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Jersey Central Power & Light Company

MADISON AVENUE AT PUNCH BOWL ROAD • MORRISTOWN, N. J. 07960 • 201-539-6111
MEMBER OF THE
General Public Utilities Corporation
GPU ELECTRIC POWER COMPANIES SYSTEM

April 22, 1974

RECEIVED APR 24 1974 U.S. ...

Mr. William H. Regan, Chief
Environmental Projects Branch #4
Directorate of Licensing
Office of Regulation
U.S. Atomic Energy Commission
Washington, DC 20545

50-219

Dear Mr. Regan:

SUBJECT: OYSTER CREEK NUCLEAR GENERATING STATION
WATER QUALITY CERTIFICATION

In accordance with your telephone request of April 16, 1974, to Mr. T. M. Crimmins, Jr., I am forwarding copies of correspondence relating to State of New Jersey Water Quality Certification for the Oyster Creek Station. Enclosed are:

(1) Mr. I. R. Finfrock, Jr., Vice President, Jersey Central Power & Light, letter dated October 15, 1973 to Mr. R. L. Sullivan, Commissioner, Department of Environmental Protection.

(2) Mr. K. Widmer, State of New Jersey, letter dated November 16, 1971 to Mr. M. K. Pastor.

(3) Mr. K. Widmer, State of New Jersey, letter dated January 6, 1972 to Mr. M. K. Pastor.

(4) Mr. R. H. Sims, Vice President, Jersey Central Power & Light, letter dated June 12, 1972 to Mr. R. L. Sullivan, Department of Environmental Protection.

Item (1) above is the most recent request for a "Section 401 Certificate" for the Oyster Creek station. This letter presents a history of our efforts to obtain Water Quality Certification for the Oyster Creek/Forked River site.

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I/

Item (2) and (3) are information requests from the State of New Jerrey concerning the subject certification and Item (4) is Jersey Central response to these requests. These latter items are forwarded for your information.

If you have any futher questions about this matter, please contact Mr. T. M. Crimmins, Jr.

Very truly yours,

Ivan R. Finfrock, Jr.
Vice President

asb

Enclosures

cc: Mr. A. Z. Roisman
Berlin, Roisman & Kessler
1712 N. Street, N.W.
Washington, DC 20036

File. O.C. water Qual.

Jersey Central Power & Light Company

MADISON AVENUE AT PUNCH BOWL ROAD • MORRISTOWN, N. J. 07960 • 201-539-6111

MEMBER OF THE General Public Utilities Corporation SYSTEM

October 15, 1973

Mr. Richard J. Sullivan
Commissioner
Department of Environmental Protection
State of New Jersey
Box 1889
Trenton, New Jersey 08625

Dear Mr. Sullivan:

SUBJECT: OYSTER CREEK NUCLEAR GENERATING STATION
WATER QUALITY CERTIFICATION

As you know, the Atomic Energy Commission is currently considering the issuance of a Full Term Operating License to the Oyster Creek Station. A pre-hearing conference was held on September 18, 1973 and public hearings are expected to be held early in 1974. The State of New Jersey is a party to these proceedings.

Section 401 of the Federal Water Pollution Control Act requires that water quality certification be furnished prior to the granting of a license or permit by a Federal Agency. Our requests for a water quality certification for the Oyster Creek/Forked River site go back to August 21, 1970. Since then, several meetings have been held to discuss changes in the designs and to keep the State DEP informed on the project (September 9, 1971, October 27, 1971 and January 19, 1972). Questions posed by the Department in letters from Dr. Kemble Widmer dated November 16, 1971 and January 6, 1972 were answered in a letter from JCP&L on June 12, 1972.

On June 8, 1973, the State did issue the necessary certification for the Forked River project.

Since the certification for the Oyster Creek Station should be presented to the Atomic Energy Commission in the near future, your cooperation in completing your review and issuing the certificate is requested.

Very truly yours,

Ivan R. Finfrock, Jr.

Ivan R. Finfrock, Jr.
Vice President

asb

bcc: Mr. J. T. Carroll
Mr. H. M. Dieckamp
Mr. D. A. Ross
Mr. J. R. Thorpe
G. F. Trowbridge, Esq.

ROUTE

NOV 1 6 1971

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON

DIVISION OF NATURAL RESOURCES

TR 2802 due 12-8

Please obtain answers and advise the Project.

PLEASE ADDRESS REPLY TO:

Bureau of Geology & Topography
P.O. Box 1889
Trenton, New Jersey 08625

302 12-7

November 16, 1971

These appear to be Oyster Creek questions, not FR 1 questions. G Wilventing is handling the assimilation of the answers, however. KP

Mr. Kenneth Pastor
GPU Service Corporation
260 Cherry Hill Rd.
Parsippany, N.J. 07054

Dear Ken:

I received the enclosed list of questions, which pertain to the impact zone of Oyster Creek and Forked River #1, from Bruce Pyle. I am sending a copy to Charlie Amato and also to Harold Haskins.

I am sending you four xerox copies, as I don't know who in your shop should get this. I talked to Jack Devine and it is our thought that Thorpe and probably Carpenter should be advised.

I think most of the answers are either available or will not be too hard to get - at least I hope so.

Have a good Thanksgiving.

Sincerely yours,

Ken

Kemble Widmer
State Geologist

KW/drs

Oyster Creek Power Plant - Questions

1. Locate and describe (horizontal and vertical) the water areas that will have temperatures in excess of 85°F as a result of discharges from the Oyster Creek Power Plant.

2. Locate and describe (horizontal and vertical) the water areas that will have temperatures in excess of 87°F as a result of discharges from the Oyster Creek Power Plant.

3. Describe the effects of temperatures in excess of 85°F upon the fin and shellfish species common to the area prior to operation of the Oyster Creek Power Plant.

4. Identify changes that have occurred in the fin and shellfish species compositions where temperatures have exceeded 85°F as a result of plant operation.

5. Identify and describe the effects of any diseases or parasites of fish, shellfish or waterfowl, or other plant or animal pests, that have become established or have changed in abundance following the discharge of waste waters from the Oyster Creek Power Plant.

6. Identify and describe any effects upon fin, shellfish, or waterfowl that detracts from or renders them unusable by man that have developed since the discharge of waste waters from the Oyster Creek Power Plant.

7. What are the range and rates of temperature decreases as the result of power plant slowdown, and what has been their effect upon fish and shellfish common/to the area?

8. What plans exist to reduce drastic temperature decreases in the heat affected area during the winter that might be caused by plant slow-down to the extent that they do not present a hazard to fishes?

9. What is the extent of mortality of entrained organisms?

10. To what extent has the discharge affected the distribution and species composition of attached aquatic vegetation.

11. To what extent, if any, does the heated discharge attract waterfowl during the winter and have they experienced any natural mortality.

RECEIVED
JAN 1 0 1972
FORKED RIVER PROJECT

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
TRENTON

DIVISION OF NATURAL RESOURCES

PLEASE ADDRESS REPLY TO
Bureau of Geology & Topography
P.O. Box 1889
Trenton, New Jersey 08625

ROUTE

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January 6, 1972

Mr. M. K. Pastor
Jersey Central Power & Light Company
260 Cherry Hill Road
Parsippany, New Jersey 07054

Dear Mr. Pastor:

This will acknowledge your letter of December 15th requesting a conference with the State people involved in the suggested Toms River pipe line. I expect to have some alternate dates within the next few days.

I am enclosing a Xerox of a memorandum I got just before Crhistmas; I will send a copy to Hal Haskins. I will get back in touch with you about Item #1, however, I have nothing on the other two items so I will have to leave that up to you if you have the information. I suspect this is requested because of the water quality program. I am quite sure they don't understand thermal pollution either.

I will get back in touch with you about all of this when I have asked a few more questions around the Department.

Sincerely yours,

Kem

Kemble Widmer
State Geologist

KW:js
Encl.

Sent to Dr Carpenter 1/21/72
Sent to Dr. Wheaty 2/8/72

MEMO

STATE OF NEW JERSEY
DEPARTMENT OF ENVIRONMENTAL PROTECTION

TO Dr. Widmer

FROM Messrs John Gaston and Steven Lubow

DATE December 23, 1971

SUBJECT Jersey Central Power and Light, Oyster Creek and Forked River Nuclear Power Plants

As agreed, although somewhat belatedly we append a list of questions and requests for information regarding the current proposal to expand subject facilities. We would ask that you forward these questions to the company for reply. Mr. Segesser has been consulted and he is in agreement with these questions.

CBW 1. All existing ecological studies and data including the consultant's conclusion of the ecological impact of the existing Oyster Creek Facility.

JHC 2. An analysis of the existing thermal discharge to Barnegat Bay including:

a. Heat load evaluation under most stringent conditions with qualitative data, preferably expressed as isotherms, at various tidal cycles.

b. Submit data gathered at existing temperature monitoring stations utilized by the company.

c. Submit data on actual thermal dispersion pattern from the Oyster Creek facility.

JHC 3. An analysis of the proposed thermal discharge including both Oyster Creek cooling water and blowdown from cooling towers for Forked River I.

a. Heat load evaluation under most stringent conditions with predicted data.

b. Quantitative effects on the thermal profile in Barnegat Bay.

Steven P. Lubow
Assistant Biologist

John W. Gaston
Senior Environmental Engineer

6027:G7

Jersey Central Power & Light Company

MADISON AVENUE AT PUNCH BOWL ROAD • MORRISTOWN, N.J. 07960 • 539-6111

June 12, 1972

Mr. Richard L. Sullivan, Chairman
State of New Jersey
Department of Environmental Protection
John Fitch Plaza
P. O. Box 1889
Trenton, New Jersey 08625

REFERENCES: (1) Letter from Dr. Kemble Widmer to Mr. Kenneth Pastor, dated November 16, 1971
(2) Letter from Dr. Kemble Widmer to Mr. M. K. Pastor, dated January 6, 1972

Dear Mr. Sullivan:

SUBJECT: FORKED RIVER NUCLEAR STATION UNIT 1
OYSTER CREEK NUCLEAR STATION UNIT 1
STATE OF NEW JERSEY
WATER QUALITY CERTIFICATE

Enclosed for your examination are twenty (20) copies of the information requested in the referenced letters in connection with the State's review of the subject item. I trust that this information is satisfactory for your purposes.

Our representatives are available should you desire any clarification on the material presented.

Very truly yours,

R. H. Sims
Vice President

mw
Enclosure

JERSEY CENTRAL POWER & LIGHT COMPANY

FORKED RIVER NUCLEAR STATION

UNIT 1

STATE OF NEW JERSEY

DEPARTMENT OF ENVIRONMENTAL PROTECTION

OYSTER CREEK AND FORKED RIVER

POWER PLANTS

QUESTIONS OF JANUARY 6, 1972

QUESTION

1. All existing ecological studies and data including the consultant's conclusion of the ecological impact of the existing Oyster Creek facility.

RESPONSE

A listing of all the ecological reports on the Oyster Creek facility is attached. An analysis of the environmental impact of the Oyster Creek plant on the local ecology is appended from Section 4.8 of the Forked River Environmental Report.

TABLE 1-1

ECOLOGICAL STUDIES OF THE OYSTER CREEK STATION

In 1966 Jersey Central Power and Light Company committed to the support of biological investigations in the vicinity of the Oyster Creek Plant. The work has been done by faculty and students of Rutgers University. Dr. R. E. Loveland was principal investigator for studies related to benthic organisms, algae and plankton. Dr. J. R. Westman was principal investigator for those studies related to finfish. Semi-annual reports were to be submitted for forwarding to the Public Utilities Commission. The reports submitted to date follow in chronological sequence.

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 THERMAL POLLUTION.
   An initial progress report, December 1966.

2. Westman, J. R. (Identified only by the covering letter.)
   BARNEGAT REACTOR FISH RESEARCH.
   Progress Report No. 1, December 15, 1966.

3. 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.

4. Westman, J. R. (Not identified in the report.)
   BARNEGAT REACTOR FISH RESEARCH SEMI-ANNUAL REPORT.
   December 1, 1966 to May 31, 1967.

5. 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.

6. Westman, J. R., K. Marcellus and J. J. Gift.
   BARNEGAT REACTOR FINFISH STUDIES.
   December 11, 1967.

7. 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.

TABLE 1-1

ECOLOGICAL STUDIES OF THE OYSTER CREEK STATION

CONTINUED

8. Westman, J. R., J. Marcellus and J. J. Gift.
BARNEGAT BAY FINFISH STUDY/THERMAL REQUIREMENTS OF MARINE FISHES.
Progress Report - June 15, 1968.

9. 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.

10. Gift, J. J.
BARNEGAT BAY FINFISH STUDY/THERMAL REQUIREMENTS OF MARINE FISHES.
October 1, 1968

11. Westman, J. R.
BARNEGAT REACTOR RESEARCH PROJECT: FINFISH FIELD STUDY
accompanied by
A DIGEST OF RESULTS OF THE PRE-OPERATIONAL, BARNEGAT BAY FINFISH STUDIES, AND A PROSPECTUS FOR RESEARCHES DURING 1969-70.
March 17, 1969.

12. 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.

13. Westman, J. R., Marcellus, K. and J. J. Gift.
BARNEGAT REACTOR FINFISH STUDY/PROGRESS REPORT/JULY 1 - DECEMBER 31, 1969.
February, 1970.

14. 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.

15. Gift, J. J. and J. R. Westman.
RESPONSES OF SOME ESTUARINE FISHES TO INCREASING THERMAL GRADIENTS.
June, 1971. (The PhD thesis of J. J. Gift published at Rutgers with financial support from JCP&L.)

OLOGICAL IMPACT

The principal biological impacts of the proposed Forked River Station have been identified as the alteration of terrestrial habitats, the destruction of aquatic biota in the cooling-water intake system, and the thermal enrichment of Barnegat Bay by the discharge of heated blowdown water from the cooling tower.

THERMAL IMPACT

Thermal addition increases the physiological or metabolic rates of aquatic life, resulting in increasing growth of some species and harmful effects in others. Because upper temperature tolerance levels are poorly known for most species and the local ecological cycle usually is not defined, the effect of such heat addition is difficult to predict.

The cooling tower planned for Forked River Station allows most of the waste heat from the plant to be rejected to the air, where no biological impact is evident, and only a small portion to be rejected to the water. Although the cooling tower blowdown can be as much as 25°F warmer than the temperature of the water in the intake canal, the volume is so small that the impact on the discharge canal is negligible. With the usual flow through the canal, the temperature effect is as low as 0.25°F, and even under minimum flow, the temperature rise is about 2.5°F after mixing. Changes generated by the presence of the Forked River Station is expected to be very slight particularly when it is noted that Oyster Creek Station has not had an observable impact on the Bay to date.

Dr. Charles B. Wurtz, Consulting Biologist, Philadelphia, Pennsylvania, was engaged in 1965 by JCP&L to examine the overall effects of heated discharges from the Oyster Creek Station. His studies continue to this date. Pertinent excerpts from his reports are reproduced here:

> Those biological effects commonly held to be undesirable concomitant effects of heated discharge include:
>
> 1) Increase in temperature will kill the aquatic life and destroy both recreational and commercial use of these natural resources.
>
> 2) Increase in temperature will lower the dissolved oxygen content of the water to a point where aquatic organisms cannot survive, since certain minimal amounts of dissolved oxygen are essential to sustain life.

3) Increase in temperature will encourage the massive development of aquatic plants, resulting in nuisance conditions.

