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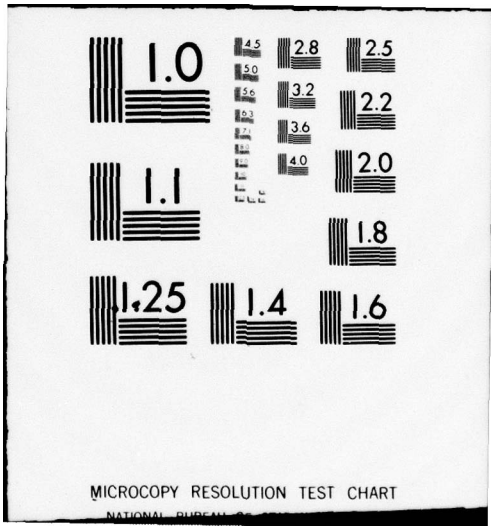
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ATLANTIC COAST · BASIN
NORTH BRANCH FORKED RIVER
OCEAN COUNTY
NEW JERSEY

LEVEL II

LAKE BARNEGAT DAM
NJ 00058

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

August 1979

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Ocean County, N.J.

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Structural Analysis
Visual inspection
National Dam Inspection Act. Report
Lake Barnegat Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number):
This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

27 NOV 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Lake Barnegat Dam in Ocean County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Lake Barnegat Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 17 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. The following remedial actions should be completed within one year from the date of approval of this report:

(1) The deteriorated areas of the exposed concrete surfaces should be patched, especially on the top of the curved crest of the spillway. Also the tops of all joints should be cleaned out and caulked.

(2) Regrade all slopes of embankment and reseed.

(3) Replace the scoured cavities along the upstream face with stone riprap or other heavy shore protection material.

(4) Install roadway curbs and drains on each side of the spillway bridge to channelize the surface run-off away from the structure.

c. Ocean County and Lacey Township should develop a checklist for periodic maintenance inspections so records of conditions and repairs can be maintained. The division of responsibility should be clarified by all involved parties.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman William J. Hughes of the Second District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

LAKE BARNEGAT DAM (NJ00058)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 2 May 1979 by Louis Berger and Associates, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Lake Barnegat Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 17 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is one half of the Probable Maximum Flood.) The decision to consider the spillway "inadequate" instead of "seriously inadequate" is based on the determination that dam failure resulting from overtopping would not significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure. To insure adequacy of the structure, the following actions, as a minimum are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980. In the interim, a detailed emergency operation plan and warning system should be promptly developed. Also, during periods of unusually heavy precipitation, around the clock surveillance should be provided.

b. The following remedial actions should be completed within one year from the date of approval of this report:

(1) The deteriorated areas of the exposed concrete surfaces should be patched, especially on the top of the curved crest of the spillway. Also the tops of all joints should be cleaned out and caulked.

(2) Regrade all slopes of embankment and reseed.

(3) Replace the scoured cavities along the upstream face with stone riprap or other heavy shore protection material.

(4) Install roadway curbs and drains on each side of the spillway bridge to channelize the surface run-off away from the structure.

c. Ocean County and Lacey Township should develop a checklist for periodic maintenance inspections so records of conditions and repairs can be maintained. The division of responsibility should be clarified by all involved parties.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 9 Nov 1979

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Lake Barnegat Dam Fed ID# NJ 00058
NJ ID# 271

State Located New Jersey
County Located Ocean
Coordinates Lat. 3950.4 - Long. 7412.1
Stream North Branch Forked River
Date of Inspection 2 May 1979

[Contd from p. 1]

