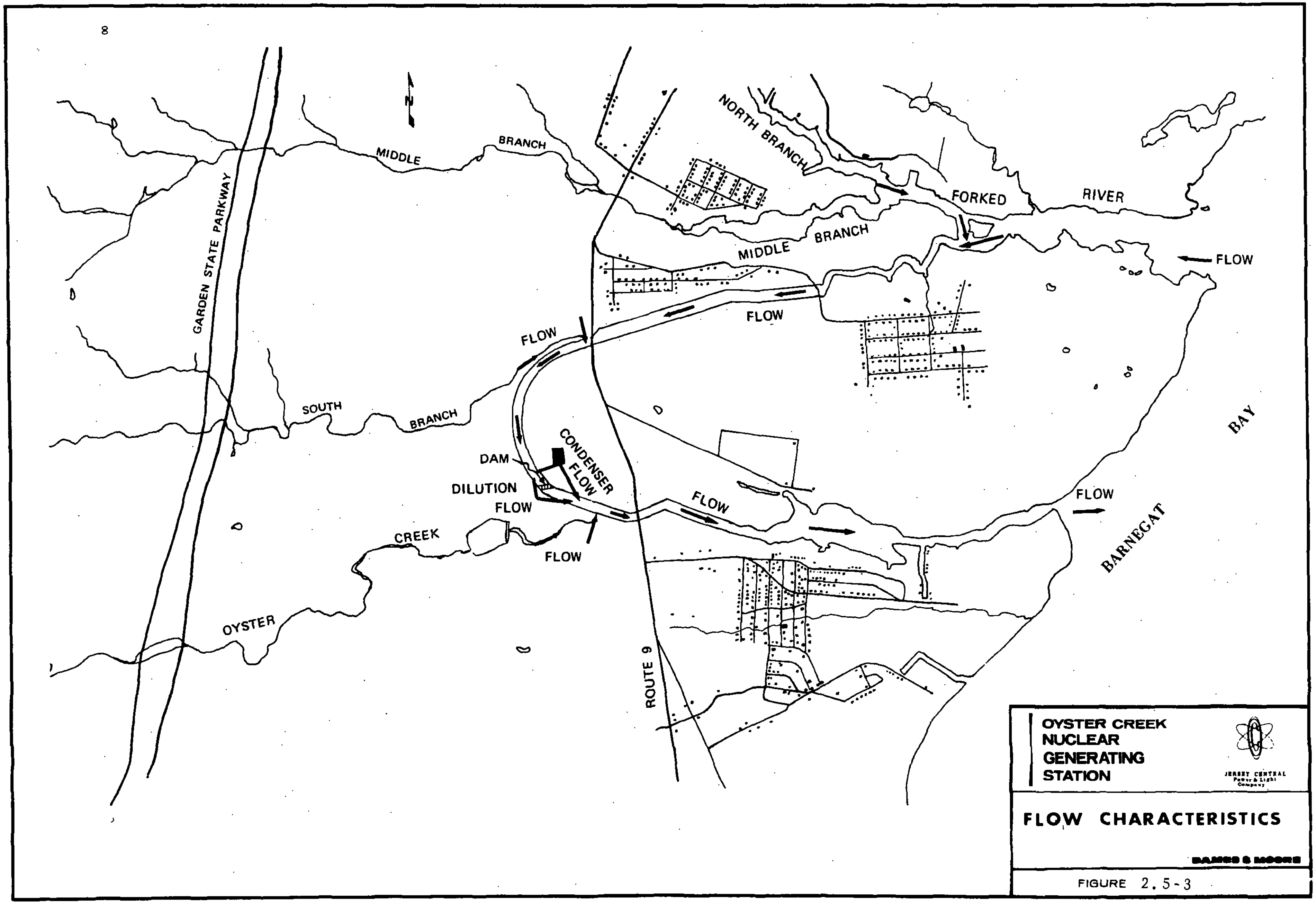
		1*	2*	3*
ANALYSIS REPORTED AS $CaCO_3$		PPM	PPM	PPM
Calcium		5.3	4.3	0.0
Magnesium		3.2	4.8	4.3
Sodium & Potassium		17.3	11.3	47.0
Total Cations		25.8	20.4	51.3
Chloride		11.2	9.9	10.1
Sulphate		6.9	0.3	40.0
Nitrate		0.3	0.8	1.2
Bicarbonate		6.9	9.4	0.0
Total Anions		25.3	20.4	51.3
CONSTITUENT				
Free Carbon Dioxide	CO_2	8	5	-
Hydrogen Ion Concentration	pH	4.8	4.8	4.0
Turbidity	-	Tr.	Tr.	5.0
Organic & Solids	-	13	5	15.9
Total Solids	-	35	20	37.9
Conductivity	mmhos	42	34	69.4
Methyl Orange Alkalinity	$CaCO_3$	4	5	0.0
Total Silica as	SiO_2	8	4	5.2
Soluble Silica as	SiO_2	-	-	-
Iron & Aluminum Oxide as	R_2O_3	1.4	1.6	0.07
Iron Total as	-	0.2	0.2	0.31
Calcium as	Ca	2	2	-
Magnesium	Mg	.8	1	-
Hardness as	$CaCO_3$	9	10	-
Sodium & Potassium as	Na & K	8	5	-
Chloride as	Cl	8	7	-
Sulfate as	SO_4	7	.3	-
Zinc as	Zn	.02	.02	0.05
Temperature	-	$21^{o}C$	-	-
Total Sulphide	-	-	-	0.03
Langlier's Index at $70^{o}F$	-	-5.69	-5.57	-
Langlier's Index at $140^{o}F$	-	-5.03	-5.01	

*Locations where samples were collected:

1. Oyster Creek Route 9 Bridge 7-14-65, 12:55 p.m. Sampled by IRF
2. Oyster Creek Route 9 Bridge 7-21-65, 2:00 p.m. Sampled by TRW
3. Raw Water from South Branch of Forked River Route 9 Highway Bridge 1-29-65, 3:00 p.m.

Both streams flow into the circulating water canal constructed for the plant. Oyster Creek flows into the canal stream downstream from the plant. As shown in Figure 2.5-3, the intake canal is up the South Branch of Forked River to a point north of the plant, where it then turns southward to flow west of the plant in a canal dredged across the dividing ridge from the South Branch of Forked River to the channel of Oyster Creek, from which a dredged channel carries both the creek and the effluent from the plant eastward to the Bay. The total canal length is about five miles from Bay to Bay. It is blocked near the plant by a dam. Water is pumped from the canal north of the dam for plant service and for dilution of the plant effluent, both streams being returned to the canal south of the dam.

By this arrangement, Bay water is drawn up the South Branch of Forked River, and much of the fresh water from the various branches of that stream is mixed with the canal stream and is diverted around the canal to the Bay. The new stream in the Oyster Creek channel thus consists of circulated Bay water and fresh water from branches of Forked River and the original Oyster Creek, with a salinity somewhat less than that of the Bay. Based on studies of the circulation patterns of the intake and discharge flows between the Oyster Creek plant and Barnegat Bay, it was determined that a portion of the water discharged to the Bay at the mouth of Oyster Creek is taken up at the intake canal near the mouth of the South Branch of Forked River. The recirculation factor was conservatively calculated to be 3.76 (Ref. 2.5-8). Thus, for a flow of 460,000 gpm through the plant, the equivalent dilution flow would be about 120,000 gpm.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N
GARDEN STATE PARKWAY
MIDDLE
BRANCH
NORTH BRANCH
FORKED
RIVER
MIDDLE
BRANCH
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BRANCH
CONDENSER
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DAM
DILUTION
FLOW
FLOW
FLOW
CREEK
FLOW
OYSTER
ROUTE 9
BAY
BARNEGAT
OYSTER CREEK
NUCLEAR
GENERATING
STATION
FLOW CHARACTERISTICS
DAMES & MOORE

FIGURE 2.5-3

The North and Middle Branches of Forked River join at a point about one-fourth mile upstream from the juncture of the canal (and the South Branch). The North Branch is tidal to U.S. Highway 9, while the Middle Branch loses tidal action some 1,000 or 2,000 feet east of the Highway. Little or no effect on the estuarine life of the North or Middle Branches of the Forked River has apparently resulted from construction of the canal. The lower regions of the South Branch of Forked River and Oyster Creek are not estuarine because of the canal flow, but are more closely related to Bay waters and environment.

Oyster Creek has been dammed a short distance upstream of the canal on power plant property, forming a small fresh water pond which provides water for fire protection and for emergency service. Overflow from the holding pond flows into the Oyster Creek discharge canal.

An agreement was reached between the State of New Jersey, Department of Public Utilities, Board of Public Utility Commissioners and the JC concerning the effect of the cooling water system on the shoaling of Forked River and Oyster Creek including their entrance channels from Barnegat Bay, main channels in the waterways, slips, lagoons, marinas, etc. (Ref. 2.5-4, page 7). According to this agreement:

A.) Each party recognizes the possibility that the large cooling water flows in Forked River and Oyster Creek may cause shoaling of the entrance channels, the main channels within these waterways, and at slips, docks, marinas and within tributary lagoons.

B.) Company agrees that it will be responsible for dredging such shoals as may be reasonably due to the cooling water flows. State representatives shall assist in determining the amount and location of dredging based among other things on Company's 1962 and 1966 surveys and State agrees to cooperate in making available its records to aid the Company to carry out its dredging programs.

The average depth in the Oyster Creek discharge canal was ten feet in June 1971, and no appreciable sediment buildup is apparent. At the discharge into Barnegat Bay a small buildup seems to be developing as indicated by one to two foot shallows there, as compared to a depth of approximately three feet shown on a 1954 USGS map. This discharge area is west of the Intra-coastal Waterway.

2.5.3 Ground Water

2.5.3.1 General

At least five distinct bodies of fresh ground water exist in the vicinity of the Oyster Creek Nuclear Generating Station. From the surface downward they are:

1. Unconfined, Recent and Upper Cape May Formation
2. Confined, Lower Cape May Formation
3. Confined, Cohansey Sand
4. Confined, upper zone in the Kirkwood Formation

5. Confined, lower zone in the Kirkwood Formation

The plan view of geologic formations in the area is shown in Figure 2.5-4. The strike of the bedding of the formations is generally in a NE direction with dip to the SE. The vertical relationship of the formations and water levels of the various formations are shown on Figure 2.5-5.

Another aquifer that exists in the area is the Raritan-Magothy which occurs at depths of about 1,800 feet near the site. However, due to the greater depths of this aquifer and the possibility that it is within the zone of salt water intrusion it is not widely used in this area (Ref. 2.5-5).

2.5.3.2 Replenishment and Circulation

The unconfined Recent and Cape May Formations are replenished directly by precipitation. The topography and the porous nature of the sediments exposed in the area are such that most of the precipitation infiltrates into the ground water body with relatively small amounts of surface runoff. Part of the water that sinks into the ground is discharged by evapotranspiration to the atmosphere. Most of the remainder percolates down to the water table and moves in the general direction of the slope of the land surface - from the higher ground in the west toward Barnegat Bay. The upper ground water body intersects the eastward flowing streams in the area (including Oyster Creek and Forked River) and is the source of base flow of these streams. In addition, the unconfined aquifer is in contact with, and discharges directly into Barnegat Bay. Approximately one-half of the average annual precipitation (42 inches) is surface stream flow, and the remainder is evapotranspiration, recharge to deeper aquifers and direct discharge to the Bay.

The outcrop areas of the confined aquifers (Lower Cape May Formation, Cohansey Sand and Kirkwood Formations) are generally to the west of the site at higher elevations (Figure 2.5-4 and 2.5-5). The recharge to the confined aquifers occurs primarily from direct rainfall penetration on the outcrops, and from vertical leakage downward from the unconfined aquifer through the confining layers (aquitards) of silt and clay. Recharge of the confined aquifers from areas of higher elevation to the west has resulted in artesian pressures sufficient to cause the water in wells penetrating the aquifers to rise above the elevation at which the aquifers are encountered.

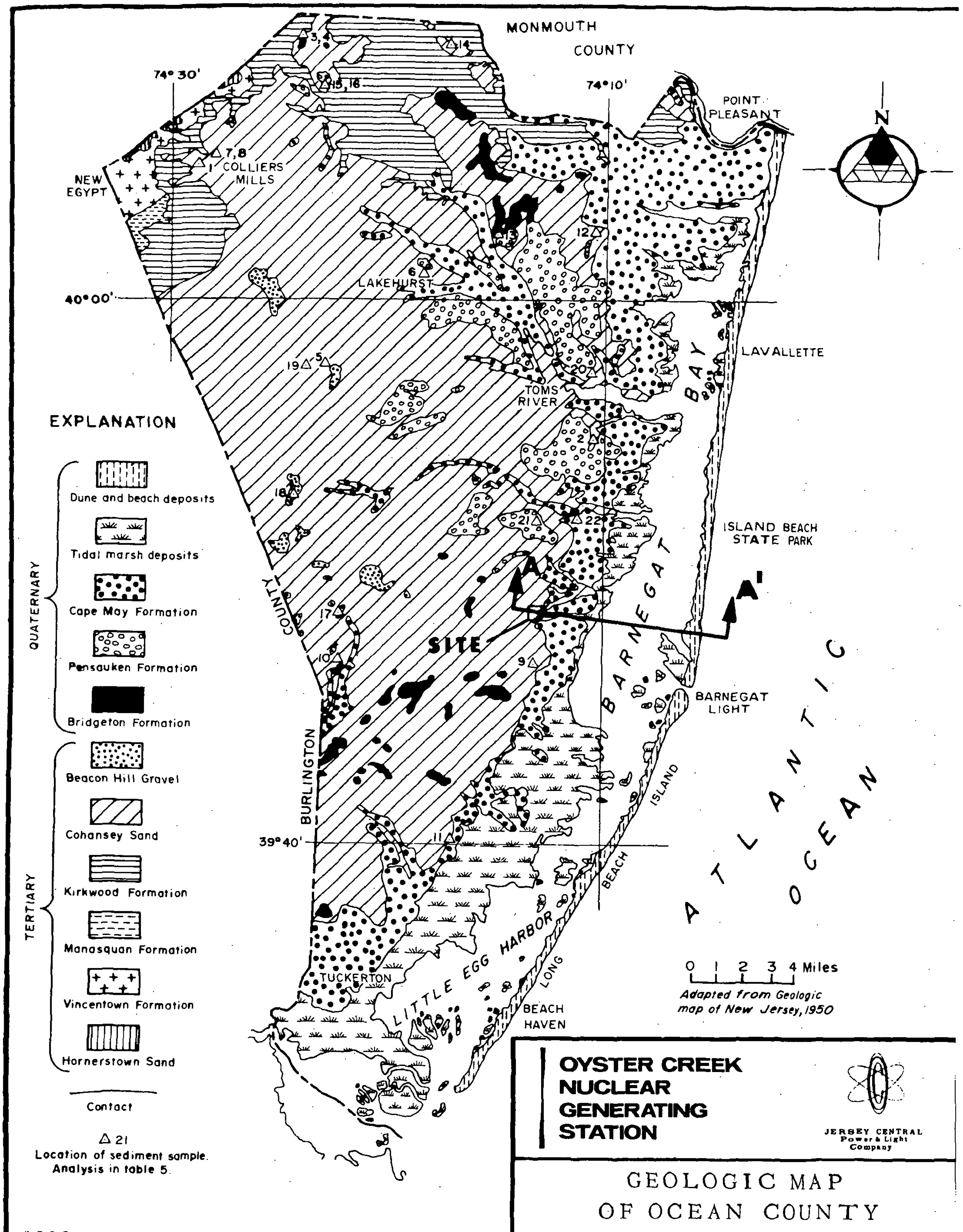
Information on piezometric surface of the different aquifer zones at the site was obtained from test borings for foundation investigation and for the deep well used for water supply at the plant. The observed piezometric surfaces for the various pressure aquifers are as follows:

Aquifer	Approximate Depth Range (feet)	Elevation (MSL) of Piezometric Surface
Upper confined	10 to 30±	+ 8 feet at Oyster Creek
Cohansey Sand	10 to 90±	+14 feet at Forked River Site +10 feet at Oyster Creek Site + 4 feet at Barnegat Bay
Kirkwood Formation	90 to 300±	+20 feet at Oyster Creek Site

Based on test drilling done at Oyster Creek, Forked River and other sites in the area, it appears that the clayey-silt layers that act as confining layers between the upper aquifers are extensive lenses rather than continuous layers. Thus, at some locations where pumping tests were made in various aquifers there was no apparent hydraulic connection between upper unconfined and upper artesian aquifers, but at other locations there were indications of some degree of hydraulic connection.

2.5.3.3 Aquifer Characteristics

The physical properties that have an important bearing on the capacity of an aquifer to transmit and store water include: permeability, transmissibility and storage coefficient. Information on these physical properties of the aquifers near the Oyster Creek plant is based on test borings, pumping tests and yields of wells near the site. The results of the analysis of the test data obtained for Oyster Creek are compared with similar tests of these same aquifers in adjacent areas where more complete aquifer tests have been performed (Ref. 2.5-6). Table 2.5-3 shows a tabulation of estimated values of the physical properties of the aquifers



R E F E R E N C E:

GEOLOGY AND GROUND-WATER RESOURCES OF OCEAN COUNTY, NEW JERSEY, STATE OF NEW JERSEY, DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT, SPECIAL REPORT NO. 29.

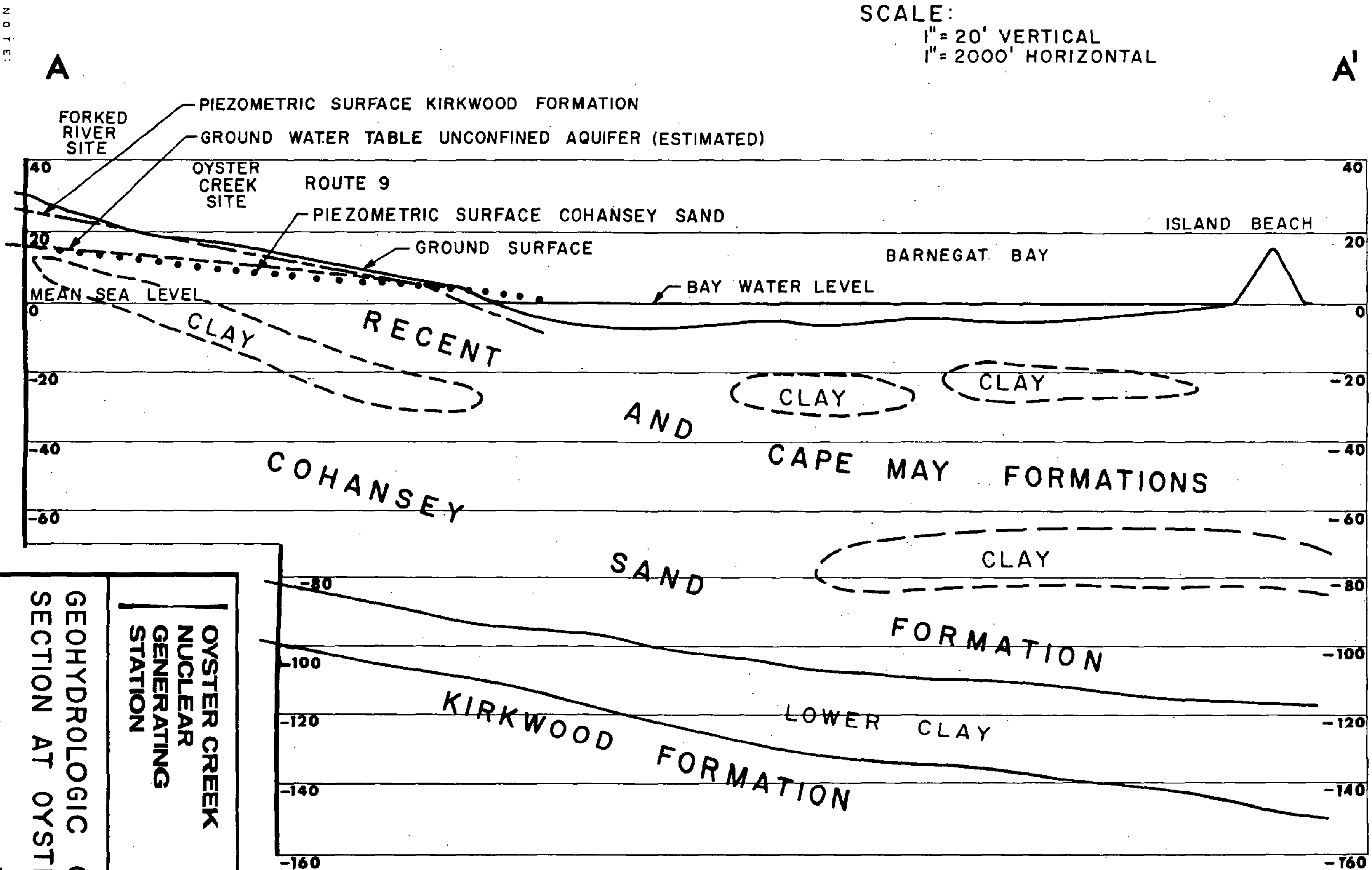
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

GEOLOGIC MAP OF OCEAN COUNTY

DAMES & MOORE

FIGURE 2.5-4



NOTE:
THE SUBSURFACE SECTIONS SHOWN REPRESENT OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

GEOHYDROLOGIC CROSS-SECTION AT OYSTER CREEK

DAMES & MOORE

FIGURE 2.5-5

Table 2.5-3. Physical Properties of Aquifers Near Oyster Creek.

AQUIFER	AVERAGE THICKNESS (feet)	YIELDS OF WELLS (gpm)	PERMEABILITY (gpd/ft^2)	TRANSMISSIBILITY (gpd/ft)	STORAGE COEFFICIENT
Unconfined, Recent to Upper Cape May Formation	50	10 to 1500	10 to 2000	500 to 30000	0.10 to 0.20
Confined, Lower Cape May Formation	30	10 to 300	100 to 1000	1000 to 15000	1×10^{-3}
Cohansey Sand	60	400 to 1200	100 to 2000	20000 to 70000	1×10^{-3}
Kirkwood Formation Upper Sand	50	300	100 to 1000	10000 to 40000	1×10^{-4}
Kirkwood Formation Lower Sand	90	500 to 1200	200 to 1200	20000 to 70000	1×10^{-4}

in the region near Oyster Creek.

Using the aquifer characteristics in the Table, and approximations of slope of the ground water surface and the storage coefficient it is possible to estimate quantities and rates of flow for the various aquifers. For example, if the upper unconfined aquifer has an average permeability of 500 gallons per day per square foot, a water table slope of one foot per thousand feet toward Barnegat Bay and a storage coefficient of 0.20 (Ref. 2.5-5, page 13) then the formation would transmit about five-tenths of a gallon per day per square foot at a true velocity of about five-tenths of a foot per day. The quantity of subsurface flow for a saturated thickness of 20 feet for a length of aquifer or 1,000 feet would be about 10,000 gallons per day.

The total quantity of subsurface flow into Barnegat Bay is occurring by direct recharge from the Cape May and portions of the Cohansey aquifers, and by upward flow through aquitards overlying portions of the Cohansey and the Kirkwood aquifers. The total area of subsurface inflow in Barnegat Bay is in excess of 40,000 acres and it is estimated that the ground water inflow could be equal to, or greater than the surface water inflow.

2.5.3.4 Quality of Water

As water flows across and under the ground, quantities of mineral matter are dissolved. The amount and nature of the material dissolved are directly related to:

1) Initial character of the water;

2) Length of time the water is in contact with the sediments; and

3) Solubility of the materials composing the sediments.

The temperature of ground water below a depth of about ten feet is equal approximately to the mean annual air temperature, which is about 56°F. There is a normal increase in temperature with depth of about 2°F for each 100 feet of depth.

On Table 2.5-4 is shown a tabulation of the major aquifers in the area with expected ranges in values of the various constituents. The well being used at the Oyster Creek plant obtains water from the Kirkwood Formation. The mineral characteristics of water from this well are shown on Table 2.5-5.

The base flow of streams in the area is from effluent ground water seepage, mostly from the uppermost unconfined aquifer and it can be expected that the water quality characteristics of the streams would most closely resemble the quality characteristics of this aquifer.

2.5.3.5 Wells

Most water supplies in the area surrounding the site are derived from wells. The wells are reported to range in depth from 34 feet to 350

Table 2.5-4. Chemical Composition of Water in the Major Aquifers in the Oyster Creek Area.

AQUIFER	TEMPERATURE (°F)	TOTAL IRON* (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	CHLORIDE (Cl)	TOTAL DISSOLVED SOLIDS	pH
Unconfined, Recent Cape May Formation	56 to 59	.2 to 10.	(12 to	300)**	15 to 44		6.1 to 8.4 mostly acidic
Confined, Lower Cape May Formation	58 to 62	.5 to 1.4	9 to 26	1 to 8	11 to 17	80 to 170	6.9 to 7.6
Cohansey Sand	57 to 62	.1 to 4.0	6 to 98	2 to 56	11 to 64	100 to 400	6.9 to 8.2
Kirkwood Formation (Upper and Lower zones)	60 to 67	.1 to 1.7	9 to 43	2 to 12	4 to 42		6.1 to 8.3

* With the exception of temperature and pH, all values for constituents are given in parts per million.

** Values given are for combined total of calcium and magnesium.

Table 2.5-5. Oyster Creek Well Water Analysis.

Constituent	Parts per Million
Calcium	5.82
Magnesium	1.30
Sodium and Potassium (by difference)	16.56
Chloride	19.00
Sulfate	7.50
Nitrate	0.25
Phosphate	1.95
Bicarbonate	0.00
Silica	10.80
Iron (Total)	3.75
Manganese	.01
Total Residue	96.0
Suspended Matter	.0
Volatile Residue	36.0
Hardness as Calcium Carbonate ($CaCO_3$)	26.6 (Ca, Mg & Fe)
Phenol Phthalein Alkalinity ($CaCO_3$)	0.0
Methyl Orange Alkalinity ($CaCO_3$)	18.0
pH	6.35
Biochemical Oxygen Demand	0

feet and are used for municipal, industrial, irrigation and domestic purposes. In the past, many wells less than 30 feet deep were used for domestic and irrigation purposes but, due to water quality problems caused by septic tank contamination the water became unfit for use as a potable water supply. In some cases it was possible to obtain water of satisfactory quality by deepening the wells to about 60 feet in order to tap aquifers of better quality underlying impermeable confining layers.

It is estimated that one million gallons per day per square mile is potentially available from the ground water aquifers in the region. Although this amount of water could probably be obtained from the aquifers in the site area under present geohydrologic conditions, it should be revised downward (to about one-half mgd per square mile) for a more conservative estimate of long-term yield. This conservative estimate depends in part on the proximity of the salt water canals which could be a potential source of salt water intrusion (see Section 2.5.3.6 below), but principally on the anticipated future public pumpage of ground water from the area which will cause a significant decrease in head on the aquifers.

The locations of wells being used within a radius of about five miles of the site are shown on Figure 2.2-12, in the Water Use section of this report. The quantity of water being used is probably less than one million gallons per day. A conservative estimate of the potential for ground water development for aquifers in this 80 square mile area would be on the order of 40 million gallons per day (using the factor of one-half million gallons of ground water potential per square mile).

2.5.3.6 Salt Water Intrusion

During the planning phase of the Oyster Creek plant, it was obvious that there could be a potential salt water intrusion problem caused by the construction of the intake-discharge canals between Barnegat Bay and the plant. Test borings were made along the proposed canal route to determine if there was an impermeable layer or zone underlying the canal which would prevent contamination of the deeper Cohansey Sand Formation at the site.

Along the discharge channel (Oyster Creek area) an impervious clay layer was encountered in all test borings throughout the entire length of the channel from U.S. Highway 9 for a distance of 9,000 feet eastward toward the Bay. The average thickness of the clay layer was about ten feet and varied in depth from about eight feet to 25 feet near the Highway, to about 45 feet to 60 feet at a point 9,000 feet east of the Highway (Ref. 2.5-7).

Test borings were made along the proposed intake channel from U.S. Highway 9 to a point about 5,500 feet eastward of Highway 9 along the South Branch of Forked River. Based on these borings it appeared that the uppermost silt and clay zones in this area are shallower and less extensive than the silt and clay zones along the proposed Oyster Creek discharge channel. Clay and/or silt layers were encountered at elevation -1 to 5 (Boring 19) near U.S. Highway 9, to elevations 19 to 27 (Boring 25) at a point 5,500 feet east of Highway 9. At some of the borings between Boring 19 and Boring 25 the uppermost clay-silt zone was not encountered.

In the sector of the intake-discharge canal west of U.S. Highway 9, the bottom of the clay lens was encountered approximately at sea level and was breached by the canal excavation which extended to elevations below the clay (Ref. 2.5-3, page 8). Along a portion of the intake canal west of Highway 9 it was decided to construct fresh water canals north and south of the intake canal with sufficient head to prevent salt water intrusion of the deeper aquifers at this location. In order to observe any salt water intrusion of the aquifers a series of nine observation wells were installed near the fresh water canal to elevations of -30 and-70 feet (msl). Based on measurements taken from these wells during two years of operation of the salt water intake canal, there has been no indication of salt water intrusion.

The discharge (southerly) portion of the canal west of U.S. Highway 9 also breached the clay layer during excavation. Based on the existing head on the aquifers in this reach of the canal it was decided that salt water movement into the aquifers would be minimal and no additional measures would be required except for observation or outpost wells along the easterly line of the property of the Company, and perpendicular thereto at intervals along the boundary (Ref. 2.5-3, page 27).

Prior to the construction of the Oyster Creek discharge canal the quality of surface water in Oyster Creek was relatively unaffected by salt water intrusion to a point about 2,500 feet east of U.S. Highway 9, and it is probable that the shallow and deeper aquifers adjacent to this reach of the creek were not affected by salt water intrusion. Salinity and depth to water measurements were made in existing active wells along the south side of the creek, from the Highway eastward toward the Bay. Data are not available on the chloride measurements made in these wells before and subsequent to the operation of the discharge canal, and it is not possible to substantiate whether or not salt water intrusion has occurred in the shallow aquifer overlying the upper clay layer previously described.

The South Branch of Forked River near the proposed intake canal was affected by tidal flow at least as far upstream as Boring 25 which was located about 5,500 feet eastward from U.S. Highway 9. Based on the results of the test boring program along the proposed intake canal it was apparent that the intake channel would breach the shallow clay-silt zone in some locations, or would be in direct contact with the shallow aquifer where the impermeable zone did not exist. However, in view of the fact that dredging for the existing marina on the North Branch of Forked River allowed tidal inflow of brackish waters as far upstream as Highway 9, it was decided that the additional contamination of shallow aquifers from this reach of the intake canal would be minimal.

REFERENCES - SECTION 2.5

2.5-1 Tide Tables High and Low Water Predictions, U.S. Coast and Geodetic Survey, 1965.

2.5-2 James H. Carpenter, Pritchard Carpenter Consultants, Baltimore, Maryland.

2.5-3 Proposed Findings of Fact, Conclusions, and Recommendations - Oyster Creek Nuclear Plant, Lacey Township, Ocean County. State of New Jersey, Department of Public Utilities, Board of Public Utilities Commissioners: Docket No. 652-60.

2.5-4 Proposed Construction by Jersey Central Power and Light Company of a Nuclear Fueled Electric Generating Plant at Oyster Creek, Lacey Township, Ocean County. State of New Jersey, Dept. of Public Utilities, Board of Public Utilities Commissioners: STIPULATION - DCED, Docket No. 652-60, February 14, 1966.

2.5-5 Anderson, H. R. and Appel, C. A., 1969, Geology and Ground Water Resources of Ocean County, New Jersey. State of New Jersey, Department of Conservation and Economic Development, Special Report #29.

2.5-6 Gill, H. E., 1962, Ground Water Resources of Cape May County, New Jersey. Salt Water Invasion of Principal Aquifers. Special Report #18, State of New Jersey, Department of Conservation and Economic Development.

2.5-7 Smith, B. L., 1966, Summary of Test Boring Data, Oyster Creek Electric Generating Station, Lacey Township, Ocean County, New Jersey.

2.5-8 F.D.S.A.R. Amendment 11. August, 1967. Oyster Creek Nuclear Power Plant, p. I-4-1.

2.6 METEOROLOGY

2.6.1 General Characteristics

The climate at the Oyster Creek site is continental, but is modified by the Atlantic Ocean. The climatic patterns are representative of the Central Atlantic Coast region.

Long-term weather data were collected at proximal weather stations to determine weather patterns the plant will be subjected to during its lifetime. The onsite meteorological data collection program has been conducted for six years and the results are used to calculate diffusion characteristics of the atmosphere. To confirm that the onsite data are typical the frequency distributions of common data between the long-term and the onsite studies were compared and found to be similar.

2.6.1.1 Temperatures

Table 2.6-1 presents temperature data from the New Jersey Agricultural Experiment Station at Pleasantville, New Jersey, located 33 miles SSW of the Oyster Creek site.

2.6.1.2 Precipitation

Figure 2.6-1 (Ref. 2.6-1) presents data that show average monthly precipitation patterns and the maximum 24-hour rainfall for Barnegat Lighthouse (seven miles SE of site), and Atlantic City (35 miles SSW of site).

Table 2.6-1. Temperature Data at Pleasantville, New Jersey (1926-1955).

Mean Highest and Lowest Temperatures Expected On A Monthly Basis			Highest and Lowest Temperatures Ever Recorded On A Monthly Basis During the Period of Record*		
Month	Mean Maximum	Mean Minimum	Month	Maximum	Minimum
Jan.	43.5	23.7	Jan.	76	-23
Feb.	44.9	24.8	Feb.	80	-11
March	51.2	31.1	March	87	2
April	60.5	39.7	April	93	19
May	71.4	50.8	May	96	28
June	80.1	59.9	June	101	37
July	84.0	64.7	July	106	42
Aug.	82.3	62.1	Aug.	102	41
Sept.	75.7	54.0	Sept.	99	30
Oct.	67.1	44.4	Oct.	94	20
Nov.	55.7	33.5	Nov.	85	1
Dec.	45.3	25.0	Dec.	70	-4

*Absolute Maximum of 106 in 1936 and Absolute Minimum of -23 in 1942.

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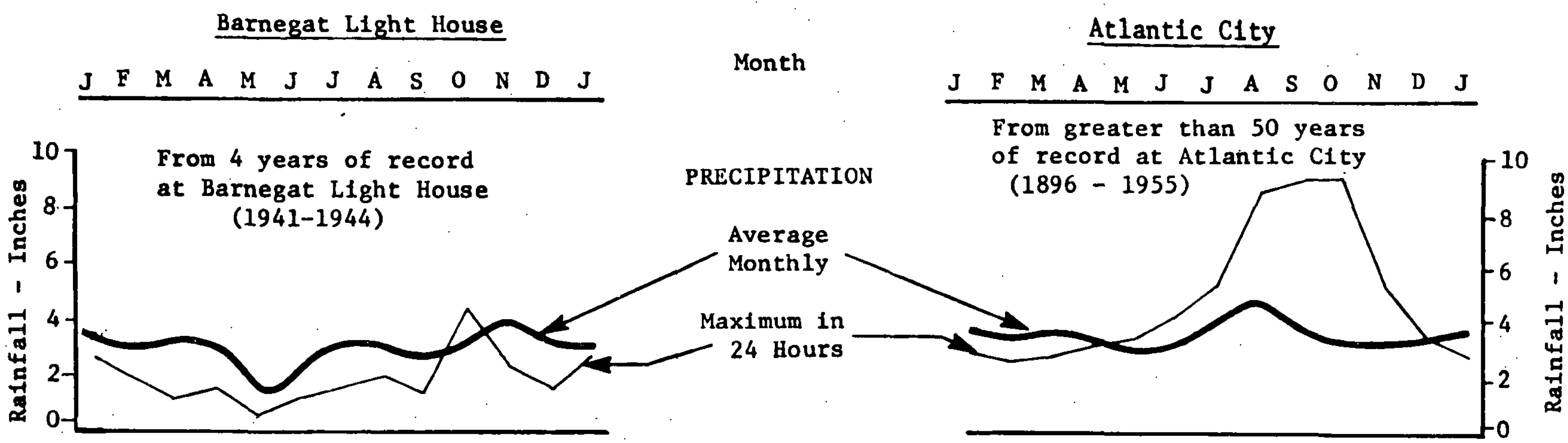

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

AVERAGE MONTHLY PRECIPITATION FOR TH OYSTER CREEK REGION

FIGURE 2.6-1

Average annual precipitation in the region of the site is about 42 inches, the average monthly rainfall is fairly uniform within the range of three to five inches. The prevailing wind during precipitation is generally ENE. Maximum precipitation in 24-hours was 4.5 inches for Barnegat Lighthouse and 9.2 inches for Atlantic City.

2.6.1.3 Wind

Percent occurrence of wind directions summed over all wind speeds are presented in Table 2.6-2, and percent occurrence of wind speed ranges summed over all wind directions are presented in Table 2.6-3 (Ref. 2.6-2) for the Oyster Creek site and for Atlantic City, New Jersey. Oyster Creek data are summarized for one year of record (February 1966 to February 1967) on a seasonal and annual basis. The Atlantic City data are based on two separate periods (1959 to 1961 and 1962 to 1964) because the wind instrument was lowered from a 73 foot height to a 20 foot height in 1962. There is good agreement of the data presented in the Tables for the wind speeds and directions at the two locations. Minor differences may be attributed to topographic effects and differences in heights of wind sensors.

2.6.1.4 Fog

A five year record from the Atlantic City Airport, approximately 31 miles south of the site, indicates the annual average number of hours in which dense fog occurred was 155 hours. Dense fog is defined as a fog which restricts visibility to less than three-eighths of a mile.

Table 2.6-2. Percent Occurrence of 16 Directions Summed Over All Wind Speeds.

	OYSTER CREEK SITE (February 1966 - February 1967) 400-ft. level (8016 hours)					ATLANTIC CITY, NEW JERSEY Height Recorded		
	Season					73' Level	20' Level	
Direction	Winter	Spring	Summer	Fall	Annual	59'-61'	62'-64'	Direction
N	1.02	0.78	1.21	1.45	4.47	5.83	6.09	N
NNE	0.98	0.74	0.71	1.32	3.75	3.62	3.92	NNE
NE	0.88	1.38	1.60	1.43	5.30	3.42	3.36	NE
ENE	0.71	1.66	1.28	0.87	5.53	4.30	4.53	ENE
E	0.51	1.31	1.26	0.87	3.95	3.46	3.50	E
ESE	0.51	0.80	0.70	1.98	3.99	3.81	3.24	ESE
SE	0.91	0.88	1.55	1.45	4.79	3.00	3.14	E
SSE	0.72	0.97	1.52	0.80	4.02	5.40	3.89	SSE
S	1.03	2.46	2.42	1.63	7.55	11.53	7.60	S
SSW	2.26	2.23	3.22	2.03	9.74	6.72	8.84	SSW
SW	1.89	1.82	3.16	1.95	8.82	6.45	7.42	SW
WSW	1.50	1.12	2.71	1.53	6.86	8.35	8.28	WSW
W	3.11	1.27	2.12	2.28	8.78	10.49	7.31	W
WNW	3.41	2.09	1.48	2.43	9.42	11.00	9.51	WNW
NW	3.02	1.52	1.19	1.87	7.61	6.17	9.78	NW
NNW	2.15	1.58	1.08	1.60	6.41	6.05	7.00	NNW
CALM*	0.02	0.01	0.03	0.04	0.11	0.53	2.59	CALM

* 88 Calm hours are included in the 8016 hours above; however, the number of such hours in each season is given. Total calm hours for the year represents 1.10%

Table 2.6-3. Percent Occurrence of Various Wind Speed Ranges Summed Over All Directions.

ATLANTIC CITY, NEW JERSEY			OYSTER CREEK SITE (FEBRUARY 1966-FEBRUARY 1967)*					
Speed Range (mph)	73-ft. Record Average 59-61	20-ft. Record Average 62-64	Winter	Spring	Summer	Fall	Annual	Speed Range (mph)
0 - 3	2.28	8.25	0.87	0.72	1.48	1.12	4.22	0 - 3 **
4 - 7	19.22	26.10	1.88	2.48	4.08	3.21	11.65	4 - 7
8 - 12	39.95	35.40	4.28	6.16	8.41	6.93	25.78	8 - 12
13 - 18	26.96	23.50	7.15	6.57	7.56	6.51	27.79	13 - 18
19 - 24	7.39	5.11	8.01	5.09	5.16	6.24	24.50	19 - 24
Over 25	4.19	1.63	2.43	1.61	0.52	1.50	6.06	Over 25

* Reading taken at the 400-ft. level (8016 Hours)
** 88 Hours of calm are included in total of 8016 hours

2.6.1.5 Hurricanes

Hurricanes passing within 100 miles of the site during the period from 1935 to 1967 were as follows (Ref. 2.6-3):

Hurricane Name	Date	Approximate Closest Approach of Hurricane Center to Oyster Creek Site
None	September 14-15, 1944	30 miles SE
None	October 21, 1944	60 miles SE*
None	September 18-19, 1945	70 miles NW*
None	August 29, 1948	100 miles NW*
Carol	August 31, 1954	50 miles E
Edna	September 11, 1954	100 miles SE
Diane	August 19, 1955	40 miles N*
Donna	September 12, 1960	40 miles SE
Alma	June 13, 1966	100 miles E

*Post-hurricane stage when near site.

Maximum wind speeds at Barnegat Lighthouse for the October 1944 and September 1945 hurricanes listed above, were both 37 mph. However, both storms were in the post-hurricane stage when they passed the site.

The highest wind speed recorded at Barnegat Lighthouse during the four year period 1942-1945 was 75 mph from the southwest, and was not associated with a hurricane. Based on 30 years of records, speeds up to 91 mph were reported at Atlantic City and they were also from the southwest.

2.6.1.6 Tornadoes

United States Weather Bureau records indicate that 33 tornadoes occurred in New Jersey during the available 47 years of record since 1920.

Table 2.6-3. Percent Occurrence of Various Wind Speed Ranges Summed Over All Directions.

ATLANTIC CITY, NEW JERSEY

Speed Range (mph)	73-ft. Record Average 59-61	20-ft. Record Average 62-64
0 - 3	2.28	8.25
4 - 7	19.22	26.10
8 - 12	39.95	35.40
13 - 18	26.96	23.50
19 - 24	7.39	5.11
Over 25	4.19	1.63

OYSTER CREEK SITE (FEBRUARY 1966-FEBRUARY 1967)*

Winter	Spring	Summer	Fall	Annual	Speed Range (mph)
0.87	0.72	1.48	1.12	4.22	0 - 3 **
1.88	2.48	4.08	3.21	11.65	4 - 7
4.28	6.16	8.41	6.93	25.78	8 - 12
7.15	6.57	7.56	6.51	27.79	13 - 18
8.01	5.09	5.16	6.24	24.50	19 - 24
2.43	1.61	0.52	1.50	6.06	Over 25

* Reading taken at the 400-ft. level (8016 Hours)
** 88 Hours of calm are included in total of 8016 hours

2.6.1.5 Hurricanes

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Donna	September 12, 1960	40 miles SE
Alma	June 13, 1966	100 miles E

*Post-hurricane stage when near site.

Maximum wind speeds at Barnegat Lighthouse for the October 1944 and September 1945 hurricanes listed above, were both 37 mph. However, both storms were in the post-hurricane stage when they passed the site.

The highest wind speed recorded at Barnegat Lighthouse during the four year period 1942-1945 was 75 mph from the southwest, and was not associated with a hurricane. Based on 30 years of records, speeds up to 91 mph were reported at Atlantic City and they were also from the southwest.

2.6.1.6 Tornadoes

United States Weather Bureau records indicate that 33 tornadoes occurred in New Jersey during the available 47 years of record since 1920.

Four of these tornadoes were in Ocean County. Two passed across the northern corner of the County about 25 miles northwest of the site, and the other two occurred about 20 miles northeast at the northern end of Barnegat Bay, near Mantoloking.

A total of 25 tornadoes were reported on 23 separate days of the period 1916 to 1958 (Ref. 2.6-4). The following is taken from the same reference and represents the occurrence of tornadoes for each month during 1916 to 1958:

Month	J	F	M	A	M	J	J	A	S	O	N	D
Total Tornadoes	0	0	1	4	3	4	6	4	1	1	1	0
Tornado Days	0	0	1	4	3	3	5	4	1	1	1	0

Thom (Ref. 2.6-5) divides the United States into one-degree squares and determines the tornado frequency for any point within each square. Using data from 1953 to 1962, Thom indicates that six tornadoes occurred within the one-degree square (about 2.3 million acres) encompassing the site. A mean recurrence interval for a tornado striking a point was calculated to be 2170 years using Thom's method.

2.6.2 Diffusion Meteorology

The dilution potential of the atmosphere for the dispersion of released effluent plumes is discussed in this section. Primarily three meteorological parameters enter into the diffusion calculations: 1) wind direction, which determines the path of the effluent plume; 2) wind speed, which determines dilution rate; and 3) atmospheric stability which determines vertical and horizontal dispersion about the center line of the plume.

The onsite meteorological programs provide information which can be used to determine the above mentioned parameters every hour. Tabulation of these data have been used to determine relative concentrations of effluent gases released to the atmosphere.

2.6.2.1 Onsite Data Collection Program

A 400 foot meteorological tower was erected February 1966, in a relatively flat, cleared area approximately 1,200 feet WSW of the Oyster Creek Station. Instrumentation for the Oyster Creek Meteorological Tower is summarized in Table 2.6-4 (Ref. 2.6-6).

A diffusion analysis was performed on the meteorological data collected between February 1966 and February 1967. These data are considered representative of a normal year (Ref. 2.6-7).

2.6.2.2 Method of Analysis

Using continuously recorded wind speed and direction data, distributions by the 16 direction sectors versus 6 wind speed classes were determined at the 400 foot level of the tower. The atmospheric stability was determined by subtracting temperature measurements at the 12 foot level from those at the 400 foot level. The differences are used to establish

Table 2.6-4. Instrumentation for Oyster Creek Meteorological Tower.

Wind Speed and Direction		
Anemometers		
	Number	2
	Location (Elevation), Feet	75 and 400
	Make	Bendix Aerovane
	Model	120
Recorders		
	Number	2
	Make	Bendix Friez
	Model	141
System Accuracy		
	Wind Speed, mph	3 to 45 ± 1.75, 45 to 100 ± 3.0
	Wind Direction, Degrees	± 3.0
Temperature		
Ambient		
	Number	1
	Location (Elevation), Feet	12
	Sensor Make	Bristol Resis. Thermometer bulb
	Sensor Model	7NA
	Sensor Range, °F	-50 to +265
	Sensor Accuracy, Percent	± 0.18 from -50°F to 110°F
	Recorder Number	1
	Recorder Make	Bristol Wide Strip Dynamaster
	Recorder Model	560 Multipoint
	Recorder Chart Scale, °F	-28 to +120
	Recorder Chart Divisions, °F	1.0
	Recorder Accuracy, Percent	±0.25% of Full Scale
	°F	0.37
Difference		
	Number of Points	3
	Location(Elevation), Feet	12 - 75 12 - 200 12 - 400
	Sensor	See Above
	Recorder	See Above
	Recorder Chart Scale, °F	-7 to +30
	Recorder Chart Divisions, °F	0.25
	Recorder Accuracy, Percent	± 0.25
	°F	± 0.09

the following stability categories (Ref. 2.6-8):

Stability Category		Vertical Temperature Difference (Δt-F^o)		
VS:	Very Stable			>2.7
MS:	Moderately Stable	2.7	to	−0.9
N:	Neutral	−0.7	to	−2.7
U:	Unstable			<−2.7

2.6.2.3 Results

Results given in Table 2.6-5 (Ref. 2.6-9) show the four stability categories classified according to wind direction. The very stable and moderately stable categories are most pronounced when the wind has an over-land trajectory or offshore flow.

Table 2.6-6 shows the percentage occurrence of the six wind speed ranges classified by the stability groups. The highest percentage (about 10.4) occurs with the moderately stable category and a 13 to 18 mph wind speed.

The percentage occurrence of the wind speed ranges broken down by direction and stability are shown on Tables 2.6-7 through 2.6-10. Each Table represents a different stability. The following percentages were obtained for each stability category from the data:

Very stable	31%
Moderately stable	33
Neutral	25

Table 2.6-5. Percent Occurrence of 16 Directions Summed Over All Wind Speeds for Four Atmospheric Stabilities.

OYSTER CREEK SITE DATA
(February 1966 - February 1967)*

Direction	VS[a]	MS	N	U
N	2.13	1.33	0.66	0.34
NNE	1.27	1.42	0.92	0.14
NE	1.35	1.27	2.32	0.36
ENE	0.60	1.35	1.88	0.70
E	0.45	0.98	1.87	0.65
ESE	0.71	1.38	1.47	0.42
SE	0.76	1.65	1.62	0.76
SSE	0.86	1.32	1.25	0.59
S	1.12	2.72	2.39	1.31
SSW	2.73	4.33	2.10	0.59
SW	3.79	3.26	1.31	0.46
WSW	3.18	1.92	1.02	0.74
W	3.67	2.79	1.55	0.77
WNW	3.11	2.93	2.03	1.35
NW	2.73	2.29	1.41	1.17
NNW	2.61	2.01	1.10	0.70

Table 2.6-6. Percent Occurrence Of Various Wind Speed Ranges Summed Over All Directions for Four Atmospheric Stabilities.

OYSTER CREEK SITE DATA
(February 1966 - February 1967)*

Speed (mph)	VS[a]	MS	N	U
0-3	1.62	1.32	0.92	0.34
4-7	3.64	2.51	4.14	1.36
8-12	7.03	6.27	8.39	4.08
13-18	8.01	10.37	6.11	3.31
19-24	9.29	9.59	3.94	1.67
Over 25	1.47	2.91	1.40	0.29

* Reading taken at 400 ft. (8016 total hours)

VS - Very stable
MS - Moderately stable
N - Neutral
U - Unstable

Note: Total of all columns adds up to about 100%

Table 2.6-7. Percent Occurrence Of Hourly Observations from the Oyster Creek Site for Various Wind Speeds and Directions - Atmospheric Stability: VERY STABLE.*

	Speed (mph) at 400 feet					
Direction	0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	Over 25
N	0.11**	0.39	0.72	0.61	0.30	0
NNE	0.15	0.31	0.70	0.11	0	0
NE	0.18	0.25	0.64	0.29	0	0
ENE	0.14	0.16	0.21	0.07	0.01	0
E	0.05	0.14	0.21	0.02	0.02	0
ESE	0.09	0.16	0.32	0.14	0	0
SE	0.09	0.19	0.31	0.15	0.03	0
SSE	0.03	0.23	0.26	0.29	0.06	0
S	0.09	0.20	0.31	0.34	0.18	0
SSW	0.06	0.24	0.61	0.67	1.01	0.14
SW	0.09	0.26	0.55	0.80	1.66	0.44
WSW	0.15	0.21	0.50	0.76	1.24	0.32
W	0.13	0.30	0.56	0.90	1.43	0.35
WNW	0.15	0.22	0.39	0.96	1.33	0.05
NW	0.09	0.18	0.27	1.12	0.98	0.07
NNW	0.05	0.20	0.46	0.77	1.02	0.10

** Total percentage of all columns adds to about 31%.

* Out of a total of 8016 hours during February 1966 - February 1967, 2491 hours were classified as VERY STABLE.

Table 2.6-8. Percent Occurrence Of Hourly Observations from the Oyster Creek Site for Various Wind Speeds and Directions - Atmospheric Stability: MODERATELY STABLE.*

Direction	0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	Over 25
N	0.31**	0.13	0.32	0.44	0.10	0.04
NNE	0.07	0.26	0.59	0.27	0.21	0.01
NE	0.01	0.17	0.34	0.37	0.28	0.08
ENE	0.17	0.16	0.42	0.24	0.15	0.20
E	0.06	0.14	0.16	0.27	0.19	0.16
ESE	0.09	0.15	0.27	0.42	0.31	0.14
SE	0.09	0.32	0.46	0.39	0.17	0.21
SSE	0.09	0.17	0.45	0.30	0.25	0.06
S	0.06	0.20	0.59	1.14	0.57	0.16
SSW	0.07	0.25	0.55	1.40	1.50	0.56
SW	0.04	0.17	0.46	1.26	1.12	0.20
WSW	0.05	0.05	0.32	0.84	0.55	0.11
W	0.04	0.10	0.42	0.86	1.06	0.31
WNW	0.06	0.07	0.30	0.88	1.24	0.37
NW	0.07	0.06	0.26	0.70	1.09	0.11
NNW	0.02	0.09	0.35	0.59	0.80	0.16

** Total percentage of all columns adds to about 33%.

* Out of a total of 8016 hours during February 1966 - February 1967, 2643 hours were classified as MODERATELY STABLE.

Table 2.6-9. Percent Occurrence Of Hourly Observations from the Oyster Creek Site for Various Wind Speeds and Directions - Atmospheric Stability: NEUTRAL.*

	Speed (mph) at 400 feet					
Direction	0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	Over 25
N	0.05**	0.17	0.17	0.26	0	0
NNE	0.11	0.39	0.30	0.06	0.06	0
NE	0.05	0.36	0.87	0.47	0.50	0.06
ENE	0.10	0.27	0.67	0.34	0.29	0.21
E	0.05	0.40	0.65	0.29	0.26	0.22
ESE	0.05	0.32	0.74	0.31	0.04	0.01
SE	0.05	0.54	0.87	0.12	0.03	0.01
SSE	0.04	0.24	0.64	0.26	0.06	0.01
S	0.02	0.21	0.88	0.85	0.34	0.08
SSW	0.12	0.25	0.46	0.66	0.50	0.10
SW	0.07	0.21	0.38	0.40	0.17	0.06
WSW	0.03	0.20	0.31	0.30	0.14	0.05
W	0.06	0.25	0.32	0.42	0.27	0.21
WNW	0.06	0.11	0.45	0.50	0.67	0.24
NW	0	0.12	0.31	0.46	0.42	0.08
NNW	0.05	0.08	0.35	0.40	0.19	0.03

** Total percentage of all columns adds to about 25%.

* Out of a total of 8016 hours during February 1966 - February 1967, 1997 hours were classified as NEUTRAL.

Table 2.6-10. Percent Occurrence of Hourly Observations from the Oyster Creek Site for Various Wind Speeds and Directions - Atmospheric Stability: UNSTABLE.*

	Speed (mph) at 400 feet					
Direction	0 - 3	4 - 7	8 - 12	13 - 18	19 - 24	Over 25
N	0.04**	0.07	0.15	0.07	0	0
NNE	0.03	0.03	0.05	0.03	0	0
NE	0	0.05	0.09	0.15	0.07	0
ENE	0	0.03	0.35	0.24	0.07	0.01
E	0.03	0.10	0.36	0.10	0.04	0.03
ESE	0.03	0.06	0.31	0.03	0	0
SE	0.03	0.11	0.49	0.14	0	0
SSE	0	0.07	0.28	0.19	0.04	0
S	0.03	0.06	0.23	0.72	0.27	0
SSW	0.02	0.06	0.13	0.26	0.10	0.01
SW	0.01	0.07	0.17	0.13	0.04	0.04
WSW	0	0.14	0.35	0.20	0.03	0.03
W	0.05	0.07	0.22	0.32	0.09	0.01
WNW	0.03	0.08	0.36	0.34	0.44	0.10
NW	0.03	0.18	0.34	0.21	0.35	0.06
NNW	0.03	0.15	0.20	0.19	0.14	0

** Total percentage of all columns adds to about 11%.

* Out of a total of 8016 hours during February 1966 - February 1967, 885 hours were classified as UNSTABLE.

Unstable	11
Total	100%

The four stability categories are also classified by season and wind speed ranges (Table 2.6-11). The very stable category for overall wind speeds occurs most frequently during the autumn months. During winter, however, moderately stable conditions persist, and neutral and unstable classifications persist during the summer months. (Tables 2.6-5 through 2.6-11 were taken from Ref. 2.6-9)

2.6.3 Relative Concentration Calculations

Ground level relative concentrations are calculated using a standard elevated dispersion equation which relates the dispersion of airborne effluent to downwind distances and to the meteorological conditions that exist during the release intervals.

2.6.3.1 Elevated Dispersion Equation

Average ground level concentration within a 22.5 degree sector for specific meteorological conditions are computed with the following elevated dispersion equation:

$$X/Q = 1/[\sqrt{2\pi}\ \theta\ x\ \sigma_z\ \bar{u}_h]\ \mathrm{EXP}\ [-h_e^2/2\sigma_z^2]$$

Table 2.6-11. Seasonal Percent Occurrences Of Stability Categories for Various Wind Speed Ranges.

Wind Speed* Range (mph)	Winter	Spring	Summer	Fall
		(Very Stable)		
0- 3	0.387**	0.199	0.500	0.536
4- 7	0.785	0.561	0.836	1.46
8-12	1.39	1.28	1.48	2.88
13-18	1.98	1.56	2.34	2.13
19-24	2.29	1.42	2.32	3.25
> 25	0.512	0.312	0.324	3.24
		(Moderately Stable)		
0- 3	0.412	0.199	0.312	0.399
4- 7	0.648	0.611	0.500	0.748
8-12	1.97	1.35	1.27	1.68
13-18	3.66	1.87	1.91	2.93
19-24	4.58	1.11	1.57	2.33
> 25	1.49	0.387	1.74	0.848
		(Neutral)		
0- 3	0.062	0.312	0.399	0.150
4- 7	0.399	1.15	1.77	0.823
8-12	0.848	2.68	2.91	2.08
13-18	1.35	2.04	1.43	1.28
19-24	0.836	1.57	0.898	0.636
> 25	0.337	0.724	0.012	0.324
		(Unstable)		
0- 3	0.012	0.012	0.274	0.037
4- 7	0.050	0.162	0.972	0.175
8-12	0.075	0.848	2.87	0.287
13-18	0.162	1.10	1.88	0.162
19-24	0.299	0.985	0.374	0.012
> 25	0.087	1.87	0.012	0.0

** Total of all columns adds to about 100 percent.

* Data are reported for the period February 1966 - February 1967.

Where: σ_z = Vertical dispersion coefficient (meters) as defined by Watson and Gamertsfelder (HW-Sa 2809).

X/Q = Ground level concentration (second/cubic meter), X as a function of release rate.

θ = Sector angle in radians (same as 22½ degrees).

x = Downwind distance (meters).

$\bar{u}_h$ = Wind speed at stack height (meters/second).

h_e = Effective stack height (meters) which is the sum of the stack height (112 meters) plus plume rise (Δh).

The plume rise for the Oyster Creek 368 foot stack is calculated by the Holland-Moses Equation (Ref. 2.6-10):

$$\Delta h = c\ [1.5V_s\ d + 4 \times 10^{-5}\ Q_h]\ /\bar{u}_h$$

Where: Δh = Plume Rise (meters).

V_s = Exit Velocity (16 meters/second).

d = Stack diameter (2.5 meters).

Q_h = Heat emission of effluent (7.35×10^5 CAL/second).

$\bar{u}_h$ = Average wind speed per speed class at stack height (meters/second).

c = Correction factor for stack diameter (2.68)

2.6.3.2 Average Annual Relative Concentrations

The average annual relative concentration at a specific directional sector and radial distance from the stack is given by:

$$\bar{X}/Q_{(ij)} = 1/\sqrt{2\sigma}\ \theta\ x \sum_i \sum_j f_{(ij)}/[\sigma_{z_{(ij)}} \bar{u}_{(ij)}] EXP\ [-h_{(j)}^2/2\sigma_{z_{(ij)}}^2]$$

Where: $\bar{X}/Q_{(ij)}$ = Average relative concentration for the ith stability condition and the jth wind speed class.

$f_{(ij)}$ = Fraction of time the wind direction occurs in the i, j condition.

$h_{(j)}$ = Effective plume rise for the wind speed class of j.

$\bar{u}_{(ij)}$ = Average relative wind speed for the ith stability condition and the jth wind speed class.

All other terms as previously defined in Section 2.6.3.1.

Table 2.6-12 (Ref. 2.6-11) summarizes the annual average relative concentrations by direction and distance from the stack. The highest value computed was 6.02×10^{-9} seconds/cubic meter and was found in the north direction, 1-1/2 miles from the stack. These values of atmospheric dilution potentials are used in Section 5.2 for calculating the routine release of radioactive effluents.

2.6.3.3 Summary

Using onsite meteorological data it is concluded that the annual average dispersion value for X/Q of 6.02×10^{-9} sec/m^3 is appropriate for calculating offsite exposures. The topography of the surrounding area is flat and therefore, would not affect these estimates.

Table 2.6-12. Annual Average Integrated Air Concentration.*

Direction From Stack	Distance In Meters And Miles				
	804(M) ½(Mi)	2412 1½	4020 2½	5628 3½	7236 4½
N	4.24(- 9)	6.02(- 9)	4.97(- 9)	3.74(- 9)	2.81(- 9)
NNE	1.79(- 9)	3.86(- 9)	3.67(- 9)	2.90(- 9)	2.29(- 9)
NE	1.39(- 9)	2.83(- 9)	2.59(- 9)	2.04(- 9)	1.60(- 9)
ENE	2.32(- 9)	3.46(- 9)	2.58(- 9)	1.97(- 9)	1.50(- 9)
E	2.35(- 9)	3.90(- 9)	3.29(- 9)	2.50(- 9)	1.91(- 9)
ESE	4.04(- 9)	5.45(- 9)	3.97(- 9)	2.99(- 9)	2.24(- 9)
SE	3.38(- 9)	4.88(- 9)	3.51(- 9)	2.53(- 9)	1.83(- 9)
SSE	2.02(- 9)	3.43(- 9)	2.65(- 9)	1.97(- 9)	1.46(- 9)
S	9.30(-10)	1.98(- 9)	1.73(- 9)	1.34(- 9)	1.04(- 9)
SSW	3.10(-10)	1.59(- 9)	1.88(- 9)	1.64(- 9)	1.43(- 9)
SW	1.13(- 9)	3.60(- 9)	3.83(- 9)	3.11(- 9)	2.52(- 9)
WSW	2.33(- 9)	3.86(- 9)	3.55(- 9)	2.78(- 9)	2.18(- 9)
W	1.96(- 9)	4.13(- 9)	3.81(- 9)	2.97(- 9)	2.32(- 9)
WNW	1.29(- 9)	3.18(- 9)	3.12(- 9)	2.50(- 9)	2.00(- 9)
NW	2.39(- 9)	4.38(- 9)	4.05(- 9)	3.20(- 9)	2.53(- 9)
NNW	1.91(- 9)	3.19(- 9)	2.82(- 9)	2.18(- 9)	1.69(- 9)
	12060 7½	24120 15	40200 25	56280 35	72360 45
N	1.20(- 9)	1.41(-10)	8.19(-12)	4.75(-13)	2.75(-14)
NNE	1.13(- 9)	1.94(-10)	1.85(-11)	1.76(-12)	1.68(-13)
NE	7.81(-10)	1.29(-10)	1.17(-11)	1.05(-12)	9.54(-14)
ENE	6.59(-10)	8.50(-11)	5.54(-12)	3.61(-13)	2.36(-14)
E	8.43(-10)	1.10(-10)	7.21(-12)	4.74(-13)	3.12(-14)
ESE	9.53(-10)	1.12(-10)	6.45(-12)	3.71(-13)	2.14(-14)
SE	6.88(-10)	5.97(-11)	2.30(-12)	8.83(-14)	3.39(-15)
SSE	5.97(-10)	6.40(-11)	3.26(-12)	1.66(-13)	8.46(-15)
S	4.92(-10)	7.47(-11)	6.06(-12)	4.92(-13)	3.99(-14)
SSW	9.54(-10)	3.46(-10)	8.95(-11)	2.31(-11)	5.99(-12)
SW	1.34(- 9)	2.77(-10)	3.39(-11)	4.14(-12)	5.06(-13)
WSW	1.06(- 9)	1.72(-10)	1.53(-11)	1.36(-12)	1.21(-13)
W	1.10(- 9)	1.71(-10)	1.42(-11)	1.18(-12)	9.85(-14)
WNW	1.03(- 9)	1.96(-10)	2.14(-11)	2.34(-12)	2.55(-13)
NW	1.26(- 9)	2.17(-10)	2.09(-11)	2.01(-12)	1.93(-13)
NNW	7.81(-10)	1.14(-10)	8.77(-12)	6.75(-13)	5.19(-14)

*** Air concentration expressed in sec/cubic meter.**

**** Exponent of 10 shown in parentheses.**

REFERENCES - SECTION 2.6

2.6-1 Facility Description and Safety Analysis Report, Volume IV, Oyster Creek Nuclear Power Plant, Amendment 13; August 30, 1967, Figure 1.

2.6-2 Ibid., Portion of Tables 2, 3, 4 and 5.

2.6-3 Some Devastating North Atlantic Hurricanes of the 20th Century, U.S. Weather Bureau, published L. S. 6303, January 1968.

2.6-4 AIA Technical Reference Guide 13-2, Tornadoes.

2.6-5 Thom, H. C. S. (1963): Tornado Probabilities, Monthly Weather Review, U.S. Weather Bureau, Washington, D.C. October-December 1963, pp. 730-736.

2.6-6 Ibid., Reference 2.6-1, Table 1.

2.6-7 Ibid., Reference 2.6-1, Section 3.2.1, page 3-1.

2.6-8 Ibid., Reference 2.6-1, Section 3.2.2.1, page 3-3.

2.6-9 Ibid., Reference 2.6-1, Table 5, 6, 7, 8, 9, 10 and 11.

2.6-10 H. Moses, G. H. Strom, and J. E. Carson, Effects of Meteorological and Engineering Factors on Stack Plume Rise, Nuclear Safety, Vol. 6, No. 1, Fall 1964.

2.6-11 Ibid., Reference 2.6-1, Modified Table 28.

2.7 BIOTA

2.7.1 Aquatic

The aquatic environment of the Oyster Creek Nuclear Generating Station includes three parts: 1) fresh water, 2) brackish estuary, and 3) salt water. Extensive investigations of the aquatic biota-benthic flora and fauna and plankton have been conducted from 1965 to the present in each of these general regions. The investigations were conducted for JC by Rutgers University. The sampling period from October 1, 1966 to October 31, 1967, was selected as the baseline period.

2.7.1.1 Benthic Flora

From 1965 to 1970, 136 species of benthic flora have been recorded. Results given in Refs. 2.7-3 and 2.7-4 show that variations in both species composition and abundance were related to seasonal and yearly samplings. For example, the smallest number of algae species occurred during the warmest months, and the greatest number of species occurred in June and December. Some large changes in relative abundance, found between 1965 and 1968, 1969 and 1970, ware not considered to be related to nuclear plant operation (Ref. 2.7-4) but to normal fluctuations in the population. A ranking of the ten most abundant species in Barnegat Bay is presented in Table 2.7-1. Additional data are available in the Rutgers University progress reports (Numbers 1 through 7).

Table 2.7-1 Ranks of the Ten Most Abundant Species of Benthic Flora in Barnegat Bay During Two Different Time Periods.

RANK		SPECIES
1965-1968	1969-1970	
1	1	Ulva lactuca
2	6	Agardhiella tenera
3	5	Ceramium fastigium
4	10	Champia parvula
5	2	Gracilaria verrucosa
6	7	Polysiphonia harveyi
7	19	Acrochaetium sp.
8	*	Polysiphonia nigrescens
9	8	Gracilaria folifera
10	4	Codium fragile

*Not present

Results from these studies indicate that the majority of the species (86.5 percent) occur less than 50 percent of the time. At least 31 species can be considered uncommon to the area since they occurred, at most, only twice during a three year period. Over half (58 percent) of the species were found less than 25 percent of the time, and only 16 species occurred more than 50 percent of the time. Part of the reason for such a skewed distribution can be attributed to the difficulty of identifying all of the uncommon species every time a sample is collected. However, it is also possible that many of these species are transient visitors to the Bay and were indeed not present when each sample was collected.

In addition to the algae forms, eel grass zostera marina is an abundant vegetative type.

2.7.1.2 Benthic Fauna

There have been 170 species of benthic fauna collected (Ref. 2.7-3). Relatively few species occurred regularly throughout the sample areas, but the species most often found were Pectinaria gouldi (the golden bristled worm), Mulinia lateralis (the little mactia) and Tellina agilis. Species of sport or commercial value known to occur in the Bay are: oysters, bay scallops, hard and soft shell clams, and the blue crab.

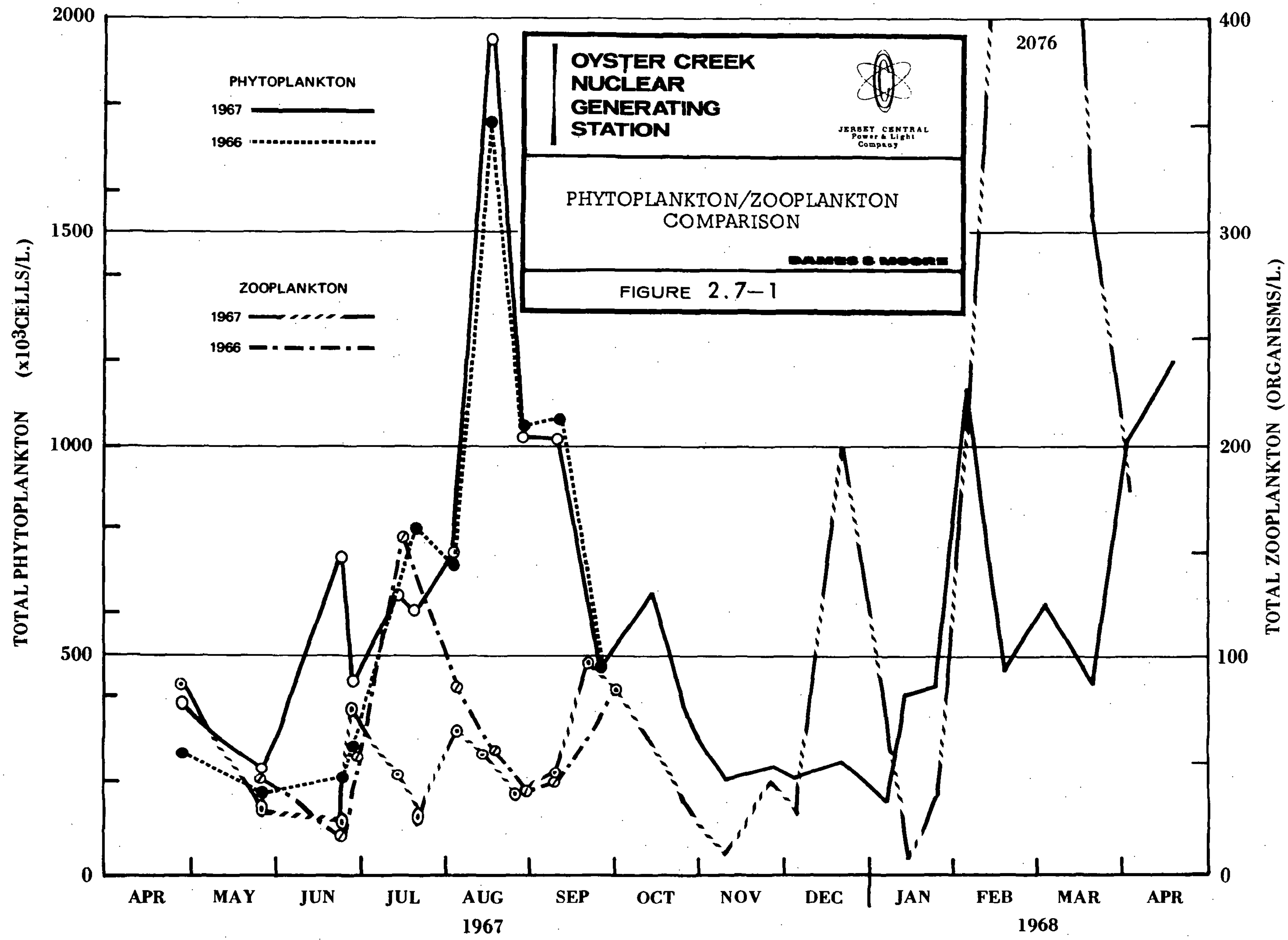
The few oysters that are present are not found in the immediate area of Oyster Creek. However, at some previous time, before these investigations were conducted, oysters must have existed there because examination of dredge spoils revealed their remains. It was beyond the scope of these studies to determine the reasons for their disappearance since it occurred before JC began site development.

Scallops, which are motile, tend to occur in clumps and are often associated with eel grass communities. These provide some sport and commercial harvest in the Bay. Clams are found near the site and in other areas, but harvesting near the site is restricted by the State of New Jersey because human habitation along the Bay has raised pollution to an unsafe level. There is a sport fishery for blue crabs nearby, though no estimates of their abundance are available.

2.7.1.3 Plankton

Plankton, phytoplankton (microscopic plant life) and zooplankton (microscopic animal life), are important links in the aquatic food chain, since they are consumed by more complex animal forms. Results in Figure 2.7-1 show phytoplankton and zooplankton relationships for the years 1967 and 1968.

The spring bloom of zooplankton begins in February, starting with Thalassiosira nordenskioldi, Detonula confervacea, and perhaps Detonula cystifera. Even though Thalassiosira was the dominant single species during the bloom, the total number of microflagellates was greater (615 of every 1119 cells were microflagellates). These tiny organisms are found in great numbers in the estuary regardless of season.


OYSTER CREEK NUCLEAR GENERATING STATION
JERSEY CENTRAL Power & Light Company
PHYTOPLANKTON/ZOOPLANKTON COMPARISON
DAMES & MOORE
FIGURE 2.7-1
PHYTOPLANKTON
1967
1966
ZOOPLANKTON
1967
1966
2076
TOTAL PHYTOPLANKTON (x10³CELLS/L.)
TOTAL ZOOPLANKTON (ORGANISMS/L.)
2000
1500
1000
500
0
400
300
200
100
0
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
1967
1968

The Thalassiosira-Detonula complex in many estuaries will be replaced by Skeletonema costatum as the water temperature approaches 20°C (68°F). Zooplankton feed on microscopic plantlife (phytoplankton) and, hence, significant zooplankton feeding, with a high standing crop of copepods, apparently prevents the intense bloom of phytoplankton from continuing. Productivity as judged by food requirements must remain high, but an equilibrium seems to exist between a succession of phytoplankters and the grazing population of zooplankters.

By June, water temperatures rising beyond the optimum of cold water diatoms and the sudden decimation of the copepod stock by predacious Ctenophores (zooplankters) brings this equilibrium to an end. Here, with warming more rapid, there is a distinct shift in the phytoplankton to a series of dinoflagellates, particularly Prorocentrum sp. At this time, occasional small "red-tide" concentrations may be observed. Dinoflagellates are distinctly dominant through much of the peak-temperature season. Concentrations exceeding a million cells per liter will form from time to time. These concentrations are capable of keeping the phytoplankton bloom in control.

The chlorophyte Nannochloris (phytoplankton) was not adequately enumerated owing to its minute size and remarkable abundance. A few estimates made during summer blooms of this organism in Barnegat Bay indicate it may superimpose populations of between 1.1 and 10.3 million cells per liter on the remaining phytoplankton community, which itself may exceed a million cells per liter at the same time.

Phytoplankton abundance approaches a minimum and a shift in species composition occurs in early January. The dinoflagellates again decrease as temperature decreases. They are replaced by a mixed diatom population of Thalassiosira and Detonula, which become seed-stock for the February spring bloom.

2.7.1.4 Zooplankton

A list of zooplankton collected in Barnegat Bay is given in Table 2.7-2. Results of zooplankton studies indicate that the spring flowering of phytoplankton provides abundant forage which will support a tremendous population of zooplankton. As the population of zooplankton increases, it is dominated by calanoid copepods, chiefly Acartia sp. In 1968, they began to appear during the first week of March. Zooplankton numbers remain fairly high through the spring, but the species begins to change with time. Through April, a number of small medusae (Periogonemus, Aequora) begin to appear. Their distribution is variable, and they appear to move about quite passively with the tide. When water temperatures exceed 15°C (59°F) the large coelenterate Cyanea capitata becomes particularly abundant. It feeds mainly on small fishes that include Menidia memedia, the metamorphosed juveniles of Anugilla americana, and small sticklebacks. Cyanea leave the Bay, usually in late May, when great numbers are seen lying senescent in the warmer shallows along the lee shore of Island Beach. None are encountered until the following spring.

Table 2.7-2 Preliminary List of Zooplankters Collected in Barnegat Bay.

1. Protozoa
   - Foraminifera -
     - Pulvinulina sp.
   - Radiolaria -
     - Unident, Radiolarian
   - Infusoria -
     - Amphileptus qutta
     - Chilodon cucullus
     - Condylostoma sp. ?
     - Dactylopusia brevicornis
     - Diophrys appendiculatus
     - Paramecium sp
     - Zoothamnium sp
     - Unident. Hypotrich protozoans
   - Tintinnoida -
     - Favella sp.
     - Tintinnus sp.
     - Unident, Tintinnids

2. Porifera
   - Unclassified Statoblasts

3. Coelenterata
   - Cnidarian Blepharoplasts
   - Cnidarian Planula
   - Aecuora sp.
   - Cyanea capitata
   - Obelia geniculata ? *
   - Perigonemus ?

4. Ctenophora
   - Beroe ovata
   - Mnemiopsis leidyi

5. Nemathelmia
   - Unidentified Nematodes *

6. Chaetognatha
   - Sagitta elegans

7. Rotifera
   - Asplanchna sp
   - Synchaeta sp.
   - Unidentified Rotifer
   - Unident. Rotifer Egg 18-1

8. Polychaeta
   - Undifferentiated Trochophores *
   - Undifferentiated Setigers *

9. Arthropoda
   - (Arachnida) - Hydrobates sp *
   - (Crustacea) -
     - Calanoid copepods, including:
       - Acartia tonsa (clausii)
       - Centropages spp.
       - Eurytemora sp
       - Temora longicornis
       - Tortanus discaudatus
     - Harpacticoid Copepods *
     - Undifferentiated Nauplii
     - Various Copepodid stages
     - Undifferentiated Copepod eggs
       including Evrytemora
   - Brachyuran Zoea -
     - Balanus (Eburneus ?) Nauplii
     - Cladocera
   - Unidentified Amphipods *
   - Undentified Mysids *
   - Unidentified Cumacid *
   - Ostracods *

10. Mollusca
    - Gastropod Veligers *
    - Pelecypod Veligers *

11. Polyzoa
    - Bryozoan Statoblasts *

12. Echinodermata
    - Pluteus Larvae *

13. Chordata (Tunicata)

14. Oikepleura Doicia
    - (Pisces) -
      - Anquilla Americana
        (post-elver juveniles)
      - Undifferentiated Fish Larvae

* Hold and Tycho-Plankters indicated.

*Fifth Progress Report, Loveland, et al., (Ref. 2.7-1).

The appearance of the ctenophore Mnemiopsis leidyi each spring in Barnegat Bay has occurred within ± one week for the past several years. The high population develops rapidly within a few days. The counts exceed $1000/m^3$. These creatures are efficient predators of the larger zooplankton, feeding with particular selectivity on the calanoid copepod Acartia (Crustacea). Consequently, the population of zooplankton is immediately reduced as the swarms of Mnemiopsis feed heavily on it. They continue to feed on the zooplankton throughout the summer. Mnemiopsis is the dominant zooplankter during most of the summer. It is unequally affected by temperature changes, being more sensitive to temperature increases than decreases. For example, when autumn specimens, acclimated to lower temperatures, are brought into the laboratory and warmed slowly to 20°C (68°F) they disintegrate in a matter of hours. On the other hand, they may be refrigerated for several days without damage. Mnemiopsis, to some extent, is replaced in autumn by a second ctenophore species Beroe ovata. However, both species apparently cease to be predators of zooplankton by about mid-October.

Despite the removal of massive predation, and perhaps because of increased thermal stress from falling temperatures, zooplankton populations continue to decrease as winter progresses. For example, results showed that it took the copepod Acartia until December to produce even a token adult population. Consequently, during the fall, exclusive of naupliar stages, the rotifers Asplanchna and Synchaeta along with tintinnid protozoa became the major species. The large loricate tintinnid Fayella has not been as abundant as the rotifers but predictable outbursts have been recorded each fall in Barnegat Bay since 1964, when collection at Mantoloking began.

A significant accumulation of zooplankton was observed by early January 1968 (Figure 2.7-1); then, during the period of minimum temperatures, only small concentrations of zooplankton could be detected. In early February, however, zooplankton began to increase, apparently because the photoplankton population increased. A lag of 27 days was observed between the apparent maximum of phytoplankton and the subsequent peak of zooplankton abundance, 2,076,100 organisms per m^3.

2.7.1.5 Fish

Studies to inventory and assess the abundance of fish in the Barnegat Bay area have been carried out from 1965 to 1971. During the period 1965 to 1968, a total of 58 species were collected. These fish encompass forms that spend all or part of their lives in the estuary system and may be grouped as follows:

1) Resident species. Those fish continuously present in the estuary and which carry out their complete life cycle in the estuary.

2) Migratory species. Those fish that enter the estuary during certain seasons of the year, either for spawning or for feeding in nursery grounds.

3) Local marine species. Those indigenous fish that have their greatest abundance in shoreline waters, but are also common in estuaries.

4) Diadromous species. Those fish that pass through the estuary to spawn in freshwater (e.g., the anadromous American shad) or in marine waters (e.g., the catadromous American eel).

5) Freshwater species. Those fish that are predominantly freshwater forms, but that have enough tolerance to salinity to occur at least sporadically in the estuary.

The following is a list of fish species found in the Barnegat Bay area:

Species*	No. Captured 1966-1968	Habit**
Alewife	8	Mig.
American Eel	98	Catad.
American Shad	1	Anad.
Atlantic Herring	1,405	Mig.
Atlantic Menhaden	7	Mig.
Atlantic Needlefish	242	Resid.
Atlantic Round Herring	?	Mig.
Atlantic Silversides	69,594	Resid.
Banded Killifish	416	Fresh
Bay Anchovy	25,950	Resid.
Black Drum	2	Mig.
Blueback Herring	81	Mig.
Bluefish	153	Mig.
Butterfish	1	Mig.
Chain Pickeral	1	Fresh
Crevalle Jack	2	Mar.
Cunner	14	Resid.
Fourspine Stickleback	20,169	Resid.
Gizzard Shad	3	Mig.-Anad.
Golden Shiner	1	Fresh
Grubby	13	Resid.
Hogchoker	6	Resid.
Horse-eye Jack	52	Mar.
Lookdown	13	Mar.
Mummichog	1,940	Resid.
Naked Goby	64	Resid.
Northern Kingfish	247	Mig.
Northern Pipefish	1,407	Res.
Northern Searobin	8	Mar.
Orangespotted Sunfish	?	Fresh
Oyster Toad Fish	271	Resid.

Species*	No. Captured 1966-1968	Habit**
Pollock	3	Mig.
Rainwater Killifish	157	Resid.
Red Grouper	1	Mig.
Roughtail Stingray	1	Mar.
Sheepshead Minnow	110	Resid.
Shorthorn Sculpin	?	Mar.
Silver Perch	3,126	Mig.
Smallmouth Flounder	2	Mig.
Spot	6	Mig.
Spotted Burrfish	?	Mar.
Spotted Seahorse	1	Resid.
Squirrel Lake	?	Mar.
Striped Bass	1	Mig.
Striped Blenny	4	Mar.
Striped Burrfish	3	Mig.
Striped Killifish	1,506	Resid.
Striped Mullet	2	Mig.
Summer Flounder	1	Mig.
Tautog	118	Mar.
Threespine Stickleback	48	Mig.
Tidewater Silversides	1,977	Resid.
Weakfish	2	Resid.
White Mullet	1	Mig.
White Perch	155	Anad.
Window Pane	17	Mar.
Winter Flounder	1,296	Resid.

*Ref. 2.7-2

**Habit:

Resid. = Resident
Mig. = Migrant
Mar. = Local Marine
Anad. = Anadromous) Diadromous
Catad. = Catadromous)
Fresh = Freshwater

The most abundant saltwater species in terms of sport or commercial fisheries are: Atlantic silversides, tidewater silversides, winter flounder, northern puffer, fourspine stickleback, northern pipefish, silver perch and bay anchovy. The species most often sought (or caught) by sport fishermen are: northern puffer, winter flounder, bluefish and weakfish. The weakfish has apparently become much more numerous in the past two years, and the bluefish is considered a highly desirable sport fish, though not present in large numbers.

Freshwater species of fish known to have existed in the South Branch of Forked River and Oyster Creek prior to construction were: chain pickeral, redfin pickeral, eastern creek chubsucker, yellow bullhead, eastern pirate perch, mud sunfish, sphagnum sunfish, fusiforn darter and eels (Ref. 2.7-15). Brook trout were introduced into Oyster Creek, but the final success is not known.

Dredging the South Branch of Forked River and Oyster Creek changed approximately two miles of those streams from a brackish water - fresh water estuary to a saline condition. This increase in salinity will result in fishes with less saline tolerance avoiding these areas. The net impact will probably be a small restriction of their downstream range.

Prior to dredging, much of the bottom supported little or no benthic life (Ref. 2.7-1); there were toxic concentrations of hydrogen sulfide and low levels of dissolved oxygen. Consequently, the fish population was low because the stream was not suited to support a large fish population.

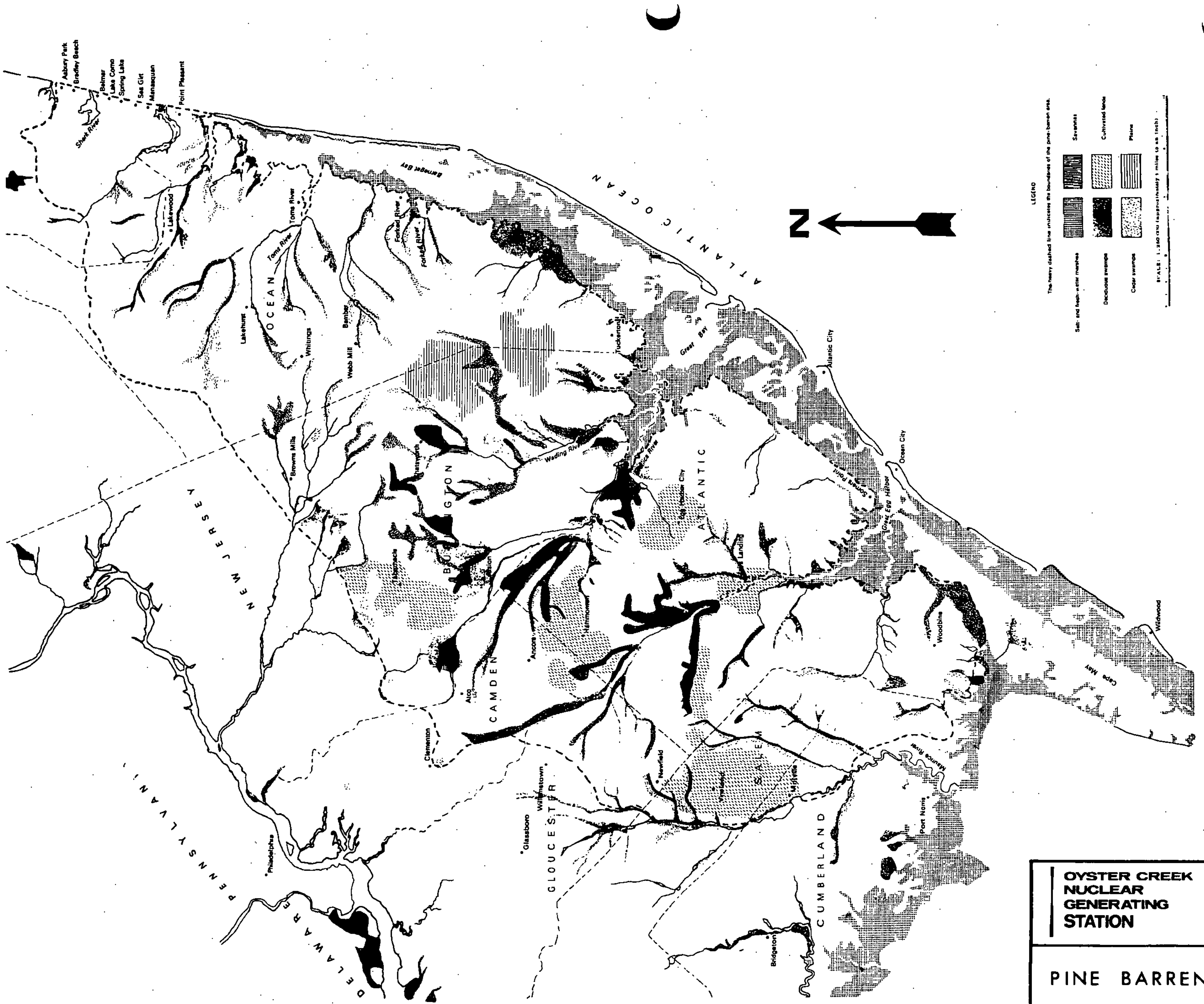
2.7.2 Terrestrial

The types of plants and animals existing in the vicinity of the plant are identified in this section. The types of vegetation are also identified and discussed in this section because types of vegetation offset the distribution of animals.

Six vegetation types characteristic of the coastal pine barrens (Figure 2.7-2) have been identified (Ref. 2.7-4) and their acreages measured from aerial photographs (Table 2.7-3). The types include white cedar (swamps), hardwoods, mixed pine hardwoods, pine sites, salt water marsh and non-forested areas. Non-forested areas within a five miles radius of the plant include primarily the Oyster Creek facility itself, farmlands, highways, lakes, and small towns. With the exception of the salt water marshes, the 755 acres west of Highway 9 were believed to have included representatives of the other five vegetative types prior to construction of the facility. Each type of vegetation present within five miles of the site, with specific examples, is given in Table 2.7-4, and briefly described in the following paragraphs. Subsequent sections describe waterfowl and wildlife found in the area.

2.7.2.1 White Cedar Swamps

White cedar swamps occur in lowland areas and occasionally along the stream beds. The dominant member of the overstory is white cedar, with an occasional red maple and sweet bay magnolia on higher ground. The understory



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

PINE BARREN MAP

FIGURE 2.7-2

Table 2.7-3. Vegetation Types and Acreage Within An Approximate Five-Mile Radius of Oyster Creek.*

Vegetation Type	Acreage	Percent of Total Area
Hardwood	4,552	11.6
White Cedar	602	1.5
Mixed Hardwood-Pine	15,926	40.5
Pine	3,766	9.5
Saltwater Marsh	1,758	4.6
Non-Forested	12,702	32.3
Total:	39,306	100.0

*Ref. 2.7-5

Table 2.7-4. Five Common Types of Vegetation in the Vicinity of the Plant Site.

HARDWOODS

Overstory	Understory
Quercus velutina-Black oak	*Quercus ilicifolia*-Scrub oak
Quercus coccinea-Scarlet oak	*Kalmia latifolia*-Mountain laurel
Quercus alba-White oak	*Vaccinium stamineum*-Deerberry
	Sassafras albidum-Sassafras
	Pteris aquilina-Bracken

MIXED SITE

Overstory	Understory
Pinus rigida-Pitch pine	*Sassafras albidum*-Sassafras
Quercus alba-White oak	*Kalmia latifolia*-Mountain Laurel
Quercus coccinea-Scarlet oak	*Kalmia angustifolia*-Sheep laurel
Quercus velutina-Black oak	*Smilax rotundifolia*-Greenbrier
Nyssa sylvatica-Black gum	*Quercus ilicifolia*-Scrub oak
	Vaccinium corymbosum-Highbush Blueberry
	Gaultheria procumbins-Teaberry
	Amelanchier canadensis-Shadbush
	Rhus copallina-Winged sumac (Dwarf Sumac)
	Comptonia peregrina-Sweetfern
	Pteris aquilina-Bracken

PINE SITE

Overstory	Understory
Pinus rigida-Pitch pine	*Acer rubrum*-Red maple
	Quercus phellos-Willow oak
Shrub Layer	*Quercus alba*-White oak
Quercus ilicifolia-Scrub oak	*Quercus velutina*-Black oak
Quercus prinoides-Scrub chestnut oak	*Sassafras albidum*-Sassafras
Myrica pennsylvanica-Bayberry	*Nyssa sylvatica*-Black gum
Kalmia angustifolia-Sheep laurel	*Diospyros virginiana*-Persimmon
	Prunus serotina-Black cherry

Table 2.7-4. (Cont'd.)

WHITE CEDAR SWAMP	Overstory	Understory
	Chamaecyparis thyoides-White cedar	Ilex glabra-Inkberry Acer rubrum-Red maple Myrica pennsylvanica-Bayberry Vaccinium corymbosum-Highbush Blueberry Parthenocissus quinquefolia-Virginia creeper Rhus vernix-Poison sumac Clethra alnifolia-Sweet pepperbush Magnolia virginiana-Sweetbay magnolia Ilex decidua-Deciduous holly Rhododendron viscosum-White swamp azalea Chamaedaphne calyculata-Leatherleaf
MARSH	Hibiscus palustris-Rose mallow Kosteletzkya virginica-Seashore mallow Sabatia stellaris-Marsh pink Asclebias incarnata-Swamp milkweed Ipomoea lacuxosa-Morning glory Verbena stricta-Blue veruan Solidago sempervirens-Seaside goldenrod Phragmites communis-Common reed Rosa palustris-Swamp rose Rhus copallina-Dwarf sumac Viburnum recognitum-Smooth arrowood Baccharis halimifolia-Groundsel bush Vaccinium corymbosum-Highbush blueberry Myrica pennsylvania-Bayberry Sassafras albidum-Sassafras Osmunda regalis-Royal fern Dicksonia pilousinscula-Hayscented fern Carex spp. - Sedges	

includes a dense growth of bayberry and highbush blueberry under the canopy. White swamp azalea and leatherleaf are predominant in the bogs. Understory in the white cedar swamps provides habitat for white-tailed deer, cottontail rabbit, raccoon, mink, and weasel. Bobwhite Quail occur in areas of light density understory with openings nearby. Curly grass fern is also indigenous to the white cedar swamps of the pine barrens.

2.7.2.2 Hardwoods

The hardwood communities are completely dominated by black, scarlet, and white oaks. The understory is principally scrub oak, mountain laurel and bracker fern which is used by deer, fox, raccoon, gray squirrel, Ruffed Grouse, and Bobwhite Quail for food and/or cover.

2.7.2.3 Mixed Pine Hardwood

The dominant species in the mixed pine hardwood sites include white and black oaks and clusters of pitch pine. The dense understory, including sassafrass, highbush blueberry, shadbush, and ferns, provide only limited nesting habitat for Bobwhite Quail, but provide adequate browse and cover for white-tailed deer and cottontail rabbit. Bobwhite and Ruffed Grouse may find the mixed sites ideal where the density of understory is light, and buds and fruits are abundant.

2.7.2.4 Pines

The pine areas are dominated by pitch pine. The understory is high, reaching an approximate height of 15 feet. A lower shrub layer is well defined and dominated with chestnut oak and scrub oak (Ref. 2.7-4).

2.7.2.5 Marsh

The predominant plant species in salt water marsh areas is the common reed. Muskrat, mink, raccoon, and numerous migratory and nesting shore birds and waterfowl utilize this habitat for feeding, loafing, or nesting. Coastal estuaries of the Atlantic are important migratory nesting and winter locales for a variety of waterfowl.

2.7.2.6 Wildlife

Wildlife indentified in the area are listed in Table 2.7-5. The principal species of wildlife of economic or recreational importance in the vicinity of the plant include the following game mammals: woodchuck; gray, red and southern flying squirrel; gray and red fox; and white-tailed deer.

The woodchuck is not very common in the coastal pine barrens of New Jersey (Ref. 2.7-9). Poor soil conditions for dens and lack of open fields with edible plants are important factors in its limited distribution.

Table 2.7-5. Wildlife Identified In The Vicinity Of The Plant Site June 1971.

FROGS AND TOADS

Green Frog - Common in all wet places.
Southern Leopard Frog - Caught in both cedar swamp sites.
Pine Barrens Treefrog - Heard calling at both cedar swamp sites.
Carpenter Frog - Heard calling at one cedar swamp site and at other swamps in the area.
Fowler's Toad - Caught on upland sites and frequently caught in salt marsh.

TURTLES

Eastern Painted Turtle - Caught at pond near cedar swamp.
Spotted Turtle - Seen along Cedar Creek.
Wood Turtle - Single individual caught in pine upland site.
Eastern Box Turtle - Very common at all sites.

LIZARDS

Northern Fence Lizard - Seen at upland mixed site.

SNAKES

Northern Black Racer - Seen along road in upland hardwood area.
Northern Water Snake - Found at lake near cedar swamp.

MAMMALS

Opossum - Two individuals seen dead along the road.
Eastern Cottontail - Very common at all sites.
Red Squirrel - Common in pine and mixed sites.
Gray Squirrel - Individuals seen in woods near Waretown.
White-footed Mouse - Thirteen individuals caught at sites #5 and #7 during 40 trap-nights.
Red-backed Vole - Single individual seen in cedar swamp.
Meadow Vole - Droppings and cuttings abundant in salt marsh.
Pine Vole - Seen frequently at upland sites.
Muskrat - Signs and houses common in salt marsh.
Eastern Mole - Tunnels common on upland sites.
Raccoon - Tracks seen at lakes in the area and in the salt marsh.
White-tailed Deer - Very common at all sites.

Table 2.7-5. (Cont'd.)

BIRDS (Species judged by Rutgers University to be nesting within the 5-mile radius area from field observations.)

Green Heron	Tufted Titmouse
Mallard	White-breasted Nuthatch
Black Duck	House Wren
Wood Duck	Mockingbird
Turkey Vulture	Catbird
Red-shouldered Hawk	Brown Thrasher
Sparrow Hawk	Robin
Ruffed Grouse	Starling
Bobwhite	Red-eyed Vireo
Killdeer	Black and White Warbler
Mourning Dove	Blue-winged Warbler
Yellow-billed Cuckcoo	Pine Warbler
Whip-poor-will	Ovenbird
Common Nighthawk	Yellowthroat
Belted Kingfisher	House Sparrow
Yellow-shafted Flicker	Red-winged Blackbird
Hairy Woodpecker	Baltimore Oriole
Downy Woodpecker	Common Grackle
Eastern Kingbird	Brown-headed Cowbird
Great Crested Flycatcher	Scarlet Tananger
Eastern Phoebe	Cardinal
Eastern Wood Pewee	American Goldfinch
Tree Swallow	Rufous-sided Towhee
Barn Swallow	Seaside Sparrow
Purple Martin	Chipping Sparrow
Blue Jay	Field Sparrow
Common Crow	Swamp Sparrow
Fish Crow	Song Sparrow
Carolina Chickadee	

Gray and red squirrels are common, primarily wherever deciduous trees are found. The seed, twigs, and bark from the four species of oak and other seed producing trees provide a food supply for the gray squirrel in the fall, winter, and early spring. There are very few squirrels on the site itself because of the scattered distribution of deciduous trees.

The gray fox is common, whereas the red fox is rare in southern New Jersey. The fox population fluctuates with changes in the abundance of prey - small mammals and game birds.

Small mammals are more common in open areas near streams, cedar swamps, and bogs (Ref. 2.7-9). Mink, weasel and muskrat are common inhabitants of streams and bogs in the pine barren region. Mink and weasel have not been seen on the site but could be expected to exist in small numbers because the area is suitable.

The largest and most significant game mammal in the area is the white-tailed deer. According to a state conservation office, white-tailed deer are abundant in the area of the site. White cedar and the associated understory vegetation of hardwoods, mixed sites, and pine provides diverse and abundant browse for the deer all year.

Colonies of beaver are found in the coastal marshes of Barnegat Bay according to a state wildlife biologist. Some local residents trap beavers each fall.

2.7.2.7 Gamebirds and Waterfowl

The important gamebirds in the area include Ruffed Grouse, Bobwhite Quail, and waterfowl. A listing of birds found in the area and their seasonal occurrence (Table 2.7-6) was compiled by personnel of Rutgers University (Ref. 2.7-6) and through other literature reviews (Refs. 2.7-7, 2.7-8, 2.7-11 and 2.7-14).

The coastal estuaries provide habitat for migrating waterfowl (Ref. 2.7-13). Long Beach State Park and the New Jersey State Game Farm near Lanoka Harbor have been designated as sanctuaries. Barnegat Bay, too, provides sufficient sanctuary for waterfowl in the area. According to a state wildlife biologist, the Bay has an abundant food supply (i.e., shell-fish and eelgrass) for the wintering birds.

Barnegat Bay is within the Atlantic Flyway, which receives ducks from several corridors (Ref. 2.7-4) traveling from the Maritime Provinces of Canada to spend the winter along the Atlantic Coast. Up to 100,000 Dabbling Ducks, including Mallards, Teal, Widgeons, Redheads, and Gadwalls, have been recorded in the Barnegat Bay area. The Atlantic Coast corridor funnels an estimated 25,000 Lesser Scaup, 225,000 Greater Scaup, and 10,000 Canvasbacks each year to the principal wintering areas of Chesapeake Bay and points southward. A few Ring-necked Ducks, Old Squaws, Scoters, and Eiders are also included.

According to a state conservation officer and wildlife biologist,

Table 2.7-6. Birds Common to the Pine Barrens and Coastal Waters Near the Plant Site.

Common Name	Scientific Name	Seasonal Occurrance*
Common Loon	Gavia immer	W
Red-Throated Loon	Gavia stellata	W
Red-necked Grebe	Padiceps grisegena	W
Horned Grebe	Padiceps auritus	M
Pied-billed Grebe	Podilymbus podiceps	S
Double-crested Cormorant	Phalacrocorax auritus	W
Common Egret	Casmerodius albus	S
Great Blue Heron	Ardea herodias	S
Green Heron	Butorides virescens	S
Black-crowned Night Heron	Nycticorax nycticorax	S
Mute Swan	Cygnus olor	W
Whistling Swan	Olor columbianus	M
Canada Goose	Branta canadensis	W
Brant	Branta bernicla	W
Snow Goose	Chen hyperborea	W
Mallard	Anas platyrhynchos	P
Black Duck	Anas rubripes	P
Pintail	Anas acuta	M
Gadwall	Anas strepera	M
American Widgeon	Mareca americana	M
European Widgeon	Mareca penelope	W
Shoveler	Spatula clypeata	M
Blue-winged Teal	Anas discors	M
Green-winged Teal	Anas carolinensia	M
Wood Duck	Aix sponsa	S
Redhead	Aythya americana	M
Canvasback	Aythya valisineria	M
Ring-necked Duck	Aythya collaris	M
Greater Scaup	Aythya marila	W
Lesser Scaup	Aythya affinis	M
Common Goldeneye	Bucephala clangula	W
Bufflehead	Bucephala albeola	W
Ruddy Duck	Oxyura jamaicensis	M
Red-breasted Merganser	Mergus serrator	M
Hooded Merganser	Lophodytas cucullatus	M
Turkey Vulture	Cathartes aura	S

Table 2.7-6. (Cont'd.)

Common Name	Scientific Name	Seasonal Occurrance *
Mourning Dove	Zenaidura macroura	S
Yellow-billed Cuckooo	Coccyzus americanus	s
Black-billed Cuckcoo	Coccyzus erythropthalmus	S
Screech Owl	Otus asio	P
Great Horned Owl	Bubo virginianus	P
Short-eared Owl	Asio flammeus	W
Saw-whet Owl	Aegolius acadicus	W
Chuck-will's-widow	Caprimulgus carolinensis	S
Whip-poor-will	Caprimulgus vociferus	S
Common Nighthawk	Chordeiles minor	S
Chimney Swift	Chaetura pelagica	S
Ruby-throated Hummingbird	Archilochus colubris	S
Belted Kingfisher	Megaceryle alcyon	S
Yellow-shafted Flicker	Colaptes auratus	P
Red headed Woodpecker	Melanerpes crythrocephalus	S
Red-bellied Woodpecker	Centurus carolinus	P
Yellow-bellied Sapsucker	Sphyrapicus varius	P
Hairy Woodpecker	Dendrocopos villosus	P
Downy Woodpecker	Dendrocopos pubescens	P
Eastern Kingbird	Tyrannus tyrannus	S
Great Crested Flycatcher	Myiarchus crinitur	S
Eastern Phoebe	Sayornis phoebe	S
Acadian Flycatcher	Empidonax virescens	S
Traill's Flycatcher	Empidonax traillii	M
Least Flycatcher	Empidonax minimus	S
Eastern Wood Pewee	Contopus virens	S
Tree Swallow	Iridoprocne bicolor	S
Rough-winged Swallow	Stelgidopteryx ruficollis	S
Barn Swallow	Hirundo rustica	S
Purple Martin	Progne subis	S
Blue Jay	Cyanocitta cristata	P
Common Crow	Corvus brachyrhynchos	P
Fish Crow	Corvus ossifragus	P
Black-capped Chickadee	Parus atricapillus	P
Carolina Chickadee	Parus carolinensis	P
Tufted Titmouse	Parus bicolor	P
White-breasted Nuthatch	Sitta carolinensis	P
Red Breasted Nuthatch	Sitta canadensis	M
Brown Creeper	Certhia familiaris	W
House Wren	Troglodytes aedon	S
Carolina Wren	Thryothorus ludovicianus	P
Long-billed Marsh Wren	Telatodytes palustris	S

Table 2.7-6. (Cont'd.)

Common Name	Scientific Name	Seasonal Occurrance*
Red-tailed Hawk	Buteo jamaicensis	P
Red-shouldered Hawk	Buteo lineatus	S
Broad-winged Hawk	Buteo platypterus	S
Marsh Hawk	Circus cyaneus	P
Osprey	Pandion haliaetus	S
Pigeon Hawk	Falco columbarius	M
Sparrow Hawk	Falco sparverius	P
Ruffed Grouse	Bonasa umbellus	P
Bobwhite	Colinus virginianus	P
Ring-necked Pheasant	Phasianus colchicus	P
Virginia Rail	Rallus limicola	S
Semipalinated Plover	Charadrius semipalmatus	M
Killdeer	Charadrius rociferus	P
Solitray sandpiper	Actitis macularia	M
Spotted sandpiper	Actitus macularia	M
Greater Yellowlegs	Totanus melanolencus	M
Lesser Yellowlegs	Totanus flavipes	M
Least Sandpiper	Erolia minutilla	M
Semipalmated Sandpiper	Ereunetes pusillus	M
American Woodcock	Philohela minor	S
Herring Gull	Larus argentatus	W
Ring-billed Gull	Larus delawarensis	W
Laughing Gull	Larus atricilla	M
Bonaparte's Gull	Larus philadelphia	W
Common Tern	Sternahirunda	M
Black Tern	Chlidonias niger	M
Black Skimmer	Rynchops nigra	M
Mockingbird	Mimus polyglottos	W
Catbird	Dumetella carolinensis	S
Brown Thrasher	Toxostoma rufum	S
Robin	Turdus migratorius	S
Wood Thrust	Hylocichla mustelina	S
HermitThrush	Hylocichla guttala	S
Swainson's Thrush	Hylocichla ustulata	M
Gray-cheeked Thrush	Hylocichla minima	M
Veery	Hylocichla fuscescens	S
Eastern Bluebird	Sialia sialis	S
Blue-gray Gnatcatcher	Polioptila caerulea	S
Golden-crowned Kinglet	Regulus satrapa	P
Ruby-crowned Kinglet	Regulus calendula	M
Cedar Waxwing	Bombycilla cedrorum	P
Loggerhead Shrike	Lanius ludovicianus	P

Table 2.7-6. (Cont'd.)