4) Increase in temperature will enhance the toxic effect of any toxic pollutants present in the water.[1]

Accurate assessment of natural limits of tolerance is not complete for many fish, and stress limits determined in the narrow environment of the laboratory are the only guidelines. According to Dr. Wurtz:

> ...Organisms are controlled by extremes rather than means. However, animals are usually much more sensitive to variations in environmental factors when they are in the egg or larval phase. This phase of most life cycles occurs in association with a spring spawning season. Up to about the middle of May ambient temperatures in Barnegat Bay will be less than 65°F. Increases in these temperatures will be biologically limiting only within the mixing zone....
> ....
>
> Physiological races of species adjusted to temperature differences associated with latitude are quite common. For example, the oyster spawns in southern waters at 66°F, but in Long Island Sound it spawns at 60.8°F. Another example would be the horseshoe crab. This animal has a lethal temperature of 115.3°F in Florida, but a corresponding temperature of 105.8°F at Woods Hole, Massachusetts.
> ....
>
> Davis (Proc. Nat'l. Shellfisheries Assn., pp. 33-38, 1949), quoting some earlier work on oysters, said, 'Loosanoff and Engle in their study of spawning and setting in Long Island Sound observed that larvae lived and set at temperature ranging from 16.6° to 28.0°C [61.9° to 82.4°F], and likewise concluded that oyster larvae can withstand rather drastic changes in temperature.'
>
> Loosanoff, Miller and Smith (Proc. Nat'l. Shellfisheries Assn., pp. 75-97, 1950) published the results of some studies on the larvae of the hard shell clam. In their conclusions they state, 'Our experiments have shown that larvae of _V. mercenaria_ may be grown from eggs within a temperature range of 18.0° - 30.0°C + 1.0°C [64.4° - 86°F + 1.8°F]. Within this range small variations, such as one or two degrees (centigrade), are not as important as it was thought previously.'
>
> Oyster larvae are a component part of the plankton of estuaries. Plankton consists of all the free floating, microscopic or near microscopic organisms that are transported by water currents. Both plant (predominantly algae) and animals compose the plankton. These organisms represent a very essential part of biological

(1) Discussion of Possible Biological Influences of Heated Discharges From the Oyster Creek Generating Plant, C. L. Wurtz, undated.

structure. The phytoplankters (plants) are the chief agents in the fixation of energy, while both the phytoplankters and zooplankters (animals) are major food items for other organisms. En masse the plankton includes innumerable species, probably of the order of magnitude of 200 to 300 on an annual basis for Barnegat Bay. Particular species will occur at particular seasons, although many species may be present throughout much of the year.

Plankters will probably not be reduced in numbers unless water temperatures approach and exceed 100°F for extended periods. Microscopic organisms as a group are more resistant to high temperatures above 100°F are not expected to occur only minor and transient effects on the plankton are to be expected.

Planktonic forms will probably be drawn through the plant's circulating system, in which case they will be destroyed by chlorination. As a result the discharge canal may have a reduced number of plankters.(1)

Dr. Wurtz's study also discusses the thermal effects on algae:

The number of plankters present in a given volume of water is a function of available nutrients and sunlight. These are essential for the development of phytoplankters, and the zooplankters are dependent upon the phytoplankters for food. Temperature may have a limiting effect upon plankton productions, but it is not of itself a controlling influence except at very high levels. The mass of plankton present as a crop is a direct function of available nutrient material and sunlight; as would be the case in a field of corn. This is in contradiction to the commonly held belief that increased temperature, _per se_, will cause nuisance growths of algae or other plants. Without a surplus of nutrient material (particularly nitrogen and phosphorus) increased production cannot take place. Temperature can be a trigger mechanism that gives the initial impetus to accelerated growth for some algal species, but it is not the causative agent for such growth.(1)

A quantitative and qualitative analysis of the benthic flora and fauna of Barnegat Bay both before and after the onset of thermal addition is part of an ongoing study program being conducted by the staff of Rutgers University for Jersey Central Power and Light.

4.8.1.1 Algae

Dr. E. T. Moul, consulting algologist, compiled test data during 1965 to 1968, before any thermal addition, and during 1969 to 1970, after thermal addition. His comparison of the two periods shows no apparent effect.

---

(1) IBID

It is interesting to note that the species which showed the highest dominance, and therefore ranked high in 1965-68, continue to remain as the dominants in the period 1969-70. Two exceptions are: a) *Polysiphonia nigrescens* has not been reported at all for 1969-70, yet it was ranked 8th out of 128 species in 1965-68. b) *Acrochaetium sp.* has also "fallen out of favor" and now ranks 19th. *Ulva lactuca* continues to rank as the most dominant species of algae. Although we cannot state that it contributes the most biomass (we are still computing biomass data), *Ulva* is certainly the most probable species of benthic algae one would encounter in our study area. Another noticeable species change seemed to involve *Codium fragile*, *Champia parvula*, *Enteromorpha intestinalis* and *Enteromorpha linza*. It is obvious that *Codium* is becoming more dominant in the bay; however, it appears to be increasing at the expense of *Champia* and the two *Enteromorpha* species. *Codium* is one of the heaviest species in wet weight, and thus, very bulky. It may be competing very successfully for space and therefore, excluding, previously common species. One other interesting observation seems to be that very few epiphytic plants grow on *Codium*. It is reported that after *Codium* firmly establishes itself in an estuary, it becomes the substrate for other species of benthic algae. We haven't noticed this phenomenon, perhaps because *Codium* seems to be drifting along the bottom, as are most of the other algal species.

The number of algal species identified in 1969-70 (total = 38) is considerably less than for the period 1965-68 (total = 128). This is because we have spent more time sorting and estimating biomass of the species and less time observing the micro-algal forms, such as epiphytes. The *decrease* in species encountered in Barnegat Bay is thus to be interpreted as a change in technique---we have found no evidence for a drastic loss of algal species in Barnegat Bay. ....
....

As in previous years, we have again found that the number of algal species reaches its lowest value during the warmest months of the year. In fact, no brown algae have ever been recorded from Barnegat Bay during the month of September. The greatest number of species occurs in June and December (Progress Report #5, March 1969); in the current year (1969-70) the same trend appears. From a baywide point of view it appears that there are no significant differences in position (i.e., from one station to another) whether one measures diversity, the number of species, or the contribution of each species to the sample. However, there are significant differences from month to month (as one would expect due to differences in algae abundance with seasons).(1)

---

(1) *The Qualitative and Quantitative Analysis of the Benthic Flora and Fauna of [illegible] the Onset of Thermal Additions*, Seventh Progress Report, [illegible] University, June 25, 1970.

Benthic Invertebrates

M. Moskowitz, a research assistant of the Department of Zoology, at Rutgers University, discusses the data for benthic invertebrates gathered before and after thermal addition for the Oyster Creek outlet:

> During the period immediately preceding the operation of the nuclear electric-generator [27 August - 5 December 1969], the region around Oyster Creek (in the bay) was characterized by a lower diversity than other regions of the bay. However, the species richness remained constant, as evidenced by a decreased evenness. Therefore, the lower diversity in the O. C. [Oyster Creek] region during pre-operation can be attributed to the presence of the dominant bivalve Mulinia leteralis. Also, during pre-operation, as a general statement, it can be said that the Forked River region had consistently higher numbers of individuals of all species except the dominants than either Stouts Creek or Oyster Creek. This pattern was evident early in this study and has persisted to date.
>
> The second sub-period [9 February - June 1970] is characterized by the presence of fewer species and individuals throughout the bay. This is the winter season, with reproductive activity being much lower. Moreover, even though this period includes the early spring months when spawning is prevalent throughout the bay, many of the benthic organisms are too small to be detected. This part of the year is considered by our study group to be the low part of the year with regard to getting meaningful comparative data (viz., the samples are harder to get in freezing weather, and the numbers of individuals and species tends to be lower).
>
> The third period [30 June - 25 September 1970]...is distinctly post-operational...
>
> In the present study, Pectinaria gouldii, the golden bristled or mason worm, along with Mulinia lateralis (little mactia) comprise the dominant species in the vicinity of the reactor. Although Pectinaria is a deposit feeder (deposit feeders are positively correlated with the clay fraction of sediments (Sanders, 1958)) it is found in a variety of sediment types; muddy with a high clay fraction to sandy with an extremely low clay fraction. However, the worm inhabits muddy areas in greater numbers than in sandy areas.......................
>
> ...certain conclusions can be made.
>
> 1) Pectinaria tended to increase from 1969 to 1970; this was especially noticeable in Forked River at the Route #9 bridge, where very favorable growing conditions seem to prevail. On

the other hand, this species showed a decrease of 78% at Oyster Creek, where the average temperature was higher during 1970. Such a decrease, although not statistically significant, was opposite in its tendency in comparison to all other bay stations. There was, therefore, a significant interaction at Oyster Creek; in other words, the Pectinaria at Oyster Creek failed to respond to 1970 (and all the variables of that year) in the same way that all other stations responded.

2) The difference in the number of Pectinaria is significantly greater from one position to another than it is from year to year. This is, again, primarily due to such rich areas as Forked River at Route #9 and such poor areas as Oyster Creek at Route #9. The Pectinaria in the bay do not appear to vary significantly from one position to another, at least for the period September through December.

....

There appears to be good correlation between the number of individuals of the dominant worm (Pectinaria) and the sediment composition: the finer the sediment, the more worms that are found. However, note that whereas the sediment at F. R. #9 is very fine (26.9u) it is also poorly sorted (S_o = 5.24). It is quite possible that Pectinaria responds more to the presence of fine, poorly sorted sediments than it does to other environmental parameters. It is obviously not responding to increased temperature at Oyster Creek since there is no significant difference between the Pectinaria at Oyster Creek and Stouts Creek. Further, the number of worms at Forked River at Route 9 might be anomalous, since they occur there in huge (20,000 per square meter) numbers; we feel that this locality is a region of optimum growing conditions for Pectinaria, given the soft bottom and the amount of organic matter presumed to be the mud.

The diversity indices at the three bay stations were not significantly different from one another, while F. R. #9 showed a lowered diversity due to the dominants (Pectinaria and Mulinia). The number of species at Oyster Creek was significantly lower than the other three areas. However, it must be recalled that the present analysis was the result for one day; it is previously stated in this report that the number of species at Forked River went up during late summer, even though the number of species at Oyster Creek remained the same.(1)

[illegible].8.1.3 Plankton

Dr. Kent Mountford of the Department of Botany, Rutgers University, has related plankton data to the temperature of the water, dissolved

---

(1) IRD

oxygen, and salinity as it related to the addition of heated waters to the Bay. A review of his summation and conclusions indicates:

> The period mid-June through mid-October was used to compare conditions before and after the onset of generation. It would have been desirable to construct this comparison over an entire annual cycle, but operations during the first winter, December, 1969, through March, 1970, were so erratic that the data are more confusing than enlightening.
>
> The year 1970, in general, was significantly less productive along the entire transect than was 1969. This difference is in no way connected with plant operations. It is probably related to lower values of solar energy income during 1970. This parameter itself is reflected in slightly cooler <u>average</u> water temperatures.
>
> Qualitative changes in the phytoplankton...from year to year during the surveys were primarily seasonal in nature, signalling essentially cold and warm-water floral shifts. Variability in occurrence dates was sufficient that no general displacements attributable to plant operations could be distinguished in a single year's experience. The average number of species occurring along the transect was also not significantly altered, although a small decline in 1970 may reflect the selective loss of several groups observed at Station II but not at Station III.
>
> The distribution of plume effects can be partially seen using temperature as a tracer.... In some cases the plume is deflected south, and back against the shore at Waretown...as predicted by Carpenter (1963). In calm weather or with westerly winds, it will often orient straight toward the East..., and under the influence of southerly winds, displacement toward the north may occur, making possible recirculation of heated water.... The observed plume areas agreed closely with those predicted by North and Adams (1969). The heated layer was rarely more than 1.5 m thick at Station III, 500 m from the outfall...
>
> The equation for gross productivity built from data taken before operation included values for temperature, chlorophyll a, salinity, microflagellate counts, and the stage of tide at sampling. The resulting calculated values for gross productivity correlated with observed data from the field at the level of +.92. This means we were able to account for some 85% of the variability using five parameters.
>
> Temperature was the variable most highly related to gross productivity, with a correlation coefficient of +.803 during the pre-operational period. It was also strongly related to gross productivity during operation but the correlation fell to +.591, a value significantly different from 1969 at the 5% level. This

seems to reflect the association, particularly at Station III, of high temperatures with reduced photosynthesis. Since a temperature change, in the absence of biocides, pumping and erosion-based turbidities, does not necessarily result in decreased productivity, the relationship is not a simple one. ....

During the copepod bloom of Feb-Apr 1971, experiments were conducted to determine the following: 1) the ability of adult copepods to lay viable eggs within 24 hours of experiencing a temperature increase of 10°C [18°F] above ambient (by passing through the cooling system of the plant), 2) the viability of 10°, 15°, 20°, & 25° [18°, 27°, 36°, 45°F] (above an ambient of 5°C in the laboratory).

The use of copepods was deemed appropriate on the basis that copepods exceed, in both numbers of individuals and numbers 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 the region of the bay near the power plant and is the form dealt with in these experiments.

To compare the viability of eggs layed by those individuals having passed through the plant with those having not, adults were collected at the intake and the outfall of the plant. Upon return to the lab they 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 are shown in Table 8.

Table 8. % eggs hatching from individuals collected at intake and outfall.

	# eggs	% hatching
intake	75	73
outfall	75	78

Thus, (when the ambient was 5°C [41°F]) the delta [increased temperature] experienced by *Acartia* on passage through the cooling condensers did not seem to affect their ability to lay viable eggs within 24 hours of exposure to the delta.

To determine the effect of a delta upon eggs directly, eggs were obtained from individuals collected at the intake and then subjected in the laboratory to temperature elevations of 10°, 15°, 20°, & 25°C [18°, 27°, 36°, 45°F] above ambient for a 2 hour duration. ...eggs subjected to deltas of 10° & 15°C [18°, 27°F] had a better hatching success than the controls, while those receiving a delta of 20°C [45°F] above the temperature at which the eggs were laid was definitely disastrous to the eggs. ....

Thus exposure of Acartia eggs to a delta of 10° or 15° [18°, 27°F] above ambient (5°) [41°F] not only results in a significant shortening of the time span needed for a cohort of eggs to hatch, but also eggs so treated show a better % of hatching success than the controls.

At the winter temperatures of the bay, we have detected no significant effect on the viability of eggs of the dominant copepod Acartia sp.. It should be cautioned, however, that these experiments were run for the cold months, so a delta of 15° [27°F] may, in fact, result in an end point temperature of 15-20°C [27°-36°F].(1)

3.1.4 Higher Plants

Regarding higher plants, Dr. Wurtz's study revealed:

The New Jersey Department of Health has expressed concern over the possible effects of increased water temperatures on certain higher plants such as eelgrass, *Zostera marina*, and widgeon grass, *Ruppia maritima*. The Department felt that these plants might develop as nuisance growths. Both these species were identified (27 February 1965) in beached material at the mouth of Oyster Creek. These two species of spermatophytes (flowering plants) are commonly found on protected submerged beaches. In general, the spermatophytes are less resistant to elevated temperature than are the algae. Excessive growths are most unlikely. Furthermore, as with the algae, such growth would depend on available nutrients, not on increased temperatures.

Eelgrass was at one time the dominant plant in many of our coastal bays. In the early 1930's, however, it became parasitized by an amoeboid protozoan that reached epidemic proportions and nearly eradicated the species. Survival was limited to low-salinity areas. The loss of the plant virtually destroyed the bay scallop industry. The plant is a desirable species in our coastal waters for several reasons, not the

(1) IBID

least of which is its effectiveness as an anti-erosive factor. The eelgrass entraps material about its roots, thereby building bars and preventing undue cutting action from wind and wave action.