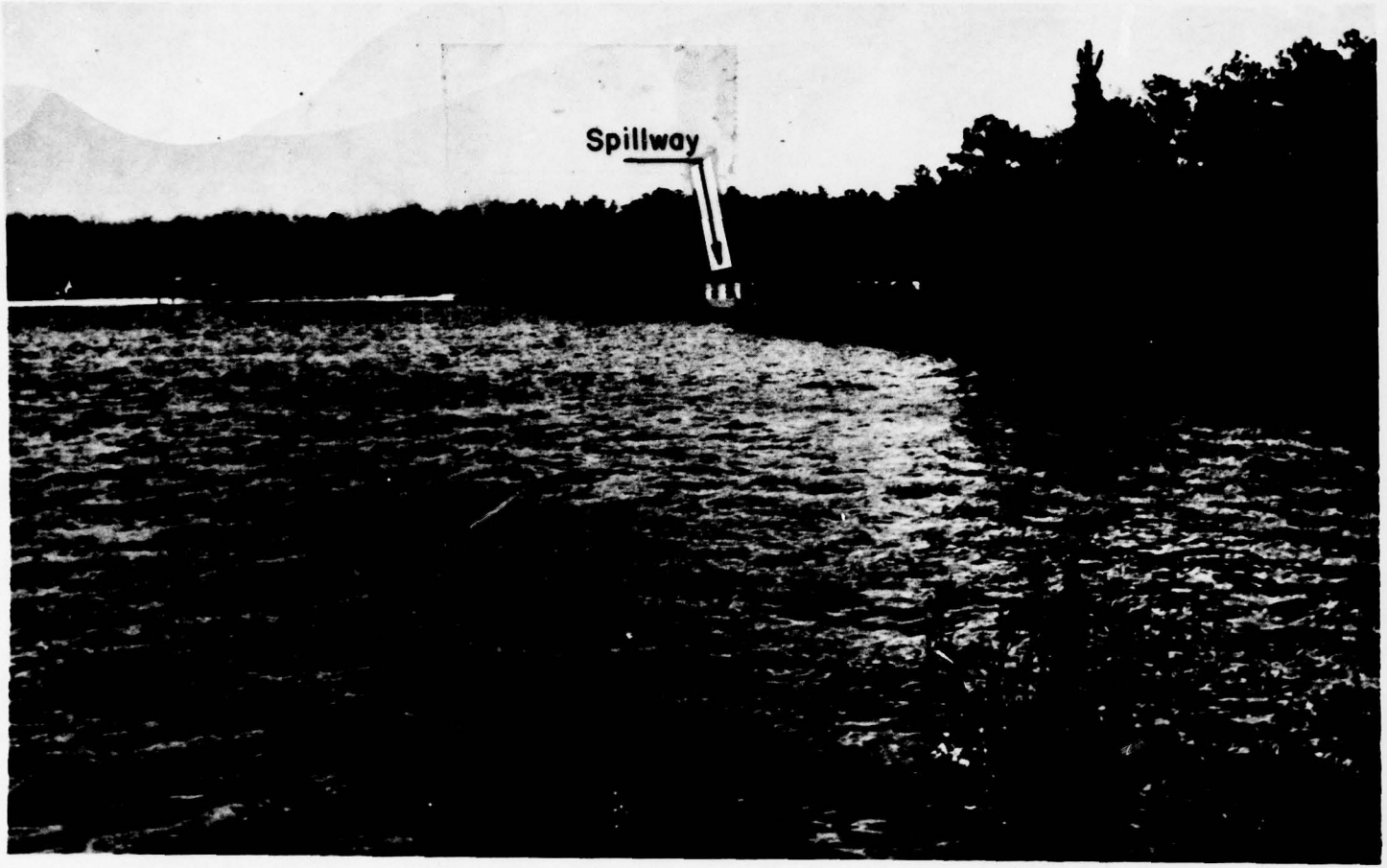
ASSESSMENT OF GENERAL CONDITIONS

Barnegat Lake dam is assessed to be in a fair overall condition. Overtopping would not substantially increase the hazard to human life downstream but a collapse could endanger a downstream dam and Route 9 highway bridge. No detrimental findings were observed to render a hazardous assessment but additional hydraulic studies are recommended. Remedial actions to be undertaken in the future include 1) regrade and seed all embankment slopes, 2) place riprap along the upstream face, 3) install additional roadway curbs and inlets and 4) patch the exposed deteriorated concrete surfaces on the spillway and caulk all open joints on the spillway bridge.

Based upon Corps of Engineers criteria, this dam has an "inadequate" spillway capacity being able to accommodate only 16% of the ½ PMF design flood but is not assessed as UNSAFE, NON-EMERGENCY as failure from overtopping would not appreciably increase the downstream hazard from that condition prior to overtopping.

The legal ownership of the dam and division of maintenance responsibility should be clarified.