Common Name	Scientific Name	Seasonal Occurrance*
Starling	Sturnus vulgaris	P
White-eyed Vireo	Vireo griseus	S
Yellow-throated Vireo	Vireo flavifrons	S
Red-eyed Vireo	Vireo olivaceus	S
Black-and-White Warbler	Mniotilta varia	S
Prothonotary Warbler	Protonotaria citrea	S
Golden-winged Warbler	Vermivora chrysoptera	S
Blue-winged Warbler	Vermivora pinus	S
Tennessee Warbler	Vermivora peregrina	M
Parula Warbler	Parula americana	S
Yellow Warbler	Dendroica petechia	S
Magnolia Warbler	Dendroica magnolia	S
Cape May Warbler	Dendroica tigrina	M
Black-throated Blue Warbler	Dendroica caerulescens	S
Myrtle Warbler	Dendroica coronata	W
Black-throated Green Warbler	Dendroica virens	S
Blackpoll Warbler	Dendroica striata	M
Pine Warbler	Dendroica pinus	S
Prairie Warbler	Dendroica discolor	S
Palm Warbler	Dendroica palmarum	M
Ovenbird	Seiurus aurocapillus	S
Northern Waterthrush	Seiurus noveboracensis	S
Yellowthroat	Geothlypis trichas	S
Yellow-breasted Chat	Icteria virens	S
Hooded Warbler	Wilsonia citrina	S
Wilson's Warbler	Wilsonia pusilla	M
American Redstart	Setophaga ruticilla	S
House Sparrow	Passer domesticus	P
Eastern Meadowlark	Sturnella magna	P
Red-winged Blackbird	Agelaius phoeniceus	S
Orchard Oriole	Icterus spurius	S
Baltimore Oriole	Icterus galbula	S
Common Grackle	Quiscalus quiscula	S
Brown-headed Cowbird	Molothrus ater	S
Scarlet Tanager	Piranga olivacea	S
Cardinal	Richmondena cardinalis	P
Rose-breasted Grosbeak	Pheucticus ludovicianus	S
Evening Grosbeak	Hesperiphona vespertina	W
Indigo Bunting	Passerina cyanea	S
Purple Finch	Carpodacus purpureus	P
Common Redpoll	Acanthis flammea	W
Pine Siskin	Spinus pinus	W

Table 2.7-6. (Cont'd.)

Common Name	Scientific Name	Seasonal Occurrance*
American Goldfinch	Spinus tristis	P
Red Crossbill	Loxia curvirostra	W
White-winged Crossbill	Loxia leucoptera	W
Rufous-sided Towhee	Pipilo erythrophthalmus	P
Henslow's Sparrow	Passerherbulus henslowii	S
Sharp-tailed Sparrow	Ammospiza caudacuta	S
Seaside Sparrow	Ammospiza maritima	S
Vesper Sparrow	Pooecetes gramineus	S
Slate-colored Junco	Junco hyemalis	W
Chipping Sparrow	Spizella passerina	S
Field Sparrow	Spizella pusilla	S
White-throated Sparrow	Zonotrichia albicollis	W
Fox Sparrow	Passerella iliaca	M
Swamp Sparrow	Melospiza georgiana	W
Song Sparrow	Melospiza melodia	P

* P = Permanent resident

S = Summer

W = Winter

M = Migratory

approximately 180,000 Brant spend the winter between Barnegat Bay and Cape May Point.

Additional birds of significance are the Osprey, an endangered species. According to a state conservation officer, six pair nested in the Ocean County area during the 1971 breeding season but no young hatched.

According to a state conservation officer, Ruffed Grouse utilize the small pockets of lowland hardwoods for breeding habitat and are not abundant on the plant site.

The partially open understory found in the hardwoods and pine sites provide adequate nesting habitat for the Bobwhite Quail (Ref. 2.7-11). The Bobwhite Quail is attracted by edge vegetation formed by brush and trees that border openings in the pine and hardwood areas. A limited number of openings occurred in the area between Highway 9 and the Garden State Parkway prior to the construction of the Oyster Creek plant. Bobwhite Quail have been seen in the plant environs.

The Ring-necked Pheasant, although abundant in the farm communities of northern New Jersey, seldom extend their range into the southern counties of the State, and therefore is not an important gamebird in the vicinity of the plant site (Ref. 2.7-12).

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3.0

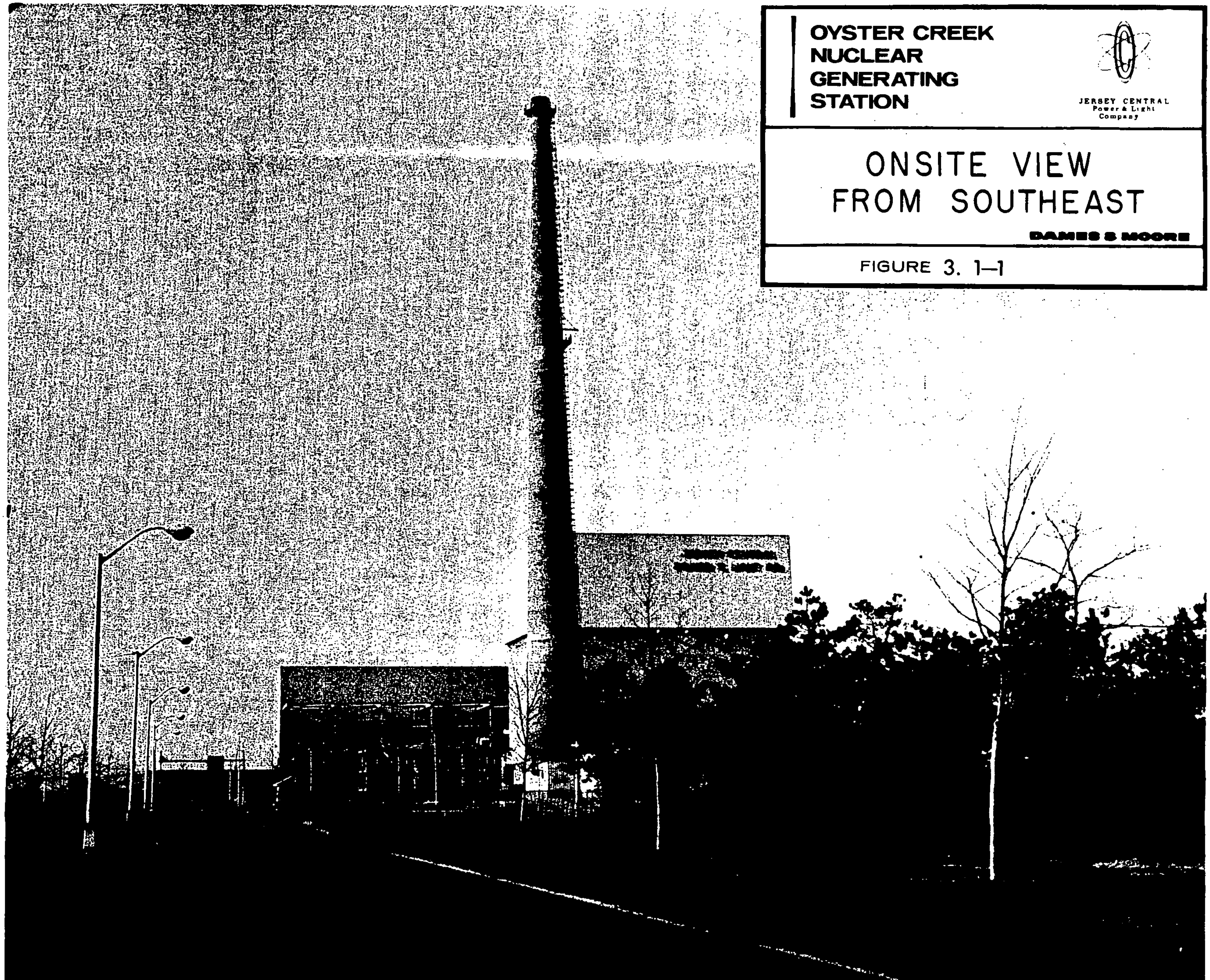
THE PLANT

3.1 EXTERNAL APPEARANCE OF PLANT

The landscape in the immediate vicinity of the plant is characterized by moderate vegetation. The foliage ranges from grass to pines and small oaks. The terrain is naturally flat, with the predominant man-made features (roadways, railroads, marinas, and beach cottages) reinforcing this horizontality.

The plant is shown in Figure 3.1-1 and is punctuated with a concrete chimney stack that rises 368 feet. The stack, about 30 feet in diameter at the base and ten feet in diameter at the top, is visible for several miles. The lower elements, though visible at shorter distances, are more massively proportioned. The reactor building is almost cubic and rises about 140 feet above grade. It is built primarily of exposed concrete, with the upper one-third being enclosed in neutral gray metal corrugated siding.

The turbine building is the largest single element in the complex. Though lower in profile than the reactor containment building, it covers more than twice the ground area. It is sheathed in metal siding to match the upper portion of the reactor building.



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

ONSITE VIEW FROM SOUTHEAST

DAMES & MOORE

FIGURE 3. 1–1

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

OFFSITE VIEW FROM SOUTHEAST

DAMES & MOORE

FIGURE 3. 1–2

to Lacey Road which was clear-cut to a width of about 160 feet. The effects of clear-cutting the right-of-way have been beneficial to wildlife in the area because it removed overstory and allowed low lying vegetation to become established which serves as feed and cover for mammals such as white-tail deer, cottontail rabbit, and Bobwhite Quail. JC has recently modified its underbrush clearing procedures to promote regrowth of natural vegetation on the right-of-way at primary and secondary road crossings to provide vegetative visual barriers at these locations.

The Oyster Creek-Manitou right-of-way crosses one state park, Double Trouble State Park, which is reserved for recreation and wildlife. Five commercial cranberry bogs were also located in the Park. JC met with representatives of the State of New Jersey, Department of Conservation and Economic Development to establish an alternate right-of-way through the Double Trouble property so the right-of-way would not handicap the outdoor recreation and conservation purpose for which the property was acquired. In addition, the right-of-way was also rerouted to avoid the bogs and a lake situated in the Park. The line was routed to avoid a cranberry bog at Jake's Branch (Figure 3.2-2), and all nearby agricultural areas. Even though the transmission right-of-way was constructed before guidelines of the Federal Power Commission Order 414 were released, JC took measures that coincidently conform to the Order (see Section 3.2.1.2).

The Ocean County Historical Society and the State Museum of New Jersey were consulted to verify that the transmission right-of-way did not affect the 47 historic sites in Ocean County listed by the State

Museum in Trenton, New Jersey. (The list of historical sites is given in Section 2.3-1.)

3.2.1.2 Segmental Analysis of the Oyster Creek-Manitou Network

A. Oyster Creek Nuclear Generating Station Switchyard to the Western Side of the Garden State Parkway

The transmission corridor has been divided into four segments, A, B, C and D. Section A of the right-of-way is 1.2 miles long and entirely clear-cut (Figure 3.2-2).

The east view from the northbound lanes of the Garden State Parkway is one with a 240 foot wide corridor with no screening present; a tunnel view exposes the switchyard. Sparse vegetation covers the first third of the corridor, but is slowly being reestablished and partial screening should be accomplished within the next few years.

The west view from the northbound lanes and both east and west views from the southbound lanes of the Parkway presents well planned transmission line crossings designed to show the passing motorist the least possible amount of cleared right-of-way. Here the right-of-way was cleared only to a width of 40 feet. Ground cover is present in this corridor, which prevents erosion and provides cover and food for wildlife. The transmission tower on the west side of the Parkway is well set back and its appearance largely masked. Only the overhead wires are visible from the Parkway. The long tunnel view to the east is entirely masked by the small clearing across the Parkway median. Even the Oyster Creek Nuclear Generating Station is invisible from this point. This road crossing conforms to guidelines of the Federal Power Commission Order 414 (specifically, Guidelines 6, 7, 8, 10, 12, 14, 19, 20, 25, 33 and 34).

B. Garden State Parkway Crossing to Lacey Road

The total distance of Section B is 3.3 miles and includes 0.9 miles of white cedar swamp. The right-of-way has been clear-cut to a width of 160 feet. Lacey Road is the only road encountered in this section and screening along the road is not effective at present. This results in a tunnel view of over two miles across a pitch pine forest and white cedar swamp. However, as at other road crossings, JC is allowing natural growth to mask the tunnel view.

The transmission line right-of-way also parallels the Garden State Parkway for the entire 3.3 miles of Section B, but is hidden from motorists' view by a 75 foot wide pitch pine forest screen. The Parkway Authority values the clear-cut right-of-way as a fire break. This section of right-of-way is an example of Guideline No. 29 of the Federal Power Commission Order 414 which states: "Long views of transmission lines parallel to highways should be avoided where possible. This may be accomplished by overhead lines being placed beyond ridges or timber areas."

C. Lacey Road to Dover Road

Section C is 5.4 miles long. The transmission lines cross Lacey Road, Pinewald-Keswick Road and Dover Road. The south view of Dover Road does not have a tunnel view, but Lacey Road has a tunnel view about two miles long looking north and Pinewald-Keswick Road has a tunnel view of approximately one mile on both sides of the road. To facilitate the regrowth of natural visual barriers, applications of chemical retardants have been eliminated at road crossings. JC also made an arrangement with the State of New Jersey whereby JC removed the stumps, prepared the area for seeding and provided grass seeds to the State. The State sowed the seed to provide habitat for wildlife and provide cover to prevent erosion.

The right-of-way was clear-cut to a width of about 240 feet, and approximately 2.0 miles of white cedar swamps were cutover in the process. A service road for the transmission line crosses ten streams. However, the largest stream, Cedar Creek, was not crossed. JC plans to allow the swamp vegetation to grow back and only that vegetation posing a fire hazard or hazard to the transmission line will be removed.

The transmission right-of-way also crosses Double Trouble State Park, but is located far enough west to avoid the lake and five cranberry bogs within the Park. The right-of-way was also routed around a similar bog on Jake's Branch.

D. Dover Road to Manitou Substation, Toms River, New Jersey

Section D comprises the final 1.2 miles of transmission line leading to the Manitou Substation. No swamps are encountered along this section. The route crosses Dover Road. Since it was clear-cut there is no real screening yet present; consequently, when looking north from the road a tunnel view of approximately one mile can be seen. In order to facilitate the regrowth of natural visual barriers, chemical applications have been eliminated near Dover Road.

A residential subdivision lies south of the right-of-way, with at least 60 homes having a possible view of the transmission line route. The potential visual impact is lessened by the presence of a large strip of pitch pine lying parallel to the transmission corridor and helping to screen the transmission line from view of the subdivision. Apparently residents in the area have not been affected by the transmission lines and the right-of-way because JC has not received complaints.

3.2.1.3 Transmission Right-of-Way Maintenance Programs

Proper maintenance of all JC rights-of-way has always been of great concern to the Company. Figure 3.2-3 shows the transmission lines involved in the JC system. Prior to 1947 the transmission line right-of-way vegetation maintenance program consisted of periodic cutting, an expensive and time consuming program. It was then decided to experiment with a pilot chemical brush control program. In 1950 the Company instituted the program on a permanent basis and placed all rights-of-way under chemical management.

The entire vegetation management maintenance program is administered by a Company forester who is a tree expert certified by the State of New Jersey, Department of Environmental Protection, Bureau of Tree Experts. The vegetation management staff is responsible for selectively controlling the vegetation on approximately 15,000 acres of transmission rights-of-way with chemicals. Current repetitive treatment cycles range from three to six years depending on the local growth rate. (A selective basal ground application method is used in the maintenance program.) The objective is to eliminate certain specified undesirable vegetation and to promote growth of a stable ground cover of grasses, wild flowers, and native low lying shrubs and trees. Available evidence indicates that wildlife has not been adversely affected by the program and that food supplies are adequate along the rights-of-way. Herds of deer, for example, have been sighted along the Oyster Creek-Manitou right-of-way. Numerous locations have been found where deer have bedded down or grazed within the right-of-way.

Public acceptance of the chemical program has been very favorable, largely due to the "selective" approach and timely scheduling of repetitive treatment which has improved the aesthetics by eliminating unsightly "brown out" areas. Since most of the transmission rights-of-way are easements, a "courtesy call" is made wherever possible to inform each property owner that JC will be traversing and chemically treating the right-of-way on his property. Objections attributable to the chemical programs over the past 23 years have been minimal, and those that did develop were usually found to have been based on misunderstandings.

JC is aware that its activities are under close public scrutiny and has modified the transmission right-of-way management program to meet certain objections of the public. For example, chemical applications have been customized to better suit local conditions. Rights-of-way in the vicinity of heavily populated areas, major recreational areas, camp sites, summer colonies, and similar facilities are treated only during the dormant season when the public is least affected.

The rates of chemical applications comply with state and federal regulations and are made in such a manner to prevent pollution of nearby reservoirs or creeks.

In 1970, JC altered its brush control program to eliminate application of chemical growth retardants on its rights-of-way at all primary and secondary road crossings to facilitate the regrowth of natural vegetation to serve as visual barriers at these locations. Presently, the vegetation is not high enough to provide effective screening, but should be adequate within the next few years.

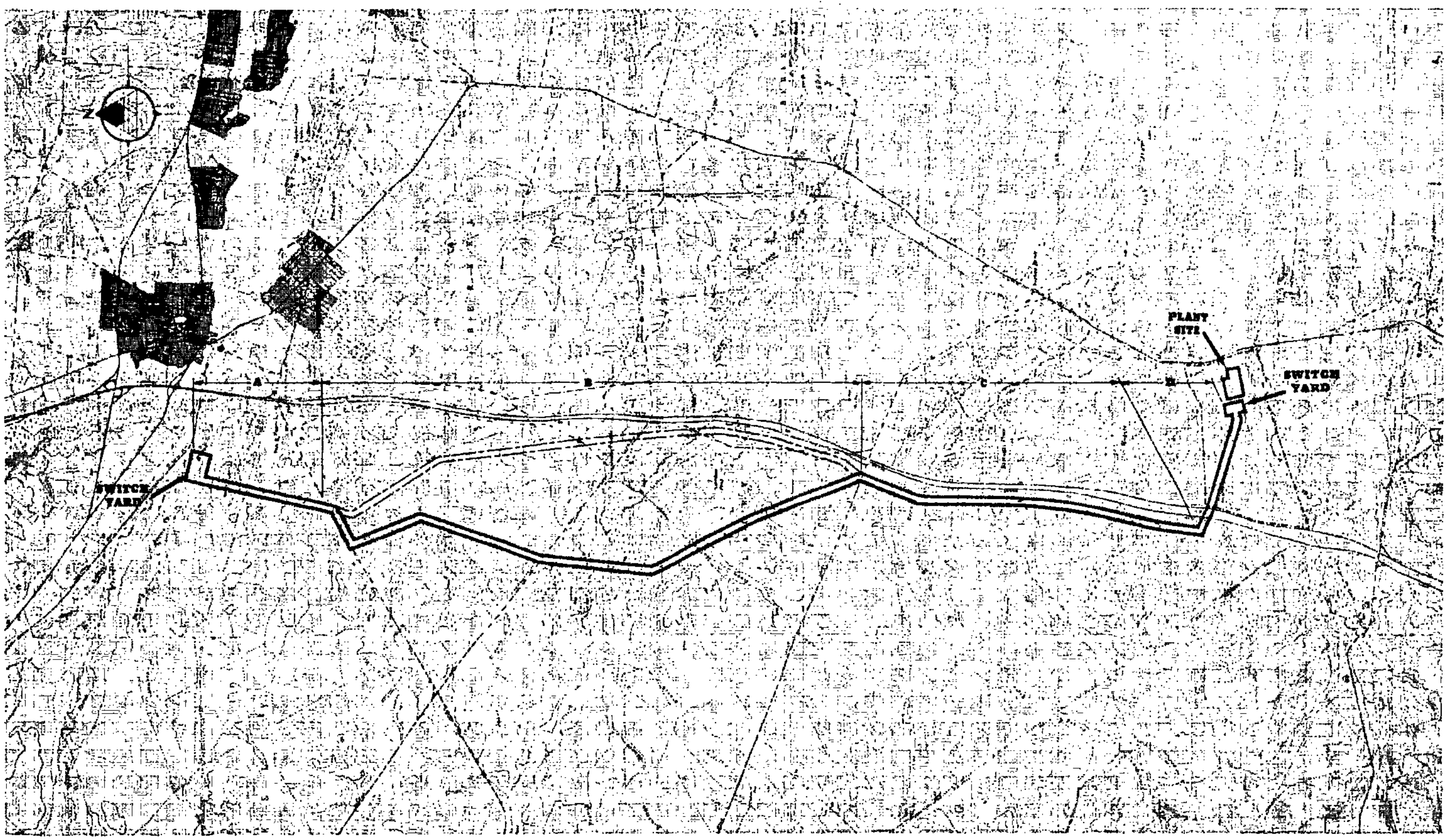
JC believes that it has been operating a sensible, well supervised, aesthetically acceptable and safe chemical program. It is its intention to continue the vegetation management maintenance program on the system transmission and distribution rights-of-way wherever it is appropriate.

3.2.2 Approvals

Table 3.2-1 lists the agencies from whom approvals were received for construction and operation of the transmission right-of-way from the Oyster Creek plant to the switchyard at the monitor substation at Toms River, New Jersey.

Table 3.2-1. Applications, Permits and Major Filings for Transmission Right-of-Way.

	Title	Agency	Status
1.	Easements for use of right-of-way. Order permitting condemnation.	State of New Jersey, Dept. of Public Utilities, Board of Public Utilities Commissioners	Approved April 21, 1967
2.	Permit for crossing of Garden State Parkway at the Oyster Creek Plant Site	New Jersey Highway Authority, Garden State Parkway	Approved Oct. 25, 1965
3.	Resolution 66-3 entitled, Resolution Authorizing Conveyance of Certain Parcels to the Jersey Central Power & Light Company. Deed: Book 2563 Page 138-142	New Jersey Highway Authority	Approved Jan. 27, 1966 Feb. 10, 1966
4.	Easement Agreement for Double Trouble Tract. Deed: Book 2623 Page 176-180	State of New Jersey Dept. of Conservation and Economic Development	Approved Feb. 24, 1966
5.	Two easements for rights-of-way in the Berkeley Township. Deeds: Book 2654 Page 19-22 and Book 2493 Page 155-162	Township of Berkeley in the County of Ocean in the State of New Jersey	Approved Dec. 23, 1966
6.	Right-of-Way Grant from Borough of South Toms River. Deed: Book 2504 Page 305-309	Borough of South Toms River, in the County of Ocean in the State of New Jersey	Approved July 12, 1965
7.	Right-of-Way Grant from the Township of Lacey for several parcels in the vicinity of Barnegat Pines Deed: Book 2567 Page 438-440.	Township of Lacey in the County of Ocean in the State of New Jersey	Approved March 3, 1966



OYSTER CREEK NUCLEAR GENERATING STATION

TRANSMISSION ROUTE

DAMES & MOORE

FIGURE 3.2-2

3.3 REACTOR AND STEAM ELECTRIC SYSTEM

The Oyster Creek Nuclear Generating Station consists of a single-cycle, forced circulation boiling water reactor that produces steam for a direct use in a steam turbine. The fuel consists of uranium dioxide pellets contained in Zircalloy-2 rods. Water serves both as the moderator and the coolant. The reactor supplier was the General Electric Company (GE).

A provisional operating license, granted August 1, 1969, authorized JC to operate the facility at power levels not to exceed 1600 MWt. Amendments to the same license authorized an increase in power level to 1690 MWt and then to 1930 MWt on November 5, 1971.

The turbine generator unit, supplied by GE, has a nameplate rating of 640,000 kW (gross*). It is an 1800 rpm, tandem compound six-flow, two-stage unit. The generator is a direct driven 60 cycle, 24,000V, 1800 rpm conductor cooled, synchronous generator rated at 687,500 KVA at 0.8 power factor. It was designed for rated steam flow plus five percent. It is this five percent design margin that allows the full design plant rating of 670 MWe (gross) at 1930 MWt to be attained.

The architect-engineer for the Oyster Creek Nuclear Generating Station was Burns and Roe, Incorporated.

*Net electrical output is equal to gross output minus station use.

3.4 WATER USE

Figure 3.4-1 presents the Oyster Creek Nuclear Generation Station Water Use Diagram. This diagram depicts in detail the flow paths to and from the various plant water systems.

Barnegat Bay supplies water to the dilution pumps and to the circulating and service water systems. These systems are used to remove waste heat from the plant via the main condenser and closed cooling water system heat exchanger. The dilution water pumps operate when necessary to control the temperature of the circulating water discharge, so that it will not exceed the State thermal limits for Oyster Creek at the buoy in Barnegat Bay stationed between the intake and discharge canals.

The intake water from the Bay is withdrawn from the South Branch of the Forked River and, as a result, much of the fresh water from the stream is mixed with the canal stream. The water salinity in the intake channel is less than in the Bay, having an average value of about 23,000 ppm compared to a Bay salinity near the intake of about 26,000 to 28,000 ppm. A typical water analysis of the facility's intake water is presented in Table 3.4-1.

The water taken from the Bay is treated with chlorine in amounts ranging from 1000 to 4000 lb./day (less than 1.0 ppm), depending on seasonal conditions. (The greater additions are made during the warmer months.) Chlorine helps prevent algae growth in the heat exchanger system. A buildup

Table 3.4-1. Oyster Creek Station Intake Water Analysis.

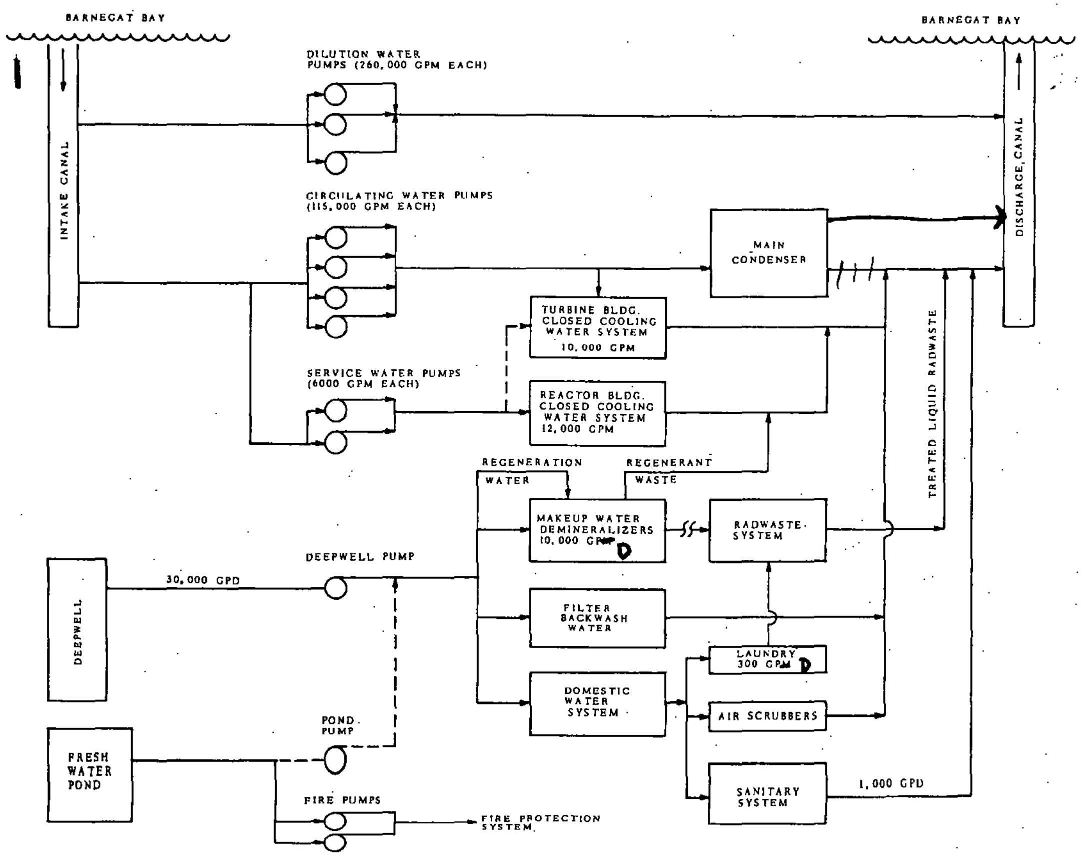
Constituents	PPM
Calcium	289.00
Magnesium	881.00
Sodium and Potassium	7,134.00
Chloride	12,680.00
Sulphate	1,816.00
Nitrate	0.00
Phosphate	0.70
Bicarbonate	100.00
Carbonate	0.00
Hydroxide	0.00
Silica	18.00
Iron	0.60
Manganese	0.01
Zinc	0.01
Total Residue	23,458.00
Suspended Matter	17.00
Volatile Residue	3,050.00
Equivalent, NaCl	20,905.00
Salinity	23,000.00
Alkalinity, CaCO	82.00
pH	6.95
Specific Gravity	1.03

of algae functions as an insulator, thus reducing the efficiency of heat exchange across the condensers to the cool water.

Cooling water circulating through the plant is used for diluting the treated radwaste before being discharged to the Bay. This dilution plus considerable treatment of wastes results in very low concentrations of discharged radioactive materials (Section 3.6).

The other primary source of water for plant use is taken from a 350 foot well which supplies domestic and makeup water demands for the plant. An analysis of the well water is presented in Table 2.5-4.

The well water is eventually discharged to the Bay as shown in Figure 3.4-1. Effluents from the radwaste and sanitary systems, and demineralizer regeneration wastes, are diluted with coolant water and released into the discharge canal. These wastes are discussed in Section 3.7.



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

WATER USE DIAGRAM

DAMES & MOORE

FIGURE 3.4-1

3.5 HEAT DISSIPATION SYSTEM

3.5.1 General Description

The circulating and dilution water for the Oyster Creek Nuclear Generating Station is drawn from Barnegat Bay through the South Branch of the Forked River canal on the north, passed through the plant condensers, and returned to Barnegat Bay through the Oyster Creek canal on the south, (Figure 2.5-3).

During the summer the dilution pumping system bypasses a large quantity of cool intake water around the plant to cool the plant discharge water to a temperature which meets the thermal limits conditionally established by the State of New Jersey for this installation. The use of dilution pumps depends on the summer temperature of the intake water and heat rejection from the plant condensers. With this flow, the water temperature measured at the monitoring buoy in Barnegat Bay is prevented from exceeding 95°F. This is in accordance with agreements reached between the State of New Jersey and JC in 1966 (the agreement is described in Section 5.1.2).

3.5.2 Components

3.5.2.1 Intake Structure

The main features of the intake structure are shown in Figures 3.5-1 and 3.5-2. The structure has two sections, each of which contains a three-section trash rack and traveling water screen; a chamber for two emergency service water pumps, one service water pump, and one screen wash system; and a separate chamber for each of two circulating water pumps. The arrangement of stop logs shown in Figure 3.5-1 allows any one traveling water screen chamber, any one service water pump chamber, or any one circulating water pump chamber, to be dewatered without interruption of the water supply to any of the other pumps. A recirculation tunnel from the circulating water discharge provides heated water through six hand operated sluice gates to prevent icing during cold weather.

Each traveling water screen consists of screen panels attached to two continuous chains riding on head-and-foot sprockets. The screens are equipped with 3/8 inch mesh openings and travel at a rate of ten feet per minute. A spray pipe with nozzles within the head assembly washes accumulated debris into a sluiceway. Two half capacity screen wash pumps discharge into a common header to the six spray pipes. Differential pressure across the screen is sensed by special controllers, which start the screen wash cycle if head loss in either section of the intake structure is above a preset value. The screen wash cycle continues until the head loss decreases to normal. Fish, aquatic plants, and trash accumulating on the screens are carried together by a flume to the discharge canal.

3.5.2.2 Circulating Water System

The circulating water system consists of four circulating water pumps and the intake and discharge tunnels; the circulating water inlet, discharge and backwash connections to the main condenser; and the circulating water connection to the turbine building closed cooling water heat exchangers. The four pumps take water from the intake structure and discharge through 66-inch lines into a 10'-6" square concrete intake tunnel to the turbine building south wall. Circulating water normally flows in parallel through each of the six condenser sections via individual 72-inch intake and discharge lines. Water then enters a 10'-6" square discharge tunnel leading to the discharge canal. The tunnel serves as a seal well since its roof is below minimum low water level in the discharge canal.

A plan view of the intake and discharge tunnels is shown in Figure 3.5-3. The intake tunnel begins above grade at the intake structure where the 66-inch pump discharge lines connect to it. It slopes downward and turns along the turbine building west wall. The discharge tunnel begins beneath the turbine building basement and runs directly beneath the intake tunnel before it turns south and empties into the discharge canal. A discharge tunnel for a possible future unit has been constructed to a point just north of the intake tunnel.

The 60-inch recirculation pipe for ice control runs below the water level.

The four circulating water pumps each have discharge capacitites of 115,000 gpm.

3.5.2.3 Dilution Water System

During the summertime one or more dilution water pumps are operated as required to control the temperature of the plant discharge water. The dilution pumps are used at other times, too, to meet minimum dilution water requirements for the radwaste system discharges when all four circulating water pumps are not operating.

The dilution water pump intake and discharge structure is shown in Figure 3.5-4. The dilution pumps are protected only by trash racks, which will permit the passage of large fish directly into and through the pumps. The low speed, axial flow pumps have seven foot diameter impellers. Consequently, damage to fish has not been a problem, as has been the experience with run-of-river hydroelectric turbines of similar characteristics. Figure 3.5-5 is a cross section through the dilution pump chamber.

3.5.2.4 Service Water System

The service water system provides cooling water from the intake structure to the reactor building and turbine building closed cooling water heat exchangers, and to the circulating water pump bearings for lubrication. In normal plant operation, the service water system supplies only the reactor building cooling water requirements. All turbine building cooling water requirements are supplied by circulating water.

The two half capacity service pumps (6000 gpm each) run in parallel and are located in the circulating water intake structure as shown in Figure 3.5-2. The service water system empties into the discharge canal and mixes with the circulating water.

Four half capacity emergency service water pumps are also located at the intake structure. These pumps are designed to provide drywell cooling, following an incident, through the containment spray heat exchanger.

3.5.3 Operation

3.5.3.1 Plant Heat Discharges

At the operating level of 1930 MWt with full circulating water capacity of 460,000 gpm (four pumps), the rise in water temperature across the condensers will be about 23°F. Present operating philosophy dictates that dilution water flow be initiated to cool the circulating water discharge so that the State established thermal limit is not exceeded.

The long discharge canal to Barnegat Bay provides a significant holdup time for the heated circulating water discharge. This holdup allows the discharge to release sufficient heat so that the temperature difference between the discharge to the Bay and the intake water to the circulating water system is small (Table 3.5-1). Observation of circulating water temperature at the monitoring buoy in the Bay has indicated that any differences between the discharge temperature and the Bay temperature are well within the daily fluctuations of the Bay temperature itself. The daily maximum temperature difference of water at the buoy in Barnegat Bay is usually no more than 2°F warmer than the temperature at the circulating water inlet (South Branch of Forked River canal). This has also been observed for less than full dilution flow conditions. Operational experience to date indicates that one dilution pump operation is sufficient during the

Table 3.5-1. Water Temperature Throughout the Circulating Water System.

Date	Power Generation MWe	At the Plant Intake	At the Plant Discharge	Highway 9 Bridge (O.C.)	Buoy Temperature
		Circulating Water Temperature - ^{o}F*			
7/26/71	534	81	102	92	80
8/2/71	543	88	108	96	86
8/3/71	522	90	110	97	86
8/4/71	527	86	107	97	85
8/5/71	551	81	101	91	75
8/23/71	540	80	98	89	-**
8/24/71	545	76	94	90	-
8/25/71	545	75	94	91	79
8/26/71	540	77	96	91	77
8/31/71	535	74	94	-	68
9/1/71	538	75	96	89	76
9/2/71	534	76	97	90	72
9/3/71	530	76	97	90	68
9/4/71	528	78	97	90	76
9/5/71	524	80	98	85	84
9/6/71	521	82	100	87	80
9/7/71	512	84	102	90	81
9/8/71	519	82	100	91	80

*Values are for the highest temperature on each given day.
**Data unavailable because of malfunctioning equipment.

summer months to maintain discharge temperatures to the Bay well below the State established limit.

Plant heat discharges via the service water system are negligible in comparison to the circulating water system. For example, the reactor building closed cooling water heat exchangers have a service water coolant flow of 6,000 gpm each with a temperature rise of about 20^{o}F. The total heat discharge contribution from the service water system is about 0.12 x 10^9 BTU per hour versus 4.5 x 10^9 BTU per hour from the circulating water system.

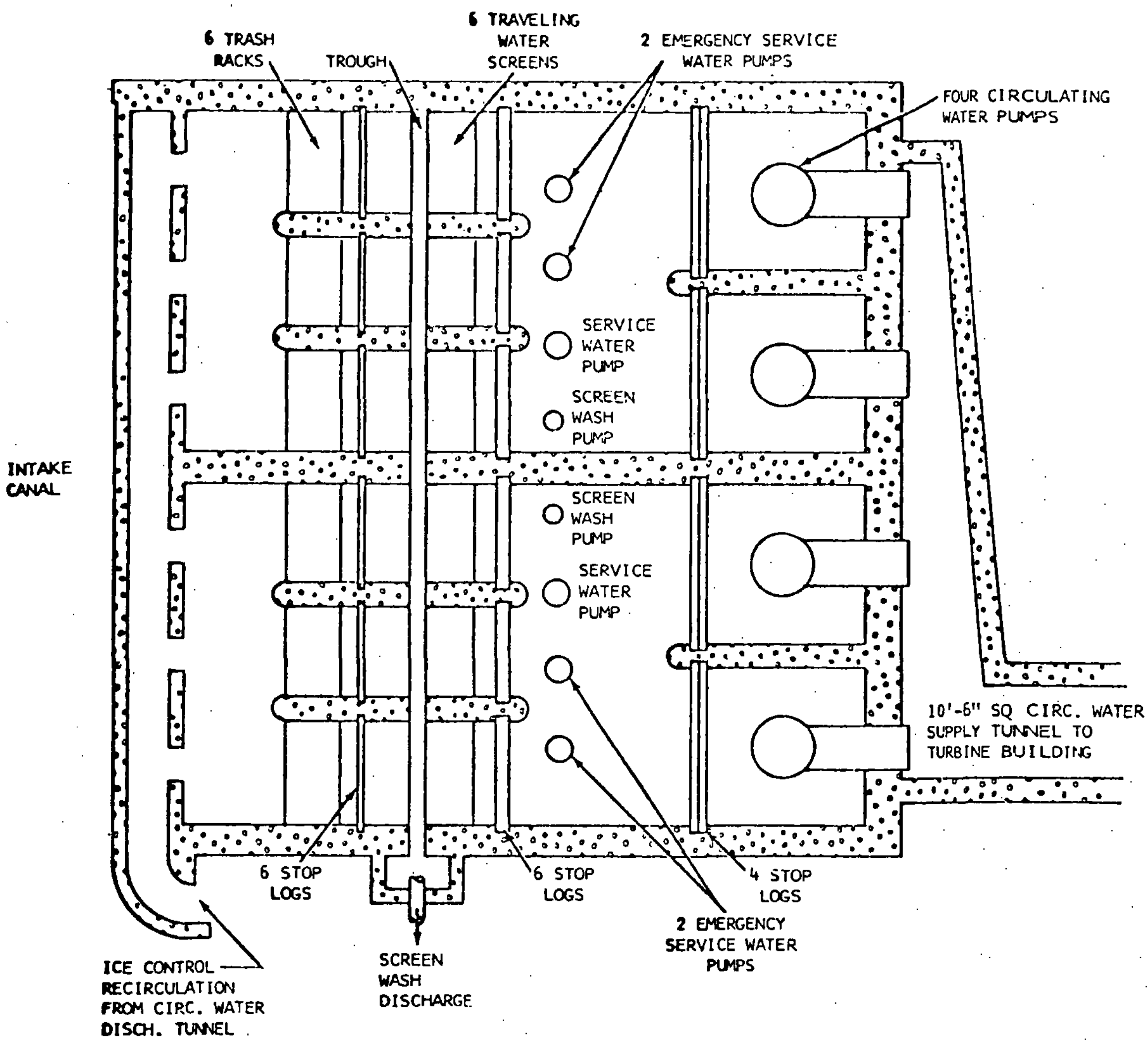
3.5.3.2 Plant Cooling Water Flow Characteristics

The plant cooling water flows up Forked River, then up the dredged portion of the South Branch of Forked River to a point just north of the generating station. The intake canal then flows to the west of the generating station where the intake structure is located. A dam at this point separates the intake canal from the discharge canal. Water from the discharge structure flows through a dredged channel to the south where it joins the enlarged Oyster Creek and flows to the Bay.

The average depth in the intake and discharge canals is about ten feet. The dredged canal width is greater than 150 feet at all locations, except at the Highway 9 bridges where the widths are approximately 100 to 125 feet. The resulting coolant flow velocity in the intake and discharge canals is less than 2.0 fps at full circulating and dilution flow (1,250,000 gpm). Without dilution flow this velocity decreases to less than 1.0 fps. The coolant flow velocity through the traveling water screens is approximately 2.3 fps at low water and 1.7 fps at normal water level. The time required for the discharge flow to reach the Bay is greater than two hours, thus allowing substantial cooling to occur prior to Bay discharge.

3.5.3.3 Chlorination

The chlorination system is designed to prevent the buildup of slime in the condenser tubes. The system is programmed to inject chlorine solution, in sequence, at ten injection points; each of the six 72-inch main condenser circulating water inlets, the 24-inch circulating water inlet to the turbine building closed cooling water heat exchangers, the main service water header, and the two main emergency service water headers. Chlorine solution flow rates are adjusted to maintain a chlorine residual of 1 ppm or less at the outlet of each treated system. The addition of chlorine ranges from about 1000 pounds per day up to 7000 pounds per day, being seasonally dependent, with the greater addition occurring in the warmer months.



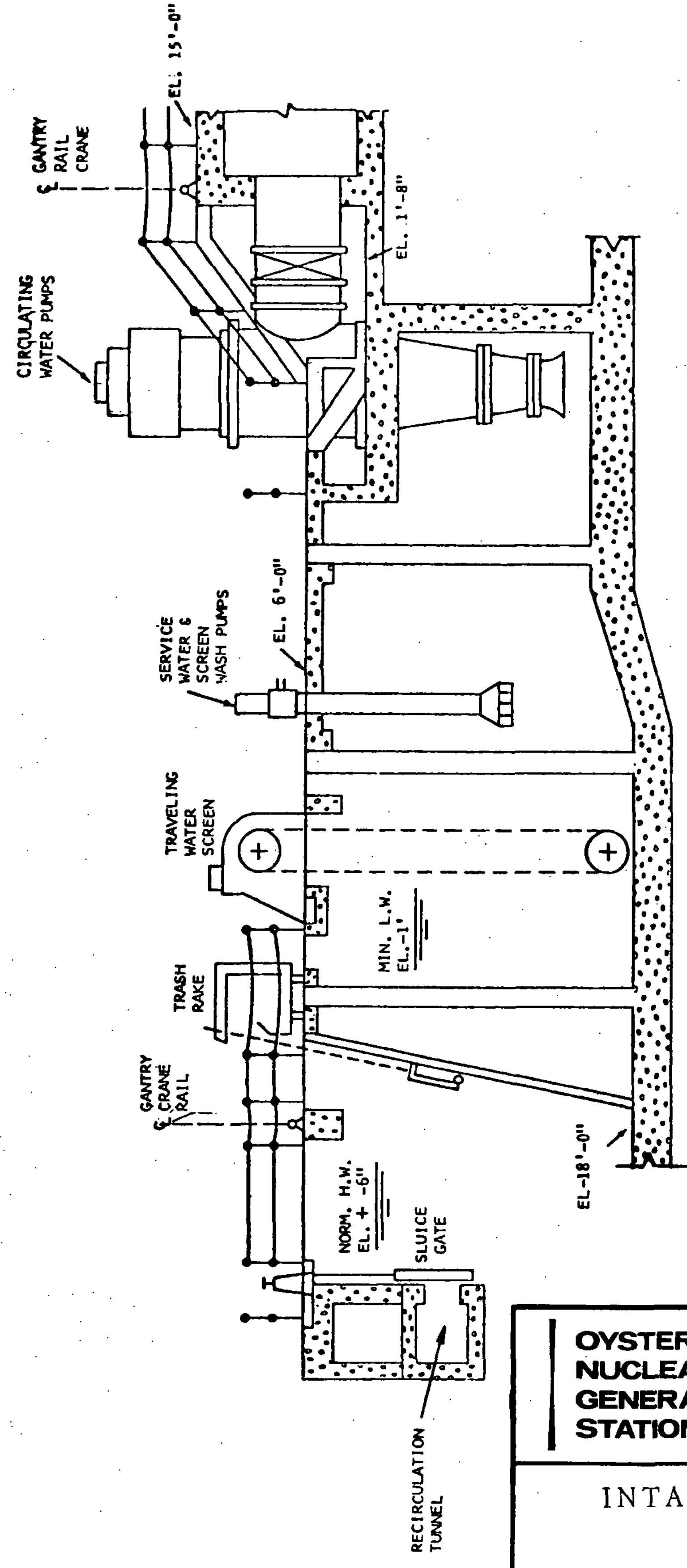
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

INTAKE STRUCTURE, PLAN AT CENTERLINE OF RECIRCULATION TUNNEL

DAMES & MOORE

FIGURE 3.5-1



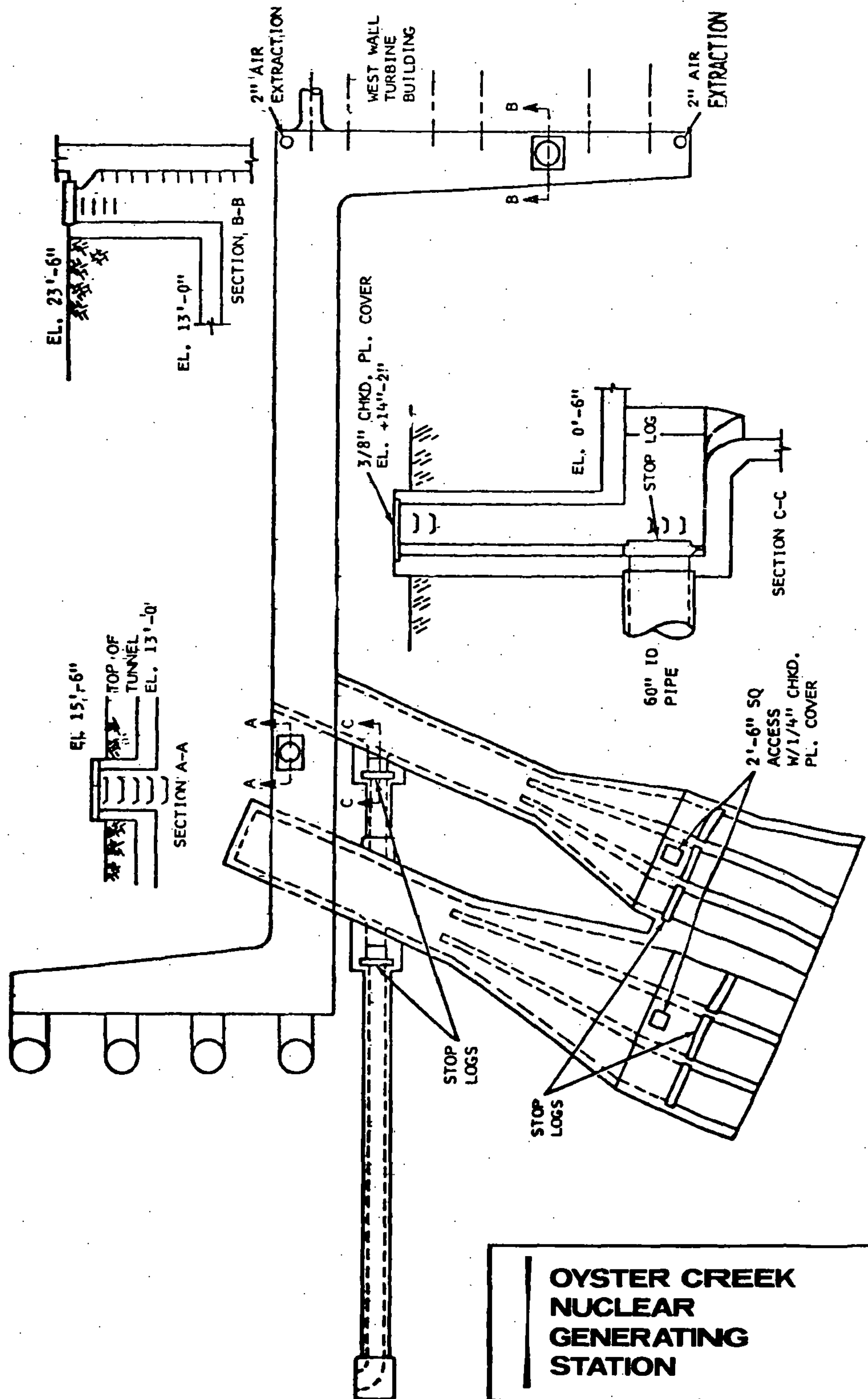
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

INTAKE STRUCTURE, SECTION

DAMES & MOORE

FIGURE 3.5-2



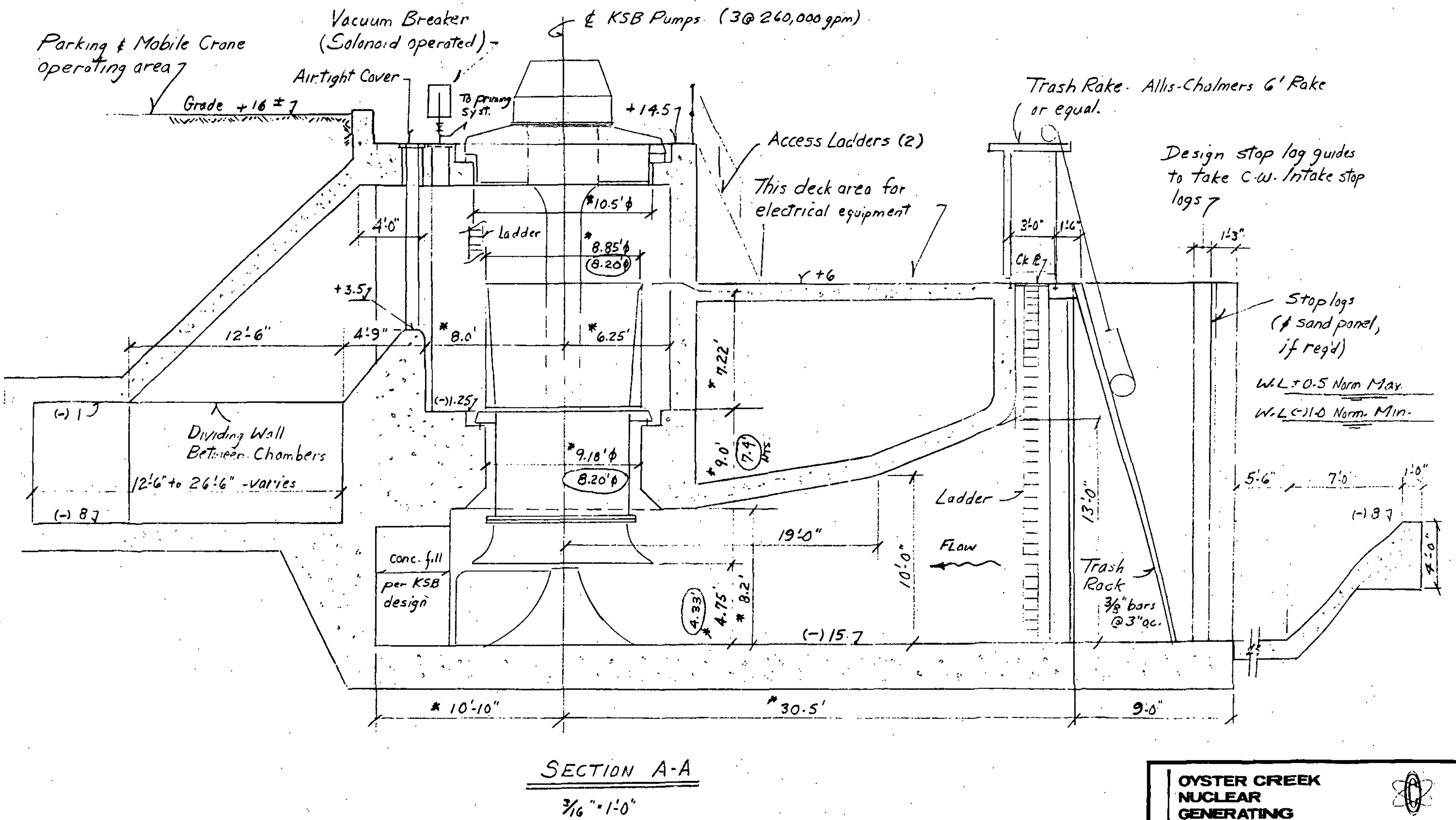
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

CIRCULATING WATER INTAKE AND DISCHARGE TUNNELS

DAMES & MOORE

FIGURE 3.5-3



SECTION A-A

3/16" = 1'-0"

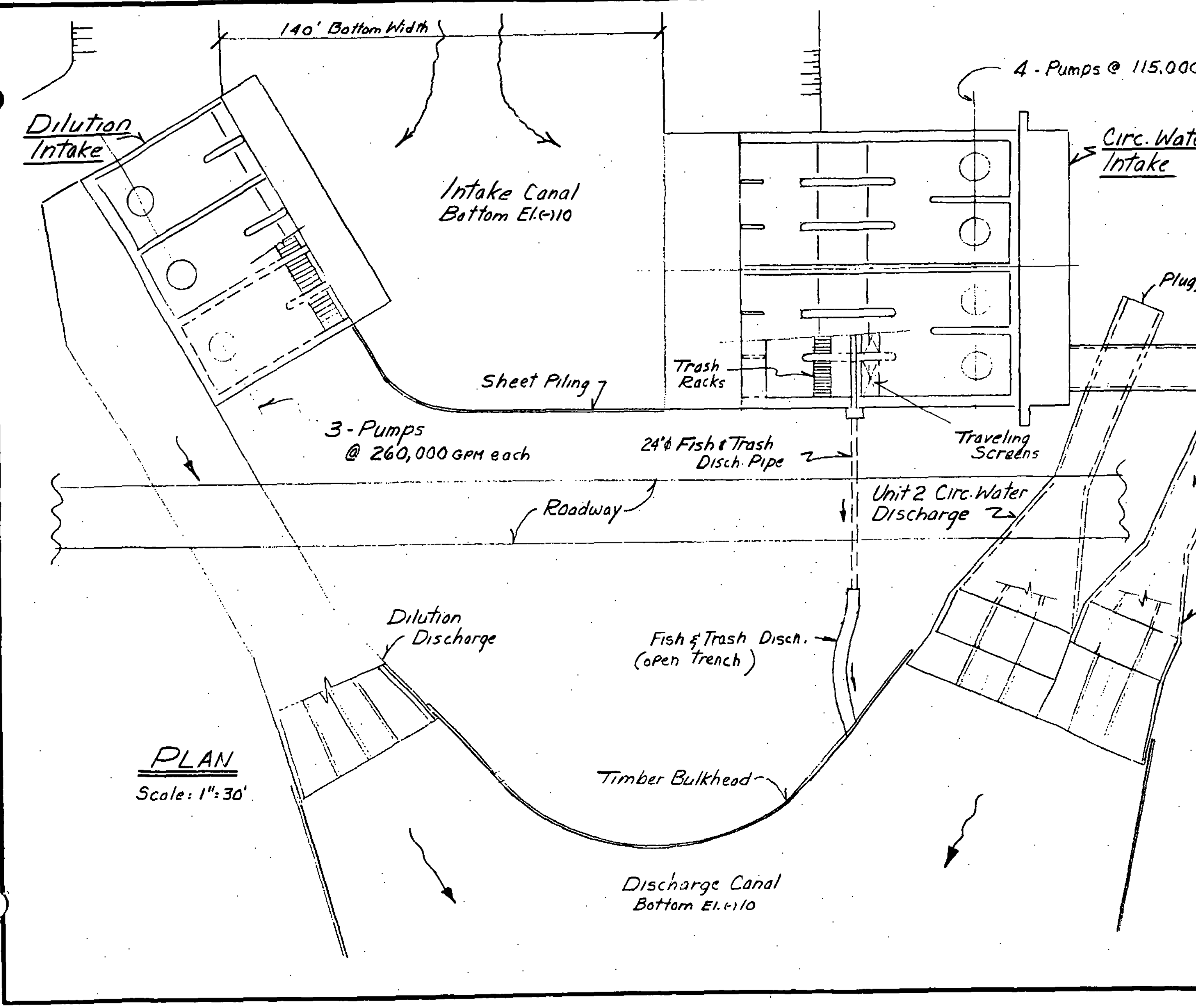
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

DILUTION PUMP STORAGE

DAMES & MOORE

FIGURE 3.5-4



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

PLAN VIEW CIRCULATING WATER STRUCTURES AND DAM

DAMES & MOORE

FIGURE 3.5-5

3.6 RADWASTE SYSTEMS

The radwaste systems described below are used exclusively for treatment of wastes from the Oyster Creek Nuclear Generating Station.

3.6.1 Liquid Waste System

3.6.1.1 General Description

The waste control system shown in Figure 3.6-1, collects, processes, stores, and reclaims or disposes of all liquids that may contain radioactive material. Liquid wastes from throughout the plant are transferred to appropriate collection tanks in the radwaste building for treatment. The primary objectives of treatment are to reduce the radioactivity in liquid effluents to as low as practicable and to reclaim high purity water for reuse in the reactor.

The wastes are processed on a batch basis by filtration, evaporation, and/or ion exchange, as appropriate for the quality and quantity of materials determined to be present. Processed liquid wastes may be returned to the low conductivity water system or, after analysis, be discharged to the environs when necessary through the circulating water discharge canal. Holdup for decay does not appreciably reduce potential exposure via the aquatic pathway. During 1971, more than half of the liquid waste processed was reclaimed and used as low conductivity water for the primary coolant system.

Protection against inadvertent discharge of liquid radioactive waste is provided for by redundancy in valving, by instrumentation for detection and alarm in case of abnormal conditions, and through procedural controls. For example, accidental discharge of the floor drain sample tank requires: 1) the remote setting of a flow rate on a control valve; 2) the remote opening of two separate stop valves; and 3) the starting of a pump. Accidental discharge of the waste sample tank requires: 1) the manual opening of a stop valve; 2) the remote opening of two stop valves; 3) the setting of a flow control valve; and 4) the starting of a pump. Two radiation monitors in the discharge line downstream of the discharge valves will alarm in the event of a release exceeding a preset limit.

3.6.1.2 Radioactivity Released to Barnegat Bay

Table 3.6-1 is a summary of radioactivity discharged into Barnegat Bay during 1969, 1970, and 1971. Dilution patterns in the Bay, based on dye tests, are shown in Figure 3.6-2.

Laundry wastes normally contain a very small amount of radioactivity. Because of this low level they can be discharged without treatment, however, they can be treated in the waste concentrator if this becomes necessary.

From May 1969 to March 1971, wastes were released from both the waste sample tank and the floor drain sample tank. Since April 1971, liquids have not been released directly to the environment from the floor

Table 3.6-1. Radioactivity Liquid Waste Discharged To Barnegat Bay.

Report Period	Volume Discharged (10^6 gallons)	Total Activity Discharged (Ci)		Average Concentration (10^{-8} u Ci/ml*)	
		Gross Beta-Gamma	Tritium	Gross Beta-Gamma	Tritium
May-December, 1969	8.65	1.97	5.07	1.68	4.28
January-June, 1970	6.74	7.22	10.35	6.40	9.1
July-December, 1970	7.06	11.24	11.51	7.67	7.9
January-June, 1971 **	3.86	8.81	9.87	7.06	8.0
July-December, 1971 **	**2.49**	**3.31**	**11.59**	**2.14**	**7.5**

* The average concentration is given at the point of release based on dilution in the cooling water discharge and assuming a recirculation factor of 3.76.

**Reduced volume of liquid waste discharged to the environment was achieved by more efficient utilization of the equipment in the radwaste facility. By processing liquid waste through both the evaporator and the demineralizer, 7,680,000 gallons of high purity water was reclaimed.

drain sample tank. Considerable effort has been made to reduce the volume of liquid that must be processed, to return as much of the liquids to the low conductivity (high purity) water system as possible, and to release only that waste that cannot be accommodated by storage tanks and the waste processing system. This effort resulted in a reduction in both liquid volume and gross beta-gamma during 1971 (Table 3.6-1).

Data obtained by isotopic analysis of liquids released from the waste sample tank during 1971 are summarized in Table 3.6-2. These data are used in Section 5.2 to evaluate potential exposure via aquatic pathways to man.

3.6.2 Gaseous Waste System

3.6.2.1 General Description

The off-gas system, shown in Figure 3.6-3, retains most of the radioactive gases for at least 60 minutes to permit radioactive decay. The system monitors the residual radioactivity after decay and discharges the gas to the atmosphere through a 368-foot high stack.

Over 99 percent of the gaseous waste comes from the main condenser air ejector and is delayed for approximately 60 minutes in piping to permit the shorter half-life radioactive gases to decay. Actual decay time depends on gas volume and over the past two years has varied from 50 to 70 minutes. After decay, the gas is discharged through a filter to remove more than 99 percent of the radioactive particulate material.

Table 3.6-2. Isotopic Composition Of Liquid Waste.

Nuclide	Half-Life	pCi/ml*	Estimated Ci/year
H-3	12.26 years	--	16.00
Xe-135	9.14 hours	160.0	7.20
Xe-133	5.27 days	41.0	1.80
Mo-99	66.7 hours	27.0	1.20
Cr-51	27.8 days	24.0	1.10
Ba-140	12.8 days	16.0	0.72
Np-239	2.35 days	12.0	0.54
Tc-99m	6.05 hours	8.7	0.39
I-131	8.05 days	6.0	0.27
I-133	20.3 hours	5.7	0.25
La-140	40.22 hours	5.2	0.23
Co-60	5.26 years	5.1	0.23
Co-58	71.3 days	1.8	0.08
Sr-90	27.7 years	1.4	0.06
Mn-54	303.0 days	0.8	0.04
Cs-137	30.0 years	Not detected	0.06
Total Excluding Tritium			14.17

*Concentration in the waste sample tank prior to dilution based on average values obtained by isotopic analysis during the first six months of 1971. The Sr-90 values determined by radiochemistry range from less than 0.005 to 3 pCi/ml. The value of 1.4 pCi/ml is a conservative estimate of the average concentration.

Gas from the gland seal condenser passes through piping which provides for a minimum holdup time of 1.75 minutes to reduce the concentration of short-lived gases and is then discharged to the atmosphere via the stack.

The inert drywell atmosphere around the reactor vessel is exposed to neutron activation and contains small quantities of activation and fission products. This inert atmosphere is replaced by air when access to the drywell is required. The drywell is also vented during plant start up to accommodate the expansion of drywell atmosphere with increased temperature. Gaseous discharge from the system is released through the stack with provisions for filtering through the standby gas treatment system, if necessary.

A stack gas monitoring system is provided to continuously measure the rate of radioactive gas discharge. Samples from the stack are also collected to measure radioactive particulate matter and halogen release.

3.6.2.2 Radioactive Emissions to the Atmosphere

Total radioactive particulate, halogen (iodine) and gaseous emissions to the atmosphere for the period May 1969 through December 1971 are given in Table 3.6-3.

Isotopic composition of off-gas is shown in Table 3.6-4. These results are based on an isotopic analysis performed on December 29, 1971, after 32 days of steady power operation at 1850 MWt. The gas was analyzed

Table 3.6-3. Radioactive Emissions To The Atmosphere.

Report Period	Curies Released for the Period: Particulate	Halogen	Noble and Activation Gas	Thermal Output (10^6 MWHt)
May-December 1969	0.0008	0.003	7,027	1.2
January-June 1970	0.0032	0.130	43,459	4.6
July-December 1970	0.0067	0.178	68,344	6.0
January-June 1971	0.0211	0.697	174,589	6.9
July-December 1971	0.0882	1.332	341,463	4.8

Table 3.6-4. Typical Isotopic Analysis of Gaseous Effluent.

Nuclide	Half-life (minutes)	Release Rate (mCi/sec)* No Decay	60 Min. Decay	Fraction of Total After Decay
Xe-138	14	59	3.0	0.063
Xe-135	548	14	13.0	0.272
Xe-133	7589	7.9	7.9	0.165
Kr-88	168	15.0	11.7	0.245
Kr-87	76	15.0	8.7	0.182
Kr-85m	264	4.2	3.5	0.073
Total		115.1	47.8	1.00

* Based on isotopic analysis performed on December 29, 1971 after 32 days of steady power operation at 1850 MWt.

before it was passed through the 60 minute holdup system.

3.6.3 Solid Waste

The solid waste system, located in the radwaste building, processes both wet and dry solid radwastes. The wet solid wastes are the spent demineralizer resins, waste concentrator bottoms and filter sludges, which are a by-product of station water treating processes. The dry solid radwastes are the other miscellaneous radioactive or contaminated solid wastes.

Standard 55-gallon steel drums, approved by the Department of Transportation (DOT) for radioactive materials, are used to package the solid wastes for temporary onsite storage, followed by shipment and permanent offsite storage.

Spent demineralizer resins and filter sludges are removed as these components are back-washed. The sludges consist of solka-floc containing corrosion products, fission products, and other materials removed from the various systems. Spent resins and filter sludges are pumped as a water slurry from their respective tanks to a centrifuge, where they are dewatered and discharged by gravity into a hopper below the centrifuge. The material is then transferred from the hoppers to steel drums. Waste evaporator bottoms are mixed with a drying agent in the drums.

Miscellaneous solid wastes resulting from operation and maintenance activities are compressed in the drums to reduce the volume. Typical of these wastes are air filters, miscellaneous paper, rags, contaminated clothing, tools, equipment parts, and solid laboratory wastes.

After the drums are filled, they are capped and stored to await loading onto a truck for transport offsite. Packaging, monitoring, labeling, and shipping is done in compliance with AEC and DOT regulations.

Solid radioactive waste from the reactor primary system, e.g., spent control rods and in-core ion chambers, are stored in the fuel storage pool for radioactive decay. After decay, they are packaged in DOT approved containers for shipment offsite.

3.6.4 Fuel Transportation

3.6.4.1 From Fabrication Plant

The GE plant in Wilmington, North Carolina, will provide the first reload fuel elements for the Oyster Creek Nuclear Generating Station. Contract negotiations are currently underway with the GE Company for processing the irradiated (spent) fuel elements in their Morris, Illinois facility. After the first fuel reloading new fuel will be supplied by Jersey Nuclear Corporation at Richland, Washington.

New GE fuel elements will be shipped to the site by truck in containers approved by the AEC and DOT as meeting their requirements for structural integrity and protection against criticality.

The route from Wilmington will most likely be Highways U.S. 117, I-95, U.S. 301, I-95, I-495, U.S. 50, U.S. 3, U.S. 695, U.S. 95, U.S. 295, New Jersey Turnpike, NJ-70, NJ-72, NJ-532 (County), and U.S. 9.

The route from Richland, Washington for Jersey nuclear fuel will probably follow I-94/90, Indiana Tollroad (80/90), Ohio Turnpike 80/90 and 80S, Pennsylvania Turnpike 76, I-276, I-95, I-495, U.S. 50, U.S. 30, U.S. 695, U.S. 95, U.S. 295, New Jersey Turnpike, NJ-70, NJ-72, NJ-532 (County), and U.S. 9.

3.6.4.2 Spent Fuel

Fission and activation products in irradiated fuel elements will be allowed to decay in the spent fuel storage pool for a minimum of 90 days before shipment by rail to the Midwest Fuel Recovery Plant in Morris, Illinois. Shipping containers for spent fuel will meet official requirements for structural integrity and protection against criticality, and will contain dense shielding material (e.g., depleted uranium) to reduce radiation exposure in transit. The spent fuel shipping cask has also been designed for circulation of coolant to remove heat from radioactive decay. The shipping cask will be the GE Model IF300 or equivalent.

The anticipated route from the site will be by the Central Railroad Company of New Jersey to Dover, New Jersey, then by the Erie Lackawanna

Railway through parts of New Jersey, Pennsylvania, New York, Ohio, and Indiana to Griffith, Indiana, and then by the Elgin, Joliet and Eastern Railway Company to the Midwest Fuel Recovery Plant.

One shipment will be made each year consisting of six casks per shipment containing 20 to 30 metric tons of uranium (MTU).

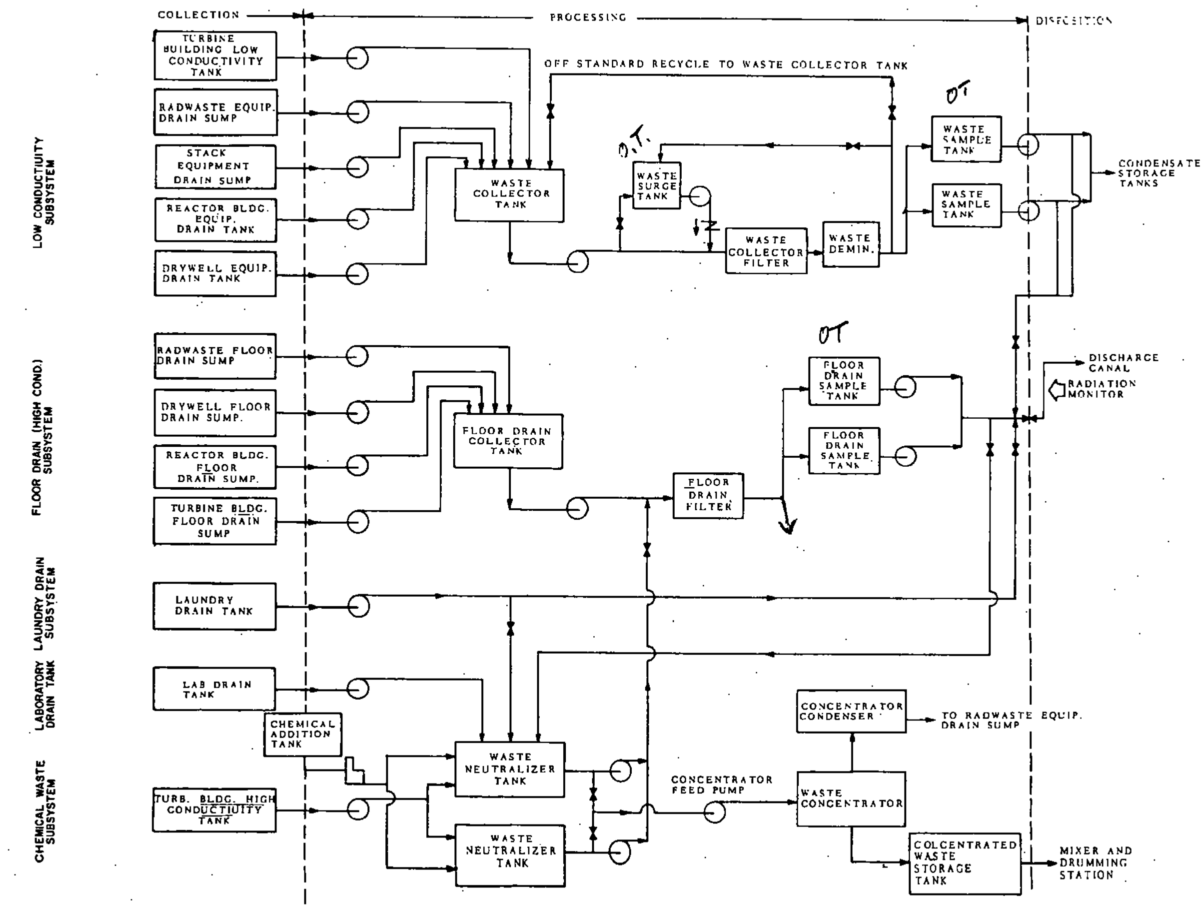
In-transit safety will be assured by: 1) the design of the shipping cask; 2) planned routing to minimize delays or stopping of the train; and 3) the use of caution signs and placards as required by DOT.

The cask will withstand temperatures ranging from -40°F to +130°F and vibrations, shocks, and wetting incident to normal transport. In addition, the casks will withstand accident conditions specified by the AEC and DOT with no release of radioactivity, except for slightly contaminated coolant and up to 1000 curies of noble gas (Kr-85). The cask will withstand a 30-foot free fall onto a completely unyielding surface, followed by a 40-inch drop onto a 6-inch diameter pin, followed by 30 minutes in a 1475°F fire, followed by eight hours immersion in three feet of water (Ref. 3.6-1).

The environmental effects of fuel shipment, especially dose to people en route, is discussed in Section 5.4.2.

REFERENCES - SECTION 3.6

3.6-1 Agent T. C. Georges Tarrif No. 23. Hazardous Materials Regulations of the Department of Transportation Including Specifications for Shipping Containers. Section 173.398. Page 127, August 3, 1969.

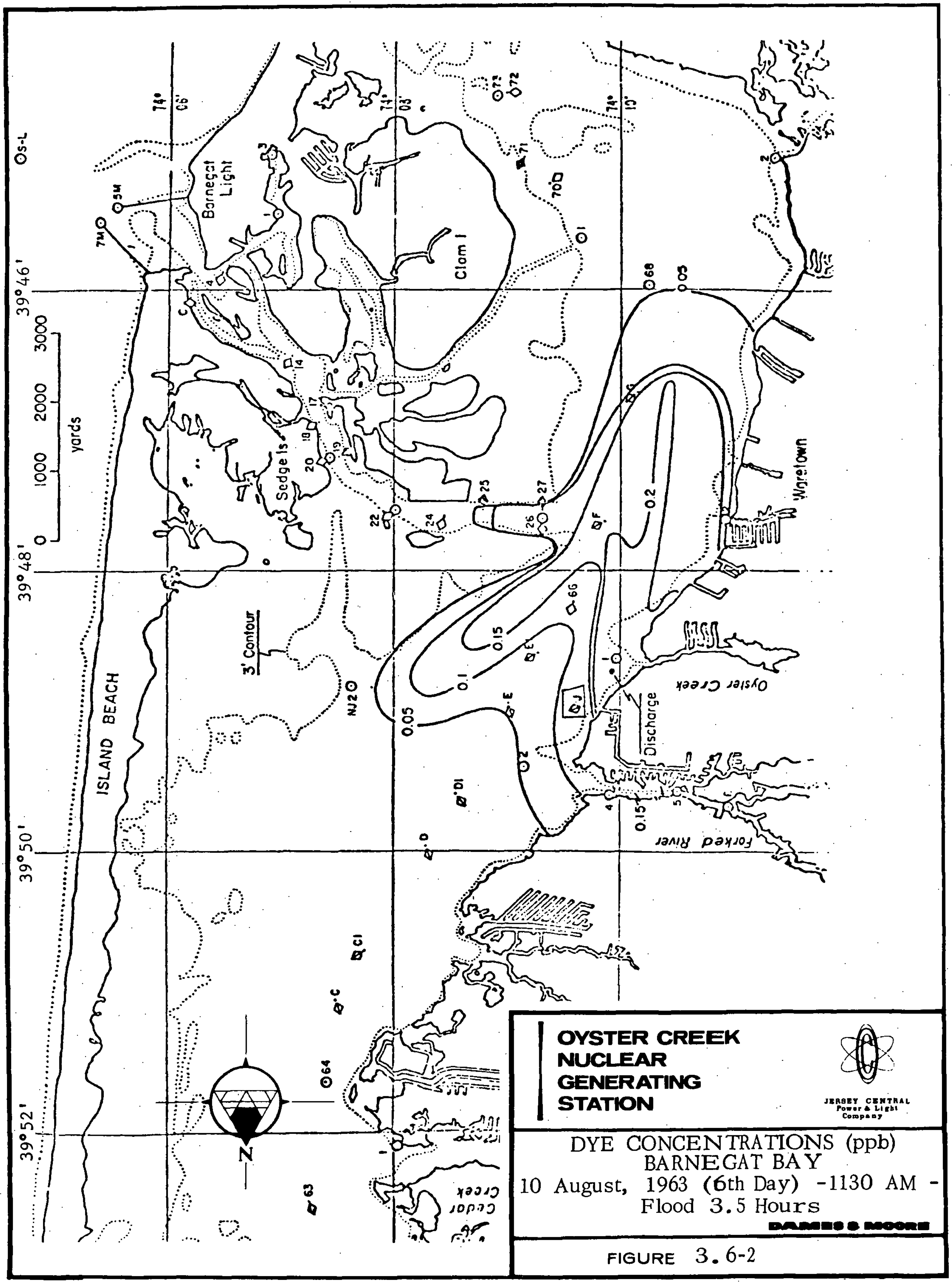


OYSTER CREEK NUCLEAR GENERATING STATION

LIQUID WASTE CONTROL SYSTEM

DAMES & MOORE

FIGURE 3.6-1



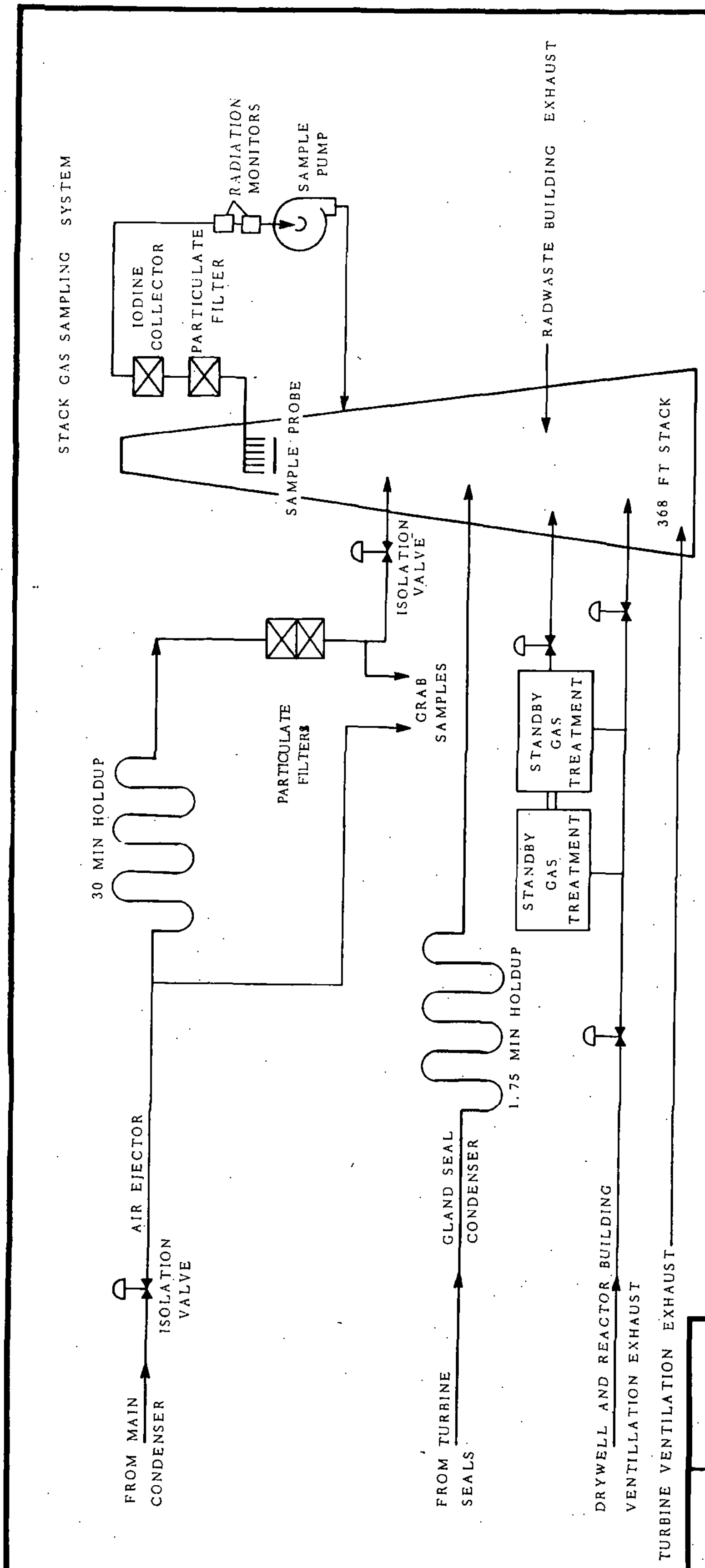
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

DYE CONCENTRATIONS (ppb)
BARNEGAT BAY
10 August, 1963 (6th Day) -1130 AM -
Flood 3.5 Hours

DAMES & MOORE

FIGURE 3.6-2



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

GASEOUS WASTE CONTROL SYSTEM

DAMES & MOORE

FIGURE 3.6-3

3.7 CHEMICAL AND SANITARY WASTES

3.7.1 Chemical Discharges

The Oyster Creek Nuclear Generating Station contains a water system which treats raw fresh water to provide a high purity product for plant processes and domestic usage. The treatment system utilizes chemicals (sulphuric acid and caustic soda) for regeneration of the demineralizers, for algae control in the condenser cooling water (chlorine), and for conditioning of the package boiler feedwater. The primary method of treating chemical effluents released from the Oyster Creek facility is dilution with circulating water so that chemical concentrations are reduced to levels well below those acceptable for discharge.

The high purity makeup water requirements for the plant are satisfied by two trains of ion exchange demineralizers. Water requirements necessitate approximately one demineralizer train (cation and anion units) regeneration every three days. The mixed bed exchangers are regenerated once for every three cation and anion regenerations. The cation exchangers use about 188 pounds of acid (H_2SO_4, 66^{o} Baume) per regeneration; the anion exchangers use 168 pounds of caustic (50 percent NaOH) per regeneration; and the mixed beds use 80 pounds each of acid and caustic per regeneration. This amounts to a daily average of about 72 pounds of sodium hydroxide and 65 pounds of 66^{o} Baume sulfuric acid discharged to the circulating water. The concentrations of both chemicals are well below 1.0 ppm in the discharge canal.

Fouling of surfaces in the circulating and service water systems from the growth of organisms is controlled by daily application of chlorine via the chlorination system. Chlorination is conducted at a feed rate resulting in a 1.0 ppm free chlorine residual, as measured at the outlet of the condenser. This chlorine residual is consumed while flow passes through the discharge tunnel. As a result, the residual after discharge to the canal is less than 1 ppm; no adverse effects have been observed (see Section 3.5.3.3).

Chemical treatment of the heating boiler feedwater results in very small releases of trisodium phosphate, sodium hydroxide, and sodium sulfite. It has been estimated that when the boiler is in operation a daily total of less than 30 grams of treatment chemicals are released in the boiler blowdown discharged to the discharge canal.

3.7.2 Sanitary Waste System

Domestic and sanitary waste water from the unrestricted non-radioactive areas in the plant is discharged to an outside sewage treatment plant. The sewage treatment system is of the aerobic type utilizing the activated sludge process. The system, manufactured by Smith & Toviless, is termed an "Oxigest" treatment plant. The process consists of screening, aeration, settling, and finally chlorination to kill pathogenic bacteria remaining in the effluent. The flow diagram of the extended aeration treatment plant is presented in Figure 3.7-1.

Untreated sewage (influent) may contain paper, sticks, and other rubbish that must be removed before the sewage passes into the aeration tank. These materials are collected on an inclined bar screen in a screening basket at the head of the treatment plant.

Water and solids passing through the screen enter the aeration tank where the sewage is mixed thoroughly with activated sludge for about 24 hours. This mixture of sewage and activated sludge is commonly called "mixed liquor." Air diffusers are located at one end of the aeration tank, near the floor. Compressed air discharged through the diffusers sets up the mixing action and provides dissolved oxygen in the mixed liquor.

The mixed liquor then flows from the aeration tank to the settling tank, where the heavier particles settle to the bottom. Floatable solids rise to the surface and are returned to the aeration tank. The activated sludge is also returned continuously to the aeration tank to be mixed with fresh sewage. The effluent from the settling tank is passed to the chlorine contact tank and from there is released to the discharge canal where dilution occurs.

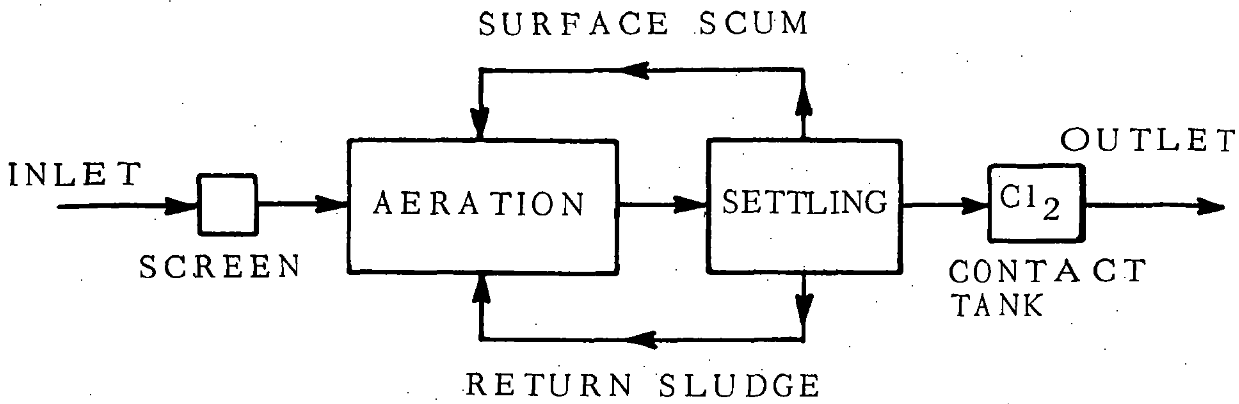
The sewage treatment plant processes a daily average of about 1,000 gallons. Daily records showing the results of chlorine residual tests and amounts of processed sewage are submitted monthly to the New Jersey State Department of Health. The sewage treatment plant is in the charge of a licensed operator.

3.8 OTHER WASTES

The Oyster Creek Nuclear Generating Station does not release combustion products to the atmosphere as a result of reactor operation. It does, however, have a "package boiler," fueled by No. 2 fuel oil, to produce auxiliary service steam for start up, service heating and radwaste processing. The exhaust from this boiler is discharged through a single stack. The amount of combustion products released per year from this boiler is very small.

Operation of the emergency diesel generators during testing also results in exhaust releases. This operation is intermittant, however, and therefore the total exhaust on an annual basis will also be very small.

The solid waste or trash removed from the canal water at the plant intake or from the office buildings and shops is hauled away to an offsite landfill area.



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

EXTENDED AERATION TREATMENT PLANT - FLOW PATTERN

DAMES & MOORE

FIGURE 3.7-1

4.0

ENVIRONMENTAL EFFECTS OF SITE PREPARATION AND PLANT CONSTRUCTION

This report is being submitted in conjunction with a request for a Full-Term Operating License, in place of the existing Provisional Operating License. The plant has been producing power for more than two years; all activities related to construction and site restoration have been completed.

Activities connected with site preparation and plant construction disturbed approximately 372 acres. Disturbances to the environment were caused by general construction noise and the minor alteration of the native ecosystem.

Noise from construction operations occurred from approximately December 1964 (date of construction permit) to August 1, 1969. Ruffed Grouse, Bobwhite Quail, fox, and mink--the most sensitive species that inhabit the area--were undoubtedly disturbed in and near the construction area while work was actually in progress.

Disturbances to the land included the removal of some pine and hardwood forest, the dredging of a canal, and the replacement of some white cedar swamp and salt water marsh with spoil from dredging and site excavation. The effect of these activities resulted in the elimination of some small non-mobile mammals (i.e., moles), reptiles, and amphibians that lived on the disturbed area surrounding the plant.

The short-term effect of the removal of 372 acres of wildlife habitat during construction did not significantly affect mobile organisms, because similar habitat was available for rehabitation. White-tailed deer, cottontail rabbits, fox, squirrels, Ruffed Grouse, Bobwhite Quail and other mobile mammals and birds simply moved to adjacent or nearby vegetated areas where they most likely established residence.

Dredging the natural channel of the South Branch of the Forked River probably had minimal impact on the abundant wildlife. The canal from the condenser discharge to and approximately 60 feet beyond the mouth of Oyster Creek was also enlarged or deepened by dredging. The material was deposited as spoil around the plant site and along the bank of the canal (280 acres). Some spoil was deposited along the edge of salt water marsh and along the retaining wall of the Baywood Farm (45 acres). Even though the abundance of wildlife was not affected by dredging, the loss of a transition zone between the stream environment and a marsh environment probably had a detrimental effect on the movements of insects, shellfish, amphibians, or reptiles that utilize the marsh or this zone during portions of their life cycle.

Coolant water pumping from the dredged canal has introduced salt water into the formerly fresh water streams of Oyster Creek and South Branch of the Forked River. The possibility of salt water intrusion into local fresh water supplies was investigated in detail, with respect to both construction excavation and the excavation and operation of the salt water cooling canals. To provide a head of fresh water and prevent salt water infiltration, an auxiliary canal was dug parallel to and immediately (approximately 12 feet) north of the South Branch of the Forked River canal. Fresh water from the South Branch of Forked River flows into this auxiliary canal and then flows into Forked River at the U.S. Highway 9 bridge. This system is designed to eliminate any salt water intrusion into the fresh water aquifer outside of the South Branch of the Forked River canal. Consequently, construction and operation of the existing facilities, including the now saline canals, has not had any adverse effect upon the local fresh water wells.

Dredging the South Branch of Forked River and Oyster Creek had minimal impact on aquatic life.

Construction activities that might have affected aquatic organisms included dredging and creation of additional estuarine environment, elimination of a small portion of the fresh water section of Oyster Creek, and the damming of Oyster Creek to create a small lake for fire protection use.

Dredging increased the length and width of lower Oyster Creek and the South Branch of the Forked River. The effect of dredging upon the aquatic life of the South Branch of the Forked River, Oyster Creek, and Barnegat Bay is largely unknown. There were few studies of benthic animals conducted prior to dredging. It can be reasonably assumed that the dredging operation killed all the benthic biota deposited on the land. It can also be assumed that the substrate was changed as dredging exposed new soil surface. The work Pectinaria gouldii, one of the two dominate forms in the benthic fauna, has a natural habitat of sandy bottoms and a preference for larger sand grain size within such bottoms (Ref. 2.7-3). If a suitable sandy substrate were exposed by dredging, it would be reasonable for Pectinaria gouldii to colonize this area in large numbers, other factors being equal. Since massive recolonization by Pectinaria gouldii has occurred in the South Branch of the Forked River channel, it can be asserted that no long-term damage was done to that species by dredging.

For an unknown length of time prior to construction, there were few benthic organisms in the estuarine portion of Oyster Creek due to low oxygen levels and high concentrations of hydrogen sulfide (Ref. 2.7-3). Dredging and the resultant increased water circulation has apparently alleviated this situation, and benthic organisms now exist in this area.

There were no permanent hazards to navigation created by the construction and site preparation of Oyster Creek Nuclear Generating Station.

Control of floods on either stream was not impaired by site preparation or construction.

In the fresh water portion of Oyster Creek, a short section was eliminated due to dredging and another short section was inundated when the lake for the emergency fire system was built. The elimination of these sections of stream probably had little biological impact on the total system. The greatest effect would probably be in the restriction of free movement between fresh and salt water by the American eel, which was known to occur in fresh water portions of the streams. Nothing is known of the extent of the eel population inhabiting Oyster Creek. However, according to a study conducted by JC (Ref. 4.0-1), it was probably not large.

REFERENCES - SECTION 4.0

4.0-1 A Biological Study of Barnegat Bay, Forked River and Oyster Creek in the Vicinity of the Oyster Creek Plant, December 3, 1965.

5.0

ENVIRONMENTAL EFFECTS OF PLANT OPERATION

5.1 EFFECTS OF RELEASED HEAT

5.1.1 Effect on Receiving Body of Water

Cooling water is taken from the Forked River canal on the north, passed through the condensers, and discharged to Barnegat Bay through the Oyster Creek canal on the south. A dilution pumping system is provided to bypass a large quantity of cool water around the condensers and pass it directly to the discharge canal, thus permitting a lowering of the plant discharge temperature to meet limits established by agreement between JC and the State of New Jersey for the Oyster Creek Nuclear Generating Station (Section 5.1.2).

Water temperatures in Barnegat Bay were investigated at five stations along a north-south transect running along the west shore of the Bay from Stouts Creek south to the middle of the basin below Oyster Creek. Temperatures taken along this transect during 1969 (pre-operational) and 1970 (operational) revealed that the Oyster Creek outlet temperatures during 1970 were 7.2^{o}F to 12.6^{o}F higher (Ref. 5.1-1) than the 1969 data. Dissolved oxygen content was measured (Ref. 5.1-5) at the intake and discharge canals and the respective concentrations were 8.6 and 7.4 ppm. Less difference can be expected at the mouth of Oyster Creek because the water temperature decreases and oxygen solubility increases. Changes in dissolved oxygen content of this magnitude will not affect aquatic life because the oxygen content does not become critical unitl it falls below 4 to 5 ppm.

Water discharged from the plant does not affect the thermal or chemical quality of water in any other state or states because: 1) the impact even in the immediate area is insignificant because there is a small amount of discharge; and 2) the location is at least 60 miles from other states.

5.1.2 Thermal Standards

Thermal standards for the Oyster Creek plant were set forth in an agreement with the State of New Jersey, Department of Public Utilities, Board of Public Utility Commissioners in the Stipulation--DCED, Docket No. 652-60 were representatives of JC and the State met on December 17, 21, and 22, 1965 (Ref. 5.1-2). The agreement was:

> "4. With respect to matters referred to in 1(c) above it is:
>
> (a) Agreed that (i) construction of the proposed intake and discharge canals will alter the present characteristics of the existing estuarine environment in Oyster Creek and the South Branch of Forked River; (ii) temperatures maintained at 86°F or lower at all times and places in the vicinity of the discharge cooling water system will not have a direct adverse effect upon finfish of the area; (iii) the most reasonable method of obtaining temperatures not exceeding 86°F at all times and places is by the construction and operation of a closed cycle cooling tower system; (iv) according to an estimate of the Company which the State is not in a position to confirm, the estimated capital cost of a closed

cycle cooling tower system would be $7 million or more than 10% of the estimated capital cost of the entire plant without this system.

(b) Agreed that the Company is willing to provide for a 2,749 cfs dilution cooling water system and that (i) according to an estimate of the Company which the State is not in a position to confirm, the Company can provide such cooling water system utilizing dilution methods of cooling the heated discharge from its generating plant condensers at a cost of approximately $1,640,000, which system when operated at full capacity would permit temperatures in portions of the 41,000 acre Barnegat Bay to exceed 86°F based upon 1964 records, being the year of record with the highest recorded water temperatures, as follows: 40+ days per year over one acre, on 29+ of those days over 50 acres, on 25+ of those days over 100 acres, on 18+ of those days over 200 acres, on 11+ of those days over 400 acres, on 2+ of those days over 600 acres, and on 1+ of those days over 1,000 acres in each year. Within the areas where the temperature would exceed 86°F during some portion of the year, the maximum temperature at any point, at any time, would not exceed 95°F.

(c) The State contends that in areas of the Bay wherein temperatures in excess of 86°F occur, such areas will be rendered either directly or indirectly unsuitable for fish and thereby significantly reduce the utilization of the affected area by finfish and fishermen.

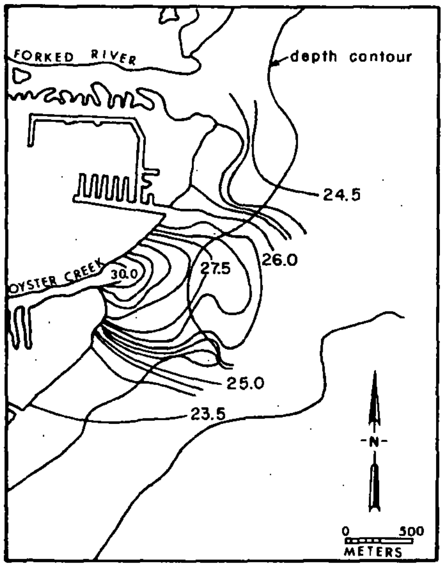
(d) It is the Company's contention that a temperature maximum of 95°F is permissible and will not significantly affect the utilization of the affected area by finfish or fishermen.

(e) In view of these contentions which are set forth in statements made by both parties in their Oral Argument of December 7, 1965, it is agreed that field surveys and other research and investigations should be instituted and conducted jointly by State and Company commencing in the Spring of 1966 and continued at least through the Winter of 1969-70 (and possibly longer) whereby the finfish population and its habitat of the estuaries of Oyster Creek, Forked River, Forked River South Branch and neighboring portions of Barnegat Bay and the environs will be studied with a view to ascertaining the effect of plant operations at discharge water temperatures, on the environment of the bay and on the marine life and environs as hereinafter set forth. Such temperatures shall be measured at the plant as provided in the Company's statement of December 7, 1965 and related to a 95°F temperature measured at the buoy. It is recognized that the temperature between the point of discharge at the plant and the buoy will at times exceed 95°F.

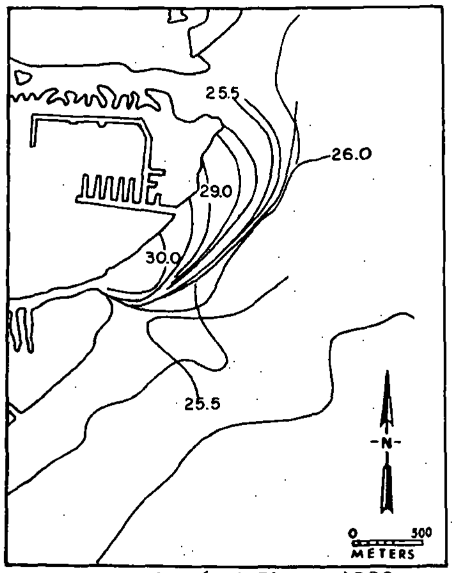
(f) It is agreed that Company and State recommend to PUC that it retain jurisdiction in this docket, until further order of PUC after Notice to the Parties for the purpose among other things of resolving any dispute between Company and State as to measures to be taken in the event that adverse effects develop in the affected portion of Barnegat Bay, (and) the estuaries aforesaid, and the environs as the result of normal plant operations."

Temperature sensors have been located at the Oyster Creek U.S. Highway 9 bridge and in Barnegat Bay. When the water temperature at the condenser outlet exceeds 96°F the dilution pumps are started. This procedure is used to maintain the water temperature at the buoy in Barnegat Bay at values lower than 95°F.

Temperature modeling studies have been conducted by the National Marine Fisheries Service Laboratory, Highlands, New Jersey (Ref. 5.1-3). Some of the results are given in Figure 5.1-1 for July and August, 1971. The plant was in operation during this time and the results show that temperatures at the mouth of Oyster Creek were 86°F (30°C) in July and 93°F (34°C) in August (also see Table 3.5-1). These temperatures are below the 95°F limit. Since these temperatures were taken during the



July 16, 1971 0854



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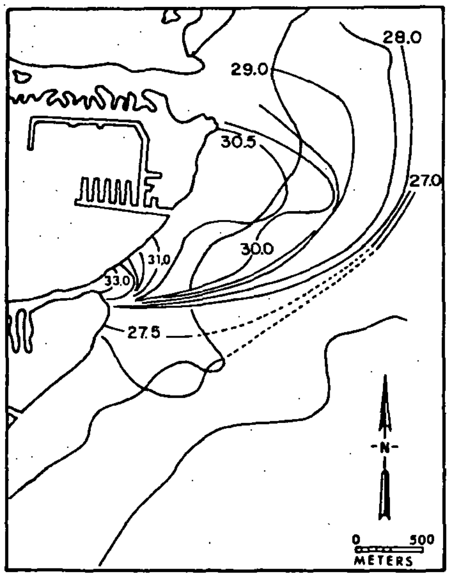
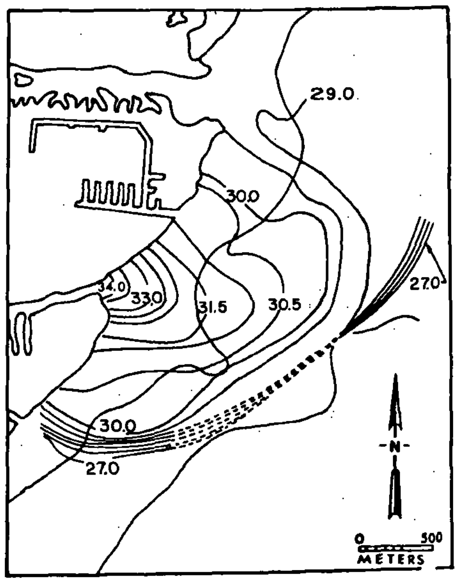


August 2, 1971 0952



August 3, 1971 0735

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

SURFACE TEMPERATURE PROFILES AT OYSTER CREEK.

DAMES & MOORE

FIGURE 5.1-1

warmest months of the year, it is clear that the temperature standards should easily be maintained throughout the remainder of the year.

5.1.3 Effects on Aquatic Biota

Pre-operational biological studies were begun in 1965 and have continued to the present. Although data analysis is about six months behind field collections, some comparisons of the species types and their abundance have been made, both before and after operation of the nuclear facility. These comparisons serve as the basis for estimating the effect of warmed water on Barnegat Bay.

5.1.3.1 Higher Plants

Eelgras (*Zostera marina*) and widgeon grass (*Ruppia maritima*) were identified off the mouth of Oyster Creek. Eelgrass is the most important spermatophyte found in the Bay and scallops are often found in association with this species.

Eelgrass was at one time the dominant plant in many coastal bays. In the 1930's, however, it became parasitized by an amoeboid protozoan that severly reduced the population and virtually destroyed the bay scallop industry. Since eelgrass is more tolerant of low salinities than the parasite that kills it, the grass spreads in years of greater precipitation and is more vulnerable in years of low precipitation (Ref. 5.1-4). Water temperature increases will not increase the abundance of eelgrass without additional nutrients being added to the water. It is possible these nutrients could come from the many dwellings along the shore of Barnegat Bay. At present, however, there have been no marked changes in the abundance of eelgrass during the time of plant operation.

5.1.3.2 Algae

The benthic algae species in Barnegat Bay that were most dominant prior to plant operation have continued to maintain that status, with only a few exceptions. The number of algal species reached its lowest density in the summers of each sample year, and the greatest number of species occurred in June and December. Such changes as have been reported reflect natural cyclic phenomena.

Statistical tests of diversity, maximum diversity, and evenness for algae were made between Oyster Creek and Stouts Creek (considered a control because it is not affected by Forked River or Oyster Creek) and defined as follows:

1) Evenness (E) is an index of the relative contribution of species to the whole sample (Ref. 5.1-9) and is determined by the following equation:

$E = \bar{H}/\log S$

Where: $\bar{H} = -\Sigma\,(Ni/N)\log Ni/N$

And: Ni = Importance value for each species (weight of each species present in sample).

N = Total of importance value (total weight of species in sample).

S = Number of species

2) Maximum diversity (MD) is defined as an index of the variety of species present and is determined as follows:

$$MD = \bar{H} - [(S-1)/\log N]$$

3) Diversity is the dry weight of macro-algae.

Statistical tests of diversity, maximum diversity, and evenness for algae were made between Oyster Creek and Stouts Creek (considered a control). These are given in Table 5.1-1 for the month of August when temperatures would be the highest.

Table 5.1-1. Comparison of Macro-Algae at Oyster Creek and Stouts Creek for Several Population Parameters.

	Oyster Creek		Stouts Creek	
	August, 1969	August, 1970	August, 1969	August, 1970
Diversity	1.0240	0.8220	0.6880	0.9190
Maximum Diversity	1.3860	1.9460	1.3860	1.7920
Evenness	0.7390	0.4230	0.4960	0.5130

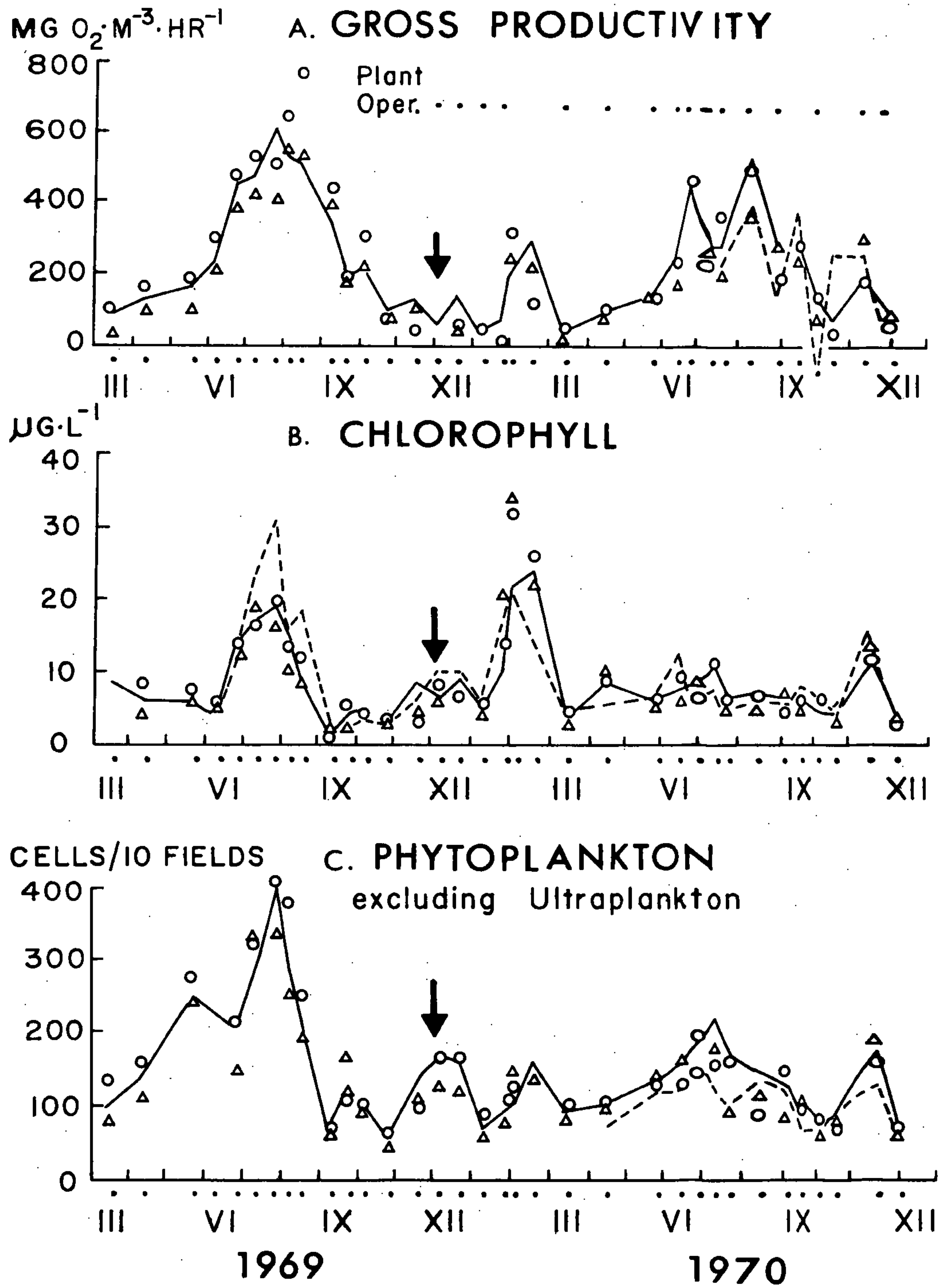
Maximum diversity was considered to be a poor index because a few dominant species were always present and the number of species was small. Evenness, a measure of the contribution of each species to the sample, remained very constant. This shows that the number and proportion of each species did not vary from point to point in the Bay. In the August samples for 1969 and 1970, the number of species increased in both Stouts Creek and Oyster Creek, which indicates that as of June, 1970, thermal discharge had not affected the algae.

5.1.3.3 Phytoplankton

Stations to collect phytoplankton samples were established off Stouts Creek (I), Forked River (II), Oyster Creek (III), at the eastern shore of the original Barnegat Bay channel (IV), and south of the channel in a basin area (V) (Ref. 5.1-5). Data were collected on chlorophyll, cell count, light and dark bottle productivity measures, and hydrographic information. Pertinent data comparing results before and during plant operations are presented in Figure 5.1-2.