Because the eelgrass is more tolerant of low salinities than the parasite that kills it, the grass spreads from the fresher water areas in wet years. In dry years, with lesser amounts of fresh water, the parasite gains the ascendancy and kills the grass. Zostera marina will probably be controlled by salinities rather than temperature.[1]

4.8.1.5 Fish

A study[2] of the potential effects of heated water on estuarine fishes known to inhabit Barnegat Bay, sponsored by JCP&L, estimated limiting temperatures:

> The upper avoidance temperatures and upper avoidance breakdown temperatures of 11 species of estuarine fishes and two species of estuarine invertebrates are presented and discussed. The upper avoidance temperatures determined represent the maximum summer temperatures at which these organisms will be found. Water temperatures above these levels will be actively avoided by these species. The upper avoidance breakdown temperature determined represents the summer water temperature, which when encountered for short periods (one hour or less), will cause a loss of the organism's locomotory control and thus, a loss of the organisms' ability to escape from conditions which will ultimately cause death.
>
> Summer water temperatures which are unacceptable to the several estuarine fishes are presented in Figure 7. [Figure 4-11]. Any water temperature above these levels will probably be actively avoided by these species. As illustrated in this figure, estuarine waters with temperatures above 87°F will be an unacceptable environment for the majority of our important fishes. It must be emphasized that most of these studies were conducted with young-of-the-year or small individuals of the fish species. 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 lifetimes (striped bass, winter flounder, bluefish).

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(1) Discussion of Biological Influences, Wurtz.

(2) Responses of Some Estuarine Fishes to Increasing Thermal Gradients, J. J. Gift and J. R. Westman, June 1971.

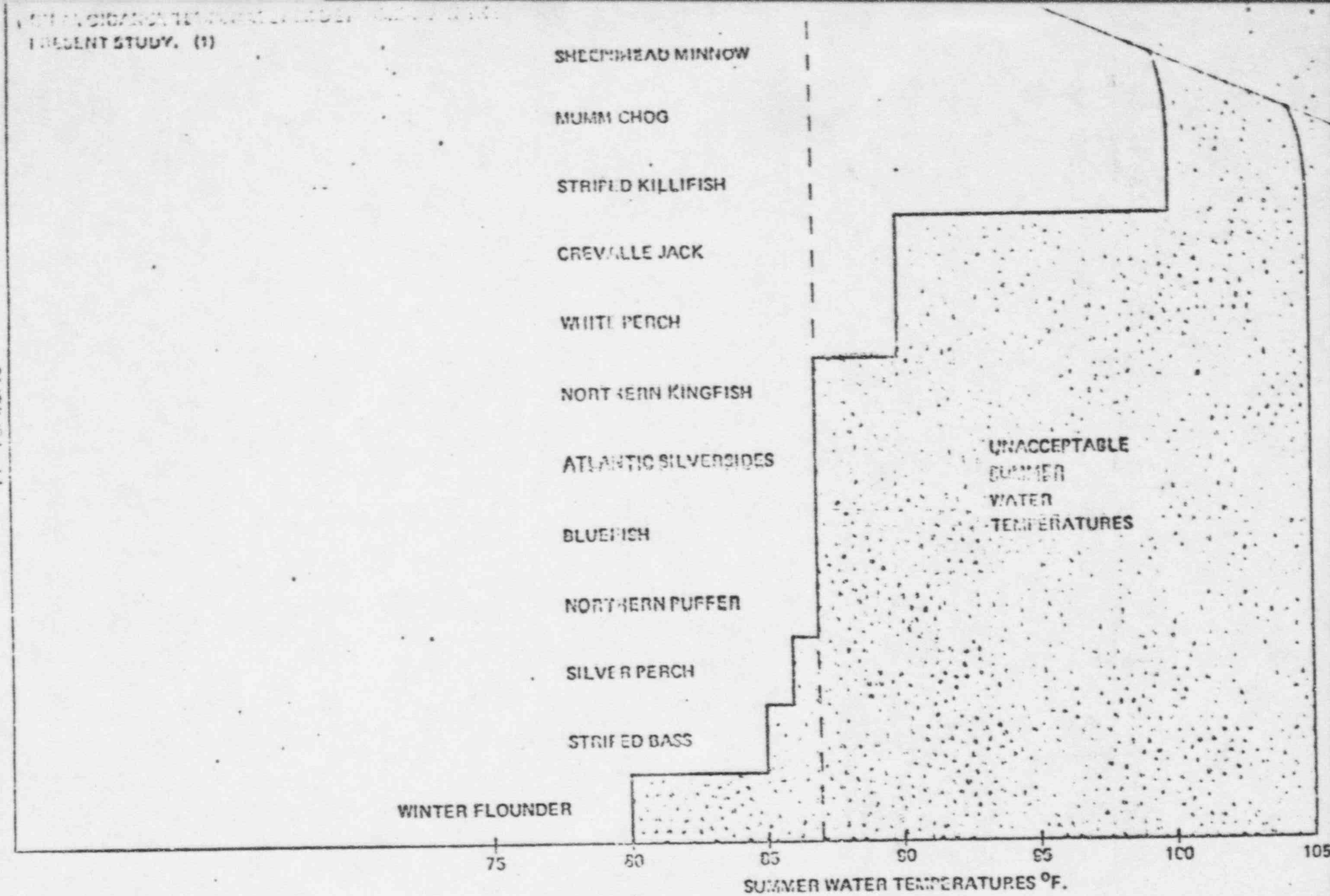

FIGURE 4-11

AVOIDANCE TEMPERATURES FOR CERTAIN FISHES

Season of the year, independent of acclimation temperatures, has been shown to influence the avoidance temperature of these fishes. The avoidance temperatures presented are summer maxima and can be expected to be lower during other seasons of the year with shorter photoperiods.

It is not implied that these fishes will occupy these water temperatures by choice. Their preferred temperatures are lower. However, under all circumstances, these fishes will avoid estuarine waters when they reach these temperature levels.

Summer water temperatures which will result in the death of estuarine fishes after short exposure (one hour or less) are presented in Figure 8. [Figure 4-12] These temperature levels are based on the upper avoidance breakdown temperatures determined in the experimental apparatus under conditions of rising temperature. Short exposures to a temperature of 94°F will result in loss of locomotory control (thus, loss of ability to escape from conditions which will result in fish death) for nearly every important species of estuarine fish. Only cyprinodont fishes can successfully survive extended exposure to this temperature.

Based on the present research, summer estuarine water temperatures should not be permitted to rise above 87.0°F. Waters warmer than 87°F will be devoid of most of our important estuarine fishes. When successful avoidance behavior is not possible, short, summer exposure to water temperatures above 94°F can be expected to result in the death of most of our important estuarine fishes.(1)

In this same study, effects on two important invertebrates, grass shrimp and blue crab, were examined. Adult grass shrimp, an important member of the estuarine food chain, showed a mean avoidance temperature of 89.7°F and mean avoidance breakdown temperature of 97.5°F. These shrimp seemed to prefer the warmer waters up to 87°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 longer acclimation may increase these temperatures. Avoidance behavior by blue crabs may not occur until near lethal breakdown temperatures.

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(1) Responses of Some Estuarine Fishes to Increasing Thermal Gradients, J. J. Gift and J. R. Westman, June 1971.

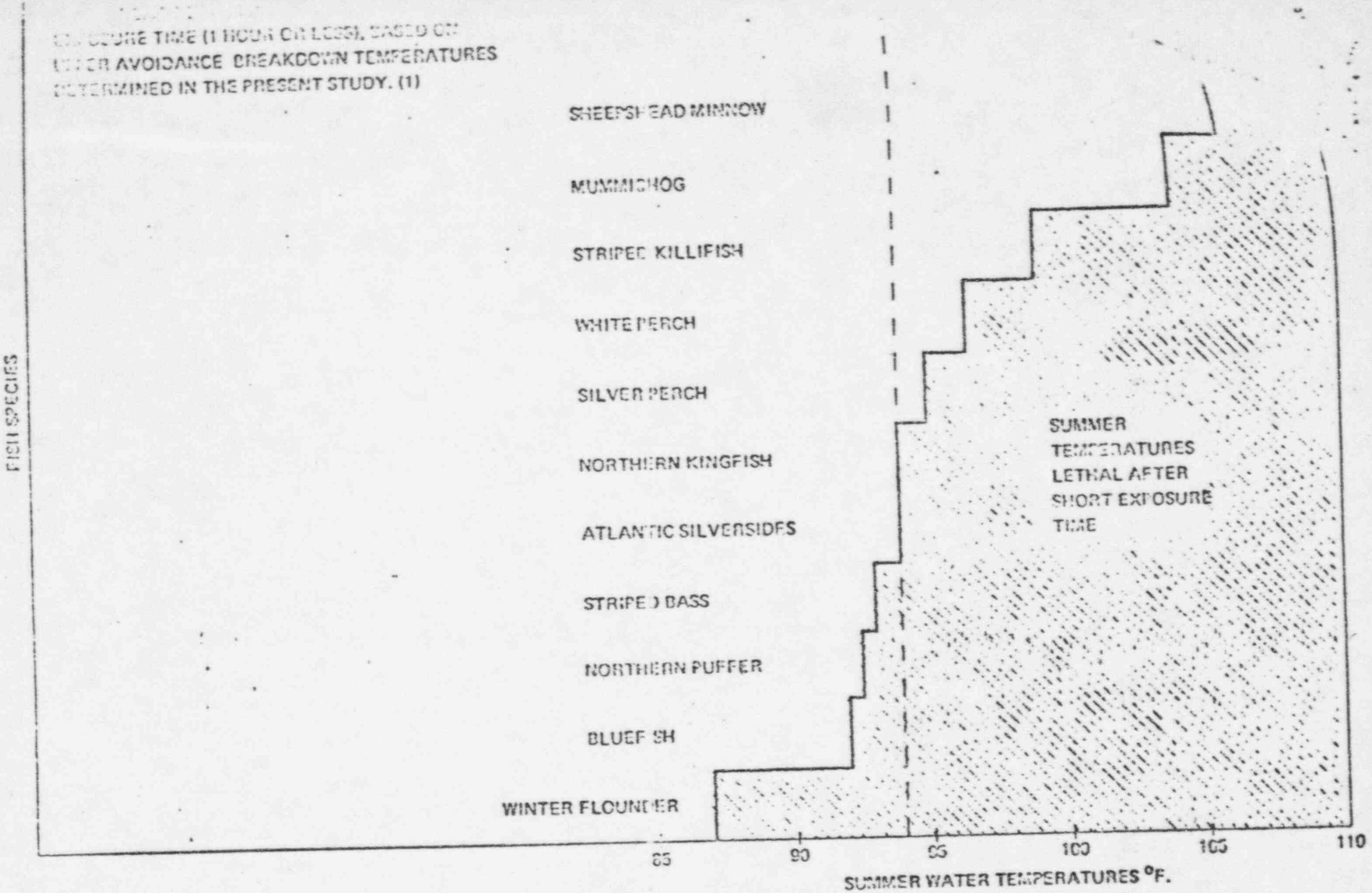

FIGURE 4-12

LETHAL TEMPERATURES FOR CERTAIN FISHES

FISH EGGS/LARVAE PASSAGE THROUGH THE CONDENSERS

Dr. Charles B. Wurtz, Consulting Biologist, has attempted to identify qualitative and quantitative effects of operation of Oyster Creek Station on fish eggs. Stresses being evaluated are chlorination and rapid temperature rise across the condensers. An extract from Dr. Wurtz's second progress report is given below, showing no significant effect.

> 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.
>
> The most significant difference found in the analysis of variance of fish egg distribution was the difference between the average number of surface and bottom eggs. The surface water was found to have the greater number of eggs by a factor of 2.7 to 1. The eggs collected were predominantly buoyant eggs. Subsequent 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 in waters of lowered specific gravity. In addition, there is some evidence to indicate they sink with aging.
>
> The most significant interaction found in the analysis of variance was that between top or bottom eggs versus diurnal period as night and day. Night eggs exceeded day eggs by a factor of 2 to 1. There were proportionately far more eggs present at the surface during the night than during the day. From this we draw the conclusion that our dominant eggs (Bay Anchovy) are deposited at the surface of the water during the night.
>
> The incompleted study of fish eggs identifications have shown that we are not picking up strongly adhesive demersal eggs or those eggs which have entangling surficial hairs. Presumably these eggs will not be entrained by plant pumping operations since our pumping method for sampling exerts local forces of velocity of 12 feet per second, which is much higher than the influence of the pumps of the Oyster Creek plant.
>
> The number of eggs taken on the flood tide as opposed to the ebb tide is greater than the latter by a factor of 1.8 to 1.
>
> In effect, the greatest number of eggs are found in the surface waters, during the night, and on a flood tide.

> If the influence of the flood tide on increased egg numbers consists primarily of entrainment of the eggs of off-shore spawning fish being introduced through the inlet, then Station 6 in 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 of 1.8 to 1 ratio in egg counts, indicating net off-shore entrainment, the numbers of eggs involved are much fewer than those found at stations in the bay. It would appear 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 was 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 at Station 2 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 Station 2 as it is for the other stations. 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 for Station 2 alone are too few to permit a rigorous assertion of the above. Moreover, Station 2 egg count averages do not decline from night through to the vesperal period as does the overall averages. On the contrary, there is an increase during the day of five eggs per sample. The increase may be due to a pumping effect or to chance variation.
>
> We believe that a statistically certain decision could be made on the importance of the possible effect of pumping on Barnegat Bay fish eggs. We base this on a comparison of the statistically reliable diurnal egg depletion in the bay and, when enough data become available, the diurnal variation in the mouth of Forked River.(1)

Dr. Wurtz recognized that eggs studied had been spawned prior to effects of heated waters, and that the effects of the plant operation on spawning in the summer of 1970 would not be felt until the summer of 1971. These data have been collected but not analyzed at this time.

---

(1) [illegible] Progress Report on Barnegat Fish Eggs, C. B. Wurtz, 12 February 1971.

Study[1] on Barnegat Bay oysters found that larvae held their position by discreteness of the tidal prisms. In uniformly saline water the larvae were uniformly distributed top to bottom, but larvae concentrated at any interface where sharp salinity increases occurred. Larvae were found to be distributed vertically by their own activity, responding to salinity changes as well as current changes and showed increased concentrations at levels of greatest current velocity. Oyster larvae were also studied[2] relative to tidal cycles.

[illegible]rther studies[3] on clam larvae also found these organisms to be some-[illegible]hat independent of water currents. In Little Egg Harbor maximum clam [illegible]arvae concentration during the day was at a depth of one meter, but [illegible] night this stratum of maximum concentration descended to near the bottom.

The blue crab larvae must be even more independent of current than the oysters and clams. Crab eggs are not planktonic but, rather, are carried by the female. The females overwinter in the more saline waters of the Bay. The eggs, laid in the spring, hatch in these more saline waters. After hatching the larvae migrate to less saline headwaters. This is a directional movement and as such must be independent of minor currents.

In general, 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 be an adaptation for resisting the net seaward transport characteristic of all positive estuaries.

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(1) Observations of the Behavior and Distribution of Oyster Larvae, T. C. Nelson, Proc. National Shellfisheries Association, 1954, pp. 23-28.

(2) Ecological Observations on the Distribution of Oyster Larvae in [illegible], M. R. Carriker, Ecological Monographs No. 21, [illegible], pp. [illegible].

(3) Some Recent [illegible] Larvae in [illegible], M. R. Carriker, Proc. National Shellfisheries Association, 1950, pp. 69-74.