F. Keith Jolls P.E.
Project Manager



OVERVIEW OF LAKE BARNEGAT DAM

MAY, 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM: LAKE BARNEGAT DAM FED #NJ 00058
AND NJ ID #271

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Corps of Engineers, Philadelphia to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of Lake Barnegat Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Lake Barnegat dam is a 850 foot long earth embankment with a bridged drop inlet spillway. The spillway is a semi-circular concrete arch weir 50 feet in length, with a 3.5" deep by 12 foot wide depressed notch in the center of the 16 foot radius horseshoe arch. There are two 36" low level sluice gates in the spillway wall. The downstream embankment has a 2H:1V slope and is covered by trees and shrubs. The upstream embankment has 1H:1V slopes above normal pool. The asphalt-paved Lakeside Drive (30 feet wide) runs along the crest of the dam which contains a timber sheeting core wall along its entire length.

[Cont'd on p. X (five page back)]

b. Location

The dam is located on the North Branch of Forked River in Lacey Township, Ocean County, New Jersey and lies ½ mile west of the intersection of Route 9 and Lacey Road and roughly 2 miles north of the Oyster Creek atomic power plant.

c. Size Classification

The dam at Lake Barnegat has a maximum height of 13 feet and a maximum storage capacity of 570 acre-feet. Accordingly, this dam is in the small size category as defined by the criteria in the Recommended Guideline for Safety Inspection of Dams (maximum impoundment less than 1,000 acre-feet and height less than 40 feet).

d. Hazard Classification

Based on Corps of Engineers criteria and the fact that in the event of a failure, excessive damage could occur to downstream properties together with the potential for loss of more than a few lives, the dam is classified as a high hazard. Immediately downstream there is another dam below which lies Route 9 and the Forked River harbor which contains extensive marine facilities.

e. Ownership

According to Division of Water Resources records, the dam is owned by Lacey Township but representatives of their engineering staff disclaim such. Ocean County representatives also deny ownership. The reservoir was originally the property of Barnegat Pines Realty Co. but was apparently deeded over to the Township in 1935 when the dam was constructed with W.P.A. funds.

f. Purpose of Dam

The dam impounds a recreational lake.

g. Design and Construction History

Barnegat Lake Dam was designed in 1936 and constructed in 1937. The design was by Mr. Oliver Newman, P.E. of Freehold, N.J. under W.P.A. Project 5-51 with Lacey Township as the Owner of Record. The contractor is unknown. An earlier dam was planned at the site by the previous owner, Barnegat Pines Realty Co. (in 1928) on the site which was previously occupied by some type of timber impoundment structure. A portion of present Lake Barnegat was called Cornelius' Pond and provided power for a revolutionary-period gristmill located in the vicinity of Route 9.

h. Normal Operating Procedures

It appears that no maintenance is presently carried out at this dam (see Section 4).

1.3 PERTINENT DATA

a. Drainage Area

Lake Barnegat has a drainage area of 15.0 square miles.

b. Total spillway capacity - 1440 cfs (@ top of dam)

c. Elevations (ft. above MSL)

Top of Dam - 18.35
Spillway Crest - 14.1
Streambed at Centreline of Dam - 5.0±

d. Reservoir

Length of Maximum Pool (top of dam) - 4,300 feet
Length of Recreation Pool (spillway crest) - 3,100 feet

e. Storage (acre-feet)

Maximum Pool - 570
Recreation Pool - 230

f. Reservoir Surface (acres)

Maximum Pool - 99.1
Recreation Pool - 61.5

g. Dam

Type - Earth embankment with concrete arch spillway
Length - 850 feet
Hydraulic Height - 13± feet
Structural Height - 18± feet
Top Width - 40 feet
Side Slopes - variable (3H:1V to 1:1)
Zoning - unknown
Core - timber sheet piling

h. Diversion and Regulating Tunnel - None

i. Spillway

Type - concrete semi-circular arch weir with two gated sluiceways
Length of Weir - 50 feet
U/S Channel - Reservoir of study dam
D/S Channel - Reservoir of Lower Lake

j. Regulating Outlets - Two 36" Armco gates (Inv. El. 5.6±)

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The contract plans for the original construction were approved for the Barnegat Lake dam in 1936 but complete copies could not be located by the inspection team. These plans indicate the overall configuration of the spillway structure but nothing is known regarding design assumptions or allowable stresses. Certain portions of the dam hydraulic design were also obtained (see Section 5). The spillway bridge was carefully detailed and dimensioned and indicates the extent of timber sheeting all around the periphery of the footings. The concrete called for was 1:2:4 which indicates relatively low allowable stresses were employed.