Qualitative changes detected in the phytoplankton from year to year were primarily seasonal in nature, signalling essentially cold and warm water floral shifts. Variations in occurrence dates were such that no general displacements attributable to plant operations could be distinguished in a single year's experience. There was no significant change in the average number of species occurring along the transect, although a small decline in 1970 could reflect the selective loss of several groups observed at Station II (Forked River) but not at Station III (Oyster Creek)

The equation for gross productivity was developed from data collected before plant operation and included values for temperature, chlorophylll a, salinity, microflagellate counts, and the stage of tide at sampling.



Legend:

- o = Sta. III (Oyster Creek)
- Δ = Sta. V (South Basin)
- ↓ = Start of Operation
- ● = Dates operating during field work
- -- = Data for mouth of discharge canal

OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

PLANKTON PARAMETERS COMPARED DURING 1969 AND 1970

DAMES & MOORE

FIGURE 5.1-2

5.1.3.4 Benthic Organisms

The effects of salinity, temperature, depth, sediments, average diversity, maximum diversity, and evenness were determined on benthic organisms at Stouts Creek, South Branch of the Forked River and Oyster Creek, plus canals.

Pectinaria gouldii, the golden bristled or mason worm, along with Mulinia lateralis dwarf surf clam comprise the dominant species in the vicinity of the reactor. During the period immediately preceding the operation of the plant (27 August - 5 December 1969), the region in the Bay around Oyster Creek was characterized by a lower diversity than other regions of the Bay. However, the species richness (variety of species present - calculated as $d = (S-1)/\log (Ni/N)$, symbols defined on page 5.1-6 remained constant, as evidenced by a decreased evenness. The lower diversity in the Oyster Creek region during pre-operation can be attributed to the presence of the dominant bivalve Mulinia lateralis. Also, during pre-operation the Forked River region has consistently higher numbers of individuals of all species, except the dominants, than either Stouts Creek or Oyster Creek. This pattern was evident early in the study and has persisted to date.

Although the numbers of individuals for all species in Barnegat Bay rise and fall with the reproductive cycle, there has not been a significant change in the benthic community of invertebrates for the time period August 1969 to September 1970.

During the pre-operation period, diversity of species in the canals was relatively similar. In the Forked River canal at U.S. Highway 9 the number of Pectinaria and Mulinia reached extremely high levels (up to 20,000 individuals/meter^2 of each species). These dominants did not increase in number in the Oyster Creek canal at U.S. Highway 9, thus accounting for higher diversity in this region. Moreover, the number of species in Forked River canal increased, while the number of species in Oyster Creek canal remained rather constant. Oyster Creek canal at U.S. Highway 9 (the effluent canal) has a sparse community of benthic invertebrates with very few individuals. Forked River at U.S. Highway 9 (the intake canal) is very rich in the dominant species and tends to have a greater variety of species present. Nevertheless, the Oyster Creek (Bay) area, the only area receiving heated effluents, is not substantially different from the Stouts Creek area, a region of the Bay which is not influenced by warmer water.

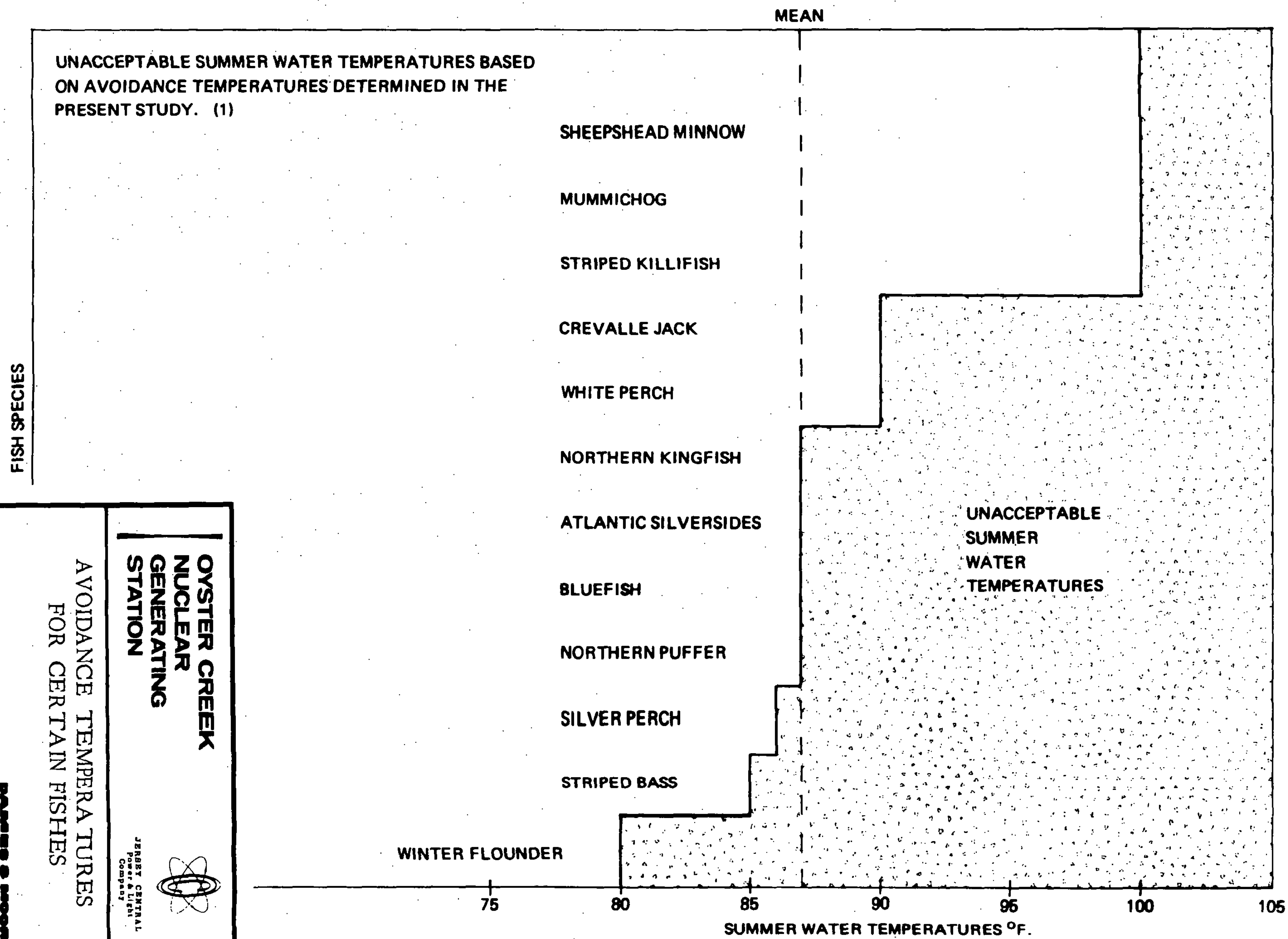
Results for the first post-operational period (Ref. 5.1-1) thus far indicate the dominant species of benthic organisms (Pectinaria and Mulinia) diminished in the region of Oyster Creek. From 1969 to 1970 Pectinaria showed a general increase at all sampling stations except Oyster Creek. The increase was especially favorable at Forked River, but a decrease of 78 percent was found at Oyster Creek. Results are not available to determine if this decrease is related to thermal discharge. The decrease of Mulinia were almost totally lost in Oyster Creek but this was also accompanied by the loss of this species throughout the Bay. The decrease is a natural cyclic process and is not related to thermal discharge of the generating station. It is predicted that Mulinia will continue to increase at Oyster Creek as the two year reproductive cycle phases in.

5.1.3.5 Fish

Direct mortality of fish may be influenced by the thermal plume, avoidance of or attraction to certain temperatures, influence of the food supply, or effects on spawning (either through changes in maturation time or direct effects on spawn).

Laboratory studies (Ref. 5.1-6) have been undertaken to define the "upper avoidance temperature" (summer temperatures which are actively avoided by fish) and "upper avoidance breakdown temperature" (summer temperatures that cause loss of locomotor ability when fish are exposed for one hour or less). These studies tested 11 species of estuarine fish and two species of estuarine invertebrates.

Summer water temperatures unacceptable to the several estuarine fishes are presented in Figure 5.1-3. Water temperatures above these levels will be actively avoided by these species. Estuarine waters with temperatures above 87°F will be an unacceptable environment for the majority of important fish species. Results in Figure 5.1-4 show that continued exposure of fish to these temperatures will cause death of most of the important estuarine species. It must be emphasized that most of these studies were conducted with young-of-the-year or small individuals of the fish species.



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

AVOIDANCE TEMPERATURES FOR CERTAIN FISHES

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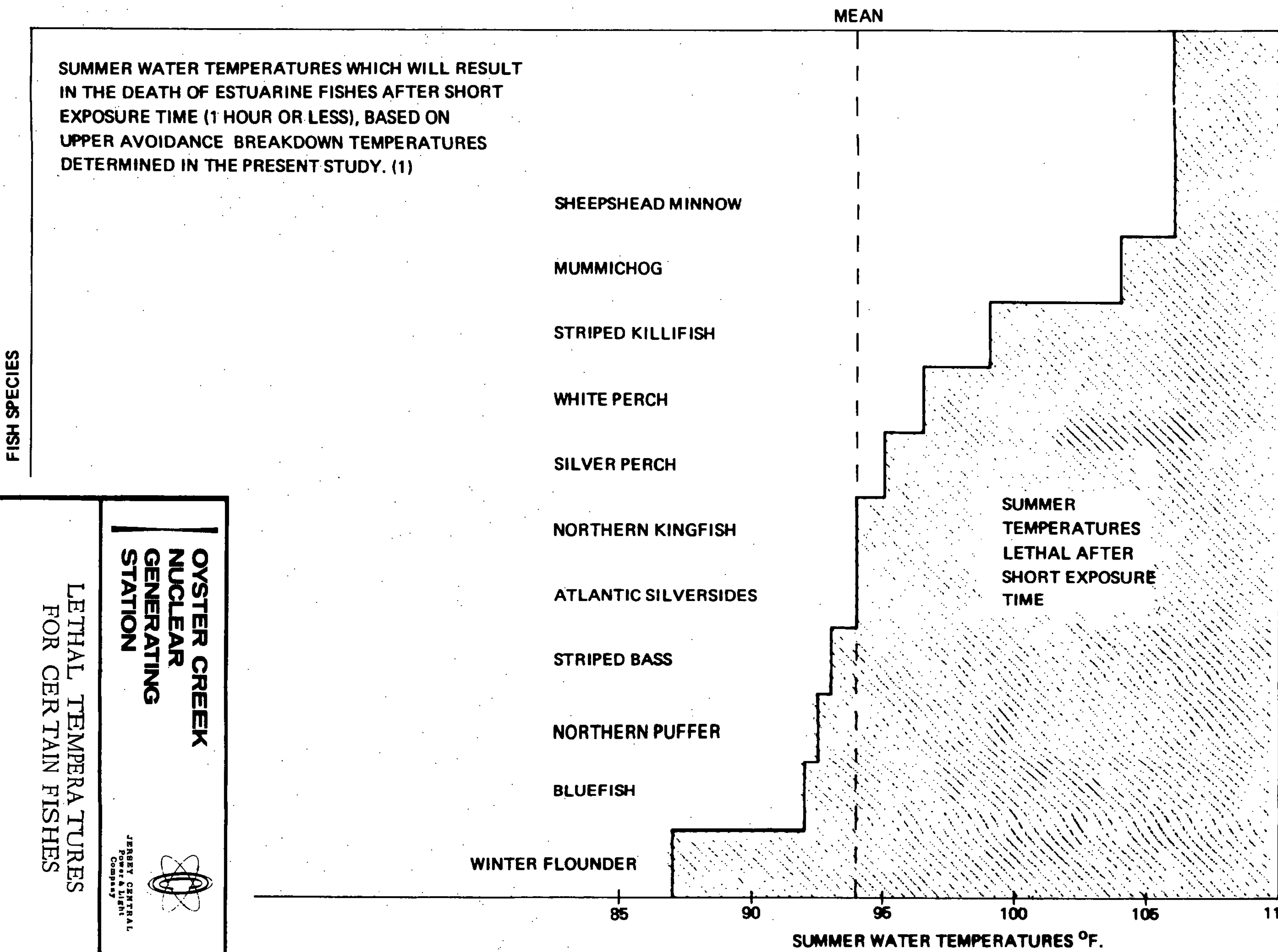
FIGURE 5.1-3



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

LETHAL TEMPERATURES FOR CERTAIN FISHES

DAMES & MOORE

FIGURE 5.1-4

The present study has demonstrated an inverse relationship between fish size and upper avoidance temperatures. It is suggested that large individuals of the species examined may actively avoid temperatures lower than the levels presented here. This is especially likely in species that attain considerable size during their lifetime (striped bass, winter flounder, bluefish).

In this same study, the effect of temperature on grass shrimp and blue crab was examined. Adult grass shrimp, an important member of the estuarine food chain, showed a mean avoidance temperature of 89.7°F and an avoidance breakdown temperature of 97.5°F. The blue crab, an important sport and food species, showed an avoidance temperature of 99.5°F and an avoidance breakdown temperature of 104°F. It appears that with a longer acclimation period these temperatures may be increased. Avoidance behavior by blue crabs may not occur until the temperature nearly reached the lethal breakdown temperature.

Studies on fish of the area were not sufficient to document changes in populations. However, observations by Dr. C. Wurtz and officials of the New Jersey Environmental Protection Department (personal communications) have indicated that the area around the Oyster Creek discharge has become popular for sport fishing. An estimated 40 to 50 people at a time on a weekend may fish at Oyster Creek and somewhat less than half this amount at Forked River.

Studies on plankton and benthic invertebrates do not indicate a decline in food supply for fish, although data specific to feeding habits of the fish of Barnegat Bay are not presently available. Most fish are able to feed on a variety of species of plankton and other fish, and their diet often shifts seasonally depending on the abundance of particular food organisms. The net effect of the warmed water on the area immediately adjacent to the discharge appears to be one of attraction of useful game and commercial fish (with the exception of the winter flounder). If a food supply is adequate, the fish remaining in the warmed water would be expected to grow faster. At present it is not known how long individual fish remain in the warmed water area, and whether they are attracted by the warmer temperature per se or by a combination of factors which may include a greater availability of food organisms. On the other hand, one species, the winter flounder, appears to avoid the discharge area. Winter flounders prefer cooler water, as can be seen in Figure 5.1-3. This species, when young, avoids temperatures above 80°F and may avoid temperatures even lower than 80° as adults.

Temperature changes often play a part in sexual maturation of fish. Usually, in temperate zones, day length, temperature, and light interact to influence gonad development and timing of spawning activities. To date, no effect of this thermal plume on the spawning activity of fish has been identified. The normal cyclic variation in the population size of each species is so great that any effect will probably not be measurable. Further, the extent of the plume is so small compared to the rest of the Bay that any small local changes would be inconsequential.

5.1.4 Effects of Passage Through Condensers

Phytoplankton and zooplankton are the two general groups of organisms which may be affected by passage over the condensers. However, the effects on fish will also be discussed. All the organisms are affected by changes in temperature, chemical concentrations, and mechancial effects. Effects may be evaluated in two ways: (1) changes in mortality or physiological parameters of the organisms that pass over the condensers, and (2) changes in populations in the general discharge area and in the Bay ecosystem.

5.1.4.1 Phytoplankton

Plankton studies described in Section 5.1.3 compared a station near Oyster Creek with other areas. Planktonic organisms in the Oyster Creek area may have passed over the condensers, may have only been exposed to the thermal plume, or may have had little or no exposure to effluent if they were recently brought in by tidal action. The results of these studies indicated that plant operation may influence productivity of phytoplankton in the Oyster Creek discharge area, but that the evidence could not be considered conclusive without a longer study period.

Studies of the direct effects of passage over the condensers were made during most of the June through October period, when samples were taken at the mouths of the intake and discharge canals and analyses made for cell count, chlorophyll, and productivity. When five available dates were compared for the two sample sites, productivity at the outfall averaged 92.3 mg $O_2 m^{-3}$ hr^{-1}

below the intake. Chlorophyll a dropped from a mean of 7.60 pg/liter to 6.93 pg/liter, compared to 10.64 at the intake and 12.87 at the outfall during 1969 (a difference of +2.23 pg/liter).

Cell counts at the intake averaged 143.3 cells/10 fields, and at the outfall 115.6. Most of the observed difference resulted from the disappearance of microflagellates (intake 127.6; outfall 98.5 cells/10 fields), but a decrease in dinoglagellates, particulary naked forms, was also detected (mean counts 7.6 intake, 3.0 outfall). The absence of species present in the intake water after transit slightly depressed phytoplankton diversity between the two stations.

5.1.4.2 Zooplankton

The parameters of importance to this group are viability and egg production. During the copepod bloom of February-April 1971, experiments were conducted to determine the following: (1) the viability of copepod eggs after exposure to temperature elevations of 10°C (50°F), 15°C (59°F), 20°C (68°F), and 25°C (77°F) (above an ambient of 5°C (41°F) in the laboratory), and (2) the ability of adult copepods to lay viable eggs within 24 hours of experiencing a temperature increase of 10°C above ambient (by passage through the cooling system of the plant).

The use of copepods was deemed appropriate on the basis that copepods exceed, in both number of individuals and number of species, all the rest of the metazoan plankton combined and are thus extremely important in food chains. In Barnegat Bay the copepod Acartia is the dominant form in that region of the Bay near the power plant and is the form dealt with in these experiments. Results from the laboratory investigation (study 1 mentioned above) showed there was no decrease in hatching until the temperature was increased to 25°C; at that temperature a drastic decline in hatchability occurred.

To compare the viability of eggs laid (study 2) by those individuals having passed through the plant with those having not, adults were collected at the intake and the outfall of the plant (Table 5.1-2). Upon return to the laboratory, adults were placed in bowls and held overnight at the ambient temperature of the intake. However, individuals collected from the outfall were maintained at the outfall temperature for two hours to simulate passage time down Oyster Creek before being returned to intake temperature. Eggs from both treatments were removed the following day and placed in small bowls for observation of hatching. The results show there were no differences in hatchability between the eggs collected from the intake water and those collected from water at the outfall.

Table 5.1-2. Percent Eggs Hatching From Individuals Collected at Intake and Outfall.

	No. Eggs	% Hatching
Intake	75	73
Outfall	75	78

5.1.4.3 Fish

Screens along the coolant water intake system prevent larger fish from entering the condenser system (Section 3.4), but eggs and young fish may pass through. Investigations have not been conducted to evaluate the effect of passage through the condensers on hatchability of fish eggs. However, studies to evaluate the effects of pumping on fish eggs have been in progress by Dr. Charles Wurtz for several seasons, but the results are inconclusive at this time.

The two obvious sources of eggs to the Bay are the in-bay product of spawning fish and the transport of eggs into the Bay by tidal incursion through the inlet. The most apparent factors for the depletion of eggs would be predation and the transport of eggs from the Bay by tidal excursion or pumping. Most resident Bay fish deposit demersal eggs, and such eggs generally hatch into larvae that are found to be more abundant near the bottom. Migrant fish generally deposit buoyant eggs outside the Bay. The demersal eggs of Bay species appear to have the ability to resist the net seaward transport characteristic of estuaries.

Collecting stations were established in the Oyster Creek, Forked River and several Bay locations to determine: (1) the abundance and species of eggs and young present, and (2) the identification of tidal and diurnal factors affecting these parameters.

The eggs collected were predominantly buoyant eggs. Subsequent preliminary identification of the eggs (a phase of the study not yet completed) has confirmed that the eggs found were chiefly those of the bay anchovy (Anchoa mitchilli). This species deposits buoyant eggs which sink with aging. The bay anchovy is one of the more important species in terms of numbers of individuals, but not as a sport or commercial fish.

If the influence of the flood tide on increased egg numbers consists primarily of entrainment of the eggs of offshore spawning fish being introduced through the inlet, the inlet should carry high concentrations of eggs on the flood tide. This has not been found to be the case. Although there is a flood tide to ebb tide ratio of 1.8 to 1 in egg counts, indicating net offshore entrainment, the number of eggs involved is much fewer than those found at stations in the Bay. It appears that all but a small proportion of the eggs introduced during the input period are the result of spawning in the Bay.

The data presently available indicate that egg attenuation during the day is not caused by the mechanical transport of eggs into the plant intake. If pumping by the plant were the cause of the day depletion of eggs, the large number of eggs per sample comprising the average number of night eggs less the average number of vesperal eggs (i.e., nine eggs per sample) would be increasingly concentrated in the mouth of Forked River. Such a concentration would occur during the attenuation period of the other stations. However, the average number of night eggs less the average number of vesperal eggs is the same at the mouth of Forked River as it is for the other stations in Oyster Creek and Barnegat Bay. Obviously this conformance of diurnal patterns among the stations discounts transport up Forked River as a factor in diurnal egg attenuation.

It must be noted that data for the diurnal distribution of fish eggs at the mouth of Forked River alone are too few to permit a rigorous assertion of the above. Moreover, the Forked River egg count averages do not decline from night through to the vesperal period as do the overall averages. On the contrary, there is an increase during the day of five eggs per sample. The reason for this variation is not known.

Studies were conducted in 1971 by Dr. Charles B. Wurtz to determine the effect of fish and crabs impinging on the plants rotary screens and transported by way of the trash flume to the head of the discharge canal. The work began April 12 and continued through July 1. A total of 95 samples was taken on 19 sampling dates. All specimens were identified and counted.

Results from the study show the most important game fish commonly found during this program was the winter flounder. The winter flounder deaths occurred at a rate of 0.17 per hour. Over a 24-hour period this would amount to four fish. This is fewer than many anglers take in a one day's fishing excursion.

From the number of fish collected over the total sampling time of 28 hours 46 minutes the Oyster Creek plant can be assumed to be having an effect on the local fishery that is approximately equivalent to that of one or two avid and competent anglers.

There is no conclusive evidence at present of any significant effects on the fish populations from mortality occurring as the result of entrainment of eggs and young fish. Large numbers of fish eggs and larvae are not being drawn through the condensers based on preliminary work. Further information will be required to statistically validate the effects of condenser passage on the populations of fish in Barnegat Bay. Meanwhile, observations in the area have shown that the region around Oyster Creek has become popular as a sport and commercial fishing area. Forty to fifty people have been reported fishing in the discharge canal during a summer weekend-day.

5.1.5 Effects of Scheduled and Unscheduled Shut-Downs

During scheduled unit shut-downs the average rate of temperature decline in the discharge canal water is normally 2 to 3°F per hour and from experience causes no apparent harm to fish or invertebrates in the canal. However, unanticipated, rapid load reductions without corresponding reductions in circulating water and dilution flow rate can be followed by sharp declines in discharge canal water temperature to that of ambient conditions in a period of 5 to 10 minutes. Under certain circumstances, this apparently can increase the possibility of harm to fish or invertebrate in the canal.

There are few field studies available documenting the effects of rapid temperature declines on fish or invertebrates. Sharp declines in temperature may result in fish mortalities. Temperature shocks may also result in lethargy, in increased susceptibility to disease, and in decreased ability to avoid predation. Warm water species are especially vulnerable to this kind of stress; however, estuarine fish are often more tolerant of temperature changes. Rather large temperature variations in shallow bays regularly occur due to solar radiation or the influx of cooler water brought in through tidal channels or heavy rainfall. Invertebrate benthic forms, which generally move little, or very slowly, are exposed to temperature extremes more often and are generally more resistant to deleterious effects of temperature changes.

Until recently there have been no empirical data on the effect of a shutdown of Oyster Creek on the aquatic environment. However, a loss of Atlantic menhaden occurred in the discharge canal after a shutdown in January 1972 and the incident is under thorough investigation. The history of the circumstances, as known to date, began last fall. At that time menhaden, which normally would have migrated from the Bay by late fall, apparently stayed in Oyster Creek. These fish were young-of-the-year and ranged chiefly from about 4 to 5 inches in length. During the period from September 17, 1971 to November 11, 1971, the plant was shut down for routine maintenance and the discharge canal water temperature was at ambient, since during this period there was no heated effluent discharged from the plant.

Following startup of the plant on November 11, 1971, rapid full load or partial load reductions (thus reducing discharge water temperature) occurred on November 16, 1971 (full), January 22, 1972 (partial), January 28, 1972 (partial followed by full) and February 3, 1972 (partial). Only the January 28, 1972 shutdown was followed by a fish kill. However, there was a strong, natural change in the ambient temperature during the 48 hours preceding this shutdown in which ambient water temperature (inlet to the plant) dropped 12°F (47°F to 35°F). The discharge water from the plant condensers, reflecting this lowering in the ambient temperature, dropped from 72°F to 60°F. The 25°F temperature rise across the plant condensers was approximately 5°F higher than normal because one of the four circulating water pumps was out of service for repairs (See Section 3.5 for description of Circulating Water System). However, one dilution pump was operating prior to and during the shutdown period. Thus, it is estimated the discharge canal water temperature was approximately 15°F higher than ambient, or 50°F prior to the shutdown.

As previously noted, the shutdown consisted of a rapid partial (approximately one-half) load reduction followed by a normal shutdown from one-half load over a period of about 6 1/2 hours. Thus, the discharge canal water temperature underwent a sharp decline of about 7°F in a short period of time followed by a gradual cooling to ambient over the next 6 1/2 hours.

The temperature data from all of these shutdowns are being collected and examined to determine, if possible, the causes of the incident.

Dead fish were first reported during the morning of January 29. The fish kill was essentially monospecific and limited almost exclusively to the Atlantic menhaden. One newspaper account reported a single perch or porgy within a drift of dead menhaden. In addition, one marina operator reported seeing one or two young bluefish among the menhaden. State personnel saw one dead anchovy, some dead silversides, and some dead alewives. However, the general consensus is that losses were at least 99.9% menhaden.

The menhaden were not all instantaneously killed. Death apparently followed loss of locomotive control. During the few days following the shutdown living menhaden were present, though obviously lacking complete motor control. These observations were made through February 1 which was more than 72 hours after the shutdown was completed. This protracted die-away suggests a threshhold lethal condition. That is, the circumstance where many, if not most, of the individual of the species will die, but hardier individuals can be expected to survive. If the killing mechanism were highly lethal, all individuals would be expected to be dead within a few hours after shutdown.

There is no evidence indicating that radioactivity or any toxic material can be related to the incident.

The extent of the fish kill cannot be verified; however, estimates range between 100,000 and 1,000,000 fish lost. Ref. 5.1-8 discusses the menahden purse seine fishery off New Jersey and gives a sense of proportion to this incident. The menhaden purse seine is a large encircling net that captures schools of fish. The authors state: "An average set of the net yields about 20 tons of fish, although sets yielding nearly 170 tons have been made." If it is assumed that the fish lost in Oyster Creek had all survived to commercial size (10 to 12 inches), and numbered 1,000,000, they would have weighed an estimated 25 tons, or slightly more than the total catch of a single net set. The estimates of weight were derived (Ref. 5.1-8) from Carlander (Handbook of Freshwater Fishery Biology, Volume I, 1969) using the gizzard shad as the base of comparison. The gizzard shad and menhaden, members of the same family, have closely comparable body forms.

In 1956 the New Jersey Fishery reached its peak and 270,000 tons of fish were landed. Almost 90% of this weight was menhaden.

In view of Jersey Central's concern about this incident, an intensive investigation has been initiated to understand the cause or causes of the incident, and subsequently to develop and implement a program to minimize the possibility of future occurrences.

Some of the major questions to be answered in this investigation are:

1. Why did the menhaden fail to migrate to the south?
2. To what extent, if any did the sharp drop in canal temperature or the extended immersion in low ambient temperature contribute to the incident.
3. What modes of operation of the Circulating Water and Dilution Water Systems, both during operation and shut down, will have the minimum impact on the environment.

REFERENCES - SECTION 5.1

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5.1-2 State of New Jersey, Department of Public Utilities, Board of Public Utility Commissioners - Proposed Findings of Fact, Conclusions and Recommendations - Oyster Creek Nuclear Plant.

5.1-3 Azarovitz, T., W. Morse, and M. Silverman, 1971, Wind and Tide Effects on a Thermal Plume in Barnegat Bay, New Jersey. An unpublished study by the National Marine Fisheries Service Laboratories, Highlands, New Jersey.

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5.1-7 June, F. C. and J. W. Reintjes, 1957, Special Scientific Report--Fisheries #222, Fish and Wildlife Service.

5.1-8 Garlander, 1969, Handbook of Freshwater Fishery Biology, Vol. I.

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5.2 EFFECTS OF RELEASED RADIOACTIVE MATERIALS

5.2.1 Radionuclides Released to the Atmosphere

Radioactive emissions to the atmosphere are discussed in Section 3.6.2.2. Pathways to man for released radionuclides are listed below in order of decreasing importance:

1) External exposure from isotopes of krypton and xenon plus their decay products.

2) Air-pasture deposition-cow-milk-child thyroid pathway for isotopes of iodine.

3) Inhalation of airborne iodine and particulate radioactivity.

4) Deposition on crops and subsequent ingestion by people.

5.2.1.1 External Exposure

External exposure to radiation near the plant comes from three primary sources:

1) Atmospheric submersion dose, where one is completely surrounded by a cloud of radioactive gas.

2) Direct radiation from the cloud as it passes overhead.

3) Direct radiation from equipment, stored waste, and radwaste systems (shine radiation).

Items 2 and 3 are important contributors to the total dose near the site boundary. Item 1 is the only important source of an external radiation dose beyond two miles.

Two types of external dose were considered: (1) maximum dose to an individual (somatic), and (2) total dose to the population (genetic). The maximum individual and population dose from sources 1 and 2 are estimated below. Source 3 does not represent dose from radioactive material released to the atmosphere, but has been measured (see Section 5.5-2).

The dose calculations for normal operation are based on an average noble gas release rate of 25,000 uCi/sec over the life of the plant (40 years). This assumption is based on several factors:

1) During the first two full years of operation (1970 and 1971) the average release rate was less than 10,000 uCi/sec;

2) Even though the release rate is increasing, approximately one-fourth of the fuel bundles will be replaced each year, thus, replacing the number of leaking assemblies;

3) Fuel technology is advancing and it is reasonable to assume that improvements will be made that will reduce fuel defects and, therefore, off-gas release rate and;

4) Improvements that will be made in the off-gas system will definitely reduce emissions to levels considerably below those experienced today.

Thus, the dose estimates discussed below represent upper limits.

Meteorological dilution factors were determined for 16 directions and the midpoint of 10 incremental distances (0.5, 1.5, 2.5, 3.5, 4.5, 7.5, 15, 25, 35 and 45 miles). These dilution factors are based on information presented in Ref. 5.2-1 and are tabulated in Table 2.6-12. The method of extrapolating meteorological data beyond the six mile distance of Ref. 5.2-1 was based on fitting exponential curves to the 16 directional distributions.

To calculate the close-in annual average dose from the sources listed above, the data in Table 23 of Ref. 5.2-1 was adjusted downward from a release rate of 1.0 Ci/sec. to an annual average release rate of 25,000 uCi/sec. This method was used to estimate individual and population dose from external radiation out to five miles. Beyond five miles, submersion dose calculations were based on the isotopic distribution of the gaseous effluent from the Oyster Creek plant (see Table 3.6-4).

The closest resident to the stack lives 4,200 feet NNE. Correcting for shielding and occupancy the dose to an individual at that distance would be 4.6 mrem which is less than one percent of the 500 mrem limit specified in 10 CFR Part 20.

The distribution of population dose based on the current population is tabulated in Tables 5.2-1 and 5.2-2. These values do not include any adjustment for shielding or occupancy. Results in Table 5.2-1 apply to the resident population only, whereas results in Table 5.2-2 also include peak seasonal population, which is assumed to be present during 25 percent of the year. This 25 percent factor was predicted on the assumption that vacationers reside in the area for an average of three months each year. This is a conservative assumption because at least some of the seasonal population probably lives within the 50 mile radius of the plant, thus producing a redistribution of population and not a full addition to the cumulative total.

Table 5.2-1. Man-Rem Per Year For Resident Population

DISTANCE IN METERS TO MIDPOINT OF POPULATION SECTOR

	804	2412	4020	5628	7236	12060	24120	40200	56280	72360
N	0.00	0.94	0.82	0.01	0.01	9.33	4.35	0.18	0.02	0.00
NNE	0.88	1.87	1.23	0.32	0.79	4.84	5.12	0.64	0.07	0.00
NE	0.86	1.28	0.79	1.55	0.69	0.69	0.06	0.00	0.00	0.00
ENE	0.00	1.85	0.27	0.37	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.39	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ESE	0.47	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE	0.27	1.35	0.04	0.00	0.00	0.27	0.00	0.00	0.00	0.00
SSE	0.02	0.85	0.27	0.03	0.06	0.22	0.00	0.00	0.00	0.00
S	0.00	0.72	0.44	1.24	0.19	0.26	0.21	0.00	0.00	0.00
SSW	0.00	0.09	0.00	0.01	0.11	0.79	0.68	0.39	1.12	0.06
SW	0.00	0.15	0.02	0.00	0.00	0.00	0.10	0.11	0.02	0.00
WSW	0.00	0.00	0.00	0.05	0.01	0.16	0.05	0.02	0.01	0.00
W	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.03	0.03	0.02
WNS	0.00	0.00	0.00	0.00	0.00	0.01	1.01	0.61	0.11	0.11
NW	0.00	0.00	0.00	0.00	0.00	0.08	0.67	0.38	0.14	0.02
NNW	0.00	0.00	0.12	0.00	0.00	0.01	0.73	0.07	0.02	0.01

CUMULATIVE SUMS OF ALL MAN-REM VERSUS DISTANCE TO OUTER BOUNDARY

MILES	1	2	3	4	5	10	20	30	40	50
MAN-REM	2.50	12.81	17.24	20.82	22[illegible]	39.34	52.39	54.82	56.36	56.58

Table 5.2-2. Man-Rem Per Year Including Resident And Seasonal Population

DISTANCE IN METERS TO MIDPOINT OF POPULATION SECTOR

	804	2412	4020	5628	7236	12060	24120	40200	56280	72360
N	0.00	1.39	1.23	0.01	0.01	11.57	4.46	0.19	0.02	0.00
NNE	1.32	2.78	1.82	0.47	0.93	6.00	5.35	0.65	0.07	0.00
NE	1.27	1.91	1.17	2.29	0.96	0.86	0.07	0.00	0.00	0.00
ENE	0.00	2.74	0.40	0.54	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.58	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ESE	0.90	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE	0.52	2.57	0.07	0.00	0.00	0.34	0.00	0.00	0.00	0.00
SSE	0.03	1.62	0.52	0.03	0.07	0.27	0.05	0.00	0.00	0.00
S	0.00	0.82	0.51	1.50	0.36	0.33	0.24	0.00	0.00	0.00
SSW	0.00	0.10	0.00	0.02	0.21	0.97	1.36	0.42	1.15	0.09
SW	0.00	0.17	0.01	0.00	0.00	0.00	0.10	0.11	0.02	0.00
WSW	0.00	0.00	0.00	0.08	0.01	0.14	0.05	0.02	0.01	0.00
W	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.03	0.03	0.02
WNW	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.81	0.11	0.10
NW	0.00	0.00	0.00	0.00	0.00	0.08	0.67	0.36	0.14	0.02
NNW	0.00	0.00	0.18	0.01	0.00	0.01	0.73	0.07	0.02	0.01

CUMULATIVE SUMS OF ALL MAN-REM VERSUS DISTANCE TO OUTER BOUNDARY

MILES	1	2	3	4	5	10	20	30	40	50
MAN-REM	4.04	20.27	26.83	31.78	34.33	54.92	69.08	71.74	73.31	73.55

Based on the maximum projected gaseous release rate, the cumulative permanent population dose out to 50 miles would be 57 man-rem. The dose would be 74 man-rem when both permanent and seasonal populations are considered. This estimate does not include any correction for occupancy or shielding and is a small fraction of the population dose attributable to natural background radiation (see Section 5.2.2.4).

5.2.1.2 Milk

Distribution of dairy cows near the plant is described in Section 2.2. The only area within a 25 mile radius having a significant number of milk cows (135) is the New Egypt area (Plumsted Township) approximately 22 miles NNW; there are no milk cows within ten miles of the site. The maximum average annual concentration of radioiodine at about 22 miles from the plant, assuming no decay or deposition in transit, is 1.2×10^{-17} uCi/cc. Intake by a child that obtains all its milk from the New Egypt area is not likely to exceed 0.01 percent of the maximum permissible intake recommended by the ICRP (Ref. 5.2-2), and the dose to the child's thyroid is unlikely to exceed 0.15 mrem/year from this source. This is less than the design objectives suggested in the proposed Appendix I 10 CFR 50.

5.2.1.3 Inhalation

Based on the projected average release rate (Section 3.6.2.2), the annual average concentration to the nearest residence located 4,200 feet NNE of the stack at this point is 1.0×10^{-16} uCi/cc for airborne particulate radioactivity and 3.4×10^{-15} uCi/cc for radioiodine. These concentrations represent 0.0001 percent and 0.003 percent of ICRP recommended limits for intake via inhalation (Ref. 5.2-2). Internal dose via inhalation is so small, when compared with the external radiation dose, that it can be considered an insignificant pathway to man for this plant.

5.2.1.4 Crops

The area within ten miles of the plant is not very productive agriculturally (Section 2.2.2). Some alfalfa is produced (approximately 100 acres), but very few crops are grown for human consumption. Deposition on crops and subsequent ingestion by man will be insignificant (<0.05 mrem/year) when compared with the external radiation dose from noble gas (4.6 mrem/year). Crops, therefore, do not represent a significant pathway to man at this plant.

5.2.2 Radionuclides Released to Oyster Creek and Barnegat Bay

5.2.2.1 Aquatic Pathways

The Oyster Creek discharge canal contains brackish water and is not potable. The most significant pathway for potential exposure to man is via seafood, especially clams and scallops, from Barnegat Bay. The pathway for exposure through water contact activities such as swimming, boating, and water skiing have been shown to be small when compared with the ingestion pathway to man (Ref. 5.2-8).

5.2.2.2 Seafood

Clams and scallops are planktonic filter feeders: in the process of feeding, they pump large quantities of water across their gill systems; substances such as algae, small zooplankton, and bacteria are removed as food. This process tends to concentrate individual radionuclides at levels much higher than exist in the water. Concentration factors for marine invertebrates is generally larger than for marine fish. Furthermore, clams and scallops do not move about as freely as fish. For these reasons, clams and scallops represent the most significant aquatic pathway to man at this site.

The potential intake of various isotopes from ingestion of clams and scallops is shown in Table 5.2-3. Total intake of all radionuclides combined represent 0.5 percent of the maximum permissible intake recommended by the ICRP (Ref. 5.2-2). The total dose to any organ in man is less than 5.0 mrem/year. Total dose to the whole body is less than 0.1 mrem/year.

5.2.2.3 Direct Exposure - Water

Direct external radiation exposure from activities such as swimming, boating, fishing, or water skiing in Barnegat Bay is expected to have a negligible effect on man. Furthermore, direct uptake by the respiratory tract, skin and gastro-intestinal tract is expected to be small.

Table 5.2-3. Potential Intake From Ingestion Of Seafood

Radionuclide	Released Concentration uCi/ml (Note 1)	Concentration Factor (Note 2)	Invertebrate Concentration uCi/g	(MPC)i uCi/g (Note 3)	Fraction of (MPC)i
H-3	7.5(-8)*	0.926	7(-8)	2.3(-1)	3.0(-7)
Mo-99	5.6(-9)	10	5.6(-8)	3.1(-3)	1.8(-5)
Cr-51	5.3(-9)	2000	1.1(-5)	1.5(-1)	7.3(-5)
Ba-140	3.4(-9)	200	6.8(-7)	1.5(-3)	4.5(-4)
Np-239	2.5(-9)	286	7.1(-7)	7.5(-3)	9.5(-5)
Tc-99m	1.8(-9)	50	9(-8)	2.3(-1)	3.9(-7)
I-131	1.2(-9)	50	6(-8)	2.3(-5)	2.6(-3)
I-133	1.1(-9)	50	5.5(-8)	7.5(-5)	7.3(-4)
La-140	1.1(-9)	1000	1.1(-6)	1.5(-3)	7.3(-4)
Co-60	1.1(-9)	1000	1.1(-6)	2.3(-3)	4.8(-4)
Co-58	3.7(-10)	1000	3.7(-7)	7.0(-3)	5.3(-5)
Sr-90	2.8(-10)	6.25	2(-9)	2.3(-5)	8.7(-5)
Mn-54	1.9(-10)	5000	9.5(-7)	7.5(-3)	1.3(-4)
Cs-137	2.8(-10)	20	5.6(-9)	1.5(-3)	3.7(-6)

*Numbers in parentheses are exponents of 10.

NOTES

1. Concentration at point of release is based on annual release estimates summarized in Section 3.6, a dilution flow of 8 x 10^{11} liters/year and a recirculation factor of 3.76.

2. Concentration factor for marine invertebrates is the radionuclide concentration per gram of invertebrate (e.g.,clams) divided by the concentration per milliliter of sea water. Values used in this table are based on Ref. 5.2-3.

3. The maximum permissible concentration in invertebrates, (MPC)i, is based on the maximum permissible intake recommended by the ICRP (Ref. 5.2-2) and assuming that a local resident consumes 0.2 Kg/week of shellfish meat taken from near the mouth of Oyster Creek. This is much higher than the reported average invertebrate consumption rate of 0.015 Kg/wk (Ref. 5.2-4).

A comparison of direct exposure from activities in or near the water with ingestion of fish or invertebrates has indicated that ingestion of invertebrates is the most limiting consideration.

5.2.2.4 Summary of Dose Estimates

The maximum doses to an individual and to a large population group from operation of the Oyster Creek plant are summarized below and are compared with other sources of radiation exposure (Ref. 5.2-5).

Type of Exposure	Individual Dose mrem/year	Population Dose man-rem/year
Doses from Oyster Creek Plant:		
External (Whole Body)	4.6	74
Ingestion of Milk (Thyroid)	0.15	-
Inhalation (Thyroid)	0.05	-
Inhalation (Other Organs)	0.05	-
Ingestion of Crops (All Organs)	0.05	-
Ingestion of Seafood (Whole Body)	0.1	-
Ingestion of Seafood (Indv. Organs)	5.0	-
Doses from Other Sources:		
Background Radiation	130	27,000,000
Medical Diagnostic X-rays	90	18,000,000
Weapons Test Fallout	5.1	1,000,000
10 CFR 20 Limit	500	

5.2.3 Long-Term Buildup in Biota and Sediment

Isotopes of ruthenium, cobalt, manganese, zinc, and cesium have been detected in clams, crabs, and other marine biota (see Section 5.5.2.1 and Ref. 5.2-6). Generally, levels of these isotopes have been lower than the naturally occurring K-40.

Clam meat and fluid seem to be among the best indicators of accumulation. No increase in background levels have been detected in sediment, although some deposition in sediment has probably occurred. Long-term buildup in the clam would appear to be the most limiting consideration. Dose to man from ingestion of the clam meat has been discussed (Section 5.2.2.2). Dose to the clam itself would be much less than that resulting from the maximum permissible concentration of radionuclides as given in 10 CFR 20. In reviewing the radiological effects of these low level radioactive liquid wastes on aquatic biota, Dr. S. I. Auerbach, Director of Ecological Sciences Divison at the Oak Ridge National Laboratory, concluded that "with dose rates to aquatic biota at or around the maximum permissible concentrations of radionuclides in 10 CFR 20, our best technologies and methods cannot demonstrate that there is any effect on these systems." (Ref. 5.2-7) Therefore, long-term buildup of these radionuclides is not expected to have any adverse effect on the marine biota in Barnegat Bay.

REFERENCES - SECTION 5.2

5.2-1 Facility Description and Safety Analysis Report, Oyster Creek Nuclear Power Plant, Amendment 13, August 30, 1967.

5.2-2 ICRP Publication 2: Report of Committee II on Permissible Dose for Internal Radiation, Pergamon Press, 1959.

5.2-3 Chapman, W. H., H. L. Fisher, M. W. Pratt. Concentration Factors of Chemical Elements in Edible Aquatic Organisms. Lawrence Radiation Laboratory, Univeristy of California, Livermore, California. Report No. UCRL-50564. December 30, 1968, 50 pp.

5.2-4 Nash, D. H., A Survey of Fish Purchases by Socio-Economic Characteristics, Bureau of Commercial Fisheries, Division of Economic Research, Working Paper #50, April 1970.

5.2-5 Ruckelshaus, W. D., Testimony Given Before the Joint Committee on Atomic Energy, Hearings on Power Reactor Regulations, June, 1971.

5.2-6 McCurdy, D., and J. J. Russo, Environmental Radiological Surveillance Program, Report by New Jersey State Department of Environmental Protection on Data Obtained in 1970, May 1971.

5.2-7 Auerbach, S. I., Ecological Considerations in Siting Nuclear Power Plants: The Long-Term Biotic Effects Problem, Nuclear Safety, Volume 12, p. 25 (Jan-Feb. 1971).

5.2-8 Evans, A. G., W. L. Marter and W. C. Reinig, Guides Limiting the Release of Radionuclides by the Savannah River Plant, Health Physics, Vol. 15, pp. 57-65 (1968).

5.3 EFFECTS OF RELEASED CHEMICAL AND SANITARY WASTES

Additions of chemicals or fecal bacteria to Barnegat Bay may come from sanitary waste disposal at the plant, from leakage and discharges of waste products into the coolant water, or from injection of chemicals into coolant water to control biological growths on the condensers.

5.3.1 Sanitary Wastes

All sanitary wastes drain into the Oyster Creek plant sewage system. These wastes undergo an extended aeration-type treatment before discharge. A permit has been granted by the State of New Jersey for the operation of the facility. Treatment reduces coliform counts to below that established as safe by the Department of Health.

The effluent includes phosphates and nitrates, which act as nutrients to the Barnegat Bay ecosystem. The amount of these nutrients is very small, especially when compared to nutrient material coming from the many residences along the Bay. Biological studies have not revealed changes in biota that would be related to operation of the sanitary system.

5.3.2 Coolant Water Discharges

Sodium hypochlorite is periodically introduced into the coolant water to control biological buildup on the condensers. Chloride is injected four to five times daily at amounts that range from 1,000 to 4,000 pounds; the larger amount is used during the warmer seasons of the year. Organisms exposed to chlorination may experience physiological harm or mortality. Specific studies have not been conducted at the site to determine the effects of chlorination. In terms of the Barnegat Bay ecosystem, however, its effects on population and productivity are important, and these parameters are being monitored by the existing biological programs.

Little effect is expected on organisms in Oyster Creek and Barnegat Bay because chloride discharge rates are controlled so that free chlorine concentrations are less than one ppm at the discharge.

Other chemicals may be released from the Oyster Creek plant (Table 5.3-1). These concentrations are generally low, and none are known to accumulate in toxic form. The potential effect of these chemicals on productivity of terrestrial and aquatic environments is expected to be negligible.

Table 5.3-1. Chemical Analyses For Oyster Creek Nuclear Generating Plant's Intake and Discharge Waters.

	Sampled 9/6/71		Sampled 11/1/71	
	Intake	Discharge	Intake	Discharge
Phos.	.326	.326	.326	0.00
NO_3	0	0	.00	.00
NH_3	.04	.21	.22	.05
Solids				
Insol.	108	102	13	75
Sol.	26,387	25,376	19,148	20,943
Total	26,495	25,428	19,161	21,018
Volatile	4,081	3,644	2,614	4,228
Cl	14,000	13,800	10,300	10,600
SO_4 *	1.7654	1.7654	1,302	1,361
Zn	.11	0.09	0.00	0.00
Cr	0.00	0.00	.03	.03
Hardness	--	--	3,240	3,300
Turbidity**	9	47	13	12
Fe	--	--	0.17	0.20
TKN	--	--	0.26	0.23
D.O.	5.6	5.3	--	--
BOD	2.3	2.2	--	--
N ***	0.63	0.84	--	--

* Reported in grams/liter, all other elements are expressed in mg/liter

** JTU units

*** Total keldgahl nitrogen

5.4 OTHER EFFECTS

5.4.1 Interaction of Transmission Lines Between Plant and Service Area

The transmission right-of-way is 11.1 miles long. Over seven miles of the route pass through pitch pine areas and most of the remainder passes through white cedar marsh. Along most of the corridor, the right-of-way was clear-cut to a width of 240 feet. Clear-cutting has removed habitat for certain animals that seek mature pine forests and/or white cedar marsh for food and cover. At the same time, the right-of-way has established openings and edge effects that provide food and cover for other types of wildlife; for example, white-tail deer, Bobwhite Quail, and songbirds.

The corridor crosses four transportation rights-of-way. Since construction of these rights-of-way JC has modified its underbrush clearing procedures to promote regrowth of natural vegetation on the right-of-way at primary and secondary road crossings; the vegetation will serve as a visual barrier at these locations. The transmission right-of-way was re-routed to avoid all agricultural and recreational areas, namely five cranberry bogs and one lake. The right-of-way also does not affect any of the 47 historical sites in Ocean County and has little or no visual impact on people residing in the vicinity of the route.

In general, construction of the right-of-way did have some aesthetic impact on the environment, such as exposing the clear-cut corridors to passing motorists. This impact is being modified as a result of JC's modified vegetation management program which will allow screens or visual barriers to grow at road crossings.

5.4.2 Fuel Transportation

Method and frequency of fuel shipment is described in Section 3.6.4, along with a discussion of routing and in-transit safety. The only significant environmental effects of these activities will be some external radiation exposure to people who may be in the proximity of the routes used. Any exposure from new fuel elements will be negligible. The following discussion applies only to spent fuel elements.

Exposure rates associated with shipments of spent fuel have been calculated for both normal and accident conditions. The maximum dose to an individual from a stationary cask will be 10 mrem/hr at six feet and 0.085 mrem/hr at 100 feet. For a cask moving at 20 miles/hr, the maximum dose to an individual is estimated to be 0.00013 mrem per cask. Assuming that all six casks per year travel the same route, and that the same individual is exposed to every cask, maximum dose to this individual will be 0.0008 mrem/yr.

To estimate population dose, the transportation route is assumed to cover 800 miles through a territory having an average population density of 334 people per square mile (the average of that area represented by New Jersey, New York, Pennsylvania and Ohio). With the shipment of six casks/yr and with each cask moving at 20 miles/hr, the population dose is estimated to be 0.004 man-rem/yr.

Dose to an individual from an accident may include direct radiation, dose from fission gas release (mostly skin dose from Kr-85), and thyroid dose from I-131. Assuming that people congregate after the accident and surround the cask beginning at 50 feet away, the direct radiation dose rate will be 8.7 mrem/hr. Further, assuming a tightly packed crowd, there will be 154 people in the front row and each person remaining there for two hours will receive a dose less than 20 mrem. This assumes that the increased radiation level will emanate from all sides of the cask - an unlikely occurrence.

No gaseous release is expected, even under accident conditions, without a substantial quantity of decay heat in the shipping cask plus the addition of external heat, such as from a fire. Under these conditions, thermal currents surrounding the cask should carry released fission gases to a height of ten meters before they are dispersed. On this basis it is calculated that the maximum dose from the release of 1000 curies of noble gases and 10 curies of I-131 would occur at a distance of 300 feet from the cask. Assuming a person stands in the plume during the entire accident, the resulting dose (mostly skin dose) would be 0.02 mrem and the maximum thyroid dose would be 18 rem. For the noble gas release, assuming a population density of 334 people per square mile, the total population dose from the accident would be 0.03 man-rem. These doses are in accordance with AEC and DOT guidelines. The skin and whole body dose is a small fraction of that due to natural background.

5.4.3 Interaction with Neighboring Plants

No other plants exist in the immediate vicinity of the Oyster Creek plant. The Forked River Nuclear Generating Station has been proposed for an adjoining site, 3,400 feet west of the Oyster Creek Station, but JC has not yet received a construction permit.

5.4.4 Enhancement of Natural Environment

JC is concerned with activities that enhance the natural environment. A number of positive steps have been taken for this purpose.

During design and construction of the transmission right-of-way, JC was careful to locate the route in areas where it would have the least environmental impact on man's activities or on the ecosystem in general. For example, the right-of-way was directed around commercial cranberry bogs, streams were crossed so as to minimize disruption and encourage regrowth of vegetation. At those points where the right-of-way crosses highways recent vegetative control procedures insure the growth of natural barriers to minimize visual disturbances. All along the transmission route, only undesirable or hazardous vegetation has been removed. Programs are currently underway to encourage new vegetation to become established that will provide protective cover for wildlife and soil.

East of U.S. Highway 9 migrating geese and ducks are allowed to use the land as a rest feeding area. Numerous other forms of wildlife are also common in this area, such as Bobwhite Quail and many different songbirds. The area is open to the public, and amateur birdwatchers frequently visit the area.

The public fishes, water skies, and boats on Oyster Creek and the South Branch of Forked River. Many people have taken advantage of the improved boating facilities and deeper channels in these streams. Many local sport fishermen report that fishing in Oyster Creek has improved since the plant began operation.

Preservation of the land around the plant has been of concern to JC. The entrance to the plant has been landscaped to improve the aesthetic qualities of the site and to provide protective soil cover. Other areas that had undergone vegetation removal during construction are being re-vegetated.

5.4.5 Economic Impact of Employment on the Plant Environs

A large construction force composed mostly of local New Jersey construction workers was employed at the site during the more than three years of construction. No accurate figures are available, but the financial benefit for the individuals, the local communities and New Jersey as a whole is indisputable. Some of the work force was not from the local area and their expenditures for housing, clothing, food and other items were clearly an asset for the local economy.

The permanent operating force at the plant is composed of approximately 100 persons who all live in the surrounding communities. The annual payroll for the plant force is $1.4 million and this adds significantly to the local economy.

During each year approximately 100 transient maintenance personnel will spend time working at the plant, mostly during the annual refueling outages. The economic impact of these workers, due to the expenditures during their stay in the area, is definitely beneficial to the local economy.

Approximately 1.5 million dollars in taxes were paid by JC to Lacey Township in 1971. This tax revenue is clearly of economic benefit to the Township.

5.5 ASSESSMENT OF ENVIRONMENTAL EFFECTS OF PLANT OPERATION

5.5.1 Overview

Radiological, meteorological, hydrological and biological monitoring programs are currently being conducted to assess the environmental effects of operating the plant. The Oyster Creek plant has been generating power for over two years; and these monitoring programs have thus far indicated that environmental effects as a consequence of plant operation have been limited to a slight buildup of radioactivity in marine biota and the loss of some fish caused by a sudden drop in ambient temperature followed by a reactor shutdown.

5.5.2 Monitoring Programs

5.5.2.1 Radiological

An environmental radioactivity monitoring program has been conducted at the Oyster Creek site since February 1966. The program is designed to measure environmental radiation and radioactivity in air, fallout, domestic water, surface water, marine life, and foodstuffs. Fallout monitoring includes radioactivity measurements of soil, vegetation, and rainwater. Surface water monitoring encompasses water and silt from Barnegat Bay, Oyster Creek, and the South Branch of Forked River. Clams were selected as the key indicator for marine life and are sampled regularly. Milk production is not significant near the site, therefore foodstuff monitoring is limited to crops.

Table 5.5-1 is a tabulated summary showing the various types and methods of monitoring, the number of sample stations, the sampling frequencies,

Table 5.5-1. Environmental Radioactivity Monitoring Program For Oyster Creek Nuclear Electric Generating Station.

Type of Monitoring	Method	No. Of Stations	Sampling Frequency	Analyses
Atmospheric				
Radiation (Radiogas)	Film Badges	17 (1)	Change badges every 4 weeks	Milliroentgen Exposure
Air Particulate	Continuous-Fixed Filter	5 (2)	Change filters every 2 weeks	Gross Beta every 2 weeks Gross Alpha every 12 weeks
Fallout				
Soil	Grab Sample	5 (2)	Every 4 weeks	Gross Beta each sample
Vegetation	Grab Sample	5 (2)	Every 4 weeks	Gross Beta each sample
Rain Water	Continuous	5 (2)	Every 4 weeks	Gross Beta each sample
Domestic Water				
Wells	Grab Sample	6	Every 4 weeks	Gross Beta each sample Gross Alpha each sample K-40, Ra-226, Ra-228, Uranium, Tritium every 12 weeks
Surface Water				
Barnegat Bay	Grab Sample	3 (3)	Every 4 weeks	Gross Beta each sample
Oyster Creek	Grab Sample	1	Every 4 weeks	Gross Alpha each sample K-40, Ra-226, Ra-228,
South Branch of Forked River	Grab Sample	1	Every 4 weeks	Uranium, Sr-90, I-131, Tritium, Cs-137, Co-58,60, Zn-65, --every 4 weeks
Silt (bottom material)	Grab Sample	5 (4)	Every 12 weeks	Gross Alpha each sample Gross Beta each sample

Table 5.5-1. (Cont'd.)

Types of Monitoring	Method	No. of Stations	Sampling Frequency	Analyses
Marine Life				
Clams	Grab Sample	3(3)	Every 4 weeks	Gross Alpha each sample Gross Beta each sample K-40, Sr-90, I-131, Cs-137, Co-58,60, Zn-65; Every 12 weeks
Foodstuffs				
Crops (when available)	Grab Sample	3	Every 12 weeks	Gross Beta each sample Sr-90 - each sample

Notes: (1 One station on-site and 16 stations at various directions and distances within 20 miles of plant.
(2) One station on-site and 4 stations within several miles of plant.
(3) Samples taken from an area north of plant discharge, in the vicinity of the plant discharge, and from an area south of the plant discharge.
(4) Samples taken at same locations as surface water.

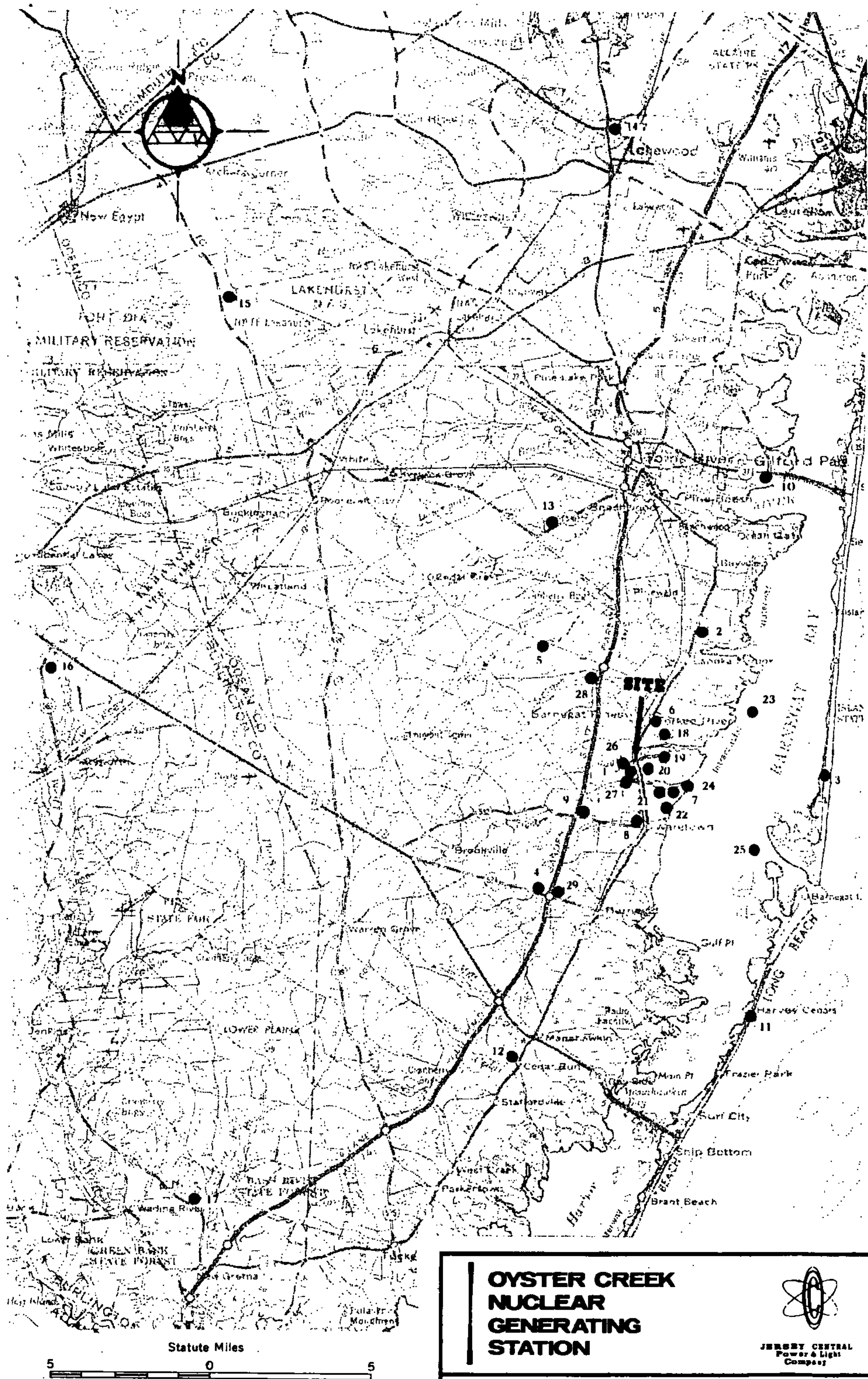
and the sample analyses. Figure 5.5-1 locates the various sampling locations, which are described in Table 5.5-2. Detection limits for various analyses and sample type are given in Table 5.5-3.

Results of the environmental monitoring program obtained since the plant began operating in May 1969, were compared with pre-operational data obtained during 1966, 1967, and 1968. Direct radiation, air particulate filters, and clams are considered the key indicators used during the pre-operational and operational periods. A summary of the data obtained by JC for these three types of monitoring is given in the paragraphs that follow; also included are a summary of data obtained by the State of New Jersey and a statement concerning future modifications to the radiological monitoring program.

Direct Radiation

Pre-operational data for film badges measuring direct radiation indicated a maximum dose of 8 to 12 mrem/month. The results for badges used during the operational period were generally equal to or less than the pre-operational levels. A few readings above background were obtained, but these were inconsistent as to location and time interval and may have been caused by film damage.

A direct radiation survey was conducted in September 1971, with a pressurized ionization chamber and a gamma spectrometer (Ref. 5.5-1). Direct (shine) radiation exposure rates along the fence line extending east-west



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

ENVIRONMENTAL MONITORING STATIONS

DAMES & MOORE

FIGURE 5.5-1

REFERENCE:

THIS MAP WAS PREPARED FROM PORTIONS OF U.S.G.S. QUADRANGLES WILMINGTON, DEL.-N.J.-MD., DATED 1966, AND NEWARK, DATED 1949.

Table 5.5-2. Location Of Environmental Radiological Monitoring Stations.

Station Number	Location from Plant	Sample Type
1	Plant Site (at Meteorological Tower)	Film Badge, Air Particulate, Soil, Vegetation, Rain, Well Water
2	5 Miles NNE (Pole No. JC3063B, 1 Span West of Pinewald Sub.)	Film Badge, Air Particulate, Soil, Vegetation, Rain
3	6 Miles E (Pole No. JC2631B, on Island Beach, 2½ Miles North of Barnegat Inlet)	Film Badge, Air Particulate, Soil, Vegetation, Rain
4	4 Miles SW (Pole No. BT-94-U, Barnegat Estates, 1st Street West of Garden State Parkway, 1 Span North of Bayshore Drive)	Film Badge, Air Particulate, Soil, Vegetation, Rain
5	4 Miles NW (Pole No. JC140L, Lacey Materials, Inc., 1 Span South of Lacey Road)	Film Badge, Air Particulate, Soil, Vegetation, Rain
6	2 Miles NNE (Pole No. JC858L, Guy Pole Behind St. Pius X Catholic Church in Forked River, N.J.)	Film Badge
7	2 Miles ESE (Pole No. JC5960N, East End of Sands Point Harbor Road)	Film Badge
8	2 Miles SSE (Pole No. JC5100N, 1 Span West of Waretown Sub.)	Film Badge
9	2 Miles SW (Pole No. JC9730N, at Intersection of Rt. 532 and Garden State Parkway)	Film Badge
10	10 Miles NNE (Pole No. JC6130DV, North Side of Island Heights Sub in Gilford Park)	Film Badge
11	9 Miles SSE (Pole No. P-8145, South of Harvey Cedars)	Film Badge
12	10 Miles SSW (Pole No. P-6630, 1½ Miles South of Manahawkin, along Rt. 9)	Film Badge
13	8 Miles NNW (Pole No. JC557B, Dover Road, 2nd from Last Pole of SW Service)	Film Badge
14	20 Miles N (Pole No. JC2HL, NE Corner of Larrabee Sub.)	Film Badge
15	20 Miles NW (Pole No. JC2048PA, Opposite Hq. 46th Air Defense Missile Sqdn., One Mile South of Pinehurst)	Film Badge

Table 5.5-2. (Cont'd.)

Station Number	Location from Plant	Sample Type
16	18 Miles WNW (Pole No. P-36282, Intersection of Rt. 72 and 563, 4 Miles North of Chatsworth)	Film Badge
17	21 Miles SW (Pole No. P-33274, Rt. 563, 1.75 Miles North of New Gretna)	Film Badge
18	Buccaneer Moorings, Forked River, N.J.	Well Water
19	Private Residence, Mr. N.M. Nelson, Forked River Beach, 60 Ft.	Well Water
20	JC Farm, East of Plant Site	Well Water , Crops
21	Private Residence, Mr. I.W. Schwartz, Sands Point Harbor, 65 Ft.	Well Water
22	Private Residence, Mrs. L. Haroldson, Skippers Cove (Mid-Jersey Water Co., 160 Ft.)	Well Water
23	Barnegat Bay--4 Miles ENE	Surface Water, Silt, Clams
24	Barnegat Bay--2 Miles E	Surface Water, Silt, Clams
25	Barnegat Bay--4 Miles SE	Surface Water, Silt, Clams
26	South Branch Forked River-½Mile W.	Surface Water, Silt
27	Oyster Creek-½ Mile W	Surface Water, Silt
28	Lacey Road at Garden State Parkway	Crops
29	Rt. 534 at Garden State Parkway	Crops

Table 5.5-3. Lower Limits of Radiological Detection.

Analysis	Sample Type and Report Units										
	Film Badge mrad/month	Air Particulate pCi/liter	Soil pCi/g	Vegetation pCi/g	Rain Water pCi/l	Well Water pCi/l	Surface Water pCi/l (Fresh)	Surface Water pCi/l (Bay)	Silt pCi/g	Clams pCi/g	Crops pCi/g
Radiation	4										
Gross Alpha		0.1							0.1	0.1	
Gross Beta		0.2	0.2	0.2					0.2	0.2	0.2
Gross Alpha (Sus)						0.1	0.1	0.3			
Gross Beta (Sus)					0.2	0.2	0.2	0.2			
Gross Alpha (Dis)						0.1	0.1	0.3			
Gross Beta (Dis)					0.2	0.2	0.2	0.2			
K-40						0.02	120	120		1.2	
Ra-226						0.2	0.2	0.2			
Ra-228						0.5	0.5	0.5			
Uranium						0.02	0.02	0.02			
Sr-90							0.2	0.2		0.002	0.002
Calcium (1)							0.01	0.01		0.01	0.01
I-131							6	6		0.06	
H-3						1000	1000	1000			
Cs-137							7	7		0.07	
Co-58							7	7		0.07	
Co-60							7	7		0.07	
Zn-65							9	9		0.09	

(1) Units are grams/liter for surface water and mg/gm for clams and crops.

about 275 feet south of the turbine building indicated a maximum of 125 mrem/year above background. Measurements made on an azimuth extending south from the turbine building showed an exposure rate of 18 mrem/year above background at the site boundary.

Air Particulate Filters

During the period between January and June 1971, the stack emission rate for airborne particulate radioactivity was higher than for any previous operational period (Table 3.6-3). During this period, environmental air particulate samples indicated the following concentrations of beta emitters:

Maximum	0.37±0.06	pCi/m^3
Minimum	0.013±0.002	pCi/m^3
Average	0.16	pCi/m^3

Although these levels are slightly above the range of pre-operational samples (0.019 to 0.28 pCi/m^3), they are well within the range for worldwide fallout and are not considered to be directly attributable to the Oyster Creek plant.

Clam Samples

Clams are considered to be the best indicator of aquatic pathways to man at the Oyster Creek site for the reasons discussed in Section 5.2.

Results obtained during the pre-operational period (February 1966 to December 1968) are compared in Table 5.5-4 with results obtained since plant start up. Although some positive ^{65}Zn results were reported in samples for each six month period, even higher levels were reported in pre-operational samples. Similarly, pre-operational levels reported for ^{58}Co and ^{60}Co exceed those reported after plant start up.

Summary of Data Obtained by the State of New Jersey

Data obtained in 1970 have been summarized by Dr. David McCurdy (Ref. 5.2-6) of the New Jersey Bureau of Radiation Protection, as follows:

> "The environmental radiation surveillance program conducted around the Oyster Creek facility has not revealed any significant increase in radioactivity levels in the immediate vicinity of the plant. Radioactivity concentrations during 1970 in surface water, soil, vegetation, and sediment samples collected at established sampling stations were consistent with levels found in previous years.
>
> Monitoring of the external gamma-ray dose from radioactive noble gases by environmental film badges revealed background levels for all exposure periods, except during the second calendar quarter of 1970 when accumulated doses of the order of 10 millirems were measured at four monitoring stations located south of the facility. No accumulated doses were measured at these sites prior to or subsequent to this exposure period. The highest accumulated dose measured outside the facility's exclusion boundary was 20 millirems, at a station two miles south of the plant. All measured doses were below recommended radiation guides established by the Federal Radiation Council.
>
> Analysis of marine specimens from Barnegat Bay has revealed the accumulation of trace amounts of radionuclides in clams, blue crabs, algae, and one specie of aquatic plant. Specific radionuclides found in clam specimens were ^{106}Ru, ^{60}Co, and ^{54}Mn, in quantities several orders of magnitude less than radioactivity guides established by the U.S. Public Health Service for shellfish.

Table 5.5-4. Radioactivity In Clams.

Isotope	Range of Concentrations Measured (pCi/g) for the Period						
	1966	1967	1968	May to Dec. 1969	Jan. to June 1970	July to Dec. 1970	Jan. to June 1971
Gross Beta	0.08 - 4.8	0.49 - 2.25	0.97 - 1.14	0.07 - 1.01	<0.1 - 1.7	0.35 - 2.3	0.68 - 1.73
^{40}K	0.6 - 8.1	1.5 - 9.8	4.7 - 6.4	3.0 - 6.0	2.8 - 3.2	1.7 - 4.5	3.1 - 5.0
^{90}Sr	<0.002 - 0.004	<0.002 - 0.005	0.005 - 0.009	0.004	0.005 - 0.006	<0.001 - 0.011	0.004 - 0.01
^{131}I	<0.07	<0.007 - 0.27	<0.02	<0.06	<0.06	<0.06	<0.06
^{137}Cs	<0.03 - 0.27	<0.02 - 0.42	<0.06 - 0.07	<0.07 - 0.11	<0.07 - 0.09	<0.07 - 0.15	0.10 - 0.11
^{58}Co	<0.014 - 1.4	<0.02 - 0.38	0.16 - 0.31	<0.07 - 0.14	<0.07	<0.07	<0.07
^{60}Co	<0.024 - 1.8	<0.02 - 0.36	0.3 - 0.5	<0.07 - 0.2	<0.07	<0.07	<0.07
^{65}Zn	<0.048 - 0.35	<0.04 - 0.47	0.1 - 0.3	<0.09 - 0.11	<0.09 - 0.12	<0.09 - 0.25	0.10 - 0.20

Radionuclide concentrations in the edible parts of crabs were of the same magnitude as those found in clams. In addition to the radionuclides found in clams, traces of ^{65}Zn and ^{137}Cs may also be present in crab specimens.

Analysis of marine vegetation in Barnegat Bay has indicated the accumulation of ^{54}Mn, ^{58}Co, and ^{60}Co in two species of algae (Codium fragile, and Ulva lactuca) and in the aquatic plant Zostera marina. This plant was found to concentrate the radionuclides to a greater extent than the two species of algae. Specimens of the plant collected near the Oyster Creek and Forked River inlet into the Bay had radioactivity concentrations statistically greater than specimens collected elsewhere in the Bay.

Gamma-ray analyses of water samples collected along the Oyster Creek estuary downstream from the facility's liquid waste discharge canal have not revealed the presence of radionuclides, other than naturally occurring potassium-40, in concentrations greater than the minimum sensitivity of the counting instrument (4 pCi/liter). Levels of tritium in water samples taken at the 12 established collection stations averaged less than 4 pCi/ml (+200 percent at the 95 percent confidence level) during 1970. Tritium concentrations below the outfall of the Oyster Creek facility were no greater than concentrations measured in fresh water streams in this area. Although levels fluctuated around the minimum sensitivity of the counting instrument, average concentrations were less than one thousandths of the maximum permissible concentration allowed for off-site streams."

On February 2, 1972, Dr. McCurdy summarized for the Oyster Creek operating personnel and their consultants the environmental surveillance data obtained during 1971. No radioactivity attributable to the Oyster Creek Station has been detected in well water, surface water from Oyster Creek, Barnegat Bay or Forked River, air, soil, vegetation, fruits, or vegetables. Radioactivity attributable to the Oyster Creek Station has been detected in aquatic vegetation (especially Gracilaria and Zostos marina), shellfish (clams and crabs), and bottom sediment that is rich in organic material. Predominant radionuclides attributable to the Oyster Creek Station were Co^{60}, Co^{58}, and Mn^{54}. Concentrations of these radionuclides in shellfish were similar to levels measured in 1970 and were less than the naturally occurring K^{40} levels.

Program Modification

An extensive study program is being carried out at the Oyster Creek plant during 1972 by the AEC and the Environmental Protection Agency (EPA) to more thoroughly document the isotopic composition of radioactive effluents from this plant, and the fate of each radionuclide in the environment. After this study is completed and guidelines for environmental monitoring have been published, appropriate modification of the environmental surveillance program will be made as indicated by operational experience and results of the current study.

5.5.2.2 Meteorological

The purpose of the meteorological monitoring program is to maintain a continuous record of pertinent meteorological parameters for use in the atmospheric dilution calculations. These meteorological data provide an estimate of the atmospheric dispersion inventory of the released effluent gases.

The meteorological monitoring program has been conducted for the Oyster Creek facility since February 1966 and will continue for the life of the plant. Meteorological data are continuously recorded from an instrumented 400 foot tower about 1,300 feet west of the plant (Figure 2.1-1). A summary of the instrumentation on the meteorological tower is presented in Table 2.6-4. The meteorological parameters pertinent to accident dose and routine stack release calculations are described and tabulated in Section 2.6.2.

5.5.2.3 Hydrological

A program to monitor the chemical characteristics of plant discharge and intake water was initiated in 1971. The purpose of the program is to insure compliance with standards set in accordance with the Refuse Act of 1899, and to provide data for evaluation of possible effects of chemical discharges on the biota of Barnegat Bay.

Samples are taken three times yearly (during March, July, and November) and are analyzed by the chemistry sections of JC and Gilbert Associates, Inc.

The analyses will examine the following parameters: phosphorus, nitrate, total keldgahl nitrogen, ammonia, chlorine, sulfate, zinc, chromium, iron; solids: insoluble, soluble, volatile, hardness, turbidity, TKN, dissolved oxygen, B.O.D.

The results of 1971 analyses are given in Table 5.3-1.

5.5.2.4 Biological

Programs to monitor and interpret changes in species, in species abundance, and in physiological parameters were begun in 1965 and have continued, with some modification, to date. The broad categories of aquatic biota examined are: macro-algae, phytoplankton, zooplankton, benthos, and fish.

These studies are all funded by JC and most of them were conducted by a team from Rutgers University. A five-member board, composed of two State representatives, one university member (Dr. Haskin), and two JC consultants, (Dr. Charles Wurtz and Dr. James Carpenter) are responsible for overseeing the studies. The JC consultants also contributed studies of their own, in addition to the Rutgers University work.

Studies that have been largely completed to date include:

1) Determination of lethal and avoidance temperatures during summer of 11 species of fish and two species of invertebrates common to the Bay;

2) Baseline studies of species types and abundance of macro-algae, plankton, benthos, and fish;

3) Studies of change in photosynthesis and species composition of phytoplankton going through the condenser system and;

4) Studies determining the effect on fish eggs of passage through the condenser.

A program of monitoring population changes in macro-algae, benthos, and fish by comparing the Oyster Creek area with other control areas in the Bay is scheduled to continue for an undefined period during plant operation.

6.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

6.1 INTRODUCTION

Several postulated events and abnormal conditions are examined in this section to determine the environmental consequences of their occurrence. These events and conditions range in severity from small, isolated activity releases to the accidents normally analyzed for establishing design bases as reported in the Safety Analysis Report. The accident analyses and environmental consequences are evaluated herein using realistic assumptions. The highly conservative assumptions and calculations used in the Safety Analysis Report are not appropriate for this environmental risk evaluation because it is not realistic to assume that all such conservative assumptions exist concurrently with the postulated event.

Assumptions used to calculate the consequences of these accidents follow the examples outlined in the proposed Annex to Appendix D of 10 CFR Part 50 (Federal Register, Volume 36, Number 231, December 1, 1971) in most respects. When the annex is not specific, realistic assumptions are made and discussed. Deviations from the assumptions are permitted by the Annex as long as the substitute assumptions are justified in the report. Since the Oyster Creek Nuclear Generating station has been operating for over two years, much actual data have been obtained and is the basis for more realistic assumptions than those recommended in the Annex for plants not yet built. For example, meteorological data are available from the Oyster Creek site, and this information is used instead of the standard meteorology of the Annex to compute off-site exposures. Methods for computing doses using the site meteorology are discussed in Section 6.2. Reactor coolant iodine activity has been assumed to be 10% of the Technical Specification limit of 8 μCi/gm. This is much higher than the maximum of 0.30 μCi/gm measured to date during operation of Oyster Creek. The assumed isotopic breakdown is given in Table 6.1-1. For obtaining typical noble gas concentrations in the main steam flow, it is assumed that the stack release after a 30 minute delay is 25,000 μCi/sec. Justification of this quantity is discussed in Section 5.2. Isotopic flow rates at rated steam flow are given in Table 6.1-2. The partition factor for iodines is assumed to be 50 based on operating data. The power level is assumed to be 1930 MWt. If fuel failure occurs during the event being considered the quantities of released fission products suggested by the Annex are assumed.

The postulated events and abnormal conditions are divided into the nine accident classes following the guidance of the Annex to Appendix D of 10 CFR 50. Table 6.1-3 outlines the postulated events and references the appropriate section which describes the analysis.

Table 6.1-1. Assumed Quantity of Iodine Isotopes in Reactor Coolant

Isotope	Fraction of Total	Quantity
I-131	0.03	.024
I-132	0.2	.160
I-133	0.13	.104
I-134	0.46	.368
I-135	0.18	.144
Total	1.0	0.800

Table 6.1-2. Assumed Fission Gas and Iodine Release Rates at Rated Steam Flow

Isotope	Half Life	Release Mixture* From Core No Decay % Mix	Assumed Rate*** After 2-Minute Delay (Based on 25,000 Ci/sec With 30-Minute Delay) (μCi/sec)
I-131	8.05 h	N/A	4.38(+2)
I-132	2.26 h	N/A	2.92(+3)
I-133	20.3 h	N/A	1.90(+3)
I-134	0.87 h	N/A	6.73(+3)
I-135	6.68 h	N/A	2.63(+3)
Kr-83M	1.86 h	5.4×10^{-2}	6.75(+3)
Kr-85M	4.4 h	8.6×10^{-2}	1.09(+3)
Kr-85	10.4 y	1.3×10^{-4}	1.65
Kr-87	1.3 h	3.0×10^{-1}	3.82(+3)
Kr-88	2.8 h	2.9×10^{-1}	3.68(+3)
Kr-89**	3.2 m	2.8×10^{0}	2.31(+4)
Xe-131M	12.0 d	1.8×10^{-4}	2.23
Xe-133M	2.3 d	3.2×10^{-3}	4.00(+1)
Xe-133	5.27 d	8.2×10^{-2}	1.05(+3)
Xe-135M**	15.0 m	4.9×10^{-1}	5.70(+3)
Xe-135	9.2 h	2.9×10^{-1}	3.70(+3)
Xe-137**	3.8 m	3.3×10^{0}	2.93(+4)
Xe-138	17.0 m	1.5×10^{0}	1.76(+4)
		100	

*Neglects isotopes with very short halflives.
**Neglected for population dose estimates.
***For iodines, release rate is based on coolant activities of 0.8 μCi/gm and a measured partition factor of 50 (mass basis).

Table 6.1-3. Outline of Events Evaluated

Accident Class	Description (per Annex)	Events Considered for Oyster Creek Station	Section
1.0	Trivial incidents	Not considered as per Annex	6.3.1
2.0	Small release outside containment	Main steam system leakage	6.3.2
3.0	Radwaste system failures	Liquid release from sample tank	6.3.3.1
		Gas release from holdup pipe sample line failure	6.3.3.2
		Liquid waste storage tank failure	6.3.3.3
4.0	Fission products to primary system (boiling water reactor)	Small release of fission products to reactor coolant (unspecified cause)	6.3.4
5.0	Fission products to primary and secondary systems (pressurized water reactor)	Not applicable to BWR	6.3.5
6.0	Refueling accidents	Fuel assembly drop	6.3.6.1
		Heavy object drops onto fuel in core	6.3.6.2
7.0	Spent fuel handling accidents	Fuel assembly drop in fuel storage pool	6.3.7.1
		Heavy object drop onto fuel rack	6.3.7.2
		Fuel cask drop	6.3.7.3
8.0	Accident initiation events considered for Design Basis Evaluation in the Safety Analysis Report	Loss of coolant (small pipe break)	6.3.8.1
		Loss of coolant (large pipe break)	6.3.8.2
		Break in instrument line from primary system that penetrates containment	6.3.8.3
		Rod drop accident	6.3.8.4
		Main steamline break (small break)	6.3.8.5
		Main steamline break (large break)	6.3.8.6
9.0	Hypothetical sequences of successive failures more severe than Design Basis accidents	Not considered as per annex	6.3.9

6.2 DOSE CALCULATION METHODS AND METEOROLOGICAL ASSUMPTIONS

6.2.1 General

Dispersion of potential airborne effluents from the plant is dependent on the wind speed and atmospheric turbulence which exist during the release. These conditions are estimated based on weather records taken from the meteorological station at the site. It is the intent in this section to describe how diffusion conditions are determined. These diffusion conditions are used when calculating potential realistic exposures from the various release events described in Section 6.3.

In particular, given that the event can occur at any random time, the diffusion condition which is not exceeded at any point on the site boundary (from stack or ground releases) during more than 50% of these assumed random times is considered appropriate. This condition is referred to herein as the median diffusion condition and is calculated based on the hourly meteorological records as described in Section 6.2.4. Likewise, the population-weighted diffusion values for use in computing median population exposure (man-rem) within a distance of 50 miles are developed as described in Section 6.2.5. These diffusion conditions are then used to determine potential doses as described in Section 6.2.6.

6.2.2 Data Base

The meteorological data used for this evaluation are from records collected at the site for one year (February 15, 1966 through

February 14, 1967). These data were collected at the 75 ft. and 400 ft. levels above grade. The 75 ft. data are used to represent releases in the wake of plant structures (ground releases) and the 400 ft. data are used for stack releases. These data include wind speed, direction and vertical temperature measurements. Estimates of turbulence at the 75 ft. level are based on wind direction range data as suggested by Slade (Ref. 6.2-1) and, for the 400 ft. level, vertical temperature structure was used as discussed in Section 2.6.2.2 of the Oyster Creek FDSAR. Calms were assumed to have a speed of 0.6 m/sec and the measured diffusion condition. The meteorology program is discussed in Section 5.5.2.2 of this report.

6.2.3 Dispersion Estimates

6.2.3.1 Dispersion Equations (Ground Releases)

For determining realistic dispersion condition probabilities, it is considered appropriate to use the sector average equation. This follows since it is not realistic to assume a centerline dose at one spot in a typical 22.5° sector for every hourly occurrence which has a direction somewhere in that sector. Vertical dilution caused by the turbulent wake of the building is accounted for by a virtual source distance correction (x'). Values of x' are assumed to be 80, 121, 165, 266, 399 and 648 meters for Pasquill stability groups A through F, respectively (Ref. 6.2-2). The equation used is shown below:

$$X/Q_{\substack{\text{sector}\\\text{average}}} = \frac{2.03}{\bar{u} \times \sigma_{z(x + x')}}$$

Where:

X	=	Average concentration in a given sector ($\mu Ci/m^3$)
Q	=	Release rate ($\mu Ci/sec$)
$\bar{u}$	=	Wind speed (m/sec)
x	=	Distance (m) -- varies in accordance with shape of site. See Table 6.2-1.
x'	=	Virtual source distance to account for building wake effects (m).
$\sigma_{z(x + x')}$	=	Vertical diffusion coefficient evaluated at x + x' (m).

6.2.3.2 Dispersion Equations (Elevated Releases)

Ground level concentrations for elevated releases are computed using the equation given in Section 2.6.3. This equation assumes average concentrations over a 22 1/2° sector for each hour and is corrected for plume buoyancy.

6.2.3.3 Computation of Gamma Dose from Stack Releases

Estimates of gamma dose from overhead plumes were made using the model described in Meteorology and Atomic Energy, 1968, Section 7.5.2.5; and in particular, equation 7.63. Using the mix of noble gas isotopes released at the stack for each event, the gamma dose was computed for each hour of meteorological data for the one year period of record.

6.2.4 <u>Median Site Boundary Diffusion Conditions for Various Time Periods</u>

Each event has an associated time period for release. Therefore, to establish the appropriate median diffusion condition, i.e., the

Table 6.2-1. Assumed Distance to Site Boundary in Each Direction Sector

Direction Sector	Distance (Meters)
N	640
NNE	460
NE	410
ENE	400
E	405
ESE	430
SE	522
SSE	540
S	487
SSW	530
SW	760
WSW	1720
W	1900
WNW	980
NW	617
NNW	590

average condition which is not exceeded during more than 50% of the release periods, it is necessary to compute the probability of average diffusion conditions for the various release time periods. To do this, a computer is used to analyze the hourly site data. Starting with each hour of data, the hourly computed diffusion conditions are added in each of 16 assumed direction sectors for the duration of the time period being evaluated. The maximum value of all the directions is stored and a new integration period is started spaced one hour later. Again, the maximum value from this next integration period is stored regardless of the direction sector in which it occurred, and so on. After processing the whole year of data, cumulative probability plots are made for each integration period. The distances to the site boundary in each direction are given in Table 6.2-1. The average X/Q values for each time period which are not exceeded more than 50% of the time anywhere on the site boundary are given in Table 6.2-2.

For gamma dose estimates for stack releases, doses as a function of activity released were computed for each isotope at the site boundary. Using the hourly gamma dose results, the dose which was not exceeded during more than 50% of the hours was determined. Results for each isotope are shown in Table 6.2-3.

6.2.5 Median Dispersion Estimates for Calculating Population Exposure

A similar method of computing diffusion conditions (or gamma dose from stack releases) over various time periods is used to compute the conditions for use in determining the median population exposure (man-rem). Instead of using only values of X/Q (or gamma dose) for the

Table 6.2-2. Median Site Boundary Diffusion Estimates

Time Period of Release (Hrs.)	Median Average Ground Level Dispersion Estimates for Ground Releases (sec/m^3)	Median Average Ground Level Dispersion for Stack Releases (sec/m^3)
1	2.6(-5)	4.0(-7)
2	2.2(-5)	3.2(-7)
4	2.0(-5)*	3.0(-7)*
8	1.8(-5)	2.8(-7)
24	1.5(-5)	2.0(-7)
96	1.0(-5)	1.1(-7)
720	7.0(-6)	8.0(-8)

*Estimated

Table 6.2-3. Median Gamma Dose from Stack Releases at Site Boundary (rem/Ci)

Isotope	Gamma Energy	Release Period (hrs) 0-2	2-8	8-24	24-96	96-720
I-131	0.389	2.2(-7)	1.6(-7)	1.1(-7)	7.2(-8)	4.5(-8)
I-132	2.115	1.2(-6)	9.1(-7)	6.0(-7)	3.9(-7)	2.4(-7)
I-133	0.660	3.6(-7)	2.7(-7)	1.8(-7)	1.1(-7)	7.3(-8)
I-134	2.380	1.4(-6)	1.1(-6)	7.0(-7)	4.6(-7)	2.8(-7)
I-135	2.167	1.3(-6)	1.0(-6)	6.5(-7)	4.3(-7)	2.8(-7)
Kr-83M	0.042	2.2(-8)	1.7(-8)	1.1(-8)	7.2(-9)	4.5(-9)
Kr-85M	0.180	9.7(-8)	7.4(-8)	4.8(-8)	3.1(-8)	1.9(-8)
Kr-85	0.003	2.8(-9)	2.1(-9)	1.4(-9)	9.2(-10)	5.7(-10)
Kr-87	1.070	6.1(-7)	4.6(-7)	3.1(-7)	2.0(-7)	1.3(-7)
Kr-88	1.700	9.7(-7)	7.4(-7)	4.8(-7)	3.1(-7)	1.9(-7)
Kr-89	0.600	3.3(-7)	2.5(-7)	1.7(-7)	1.1(-7)	6.9(-8)
Xe-131M	0.164	8.8(-8)	6.7(-7)	4.4(-8)	2.8(-8)	1.8(-8)
Xe-133M	0.230	1.3(-7)	1.0(-7)	6.5(-8)	4.2(-8)	2.6(-8)
Xe-133	0.081	3.8(-8)	2.8(-8)	1.9(-8)	1.2(-8)	7.8(-9)
Xe-135M	0.530	3.1(-7)	2.3(-7)	1.6(-7)	1.0(-7)	6.5(-8)
Xe-135	0.260	1.4(-7)	1.0(-7)	7.0(-8)	4.6(-8)	2.8(-8)
Xe-137	0.150	8.3(-8)	6.3(-8)	4.2(-8)	2.7(-8)	1.7(-8)
Xe-138	0.420	2.5(-7)	1.9(-7)	1.3(-7)	8.5(-8)	5.3(-8)

site boundary as above, these values are multiplied by the population in each of the ten distances (i.e., 0.5, 1.5, 2.5, 3.5, 4.5, 7.5, 15, 25, 35 and 45 miles. This is done for each hour of data using the population versus distance in the measured wind direction (see Figure 2.2-6 for summertime population distribution for the year 2010). These values are then added over the chosen integration period starting with each hour of data as above until one year of data have been processed. The value stored is the total for the event, not the maximum of all directions as above since an integrated population exposure is to be computed. In this manner, average values of X/Q (or gamma dose for stack releases) times population (man - X/Q or man - rem/μCi) are generated as a function of probability for each time period. The resulting average values which are not exceeded more than 50% of the time are tabulated in Table 6.2-4 for various time periods.

For gamma dose to the population for stack releases, hourly population dose values are computed for each isotope at each of the ten distances corresponding to the population annuli out to 50 miles. The population in each sector is then multiplied by each gamma dose value at each distance and these values are processed by the computer to give man-rem values as a function of release period per curie of each isotope as shown in Table 6.2-5.

6.2.6 Dose Calculation Methods

6.2.6.1 Equations Used For Plume Submersion Doses

Realistic plume submersion dose calculations are obtained for the site boundary using the following equations:

Table 6.2-4: Median Dispersion FActors for Calculating Population Doses

Time Period of Release (Hrs.)	Average Population Dispersion Factor (man-sec/m^3)	Average Population Dispersion Factor (man-sec/m^3)
1	.016	.0011
2	.019	.0012
4	.021*	.0013*
8	.024	.0015
24	.030	.0024
96	.032	.0027
720	.034	.0028

*Estimated

Table 6.2-5. Median Gamma Dose to Population from Stack Releases (man-rem/Ci)

Isotope	Gamma Energy	Release Periods (hrs.) 0-2	2-8	8-24	24-96	96-720
I-131	0.389	1.3(-3)	2.4(-3)	3.6(-3)	4.4(-3)	5.0(-3)
I-132	2.115	3.1(-4)	5.7(-4)	8.5(-4)	1.0(-3)	1.2(-3)
I-133	0.660	1.9(-3)	3.5(-3)	5.3(-3)	6.4(-3)	7.3(-3)
I-134	2.380	2.3(-3)	4.3(-3)	6.4(-3)	7.7(-3)	8.8(-3)
I-135	2.167	4.2(-3)	7.7(-3)	1.2(-2)	1.4(-2)	1.6(-2)
Kr-83M	0.042	5.8(-5)	1.1(-4)	1.6(-4)	1.9(-4)	2.2(-4)
Kr-85M	0.180	5.0(-4)	9.3(-4)	1.4(-3)	1.7(-3)	1.9(-3)
Kr-85	0.003	1.1(-5)	2.0(-5)	3.0(-5)	3.7(-5)	4.2(-5)
Kr-87	1.070	1.4(-3)	2.6(-3)	3.8(-3)	4.7(-3)	5.4(-3)
Kr-88	1.700	2.8(-3)	5.2(-3)	7.7(-3)	9.5(-3)	1.1(-2)
Kr-89	0.600	9.7(-5)	1.8(-4)	2.7(-4)	3.3(-4)	3.7(-4)
Xe-131M	0.164	4.7(-4)	8.7(-4)	1.3(-3)	1.6(-3)	1.8(-3)
Xe-133M	0.230	7.5(-4)	1.4(-3)	2.1(-3)	2.5(-3)	2.8(-3)
Xe-133	0.081	2.0(-4)	3.7(-4)	5.5(-4)	6.7(-4)	7.7(-4)
Xe-135M	0.530	3.8(-4)	7.0(-4)	1.1(-3)	1.3(-3)	1.5(-3)
Xe-135	0.260	8.6(-4)	1.6(-3)	2.4(-3)	2.9(-3)	3.3(-3)
Xe-137	0.150	3.3(-5)	6.1(-5)	9.1(-5)	1.1(-4)	1.3(-4)
Xe-138	0.420	3.3(-4)	6.1(-4)	9.1(-4)	1.1(-3)	1.3(-3)

$$D_{whole\ body_\beta} = 0.23\ X/Q_t\ \Sigma\ (C_i)_t\ (E_\beta)_i$$

$$D_{whole\ body\gamma} = 0.25\ X/Q_t\ \Sigma\ (C_i)_t\ (E_\gamma)_i$$

$$D_{thyroid} = X/Q_t\ BR\ \Sigma\ (C_i)_t\ (F_i)$$

Where:

D	=	Whole body or thyroid dose (rem).
X/Q_t	=	Median dispersion value for release period (t) from Table 6.2-2 or 6.2-4.
C_i	=	Total curies released of i^{th} isotope during time period (t) sec/m^3).
$E_{\beta i}$, $E_{\gamma i}$	=	Average β or γ energy per disintegration of i^{th} isotope (See Table 6.2-6).
BR	=	Average breathing rate ($2.32 \times 10^{-4}\ m^3/sec$) of i^{th} isotope.
F_i	=	Thyroid dose conversion factor (rem/Ci). (See Table 6.2-6).

6.2.6.2 Relationships Used When Release is from the Stack

For computing gamma dose for stack releases, the following equation was used:

$$D_\gamma = \frac{(0.2865)}{\theta R\bar{u}} \sum_{i=1}^{N} Q_i\ \mu_{a_i}\ \bar{E}_{\gamma_i}\ (I_1 + k\ I_2)_i\ \exp.\left(-\frac{\lambda_i R}{\bar{u}}\right)$$

Where:

D_γ	=	Gamma dose (rem).
θ	=	Width of 22 1/2° sector (radians).
R	=	Distance from release point (m).
$\bar{u}$	=	Wind speed during hour (m/sec).
λ_i	=	Decay constant of i^{th} isotope (sec^{-1}).

Table 6.2-6. Assumptions Used for Dose Calculations

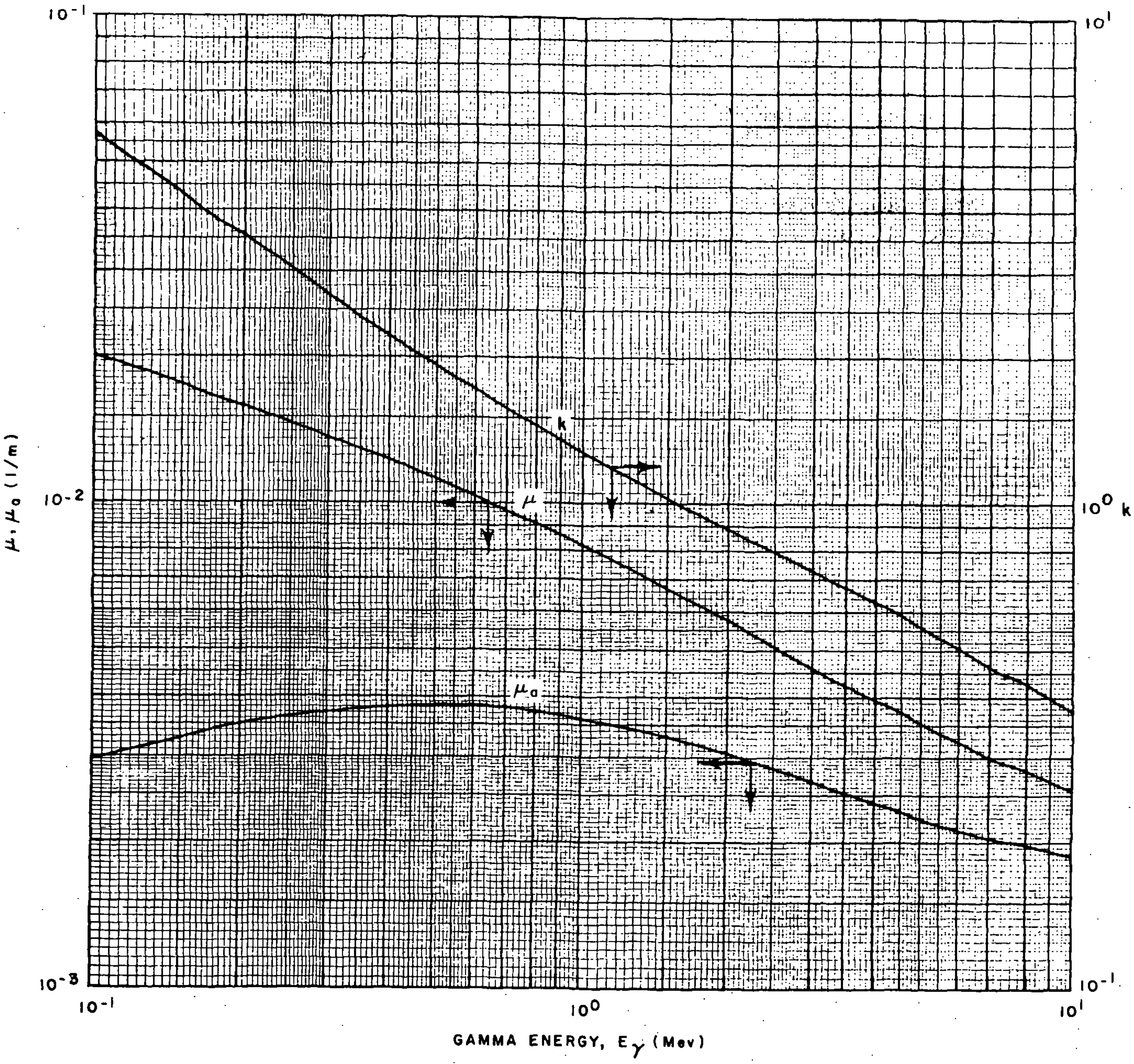
Isotope	Half Life (Hrs)	Average Energy/dis (Mev) β	Average Energy/dis (Mev) γ	Dose Conversion Factor (Thyroid) (rad/Ci)
I-131	1.93(+2)	0.191	0.389	1.48(+6)
I-132	2.26	0.458	2.115	5.35(+4)
I-133	2.03(+1)	0.414	0.660	4.00(+5)
I-134	8.67(-1)	0.570	2.380	2.50(+4)
I-135	6.68	0.305	2.167	1.24(+5)
Kr-83M	1.86	0.0	0.042	
Kr-85M	4.4	0.270	0.180	
Kr-85	9.43(+4)	0.224	0.003	
Kr-87	1.27	1.050	1.070	
Kr-88	2.8	0.330	1.700	
Kr-89	5.3(-2)	1.330	0.690	
Xe-131M	2.83(+2)	0.0	0.164	
Xe-133M	5.4(+1)	0.0	0.230	
Xe-133	1.26(+2)	0.115	0.081	
Xe-135M	2.60(-1)	0.0	0.530	
Xe-135	9.14	0.300	0.260	
Xe-137	6.30(-2)	1.310	0.150	
Xe-138	2.92(-1)	0.800	0.420	

N	=	Number of isotopes
Q_i	=	Amount of i^{th} isotope released (Ci).
μ_{a_i}	=	Energy absorption coefficient for air (m^{-1}).
μ	=	Total absorption coefficient for air (m^{-1}).
k	=	$(\mu - \mu_{a_i})/\mu$ (See Figure 6.2-1).
$\bar{E}_{\gamma i}$	=	Average gamma energy.
I_1	=	From Figure 6.2-2.
I_2	=	From Figure 6.2-3.

6.2.6.3 Calculation of Dose Estimates

To compute realistic population doses, the equations above are used except that the X/Q value is replaced by the median "man - X/Q" value for the appropriate time period from Table 6.2-4. In the case of gamma dose, the man-rem value is obtained directly by multiplying the dose values in Table 6.2-5 by the number of curies of each isotope released and summing the results.

For longer non-uniform releases, such as in the loss of coolant accidents, the releases are separated into smaller time increments and integrated for the total release period. The appropriate dispersion values from Tables 6.2-2 through 6.2-5 are used for each period.



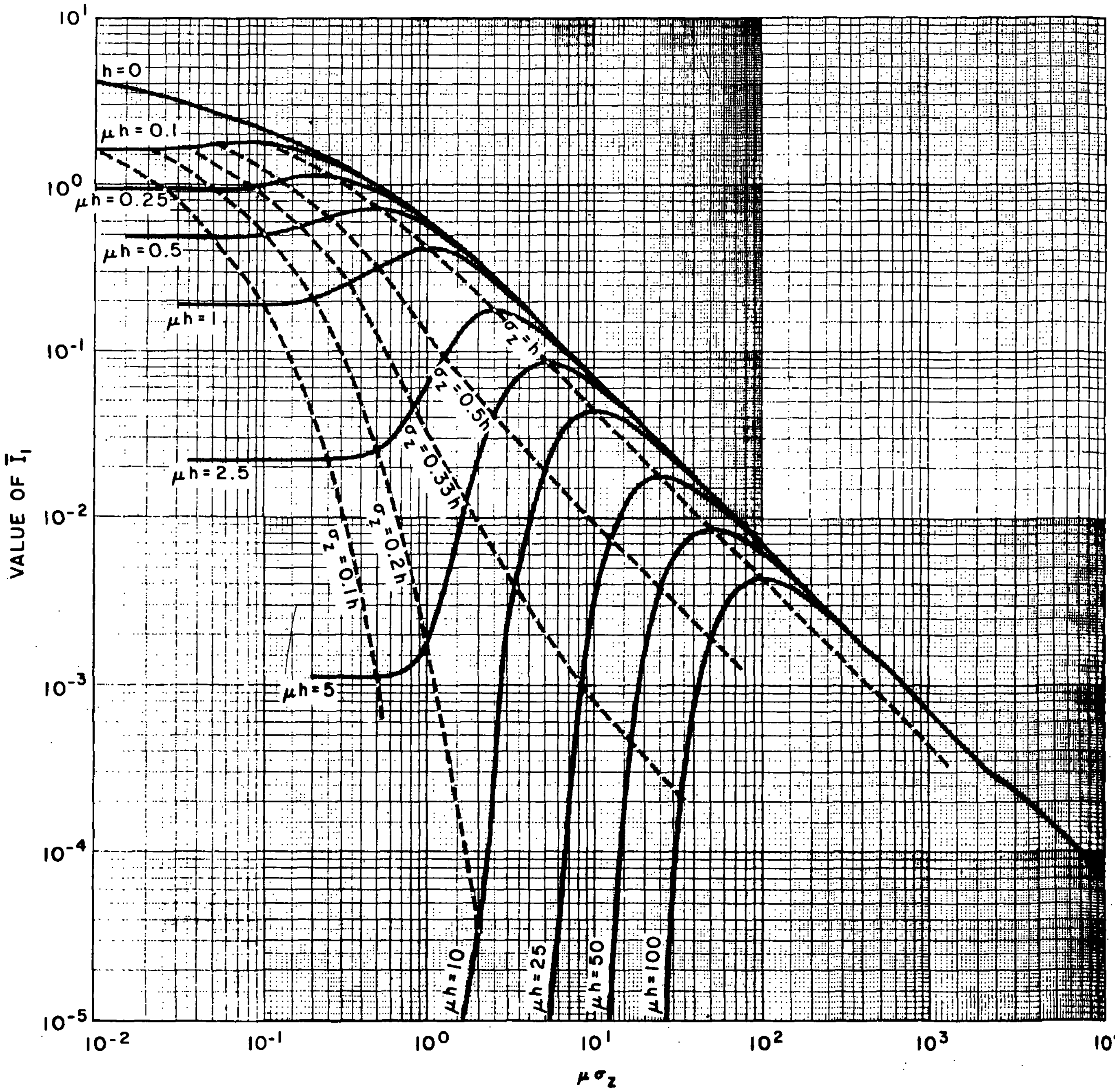
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

ABSORPTION COEFFICIENTS AND VALUES OF THE BUILDUP CONSTANT FOR AIR AT STP (REF. 6.2-3, PAGE 338)

DAMES & MOORE

FIGURE 6.2-1



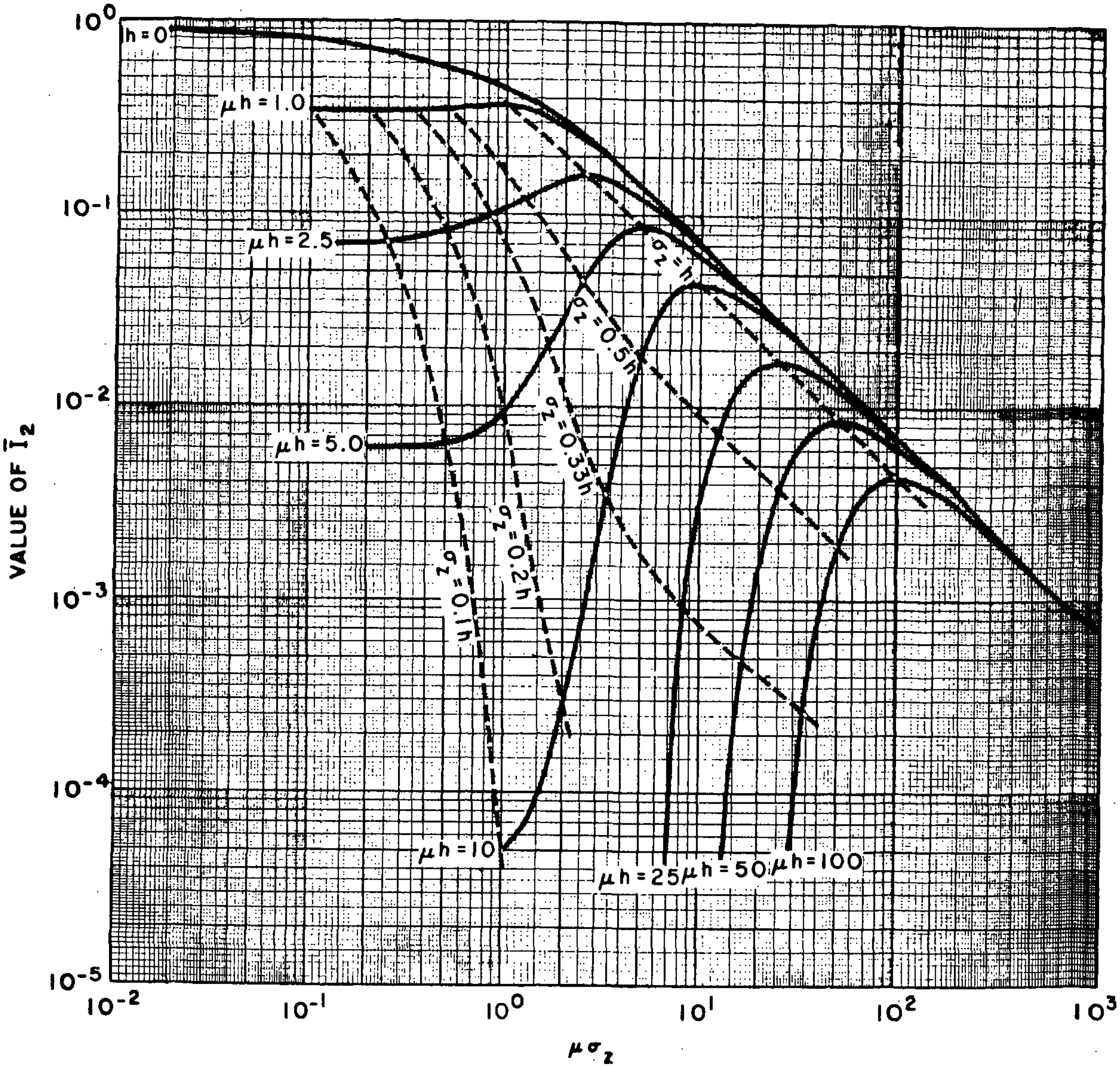
OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

VALUES OF THE $\bar{I}_1$ INTEGRAL (REF. 6.2-3, PAGE 353)

DAMES & MOORE

FIGURE 6.2-2



OYSTER CREEK NUCLEAR GENERATING STATION

JERSEY CENTRAL Power & Light Company

VALUES OF THE $\overline{I}_2$ INTEGRAL
(REF. 6.2-3, PAGE 354)

DAMES & MOORE

FIGURE 6.2-3

REFERENCES SECTION 6.2.