In general, fish eggs and larvae are not being "sucked" into the intake canal and drawn through the Oyster Creek condensers. Those eggs and larvae that do pass through the condensers survive in significant percentages. Eggs are generally more tolerant of the stress than more advanced forms.

Stresses caused by operation of the Oyster Creek Station have not apparently caused upset to Barnegat Bay. Operation of the Forked River Station should not add measurably to present stresses, because of the significantly lower water usage. The living forms in the Forked River make-up water are likely to die, however, because of passage through the nuclear services cooling water system, intensive recirculation (averaging 15 times through the circulating water system), and the addition of chlorine and small amounts of water-treating chemicals.

OTHER CONSIDERATIONS

Extensive sampling to determine the influence of Oyster Creek was conducted at two of the three usual trophic levels: primary producers, bottom organisms and fish. Change in one trophic level intimately influences the other two, therefore, the entire array need not be studied at first. Typically, bottom organisms are selected as the most indicative trophic level for sampling, since they are relatively stable and have a life cycle of at least one year. Primary producers have relatively short life cycles and require extensive sampling to obtain representative sampling. Fish are highly mobile, difficult to collect and less representative than either of the others.

An interrelated study of all three trophic levels is exceedingly complex, and fish studies, except for stable element radiological study, have been deleted to conserve resources. A significant quantity of data must be assembled and analyzed to adequately identify the local environment and a similar quantity of data is necessary after the onset of a potentially upsetting influence to that environment. To this end, JCP&L has sponsored the continuing studies noted in Section 2.4.

One form of biological impact occasionally noted is fish injury or death resulting from being drawn through pumps or held against screens by high water velocities. As discussed in Section 4.3, the water intake

QUESTION

2. An analysis of the existing thermal discharge to Barnegat Bay including:

   a. Heat load evaluation under most stringent conditions with qualatative data, preferably expressed as isotherms, at various tidal cycles.

   b. Submit data gathered at existing temperature monitoring stations utilized by the company.

   c. Submit data on actual thermal dispersion pattern from the Oyster Creek facility.

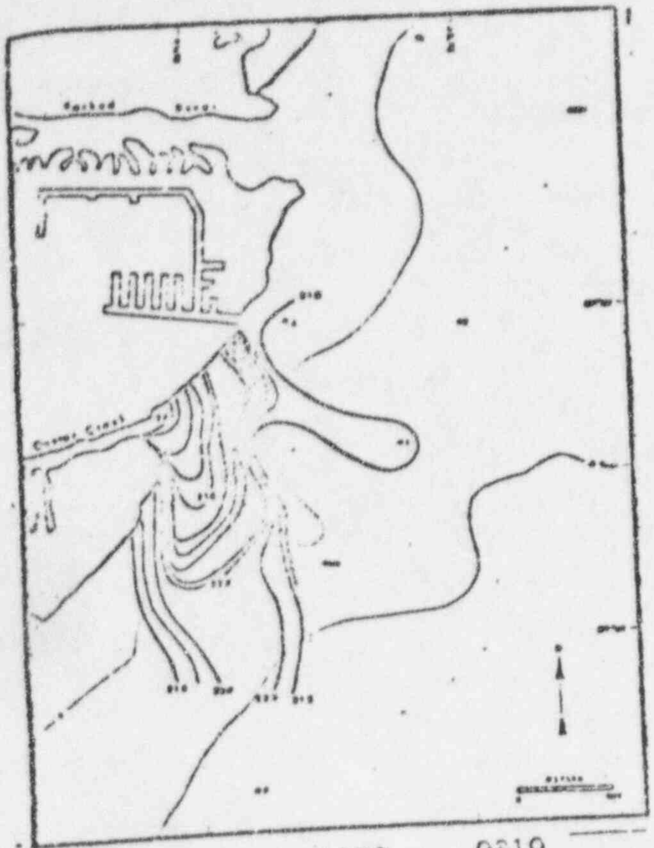
RESPONSE

a. The maximum heat load from the Oyster Creek Plant is 4.6×10^9 Btu/hr at full power (1930 MWt). Attached are figures of the Oyster Creek thermal discharge plume from the Sandy Hook Sport Fisheries Marine Laboratory.* These figures depict all the data collected by the Sandy Hook Laboratory in 1970 and 1971.

b. Table 2-1 indicates the Oyster Creek operating data, circulating water temperatures, and the Route 9 bridge temperatures corresponding to the plumes indicated in the figures. Figure 2-1 indicates the highest temperatures of each day from JCP&L's marker buoy "J" recorder in Barnegat Bay.

c. See the Sandy Hook Marine Laboratory figures included in the response to Question 2.a.

*Unpublished manuscript entitled "Wind and Tide Effects on a Thermal Plume in Barnegat Bay, New Jersey," Azarovitz, T, Morse, W., and Silverman, M., National Marine Fisheries Service, Highlands, N. J.
Note: This information is privileged and should not appear in any formal publication.



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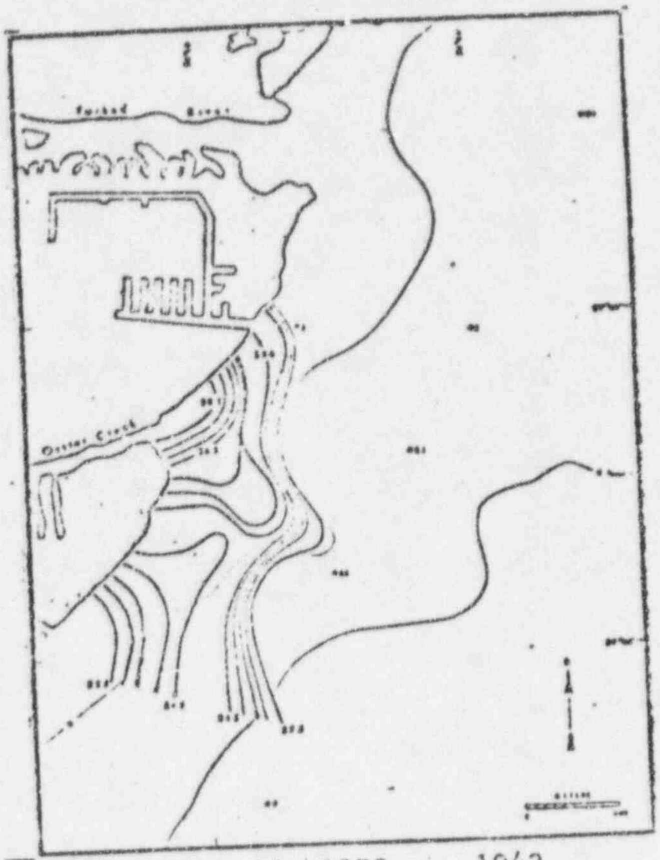

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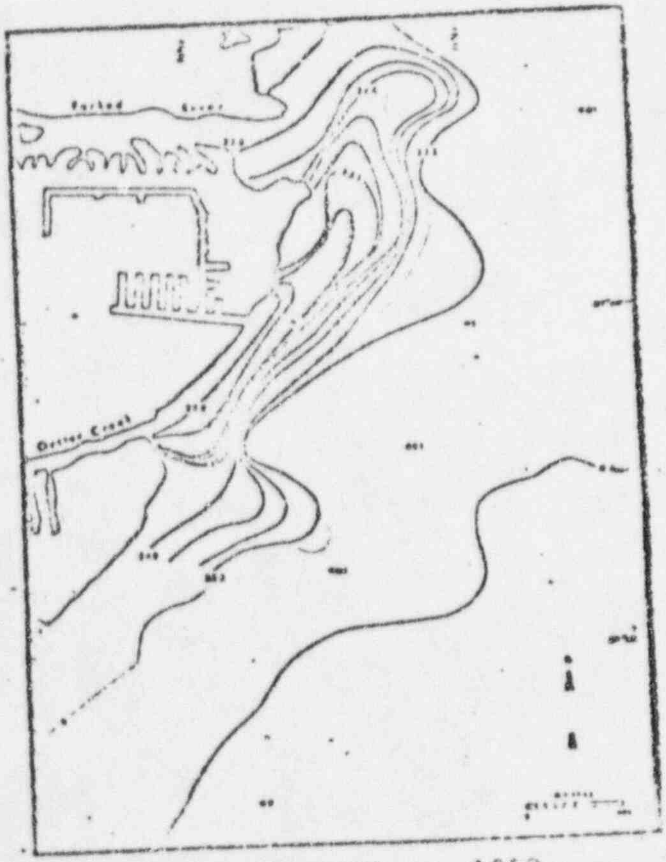

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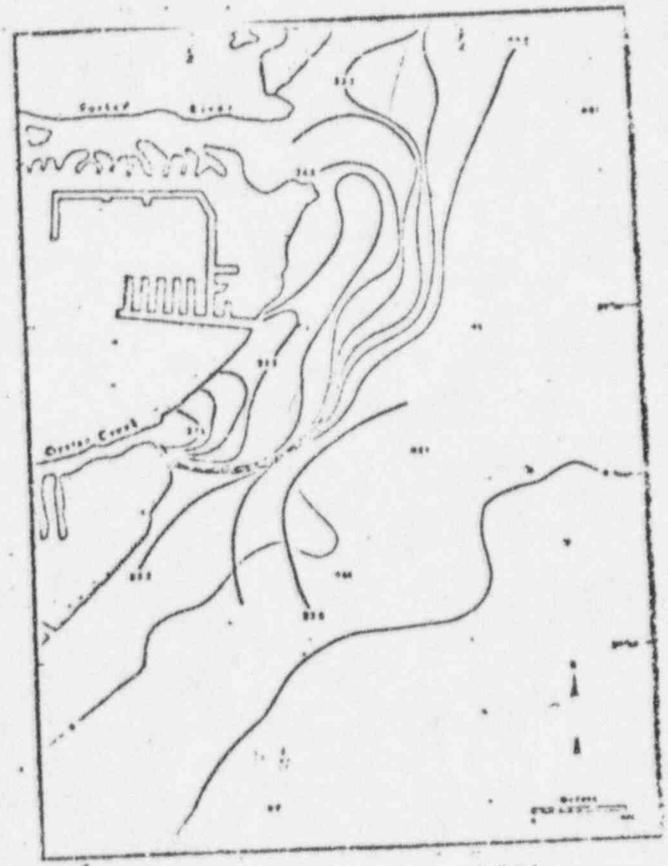
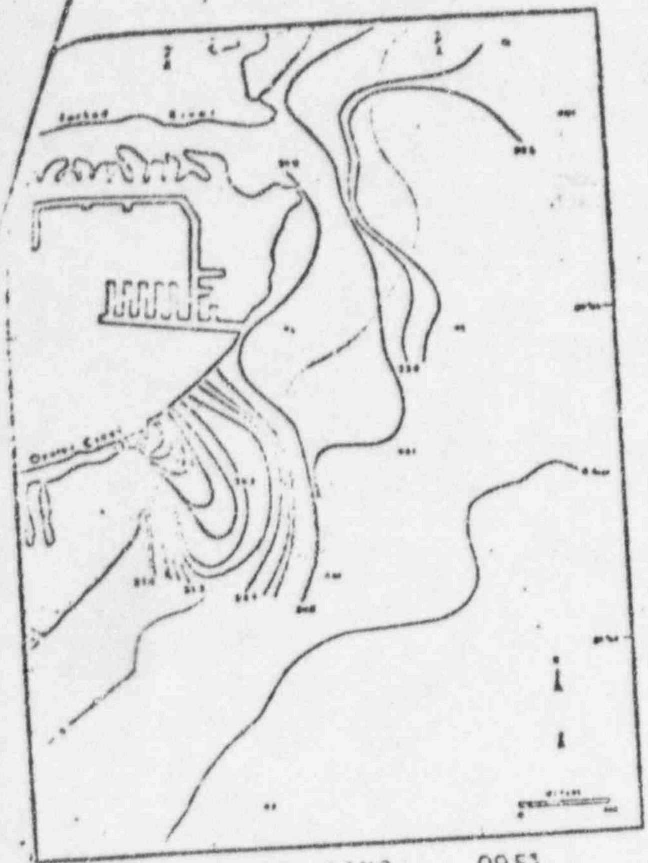


June 24, 1970 [illegible]

NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
SANDY HOOK SPORT FISHERIES MARINE LABORATORY
HIGHLANDS, NEW JERSEY [illegible]



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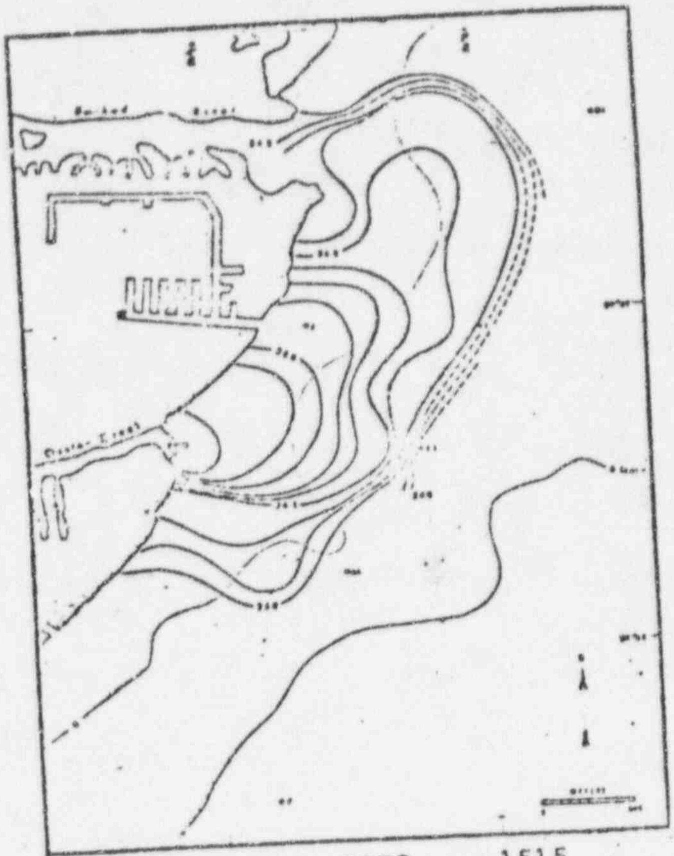