2.2 CONSTRUCTION

Various inspections made in 1936 and 1942 indicate that the construction was carried out in a workmanlike fashion. There was a considerable amount of correspondence between the Division of Water Resources and the designer regarding the timber sheeting under the spillway bridge but this appears to have been resolved satisfactorily. From the review of the design plans, it could not be determined exactly what this problem was (see Section 6 for review of the sheeting).

2.3 OPERATION

The dam appears to have been operating satisfactorily from an engineering standpoint since its completion.

2.4 EVALUATION

a. Availability

Sufficient engineering data regarding the makeup or zoning of the embankment is not available to fully assess the design of this element but it appears that locally available material was used. The underlying soils in this area are comprised of recent alluvium that is mixed with overlying swamp deposits. Below these are found the

stratified marine Cohansey sands. The silt and sand alluvium are highly variable with some clay and organic material found near the surface. The internal drainage is generally good and depth to bedrock is generally greater than 100 feet. No recent boring data was located in the immediate vicinity, but from a brief survey of the surrounding area, most heavy construction work is founded on timber piling. However, it was noted that the spillway bridge spread footings are founded on the white sands underlying the muck cedar swamp overburden.

b. Adequacy

The 1935 contract plans prepared by Mr. Newman are considered adequate to assess this dam under the purview of the Phase I inspection.

c. Validity

Based on field observations and discussions with engineering personnel of the County Engineer's office, the existing data obtained appears valid and is not challenged.

SECTION 3 - VISUAL OBSERVATIONS

3.1 FINDINGS

a. General

The visual inspection was conducted on 2 May 1979 during a period of clear weather. The lake level did not appear to flucutate during the period of a follow-up inspection which was conducted three weeks later. Due to the turbidity of the water, submerged conditions of the upstream embankment slope and the spillway invert could not be closely examined.

b. Dam

The embankment is in a satisfactory condition especially in spite of the apparent lack of maintenance. The asphalt street has few depressed areas or potholes but appears to be lightly travelled insofar as heavy wheel loads are concerned. However, the surface run-off appears to be a continual maintenance problem and numerous small erosion gullies are cut into the sideslopes. In some areas, wave action has undercut the upstream slopes right up to the edge of the pavement. There is no riprap visible except for small areas near the downstream wingwalls. The downstream slopes have retained their 2H:1V gradient but are covered with small trees (4-6 inch diameter) and secondary growth brush. The height of over three quarters of the dam is only 6 to 8 feet at the toe of downstream slope and the lower lake reservoir extends almost up to the toe of slope in the vicinity of the spillway. There is no evidence of seepage.

c. Appurtenant Structures

The reinforced concrete spillway is located 300 feet from the right abutment and displays severe weathering, reflecting its age and proximity to the ocean shoreline. It appears to be in an overall integral condition with

few major structural cracks. The horseshoe weir is in solid condition but the exposed crest and walls are skinned and the coarse aggregate is exposed. This may be the result of a highly acidic condition of the water (rather than a poor quality concrete). The depth of flow precluded a detailed structural inspection. The two vertical-lift sluicegates located at the third-points along the spillway appear to be abandoned and their gate wheels have been removed or vandalized. There is a considerable amount of silt in front of the dam but it could not be determined by probing whether or not the inlets were buried.

The bridge superstructure has 2 fifteen foot clear spans and is in satisfactory condition but the center pier and downstream wingwalls of the substructure have several pronounced cracks and spalled areas. The perimeter of the footings are protected by 3 inch T.&G. timber sheeting (12 feet long) but the walls are founded on spread footings and are not pile-supported; a questionable design configuration in the opinion of the inspection team. However, the structure has stood for almost 45 years with little evidence of serious differential settlement. According to construction records, the muck cedar swamp bottom soils were excavated down to elevation zero where a dense clean sand formed the load-bearing stratum.