6.2-1 Slade, D. H., April 1966, "Estimates of Dispersion from Pollution Releases of a Few Seconds to Eight Hours in Duration", Environmental Science Services Administration, Technical Note 39-ARL-3.

6.2-2 Pasquill, F., February 1961, "Estimation of the Dispersion of Windborne Material", Meteorology Magazine 90 (1063), pp. 33-49.

6.2-3 Slade, D. H., July 1968, Meteorology and Atomic Energy 1968, USAEC, Division of Technical Information.

6.3 DESCRIPTION AND METHOD OF ANALYSIS FOR POSTULATED ACCIDENTS

In this section each of the events considered under the nine accident categories are described and the analysis and resulting doses are discussed. The realistic doses at the site boundary for each event are listed in Table 6.3-1 and the population doses in man-rem out to a 50 mile radius for each event are listed in Table 6.3-2.

No attempt has been made here to define or estimate the probability of occurrence of any of these events. None of the events result in significant adverse environmental effects. Therefore, in agreement with the Annex, probabilities or frequencies of occurrence need not be evaluated. Nevertheless, it is important to note that the entire Oyster Creek Station has been designed and constructed to minimize both the possibility of occurrence and the consequences of the events should they occur. High quality materials, multiple boundaries, quality workmanship, redundancy of safety systems, multiplicity of instrumentation, extensive analysis and evaluation have all been combined to produce a plant that is very reliable and affords a very high degree of protection for the public. In addition, the men who operate the Oyster Creek Station are well experienced, competent technicians and engineers.

The high quality facility and proficient specialists result in a high degree of assurance that the events discussed here will occur rarely, and even if they do occur, the consequences will not result in a significant adverse effect on the environment. A broader discussion of the significance of the exposure levels received from these events can be found in Section 6.4.

Table 6.3-1. Realistic Dose Estimates for Accident Events (Site Boundary)
Oyster Creek Nuclear Station

Accident Class	Accidents Considered for Oyster Creek Nuclear Station	Period of Release	Release Point	Assumed Average X/Q (sec/m^3)	Whole Body Gamma Dose (rem)	Surface Body Beta Dose (rem)	Thyroid Dose (rem)
2	Main steam system leakage	30 days	Ground	7.0(-6)	7.3(-5)	1.3(-4)	3.0(-4)
3	Gas release from holdup pipe sample line failure	4 hrs.	Ground	2.0(-5)	6.0(-6)	1.1(-5)	5.4(-7)
4	Small release of fission products to reactor coolant (unspecified cause)	24 hrs.	Ground	1.5(-5)	1.7(-4)	9.5(-5)	3.5(-4)
6	Fuel bundle drop	1 hr.	Stack	8.0(-8)	9.4(-6)	3.5(-7)	4.8(-8)
6	Heavy object drops onto fuel in core	1 hr.	Stack	8.0(-8)	6.4(-5)	2.4(-6)	3.4(-7)
7	Fuel assembly drop in fuel storage pool	1 hr.	Stack	8.0(-8)	5.5(-6)	2.4(-7)	4.6(-8)
7	Heavy object drop onto fuel rack	1 hr.	Stack	8.0(-8)	1.6(-6)	9.6(-9)	4.9(-9)
7	Fuel cask drop	1 hr.	Stack	8.0(-8)	6.2(-7)	9.1(-7)	-
8	Loss of coolant (small pipe break)	30 days	Stack	Variable	1.5(-9)	2.2(-10)	7.5(-9)
8	Loss of coolant (large pipe break)	30 days	Stack	Variable	2.6(-4)	1.5(-6)	1.2(-4)
8	Break in instrument line from primary system penetrating containment	4 hrs.	Stack	3.0(-7)	2.3(-8)	6.1(-7)	1.4(-7)
8	Rod drop accident	24 hrs.	Ground	1.5(-5)	2.2(-4)	1.2(-6)	4.5(-4)
8	Main steamline break (small break)	1 hr.	Ground	2.6(-5)	3.1(-6)	1.8(-6)	1.5(-4)
8	Main steamline break (large break)	1 hr.	Ground	2.6(-5)	2.0(-4)	4.6(-5)	1.3(-2)

*Doses which are exceeded no more than 50% of the time assuming accident can occur at any random time.

Table 6.3-2. Realistic Population Dose Estimates* for Accident Events
(man-rem to Population Within a 50 Mile Radius)

Accident Class	Accidents Considered for Oyster Creek Nuclear Station	Period of Release	Release Point	Assumed Average X/Q (man-sec/m^3)	Whole Body Gamma Dose (man-rem)	Surface Body Beta Dose (man-rem)	Thyroid Dose (man-rem)
2	Main steam system leakage	30 days	Ground	0.034	3.5(-1)	6.2(-1)	1.46
3	Gas release from holdup pipe sample line failure	4 hrs.	Ground	0.021	6.3(-3)	1.2(-2)	5.7(-4)
4	Small release of fission products to reactor coolant (unspecified cause)	24 hrs.	Ground	0.03	3.5(-1)	1.9(-1)	7.1(-1)
6	Fuel bundle drop	1 hr.	Stack	0.0011	4.9(-2)	4.8(-3)	6.7(-4)
6	Heavy object drops onto fuel in core	1 hr.	Stack	0.0011	3.5(-1)	3.4(-2)	4.7(-3)
7	Fuel assembly drop in fuel storage pool	1 hr.	Stack	0.0011	2.9(-2)	3.3(-3)	6.3(-4)
7	Heavy object drop onto fuel rack	1 hr.	Stack	0.0011	8.4(-3)	1.3(-4)	6.8(-5)
7	Fuel cask drop	1 hr.	Stack	0.0011	2.5(-3)	1.2(-2)	-
8	Loss of coolant (small pipe break)	30 days	Stack	Variable	1.6(-5)	1.5(-6)	1.2(-4)
8	Loss of coolant (large pipe break)	30 days	Stack	Variable	8.5	6.3(-1)	2.51
8	Break in instrument line from primary system penetrating containment	4 hrs.	Stack	0.0013	3.0(-3)	2.6(-3)	6.2(-4)
8	Rod drop accident	24 hrs.	Ground	0.03	4.3(-1)	2.4(-1)	8.9(-1)
8	Main steamline break (small break)	1 hr.	Ground	0.016	1.8(-3)	1.1(-5)	9.5(-2)
8	Main steamline break (large break)	1 hr.	Ground	0.016	1.2(-1)	2.8(-2)	7.9

* Population doses which are exceeded no more than 50% of the time assuming accident can occur at any random time.

6.3.1 Class 1.0 - Trivial Incidents

In accordance with the guidelines of the Annex, incidents in this class will not be evaluated because of their trivial consequences.

6.3.2 Class 2.0 - Small Release Outside Containment

Description

The event to be evaluated for this class is a leak in the main steam system outside the secondary containment. The steam leakrate is assumed to be equivalent to 7 gpm of saturated liquid and is located on the upper turbine floor.

Assumptions

The isotopic release rates given in Table 6.1-2 are for rated steam flow conditions. To compute release rates for the leak, it is assumed that the activity releases are proportional to the ratio of steam leakage to rated steam flow. The 30 day total releases of each isotope are given in Table 6.3-3. A reduction factor of 10 was assumed for iodine plateout in the turbine building before release to the environment. Most of the turbine building volume containing steamlines is ventilated up the plant stack. However, since some of the turbine building ventilation system does discharge the gases from the roof of the building, the atmospheric diffusion model for a ground release is used.

Results

Table 6.3-3 lists the quantity of each isotope released to the environment during this event. Using the methods discussed in

Table 6.3-3. Activity Release from Steam Leak (Class 2)

Isotope	Activity Released in 30 Days (μCi)
I-131	3.98(4)
I-132	2.66(5)
I-133	1.73(5)
I-134	6.12(5)
I-135	2.40(5)
Kr-83M	6.14(6)
Kr-85M	9.91(5)
Kr-85	1.50(3)
Kr-87	3.47(6)
Kr-88	3.35(6)
Kr-89	2.10(7)
Xe-131M	2.03(3)
Xe-133M	3.64(4)
Xe-133	9.55(5)
Xe-135M	5.18(6)
Xe-135	3.38(6)
Xe-137	2.66(7)
Xe-138	1.60(7)

Section 6.2 the realistic dose to an individual at the worst location off-site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.3 Class 3.0 - Radwaste System Failures

Three types of radiological waste (radwaste) treatment system failures are evaluated in the next three subsections using the Annex examples as guides.

6.3.3.1 Liquid Release from Sample Tank

Description

Discharges of radioactive liquid wastes are normally made from sample tanks after a sample has been taken and analysis shows that the tank contents are acceptable for release. For this incident, it is assumed that an operator inadvertently initiates release of a batch which contains twice the acceptable amount. Thus, the tank activity would be about 0.64 curies. Based on operating experience this would be a factor of about 10 above the normal amount in the tank. The release continues until 25% of the tank has been emptied.

Assumptions

The two discharge line monitors are assumed to fail unnoticed in this case. Twenty-five percent of the tank contents are discharged before the error is discovered and the discharge secured. The effects of this event are determined by comparison with the annual amount of activity release which has been shown in Section 5.2 to result in 0.4 mrem through the seafood pathway to man. The assumed release contains 0.16 curies which is equivalent to about 1.1% of the typical annual release.

Results

Since the canal's water is saline, and is not used for drinking water, the most significant pathway is through ingestion of seafood. In Section 5.2, it is concluded that the expected annual release of activity results in a maximum dose to an individual of 0.4 mrem/year; this assumed release would result in a dose of 0.004 mrem.

6.3.2.2 Gas Release from 30 Minute Holdup Pipe Sample Line Failure

Description

Radioactive noble gases in the plant are routed through an unpressurized pipe where they are held up for a period of 30 minutes for decay and then released via the stack. For this evaluation, it is assumed that a failure occurs in a sample line connected to the holdup pipe releasing gas which has undergone only a two minute delay. The gas is assumed to be released to the environment for an assumed period of four hours before the break is isolated.

Assumptions

The gas release rate is assumed to be that corresponding to the two minute delay rate given in Table 6.1-2. The flow rate from the break is computed to be 0.2% of the total flow by ratioing the flow to the pipe diameters. It was assumed that the release is at ground level. Since the iodine must first go through the condenser, a decontamination factor of 500 was assumed based on Oyster Creek operating experience. The quantities of each isotope estimated to be released are given in Table 6.3-4.

Results

Using the releases in Table 6.3-4 and the methods described in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.3.3 Liquid Waste Storage Tank Failure

Description

Liquid radioactive wastes are stored in tanks prior to release or recycle. The contents of these tanks are strictly controlled to assure that the technical specification limits on curie quantity are not exceeded.

For purposes of this analysis, it is assumed that the largest tank fails releasing 100% of the average contents of the tank. The liquid will not flow directly to the canal since there is no path for it to follow. Instead, it will seep into the sandy soil and eventually (after many days) reach the canal. The average quantity in this tank is estimated to be 0.5 curies of the composition shown in Table 5.2-3.

Table 6.3-4. Activity Release from Holdup Pipe Sample Line Failure (Class 3)

Isotope	Activity Released in Four Hours (μCi)
I-131	2.52(1)
I-132	1.68(2)
I-133	1.09(2)
I-134	3.87(2)
I-135	1.51(2)
Kr-83M	1.94(5)
Kr-85M	3.14(4)
Kr-85	4.75(1)
Kr-87	1.10(5)
Kr-88	1.06(5)
Kr-89	6.65(5)
Xe-131M	6.42(1)
Xe-133M	1.15(3)
Xe-133	3.02(4)
Xe-135M	1.64(5)
Xe-135	1.06(5)
Xe-137	8.44(5)
Xe-138	5.07(5)

Assumptions

The contents of these tanks contain very small quantities of dissolved gases and other volatile fission products. The most significant environmental effect of this accident is the exposure through the seafood pathway to man. Again, the effects of the accident are evaluated by comparison with the seafood pathway exposures calculated in Section 5.2. The release from tank failure would be filtered by the soil and take considerable time to reach the canal; however, these effects are neglected.

Results

The analysis in Section 5.2 assumed a total release of 14.0 curies compared with the 0.5 curies of the same mixture assumed here. Thus, the maximum dose to a person eating seafood would be 0.014 mrem.

6.3.4 Class 4.0 - Release of Fission Products to Reactor Coolant (BWR)

Description

The plant will normally operate with some leakage of fission products from the fuel to the coolant. The gases which are released from the fuel are held up for at least 30 minutes and then released to the environment after delay.

The redundant Reactor Protective System and safeguard systems are actuated automatically during abnormal operational occurrences so that additional fuel failures do not occur as a result of such transients. Therefore, there are no events which should be evaluated in this class. Any event that does result in additional fuel failures is classified as an accident (instead of transient) and these are considered in Class 8.

The Annex, however, suggests that transients which do release small amounts of activity to the coolant should be evaluated in this class. Therefore, the assumptions outlined in the Annex are followed and it is assumed that 0.02% of the core inventory of fission products are released to the coolant from an unspecified cause.

Assumptions

The assumptions used are listed below:

1. 0.02% of core inventory of noble gases and halogens are released to the coolant.
2. 1.0% of the halogens in the coolant and all of the noble gases reach the condenser.
3. The reactor is shutdown and the mechanical vacuum pump is isolated.
4. 10.0% of the halogens and all of the noble gases are available for release to the environment at the rate of 0.5%/day for 24 hours.
5. The method for atmospheric dilution for a ground release is assumed.

Results

Table 6.3-5 lists the quantities of each isotope assumed to be released over the 24 hour duration of this event. Using the methods discussed

Table 6.3-5. Activity Release from Fission Product Release to Coolant (Class 4)

Isotope	Amount Released to Environment (Ci)
I-131	4.55(-2)
I-132	1.01(-2)
I-133	7.40(-2)
I-134	7.18(-3)
I-135	3.81(-2)
Kr-83M	6.56
Kr-85M	5.51
Kr-85	3.86(-1)
Kr-87	3.23
Kr-88	9.98
Kr-87	1.55
Xe-131M	4.68(-1)
Xe-133M	2.54(1)
Xe-133	1.01(2)
Xe-135M	7.07(-1)
Xe-135	1.38(1)
Xe-137	2.00
Xe-138	2.57

in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.5 Class 5.0 - Fission Products to Primary and Secondary Systems (PWR)

In accordance with the Annex, this class pertains only to pressurized water reactors. Therefore, there are no events in this class for the Oyster Creek Station which is a boiling water reactor.

6.3.6 Class 6.0 - Refueling Accident

Two refueling accidents are evaluated in this section in accordance with the examples given in the Annex.

6.3.6.1 Fuel Assembly Drop

Description

In the process of moving a fuel assembly from the core region to the appropriate rack in the spent fuel pool, it is assumed that the assembly falls damaging the fuel pins.

Assumptions

Following are the assumptions used for this analysis:

1. 1.0% of the noble gases and halogens in one row of pins (7 pins) in an average core are released into the water.
2. There is a four day decay period before fuel is moved (this is a realistic period based on Oyster Creek operating experience).

3. A reduction factor of 500 is assumed for removal of iodine in the pool water before reaching the surface.

4. The charcoal filter efficiency for iodines is 99% in the Standby Gas Treatment System (SGTS).

5. All fission products are released in one hour.

6. Release is from the stack.

Results

Table 6.3-6 lists the quantities of each isotope released following this accident. Using the methods discussed in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Table 6.3-1 and 6.3-2, respectively.

6.3.6.2 Heavy Object Drop Onto Fuel in Core

Description

It is assumed that a fuel assembly which is being removed from the core accidentally falls on top of the core. In doing so, it damages all the pins in one average fuel assembly.

Assumptions

The assumptions for this event are identical to the fuel bundle drop accident in Section 6.3.6.1 except that 49 pins are assumed to fail instead of seven.

Table 6.3-6. Activity Release from Fuel Handling Accident (Class 6)

Isotope	Amount Released to Environment (Ci)
I-131	1.72(-3)
I-132	–
I-133	2.08(-4)
I-134	–
I-135	–
Kr-83M	–
Kr-85M	1.43(-5)
Kr-85	9.89(-1)
Kr-87	–
Kr-88	–
Kr-89	–
Xe-131M	9.77(-1)
Xe-133M	2.22(1)
Xe-133	1.63(2)
Xe-135M	–
Xe-135	5.14(-2)
Xe-137	–
Xe-138	–

Results

The activity released to the environment as a result of this accident is shown in Table 6.3-7. The results are a factor of seven higher than for the case in Section 6.3.6.1 as shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.7 Class 7.0 - Spent Fuel Handling Accident

Three types of accidents involving spent fuel are evaluated in this section in accordance with the assumptions given in the Annex.

6.3.7.1 Fuel Assembly Drops in Fuel Storage Pool

Description

In the Oyster Creek design, the spent storage pool is located within the confines of the secondary containment building. Therefore, any releases from the pool would pass through filters and be released at the stack as was the case for the fuel assembly drop analyzed in Section 6.3.6.1.

Assumptions

The assumptions are identical to those used for the fuel assembly drop analyzed in Section 6.3.6.1 except that in accordance with the Annex the delay time is assumed to be one (1) week.

Results

Quantities of each isotope released from the stack are given in Table 6.3-8. Using the methods given in Section 6.2, the realistic

Table 6.3-7. Activity Release from Drop of Heavy Object on Fuel (Class 6)

Isotope	Amount Released to Environment (Ci)
I-131	1.2(-2)
I-132	–
I-133	1.45(-3)
I-134	–
I-135	–
Kr-83M	–
Kr-85M	1.00(-4)
Kr-85	6.92
Kr-87	–
Kr-88	–
Kr-89	–
Xe-131M	6.84
Xe-133M	1.55(2)
Xe-133	1.14(3)
Xe-135M	–
Xe-135	3.60(-1)
Xe-137	–
Xe-138	–

Table 6.3-8. Activity Release from Fuel Assembly Drop (Class 7)

Isotope	Amount Released to Environment (Ci)
I-131	1.32(-3)
I-132	-
I-133	1.80(-5)
I-134	-
I-135	-
Kr-83M	-
Kr-85M	-
Kr-85	9.88(-1)
Kr-87	-
Kr-88	-
Kr-89	-
Xe-131M	8.20(-1)
Xe-133M	8.91
Xe-133	1.11(2)
Xe-135M	-
Xe-135	2.19(-4)
Xe-137	-
Xe-138	-

dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.7.2 Heavy Object Drop onto Fuel Rack

Description

For this accident it is assumed that a heavy object is dropped on the fuel assembly storage racks in the fuel storage pool, after a delay of 30 days, the heavy object is assumed to damage the 49 pins in one average fuel assembly.

Assumptions

The assumptions are identical to those in Section 6.3.6.2 for the heavy object drop onto fuel in the core except for the delay of 30 days.

Results

Table 6.3-9 lists the quantities of each isotope released following this accident. Using the methods discussed in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

Table 6.3-9. Activity Release from Drop of Heavy Object in Fuel Pool (Class 7)

Isotope	Activity Release to Environment
I-131	1.27(-3)
I-132	-
I-133	-
I-134	-
I-135	-
Kr-83M	-
Kr-85M	-
Kr-85	6.88
Kr-87	-
Kr-88	-
Kr-89	-
Xe-131M	1.49
Xe-133M	5.62(-2)
Xe-133	3.77(1)
Xe-135M	-
Xe-135	-
Xe-137	-
Xe-138	-

6.3.7.3 Fuel Cask Drop

Description

In spite of the precautions taken to prevent droping of a fuel cask, it is assumed that such an event occurs as the cask is being lowered to the rail car in the reactor building. This drop is assumed to result in failure of the cask.

Assumptions

The assumptions used in this analysis following the Annex example are:

1. 120 day cooling before drop.
2. 1% of the noble gases in the fuel is released to the environment.
3. All gases are released from the stack in a period of one hour.
4. The cask holds 32 assemblies.

Results

The resulting quantities of each isotope released are given in Table 6.3-10. Using the methods discussed in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

Table 6.3-10: Activity Released From Cask Drop Accident (Class 7)

Isotope	Activity Released to Environment (Ci)
I-131	-
I-132	-
I-133	-
I-134	-
I-135	-
Kr-83M	-
Kr-85M	-
Kr-85	2.15(2)
Kr-87	-
Kr-88	-
Kr-89	-
Xe-131M	2.43(-1)
Xe-133M	-
Xe-133	8.86(-3)
Xe-135M	-
Xe-135	-
Xe-137	-
Xe-138	-

6.3.8 Class 8.0 - Accident Initiation Events Considered in Design Basis Evaluations in the Safety Analysis Report

In this section, a number of accidents are evaluated using realistic assumptions to compute releases of radioactive materials to the environment. The events suggested in the Annex have been used for guidance. Following are descriptions, assumptions and results of the six accidents considered in the Class 8.0 category.

6.3.8.1 Loss of Coolant (Small Pipe Break)

Description

It is assumed that a break occurs in a pipe of less than six inch diameter connected to the reactor coolant system. All fission products contained in the coolant are released to the containment, however, in accordance with the Annex, no core damage occurs.

Assumptions

Assumptions are as follows:

1. Reactor coolant iodine activity is as given in Table 6.1-1.
2. The SGTS filters remove 99% of the iodines.
3. A decontamination factor of 20 for iodines due to the combined effects of building mixing, plateout, sprays, and the suppression pool is used.
4. The containment leak rate is realistically assumed to be 0.5%/day.
5. The meteorological dilution factors are separated into five time periods as shown in Tables 6.2-2 and 6.2-4.

Results

The resulting quantities of isotopes released are given in Table 6.3-11. Using the methods discussed in Section 6.2, the realistic dose to the individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.8.2 Loss of Coolant Accident (Large Break)

Description

A large pipe connected to the reactor coolant system ruptures and blowdown of the coolant occurs releasing all coolant activity to the containment. The emergency core cooling system limits fuel failure to a small amount.

Assumptions

For this analysis, the following assumptions are made:

1. Reactor coolant iodine activity based on Table 6.1-1 is released to the primary containment.
2. 0.2% of the core halogens and noble gases are released.
3. The SGTS filters remove 99% of the iodines.
4. A decontamination factor of 20 for iodines due to the combined effects of building mixing, plateout, sprays, and the suppression pool is used.
5. The containment leaks at a rate of 0.5%/day.

Table 6.3-11. Activity Release from the Loss of Coolant Accident - Small Break (Class 8)

Isotope	Amount Released to Environment During Each Time Period (Ci) 0-2 hrs	2-8 hrs	8-24 hrs	24-96 hrs	96-720 hrs
I-131	9.70(-7)	2.87(-6)	7.36(-6)	2.83(-5)	8.57(-5)
I-132	4.90(-6)	5.00(-6)	9.82(-7)	-	-
I-133	4.09(-6)	1.07(-5)	1.98(-5)	2.51(-5)	2.37(-6)
I-134	7.80(-6)	1.96(-6)	1.63(-8)	-	-
I-135	5.31(-6)	1.08(-5)	1.05(-5)	2.65(-6)	1.98(-9)
Kr-83M	4.25(-4)	3.43(-4)	4.12(-5)	1.07(-7)	-
Kr-85M	8.31(-5)	1.37(-4)	8.07(-5)	7.12(-6)	-
Kr-85	1.45(-7)	4.37(-7)	1.16(-6)	5.24(-6)	4.53(-5)
Kr-87	2.12(-4)	1.04(-4)	4.27(-6)	-	-
Kr-88	2.60(-4)	3.13(-4)	9.03(-5)	1.77(-6)	-
Kr-89	5.12(-4)	-	-	-	-
Xe-131M	1.97(-7)	5.85(-7)	1.52(-6)	6.15(-6)	2.50(-5)
Xe-133M	3.50(-6)	9.99(-6)	2.32(-5)	6.17(-5)	4.12(-5)
Xe-133	9.24(-5)	2.71(-4)	6.81(-4)	2.42(-3)	4.85(-3)
Xe-135M	1.44(-4)	7.09(-7)	-	-	-
Xe-135	3.04(-4)	6.80(-4)	8.30(-4)	3.49(-4)	1.49(-6)
Xe-137	6.50(-4)	-	-	-	-
Xe-138	4.65(-4)	4.11(-6)	-	-	-

6. Meteorological dilution factors are separated into five time periods as shown in Tables 6.2-2 and 6.2-4.

Results

Table 6.3-12 lists the quantity of each isotope released during the five time periods. Using the methods discussed in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.8.3 Break in Instrument Line from Primary System that Penetrates Containment

Description

One of the small instrument lines which penetrates the primary containment is assumed to fail releasing reactor coolant outside primary containment into the secondary building. The activity released is drawn into the SGTS and released at the stack after filtration. All activity is assumed to be released in four hours.

Assumptions

Assumptions used in this accident are as follows:

1. Iodine and noble gas activities in the reactor coolant and steam areas as given in Tables 6.1-1 and 6.1-2, respectively.
2. Reduction in flow is assumed based on system pressure decay.
3. The amount of noble gas in the break flow is proportional to the main steam activity and flow rate.

Table 6.3-12 Activity Release from the Loss of Coolant Accident Large Break (Class 8)

Isotope	Amount Released to Environment During Each Time Period (Ci) 0-2 hrs.	2-8 hrs.	8-24 hrs.	24-96 hrs.	96-720 hrs.
I-131	1.97(-2)	5.83(-2)	1.49(-1)	5.75(-1)	1.74
I-132	2.28(-2)	2.32(-2)	4.55(-3)	-	-
I-133	4.38(-2)	1.14(-1)	2.12(-1)	2.68(-1)	2.53(-2)
I-134	2.86(-2)	7.19(-3)	5.97(-5)	-	-
I-135	3.79(-2)	7.73(-2)	7.50(-2)	1.89(-2)	-
Kr-83M	3.44(+1)	2.78(+1)	3.33	8.70(-3)	-
Kr-85M	1.52(+1)	2.52(+1)	1.47(+1)	1.30	-
Kr-85	3.21(-1)	9.65(-1)	2.57	1.15(+1)	1.00(+2)
Kr-87	2.13(+1)	1.05(+1)	4.30(-1)	-	-
Kr-88	3.90(+1)	4.72(+1)	1.36(+1)	2.66(-1)	-
Kr-89	1.55(+1)	-	-	-	-
Xe-131M	4.01(-1)	1.19	3.09	1.25(+1)	5.09(+1)
Xe-133M	2.43(+1)	6.93(+1)	1.61(+2)	4.28(+2)	2.86(+2)
Xe-133	8.97(+1)	2.63(+2)	6.61(+2)	2.35(+3)	4.71(+3)
Xe-135M	7.04	3.46(-2)	-	-	-
Xe-135	2.33(+1)	5.20(+1)	6.34(+1)	2.67(+1)	1.14(-1)
Xe-137	2.00(+1)	-	-	-	-
Xe-138	2.55(+1)	2.24(-1)	-	-	-

4. SGTS filter efficiency is 99%.

5. The decontamination factor for the combined plateout and building mixing is 10.

6. The atmospheric diffusion factors for one hour are used to conservatively represent the four hour release period.

Results

The resulting release of fission products is given in Table 6.3-13. Using the methods discussed in Section 6.2, the realistic doses to an individual at the worst location off site, and the population dose within a 50 mile radius are shown in Tables 3.6-1 and 3.6-2, respectively.

6.3.8.4 Control Rod Drop Accident (CRDA)

The postulated accident is a reactivity excursion caused by accidental removal of a control rod from the core at a rate more rapid than can be achieved by the use of the control rod drive mechanism. In the CRDA, a fully inserted control rod is assumed to fall out of the core after becoming disconnected from its drive and after the drive has been removed to the fully withdrawn position. The design of the control rod velocity limiter limits the free fall velocity to 3 ft./sec. Based on this velocity and assuming the reactor is at full power, the maximum rod worth is approximately 1%, resulting in the perforation of less than 10 rods, but with a high probability that none will actually fail.

Assumptions

Following the Annex, assumptions made in this analysis are given below:

Table 6.3-13. Activity Released from Instrument Line Break Accident (Class 8)

Isotope	Activity Released in Four Hours (Ci)
I-131	1.74(-4)
I-132	1.16(-3)
I-133	7.55(-4)
I-134	2.67(-3)
I-135	1.04(-3)
Kr-83M	6.57(-1)
Kr-85M	1.06(-1)
Kr-85	1.62(-4)
Kr-87	3.72(-1)
Kr-88	3.58(-1)
Kr-89	2.25
Xe-131M	2.18(-4)
Xe-133M	3.9(-3)
Xe-133	1.02(-1)
Xe-135M	5.54(-1)
Xe-135	3.61(-1)
Xe-137	2.85
Xe-138	1.73

1. 0.025% of the core inventory of noble gases and halogens are released to the coolant.
2. 1% of the halogens and all of the noble gases released to the coolant reach the condenser.
3. 10% of the halogens in the condenser are released at the rate of 0.5%/day for 24 hours.
4. Releases are in the wake of the building (ground release).

Results

Table 6.3-14 lists the quantity of each isotope assumed to be released to the environment. Using the methods discussed in Section 6.2, the realistic doses to an individual at the worst location off site, and the population dose within a 50 mile radius are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.8.5 Main Steamline Break (Small Break)

Description

A steam pipe of flow area less than 0.25 ft^2 is assumed to break outside secondary containment. Steam and the contained fission products are released in the wake of the building until the break is isolated.

Assumptions

Following the Annex, the assumtpions used are outlined below:

1. The noble gas activity content in steam is listed in Table 6.1-2.
2. The coolant iodine activity is given in Table 6.1-1.

Table 6.3-14. **Activity Release from Rod Drop Accident (Class 8)**

Isotope	Amount Released to Environment (Ci)
I-131	5.71(-2)
I-132	1.27(-2)
I-133	9.3(-2)
I-134	9.03(-3)
I-135	4.78(-2)
Kr-83M	8.24
Kr-85M	6.93
Kr-85	4.85(-1)
Kr-87	4.06
Kr-88	1.25(1)
Kr-89	1.95
Xe-131M	5.88(-1)
Xe-133M	3.20(1)
Xe-133	1.27(2)
Xe-135M	8.89(-1)
Xe-135	1.74(1)
Xe-137	2.52
Xe-138	3.23

3. The release of steam continues until the steam line is isolated in 8 seconds. An 8 second isolation time is realistic for Oyster Creek.
4. 10% of the iodine in the steam reaches the site boundary.
5. The release is at ground level for one hour.

Results

Table 6.3-15 lists the quantities of each isotope assumed to be released during the transient. Using the methods discussed in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.8.6 Steam Line Break (Large Break)

Description

One main steamline is assumed to rupture releasing steam for an 8 second period prior to closure of the isolation valves as suggested in the Annex. The release of steam assumed to be at ground level in the turbulent wake of the building.

Assumptions

Assumptions for this accident are the same as for the small steamline break with the following exceptions:

1. In this case 75,000 lbs. of steam are released prior to isolation.

Table 6.3-15. Activity Release for Small Steamline Break (Class 8)

Isotope	Quantity (μCi)
I-131	5.44(3)
I-132	3.63(4)
I-133	2.36(4)
I-134	8.35(4)
I-135	3.27(4)
Kr-83M	1.68(4)
Kr-85M	2.72(3)
Kr-85	4.12
Kr-87	9.55(3)
Kr-88	9.20(3)
Kr-89	5.77(4)
Xe-131M	5.57
Xe-133M	1.00(2)
Xe-133	2.62(3)
Xe-135M	1.42(4)
Xe-135	9.25(3)
Xe-137	7.32(4)
Xe-138	4.40(4)

2. According to the Annex, 50% of the iodines reach the site boundary.

Results

Table 6.3-16 lists the quantities of each isotope released during the large steamline break. Using the methods discussed in Section 6.2, the realistic dose to an individual at the worst location off site, and the population dose within a 50 mile radius of the site are shown in Tables 6.3-1 and 6.3-2, respectively.

6.3.9 Class 9.0 - Failure Sequences More Severe than those Considered for the Design Basis

In accordance with the Annex, these events will not be evaluated because the probability of occurrence is so remote that the environmental risk is extremely low.

Table 6.3-16. Activity Release from the Large Main Steam Break (Class 8)

Isotope	Amount Released (μCi)
I-131	4.52(5)
I-132	3.02(6)
I-133	1.96(6)
I-134	6.93(6)
I-135	2.71(6)
Kr-83M	5.4(4)
Kr-85M	8.72(3)
Kr-85	1.32(1)
Kr-87	3.05(4)
Kr-88	2.94(4)
Kr-89	1.84(5)
Xe-131M	1.78(1)
Xe-133M	3.20(2)
Xe-133	8.40(3)
Xe-135M	4.56(4)
Xe-135	2.96(4)
Xe-137	2.34(5)
Xe-138	1.41(5)

6.4 RADIATION EXPOSURE IN PERSPECTIVE

We are all exposed to radiation in varying degrees from the ground, sky, and air around us as well as from the food we eat. The degree of exposure depends on where we live, the type of house we live in, and the type of food we eat. The average natural radiation exposure to persons living in the United States is estimated to be about 0.125 rem per year. The average exposure along the New Jersey Coast may be lower due to different geologic formations.

The source of this exposure is cosmic rays and naturally occurring radioactive elements in the earth. The exposure to cosmic radiation increases with elevation above sea level, therefore, persons living in mountainous areas or who frequently fly in airplanes receive a greater annual exposure than persons at sea level. We receive radiation directly from many minerals containing uranium and thorium isotopes in the ground or in the construction materials in our homes. A radioisotope of potassium is the most significant radioactive substance in our food. An additional small amount of exposure is received through radioactive gases in the air.

We are also exposed to man made sources such as medical x-rays, luminous dials on watches, bomb detonations in the atmosphere, and television. It is estimated than an additional exposure of 0.070 rem per year may be received on the average from other than natural sources.

6.4.1 The Man-Rem Concept

Man has not been adversely affected by the natural background radiation which has existed in the environment throughout his evolution. Consequently, it is appropriate to compare new exposures to population groups with their exposure to natural background. One measure of the extent of population exposure is to add all the radiation exposures received by each individual in a population group. This resulting quantity is referred to as man-rem. The natural background population exposure within a 50 mile radius of the site is computed to be about 27,000,000 man-rem. The man-rem exposure for each event associated with the operation of the Oyster Creek plant, as discussed in Section 6.3, is less than the annual natural background dose by at least a factor of one million.

The whole body gamma doses listed for each event should be compared to the background dose. The external body beta dose affects only the external parts of the body, which are less sensitive to raidation than other parts of the body. The iodine doses listed for each event affect primarily the thyroid gland, which again is less sensitive to radiation than other parts of the body.

6.4.2 Effects of Radiation Exposure

For many years standards committees and scientists have exerted considerable effort to determine the effect of radiation on man. As a result, a set of guidelines has been developed to define maximum levels of radiation exposure which are acceptable for any individual to receive every year. These recommendations are embodied in regulation 10 CFR 20, which limits whole-body exposure to less than 0.500 rem per year.

The site boundary doses from the events considered here and shown in Table 6.3-1 are well below both the natural background level of 0.125 rem/yr, and the 10 CFR Part 20 AEC regulatory limit of 0.500 rem/yr.

7.0

UNAVOIDABLE ADVERSE EFFECTS OF PLANT CONSTRUCTION AND OPERATION

7.1 OVERVIEW

The environmental effects of plant construction and operation have been discussed in Sections 4, 5 and 6. Even though these sections support the contentions of JC that these effects are not significant, it must be recognized that certain unavoidable adverse effects of plant construction and operation have occurred.

7.2 AESTHETIC

The description of the plant and site in Section 3.1 indicated that the natural landscape before the plant was constructed was of only moderate aesthetic quality and consisted primarily of marginal foliage rising from flat sandy soil. Nonetheless, the construction of a building complex of the magnitude of the Oyster Creek Nuclear Generation Station would obviously affect any landscape on which it were placed. Mere size, however, is not the only factor; heights, proportions, scale (in relationship to the human user and viewer), texture, and color are also to be considered.

An aesthetic dichotomy occurs between onsite views at close range and offsite views from more distant vantage points (see Figures 3.1-1 and 3.1-2). At close range, the building complex takes on the characteristics typical of power generating facilities; massive scale, awkward proportions, solid exterior surfaces, minimal visual penetration, and complexity of form caused by arrays of equipment. In contrast to this, when viewed from a distance, the subdued colors of the plant allow its impact to be reduced to a softened gray silouette, and the effect is not objectionable to local residents or transient viewers.

The primary adverse effect is that imposed on the landscape of the immediate site. Excavation and deposition of construction wastes on approximately 325 acres, where soil and foliage already had a tenuous relationship, has caused some aesthetic impact. Grass was seeded along the canals and in the vicinity of the plant, but germination and stand establishment were not very good.

7.3 LAND USE EFFECTS

Most of the 1,416 acres purchased by JC for the site is lying idle. The generating station switchyard, access roads, transmission right-of-way and dredged canals utilize approximately 325 acres. These effects were unavoidable. The greatest impact occurred in those areas where vegetative cover used by terrestrial wildlife was removed and where the South Branch of Forked River and Oyster Creek were dredged. The impact on terrestrial wildlife is considered temporary. Vegetative cover is returning, except along the dredged canals. Canal dredging changed the aquatic biota in the South Branch of Forked River and Oyster Creek somewhat, but did not adversely affect sport fishing.

The aesthetic impact of transmission lines is most obvious at several road crossings. However, this impact is being minimized since JC has adopted a right-of-way maintenance program that encourages regrowth of vegetation at highway crossings to provide natural screening of the right-of-way.

The plant itself has had no impact on regional land use. Of more importance has been the requirement to provide housing and related services for the plant's operating personnel. These requirements, however, have not disrupted the local economy or service base. All personnel required for full operation of the plant have already been integrated into the local communities without influencing land use. Existing development in the area was of such magnitude that it was possible for the small influx of plant personnel to be easily absorbed.

Operation of the plant is very quiet and consequently does not have an adverse impact in the vicinity of the plant. The operation of the plant and transmission lines have not had an adverse impact on recreation in the area. In fact, it has been reported by fishermen in the area that fishing in Oyster Creek has improved since the plant began operation.

7.4 EFFECTS OF CHEMICAL AND RADIOACTIVE EFFLUENTS

In general, the impact of unavoidable chemical and radiological discharges has been negligible. There has been some slight accumulation of radioactivity in clams. On the other hand, results show that chemicals and radioactivity are not accumulating in the ground water. Odors are not being emitted from the plant. Radioactive gaseous effluents, however, could be further reduced by the installation of charcoal beds to delay the release of the gas until more of the short half-life radionuclides have decayed. This modification of the gaseous waste treatment system is planned. Consideration of alternatives shows that the only way of avoiding the emission of chemical and radioactive wastes is to avoid the production of power in this or any other region of the country.

The standards set by Federal and State agencies for concentration of pollutants in air and water or in effluents have been well satisfied during the operation of the plant. It has been demonstrated elsewhere in this report that concentrations of effluents resulting from normal plant operation does not directly or indirectly impose a significant hazard to human health. The dose concentrations from radioactive wastes discharged from the plant are an extremely small percentage of normal background radiation. The direct effect of plant operation on the accumulation of chemicals and radioactivity in aquatic biota is very small.

7.5 THERMAL EFFECTS

Three adverse effects of thermal addition to Barnegat Bay have been noted. These are: (1) a loss of some flagellates in passage through the condensers; (2) a decrease in the population levels of *Pectinaria gouldii* in the Oyster Creek channel (Ref. 7.5-1); and (3) the loss of a number of fish in the discharge canal in January 1972 when the plant was shut down for regular maintenance. Previous to this shutdown, fish had not been lost and this incident is under intensive investigation aimed at avoiding similar events in the future. No other deleterious effects from thermal addition to the Bay have been demonstrated. Furthermore, the effects of thermal addition on the biota, as documented, have not thus far been harmful to the utilization of the Bay, or to its current overall productivity or species diversity.

The warmer water in Oyster Creek has been of benefit to the marina operators. The water in the marinas no longer freezes, hence, there is no impact of ice on the boats.

REFERENCES - SECTION 7.5

7.5-1 Loveland, R. E., et al., June 25, 1970. The Qualitative and Quantitative Analysis of the Benthic Flora and Fauna of Barnegat Bay, Seventh Progress Report, Rutgers, The State University, Contract No. 27-4656.

8.0

ALTERNATIVES TO CONSTRUCTION AND OPERATION OF THE PLANT

So far as alternatives are concerned, Oyster Creek presents a special situation, in that it is an existing and operating plant. Alternatives to its construction can be considered only if discussion is related to conditions existing in 1963-1964. On the other hand, alternatives to its continued operation must be considered in the light of anticipated future conditions, as foreseen in 1972. Consequently, separate consideration will be given to: (8.1) Alternatives to construction and (8.2) Alternatives to Continued Operation.

8.1 ALTERNATIVES TO CONSTRUCTION

Because Oyster Creek was the first of the large nuclear units that was ordered on the basis of its expected economic advantage, the economic analysis that led to the decision to proceed with the project was carefully documented. The "Report on Economic Analysis for Oyster Creek Nuclear Electric Generation Station," dated February 17, 1964 and prepared by JC explains the selection of the site in New Jersey as well as the advantages of the nuclear capacity compared to fossil-fired capacity at the same site or at a mine-mouth location in western Pennsylvania.

Copies of the report are included here as Appendix B. There is little that can be added to this document beyond a statement that

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8.0

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8.1 ALTERNATIVES TO CONSTRUCTION

Because Oyster Creek was the first of the large nuclear units that was ordered on the basis of its expected economic advantage, the economic analysis that led to the decision to proceed with the project was carefully documented. The "Report on Economic Analysis for Oyster Creek Nuclear Electric Generation Station," dated February 17, 1964 and prepared by JC explains the selection of the site in New Jersey as well as the advantages of the nuclear capacity compared to fossil-fired capacity at the same site or at a mine-mouth location in western Pennsylvania.

Copies of the report are included here as Appendix B. There is little that can be added to this document beyond a statement that subsequent changes in cost have confirmed the wisdom of the 1963 decision to proceed with a large nuclear unit at Oyster Creek. Practically all costs have increased, as compared to those used in the estimates; but the major factor favorable to the Oyster Creek decision has been the relative stability of nuclear fuel costs as contrasted with an approximate doubling of fossil-fuel costs.

In addition to the economic advantage of Oyster Creek construction, it is also evident (although it was not a major factor in the 1963 decision) that no alternative fossil-fired plant could have been constructed and operated to provide comparable service with less environmental impact.

8.2 ALTERNATIVES TO CONTINUED OPERATION

8.2.1 Immediate Effects

If the operation of Oyster Creek were to be terminated, the immediate effects would be:

1. A decrease in the reliability of service provided by JC, by the GPU System, and by PJM, particularly that portion in New Jersey and southeastern Pennsylvania.
2. An increase in generation by older, less efficient fossil-fired units and by combustion turbines with consequent release of additional pollutants to the atmosphere.
3. A very substantial increase in cost of service to customers supplied by JC. For the most part, the

increased cost of fuel burned to replace the Oyster Creek generation would be very soon reflected in increased charges for power through operation of fuel cost adjustments in various rate schedules.

4. A severe impact on the financial status of JC and of GPU, because the required write-off of its investment in Oyster Creek plus all the costs associated with its withdrawal from service.

Since continuation of the first three of these conditions would be unacceptable to the utilities involved and to the regulatory commission in New Jersey, JC would have to move promptly to provide substitute capacity for that removed from service (see Section 8.2.6).

8.2.2 Decrease in Reliability of Service

The effects of Oyster Creek on the expected generating capacity reserves in the summers of 1972 and 1973 are shown in the following tabulation:

Installed Generating Capacity Reserves
At Time of Summer Peak Loads

	JC & NJ		GPU		PJM	
In percent of peak	1972	1973	1972	1973	1972	1973
	% of Peak					
with Oyster Creek	5.9	4.8	12.5	15.8	19.9	22.0
without Oyster Creek	-22.1	-20.2	0.2	4.6	17.8	20.1

Ordinarily, the negative reserves in JC and NJ and low reserves in GPU can be offset by interchange from and temporary payment for reserve capacity to other PJM companies; but this possibility must be considered in relation to (i) possible delays in other nuclear units now under construction (it is difficult to imagine, in the absence of accident, that the operation of an existing plant would be terminated, while construction proceeds on other generally similar plants) and (ii) limitations imposed by environmental considerations on construction of needed transmission. The first consideration needs no additional comment; but the second one does require further explanation.

At the present time the transmission connecting the portion of PJM in southern New Jersey and southeastern Pennsylvania, to the remainder of PJM is inadequate to meet the Mid-Atlantic Area Coordination (MAAC) Group Standards. In 1972 or 1973, without Oyster Creek, JC must import approximately one third of the peak energy requirement to meet their load, assuming that none of the units are forced out of service. Should the two largest remaining units be considered out of service, this requirement would exceed 1000 megawatts in either year. Under this condition, the PJM west to east transmission system is overburdened, for even with Oyster Creek in service, the transmission system requires special operating procedures in order to avoid overloads.

8.2.3 Increased Use of Older Units

Suspension of operation of Oyster Creek will result in additional generation by existing older and relatively inefficient fossil-fired steam units and by increased use of combustion turbines. Estimates of this additional generation were recently made in connection with estimates of the effect of delay in nuclear unit construction.

Because of the interconnected and coordinated operation of PJM, a deficiency in energy available to any one company, for example, a deficiency due to unavailability of Oyster Creek will be made up by use of the resources available to the whole PJM. From hour to hour, the most economical and then available sources of additional generation will be used to replace the nuclear generation that is not available.

If this additional generation happens to be a plant of some company other than the owner of the nuclear plant, the latter company purchases the additional energy under the existing PJM interchange arrangements. This means that the additional generation is spread widely in PJM and it is impossible to separate that amount which is additional because of Oyster Creek, delay in construction of some other nuclear unit, or any other cause. Consequently, in using previously prepared estimates related to the effects of delay in nuclear unit construction, Oyster Creek has been assigned, in proportion to the output that becomes available, a responsibility for part of all the additional generation occasioned by the nuclear units that are unavailable in that year. This responsibility has been related to certain physical quantities involved in production of the replacement energy, as in the following tabulation:

	Unavailability of Oyster Creek
Capacity rating	600-625 MW
Loss of nuclear generation for 1 year at 80% load factor	4,300,000 MWH
Approximate required use of additional fossil fuel per year	
Coal - Tons	520,000
Oil - Barrels	6,300,000
Approximate stack discharges per year	
SO_2 - Tons	20,000
Particulates - Tons	1,600
NO_x - Tons	4,000

Insufficient data are available from testing to determine with a satisfactory degree of accuracy the precise amount of NO_x emitted from the combustion sources of the PJM System. Accordingly, the above estimates of NO_x emissions have been derived on a generalized basis from published information on nation-wide emissions from stationary sources in the United States released by National Air Pollution Control Administration (NAPCA) in 1970 and have been estimated as a percentage of the SO_2 emitted.

8.2.4 Increased Cost of Power

Suspension of operation of Oyster Creek would result in greatly increased cost of generation and of interchange purchases by JC and, in fact, by the whole of the GPU System. Most of these increased costs would be promptly passed along to customers by operation of the fuel adjustment clauses and all such increased costs will ultimately be included in the higher rates that result through normal regulatory practices.

Estimates of such increased costs for the next several years can be based on 1971 experience, adjusted only for the recently increased rating of the Oyster Creek unit. There will undoubtedly be changes in the use factor of the Oyster Creek unit, in its costs of operation, and in the cost of interchange purchase and of other generation that would be used to replace the Oyster Creek operation. These differences, however, are likely to be small as compared to the totals of the following estimates, and are comparable to the uncertainties inherent in a projection of future costs. On the basis of 1971 experience, the annual increased cost of power to GPU during the next several years, resulting from assumed suspension of Oyster Creek operation, would be:

	Million Dollars
Increased cost of production in older plants and increased interchange costs, covering:	
energy (4137 x 10^6 kwh at 9 mills)	37.2
operating cap. (avg. of 470 x 10^3 kw at $15)	7.0
installed cap. (avg. of 470 x 10^3 kw at $12.48)	5.8
	50.0
Less: operation & maintenance of Oyster Creek plant at 1971 cost/kwh	
(4137 x 10^6 kwh at 2.5 mills)	(10.3)
Net annual increased cost (million dollars)	39.3

The estimated increased annual cost of System operation, $39,300,000, has been determined without inclusion of any continuing costs at Oyster Creek incident to its shutdown and deactivation.

8.2.5 Impact of Write-Off to Plant Costs, Etc.

The loss of electrical generating capacity and resultant revenue would not encompass the complete impact to the Company and ultimately its customers, should the Oyster Creek plant be forced to shut down. Depending on the degree to which the site is to be returned to its original condition, the cost of retirement varies widely.

The minimum cost would be incurred in a plan which would involve removal of all fuel, some decontamination, sealing of the buildings and permanent security. This plan would cost at least $5,000,000.00 (not counting annual operating cost of security force).

It is not likely that this plan would be acceptable because of objections to the impact of the remaining portion of the plant on the environment. Another plan was evaluated using the assumption that the site would be returned to as close to its original state as possible. Because of the requirements to decontaminate and ship much of the hardware to permanent storage sites, plus the requirement to demolish the enormous and thick concrete and steel structures, the cost of such a plant removal and site restoration project would be more than $25,000,000. These two plans bracket the probable cost of plant deactivation but they do not include the financial burden on the Company associated with the deactivation of a revenue producing asset. The total investment in the plant and the fuel as well as in presently existing contracts for future service would have to be absorbed by the Company and written off over some reasonable period of time as approved by the New Jersey Public Utility Commission and the Federal Power Commission. Due to the uncertainties as to how this liability would be written off, the financial impact cannot be clearly defined but it is clear that it would be a severe burden on both JC and its customers.

8.2.6 Long Range Effects

To alleviate the effects discussed in 8.2.2, 8.2.3 and 8.2.4, the GPU System would have to provide, as soon as possible, for additional generating capacity to replace that removed from service at Oyster Creek.

As indicated above, the initial replacement of this capacity in JC and in the GPU System would be through interchange purchases. These might be subsequently supplemented by firm or other type of temporary purchase from neighboring utilities. Purchases, however, do not create new facilities, changed physical conditions, or differences in PJM operation, which is governed by overall economy, without reference to ownership or purchase contracts. Consequently, neither interchange nor other type of purchase will improve reliability, reduce atmospheric pollution, or change the overall costs of providing service.

The first reduction of the adverse effects of suspended Oyster Creek operation might appear in 1973 or 1974, as additional combustion turbines are placed in operation. These would improve reliability, but probably would have little effect on pollution or costs. In 1974 or 1975, however, it may be possible for GPU to place in service additional combined cycle capacity (combustion turbines from which exhaust heat is used in a closely associated steam boiler supplying a turbine generator). These, too, would improve reliability; but also, because of their better fuel economy, they would reduce both pollution and costs as compared to a gas turbine. Nevertheless, such units could not be considered as replacements for Oyster Creek, since they are not designed for base load operation and are economically not suited for that service, because of still relatively high energy costs.

This additional capacity might be considered as earlier installation of units that were already scheduled by GPU, but for use at a later date (see tabulation of planned additions in part 8.2.8). This being the case, it is unnecessary to dwell on this advance of already scheduled capacity or to speculate on the exact program or cost of using it temporarily to replace Oyster Creek. Rather, attention should be directed to the measures that could be taken, on a long-range basis, to offset the loss of the Oyster Creek output. These could include (i) limitation on load growth, (ii) other nuclear capacity, or (iii) other base load fossil-fired generation.

8.2.7 Limitation on Load Growth

If limitation on load growth were to be the accepted practice for environmental improvement and were to be required by appropriate regulatory authority, it is questionable whether it has any applicability to the possible suspension of Oyster Creek operation. Oyster Creek is now supplying existing electrical requirements, requirements which have increased since Oyster Creek was placed in service and which will continue to increase, because of population growth, increased per capita usage, and of the needs of environmental improvement programs. If there is any reduction in need for future electric generating facilities, the reduction can be more properly applied to the facilities planned to meet future growth, rather than to the replacement of an existing facility such as the Oyster Creek plant.

The question, however, is academic in the absence of a public policy to restrict consumption of electric power. The GPU operating companies have obligations under the Public Service Laws of the Commonwealth of Pennsylvania and of the State of New Jersey to plan for and to provide an adequate and reliable supply of electric power. This is a matter of serious concern to the regulatory commissions of these states. The several commissions having responsibility for rates, service and facilities in the states served by GPU and other PJM companies have called the executives of these companies into annual meetings for review of company forecasts of load and of planned additions, and have requested periodic reports from the companies. Their major concern is that the companies plan for adequate generating capacity, so that the risks of load curtailment, voltage reductions, etc. are minimized. A surveillance committee, consisting of a commission member or other representative from each state has been designated to follow the operation and planning of PJM. These representatives, and a representative of the Federal Power Commission, regularly attend meetings of the PJM Interconnection, which is concerned with the reliable operation and planning of the PJM area.

National policy on this question has been clearly stated in Section 202 of the Federal Power Act, which grants to the FPC certain powers "For the purpose of assuring an abundant supply of electric energy through the United States with the greatest possible economy... etc." To this end, the FPC has established regional advisory committees, composed of representatives of the utility industry, which are concerned among other things with regional load growth and all practicable opportunities for more efficient and reliable development of power systems in each region. These committees have been active in updating the national power survey. To obtain current information as to regional and area load forecasts and plans for generation and transmission to meet these loads, the FPC has required (Order 383-2, Docket R-362) annual reports from areas such as that served by PJM. This report is prepared and filed with FPC by MAAC, with copies going also to the State commissions.

8.2.8 Types of Alternative Capacity

Because of the varying customer demands for electric power on daily, weekly and seasonal cycles, there is opportunity to use to advantage various types of generating capacity in meeting these customer requirements. The utility system must, of course, install or purchase capacity equal to the expected maximum demand plus a reasonable reserve, currently about 20 percent, but all this capacity should not be of the same character.

A certain portion of the electric demand (40 to 50 percent) is continuous, and to supply this type of service, including additional pumping load for pumped storage plants, GPU needs to have 50 to 60 percent of its installed capacity in the form of base load units. Generally, these units will have a relatively high installed cost, which is justified by their ability to operate and produce energy at a relatively low cost (including cost of fuel consumed). Nuclear units, mine-mouth coal-fired units, other efficient fossil-fired units and certain hydro plants would be suitable for this type of operation.

For electric demands that exist for only a portion of the time, represented by the heavy load periods of the day (in the neighborhood of 4,000 hours per year), the cost of producing energy is somewhat less important than it is for the base portion of the load, and a different type of unit can be justified. Often these will be the older units on a system, that were once used for base operation; but they may also be units specially designed for this type of service. These latter units might be combined cycle units or oil-fired cycling units. For these, the higher energy cost (the result of higher fuel costs or lesser efficiency) is compensated for by lower installed cost.

For that portion of the electric demands that exist only over peak periods (less than 2,000 hours per year), there are now a variety of suitable generating sources. These are characterized by low installed costs and generally high energy costs. Peak portions of the load in the GPU System are supplied by older and inefficient steam generation, by several small hydro plants, by pumped storage, and by combustion turbines.

Because of these differences in cost characteristics (as well as physical capability in the case of hydro or pumped storage), not all of the capacity that might be installed by a utility system can be considered as an alternative installation to a nuclear plant.

The capacity now planned for the GPU System through 1982 is shown in the following tabulation (see Table 8.2-1) which indicates a reasonably well balanced supply among the various possible sources. To maintain that balance, Oyster Creek would have to be replaced with other base load generation.

8.2.9 Alternative Nuclear Capacity

If Oyster Creek were replaced, another nuclear unit would be preferred. The replacement of Oyster Creek with another nuclear unit would not be possible until at least 1980. The adverse effect on reliability of power supply that would be caused by the shutdown of Oyster Creek could be corrected as early as 1973-75 by the installation of other types of power generation units. However, there would still be adverse effects caused by atmospheric pollution and increased cost of service that would result from the replacement of a base load nuclear supply by relatively high cost oil-fired combustion turbines, or combined cycle plants. Assuming that additional nuclear power generating capacity becomes available in or about 1980, there would remain a substantial extra burden of cost from the

Table 8.2-1. GPU System Planned Capacity*.

	Nuclear	Mine-Mouth Coal Fired	Other Fossil Steam & Comb. Cycle	Hydro and Pump. Stor.	Diesel and Comb. Turb.	Total
	MW					
Existing, 12/31/71	600	1,925	1,684	297	502	5,008
Additions, prior to						
Summer 1972	-	50**	-	-	488	538
1973	-	-	190	-	162	352
1974	792	-	263**	(50)**	-	1,005
1975	880	-	-	-	-	880
1976	-	320	400	-	-	720
1977	-	140	238**	175	-	553
1978	1,070	-	-	-	-	1,070
1979	-	-	316	-	200	516
1980	-	640	-	280	175	1,095
1981	1,250**	-	-	-	-	1,250
1982	-	-	-	775	200	975
Total 1982	4,592	3,075	3,091	1,477	1,727	13,962
% of Total	33	22	22	11	12	100

*Generating Capacity - Existing, under Construction and Proposed - 1/26/72 (Summer Ratings, in MW).

**Includes rerating of previously installed capacity and other adjustments.

power generation systems that were substituted in 1973-75 for the Oyster Creek plant.

The cost of generation from new nuclear capacity is compared with costs for generation from Oyster Creek in the following tabulation. For this purpose, costs for new nuclear capacity are based on costs heretofore estimated for the Forked River Nuclear Generating Station, since these costs are readily available, have been used in statements submitted to AEC, and are reasonable estimates (except for additional escalation) of costs that might apply to an alternative in 1980. Attention is drawn to the fact that annual fixed charges on the investment in Oyster Creek are appropriately omitted from this comparison since these costs (less savings from plant retirement, if effected) would be incurred whether Oyster Creek is operated or is shut down.

<u>Oyster Creek</u>		
Total investment		$89,883,394
Installed capacity		620 MW
Unit investment cost		145/KW
Nuclear fuel investment		43
Total	$	188/KW

	Annual Hours of Operation	
	4000	7000
Annual Cost - $/KW yr. (Adjusted to 1980)		
Fixed charges	-	-
Operation and maintenance, nuclear insurance	6.00	6.00
Fuel at 1.35 mills/kwh	5.40	9.45
Total	11.40	15.45

Nuclear Replacement

Unit investment cost, 1980	$ 486/KW
Nuclear fuel investment	31/KW
Total	$ 517/KW

Annual Cost - $/KW yr.	4000	7000
Fixed charges at 13.5 percent	69.80	69.80
Operation and maintenance, nuclear insurance	5.00	5.00
Fuel at 1.35 mills/kwh	5.40	9.45
Total	80.20	84.25

These figures show that the saving by operating Oyster Creek instead of a nuclear replacement plant for the 7,000 hour base load period as contemplated, is estimated to be $68.80 per kilowatt year ($84.25 minus $15.45). For the 620 MW rated capacity of Oyster Creek this would amount to $42,700,000 per year in 1980, the first year in which replacement capacity could be in service.

8.2.10 Alternative Fossil-Fired Capacity

Consideration of fossil-fired base load generation as the replacement for Oyster Creek is favored by the possible earlier date at which such capcity might be made available. Although environmental considerations are also resulting in delays of fossil-fired units, it is possible that an oil-fired unit might be completed in 1976 or 1977 and a coal-fired unit only a little later. Since the coal-fired unit would probably be at mine-mouth, its use would require substantial transmission construction.

The fossil-fired substitutes for Oyster Creek would, even when in compliance with all regulations, continue to contribute to atmospheric pollution. There are other ways which fossil fuel plants would be less desirable than the nuclear plant from an environmental standpoint, including potential oil spills and the problems of ash disposal. Their costs would also be substantially above that of Oyster Creek. When comparing the following fossil-fired plant costs with that of the previously discussed nuclear substitute for Oyster Creek, note should also be made of the assumed differences in time of initial operation and hence of different escalation applying to the cost estimates.

		Annual Hours of Operation	
		4000	7000
Oyster Creek			
Annual Cost - $/KW yr.		11.40	15.45
Coal Base Load			
Unit investment cost, 1977 $/KW			
"Normal" plant	262.50		
SO_2 removal equipment	46.00		
Bulk transmission to eastern load	52.50		
Total	$361.00		
Annual Cost - $/KW yr.			
Fixed charges @ 13.25%		47.85	47.85
Operation and maintenance		3.25	4.15
Fuel @ 4.3 mills/KWH*		17.20	30.10
Total		68.30	82.10
Oil Base Load			
Unit investment cost, 1977	$247/KW		
Annual Cost - $/KW yr.			
Fixed charges @ 13.25%		32.70	32.70
Operation and maintenance		2.70	3.40
Fuel @ 8.35 mills/KWH**		33.40	58.45
Total		68.80	94.55
Combined Cycle			
Unit investment cost, 1977	$198/KW		
Annual Cost - $/KW yr.			
Fixed charges @ 13.0%		25.75	25.75
Operation and maintenance		4.35	6.60
Fuel @ 8.8 mills/KWH***		35.20	61.60
Total		65.30	93.95

*Coal at 46¢/10^6 BTU.
**Oil at 91¢/10^6 BTU.
***Oil at 91¢/10^6 BTU plus 3.0¢/10^6 BTU for vanadium and sodium treatment.

8.3 ALTERNATIVE COOLING SYSTEMS

8.3.1 General

In this section, various alternate methods of dissipating the rejected heat load are evaluated against the existing once-through cooling system, and interpreted from the combined standpoint of additional cost and relative environmental impact.

Several alternative cooling schemes were evaluated at the time Oyster Creek Nuclear Generating Station was built. The once-through cooling system was chosen based on both economic and environmental considerations. Due to the unavailability of data on the effects of such a system on the environment, JC and the State of New Jersey agreed to conduct a joint study to determine these effects. Based on the results of this study, present restrictions on operation of the system are to be adjusted. Results from studies thus far conducted indicate operation of the cooling system has not significantly affected the environment. Therefore, it is not anticipated that it will be necessary to utilize any other type of cooling scheme, but several possible alternatives are discussed below.

8.3.2 Temperature Requirements for Cooling Water System

Details of the temperature requirements in Barnegat Bay for the Oyster Creek plant cooling water system are given in Ref. 8.3-1, pages five to seven, and in Section 5.1. Essentially, the agreement states the cooling water system, when operating at full capacity, would permit temperatures in Barnegat Bay to exceed 86°F within certain areas, but the maximum temperature should not exceed 95°F.

8.3.3 Plant Thermal Discharge

The design objectives of the various cooling alternatives for the Oyster Creek plant include the following:

1. Dispose of 4.5×10^9 BTU/hour from the circulating water system.
2. Dispose of 0.12×10^9 BTU/hour from the service water system.
3. Circulate 460,000 gallons per minute through the steam condensers.
4. Use those portions of the once-through systems which are applicable.

8.3.4 Alternative Cooling Methods Evaluated

An extensive study of various cooling methods was made for the proposed Forked River Nuclear Generating Station which will be located 3,400 feet west of the Oyster Creek plant. The main cooling alternatives considered for the Forked River plant were ocean discharge, cooling towers, cooling pond and spray pond with various sources of water and modes of operation. A total of 14 various schemes were evaluated and compared with the Ocean Discharge System (ODS). Based on this study it was determined that the most feasible schemes were the natural draft cooling tower with salt water makeup and the spray pond with salt water makeup. These two alternates along with the ocean discharge system have been selected for discussion as the main cooling system alternates for the Oyster Creek Nuclear Generating Station.

8.3.5 Existing Once-Through System

The existing once-through cooling system consists of intake-discharge canals, about five miles in length, extending from the point of intake which is at the mouth of the South Branch of Forked River and Barnegat Bay, to the plant, and back to Barnegat Bay to the point of discharge at the mouth of Oyster Creek. The flow through the main condensers and auxiliary systems at the plant is about 470,000 gpm with a $23^{\circ}F$ rise in temperature for water passing through the condensers. During the summer months dilution pumps (total capacity 780,000 gpm) may be used to decrease the temperature of water in the discharge canal to meet thermal limits. The length of time required for the plant discharge to reach Barnegat Bay is approximately two hours and based on data obtained from over two years of operating experience there is considerable dissipation of the plant heat load in the discharge canal. The increase in temperature of the water at Barnegat Bay between point of intake near the South Branch of Forked River and the point of discharge at the mouth of Oyster Creek is very small (Table 3.5-1).

One of the operational problems with the existing once-through cooling systems is the timing of plant shutdowns to cause minimal water temperature change and shock to the biota in the thermal plume. During a recent shutdown in January 1972 there was a coincident sharp drop in ambient air and water temperatures caused by climatic conditions, resulting in a loss of fish (Section 5.1).

The only adverse effects of thermal discharge which have been observed after more than two years of plant operation and based on the results of an extensive monitoring program are relatively minor in nature, including:

1. Loss of some flagellates through the condensers.
2. Decrease in propagation levels of Pectinaria in Oyster Creek.

An additional effect which should be considered is the Mean Avoidance Temperatures (MAT) of some important forms of aquatic biota including invertebrates - the grass shrimp (MAT 90°F), and most important fishes such as striped bass, bluefish and winter flounder (MAT >87°F).

The cost of the existing once-through cooling system was $1,640,000 (Ref. 8.3-1).

8.3.6 Natural Draft Cooling Tower (Salt Water Makeup)

A single natural draft cooling tower over 400 feet high, circular in all horizontal cross sections, and hyperbolic in vertical cross section has been considered. Hot water from the condenser is pumped to the tower and cooled within the tower as it cascades over the baffle plates on the tower. The cooled water from the base of the tower is returned to the steam condensers and then recycled. Water is lost from the system by evaporation and drift. Makeup water from the intake canal is required to replace the water lost. Additional makeup water is also added to the system from the intake canal to prevent excessive accumulation of mineral content in the system. This water is returned to the discharge canal as blowdown.

The following evaluation of cooling tower performance was based on a wet-bulb temperature of $67^{o}F$ and a relative humidity of 73 percent. The heat discharge rate to the discharge canal that would occur if a natural draft cooling tower were used at the plant would be about 1.3×10^{8} BTU/hour, or about three percent of the heat load from the once-through system. The evaporation rate from the tower would be about 9,000 gpm and to maintain a concentration ratio of 1.5 of the minerals in the cooling water, the blowdown rate from the tower would be about 18,000 gpm while the makeup rate to the tower would be about 27,000 gpm.

The main advantages of the natural draft cooling tower are: (1) small thermal release to the natural water body and; (2) relatively simple maintenance.

A disadvantage of the natural draft cooling tower at Oyster Creek is that if the cooling tower is higher than 150 feet and close to the stack, then it may effect the dispersal of gaseous effluent. With a natural draft cooling tower the assumptions used in calculating the dispersion and dose rate (somatic and genetic) from radioactive gases under these certain wind conditions may require that a ground level release rather than elevated stack release be assumed (Ref. 8.3-2). If a natural draft cooling tower is installed at Oyster Creek it may in itself, require further alteration of the off-gas system. (Ref. 8.3-3)

Other disadvantages of the natural draft cooling tower with salt water makeup are: (1) potential salt drift and; (2) possible fogging and icing. Evaluation of the potential salt drift problem shows that the salt concentrations and accumulations from the cooling tower are not as great as the salt concentration and accumulation caused by natural wind-drifted salt spray from Barnegat Bay. The potential for fogging from the cooling tower would occur less than two percent of the time. The potential for icing would occur only on nearby structures (greater than 200 feet high) about 64 hours per year (Ref. 8.3-4).

An estimate of the costs of the natural draft cooling tower is shown below:

(1) Capital Costs

Direct Costs

Tower cost	$ 6,200,000.
Piping cost (modifications, etc.)	750,000.
Makeup system	400,000.
Electric system	500,000.
	$ 7,850,000.

Indirect Costs

(Assume 67% of direct cost)	5,250,000.

Pumping Cost (generation capacity lost cost)

7000 Kw x $80/Kw	560,000.
	$13,660,000.

(2) Annual Operating Cost

Charge for energy used in pumping (7×10^3 Kw x 7×10^3 hr/yr x $0.005 / Kw/hr)	245,000.
Maintenance & miscellaneous	100,000.
	$ 345,000.

8.3.7 Spray Pond (Salt Water Makeup)

A vinyl-lined recirculating spray pond with 23°F approach temperature has been considered as the second alternative cooling system at Oyster Creek. The spray pond was assumed to have the following characteristics: a long canal (1.5 miles in length) with a width of 200 feet and a depth of 8 feet. A large number of floating independent modules (272 units, 4 nozzles per unit), each including a pump and motor assembly, are distributed along its length. Water enters the canal from the condensers and moves slowly down the canal with cooling by natural evaporation from the spray plumes. The spray pattern, 20 feet high and 40 feet in diameter, is made up of large drops of water over 0.25 inch in diameter. Because of the large size of the drops, drift is limited. At the end of the canal the water returns to the condensers.

The evaporation rate from the modules would be about 9,000 gpm and the blowdown and makeup rates from and to the pond would be similar to those of the natural draft cooling tower - about 18,000 gpm and 27,000 gpm, respectively.

The advantages of the spray pond are: (1) small thermal release to the natural water body; (2) the ponds may be aesthetically more acceptable to some than the natural draft cooling tower and; (3) calculations of dispersion and dose rates of radioactive exhaust gases can be made from the existing elevated stack (375 feet high), rather than ground level.

The disadvantages are: (1) potential salt drift problem; (2) potential icing and fogging problem and; (3) would take up a large area. The potential problems of salt drift and icing and fogging can be minimized by use of spray modules which produce large droplets. Manufacturers of these modules assure that the fog formed from the spray dissipates within a limited distance, and that drift is limited to a distance of about 200 yards.

Cost of the spray pond system (not including power costs, and assuming normal soil conditions) is about $8,600,000. The cost required to operate the 16,000 horsepower system is about $1,300,000. The operation cost is based on the fact that it costs approximately $80 per horsepower to operate the pumps. Coincidentally, the cost of power is $80/KW hence, the cost to operate the pumps and generate power are approximately equal. The remaining annual operating costs are about $570,000. 84,25

8.3.8 Ocean Discharge System (ODS)

Information on the ODS is based on previous studies made for the disposal of waters from the once-through cooling system for the proposed Forked River Nuclear Generating Station, and for the Oyster Creek plant.

This system consisted of a 7.5 mile pipeline from the site across Barnegat Bay and Island Beach State Park, extending 2,000 feet into the Atlantic Ocean. The heated circulating water from both the existing Oyster Creek plant and the proposed Forked River plant was to be discharged through this pipe, thereby eliminating all thermal discharges to Barnegat Bay.

The advantages of the ODS are: (1) no thermal discharge to Barnegat Bay; (2) good dilution with no recirculation problems.

The disadvantages are: (1) dredging operations would have an adverse effect of aquatic life in the vicinity and a severe impact due to siltation, and loss of recreational and navigational use of the Bay during construction; (2) any entrained organisms would be subjected to high temperatures for a longer period of time. They would also be displaced from their natural habitat; (3) the salinity of the discharged waters would be different from the receiving waters and; (4) temperature and radioactive monitoring in the effluent area would be more difficult than for the present system.

The total evaluated cost was $90,500,000 in 1969. Assuming the total cost was distributed between the Forked River plant and the Oyster Creek plant, a charge of $40,500,000 was assigned to the Oyster Creek plant.

REFERENCES - SECTION 8.3

8.3-1 Proposed Construction by Jersey Central Power and Light Company of a Nuclear Fueled Electric Generating Plant at Oyster Creek, Lacey Township, Ocean County. Stipulation - DCED Docket No. 652-60 by State of New Jersey, Department of Public Utilites, Board of Public Utility Commissioners. February 14, 1966.

8.3-2 Safety Guides for Water Cooled Nuclear Generating Plants, December 1, 1970.

8.3-3 Meteorology Study of Ground Level Dispersion of Radioactive Gases for Oyster Creek Plant. Dames & Moore, January 1972.

8.3-4 Meteorology of Distribution and Concentration of Salt from Natural Draft Cooling Tower (Salt Water Makeup) for Oyster Creek Plant. Dames & Moore, January 1972.

8.4 ALTERNATE RADWASTE SYSTEMS

8.4.1 Air Ejector Off-Gas

The pathway to man evaluation in Section 5.2 indicates that external radiation exposure from gaseous emissions is the major source of exposure to an individual living near the plant and to the general population within 50 miles of the plant. JC is evaluating various plant modifications to provide additional gaseous radwaste treatment capability to be responsive in a timely manner to the requirements of 10 CFR 20 to maintain releases of radioactivity as low as practicable. Dose reduction will be achieved by providing longer holdup of the radioactive gases to permit more of the shorter half-life gases to decay prior to release. One of the alternatives discussed below will be selected for backfitting at the Oyster Creek plant. The method that is selected will be designed to achieve a level of dose reduction consistent with Appendix I of 10 CFR 50 when it is adopted.

8.4.1.1 Catalytic Recombination

Oxygen and hydrogen are produced in the reactor by radiolytic decomposition of water. This additional gas adds significantly to the volume of air ejector discharge. If this discharge is passed through a catalytic chamber, the hydrogen and oxygen are recombined to form water. By this process the total volume of gas is reduced. When this reduced volume of gas is passed through the holdup line, the decay time will be much longer than 60 minutes (at least five hours) and the resultant dose will be less. Based on the isotopic analysis of the gas from Oyster Creek reported in Table 3.6-4, a significant dose reduction will be achieved. Essentially all of the Xe-138 and Kr-87 will have decayed during this longer holdup time and most of the Kr-88. This will provide a dose reduction factor of at least ten from the level that can be achieved with the standard 60 minute holdup. The estimated approximate cost for installing this system is $1,000,000.

8.4.1.2 Charcoal Absorption

Thick beds of charcoal can be used to delay the passage of krypton and xenon. This is perhaps the simplest system other than the 60 minute holdup and requires a minimum of maintenance and operational supervision. Furthermore, the charcoal beds will remove essentially all of the radioiodine. The absorption coefficient of charcoal is much larger for xenon than for krypton so the xenon isotopes are retained longer. The shorter retention time for krypton is not a significant disadvantage since Kr-85, the only long half-life isotope of krypton present, contributes very little to the total dose. Almost all of the radioactivity in Table 3.6-4 will decay in the charcoal bed except for some of the Xe-133. The amount of Xe-133 remaining will depend on the exact design of the charcoal beds; however, the small contribution of Xe-133 to dose (Table 3.6-4) means that a dose reduction factor for this off-gas stream of at least 100 should be achieved. This system has the advantage of no moving parts, almost no maintenance or operating cost and proven performance in BWR's in Germany (Ref. 8.4-1). The estimated cost for installing this system is approximately $2,000,000.

Minimal additional operating cost is anticipated.

8.4.1.3 Catalytic Recombination Followed by Charcoal Absorption

By reducing the gas volume with catalytic recombination as discussed previously, a smaller charcoal bed can be used to achieve the same dose reduction factor. Theoretically, a larger dose reduction factor could be achieved by keeping the larger bed and adding catalytic recombination; however, dose reduction factors greater than 100 for gas from the air ejector achieves very little additional total dose reduction because other routes to the atmoshpere, e.g. drywell purging and turbine gland seal exhaust become increasingly important. The estimated cost for installing this system is approximately $3,500,000.

8.4.1.4 Reduced Temperature Charcoal Absorption

By cooling the charcoal bed below ambient temperatures, the krypton and xenon are retained for a longer period. This permits the use of a smaller charcoal bed for the same dose reduction factor. This technique can be used to achieve even higher dose reduction factors by cooling the larger size (deeper) charcoal beds; however, factors much larger than 100 are of diminishing value for the reasons given above. The estimated cost for installing this system is approximately $2,500,000.

8.4.1.5 Cryogenic Processes

In terms of total dose reduction capability, cryogenic methods are at least equal to the charcoal system but they are more expensive and difficult to maintain. They require a constant supply of liquid nitrogen and more attention by operating personnel. They may not have the inherent long-term reliability expected for fixed charcoal beds. The estimated cost for installing this system is approximately $4,000,000.

8.4.1.6 Permselective Membranes

Thin sheets of methylphenyl silicone rubber may be used to separate krypton and xenon from air. The krypton and xenon pass through these thin membranes more rapidly than does oxygen or nitrogen. To obtain the required degree of gas separation, multiple stages are necessary. Testing with single stages have demonstrated the technique but a fully engineered system has not been tested sufficiently to be considered for the Oyster Creek plant.

8.4.2 Turbine Gland Seal Leakage

The alternatives discussed above apply to the air ejector off-gas system which is the most important source of radioactive emissions to the atmosphere as the plant is now operating. As the dose contribution from this major source is reduced, exhaust from the turbine gland seal system becomes relatively more important. Radioactive emissions from the gland seal condenser can be reduced significantly by using a non-radioactive source of steam in the gland seal system. This modification is being considered in conjunction with one of the alternatives described above to eliminate a portion of the radioactive exhaust steam. The estimated cost for installing this system is approximately $205,000.

8.4.3 Liquid Radwaste Treatment

The liquid radwaste treatment system includes evaporation, ion exchange and filtration. The combination of these three processes is the best technology available. However, the effort to reduce radioactive discharges to the environment to as low as practicable has occasionally overloaded the existing system. Increased volume of waste water resulting from the plant outage in late 1971 caused plugging of the waste evaporator and subsequent depletion of the radwaste demineralizer and created a temporary water storage problem. To avoid this problem in the future, more spare parts are being acquired for the waste evaporator and consideration is being given to the installation of a second waste evaporator (Ref. 8.4-2). Modification of the liquid radwaste system is estimated to cost approximately $546,000.

REFERENCES - SECTION 8.4

8.4-1 Schroeder, H. J., et.al. Off-gas Facility at the Gundrenninger Nuclear Power Plant, Kern Technik, Vol. 13, No. 5. May 1971, p. 205-213.

8.4-2 Finfrock, I.R., Report by Jersey Central Power & Light Company to AEC, Atomic Energy Clearinghouse, Vol. 18, No. 2, page 20, January 10, 1972.

8.5 LONGER HOLDUP TIME FOR SPENT FUEL OR RADIOACTIVE EFFLUENTS

8.5.1 Longer Holdup Time for Spent Fuel

Fission and activation products in irradiated fuel elements will be allowed to decay in the spent fuel storage pool for a minimum of 90 days before shipment by rail to the Midwest Fuel Recovery Plant in Morris, Illinois. The main objective of the fuel storage program is to allow radioactive decay so that the shipment of these products will not result in excessive radiation exposure to individuals, or the population, en route between the Oyster Creek plant and the fuel processing facility. Based on the 90 day storage period it has been calculated that the levels of exposure to persons en route are acceptable.

8.5.2 Longer Holdup Time for Radioactive Effluent (Liquid)

Liquid wastes from the plant are transferred to the appropriate collection tanks in the radwaste building for treatment, with the primary objectives to reduce radioactive effluents to as low as practicable and to reclaim high purity water for use in the reactor. The wastes are processed by filtration, evaporation, and/or ion exchange. Since filtration, evaporation and ion exchange can reduce the concentration of fission products and corrosion products to levels that are as low as practicable, additional liquid holdup does not significantly reduce the radioactivity discharged.

8.5.3 Longer Holdup Time for Radioactive Effluent (Gas)

JC has decided to provide additional gaseous radwaste treatment capability primarily by providing longer holdup of the radioactive gases to permit more of the shorter half-life gases to decay prior to release. The various alternative methods of radioactive gas treatment is included in Section 8.4-1.

8.6 EFFECT OF ALTERNATE HEAT DISPOSAL METHODS ON LIQUID RADWASTE SYSTEMS

Oyster Creek Nuclear Generating Station is designed to use water from Barnegat Bay for cooling the condensers. This circulating water is isolated from the nuclear systems, so the only radioactivity entering the natural water body is the controlled discharge from the liquid radwaste system. The quantity of flow in the existing once-through circulating system is 460,000 gpm. This large flow which was required to remove excess heat, provides adequate dilution for the small releases of radioactivity. Considering the recirculation factor of 3.76, the normal plant flow of 460,000 gpm is equivalent to a dilution flow of about 120,000 gpm.

The cooling plant alternatives of natural draft cooling tower, and spray pond would both require a makeup flow of about 27,000 gpm and a blowdown of about 18,000 gpm. The blowdown rate of 18,000 gpm would be discharged into the Oyster Creek discharge canal and would be the minimum dilution flow for liquid radwaste and chemical discharge from the plant. The blowdown flow of 18,000 gpm is sufficient to minimize the need for treatment of chemical plant effluent and would not result in excessive levels of radioactivity.

The pathway to man for liquid radioactivity discharges from the plant would be through the seafood chain. This topic has been discussed in Section 5.2. The concentration levels of the various isotopes found in invertebrates in the area, and the MPC for these isotopes are listed in Table 5.2-3. Based on this table, it can be seen that even if the concentration levels of liquid radwaste were increased by a factor of ten, which is the estimated maximum increase that would occur with a discharge flow of 18,000 gpm, the resulting concentration of radioisotopes in the seafood would still be below MPC values by three to seven orders of magnitude. In the event that further dilution would be required the existing dilution pumps could be used to supply the required quantity of flow.

Direct external radiation exposure from activities such as swimming, boating, fishing, or water skiing in Barnegat Bay is expected to have a negligible effect on man. A comparison of direct exposure from activities in or near the water, with ingestion of fish or invertebrates has indicated that ingestion of invertebrates is the most limiting consideration.

9.0

SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The short-term uses on the area occupied by the Oyster Creek facility refer to economic significance and environmental effects during the estimated life of the plant (from 1969 to the year of decommissioning, approximately 2010). "Long-term productivity" related to creativity and utility of the local and more remote environment as it may be affected by the presence of the Oyster Creek plant. The Oyster Creek Station will satisfy current demands for power to maintain and enhance the standard of living in its service area. The generation of power should be compatible with other demands placed on the environment in order to maintain and enhance the "quality of life" available to each individual. To insure the "quality of life", power is needed to accomplish such environmental improvement projects as solid waste treatment plants, sewage plants, air purification equipment and mass transportation - also the social objectives of improving the quality of life for all by making available labor saving devices and other comforts and amenities to as large a population group as possible.

The causes of possible adverse environmental effects resulting from operation of the nuclear facility primarily include radiation, sewage and chemical waste disposal, discharge of heated cooling water into Barnegat Bay, aesthetics, salt water intrusion into aquifers via the intake and discharge canals and utilization of land and coastal estuaries.

The addition of heated cooling water has had a discernable but minor effect on organisms during the two years of operation. The effects of heated cooling water on biological systems in estuaries may be accumulative with other man-made and/or natural alterations of the environment.

Heated water from the Oyster Creek facility will be discharged for the life of the plant. The canal may be utilized for additional future facilities, so that the period of heated water discharge into Barnegat Bay and adjacent estuaries may be indeterminate. The effect of additional heated water on Barnegat Bay's ability to maintain a diverse fauna and flora is still uncertain. An annual accumulation of warm water or a rise in seasonal water temperatures from operation of the Oyster Creek facility is not expected to produce any significant deleterious effect.

Approximately five acres of land were removed from biological productivity when the plant and supporting facilities such as the parking lot were constructed. The remaining 1,411 acres has been designated for recreation and long-term economic productivity. Approximately 670 acres are available for wildlife, such as migratory waterfowl. The remainder of the property (755 acres) includes the present facility and an area to be utilized for future power generation facilities. Most of this latter property will also be available to wildlife.

The land under the buildings will remain economically unproductive for several years following plant decommissioning. However, if the plant were removed and the canal closed in, it is anticipated that the soil in the immediate area would return to its natural state within ten years. The soil would probably have a slight accumulation of salinity, but fresh water from the South Branch of Forked River and Oyster Creek, together with precipitation, would quickly remove it because the soils are sandy and, consequently, amenable to water percolation and leaching.

The construction and operation of the Oyster Creek facility has altered portions of the environment in order to facilitate economic and social long-term productivity. However, this alteration has been small in relation to the benefit that is derived from the production of power. All of the alterations are reversible and within ten years after the plant is decommissioned and the debris removed, the land and water would return to its natural state if this is the intended use of the land at the time of decommissioning.

Detrimental environmental effects will largely be localized during the short-term period. Beneficial environmental effects such as the social and economic advancement realized from the generation of power are not localized.

10.0

RESOURCES COMMITTED IN PLANT CONSTRUCTION AND OPERATION

Construction and operation of the Oyster Creek Nuclear Generating Station has involved the commitment and use of certain natural resources. The commitment of these resources will not curtail the range of beneficial uses of the environment. The resources have been divided into three categories: human, mineral and environmental.

Human resources involve the time and effort required to design, build, and operate the plant. This resource is irretrievable even if operation of the plant were discontinued. Experience gained in designing, building, and operating the plant, however, can be considered a retrievable resource. It would be difficult to demonstrate that any alternative method of producing power would directly involve significantly less human resource than a nuclear generating station. To develop more efficient methods of nuclear power generation would involve substantial time and effort, but would eventually lead to even lower rates of resource use per unit of power consumed. Further consumption of human resources would be minimized with the continued operation of the present facility. Construction of an alternative method of power generation would involve further and even duplicate commitments of time and effort.

The use of fuel resources, namely uranium-235, for power production is an example of mineral commitment. The use of this natural resource can be compared to the use of fossil fuels. Even though known reserves of nuclear fuel are not significantly greater than known fossil fuel reserves, it is apparent that as nuclear technology develops in the area of "breeder" reactors, real reserves will increase. Consequently, there should not be a shortage of nuclear fuel for some time to come. Under the premise that power must be produced, commitment of nuclear fuel resources to the production of power at the Oyster Creek Nuclear Generating Station can be considered a positive commitment and one which is favorable in the long-term.

Only the various forms of hydroelectric power, the harnessing of solar energy, or the development of other energy converters such as fuel cells, are more advantageous than nuclear plants in regard to fuel resource commitment. The production of power by hydroelectric means also presents certain environmental problems. The hydroelectric power sites in the area served by the Oyster Creek facility are very limited and the use of the other energy converters mentioned above has not yet been proven feasible.

Other mineral commitments include the fuel consumed by the package boiler (No. 2 fuel oil) to produce auxiliary service steam for start up and service heating. Diesel fuel is also consumed by emergency diesel generators. These two fuel commitments are not necessarily irretrievable but in any event are of insignificant quantity.

The commitment of construction materials has already been made. Only if the plant were abandoned at this time and a completely different alternative adopted, would additional resources of this kind be required.

Most of the structural material required for the facility is irreversibly committed. The concrete and structural steel would be only partially salvageable upon dismantling the plant. A large commitment of material has been made for support equipment necessary for operating the plant and transmitting electricity. Most of this equipment will be partially salvageable after it has outlived its useful life. These quantities, however, are insignificant in terms of the overall supply of raw materials.

Chemicals, such as lime, resinous demineralizers, chlorine, filter aids and assorted quantities of housekeeping materials needed for operating the plant will continue to be committed for as long as the plant is in operation.

During the life of the plant, the land occupied by the Station and its structures cannot be used for other purposes. When the plant is decommissioned, however, the range of land uses will not be curtailed because the quality of land, air, and water will not have been affected by the operation of the plant.

The use of the environment does not represent a significant irreversible or irretrievable commitment of resources but rather a relatively short-term investment. Hence, a very small amount of resources will be required to provide a substantial quantity of electricity.

11.0

COST AND BENEFITS OF PLANT AND ALTERNATIVES

In this section, data are presented for benefit-cost analysis according to guidelines issued May 1972 to meet the requirements of the Atomic Energy Commission's revised regulations (10CFR50, Appendix D),

The data have been quantified wherever possible and have been utilized to define an environmentally optimum system and to establish a basis for justification of the system proposed for licensing. This proposed system consists of the existing plant as augmented by two radwaste subsystems: a.) a charcoal holdup system with catalytic recombination and b.) a redundant liquid waste evaporator.

11.1 BENEFITS

The benefits from Oyster Creek power station are summarized in Table 11.1-1. The base year for the study is 1970, the first year of continuous production.

11.1.1 Direct Benefits

The Oyster Creek power station has a levelized, installed annual capacity of 620 megawatts. The station is operated as part of the base load and a load factor of 80 percent is used to determine output. On the basis of an 80 percent load factor, the power output of 4,344,960 megawatt hours is delivered to the four classes of consumers as per the 1970 distribution for Jersey Central as follows:

Residential	39.6 percent
Industrial	31.7 percent
Commercial	25.1 percent
Other	3.6 percent

11.1.1.1 Electric Power Consumption in Jersey Central Service Area

Jersey Central sold 5,855,800,000 kwh's of electric power to its customers in 1970. The Oyster Creek plant can produce 4,344,960,000 kwh's annually. Thus, on the basis of 1970 statistics, Oyster Creek can produce the equivalent of 74.2 percent of the demand requirements of the Jersey Central system. This percentage has been used to estimate the benefits accruing from the Oyster Creek plant.

Residential Consumption

In 1970 Jersey Central sold 2,318,452,000 kwh's of electric power to 363,676 residential customers (Refer to Table 11.1-2). In New Jersey there are on an average 3.17 persons per household (Ref. 11.1-1). Jersey Central meets the residential electric power requirements of 1,152,853 people. In 1970 production from Oyster Creek supplied 855,417 people.

Industrial Consumption

At year end 1970, Jersey Central served 1,700 industrial customers throughout the service area who consumed 1,858,229,000 kwh's of electrical power (Refer to Table 11.1-3). These industrial customers employed 75,870 workers and provided annual payrolls of $716,609,200. In addition, these customers produced a value added to the economy of $1.744 billion.

TABLE 11.1-1

BENEFITS FROM OYSTER CREEK STATION

Direct Benefits	
Expected Average Annual Generation in Kilowatt Hours	4,344,960,000
Capacity in Kilowatts	620,000
Proportional Distribution of Electrical Energy - Expected Annual Delivery in Kilowatt Hours (based upon 1970 data)	KW Hours
Industrial	1,377,352,320
Commercial	1,090,584,960
Residential	1,720,604,160
Other	156,418,560
Expected Average Annual Btu (in millions) of Steam Sold from the Facility	-0-
Expected Average Annual Delivery of Other Beneficial Products (appropriate physical units)	-0-
Revenues from Delivered Benefits (Annual)	
Electrical Energy Generated $	90,279,579
Steam Sold	-0-
Other Products	-0-
Indirect Benefits (as appropriate)	
Taxes (Local, State, Federal) $	13,638,476
Research — During Construction $	414,000
Research — Annual $	27,000
Regional Product $	5,053,511,000
Environmental Enhancement	
Recreation	6.3 man-yrs.
Navigation	-0-
Air Quality (emissions spared the environment):	
SO_2	83,478.9 Tons/Yr.
NO_x	25,038.4 Tons/Yr.
Particulates	990.5 Tons/Yr.
Employment $	2,700,000
Education	785 People/Yr.

TABLE 11.1-2

HOUSEHOLDS IN JERSEY CENTRAL SERVICE AREA

(Jersey Central Divisions - Bay, Coast, Southern and Central)

No.	County	Number of Households in County (1)	Households in Jersey Central Service Area (2)	Population of County in Jersey Central Service Area (percentage)
1	Burlington	84,788	8,749	10
2	Essex	303,000	31,815	10.5
3	Mercer	93,486	9,345	10
4	Middlesex	168,076	53,784	32
5	Monmouth	135,230	135,230	100
6	Morris	109,823	32,957	30
7	Ocean	68,362	51,474	75
8	Passaic	147,214	20,610	14
9	Somerset	57,013	11,403	20
10	Union	171,580	8,579	05

Total Households in Service Area 363,676

(1) United States Bureau of Census - General Population Characteristics - N.J. PC (1) - B 32.

(2) GPU Service Corporation - 1970 Statistics

TABLE 11.1-3

INDUSTRIAL CONSUMPTION - 1970

Jersey Central Power & Light Company (1)

SIC (2)	Name	1970 percentage of Total Ind. Consumption	1970 Kwh x 10^3
20	Food & Kindred Products	5.3	98,487
26	Paper & Allied Products	9.4	174,674
27	Printing & Publishing	1.9	35,306
28	Chemical & Allied Products	16.3	302,891
29	Petroleum Refining & Related Products	2.5	46,456
30	Rubber & Miscellaneous Products	5.9	109,636
32	Stone, Clay & Glass Products	5.2	96,627
33	Primary Metal Industries	2.6	48,314
34	Fabricated Metal Products	2.3	42,739
35	Non-electrical Machinery	2.7	50,172
36	Electrical Machinery & Equipment	15.7	291,742
38	Instruments & Related Products	4.1	76,187
39	Other (Miscellaneous)	6.9	128,218
X	Military Establishment	11.8	219,271
X	Municipal Water & Sanitation	7.4	137,509
	Total Industrial Consumption	100.0	1,858,229

(1) GPU Service Corporation - 1970 Statistics

(2) Standard Industrial Classification Number

Commercial Consumption

The needs of the people residing in the Jersey Central service area in 1970 were served by 39,616 commercial firms which employed 178,678 workers and consumed 1,469,035,000 kwh's of electrical power energy. The annual payroll for the 178,698 employees amounted to $989,648,000.

Revenues from Delivered Benefits

Annual revenue derived from the electric power delivered is determined for each category of user above, using the 1970 rates as follows:

	¢/kwh
Industrial	1.22
Commercial	2.38
Residential	2.56
Other	2.22

Total revenue for 1970 was $90,279,578.88.

11.1.2 Indirect Benefits

11.1.2.1 Taxes

Taxes are levied against Oyster Creek plant operations at three governmental levels, local, state and federal, and are estimated herein on the basis of 1970 tax rates. Real estate taxes at the local level for land and buildings were paid in 1970 at the rate of 1.94 mils per thousand dollars of assessed evaluation. Taxes paid in 1970 to Lacey and Ocean Townships totaled $42,429.

Taxes were paid to the State of New Jersey in three tax categories. A gross receipts tax of 7.5% was levied against taxable sales revenues of $88,709,437 to yield an estimated $6,653,208. A franchise tax applicable to transmission lines located on public highways amounted to 5% of taxable sales revenue; this levy was pro-rated to apply to the 70.2039% of the lines that are situated on New Jersey lands, yielded an estimated $3,113,874. A surtax was levied at the rate of 12.5% of the combined gross receipts tax and franchise tax to yield an estimated $1,220,885. Taxes due the state thus totaled an estimated $10,987,967.

Income taxes are paid to the federal government at an estimated average annual rate of $2,609,080 over the operating life of the plant.

On the basis of these 1970 figures, the annual taxes for the operation of Oyster Creek are summarized as follows:

Local Real Estate - Lacey & Ocean Townships		$ 42,429
State of New Jersey		
Gross receipts tax	$ 6,653,208	
Franchise tax	3,113,874	
Surtax	1,220,885	
Subtotal	$ 10,987,967	10,987,967
Federal Income Tax (projected annual)		2,609,080
Total Tax		$13,638,476

11.1.2.2 Research

Dating from the inception of planning for Oyster Creek in the early

1960's through the present, a sizeable and continuing effort has been expended on basic research leading to the improvement of the plant environment. Although funding for such research was relatively more intensive during the planning, engineering and construction phases, the program remains as a continuing effort. Past and continuing expenditures are tabulated as follows:

EXPENDITURES FOR RESEARCH

	During Construction	Annual Operation
Hydrology, Geology, Seismology	30,000	--
Barnegat Bay Studies	104,000	--
Meteorology	187,000	7,000
Environmental Radiation Surveys	77,000	20,000
Miscellaneous Studies	16,000	--
Total Initial Research Expenditures	$ 414,000	

Continuing Research Expenditure $ 27,000 per annum

11.1.2.3 Regional Product

With respect to determining regional product, it is assumed that the region of interest is coterminous with the Jersey Central service area (see Fig. 1.3-1) as pro-rated for the percentage production from Oyster Creek.

Gross regional product was determined relative to disposable income for the households in the service area, (Refer to Table 11.1-4 Regional Product). A multiplier of 2.725 based on a marginal propensity to consume (mpc) of 0.633 (Ref. 11.1-1) was used to determine the magnitude of the impact of the Oyster Creek plant investment. The multiplier is defined as $\frac{1}{1\text{-mpc}}$ where mpc is the ratio of average annual change in personal consumption expenditures to the average annual change in gross national product of the United States for the period 1965 through 1971. Consideration is also given to the effect on the level of regional product of: a) the annual operating payrolls at the Oyster Creek Station in the amount of $1.4 million per year for 100 employees and b) an annual expenditure for additional outside consulting, engineering, and operational services, directly related with the operation and maintenance of the plant in the amount of $1.3 million.

The computation to obtain Regional Product is:

(From Table 11.1-4)

Disposable Income for service area: $4,427,298,000

Disposable Income attributable to Oyster Creek =

($4,427,298,000)x(0.742) = $3,285,055,000

Gross Regional Product attributable to Oyster Creek is

($ 3,285,055,000) ÷ (0.651) = $ 5,046,167,000

where: .651 is the ratio of disposable income to Gross National Product for the United States for 1970 (Ref. 11.1-1)

add: Annual Payroll-Oyster Creek Plant

100 employees:	$ 1,400,000
Annual expense for outside services performed at plant	1,300,000
Total Annual Expenditure	$ 2,700,000

Multiplier is: $\frac{1}{1\text{-mpc}} = \frac{1}{1-.633} = 2.725$

Increase in Gross Regional Product from new annual expenditures =

$2,700,000 (2.725) = $ 7,344,000

New Level of Gross Regional Product = $ 5,053,511,000

No attendant decrease in product outside of the region can be perceived as a result of production at Oyster Creek.

In addition to the permanent increase in regional product as described above, a temporary increase in regional product is obtained through the introduction of the plant investment in the amount which was spent within the region. This benefit is thus noted, but is not included in the annual benefits.

($89,883,000) x (2.725) = $244,931,000

Through this investment, therefore, an increase of $244,931,000 is induced in the economy as a whole.

TABLE 11.1-4

REGIONAL PRODUCT

Region: Jersey Central Service Area

No.	County	Households in Jersey Central Service Area (1)	Disposable Income per Household (2)	Disposable Income in $1000
1	Burlington	8,479	$ 11,949	101,316
2	Essex	31,815	14,088	448,210
3	Mercer	9,345	12,380	115,691
4	Middlesex	53,784	12,075	649,442
5	Monmouth	135,236	12,003	1,623,166
6	Morris	32,957	15,458	509,449
7	Ocean	51,474	9,030	464,810
8	Passaic	20,616	11,242	231,698
9	Somerset	11,403	13,478	153,690
10	Union	8,579	15,133	129,826
		Disposable Income for Service Area		$4,427,298

Net Income Attributable to Oyster Creek Station
= $4,427,298 x 74.2 percent = $3,285,055

(1) Number of Households in Jersey Central Service Area by County - See Table 11.1-2

(2) Disposable Income per Household (1970)
Source: 1971 Survey of Buying Power, July 10, 1971, Vol. 107, No. 2
Sales Management, Inc., New York

11.1.2.4 Environmental Enhancement

Some environmental qualities have been enhanced as a result of placement of the plant at the Oyster Creek site. Among these are increased opportunity for recreation through sport fishing and increased safety of navigation for local boaters. A clear benefit is the substitution of a new and cleaner generating plant in place of fossil plants which might have emitted considerably higher levels of gasses and particulates into the atmosphere.

Recreation

With the placement of bridges over the Forked River and Oyster Creek segments of the canal along U.S. Highway 9, and the discharge of large quantities of heated water from the plant, the Oyster Creek and Forked River Bridges have become focal points for local fishermen. The catch is high and during the mild seasons the number of sportsmen using the stream banks and bridge at any time of day will range from 25 to 30 on weekdays to 70 to 105 on weekends and holidays.

It is estimated that recreational enjoyment is increased in the amount of 6.3 man-years annually.

In addition to the enhanced fishing, the excavation of the Oyster Creek Canal has provided new waterways for use by recreational boaters.

Navigation

Deepening and widening of portions of the south branch of Forked River and the Oyster Creek have improved the quality of navigation for boaters along these stretches of water. A count of boats moored in marinas and piers in 1963 revealed the presence of 437 craft. A comparable count was made for the same area in 1971. The latter count, made after the plant was constructed and the rivers dredged, showed the presence of 707 craft, an increase of 270 boats. Warm water from Oyster Creek's discharge has been found to help minimize icing conditions in the adjacent marina areas.

Air Quality

The installation of Oyster Creek Nuclear Station supplants power generation by fossil fuels and substitutes for alternative fossil fuel-fired generating capacity. In this manner, indirect benefits are derived from the elimination of practically all gas emissions. Only a few emissions are generated by the package boiler used to produce auxiliary service steam. A comparison of emissions from Oyster Creek with those from an equivalent coal-fired plant is made as follows:

	Tons of Noxious Gases Emitted Per Year		
	Coal fired plant	Oyster Creek	Reduction
SO_2	83,478.9	9.4	83,469.5
NO_x	25,038.4	38.0	25,000.4
Particulates	990.5	0.2	990.3

The true benefit of these reduced emissions lies in the improved health of the population. Additional benefits are derived from the reduction of corrosive attack by gases upon paints and other finishes on buildings and structures and upon exposed metal surfaces.

Employment

The plant has a permanent operating staff averaging 100 people receiving an annual payroll of $1.4 million. As the average household in New Jersey contains 3.17 people, this disbursement provides the basic life support for an estimated 317 people. Another $1.3 million is paid each year for wages and services to outside consultants, technicians, and service people for performance of work at the plant site. Thus, the annual expenditures for salaries and wages at the Oyster Creek Station total $2.7 million dollars.

Many other people earn their livelihood as a result of the existence of the Oyster Creek Station. They include the corporate staff of Jersey Central who are either assigned directly to Oyster Creek or support the operation as required. They represent a broad spectrum of skills such as corporate officers, engineers, technicians, custodial and maintenance workers. Credit will not be considered herein for these benefits.

Education

A high proportion of the operating staff is technical personnel. Many are trained for specialty skills at plant expense. Such training continues and represents a substantial expenditure of time and monies. At least $1,369,312 have been spent for such education and training.

About 285 guests visit the plant each year. Many are from foreign countries. The large majority are scientists and engineers who desire to increase their knowledge of nuclear power plant operation.

Plant personnel frequently give lectures on nuclear energy to various civic and social groups in nearby communities. Approximately 25 such lectures are given each year. Average attendance is about 20 people per lecture. It is estimated that the total of visitor-and-lecture people hours total 3,280 hours per year or 0.4 man-year per year.

REFERENCES - SECTION 11.1

11.1-1 U. S. Bureau of the Census, Statistical Abstract of the United States, 92nd Edition, Washington, D. C., 1971

11.2 EVALUATION OF ALTERNATIVE PLANT DESIGNS

This portion of the report presents a discussion of the three plant configurations along with alternative cooling and radwaste systems evaluated in the benefit-cost analysis of Oyster Creek nuclear power station.

The three alternative plant configurations are:

A) existing plant;

B) plant with minimal environmental impact; and

C) plant under license application.

The alternative cooling systems as referred to in Section 8.3 are:

1) existing cooling - once through;

2) natural draft cooling tower - salt water makeup;

3) spray pond - salt water makeup; and

4) ocean discharge system.

The alternative radwaste systems as referred to in Section 8.4 are:

a) existing radwaste system;

b) catalytic recombination with charcoal absorption;

c) additional liquid waste evaporator; and

d) the existing system plus a combination of (b) and (c).

The environmental effects of alternative system installation and operation are examined in light of the AEC Benefit-Cost guidelines and are summarized in Table 11.2-1. A discussion along with methods of computation and analysis for each feature of the environment affected, as outlined in Table 11.2-1, is presented in Sections 11.2.2.1 through 11.2.2.4. These may be correlated with Table 11.2-1 by an item number identification.

11.2.1 Alternative Designs

Alternative A is the plant as constructed and currently operated (Refer to Section 3.0). All plant emissions meet governmental standards. Current operational procedures not only maintain the emissions of radionuclides far below the levels required by existing 10CFR20 regulations, but also consistently meet the low levels proposed within the 10CFR50 guidelines.

Alternative B is the plant design which results in the overall minimal environmental cost by incorporating those cooling and radwaste subsystems having the least environmental effect.

Alternative C, the proposed plant configuration, is the existing plant with the addition of radwaste system Alternative d. This is submitted by Jersey Central as being the optimum combination to achieve the goals of Appendix I while offering a realistic balance between environmental benefits and economic cost.

11.2.2 Generating Cost

The generating cost in terms of present worth and annualized expense, lost plant capacity, and as incremental environmental effects are summarized in Table 11.2-2.