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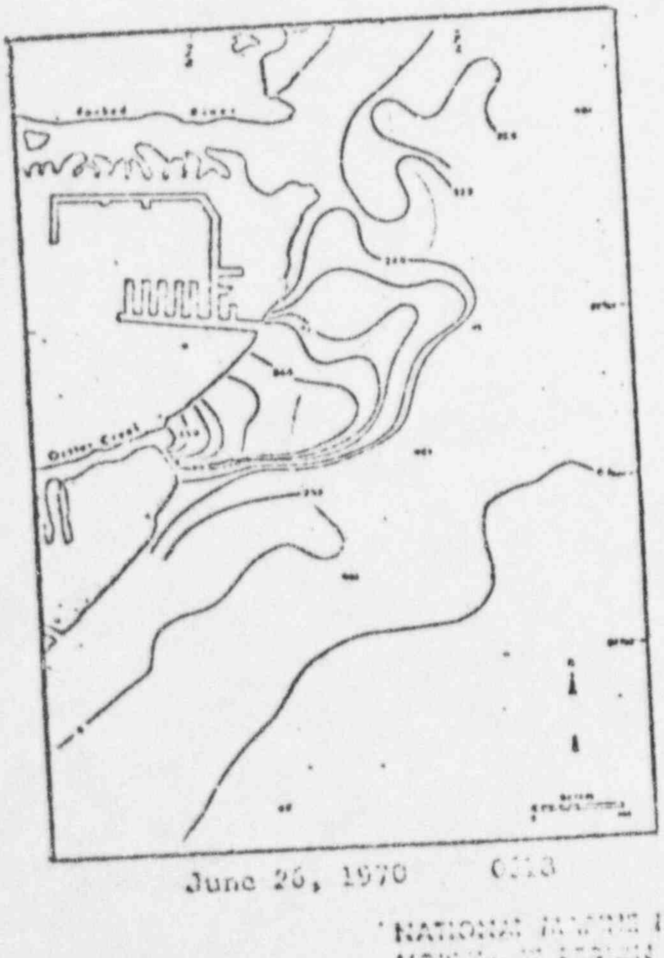
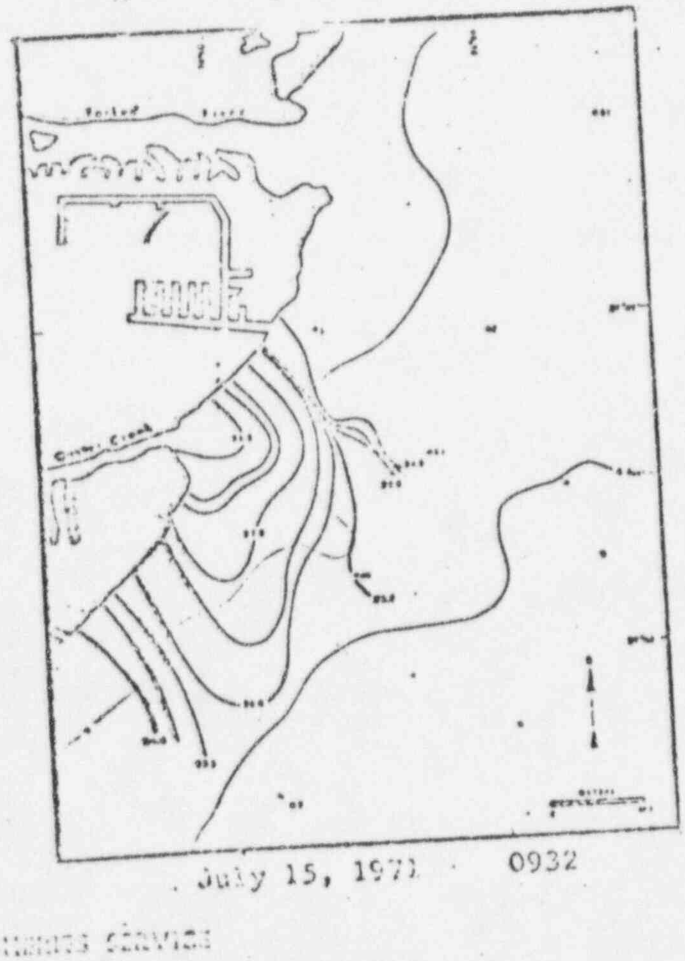


June 26, 1970 0[illegible]13



July 15, 1971 0932

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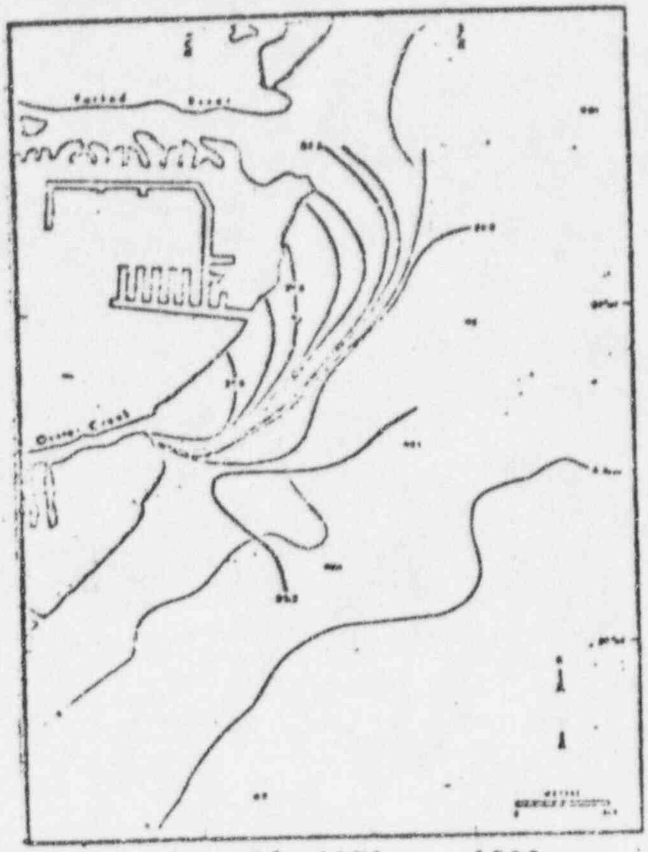

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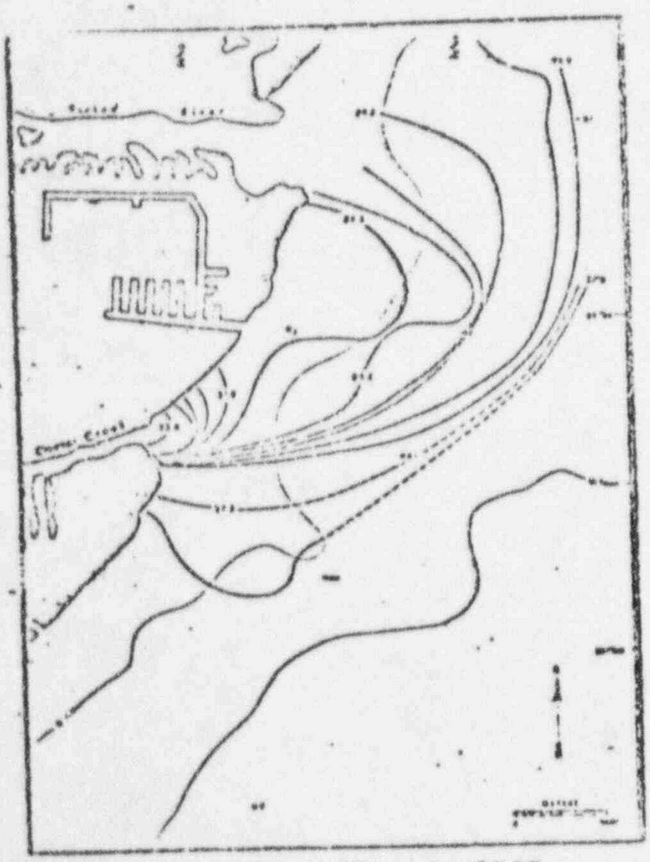

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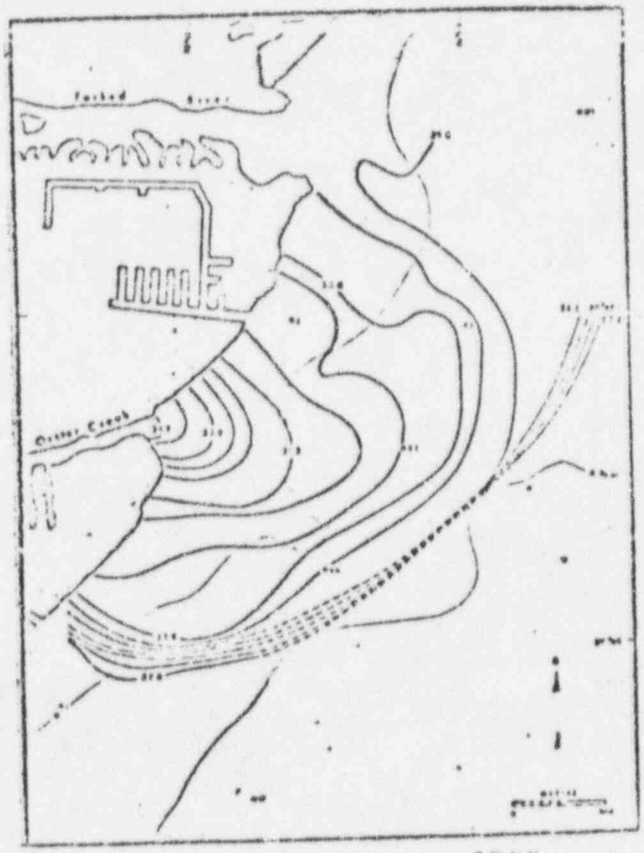

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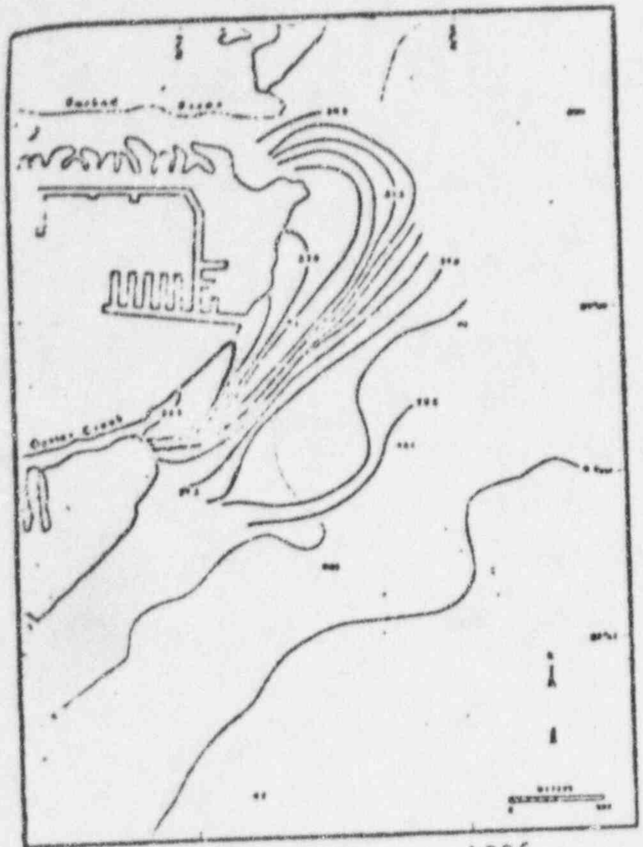

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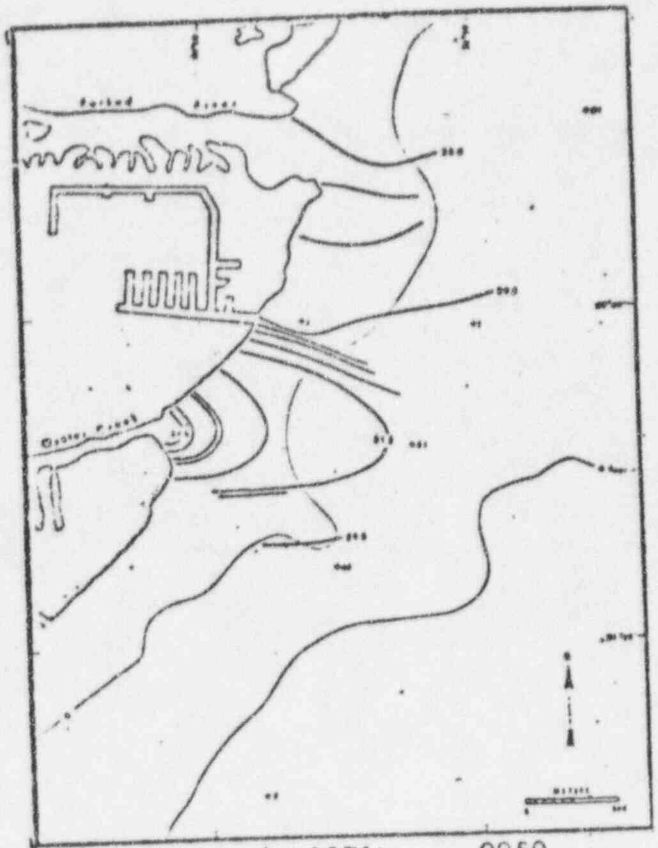

Aug. 4, 1971 0950

Aug. 5, 1971 0957

Aug. 5, 1971 1410

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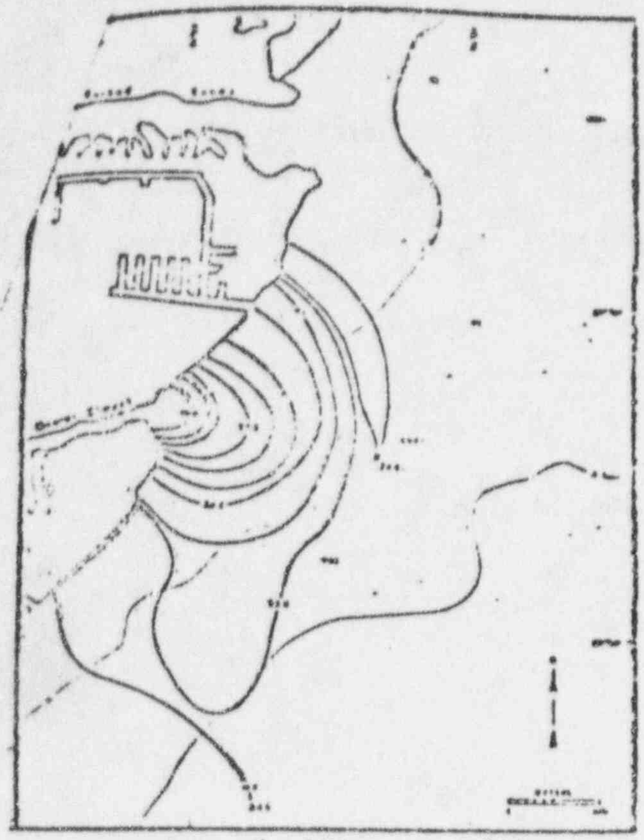

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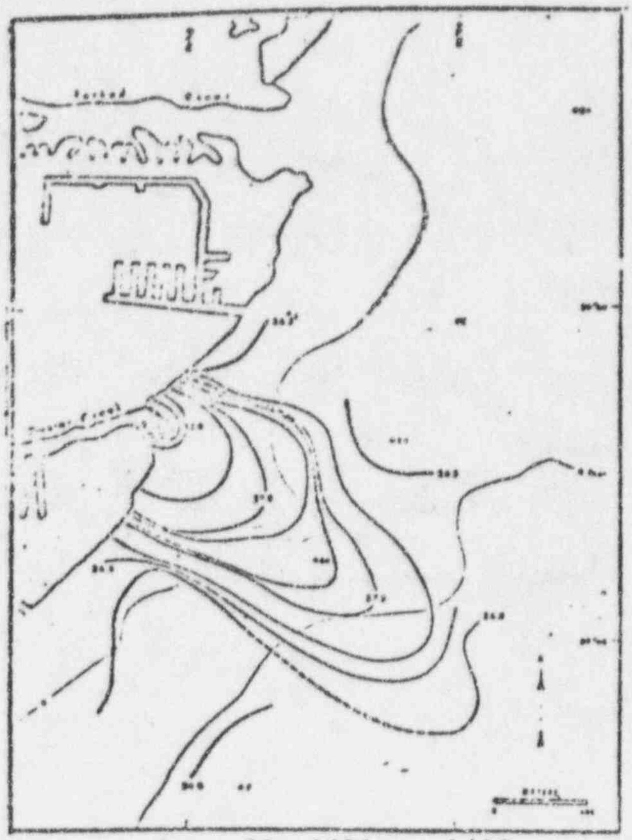