TABLE 11.2-1

EVALUATION OF PLANT DESIGN - SUMMARY

ALTERNATIVES		A: Plant As Is (Base Design)	B: Plant With Minimal Environmental Impact	C: Proposed Plant Operating License Request
		ALTERNATIVE PLANT DESIGN		
IDENTIFICATION OF SUBSYSTEMS			(Spray Pond)	
Alternative Cooling Systems (I)		1	3	1
Alternative Rad Waste System (II)		a	d	d
Alternative Chemical Effluent Systems (III)		-	-	-
Alternative System (specify) (IV)		-	-	-
GENERATING COST: Present Worth		$ 168,202,199	$ 199,035,545	$ 172,807,215
GENERATING COST: Annualized		17,842,763	21,113,542	18,331,259
LOST CAPACITY (KWe)		3,000	19,250	3,000
INCREMENTAL ENVIRONMENTAL EFFECTS (Primary Impact; Population or Resource Affected)	Units			
1. Natural Surface Water Body; 1.1 Cooling Water Intake Structure; 1.1.1 Fish	Lost Pounds of Fish/Yr.	16,047	1,652	16,047
1.2 Passage Through the Condenser and Retention in Closed Cycle Cooling Systems; 1.2.1 Primary Producers and Consumers	Lost Pounds of Fish/Yr.	1,485	550	1,485
1.2.2 Fish	Lost Pounds of Fish/Yr.	3,707 - 37,071	1,969 - 19,697	3,707 - 37,071
1.3 Discharge Area and Thermal Plume; 1.3.1 Water Quality, *Physical*	BTU/Hr.	4.62×10^9	2.5×10^8	4.62×10^9
	Area Affect. Acres +2°	730	Less than A or C	730
	Area Affect. Acres +3°	576		576
	Area Affect. Acres +5°	442		442
1.3.2 Oxygen Availability	Acre Feet	0	Data Not Available	0

TABLE 11.2-1 (continued)

			ALTERNATIVE PLANT DESIGN		
		UNITS	A	B	C
		Acreage Lost/Day	42	Less than A or C	42
	1.3.3 Aquatic Biota	Pounds of Fish/Shutdown	16,666	Less than A or C	16,666
	1.3.4 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	Acres	Negligible	Negligible	Negligible
	1.3.5 Fish, Migration	Migration Influence	Minor local Influence	Less than A or C	Minor local Influence
1.4 Chemical Effluents	1.4.1 Water Quality, Chemical		Insufficient Data -- Unable to Calculate		
	1.4.2 Aquatic Biota	Fish lbs/Yr	Negligible	Negligible	Negligible
	1.4.3 Wildlife (including birds aquatic and amphibious mammals, and reptiles)	Acres	None	None	None
	1.4.4 People	Lost Ann. User Days	None	None	None
1.5 Radionuclides Discharged to Water Body	1.5.1 Aquatic Organisms	Rem/Yr.	0.14	0.07	<0.01
	1.5.2 People, External	Rem/Yr.	Negligible	Negligible	Negligible
		Man-Rem/Yr.	Negligible	Negligible	Negligible
	1.5.3 People, Ingestion	Rem/Yr.	0.0001	0.007	0.0001
		Man-Rem/Yr.	Negligible	Negligible	Negligible
1.6 Consumptive Use (evaporative losses)	1.6.1 People	Gallons/Yr.	None	None	None
	1.6.2 Property	Acre Feet/Yr.	None	None	None
1.7 Other Impacts					
1.8 Combined or Interactive Effects					

TABLE 11.2-1 (continued)

		UNITS	ALTERNATIVE PLANT DESIGN A	B	C
2. Groundwater					
2.1 Raising/Lowering of Groundwater Levels	2.1.1 People	Gallons/Yr.	Negligible	Negligible	Negligible
	2.1.2 Plants	Acres	Negligible	Negligible	Negligible
2.2 Chemical Contamination of Groundwater	2.2.1 People	Gallons/Yr.	None	None	None
	2.2.2 Plants	Acres	None	None	None
2.3 Radionuclide Contamination of Groundwater	2.3.1 People	Rem/Yr.	Negligible	Negligible	Negligible
		Man Rem/Yr.	Negligible	Negligible	Negligible
	2.3.2 Plants and Animals	Rem/Yr.	Negligible	Negligible	Negligible
2.4 Other Impacts on Groundwater					
3. Air					
3.1 Fogging and Icing (caused by evaporation and drift)	3.1.1 Ground Transportation	Hrs./Yr.	None	1 to 4	None
	3.1.2 Air Transportation	Hrs./Yr.	None	None	None
	3.1.3 Water Transportation	Hrs./Yr.	None	None	None
	3.1.4 Plants	Acres/Crop	None	None	None
3.2 Chemical Discharge to Ambient Air	3.2.1 Air Quality, Chemical SO_2	% of Standard	13.8	27.6	27.6
		Tons/Yr.	9.348	18.696	18.696
	NO_x	% of Standard	None	None	None
		Tons/Yr.	37.99	75.98	75.98
	Particulates	% of Standard	.068	.136	.136
		Lbs./Yr.	476	952	952
	3.2.2 Air Quality, Odor	Statement	None	None	None
3.3 Radionuclides Discharged to Ambient Air	3.3.1 People, External	Rem/Yr.	0.0046	0.0005	<0.00005
		Man-Rem/Yr.	74	0.74	0.74
	3.3.2 People, Ingestion	Rem/Yr.	0.00015	<0.0000015	<0.0000015
		Man-Rem/Yr.	Negligible	Negligible	Negligible
	3.3.3 Plants and Animals	Rem/Yr.	0.01	<0.0001	<0.0001
3.4 Other Impacts on Air					

TABLE 11.2-1 (continued)

		UNITS	ALTERNATIVE PLANT DESIGN A	B	C
4. Land					
4.1 Pre-emption of Land	4.1.1 Land, Amount	Acres	None	None	None
4.2 Plant Construction and Operation	4.2.1 People (amenities)	See Text	None	None	None
	4.2.2 People (aesthetics)	Qualified Opinion	Moderate	Moderate	Moderate
	4.2.3 Wildlife	Qualified Opinion	Negligible	Negligible	Negligible
	4.2.4 Land, Flood Control	n.a.	No Implications		
4.3 Salts Discharged from Cooling Towers	4.3.1 People	$Lbs/Ft^2/Yr.$	n.a.	Average of 0.49	n.a.
	4.3.2 Plants and Animals	Acres	n.a.	Negligible	n.a.
	4.3.3 Property Resources	Dollars/Yr.	n.a.	Negligible	n.a.
4.4 Other Land Impacts					
4.5 Combined or Interactive Effects					

n.a. means not applicable

TABLE 11.2-1 (continued)

ALTERNATIVES			ALTERNATIVE COOLING SYSTEMS 1 Once through Existing System	2 Natural Draft Cooling Tower	3 Spray Pond	4 Ocean Discharge
INCREMENTAL GENERATING COST	Present Worth		3,902,459	16,912,285	26,228,330	41,828,292
	Annualized		413,970	1,794,042	2,782,282	4,437,114
LOST CAPACITY (KWe)			3,000	7,000	16,250	3,075
INCREMENTAL ENVIRONMENTAL EFFECTS		UNITS				
Primary Impact	Population or Resource Affected					
1. Natural Surface Water Body						
1.1 Cooling Water Intake Structure	1.1.1 Fish	Lost Pounds of Fish/Yr.	16,047	1,652	1,652	16,047
1.2 Passage Thru the Condenser and Retention in Closed Cycle Cooling Systems	1.2.1 Primary Producers and Consumers	Lost Pounds of Fish/Yr.	1,485	550	550	1,485-5,800
	1.2.2 Fish	Lost Pounds of Fish/Yr.	3,707-37,071	1,969-19,697	1,969-19,697	3,707-37,071
1.3 Discharge Area and Thermal Plume		Btu/Hr.	4.62×10^9	2.5×10^8	2.5×10^8	4.62×10^9
	1.3.1 Water Quality, Physical	Areas Affected Acres +2°	730	Less than 1 or 4	Less than 1 or 4	730
		+3°	576			576
		+5°	442			442
	1.3.2 Oxygen Availability	Acre Feet	0	Data Not Available	Data Not Available	0
	1.3.3 Aquatic Biota	Acreage Lost/Day	42	Less than 1 or 4	Less than 1 or 4	42
		Lbs. of Fish/Shutdown	16,666	Less than 1 or 4	Less than 1 or 4	16,666
	1.3.4 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	Acres	Negligible	Negligible	Negligible	Negligible

TABLE 11.2-1 (continued)

		UNITS	ALTERNATIVE COOLING SYSTEM 1	2	3	4
	1.3.5 Fish, Migration	Migration Influence	Minor Local Influence	Less Than 1 or 4	Less Than 1 or 4	Minor Local Influence
1.4 Chemical Effluents	1.4.1 Water Quality, Chemical		Insufficient Data -- Unable to Calculate			
	1.4.2 Aquatic Biota	Fish lbs/Yr.	Negligible	Negligible	Negligible	Negligible
	1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	Acres	None	None	None	None
	1.4.4 People	Lost Ann. User Days	None	None	None	None
1.5 Radionuclides Discharged to Water Body	1.5.1 Aquatic Organisms	Rem/Yr.	0.14	0.98	0.98	<0.01
	1.5.2 People, External	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
		Man-Rem/Yr.	Negligible	Negligible	Negligible	Negligible
	1.5.3 People, Ingestion	Rem/Yr.	0.0001	0.0007	0.0007	0.0001
		Man-Rem/Yr.	Negligible	Negligible	Negligible	Negligible
1.6 Consumptive Use (evaporative losses)	1.6.1 People	Gallons/Yr.	None	None	None	None
	1.6.2 Property	Acre Feet/Yr.	None	None	None	None
1.7 Other Impacts						
1.8 Combined or Interactive Effects						
2. Groundwater 2.1 Raising/Lowering of Groundwater Levels	2.1.1 People	Gallons/Yr.	Negligible	Negligible	Negligible	Neg.igible
	2.1.2 Plants	Acres	Negligible	Negligible	Negligible	Negligible

TABLE 11.2-1 (continued)

		Units	ALTERNATIVE COOLING SYSTEMS 1	2	3	4
2.2 Chemical Contamination of Groundwater (excluding salt)	2.2.1 People	Gallons/Yr.	None	None	None	None
	2.2.2 Plants	Acres	None	None	None	None
2.3 Radionuclide Contamination of Groundwater	2.3.1 People	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
		Man Rem/Yr.	Negligible	Negligible	Negligible	Negligible
	2.3.2 Plants and Animals	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
2.4 Other Impacts on Groundwater						
3. Air 3.1 Fogging and Icing (caused by evaporation and drift)	3.1.1 Ground Transportation	Hrs./Yr.	None	None	1 to 4	None
	3.1.2 Air Transportation	Hrs./Yr.	None	None	None	None
	3.1.3 Water Transportation	Hrs./Yr.	None	None	None	None
	3.1.4 Plants	Acres/Crop	None	None	None	None
3.2 Chemical Discharge to Ambient Air	3.2.1 Air Quality, Chemical	% of Standard Tons/Yr. % of Standard Tons/Yr. % of Standard Pounds/Yr.	n.a.	n.a.	n.a.	n.a.
	3.2.2 Air Quality, Odor	Statement	None	None	None	None
3.3 Radionuclides Discharged to Ambient Air	3.3.1 People, External	Rem/Yr.	0.0046	0.23	0.0046	0.0046
		Man Rem/Yr.	74	3,700	74	74
	3.3.2 People, Ingestion	Rem/Yr.	0.00015	0.075	0.00015	0.00015
		Man Rem/Yr.	Negligible	Negligible	Negligible	Negligible
	3.3.3 Plants and Animals	Rem/Yr.	0.01	0.5	0.01	0.01
3.4 Other Impacts on Air						

n.a. means not applicable.

TABLE 11.2-1 (continued)

		UNITS	ALTERNATIVE COOLING SYSTEMS 1	2	3	4
4. Land						
4.1 Pre-emption of Land	4.1.1 Land, Amount	Acres	None	None	None	0.1
4.2 Plant Construction and Operation	4.2.1 People (amenities)	See Text	None	None	None	None
	4.2.2 People (aesthetics)	Qualified Opinion	None	Considerable	Negligible	Negligible
	4.2.3 Wildlife	Qualified Opinion	Negligible	Negligible	Negligible	Negligible
	4.2.4 Land, Flood Control	n.a.	No Implications			
4.3 Salts Discharged from Cooling Towers	4.3.1 People	Lbs/Ft^2/Yr.	n.a.	Maximum of 4.65×10^{-5}	Average of 0.49	n.a.
	4.3.2 Plants and Animals	Acres	n.a.	Negligible	Negligible	n.a.
	4.3.3 Property Resources	Dollars/Yr.	n.a.	Negligible	Negligible	n.a.
4.4 Other Land Impacts						
4.5 Combined or Interactive Effects						

n.a. means not applicable

TABLE 11.2-1 (continued)

ALTERNATIVES			ALTERNATIVE RADWASTE SYSTEMS a: Existing System	b: Catalytic Recom. & Charcoal Absor.	c: Additional Water Evaporator	d: Existing System to Systems b & c
INCREMENTAL GENERATING COST	Present Worth		4,014,613	4,032,620	572,395	4,605,016
	Annualized		428,720	427,777	60,719	488,497
LOST CAPACITY (KWe)			0	0	0	0
INCREMENTAL ENVIRONMENTAL EFFECTS		UNITS				
Primary Impact	Population or Resource Affected					
1. Natural Surface Water Body						
1.1 Cooling Water Intake Structure	1.1.1 Fish	Lost Pounds of Fish/Yr.	n.a.	n.a.	n.a.	n.a.
1.2 Passage Through the Condenser and Retention in Closed Cycle Cooling Systems	1.2.1 Primary Producers and Consumers	Lost Pounds of Fish/Yr.	n.a.	n.a.	n.a.	n.a.
	1.2.2 Fish	Lost Pounds of Fish/Yr.	n.a.	n.a.	n.a.	n.a.
1.3 Discharge Area and Thermal Plume	1.3.1 Water Quality, Physical	Btu/Hr.	n.a.	n.a.	n.a.	n.a.
		Areas Affected Acres +2° +3° +5°	n.a.	n.a.	n.a.	n.a.
	1.3.2 Oxygen Availability	Acre Feet	n.a.	n.a.	n.a.	n.a.
	1.3.3 Aquatic Biota	Acreage Lost/Day	n.a.	n.a.	n.a.	n.a.
		Lbs. of Fish/Shutdown	n.a.	n.a.	n.a.	n.a.
	1.3.4 Wildlife (including birds aquatic and amphibious mammals, and retiles)	Acres	n.a.	n.a.	n.a.	n.a.

TABLE 11.2-1 (continued)

		Units	ALTERNATIVE RADWASTE SYSTEMS a	b	c	d
	1.3.5 Fish, Migration	Migration Influence	n.a.	n.a.	n.a.	n.a.
1.4 Chemical Effluents	1.4.1 Water Quality, Chemical		Insufficient Data - Unable to Calculate			
	1.4.2 Aquatic Biota	Fish lbs/yr.	n.a.	n.a.	n.a.	n.a.
	1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	Acres	n.a.	n.a.	n.a.	n.a.
	1.4.4 People	Lost Ann. User Days	n.a.	n.a.	n.a.	n.a.
1.5 Radionuclides Discharged to Water Body	1.5.1 Aquatic Organisms	Rem/Yr.	0.14	0.14	<0.01 (1&2)	<0.01 (1&2)
	1.5.3 People, Ingestion	Rem/Yr.	0.0001	0.0001	0.0001	0.0001
		Man Rem/Yr.	Negligible	Negligible	Negligible	Negligible
1.6 Consumptive Use (evaporative losses)	1.6.1 People	Gallons/Yr.	n.a.	n.a.	n.a.	n.a.
	1.6.2 Property	Gallons/Yr.	n.a.	n.a.	n.a.	n.a.
1.7 Other Impacts						
1.8 Combined or Interactive Effects						
2. Groundwater						
2.1 Raising/Lowering of Groundwater Levels	2.1.1 People	Gallons/Yr.	n.a.	n.a.	n.a.	n.a.
	2.1.2 Plants	Acres	n.a.	n.a.	n.a.	n.a.

n.a. means not applicable

1. Chapman, W.H., H.L., Fisher, M.W. Pratt. Concentration Factors of Chemical Elements in Edible Aquatic Organisms. Lawrence Radiation Laboratory, University of California, Livermore, California. Report No. UCRL-50564. December 30, 1968, 50 pp.

2. National Research Council, Committee on Oceanography, Panel on Radioactivity in the Marine Environment, "Radioactivity in the Marine Environment", pages 168 and 169, 1971 National Academy of Sciences.

TABLE 11.2-1 (continued)

		Units	ALTERNATIVE RADWASTE SYSTEMS a	b	c	d
2.2 Chemical Contamination of Groundwater (excluding salt)	2.2.1 People	Gallons/Yr.	n.a.	n.a.	n.a.	n.a.
	2.2.2 Plants	Acres	n.a.	n.a.	n.a.	n.a.
2.3 Radionuclide Contamination of Groundwater	2.3.1 People	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
		Man Rem/Yr.	Negligible	Negligible	Negligible	Negligible
	2.3.2 Plants and Animals	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
2.4 Other Impacts on Groundwater			n.a.	n.a.	n.a.	n.a.
3. AIR						
3.1 Fogging and Icing (caused by evaporation and drift)	3.1.1 Ground Transportation	Hrs/Yr.	n.a.	n.a.	n.a.	n.a.
	3.1.2 Air Transportation	Hrs/Yr.	n.a.	n.a.	n.a.	n.a.
	3.1.3 Water Transportation	Hrs/Yr.	n.a.	n.a.	n.a.	n.a.
	3.1.4 Plants	Acres/Crop	n.a.	n.a.	n.a.	n.a.
3.2 Chemical Discharge to Ambient Air	3.2.1 Air Quality, Chemical	% of Standard	n.a.	n.a.	27.6	27.6
		Tons/Yr.	n.a.	n.a.	18,696	18,696
		% of Standard	n.a.	n.a.	None	None
		Tons/Yr.	n.a.	n.a.	75.98	75.98
		% of Standard	n.a.	n.a.	.136	.36
		Pounds/Yr.	n.a.	n.a.	952	952
	3.2.2 Air Quality, Odor	Statement	n.a.	n.a.	None	None
3.3 Radionuclides Discharged to Ambient Air	3.3.1 People, External	Rem./Yr.	0.0046	<0.00005	0.0045	<0.00005
		Man Rem/Yr.	74	0.74	74	0.74
	3.3.2 People, Ingestion	Rem/Yr.	0.00015	<0.0000015	0.00015	<0.0000015
		Man Rem/Yr.	Negligible	Negligible	Negligible	Negligible
	3.3.3 Plants and Animals	Rem/Yr.	0.01	0.0001	0.01	<0.0001
3.4 Other Impacts on Air						

n.a. means not applicable

TABLE 11.2-1 (continued)

		Units	ALTERNATIVE RADWASTE SYSTEMS			
			a	b	c	d
4. LAND						
4.1 Pre-emption of Land	4.1.1 Land, Amount	Acres	n.a.	n.a.	n.a.	n.a.
4.2 Plant Construction and Operation	4.2.1 People (amenities)	See Text	n.a.	n.a.	n.a.	n.a.
	4.2.2 People (aesthetics)	Qualified Opinion	n.a.	n.a.	n.a.	n.a.
	4.2.3 Wildlife	Qualified Opinion	n.a.	n.a.	n.a.	n.a.
	4.2.4 Land, Flood Control	n.a.	n.a.	n.a.	n.a.	n.a.
4.3 Salts Discharged from Cooling Towers	4.3.1 People	$lbs/ft^2/Yr.$	n.a.	n.a.	n.a.	n.a.
	4.3.2 Plants and Animals	Acres	n.a.	n.a.	n.a.	n.a.
	4.3.3 Property Resources	Dollars/Yr.	n.a.	n.a.	n.a.	n.a.
4.4 Other Land Impacts			n.a.	n.a.	n.a.	n.a.
4.5 Combined or Interactive Effects			n.a.	n.a.	n.a.	n.a.

n.a. means not applicable

TABLE 11.2-2

ECONOMIC COST SUMMARY
(Dollars)

		CAPITAL COST C_I	ANNUAL OPERATING COST O_t	ANNUAL FUEL COSTS F_t	GENERATING COST PRESENT WORTH GC_p	GENERATING COST ANNUALIZED GC_a	LOST CAPACITY (kWe)
ALTERNATIVE PLANT DESIGNS	A	89,883,394	2,666,000	5,642,000	168,202,199	17,842,763	3,000
	B	102,529,394	$(O_t + F_t)$ =	10,237,300	199,035,545	21,113,542	19,250
	C	93,929,394	$(O_t + F_t)$ =	8,367,300	172,807,215	18,331,259	3,000
ALTERNATIVE COOLING SYSTEMS	1	1,640,000	(1)	240,000	3,902,459	413,970	3,000
	2	13,660,000	245,000	100,000	16,912,285	1,794,042	7,000
	3	8,600,000	570,000	1,300,000	26,228,330	2,782,282	16,250
	4	40,342,375	50,000	107,625	41,828,292	4,437,114	3,075
ALTERNATIVE RADWASTE SYSTEMS	a	998,000 (2)	320,000	0	4,014,613	428,720	0
	b	3,500,000	$(O_t + F_t)$ =	56,500	4,032,620	427,777	0
	c	546,000	$(O_t + F_t)$ =	2,800	572,395	60,719	0
	d	4,046,000	$(O_t + F_t)$ =	59,300	4,605,016	488,497	0

(1) Not separated from other plant operating costs.
(2) Cost of radwaste building not included. ($658,000)

11.2.3 Incremental Environmental Effects

The environmental effects resulting from construction and operation of various configurations and systems are presented in Table 11.2-1 and are discussed below.

11.2.3.1 Natural Surface Water Body (Item 1.0)

Cooling Water Intake Structure (Item 1.1)

Fish (Item 1.1.1)

Dr. C. B. Wurtz derived percent mortality and entrapment-per-hour values for several species of fish entrained on the water intake screens for Alternative Cooling System 1 (Ref. 11.2-1). By estimating an average weight loss of fish by individual species, it is possible to estimate the pounds lost per year by species. For example:

(No. of fish entrapped by species per hour) (Average Wt./Species) (% Mortality/Species) = Lost Wt./hour.

(Lost Wt./hour) (8760 hours/year) = Lost pounds of fish by species per year.

It is assumed for Alternatives 1 and 2 that intake mortality is in direct proportion to intake volume and velocity, and that the intake structure remains unchanged. Thus, it is possible by a direct proportion using derived values from Alternative Cooling System 1 to calculate lost pounds of fish per year for Alternatives 2 through 4.

Lost pounds of fish per year for Alternative 4 will be the same as in Alternative 1 and Alternative 2 will equal Alternative 3 due to similar intake volumes in both cases. See Table 11.2-3 for lost pounds of fish per year by species for Alternatives 1 through 4. The data for Alternative 1 and Alternative 4 are based on an average plant flow of 367,000 gpm in accordance with the application for a discharge submitted to the Corps of Engineers, refer to Section 12.2. The data for Alternatives 2 and 3 are based on 39,000 gpm which includes makeup water requirements plus service water volume. The fish species of commercial and sport fishing importance are identified in Table 11.2-3.

Passage Through the Condenser and Retention in Closed Cycle Cooling Systems (Item 1.2)

Primary Producers and Consumers (Item 1.2.1)

Alternative 1 causes phytoplankton productivity to drop by an average of 92.3 mg. O_2/m^3-hr. (Ref. 5.1-5). This loss in the amount of sunlight converted to organic matter has been attributed to passage through the condenser (Refer to Section 5.1.4.1). Copepod (zooplankton) egg viability and egg laying are unaffected by passage through the condensers in Alternative 1.

Calculations for lost algal biomass were derived as follows: From the formula for photosynthesis, the ratio of O_2 production to that of C is 1:1. The ratio of C to $C_{106}H_{108}N_{16}O_{46}P$ is 1:2. Thus, the ratio of O_2 to $C_{106}H_{108}N_{16}O_{46}P$ is approximately 1:2. The average primary productivity of phytoplankton lost in Alternative A is 92.3 mg. O_2/m^3-hr.

TABLE 11.2-3

LOST POUNDS OF FISH PER YEAR

	Average Weight of Individual	1 (lbs.)	2 (lbs.)	3 (lbs.)	4 (lbs.)	Commercial or Sport Importance
Blueback herring	1 oz.	209.40	21.56	21.56	209.40	X
Alewife	1 oz.	77.03	7.92	7.92	77.03	X
Atlantic herring	1 oz.	438.00	45.11	45.11	438.00	X
Bay Anchovy	.5 oz.	1978.39	203.34	203.34	1978.39	
American Eel	16 oz.	604.44	62.24	62.24	604.44	X
Atlantic Needlefish	4 oz.	2442.94	251.61	251.61	2442.94	
Banded killifish	.5 oz.	1.01	.10	.10	1.01	
Pollock	8 oz.	296.70	30.55	30.55	296.70	X
Fourspine stickleback	.5 oz.	143.71	14.80	14.80	143.71	
Thruspine stickleback	.5 oz.	77.03	7.92	7.92	77.03	
Northern Pipefish	4 oz.	2844.37	292.95	292.95	2844.37	
Spotted seahorse	.5 oz.	29.12	3.00	3.00	29.12	
White perch	6 oz.	809.42	83.36	83.36	809.42	X
Bluefish	18 oz.	2365.20	243.60	243.60	2365.20	X
Crevalle jack	8 oz.	153.30	15.78	15.78	153.30	X
Silver perch	5 oz.	95.81	9.86	9.86	95.81	
Weakfish	16 oz.	306.60	31.57	31.57	306.60	X
Crested curb eel	10 oz.	191.62	19.73	19.73	191.62	
Atlantic silverside	.5 oz.	465.75	47.96	47.96	465.75	
Smallmouth flounder	10 oz.	377.77	38.91	38.91	377.77	X
Winter flounder	8 oz.	5475.00	563.91	563.91	5475.00	X
Northern puffer	4 oz.	913.44	94.08	94.08	913.44	X
Oyster toadfish	4 oz.	75.55	7.77	7.77	75.55	
Blue Crab	1 oz.	4021.11	414.16	414.16	4021.11	X
Total Commercial & Sport Fish		16047.41	1652.75	1652.75	16047.41	
Total Food Chain only		8345.30	859.04	859.04	8345.30	
GRAND TOTAL FISH		24392.71	2511.79	2511.79	24392.71	

The exact trophic level-biomass ratio needed to convert phytoplankton productivity into pounds of fish has not been determined for the waters in the plant area. Eugene P. Odum, however, gives approximate trophic levels as being in the order of 809:11:1.5 for producer; primary carnivore: primary consumer (Ref. 11.2-2). Thus, the conversion from biomass of phytoplankton to fish may reasonably be made using this ratio to yield an approximate equivalent in pounds of fish.

For Alternative 1:

(92.3 mg.O_2/m^3-yr.)(4334 hrs/yr.) = 400,028 mg. O_2/m^3-yr.

(400,028 mg. O_2/m^3-yr.)(2 $C_{106}H_{108}N_{16}O_{46}P/O_2$) = 800,056 mg. $C_{106}H_{108}N_{16}O_{46}P/m^3$-yr.

The equivalent annual fish loss would be 1,485 pounds. x Cool. Flow m³/yr

For Alternatives 2 and 3:

These systems use 10.5% as much water as Alternative 1. Maximum productivity would be 360 mg.O_2/m^3-hr. for phytoplankton. Thus, the lost biomass would approximate 330,770 mg. $C_{106}H_{108}N_{16}O_{46}P/m^3$-yr.

All zooplankton and their eggs would be killed. The equivalent annual fish loss would be 615 pounds.

For Alternative 4:

Alternative 4 would involve greater loss of life than Alternative 1 due to a longer entrainment period. Phytoplankton productivity lost would range from at least 92.3 mg. O_2/m^3-hr. to an assumed maximum of 360 mg. O_2/m^3-hr. Thus, the range of lost algal biomass would be 800,056 mg. to 3,120,480 mg. $C_{106}H_{108}N_{16}O_{46}P/m^3$-yr.

All entrained copepods would be assumed to be killed. The equivalent annual fish loss would range from 1,485 to 5,800 pounds.

In Alternative 1, the mortality rate would be 1,485 pounds per year; in Alternatives 2 and 3 - 615 pounds per year; and in Alternative 4 from 1,485 to 5,800 pounds per year.

Fish (Item 1.2.2)

Larval fish and eggs small enough to pass through the 3/8-inch mesh intake screens could be transported through the condensers of the closed and open-cycle cooling systems. Preliminary research indicates that eggs collected in Oyster Creek, Forked River, and several bay locations are primarily those of the bay anchovy (Refer to Section 5.1.4.3); that surface water densities of eggs give a mean value of 12.30 eggs/40 gallons; and that densities of larvae are too low to consider (Ref. 2.7-3).

Assuming that these figures represent a rough estimate of existing fish egg and larval densities, Alternatives 1, 2, 3 and 4 would take in 112,853; 11,992; 11,992; and 112,853 eggs/minute, respectively. The estimated condenser mortality rate for once-through systems is 10-20%, and that closed cycle systems is 100%. (Ref. 11.2-3). The resultant mortality would be approximately 11,285 to 22,570 eggs/minute for Alternatives 1 and 4 and 11,992 eggs/minute for Alternatives 2 and 3.

To estimate an annual poundage of fish loss, the following assumptions are made:

1) One hundred percent of the living fish eggs taken into the system are bay anchovy eggs. Sect 5.1.4.3 of ER

2) The density of the eggs remains constant throughout the year.

3) A year old bay anchovy weighs an average of 0.5 ounces.

4) The natural survival rate for bay anchovy eggs and larval is 0.01 to 0.001% per year.

DEM based on past exp.

The lost weight per year of bay anchovies is calculated as follows:

Alternatives 1 and 4:

(525,600 minutes/yr.) (22,570 eggs/minute) = 11,862,792,000 eggs/yr.

(0.5 oz.) (11,862,792,000 eggs/yr.) = 5,931,396,000 oz./yr.

$$\frac{5,931,396,000 \text{ oz./yr.}}{16 \text{ oz.}} = 370,712,000 \text{ lbs./yr.}$$

$$(370,712,000 \text{ lbs./yr.}) \times \begin{pmatrix} .0001 \\ .00001 \end{pmatrix} = 3,707 \text{ to } 37,071 \text{ lbs./yr. of bay anchovies lost}$$

Alternatives 2 and 3:

The annual loss of bay anchovies would be 1,969 to 19,697 pounds.

The bay anchovy is one of the most important forage species in the aquatic ecosystem in Barnegat Bay (Ref. 11.2-4).

Discharge Area and Thermal Plume (Item 1.3)

Water Quality, Physical (Item 1.3.1)

The maximum heat discharge from the Oyster Creek Plant for Alternatives 1 and 4 is 4.5×10^9 BTU/hr.

The heat discharge from closed-cycle cooling systems for Alternatives 2 and 3 would be about 1.3×10^8 BTU/hr., or about 3% of the heat load from the once-through systems 1 and 4.

An additional 0.12×10^9 BTU/hr. would be discharged from alternative systems 1 through 4 from the service water systems. These figures are based on a maximum circulation of 460,000 gpm through the steam condensers (Refer to Section 8.3.3).

Average areas enclosed in the 2°, 3° and 5°F. isotherm were calculated for Alternatives 1 and possibly 4, based on the results of a recent study (Ref. 11.2-5).

Using Figure 4 from Ref. 11.2-5, areas were calculated based on a circulating water flow of 493,713 gpm.

Degrees above Ambient Temperature (°F)	Areas Affected (acres)
+2	729.7
+3	576.7
+5	441.5

The total volume of water of 5°F or more above ambient temperature is approximately 1 million cubic yards or 619.8 acre-feet. (From Answer 2, questionnaire from New Jersey Department of Environmental Protection, November 16, 1971.)

Oxygen Availability (Item 1.3.2)

With respect to Alternative 1, dissolved oxygen concentration at the intake and discharge channels was measured at 8.6 and 7.4 ppm, respectively (Ref. 5.1-5). Changes in dissolved oxygen content of this magnitude are not detrimental to aquatic life because the oxygen content does not become critical until it falls below 4 to 5 ppm (Refer to Section 2.7.1). In addition, 7.4 ppm oxygen concentration is well above the State of New Jersey standards of 6.0 ppm for these waters (Ref. 11.2-6).

According to studies by Alabaster and Downing (Ref. 11.2-7) and Adams (Ref. 11.2-8), it was found that when dissolved oxygen levels were measured in a heated effluent, they were not reduced to saturation but remained at the same concentration with subsequent supersaturation. As a result, it is judged that a similar phenomenon will occur with respect to dissolved oxygen concentrations in Alternatives 1 through 4. The degree of supersaturation is proportional to the volume of discharge and area affected, thus giving similar dissolved oxygen concentrations in both the intake and discharge channels.

Areas affected would be less for Alternatives 2 and 3 than for 1 and 4 because of the smaller discharge volumes. The volume of water affected with concentrations below 5 ppm for Alternatives 1 and 4 is none. Volumes of water affected for Alternates 2 and 3 are not calculated as data is not available.

Aquatic Biota (Item 1.3.3)

The negligible effects of Alternative 1 upon the aquatic biota have been extensively discussed in Section 5.1.3.

Considering 87°F as the avoidance temperature for the majority of adult fish, the largest habitat lost in one day of any year would be 1,000 acres (Refer to Section 5.1.2). The average for lost habitat would be about 41.67 acres per day above 86°F, the average as calculated from data in Section 5.1.2.

Quantified data on biomass is not available to compute the lost weight of organisms per year for the alternatives.

The only data available is for lost pounds of fish due to thermal shock and is discussed in Section 5.1.5 for the Menhaden mortality at the Oyster Creek plant. If it is assumed that the fish lost in Oyster Creek had all survived to commercial size (10 to 12 inches) and numbered 1,000,000, they would have weighed an estimated 25 tons. As one such incident occurred in three years of operation, it is recognized that this represents an extreme incidence of mortality and constitutes the worst possible case.

Alternatives 2 and 3 would have less effect upon the aquatic biota of Oyster Creek or Barnegat Bay than Alternative 1 because of the lower rate of heat discharge.

Alternative 4 would have no thermal effect upon Barnegat Bay. However, it would pose some of the same problems with respect to offshore fish as is currently posed with respect to bay fish. That is, some fish might be subject to thermal shock inherent in the shutdown of the facility.

Wildlife (Item 1.3.4)

Although some habitat might be lost to birds, aquatic, and amphibious reptiles through thermal discharge, this loss cannot be measured within present techniques; however, approximately 33 acres of habitat have been added to the intake section of the canal. It has been assumed that any habitat loss is offset by the gain and is therefore negligible.

Fish Migration (Item 1.3.5)

Quantifying the fish migration in terms of pounds is not possible at this time due to insufficient data, but, an estimate of migration influence has been made based on temperature changes and local migration patterns. Therefore, the migration effect is reported by degree of migration influence rather than pounds of fish per year.

Alternative 1 does not block Barnegat Bay with its thermal plume. Migrating fish may be deflected by the plume and impeded from beginning to migrate.

Alternatives 2 and 3 would have much less effect upon migrating fish than Alternative 1 because the heat load to the bay is 97% less.

Alternative 4 might also deflect some migrating fish.

Questions about whether or not the thermal discharge from Alternative 1 impedes the Atlantic menhaden from beginning its annual southerly fall migration from Barnegat Bay are discussed in Section 5.1.5. This migration condition could also exist for Alternative 4. Alternatives 2 and 3, due to their lower heat load to the receiving waters, would affect migration to lesser degrees.

Temperature changes often play a part in sexual maturation of fish. Usually in temperate zones, day length, temperature, and light interact to influence gonad development and timing of spawning activities.

To date, no effect of the present thermal plume on the spawning activity of fish has been identified. The normal cyclic variation in the population size of each species is so great that probably no effect will be measurable. Further, the extent of the plume is so small compared to the rest of the Bay that any small local changes would be inconsequential. Therefore, the overall influence on spawning is judged to be minor for Alternatives 1 and 4 and even less for Alternatives 2 and 3.

Water Quality, Chemical (Item 1.4.1)

The primary method of treating chemical effluents released from the Oyster Creek facility is dilution with circulating water refer to Section 3.7.1.

Water quality criteria (Ref. 11.2-6), established for tidal waters in 1971 by the New Jersey Department of Environmental Protection (Class TW-1) does not specify limits on the concentrations of individual dissolved or suspended materials in excess of background levels except for dissolved oxygen, radioactivity, and bacteria. Therefore, the minimum required dilution volumes for the chemicals released were not calculated.

The amounts (lbs/day) of chemicals discharged are assumed to be the same for all cooling systems considered except for chlorine, which is discussed under the items following.

Aquatic Biota (Item 1.4.2)

a. Chlorine Toxicity

There is insufficient data on chlorine toxicity to fish to estimate tolerance limits that would be applicable to the Oyster Creek discharge; however, since there have been no reported instances of fish mortality due to chlorine toxicity in Oyster Creek below the point of discharge, it is judged that none of the alternative cooling methods would have a measurable adverse effect on fish populations. The effect is thus considered negligible.

b. Salinity

Due to the relatively low average flow rate (Refer to Section 2.5.2) of fresh water from the Oyster Creek drainage area, the salinity occurring in Oyster Creek below the plant discharge would be slightly lower than that of the discharge itself and slightly higher than Barnegat Bay background levels. Since salinity measurements as such are not available, a comparison can be made on the basis of total dissolved solids (TDS) concentrations as shown below.

The following are total dissolved solids (ppm) calculated yearly averages:

	Oyster Creek in the Vicinity of the Plant Discharge	Percent Increase Above Barnegat Bay Background Level
Present once-through cooling system	24,700	0.99
Closed-cycle cooling systems	25,150	1.2

Although some measurable changes in species composition and distribution can be expected to result from the water quality changes in Oyster Creek and in the bay area affected by the discharge plume, no net loss of fish or aquatic habitat would occur.

The ocean discharge system, Alternative 4, would allow Oyster Creek to return to its original estuarine quality and eventually to reestablish a biotic community similar to what existed prior to its utilization as a discharge canal.

Wildlife (Item 1.4.3)

No effects upon wildlife are perceived.

People (Item 1.4.4)

The impact of the various cooling methods (Alternatives 1 through 4) on the chemistry and biology of the aquatic environment is not expected to impair commercial or recreational use of the water. This judgment is based on the considerations presented under Water Quality (Item 1.4.1), Aquatic Biota (Item 1.4.2), and Wildlife (Item 1.4.3) in this section.

Radionuclides Discharged to Water Body (Item 1.5)

Aquatic Organisms (Item 1.5.1)

Of the radionuclides released from the Oyster Creek Station, only Mn-54, Co-58 and Co-60 have been detected in marine biota in Barnegat Bay (Refer to Section 5.5). Organisms with a large surface to mass ratio, mollusks and aquatic vegetation are expected to exhibit the highest accumulation factors for these radionuclides. Small organisms, e.g., phytoplankton or zooplankton, may have high accumulation factors, but the dose to the organism would be low because most of the energy from the radiation is absorbed in the water. For example, the volume ratio of zooplankton to water ranges from 8×10^{-8} to 8×10^{-7} for coastal water (Ref. 11.2-10, page 175). Since the dimensions of these organisms are small compared with the range of radiation from Mn-54, Co-58 and Co-60, the fraction of the total energy absorbed is approximately equal to the volume ratio. Thus, the dose to these organisms will be small. Measurements made by the New Jersey Bureau of Radiation Protection indicate that the highest detected concentration in July and October of 1971 occurred in the plant species Gracilaria, with concentrations ranging up to 2.2 p Ci/g (wet weight) for Co-60 and Mn-54, refer to Section 5.5.2.1. A much lower concentration of Co-58 was measured and this radionuclide will contribute less than 5% of the dose. Concentration of these neutron activation products in clam meat were more than an order of magnitude lower than the concentrations in marine vegetation. If all of the radiation energy is assumed to be absorbed by the organism, the dose from the existing once-through cooling system would be approximately 0.14 rem/year for Gracilaria and less than 0.01 rem/year for clams. The method of dose calculation was similar to the method used by the International Commission on Radiological Protection (Ref. 5.2-2). A large fraction of the gamma radiation energy is not absorbed by the organism but this is partially offset by the additional dose from sediment and other nearby organisms. The above values are believed to represent an upper-limit estimate of the dose to marine organisms from aquatic pathways.

The dose for other methods of cooling have been estimated by direct comparison with the once-through cooling system as follows:

Impact of Natural Draft Cooling Tower on Radiation Dose

The 18,000 gallons per minute blowdown would provide less dilution volume than the 460,000 gallons per minute from once-through cooling. With the lower flow rate, the recirculation factor will be less; i.e., close to 1.0 instead of the 3.76 which was assumed for once-through cooling (see Table 5.2-3). The net effect of less dilution and less recirculation would be an increase in the radiation concentration to which marine biota in Oyster Creek are exposed. Consideration of the above factors indicates that the dose from aquatic pathways in Alternative 2 would be seven times the dose estimated for once-through cooling.

Impact of Spray Pond on Radiation Dose

The blowdown flow rate from the pond is expected to be the same as from the cooling tower and the same comments apply if dilution occurs in the blowdown pipe. The dose to man and aquatic organisms would be seven times the dose estimated for once-through cooling.

Impact of Ocean Discharge on Radiation Dose

Radioactivity attributable to the Oyster Creek Station has been detected in aquatic vegetation (Gracilaria and Nostos marina), planktonic filter feeders (clams) and bottom sediment that is rich in organic material. Predominant radionuclides were neutron activation products (Co-60, Co-58, and Mn-54). Accumulation in these marine organisms and in bottom sediment would be reduced by ocean discharge. The critical pathway to man would be fish muscle instead of mollusk muscle. The accumulation factors for fish muscle are one to two orders of magnitude lower than for mollusk muscle, (Ref. 11.2-10, page 169). With a lower accumulation factor and a higher rate of dispersion (dilution) in the ocean, the dose to man would be approximately 0.01 times the dose estimated for once-through cooling with discharge of liquid effluent in the cooling water to Barnegat Bay.

Effect of Proposed Waste Evaporator on Radiation Dose

A concerted effort to keep radioactivity discharged in liquids to Barnegat Bay to levels as low as practicable resulted in a reduction in both volume and radioactivity of waste liquids discharged in 1971 (Refer to Table 3.6-1). However, the large volume of liquid waste generated during the plant outage in late 1971 overloaded the existing system and created a temporary water storage problem. Installation of a second waste evaporator would reduce the liquid radwaste discharge to the residual concentration in the evaporator distillate. The concentrations of individual radionuclides (isotopic composition) in this distillate are indicated by the data in Table 11.2-4. Based on these data and published concentration factors for marine biota (Ref. 5.2-2 and 11.2-10), the activation products will be responsible for over 90% of the dose from ingestion of seafood which is the critical pathway for liquid discharges. The dose, calculated by the same method used

TABLE 11.2 - 4

ISOTOPIC COMPOSITION OF EVAPORATOR DISTILLATE

Nuclide	Half-life	Evaporator Distillate, pCi/ml [1] Sample 1	Sample 2	Sample 3	Estimated [2] Ci/year
Fission Products:					
Zr-95	65 days	<0.22	<0.20	<0.24	0.005
Nb-95	35 days	0.11	0.42	0.45	0.009
I-131	8 days	<0.11	<0.15	0.44	0.008
CS-134	2 years	0.11	0.16	0.15	0.003
Cs-137	30 years	0.11	0.14	0.20	0.004
Ce-141	33 days	0.21	<0.25	<0.24	0.004
Ce-144	284 days	0.85	4.0	<0.11	0.075
Bar La-140	12.8 days	0.18	0.27	0.25	0.005
Activation Products:					
Cr-51	27.8 days	<1.0	<1.3	<1.2	0.009
Mn-54	303 days	0.14	0.17	0.47	0.009
Fe-59	45 days	0.27	<0.31	<0.36	0.005
Co-58	71 days	0.12	0.14	0.46	0.009
Co-60	5.26 years	0.13	0.29	0.19	0.005
Zn-65	245 days	0.33	<0.37	<0.39	0.006
Sb-124	60 days	0.41	0.50	<0.72	0.009
Total					0.165

(1) Samples taken February 15, 18 and 23 of 1972

(2) Total volume of waste discharged estimated to be 5×10^6 gallons/year based on actual experience during last six months of 1971.

in Table 5.2-3, to any individual organ or the whole body dose to an individual will be less than 0.1 mrem/year. The population dose from all aquatic pathways will be negligible.

Radiation doses calculated for each alternative cooling system with the complete radwaste system superimposed are shown in Table 11.2-5. As all doses lie well within the proposed Appendix I guidelines, and since no other environmental effects are perceived to be associated with the radwaste systems, no further consideration has been given to the radwaste subsystems in this analysis. These data serve to show that the three alternative plant configurations A, B and C are all acceptable.

People, External (Item 1.5.2)

The population external dose from all aquatic pathways was found to be negligible, refer to aquatic organisms (Item 1.5.1) of this section.

People, Ingestion (Item 1.5.3)

The dose to aquatic organisms is small (Refer to Item 1.5.1) hence the dose to people from ingestion of seafood is small.

Consumption Use - Evaporative losses (Item 1.6)

People (Item 1.6.1)

There are no apparent environmental costs involved.

Property (Item 1.6.2)

Agriculture does not utilize saline water, therefore, withdrawal of these waters for cooling purposes has no effect.

TABLE 11.2-5

RADIATION DOSE CALCULATIONS FOR COOLING SUBSYSTEM WITH ALL RADWASTE SYSTEMS SUPERIMPOSED

		ALTERNATIVE COOLING SYSTEM			
Item	Units	Once Through 1	Cooling Tower 2	Spray Pond 3	Ocean Discharge 4
1.5.1	Rem/Yr.	0.001	0.07	0.07	0.1
1.5.2	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
1.5.2	Man-Rem/Yr.	Negligible	Negligible	Negligible	Negligible
1.5.3	Rem/Yr.	0.0001	0.0007	0.0007	0.0001
1.5.3	Man-Rem/Yr.	Negligible	Negligible	Negligible	Negligible
2.3.1	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
2.3.1	Man-Rem/Yr.	Negligible	Negligible	Negligible	Negligible
2.3.2	Rem/Yr.	Negligible	Negligible	Negligible	Negligible
3.3.1	Rem/Yr.	0.0005	0.0023	0.0005	0.0005
3.3.1	Man-Rem/Yr.	0.74	37	0.74	0.74
3.3.2	Rem/Yr.	.0000015	.001	.0000015	.0000015
3.3.2	Man-Rem/Yr.	Negligible	Negligible	Negligible	Negligible
3.3.3	Rem/Yr.	0.0001	0.005	0.0001	.0001

No commercial agriculture is carried on in the immediate plant vicinity.

11.2.3.2 Groundwater (Item 2.0)

Raising/Lowering Groundwater (Item 2.1)

People (Item 2.1.1)

No effects are perceived and therefore are considered negligible, (Refer to Section 2.5.3.6).

Plants (Item 2.1.2)

No effects are perceived and therefore are considered negligible.

Chemical Contamination of Groundwater (Item 2.2)

People (Item 2.2.1)

No potable water loss is perceived, (Refer to Section 2.5.3.4).

Plants (Item 2.2.2)

No toxic effects are perceived.

Radionuclide Contamination of Groundwater (Item 2.3)

People (Item 2.3.1)

There are no apparent radiation effects, refer to aquatic organisms (Item 1.5.1) of Section 11.2.2.1.

Plants and Animals (Item 2.3.2)

There are no apparent radiation effects, refer to aquatic organisms (Item 1.5.1) of Section 11.2.2.1.

11.2.3.3 Air (Item 3.0)

Fogging and Icing (caused by Evaporation and Drift)(Item 3.1)

Ground Transportation (Item 3.1.1)

Only the cooling tower and spray pond have any potential for fogging and icing. These are of minimal effect.

The plume from a cooling tower could cause fogging and icing in winter; however, it is judged that the plume would approach no lower than 200 feet to ground level. Since there are no nearby structures approaching this elevation, no effect is foreseen and is considered to be none.

No icing is expected to occur upon roads as a result of operation of the possible spray pond because drift would be limited to 200 yards from the edge of the spray pattern and this minimum distance for separation from routes of transportation would be a design criterion. It is estimated that from 1 to 4 hours per year of fogging might occur beyond 1,000 feet from the spray pattern. This effect is considered minimal or negligible herein. Further evaluation appears to lie beyond the present state of the art.

Air Transportation (Item 3.1.2)

As no airfields are located near the plant, there is no effect on air transportation.

Plants (Item 3.1.4)

As the plume from a cooling tower would not approach closer than 200 feet to the ground, no fauna are jeopardized. In the operation of the cooling ponds, icing would be limited to within 200 yards of the spray pattern. Since this land is already dedicated to plant operation, no undesirable effects can be ascribed to fauna.

Chemical Discharge to Ambient Air (Item 3.2)

Air Quality, Chemical (Item 3.2.1)

Small amounts of SO_2, NO_x, and particulates are emitted from the package boiler. These total 9.348 tons/year of SO_2, 37.99 tons/year of NO_x, and 476 pounds/year of particulates. The 476 pounds/year of particulates yields a concentration of 3.091 ppm by weight.

The New Jersey Air Pollution Control Code, Air-D41, April, 1970, Chapter 10 - Sulfur in Fuels, Section 2 - Commercial Fuel Oil, permits No. 2 fuel oil to have, after October 1, 1971, a sulfur content not to exceed 0.2% sulfur. Jersey Central uses No. 2 commercial fuel oil in the package boiler supplied from two sources. The bulk of the fuel is purchased from the Port Arthur Refinery of Gulf Oil Company who guarantee a maximum of 0.16% sulfur by weight. A small amount is purchased locally from Humble Oil Company, who guarantee 0.20% sulfur or less. Use of this fuel meets the New Jersey standards.

There is no New Jersey pollutant emission standard for NO_x.

The Air Pollution Control Code, AIR D-27, June 1969, Chapter 7 - Solid Particles Section 2.16, defines the basic and allowable emission for fine solid particles. Using the basic emission chart number 2, Chapter 7 Section 2.16 for fine solid particles, a package boiler stack height of 40 feet and a distance of 1,500 feet from the stack to the nearest property line, results in an allowable emission of 100 pounds/hour.

Based on this, the particulate emission of Oyster Creek is .068 percent of the emission standard. Considering the Alternative d for the radwaste system, results in a particulate emission of 952 pounds/year or .136 percent of the emission standards.

The emissions also meet the air quality standards (SO_2 and particules) of the New Jersey Air Pollution Control Code, AIR-D33.

Air Quality, Odor (Item 3.2.2)

No odor has been found originating from the plant site. (refer Section 7.4).

Radionuclides Discharged to Ambient Air (Item 3.3.3)

People, External (Item 3.3.1)

In the existing radwaste system (Alternative a), over 99 percent of the gaseous waste comes from the main condenser air ejector (refer to Section 3.6) and these gaseous emissions to the atmosphere are responsible for most of the whole body radiation dose associated with operation of the Oyster Creek Station. The dose to an individual from this pathway has been estimated to be 4.6 mrem/year, and is within the numerical guides set forth in the proposed amendments to 10CFR Part 50 (Appendix I). Under these conditions the Benefit Cost Guide suggests that no further consideration needs to be given to formulating alternatives for the radwaste system.

The operation of natural draft cooling towers may increase the dose from gaseous emissions by a factor of 50 and would indicate the need for an alternative method of radwaste treatment to provide a dose reduction factor of 0.02, or a decontamination factor (DF) of at least 50. A thorough discussion of alternate radwaste systems is included in Section 8.4. The system selected as the most appropriate for backfitting at Oyster Creek consists of catalytic recombination of oxygen and hydrogen followed by charcoal absorption (delay) of the noble gases. This alternative obtains a DF of 500 based on concentration and a DF greater than 500 based on dose from the air ejector off-gas, by providing a 50-hour delay for passage of krypton and a 1,000-hour delay for passage of xenon. This permits krypton and xenon isotopes to decay except Kr-85 and trace concentrations of Xe-133.

The DF based on whole body dose from the air ejector off-gas is considerably greater than 500. The air ejector off-gas would be essentially eliminated as a source and previously minor sources, e.g, vacuum pump discharge, steam leaks, etc., would become the major sources for exposure. It has been estimated in Section 3.6 that these other sources contribute less than 1% of the dose from gaseous emissions; therefore, alternative radwaste system b provides a dose reduction factor of 0.01 when all sources of gaseous emissions are considered.

The dose for other methods of cooling have been estimated by direct comparison with the once-through cooling system as follows:

A 400 feet high cooling tower close to the stack may affect the disposal of gaseous effluent. The assumption of a ground level release for this case increases the dose estimate for an individual living near the site and for the population group living within 50 miles of the site. The increase calculated in the same way as data discussed in Section 5.2 is a factor of approximately 50 times the dose estimated for once-through cooling. If the cooling tower alternative were adopted, the installation of additional gaseous radwaste treatment would be required.

The spray pond is not expected to have any significant impact on the dispersion of gaseous effluent in the atmosphere. The dose would be the same as estimated for once-through cooling.

The ocean discharge would not have an effect on dispersion of gaseous effluent in the atmosphere. The dose to man would be the same as estimated for once-through cooling.

People, Ingestion (Item 3.3.2)

Refer to Item 3.3.1 for radiation dose

Plants and Animals (Item 3.3.3)

Refer to Item 3.3.1 for radiation dose

11.2.3.4 Land (Item 4.0)

Pre-emption of Land (Item 4.1)

The original land parcel comprising the Oyster Creek site consisted of 1,416 acres, and is broadly divided into two parts by the presence of U. S. Highway 9. The land west of the highway aggregates 755 acres and the land east of the highway totals 661 acres. These lands are sufficient to accommodate any of the alternative systems under consideration, with the exception of the Ocean Discharge System which would require the additional demand for a right-of-way easement across Barnegat Bay and Island Beach, and for the placement of a small control building on Island Beach itself. The control building on Island Beach Park will require approximately 0.1 acres.

Plant Construction and Operation (Item 4.2)

People - Amenities (Item 4.2.1)

Other considerations were given this item as the proposed HUD Criterion Guidelines on Non-Aircraft Noise was not available (6/21/72).

The plant is isolated from most human activities so that construction would impose no stress upon the populace. The closest residences are over a mile away to the north-northeast and south-southwest. Only those people pursuing aquatic recreation on the Forked River, and Oyster Creek bridges, or travelling in vehicles on U. S. Highway 9 would have any view of plant activities. This impact is judged to be negligible.

Operation of the plant (Alternative A) creates no unpleasant effects which might distract the populace. The only discernable plant manifestation is the discharge of heated water into the Oyster Creek Canal, which proved to be an incremental benefit to the sports fishermen at the Oyster Creek bridge.

Construction and operation of a large natural draft salt-water cooling tower as projected in Alternative B would pose unique problems upon the sensibilities of those living in the area, but would not measurably affect their physical environment. Actual construction would be too distant to affect the public with noise.

Construction and operation of a spray pond would not affect the local populace. The pond probably would be situated east of Highway 9 between Forked River and Oyster Creek Canal. Design parameters would dictate that the pond be located far enough away so that the spray and drift would not reach the highway. The effects of salt drift would be less than those from Alternative 2.

Operation of Alternative 4 (Ocean Discharge System) would not be perceptible to the populace. Construction of the ocean discharge system would have minor effects upon the boating public through the presence of dredging and pipelaying equipment temporarily blocking short stretches of water along the Intracoastal Waterway. This, however, would be of short duration and is considered to be negligible.

People - aesthetics (Item 4.2.2)

The aesthetic quality of the plant environment has been affected by the presence of the facility, which might disturb the viewer. A survey was made to determine the probability of viewing of the plant, the transmission lines and by a possible 400-foot high natural draft cooling tower, from the various surrounding sectors. The results showed that in the local vicinity, the existing plant can be viewed for only about a mile due to the density of local vegetation and thus has a moderate impact. At greater distances, the plant is viewed as a subdued silhouette on the landscape giving a moderate visual impact. Most of the transmission line is well hidden. A cooling tower located at the site would have a considerable visible impact. The visual impact of the spray pond is considered to be negligible because of its very low profile. The visual impact of the Ocean Discharge System would be limited to a small control building on Island Beach Park and is considered negligible.

Wildlife (Item 4.2.3)

In preparing the site for the Oyster Creek plant, about 352 acres of habitat were lost through clearing, spoils emplacement, and canalization. Although the loss of this small acreage of habitat is not considered significant, it is important to place the loss in perspective by placing an environmental cost on the loss. One way that this might be done is to consider the productivity of the land in terms of game animals -- this may be done statistically as follows:

In Section 2.7.2.6 it was noted that the largest and most significant game animal in the area is the white-tailed deer. According to New Jersey State Fish & Game statistics, Ocean County in 1970 yielded the following data as outlined in Table 11.2-6.

TABLE 11.2-6

NEW JERSEY FISH AND GAME STATISTICS

Animal Hunted	Estimated Hunters	Avg. Days Hunted	Total Man-Days	Number of Harvest	Mean Bag
Pheasant	8,133	7.91	64,332	32,125	3.95
Rabbit	6,796	9.27	64,668	35,157	5.91
Squirrel	3,097	8.12	25,148	7,773	2.51
Grouse	5,519	7.40	40,841	4,856	0.88
Quail	8,908	7.11	63,336	40,531	4.55
Woodchuck	2,129	7.27	15,478	2,618	1.23
Duck	12,200	7.65	93,330	123,000	10.09
Geese	7,649	6.98	53,390	3,136	0.41
Brant	8,230	6.69	55,059	-	-
Copper Brant	1,160	6.00	6,960	8,282	7.14
Deer	10,941	4.0	43,764	470	-
			47,124,700		

The harvest in Ocean County was 470 deer. These were hunted by 10,941 hunters, who spent an average of 4.0 days each in hunting. Ocean County has an area of 208,470 square miles; thus:

470/208,470 = .00225 deer per square mile; then:

The proportionate loss for the plant site was:

.00225 (352 acres/640 acres per mile squared) = 0.00124 deer per year

This loss is judged negligible.

The lands in question are adjacent to U. S. Highway 9 and in close proximity to areas of high human activity; therefore, it is doubtful that the actual plant lands have had any great impact in recent years as an actively productive habitat having significance to man.

In considering Alternative 4, the loss of land to wildlife through the emplacement of a control station at Island Beach Park is not significant due to the small area involved.

Salts Discharged from Cooling Towers (Item 4.3)

People (Item 4.3.1)

Salts discharged from a cooling tower may be calculated from data contained in Figure 4-19 and Figure 4-20 of the Forked River Environmental Report (Ref. 11.2-9). Comparable data adjusted to the Oyster Creek tower is obtained by multiplying by the ratio of makeup water or 27,000 gpm divided by 36,000 gpm or 75%. The maximum predicted annual deposition rate will be 4.65×10^{-5} lbs/ft^2/yr in the east-southeast sector at a distance of from 4 to 5 miles from the probable tower location.

Salts discharged from a spray pond would, according to the manufacturer,be limited to an area within a distance of 200 yards from the edge of the spray pattern.

The maximum salt drift is estimated as follows:

The manufacturer guarantees drift at 0.004% of the total circulation, thus,

(.00004) (460,000 gpm) (8.33#/gal.) (60m/hr)

(.036 saline content) = 331 lbs/hour

(331) (7000) = 2,317,000 lbs of salt/year

Area = (1.5 miles) (5,280 feet) (600 feet) = 4,752,000 ft^2

Therefore, 2,317,000/4,752,000 = 0.49 lbs/ft^2/year

Plants and Animals (4.3.2)

No loss of plants or animals is perceivable through installation and operation of the possible cooling tower. The effects are considered as negligible.

A loss of habitat will occur with installation of a spray pond in the approximate amount of

$$\frac{(5,280 \text{ feet})(1.5 \text{ miles})(600 \text{ feet})}{43,560 \text{ ft}^2/\text{acre}} = 109 \text{ acres}$$

As shown by the reasoning in Item 4.2.3 in this section, this loss of habitat is negligible.

Property Resources (Item 4.3.3)

Negligible, refer to Reference 11.2-9, Page 4-13.4.

REFERENCES - SECTION 11.2

11.2-1 Wurtz, Charles B., 1972, Fish and Crabs on the Screens of the Oyster Creek Plant During 1971, Jersey Central Power and Light Company, Parsippany, New Jersey.

11.2-2 Saunders, W. B., 1971 Fundamentals of Ecology, 2nd Edition, page 142.

11.2-3 Westinghouse Electric Corporation, Environmental Systems Department, 1971, Performance and Environmental Aspects of Cooling Towers.

11.2-4 Westman, J. R., Research Professor, Department of Environmental Research, Rutgers University, New Brunswick, New Jersey, Personal Communication.

11.2-5 Pritchard and Carpenter, 1963, Recirculation and Effluent Distribution for Oyster Creek Site, John Hopkins University, Baltimore, Maryland.

11.2-6 The Department of Environmental Protection, Surface Water Quality Criteria, June 30, 1971 (Classification TW-1)

11.2-7 Alabaster, J.S. and A. L. Downing, 1966, A Field and Laboratory Investigation of the Effect of Heated Effluents on Fish. Invest. Series #1, Ministry of Agriculture, Fisheries and Food, United Kingdom, Vol. 6 (4) pp. 1-42.

11.2-8 Adams, J. R., 1969, Thermal Power, Aquatic Life, and Kilowatts on the Pacific Coast, Nuclear News, pp. 7-79.

11.2-9 Environmental Report, Forked River Unit No. 1, January 21, 1972, Jersey Central Power and Light Company, Parsippany, New Jersey.

11.2-10 National Research Council, 1971, Panel on Radioactivity in the Marine Environment, Committee on Oceanography, in: Radioactivity in the Marine Environment, National Academy of Sciences, 272 pages.

11.3 SUMMARY AND CONCLUSIONS

As in all nuclear power plants, the decisive factors in plant design are safety and radiation protection. At present, the plant is in full compliance with the current standards (10CFR20). Under the proposed standards of Appendix I of 10CFR50, however, the emissions from Oyster Creek approach the maximum permissible, and the proposed Alternative C may be required. In any case, Jersey Central will comply with the adopted Appendix I Guidelines.

The environmental effects of various system alternatives have been presented in Section 11.2.3. The existing plant (Alternative A) is environmentally acceptable under current governmental standards.

Inspection of the Table 11.2-1, which shows incremental environmental effects reveals that the cooling tower (Alternative Cooling System 2) and the spray pond (Alternative Cooling System 3) have slightly lower environmental effects than the other two systems. The spray pond has the lowest environmental effects due to factors of lower radiation dose levels, lower fish mortality and aesthetics. Potential effects of misting will be confined to the pond area. Thus, the spray pond is determined to be the system having the lowest environmental effect of all those considered and is so designated as Alternative B.

The proposed Alternative C includes a charcoal absorption and catalytic recombination system in conjunction with a redundant liquid waste evaporator which are designed to reduce all calculated radiation doses to levels which are well within the proposed Appendix I standards.

Inspection of Table 11.2-1 also reveals that the ocean discharge system (Cooling Alternative 4) has environmental effects comparable to the existing system and thus offers little or no environmental advantage over the former. Consequently, the ocean discharge system is not considered a worthwhile alternative.

Although the spray pond offers the least environmental effects of all the systems studied, Alternative B is not proposed for licensing because the trade-off of increased annualized operating cost of Alternative B over Alternative C is not balanced by the environmental benefits which would be achieved.

The installation of a spray pond would require an annual expenditure of $2,782,282 or the installation of a cooling tower would require an annual expenditure of $1,794,042 to obtain a savings of 32,704 pounds of fish-equivalent. At the average commercial value of fish (1970) of 8.1 cents per pound the dollar loss of fishing would approximate $2,649 per year.

The comparison of dollar equivalent loss of fish to the annualized costs of a spray pond (or cooling tower) indicates that such comparison would be disparate and unjustified.

It is therefore concluded that the existing plant (Alternative A), modified only by radwaste systems appropriate to meet the proposed radiation standards of pending Appendix I of 10CFR50, constitutes the most viable configuration (Alternative C) for overall benefit to the populace.

12.0

ENVIRONMENTAL APPROVALS AND CONSULTATION

12.1 LIST OF LICENSES, PERMITS AND APPROVALS

Table 12.0-1 lists the private, local, State and Federal agencies from whom approvals have been received for construction and operation of the Oyster Creek Nuclear Generating Station.

12.2 STATUS UNDER SECTION 21(b) OF THE FEDERAL WATER POLLUTION CONTROL ACT

At the time the Oyster Creek Nuclear Generating Station was licensed, the State of New Jersey and JC made agreements with the State of New Jersey (Ref. 2.7-15) concerning thermal discharges as well as other environmental and safety matters. The thermal limits agreed to are subject to revision should a joint study involving the State and JC (see Section 5.1) conclude that operation within these limits is detrimental.

A meeting was held recently with representatives from the New Jersey Department of Environmental Protection to determine what they require in order to issue the required Water Quality Certification. A set of questions developed by the State is currently being answered by JC. The answers to these questions and the formal request for the Certification that the Oyster Creek Nuclear Generating Station meets applicable water quality standards will be submitted to the State shortly.

Table 12.0-1. Licenses, Permits and Approvals Issued for Construction and Operation of the Oyster Creek Nuclear Generating Station.

Federal Title/Purpose	Number	Authority	Date Issued/Received
Provisional Construction Permit	CPR	Atomic Energy Commission	December 16, 1964
Provisional Operating License	DPR	Atomic Energy Commission	April 9, 1969
Amendment No. 1 (1600 MWt)	Amend. No. 1 to DPR-16	Atomic Energy Commission	August 1, 1969
Amendment No. 2 (1690 MWt)	Amend No. 2 to DPR-16	Atomic Energy Commission	December 2, 1970
Amendment No. 3 (1930 MWt)	Amend. No. 3 to DPR-16	Atomic Energy Commission	November 5, 1971
Special Materials Storage License	SNM-1037	Atomic Energy Commission	October 3, 1967
Byproduct Materials License	29-12773-01	Atomic Energy Commission	May 15, 1968
Dredging Permit for Oyster Creek		Department of the Army Corps of Engineers	August 17, 1966
Dredging Permit for Barnegat Bay		Department of the Army Corps of Engineers	August 17, 1966
Discharge of Plant Effluent (Refuse Act of 1899)	25D OXO 3 000522	Department of the Army Corps of Engineers	Application filed Oct.7, 1971;pending
Determination of No Hazard to Air Navigation - Meteorological Tower	EA-OE-65-307	Federal Aviation Administration	July 29, 1970

Table 12.0-1. (Cont'd.)

State of New Jersey Title/Purpose	Number	Authority	Date Issued/Received
Reconstruction of State Highway 9 Bridges over Oyster Creek and Forked River		Department of Conservation and Economic Development (DCED) and Highway Dept.	May 23, 1966
Construction of railroad bridges over Oyster Creek and Forked River		DCED	September 11, 1967
Encroachment Permit for Railroad Bridges		DCED, Division of Water Policy and Supply	
Agreement concerning the Plan for Implementation of Protective Action Guides		Department of Health	January 12, 1970
Deep Well Drilling Permit	33-1095	DCED, Division of Water Policy and Supply	September 2, 1964
Encroachment Permit for Highway Bridges	4381	DCED, Division of Water Policy and Supply	May 23, 1966
Dredging Permit for Barnegat Bay	66-42	DCED, Bureau of Navigation	July 13, 1966
Diversion Permit for Excavation Dewatering	P-241	DCED, Division of Water Policy and Supply	May 20, 1965
Dredging Permits in Estuaries (3)	66-28	DCED, Bureau of Navigation	July 1966
State Highway 9 Access Permit	E-3-259	Highway Department Bureau of Maintenance	September 21, 1964
Sewage Treatment Plant Permit	S-1-68-3144	Department of Health	March 12, 1968

Table 12.0-1. (Cont'd.)

State of New Jersey Title/Purpose	Number	Authority	Date Issued/Received
Building Safety Permits Certification of Plan Approval		DCED, Bureau of Engineering and Safety	
Reactor Building Foundation	14580		November 9, 1964
Elevated Water Tank Foundation	14581		November 9, 1964
Elevated Water Tank	14830		December 30, 1964
Turbine Building	15711		July 28, 1965
Circulating Water Structures	15712		July 28, 1965
Reactor Building and Office Building	16968		April 22, 1966
All Buildings Mechanical Equipment	19343		July 14, 1967
Mechanical and Electrical Work	72091		July 14, 1967
Dredging Permit for Channel from Intracoastal Waterway to Oyster Creek	66-49	DCED, Bureau of Navigation	
Riparian Grant		DCED	
Stipulation concerning Thermal Discharge and other environmental and safety matters	Docket No. 652-60	Public Utilities Commission	February 14, 1966
Anchorage of CAN Buoy in Barnegat Bay (temperature monitoring)	62-191	DCED, Bureau of Navigation	1963
<u>Ocean County</u>			
County Bridge Reconstruction Agreement		Ocean County Board of Freeholders	

Table 12.0-1. (Cont'd.)

State of New Jersey Title/Purpose	Number	Authority	Date Issued/Received
<u>Lacey Township</u>			
Building Permit	969	Department of Permits Licensing and Zoning	October 27, 1964
Permit for Sewage Treatment Plant	37	Department of Health	October 27, 1964
<u>Others</u>			
Railroad Crossing Agreement	Lease No. 8427	Central Railroad of New Jersey	January 12, 1968

APPENDIX A

QUALIFICATIONS OF PRINCIPAL INVESTIGATORS

PHILIP SHERLOCK
Civil Engineering
Water Resource Development, Mining

Mr. Sherlock became an associate with Dames & Moore in 1970. He has had 20 years of management and professional experience in many fields including civil engineering, foundation engineering, mining, water resource development and hydro-electric power.

He studied aeronautical engineering at-the Royal Aircraft Establishment College, then attended the University of the Witwatersrand, Johannesburg, Republic of South Africa, where he received a degree in civil engineering, majoring in soil mechanics. He has also conducted post-graduate work at the Illinois Institute of Technology.

Prior to joining Dames & Moore, Mr. Sherlock was employed for eight years with the Harza Engineering Company, Chicago, as head of the special projects department and as project manager on a number of major projects. These projects included the review of the designs of Mangla and Tarbela Dams, management of Mangla Spillway project, Plowshare studies for the excavation of the Atlantic-Pacific canal by nuclear means, repairs to the Kinzua pumped storage project, and design studies for an airport in the Lake Michigan area.

In 1961 and early 1962, Mr. Sherlock was chief engineer of Christiani-Shand, a joint venture of Christiani and Nielsen and Lehane, McKenzie Shand. In 1960 Mr. Sherlock was in West Pakistan to perform site evaluation, foundation investigation and design for an oil refinery, pipeline and tank farm. Remaining in Pakistan to start a firm specializing in soil and rock mechanics, Mr. Sherlock performed work on a number of dam sites including Mangla, Tarbela and Mailsi.

In England for a year as a project engineer with Soil Mechanics Limited, London, he worked on foundation investigations and design recommendations for nuclear power plants and major industrial structures.

Prior to employment in England, Mr. Sherlock lived in South and Central Africa and worked with Roberts Construction Company and DeBeers Consolidated Mines Limited. With Roberts Construction Company he gained design and construction experience on bridges, mining works, and industrial structures. With DeBeers Consolidated Mines Mr. Sherlock worked underground as a learner official.

At the Royal Aircraft Establishment he performed research in the Aerodynamics and Instrumentation Departments while pursuing his studies.

Mr. Sherlock is a registered professional engineer in Illinois, a chartered civil engineer in the United Kingdom and the Republic of South Africa, and a member of the United States Committee on Large Dams and several societies in the United States and overseas.

Recently Mr. Sherlock has consulted on environmental studies and reports for a nuclear-pumped storage power complex and an underground gas stimulation project. He has recently been appointed to an ASCE Power Division Committee on Environmental Effects of Power Plants.

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GERALD A. PLACE

Agronomy

Land Use and Development

Dr. Place is a senior soils scientist on the environmental staff of Dames & Moore. He received his B.S. and M.S. degrees in soil science from the University of Arkansas in 1958 and 1960, respectively. In 1963, he received his Ph.D. from Purdue University, where his major field of study was soil chemistry and plant nutrition. He has studied extensively in physical and inorganic chemistry, biochemistry and plant physiology. He joined the University of Arkansas Agronomy Department in 1962 and attained the academic rank of associate professor. He was employed in this position until he accepted employment with Dames & Moore.

He has had ten years of professional experience as a soil scientist and agricultural specialist at Purdue University and the University of Arkansas that has included teaching, research and consultation with commercial growers and personnel of related industries. He has taught courses in introductory soil science and physical chemistry of soils. In his last year on the University of Arkansas staff, time was devoted to developing a course for an environmental science curriculum entitled "Soils and Man's Environment."

While on the staff of the University of Arkansas, Dr. Place was active in investigating certain aspects of environmental quality in agricultural ecosystems. He was the director of soils research projects on terrestrial ecology, land utilization and water use. Investigations included pollution problems of irrigation return flow; relationships of soil chemical, physical and mineralogical properties to engineering properties: reclamation of alkaline, saline and sodic soils; and chemical conversions in submerged soils. Facets of these studies were directed toward evaluating the effects of specific practices and substances, including the effects of chemicals of agricultural and nonagricultural origin on environmental quality, ecosystems and the quality of products from agricultural ecosystems. Consideration was also given to environmental quality aspects of land use and development.

In addition to the above mentioned areas of responsibility, Dr. Place has experience in the use of ionizing radiation. Not only has he received formal instruction in bionucleonics, but he has utilized ionizing radiation in his M.S. and Ph.D. research program and at various times during his professional research activities.

Dr. Place has authored and co-authored over twenty journal articles and technical papers. He is an active member of several professional societies, including the American Society of Agronomy, Soil Science Society of America, and the International Soil Science Society.

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STANLEY R. KOZLOWSKI
Meteorology

Mr. Kozlowski is a project meteorologist in the Meteorological Division of Dames & Moore. He joined the firm in January, 1968. He received his B.S. in Geography and Science from the University of Buffalo in New York in 1962. During the summers, he worked for Pittsburgh Testing Laboratories and Erdman, Anthony and Hosely, a civil engineering firm. In 1962, he joined the U. S. Air Force and was accepted at the University of Oklahoma for one year of graduate work in meteorology under the A.F.I.T. program.

In 1963, Mr. Kozlowski became a duty weather forecaster at the Souix City Air Force Base and then was transferred, in 1965, to Laredo Air Force Base as a meteological instructor for Air Force pilots. In 1967, prior to joining Dames & Moore he was a mathematics and science instructor in Buffalo.

Since joining Dames & Moore, he has participated or directed the meteorological and population portions of numerous Safety Analysis Reports. Included within the scope of these Preliminary Safety Analysis Reports were determinations of the climatological conditions of the site and surrounding areas, including evaluations of the climatic influences upon proposed facilities and evaluations of the climatic diffusive capability of the atmosphere.

Mr. Kozlowski has also assisted in the development of techniques for evaluating the meteorologic influences upon cooling towers of several large power plants. These influences affect the design capacity of each cooling tower, its location and orientation with respect to the facility, and the fogging and icing potential of the plume in the vicinity.

Mr. Kozlowski has been project meteorologist for numerous site selection studies for nuclear and fossil fuel power plants. He has also assisted in chemical air quality and air pollution laboratory work that the firm has been conducting for the Salt River Project's large Navajo Generating Station near Page, Arizona.

Mr. Kozlowski has developed many computer programs for the calculation of vent stack designs, cooling tower orientation, nuclear diffusion studies and man-rem (radiological) studies.

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ALAN L. KOECHLEIN
Wildlife Biology

Mr. Koechlein is an assistant ecologist with Dames & Moore. He received his B.S. degree in biology from Alma College, an M.S. in biology from Central Michigan University, and an M.S. in wildlife management from Michigan State University.

His field experience includes the testing of a bird control device on nuisance gulls and describing characteristics that were common among nest sites selected by mute swans.

Areas of primary interest include habitat preferences of wildlife, land management for waterfowl and upland game birds, and the effects of land development upon wildlife resources.

Since joining Dames & Moore, Mr. Koechlein has participated in writing environmental statements describing the impact of nulcear power plants on terrestrial ecosystems. He has been involved in a field investigation to determine the pre-construction baseline of terrestrial communities and the environmental impact of an operating nuclear power plant in New York. In addition, he is participating in a multi-disciplined environmental investigation to monitor the impact on the terrestrial biology of a proposed combined hydro and nuclear electric power facility in South Carolina.

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CHARLES W. PROCTOR, JR.
Ecology

Mr. Proctor is an environmetalist with Dames & Moore. He received his B.S. in biology from Centenary College at Louisiana in 1966 and his M.S. in entomology from the University of Georgia in 1970. During the academic year 1970-71, he took course work for a Ph.D. in ecology.

While still a student Mr. Proctor did summer work for the U.S. Department of Agruculture as a plant pest control technician and for the Enforcement and Protection Division of the U.S. National Park Service. He also held research and teaching assistantships with the University of Georgia during the years 1968-71. During the summer of 1970, he did research for the International Biological Programme, Grassland Biome, at Fort Collins, Colorado.

Since joining Dames & Moore, Mr. Proctor has investigated the interrelationships and energy levels of a number of ecological systems in their undisturbed states and has analyzed the impact of construction and operation of diverse man-made facilities, including electrical generating plants, on the local environment.

Mr. Proctor is a qualified field biologist and is a specialist in the classification of microarthropods, mites and other insects. He holds memberships in the Entomological Society of America and Sigma Xi.

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ROBERT C. ERICKSON
Aquatic Ecologist

Dr. Erickson is a staff ecologist. He received his B.S. degree in Zoology from San Jose State College and his M.S. degree in fisheries from the College of Fisheries, University of Washington. He was awarded a Ph.C. and a Ph.D., also from the College of Fisheries. Research at the university centered around the effects of radioactive elements on the behavior, reproduction and growth of fish.

Areas of primary interest include aquatic ecology, fish behavior, sport fisheries and an evaluation of thermal and radioactive effluents on aquatic life.

His experience includes study in Alaska where he was responsible for collecting survival and growth data on sockeye salmon. Field surveys were an integral part of the investigation.

Dr. Erickson has participated in several studies related to the effects of radiouclides on aquatic life. His M.S. thesis was related to the effects of radioactive zinc on the swimming behavior of rainbow trout. This was conducted as an AEC Fellow at the Hanford Atomic plant site in Washington. His Ph.D. thesis described the effects of tritiated water on the growth, sexual behavior and mortality of the guppy. For three years he was a research assistant at the Laboratory of Radiation Ecology, University of Washington, where he collected and analyzed data from organisms along the Washington coast exposed to radioactive contamination from the Columbia River. In 1967, he was a member of the Bikini Resurvey Party, with responsibility for identifying the kinds and amounts of radionuclides present in plants and animals in the Bikini Test Site area.

Dr. Erickson has participated in multi-disciplined environmental investigations designed to evaluate the impact of a facility (such as a nuclear power plant or pipeline) on the aquatic system.

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FREDERICK B. LOBBIN
Nuclear Engineering

Mr. Lobbin received his B.S. degree in Nuclear Science from the New York State Maritime College and his M.S. degree in Nuclear Engineering from The Catholic University of America.

Mr. Lobbin joined Southern Nuclear Engineering, Inc., in March of 1971 and has been primarily associated with the Kewaunee Nuclear Power Plant project since that time. This association has included preparation of preoperational test procedures for various plant systems in addition to general licensing assistance. At Southern Nuclear Engineering, Mr. Lobbin is a Staff Engineer, and as such provides a wide variety of consulting services for nuclear power plant projects.

Prior to joining Southern Nuclear Engineering, Mr. Lobbin was employed by Hittman Nuclear & Development Corporation as a thermal-hydraulic analyst. During part of that time he was a project engineer responsible for the safety analysis of a small, multipurpose pressurized water reactor (SURFSIDE project) which was being planned for the New York State Atomic and Spare Development Authority. Additional responsibilities included Technical Specification revisions for the U.S. Savannah and the North Carolina State University PULSTAR research reactor. Mr. Lobbin also provided fuel fabrication quality assurance services for the PULSTAR reactor.

Mr. Lobbin is a member of the American Nuclear Society and the Society of the Sigma Xi. He also holds a U.S. Coast Guard license as a Third Assistant Engineer in the Merchant Marine.

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ERIC L. GEIGER

Manager, Department of Nuclear Sciences

Mr. Geiger was born in 1930 in Lucedale, Mississippi. In 1952 he received a B.S. degree in Chemistry from the University of Southern Mississippi. He accepted an AEC Fellowship in Radiological Physics and transferred to Vanderbilt University for graduate study under this fellowship program. After the successful completion of this work, he received three months on-the-job training at the Oak Ridge National Laboratory.

In 1953 Mr. Geiger joined the Health Physics Section at the AEC-DuPont Savannah River Plant where he helped develop the environmental monitoring and bioassay program for that facility. In 1958 he went to the Nevada Test Site where he set up an on-site laboratory to support the comprehensive health and safety program there. In 1960 he transferred to Santa Fe to develop a service program for EIC, including analytical chemistry, environmental surveillance, and dosimetry. He contributed greatly to the groundwork necessary for EIC to be selected by the AEC for the radiological services contract in 1967. From 1967 to 1970 he helped develop the radiological control, radiation monitoring, instrument maintenance, decontamination, and other radiological services provided at customer's sites.

Mr. Geiger is a member of the American Chemical Society and the Helath Physics Society. He is certified by the American Board of Health Physics.

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JOHN F. PRATT
Demographer

Mr. Pratt is a soils engineer with Dames & Moore. He received his B.S. in civil engineering and M.S. in soils engineering from Clarkson College of Technology in Potsdam, New York, respectively in 1966 and 1967.

During summer breaks in his education, Mr. Pratt gained engineering experience with both the U.S. Forest Service and the U.S. Soil Conservation Service.

Mr. Pratt joined Dames & Moore in 1967. Since then he has been involved in field control of site investigations for projects concerning sanitary, power and petroleum related facilities. He has participated in design team efforts for the development of marginal land area on the Hudson River to be used for sewage treatment facilities. He has developed demographic characteristics and land use studies for areas surrounding electrical generating plants.

Mr. Pratt is an associate member of the American Society of Civil Engineers and a member of Tau Beta Pi and Chi Epsilon, Honorary Societies.

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BERNARD ARCHER
Engineering and Ground Water Geology

Mr. Archer is a senior geologist with Dames & Moore. He obtained his B.S. in geology from the University of New Mexico in 1952.

Mr. Archer has broad experience in the fields of engineering geology, ground water geology, and exploration geology. He worked as a mining geologist with the Reynolds Metals & Mining Company for three years. During this time, he assisted in the planning and supervised the deep drilling operations for bauxite exploration and researched the geologic history of Arkansas to predict possible ore locations. He also explored and mapped limestone deposits in northern Arkansas.

Mr. Archer first joined Dames & Moore in 1957. He was responsible for engineering geologic, hydrologic, rock mechanics, and soils engineering investigations. His responsibilities also included job organization, planning, supervision and interpretation of field data, analysis, report preparation, and client relations. He was involved in planning environmental studies for one of New York state's first nuclear power plants. These specifications, approved and adopted by AEC, provided the basis for subsequent nuclear power plant environmental site studies.

Mr. Archer left Dames & Moore in 1964 to form a well drilling and test boring contracting firm, which grew to 18 men and conducted investigations for the Port Authority of New York, New York City Transit Authority, New York City Board of Education, as well as for numerous consulting soil engineers, architects, and developers.

In April 1967 Mr. Archer sold his drilling business and became vice president of International Earth Science Corporation, a small consulting firm in New York offering services in engineering geology, geophysics, and soils engineering. His responsibilities there included client contact, job organization and planning and supervision of all geological, hydrological, and geophysical investigations.

From 1968 until rejoining Dames & Moore in 1970, Mr. Archer worked as an independent consultant providing services in engineering geology, soil and rock mechanics, and engineering geophysics. These studies included geologic reconnaissance and evaluation of prospective sites, subsurface investigations and recommendations for foundation design criteria and optimum land use, cost estimates, and specifications and foundation construction schedules.

Recently Mr. Archer has been project manager on environmental studies and site selection for a proposed nuclear power generating station for Potomac Electric Power Company, and the Pennsylvania Power & Light Company. In addition he has been project geologist for environmental-geology studies on projects for Nuclear Fuel Services Inc. and the New York Atomic Space Development Authority in northern New York State as well as for the South Carolina Gas and Electric Company Nuclear-Pumped Storage project in South Carolina.

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GERALD M. BUDLONG
Geographer

Mr. Budlong is an assistant geographer on the environmental staff of Dames & Moore. He received his B.A. in geography from San Fernando Valley State College, California in 1968 and his M.S. in geography from Chico State College, California in 1971. He joined the firm in September, 1971.

Mr. Budlong has participated in several environmental team studies which measured the impact of construction and operation of nuclear power generating stations on the local environment, with special reference to population and land use. He has also participated in environmental impact studies for the routes of high tension transmission lines.

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LEOPOLD M. PAGE
Ground Water Geologist
Hydrologist

Mr. Page has more than 15 years of experience as a ground water geologist, hydrologist and engineering geologist.

Mr. Page originally worked for Dames & Moore from 1955 to 1957 and has only recently rejoined our staff. He received his B.S. degree in geology from Harvard University in 1947. He has taken post-graduate studies in sanitary engineering at Harvard University and additional post-graduate work in geology at San Jose State College at San Jose where he expects to receive a M.S. degree in 1971.

From 1948-1952, Mr. Page was a ground water geologist with the U.S. Geological Survey in the New York-New England area and from 1957 to 1958 he designed storm drain systems for major highways in the eastern United States. From 1958 to 1959 he was employed as an engineering geologist in San Francisco, California. From 1959 to 1962, Mr. Page worked for the San Francisco Water Department. He was responsible for designing pipelines and a pump station and he conducted geologic studies for the Turner Dam. From 1962 until recently, Mr. Page was employed by the Santa Clara County Flood Control District. He was responsible for performing qualitative and quantitative analyses of the geologic and hydrologic conditions in Santa Clara County, California. This included extensive use of computers to solve ground water problems. This agency has been conducting pioneering work in water conservation.

During his career, Mr. Page conducted a research project with Stanford University on the use of electrical resistivity methods to investigate geohydrologic conditions in Santa Clara County. For a period of three years he also directed resistivity studies to delineate ground water recharge-withdrawal sites in the County.

He has authored several articles on hydrologic conditions in the Santa Clara Valley of California for professional society publications. Mr. Page is a member of the American Geophysical Union. He is a registered geologist and certified engineering geologist in the State of California.

DR. NANCY W. WALLS
Biologist

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She has more than fifteen years of research and teaching experience in applied biology at the University of Michigan, Emory University, and Georgia Institute of Technology.

She has authored or co-authored more than thirty major reports and publications, including three environmental reports for nuclear power stations.

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Report *on Economic Analysis for*

Oyster Creek Nuclear Electric Generating Station

Jersey Central
POWER & LIGHT COMPANY

GPU ELECTRIC POWER COMPANIES

Foreword

On May 31, 1963, Jersey Central Power & Light Company, after several months of preliminary negotiations, invited the submission of proposals for a nuclear electric generating station at Oyster Creek, New Jersey. In accordance with the procedure specified in the invitation, the proposals were submitted on July 1, 1963, in two parts: (1) sealed base bids, and (2) detailed engineering and operating characteristics and data other than the base bids. The proposals (other than the sealed base bids) were carefully analyzed and evaluated over the next several months. On December 5, 1963, Jersey Central Power & Light Company opened the sealed base bids and, on December 12, 1963, it announced its decision to accept a proposal of General Electric ("GE").

As a result of the public announcement of the decision to proceed with the project, numerous requests for detailed economic data were received. In response thereto, the preparation of this report was undertaken. It was recognized that the preparation and verification of the data contained in the report would require several weeks and that the report would be most useful if it could be released at the earliest practicable date. This posed a problem, because Jersey Central had not then made a final decision between two alternative proposals submitted by GE.

One GE proposal involved a single cycle station with an expected maximum capability of 640,000 kilowatts and the other a dual cycle station with an expected maximum capability of 620,000 kilowatts. The base bid and the operating costs for the single cycle station (including a provision for reversal of flow in the canal and other designated options) were lower than for the dual cycle station. In order that substantial progress could be made on this report while a final selection between the single cycle and dual cycle proposals was under consideration, it was concluded that this report should be prepared on the basis of the dual cycle station since that involved higher investment and operating costs.

After the report had been completed but was being checked and verified, the single cycle proposal was selected. As a consequence, this report overstates the investment and operating costs of the selected station. Revision of the data in this report to reflect this decision would delay the release of the report by about 5 weeks. Since the only effect is to increase the economic margin in favor of the nuclear station, Jersey Central has concluded that the benefits of prompt release of the report outweigh the advantages of such revision.

JERSEY CENTRAL POWER & LIGHT COMPANY

Report on Economic Analysis for

OYSTER CREEK NUCLEAR ELECTRIC GENERATING STATION

(February 17, 1964)

SUMMARY

Jersey Central Power & Light Company, a subsidiary of General Public Utilities Corporation ("GPU"), is undertaking the installation of a nuclear electric generating station on an Atlantic Ocean tidewater site, about 40 miles north of Atlantic City, about 10 miles south of Toms River, and about 60 miles east of Philadelphia.

The decision to construct the Oyster Creek nuclear station was based solely on economic and engineering considerations. No government financial assistance is being sought in connection with the construction or operation of the station. After a reasonable break-in period, the station is expected to produce electric power at a total cost of less than four mills per kilowatt hour—which is appreciably below the expected total cost of power from any other type of station that Jersey Central could install at this location.

The annexed Tables 1, 2 and 3 set forth the estimated cost of power from the Oyster Creek nuclear station (on the basis of its expected capability of 620,000 kilowatts, its guaranteed minimum capability of 515,000 kilowatts and an intermediate capability of 565,000 kilowatts) and the comparative estimated cost of power from the fossil fuel-fired stations considered as possible alternates. (All capability figures used in this report are on a net basis *i.e.* gross station output less portion thereof used for station service including auxiliaries.)

It is usual to express the costs of generating electric power in terms of mills per kilowatt hour and, in conformity with that practice, the comparative estimated costs of power produced by the nuclear station and by the alternative fossil fuel-fired stations are expressed on that basis in Tables 1, 2 and 3. However, the numbers of kilowatt hours involved are so large (literally several thousand million kilowatt hours per year), that a difference in cost of only a small fraction of one mill per kilowatt hour represents a very large difference in annual dollar costs. For this reason, a statement of total annual costs per kilowatt of the nuclear station capability appears to provide a more meaningful basis of comparison. (For example, a $1 difference in total annual costs per kilowatt multiplied by the expected 620,000 kilowatt capability of the Oyster Creek nuclear station represents a difference in total costs of $620,000 per year.) The lower sections of Tables 1, 2 and 3 therefore state the comparative costs of the nuclear and fossil stations in terms of dollars per kilowatt per year.

The economic advantage of the nuclear station over the fossil fuel-fired stations with which it was compared varies from year to year, and is primarily affected by

(a) the assigned capability of the nuclear station;

(b) the annual use factor in the year;

(c) the substitution, commencing in the seventh year of operation of the nuclear station, of the investment in nuclear fuel working capital for the use and depletion charges theretofore paid to the Federal government;

(d) the subsequent variations in the nuclear fuel working capital requirement of the nuclear station;

(e) changes in nuclear fuel costs, resulting from changes in uranium and uranium processing prices; and

(f) the gradual decline in fixed charge rates applicable to depreciable property as a result of the impact of provisions for depreciation.

On the basis of the factors and data discussed below in this report, the Oyster Creek nuclear station demonstrates clear economic advantages over a fossil fuel-fired station at the same location at all three levels of nuclear station capability investigated. On the basis of the 620,000 KW expected capability of the nuclear station, such advantage is approximately $2,600,000 per year for the first five years, $3,200,000 per year for the next five years, $2,600,000 per year for the next 10 years, and $1,200,000 for the last 10 years; on the average for the entire 30-year lifetime of the station, this advantage (on a present worth basis) is approximately $2,500,000 per year.

On the basis of the 515,000 KW minimum guaranteed capability, the economic advantage of the nuclear station is approximately $400,000 per year for the first 5 years, $900,000 per year for the next 5 years, and $500,000 per year for the next 10 years, and an economic disadvantage of approximately $400,000 per year for the last 10 years; on the average for the entire 30-year lifetime, this net advantage (on a present worth basis) is approximately $400,000 per year.

On the basis of a 565,000 KW intermediate capability for the nuclear station, the annual advantage of the nuclear station is approximately $1,400,000 for the first five years, $2,000,000 per year for the next 5 years, $1,500,000 for the next 10 years, and $400,000 per year for the last 10 years, with an average advantage over the 30-year period (on a present worth basis) of approximately $1,400,000 per year.

It may be noted that, even though Jersey Central's present cost for fossil fuel is approximately 29.5¢ per million Btu, the delivered cost of fossil fuel at the Oyster Creek site was assumed to be 26¢ per million Btu since a proposal to supply fossil fuel at that site at prices equivalent to about 26¢ per million Btu was received by Jersey Central. In order to offset the economic advantage of the nuclear station at the 620,000 KW expected capability, the delivered cost of fossil fuel at the Oyster Creek site would have to be less than 20¢ per million Btu.

The economic studies also compared the Oyster Creek nuclear station with a fossil fuel-fired station located on a mine-mouth site in western Pennsylvania. On this basis, the Oyster Creek nuclear station demonstrates significant economic advantages at its expected capability of 620,000 KW. Such advantage amounts to approximately $800,000 per year for the first 5 years, $1,700,000 per year for the next 5 years, $1,200,000 per year for the next 10 years, and $600,000 per year for the last 10 years, with a 30-year annual average (on a present worth basis) of $1,100,000 per year.

On the basis of the 515,000 KW guaranteed minimum capability, the nuclear station would be at an economic disadvantage in comparison with the western fossil-fuel station, this disadvantage amounting to approximately $1,100,000 per year for the first 5 years, $300,000 per year for the next 5 years, $600,000 per year for the next 10 years, and $1,000,000 per year for the last 10 years, with a 30-year annual average disadvantage (on a present worth basis) of $800,000 per year.

On the basis of the 565,000 KW intermediate capability, the nuclear station has a modest over-all advantage as against the western fossil fuel-fired station, with a $200,000 per year disadvantage for the first 5 years, a $600,000 advantage per year for the next 5 years, a $300,000 per year advantage for the next 10 years and a $200,000 per year disadvantage for the last 10 years, with a 30-year annual average advantage (on a present worth basis) of $100,000 per year.

In the economic analysis, a 30-year estimated service life has been used for the nuclear and fossil stations, for both book and tax purposes. Income taxes have been computed on the basis of a 52% Federal corporate income tax rate and tax depreciation deductions have been computed on the basis of employment of the sum-of-the-years-digits ("SYD") method of liberalized depreciation which has been used by Jersey Central for all qualifying property since 1954. It is the rate-making practice of the Board of Public Utilities of the State of New Jersey and, as recently announced, of the Federal Power Commission to determine allowances for Federal income taxes on the so-called "actual tax" method. On the basis of a 30-year life for the station, this has the effect of reducing the Federal income tax component of fixed charges on depreciable plant during the first 15 years and increasing them thereafter. As shown by Table 9 (which sets forth the details of the fixed charges for each year), the total fixed charge rate for the first year of operation is 10.6152% and gradually declines thereafter.

Economic considerations are not, of course, the sole element entering into the decision to install the nuclear station. The maintenance of an appropriate balance between western and eastern generating installations in the GPU System makes it desirable that this particular segment of base load generating capacity be located at the eastern end of the system. It has been the GPU System's policy for more than a decade to have a relative concentration of fossil fuel base load generating capacity located in the low-cost fossil fuel areas of central and western Pennsylvania but also periodically to install some base load generating capacity near the eastern GPU load centers in order to maintain a sound balance and provide adequate service area protection. Such a relative western concentration exists at the present time and will be increased by reason of Jersey Central's participation in the Keystone Station. In order to restore the desired balance, the block of generating capacity involved in the Oyster Creek nuclear station should therefore be installed at the eastern end of the GPU system. Fortunately, the economic considerations in favor of the nuclear station therefore merely serve to reinforce the engineering and operating factors which make its installation desirable.

The GPU Integrated System

The GPU integrated system, of which the Oyster Creek station will be a part, embraces a 24,294 square mile service area in Pennsylvania and New Jersey, extending from Lake Erie to the Atlantic Ocean, and serving more than a million customers. The system today includes approximately

- 850,000 kilowatts of coal-fired generating capacity located at or near mine-mouth,
- 1,800,000 kilowatts of other coal-fired generating capacity, part of which is also capable of burning either oil or gas,
- 60,000 kilowatts of hydroelectric generating capacity,
- 2,500 circuit miles of 230,000 and 115,000 volt transmission lines,
- 2,100 circuit miles of lower voltage transmission lines,
- 35,000 pole miles of distribution lines.

The total investment in utility plant in the GPU System is approximately one billion dollars and it is now growing at an average annual rate of approximately one hundred million dollars.

While the Oyster Creek station is being completed, other major facilities will be under construction. Such other facilities include participation with non-affiliated companies in the

1,800,000 kilowatt mine-mouth Keystone generating station,

500,000 volt transmission facilities from the Keystone station to terminals near Philadelphia and Newark,

330,000 kilowatt pumped storage station, the first stage of the Kittatinny Mountain project, which is expected to have an ultimate capability in excess of 1,300,000 kilowatts.

A map of the GPU integrated system, showing the location of the Oyster Creek station, appears on page 18.

Jersey Central and the other GPU System companies are also a part of the Pennsylvania-New Jersey-Maryland Interconnection, a closely coordinated and integrated group of companies serving more than 17 million customers in New Jersey, Pennsylvania, Maryland, Delaware and the District of Columbia.

The Oyster Creek Station

The Oyster Creek Station will initially include a single boiling water nuclear reactor, turbo-generator and accessory equipment, but will be so designed and so located on the site that it will be capable of subsequent expansion. The station will be constructed and all initial equipment installed by General Electric Company ("GE"), with Burns & Roe, Incorporated acting as the latter's engineer-constructor. The unit will be much larger than any boiling water reactor heretofore constructed and will incorporate some technological advances. Boiling water reactors have operated successfully at Commonwealth Edison Company's Dresden Station, Pacific Gas and Electric Company's Humboldt Bay Station and Consumer Power Company's Big Rock Point Station.

The station will be constructed and all initial equipment installed pursuant to a fixed price contract with GE; this price is subject to the escalation provisions that are usual in connection with major equipment purchases by electric utilities. The estimated total cost of the station is $68,000,000. This consists of (a) contract price (including designated options)—$60,000,000, (b) Jersey Central desired modifications—$460,000, (c) interest during construction on station, excluding land—$4,306,000, (d) land, including interest during construction—$775,000, (e) employee training and licensing costs—$1,414,000, and (f) provision for contingencies—$1,045,000.

The minimum initial rating of the station is 515,000 kilowatts, but the station is ultimately expected to provide a net capability of at least 620,000 KW.

A conceptual sketch of the Oyster Creek Station appears at page 19.

Economic Analysis

The decision to build the Oyster Creek Station was made after detailed studies over a period of several years and actual experience during the past five years with the design, construction and operation of the GPU System developmental power reactor at Saxton, Pennsylvania. The

Saxton reactor was built for the specific purposes of enabling GPU system personnel to acquire first-hand familiarity with these matters and of contributing to nuclear technology. The Saxton reactor was constructed under a fixed price contract with the GPU System investment and operating costs being shared by the System operating companies. Jersey Central is bearing approximately one-third of such costs.

In its studies, Jersey Central has been assisted by the firm of Pickard-Warren-Lowe Associates with respect to nuclear engineering matters and by the firm of Gilbert Associates, Inc. with respect to mechanical, electrical and civil engineering matters. The nuclear cost assumptions made in such studies, which are set forth in Table 4, have been selected after consultations with Jersey Central's nuclear consultants. The calculations made in the economic analysis have been reviewed by Messrs. Lybrand, Ross Bros. & Montgomery, independent certified public accountants, and they have advised Jersey Central that in their opinion the calculations in all material respects are mathematically accurate and are based upon the consistent application of the underlying methods and assumptions employed.

A. Basis of Economic Analysis of Oyster Creek Nuclear Station

There were six principal elements in the economic analysis of the Oyster Creek Nuclear Station. They were as follows:

1. *To determine the estimated cost of the station.* Jersey Central already owns the site of the station so that the land cost for the station was readily determinable. As noted above, the station will be constructed and all initial equipment installed by GE under a fixed price contract which is subject to the normal type of escalation that would also be applicable to the equipment for a fossil fuel-fired station. Gilbert Associates, Inc. and Pickard-Warren-Lowe Associates reviewed the GE proposal for completeness and adequacy of the station and accessory equipment to be supplied by GE including cost estimates for desired modifications. Pickard-Warren-Lowe Associates also reviewed the estimates of licensing and employee training costs. Based upon its own analyses and such review by its engineering consultants, Jersey Central is satisfied that, subject to normal escalation, the estimated cost of $68,000,000 will provide a completely equipped and operable station.

2. *To determine the capability of the station.* The guaranteed minimum rating of the station is 515,000 KW. Jersey Central, Pickard-Warren-Lowe Associates and GE unanimously believe that the reactor will produce substantially more steam than required to achieve this rating. In contemplation of this possibility, the bid specifications required the bidders to make provision, item by item, throughout the station, in order to take advantage of such excess steam-producing capability of the reactor. In response, the GE proposal represents that the turbo-generator, piping, pumps, and all other accessory equipment are adequate so that the station can operate efficiently and economically at a capability in excess of 620,000 KW when the reactor achieves its expected steam output. Jersey Central and Gilbert Associates, Inc. have reviewed the capabilities of each of such items of equipment to be installed and are satisfied with GE's representations in this regard.

The capability of the station has a significant effect on the cost per kilowatt-year and per kilowatt hour, primarily because it affects the fixed charge component (return on capital, depreciation, and income taxes) of such unit cost—*i.e.*, it affects the base over which the total dollars of fixed charge costs have to be allocated. In order to give a rounded picture, comparisons with the alternative fossil plants were made on three levels of assumed net capability for the nuclear station, namely, (1) the 620,000 KW expected capability, (2) the guaranteed 515,000 KW capability and (3) an intermediate 565,000 KW capability—which is generally comparable to the relationship of actual capability to guaranteed rating experienced in large fossil fuel-fired stations.

3. *To determine the use factor at which the station would operate.* Studies were made of the probable use factor of each station for each year over its anticipated service life. These studies indicated that, after a reasonable break-in period, the nuclear station will operate as a base load plant for slightly more than half its service life and then decline gradually to a 50% use factor. While any long-range forecast of this character is necessarily subject to infirmities, it provides the best available measure of the relative performance and economic characteristics of alternative developments and recognizes that (a) any generating station will decline in use as newer generating capacity with lower operating costs is added to the system, and (b) the time when such decline in use will begin and the rate of decline are functions of the relative operating costs of existing and projected capacity. A forecast of this character therefore provides a more accurate basis for economic decision than the assumption of a lifetime constant use factor. The results of the use factor studies were verified against similar use factor studies made as a basis for deciding to proceed with the Keystone station.

Although the alternative fossil fuel-fired stations with which the nuclear plant was compared would operate at a lower use factor than the nuclear station, the fossil fuel-fired stations were assigned the same use factor in order to give them the same energy base over which to distribute their fixed charges. However, where their own use factors would be below those of the nuclear station because lower-cost energy would be available from other sources, each fossil fuel station was given the benefit of such available lower-cost energy for the block of energy between its and the nuclear plant's use factor.

(A diagram representing the relative use factors for the nuclear and fossil plants is set forth in Table 5.)

4. *To determine the nuclear fuel and other operating and maintenance costs.* There are four principal elements which enter into nuclear fuel operating costs, although there are a number of other minor elements which also affect it. These principal elements are (1) the value of the fissionable materials consumed, commonly referred to as depletion, (2) the cost of fabrication of the core, (3) the cost of reprocessing the core so as to remove the plutonium and separate and convert the other special nuclear materials in the irradiated core to a re-usable form, and (4) the credit for the plutonium produced. In the economic analysis, the depletion cost and plutonium credit were based on the present AEC prices through 1969 with some reductions thereafter. The fabrication cost was based upon firm proposals received from GE for the first three cores. Jersey Central has an option as to whether to accept such proposals for the second and third cores, and therefore such proposals may properly be viewed as a ceiling—and not as a floor—on fabrication costs for those cores. The reprocessing costs were based upon estimates derived from model contracts offered by Nuclear Fuel Services, Incorporated.

It was assumed in these studies that the fourth and all subsequent cores would have the same fabrication costs and design characteristics as the third core, notwithstanding the universal expectation that improvements in technology and manufacturing, together with changes in ore prices, processing charges and similar items, should tend to reduce future nuclear fuel costs.

It was recognized that the plutonium credit has been a subject of some controversy. Thus far, the weapons program has been virtually the sole user of plutonium. On the other hand, wholly apart from the weapons program, the energy content of plutonium is a reality and the use of such energy content for non-weapons purposes appears to be a near-term prospect. Realistic economic analysis therefore requires the assignment of a value to the plutonium produced, and the current AEC prices through 1969 with a reduction thereafter related to the assumed reduction in the cost of uranium afford the best available basis for such assignment. It should be noted that the exact value assigned to the plutonium credit is not central to the economic analysis, since the total plutonium credit averages less than 0.25 mills per KWH.

In summary on the subject of nuclear fuel operating costs, the nuclear fuel cost estimates have been based upon what Jersey Central and its nuclear consultants believe is a realistic compromise of the various assumptions made by the AEC, GE and others. Reasonable variations in these assumptions could involve a change in estimates of fuel costs which could range from an increase of about 0.32 mills per KWH or $2.49 per KW/year, to a decrease of about 0.21 mills per KWH or $1.61 per KW/year. It is unlikely that any such change would occur during the first five years of the nuclear station's service life and decreases in cost thereafter are more likely than increases.

(The components, per core and per KWH, of the nuclear fuel operating costs are set forth, for each of the three levels of station output investigated, in the summary tables appearing on pages 1 of Tables 6, 7 and 8.)

The other operating and maintenance costs of the nuclear station consist primarily of the following:

(a) Operating and maintenance labor costs. These were determined on the basis of a manning table prepared by Jersey Central, using current wage rates adjusted for experienced overtime, payroll taxes and all payroll overheads, including all such items which are normally a part of administrative and general expense;

(b) Materials, supplies and services. Provision was made for all operating and maintenance supplies, chemicals, resins, waste disposal, heating, communications, contract maintenance and control rod replacements. Some of these expenses were included on a uniform basis each year, although variations from year to year may be expected; however, other items which vary with plant output (such as chemicals and resins) were varied in proportion to level of output. Control rod replacements are not expected to become necessary until the ninth year, but were included as an annual expense for each year on a levelized present-worth basis. Overheads of 10% were applied to all such non-payroll expense.

(c) Insurance premium costs. Liability insurance costs were based on NELIA premium rates in effect prior to January 1, 1964 taking into consideration the present worth of the estimated reserve premium refund to be developed by application of the "industry credit rating plan". Although the effect of the new premium rates effective after January 1, 1964 cannot be determined until data required for the

Hazards Report become available, it may be noted that studies made by Jersey Central indicate that the "population factor", calculated in accordance with the AEC formula, is 1.1. The costs for government indemnity under the Price-Anderson Act were based upon the statutory rate of $30 per year per thermal megawatt. The physical damage insurance cost (which was applied to 90% of the investment in the core and in the station excluding land) was based upon an annual premium rate of $4.70 per $1,000 of value.

5. *To determine the nuclear fuel working capital costs.* The use charges payable to the Federal government represent the carrying charges made by the Federal government for its investment in the nuclear fuel so long as government ownership of nuclear fuel continues to be required. It has been proposed by the AEC that private ownership of nuclear fuel begin in 1973, and, in the economic studies made, it has been assumed that private ownership of nuclear fuel will both begin and become fully effective on July 1, 1973—i.e., in the 7th year of operation of the station.

The fixed charges associated with the investment in nuclear fuel working capital arising out of private ownership will be substantially greater than the government's use charges. Consequently, any delay in the full transition to private ownership will reduce the total costs of energy from the nuclear plant for the period of such delay.

Even before private ownership of nuclear fuel, the nuclear fuel working capital requirements are 3 to 4 times the fuel working capital required by a fossil fuel-fired plant, *i.e.*, approximately $11 to $13 per KW for the nuclear plant as against $3 to $4 for the fossil fuel-fired plant. With private ownership of nuclear fuel, the working capital investment in nuclear fuel becomes $22 to $30 per KW. Detailed analysis of the impact of the nuclear fuel cycle on such working capital requirements is therefore required.

In the economic studies made, it has been assumed that nuclear fuel working capital would be financed with a normal capitalization—*i.e.*, approximately 63% funded debt and 37% common stock equity.

The nuclear fuel working capital requirements arise principally out of these elements:

(a) The amounts paid for fabricating nuclear fuel cores (both those in operation in the reactor and those being prepared for later use) in advance of the time when such fabrication costs are properly chargeable to nuclear fuel expense;

(b) During the first six years, the portions of the use charges and depletion charges which are payable to the Federal government before the time they are properly chargeable to nuclear fuel expense;

(c) After the sixth year, the average investment in special nuclear materials to cover the entire cycle of fabrication, exposure in the reactor, storage for cooling, shipment, reprocessing and conversion;

(d) The portion of the credit for plutonium which represents a partial offset to nuclear fuel operating expense but which is not payable by the AEC until the plutonium is delivered to the AEC—a period of at least 26 months for the initial core section, after taking into consideration the period of exposure of the core in the reactor (when the plutonium is produced), removal from the reactor, storage for cooling, shipment, reprocessing and conversion;

(e) The nuclear fuel working capital is reduced by an item shown in Tables 6, 7 and 8 as "reprocessing, losses and shipping". Provision for the cost for such reprocessing, losses and shipping is charged as a part of nuclear fuel expense while the core is being exposed in the reactor. However, payment for such reprocessing, losses and shipping is not made until after the core with which it is associated has been removed from the reactor, stored for cooling, shipped to the reprocessor and the reusable materials recovered from the core. Consequently, the charge to operating expense for these items before payment need be made therefor operates to reduce the nuclear fuel working capital requirement.

The nuclear fuel working capital requirements are affected directly by the level of output of the nuclear station and have, therefore, been separately determined for each level of output investigated. (The components of such nuclear working capital, year by year, for each such level of output are set forth in Tables 6, 7, and 8.)

6. *To determine the fixed charge costs to be applied to the investment in the nuclear plant and working capital.* The fixed charges consist of (a) return on investment, (b) income taxes, and (c) depreciation on depreciable items (*i.e.*, excluding land and working capital).

New Jersey gross receipts taxes are not viewed as a component of fixed charges since they are a function of total revenues (i.e. the revenues required to meet operating and maintenance expenses as well as the revenues required to meet return on investment, depreciation and other taxes). Such gross receipts taxes have not been included in this economic study since the only effect thereof would be to increase, by the same percentage, the total revenue requirements of each station compared and thereby to increase the economic advantage of the station with the lowest total costs.

Return on investment was calculated at the rate of about 6⅜%, which is approximately the upper end of the range of reasonableness determined in the last major electric rate case decided by the Board of Public Utility Commissioners of the State of New Jersey. Any reduction in this assigned rate of return would enhance the competitive position of the nuclear station since it has a larger investment in plant and working capital than the fossil fuel-fired plants. Of the total investment, 63% was assumed to consist of funded debt (mortgage bonds and debentures) and 37% of common stock equity capital.

It is the over-all rate of return, rather than the particular rates of return assigned to the debt and common stock equity components thereof, which is a component of the fixed charge costs. However, the rates of return assigned to debt capital and equity capital do affect taxable income (since interest is a tax deduction and dividends are not) and, therefore, do affect the income tax component of the fixed charges. An interest rate of 4¼% was assigned to the debt capital and of 10% to the common stock equity capital. The 4¼% rate is slightly below current interest costs of debt capital and takes cognizance of the probable impact of refundings during the life of the plant. The assignment of a higher interest rate, within the over-all 6⅜% return, would reduce the common stock equity return and correspondingly the associated income taxes and, therefore, simply improve the competitive position of the nuclear station because it has a larger investment in plant and working capital than the fossil fuel-fired stations.

The income tax component of the fixed charge rate has been determined on the basis of the current 52% Federal corporate income tax rate. (New Jersey does not have a corporate income tax.) For non-depreciable property, the income tax is, therefore, equal to 108⅓% of the equity component of the over-all return, bringing the total annual fixed charge on non-depreciable investment (land and working capital) to 10.39%, *i.e.*,

Total return	6.3775%
Federal income tax on return at 52% (1.0833 x 3.7%) ..	4.0083%
Total	10.3858%
Rounded to	10.39%

A reduction in the Federal income tax rate to 50% would reduce the Federal income tax component of the annual fixed charges to 3.7%, and the over-all annual fixed charges on non-depreciable investment to 10.08%. Once again, such a change would increase the economic advantage in favor of the nuclear station.

In the case of non-depreciable investment, the annual fixed charge rate remains constant throughout the life of the facility. In the case of depreciable plant, the effect of depreciation can be reflected either as a reduction in the base to which a constant fixed charge rate is applied or as a declining fixed charge rate applied to a constant base; the results are identical. The latter method of presentation has been employed in these studies for purposes of convenience.

Depreciation affects annual fixed charges of depreciable plant in two ways, first as a direct component of the fixed charge rate, and second by virtue of its impact on income taxes. For all purposes, depreciation has been based on an assumed 30-year service life for both the nuclear and fossil fuel-fired plants, even though there is technical support for the view that nuclear plants are sufficiently adaptable to changes and improvements in technology, with partial but not full replacements of components, that their over-all estimated service lives should be greater than those of fossil fuel-fired plants installed at the same time.

For similar reasons, the economic studies did not take cognizance of the fact that the depreciation "Guidelines and Rules" of the Internal Revenue Service permit the use of shorter estimated service lives for nuclear generating stations (20 years) than for fossil fuel-fired stations (28 years). Recognition of this differential in "Guidelines" service lives, while using the 30-year service lives for other purposes, would, once again, have simply increased the economic margin in favor of the nuclear station during the early years and, therefore, for the entire lifetime of the stations on a present worth basis.

One of the "liberalized" methods of computing income tax depreciation deductions, namely, the sum-of-the-years digits ("SYD") method, which has been employed by Jersey Central for all qualifying property since 1954, has been employed in the economic analysis. The effect of this method is to reduce the income tax component of the annual fixed charge rate for the first 14 years and thereafter to increase it. In determining the income tax component of fixed charges, no effect was given to the 3% investment tax credit which is only applicable to a single year (the year of completion). Recognition of the credit would have increased by a modest amount the competitive position of the nuclear plant.

Fixed charges for the depreciable portion of transmission investments were determined in the same manner as for depreciable power-plant investment except that a book life of 40 years and a tax life of 30 years was used. A fixed charge rate of 10.39% was applied to non-depreciable transmission property.

(The components of the annual fixed charge rates for each of the years for depreciable power-plant property are set forth in Table 9.)

The total amount required to meet the sum of the total operating and maintenance expenses and the fixed charges on investment in the nuclear plant and the nuclear working capital is referred to as "Total Revenue Requirements" and it appears on line 32 of Tables 10, 11 and 12, and, as divided by the number of kilowatthours produced and by the number of kilowatts, is reflected in summary form in Tables 1, 2 and 3.

B. Basis of Economic Analysis of Fossil Fuel-Fired Stations

The method and basis of economic analysis of the fossil fuel-fired stations considered as possible alternatives to the Oyster Creek nuclear station were essentially similar to those employed for the nuclear station.

Two fossil fuel-fired stations were considered as possible alternatives, namely, one to be located on the same site which was used for the nuclear station and the other at a mine-mouth site in western Pennsylvania. Since Jersey Central is participating in the 1,800,000 KW Keystone Station, it had ready access to the information developed in connection with that station.

There were six principal elements in the economic analysis of the fossil fuel-fired stations. They were as follows:

1. *To determine the estimated cost of the fossil fuel-fired station.* The costs per kilowatt of the fossil fuel-fired stations considered as possible alternatives to the Oyster Creek nuclear station have been derived from the cost of the Keystone station, since the per kilowatt cost of the Keystone station is substantially below that of any other modern base load fossil fuel-fired generating capacity now in being or under construction in the Pennsylvania-New Jersey-Maryland Interconnection area. Costs derived from the Keystone station therefore provide an appropriately severe test for the economic feasibility of the nuclear station.

The two-unit Keystone station is under construction with the first unit scheduled for service in 1967 and the second in 1968. Contracts for the major equipment items (turbo generators, boilers and some accessories) of the station were executed during 1963; and the estimated cost for the station is, therefore, both reasonably definitive and timely. However, an adjustment to that cost in determining the cost of the fossil fuel-fired alternates to the Oyster Creek nuclear station is necessary for three reasons:

(a) The Keystone station is a two unit station whereas, since the Oyster Creek nuclear station will be a single unit station for some time, the appropriate fossil fuel-fired alternate to the Oyster Creek nuclear station is also a single unit station. There are certain costs, such as site development, civil works, communications, etc., frequently referred to as "cover charges," which are almost as great for a single unit station as for a two-unit station. Consequently, the per kilowatt "cover charge" component of the Keystone costs must be increased in arriving at the per kilowatt capital cost of the fossil fuel-fired station alternatives to the Oyster Creek nuclear station;

(b) The Keystone station equipment costs are somewhat below the costs available today, even though only a few months have elapsed since the contracts for the Keystone station equipment were placed; and

(c) The Keystone units are 900,000 KW units. Use of a 50% smaller fossil fuel-fired unit size (i.e. one of approximately 600,000 KW) so as to be comparable to the nuclear unit, results in a modest increase in cost per kilowatt for the fossil fuel-fired capacity.

Adjustment of the Keystone station costs for these three factors produces a cost of $102 per KW for fossil fuel-fired capacity at a western Pennsylvania site. Delivery of the western capacity to the eastern load centers involves 3% transmission losses, and thereby increases the delivered cost of western fossil fuel-fired generating capacity to $105 per KW.

Construction costs in New Jersey are somewhat higher than in western Pennsylvania and add about $8 per KW to the $102 per KW cost at the western Pennsylvania site, making the estimated cost of the eastern fossil fuel-fired generating capacity approximately $110 per KW.

2. *To determine the estimated transmission investment.* The $2,500,000 estimated transmission investment from the Oyster Creek site was determined on the basis of careful studies by Jersey Central. Such required transmission investment is not affected by the question of whether the station at that site is nuclear or fossil fuel-fired and is here assumed to be unaffected by the question of whether the unit size is 515,000 KW or somewhat larger. Hence, when related to a larger unit size, this transmission investment becomes somewhat smaller on a per kilowatt basis. It is for this reason that the transmission investment of $2,500,000 has been expressed as $4 per KW for the nuclear station at 620,000 KW capability, and $5 per KW for the nuclear station at the minimum 515,000 KW capability and the intermediate 565,000 KW capability. For the same reason, such transmission investment becomes $3 per KW when related to a larger fossil fuel-fired unit at the Oyster Creek site.

In the case of the western Pennsylvania fossil fuel-fired alternate, a substantial transmission investment is required to deliver the output of that station to the eastern load centers. An estimated cost of $30 per KW for such investment was determined on the basis of the cost per kilowatt for transmitting the output of the Keystone station to the eastern load centers. (The portion of the Keystone transmission facilities used for purposes other than the delivery of the Keystone station output to the east was excluded in making this estimate.)

3. *To determine the use factor at which the fossil fuel stations would operate.* As noted under Item 3 of Section A above, studies were made of the capacity use factor of each of the stations over its estimated service life and the results of such study are presented in the diagram on Table 5. It will be noted that the use factor for the eastern fossil fuel unit begins to decline at an earlier date and more rapidly than the western fossil fuel unit. This merely represents the differential in the fossil fuel costs at the two locations and the

fact that, where two identical generating units are involved, the unit which has the lowest incremental operating costs will be more fully loaded.

It must be emphasized that in order to provide the same energy base over which to spread the fixed charges, and thus avoid penalizing the fossil fuel-fired stations for the fact that they would operate at a lower use factor, the fossil fuel-fired stations were assigned the same use factor as the nuclear station. If, however, the fossil fuel-fired stations were assigned operating costs for their own operations for the periods when they would not, in fact, operate—because economy energy would be available from other sources at a lower cost—the operating costs associated with the fossil fuel-fired units would have been unrealistically high. For this reason, the energy cost associated with each fossil fuel station was the cost applicable to its own operation up to the point where it would in fact operate plus the cost of the more economic energy available from other sources for the block of energy representing the difference between (i) the actual use factor for the fossil fuel-fired station and (ii) the use factor for the nuclear station.

4. *To determine the fossil fuel and other operating and maintenance costs.* Within the past year there has been a substantial decline in the cost of fossil fuel delivered to New Jersey generating station sites (and to other sites on the Atlantic seaboard). In 1962 and for several years before, the cost of coal at New Jersey sites was in the neighborhood of 34¢ per million Btu. In 1963 these costs declined, so that by the end of 1963 Jersey Central was experiencing coal costs of 29.5¢ per million Btu.

Further reductions in coal costs delivered to the Oyster Creek site appear feasible and probable. This was borne out by the fact that, after the announcement that Jersey Central was considering the possible installation of the nuclear unit, a proposal was made to it for coal supplied at that site at substantially lower prices under long-term contracts. This proposal was carefully considered and the prospective suppliers were invited to submit their most favorable offer. Their offer as submitted was the equivalent of about 26¢ per million Btu; this offer was based upon the use of unit trains and upon ownership by Jersey Central of a portion of the investment in railroad cars and some related facilities. In the light of this offer, an estimated fuel cost of 26¢ per million Btu was used for the Oyster Creek fossil fuel-fired station alternate. A footnote on Tables 1, 2 and 3 indicates that a reduction of 1¢ per million Btu from the 26¢ figure used would reduce the total cost of power delivered from the Oyster Creek fossil fuel-fired station by 9/100ths mills per KWH or by 70¢ per KW/year in years 1 to 10, 68¢ per KW/year in years 11 to 20 and 49¢ per KW/year in years 21 to 30.

For the western Pennsylvania fuel-fired station alternative, a fossil fuel cost of 17¢ per million Btu was employed. This was based upon the coal contracts recently negotiated for the Keystone station, and assumes that a large part of the coal supplied will be from mines located at or adjacent to the station. A footnote on Tables 1, 2 and 3 indicates that a reduction of 1¢ per million Btu from the 17¢ figure used would reduce the total cost of power delivered from the western Pennsylvania fossil fuel-fired station by 9/100ths mill per KWH or by 73¢ per KW/year in years 1 to 10, 71¢ per KW/year in years 11 to 20 and 51¢ per KW/year in years 21 to 30.

In making its economic analysis, there was available to Jersey Central a draft of a report prepared by the Fuels Special Technical Committee of the Federal Power Commission's National Power Survey, which report in final form (dated December 1963) has since been released by the Commission as Advisory Report No. 21. That report envisages that, for the period 1970-80, the average coal price f.o.b. mine for electric utilities will be approximately 10% lower than in 1961, assuming a constant general price level. That report points out that the levels of such coal prices are difficult to predict because of the many variables involved, including differences in coal quality and in mine and machine running time, the significant changes that are developing in methods and costs of coal transportation and in the transmission of coal-produced power, the possible changes in wage rates and offsetting efficiencies, the need for reasonable profits to the coal industry, the changes taking place in competitive fuels, and many other factors. The report also states that, even though there are limitations to increased mechanization, there are excellent potentials for further increases in the production of coal because of the potential for increased machine running time, the development of new mines specifically adapted for new types of machinery, and the increasing concentration of coal production in highly mechanized mines. It also points out that, in addition to these influences for stable-to-lower coal prices f.o.b. mines, there are strong pressures of competing sources of energy.

Advisory Report No. 21 also envisages continuing progress by the railroad industry in providing more efficient and lower cost coal transportation by rail. In this connection the Fuels Special Technical Committee paid particular attention to the development of coal freight rates better designed to fit the needs and circumstances of individual utilities, the use of "unit train" operations and specially designed coal cars and loading and unloading facilities, and the development of "integral trains". The Fuels Special Technical Committee pointed out that it had not tried to take into account the institutional and regulatory obstacles that may stand in the way of rate reductions for coal transportation and had instead assumed that, over the long run, such obstacles would be overcome to permit the exploitation of the technical opportunities. On this basis, the Committee estimated that, by 1980, the cost of rail transportation for coal for electric utility use could be expected to be at least 15% below presently prevailing rates, in terms of constant dollars, and might well be substantially lower than that figure.

The Special Fuel Technical Committee also gave consideration to the influence of coal pipe lines affecting the cost of coal for electric generation in the 1970-80 decade. The Committee pointed out that coal pipe lines transporting slurry are an effective way to deliver coal, but that acceptable costs resulting from the use of pipe lines are dependent upon large volumes and that whether a coal pipe line project develops depends to a great degree on whether other methods of transportation can maintain prices which discourage investment in a new venture of this type and whether other obstacles to construction can be eliminated. In this connection this Committee referred to the demonstration conducted by Jersey Central in October 1961 at its Werner Station which established the technical and operational feasibility of firing coal slurry directly into a cyclone burner with a minimum of trouble.

One of Jersey Central's present generating stations is equipped to burn either coal or natural gas and another is equipped to burn either coal or residual fuel oil. Except for small quantities of off-peak gas, neither natural gas nor residual fuel oil have recently been competitive with coal in Jersey Central's generating stations. Jersey Central has no reason to believe that either natural gas or residual fuel oil will be available at the Oyster Creek site, in quantities required to meet the station's needs, at prices below the 29.5¢ per million Btu coal cost experienced at the end of 1963, let alone below the 26¢ per million Btu coal cost estimate used in this study.

This conclusion appears to be borne out by Advisory Committee Report No. 21 which concluded that, within the region in which Jersey Central operates, electric utilities will continue to buy about the same amount of natural gas that they presently purchase, and that, although the gas industry will have transmission capacity to supply more, under present and expected price relationships the price of gas would be above competing energy sources. In the case of residual fuel oil, the Committee referred to the fact that a projection of the availability for electric generation of residual fuel oil at competitive prices is an extremely complex assignment which is entwined with international pressures beyond the ordinary elements of supply and demand, sociological changes and the world economy. The Committee concluded, however, that residual oil is not expected to increase its percentage of the total amount of energy consumed by electric utilities; that this percentage will probably decrease; and that the extent to which residual fuel oil remains competitive depends to some extent upon the degree to which other fuels, especially coal, can realize greater economies in production and transportation and, in turn, reflect these economies in lower prices to electric utilities.

The views presented in Advisory Committee Report No. 21 are consonant with Jersey Central's own experience and its belief that, in terms of constant dollars, the trend of delivered fossil fuel to its generating station sites will be toward appreciably lower costs, but that these reductions will not come about overnight. In making its decision to proceed with the Oyster Creek nuclear station, Jersey Central concluded that it should not attempt to give quantitative weight to these probable reductions in the long-term trends of fossil fuel costs, just as it should not attempt to give quantitative weight to the expected reduction in the cost of nuclear fuel after the third core. If, as Jersey Central expects, a substantial part of the projected reduction in the delivered cost of coal is achieved, the interplay of competitive factors should also be such as to stimulate and accelerate the anticipated reductions in the cost of nuclear fuel. As applied to this particular station at Oyster Creek on the basis of the known facts and presently identifiable and available costs, the economic margin in favor of nuclear development appears to be sufficiently large that it is unlikely that it would be disturbed by differences in the future long term trends of nuclear and fossil fuels.

The net plant heat rates for the fossil fuel-fired stations, adjusted to average operating conditions and, in the case of the western Pennsylvania station, for transmission losses for delivery to New Jersey, were assumed to be 9,110 Btu per KWH for the fossil fuel-fired station at the Oyster Creek site, and 9,155 Btu per KWH for the western Pennsylvania station.

Other operating and maintenance costs for the fossil fuel-fired stations were derived from the studies made in connection with the Keystone and Oyster Creek stations.

5. *To determine working capital requirements*. Working capital for the fossil fuel-fired stations was based upon (a) the maintenance of a 30-day fuel inventory, (b) materials

and supplies equal to 1% of station cost, (c) prepaid insurance premiums and (d) provision for operating and maintenance expenses (including fuel expense but excluding insurance) for 45 days, reduced by (e) federal income tax expenses charged to operations prior to payment to the government.

6. *To determine the fixed charge costs to be applied to the investment in the fossil fuel-fired plant and working capital.* Except for the inclusion of the applicable portion (one-third) of the Pennsylvania 6% state income tax in the western Pennsylvania fossil fuel-fired station, the fixed charges applicable to the investment in the fossil fuel-fired station, and their working capital, and the derivation of such fixed charges assuming a 30-year life for the fossil fuel-fired station for all purposes, are identical with those for the nuclear station. They are discussed in Item 6 of Section A, and the components of the annual fixed charges for each of the years for depreciable property are set forth in Table 9. For non-depreciable property, the annual fixed charge rate is identical with that for the nuclear station, namely, 10.39%, based on the corporate federal income tax rate of 52%, except that, in the case of the western Pennsylvania alternative, the applicable portion of the Pennsylvania income tax also had to be added.

C. Results of Economic Analysis

On the basis of the factors discussed above in this report, the Oyster Creek nuclear station demonstrates economic advantages over a fossil fuel-fired station at the same location at all three levels of nuclear station capability investigated. The annual amount of such advantage varies from year to year, and the following table sets forth the approximate annual amounts of such advantages (disadvantages).

Years	620,000 KW Expected Capability (millions)	515,000 KW Minimum Capability (millions)	565,000 KW Intermediate Capability (millions)
1-5	$2.6	$.4	$1.4
6-10	3.2	.9	2.0
11-20	2.6	.5	1.5
21-30	1.2	(.4)	.4
30-year average (present worth)	$2.5	$.4	$1.4

As against a western Pennsylvania fossil fuel-fired station, the Oyster Creek nuclear station demonstrates significant economic advantages at its expected 620,000 KW capability, disadvantages of almost the same magnitude at the 515,000 KW guaranteed minimum capability and modest advantages at the intermediate 565,000 KW capacity. The following table sets forth these approximate annual advantages (disadvantages).

Years	620,000 KW Expected Capability (millions)	515,000 KW Minimum Capability (millions)	565,000 KW Intermediate Capability (millions)
1-5	$ .8	($1.1)	($ .2)
6-10	1.7	(.3)	.6
11-20	1.2	(.6)	.3
21-30	.6	(1.0)	(.2)
30-year average (present worth)	$1.1	($ .8)	$ .1

The comparative costs of power in terms of mills per kilowatthour and total annual costs per kilowatt are set forth in detail in Tables 1, 2 and 3 and are summarized below:

	Fossil Fuel Plants		Nuclear		
	Western Penna.	Oyster Creek	620,000 KW	515,000 KW	565,000 KW
Annual Costs—Mills per KWH					
Years 1 to 5...	*3.98*	*4.34*	*3.79*	*4.25*	*4.02*
6 to 10...	*3.86*	*4.18*	*3.50*	*3.94*	*3.71*
11 to 20...	*3.68*	*3.98*	*3.42*	*3.84*	*3.62*
21 to 30...	*4.14*	*4.33*	*3.97*	*4.49*	*4.21*
Annual Costs—Dollars per KW					
Years 1 to 5...	$30.63	$33.52	$29.26	$32.74	$30.98
6 to 10...	29.75	32.20	26.97	30.41	28.61
11 to 20...	27.60	29.82	25.61	28.78	27.09
21 to 30...	22.32	23.32	21.41	24.19	22.68
30-year average present worth) ...	$28.28	$30.59	$26.52	$29.80	$28.08

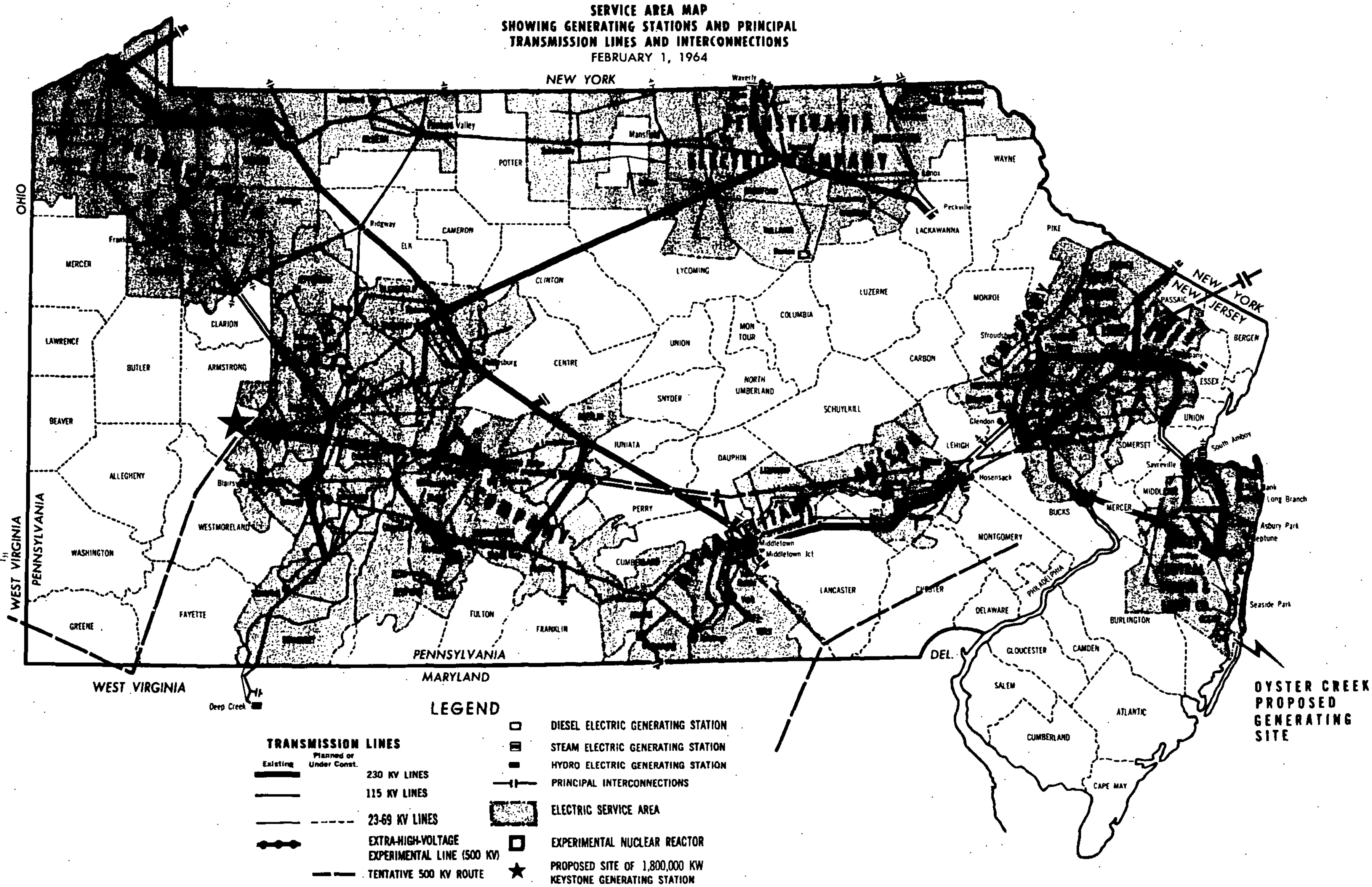
Engineering aspects of this study have been under the supervision of Mr. J. E. Logan, Vice President of Jersey Central, and economic aspects under the supervision of Mr. W. E. Liepe, Manager of Research and Rates of Jersey Central.

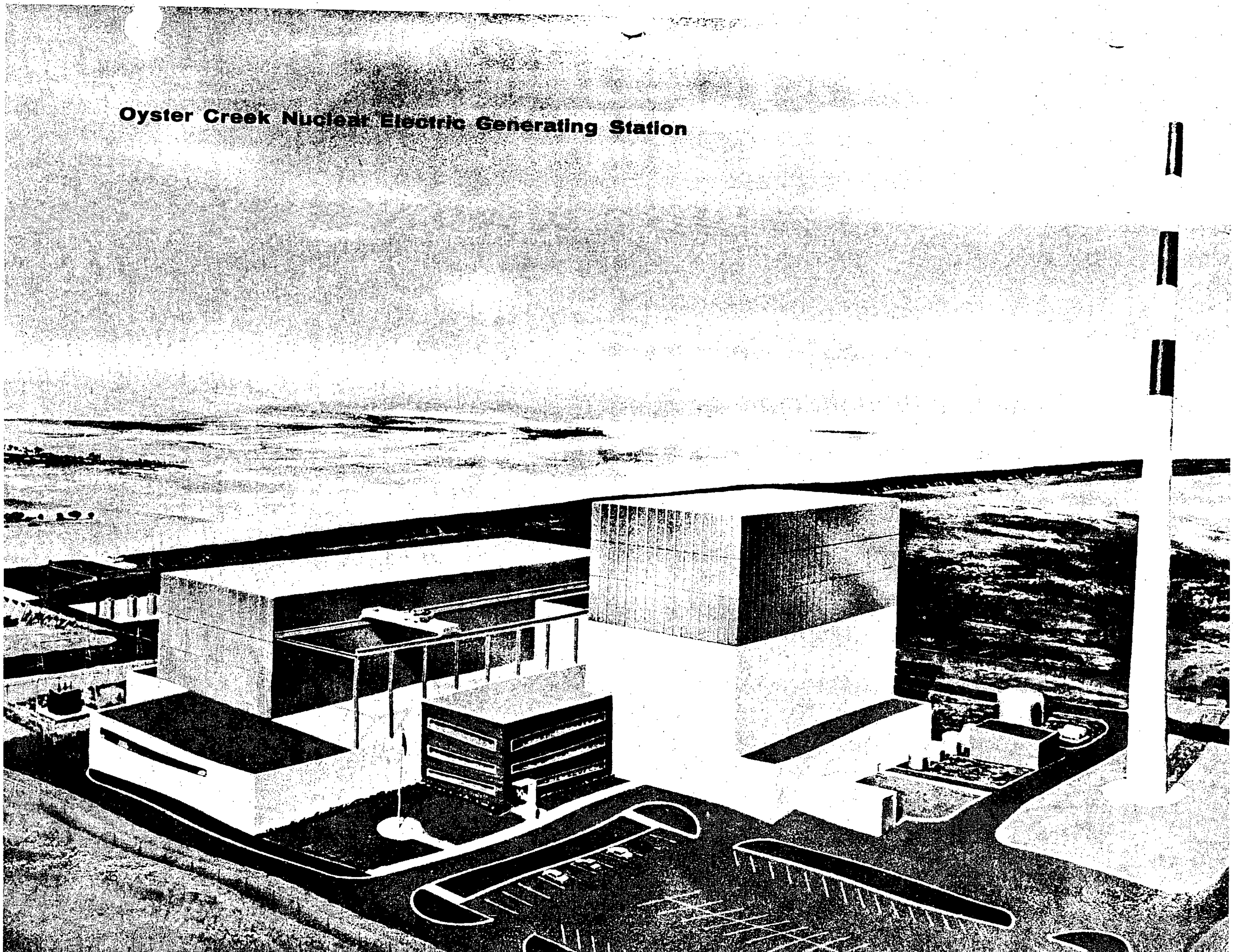
JERSEY CENTRAL POWER & LIGHT COMPANY

W. H. MCELWAIN
President

GENERAL PUBLIC UTILITIES CORPORATION

SERVICE AREA MAP
SHOWING GENERATING STATIONS AND PRINCIPAL TRANSMISSION LINES AND INTERCONNECTIONS
FEBRUARY 1, 1964




Oyster Creek Nuclear Electric Generating Station

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY

TABLES

TABLE No. 1

COMPARISON OF FOSSIL FUEL PLANTS IN WESTERN PENNA. AND AT OYSTER CREEK WITH OYSTER CREEK NUCLEAR PLANT OPERATING AT 620 MW (NET) OUTPUT

Return — *6.3775%*; Generating Plant Life — 30 Years Book and Tax; Plant Factors — Declining
Nuclear Plant Cost — $68,000,000; Transmission Cost for New Jersey Plant — $2,500,000

	Fossil Fuel Plant		Oyster Creek Nuclear Plant			
	Western Penna.*	Oyster Creek**	Years 1 to 5	Years 6 to 10	Years 11 to 20	Years 21 to 30
INVESTMENT — PER KW						
Generation (D'lvd. in N. J.)	$105	$110	$110	$110	$110	$110
Transmission	30	3	4	4	4	4
Working Capital (Other than Fuel)	2	1	2	2	1	***
Subtotal	$137	$114	$116	$116	$115	$114
Working Capital (Fuel)	3	4	11	22	26	24
Total	$140	$118	$127	$138	$141	$138
INVESTMENT — TOTAL AMOUNT (000's)	$86,800	$73,200	$78,500	$85,400	$87,000	$85,700
ANNUAL COSTS (Mills per KWH)						
Years 1 to 5						
Fixed Charge:						
Plant & Other Working Capital	*1.83*	*1.52*	*1.55*			
Fuel Working Capital	*0.04*	*0.05*	*0.14*			
Fuel Expense	*1.61*	*2.35*	*1.62*			
Other O & M Expense	*0.50*	*0.42*	*0.48*			
Total	*3.98*	*4.34*	*3.79*			
Years 6 to 10						
Fixed Charge:						
Plant & Other Working Capital	*1.73*	*1.43*		*1.45*		
Fuel Working Capital	*0.03*	*0.05*		*0.30*		
Fuel Expense	*1.61*	*2.31*		*1.27*		
Other O & M Expense	*0.49*	*0.39*		*0.48*		
Total	*3.86*	*4.18*		*3.50*		
Years 11 to 20						
Fixed Charge:						
Plant & Other Working Capital	*1.62*	*1.32*			*1.34*	
Fuel Working Capital	*0.03*	*0.04*			*0.36*	
Fuel Expense	*1.58*	*2.25*			*1.23*	
Other O & M Expense	*0.45*	*0.37*			*0.49*	
Total	*3.68*	*3.98*			*3.42*	
Years 21 to 30						
Fixed Charge:						
Plant & Other Working Capital	*1.97*	*1.56*				*1.59*
Fuel Working Capital	*0.03*	*0.05*				*0.47*
Fuel Expense	*1.58*	*2.26*				*1.23*
Other O & M Expense	*0.56*	*0.46*				*0.68*
Total	*4.14*	*4.33*				*3.97*
ANNUAL COSTS (Dollars per KW)						
Years 1 to 5						
Fixed Charge:						
Plant & Other Working Capital	$14.07	$11.75	$11.96			
Fuel Working Capital	0.29	0.4[illegible]	1.09			
Fuel Expense	12.41	18.14	12.52			
Other O & M Expense	3.86	3.22	3.69			
Total	$30.63	$33.52	$29.26			
Years 6 to 10						
Fixed Charge:						
Plant & Other Working Capital	$13.30	$11.01		$11.17		
Fuel Working Capital	0.26	0.38		2.33		
Fuel Expense	12.39	17.78		9.78		
Other O & M Expense	3.80	3.03		3.69		
Total	$29.75	$32.20		$26.97		
Years 11 to 20						
Fixed Charge:						
Plant & Other Working Capital	$12.14	$ 9.89			$10.06	
Fuel Working Capital	0.22	0.32			2.67	
Fuel Expense	11.86	16.85			9.19	
Other O & M Expense	3.38	2.76			3.69	
Total	$27.60	$29.82			$25.61	
Years 21 to 30						
Fixed Charge:						
Plant & Other Working Capital	$10.60	$ 8.40				$ 8.57
Fuel Working Capital	0.17	0.25				2.54
Fuel Expense	8.53	12.16				6.61
Other O & M Expense	3.02	2.51				3.69
Total	$22.32	$23.32				$21.41
Thirty Years — Present Worth Average	$28.28	$30.59				$26.52

*1¢/MBTU = .09 Mills/KWH or $0.73/KW in Years 1 to 10; $0.71/KW in Years 11 to 20; $0.51/KW in Years 21 to 30

**1¢/MBTU = .09 Mills/KWH or $0.70/KW in Years 1 to 10; $0.68/KW in Years 11 to 20; $0.49/KW in Years 21 to 30

***Less than 50¢

TABLE No. 2

COMPARISON OF FOSSIL FUEL PLANTS IN WESTERN PENNA. AND AT OYSTER CREEK WITH OYSTER CREEK NUCLEAR PLANT OPERATING AT 515 MW (NET) OUTPUT

Return — *6.3775%*; Generating Plant Life — 30 Years Book and Tax; Plant Factors — Declining Nuclear Plant Cost — $68,000,000; Transmission Cost for New Jersey Plant — $2,500,000

	Fossil Fuel Plant		Oyster Creek Nuclear Plant			
	Western Penna.*	Oyster Creek**	Years 1 to 5	Years 6 to 10	Years 11 to 20	Years 21 to 30
INVESTMENT — PER KW						
Generation (D'lvd. in N. J.)	$105	$110	$132	$132	$132	$132
Transmission	30	3	5	5	5	5
Working Capital (Other than Fuel)	2	1	3	2	1	***
Subtotal	$137	$114	$140	$139	$138	$137
Working Capital (Fuel)	3	4	13	27	30	28
Total	$140	$118	$153	$166	$168	$165
INVESTMENT — TOTAL AMOUNT (000's)	$71,900	$61,000	$78,400	$85,100	$86,600	$85,100
ANNUAL COSTS (Mills per KWH)						
Years 1 to 5						
Fixed Charge:						
Plant & Other Working Capital	*1.83*	*1.52*	*1.87*			
Fuel Working Capital	*0.04*	*0.05*	*0.17*			
Fuel Expense	*1.61*	*2.35*	*1.66*			
Other O & M Expense	*0.50*	*0.42*	*0.55*			
Total	*3.98*	*4.34*	*4.25*			
Years 6 to 10						
Fixed Charge:						
Plant & Other Working Capital	*1.73*	*1.43*		*1.74*		
Fuel Working Capital	*0.03*	*0.05*		*0.36*		
Fuel Expense	*1.61*	*2.31*		*1.29*		
Other O & M Expense	*0.49*	*0.39*		*0.55*		
Total	*3.86*	*4.18*		*3.94*		
Years 11 to 20						
Fixed Charge:						
Plant & Other Working Capital	*1.62*	*1.32*			*1.61*	
Fuel Working Capital	*0.03*	*0.04*			*0.42*	
Fuel Expense	*1.58*	*2.25*			*1.24*	
Other O & M Expense	*0.45*	*0.37*			*0.57*	
Total	*3.68*	*3.98*			*3.84*	
Years 21 to 30						
Fixed Charge:						
Plant & Other Working Capital	*1.97*	*1.56*				*1.91*
Fuel Working Capital	*0.03*	*0.05*				*0.55*
Fuel Expense	*1.58*	*2.26*				*1.24*
Other O & M Expense	*0.56*	*0.46*				*0.79*
Total	*4.14*	*4.33*				*4.49*
ANNUAL COSTS (Dollars per KW)						
Years 1 to 5						
Fixed Charge:						
Plant & Other Working Capital	$14.07	$11.75	$14.37			
Fuel Working Capital	0.29	0.41	1.33			
Fuel Expense	12.41	18.14	12.79			
Other O & M Expense	3.86	3.22	4.25			
Total	$30.63	$33.52	$32.74			
Years 6 to 10						
Fixed Charge:						
Plant & Other Working Capital	$13.30	$11.01		$13.42		
Fuel Working Capital	0.26	0.38		2.78		
Fuel Expense	12.39	17.78		9.96		
Other O & M Expense	3.80	3.03		4.25		
Total	$29.75	$32.20		$30.41		
Years 11 to 20						
Fixed Charge:						
Plant & Other Working Capital	$12.14	$ 9.89			$12.08	
Fuel Working Capital	0.22	0.32			3.15	
Fuel Expense	11.86	16.85			9.30	
Other O & M Expense	3.38	2.76			4.25	
Total	$27.60	$29.82			$28.78	
Years 21 to 30						
Fixed Charge:						
Plant & Other Working Capital	$10.60	$ 8.40				$10.30
Fuel Working Capital	0.17	0.25				2.95
Fuel Expense	8.53	12.16				6.69
Other O & M Expense	3.02	2.51				4.25
Total	$22.32	$23.32				$24.19
Thirty Years — Present Worth Average	$28.28	$30.59				$29.80

*1¢/MBTU = .09 Mills/KWH or $0.73/KW in Years 1 to 10, $0.71/KW in Years 11 to 20, $0.51/KW in Years 21 to 30

**1¢/MBTU = .09 Mills/KWH or $0.70/KW in Years 1 to 10, $0.68/KW in Years 11 to 20, $0.49/KW in Years 21 to 30

***Less than 50¢

TABLE No. 3

COMPARISON OF FOSSIL FUEL PLANTS IN WESTERN PENNA. AND AT OYSTER CREEK WITH OYSTER CREEK NUCLEAR PLANT OPERATING AT 565 MW (NET) OUTPUT

Return — *6.3775%*; Generating Plant Life — 30 Years Book and Tax; Plant Factors — Declining
Nuclear Plant Cost — $68,000,000; Transmission Cost for New Jersey Plant — $2,500,000

	Fossil Fuel Plant		Oyster Creek Nuclear Plant			
	Western Penna*	Oyster Creek**	Years 1 to 5	Years 6 to 10	Years 11 to 20	Years 21 to 30
INVESTMENT — PER KW						
Generation (D'lvd. in N. J.)	$105	$110	$120	$120	$120	$120
Transmission	30	3	5	5	5	5
Working Capital (Other than Fuel)	2	1	2	2	1	***
Subtotal	$137	$114	$127	$127	$126	$125
Working Capital (Fuel)	3	4	12	24	28	26
Total	$140	$118	$139	$151	$154	$151
INVESTMENT — TOTAL AMOUNT (000's)	$78,900	$66,900	$78,800	$85,100	$86,900	$85,300
ANNUAL COSTS (Mills per KWH)						
Years 1 to 5						
Fixed Charge:						
Plant & Other Working Capital	*1.83*	*1.52*	*1.70*			
Fuel Working Capital	*0.04*	*0.05*	*0.17*			
Fuel Expense	*1.61*	*2.35*	*1.64*			
Other O & M Expense	*0.50*	*0.42*	*0.51*			
Total	*3.98*	*4.34*	*4.02*			
Years 6 to 10						
Fixed Charge:						
Plant & Other Working Capital	*1.73*	*1.43*		*1.59*		
Fuel Working Capital	*0.03*	*0.05*		*0.33*		
Fuel Expense	*1.61*	*2.31*		*1.28*		
Other O & M Expense	*0.49*	*0.39*		*0.51*		
Total	*3.86*	*4.18*		*3.71*		
Years 11 to 20						
Fixed Charge:						
Plant & Other Working Capital	*1.62*	*1.32*			*1.47*	
Fuel Working Capital	*0.03*	*0.04*			*0.39*	
Fuel Expense	*1.58*	*2.25*			*1.23*	
Other O & M Expense	*0.45*	*0.37*			*0.53*	
Total	*3.68*	*3.98*			*3.62*	
Years 21 to 30						
Fixed Charge:						
Plant & Other Working Capital	*1.97*	*1.56*				*1.74*
Fuel Working Capital	*0.03*	*0.05*				*0.51*
Fuel Expense	*1.58*	*2.26*				*1.23*
Other O & M Expense	*0.56*	*0.46*				*0.73*
Total	*4.14*	*4.33*				*4.21*
ANNUAL COSTS (Dollars per KW)						
Years 1 to 5						
Fixed Charge:						
Plant & Other Working Capital	$14.07	$11.75	$13.11			
Fuel Working Capital	0.29	0.41	1.26			
Fuel Expense	12.41	18.14	12.65			
Other O & M Expense	3.86	3.22	3.96			
Total	$30.63	$33.52	$30.98			
Years 6 to 10						
Fixed Charge:						
Plant & Other Working Capital	$13.30	$11.01		$12.24		
Fuel Working Capital	0.26	0.38		2.53		
Fuel Expense	12.39	17.78		9.88		
Other O & M Expense	3.80	3.03		3.96		
Total	$29.75	$32.20		$28.61		
Years 11 to 20						
Fixed Charge:						
Plant & Other Working Capital	$12.14	$ 9.89			$11.02	
Fuel Working Capital	0.22	0.32			2.92	
Fuel Expense	11.86	16.85			9.19	
Other O & M Expense	3.38	2.76			3.96	
Total	$27.60	$29.82			$27.09	
Years 21 to 30						
Fixed Charge:						
Plant & Other Working Capital	$10.60	$ 8.40				$ 9.39
Fuel Working Capital	0.17	0.25				2.72
Fuel Expense	8.53	12.16				6.61
Other O & M Expense	3.02	2.51				3.96
Total	$22.32	$23.32				$22.68
Thirty Years — Present Worth Average	$28.28	$30.59				$28.08

*1¢/MBTU = .09 Mills/KWH or $0.73/KW in Years 1 to 10
$0.71/KW in Years 11 to 20
$0.51/KW in Years 21 to 30

**1¢/MBTU = .09 Mills/KWH or $0.70/KW in Years 1 to 10
$0.68/KW in Years 11 to 20
$0.49/KW in Years 21 to 30

***Less than 50¢

TABLE No. 4

OYSTER CREEK NUCLEAR PLANT STUDY

BASIC FINANCIAL AND ECONOMIC ASSUMPTIONS

FINANCIAL

Debt Capital—*63%* at *4.25%* Interest Rate	*2.6775%*
Equity Capital— *37%* at *10%* Earnings Rate	*3.7000*
Total Return	*6.3775%*

Interest during construction — 6% Simple Interest

DEPRECIATION

	Nuclear	Fossil	Transmission
Book Life — Years	30	30	40
Tax Life — Years	30	30	30

No salvage or allowance for interim replacements. Tax Depreciation adjusted to S.Y.D. basis. Effect of 3% investment credit is not included and tax depreciation has not been applied to the interest during construction added to plant investment.

TAX RATES

Federal Income Tax — *52%*
Pa. Income Tax — 6% (⅓rd applicable)
N. J. Revenue Taxes — Not applied

NUCLEAR COSTS

(a) **Fuel**

	Up to 12-31-69	1-1-70 to 6-1-73	After 6-1-73
Yellow Cake (per lb.)	Pres. AEC	$ 6	$ 6
Separative Cost (per Kg.)	Pres. AEC	$25	$25
Fuel Ownership	AEC	AEC	Private
Pu (239 and 241 only) (per gram)	$10.00	$8.00	$8.00

(b) **Processing** — Based on N.F.S. Contract

	Up to 12-31-74 Enrichment of U Charged	After 12-31-74 Enrichment of U Charged
	3% or Less	3% or Less
Per Metric Ton	$ 23,500	$ 21,150
Turnaround Cost/Metric Ton	7,833	7,050
Turnaround Cost — Minimum	188,000	169,200

(c) **Insurance** — Annual Premium

Liability — First $60,000,000 (Nelia)	$170,000
Liability — $500,000,000 (Federal)	$30 per MWt.
Physical Damage (90% of Investment excl. Land)	$4.70 per $1,000

FOSSIL FUEL COST

Western — 17 cents per million B.t.u.
Eastern — 26 cents per million B.t.u.

PLANT FACTOR (See also Table 5)

Years	Nuclear	Fossil: Eastern Plant	Fossil: Western Plants
1- 5	*88%*	*84%*	*88%*
6-10	*88*	*73*	*85*
11-15	*88*	*62*	*70*
16-20	*83*	*53*	*59*
21-25	*67*	*46*	*50*
26-30	*56*	*40*	*43*

All fossil plant studies adjusted to nuclear plant factors by replacing energy deficiency for Eastern Plant at 2 mills/KWH and Western Plants at 1.5 mills/KWH.

TABLE No. 5

ESTIMATED PLANT USE FACTOR BY YEARS OVER 30-YEAR SERVICE LIFE

For Nuclear or Fossil Fuel Plant Placed in Service in 1967

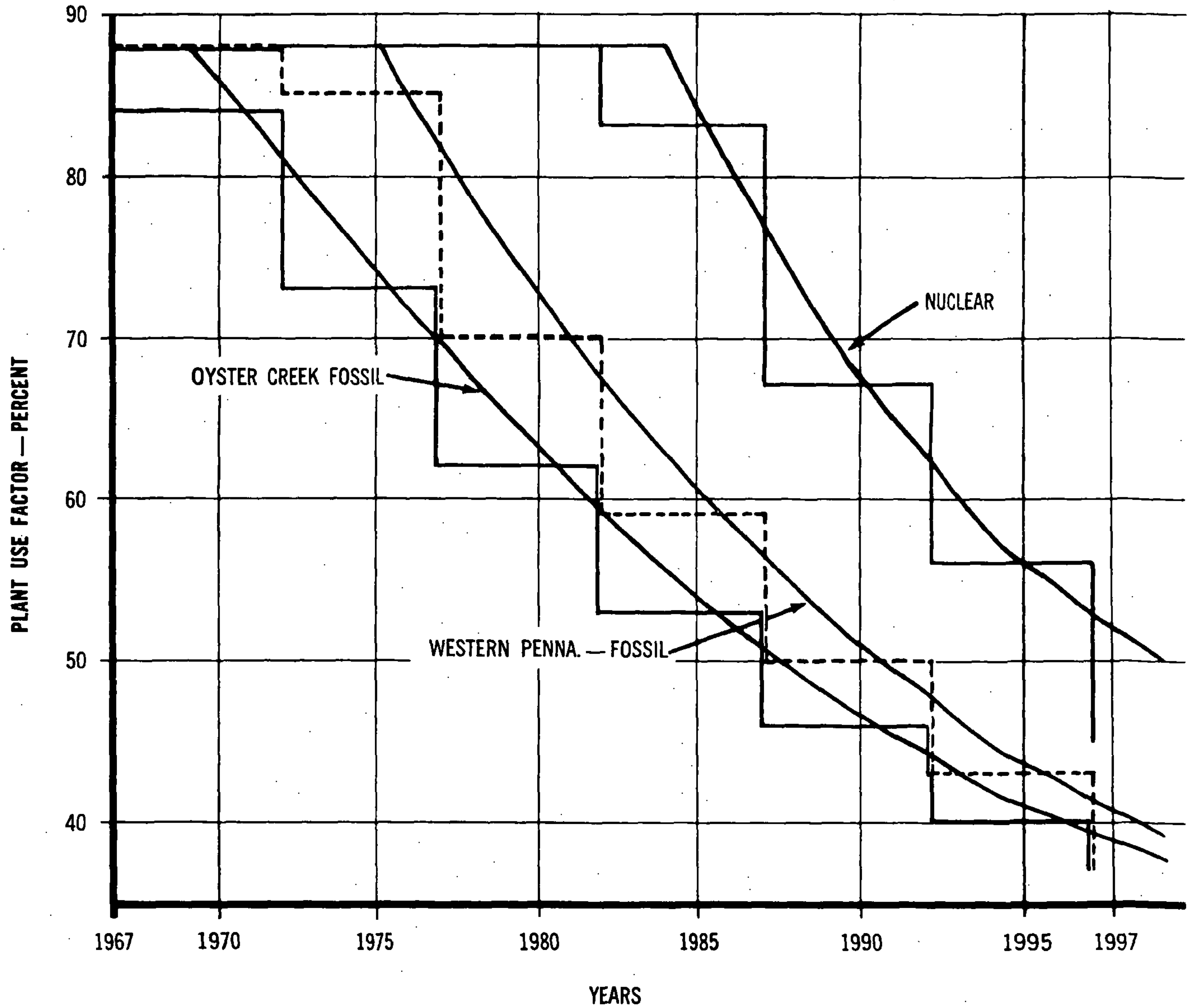


TABLE No. 6
Page 1 of 3

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 620 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

(000's Omitted)

Line No.		YEARS 1	2	3	4	5	6	7	8	9	10
1	**Fabrication**										
2	Balance — Start of Year....................	$ 7,962.1	$ 5,052.1	$ 5,290.2	$ 4,303.4	$ 3,715.7	$ 2,986.3	$ 4,251.2	$ 3,749.0	$ 3,246.7	$ 4,616.5
3	Added — Start of Year....................	437.3	—	—	—	—	1,865.3	—	—	—	—
4	Total — Start of Year....................	$ 8,399.4	$ 5,052.1	$ 5,290.2	$ 4,303.4	$ 3,715.7	$ 4,851.6	$ 4,251.2	$ 3,749.0	$ 3,246.7	$ 4,616.5
5	Transfer to Fuel Expense..................	3,776.0	3,776.1	2,993.9	2,594.7	2,594.6	2,465.6	2,367.5	2,367.5	2,360.7	2,351.1
6	Subtotal	$ 4,623.4	$ 1,276.0	$ 2,296.3	$ 1,708.7	$ 1,121.1	$ 2,386.0	$ 1,883.7	$ 1,381.5	$ 886.0	$ 2,265.4
7	Added during the Year....................	428.7	4,014.2	2,007.1	2,007.0	1,865.2	1,865.2	1,865.3	1,865.2	3,730.5	1,865.3
8	Total — End of Year......................	$ 5,052.1	$ 5,290.2	$ 4,303.4	$ 3,715.7	$ 2,986.3	$ 4,251.2	$ 3,749.0	$ 3,246.7	$ 4,616.5	$ 4,130.7
9	Average (Line 4+8)......................	6,725.8	5,171.2	4,796.8	4,009.6	3,351.0	4,551.4	4,000.1	3,497.8	3,931.6	4,373.6
10	Progress Payment (Avg. Bal.)...............	125.4	1,909.6	1,170.9	1,049.2	1,301.9	1,010.4	1,146.4	1,107.6	1,321.3	913.3
11	TOTAL FABRICATION WORKING CAPITAL........	$ 6,851.2	$ 7,080.8	$ 5,967.7	$ 5,058.8	$ 4,652.9	$ 5,561.8	$ 5,146.5	$ 4,605.4	$ 5,252.9	$ 5,286.9
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment..................	$ —	$ —	$ —	$ —	$ —	$ —	$10,571.0	$10,945.5	$10,764.7	$10,496.1
14	Plutonium (Avg. Bal.)......................	709.8	2,020.1	2,215.1	2,109.9	2,280.5	2,253.5	2,272.1	2,355.8	2,234.7	2,313.4
15	Use Charge (Avg. Bal.)....................	102.5	113.6	140.3	158.9	66.2	(123.4)	—	—	—	—
16	Depletion (Avg. Bal.)......................	(203.9)	647.4	725.8	839.4	669.1	435.5	—	—	—	—
17	Subtotal (Lines 13+14+15+16)...........	608.4	2,781.1	3,081.2	3,108.2	3,015.8	2,565.6	12,843.1	13,301.3	12,999.4	12,809.5
18	Less Reprocessing, Losses & Shipping.......	825.5	2,270.5	2,245.2	2,043.0	2,255.2	2,260.2	2,171.2	2,097.5	2,059.6	2,094.0
19	TOTAL OTHER NUCLEAR WORKING CAPITAL (Line 17−18)	$ (217.1)	$ 510.6	$ 836.0	$ 1,065.2	$ 760.6	$ 305.4	$10,671.9	$11,203.8	$10,939.8	$10,715.5
20	TOTAL NUCLEAR (Line 11+19)...............	$ 6,634.1	$ 7,591.4	$ 6,803.7	$ 6,124.0	$ 5,413.5	$ 5,867.2	$15,818.4	$15,809.2	$16,192.7	$16,002.4

SUMMARY OF EXPENSE PER CORE

Core Calculations	Total Cost ($000's)				Cost per KWH (Mills)			
Core Number	I	II	III	IV	I	II	III	IV
KWH × 10⁶...................	11,174.3	14,788.8	15,062.6	15,167.2	*11,174.3*	*14,788.8*	*15,062.6*	*15,167.2*
Fabrication, Depletion and Shipping	19,469.9	19,971.2	19,009.4	19,064.3	*1.743*	*1.351*	*1.262*	*1.257*
Reprocessing & Losses.........	3,184.5	3,134.3	2,929.7	2,862.2	*0.285*	*0.212*	*0.195*	*0.188*
Plutonium Credit	(3,062.8)	(3,296.5)	(3,312.0)	(3,312.0)	*(0.274)*	*(0.223)*	*(0.220)*	*(0.218)*
Use Charge	1,075.9	1,274.9	441.0	—	*0.096*	*0.086*	*0.029*	—
TOTAL	20,667.5	21,083.9	19,068.1	18,614.5	*1.850*	*1.426*	*1.266*	*1.227*

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 620 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

(000's Omitted)

Line No.		YEARS 11	12	13	14	15	16	17	18	19	20
1	**Fabrication**										
2	Balance — Start of Year	$ 4,130.7	$ 3,644.7	$ 3,162.7	$ 4,558.0	$ 4,088.0	$ 3,622.9	$ 3,253.3	$ 2,883.8	$ 4,379.5	$ 4,187.4
3	Added — Start of Year	—	—	1,865.2	—	—	—	—	1,865.2	—	—
4	Total — Start of Year	$ 4,130.7	$ 3,644.7	$ 5,027.9	$ 4,558.0	$ 4,088.0	$ 3,622.9	$ 3,253.3	$ 4,749.0	$ 4,379.5	$ 4,187.4
5	Transfer to Fuel Expense	2,351.2	2,347.3	2,335.2	2,335.2	2,330.4	2,234.8	2,234.8	2,234.8	2,057.3	1,984.6
6	Subtotal	$ 1,779.5	$ 1,297.4	$ 2,692.7	$ 2,222.8	$ 1,757.6	$ 1,388.1	$ 1,018.5	$ 2,514.2	$ 2,322.2	$ 2,202.8
7	Added during the Year	1,865.2	1,865.3	1,865.3	1,865.2	1,865.3	1,865.2	1,865.3	1,865.3	1,865.2	1,865.3
8	Total — End of Year	$ 3,644.7	$ 3,162.7	$ 4,558.0	$ 4,088.0	$ 3,622.9	$ 3,253.3	$ 2,883.8	$ 4,379.5	$ 4,187.4	$ 4,068.1
9	Average (Line 4+8)	3,887.7	3,403.7	4,793.0	4,323.0	3,855.4	3,438.1	3,068.6	4,564.2	4,283.4	4,127.8
10	Progress Payment (Avg. Bal.)	1,107.5	1,243.6	1,165.9	1,036.2	984.6	1,088.2	1,321.2	1,010.4	880.9	945.7
11	TOTAL FABRICATION WORKING CAPITAL	$ 4,995.2	$ 4,647.3	$ 5,958.9	$ 5,359.2	$ 4,840.0	$ 4,526.3	$ 4,389.8	$ 5,574.6	$ 5,164.3	$ 5,073.5
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$10,496.7	$11,054.9	$10,658.7	$10,378.8	$10,716.2	$10,762.2	$10,616.7	$10,562.9	$10,511.4	$10,852.8
14	Plutonium (Avg. Bal.)	2,320.7	2,330.2	2,265.0	2,265.2	2,336.4	2,243.7	2,199.6	2,294.5	2,221.3	2,138.7
15	Subtotal (Line 13+14)	$12,817.4	$13,385.1	$12,923.7	$12,644.0	$13,052.6	$13,005.9	$12,816.3	$12,857.4	$12,732.7	$12,991.5
16	Less Reprocessing, Losses & Shipping	2,123.5	2,069.8	2,059.2	2,081.5	2,104.2	2,017.8	2,029.9	2,089.9	2,024.3	1,924.5
17	TOTAL OTHER NUCLEAR WORKING CAPITAL (Line 15−16)	$10,693.9	$11,315.3	$10,864.5	$10,562.5	$10,948.4	$10,988.1	$10,786.4	$10,767.5	$10,708.4	$11,067.0
18	TOTAL NUCLEAR (Line 11+17)	$15,689.1	$15,962.6	$16,823.4	$15,921.7	$15,788.4	$15,514.4	$15,176.2	$16,342.1	$15,872.7	$16,140.5

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 620 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

(000's Omitted)

Line No.		YEARS									
		21	22	23	24	25	26	27	28	29	30
1	**Fabrication**										
2	Balance — Start of Year	$ 4,068.1	$ 3,948.6	$ 3,829.3	$ 3,992.9	$ 4,171.4	$ 4,349.7	$ 4,528.2	$ 2,939.9	$ 3,304.3	$ 3,668.8
3	Added — Start of Year	—	—	—	—	—	—	—	1,865.2	—	—
4	Total — Start of Year	$ 4,068.1	$ 3,948.6	$ 3,829.3	$ 3,992.9	$ 4,171.4	$ 4,349.7	$ 4,528.2	$ 4,805.1	$ 3,304.3	$ 3,668.8
5	Transfer to Fuel Expense	1,984.7	1,984.6	1,701.6	1,686.8	1,686.9	1,686.8	1,588.3	1,500.8	1,500.8	1,500.9
6	Subtotal	$ 2,083.4	$ 1,964.0	$ 2,127.7	$ 2,306.1	$ 2,484.5	$ 2,662.9	$ 2,939.9	$ 3,304.3	$ 1,803.5	$ 2,167.9
7	Added during the Year	1,865.2	1,865.3	1,865.2	1,865.3	1,865.2	1,865.3	—	—	1,865.3	1,865.2
8	Total — End of Year	$ 3,948.6	$ 3,829.3	$ 3,992.9	$ 4,171.4	$ 4,349.7	$ 4,528.2	$ 2,939.9	$ 3,304.3	$ 3,668.8	$ 4,033.1
9	Average (Line 4+8)	4,008.4	3,889.0	3,911.1	4,082.2	4,260.6	4,439.0	3,734.1	4,054.7	3,486.5	3,850.9
10	Progress Payment (Avg. Bal.)	919.7	855.0	829.0	874.4	990.9	855.0	699.5	414.6	654.2	952.0
11	TOTAL FABRICATION WORKING CAPITAL	$ 4,928.1	$ 4,744.0	$ 4,740.1	$ 4,956.6	$ 5,251.5	$ 5,294.0	$ 4,433.6	$ 4,469.3	$ 4,140.7	$ 4,802.9
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$10,578.2	$10,317.4	$10,365.4	$10,409.8	$10,401.2	$10,413.3	$ 9,969.9	$ 9,764.8	$ 9,907.1	$ 9,976.8
14	Plutonium (Avg. Bal.)	2,121.1	2,107.0	2,095.9	2,084.6	2,004.1	1,995.4	2,041.5	2,093.9	2,137.9	2,043.8
15	Subtotal (Line 13+14)	$12,699.3	$12,424.4	$12,461.3	$12,494.4	$12,405.3	$12,408.7	$12,011.4	$11,858.7	$12,045.0	$12,020.6
16	Less Reprocessing, Losses & Shipping	1,921.5	1,938.3	1,927.4	1,918.3	1,853.2	1,842.3	1,853.2	1,892.7	1,937.0	1,966.2
17	TOTAL OTHER NUCLEAR WORKING CAPITAL (Line 15−16)	$10,777.8	$10,486.1	$10,533.9	$10,576.1	$10,552.1	$10,566.4	$10,158.2	$ 9,966.0	$10,108.0	$10,054.4
18	TOTAL NUCLEAR (Line 11+17)	$15,705.9	$15,230.1	$15,274.0	$15,532.7	$15,803.6	$15,860.4	$14,591.8	$14,435.3	$14,248.7	$14,857.3

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 515 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

(000's Omitted)

Line No.		YEARS 1	2	3	4	5	6	7	8	9	10
1	**Fabrication**										
2	Balance — Start of Year	$ 7,962.1	$ 5,691.3	$ 4,561.6	$ 3,614.0	$ 3,465.4	$ 3,316.6	$ 3,026.1	$ 4,688.2	$ 4,586.8	$ 4,485.4
3	Added — Start of Year	437.3	—	—	2,007.1	2,007.0	—	1,865.3	—	—	—
4	Total — Start of Year	$ 8,399.4	$ 5,691.3	$ 4,561.6	$ 5,621.1	$ 5,472.4	$ 3,316.6	$ 4,891.4	$ 4,688.2	$ 4,586.8	$ 4,485.4
5	Transfer to Fuel Expense	3,136.8	3,136.8	2,954.7	2,155.7	2,155.8	2,155.7	2,068.4	1,966.7	1,966.6	1,966.7
6	Subtotal	$ 5,262.6	$ 2,554.5	$ 1,606.9	$ 3,465.4	$ 3,316.6	$ 1,160.9	$ 2,823.0	$ 2,721.5	$ 2,620.2	$ 2,518.7
7	Added during the Year	428.7	2,007.1	2,007.1	—	—	1,865.2	1,865.2	1,865.3	1,865.2	1,865.3
8	Total — End of Year	$ 5,691.3	$ 4,561.6	$ 3,614.0	$ 3,465.4	$ 3,316.6	$ 3,026.1	$ 4,688.2	$ 4,586.8	$ 4,485.4	$ 4,384.0
9	Average (Line 4+8)	$ 7,045.4	$ 5,126.4	$ 4,087.8	$ 4,543.2	$ 4,394.5	$ 3,171.4	$ 4,789.8	$ 4,637.5	$ 4,536.1	$ 4,434.7
10	Progress Payment (Avg. Bal.)	—	1,254.5	1,505.4	919.9	711.3	1,165.9	1,010.4	855.0	1,010.3	855.0
11	TOTAL FABRICATION WORKING CAPITAL	$ 7,045.4	$ 6,380.9	$ 5,593.2	$ 5,463.1	$ 5,105.8	$ 4,337.3	$ 5,800.2	$ 5,492.5	$ 5,546.4	$ 5,289.7
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$ —	$ —	$ —	$ —	$ —	$ —	$10,482.0	$10,263.7	$10,108.0	$10,263.3
14	Plutonium (Avg. Bal.)	589.6	1,678.0	2,220.3	1,913.7	1,975.8	2,279.7	2,209.7	2,189.4	2,164.6	2,210.5
15	Use Charge (Avg. Bal.)	119.7	144.9	149.7	158.7	137.6	28.5	—	—	—	—
16	Depletion (Avg. Bal.)	(106.0)	884.9	852.0	773.7	776.8	693.1	—	—	—	—
17	Subtotal (Lines 13+14+15+16)	$ 603.3	$ 2,707.8	$ 3,222.0	$ 2,846.1	$ 2,890.2	$ 3,001.3	$12,691.7	$12,453.1	$12,272.6	$12,473.8
18	Less Reprocessing, Losses and Shipping	685.8	1,937.5	2,295.4	1,954.7	1,968.9	2,203.1	2,092.3	2,087.9	1,991.2	2,035.7
19	TOTAL — OTHER NUCLEAR WORKING CAPITAL (Line 17−18)	$ (82.5)	$ 770.3	$ 926.6	$ 891.4	$ 921.3	$ 798.2	$10,599.4	$10,365.2	$10,281.4	$10,438.1
20	TOTAL NUCLEAR (Line 11+19)	$ 6,962.9	$ 7,151.2	$ 6,519.8	$ 6,354.5	$ 6,027.1	$ 5,135.5	$16,399.6	$15,857.7	$15,827.8	$15,727.8

SUMMARY OF EXPENSE PER CORE

Core Calculations	Total Cost ($000's)			Cost Per KWH (Mills)		
Core Number	I	II	III	I	II	III
KWH × 10⁶	11,174.3	14,788.8	15,062.6	*11,174.3*	*14,788.8*	*15,062.6*
Fabrication, Depletion and Shipping	19,358.8	19,698.6	19,027.7	*1.733*	*1.333*	*1.263*
Reprocessing	3,184.5	3,066.8	2,862.2	*0.285*	*0.207*	*0.190*
Plutonium Credit	(3,062.8)	(3,296.5)	(3,312.0)	*(0.274)*	*(0.223)*	*(0.220)*
Use Charge	1,231.2	1,326.0	140.8	*0.110*	*0.090*	*0.009*
Total	20,711.7	20,794.9	18,718.7	*1.854*	*1.407*	*1.242*

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 515 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

(000's Omitted)

Line No.		YEARS 11	12	13	14	15	16	17	18	19	20
1	**Fabrication**										
2	Balance — Start of Year	$ 4,384.0	$ 4,294.5	$ 4,211.1	$ 4,127.7	$ 4,044.3	$ 4,027.1	$ 4,022.7	$ 4,018.1	$ 4,013.7	$ 4,211.9
3	Added — Start of Year	—	—	—	—	—	—	—	—	—	—
4	Total — Start of Year	$ 4,384.0	$ 4,294.5	$ 4,211.1	$ 4,127.7	$ 4,044.3	$ 4,027.1	$ 4,022.7	$ 4,018.1	$ 4,013.7	$ 4,211.9
5	Transfer to Fuel Expense	1,954.7	1,948.7	1,948.6	1,948.7	1,882.4	1,869.7	1,869.8	1,869.7	1,667.0	1,630.8
6	Subtotal	$ 2,429.3	$ 2,345.8	$ 2,262.5	$ 2,179.0	$ 2,161.9	$ 2,157.4	$ 2,152.9	$ 2,148.4	$ 2,346.7	$ 2,581.1
7	Added during the Year	1,865.2	1,865.3	1,865.2	1,865.3	1,865.2	1,865.3	1,865.2	1,865.3	1,865.2	1,865.3
8	Total — End of Year	$ 4,294.5	$ 4,211.1	$ 4,127.7	$ 4,044.3	$ 4,027.1	$ 4,022.7	$ 4,018.1	$ 4,013.7	$ 4,211.9	$ 4,446.4
9	Average (Line 4+8)	$ 4,339.2	$ 4,252.8	$ 4,169.4	$ 4,086.0	$ 4,035.7	$ 4,024.9	$ 4,020.4	$ 4,015.9	$ 4,112.8	$ 4,329.2
10	Progress Payment (Avg. Bal.)	855.0	874.4	990.9	855.0	855.0	913.3	952.0	855.0	855.0	855.0
11	TOTAL FABRICATION WORKING CAPITAL	$ 5,194.2	$ 5,127.2	$ 5,160.3	$ 4,941.0	$ 4,890.7	$ 4,938.2	$ 4,972.4	$ 4,870.9	$ 4,967.8	$ 5,184.2
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$10,349.1	$10,233.2	$10,353.5	$10,210.4	$10,361.7	$10,311.5	$10,315.9	$10,341.0	$10,476.5	$10,837.6
14	Plutonium (Avg. Bal.)	2,184.4	2,221.2	2,188.0	2,226.1	2,180.9	2,113.5	2,114.6	2,187.3	2,147.7	2,044.2
15	Subtotal (Lines 13+14)	$12,533.5	$12,454.4	$12,541.5	$12,436.5	$12,542.6	$12,425.0	$12,430.5	$12,528.3	$12,624.2	$12,881.8
16	Less Reprocessing, Losses and Shipping	1,996.7	2,013.3	2,002.6	2,052.0	1,993.6	1,941.7	1,944.3	1,979.9	1,940.2	1,839.5
17	TOTAL OTHER NUCLEAR WORKING CAPITAL (Line 15−16)	$10,536.8	$10,441.1	$10,538.9	$10,384.5	$10,549.0	$10,483.3	$10,486.2	$10,548.4	$10,684.0	$11,042.3
18	TOTAL NUCLEAR (Line 11+17)	$15,731.0	$15,568.3	$15,699.2	$15,325.5	$15,439.7	$15,421.5	$15,458.6	$15,419.3	$15,651.8	$16,226.5

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 515 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

(000's Omitted)

Line No.		YEARS 21	22	23	24	25	26	27	28	29	30
1	**Fabrication**										
2	Balance — Start of Year	$ 4,446.4	$ 4,680.8	$ 3,049.9	$ 3,363.2	$ 3,885.6	$ 4,408.1	$ 3,065.3	$ 3,587.7	$ 4,110.1	$ 2,839.0
3	Added — Start of Year	—	—	1,865.3	—	—	—	1,865.2	—	—	1,865.2
4	Total — Start of Year	$ 4,446.4	$ 4,680.8	$ 4,915.2	$ 3,363.2	$ 3,885.6	$ 4,408.1	$ 4,930.5	$ 3,587.7	$ 4,110.1	$ 4,704.2
5	Transfer to Fuel Expense	1,630.8	1,630.9	1,552.0	1,342.8	1,342.8	1,342.8	1,342.8	1,342.9	1,271.1	1,242.8
6	Subtotal	$ 2,815.6	$ 3,049.9	$ 3,363.2	$ 2,020.4	$ 2,542.8	$ 3,065.3	$ 3,587.7	$ 2,244.8	$ 2,839.0	$ 3,461.4
7	Added during the Year	1,865.2	—	—	1,865.2	1,865.3	—	—	1,865.3	—	—
8	Total — End of Year	$ 4,680.8	$ 3,049.9	$ 3,363.2	$ 3,885.6	$ 4,408.1	$ 3,065.3	$ 3,587.7	$ 4,110.1	$ 2,839.0	$ 3,461.4
9	Average (Line 4+8)	$ 4,563.6	$ 3,865.4	$ 4,139.2	$ 3,624.4	$ 4,146.8	$ 3,736.7	$ 4,259.1	$ 3,848.9	$ 3,474.6	$ 4,082.8
10	Progress Payment (Avg. Bal.)	1,010.3	544.1	466.3	699.5	855.0	854.9	181.3	829.1	699.5	181.3
11	TOTAL FABRICATION WORKING CAPITAL	$ 5,573.9	$ 4,409.5	$ 4,605.5	$ 4,323.9	$ 5,001.8	$ 4,591.6	$ 4,440.4	$ 4,678.0	$ 4,174.1	$ 4,264.1
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$10,337.5	$ 9,975.0	$ 9,531.6	$10,131.4	$10,421.9	$ 9,885.5	$ 9,480.2	$10,240.4	$ 9,407.1	$ 9,161.2
14	Plutonium (Avg. Bal.)	1,856.4	2,044.1	2,071.1	2,075.6	1,911.9	1,817.2	2,000.1	2,045.3	1,869.3	2,008.0
15	Subtotal (Lines 13+14)	$12,193.9	$12,019.1	$11,602.7	$12,207.0	$12,333.8	$11,702.7	$11,480.3	$12,285.7	$11,276.4	$11,169.2
16	Less Reprocessing, Losses and Shipping	1,775.7	1,837.9	1,897.7	1,902.7	1,830.4	1,690.0	1,796.8	1,926.4	1,772.1	1,837.2
17	TOTAL OTHER NUCLEAR WORKING CAPITAL (Line 15—16)	$10,418.2	$10,181.2	$ 9,705.0	$10,304.3	$10,503.4	$10,012.7	$ 9,683.5	$10,359.3	$ 9,504.3	$ 9,332.0
18	TOTAL NUCLEAR (Line 11+17)	$15,992.1	$14,590.7	$14,310.5	$14,628.2	$15,505.2	$14,604.3	$14,123.9	$15,037.3	$13,678.4	$13,596.1

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 565 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

(000's Omitted)

Line No.		YEARS 1	2	3	4	5	6	7	8	9	10
1	**Fabrication**										
2	Balance — Start of Year	$ 7,962.1	$ 5,387.7	$ 3,954.4	$ 4,995.0	$ 4,637.3	$ 4,137.8	$ 3,646.4	$ 3,354.0	$ 3,061.7	$ 4,634.6
3	Added — Start of Year	437.3	—	2,007.1	—	—	—	—	—	1,865.2	—
4	Total — Start of Year	$ 8,399.4	$ 5,387.7	$ 5,961.5	$ 4,995.0	$ 4,637.3	$ 4,137.8	$ 3,646.4	$ 3,354.0	$ 4,926.9	$ 4,634.6
5	Transfer to Fuel Expense	3,440.4	3,440.4	2,973.6	2,364.7	2,364.7	2,356.7	2,157.6	2,157.6	2,157.6	2,149.0
6	Subtotal	$ 4,959.0	$ 1,947.3	$ 2,987.9	$ 2,630.3	$ 2,272.6	$ 1,781.1	$ 1,488.8	$ 1,196.4	$ 2,769.3	$ 2,485.6
7	Added during the Year	428.7	2,007.1	2,007.1	2,007.0	1,865.2	1,865.3	1,865.2	1,865.3	1,865.3	1,865.2
8	Total — End of Year	$ 5,387.7	$ 3,954.4	$ 4,995.0	$ 4,637.3	$ 4,137.8	$ 3,646.4	$ 3,354.0	$ 3,061.7	$ 4,634.6	$ 4,350.8
9	Average (Line 4+8)	6,893.6	4,671.0	5,478.2	4,816.2	4,387.6	3,892.1	3,500.2	3,207.8	4,780.8	4,492.7
10	Progress Payment (Avg. Bal.)	62.7	1,609.9	1,254.5	978.2	978.0	984.6	1,088.2	1,165.8	1,165.9	855.0
11	TOTAL FABRICATION WORKING CAPITAL	$ 6,956.3	$ 6,280.9	$ 6,732.7	$ 5,794.4	$ 5,365.6	$ 4,876.7	$ 4,588.4	$ 4,373.6	$ 5,946.7	$ 5,347.7
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$ —	$ —	$ —	$ —	$ —	$ —	$10,776.5	$10,539.7	$10,654.6	$10,388.2
14	Plutonium (Avg. Bal.)	646.1	1,839.6	2,211.1	2,028.2	$2,109.9	2,347.0	2,214.9	2,205.6	2,265.6	2,257.9
15	Use Charge (Avg. Bal.)	111.4	113.5	137.1	181.0	176.5	3.6	—	—	—	—
16	Depletion (Avg. Bal.)	(147.5)	784.5	800.0	811.9	787.8	540.8	—	—	—	—
17	Subtotal (Lines 13+14+15+16)	$ 610.0	$ 2,737.6	$ 3,148.2	$ 3,021.1	$ 3,074.2	$ 2,891.4	$12,991.4	$12,745.3	$12,920.2	$12,646.1
18	Less Reprocessing, Losses and Shipping	752.1	2,097.8	2,251.2	2,043.8	2,116.5	2,289.3	2,101.8	2,038.6	2,057.7	2,047.5
19	TOTAL — OTHER NUCLEAR WORKING CAPITAL (Line 17−18)	$ (142.1)	$ 639.8	$ 897.0	$ 977.3	$ 957.7	$ 602.1	$10,889.6	$10,706.7	$10,862.5	$10,598.6
20	TOTAL NUCLEAR (Line 11+19)	$ 6,814.2	$ 6,920.7	$ 7,629.7	$ 6,771.7	$ 6,323.3	$ 5,478.8	$15,478.0	$15,080.3	$16,809.2	$15,946.3

SUMMARY OF EXPENSE PER CORE

Core Calculations	Total Cost ($000's)				Cost per KWH (Mills)			
Core Number	I	II	III	IV	I	II	III	IV
KWH × 10^6	11,174.3	14,788.8	15,062.6	15,167.2	*11,174.3*	*14,788.8*	*15,062.6*	*15,167.2*
Fabrication, Depletion and Shipping	19,416.4	19,832.4	19,027.7	19,064.3	*1.737*	*1.341*	*1.264*	*1.257*
Reprocessing	3,184.5	3,134.3	2,862.2	2,862.2	*.285*	*.212*	*.190*	*.188*
Plutonium Credit	(3,062.8)	(3,296.5)	(3,312.0)	(3,312.0)	*(.274)*	*(.223)*	*(.220)*	*(.218)*
Use Charge	1,150.3	1,313.2	290.0	—	*.103*	*.089*	*.019*	—
TOTAL	20,688.4	20,983.4	18,867.9	18,614.5	*1.851*	*1.419*	*1.253*	*1.227*

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 565 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

(000's Omitted)

Line No.		YEARS 11	12	13	14	15	16	17	18	19	20
1	**Fabrication**										
2	Balance — Start of Year	$ 4,350.8	$ 4,073.4	$ 3,795.9	$ 3,523.7	$ 3,299.6	$ 3,075.6	$ 4,716.8	$ 4,564.7	$ 4,477.4	$ 4,390.0
3	Added — Start of Year	—	—	—	—	—	1,865.2	—	—	—	—
4	Total — Start of Year	$ 4,350.8	$ 4,073.4	$ 3,795.9	$ 3,523.7	$ 3,299.6	$ 4,940.8	$ 4,716.8	$ 4,564.7	$ 4,477.4	$ 4,390.0
5	Transfer to Fuel Expense	2,142.7	2,142.7	2,137.5	2,089.3	2,089.3	2,089.3	2,017.3	1,952.6	1,952.6	1,952.6
6	Subtotal	$ 2,208.1	$ 1,930.7	$ 1,658.4	$ 1,434.4	$ 1,210.3	$ 2,851.5	$ 2,699.5	$ 2,612.1	$ 2,524.8	$ 2,437.4
7	Added during the Year	1,865.3	1,865.2	1,865.3	1,865.2	1,865.3	1,865.3	1,865.2	1,865.3	1,865.2	1,865.3
8	Total — End of Year	$ 4,073.4	$ 3,795.9	$ 3,523.7	$ 3,299.6	$ 3,075.6	$ 4,716.8	$ 4,564.7	$ 4,477.4	$ 4,390.0	$ 4,302.7
9	Average (Line 4+8)	4,212.1	3,934.6	3,659.8	3,411.6	3,187.6	4,828.8	4,640.8	4,521.0	4,433.7	4,346.4
10	Progress Payment (Avg. Bal.)	913.3	1,029.8	1,036.4	984.5	1,165.8	1,165.9	855.0	855.0	1,010.3	855.0
11	TOTAL FABRICATION WORKING CAPITAL	$ 5,125.4	$ 4,964.4	$ 4,696.2	$ 4,396.1	$ 4,353.4	$ 5,994.7	$ 5,495.8	$ 5,376.0	$ 5,444.0	$ 5,201.4
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$10,450.4	$10,279.1	$10,916.5	$10,718.0	$10,520.3	$10,686.0	$10,311.1	$10,401.9	$10,511.5	$10,649.1
14	Plutonium (Avg. Bal.)	2,243.4	2,296.2	2,281.8	2,252.5	2,143.6	2,174.0	2,196.1	2,172.8	2,142.5	2,182.8
15	Subtotal (Lines 13+14)	$12,693.8	$12,575.3	$13,198.3	$12,970.5	$12,663.9	$12,860.0	$12,507.2	$12,574.7	$12,654.0	$12,831.9
16	Less Reprocessing Losses and Shipping	2,041.1	2,085.9	2,036.4	1,986.4	1,968.1	1,997.8	1,984.5	1,974.9	1,955.1	1,960.3
17	TOTAL OTHER NUCLEAR WORKING CAPITAL (Line 15−16)	$10,652.7	$10,489.4	$11,161.9	$10,984.1	$10,695.8	$10,862.2	$10,522.7	$10,599.8	$10,698.9	$10,871.6
18	TOTAL NUCLEAR (Line 11+17)	$15,778.1	$15,453.8	$15,858.1	$15,380.2	$15,049.2	$16,856.9	$16,018.5	$15,975.8	$16,142.9	$16,073.0

OYSTER CREEK NUCLEAR ELECTRIC GENERATING PLANT STUDY
NUCLEAR WORKING CAPITAL

OUTPUT: 565 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

(000's Omitted)

Line No.		YEARS 21	22	23	24	25	26	27	28	29	30
1	**Fabrication**										
2	Balance — Start of Year	$ 4,302.7	$ 4,442.4	$ 4,676.5	$ 3,045.3	$ 3,279.3	$ 3,544.6	$ 4,012.3	$ 4,480.1	$ 3,082.6	$ 3,550.3
3	Added — Start of Year	—	—	—	1,865.2	—	—	—	—	—	—
4	Total — Start of Year	$ 4,302.7	$ 4,442.4	$ 4,676.5	$ 4,910.5	$ 3,279.3	$ 3,544.6	$ 4,012.3	$ 4,480.1	$ 3,082.6	$ 3,550.3
5	*Transfer to Fuel Expense*	1,725.5	1,631.2	1,631.2	1,631.2	1,600.0	1,397.5	1,397.5	1,397.5	1,397.5	1,397.5
6	Subtotal	$ 2,577.2	$ 2,811.2	$ 3,045.3	$ 3,279.3	$ 1,679.3	$ 2,147.1	$ 2,614.8	$ 3,082.6	$ 1,685.1	$ 2,152.8
7	Added during the Year	1,865.2	1,865.3	—	—	1,865.3	1,865.2	1,865.3	—	1,865.2	1,865.3
8	Total — End of Year	$ 4,442.4	$ 4,676.5	$ 3,045.3	$ 3,279.3	$ 3,544.6	$ 4,012.3	$ 4,480.1	$ 3,082.6	$ 3,550.3	$ 4,018.1
9	Average (Line 5+9)	4,372.6	4,559.4	3,860.9	4,094.9	3,412.0	3,778.4	4,246.2	3,781.4	3,316.4	3,784.2
10	*Progress Payment (Avg. Bal.)*	855.0	855.0	699.5	699.5	621.8	699.5	855.0	544.0	855.0	466.3
11	TOTAL FABRICATION WORKING CAPITAL	$ 5,227.6	$ 5,414.4	$ 4,560.4	$ 4,794.4	$ 4,033.8	$ 4,477.9	$ 5,101.2	$ 4,325.4	$ 4,171.4	$ 4,250.5
12	**Other Nuclear Working Capital**										
13	Average Fuel Investment	$10,251.2	$10,363.6	$ 9,968.6	$10,118.7	$ 9,919.7	$10,403.9	$ 9,984.3	$ 9,455.5	$ 9,527.7	$10,131.7
14	Plutonium (Avg. Bal.)	2,045.1	2,014.4	2,048.0	2,081.9	2,046.4	2,080.8	1,871.8	1,939.4	2,076.9	2,077.9
15	Subtotal (Lines 13+14)	$12,296.3	$12,378.0	$12,016.6	$12,200.6	$11,966.1	$12,484.7	$11,856.1	$11,394.9	$11,604.6	$12,209.6
16	Less Reprocessing Losses and Shipping	1,882.0	1,853.3	1,840.6	1,906.8	1,870.3	1,870.8	1,813.5	1,781.5	1,903.4	1,955.9
17	TOTAL OTHER NUCLEAR WORKING CAPITAL (Line 15−16)	$10,414.3	$10,524.7	$10,176.0	$10,293.8	$10,095.8	$10,613.9	$10,042.6	$ 9,613.4	$ 9,701.2	$10,253.7
18	TOTAL NUCLEAR (Line 11+17)	$15,641.9	$15,939.1	$14,736.4	$15,088.2	$14,129.6	$15,091.8	$15,143.8	$13,938.8	$13,872.6	$14,504.2

OYSTER CREEK NUCLEAR PLANT STUDY
FIXED CHARGES ON DEPRECIABLE PLANT BASED ON 30 YEAR BOOK AND TAX LIFE
6.3775% Return

Line No.		YEARS 1	2	3	4	5	Total Years 1 to 5	6	7	8	9	10	Total Years 6 to 10
1	**Basic Fixed Charges without effect of SYD Depreciation**												
2	Bonds—63% @ 4.25% Interest—Start of Year	2.6775	2.5883	2.4990	2.4098	2.3206	—	2.2313	2.1421	2.0528	1.9636	1.8743	—
3	—End of Year	2.5883	2.4990	2.4098	2.3206	2.2313	—	2.1421	2.0528	1.9636	1.8743	1.7850	—
4	—Average	2.6329	2.5436	2.4544	2.3651	2.2759	12.2719	2.1867	2.0974	2.0082	1.9189	1.8297	10.0409
5	Equity—37% @ 10.00% Earnings—Start of Year	3.7000	3.5766	3.4533	3.3300	3.2067	—	3.0834	2.9600	2.8367	2.7134	2.5900	—
6	—End of Year	3.5766	3.4533	3.3300	3.2067	3.0834	—	2.9600	2.8367	2.7134	2.5900	2.4667	—
7	—Average	3.6383	3.5150	3.3917	3.2684	3.1451	16.9585	3.0217	2.8984	2.7751	2.6517	2.5284	13.8753
8	Total Return—Average (Line 4+7)	6.2712	6.0586	5.8461	5.6335	5.4210	29.2304	5.2084	4.9958	4.7833	4.5706	4.3581	23.9162
9	Depreciation—Book	3.3333	3.3333	3.3333	3.3333	3.3333	16.6665	3.3333	3.3333	3.3333	3.3333	3.3333	16.6665
10	F.I.T. (excl. effect of SYD) (Line 7 × 1.08333)	3.9415	3.8079	3.6743	3.5407	3.4072	18.3716	3.2735	3.1399	3.0063	2.8727	2.7391	15.0315
11	TOTAL FIXED CHARGE (excl. effect of SYD)	13.5460	13.1998	12.8537	12.5075	12.1615	64.2685	11.8152	11.4690	11.1229	10.7766	10.4305	55.6142
12	**Effect of SYD Depreciation**												
13	SYD Rate (n + N(N + 1)/2) where N = 30)	6.4516	6.2366	6.0215	5.8065	5.5914	30.1076	5.3764	5.1613	4.9462	4.7312	4.5161	24.7312
14	Effective SYD Rate (Line 13 × 0.936*)	6.0387	5.8375	5.6361	5.4349	5.2336	28.1808	5.0323	4.8310	4.6296	4.4284	4.2271	23.1484
15	Less Book Depreciation (Line 9)	3.3333	3.3333	3.3333	3.3333	3.3333	16.6665	3.3333	3.3333	3.3333	3.3333	3.3333	16.6665
16	Excess of SYD over Book Deprec. (Line 14−15)	2.7054	2.5042	2.3028	2.1016	1.9003	11.5143	1.6990	1.4977	1.2963	1.0951	0.8938	6.4819
17	Reduction in F.I.T. (Line 16 × 1.08333)	2.9308	2.7129	2.4947	2.2767	2.0587	12.4738	1.8406	1.6225	1.4043	1.1864	0.9683	7.0221
18	**Fixed Charges incl. effects of SYD**												
19	F.I.T. (excl. effect of SYD) (Line 10)	3.9415	3.8079	3.6743	3.5407	3.4072	18.3716	3.2735	3.1399	3.0063	2.8727	2.7391	15.0315
20	Less reduction in F.I.T. due to SYD (Line 17)	2.9308	2.7129	2.4947	2.2767	2.0587	12.4738	1.8406	1.6225	1.4043	1.1864	0.9683	7.0221
21	F.I.T. (incl. effect of SYD) (Line 19−20)	1.0107	1.0950	1.1796	1.2640	1.3485	5.8978	1.4329	1.5174	1.6020	1.6863	1.7708	8.0094
22	Fixed Charge (excl. effect of SYD) (Line 11)	13.5460	13.1998	12.8537	12.5075	12.1615	64.2685	11.8152	11.4690	11.1229	10.7766	10.4305	55.6142
23	Less reduction in F.I.T. due to SYD (Line 17)	2.9308	2.7129	2.4947	2.2767	2.0587	12.4738	1.8406	1.6225	1.4043	1.1864	0.9683	7.0221
24	Fixed Charge (incl. effect of SYD) (Line 22−23)	10.6152	10.4869	10.3590	10.2308	10.1028	51.7947	9.9746	9.8465	9.7186	9.5902	9.4622	48.5921
25	Present Worth of Fixed Charges	9.9783	9.2673	8.6052	7.9892	7.4165	43.2565	6.8835	6.3874	5.9264	5.4981	5.0992	29.7946
26	Present Worth Factor @ 6.3775%	0.9400	0.8837	0.8307	0.7809	0.7341	4.1694	0.6901	0.6487	0.6098	0.5733	0.5389	3.0608

* To allow for non-depreciable interest during construction, based on G. E. payment schedule.

OYSTER CREEK NUCLEAR PLANT STUDY
FIXED CHARGES ON DEPRECIABLE PLANT BASED ON 30 YEAR BOOK AND TAX LIFE
6.3775% Return

Line No.		YEARS 11	12	13	14	15	16	17	18	19	20	Total Years 11 to 20
1	**Basic Fixed Charges without effect of SYD Depreciation**											
2	Bond—Average	1.7405	1.6512	1.5620	1.4727	1.3835	1.2942	1.2050	1.1157	1.0265	0.9372	13.3885
3	Equity—Average	2.4051	2.2817	2.1584	2.0351	1.9118	1.7884	1.6651	1.5418	1.4184	1.2951	18.5009
4	Total Return—Average (Lines 2+3)	4.1456	3.9329	3.7204	3.5078	3.2953	3.0826	2.8701	2.6575	2.4449	2.2323	31.8894
5	Depreciation—Book	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	33.3330
6	F.I.T. (excl. effect of SYD) (Line 3 × *1.08333*)	2.6055	2.4718	2.3383	2.2047	2.0711	1.9374	1.8039	1.6703	1.5366	1.4030	20.0426
7	TOTAL FIXED CHARGES (excl. effect of SYD)	10.0844	9.7380	9.3920	9.0458	8.6997	8.3533	8.0073	7.6611	7.3148	6.9686	85.2650
8	**Effect of SYD Depreciation**											
9												
10	SYD Rate (n ÷ N (N+1)/2) where N = 30	4.3011	4.0860	3.8710	3.6559	3.4409	3.2258	3.0108	2.7957	2.5807	2.3656	33.3335
11	Effective SYD Rate (Line 10 × *0.9360*)	4.0258	3.8245	3.6233	3.4219	3.2207	3.0193	2.8181	2.6168	2.4155	2.2142	31.2001
12	Less Book Depreciation (Line 5)	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	33.3330
13	Excess of SYD over Book Deprec. (Line 11−12)	0.6925	0.4912	0.2900	0.0886	−0.1126	−0.3140	−0.5152	−0.7165	−0.9178	−1.1191	−2.1329
14	Reduction in F.I.T. (Line 13 × *1.08333*)	0.7502	0.5321	0.3142	0.0960	−0.1220	−0.3402	−0.5581	−0.7762	−0.9943	−1.2124	−2.3107
15	**Fixed Charges incl. effect of SYD**											
16	F.I.T. (excl. effect of SYD) (Line 6)	2.6055	2.4718	2.3383	2.2047	2.0711	1.9374	1.8039	1.6703	1.5366	1.4030	20.0426
17	Less reduction in F.I.T. due to SYD (Line 14)	0.7502	0.5321	0.3142	0.0960	−0.1220	−0.3402	−0.5581	−0.7762	−0.9943	−1.2124	−2.3107
18	F.I.T. (incl. effect of SYD) (Line 16−17)	1.8553	1.9397	2.0241	2.1087	2.1931	2.2776	2.3620	2.4465	2.5309	2.6154	22.3533
19	Fixed Charges (excl. effect of SYD) (Line 7)	10.0844	9.7380	9.3920	9.0458	8.6997	8.3533	8.0073	7.6611	7.3148	6.9686	85.2650
20	Less reduction in F.I.T. due to SYD (Line 14)	0.7502	0.5321	0.3142	0.0960	−0.1220	−0.3402	−0.5581	−0.7762	−0.9943	−1.2124	−2.3107
21	Fixed Charges (incl. effect of SYD) (Line 19−20)	9.3342	9.2059	9.0778	8.9498	8.8217	8.6935	8.5654	8.4373	8.3091	8.1810	87.5757
22	Present Worth of Fixed Charges	4.7287	4.3838	4.0641	3.7661	3.4899	3.2331	2.9945	2.7725	2.5667	2.3758	34.3752
23	Present Worth Factor @ *6.3775%*	0.5066	0.4762	0.4477	0.4208	0.3956	0.3719	0.3496	0.3286	0.3089	0.2904	3.8963

OYSTER CREEK NUCLEAR PLANT STUDY

FIXED CHARGES ON DEPRECIABLE PLANT BASED ON 30 YEAR BOOK AND TAX LIFE

6.3775% Return

Line No.		YEARS 21	22	23	24	25	26	27	28	29	30	Total Years 21 to 30	Avg. 30 Yrs.
1	**Basic Fixed Charges without effect of SYD Depreciation**												
2	Bond—Average	0.8480	0.7587	0.6695	0.5802	0.4910	0.4017	0.3125	0.2232	0.1340	0.0447	4.4635	—
3	Equity—Average	1.1718	1.0484	0.9251	0.8018	0.6785	0.5551	0.4318	0.3085	0.1851	0.0618	6.1679	—
4	Total Return—Average (Lines 2+3)	2.0198	1.8071	1.5946	1.3820	1.1695	0.9568	0.7443	0.5317	0.3191	0.1065	10.6314	—
5	Depreciation—Book	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	33.3330	—
6	F.I.T. (excl. effect of SYD) (Line 3 × *1.08333*)	1.2694	1.1358	1.0022	0.8686	0.7350	0.6014	0.4678	0.3342	0.2005	0.0669	6.6818	—
7	TOTAL FIXED CHARGES (excl. effect of SYD)	6.6225	6.2762	5.9301	5.5839	5.2378	4.8915	4.5454	4.1992	3.8529	3.5067	50.6462	—
8	**Effect of SYD Depreciation**												
9													
10	SYD Rate (n ÷ N (N+1)/2) where N = 30	2.1506	1.9355	1.7205	1.5054	1.2904	1.0753	0.8603	0.6452	0.4302	0.2151	11.8285	—
11	Effective SYD Rate (Line 10 × *0.936*)	2.0130	1.8116	1.6103	1.4091	1.2078	1.0065	0.8052	0.6039	0.4027	0.2013	11.0714	—
12	Less Book Depreciation (Line 5)	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	3.3333	33.3330	—
13	Excess of SYD over Book Deprec. (Line 11−12)	−1.3203	−1.5217	−1.7230	−1.9242	−2.1255	−2.3268	−2.5281	−2.7294	−2.9306	−3.1320	−22.2616	—
14	Reduction in F.I.T. (Line 13 × *1.08333*)	−1.4303	−1.6485	−1.8666	−2.0845	−2.3026	−2.5207	−2.7388	−2.9568	−3.1748	−3.3930	−24.1166	—
15	**Fixed Charges incl. effect of SYD**												
16	F.I.T. (excl. effect of SYD) (Line 6)	1.2694	1.1358	1.0022	0.8686	0.7350	0.6014	0.4678	0.3342	0.2005	0.0669	6.6818	—
17	Less reduction in F.I.T. due to SYD (Line 14)	−1.4303	−1.6485	−1.8666	−2.0845	−2.3026	−2.5207	−2.7388	−2.9568	−3.1748	−3.3930	−24.1166	—
18	F.I.T. (incl. effect of SYD) (Line 16−17)	2.6997	2.7843	2.8688	2.9531	3.0376	3.1221	3.2066	3.2910	3.3753	3.4599	30.7984	—
19	Fixed Charges (excl. effect of SYD) (Line 7)	6.6225	6.2762	5.9301	5.5839	5.2378	4.8915	4.5454	4.1992	3.8529	3.5067	50.6462	—
20	Less reduction in F.I.T. due to SYD (Line 14)	−1.4303	−1.6485	−1.8666	−2.0845	−2.3026	−2.5207	−2.7388	−2.9568	−3.1748	−3.3930	−24.1166	—
21	Fixed Charges (incl. effect of SYD) (Line 19−20)	8.0528	7.9247	7.7967	7.6684	7.5404	7.4122	7.2842	7.1560	7.0277	6.8997	74.7628	8.7575
22	Present Worth of Fixed Charges	2.1984	2.0335	1.8813	1.7392	1.6076	1.4854	1.3723	1.2673	1.1701	1.0798	15.8349	9.3193
23	Present Worth Factor @ *6.3775%*	0.2730	0.2566	0.2413	0.2268	0.2132	0.2004	0.1884	0.1771	0.1665	0.1565	2.0998	13.2263

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 620 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS											
		1	2	3	4	5	Total 1 to 5	6	7	8	9	10	Total 6 to 10
1	**Depreciable Generating Plant — Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge — %	*10.62*	*10.49*	*10.36*	*10.23*	*10.10*	*51.80*	*9.97*	*9.85*	*9.72*	*9.59*	*9.46*	*48.59*
4	Fixed Charge — Amount	$ 7,139.3	$ 7,051.9	$ 6,964.5	$ 6,877.1	$ 6,789.7	$34,822.5	$ 6,702.3	$ 6,621.7	$ 6,534.3	$ 6,446.9	$ 6,359.5	$32,664.7
5	**Depreciable Transmission Plant — Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge — %	*8.82*	*8.79*	*8.75*	*8.71*	*8.67*	*43.74*	*8.63*	*8.59*	*8.56*	*8.52*	*8.48*	*42.78*
8	Fixed Charge — Amount	$ 220.5	$ 219.8	$ 218.7	$ 217.8	$ 216.7	$ 1,093.5	$ 215.7	$ 214.8	$ 214.0	$ 213.0	$ 212.0	$ 1,069.5
9	**Non-Depreciable Plant — Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775.	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charge @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 7,440.3	$ 7,352.2	$ 7,263.7	$ 7,175.4	$ 7,086.9	$36,318.5	$ 6,998.5	$ 6,917.0	$ 6,828.8	$ 6,740.4	$ 6,652.0	$34,136.7
13	**Fuel Working Capital — Fixed Charges**												
14	Amount (Table 6, Line 20)	$ 6,634.1	$ 7,591.4	$ 6,803.7	$ 6,124.0	$ 5,413.5	$32,566.7	$ 5,867.2	$15,818.4	$15,809.2	$16,192.7	$16,002.4	$69,689.9
15	Fixed Charges @ *10.39%*	689.3	788.7	706.9	636.3	562.5	3,383.7	609.6	1,643.5	1,642.6	1,682.4	1,662.6	7,240.7
16	**Other Working Capital — Fixed Charges**												
17	Materials & Supplies — *1%* of Lines (2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3.485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	1.315.3	1,315.3	1,146.8	1,062.0	1,062.0	5,901.4	1,007.0	966.4	966.4	956.8	943.1	4,839.7
19	Insurance (0.456 Annual Premium)	276.3	276.3	276.3	276.3	276.3	1,381.5	276.3	276.3	276.3	276.3	276.3	1,381.5
20	Subtotal	$ 2,288.6	$ 2,288.6	$ 2,120.1	$ 2,035.3	$ 2,035.3	$10,767.9	$ 1,980.3	$ 1,939.7	$ 1,939.7	$ 1,930.1	$ 1,916.4	$ 9,706.2
21	F.I.T. (Avg. Bal.) (credit)	609.1	665.1	677.4	694.0	711.9	3,357.5	755.0	1,015.5	1,049.5	1,092.0	1,121.6	5,033.6
22	Total	$ 1,679.5	$ 1,623.5	$ 1,442.7	$ 1,341.3	$ 1,323.4	$ 7,410.4	$ 1,225.3	$ 924.2	$ 890.2	$ 838.1	$ 794.8	$ 4,672.6
23	Fixed Charges @ *10.39%*	174.5	168.7	149.9	139.4	137.5	770.0	127.3	96.0	92.5	87.1	82.6	485.5
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 8,304.1	$ 8,309.6	$ 8,120.5	$ 7,951.1	$ 7,786.9	$40,472.2	$ 7,735.4	$ 8,656.5	$ 8,563.9	$ 8,509.9	$ 8,397.2	$41,862.9
25	**Operating and Maintenance Expense**												
26	Expense other than Fuel and Ins.	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 8,400.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 8,400.0
27	Insurance	606.0	606.0	606.0	606.0	606.0	3,030.0	606.0	606.0	606.0	606.0	606.0	3,030.0
28	Fuel: KWH × 10^6 Generated	4,779.6	4,779.6	4,779.6	4,779.6	4,779.6	23,898.0	4,779.6	4,779.6	4,779.6	4,779.6	4,779.6	23,898.0
29	Cost/KWH — Mills (Table 6)	*1.850*	*1.850*	*1.568*	*1.426*	*1.426*	*1.624*	*1.334*	*1.266*	*1.266*	*1.250*	*1.227*	*1.269*
30	Total Fuel Expense	$ 8,842.3	$ 8,842.3	$ 7,494.4	$ 6,815.7	$ 6,815.7	$38,810.4	$ 6,376.0	$ 6,051.0	$ 6,051.0	$ 5,974.5	$ 5,864.6	$30,317.1
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$11,128.3	$11,128.3	$ 9,780.4	$ 9,101.7	$ 9,101.7	$50,240.4	$ 8,662.0	$ 8,337.0	$ 8,337.0	$ 8,260.5	$ 8,150.6	$41,747.1
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$19,432.4	$19,437.9	$17,900.9	$17,052.8	$16,888.6	$90,712.6	$16,397.4	$16,993.5	$16,900.9	$16,770.4	$16,547.8	$83,610.0
33	Total per KWH — Mills	*4.07*	*4.07*	*3.75*	*3.57*	*3.53*	*3.79*	*3.43*	*3.56*	*3.54*	*3.51*	*3.46*	*3.50*
34	Total per KW — Dollars	$ 31.34	$ 31.35	$ 28.87	$ 27.50	$ 27.24	$ 29.26	$ 26.45	$ 27.41	$ 27.26	$ 27.05	$ 26.69	$ 26.97
35	Present Worth Factor	0.9400	0.8837	0.8307	0.7809	0.7341	4.1694	0.6901	0.6487	0.6098	0.5733	0.5389	3.0608
36	Present Worth of Revenue Requirements (Line 32×35)	$18,266.5	$17,177.3	$14,870.3	$13,316.5	$12,397.9	$76,028.5	$11,315.8	$11,023.7	$10,306.2	$ 9,614.5	$ 8,917.6	$51,177.8

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 620 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 11	12	13	14	15	Total 11 to 15	16	17	18	19	20	Total 16 to 20
1	**Depreciable Generating Plant — Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge — %	*9.33*	*9.21*	*9.08*	*8.95*	*8.82*	*45.39*	*8.69*	*8.57*	*8.44*	*8.31*	*8.18*	*42.19*
4	Fixed Charge — Amount	$ 6,272.1	$ 6,191.4	$ 6,104.0	$ 6,016.6	$ 5,929.2	$30,513.3	$ 5,841.9	$ 5,761.2	$ 5,673.8	$ 5,586.4	$ 5,499.0	$28,362.3
5	**Depreciable Transmission Plant — Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge — %	*8.44*	*8.40*	*8.36*	*8.33*	*8.29*	*41.82*	*8.25*	*8.21*	*8.17*	*8.13*	*8.10*	*40.86*
8	Fixed Charge — Amount	$ 211.0	$ 210.0	$ 209.0	$ 208.3	$ 207.3	$ 1,045.6	$ 206.3	$ 205.3	$ 204.3	$ 203.3	$ 202.5	$ 1,021.7
9	**Non-Depreciable Plant — Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charges @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 6,563.6	$ 6,481.9	$ 6,393.5	$ 6,305.4	$ 6,217.0	$31,961.4	$ 6,128.7	$ 6,047.0	$ 5,958.6	$ 5,870.2	$ 5,782.0	$29,786.5
13	**Fuel Working Capital — Fixed Charges**												
14	Amount (Table 6, Line 20)................	$15,689.1	$15,962.6	$16,823.4	$15,921.7	$15,788.4	$80,185.2	$15,514.4	$15,176.2	$16,342.1	$15,872.7	$16,140.5	$79,045.9
15	Fixed Charges @ *10.39%*	1,630.1	1,658.5	1,748.0	1,654.3	1,640.4	8,331.3	1,611.9	1,576.8	1,697.9	1,649.2	1,677.0	8,212.8
16	**Other Working Capital — Fixed Charges**												
17	Materials & Supplies — *1%* of Lines (2+6)..	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	943.1	943.1	943.1	943.1	943.1	4,715.5	901.4	901.4	901.4	901.4	901.4	4,507.0
19	Insurance (0.456 Annual Premium)..........	276.3	276.3	276.3	276.3	276.3	1,381.5	276.3	276.3	276.3	276.3	276.3	1,381.5
20	Subtotal	$ 1,916.4	$ 1,916.4	$ 1,916.4	$ 1,916.4	$ 1,916.4	$ 9,582.0	$ 1,874.7	$ 1,874.7	$ 1,874.7	$ 1,874.7	$ 1,874.7	$ 9,373.5
21	F.I.T. (Avg. Bal.) (credit).................	1,148.5	1,188.8	1,242.5	1,256.3	1,287.1	6,123.2	1,314.0	1,340.3	1,401.0	1,424.3	1,464.5	6,944.1
22	Total	$ 767.9	$ 727.6	$ 673.9	$ 660.1	$ 629.3	$ 3,458.8	$ 560.7	$ 534.4	$ 473.7	$ 450.4	$ 410.2	$ 2,429.4
23	Fixed Charges @ *10.39%*	79.8	75.6	70.0	68.6	65.4	359.4	58.3	55.5	49.2	46.8	42.6	252.4
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 8,273.5	$ 8,216.0	$ 8,211.5	$ 8,028.3	$ 7,922.8	$40,652.1	$ 7,798.9	$ 7,679.3	$ 7,705.7	$ 7,566.2	$ 7,501.6	$38,251.7
25	**Operating and Maintenance Expense**												
26	Expense other than Fuel and Ins.	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 8,400.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 8,400.0
27	Insurance	606.0	606.0	606.0	606.0	606.0	3,030.0	606.0	606.0	606.0	606.0	606.0	3,030.0
28	Fuel: KWH × 10^6 Generated..............	4,779.6	4,779.6	4,779.6	4,779.6	4,779.6	23,898.0	4,508.0	4,508.0	4,508.0	4,508.0	4,508.0	22,540.0
29	Cost/KWH — Mills (Table 6)...........	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*
30	Total Fuel Expense.................	$ 5,864.6	$ 5,864.6	$ 5,864.6	$ 5,864.6	$ 5,864.6	$29,323.0	$ 5,531.3	$ 5,531.3	$ 5,531.3	$ 5,531.3	$ 5,531.3	$27,656.5
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$ 8,150.6	$ 8,150.6	$ 8,150.6	$ 8,150.6	$ 8,150.6	$40,753.0	$ 7,817.3	$ 7,817.3	$ 7,817.3	$ 7,817.3	$ 7,817.3	$39,086.5
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)..	$16,424.1	$16,366.6	$16,362.1	$16,178.9	$16,073.4	$81,405.1	$15,616.2	$15,496.6	$15,523.0	$15,383.5	$15,318.9	$77,338.2
33	Total per KWH — Mills.....................	*3.44*	*3.42*	*3.42*	*3.38*	*3.36*	*3.41*	*3.46*	*3.44*	*3.44*	*3.41*	*3.40*	*3.43*
34	Total per KW — Dollars	$ 26.49	$ 26.40	$ 26.39	$ 26.09	$ 25.92	$ 26.26	$ 25.19	$ 24.99	$ 25.04	$ 24.81	$ 24.71	$ 24.95
35	Present Worth Factor......................	0.5066	0.4762	0.4477	0.4208	0.3956	2.2469	0.3719	0.3496	0.3286	0.3089	0.2904	1.6494
36	Present Worth of Revenue Requirements (Line 32 × 35)............................	$ 8,320.4	$ 7,793.8	$ 7,325.3	$ 6,808.1	$ 6,358.6	$36,606.2	$ 5,807.7	$ 5,417.6	$ 5,100.8	$ 4,752.0	$ 4,448.6	$25,526.7