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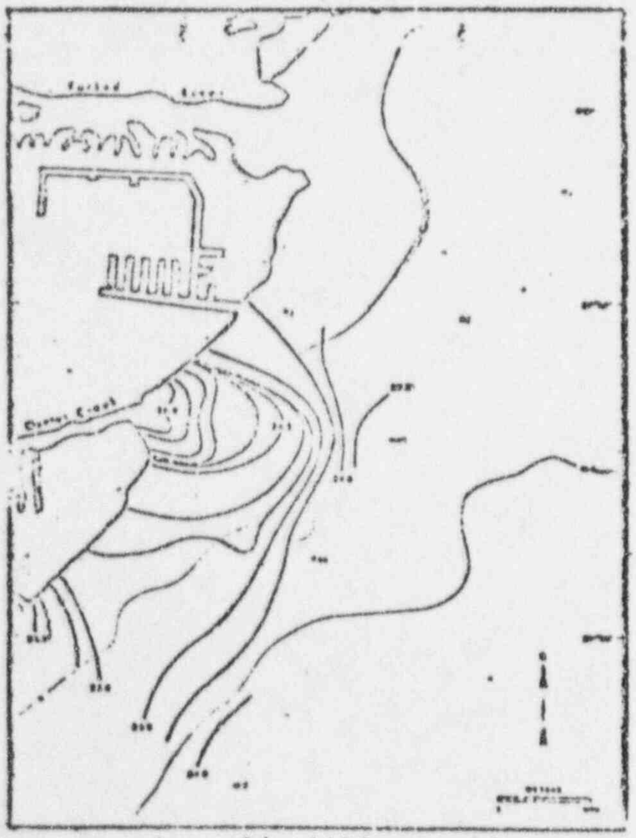

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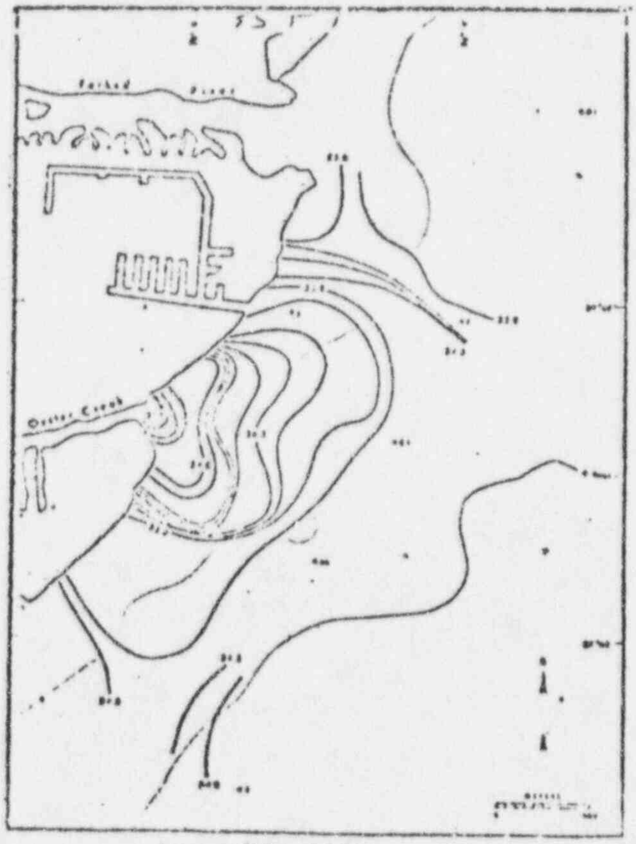

Aug. 25, 1971 0656

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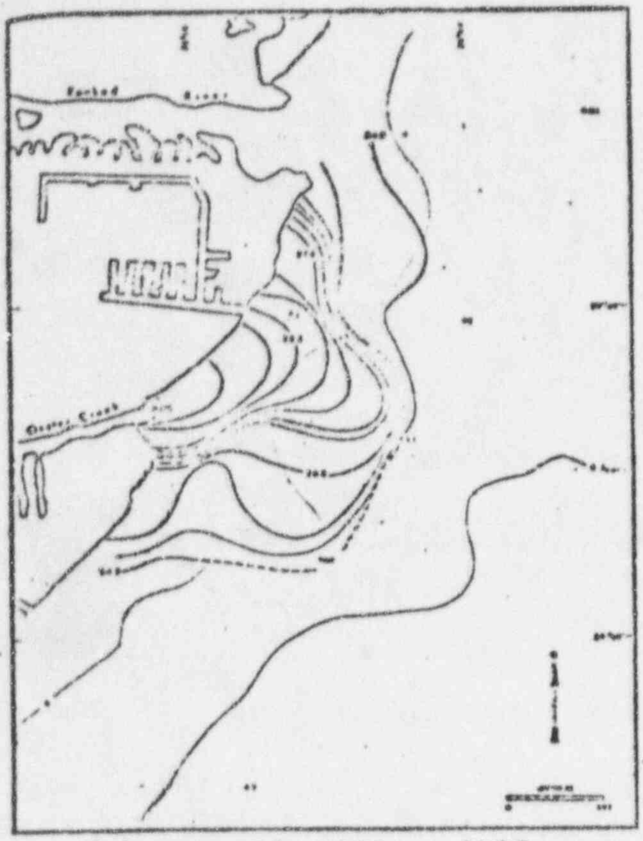

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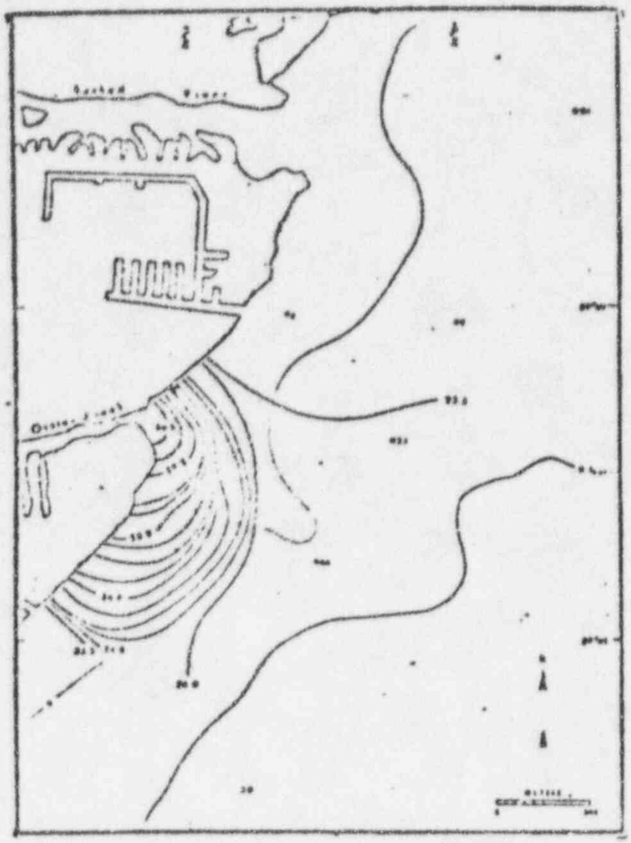
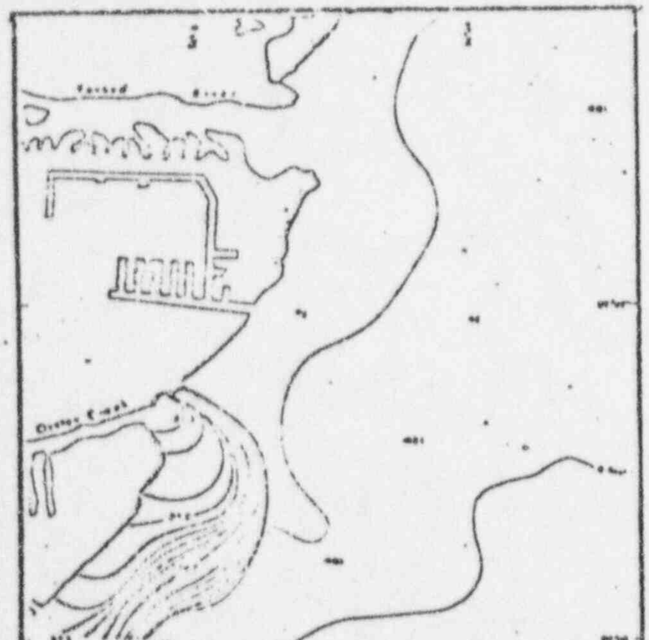


Aug. 31, 1971 0718



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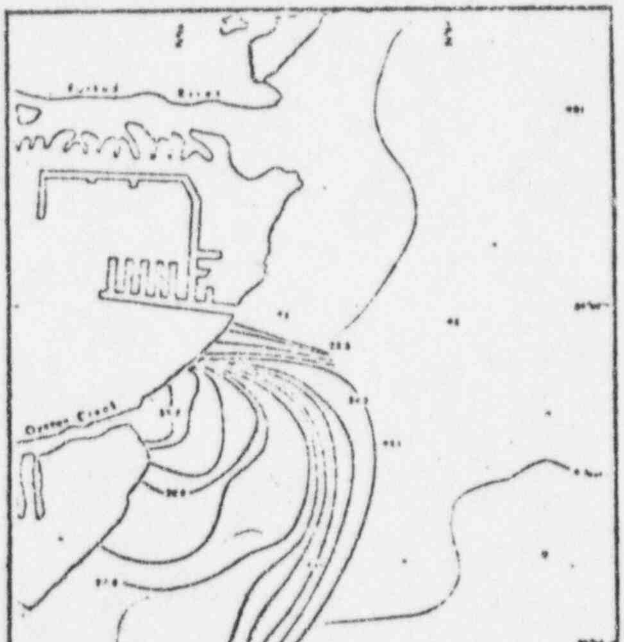

Sept. 1, 1971 1015

NATIONAL MARINE FISHERIES SERVICE
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SANDY HOOK SPORT FISHERIES MARINE LABORATORY
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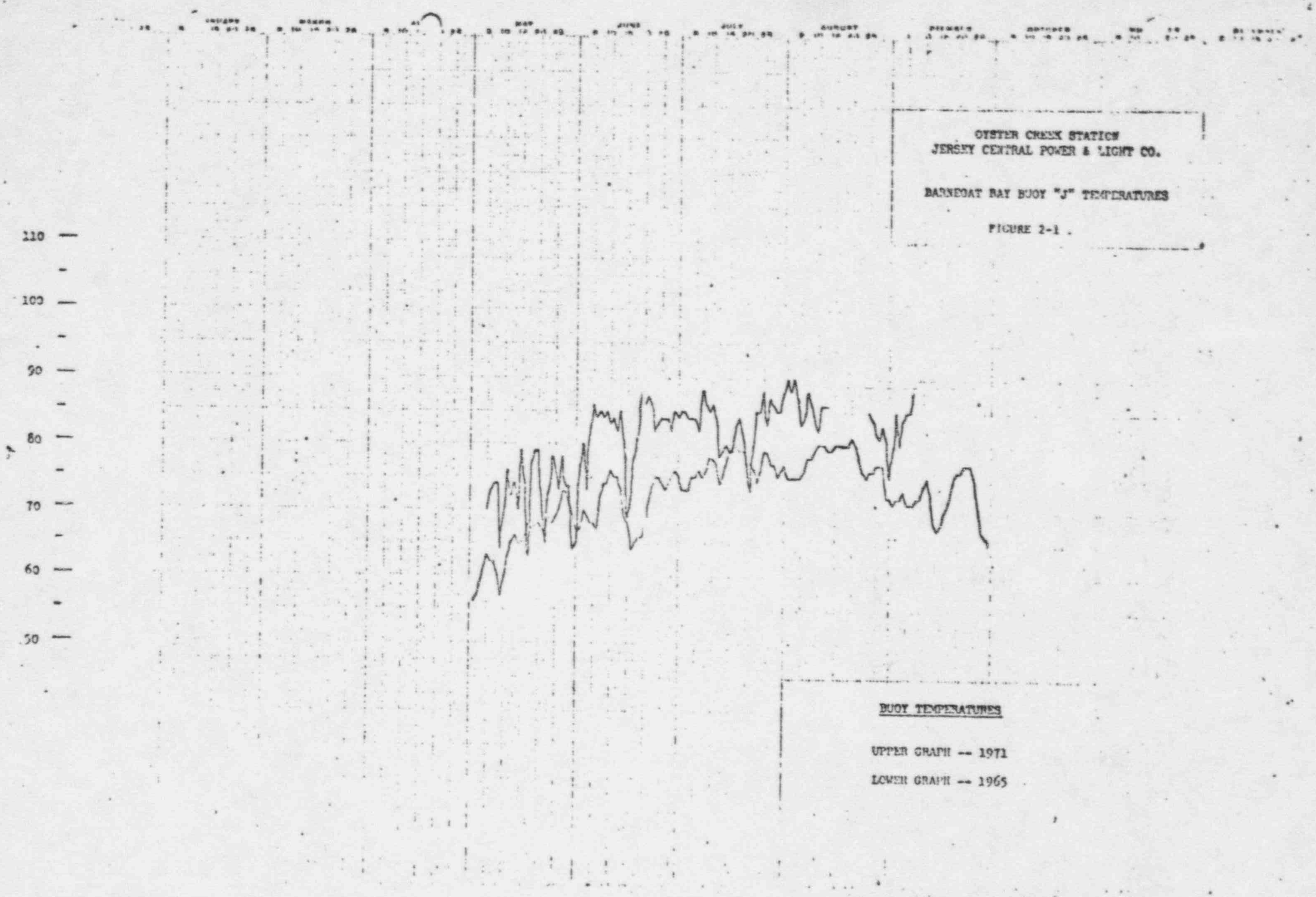


OYSTER CREEK STATION
JERSEY CENTRAL POWER & LIGHT CO.

BARNEGAT BAY BUOY "J" TEMPERATURES

FIGURE 2-1 .

TABLE 7-1

OYSTER CREEK NUCLEAR GENERATING STATION

OPERATING DATA

Date	Time	Reactor Power (MWt)	Electrical Power (MWe)	Circulating Water Inlet °F	Circulating Water Outlet °F	Route 9 Bridge °F	Circulating Water Flow
6/23/70	1215	1323	430				1022.4
	1355	1355	530	72	93		
	1830	1587	543	75	93	78	
6/24/70	0135	1450	480	73	90	84	652.4
	1100	1520	5[illegible]				
	1130	1556	5[illegible]				
	1430	1515	52[illegible]	78	94	76	
	1715	[illegible]	519	78	95	79	
	2330	1539	510	80	95	82	
6/25/70	0030	1540	510				652.4
	0855	1513	510	75	94	85	
	2230	1523	518	84	99	80	
6/26/70	0020	1545	520	82	97	86	1022.4
7/15/71	0150	1687	563	76	96		1022.4
	1042	1625	566	75	94		
	1650	1688	539	79	99	87	
7/16/71	0125	1685	560	79	99		1022.4
	1525	1684	538	80	100	90	
7/26/71	0330	1686	534	81	102	92	1022.4
	1045	1682	556	78	98		
	1720	1685	559	80	99		
8/2/71	0000	1690	549	86	107		1022.4
	1150	1675	550	84	104		
	1905	1683	543	88	108	98	
8/3/71	0605	1687	551	82	102		1022.4
	0940	1683	550	84	105		
	17[illegible]	[illegible]	5[illegible]	90	110	97	
8/4/71	0305	1653	527	86	107	97	1022.4
	0945	1655	551	83	103		
	1655	1663	548	83	103		
8/5/71	0510	1650	551	81	107	91	1022.4
	1025	1660	561	74	98		
	1740	1657	557	80	99		
8/6/71	0215	1679	559	77	96		1022.4
	1015	1681	561	76	96		
8/23/71	0225	1649	540	80	98	89	1022.4
	1430	1643	537	79	98		
	1715	1646	540	78	97		
8/24/71	0220	1649	550	76	94		733.65
	1115	1643	550	74	92		
	1725	1643	545	76	94	90	
8/25/71	0120	1644	546	72	93		652.4
	1030	1635	545	72	91		
	1700	1642	545	75	94	91	
8/26/71	0105	1643	540	77	96	91	657.4
	0855	1641	544	75	93		
8/31/71	0600	1625	535	74	94	90	652.4
	0930	1619	539	75	93		
	1630	1622	538	74	93		
9/1/71	0110	1625	537	74	93		652.4
	1005	1626	541	71	89		

TABLE 1-1

FORKED RIVER SEASONAL HEAT DISSIPATION[1]

Season	Bay Temperature °F	Wet-Bulb Temperature °F	Average Condenser Discharge Temperature °F(2)	Cooling Tower Basin Temperature °F(3)	Heat Input to the Bay Btu/hr (10⁶)	Blowdown Temperature Above Bay Temperature °F	Blowdown Temperature Above/Below Oyster Creek Condenser Discharge Temperature °F	Blowdown Temperature Above Bay Temperature °F(4)	Combined Mixing Temperature At Route [illegible]
Summer	73.6	57	92.9	89.1	190	15.8	-3.5	+2.7	92.7
Fall	56.7	52	76.0	80.[illegible]	287	23.9	+4.6	+4.1	76.2
Winter	43.1	32	62.4	69.[illegible]	320	26.7	+7.4	+4.6	62.8
Spring	56.7	46	76.0	77.[illegible]	252	21.0	+1.7	+3.6	76.1
Peak(5)	82.0	78	101.3	87.[illegible]	185	15.4	-3.9	+2.7	101.1

NOTES:
1. Based on design conditions and a maximum basin salinity concentration of 45,000 ppm.
2. Oyster Creek Unit 1 at full power.
3. Nuclear services cooling water was estimated at 36,000 gpm with a temperature rise of 7°F. Return is discharged into the cooling tower basin.
4. Oyster Creek not operating but after mixing with one circulating water pump (115,000 gpm).
5. Peak bay temperatures in conjunction with a wet-bulb temperature greater than 78°F (occurs less than 1% of the time in summer).
6. Based on 460,000 gpm circulating water flow from Oyster Creek and 24,000 gpm blowdown flow from Forked River.

JERSEY CENTRAL POWER & LIGHT COMPANY

FORKED RIVER NUCLEAR STATION

UNIT 1

STATE OF NEW JERSEY

DEPARTMENT OF ENVIRONMENTAL PROTECTION

OYSTER CREEK POWER PLANT

QUESTIONS OF NOVEMBER 16, 1971

QUESTION

1. Locate and describe (horizontal and vertical) the water area that will have temperatures in excess of 85° F. as a result of discharges from the Oyster Creek Power Plant.

RESPONSE

The vertical distribution of waters with temperatures greater than 85° F. or 87° F. appears to be the upper three feet except in an area extending approximately 100 yards from the mouth of Oyster Creek. The attached Figure 1-1 is a plot of data collected on June 7, 1970. The ambient Bay water temperature on this date was 68° F. Maximum ambient Bay water temperatures are approximately 80° F., so that 85° F. would be a 5° F. increment and 87° F. would be a 7° F. increment. As may be seen in Figure 1-1, a 5° F. increment or 73° F. was confined to the upper three feet except immediately off Oyster Creek entrance.

The horizontal distribution of the warmed discharge from Oyster Creek varies with the tide and wind direction and intensity. With each tide a new plume develops and reaches a length that corresponds to the "tidal excursion" that is the resultant of the tidal and wind forces. For example, consider a cycle beginning with slack before ebb. The waters leaving Oyster Creek will move offshore as a result of the momentum in that direction. As the ebb tidal current develops the plume will be deflected to the south or along shore and become longer. The plume continues to form throughout the tide and at the end of the ebb tide will extend as an elongate volume to the south. At slack between ebb and flood, a new offshore trajectory for the discharge from Oyster Creek develops and a small offshore plume develops. As the tide turns to flood, the new plume is deflected to the north and a new plume continues to develop throughout the flood tide. The previously formed plume becomes more dispersed during the slack and early stages of the new tide so that its identity is nearly lost as it moves to the north and partly mixes with the new plume.

With a west or offshore wind, the plumes are observed to move offshore to the area of the Intracoastal Waterway buoys. With an east or onshore wind, the plumes lie nearer the shoreline. With winds from the north, the flood tide excursion is reduced and waters from Oyster Creek do not reach the entrance to Forked River at the end of flood tide. North winds move the ebb plume further south so that it is found offshore of Waretown or the Holiday Harbor Marina. During the summer, the most frequent wind direction is from the south or southeast and the flood plume extends 200-400 yards north of the Forked River channel entrance and the ebb plume extent is reduced. These tidal variations are illustrated in Figure 1-2.*

As may be seen in Figure 1-2, temperature at a given position is variable throughout the day or tidal cycle. It appears that the locations with persistent temperatures in excess of 85° F. or 87° F. are limited to a semicircle with a radius of approximately 500 yards that is centered on the mouth of Oyster Creek.

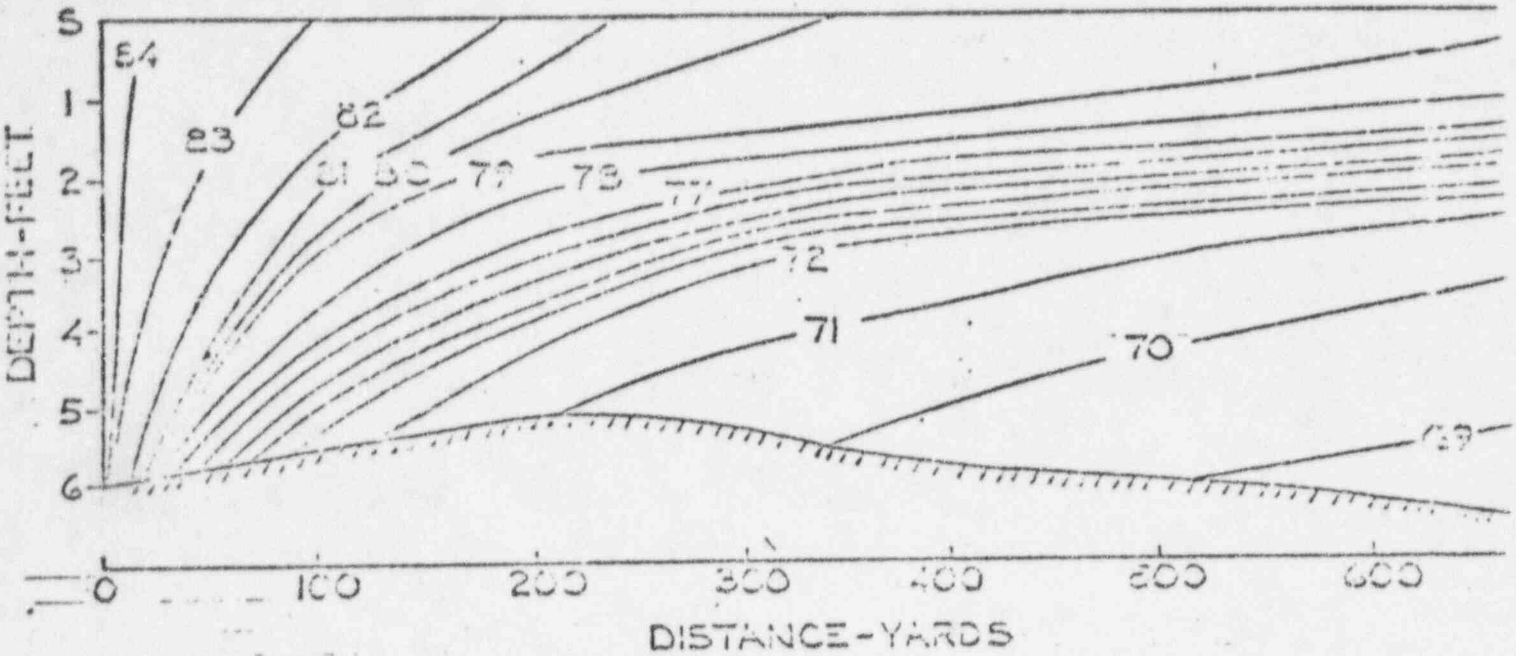
*Unpublished manuscript entitled, "Wind and Tide Effects on a Thermal Plume in Barnegat Bay, New Jersey," Azarovitz, T., Morse, W., and Silverman, M., National Marine Fisheries Service, Highlands, N.J.
Note: This information is priviledged and should not appear in any formal publication.

The extremes of the areas above 85° F when the ambient Bay temperatures are 80° F appear to be 2000 yards in length and 500 yards in width and occur at the end of flood tides with winds from the southeast, i.e., the plume extends from Oyster Creek to north of the mouth of Forked River. Plumes to the south extend approximately 1500 yards in length and 750 yards in width at the end of ebb tide.

While the position of the area or volume with temperatures in excess of 85° F is variable with time, the total volume is relatively constant and amounts to approximately 1 million cubic yards. The volume of the Bay that exchanges with the plume area during the course of a few days may be considered as running from Sunrise Beach Marsh to Waretown and across the Bay to the shallows. This 7000 by 3000 yard area has depths of 2 yards and the volume is roughly 42 million cubic yards. The fraction of the floating population that is present in the area above 85° F is 2.4 percent and any modification of growth rate or mortality of the population from such temperatures will be extremely difficult to perceive as a change in abundance of the organisms.

FIGURE I-1

OYSTER CREEK ENTRANCE CHANNEL
TEMPERATURE-°F



SANDS POINT LINE
TEMPERATURE-°F

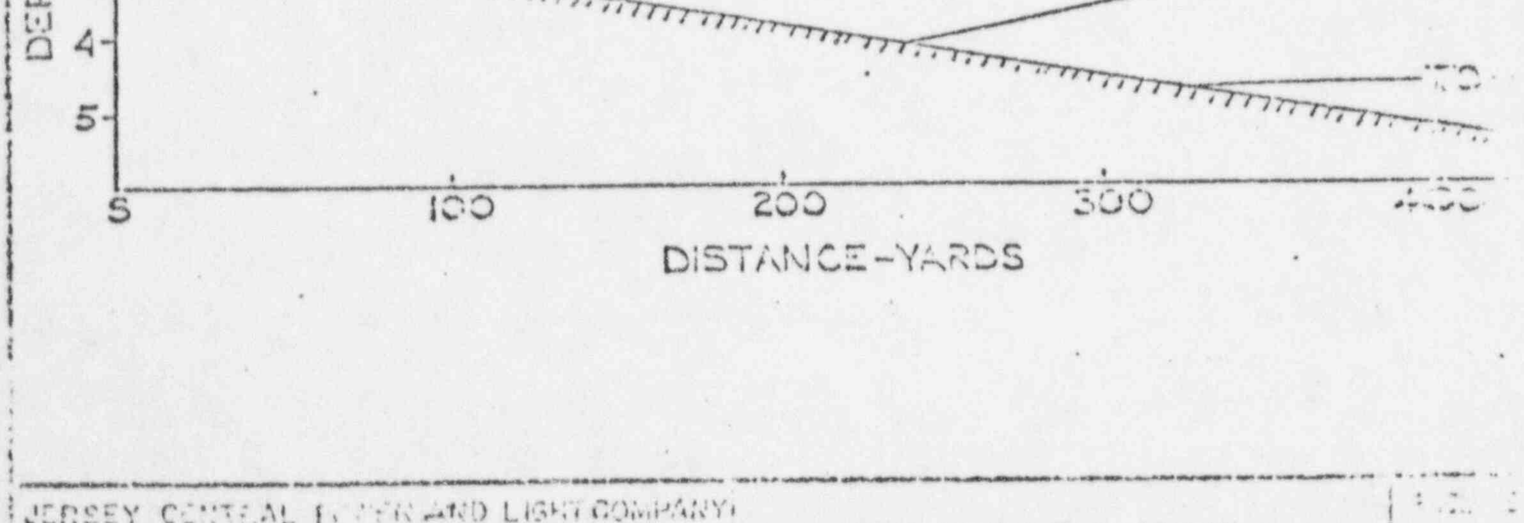
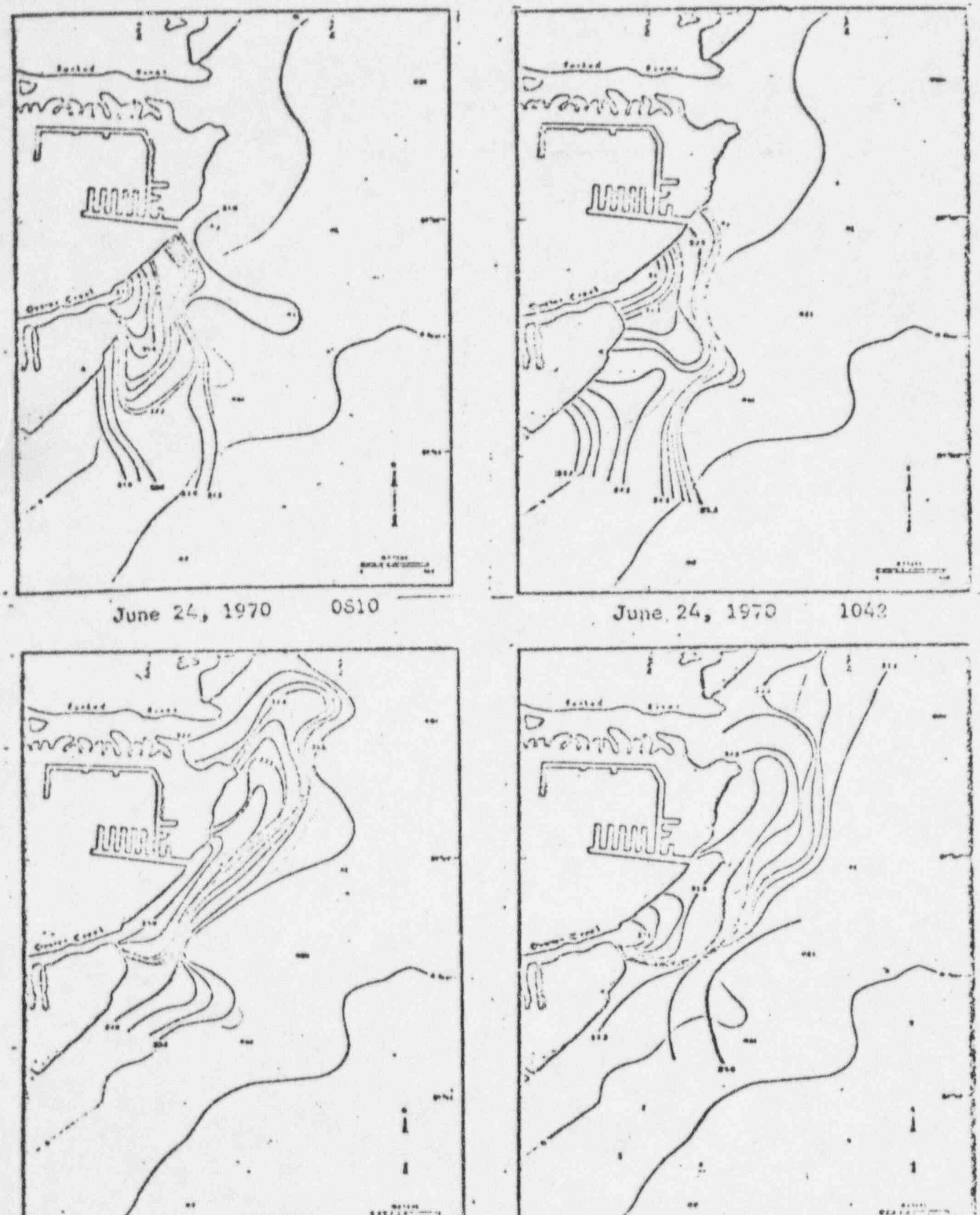


FIGURE 1-2



June 24, 1970 0810

June 24, 1970 1042

June 24, 1970 1320

June 24, 1970 2020

NATIONAL MARINE FISHERIES SERVICE
NORTHEAST REGION
SANDY HOOK SPORT FISHERIES MARINE LABORATORY
Highlands, New Jersey 07732

QUESTION

2. Locate and describe (horizontal and vertical) the water areas that will have temperatures in excess of 87° F as a result of discharges from the Oyster Creek Power Plant.