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 620 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 21	22	23	24	25	Total 21 to 25	26	27	28	29	30	Total 26 to 30
1	**Depreciable Generating Plant — Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge — %	*8.05*	*7.92*	*7.80*	*7.67*	*7.54*	*38.98*	*7.41*	*7.28*	*7.16*	*7.03*	*6.90*	*35.78*
4	Fixed Charge — Amount	$ 5,411.6	$ 5,324.2	$ 5,243.6	$ 5,156.1	$ 5,068.8	$26,204.3	$ 4,981.4	$ 4,894.0	$ 4,813.3	$ 4,725.9	$ 4,638.5	$24,053.1
5	**Depreciable Transmission Plant — Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge — %	*8.06*	*8.02*	*7.98*	*7.94*	*7.91*	*39.91*	*7.87*	*7.83*	*7.79*	*7.75*	*7.71*	*38.95*
8	Fixed Charge — Amount	$ 201.5	$ 200.5	$ 199.5	$ 198.5	$ 197.8	$ 997.8	196.7	195.8	194.7	193.8	192.7	973.7
9	**Non-Depreciable Plant — Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charge @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 5,693.6	$ 5,605.2	$ 5,523.6	$ 5,435.1	$ 5,347.1	$27,604.6	$ 5,258.6	$ 5,170.3	$ 5,088.5	$ 5,000.2	$ 4,911.7	$25,429.3
13	**Fuel Working Capital — Fixed Charges**												
14	Amount (Table 6, Line 20)	$15,705.9	$15,230.1	$15,274.0	$15,532.7	$15,803.6	$77,546.3	$15,860.4	$14,591.8	$14,435.3	$14,248.7	$14,857.3	$73,993.5
15	Fixed Charges @ *10.39%*	1,631.8	1,582.4	1,587.0	1,613.8	1,642.0	8,057.0	1,647.9	1,516.1	1,499.8	1,480.4	1,543.7	7,687.9
16	**Other Working Capital — Fixed Charges**												
17	Materials & Supplies — *1%* of Lines (2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	768.1	768.1	768.1	768.1	768.1	3,840.5	676.5	676.5	676.5	676.5	676.5	3,382.5
19	Insurance (0.456 Annual Premium)	276.3	276.3	276.3	276.3	276.3	1,381.5	276.3	276.3	276.3	276.3	276.3	1,381.5
20	Subtotal	$ 1,741.4	$ 1,741.4	$ 1,741.4	$ 1,741.4	$ 1,741.4	$ 8,707.0	$ 1,649.8	$ 1,649.8	$ 1,649.8	$ 1,649.8	$ 1,649.8	$ 8,249.0
21	F.I.T. (Avg. Bal.) (credit)	1,485.6	1,508.8	1,544.0	1,584.0	1,624.2	7,746.6	1,657.5	1,661.8	1,693.1	1,722.9	1,770.9	8,506.2
22	Total	$ 255.8	$ 232.6	$ 197.4	$ 157.4	$ 117.2	$ 960.4	$ −7.7	$ −12.0	$ −43.3	$ −73.1	$ −121.1	$ −257.2
23	Fixed Charges @ *10.39%*	26.6	24.2	20.5	16.4	12.2	99.9	−0.8	− 1.2	$ − 4.5	− 7.6	− 12.6	− 26.7
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 7,352.0	$ 7,211.8	$ 7,131.1	$ 7,065.3	$ 7,001.3	$35,761.5	$ 6,905.7	$ 6,685.2	$ 6,583.8	$ 6,473.0	$ 6,442.8	$33,090.5
25	**Operating & Maintenance Expense**												
26	Expense other than Fuel and Ins.	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 8,400.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 1,680.0	$ 8,400.0
27	Insurance	606.0	606.0	606.0	606.0	606.0	3,030.0	606.0	606.0	606.0	606.0	606.0	3,030.0
28	Fuel: KWH × 10^6 Generated	3,638.8	3,638.8	3,638.8	3,638.8	3,638.8	18,194.0	3,041.7	3,041.7	3,041.7	3,041.7	3,041.7	15,208.5
29	Cost/KWH — Mills (Table 6)	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*
30	Total Fuel Expense	$ 4,464.8	$ 4,464.8	$ 4,464.8	$ 4,464.8	$ 4,464.8	$22,324.0	$ 3,732.2	$ 3,732.2	$ 3,732.2	$ 3,732.2	$ 3,732.2	$18,661.0
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$ 6,750.8	$ 6,750.8	$ 6,750.8	$ 6,750.8	$ 6,750.8	$33,754.0	$ 6,018.2	$ 6,018.2	$ 6,018.2	$ 6,018.2	$ 6,018.2	$30,091.0
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$14,102.8	$13,962.6	$13,881.9	$13,816.1	$13,752.1	$69,515.5	$12,923.9	$12,703.4	$12,602.0	$12,491.2	$12,461.0	$63,181.5
33	Total per KWH — Mills	*3.88*	*3.84*	*3.81*	*3.80*	*3.78*	*3.82*	*4.25*	*4.18*	*4.14*	*4.11*	*4.10*	*4.15*
34	Total per KW — Dollars	$ 22.75	$ 22.52	$ 22.39	$ 22.28	$ 22.18	$ 22.42	$ 20.85	$ 20.49	$ 20.33	$ 20.15	$ 20.10	$ 20.38
35	Present Worth Factor	0.2730	0.2566	0.2413	0.2268	0.2132	1.2109	0.2004	0.1884	0.1771	0.1665	0.1565	0.8889
36	Present Worth of Revenue Requirements (Line 32 × 35)	$ 3,850.1	$ 3,582.8	$ 3,349.7	$ 3,133.5	$ 2,931.9	$16,848.0	$ 2,589.9	$ 2,393.3	$ 2,231.8	$ 2,079.8	$ 1,950.1	$11,244.9

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 515 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 1	2	3	4	5	Total 1-5	6	7	8	9	10	Total 6-10
1	**Depreciable Generating Plant—Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge—% (Table 10 Line 24)	*10.62*	*10.49*	*10.36*	*10.23*	*10.10*	*51.80*	*9.97*	*9.85*	*9.72*	*9.59*	*9.46*	*48.59*
4	Fixed Charge—Amount	$ 7,139.3	$ 7,051.9	$ 6,964.5	$ 6,877.1	$ 6,789.7	$34,822.5	$ 6,702.3	$ 6,621.7	$ 6,534.3	$ 6,446.9	$ 6,359.5	$32,664.7
5	**Depreciable Transmission Plant—Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge—%	*8.82*	*8.79*	*8.75*	*8.71*	*8.67*	*43.74*	*8.63*	*8.59*	*8.56*	*8.52*	*8.48*	*42.78*
8	Fixed Charge—Amount	$ 220.5	$ 219.8	$ 218.7	$ 217.8	$ 216.7	$ 1,093.5	$ 215.7	$ 214.8	$ 214.0	$ 213.0	$ 212.0	$ 1,069.5
9	**Non-Depreciable Plant—Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charges @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 7,440.3	$ 7,352.2	$ 7,263.7	$ 7,175.4	$ 7,086.9	$36,318.5	$ 6,998.5	$ 6,917.0	$ 6,828.8	$ 6,740.4	$ 6,652.0	$34,136.7
13	**Fuel Working Capital—Fixed Charges**												
14	Amount (Table 7, Line 20)	$ 6,962.9	$ 7,151.2	$ 6,519.8	$ 6,354.5	$ 6,027.1	$33,015.5	$ 5,135.5	$16,399.6	$15,857.7	$15,827.8	$15,727.8	$68,948.4
15	Fixed Charges @ *10.39%*	723.4	743.0	677.4	660.2	626.2	3,430.2	533.6	1,703.9	1,647.6	1,644.5	1,634.1	7,163.7
16	**Other Working Capital—Fixed Charges**												
17	Materials & Supplies—*1%* of Lines (2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	1,119.0	1,119.0	1,077.4	897.2	897.2	5,109.8	897.2	858.0	815.3	815.3	815.3	4,201.1
19	Insurance (0.456 Annual Premium)	272.2	272.2	272.2	272.2	272.2	1,361.0	272.2	272.2	272.2	272.2	272.2	1,361.0
20	Subtotal	$ 2,088.2	$ 2,088.2	$ 2,046.6	$ 1,866.4	$ 1,866.4	$ 9,955.8	$ 1,866.4	$ 1,827.2	$ 1,784.5	$ 1,784.5	$ 1,784.5	$ 9,047.1
21	F.I.T. Avg. Bal. (credit)	612.1	650.4	669.2	695.4	722.0	3,349.1	735.7	1,026.3	1,047.0	1,080.4	1,112.3	5,001.7
22	Total	$ 1,476.1	$ 1,437.8	$ 1,377.4	$ 1,171.0	$ 1,144.4	$ 6,606.7	$ 1,130.7	$ 800.9	$ 737.5	$ 704.1	$ 672.2	$ 4,045.4
23	Fixed Charges @ *10.39%*	153.4	149.4	143.1	127.7	118.9	686.5	117.5	83.2	76.6	73.2	69.8	420.3
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 8,317.1	$ 8,244.6	$ 8,084.2	$ 7,957.3	$ 7,832.0	$40,435.2	$ 7,649.6	$ 8,704.1	$ 8,553.0	$ 8,458.1	$ 8,355.9	$41,720.7
25	**Operating & Maintenance Expense**												
26	Expense other than Fuel & Ins.	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 7,960.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 7,960.0
27	Insurance	597.0	597.0	597.0	597.0	597.0	2,985.0	597.0	597.0	597.0	597.0	597.0	2,985.0
28	Fuel: KWH × 10^6 Generated	3,970.0	3,970.0	3,970.0	3,970.0	3,970.0	19,850.0	3,970.0	3,970.0	3,970.0	3,970.0	3,970.0	19,850.0
29	Cost/KWH-Mills (Table 7)	*1.854*	*1.854*	*1.770*	*1.407*	*1.407*	*1.658*	*1.407*	*1.328*	*1.242*	*1.242*	*1.242*	*1.292*
30	Total Fuel Expense	$ 7,360.4	$ 7,360.4	$ 7,026.9	$ 5,585.8	$ 5,585.8	$32,919.3	$ 5,585.8	$ 5,272.2	$ 4,930.7	$ 4,930.7	$ 4,930.7	$25,650.1
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$ 9,549.4	$ 9,549.4	$ 9,215.9	$ 7,774.8	$ 7,774.8	$43,864.3	$ 7,774.8	$ 7,461.2	$ 7,119.7	$ 7,119.7	$ 7,119.7	$36,595.1
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$17,866.5	$17,794.0	$17,300.1	$15,732.1	$15,606.8	$84,299.5	$15,424.4	$16,165.3	$15,672.7	$15,577.8	$15,475.6	$78,315.8
33	Total per KWH—Mills	*4.50*	*4.48*	*4.36*	*3.96*	*3.93*	*4.25*	*3.89*	*4.07*	*3.95*	*3.92*	*3.90*	*3.94*
34	Total per KW—Dollars	$ 34.69	$ 34.55	$ 33.59	$ 30.55	$ 30.30	$ 32.74	$ 29.95	$ 31.39	$ 30.43	$ 30.25	$ 30.05	$ 30.41
35	Present Worth Factor	0.9400	0.8837	0.8307	0.7809	0.7341	4.1694	0.6901	0.6487	0.6098	0.5733	0.5389	3.0608
36	Present Worth of Revenue Requirements (Line 32 × 35)	$16,794.5	$15,724.6	$14,371.2	$12,285.2	$11,457.0	$70,632.5	$10,644.4	$10,486.4	$ 9,557.2	$ 8,930.8	$ 8,339.8	$47,958.6

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 515 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 11	12	13	14	15	Total 11-15	16	17	18	19	20	Total 16-20
1	**Depreciable Generating Plant—Fixed Charges**												
2	Cost of Plant Incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge—% (Table 10 pg. 2, Line 21)	*9.33*	*9.21*	*9.08*	*8.95*	*8.82*	*45.39*	*8.69*	*8.57*	*8.44*	*8.31*	*8.18*	*42.19*
4	Fixed Charge—Amount	$ 6,272.1	$ 6,191.4	$ 6,104.0	$ 6,016.6	$ 5,929.2	$30,513.3	$ 5,841.9	$ 5,761.2	$ 5,673.8	$ 5,586.4	$ 5,499.0	$28,362.3
5	**Depreciable Transmission Plant—Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge—%	*8.44*	*8.40*	*8.36*	*8.33*	*8.29*	*41.82*	*8.25*	*8.21*	*8.17*	*8.13*	*8.10*	*40.86*
8	Fixed Charge—Amount	$ 211.0	$ 210.0	$ 209.0	$ 208.3	$ 207.3	$ 1,045.6	$ 206.3	$ 205.3	$ 204.3	$ 203.3	$ 202.5	$ 1,021.7
9	**Non-Depreciable Plant—Fixed Charges**												
10	Land Incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charge @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 6,563.6	$ 6,481.9	$ 6,393.5	$ 6,305.4	$ 6,217.0	$31,961.4	$ 6,128.7	$ 6,047.0	$ 5,958.6	$ 5,870.2	$ 5,782.0	$29,786.5
13	**Fuel Working Capital—Fixed Charges**												
14	Amount (Table 7, Line 20)	$15,731.0	$15,568.3	$15,699.2	$15,325.5	$15,439.7	$77,763.7	$15,421.5	$15,458.6	$15,419.3	$15,651.8	$16,226.5	$78,177.7
15	Fixed Charges @ *10.39%*	1,634.5	1,617.5	1,631.1	1,592.3	1,604.2	8,079.6	1,602.3	1,606.1	1,602.1	1,626.2	1,685.9	8,122.6
16	**Other Working Capital—Fixed Charges**												
17	Materials & Supplies — *1%* of Lines (2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	815.3	815.3	815.3	815.3	815.3	4,076.5	780.3	780.3	780.3	780.3	780.3	3,901.5
19	Insurance (0.456 Annual Premium)	272.2	272.2	272.2	272.2	272.2	1,361.0	272.2	272.2	272.2	272.2	272.2	1,361.0
20	Subtotal	$ 1,784.5	$ 1,784.5	$ 1,784.5	$ 1,784.5	$ 1,784.5	$8,922.5	$ 1,749.5	$ 1,749.5	$ 1,749.5	$ 1,749.5	$ 1,749.5	$ 8,747.5
21	F.I.T. (Avg. Bal.) (credit)	1,146.4	1,176.8	1,213.8	1,239.4	1,276.1	6,052.5	1,308.9	1,343.8	1,377.0	1,416.4	1,463.6	6,909.7
22	Total	$ 638.1	$ 607.7	$ 570.7	$ 545.1	$ 508.4	$ 2,870.0	$ 440.6	$ 405.7	$ 372.5	$ 333.1	$ 285.9	$ 1,837.8
23	Fixed Charges @ *10.39%*	66.3	63.1	59.3	56.6	52.8	298.1	45.8	42.2	38.7	34.6	29.7	191.0
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 8,264.4	$ 8,162.5	$ 8,083.9	$ 7,954.3	$ 7,874.0	$40,339.1	$ 7,776.8	$ 7,695.3	$ 7,599.4	$ 7,531.0	$ 7,497.6	$38,100.1
25	**Operating & Maintenance Expense**												
26	Expense other than Fuel & Ins.	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 7,960.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 7,960.0
27	Insurance	597.0	597.0	597.0	597.0	597.0	2,985.0	597.0	597.0	597.0	597.0	597.0	2,985.0
28	Fuel: KWH × 10^6 Generated	3,970.0	3,970.0	3,970.0	3,970.0	3,970.0	19,850.0	3,744.0	3,744.0	3,744.0	3,744.0	3,744.0	18,720.0
29	Cost/KWH-Mills (Table 7)	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*
30	Total Fuel Expense	$ 4,930.7	$ 4,930.7	$ 4,930.7	$ 4,930.7	$ 4,930.7	$24,653.5	$ 4,650.0	$ 4,650.0	$ 4,650.0	$ 4,650.0	$ 4,650.0	$23,250.0
31	TOTAL OPERATING & MAINTENANCE EXPENSE (*Lines 26+27+30*)	$ 7,119.7	$ 7,119.7	$ 7,119.7	$ 7,119.7	$ 7,119.7	$35,598.5	$ 6,839.0	$ 6,839.0	$ 6,839.0	$ 6,839.0	$ 6,839.0	$34,195.0
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$15,384.1	$15,282.2	$15,203.6	$15,074.0	$14,993.7	$75,937.6	$14,615.8	$14,534.3	$14,438.4	$14,370.0	$14,336.6	$72,295.1
33	Total per KWH—Mills	*3.88*	*3.85*	*3.83*	*3.80*	*3.78*	*3.83*	*3.90*	*3.88*	*3.86*	*3.84*	*3.83*	*3.86*
34	Total per KW—Dollars	$ 29.87	$ 29.67	$ 29.52	$ 29.27	$ 29.11	$ 29.49	$ 28.38	$ 28.22	$ 28.04	$ 27.90	$ 27.84	$ 28.08
35	Present Worth Factor	0.5066	0.4762	0.4477	0.4208	0.3956	2.2469	0.3719	0.3496	0.3286	0.3089	0.2904	1.6494
36	Present Worth of Revenue Requirements (Line 32 × 35)	$ 7,793.6	$ 7,277.4	$ 6,806.7	$ 6,343.1	$ 5,931.5	$34,152.3	$ 5,435.6	$ 5,081.2	$ 4,744.5	$ 4,438.9	$ 4,163.3	$23,863.5

TABLE No. 11
Page 3 of 3

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 515 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 21	22	23	24	25	Total 21-25	26	27	28	29	30	Total 26-30
1	**Depreciable Generating Plant—Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge—% (Table 10, pg. 3, Line 21)	*8.05*	*7.92*	*7.80*	*7.67*	*7.54*	*38.98*	*7.41*	*7.28*	*7.16*	*7.03*	*6.90*	*35.78*
4	Fixed Charge—Amount	$ 5,411.6	$ 5,324.2	$ 5,243.6	$ 5,156.1	$ 5,068.8	$26,204.3	$ 4,981.4	$ 4,894.0	$ 4,813.3	$ 4,725.9	$ 4,638.5	$24,053.1
5	**Depreciable Transmission Plant—Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge—%	*8.06*	*8.02*	*7.98*	*7.94*	*7.91*	*39.91*	*7.87*	*7.83*	*7.79*	*7.75*	*7.71*	*38.95*
8	Fixed Charge—Amount	$ 201.5	$ 200.5	$ 199.5	$ 198.5	$ 197.8	$ 997.8	$ 196.7	$ 195.8	$ 194.7	$ 193.8	$ 192.7	$ 973.7
9	**Non-Depreciable Plant—Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charge @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 5,693.6	$ 5,605.2	$ 5,523.6	$ 5,435.1	$ 5,347.1	$27,604.6	$ 5,258.6	$ 5,170.3	$ 5,088.5	$ 5,000.2	$ 4,911.7	$25,429.3
13	**Fuel Working Capital—Fixed Charges**												
14	Amount (Table 7, Line 20)	$15,992.1	$14,590.7	$14,310.5	$14,628.2	$15,505.2	$75,026.7	$14,604.3	$14,123.9	$15,037.3	$13,678.4	$13,596.1	$71,040.0
15	Fixed Charges @ *10.39%*	1,661.6	1,516.0	1,486.9	1,519.9	1,611.0	7,795.4	1,517.3	1,467.5	1,562.4	1,421.2	1,412.6	7,381.0
16	**Other Working Capital—Fixed Charges**												
17	Materials & Supplies — *1%* of Lines (2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	742.9	742.9	742.9	742.9	742.9	3,714.5	591.2	591.2	591.2	591.2	591.2	2,956.0
19	Insurance (0.456 Annual Premium)	272.2	272.2	272.2	272.2	272.2	1,361.0	272.2	272.2	272.2	272.2	272.2	1,361.0
20	Subtotal	$ 1,712.1	$ 1,712.1	$ 1,712.1	$ 1,712.1	$ 1,712.1	$ 8,560.5	$ 1,560.4	$ 1,560.4	$ 1,560.4	$ 1,560.4	$ 1,560.4	$ 7,802.0
21	F.I.T. (Avg. Bal.) (credit)	1,491.5	1,493.6	1,521.3	1,562.7	1,616.8	7,685.9	1,626.8	1,649.1	1,704.9	1,707.8	1,740.1	8,428.7
22	Total	$ 220.6	$ 218.5	$ 190.8	$ 149.4	$ 95.3	$ 874.6	$ –66.4	$ –88.7	$ –144.5	$ –147.4	$ –179.7	$ –626.7
23	Fixed Charges @ *10.39%*	22.9	22.7	19.8	15.5	9.9	90.8	– 6.9	– 9.2	– 15.0	– 15.3	– 18.7	– 65.1
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 7,378.1	$ 7,143.9	$ 7,030.3	$ 6,970.5	$ 6,968.0	$35,490.8	$ 6,769.0	$ 6,628.6	$ 6,635.9	$ 6,406.1	$ 6,305.6	$32,745.2
25	**Operating & Maintenance Expense**												
26	Expense other than Fuel & Ins.	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 7,960.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 1,592.0	$ 7,960.0
27	Insurance	597.0	597.0	597.0	597.0	597.0	2,985.0	597.0	597.0	597.0	597.0	597.0	2,985.0
28	Fuel: KWH × 10^6 Generated	3,022.5	3,022.5	3,022.5	3,022.5	3,022.5	15,112.5	2,526.6	2,526.6	2,526.6	2,526.6	2,526.6	12,633.0
29	Cost/KWH-Mills (Table 7)	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*	*1.242*
30	Total Fuel Expense	$ 3,753.9	$ 3,753.9	$ 3,753.9	$ 3,753.9	$ 3,753.9	$18,769.5	$ 3,138.0	$ 3,138.0	$ 3,138.0	$ 3,138.0	$ 3,138.0	$15,690.0
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$ 5,942.9	$ 5,942.9	$ 5,942.9	$ 5,942.9	$ 5,942.9	$29,714.5	$ 5,327.0	$ 5,327.0	$ 5,327.0	$ 5,327.0	$ 5,327.0	$26,635.0
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$13,321.0	$13,086.8	$12,973.2	$12,913.4	$12,910.9	$65,205.3	$12,096.0	$11,955.6	$11,962.9	$11,733.1	$11,632.6	$59,380.2
33	Total per KWH—Mills	*4.41*	*4.33*	*4.29*	*4.27*	*4.27*	*4.31*	*4.79*	*4.73*	*4.73*	*4.64*	*4.60*	*4.70*
34	Total per KW—Dollars	$ 25.87	$ 25.41	$ 25.19	$ 25.07	$ 25.07	$ 25.32	$ 23.49	$ 23.21	$ 23.23	$ 22.78	$ 22.59	$ 23.06
35	Present Worth Factor	0.2730	0.2566	0.2413	0.2268	0.2132	1.2109	0.2004	0.1884	0.1771	0.1665	0.1565	0.8889
36	Present Worth of Revenue Requirements (Line 32 × 35)	$ 3,636.6	$ 3,358.1	$ 3,130.4	$ 2,928.8	$ 2,752.6	$15,806.5	$ 2,424.0	$ 2,252.4	$ 2,118.6	$ 1,953.6	$ 1,820.5	$10,569.1

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 565 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 1	2	3	4	5	Total 1 to 5	6	7	8	9	10	Total 6 to 10
1	**Depreciable Generating Plant — Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge — %	*10.62*	*10.49*	*10.36*	*10.23*	*10.10*	*51.80*	*9.97*	*9.85*	*9.72*	*9.59*	*9.46*	*48.59*
4	Fixed Charge — Amount	$ 7,139.3	$ 7,051.9	$ 6,964.5	$ 6,877.1	$ 6,789.7	$34,822.5	$ 6,702.3	$ 6,621.7	$ 6,534.3	$ 6,446.9	$ 6,359.5	$32,664.7
5	**Depreciable Transmission Plant — Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge — %	*8.82*	*8.79*	*8.75*	*8.71*	*8.67*	*43.74*	*8.63*	*8.59*	*8.56*	*8.52*	*8.48*	*42.78*
8	Fixed Charge — Amount	$ 220.5	$ 219.8	$ 218.7	$ 217.8	$ 216.7	$ 1,093.5	$ 215.7	$ 214.8	$ 214.0	$ 213.0	$ 212.0	$ 1,069.5
9	**Non-Depreciable Plant — Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charge @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 7,440.3	$ 7,352.2	$ 7,263.7	$ 7,175.4	$ 7,086.9	$36,318.5	$ 6,998.5	$ 6,917.0	$ 6,828.8	$ 6,740.4	$ 6,652.0	$34,136.7
13	**Fuel Working Capital — Fixed Charges**												
14	Amount (Table 8, Line 20)	$ 6,814.2	$ 6,920.7	$ 7,629.7	$ 6,771.7	$ 6,323.3	$34,459.6	$ 5,478.8	$15,478.0	$15,080.3	$16,809.2	$15,946.3	$68,792.6
15	Fixed Charges @ *10.39%*	708.0	719.1	792.7	703.6	657.0	3,580.4	569.2	1,608.2	1,566.8	1,746.5	1,656.8	7,147.5
16	**Other Working Capital — Fixed Charges**												
17	Materials & Supplies — *1%* of Lines 2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	1,211.9	1,211.9	1,110.1	976.7	976.7	5,487.3	972.9	886.3	886.3	886.3	877.6	4,509.4
19	Insurance (0.456 Annual Premium)	274.5	274.5	274.5	274.5	274.5	1,372.5	274.5	274.5	274.5	274.5	274.5	1,372.5
20	Subtotal	$ 2,183.4	$ 2,183.4	$ 2,081.6	$ 1,948.2	$ 1,948.2	$10,344.8	$ 1,944.4	$ 1,857.8	$ 1,857.8	$ 1,857.8	$ 1,849.1	$ 9,366.9
21	F.I.T. (Avg. Bal.) (credit)	610.9	647.3	695.4	706.8	730.6	3,391.0	745.3	1,005.9	1,031.0	1,104.5	1,118.7	5,005.4
22	Total	$ 1,572.5	$ 1,536.1	$ 1,386.2	$ 1,241.4	$ 1,217.6	$ 6,953.8	$ 1,199.1	$ 851.9	$ 826.8	$ 753.3	$ 730.4	$ 4,361.5
23	Fixed Charges @ *10.39%*	163.4	159.6	144.0	129.0	126.5	722.5	124.6	88.5	85.9	78.3	75.9	453.2
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 8,311.7	$ 8,230.9	$ 8,200.4	$ 8,008.0	$ 7,870.4	$40,621.4	$ 7,692.3	$ 8,613.7	$ 8,481.5	$ 8,565.2	$ 8,384.7	$41,737.4
25	**Operating & Maintenance Expense**												
26	Expense other than Fuel & Ins.	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 8,165.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 8,165.0
27	Insurance	602.0	602.0	602.0	602.0	602.0	3,010.0	602.0	602.0	602.0	602.0	602.0	3,010.0
28	Fuel: KWH × 10^6 Generated	4,355.6	4,355.6	4,355.6	4,355.6	4,355.6	21,778.0	4,355.6	4,355.6	4,355.6	4,355.6	4,355.6	21,778.0
29	Cost/KWH — Mills (Table 8)	*1.851*	*1.851*	*1.664*	*1.419*	*1.419*	*1.641*	*1.412*	*1.253*	*1.253*	*1.253*	*1.237*	*1.282*
30	Total Fuel Expense	8,062.2	8,062.2	7,247.7	6,180.6	6,180.6	35,733.3	6,150.1	5,457.6	5,457.6	5,457.6	5,387.8	27,910.7
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$10,297.2	$10,297.2	$ 9,482.7	$ 8,415.6	$ 8,415.6	$46,908.3	$ 8,385.1	$ 7,692.6	$ 7,692.6	$ 7,692.6	$ 7,622.8	$39,085.7
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$18,608.9	$18,528.1	$17,683.1	$16,423.6	$16,286.0	$87,529.7	$16,077.4	$16,306.3	$16,174.1	$16,257.8	$16,007.5	$80,823.1
33	Total per KWH — Mills	*4.27*	*4.25*	*4.06*	*3.77*	*3.74*	*4.019*	*3.69*	*3.74*	*3.71*	*3.73*	*3.68*	*3.711*
34	Total per KW — Dollars	$ 32.94	$ 32.79	$ 31.30	$ 29.07	$ 28.82	$ 30.984	$ 28.46	$ 28.86	$ 28.63	$ 28.77	$ 28.33	$ 28.610
35	Present Worth Factor	0.9400	0.8837	0.8307	0.7809	0.7341	4.1694	0.6901	0.6487	0.6098	0.5733	0.5389	3.0608
36	Present Worth of Revenue Requirements (Line 32×35)	$17,492.4	$16,373.3	$14,689.4	$12,825.2	$11,955.6	$73,335.9	$11,095.0	$10,577.9	$ 9,863.0	$ 9,320.6	$ 8,626.4	$49,482.9

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 565 MW (Net); PLANT FACTOR: *88%* — 15 Yrs.; *83%* — 5 Yrs.; *67%* — 5 Yrs.; *56%* — 5 Yrs.

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 11	12	13	14	15	Total 11 to 15	16	17	18	19	20	Total 16 to 20
1	**Depreciable Generating Plant — Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge — %	*9.33*	*9.21*	*9.08*	*8.95*	*8.82*	*45.39*	*8.69*	*8.57*	*8.44*	*8.31*	*8.18*	*42.19*
4	Fixed Charge — Amount	$ 6,272.1	$ 6,191.4	$ 6,104.0	$ 6,016.6	$ 5,929.2	$30,513.3	$ 5,841.9	$ 5,761.2	$ 5,673.8	$ 5,586.4	$ 5,499.0	$28,362.3
5	**Depreciable Transmission Plant — Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge — %	*8.44*	*8.40*	*8.36*	*8.33*	*8.29*	*41.82*	*8.25*	*8.21*	*8.17*	*8.13*	*8.10*	*40.86*
8	Fixed Charge — Amount	$ 211.0	$ 210.0	$ 209.0	$ 208.3	$ 207.3	$ 1,045.6	$ 206.3	$ 205.3	$ 204.3	$ 203.3	$ 202.5	$ 1,021.7
9	**Non-Depreciable Plant — Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charge @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 6,563.6	$ 6,481.9	$ 6,393.5	$ 6,305.4	$ 6,217.0	$31,961.4	$ 6,128.7	$ 6,047.0	$ 5,958.6	$ 5,870.2	$ 5,782.0	$29,786.5
13	**Fuel Working Capital — Fixed Charges**												
14	Amount (Table 8, Line 20)	$15,778.1	$15,453.8	$15,858.1	$15,380.2	$15,049.2	$77,519.4	$16,856.9	$16,018.5	$15,975.8	$16,142.9	$16,073.0	$81,067.1
15	Fixed Charges @ *10.39%*	1,639.3	1,605.6	1,647.7	1,598.0	1,563.6	8,054.2	1,751.4	1,664.3	1,659.9	1,677.2	1,670.0	8,422.8
16	**Other Working Capital — Fixed Charges**												
17	Materials & Supplies — *1%* of Lines (2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	872.2	872.2	872.2	872.2	872.2	4,361.0	834.2	834.2	834.2	834.2	834.2	4,171.0
19	Insurance (0.456 Annual Premium)	274.5	274.5	274.5	274.5	274.5	1,372.5	274.5	274.5	274.5	274.5	274.5	1,372.5
20	Subtotal	$ 1,843.7	$ 1,843.7	$ 1,843.7	$ 1,843.7	$ 1,843.7	$ 9,218.5	$ 1,805.7	$ 1,805.7	$ 1,805.7	$ 1,805.7	$ 1,805.7	$ 9,028.5
21	F.I.T. (Avg. Bal.) (credit)	1,148.8	1,175.5	1,218.7	1,242.0	1,268.5	6,053.5	1,343.0	1,357.9	1,391.0	1,428.9	1,461.4	6,982.2
22	Total	$ 694.9	$ 668.2	$ 625.0	$ 601.7	$ 575.2	$ 3,165.0	$ 462.7	$ 447.8	$ 414.7	$ 376.8	$ 344.3	$ 2,046.3
23	Fixed Charges @ *10.39%*	72.2	69.4	64.9	62.5	59.8	328.8	48.1	46.5	43.1	39.1	35.8	212.6
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 8,275.1	$ 8,156.9	$ 8,106.1	$ 7,965.9	$ 7,840.4	$40,344.4	$ 7,928.2	$ 7,757.8	$ 7,661.6	$ 7,586.5	$ 7,487.8	$38,421.9
25	**Operating & Maintenance Expense**												
26	Expense other than Fuel & Ins.	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 8,165.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 8,165.0
27	Insurance	602.0	602.0	602.0	602.0	602.0	3,010.0	602.0	602.0	602.0	602.0	602.0	3,010.0
28	Fuel: KWH × 10^6 Generated	4,355.6	4,355.6	4,355.6	4,355.6	4,355.6	21,778.0	4,108.1	4,108.1	4,108.1	4,108.1	4,108.1	20,540.5
29	Cost/KWH — Mills (Table 8)	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*
30	Total Fuel Expense	5,344.3	5,344.3	5,344.3	5,344.3	5,344.3	26,721.5	5,040.6	5,040.6	5,040.6	5,040.6	5,040.6	25,203.0
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$ 7,579.3	$ 7,579.3	$ 7,579.3	$ 7,579.3	$ 7,579.3	$37,896.5	$ 7,275.6	$ 7,275.6	$ 7,275.6	$ 7,275.6	$ 7,275.6	$36,378.0
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$15,854.4	$15,736.2	$15,685.4	$15,545.2	$15,419.7	$78,240.9	$15,203.8	$15,033.4	$14,937.2	$14,862.1	$14,763.4	$74,799.9
33	Total per KWH — Mills	*3.64*	*3.61*	*3.60*	*3.57*	*3.54*	*3.593*	*3.70*	*3.66*	*3.64*	*3.62*	*3.59*	*3.642*
34	Total per KW — Dollars	$ 28.06	$ 27.85	$ 27.76	$ 27.51	$ 27.29	$ 27.696	$ 26.91	$ 26.61	$ 26.44	$ 26.30	$ 26.13	$ 26.478
35	Present Worth Factor	0.5066	0.4762	0.4477	0.4208	0.3956	2.2469	0.3719	0.3496	0.3286	0.3089	0.2904	1.6494
36	Present Worth of Revenue Requirements (Line 32×35)	$ 8,031.8	$ 7,493.6	$ 7,022.4	$ 6,541.4	$ 6,100.0	$35,189.2	$ 5,654.3	$ 5,255.7	$ 4,908.4	$ 4,590.9	$ 4,287.3	$24,696.6

TABLE NO. 12
Page 3 of 3

OYSTER CREEK NUCLEAR PLANT REVENUE REQUIREMENTS

OUTPUT: 565 MW (Net); PLANT FACTOR: *88%* **— 15 Yrs.;** *83%* **— 5 Yrs.;** *67%* **— 5 Yrs.;** *56%* **— 5 Yrs.**

DEPRECIATION LIVES: Nuclear 30 Year Book — 30 Year Tax; TRANSMISSION: 40 Year Book — 30 Year Tax; Return — *6.3775%*

(000's Omitted)

Line No.		YEARS 21	22	23	24	25	Total 21 to 25	26	27	28	29	30	Total 26 to 30
1	**Depreciable Generating Plant — Fixed Charges**												
2	Cost of Plant incl. Int. during Const.	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 67,225	$ 336,125
3	Fixed Charge — %	*8.05*	*7.92*	*7.80*	*7.67*	*7.54*	*38.98*	*7.41*	*7.28*	*7.16*	*7.03*	*6.90*	*35.78*
4	Fixed Charge — Amount	$ 5,411.6	$ 5,324.2	$ 5,243.6	$ 5,156.1	$ 5,068.8	$26,204.3	$ 4,981.4	$ 4,894.0	$ 4,813.3	$ 4,725.9	$ 4,638.5	$24,053.1
5	**Depreciable Transmission Plant — Fixed Charges**												
6	Cost of Plant incl. Int. during Const.	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 2,500	$ 12,500
7	Fixed Charge — %	*8.06*	*8.02*	*7.98*	*7.94*	*7.91*	*39.91*	*7.87*	*7.83*	*7.79*	*7.75*	*7.71*	*38.95*
8	Fixed Charge — Amount	$ 201.5	$ 200.5	$ 199.5	$ 198.5	$ 197.8	$ 997.8	$ 196.7	$ 195.8	$ 194.7	$ 193.8	$ 192.7	$ 973.7
9	**Non-Depreciable Plant — Fixed Charges**												
10	Land incl. Int. during Const.	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875	$ 775	$ 775	$ 775	$ 775	$ 775	$ 3,875
11	Fixed Charge @ *10.39%*	80.5	80.5	80.5	80.5	80.5	402.5	80.5	80.5	80.5	80.5	80.5	402.5
12	TOTAL PLANT — FIXED CHARGES (Lines 4+8+11)	$ 5,693.6	$ 5,605.2	$ 5,523.6	$ 5,435.1	$ 5,347.1	$27,604.6	$ 5,258.6	$ 5,170.3	$ 5,088.5	$ 5,000.2	$ 4,911.7	$25,429.3
13	**Fuel Working Capital — Fixed Charges**												
14	Amount (Table 8, Line 20)	$15,641.9	$15,929.1	$14,736.4	$15,088.2	$14,129.6	$75,525.2	$15,091.8	$15,143.8	$13,938.8	$13,872.6	$14,504.2	$72,551.2
15	Fixed Charges @ *10.39%*	1,625.2	1,655.0	1,531.1	1,567.7	1,468.1	7,847.1	1,568.0	1,573.4	1,448.2	1,441.4	1,507.0	7,538.0
16	**Other Working Capital — Fixed Charges**												
17	Materials & Supplies — *1%* of Lines 2+6)	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 697.0	$ 3,485.0
18	*12.5%* Oper. & Maint. Exp. excl. Ins.	712.7	712.7	712.7	712.7	712.7	3,563.5	629.3	629.3	629.3	629.3	629.3	3,146.5
19	Insurance (0.456 Annual Premium)	274.5	274.5	274.5	274.5	274.5	1,372.5	274.5	274.5	274.5	274.5	274.5	1,372.5
20	Subtotal	$ 1,684.2	$ 1,684.2	$ 1,684.2	$ 1,684.2	$ 1,684.2	$ 8,421.0	$ 1,600.8	$ 1,600.8	$ 1,600.8	$ 1,600.8	$ 1,600.8	$ 8,004.0
21	F.I.T. (Avg. Bal.) (credit)	1,482.8	1,523.5	1,530.4	1,572.5	1,584.7	7,693.9	1,638.9	1,673.3	1,680.7	1,713.2	1,761.8	8,467.9
22	Total	$ 201.4	$ 160.7	$ 153.8	$ 111.7	$ 99.5	$ 727.1	$ —38.1	$ —72.5	$ —79.9	$—112.4	$—161.0	$—463.9
23	Fixed Charges @ *10.39%*	20.9	16.7	16.0	11.6	10.3	75.5	— 4.0	— 7.5	— 8.3	— 11.7	— 16.7	— 48.2
24	TOTAL PLANT & WORKING CAPITAL FIXED CHARGES	$ 7,339.7	$ 7,276.9	$ 7,070.7	$ 7,014.4	$ 6,825.5	$35,527.2	$ 6,822.6	$ 6,736.2	$ 6,528.4	$ 6,429.9	$ 6,402.0	$32,919.1
25	**Operating & Maintenance Expense**												
26	Expense other than Fuel & Ins.	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 8,165.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 1,633.0	$ 8,165.0
27	Insurance	602.0	602.0	602.0	602.0	602.0	3,010.0	602.0	602.0	602.0	602.0	602.0	3,010.0
28	Fuel: KWH × 10^6 Generated	3,316.0	3,316.0	3,316.0	3,316.0	3,316.0	16,580.0	2,771.9	2,771.9	2,771.9	2,771.9	2,771.9	13,859.5
29	Cost/KWH — Mills (Table 8)	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*	*1.227*
30	Total Fuel Expense	4,068.7	4,068.7	4,068.7	4,068.7	4,068.7	20,343.5	3,401.1	3,401.1	3,401.1	3,401.1	3,401.1	17,005.5
31	TOTAL OPERATING & MAINTENANCE EXPENSE (Lines 26+27+30)	$ 6,303.7	$ 6,303.7	$ 6,303.7	$ 6,303.7	$ 6,303.7	$31,518.5	$ 5,636.1	$ 5,636.1	$ 5,636.1	$ 5,636.1	$ 5,636.1	$28,180.5
32	TOTAL REVENUE REQUIREMENTS (Lines 24+31)	$13,643.4	$13,580.6	$13,374.4	$13,318.1	$13,129.2	$67,045.7	$12,458.7	$12,372.3	$12,164.5	$12,066.0	$12,038.1	$61,099.6
33	Total per KWH — Mills	*4.11*	*4.10*	*4.03*	*4.02*	*3.96*	*4.044*	*4.49*	*4.46*	*4.39*	*4.35*	*4.34*	*4.409*
34	Total per KW — Dollars	$ 24.15	$ 24.04	$ 23.67	$ 23.57	$ 23.24	$ 23.733	$ 22.05	$ 21.90	$ 21.53	$ 21.36	$ 21.31	$ 21.628
35	Present Worth Factor	0.2730	0.2566	0.2413	0.2268	0.2132	1.2109	0.2004	0.1884	0.1771	0.1665	0.1565	0.8889
36	Present Worth of Revenue Requirements (Line 32×35)	$ 3,724.6	$ 3,484.8	$ 3,227.2	$ 3,020.5	$ 2,799.1	$16,256.2	$ 2,496.7	$ 2,330.9	$ 2,154.3	$ 2,009.0	$ 1,884.0	$10,874.9

APPENDIX C

This appendix is submitted in response to a group of questions transmitted via U. S. Atomic Energy Commission letter dated October 24, 1972 from Mr. Daniel R. Muller, Assistant Director for Environmental Projects, Directorate of Licensing, to M. R. H. Sims, Vice President, Jersey Central Power & Light Company.

Each question is listed, followed by a response to the question.

QUESTION

A1 Describe the pre-construction condition of the Oyster Creek site with particular reference to man-made causes of pollution. Provide backup references.

RESPONSE

The land use within the plant site is described in Section 2.2.2.2 of the Oyster Creek Environmental Report.

Housing developments for permanent and summer populations within the vicinity of Oyster Creek had one of the major effects on the pre-construction condition of the Oyster Creek site area. Construction of housing occurred along the Barnegat Bay line and marina facilities which were near the site area. The permanent and summer homes required land changes such as excavation and removal of vegetation which exposed the sandy soils making them vulnerable to wind erosion.

The construction of highways and transmission line right-of-ways also required the removal of vegetation. The soils of the pine barrens region are sandy and have low fertility, which make the reestablishment of vegetation by natural succession very slow. Hence, the effect of construction has been visible for several years.

Pesticide accumulation in soils in the vicinity of the Oyster Creek plant should have been small. Scale insects in the area were controlled in the spring with parathion or malathion applied with superior oil. Blossom weavils were controlled with dieldrin, a derivative of DDT, up until five years ago. Outhion or parathion are now applied by aerial spraying three or four times in the spring. Review of the 1965 USGS aerial photographs indicate that crops were not grown within the exclusion boundary of the plant site. However, Baywood farm did use the area for raising beef cattle for show purposes. The amounts and kinds of pesticides used on the farm are not known.

The control of the New Jersey salt marsh mosquitos (aedes sollicitana) and fresh water mosquitos (cules sp. and aedes vezana) was accomplished with aerial applications of DDT in the early 1960's.
The extensive irrigation system at Baywood farm reduced the probability of mosquitos and, hence, applications of mosquito-cides were seldom used directly on the Oyster Creek site. Malathion or abate are now used to control mosquitos along the coastal estuaries.

Vegetation in the vicinity of the plant has been in a successional stage since Jersey Central obtained possession of the land. It was previously used for agricultural production (livestock) and had been treated accordingly. The salt marsh area had been drained and used for pasture production. Trees and shrubs had been removed from other sections of the land. Since agricultural practices have been discontinued, the salt marsh is slowly beginning to return which is also encouraging the estuary to return.

REFERENCES

1. Roe, Kenneth A. 1960 "Oyster Creek Site Investigation for New Jersey Power & Light Company." Burnes and Roe, Inc., New York.

2. New Jersey Department of Agriculture. 1971. "1970 New Jersey Agricultural Statistics." New Jersey Crop Reporting Service, Trenton. 61 pages.

3. McCormick, Jack. 1970. "The Pine Barrens, a Preliminary Ecological Inventory." Report 2. New Jersey State Museum, Trenton. 103 pages.

QUESTION

A2 Develop the rationale and impact of not cutting in dilution pumps at 87°F at the railroad bridge.

RESPONSE

As discussed in the Environmental Report Section 5.1.2, thermal discharges have been regulated by the State of New Jersey by means of a limit established during Public Utility Commission public hearings prior to initial operation of the Oyster Creek Station. This limit (concurred in by the State of New Jersey and Jersey Central) states that a temperature of 95°F shall not be exceeded at a specific temperature buoy located in Barnegat Bay. It was also agreed at that time that should studies conducted under the direction of the State and Jersey Central demonstrate that operation under this limit is detrimental to the environment, then the limit will be appropriately adjusted. It should also be pointed out that this limit was arrived at after consideration by the PUC public hearing board of both the environmental impact and the costs of cooling alternatives necessary to guarantee compliance with a lower limit.

Since the temperature at this designated buoy is not indicated in the Oyster Creek Station control room, Jersey Central determined to maintain temperatures in the discharge canal at the Route 9 bridge below approximately 95°F in order to comply with this agreement. If the water temperature at the bridge is maintained at or below 95°F then the bay temperature <u>at any point</u> will not exceed 95°F. This procedure has been utilized since the Oyster Creek plant began operations in 1969.

Since that time, extensive surveys of the flora and fauna of this area of Barnegat Bay have been conducted by the Rutgers University study group. No effect on the environment has been perceived which can be distinguished from the natural cyclic changes in the populations and species identified before plant operation. Therefore, with respect to the local aquatic ecology, the environmental effect of a 95°F water temperature in the discharge canal has been minimal.

To suggest a lowering of this limit in the absence of justification in the form of clearly defined detrimental effects of present operation is at best overly conservative. Furthermore, there are several valid reasons for not insisting upon the mandatory use of the dilution pumps because of known detrimental environmental and economic factors associated with such operation.

These are discussed below at least qualitatively, if not quantatively:

1. The present flow in the canals does cause some erosion and setting which will require periodic dredging of the canals about once every four years. Any increase in flow due to operation of the dilution pumps (operation of 2 dilution pumps more than doubles the flow in the canal) would considerably accelerate these problems and probably result in dredging once every two years. Although the economic costs of these dredging operations can be quantified (Refer to Question F16), the environmental costs cannot, but it is certain that any proposal to increase dilution flow, including maintaining a limit of 87°F at the bridge, would result in increased dredging and increased environmental impact and cost.

2. The runoff from the cedar tree stands in the local area contains chemicals that produce a foam when agitated. This problem is particularly acute at the dilution pump structure because of the high flow and absence of a back pressure. This foam has already been a problem from an aesthetic point of view and any increase in dilution pump use would aggrevate this problem (Refer to Figure A8-2).

3. Using the pre-operational Barnegat Bay buoy temperature as typical summer bay temperatures, maintaining temperature at the bridge at 87°F or below would require operation of the dilution pumps approximately as follows:

   1 pump - 50 days/year
   2 pumps- 33 days/year
   3 pumps- 28 days/year

   This is in comparison with the present procedure which requires operation of 1 pump about 48 days/year and 2 pumps about 1 day/year.

   The incremental cost associated with this additional operation is minimal, about $20,000 per year. (Based on $80 per KW/year).

4. The use of more dilution pumps will increase the velocity in the canals and will result in increased accumulation of trash at the intake structure. During the early summer, grass that grows in the Bay floats up the intake canal in large masses and has clogged the

intake structure requiring plant slowdown or shutdown. This problem has been solved by the use of barriers and the operation of a dilution pump to draw the grass away from the circulating water system intake (Refer to Figure A8-1). However, operation of more than one dilution pump will most likely increase the grass quantity, and the present solution may not remain adequate. Lost plant operational time as well as the cost of a system to handle the grass buildup mitigates against the increase of flow in the canal.

5. Since the plant began operating, several condenser tubes have begun to leak. It has been determined that the mechanism producing these holes is erosion. Apparently, organisms attached to the tube surface cause the flow to be turbulent and the entrained sand and silt in the circulating water impinges on the tube wall, eventually wearing through. By mid September 1972, 116 tubes had been plugged because of leaks. Eventually, if this trend continues, tubes will have to be replaced at great cost both for the specific operation and for the plant downtime. Increased canal flow and resulting velocity, will result in greater sand and other solid transport in the circulating water, aggrevating this erosion problem. Since tubes have not been replaced in this condenser to date, it is difficult to estimate the cost of such activities, but whatever the cost, any increase in tube penetrations will greatly increase the cost since shutdown for repair will occur more frequently.

The question of how much these effects will be increased by lowering the temperature limit at the bridge from 95°F to 87°F is impossible to estimate. But it is clear that there would be both economic and environmental costs involved. In light of the lack of demonstrated detrimental effects of present operation even after extensive study, there appears to be no clearly defined environmental benefit associated with the lowering of this limit.

QUESTION

A3 Describe alternative methods of cleaning the condenser tubes and contrast their effectiveness and environmental impact as compared to chlorination.

RESPONSE

Chlorine has been applied at Oyster Creek for the prevention of marine fouling in the cooling water circuits which were designed to function with chlorinated brackish cooling water. The primary types of biological foulents of critical concern are barnacles and black mussels. Of somewhat less concern, but also present are sponges, tunicates, bryozos and bacterial slimes.

All of the foregoing organisms can cause heavy voluminous growths on the surfaces of piping, tunnel walls, water boxes, racks, screens and similar areas within the main condenser cooling water system, as well as in the less accessible areas of the auxiliary cooling water systems. These latter systems take less cooling water flow but are still as critical in function as the larger system. The auxiliary systems comprise turbine building cooling systems and similar uses, as well as emergency service water pumps, fire pumps and containment cooling systems. These last three systems are not continuously circulating, but their integrity depends upon unhindered flow at the off-take points from the main system.

Growths of these organisms in the cooling systems can restrict cooling water flow to the main condenser and auxiliary systems, and cause a loss in heat rejection efficiency. In the main condenser, this would cause a back pressure on the turbine and directly decrease the generating efficiency. Auxiliary systems would similarly become blocked with growths and cause overheating in the vital turbine cooling system and loss of function in the other standby services.

Marine growths in areas preceding the condenser can and have caused tube losses in the main condensers. This is caused by large pieces of barnacle shells breaking away from water box or tunnel surfaces and lodging in the tubes. High velocity water jets and scouring at these points, due to the flow restrictions, causes loss of tube metal and perforations at these points. Saltwater then leaks into the condensers. The mineral matter introduced into the station condensate and feedwater system must be removed before re-entering the reactor steam generator to insure proper chemistry and keep heat exchanger surfaces free of scale or deposits.

Bacterial slimes and organic type films will develop on all surfaces contacted by the cooling waters at Oyster Creek even under the coldest winter conditions. Chlorine applied at a low level intermittently will prevent these films from interfering with the maintenance of the design "cleanliness coefficient" or heat exchange efficiency.

Chlorine is the best available agent to restrict marine type growths and the plant was originally designed to use it. Chlorine is applied intermittently on 1/6th of the total cooling water volume. It is then mixed in the outlet tunnel with 5/6th of the circulated volume after passage through one side of the six condenser halves. When mixed in this manner, little or no residual chlorine is discharged to the effluent canal. "Chlorine demand" in the unchlorinated portion rapidly depletes the chlorine residual returning to the discharge canal.

There are alternate means of cleaning condenser tubes, but it is essential to realize that the system integrity is more directly dependent on preventing growths in the tunnels and conveyance piping and water boxes ahead of the condensers and in the auxiliary cooling systems themselves, than in removing them once they are attached.

Alternate Means

I. Mechanical

a. Amertap System

The Amertap system involves circulating rubber balls coated with mild abrasive which pass through the condenser tubes and scrape the surfaces clean. After passage through the condenser, the balls are collected and pumped back to the inlet of the condensers for recycling.

Amertap systems work successfully in some installations where deposits on the tubes from materials in the cooling water are a problem. These would be substances like silt, iron oxide, organics, and manganese which form depositions on the tube surfaces. Amertap is helpful also where bio-slime problems exist on condenser tube surfaces but does not prevent marine growths in the remainder of the cooling water circuits.

b. MAN System

The MAN System, which uses reciprocating brushes within the condensers, is similar in function to the Amertap system. However, both would, in the case of Oyster Creek, offer little or no benefit in the condensers.

c. Manual Mechanical Cleaning

Manual mechanical cleaning is often used as an adjunct to but not a replacement of chlorination at many plants. This involves the rodding out of tubes or shooting brushes through the tubes with water and compressed air to keep the system clean.

d. Reversing the Flow of Water

Reversing the flow of water is effective in removing shells and deposits from tubes and is currently practiced at Oyster Creek.

All of the foregoing methods have little or no significant ecological impact.

II. Other Chemicals and Methods

Hyochlorites, ozone, biocides and paints all must exercise a killing effect similar to chlorine in order to be effective. Ozone is reportedly less "residual" in waters treated by ozonation but operating experience in large generating station cooling systems is not available. Other biocides, such as aerolein, have been used with success, but use has been limited by handling problems and toxicity considerations. Paints based on copper or organic tin compounds all must be toxic to be effective and have limited usefulness. Some plants report success but most installations report loss in effectiveness due to organic filming and "wearaway" attrition.

Polyelectrolyte cleaning using high molecule weight polymeric materials applied intermittently have been useful to remove deposits, but effectiveness on marine growths in auxiliaries and in the tunnels is negligible. They are "non-toxic".

Thermal killing of mussels, barnacles and other forms is also practiced. This involves dropping generating load and reversing the heated water flow slowly through the condenser and out through the intake tunnel. This will kill marine forms at temperatures of 105° F. to 115° F. but will, of course, also attenuate all other heat sensitive forms in the water.

Removable screens installed in front of the condenser tube sheets have been used in at least one installation for preventing shells and debris from penetrating the condensers.

QUESTION

A4 Discuss the historical sequence of construction activities including pictorial records of progress to delineate:

a. Dredging and spoil handling,
b. Foundation excavation and drainage, and
c. Canal excavation and spoil handling.

RESPONSE

Dredging and Spoil Handling

Figure A4-1 provides the available photographs of the dredging and spoil handling for the intake and discharge canals east of Route 9. The historical sequence of this construction effort is presented in the response to Question E4 (Also refer to Figure E4-1). A description of the photographs is as follows:

Frame "A" - View of the 20" sump pump area set up for draining Main Disposal Area #9 for the Oyster Creek canal dredging (August 9, 1966).

Frame "B" - View of discharge of hydraulic fill into Main Disposal Area #9 (August 9, 1966).

Frame "C" - View looking northeast at the Main Disposal Area #9 (August 11, 1966).

Frame "D" - Hydraulic dredging of Oyster Creek opposite Disposal Area #1 (eastern end) (October 6, 1966).

Frame "E" - Start of dredging of the South Branch of Forked River by hydraulic dredge (left background) and dragline dredge (center background). The dike in the foreground is the embankment for Disposal Area #6 (October 25, 1966).

Frame "F" - Looking south at the Main Disposal Area #9 for Oyster Creek dredging from the sump pump area. The dike is on the right hand side. (October 28, 1966)

Foundation Excavation and Drainage

Figure A4-2 provides the available photographs of the foundation excavation for the Oyster Creek Station. The historical sequence of this construction effort is presented below. A description of the photographs is as follows:

Frame "A" – Overall site aerial view with excavation in the background and the disposal area for the reactor and turbine buildings in the foreground (November 1964).

Frame "B" – Aerial view of the excavation of the reactor and turbine buildings. (November 1964).

Frame "C" – View of excavation for reactor and turbine buildings. (November 1964).

Excavation started on October 5, 1964 with the start of a drainage ditch from the power plant area to the Oyster Creek streambed to relieve surface water and dissipate groundwater from the upper reaches of the excavation. The balance of the total excavation of 228,000 cubic yards (cy) was carried out with the site dewatered using a wellpoint system. Maximum depth of the excavation was to El. -30' (MSL) for the reactor building foundation. After the reactor building foundation mat was poured during February of 1964, the groundwater level was allowed to rise 10' to approximately El -25'. This level of groundwater was maintained until completion of all the foundations for the structures. On June 15, 1967, the dewatering wellpoint system was shut down. Of the 228,000 cy of material excavated for the turbine and reactor buildings, approximately 80,000 cy was used for backfill around these buildings, the balance was used to build the plant site to El. +21' and/or spoiled on the southern streambed of the South Branch of Forked River just north of the Oyster Creek substation.

Canal Excavation and Spoil Handling

Figure A4-3 provides the available photographs of the canal excavation and spoil handling west of Route 9. The historical sequence of this construction effort is presented in the response to Question E4 (Also refer to Figure E4-1). A description of the photographs is as follows:

Frame "A" – View of dragline working on discharge canal. (August 13, 1966)

Frame "B" – View looking west along excavation of discharge canal in the original Oyster Creek streambed (August 16, 1966).

Frame "C" – View of diversion of Oyster Creek streambed to area south of the discharge canal (August 16, 1966).

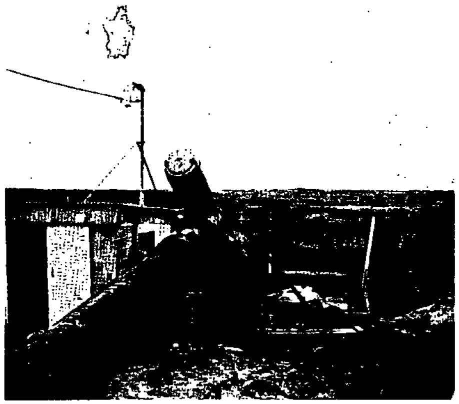
Frame "D" – View of the Oyster Creek flow being diverted through a pipe into the discharge canal (August 16, 1966).

Frame "E" – View of dragline excavation of discharge canal. (August 24, 1966).

Frame "F" – Dragline widening discharge canal (original Oyster Creek streambed) (September 9, 1966).

Frame "G" - View of discharge canal excavation west of Route 9 (September 30, 1966)

Frame "H" - View of the discharge canal excavation in back of the station. (November 9, 1966)

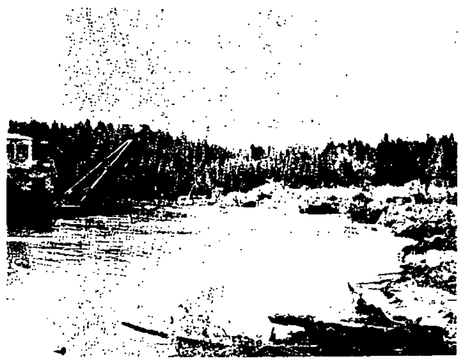


A

C

E

B



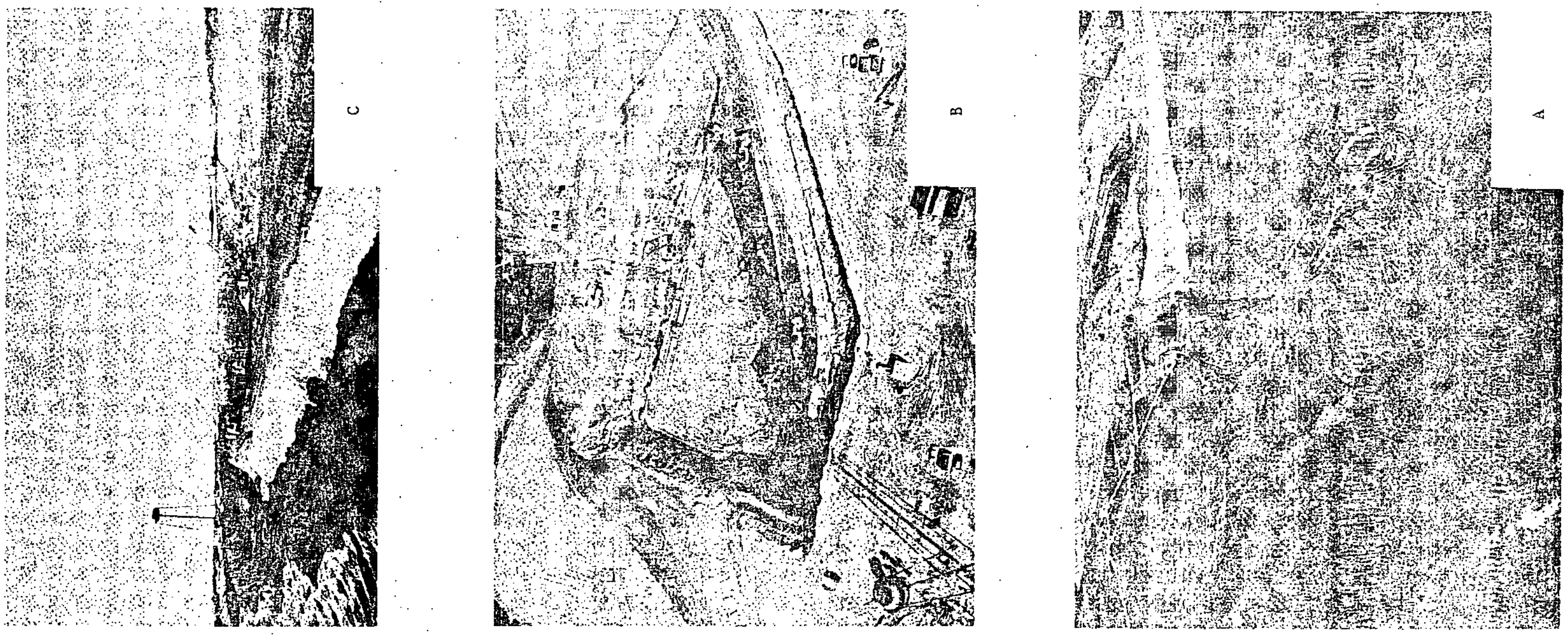
D

F

DREDGING AND SPOIL HANDLING

FIGURE A4-1

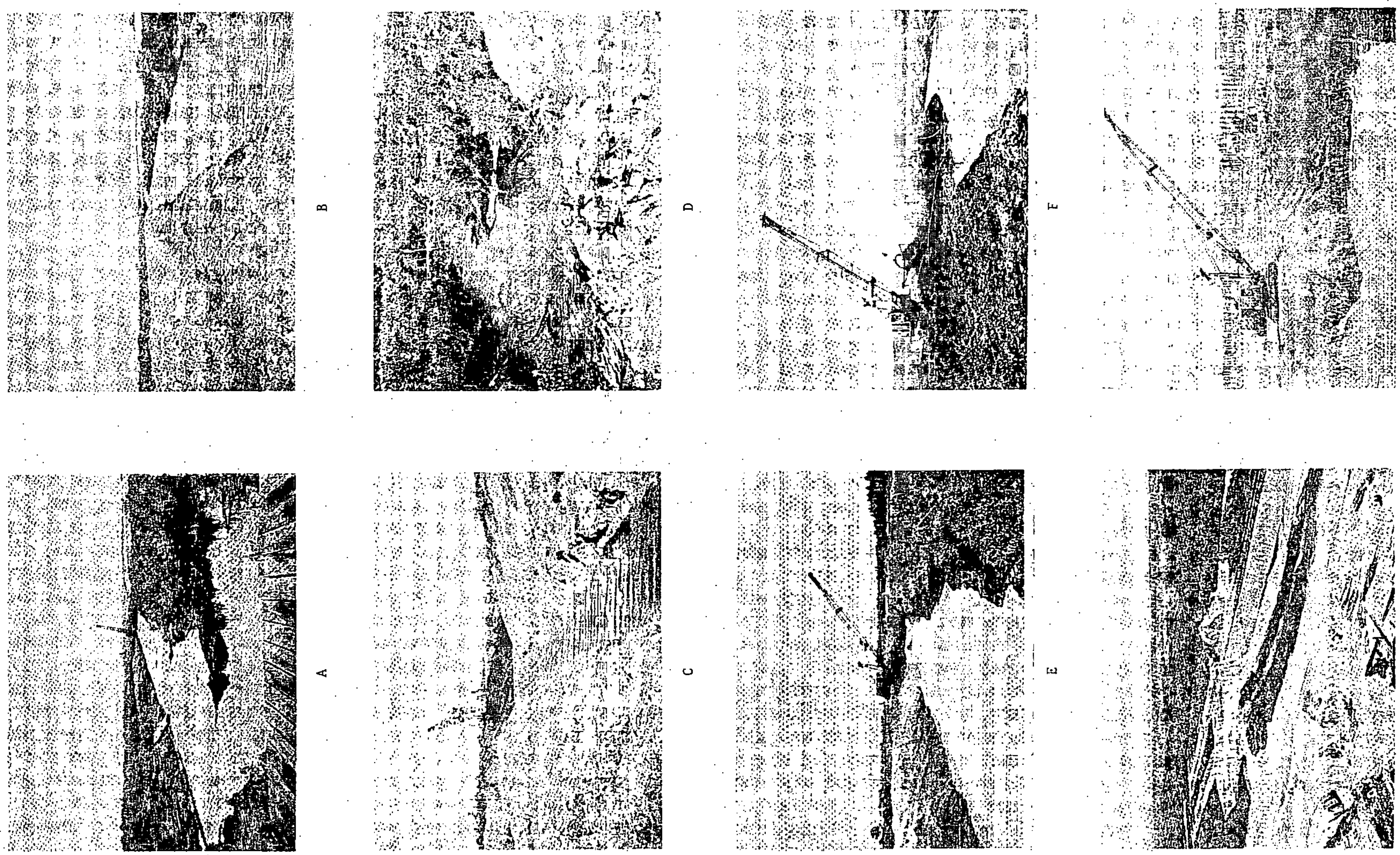
Amendment 2



FOUNDATION EXCAVATION

FIGURE A4-2

Amendment 2



CANAL EXCAVATION AND
SPOIL HANDLING

FIGURE A4-3

QUESTION

A5 Describe the sequence of physical phenomena leading to the present condition of the canal banks and its environmental impact.

RESPONSE

The canal banks at Oyster Creek were originally dredged to slopes of 1-1/2 on 1 with a bottom elevation as low as minus 10 feet (MSL). The banks extended to natural ground elevation as high as plus 24 in the immediate vicinity of the plant. To the east the natural ground elevation falls off rapidly to about plus 8 near Route 9 and progressively lower to the east.

Since the construction of the canals the banks have suffered erosion, locally intense. Erosion takes the form of gulley formation, with essentially unaltered bank sections between the gulleys. Attempts to stabilize the banks with vegetation have not been successful.

The sand eroded from the banks has formed a berm about 15 feet wide near sea level. Where the clays and peats at the interface between the Cape May and Cohansey sands are relatively thick, near vertical slope segments have developed.

East of Route 9, where the natural ground elevation is plus 8 and lower, the banks show little erosion. Properties not owned by Jersey Central, on the south side of Oyster Creek and on either side of the South Branch of Forked River, are to a large extent protected by bulkheads to provide full utilization of the property.

Two physical phenomena have lead to the conditions described above. The first is simple run off resulting from precipitation of about 42 inches per year. In the Oyster Creek area run off is limited due to the high infiltration rate of the soils adjacent to the canals. However, during prolonged rains saturation of the upper soils leads to increased run off and contributes to bank erosion.

The second phenomenon contributing to the present condition of the canal banks is the constant discharge of ground water into the canal. Over the New Jersey Coastal Plain the surface water and ground water bodies are freely interconnected. Ground water entering the canals at or slightly above the water level in the canal hold the sand berms near sea level. Pump induced flow in the canal distributes the erosion products longitudinally and maintains the steep channel side slope of the berms.

The environmental impact of the present condition of the canal banks is minimal. The eroded banks may be unsightly to some. However, the same condition exists on the higher banks of natural streams in the area. Within the high bank area all of the land adjacent to the canal is owned by Jersey Central.

QUESTION

A6 State the environmental impact of periodic dredging of the canal.

RESPONSE

An evaluation of the environmental impact that might occur as a result of periodic dredging of the canal, entails a review of previous dredging activities. This is presented in the response to Question E4. The effects of dredging would be most pronounced on the benthic organisms in the area to be dredged as no wildlife inhabits the spoils area.

The dominant bottom organisms found in Oyster Creek have been identified and discussed in a series of seven semi-annual reports prepared by the Department of Zoology, Rutgers University. Sampling sites, collecting techniques, and manner of presentation of the data in the Rutgers' reports varied during the course of the several years of study.

To date, 170 macroinvertibrates (benthic) species have been identified. The first Rutgers report identified nine of these species as dominant forms while the sixth Rutgers report added three further species to the list of dominants. Those dominant species along with their approximate adult sizes are presented below.

WORMS

1. Glycera dibranchiata - Bloodworm - Approximately 9 inches long by 1/2 inch wide.

2. Maldanopsis elongata - Bamboo worm - Approximately 6 inches long by 1/5 inch wide.

3. Pectinaria gouldii - Mason worm - A tube-building worm about 1-1/2 inch long by 1/4 inch wide.

SNAILS

4. Retusa canaliculata - Channel barrel-bubble - Shell about 1/4 inch long.

5. Bittium alternatum - Alternate bittium - Shell 1/8 to 1/4 inch long.

6. Mitrella lunata - Lunar dove-shell. Shell 3/16 to 1/4 inch long.

CLAMS

7. Tellina agilis - Northern dwarf tellin - Shell 1/3 to 1/2 inch long.

8. Mulinia lateralis - Dwarf surf clam - Shell 1/2 to 1-1/2 inches long.

ISOPODS

9. Idothea baltica - Pill bug - Approximately 3/4 to 1 inch long.

AMPHIPODS

10. Amperisca macrocephala - Scud or side-swimmer. A tube swelling species 1/4 to 1/2 inch long.

CRABS

11. Neopanope texana - Mud crab - About 1 inch wide.

12. Rithropanopeus Harrisii - Mud crab - About 5/8 inch wide.

These 12 dominant species represent the bulk of the bottom organisms affected by the dredging of the canal. The complete life cycle of the species is unknown. However, small estuarine animals generally have extended breeding seasons which last through the warm weather season. Further, they usually reach maturity (though not necessarily maximum size) in less than a year. Rate of growth and maturity is in part temperature dependent - warmer waters hasten the processes. Length of life for the individual organism would be on the order of magnitude of one or two years.

The worms, snails and clams discharge eggs and sperm into the open water where fertilization occurs. The larvae which develop from fertilized eggs are planktonic and distributed by water currents. The larvae eventually settle to the bottom and metamorphose into the adult form. The planktonic stage can last from less than a day to as much as two weeks. Distribution is chiefly affected during this planktonic stage, although the adult forms can, and do, move about.

The isopods, amphipods and crabs copulate for egg fertilization. Usually the eggs are carried by the female until they hatch. With the amphipods and isopods the eggs hatch into the adult form. These animals move readily and rapidly and are among the first invaders to enter a dredged area. Crab eggs hatch into planktonic larvae. These, like those of the worms, etc., settle to the bottom and metamorphose to the adult form. In addition, adult crabs, which travel very rapidly, would quickly invade a dredged area.

In general, an area denuded by dredging would show evidence of re-population in less than one week provided a breeding population of organisms existed in the vicinity. These conditions existed in Oyster Creek when it was dredged in 1966-1967. Outside the dredged channel the resident population was undisturbed, and the organisms forming that population were a source of "seed" for the dredged channel bottom.

The data on bottom organisms presented in the first three Rutgers reports bracket the period of the original dredging in Oyster Creek. These data do not reflect any loss of bottom organisms by the dredging operation. In fact, the dredging is not even mentioned in these reports. It is apparent that the effects of the dredging were not recognized. Such effects must have been quite local and very transient.

Based on experience with the Oyster Creek Station construction, it can be estimated that dredging will be done at an average rate of about 180 feet per day. The re-population of the bottom by benthic species after dredging will begin at once and will be essentially completed within two weeks. Dredging the canal is not a single, continous operation that will completely denude the bottom for an extended period of time along a strip several miles long. The effects of dredging on the bottom organisms will probably not be recognizable at any time for a distance of more than about 2500 feet.

Assigning an economic value to the bottom organisms that will be killed by deposition of the spoil on a land site cannot be done. Such value as these animals have, rests in their availability as food for other organisms such as fish. The transient loss of these forms from a relatively small area at any one time would not have a measurable effect in an area the size of Barnegat Bay.

The deposition of the dredged material in the spoils area will not displace wildlife habitat as the area does not appear to be utilized by wildlife. The spoils area does not contain any vegetation which would provide food or shelter for wildlife.

REFERENCES

1. Loveland, R. E. and E. T. Moul
THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF THE BENTHIC FLORA AND FAUNA OF BARNEGAT BAY BEFORE AND AFTER THE ONSET OF THEMAL POLLUTION.
An initial progress report, December 1966.

2. Loveland, R. E., E. T. Moul, F. X. Phillips and J. E. Taylor.
THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF THE BENTHIC FLORA AND FAUNA OF BARNEGAT BAY BEFORE AND AFTER THE ONSET OF THERMAL POLLUTION.
Second Progress Report, June 1967.

3. Moul, E. T., R. E. Loveland, J. E. Thaylor, F. X. Phillips and K. Mountford.
BARNEGAT BAY THERMAL ADDITION
Progress Report No. 3, January 1968.

4. Loveland, R. E., E. T. Moul, J. E. Taylor, K. Mountford and F. X. Phillips.
THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF THE BENTHIC FLORA AND FAUNA OF BARNEGAT BAY BEFORE AND AFTER THE ONSET OF THERMAL ADDITION.
Progress Report No. 4, June 1968.

5. Loveland, R. E., E. T. Moul, F. X. Phillips, J. E. Taylor and K. Mountford.
THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF THE BENTHIC FLORA AND FAUNA OF BARNEGAT BAY BEFORE AND AFTER THE ONSET OF THERMAL ADDITION.
Fifth Progress Report - March 15, 1969.

6. Loveland, R. E., E. T. Moul, K. Mountford, P. Sandine, D. Busch, E. Cohen, N. Kirk, M. Moskowitz and C. Messing. THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF THE BENTHIC FLORA AND FAUNA OF BARNEGAT BAY BEFORE AND AFTER THE ONSET OF THERMAL ADDITION. Sixth Progress Report, June 1, 1970.

7. Loveland, R.E., K. Mountford, E. T. Moul, D. A. Busch, P. H. Sandine and M. Moskowitz. THE QUALITATIVE AND QUANTITATIVE ANALYSIS OF THE BENTHIC FLORA AND FAUNA OF BARNEGAT BAY BEFORE AND AFTER THE ONSET OF THERMAL ADDITION. Seventh Progress Report, June 25, 1971.

QUESTION

A7 State the amount of sand transported into the condenser from the canal.

RESPONSE

Analysis performed in conjunction with the application for an Oyster Creek Generating Station 1899 Refuse Act discharge permit indicates that the system intake water contains approximately 39 milligrams per liter of suspended solids. For a circulating water flow of 460,000 gallons perminute this represents the passage of approximately 215,000 pounds per day of solids through the system. Additional analysis indicates that about one third of these solids are volatile. If it is assumed that the remaining two thirds of these solids, which represent the mineral fraction thereof, are totally composed of sand this provides a figure of about 143,500 pounds per day transported through the condenser.

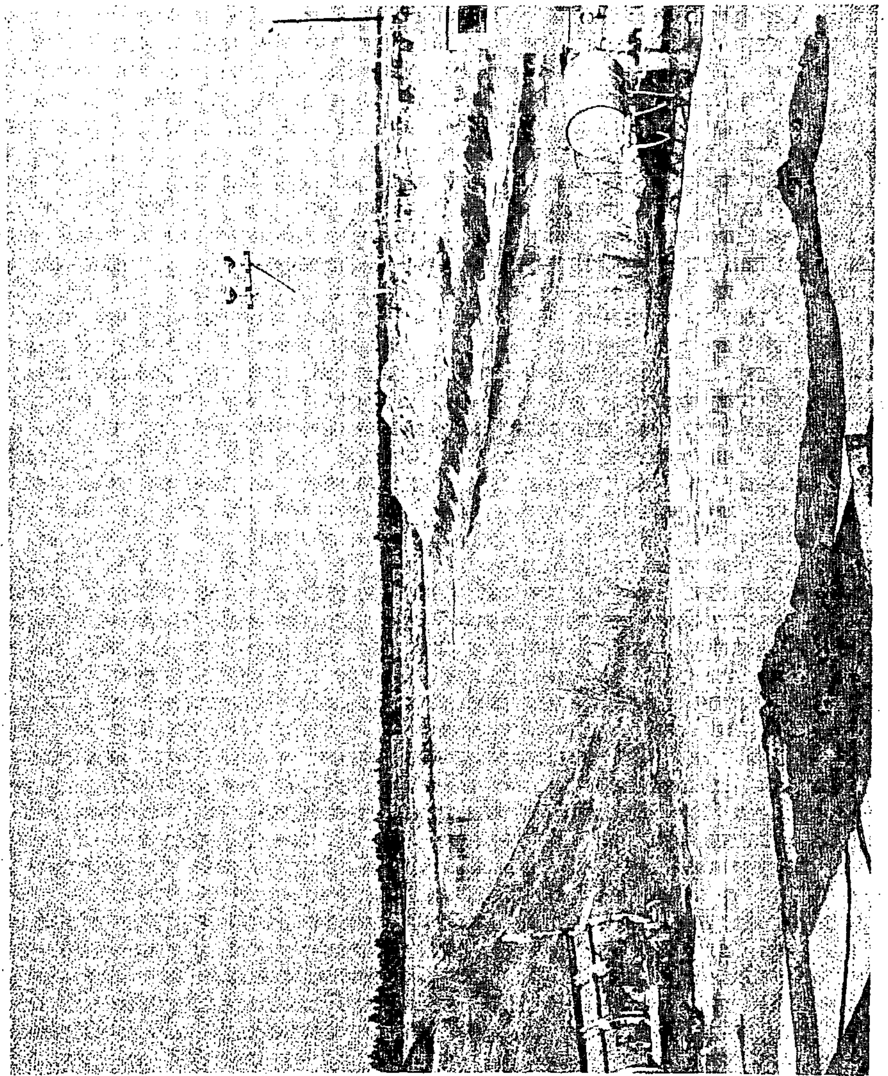
This analysis is overly conservative since the bulk of the mineral fraction of suspended solids is probably composed of silt, clay, heavy minerals, and mica. Additionally, since the circulating water system through the condenser is essentially a cooling system with no water use these solids are not removed from river flow, but simply pass through the system. There have been no indications of sand buildup anywhere within the condensers or the circulating water system piping and tunnels.

QUESTION

A8 Provide clear recent photographs of the canal banks for a quarter mile upstream and downstream of the dilution pump. (This should require only two photos if care is taken).

RESPONSE

Figures A8-1 and A8-2 present photographs upstream and downstream of the dilution pumps.



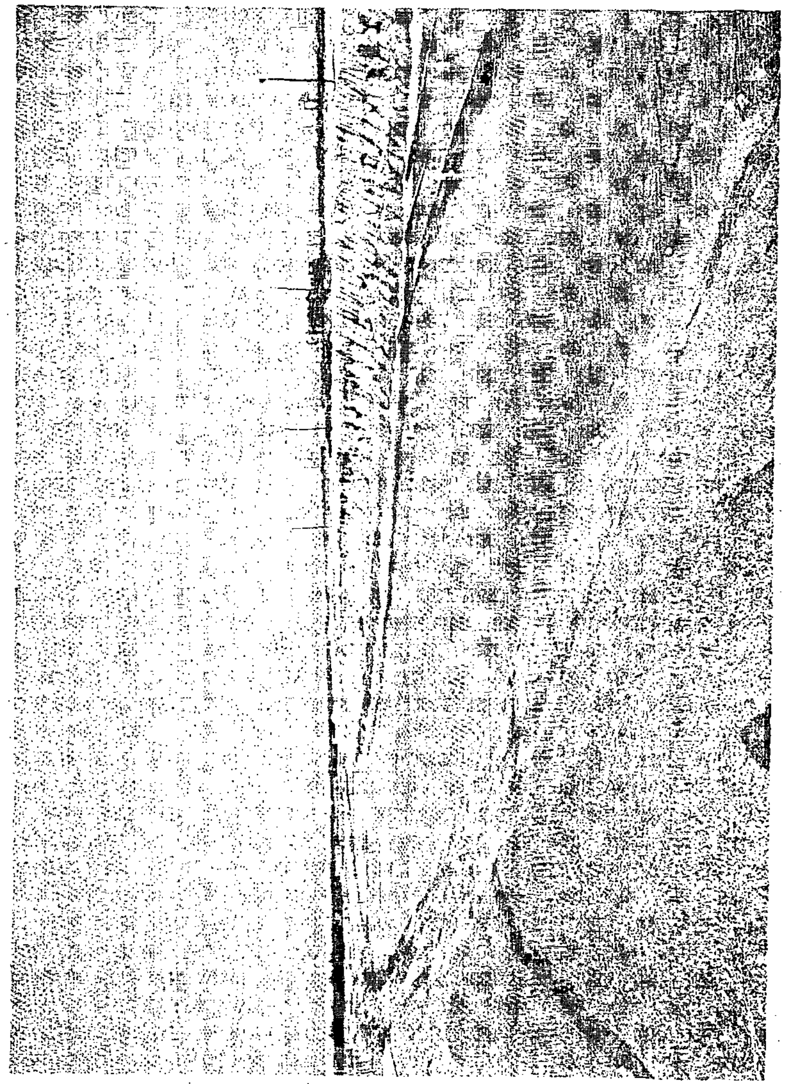
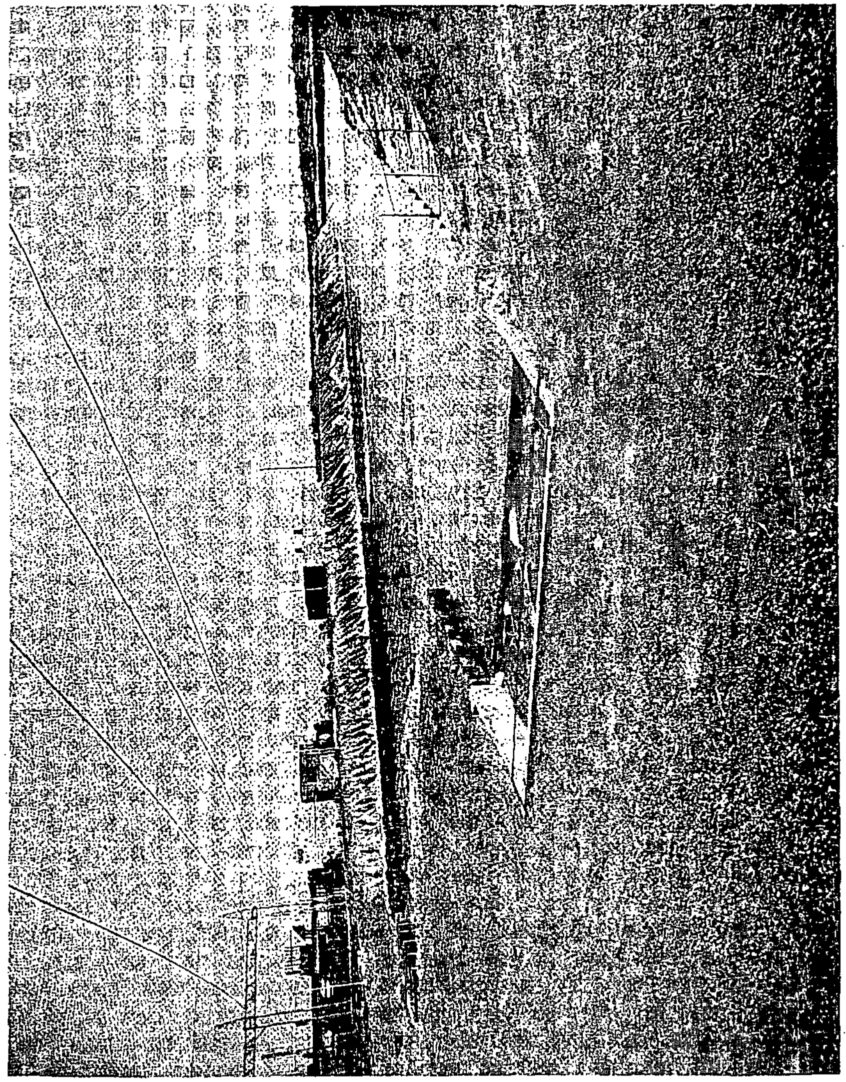


FIGURE A8-1

UPSTREAM OF DILUTION PUMPS

Amendment 2



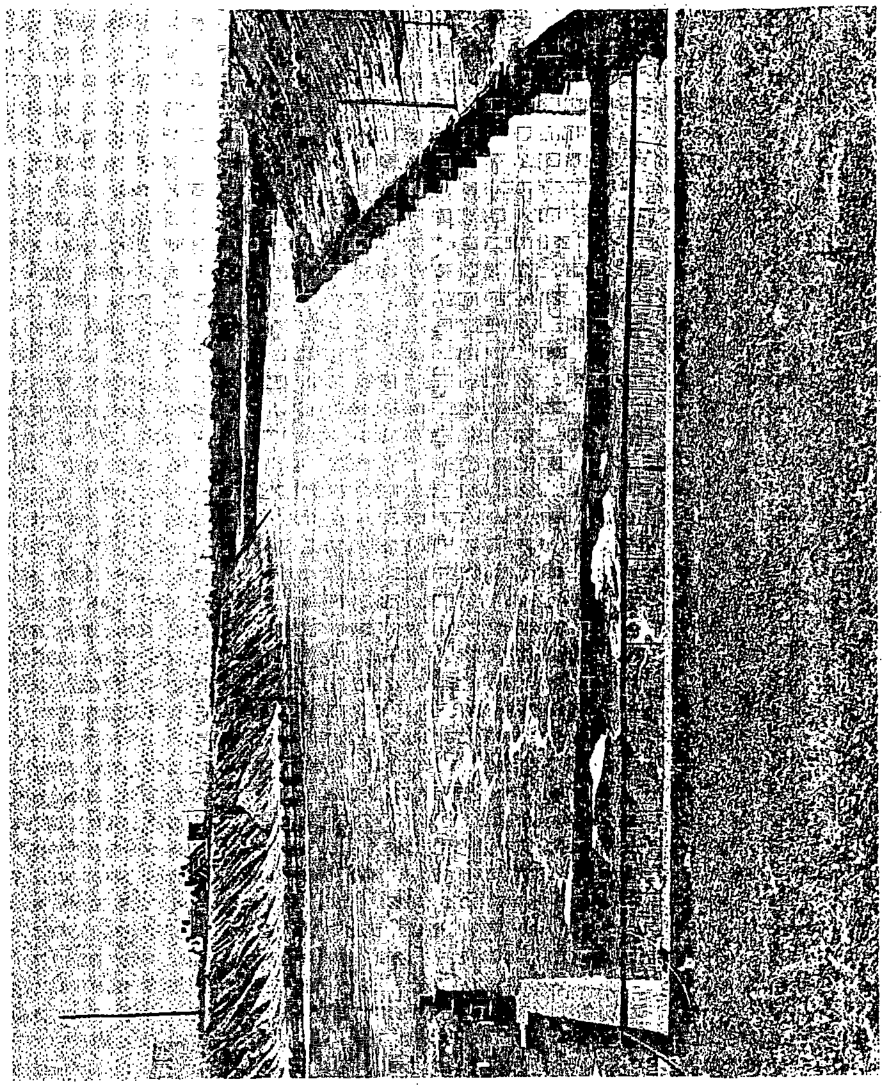


FIGURE A8-2

DOWNSTREAM OF DILUTION PUMPS

Amendment 2

QUESTION

A9 State the reason for providing the parking lot and fishing access at the railroad bridge location of the discharge side of the canal, instead of at any other location along the full length of the canal, including the intake side.

RESPONSE

Soon after the Oyster Creek Station started operating, the Route 9 bridge across the discharge canal became a popular fishing spot. Parking for the fisherman created a traffic hazard on the highway, and eventually these fishermen began parking on the Jersey Central property there (See "Unnumbered Area" on Figure E4-1). Jersey Central graded this former spoils area and provided trash receptacles for public use.

While fishermen are also active along the intake and discharge canals east of Route 9, and specifically at the Route 9 bridge over the intake canal, sufficient parking facilities are available on side streets and land adjacent to the waterways to accomodate these vehicles.

QUESTION

A10 Provide monthly average salinities and water temperatures at representative locations for the Forked River intake, canal, and Barnegat Bay near the thermal buoy, as available, along with corresponding discharge canal temperatures.

RESPONSE

The monthly average salinities for Forked River and the intake canal are presented in Table A10-1. These salinities are measured monthly and used as a base measurement in monitoring any salinity changes that have occurred in the water mound observation wells. The monthly average water temperatures for the intake, the bridge or discharge canal, and the temperature buoy are found in Tables A10-2 through A10-4, respectively. The geographic locations of these data collection points are identified in Figure A10-1.

All data presented in these tables have been reduced from measurements and recordings taken by the Oyster Creek Station.

TABLE A10-1

NaCl CONCENTRATION IN PPM

DATE	FORKED RIVER	INTAKE
January, 1969	4,600	18,500
February, 1969	19,150	22,800
March, 1969	26,200	24,100
April, 1969	13,600	9,500
May, 1969	18,400	23,600
June, 1969	8,700	7,400
August, 1969	21,600	28,400
October, 1969	19,200	21,300
November, 1969	4,800	18,900
January, 1970	5,400	16,700
Feburary, 1970	19,000	19,500
March, 1970	29,700	24,200
April, 1970	7,500	4,300
May, 1970	14,500	15,700
June, 1970	14,900	16,300
July, 1970	13,000	14,500
August, 1970	18,400	18,000
September, 1970	21,000	20,000
October, 1970	18,800	21,000
November, 1970	17,800	19,600
December, 1970	21,400	20,200

TABLE A10-1 (Cont'd.)

DATE	FORKED RIVER	INTAKE
January, 1971	14,700	16,700
February, 1971	15,300	17,300
March, 1971	14,500	16,200
April, 1971	8,000	17,400
May, 1971	16,900	19,700
June, 1971	29,400	29,400
July, 1971	2,410	2,460
August, 1971	21,300	24,400
October, 1971	14,300	17,200
November, 1971	18,200	18,000
December, 1971	22,796	21,796
January, 1972	12,000	15,800
February, 1972	24,600	20,500
March, 1972	21,400	21,950
April, 1972	17,800	17,900
May, 1972	18,300	17,000
June, 1972	20,000	20,000
July, 1972	19,000	19,000
August, 1972	16,900	20,200

TABLE A10-2

INTAKE TEMPERATURE

MONTH	YEAR	(°F) AVE. TEMP.
July	1970	80.32
August	1970	83.10
September	1970	78.81
October	1970	O. O. S.*
November	1970	O. O. S.
December	1970	41.76
January	1971	34.96
February	1971	37.53
March	1971	47.26
April	1971	54.35
May	1971	62.19
June	1971	73.83
July	1971	80.03
August	1971	79.29
September	1971	77.72 (O.O.S. 12 days)
October	1971	O. O. S.
November	1971	44.85 (O.O.S. 11 days)
December	1971	42.41
January	1972	38.48
February	1972	35.65

*O. O. S. Means out of service

TABLE A10-2 (Cont'd.)

INTAKE TEMPERATURE

MONTH	YEAR	(°F) AVE. TEMP.
March	1972	44.09
April	1972	51.50
May	1972	O. O. S*
June	1972	70.33 (O.O.S 21 days)
July	1972	82.16
August	1972	76.73 (O.O.S. 5 days)
September	1972	72.70
October 15th	1972	63.86

* O. O. S. Means out of service

TABLE A10-3

BRIDGE TEMPERATURE

MONTH	YEAR	(°F) AVE. TEMP.
July	1970	84.65
August	1970	84.35
September	1970	78.53
October	1970	80.47
November	1970	68.80
December	1970	52.57
January	1971	DATA NOT AVAILABLE
February	1971	DATA NOT AVAILABLE
March	1971	DATA NOT AVAILABLE
April 20th	1971	69.00°
May	1971	74.61
June	1971	85.06
July	1971	89.51
August	1971	90.61
September	1971	81.75
October	1971	DATA NOT AVAILABLE
November	1971	DATA NOT AVAILABLE
December	1971	DATA NOT AVAILABLE
January	1972	53.46
February	1972	46.29
March	1972	55.51

TABLE A10-3 (Cont'd.)

BRIDGE TEMPERATURE

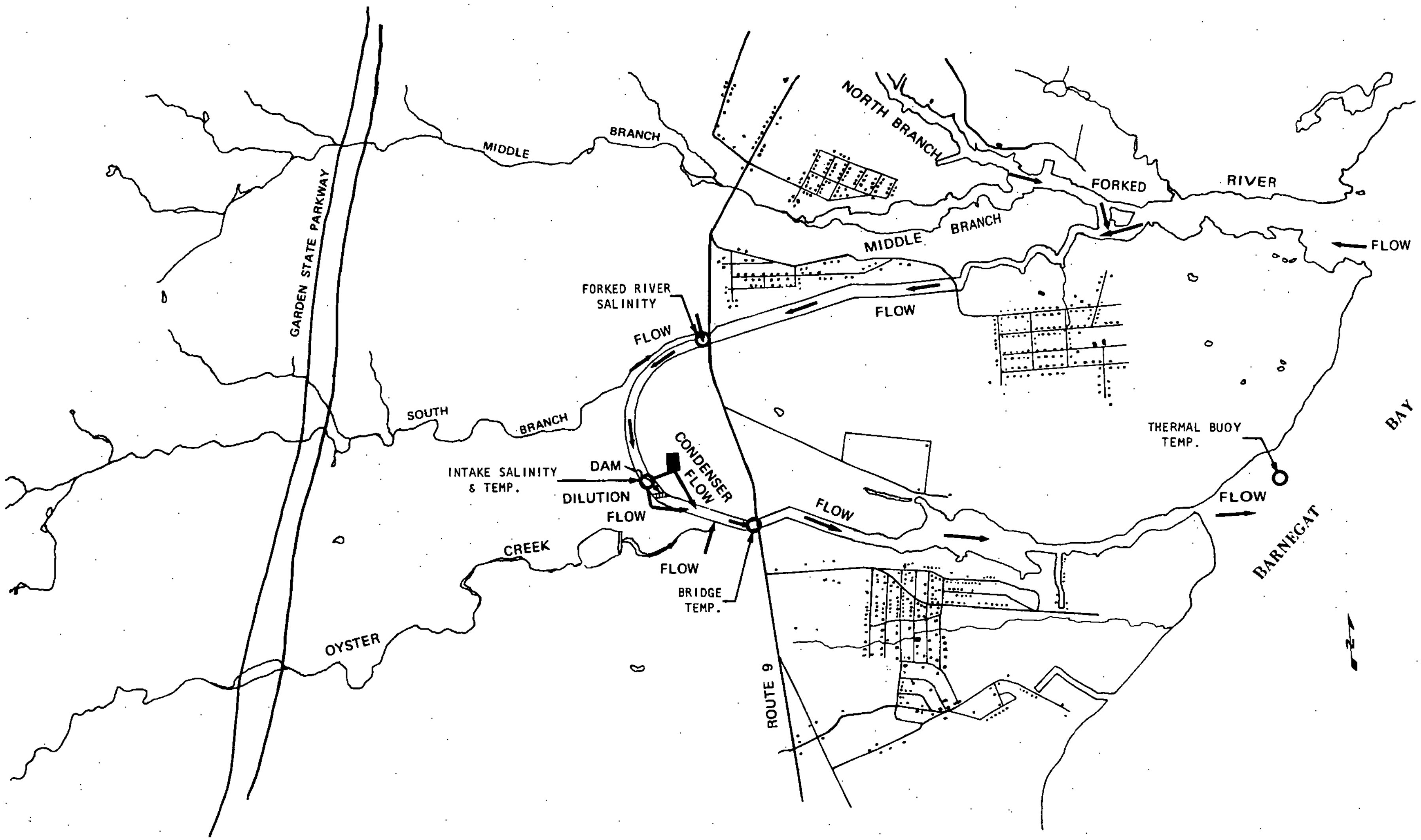
MONTH	YEAR	(°F) AVE. TEMP.
April	1972	59.60
May	1972	63.55
June	1972	78.57
July	1972	89.64
August	1972	86.95
September	1972	80.50
October 17th	1972	76.88

TABLE A10-4

THERMAL BUOY TEMPERATURES

MONTH	YEAR	AVE. TEMP. °F
May	1969	65.99
June	1969	73.96
July	1969	78.61
August	1969	75.00
May	1971	57.22
June	1971	65.64
July	1971	72.41
August	1971	78.52
September	1971	76.25
October	1971	O. O. S.*
November	1971	O. O. S.
December	1971	O. O. S.
January	1972	O. O. S.
February	1972	O. O. S.
March	1972	O. O. S.
April	1972	O. O. S.
May	1972	O. O. S.
June	1972	O. O. S.
July	1972	76.50
August	1972	72.17

* O. O. S. Means out of service



SAMPLE LOCATION POINT FOR SALINITY AND RIVER WATER TEMPERATURES

FIGURE A10-1

DAMES & MOORE

QUESTION

A11 Provide updated probabilities of temperatures in Barnegat Bay through July 1972 (i.e., update tabulations on page 2.5-5, ER).

RESPONSE

The updated tabulations appear in Table A11-1. The period (calendar year) represents 2,256 hours, which is consistent with Table P-14, on page 5, in Docket No. 652-60 from the State of New Jersey, Board of Public Utility Commission and the table appearing on page 2.5-5 of the Oyster Creek Environmental Report.

The data presented in the tabulation were reduced from the thermal buoy temperature recordings for the years 1965, 1966, 1969, 1971, and the first eight months of 1972, also presented in the tabulation are the number of days the buoy was in the bay waters. During the winter months the buoy was removed from the water for maintenance and service. Temperature recordings for 1967, 1968 and 1970 are not available.

REFERENCE

"In the matter of proposed construction by Jersey Central Power & Light Company of a Nuclear Fueled Electric Generating Plant at Oyster Creek, Lacey Township, Ocean County." State of New Jersey, Department of Public Utilities, Board of Public Utility Commission, Docket No. 652-60.

TABLE A11-1

TEMPERATURE DATA FROM BUOY IN BARNEGAT BAY

PERIOD (Calendar Year)	TEMPERATURE (°F)	HOURS	% OF PERIOD TEMPERATURE IS EQUALED OR EXCEEDED	NO. OF DAYS TEMPERATURE BUOY IN WATER
1963	over 70	1583	70.2	
1963	over 75	571	25.3	180.0
1963	over 80	26	1.1	
1964	over 70	2012	89.0	
1964	over 75	704	31.2	163.3
1964	over 80	98	4.3	
1965	over 70	1539	68.2	
1965	over 75	721	31.9	194.7
1965	over 80	4	0.2	
1966	over 70	456	20.2	
1966	over 75	428	18.9	141.7
1966	over 80	46	2.0	

TABLE A11-1

TEMPERATURE DATA FROM BUOY IN BARNEGAT BAY (Continued)

PERIOD (Calendar Year)	TEMPERATURE (°F)	HOURS	% OF PERIOD TEMPERATURE IS EQUALED OR EXCEEDED	NO.OF DAYS TEMPERATURE BUOY IN WATER
1969	over 70	720	31.9	
1969	over 75	708	31.3	79
1969	over 80	258	11.4	
1971	over 70	448	19.8	
1971	over 75	278	12.3	112.6
1971	over 80	374	16.6	
1972	over 70	236	10.4	
1972	over 75	134	5.9	28.7
1972	over 80	32	1.4	

QUESTION

A12 Name chemicals used for weed control in transmission corridors and estimate residual concentrations that percolate into the regional aquifer.

RESPONSE

Table A12-1 lists the chemicals currently in use in the Jersey Central vegetation management program.

The concentration of the chemicals applied are quite low and are always applied selectively. The types of chemicals in use, methods of application and concentration used are such that residual persistance is relatively short and these chemicals do not accumulate and create a hazard to the environment.

TABLE A12-1

Vegetation Management Program
Chemicals Currently in Use

Name	Composition	Dilution	Manufacturer	(Approximate) Persistance in Soils
Tordon 101	2,4-D/Picloram	1 Gal./99 Gal. of water	Dow Chemical Co. Midland, Michigan	1 to 12 months
Tordon 155	2,4,5-T/Picloram	1 Gal./99 Gal. of fuel oil	Dow Chemical Co. Midland, Michigan	6 to 12 months
Industrial Brush Killer or Esteron Brush Killer	2,4-D/2,4,5-T	4 Gal./96 Gal. of water and/or fuel oil	Dow Chemical Co. Midland, Michigan Amchem Products Ambler, Pa.	1 to 6 months
Ammate XNI	Ammonium Sulfamate	60 lbs./100 Gal. of water	Dupont Wilmington, Del.	6 months
Dowpon "C"	-	15 lbs./100 Gal. of water	Dow Chemical Co. Midland, Michigan	12 months
Banvel	Dicamba	Various, in combination with 2,4-D or 2,4,5-T	Velsical Chemical Corp. Chicago, Illinois	Not Available

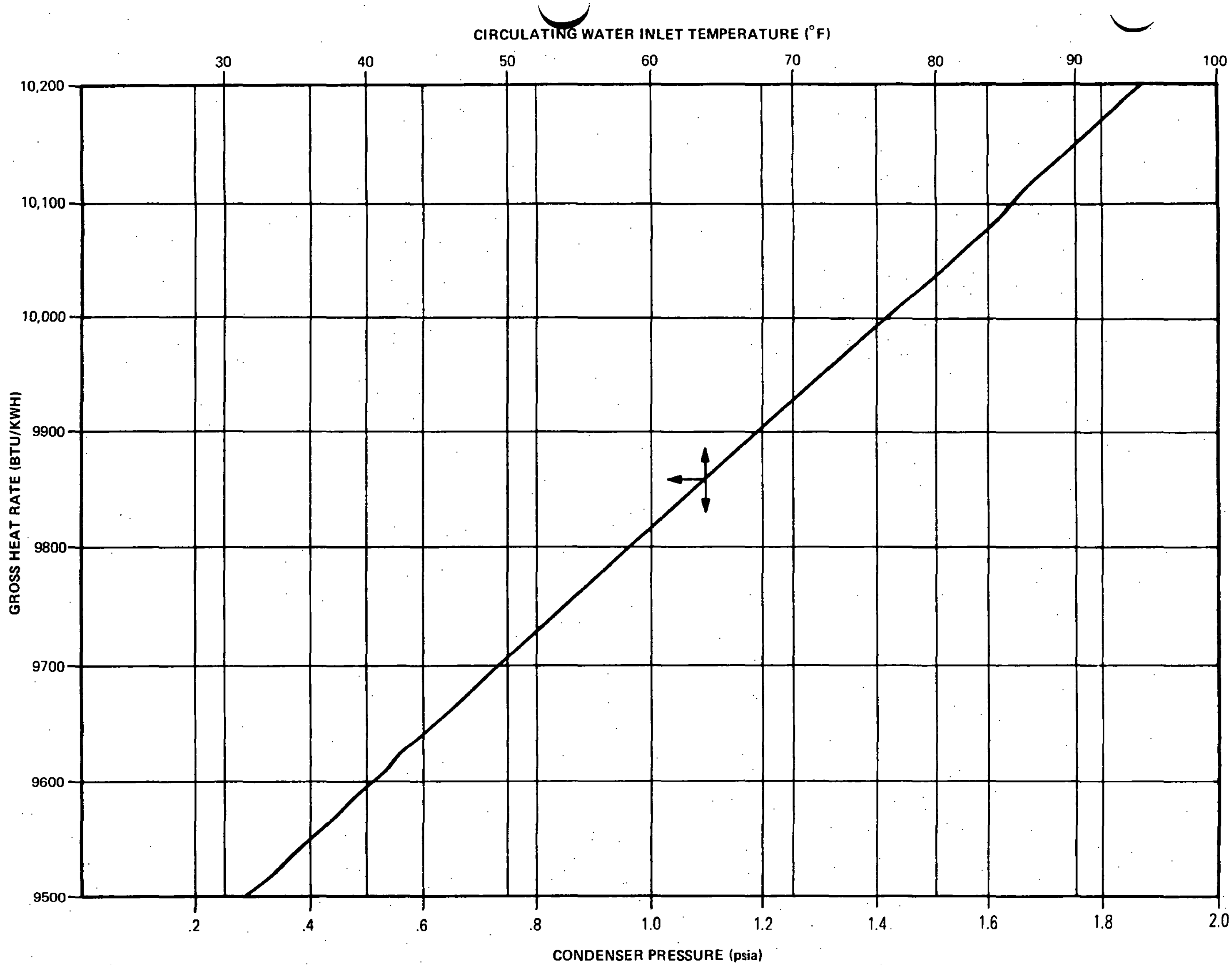
Also various additives which act as spreaders, stickers and thickening agents.

QUESTION

A13 Provide back-pressure - heat rate curve for the turbine generator to permit estimate of performance penalty for options.

RESPONSE

Figure A13-1 presents the heat rate versus condenser pressure (absolute) - circulating water inlet temperature.