RESPONSE

Refer to the response to Question 1.

QUESTION

3. Describe the effects of temperatures in excess of 85°F upon the fin and shellfish species common to the area prior to operation of the Oyster Creek Power Plant.

RESPONSE

Very little information is available for Barnegat Bay on the affect of temperatures above 85°F on fish, and none on shellfish. A fishkill investigation report by the New Jersey Fisheries Laboratory at Lebanon (dated July 30, 1968) presented the results of a fishkill that began July 20, 1968. Dead fish had been reported following three of the hottest days of the summer. The fish were identified as juvenile flounder three to seven inches long, and these died over a wide expanse in the northern part of the bay. This report suggested that the kill was associated with elevated temperatures. The maximum temperature recorded (offshore and north of Barnegat Beach) was 86°F, which prevailed from July 17 through July 20. The report also noted that 86°F was the upper limit of the temperature recorder. Elevated temperatures as the cause of the fishkill, however, was not clearly demonstrated but, rather, hypothesized. The report referred to a similar flounder mortality in the same general area in July 1966 following a hot spell. The text of the report referred to bioassay studies of winter flounder (*Pseudopleuronectes americanus*) and for this reason it is presumed this was the flounder species that was involved in the fishkill.

QUESTION

4. Identify changes that have occurred in the fin and shellfish species compositions where temperatures have exceeded 85°F as a result of plant operation.

RESPONSE

Those investigations by the Rutgers University group that relate to fish have not yet been made available for the period following the startup of the plant. Dr. James R. Westman, principal investigator for this group, has advised orally that the temperatures outside the mouth of Oyster Creek have not been found to exceed 85°F. The warmer water in Oyster Creek has apparently been beneficial to anglers by serving as an attractant for both fish and crabs. Any changes in species composition of the community have not been identified. The maximum recorded temperature inside the mouth of Oyster Creek during 1970, the year after the plant began operation, was 93°F. This temperature was found June 5, June 12 and July 20, during the course of semi-weekly sampling for fish eggs and larvae.

QUESTION

5. Identify and describe the effects of any diseases or parasites of fish, shellfish or waterfowl, or other plant or animal pests, that have become established or have changed in abundance following the discharge of waste waters from the Oyster Creek Power Plant.

RESPONSE

There has been no recorded instance of increased abundance of fish or shellfish disease or parasite subsequent to the discharge of waste water from the Oyster Creek Plant.

An increase in the abundance of shipworms (*Bankia gouldi*) has been alleged, and this is currently under investigation. The parties making the allegation are resident along Oyster Creek proper, which is the discharge canal.

Shipworms (a form of wood-boring clam) are natural residents of these waters. In general, the population is too small for dock owners to bother using treated timber in construction. Historically, untreated docks last ten to twelve years in the area before shipworm damage compels replacement. The age of standing docks along Oyster Creek has not been determined. Field investigators from Rutgers University have reported that most recent dock structures in the tributary streams of Barnegat Bay are built of treated wood (using creosote).

Wooden test panels put into Oyster Creek and other tributary streams by the Rutgers' group have, to date, shown very light infestations by shipworms, and no differences in density between Oyster Creek and other streams.

TABLE 6-1
OYSTER CREEK STATION
LIQUID RADIOACTIVE DISCHARGES
1971(1)

Isotope	(1) Discharge Ci/yr	(2) Avg. Conc. in Bay µCi/cc	(3) MPC µCi/cc	Fraction of MPC
H-3	23.18	3.17(-10)	3(-3)	1.06(-7)
Ba+La-140	0.212	2.90(-12)	2(-5)	1.45(-7)
I-131	0.534	7.31(-12)	3(-7)	2.44(-5)
Xe-133	0.772	1.06(-11)	-	-
Xe-135	1.662	2.28(-11)	-	-
Cs-137	0.252	3.45(-12)	2(-5)	1.72(-7)
Cs-134	0.058	7.94(-13)	9(-6)	8.82(-6)
Co-58	1.532	2.10(-11)	9(-5)	2.33(-5)
Co-60	0.202	2.77(-12)	3(-5)	9.22(-6)
Cr-51	0.168	2.30(-12)	2(-3)	1.15(-9)
Mn-54	0.804	1.10(-11)	1(-4)	1.10(-7)
Sr-90	0.480	6.57(-12)	3(-7)	2.19(-5)
I-133	0.574	7.86(-12)	1(-6)	7.86(-6)
Np-239	1.312	1.80(-11)	1(-4)	1.80(-7)
Tc-99m	0.150	2.05(-12)	3(-3)	6.85(-8)
Y-91m	0.002	2.74(-14)	3(-3)	9.13(-8)
Sr-91	0.100	1.37(-12)	5(-5)	2.74(-6)
Mo-99	0.206	2.82(-12)	4(-5)	7.05(-6)
Kr-85m	0.062	8.49(-13)	-	-
Kr-88	0.014	1.92(-13)	-	-
Sb-124	0.006	8.21(-14)	2(-5)	4.11(-9)
Total	29.798			1.06(-4)

NOTES: (1) Oyster Creek Nuclear Generating Station: "Report of Operations, Semi-Annual Report No. 5, July 1, 1971 to December 31, 1971." This was the first reporting period that Oyster Creek was required to present an isotopic breakdown of radioactive liquid discharges. The discharges during this period are considered typical of Oyster Creek Station operations and have been doubled to yield yearly discharge values.

(2) Based on 5×10^{-13} µCi/cc concentration in Bay per µCi/day of material released from Oyster Creek. See Oyster Creek Station Facility Description and Safety Analysis Report, Section II-4.3 and Figure II-4-2.

(3) 10 CFR 20, Appendix B, Table II, Column 2, soluble or insoluble, whichever has the lower value.

QUESTION

7. What are the range and rates of temperature decreases as the result of power plant slowdown, and what has been their effect upon fish and shellfish common to the area?

RESPONSE

Based on information from the Oyster Creek Plant (See Table 7-1 and Figure 7-1), a typical plant shutdown results in a circulating water cooldown rate at the discharge canal Rt. 9 bridge (property line) of about 1.82°F/hr. The rate at the condenser outlet is greater (about 4°F/hr.). These numbers are typical for the normal plant shutdowns and on the average one would expect 2-6 of these each year.

Power reductions and increases necessitated by surveillance testing and preventative maintenance would involve changes at these rates or less but most likely over a range of temperatures about 1/10 to 1/2 of that associated with a shutdown (i.e., 1°-6°F at the bridge; 2°-10°F at the condenser outlet.). These reductions occur on a fairly routine basis - about once every two months.

Normal operational transients that involve a scram would result in more rapid circulating water cooldown rates initially, followed by rates similar to those mentioned above for normal cooldowns. If an event occurs that results in a reactor isolation, the temperature in the discharge canal would drop rapidly to that of the intake canal, probably in less than one hour. These scram and isolation events are, of course, very infrequent.

Previous to January 1972, there had been no deleterious effect upon fish and shellfish common to this area. A loss of a number of fish in the discharge canal occurred in January 1972 when the Oyster Creek plant was shut down for regular maintenance. A copy of the preliminary report on this incident is attached.

TABLE 7-1
CHRONOLOGY OF EVENTS

9-17-71

10:08 p.m.	Start controlled shutdown by insertion of control rods

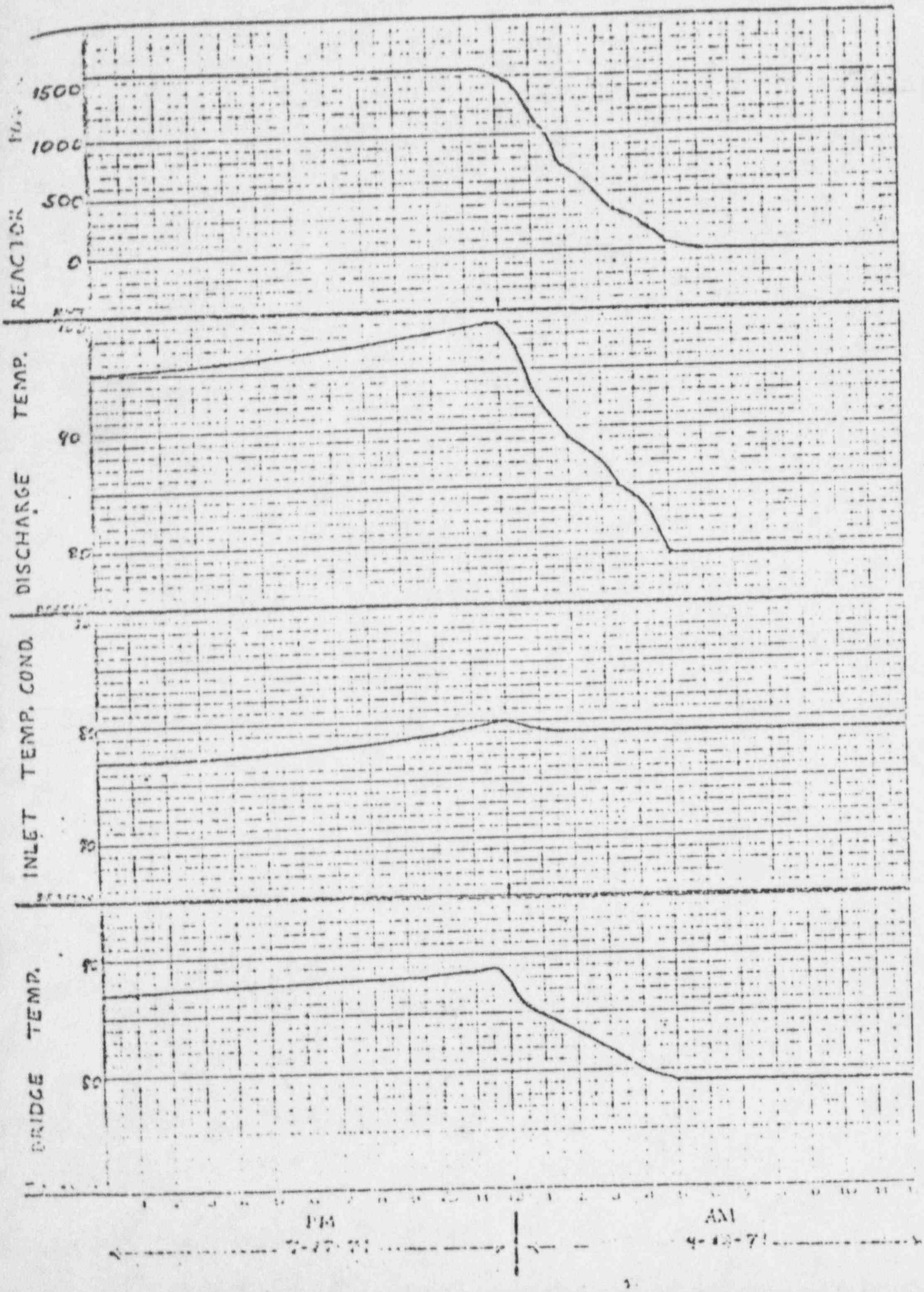
9-18-71

2:05 a.m.	Main Steam Isolation Valve Tests
2:30	Feedwater heaters taken out of service
2:50 & 3:40	"B" & "C" feedwater pumps off
4:44	Generator off line
6:22	A feedwater pump off and begin decrease of reactor recirculation flow
6:46	Recirculation flow down to minimum
7:55	All rods inserted, closed MSIV, start shutdown cooling process

NOTE:

During this entire time period four (4) circulating water pumps were in operation and no dilution pumps were in use.

FIGURE 7-1



1500
1000
500
0
REACTOR
TEMP.
90
80
DISCHARGE
TEMP. COND.
INLET
80
70
TEMP.
BRIDGE
PM
AM

QUESTION

8. What plans exist to reduce drastic temperature decreases in the heat affected area during the winter that might be caused by plant slow-down to the extent that they do not present a hazard to fishes?

RESPONSE

As indicated in the response to Question 7, changes in the Oyster Creek discharge and temperature resulting from startup, shut down or trips prior to January 1972 have never resulted in any deleterious effects on fish in the canal or bay. Consequently, there have never been any special procedures to reduce the temperature transients. However, as a result of the incident in January 1972, the problem is under intensive investigation aimed at avoiding any similar events in the future. These plans will be made available for your review as soon as the investigation is completed.

QUESTION

9. What is the extent of mortality of entrained organisms?

RESPONSE

No specific study has been made of entrained organisms passing through the plant. Those bay studies associated with the planktonic forms of life that may be transported through the condenser tubes, and including fish eggs and larvae, reflect no diminution of population associated with the operation of the Oyster Creek Plant.

Studies have been made of the larger organisms that become entrained, impinge upon the screens, and are flushed down a flume for return to the bay.[1] These studies extend from April 15 through July 1, 1971. After July 1st the weight of the algae flushed from the screens into the flume made it physically impossible to continue the study. Some results are presented here.

A total of 4,226 blue crabs *(Callinectes sapidus)* was taken of which 198 (5.0%) were dead. A total of 701 fish representing 30 species was also taken. Of these, 433 (62%) were dead. Six fish species represented 81% (567 fish) of the total found. These included:

Bay anchovy *(Anchoa mitchilli)* 210 fish, 208 (99%) dead.
Winter flounder *(Pseudopleuronectes americanus)* 112 fish, 17 (13.0%) dead.
Northern pipefish *(Syngnathus fuscus)* 110 fish, 33 (34.0%) dead.
Oyster toadfish *(Opsanus tau)* 33 fish, 1 (3%) dead.

These four fish species represented 66% (455).

These fish losses from the screens are not considered a significant loss from the fish community of the environment.

(1) Wurtz, Dr. C. B.; "Fish and Crabs on the Screens of the Oyster Creek Plant During 1971"; January 14, 1972.

QUESTION

10. To what extent has the discharge affected the distribution and species composition of attached aquatic vegetation.

RESPONSE

The research investigations made by the students and faculty of Rutgers University include studies of the benthic algae. The seventh Progress Report on this work, dated June 25, 1971, stated: "...we have found no evidence for a drastic loss of algal species in Barnegat Bay."

The only vascular plant of common occurrence is the eel grass (*Zostera* species). This grass appeared regularly in the samples collected by the investigators.

The conclusions drawn to date by the investigating group are on collections that include about 135 species of benthic algae with the number of species per sample ranging from two to eight. The report points out that the number of species, and the proportion of each species, in random samples drawn from the study area do not vary significantly from point to point in the bay.

In view of these studies it would appear that the discharge from the Oyster Creek Plant has not affected the distribution or species composition of attached aquatic vegetation.

QUESTION

11. To what extent, if any, does the heated discharge attract waterfowl during the winter and have they experienced any natural mortality.

RESPONSE

Waterfowl (mainly sea gulls) are attracted to the Oyster Creek discharge canal by the fish which inhabit this warm water area during the winter. JCP&L does not study waterfowl; however, there are no qualitative indications of any increased natural mortality attributable to plant operations.