Oyster Creek Station Gross Heat Rate
Versus Condenser Pressure
and Circulating Water Inlet Temperature

FIGURE A13-1

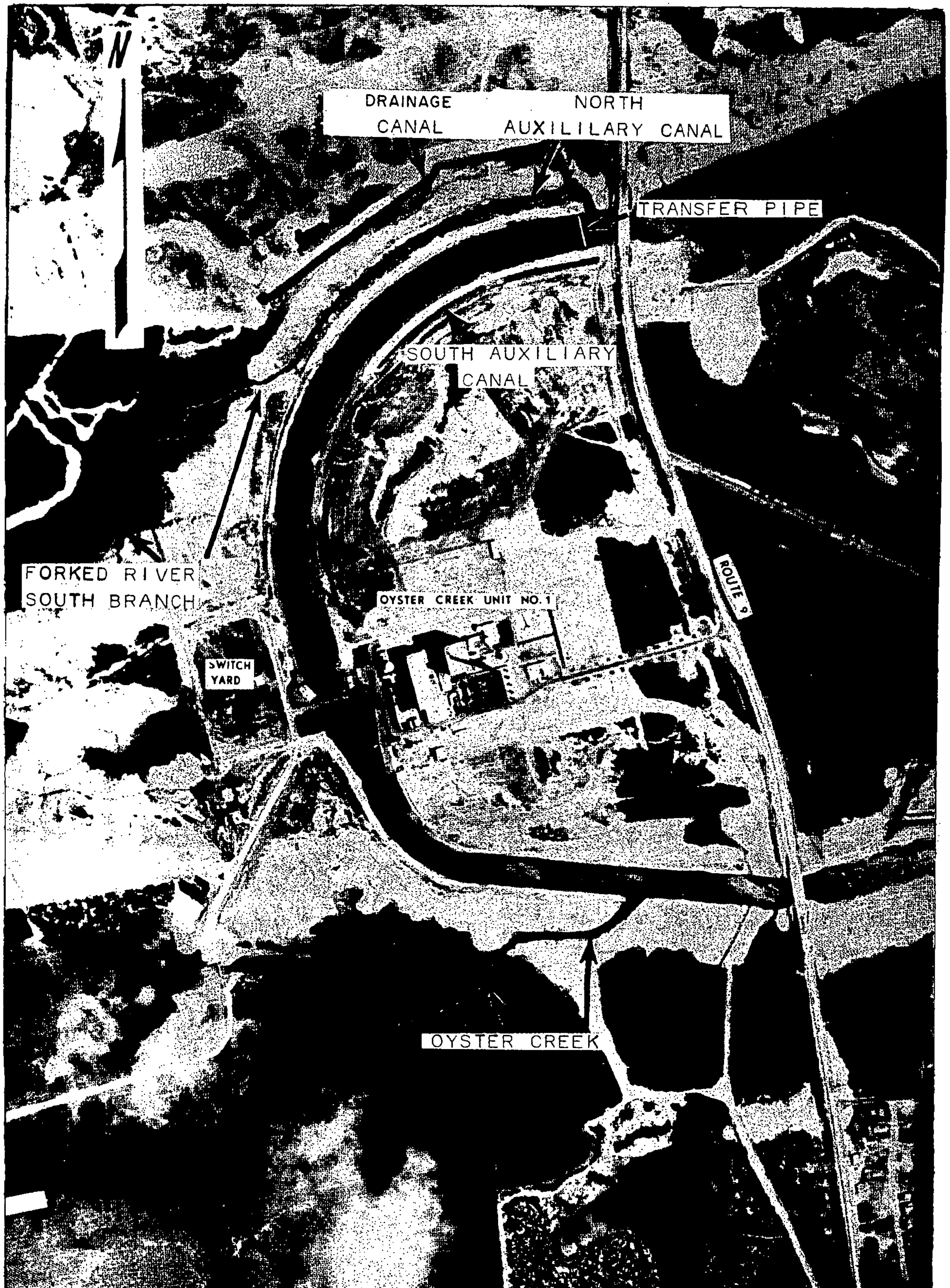
Amendment 2

QUESTION

A14 Identify the location of the auxiliary canals preventing salt water intrusion into fresh water aquifers near the South Branch of Forked River.

RESPONSE

There are two auxiliary fresh water canals (or water mounds) running parallel to the cooling water intake canal west of Highway 9 as shown in Figure A14-1. The canals start just west of Highway 9 and continue for a distance of 1400 feet. As noted in this figure there is a water "cross-over" pipe suspended above the intake canal which supplies fresh water to the south auxiliary canal by gravity flow. The canal seen just above the north auxiliary canal (which is actually the relocated streambed of the South Branch of Forked River), and the cooling water intake canal was constructed to provide a drainage canal for the adjacent property owner.



AUXILIARY CANAL LOCATION

FIGURE A14-1

DAMES & MOORE

QUESTION

B1 Provide estimated travel time from condenser cooling water outlets to the circulating water outfall in the canal and state the water velocity in the discharge side of the canal.

RESPONSE

The estimated travel time from the condenser cooling water outlets to the circulating water outfall is 1.006 minutes.

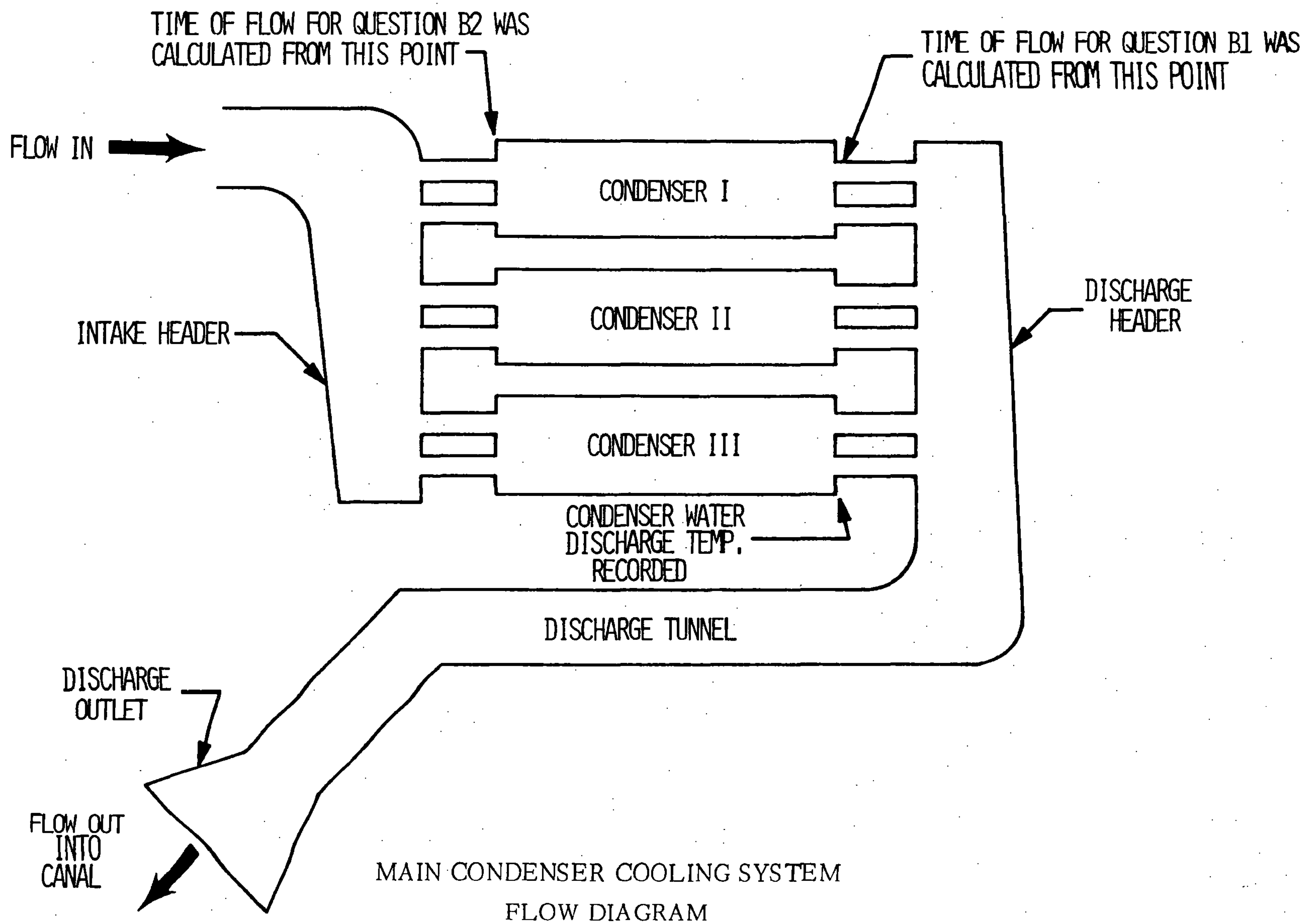
This was calculated by considering the volume of the pipe and tunnels downstream of the main cooling condensers (refer to the main condenser cooling flow diagram Figure B1-1) at a flow of 460,000 gpm.

The water velocities in the discharge side of the canal are as follows:

Position	Velocity (knots)	Depth from Surface
Surface	1.5	0
Mid-depth	1.4	4 ft. 5 in.
Bottom	1.3	*8 ft. 10 in.

* Note: The current meter stood off the bottom 1 ft. 7 inches due to its supports, therefore, the total canal depth at mid stream was 10 ft. 5 inches.

These data are an average taken over six measurements at each level with a current speed sensor and speed read out module. The above measurements were taken at the railroad trestle adjacent to the Route 9 bridge which spans the discharge canal. At the time of measurement, 460,000 gpm was flowing through the main condenser plus 250,000 gpm from one dilution pump. High tide was at its peak during the current measurements.



MAIN CONDENSER COOLING SYSTEM
FLOW DIAGRAM

FIGURE B1-1
DAMES & MOORE

Amendment 2

QUESTION

B2. Provide analytical data on the chlorine demand of the circulating water at the intake to the station. The time period over which chlorine demand is determined should be approximately the same as the travel time in the discharge channel to the outfall. Include seasonal variations.

RESPONSE

The following table of chlorine demand data (ppm) was compiled during a survey of the main condenser cooling waters at Oyster Creek Station during the period of March 1971 through January 1972. Grab samples were taken near the cooling water intake structure of the station under various tidal conditions, times of day and under all types of weather conditions.

Table of Chlorine Demand Values

Date	Chlorine Demand 5 Min.	Chlorine Demand 1 min.	Tide	Time	Temperature
March 29, 1971	0.45	0.11	High	A.M.	41.5°F
March 29, 1971	0.50	0.13	Low	P.M.	43.0°F
April 22, 1971	0.65	0.16	Mid	P.M.	56.0°F
May 17, 1971	1.10	0.28	Mid	P.M.	63.0°F
June 29, 1971	1.60	0.40	High	P.M.	77.0°F
July 30, 1971	2.20	0.55	Mid	P.M.	80.5°F
August 27, 1971	2.50	0.63	High	P.M.	78.0°F
Sept. 17, 1971	2.85	0.71	Low	P.M.	79.0°F
October 27, 1971	2.80	0.70	High	P.M.	64.2°F
Nov. 24, 1971	0.45	0.11	Low	P.M.	39.0°F
Dec. 14, 1971	0.65	0.16	Mid	P.M.	42.0°F
Jan. 31, 1972	0.50	0.13	Mid	P.M.	32.5°F

The values presented in column two "chlorine demand, 1 min." were calculated on the basis of a travel or contact time of 1 minute. This is the approximate time required for the cooling water to flow from the condenser inlets to the outfall at the canal (refer to Figure B1).

Indications are that tidal conditions, time of day or meteorological conditions have little direct apparent effect upon the chlorine demand which appears governed more by general seasonal influences. The observed increases are gradual as the seasonal temperatures advance.

QUESTION

B3 Provide analytical data on the chlorine residual found in the circulating and service water discharges, based upon an analytical method with detection capability below 0.1 ppm.

RESPONSE

The chlorine analysis results are as follows:

Location	Total Residual Chlorine (mg/1)
a) main condenser water	.910
b) service water discharge or outfall	.01

The method used in determining the total residual chlorine was Standard Methods, 13th Edition, 1971, Iodometric Method 114A, page 110. The detection capability was .04 ppm.

Grab samples for the main condenser water were taken at the discharge outlet(Refer to Figure B1-1). Grab samples for the service water were taken at the service water discahrge point into the canal. Note that the chlorinated circulating water flow is diluted with 260,000 gpm, 520,000 gpm or 780,000 gpm dilution pump flow, depending on the number of dilution pumps operating. The chlorinated service water is diluted by both the circulating water flow and any dilution pump flow.

QUESTION

B4 Provide analytical data on copper concentrations in circulating water samples collected at the inlet and at the outlet.

RESPONSE

The results of the analysis of copper concentrations at the intake and the outlet points of the main condenser circulating water are as follows:

Date Samples Taken (1972)	Copper Concentration (mg/1) intake	outlet
Oct. 4	.10	.09
Oct. 5	.08	.07
Nov. 3	.030	.025
Nov. 6	.045	.035
Nov. 9	.018	.013

All samples were analyzed by the atomic absorption spectrophotometric method for metals in water. The samples taken during November were exposed to fresh water "run off" due to rain in the area.

QUESTION

B5 Describe the frequency of sludge removal from the package sewage treatment plant as well as who removes it and how it is disposed of.

RESPONSE

Sewage was removed from the package sewage treatment plant on September 2, 1970 and August 18, 1971. The volume of material removed each time was 1,000 gallons.

At the time of removal, the waste was disposed of in private open burial sites in Lacey Township. The municipal disposal site is used now.

The commercial service used is as follows:

Olson Sanitary Septic Service
1730 Mohawk Drive
Toms River, New Jersey

QUESTION

B6 List and identify location of release and quantity estimates (lbs/yr and maximum hourly release) for all chemical and exotic additives, cleaning agents and toxic materials released to the discharge canal.

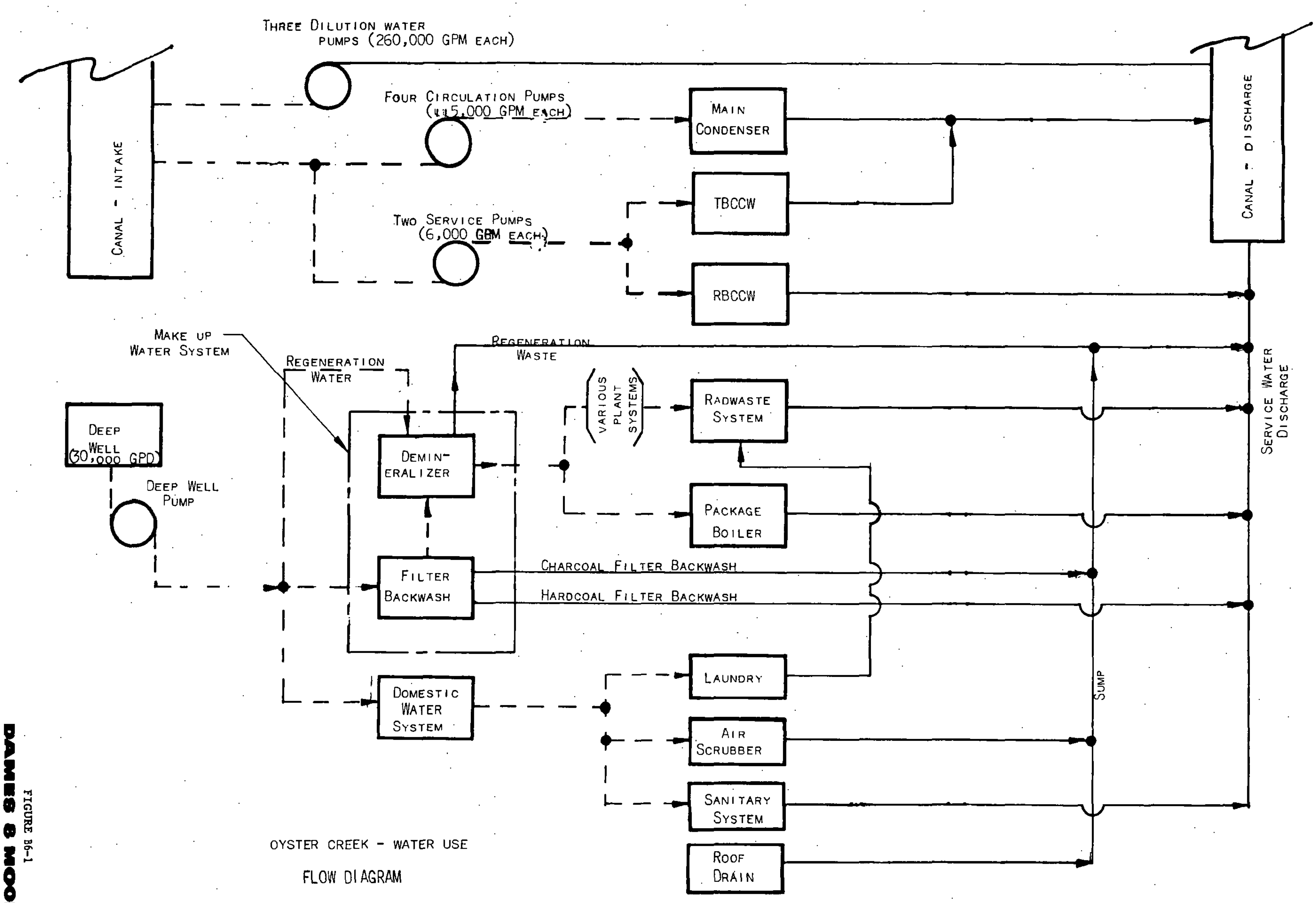
RESPONSE

Listed in Table B6-1 "Chemical Additions" are all the chemical additions, and materials used by the Oyster Creek Station. Refer to Figure B6-1 for point of additions and releases.

TABLE B6-1

CHEMICAL ADDITIONS

LOCATION OF CHEMICAL ADDITION	CHEMICAL	AMOUNT	DURATION OF ADDITION	FREQUENCY OF ADDITIONS
Domestic Water	1) Hypochlorite (NaOCl)	1.5 gpd	Continuous	--
	2) Micromet (glassy phosphate)	0.8 lbs/day	Continuous	--
Sewage Wastes	1) Hypochlorite (NaOCl)	1.5 gpd	Continuous	--
Condenser Cooling Water and Service Water	1) Liquid Chlorine	2000 lbs/day during summer 1000 lbs/day during winter	3.5 hours on .5 hours off	Continuous
	2) Wizard (leak repair)	1100 lbs/yr.	on demand	on demand
Package Boiler Treatment	1) Sodium Hydroxide (NaOH)	80 lbs/yr	batch	Once every 2 or 3 days
	2) Sodium Phosphate (Na_3PO_4)	100 lbs/yr	batch	Once every 2 or 3 days
	3) Sodium Sulfite (Na_2SO_3)	100 lbs/yr	batch	Once every 2 or 3 days
Make-up Water System	1) Cation regeneration: Sulfuric Acid (H_2SO_4, 66° Baume)	188 lbs/ regeneration	30 min	Once per week
	2) Anion Regeneration Sodium Hydroxide (50% NaOH)	170 lbs/ regeneration	60 min	Once per week
	3) Mix Bed regeneration			
	H_2SO_4	80 lbs/ regeneration	10 min	Once per week
	NaOH	80 lbs/ regeneration	16.5 min	Once per week



OYSTER CREEK - WATER USE

FLOW DIAGRAM

FIGURE B6-1

DAMES & MOORE

Amendment 2

QUESTION

B7 Provide emission data or estimates of combustion products released to the atmosphere from the operation of the auxiliary boiler (s) and emergency diesel generators. Information should include release rates (e.g. lbs/hr) for aldehydes, carbon monoxide, hydrocarbons, oxides of nitrogen, oxides of sulfur, organic acids, and particulates. Provide estimates of fuel consumption rate and estimated annual operation time.

RESPONSE

The following tabulation presents calculated combustion products released to the atmosphere from two diesel generators and one Cleaver Brooks boiler unit.

	Diesel Emissions (Max.) Emission Rate lbs/hour	Rate tons/year	Boiler Emissions (Max.) Emission Rate lbs/hour	Rate tons/year
Particulates	2.6	0.05	1.77	2.5
SO_2	8.4	0.16	9.28	13.15
CO	45	0.84	0.009	0.013
Hydrocarbons	7.4	0.14	0.44	0.625
NO_2	74	1.4	23.2	32.88
Aldehydes	0.6	0.01	0.22	0.313
Organic Acids	0.6	0.01	0.155	0.219

The emissions were calculated using accepted emission factors. These factors were obtained from a publication issued by the office of Air Programs of EPA in February, 1972, entitled "Compilation of Air Pollutant Emission Factors."

The fuel used for both the diesels and boiler is number 2 fuel oil with 0.3 percent sulfur. In the calculations for SO_2, the actual weight percent of sulfur in the fuel was used. The density of diesel fuel was assumed to be 7 pounds per gallon. In each case, the emission rate in pounds per hour represents the maximum rate, while the emissions in tons per year reflects actual amounts based on the number of operating hours per year. The two diesel units are each operated 52 hours per year. In the case of the boiler, the maximum fuel rate is 221 gallons per hour. This maximum rate usually occurs during the months of December and January with the rate dropping to between 110 and 144 gallons per hour during the remainder of the year.

QUESTION

C1 Identify the nearest land that could be used to pasture a cow.

RESPONSE

The closest land outside Jersey Central property that could be used as a pasture is located 1.2 miles east of the plant.

QUESTION

C2 Identify the locations of poultry listed in Table 2.2-8 of the ER.

RESPONSE

The 5,000 chickens (layers) in Union Township are located in the town of Barnegat, 4-1/4 miles south of the Oyster Creek Station.

Table 2.2-8 which lists four townships and Ocean County is confusing. The footnotes explain, however, that only Berkeley, Lacey, and Union Townships are located within a 10-mile radius of the Oyster Creek Nuclear Generating Station. Plumsted Township and Ocean County were included in Table 2.2-8 in order to point out that agriculture is of little importance within a 10-mile radius of the plant.

Plumsted Township is located in the extreme northwest corner of Ocean County, 18 miles northwest of the plant and is the best agricultural producing township in Ocean County.

REFERENCES

1. Personal communication, Mrs. Charles Jablonski, owner of the chicken farm in Union Township.

2. Letter from Mr. Shelley Dubnick, County Farm Extension Service Agent, Ocean County, September 5, 1972.

QUESTION

C3 Identify the sources of feed for local poultry.

RESPONSE

See the response to Question C2 which comments on ER Table 2.2-8.

The sole source of feed for the 5,000 layers in Union Township is from the town of Mt. Holly, Burlington County, New Jersey.

REFERENCE

Personal communication with Mrs. Charles Jablonski, owner of the chicken farm in Union Township.

QUESTION

C4 Provide the probable annual average flow of water to be provided by the dilution pumps.

RESPONSE

Based on calculations of dilution pump effectiveness and time-temperature profiles of Barnegat Bay, the following number of dilution pumps would be required to operate to maintain a maximum discharge temperature of 87° F or 95°F at the Route 9 bridge.

For 87°F bridge temperature:
- 1 pump for 50 days per year.
- 2 pumps for 33 days per year.
- 3 pumps for 28 days per year.

Total flow equals approximately 63 billion gallons per year.

For 95°F bridge temperature:
- 1 pump 48 days per year.
- 2 pumps 1 day per year.
- 3 pumps 0 days per year.

Total flow equals approximately 28 billion gallons per year.

QUESTION

D1 Provide reference and quantify spray pond manufacturer's experience indicating that fog dissipates within a limited distance, that drift from spray devices is limited to 200 yards, and that the diameter of the spray droplets exceeds 0.25 inch.

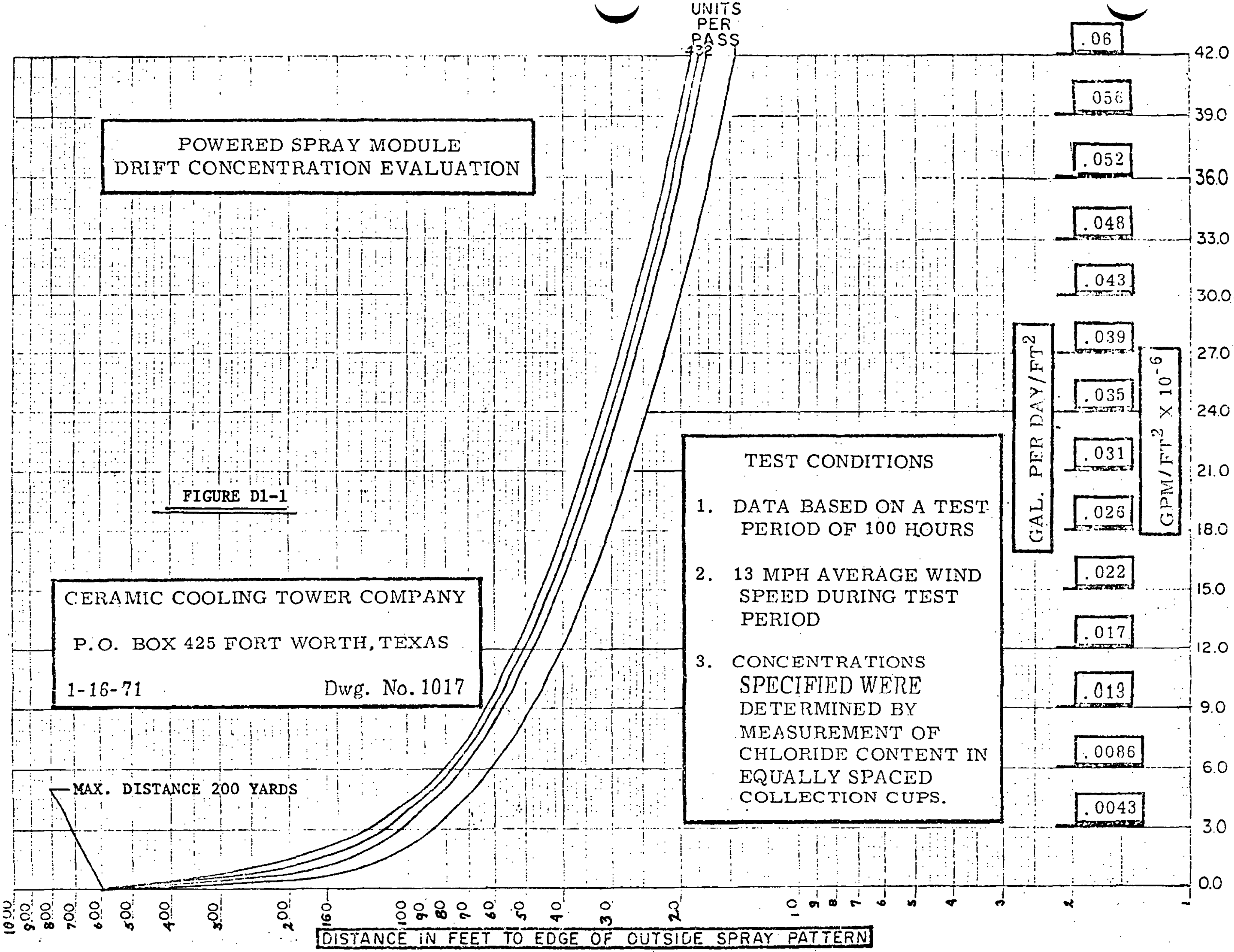
RESPONSE

Drift from spray devices is limited to 200 yards. Refer to attached graph Figure D1-1 from the Ceramic Cooling Tower Company, a manufacturer of powered spray modules.

Ceramic Cooling Tower Company has stated that test results from a spray unit of four spray heads each pumping 2500 gpm indicate that droplet size ranges from 0.25 to 0.5 inches in diameter.

Experience of limited fogging due to use of powered spray modules are as follows:

> Public Service Company of New Hampshire
> Paul Boham, personal communication
> Public Service has had a test model, consisting of nine units in operation for the past 18 months. The worst fogging observed occurred on still winter days when fog rose to a maximum of 300 feet directly over the spray units with no lateral movement. Under a wind condition, the fog moved laterally and was found to dissipate 400 to 500 feet beyond the spray pattern.


POWERED SPRAY MODULE
DRIFT CONCENTRATION EVALUATION
FIGURE D1-1
UNITS PER PASS
4 3 2
CERAMIC COOLING TOWER COMPANY
P.O. BOX 425 FORT WORTH, TEXAS
1-16-71
Dwg. No. 1017
MAX. DISTANCE 200 YARDS
TEST CONDITIONS
1. DATA BASED ON A TEST PERIOD OF 100 HOURS
2. 13 MPH AVERAGE WIND SPEED DURING TEST PERIOD
3. CONCENTRATIONS SPECIFIED WERE DETERMINED BY MEASUREMENT OF CHLORIDE CONTENT IN EQUALLY SPACED COLLECTION CUPS.
GAL. PER DAY/FT²
GPM/FT² X 10⁻⁶
.06
.056
.052
.048
.043
.039
.035
.031
.026
.022
.017
.013
.0086
.0043
42.0
39.0
36.0
33.0
30.0
27.0
24.0
21.0
18.0
15.0
12.0
9.0
6.0
3.0
0.0
1000 900 800 700 600 500 400 300 200 160 100 90 80 70 60 50 40 30 20 10 9 8 7 6 5 4 3 2 1
DISTANCE IN FEET TO EDGE OF OUTSIDE SPRAY PATTERN

QUESTION

D2. "Provide data on the observed frequency of occurrence, extent, and impact of fogging and icing due to the existing discharge system, identifying the worst occurrences of fogging and icing and whether they were 'chance' observations, or part of a monitoring program."

RESPONSE

Fogging has been observed mostly in late fall and early winter months. The extent of fogging has not been formally monitored, documented, or recorded, although, it has been observed to rise to a maximum height of 15 feet above the canal with little lateral movement over the banks. This type of "stream" fog results from intensive evaporation of vapor from the warm canal water surface into a relatively cooler air mass and is usually confined to the immediate area of the canal. Observations made during area fogging caused by natural meteorological conditions indicate that the canal contributions to the area fog are negligible.

To date no fogging or icing problems at either Highway 9 or within the plant property, which can be attributed to the canal fog, have been noted.

QUESTION

E1 Provide biological monitoring data subsequent to those presented in the ER through Progress Report No. 8.

RESPONSE

The report entitled "The Qualitative and Quantitative Analysis of the Benthic Flora and Fauna of Barnegat Bay Before and After the Onset of Thermal Addition - Eighth Progress Report - August 18, 1972" is in draft form but has not been reviewed and approved by the Rutgers University Joint Study Group that supervises the program. As soon as this Group issues this document, the information will be made available to AEC consultants.

QUESTION

E2 Provide data on the environmental impact of canal construction on the South Branch of Forked River and Oyster Creek.

RESPONSE

Refer to the response to Question A6 which discusses the environmental impact of canal construction.

QUESTION

E3 Provide the criteria used to select Stouts Creek as a control for studies of benthic organisms. Include data comparisons on the physical, chemical and biological parameters used to establish Stouts Creek as a control.

RESPONSE

The general qualifications of any control area are that it (1) provide the same (or as similar as possible) physical, chemical and biological parameters as the study area; (2) be exposed to any natural factors that may influence the study area and (3) be outside the influence of changes brought about in the study area.

Stouts Creek was selected as the control area for studies of benthic organisms. Its physical characteristics are similar to those of Oyster Creek with respect to topography, depth, substrate and sediment composition. Other creeks in the area are larger than Oyster Creek and were not considered to be suitable control areas. Creeks to the south of the study area are subject to differing ocean influences due to the Barnegat Bay Island Beach Inlet. Additionally, any movement of the effluent from the study area toward the ocean would be through the Inlet and such movement would influence a control area located to the south.

The water quality of Stouts Creek was considered to be similar as it drains a fresh water area, is located on the same Bay, and is in close proximity to the study area and therefore is subject to the same natural occurences, while at the same time is not influenced by changes brought about in the study area.

The similarity in physical and chemical parameters makes it logical to assume that Stouts Creek is also similar biologically. Although there were no specific studies prior to the selection of Stouts Creek as the control area, subsequent pre-operational work has confirmed this assumption.

Comparative data for pre-operational physical, chemical and biological parameters will be presented in the Eight Progress Reports prepared by Rutgers University.

QUESTION

E4 Provide detailed discussion of the dredging activities in Oyster Creek and the South Branch of Forked River. Include:

a. the type of dredge used,

b. retention of dredge effluent in the spoil areas,

c. the influent point and effluent point for each spoil area,

d. the cost of reseeding the spoil areas,

e. *the concentration of hydrogen sulfide in the sediments of South Branch Forked River and Oyster Creek, and

f. *the percent volatile solids in the sediments of South Branch Forked River and Oyster Creek.

RESPONSE for a, b, c, and d.

Before discussing the dredging activities in Oyster Creek and the South Branch of Forked River, a brief description of the resulting canal is presented (refer to Figure E4-1).

The intake canal uses the Forked River estuary for the first 4000' then it cuts through the original South Branch of the Forked River streambed for a distance of 7500' to the point where it intersects Route 9. This section of the canal averages a 220' bottom width which is at between 6' and 8' below mean sea level. From the Route 9 bridge, the canal runs inland (to the intake structure) for 2800' through original ground and has a depth of 10' and a bottom width of 134'.

The discharge canal runs from the discharge structure for a distance of 2500' through original ground to the point of intersection of Route 9 and the Oyster Creek streambed. This section of the discharge canal has a bottom width of 100' and a depth of 10' below mean sea level. The balance of the discharge canal is 10' deep with a minimum bottom width of 105'. Twenty-six hundred feet of the discharge canal east of Route 9 runs through the original streambed of the Oyster Creek of which the last 700' was tidal water. The balance of the canal runs in the Oyster Creek estuary and is 10' deep and 100'to 116' wide at the bottom. From the Oyster Creek inlet to the inland waterway a 75' x 10' to 12' deep channel was dredged to provide passage for the barge that transported the reactor pressure vessel.

*Data should be provided for at least three locations in each stream.

PERMITS AND RESTRICTIONS

Dredging of the Oyster Creek canals was performed under a permit dated July 13, 1966 from the State of New Jersey, Department of Conservation, Bureau of Navigation. Dredging was performed in accordance with the terms of this permit which, among other things, specified the maximum allowable inorganic suspended material to be returned to the estuary system. In addition, potable water wells along the canal right-of-way were monitored for saltwater intrusion in accordance with a Public Utilities Commision (PUC) order dated June 1966. Also, in accordance with this same PUC order, three bottom samples were taken in the area that was dredged each day.

The permits issued by the New Jersey Department of Conservation involving any tidal waters or rivers were subject to approval by the U. S. Army Corps of Engineers.

HISTORY OF CANAL CONSTRUCTION

Initially it was planned to spoil all excavated material from the plant and canal construction in the area between the plant site and the Garden State Parkway. When the contract was awarded in May of 1966 the canal contractor cleared approximately 25 acres next to the Parkway before the decision was reached to spoil in other areas. This was mainly due to the fact that Jersey Central purchased the entire Baywood Farm between Route 9 and the bay area. In addition, agreements with property owners along the Forked River canal right-of-way resulted in the availability of the remaining low areas of the Forked River as spoil areas.

The spoil was placed near the three main construction areas:

1. The Oyster Creek canal area (east of Route 9),
2. The power plant area (or west of Route 9), and
3. The South Branch of Forked River area (east of Route 9).

OYSTER CREEK DISCHARGE CANAL, EAST OF ROUTE 9

Three spoil areas were developed for this part of the construction work which involved moving 435,000 cubic yards of material. These areas are as follows:

1. <u>Main Disposal Area</u> indicated as Disposal Area #9 on Figure E4-1 which comprised a 150 acre section on the SE corner of the Baywood farm. This was a 75% saltswamp area. The entire area was diked and 370,000 cubic yards (cy) of material was deposited within that area by hydraulic dredge. Controlling the effluent from this operation was by a 20" sump pump which discharged into a ditch before being discharged back into the bay.

2. Disposal Area #1 - This area is an island in the Oyster Creek streambed and is approximately 2000' long and is located on the south side of the Baywood farm about 500' east of Route 9. This island was cleared for approximately 20 acres and a dike was built along the canal right-of-way out of the organic material from the streambed of Oyster Creek. Approximately 3 acres on the western tip of the island was covered with approximately 25,000 cubic yards of till which was placed with a dragline type dredge. This fill did not produce enough effluent to warrant control other than the diked enclosure.

3. Unnumbered Disposal Area - This 11 acre area was just east of Route 9 and south of the streambed of Oyster Creek. This area was diked along the canal right-of-way and approximately 40,000 cubic yards of material was deposited in this area with a dragline type dredge. Effluent in this area did not warrant special control.

Hydraulic dredging was started on the 13th of August 1966 and stopped the 17th of October 1966. The reason for discontinuing hydraulic dredging was the extreme amount of downtime due to stumps, etc., getting stuck in the dredge pump. On the 17th of October, a dragline dredge was moved in that had a 16 cubic yard bucket. Excavation of the remaining 1150' of the Oyster Creek canal east of Route 9 was completed on October 22, 1966.

Miscellaneous cleanup and dressing of the banks of spoil areas was carried on through the summer of 1967. No site restoration of these areas has been done.

AREA WEST OF ROUTE 9 INCLUDING THE POWER PLANT EXCAVATION

Excavation for the turbine and reactor buildings was completed in October and November 1964, respectively. A total of 228,000 cy of material was moved and spoiled in the area west of the discharge canal along the bank of Oyster Creek.

Excavation for the canals west of Route 9 was started the 18th of August 1966. Work in the streambeds was done by dragline and both the Oyster Creek and Forked River streams were diverted to run along the canal cuts. Excavation of the bulk of the inland sections west of Route 9 was carried out in the dry using belly scrapers and bulldozers. The area was dewatered for this purpose using a wellpoint system. Excavation with belly scrapers started on October 22, 1966 and was completed in early 1967.

During the spring and the early summer of 1967 the Route 9 highway and railroad bridges (two each) were constructed and an elevated bridge was constructed over Forked River at the county road crossing (Beach Boulevard Bridge). All were open to traffic by August 10, 1967.

In this period through September 1967, because of concern for possible saltwater intrusion into the aquafier in the area between the highway bridges at Forked River and the plant, a freshwater mound was constructed and put into operation which provided a hydrostatic head of freshwater on both sides of the intake canal for a distance of 1400'. After this, the plugs at the Oyster Creek and Forked River were removed and the entire length of the canals became subject to tidal action. All grading of banks and spoil areas was completed by mid October 1967.

In early April 1968 a contract for a limited amount of site restoration work was awarded and a total of $60,000 was expended as follows:

$17,500	for an experimental canal banks protection area of 10 acres (which did not work)
$39,000	expended to seed about 60 acres which included some 40 acres around the plant site and 20 acres of the 112 acre spoil area west of the plant.
$ 2,500	was expended to transplant a row of pine trees along the road to the freshwater pond.

Spoil areas for the work west of Route 9 included the initial clearing of 25 acres near the Garden State Parkway. However, this area was not used. The actual spoil area was approximately 112 acres for all spoil to the west of the canals. This included some 80 acres of swampy areas; the balance was scrubpine covered sandy areas typical of the area.

The areas between the canals and Route 9 were partially scrubpine and part streambed of the Oyster Creek, divided about equally.

THE SOUTH BRANCH OF THE FORKED RIVER CANAL EAST OF ROUTE 9

This canal was dug immediately after the Oyster Creek canal was completed. It was started on the 26th of October 1966 and completed on December 12th, 1966. Work was carried out by hydraulic dredge which moved a total of 258,115 cy which was spoiled in three different areas, and by dragline dredge which moved 426,541 cy of material.

Spoil was distributed as follows:

In the area north of the canal on 16 acres of lands owned by a Mr. Wilbert, a total of 93,186 cy of material was placed with a dragline dredge. The area was first cleared and was essentially in the floodplain of Forked River (South Branch). In the area east of the Wilbert area on 11.8 acres of land owned by a Mr. Pearl, a total of 162,825 cy of material was placed also with a dragline dredge. Although the Pearl area is on similar lands as the Wilbert area, this was considered salt water marsh.

On the south side of the South Branch of Forked River on 5.6 acres of salt marsh owned by JCP&L (Baywood Farm) 57,550 cy of material was placed by dragline dredge.

On 5.1 acres of salt marsh, owned by Jersey Central on the south side of the canal and just east of the county road bridge 49,904 cy of material was deposited by hydraulic dredge.

On 3.9 acres of salt marsh land, known as the Club House area, 48,813 cy of fill was placed with the hydraulic dredge. This land is owned by the Forked River Country Club.

The last area, known as Disposal Area #6, was cleared and diked and 159,398 cy of material was deposited in this area with the hydraulic dredge. Also, 94,330 cy of material was placed by dragline dredge for a total of 253,728 cy for that area of 24.7 acres.

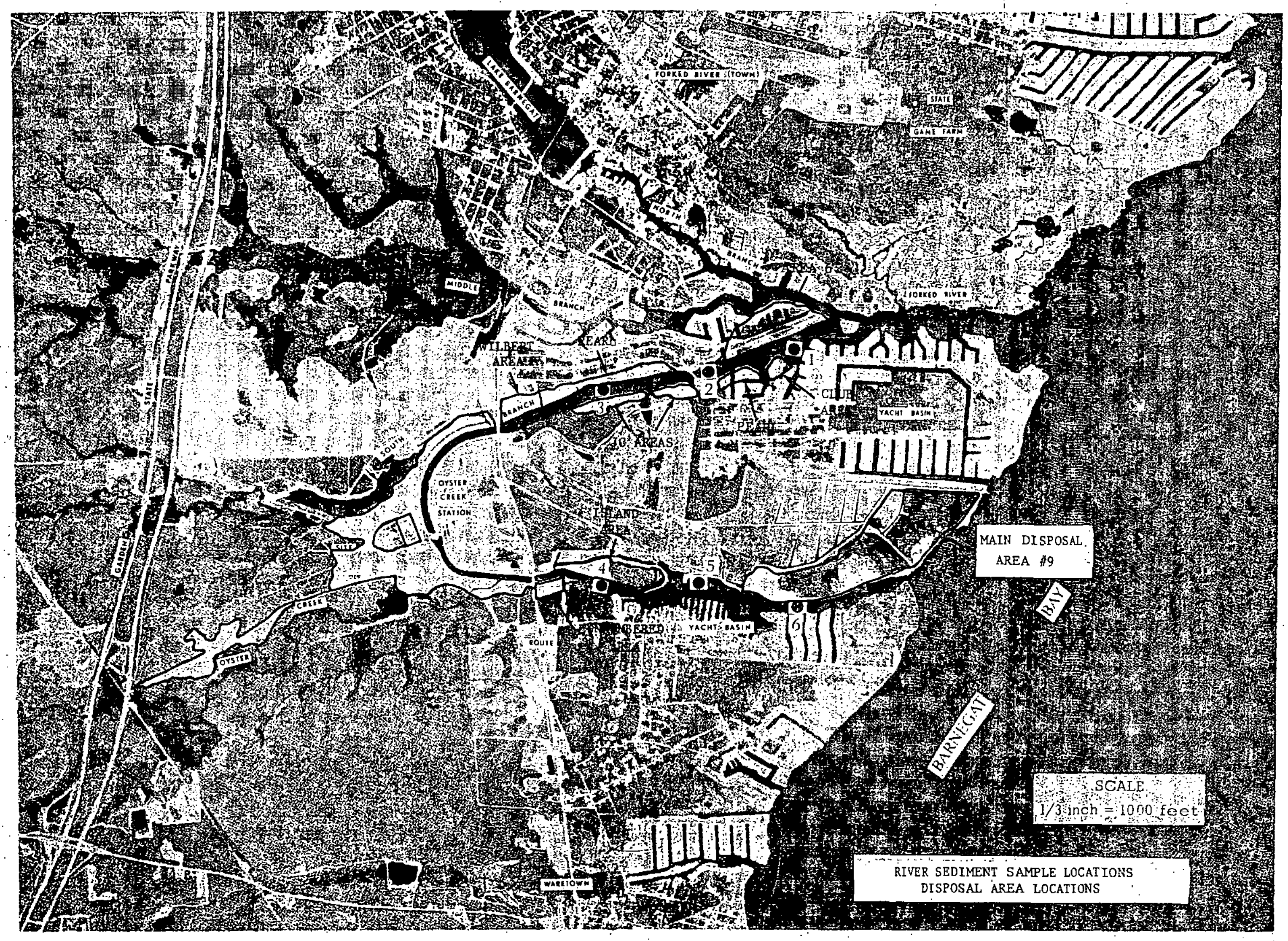
No site restoration of these areas was done. Lagoons have since been dug into the Disposal Area #6.

RESPONSE for e and f.

The concentration of hydrogen sulfide and percent of volatile solids found in the South Branch of Forked River and Oyster Creek are tabulated below. The location of the sediment sampling stations are shown in Figure E4-1.

Area	Sample Location	(Wet) H_2S (mg/kg)	H_2O (%)	(Dry) Volatile Solids %
Forked River	1	732	64	11.1
	3	20	62	20.7
South Branch	2	1608	66	10.7
	4	283	54	8.3
Oyster Creek	5	290	55	19.9
	6	187	54	9.1

A total of six grab samples were taken from the South Branch of Forked River and from Oyster Creek during September of 1972. The significant quantities of H_2S reported in Forked River are believed to reflect the possible deposition of raw sewage solids from the adjacent densely populated area and yacht harbor. The low H_2S concentration reported for sample 3 may be misleading. Observation of this sample indicates the presence of darkly colored sediments with a distinct odor characteristic of sulfur compounds. The reported value of H_2S concentration for this sample has been confirmed, however, the exhibited characteristics indicate the probable presence of other sulfur related compounds.



RIVER SEDIMENT SAMPLE LOCATIONS
DISPOSAL AREA LOCATIONS

FIGURE E4-1
DAMES & MOORE

QUESTION

E5 Provide data on the environmental impact and the economic penalty for maintaining an effluent discharge temperature of no greater than 87°F at the end of the discharge canal.

RESPONSE

The impacts on ecological parameters associated with maintaining an effluent discharge temperature of 87°F at the end of the discharge canal by operation of additional pumps would be 1) lower temperature of the plume, 2) larger area of the plume, 3) higher current velocity near the discharge, and 4) greater exposure of organisms to the mechanical shock of the pumps. The economic costs associated with maintaining 87°F at the end of the discharge canal are discussed in the response to Question A2.

Lowering the temperature of the plume would have a positive environmental effect. Fish (sliversides, young anchovies, and puffers) avoidance of areas in which temperatures exceed 30°C (86°F) has been indicated at the outfall of Oyster Creek in a study by Marcellus (Ref. 1). Thus, a lower temperature would be less likely to cause exclusion of fish. Oxygen availability would also be greater at the lower temperature. In addition, Cairns has shown that algal population dominance type may shift with increasing temperature (Ref. 2). In his study, green algal became dominant at low temperatures while the less desirable blue-green algal were most conspicuous at high temperatures.

Higher current velocities would be detrimental in that it would increase turbidity and also cause shifts in bottom sediments.

Dr. Wurtz has reported that 24.44 fish/hr. were impinged upon the intake screens of the condensers (Ref. 3). The kill averaged 62%. Blue crabs were caught at an average of 137.4/hr. This was with a condenser circulation pump flow of 460,000 gpm. If it can be assumed that the number is proportional to the flow rate, then 13 fish and 75 blue crabs would pass through each dilution pump/hr. The physical damage would probably be negligible as the dilution pumps are protected only by 3 x 6 inch screened trash racks which allow most fish and crabs to pass. The large pump cavities and associated pipes are also judged to have negligible effect on fish and crabs.

REFERENCES

1. Marcellus, K. L., 1972, "Fishes of Barnegat Bay, New Jersey, with Particular Reference to Seasonal Influences and the Possible Effects of Thermal Discharge", PhD. Thesis, Rutgers University, New Brunswick, New Jersey, 190 pp.

2. Cairns, J., Jr. 1956, "Effects of Heat on Fish," Ind. Wastes, 1 (5) 180-183 pp.

3. Wurtz, C. B., PhD., 1972, "Fish and Crabs on the Screens of the Oyster Creek Plant During 1971," unpublished report.

QUESTION

E6 Provide the dissolved oxygen concentration for Oyster Creek prior to station start-up. Provide explanation for low dissolved oxygen levels presently observed in Oyster Creek.

RESPONSE

Analyses performed by Rutgers University in October, 1967 (Third and Fifth Progress Reports) have yielded dissolved oxygen concentrations in Oyster Creek of 8.1, 7.96, 8.11 and 8.01 mg/l with a mean of 8.04 mg/l. Data from water quality surveys, conducted by the U. S. Environmental Protection Agency together with the New Jersey Department of Environmental Protection during the summer of 1966 and the summer of 1967, have shown that the dissolved oxygen concentrations of seventeen samples were above the applicable criteria for Oyster Creek (Reference 3).

The mean dissolved oxygen concentration in Oyster Creek for the period June, 1970 through March, 1971 was 7.41 mg/l (Rutgers University, Seventh Progress Report).

All of the observed dissolved oxygen values, both pre- and post-operational, are greater than the criteria for Oyster Creek. The applicable criteria are: "Daily average not less than 5.0 mg/l. Not less than 4.0 mg/l at any time." In light of the criteria, the dissolved oxygen levels in Oyster Creek should not be construed as "low".

REFERENCES

1. Moul, E. T., R. E. Loveland, J. Z. Taylor, F. X. Phillips and K. Mountford, "Barnegat Bay Thermal Addition: Progress Report No. 3, January 1968.

2. Loveland, R. E., E. T. Moul, F. X. Phillips, J. Z. Taylor and K. Mountford. "The Qualitative and Quantitative Analyses of the Benthic Flora and Fauna of Barnegat Bay Before and After the Onset of Thermal Addition." Fifth Progress Report - March 15, 1969.

3. "Pre-conference Report for Water Quality Standards Setting/Revision Cenference, New Jersey Atlantic Coastal Area", U. S. Environmental Protection Agency, Region II Office, New York, New York, May 1972 and Personal Communication.

4. Loveland, R. E., K. Mountford, E. T. Moul, D. A. Busch, P. H. Sandine and M. Moskowitz. "The Qualititative and Quantitative Analyses of the Benthic Flora and Fauna of Barnegat Bay Before and After the Onset of Thermal Addition." Seventh Progress Report, June 25, 1971.

QUESTION

E7 State plans for avoiding recurrences of finfish mortality due to cold shock induced by plant shutdown. Provide answers to questions posed in Section 5.1.5 ER.

RESPONSE

A two-pronged study of the population and migratory habits of Atlantic menhaden in the Oyster Creek Nuclear Generating Station area is underway by federal government and private biologists retained by Jersey Central.

The program, which will take several months, will include field studies and an analysis of published and unpublished environmental data pertaining to young menhaden in Mid-Atlantic estuaries.

John W. Reintjes, a fishery biologist with the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA), will correlate the published and unpublished material, and Dr. Charles B. Wurtz, a consulting biologist, will supervise the field observation.

The study has been initiated by Jersey Central to determine the number of juvenile menhaden in Oyster Creek and the South Branch of the Forked River and their seasonal movement in an effort to eliminate the possibility of a menhaden kill as was experienced last winter when the Oyster Creek Station was shut down for maintenance.

Mr. Reintjes, with headquarters at the Atlantic Estuarine Fisheries Center, Beaufort, N. C., will analyze data on the Atlantic menhaden specie to determine "temporal changes in the estuarine environment that will induce the emigration of young Atlantic menhaden from estuarine nurseries without causing mortalities to the menhaden."

Mr. Rentjes noted that menhaden spawn in the ocean and move into estuarine waters where the larvae transforms into juveniles which remain in the creeks and rivers until autumn when they usually migrate to the ocean.

What has perplexed biologists is why the menhaden did not leave Oyster Creek last fall when the power plant was shut down for maintenance and the creek water temperature lowered to the temperature of Barnegat Bay.

The menhaden kill, attributed to thermal shock, happened during the last weekend of January when the power plant again was shut down for maintenance and the water in Oyster Creek cooled to the bay temperature which was in the high thirties at the time. This drop in water temperature did not affect the other fish in Oyster Creek.

A field study also is in progress to determine the abundance and distribution of the menhaden in Oyster Creek and the South Branch of the Forked River. A similar check also will be made in Stout's Creek, a few miles north of the generating station as a control check on the two streams that provide the plant's intake and discharge. The field study will continue until next January.

It is expected that out of this scientific study of the Atlantic menhaden, the first of its kind in the Barnegat Bay estuarine nurseries, a complete knowledge of the life style and habits of the fish will become known.

These facts will permit Jersey Central to alter its power generation procedure at the time the fish migrate to the ocean so that none should be in the warm water of Oyster Creek if the generating station is shut down during the winter when the natural bay water temperature could be low enough to kill the menhaden.

This is the latest in a series of scientific studies that are being made in the bay in the vicinity of the generating station to determine the plant's effect on the environment. These studies started while the station was being constructed and now are a continuing program of federal and state agencies and by consultants retained by Jersey Central.

QUESTION

E8 Provide annual value and weight of the commercial marine fishery, by species, for all coastal New Jersey counties.

RESPONSE

The annual value and weight of commercial marine fishery, by species, for all coastal New Jersey counties are shown in Table E8-1. It should be noted that the dollar value of certain species listed varies from county to county. This is due to the ultimate market for the product; i.e., for human consumption or processed for other uses.

REFERENCES

1. Mr. Russell T. Norris, Regional Director, N. E. Region, National Marine Fisheries, Gloucester, Massachusetts 01930.

2. Mr. Eugene A. Lo Verde, Fishery Reporting Specialist, U. S. Department of Commerce, NOAA, National Marine Fisheries Services, Toms River, New Jersey 08753.

TABLE E8-1

ATLANTIC COUNTY

SPECIES	LBS.	VALUE
Alewives	7,000	280
Bluefish	72,500	6,811
Butterfish	52,400	15,196
Cod	16,600	2,648
Blackback	45,900	6,590
Fluke	450,700	176,229
Gray Sole	9,100	876
Yellowtail	496,400	40,259
Haddock	400	190
Ling	10,900	441
Hake	13,200	1,310
Herring	700	28
Mackerel	63,800	5,802
Menhaden	100	5
Pollock	100	7
Scup	454,400	101,339
Sea Bass	10,800	3,363
Weakfish	238,600	22,478
Shad	5,400	637
Squid	42,900	8,954
Oysters	18,000	27,153
St. Bass	93,900	27,193
Strugeon	600	101
Swordfish	200	75
Tautog	1,100	61
Tilefish	6,100	928
Bluefin Tuna	100	8
White Perch	23,400	5,193
Whiting	86,400	8,052
King Whiting	1,500	183
Spots	100	8
Redfish	100	15
Lemon Sole	6,900	2,172
Unclassified for food	800	99
Bait, reduction, etc.	5,300	320
Hard Crabs	59,100	9,361
Rk. Crabs	47,800	2,397
Lobster	319,700	327,782
Hard Clams	831,700	567,922
Surf Clams	2,545,000	307,609
Sea Scallops	12,200	17,437

Table E8-1 (Continued)

MONMOUTH COUNTY

SPECIES	LBS.	VALUE
Alewives	500	20
Bluefish	194,200	28,837
Bonito	100	25
Butterfish	50,900	8,949
Cod	4,200	1,037
Common Eels	54,100	10,759
Blackback	2,800	346
Dab	1,000	47
Fluke	12,500	5,498
Yellowtail	52,300	4,434
Ling	73,200	3,894
Herring	15,500	785
Mackerel	1,200	116
Menhaden	60,388,300	1,038,082
Pollock	100	9
Scup	4,800	1,400
Sea Bass	900	290
Sea Robin	600	16
Weakfish	78,100	13,402
Shad	16,400	1,604
Grayfish	300	12
St. Bass	26,900	10,522
Sturgeon	1,300	248
Tautog	7,500	472
Tilefish	1,700	340
White Perch	1,500	341
Whiting	155,200	17,071
Unclassified for food	1,400	163
Albacore	900	52
King Whiting	500	38
Daylights	200	9
Skipjack Tuna	300	14
Drum	100	6
Pilotfish	100	5
Hard Crabs	49,200	9,057
Rk. Crabs	1,400	74
Lobsters	254,200	322,222
Hard Clams	144,400	93,140
Soft Clams	48,400	27,722
Surf Clams	305,200	53,850
Squid	100	30
Loggerhead Turtles	600	60

Table E8-1 (Continued)

OCEAN COUNTY

SPECIES	LBS.	VALUE
Alewives	800	32
Anglerfish	1,400	49
Bluefish	586,900	79,445
Bonito	1,000	202
Butterfish	185,200	32,046
Cod	74,200	17,858
Blackback	17,600	1,548
Fluke	87,000	40,397
Gray Sole	4,200	710
Yellowtail	99,000	6,829
Ling	471,700	26,130
Hake	27,300	3,076
Herring	3,900	100
King Whiting	100	18
Mackerel	33,600	4,265
Menhaden	5,700	277
Pollock	500	35
Scup	142,100	39,612
Sea Bass	8,200	3,004
Weakfish	248,000	30,058
Shad	1,300	146
St. Bass	18,100	6,853
Tautog	500	19
Tilefish	21,100	3,480
Bluefin Tuna	1,200	407
White Perch	11,000	2,530
Whiting	2,973,400	303,404
Unclassified for food	3,500	712
Albacore	300	17
Drum	100	7
Lemon Sole	400	120
Common Eels	70,100	14,020
Hard Crabs	93,400	14,853
Rk. Crabs	1,700	124
Lobsters	567,000	627,632
Hard Clams	1,371,000	930,730
Surf Clams	4,580,000	680,210
Oysters	900	1,500
Sea Scallops	13,500	20,527
Squid	56,391	12,785

Table E8-1 (Continued)

SALEM COUNTY

SPECIES	LBS.	VALUE
Shad	2,600	264
St. Bass	2,500	750
White Perch	13,900	2,919
Hard Crabs	70,900	10,990
Peeler Crabs	200	60
Snapper Turtle	44,600	8,028
Diamondback Terrapin	700	315
Painted Turtles	500	30

BERGEN COUNTY

Shad	100,800	18,137

BURLINGTON COUNTY

Hard Clams	90,900	61,879
Oysters	31,900	49,098

Table E8-1 (Continued)

CAPE MAY COUNTY

SPECIES	LBS.	VALUE
Alewives	1,200	48
Anglerfish	100	5
Bluefish	113,700	8,854
Butterfish	955,000	137,114
Cod	11,000	2,368
Common Eels	46,100	16,106
Conger Eels	1,000	108
Blackback	19,600	1,146
Fluke	1,299,300	450,536
Gray Sole	11,100	902
Yellowtail	649,400	45,593
Ling	156,400	4,492
Hake	2,600	158
Herring	64,400	1,338
Mackerel	879,900	38,238
Menhaden	85,300	3,384
Scup	1,466,800	299,914
Sea Bass	287,700	100,915
Weakfish	2,453,900	174,972
Shad	10,300	624
Grayfish	12,000	605
Unclassified Sharks	100	5
St. Bass	115,800	30,522
Sturgeon	9,700	1,432
Swellfish	100	5
Tautog	5,400	141
Tilefish	3,800	552
Bluefin Tuna	2,021,700	404,341
White Perch	17,400	3,726
Whiting	733,100	46,167
Unclassified for food	1,700	242
Bait, reduction and animal food	144,700	2,895
Albacore	400	16
Drum	44,522	2,208
Grunts	1,100	78
King Whiting	5,100	518
Spots	3,000	207
Spanish Mackerel	100	12
Croaker	100	14
Rk. Crabs	300	21
Lobsters	182,100	181,887
Grass Shrimp	700	290

Table E8-1 (Continued)

CAPE MAY COUNTY (Continued)

SPECIES	LBS.	VALUE
Hard Clams	37,300	25,289
Surf Clams	21,291,200	2,834,825
Conchs	80,500	9,996
Oysters	2,700	3,150
Sea Scallops	86,200	124,178
Squid	105,900	15,745

CUMBERLAND COUNTY

Bluefish	11,900	1,673
Carp	15,400	1,161
Catfish	1,400	168
Common Eels	61,600	12,740
Butterfish	100	20
Fluke	300	90
Menhaden	83,800	3,352
Weakfish	80,400	13,494
Shad	4,000	320
St. Bass	33,100	9,569
White Perch	19,800	4,061
Hard Crabs	830,000	127,850
Peeler Crabs	13,100	3,950
Horseshoe Crabs	4,500	45
Oysters	818,000	627,729
Snapper Turtles	2,700	405

QUESTION

E9 Provide the seasonal occurrence, duration, and frequency of wind conditions sufficient to mix Barnegat Bay waters and to alter the configuration of the thermal plume.

RESPONSE

Meterological data is available from the Oyster Creek Station, but it is not known what winds affect the thermal plume or to what extent. It is known, though, that the movement of the plume is affected by both winds and tides from actual plots of the plume derived from aerial infra-red photographs and boat temperature traces. However, there is no adequate theory or empirical method to define or derive the probable flow pattern in the case of wind driven turbulent tidal flow similar to the Oyster Creek discharge.

QUESTION

E10 Provide a complete explanation for the calculations presented in Amendment I, page 11.2-14. State the reason for calculating on the basis of 4,334 hrs/yr; also, identify where in the equation the volume of flow through the condensers was considered.

RESPONSE

The calculations using 4,334 hrs/yr are found on page 11.2-19, therefore the response will address the calculation for alternative 1, 2, 3 and 4 of this page.

Photosynthesis only occurs during day-light hours, therefore day-light occurs an average of 12 hours per day or approximately 4,334 hours per year.

The volume of flow through the condenser has not been considered in the calculations presented on page 11.2-19 of the Oyster Creek ER. The observations of depressed oxygen production in the discharge plume indicates the existence of a steady state condition in which below normal rates of photosynthesis extend over some limited, but variable, area of the plume. Studies to date have not taken measurements extensive enough to permit an estimation of the actual range of the area affected. It is felt that such areas would be independent of total condenser flow volume but could be determined by such parameters as; temperature differential, the ambient temperature, turbidity, biocide treatment, and flow rate at the time of measurement. Without knowledge of the total plume area affected, and based on existing data, the corresponding volume of the photic zone cannot be calculated, therefore, the total annual losses cannot reasonably be derived. The values in the tables in ER Section 11 are still in error, though, and will be corrected in Amendment 3.

QUESTION

E11 Provide reference or more detailed justification for assumptions cited in Amendment 1, page 11.2-21.

RESPONSE

Assumption 1 - One hundred percent of the living fish eggs taken into the system are bay anchovy eggs.

Of eggs collected by Dr. Wurtz during one study, 99% were of the bay anchovy (Anchos mitchilli). These were collected at stations at the mouth of and within Forked River. (A report on studies related to potential entrainment of fish eggs and fish larvae at the Oyster Creek Plant, 1972).

Assumption 2 - The density of the eggs remains constant throughout the year.

The mean value obtained by Dr. Wurtz (12.3 eggs/40 gal.) in ER Ref. 2.7-3 is not an annual mean as first assumed. Sampling by Dr. Wurtz was conducted only during the spawning period (25 May - 21 August). No eggs would be present during the non-spawning period. Doctoral work now in progress (by Eileen Setzler) at the University of Georgia Marine Institute indicates spawning occurs from April throughout the summer. Peak periods appear in May and June. Spawning appears to be delayed approximately one month at the New Jersey latitude (Wurtz, per. comm.). Thus Dr. Wurtz's sampling probably encompassed most of the variability within the spawning season. Therefore it can be assumed that the mean density of eggs obtained by Dr. Wurtz represents an average value for the approximately six month spawning period. This assumption will affect the values as presented in Table 1 Item 1.2.2 and Page 11.2-21. These new values will be presented as part of Amendment 3 to the Oyster Creek ER.

Assumption 3 - A year old anchovy weighs an average of 0.5 ounce.

Striped anchovy (Anchoa hepsetus) of 4-1/2 inch length have an average weight of 0.5 ounce. The average length of bay anchovies is 3 inches. Thus mature bay anchovies weigh somewhat less, but 0.5 ounce is a reasonable estimate. (Hilderbrand, S. F. & Louella E. Cable. 1930. Development and life history of 14 teolostean fishes at Beaufort, North Carolina. U. S. Bureau of Fisheries Bulletin. 46:383-488).

Assumption 4 - The natural survival rate for bay anchovy eggs and larvae is 0.01 to 0.001% per year.

This is simply an estimated range. Survival rate of steelhead trout stocked in a pond was 1.4% (Coche, Andre G. 1967. Production of juvenile steelhead trout in a freshwater impoundment. Ecological Monographs 37(3):201-228). Other figures given in the same article for lentic salmonids ranged from 79.2% - 6.1% survival for one year. It is believed that survival rate for anchovies would be much lower because the trout estimates were made in somewhat controlled environments with correspondingly lower predation pressures. In addition, the trout were stocked as fingerling so that egg mortality was not included.

QUESTION

E12 Provide more detailed discussion to support the statement (Amendment I, page 11.2-26) that the thermal plume has no effect on fish spawning activity.

RESPONSE

At the time of the Benefit-Cost section publication, a complete assessment of the spawning activities and life cycles of the diverse fish which populate Barnegat Bay had yet to be accomplished. However, fish population trends in the area of Oyster Creek may provide some insight as to the effects of the thermal plume on fish spawning activity

In a recent study, it was reported that there was a relatively high and uniform similarity in fish species composition in the Forked River - Oyster Creek area and a wide distribution of these species in Barnegat Bay. In general, the number of fish caught per effort (C/E) increased from January through April. A decrease in number was usually observed in May, but was followed by an increase in June. Late July and early August C/E values were generally lower than early July values as water temperatures reached their maximum during the last week in July. This decline in abundance of fish was usually followed by an increase in September and October. It appears that fish move away from shore into the deeper waters of Barnegat Bay during periods of Maximum near-shore water temperatures and then move back in towards shore as the waters cool. The thermal plume similarly affects fish distribution in the Forked River - Oyster Creek area. Some fish tend to be attracted to the thermal plume in the winter months and tend to avoid the plume during the mid-summer months.

Over the four-year period of study (1966-1970), fifteen species of fish comprised nearly 99 percent of the total catch and, of these fifteen species, the Atlantic silverside represented more than 50 percent of the total. Due to the prevalence of the resident Atlantic silverside, this species may be considered as an indicator with respect to the influence of the thermal plume, recognizing, of course, that other species may react differently.

The study of Atlantic silverside indicates that the species is attracted to the thermal plume in the winter. During the Oyster Creek Station pre-operational study period, the Atlantic silverside was most abundant between late June and early July. Post-operational Oyster Creek Station studies have found this psecies to be most abundant during June.

Due to the presence of the thermal plume, spawning may have been advanced and/or growth rate increased. The warmer temperatures may have triggered earlier spawning while increased growth may be due to an increase in the food supply in the plume. The extent of the thermal plume is small compared to the rest of Barnegat Bay and any effects on spawning activity would be localized. Some species of fish in the Bay will avoid the thermal plume and spawn elsewhere, while the spawning of fish in the vicinity of the plume may follow the same pattern as that for the Atlantic silverside. Additionally, the plume may attract fish and contribute to increased growth rates due to the abundant food supply. Further, the wide distribution and composition of species in Barnegat Bay make it improbable that the thermal plume would have any significant adverse effect on fish spawning activity.

REFERENCE

Marcellus, K. L., "Fishes of Barnegat Bay, New Jersey, with Particular Emphasis to Seasonal Influences and the Possible Effects of Thermal Discharges", Agriculture Library, College of Agriculture and Environmental Science, Rutgers University, May 1972.

QUESTION

E13 Provide data on the annual increase in small craft (30 ft. and below) in New Jersey coastal waters from 1963-1971.

RESPONSE

Tables E13-1 and E13-2 present the total boats registered and the annual increase from 1963 to 1971.

Table E13-1 includes the total Class A (16') and Class I (16' to 26') craft in New Jersey from 1966 to 1971.

Table E13-2 lists the total craft in New Jersey which include all classes of boats and all hull types from 1963 to 1965. Note that the data for these years were not recorded by Class A and I, but only listed as total number of boats.

The data in Tables E13-1 and E13-2 are based upon registered power boats and do not include sailboats, rowboats or canoes. The State of New Jersey does not maintain records on the number of boats used in the coastal waters; therefore, the figures presented in the tables are for the total state.

In Table E13-1, the marked decrease from 1969 to 1970 was caused by the state not purging their boat registration records for two or three years. This resulted in boats being given duplicate registration during that time period and when the state registration records were purged, there was a marked decrease.

REFERENCES

1. Publication CG-357 for 1963-1971 from the Department of Transportation, United States Coast Guard.

2. Personal communication, Mr. Hakes, U. S. Coast Guard Office of Boating Safety, Washington, D.C.

3. Personal communication from Mr. J. Kent, Department of Environmental Protection, Supervisor of Motor Boat Numbering, Trenton, New Jersey.

TABLE E13-1
CLASS A (16') and CLASS I (16' to 26') CRAFT IN NEW JERSEY

YEAR	TOTAL BOATS	INCREASE
1966	112,526	
1967	116,512	3.986
1968	119,387	2,875
1969	120,180	793
1970	107,403	-12,777
1971	108,397	994

TABLE E13-2
CLASS A (16') and CLASS I (16' to 26') CRAFT IN NEW JERSEY

YEAR	TOTAL BOATS	INCREASE
1963	95,726	19,496
1964	106,757	11,031
1965	120,090	13,333

QUESTION

E14 State the dominant species of finfish caught in the canal by seasons.

RESPONSE

The dominant species of finfish caught in the discharge canal are blow fish, weakfish, striped bass, and eel in the spring and fall. Blue fish are caught during the summer months with flounder and white perch being taken year round.

The following Table E14-1 lists the finfish that are found both in Oyster Creek and Forked River at various times of the year.

REFERENCES

1. Allen, Mr., Assistant Manager, Forked River Marina, Forked River, New Jersey, Personal communication, Ph. 609-693-5044.

2. Marcellus, K. L., "Fishes of Barnegat Bay, New Jersey, with Particular Emphasis to Seasonal Influences and the Possible Effects of Thermal Discharges", Agriculture Library, College of Agriculture and Environmental Science, Rutgers University, May 1972.

3. Various fishermen surveyed at Highway 9 and canal area.

4. Verdier, J., Park Superintendent, Island Beach State Park, New Jersey. Personal communication, Ph. 201-793-0506.

TABLE E14-1

FIN FISH FOUND IN OYSTER CREEK AND FORKED RIVER

Common Name	Scientific Name
Tidewater silverside	*Menidia beryllina* (Cope)
Atlantic silverside	*Menidia menidia* (Linnaeus)
Bay anchovy	*Anchoa mitchilli* (Valenciennes)
Silver perch	*Bairdiella chrysura* (Lacepede)
Northern kinfish	*Menticirrhus saxatilis* (Bloch & Schneider)
Weakfish	*Cynoscion regalis* (Bloch & Schneider)
Fourspine stickleback	*Apeltes quadracus* (Mitchill)
Threespine stickleback	*Gasterosteus aculeatus* Linnaeus
Northern puffer	*Sphoeroides maculatus* (Bloch & Schneider)
Winter flounder	*Pseudopleuronectes americanus* (Walbaum)
Summer flounder	*Paralichthys dentatus* (Linnaeus)
Blueback herring	*Alosa aestivalis* (Mitchell)
Alewife	*Alosa pseudoharengus* (Wilson)
Atlantic menhaden	*Brevoortia tyrannus* (Latrobe)
Atlantic herring	*Clupea harengus harengus* Linnaeus
Northern pipefish	*Syngnathus fuscus* Storer
Sheepshead minnow	*Cyprinodon variegatus* Lacepede
Banded killifish	*Fundulus diaphanus* (Lesueur)
Mummichog	*Fundulus heteroclitus* (Linnaeus)
Rainwater killifish	*Lucania parva* (Baird)
American eel	*Anguilla rostrata* (Lesueur)
Atlantic needlefish	*Strongylura marina* (Walbaum)
Bluefish	*Pomatomus saltatrix* (Linnaeus)
Crevalle jack	*Caranx hippos* (Linnaeus)
White perch	*Morone americana* (Gmelin)
Oyster toadfish	*Opsanus tau* (Linnaeus)
Naked goby	*Gobiosoma bosci* (Lacepede)
White mullet	*Mugil curema* Valenciennes
Pinfish	*Lagodon rhomboides* (Linnaeus)

QUESTION

F1 Provide an estimate of the cost differential between mine-mouth coal price and coal price at the Oyster Creek site for 1977.

RESPONSE

Bituminous coal in volume suitable to meet the New Jersey sulphur regulation of 1% maximum would have to orginate in southern West Virginia or Virginia. The largest coal company in that area can supply 13,000 Btu/lb (as received) and under 1% sulphur coal. The present price of this product is $8.01 per ton FOB mine. This price is estimated to escalate to $12.00 per ton in 1977.

At present there are no trainload rates to Oyster Creek from these mines in southern West Virginia or Virginia. The average distance from these mines to Waretown, N. J. (about 2 miles south of Oyster Creek) is 763 miles. Based on present single car and trainload rates to New Jersey points and escalating some 6% per year would create an estimated freight rate of $9.23 per ton in 1977 on trainload movements to Oyster Creek.

Combining estimated product cost and freight rate would result in a delivered cost in 1977 of $21.23 per ton or $0.816 per million Btu.

QUESTION

F2 Provide the forecasted escalation factors on the total investment cost, annual operating cost and fuel costs for nuclear, coal, oil, and combined cycle installations for the 1970's.

RESPONSE

Table F2-1 lists the costs and escalation factors requested by this question. Investment costs used in Section 8.0 of the Oyster Creek Environmental Report were generally based on engineering consultants' budget estimates for actual generating additions scheduled for completion in the mid-70's. Hence the escalation factors apply only to the period between those dates and 1980 for the nuclear replacement, or 1977 for all other plants. The consultants' estimates themselves include allowances for escalation up to the plant completion date. They are in principle of the same order of magnitude as shown on the tabulation but have been matched to the actual labor and material items in the estimates and to the timing of the expenditures.

Specifically, investment estimates have been based on the following:

Nuclear Replacement	Forked River 1120 MW unit (1978)
Coal Base Load	Homer City Unit No. 3 600 MW (1976)
Oil Base Load	Union Beach Units No. 1 and 2 400 MW each (1976)
Combined Cycle	Gilbert Station Combined Cycle Unit 351 MW (1974)

TABLE F2-1

ESCALATION FACTORS

	Investment: Starting Base $/kw	Investment: Annual Escalation	Investment: Escalated Base $/kw	Annual Operating: Starting Base $/kw/yr (7000 hr/yr.)	Annual Operating: Annual Escalation	Annual Operating: Escalated Base $/kw/yr (7000 hr/yr)	Fuel: Starting Base ¢/10^6 Btu	Fuel: Annual Escalation	Fuel: Escalated Base ¢/10^6 Btu
Oyster Creek									
Plant	145 -Actual			3.40 -72	5%	5.04 -80	1.30 -71 (mills/kwh)	2% after 1977	1.35 -80 (mills/kwh)
Fuel Inventory	43 -80 (a)				Insurance	1.00			
Total	188	-	188 -80			6.04 -80			
Nuclear Replacement									
Plant	444 -78	5%	486 -80	4.60 -78 (c)	5%	5.07 -80	1.30 -71 (mills/kwh)	2% after 1977	1.35 -80 (mills/kwh
Fuel Inventory	28 -78 (b)	5%	31 -80						
Total	472		517 -80						
Coal Base Load									
Plant]	250 -76	5%	262 -77	3.55 -74	5%	4.15 -77	40 -74	5%	46 -77
SO_2 Removal	40 -74	5%	46 -77						
Transmission	50 -76	5%	53 -77						
Total	340		361 -77						
Oil Base Load									
Plant Total	235 -76	5%	247 -77	2.90 -74	5%	3.40 -77	67.7 -71	5%	90.7 -77
Combined Cycle									
Plant Total	169 -74	5 1/2%	198 -77	4.85 -71	5%	6.60 -77	67.7 -71	5%	90.7 -77 +3.0

NOTE: Figures above are referenced to the year of applicability by the two digits following the hyphen. For Example, 1980 is -80.

(a) Estimated replacement cost of 3rd core.

(b) Estimated cost for Forked River Nuclear Plant, adjusted upward for slight decrease in nameplate rating.

(c) Reflects advantage of increased reactor rating compared with Oyster Creek. Nuclear insurance included.

QUESTION

F3 State the return on capital desired from capital investments.

RESPONSE

The question as to return must be related to a time period, since this element of cost has changed as much as or more than some other costs.

The return on investment, as used in the 1964 "Report on Economic Analysis for Oyster Creek . . . " (Appendix B of Environmental Report), was shown at page 24 to be as follows:

Debt Capital - 63% at 4.25%	Interest Rate	2.6755%
Equity Capital - 37% at 10%	Earnings Rate	3.7000
	Total Return	6.3775%

The currently expected return on new investment, as used in the Environmental Report for both present and future conditions, is as follows:

Debt	60% at 8%	4.8%
Preferred stock, 10% at 8.5%)	Equity,	
Common equity, 30% at 14.5%)	40% at 13%	5.2
		10.0%

Note that the 10% derived above is not the return that would be claimed, or is likely to be allowed in a rate case, when consideration is given primarily to imbedded interest costs (at lower average rates), rather than to the cost of incremental capital.

The above derivation of the 10% return is the basis for the discount rate, which is the subject of Question F~~6~~4. It is also the basis of the fixed charge rates used on pages 8.2-16 and 8.2-18 of the Environmental Report which are:

Nuclear plant	13.5%
Coal and oil, base load	13.25
Combined cycle	13.0

The different rates result from the composition of the investment in each case, particularly the interest during construction (IDC) included in each estimate of cost. Because of the long construction period, IDC is highest for the nuclear plant; and because of the short construction period, it is least for the combined cycle plant. IDC is part of the depreciable cost for ordinary accounting purposes, but it is not depreciable for tax purposes. Therefore, the higher IDC results in relatively higher income taxes for the nuclear plant.

The above rates are the levelized charges over the estimated life (30 years) of each plant. Lives may vary from 30 years, but the fixed charge rate is not sensitive to a reasonable change in estimated life, because changes in levelized return and depreciation are offset by changes in taxes. The levelized charges, as they would be applied to the original cost of plant, are composed of the following elements for the combined cycle plant:

Levelized 10% return	7.3%
Straight line depreciation (30 years)	3.3
Balance - net of taxes and effect of 4% Investment Tax Credit	2.4
	13.0%

QUESTION

F4 Document the discount rate of 10% used in the benefit-cost analysis section of the ER.

RESPONSE

The discount rate is the currently expected return on new investment, as derived in the response to Question F3.

QUESTION

F5 Discuss the economic value of site land for subdivision similar to nearby subdivisions along the Bay and Forked River.

RESPONSE

Ranges of values for Ocean County are as follows based on information supplied by experienced real estate brokers:

Forest	-	$200 to $2,700 per Acre
Farm	-	$500 to 2,500 per Acre
Industrial	-	$1000 to 10,000 per Acre
Residential		$1000 to 40,000 per Acre

The residential range high results from using an incompatable unit (acre) for individual lot sales; i.e., 1/8 acre lot @ $5,000. Jersey Central experience in transmission right of way acquisitions in the above categories are as follows:

Forest	-	$550 to $1,500 per Acre
Farm	-	1,100 to 1,400 per Acre
Residential	-	1,100 to 2,300 per Acre
Industrial	-	1,800 to 3,000 per Acre

QUESTION

F6 Provide reference used to obtain the 8.1 ¢/lb value for fish.

RESPONSE

The reference for the price per pound of fish, as stated in paragraph 3 on page 11.3-2 of the Oyster Creek ER, is from NOAA NMFS CFS - 5900, "Fisheries of the United States, 1971, Current Fishery Statistics number 5900," U. S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Page 12, under total fish for 1970, as follows:

$$\frac{\$\ 326{,}689{,}000}{4{,}006{,}682{,}000 \text{ lbs.}} = 0.0815 \text{ or } 8.1\ \text{¢/lb}$$

QUESTION

F7 State the dollar value for a recreational man-day if the State of New Jersey has identified such a figure.

RESPONSE

As of September 26, 1972, the State of New Jersey has not computed any value for a recreational man day.

REFERENCE

Personal communication, Mr. Thomas Haigh of the New Jersey Department of Parks, Trenton, New Jersey.

QUESTION

F8 Explain the $80/kw figure shown on page 8.3-7.

RESPONSE

On page 8.3-7, a computation is made of the cost of supplying 7000 kw of additional station service, resulting from cooling tower operation. As presented here, the cost is determined separately for the reduction in plant net capacity and for the reduction in net energy generation. This presentation leads to duplicate counting of the energy cost.

The $80/kw amount (should be $80/kw/year) is intended to be the approximate total cost of both capacity and energy, based on 1 kw of capacity with 7000 hours of operation to produce 7000 kwh. Such costs can be found on several earlier pages of the report:

p. 8.2-16	new nuclear unit (1980)	$84.25/kw/year
p. 8.2-18	mine-mouth coal unit (1977)	82.10
	oil base-load unit (1977)	94.55
	combined cycle unit (1977)	93.95

In addition, such costs as these can be derived from the interchange cost data for 1971 that are shown on page 8.2-6. (In this connection, see the response to Question F18 for the explanation of capacity costs.) These interchange data provide the basis for the following:

energy (7000 kwh/kw at 9 mills)	=	$63/kw/year
operating capacity		15
installed capacity		12.48
total		$90/kw/year

All of the above point to a cost slightly in excess of $80 per year for 1 kw and the associated 7000 kwh of energy generation. It is not necessary to give much weight to the approximate $94 cost shown for the oil and combined cycle units, for neither is likely to be operated at as high a use factor as 7000 hours per year (80%). Also, it is likely that the marginal cost of interchange capacity and energy in future years may be somewhat less than in 1971, when energy costs reflected an existing shortage of generating capacity.

Since the $80/kw/year represents the full cost of supplying 1 kw of capacity and 7000 kwh of energy, there is no reason to make an additional charge for energy generation (as done on page 8.3-7) at a rate of 5 mills/kwh. The pages in Chapters 8 and 11 where this has occurred will be revised and submitted in Amendment 3 to the ER.

QUESTION

F9 Provide actual values or projections for the operating capacity, reserve margins, and peak loads for JC, GPU and PJM for the period 1966-1980.

RESPONSE

The requested actual values and forecasts are shown in Tables F9-1, F9-2, F9-3, and F9-4, but with respect to this response it is necessary to make the following observations:

1. Installed capacity has been reported rather than operating capacity. For an explanation of the difference and why it is more appropriate to report installed capacity, see the response to Question F18.

2. The response has been limited to summer peak loads and to capacity and reserves at that time, since summer peaks are the usual basis for capacity planning in PJM.

3. The response is based on load and capacity forecasts (for 1973 and subsequent years) available at the time of preparation of the Oyster Creek Environmental Report. Although revisions in these load forecasts are anticipated and there have been known delays in the completion of some new units, revised data are not available on any more recent basis. It is unlikely that the revision will materially change the forecast reserve margins, since capacity installations will be rescheduled as required.

4. Data are shown for the combined JC and NJ companies (New Jersey Power & Light Company), because JC has, since sometime prior to 1966, been installing the generating capacity required by N.J.; and an early merger of JC and NJ is anticipated. For this reason, data for JC alone would not be significant and its large planned reserves would be misleading.

TABLE F9-1

OYSTER CREEK
ENVIRONMENTAL REPORT
JC LOAD-CAPACITY-RESERVE

Year	Summer Peak Load	Installed Capacity (Summer Rating)	Reserves MW	Reserves %
1966	864	646	-218	-25.2
1967	906	610	-296	-32.7
1968	1124	760	-364	-32.4
1969	1240	912	-328	-26.4
1970	1316	1554	238	18.1
1971	1452	1745	293	20.2
1972	1643	2123	480	29.2
1973	1850	2367	517	27.9
1974	2080	2641	561	27.0
1975	2325	2861	536	23.1
1976	2600	3261	661	25.4
1977	2907	3836	929	32.0
1978	3250	4906	1656	51.0
1979	3633	5222	1589	43.7
1980	4062	5677	1615	39.8

TABLE F9-2

OYSTER CREEK
ENVIRONMENTAL REPORT
JC/NJ LOAD-CAPACITY-RESERVE

Year	Summer Peak Load	Installed Capacity (Summer Rating)	Reserves	
			MW	%
1966	1125	770	-355	-31.6
1967	1190	734	-456	-38.3
1968	1455	884	-571	-39.2
1969	1604	1036	-568	-35.4
1970	1727	1701	-26	-1.5
1971	1880	1892	12	0.6
1972	2144	2270	126	5.9
1973	2398	2514	116	4.8
1974	2680	2788	108	4.0
1975	2969	3201	232	7.8
1976	3306	3408	102	3.1
1977	3682	3983	301	8.2
1978	4101	5053	952	23.2
1979	4567	5369	802	17.6
1980	5087	5824	737	14.5

TABLE F9-3

OYSTER CREEK
ENVIRONMENTAL REPORT
GPU LOAD-CAPACITY-RESERVE

Year	Summer Peak Load	Installed Capacity (Summer Rating)	Reserves MW	Reserves %
1966	2921	3111	190	6.5
1967	3061	2791	-270	-8.8
1968	3540	2973	-567	-16.0
1969	3868	3125	-743	-19.2
1970	4113	4440	327	8.0
1971	4355	5008	653	15.0
1972	4934	5546	612	12.5
1973	5379	6228	849	15.8
1974	5863	7093	1230	21.0
1975	6377	8168	1791	28.1
1976	6954	8503	1549	22.3
1977	7583	9056	1473	19.4
1978	8269	10126	1857	22.5
1979	9022	10642	1620	18.0
1980	9851	11737	1886	19.1

TABLE F9-4

OYSTER CREEK
ENVIRONMENTAL REPORT
PJM LOAD-CAPACITY-RESERVE

Year	Summer Peak Load	Installed Capacity (Summer Rating)	Reserves MW	Reserves %
1966	17852	19050	1198	6.7
1967	18355	20447	2092	11.4
1968	21206	22761	1555	7.3
1969	23988	25057	1069	4.5
1970	23838	28012	4174	17.5
1971	25529	31094	5565	21.8
1972	28860	34589	5729	19.9
1973	31380	38272	6892	22.0
1974	34110	42494	8384	24.6
1975	37085	48512	11427	30.8
1976	40280	51105	10825	26.9
1977	43605	55723	12118	27.8
1978	47225	59127	11902	25.2
1979	50905	65805	14900	29.3
1980	54940	70400	15460	28.1

QUESTION

F10 State the amount of U-235 expected to be consumed over the 30 years of operation of the Oyster Creek reactor.

RESPONSE

It is estimated that the Oyster Creek reactor, in the first 30 years of operation, will consume on the order of 11.5 metric tons of U-235. This value is an upper limit since a number of factors unaccounted for in the estimate would tend to reduce the U-235 requirements; e.g., plant capacity factor reduction with age, impact of plutonium recycle and improved fuel design.

QUESTION

F11 Describe in greater detail the increased use of older units (ER Section 8.2.3). Identify in the discussion any units which have been removed from service as a result of Oyster Creek operation. State whether the data given in the table on page 8.2-5 are representative of the discharges of the removed units. State the cost of operating the older units, in the event the table on page 8.2-6 is not directly applicable.

RESPONSE

As noted in the Environmental Report (p. 8.2-4) the unavailability of Oyster Creek would be reflected in increased generation of older and less efficient units in the whole of PJM. In fact, the effect would extend beyond PJM, resulting in decreased sales to or increased purchases from other power supply areas. The data furnished on pages 8.2-5 and 8.2-6 result from a PJM study that involved all of the PJM units, and the results were applicable to delay in operation, or unavailability of any nuclear unit planned for operation in PJM.

When Oyster Creek (or other nuclear unit) operates, it does so at full output due to its favorably low incremental fuel and maintenance cost. Because it is thus base loaded and has first preference in satisfying load requirements, many other generating units in PJM are then called upon for slightly lesser output and somewhat shorter operating times than if Oyster Creek were shut down. Marginal operating units are the ones which feel the effect of removal of a base load unit from service and they are mostly the less efficient, higher cost units in a system. All such units in PJM are so affected, and none can be isolated as bearing the sole impact of the removal. The added costs shown on page 8.2-6 for operation of older units, upon the assumed suspension of Oyster Creek, were measured as the difference in total PJM production costs with and without specified nuclear capacity.

The data on page 8.2-5 are typical of the units which would in the aggregate run for longer periods if operation of Oyster Creek were suspended, and the costs on page 8.2-6 are the resulting aggregate additional costs to GPU of its production and of its interchange purchases. In the computer printouts from which these results were derived, as averages of computations for several future years, costs are shown for individual units or groups of units. However, because there are now more than 500 generating units in PJM, with a total capacity of about 34,000 MW, it is impractical to detail the costs by units.

No existing older unit has been removed from service as a result of Oyster Creek operation. Older units in the GPU system are generally retired from service for reasons associated with their age, and high operating cost or need for expensive repairs. Retirements necessitate equivalent replacement capacity; capacity additions are not of themselves the occasion for retirements.

Table F11-1 shows the characteristics of the marginal units in the GPU System, the operation of which would be affected by the unavailability of Oyster Creek. These are typical of the much larger number of similar units in the whole of PJM. Not included are the GPU plants that are normally base loaded and thus not affected by Oyster Creek operation.

TABLE F11-1

SIZE, AGE AND OTHER CHARACTERISTICS OF GPU MARGINAL GENERATING CAPACITY

	Plant Name	Sayreville	Werner	Gilbert	Portland	Titus	Eyler
	Number of Turbo Generator Units	5	3	3	2	3	3
	Installed Capacity (MW)	343.8	116.2	126.1	426.7	225.0	84.0
	Years of Installation	1930-58	1930-53	1930-49	1958-62	1951-53	1919-41
	Fuel	oil	oil	oil	coal	coal	oil
	1971 Avg. Use Factor %	70.09	53.84	71.84	69.36	72.75	13.14
	Avg. Heat Rate btu/kwh	11,016	12,461	12,320	9,749	10,384	19,670
	Avg. 1971 Fuel Cost ¢/10[6] btu	61.84	64.69	62.84	55.27	52.79	65.35
Avg.	Fuel mills/kwh	6.81	8.06	7.74	5.39	5.48	12.86
Energy	Other O&M " "	1.26	3.52	1.54	0.95	2.27	11.28
Cost	Total Prod. " "	8.07	11.58	9.28	6.34	7.75	24.14

	Plant Name	Crawford	Saxton	Williamsburg	Warren	Front St	Diesels	Combustion Turbines
	Number of Turbo Generator Units	4	2	2	2	5	16	23
	Installed Capacity (MW)	116.7	39.1	30.0	81.2	118.8	38.0	470.4
	Years of Installation	1924-47	1923-26	1916-44	1948-49	1917-53	1960-70	1967-71
	Fuel	coal/oil	coal	coal	coal	coal	oil	oil
	1971 Avg. Use Factor %	27.16	16.01	67.78	74.64	51.54	4.32	19.17
	Avg. Heat Rate btu/kwh	16,357	28,638	14,349	13,458	12,504	10,650	14,847
	Avg. 1971 Fuel Cost ¢/10[6] btu	61.63	42.12	33.64	33.31	45.58	100.64	71.21
Avg.	Fuel mills/kwh	10.08	12.06	4.83	4.48	5.70	10.72	10.57
Energy	Other O&M " "	5.15	14.54	4.91	1.69	2.83	10.85	0.93
Cost	Total Prod. " "	15.23	26.60	9.74	6.17	8.53	21.57	11.50

QUESTION

F12 Discuss briefly the scientific benefits associated with the plant's on-going environmental monitoring and environmental impact studies.

RESPONSE

The extensive study of the Barnegat Bay environment being conducted by a team of Rutgers University professors and graduate students has added significantly to the wealth of biological knowledge of estuarine marine life. The results of all of these studies have been published and are available to the public. The information contained in the ER has added enormously to the knowledge of the effects of power plant operation on the environment, since few environmental reports have been written with the benefit of years of environmental as well as operational data together with the studies necessary to link the two.

Specific research, supported by Jersey Central has also resulted in several published papers and presentations at scientific meetings.

Furthermore, much of the collected data has been unique. As an example, the study presently underway to determine the migratory habits of the Atlantic menhaden is the first study of its kind.

The data collected in all of the on-going environmental impact studies is available to the engineering and scientific communities for use and study.

QUESTION

F13 State any observed correlation between fishing pressure and the observed coolant discharge temperature.

RESPONSE

Operation of the Oyster Creek Station has resulted in an increase in the temperature in the discharge canal. This warmer water has been beneficial to anglers by serving as an attractant for both fish and crabs. Indeed, there is fishing all year round. However, the Oyster Creek Station personnel indicate that no direct correlation has been made between the observed number of people fishing and the coolant discharge temperature.

A review of the seasonal discharge canal temperatures taken at the Highway 9 bridge shows that the temperature reaches a low during the months of December through February of 52 to 46°F. The highest water temperatures are found during the months of July and August.

There is active sport fishing at both Highway 9 bridges and the adjacent canal banks during most of the year with January and February being the slack months. During the spring, summer, and fall, the average population of fishermen (women) during week days number approximately 5 at the Forked River Bridge and 20 to 25 at the Oyster Creek Bridge. During weekends and holidays 20 people can be found at the Forked River Bridge and between 50 to 75 at the Oyster Creek Bridge.

QUESTION

F14 As a result of plant construction, state the amount of salt water swamp land covered with spoil, the amount of fresh water swamp land drained or covered with spoil, the amount of land cleared of trees and the amount of land inextricably committed to power production for the life of the plant and for the plant when decommissioned.

RESPONSE

A complete description of all the spoil areas used during plant construction and the land areas cleared are discussed in the response to Question E4. Tabulated below are the amount of spoil area, cleared lands and lands committed to power production.

Area	Amount of Land (acres)
salt water swamp covered with spoil	41.2
fresh water swamp drained or covered with spoil	80
cleared of trees	176.7
committed to power production	48
land use after plant is decommissioned	13.7

QUESTION

F15 Provide information justifying the use of 41.67 acres identified on page [11.2-24] of the ER. What are the probable number of days this average acreage will be above 87°F? Provide information used as a basis for those estimates.

RESPONSE

The average for lost or displaced habitat was based on 1964 records of water temperatures exceeding 86°F in Barnegat Bay. This data is found in Section 5.1.2 of the ER and set forth in an agreement between Jersey Central Power and Light Co. and the State of New Jersey, Department of Public Utilities Board of Public Utility Commissioners in the Stipulation -- DCED, Docket No. 652-60. The agreement was:

"(b) Agreed that the Company is willing to provide for a 2,749 cfs dilution cooling water system and that (i) according to an estimate of the Company which the State is not in a position to confirm, the Company can provide such cooling water system utilizing dilution methods of cooling the heated discharge from its generating plant condensers at a cost of approximately $1,640,000, which system when operated at full capacity would permit temperatures in portions of the 41,000 acre Barnegat Bay to exceed 86°F based upon 1964 records, being the year of record with the highest recorded water temperatures, as follows: 40+ days per year over one acre, on 29+ of those days over 50 acres, on 25+ of those days over 100 acres, on 18+ of those days over 200 acres, on 11+ of those days over 200 acres, those days 600 acres, and on 1+ of those areas where the temperature would exceed 86°F during some portion of the year, the maximum temperature at any point, at any time, would not exceed 95°F."

The lost or displaced habitat is calculated as follows:

Days/Year		Acres		Acres/Day
40/365	X	1	=	.11
29/365	X	50	=	3.97
25/365	X	100	=	6.84
18/365	X	200	=	9.86
11/365	X	400	=	12.04
2/365	X	600	=	3.24
1/365	X	1000	=	2.70
		Total Acres per day		38.76

The probable number of days this acreage would be above 87°F would be approximately 126.

The calculated 38.76 acres average daily lost habitat does not imply a net loss of aquatic biota in Barnegat Bay but indicates the existence of a temperature regime that would probably be avoided by most fish. The displaced fish could move into lateral waters adjacent to the plume or into deeper water beneath the plume presumably without reducing the overall productivity of the biota. The loss of primary productivity in a limited region of the plume has already been discussed in the Benefit-Cost analysis and an estimate of the probable annual fish loss was made (page 11.2-17,-20).

QUESTION

F16 Provide the costs associated with canal maintenance. Include the costs associated with dredging and spoil removal to an onsite or offsite location. Provide current estimates of the number of cubic yards of spoil that will have to be handled during the 30 years of plant operation and the reduction that may be expected by bulkheading. Provide the cost of lining or of bulkheading the entire canal.

RESPONSE

Based on soundings taken in the intake and discharge canals, it has been determined that these canals are silting at an average rate of 42,000 cubic yards per year. The cost of dredging this amount of material is estimated to be $2.44/cubic yard or $102,480 per year, without escalation. Over a period of 30 years, this amount of silting would require disposal of 1.3 million cubic yards of material. There is sufficient land on the site to dispose of this, in fact, Disposal Area #9 alone could handle this quantity of spoils (Refer to Figure E4-1).

It is not possible to estimate the cost of disposing of these spoils offsite. The spoils would have to be deposited on Jersey Central land first and allowed to drain before being loaded onto trucks and hauled away for ultimate disposal. There are no known disposal areas in the vicinity of the station that could handle these spoils.

The cost of stabilizing the banks of the intake and discharge canals west of Route 9 by bulkheading and placement of rip rap in a similar manner as the dilution pump structure (See Figure A8-2) is as follows:

Cost of Timber Bulkhead	$451,500
Cost of Earth work to Repair Slopes	73,000
Cost of Rip Rap for Slope Protection	70,000
Total	$594,500

It has been conservatively estimated that bulkheading reduces the yearly silting rate by 75%. Thus, the cost for yearly canal maintenance would be $25,620 without escalation.

QUESTION

F17 Describe the additional costs associated with running dilution pumps continually. Discussion should include costs attribritable to increased rate of silting, higher rate of condenser tube replacement, loss of electrical capacity, inlet canal modification to allow some settling of entrained silt, and froth abatement.

RESPONSE

Refer to the responses to Questions A2 and F16.

QUESTION

F18 Explain the meaning of the terms, operating capacity and installed capacity, as used in the table on page 8.2-6 of the ER.

RESPONSE

The separate pricing of energy, operating capacity and installed capacity in the determination of the cost of replacement power is a practice that may be peculiar to PJM and perhaps a few other power supply areas. The distinction between the two types of capacity is particularly important, in view of possible misunderstanding of the terms, as evidenced by Question F9. This distinction, as related to an amount of capacity, is first explained, followed by an explanation of the costs associated with each type of capacity.

Installed capacity is an amount of capacity equal to the total generating capability of a utility system (usually including purchased capacity as well as owned capacity) as determined under some specified conditions. The specified conditions are necessary because capability often varies with temperature and possible other variable conditions, such as head and water availability for hydro units. In the PMJ area, installed capacity is usually rated for planning purposes in terms of capability expected at the time of summer peak loads, which are usually also the annual peak loads for the whole of PJM. Because of summer temperatures, this installed capacity rating is less than the capability available at other times during the year. Nevertheless, the amount of installed capacity remains constant until there is an addition or retirement of a generating plant or unit or until there is some other physical change in what the plants or units can produce under summer conditions.

Operating capacity is an amount of capacity equal to the actual capability of the plants and units that are being (or are to be) operated at a given time. It is therefore a variable quantity, changing from day to day and even within the day. It varies with the scheduled operation of various units, as determined by economy, reliability, environmental restraints, and forced or scheduled outages. Also the capability of individual units varies seasonally, as noted above, and because of outages of various components of a unit (such as fans or pumps). Operating capacity often is permitted to include "quick-start" capacity, which may be idle but ready to run on short notice. Operating capacity in amount is that capacity which is required for production of system energy plus an additional "spinning reserve," which protects against either unexpected changes in load or forced outages of equipment and provides the necessary margin for system regulation (tie line loads and frequency).

The costs of installed and operating capacity result from obligations existing among the members of the GPU System and among the members of PJM. There are requirements that certain amounts of installed capacity be made available as reserves, in excess of both annual and weekly peak loads. There are also requirements that certain amounts of operating capacity be made available as spinning reserve in excess of expected loads during three periods of each weekday and during two periods of Saturday and of Sunday. If a utility is not able to meet these reserve requirements from its own resources, it is required to purchase capacity from others, who are able to supply it.

The rate for installed capacity is presently fixed by the PJM contract at $0.24 per KW per week.

The rate for operating capacity is not fixed, since this is part of the daily PJM interchange of both energy and operating capacity. This interchange involves both economy and emergency transactions. In economy transactions, where there is a savings represented by the difference between the supplier's cost and the purchaser's replacement value, the price is established to divide the savings equally. In emergency transactions, the price is the supplier's cost plus 10%. The costs involved in operating capacity transactions are fuel and incremental maintenance costs of making the unit ready for operation, but not including any energy generation, or of maintaining it in an operating state when it is not needed for energy production. Such costs are sometimes called "peak-prepared-for" costs. The costs shown on page 8.2-6 for operating capacity are based on actual 1971 PJM experience.

In many power supply areas, no separation is made between energy and operating capacity costs, since both represent costs of fuel and incremental maintenance for the units that are in operation. In PJM, however, it has been the practice to separate these costs for purposes of interchange pricing. Consequently, energy costs in PJM usually involve only the incremental costs of loading a unit, after it is in an operating state. The variable costs of putting it in that state or of maintaining it ready for energy production are the operating capacity costs.

Estimates are made of installed capacity for years in advance, in order that sufficient capacity be installed to meet expected peak loads. Estimates of operating capacity are made only from day to day as required for current operating purposes.

QUESTION

F19 Based upon 1972 dollars, state the decommissioning cost and the annual cost to maintain the decommissioned plant in a safe condition.

RESPONSE

At the time of its retirement, it is anticipated that the Oyster Creek Station will have other nuclear power plant(s) on the site. Under this consideration it is assumed that the Oyster Creek operating license will be changed to a "possession only" license. Using this assumption, a minimum cost plan to retire Oyster Creek is described in Table F19-1.

Table F19-2 presents a plan which is felt to approximate the maximum cost for retirement of Oyster Creek, based on the assumption of on-site burial of radioactive materials.

It is felt that the two plans presented reflect the lower and upper limits of cost and effort involved in the future retirement of the Oyster Creek Nuclear Power Plant. It is recognized that various plans lie between the two presented. The reason for considering only upper and lower limits at this time is that the exact plan to retire Oyster Creek will depend on AEC regulations in force at the time of its retirement.

TABLE F19-1

MINIMUM COST PLAN

PHASE I

		COST
1.	Remove all spent fuel from the reactor vessel, place the elements in a suitable transfer cask for shipment from site (560 elements).	
	560 elements ÷ 10 elements per shpmt. x $18,000 per shpmt.	1,008,000
2.	Remove all new fuel from new fuel storage vault and ship from site (185 elements 1/3 core).	
	185 elements ÷ 40 elements/shpmt. x $11,000	50,875
3.	Remove the control rods from the reactor vessel, place in suitable shipping cask and ship from the site	
	137 elements x 3 cu ft/element x $1,500 cu. ft. for ver high level waste.	615,500
4.	Perform an initial, plant wide, radiation survey to provide a base line for decision making on decontamination and/or removal of equipment and piping systems.	1,000
5.	Prepare the reactor vessel to receive the internals and reinstall the reactor internals and reactor vessel head. The vessel will serve as a permanent storage location for these internals.	5,000

TABLE F19-1 Cont'd.

PHASE II

		COST
1.	Decontaminate the Reactor Building and all piping systems and components outside of the drywell.	$ 350,000
2.	Decontaminate the Drywell and all piping systems and components contained therein.	500,000
3.	Decontaminate the Turbine Building, piping system and components contained therein.	1,000,000
4.	Decontaminate the Radiation Waste Disposal Building, piping systems and components contained therein.	250,000
5.	Decontaminate the gaseous effluent stack.	300,000
6.	Ship radioactive solid materials, exclusive of that material to be stored in the drywell, for burial. Costs range from $2/cu ft for low level to $500/cu ft for waste in the 5R to 20R/hr range.	150,000
7.	Ship radioactive liquids which include decontamination solution and residual liquids in the rad waste facility for burial. 450,000 gallons at $.60/gallon.	270,000

PHASE III

1.	Remove and transport all radioactive piping and components which exceed 10CFR20 limits to the drywell for storage	125,000
2.	Permanently seal the drywell entrance	2,000
3.	Completely fence the station	5,000
4.	Perform final radiation survey	1,000

TABLE F19-1 Cont'd.
PHASE IV

1.	Prepare necessary Amendments to the facility license to provide for ownership and possession but not operation of the reactor.	1,000
2.	Prepare an application for a by-product materials license to be effective upon termination of the facility license	1,000
3.	The Oyster Creek Nuclear Unit No. 1 is located on the same site as the future Forked River Unit No. 1 plant and will remain under Jersey Central surveillance.	
	TOTAL COST	4,635,375

TABLE F19-2

MAXIMUM COST PLAN

PHASE I

		COST
1.	Remove all used fuel from the reactor vessel, place it in suitable shipping containers and ship from the site.	
	560 elements ÷ 10 elements/shipment x $18,000	1,008,000
2.	Remove all new fuel from the new fuel storage vault place in suitable shipping containers and ship from the site.	
	185 elements ÷ 40 elements/shipment x $11,000	50,875
3.	Remove control rods from the reactor vessel, place in a suitable shipping container and ship from the site.	
	(137 rods x 3 cu ft/rod x $1,500/cu.ft on very high radioactivity level waste)	615,500
4.	Remove reactor internals from the reactor vessel, section and place in a suitable shipping container for shipment from the site. (Must be shipped as high level rad waste).	1,000,000

PHASE II

1.	Decontaminate the reactor building, piping systems, and components outside of the drywell.	350,000
2.	Remove, section and ship all piping and components in the reactor building that cannot be decontaminated to 10CFR20 levels.	250,000
3.	Decontaminate the drywell, piping systems and components contained therin.	500,000
4.	Remove, section and ship all piping and components contained in the drywell that cannot be decontaminated to 10CFR20 limits.	1,000,000
5.	Decontaminate the turbine building, piping systems and components contained therein.	1,000,000

TABLE F19-2 Cont'd.

6.	Remove, section and ship all piping and components contained in the turbine building that cannot be decontaminated to 10CFR20 limits.	$ 250,000
7.	Decontaminate the rad waste disposal building, piping systems and components contained therein.	250,000
8.	Remove, section and ship all piping and components contained in the rad waste building that cannot be decontaminated to 10CFR20 limits.	100,000
9.	Decontaminate the gaseous effluent stack.	300,000
10.	Prepare the operating floor level of the reactor building for sectioning the reactor vessel and vessel head for ultimate disposal.	25,000
11.	Section and dispose of reactor vessel and head	5,000,000
12.	Shipment of remainder of solid rad waste for ultimate burial.	200,000
13.	Shipment of all radioactive fluids which include decontamination solutions and residual rad waste liquids for burial.	400,000
14.	Salvage of the turbine, components and piping in the turbine building.	-150,000

PHASE III

Demolition of structures and leveling to grade (EL. +23' MSL)

1.	Reactor building 26,485 cu yd. of concrete above grade to be disposed of.	
	(26,485 cu yd x $250/cu yd)	6,621,250
2.	Turbine building is estimated to contain 50% of its concrete below grade which yields 21,500 cu yd to be disposed of.	
	(21,500 cu yd x $250/cu yd.)	5,375,000
3.	Rad waste building is estimated to contain 40% of its concrete below grade which yields 3300 cu yd to be disposed of.	
	(3300 cu yd x $250/cu yd)	825,000
4.	Gaseous effluent stack contains 970 cu yd.	
	(970 cu yd x $250/cu yd.)	242,500

TABLE F19-2 Cont'd.

PHASE IV

1.	Prepare necessary amendment to the facility license to reflect the decommissioning of the plant.	$ 1,000
2.	Perform final radiation survey of the site.	1,000
	TOTAL COST	$25,215,125

QUESTION

F20 Provide estimates of any adverse environmental impacts from increasing the loads over transmission pathways beyond Manitou, attributable to Oyster Creek operation.

RESPONSE

The environmental impacts associated with loads on transmission lines, such as radio interference and corona discharges, are voltage dependent. The voltage carried by the transmission lines is not changed by the addition of the Oyster Creek Station; hence, these effects are not increased. Cable heating is a function of current flow, and this effect will be increased by the addition of the Oyster Creek Station load to those transmission lines beyond the Monitou Substation. However, these lines were originally designed to handle this additional load. This heating effect is localized to the immediate vicinity of the lines themselves.

QUESTION

F21 Discuss alternative site considered for disposal of dredge spoils.

RESPONSE

Consideration was given to disposal of all canal and plant construction spoils in the western portion of the site near the Garden State Parkway. However, this was not done because sufficient area was available near the excavations and the fill was desired to raise the ground levels around the plant and along the canals.

(See also the response to Question E4)

QUESTION

F22 State the direction and mileage distance of historical sites listed in ER Table 2.3-1, within ten miles of the plant or the new transmission line.

RESPONSE

Table 2.3-1 of the ER not only lists the historical sites within 10 miles of the site, but also lists their location. The exact radial distance and direction to each of these sites from the plant or the transmission line can be obtained by locating them on the Ocean County and other road maps already made available to AEC consultants.