There is considerable localized erosion at each corner of the bridge but stone slope protection has been placed behind the downstream wings.

d. Reservoir

The Barnegat Lake reservoir extends almost a mile upstream to a new bridge and small spillway recently completed by Ocean County at Dear Head Lake. There is a recreation beach on the north shore and the side slopes are very flat. The lake is clear of debris and except near the dam, appears free of silt.

e. Downstream Channel

The North Branch discharges directly into Lower Lake which is impounded by a similar roadway embankment and a timber spillway/bridge overflow. Further east, the stream discharges into the Forked River harbor at sea level. A railroad trestle crosses Lower Lake at its midpoint and although reportedly abandoned, it appears that it has been used periodically to service the atomic power plant. It was noted that the original stream bed was located about 150 feet north of the spillway.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

Operational procedures were discussed with personnel of the Ocean County Engineers office. These are conducted principally on an as-needed basis and there are no formally established schedules for inspection or maintenance.

4.2 MAINTENANCE OF DAM

There is no evidence of any recent maintenance.

4.3 MAINTENANCE OF OPERATING FACILITIES

None exists except for monitoring by County and Township personnel and local police during heavy storms. It could not be determined who maintains or operates the gates.

4.5 EVALUATION

Little exists that could be evaluated regarding safe operational procedures. However, in view of the apparent lack of maintenance and the somewhat questionable status of who is responsible for operations, the present procedures are deemed to be less than adequate until such time as the ownership is clarified.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data

Based on the criteria in the Recommended Guidelines for Safety Inspection of Dams, Lake Barnegat Dam is small in size and is placed in the high hazard category. Accordingly, one half the probable maximum flood (PMF) was selected as the design storm by the inspecting engineers. The inflow hydrograph was obtained utilizing precipitation data from Hydrometeorological Report #33. Inflow to, and routing through the reservoir were calculated using the HEC-1 computer program. This gave a peak inflow to the reservoir for the ½ PMF of 9,214 cfs and when routed, reduced insignificantly to 9,132 cfs. The spillway has a maximum discharge capacity of 1,440 cfs before overtopping occurs and therefore can accommodate 16% of the design flood.

b. Experience Data

There was no recorded evidence as to the hydraulic performance of Lake Barnegat Dam since its construction. The dam does not appear to have ever been overtopped with an evidence of damage. There are no streamflow records available.

c. Visual Observations

The spillway appears to function satisfactorily and is of comparable size to the outlet at the Lower Lake dam. It was observed that the inlet at the upstream Deer Head Lake dam has only about a 30 foot effective width which would severely restrict the discharge into Barnegat Lake during heavy storms.

d. Overtopping Potential

It is unknown if the dam has been overtopped in the past. However, the spillway is clearly not

capable of transmitting the design flood without overtopping and thus, the potential remains substantial. A reasonable depth of overtopping above 2 feet cannot be foreseen because at that elevation, the water would inundate large portions of the surrounding community both north and south of the dam and further rising of the flood would not be expected. This may account for the lack of historic information regarding the dam's performance.

e. Drawdown

Drawdown is provided by two 36" Armco steel gates at the base of the spillway wall. Assuming an inflow of 1 cfs per square mile, it would take approximately 1½ days to drawdown the reservoir from the normal recreation pool elevation.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Based on the visual inspection and review of the available design plans, Barnegat Lake Dam is deemed to be in a sound structural condition as long as the embankment is not breached either side of the spillway. The full length 3" timber cut-off wall on the dam axis extends almost to the crest elevation and with the low height to width ratio, places the trapozoidal embankment in a very stable condition with adequate factors of safety against sliding, overturning and earthquake loadings. A wash-out or undercutting of the spillway structure however could easily lead to its collapse, especially along the downstream wingwalls. The various components of the bridge were all cast separately (the walls, center pier, invert slab and deck slab units) and are properly dowelled together but in view of the acid and/or salt water environment, the dowels could be seriously corroded as there are no apparent waterstops or mastic joint sealing in the "cold" construction joints. Also, in most areas, the dowels are placed at the centroid of the section and even if not rusted, could allow considerable articulation if a collapse mechanism developed. Further, it appears that the timber sheeting installed under the spillway sidewalls (under the bridge) is set back 2'-0" from the toe, or outer edge, of the semi-gravity wall footing. Thus, the most important zone of the spread footing (where the pressures are highest) is outside the protected confines of the timber cofferdam. The white marine "beach" sand at founding elevation is very compact and dense when confined but flows readily when exposed in a loose condition, as could be the case outside the cofferdam sheeting. In summary, the spillway is believed to be stable as long as it is not undermined and the surrounding embankment remains in place. There is no practical or feasible way this condition could be further investigated.

b. Design and Construction Data

The original design computations for stress analysis and overturning stability were unavailable but all elements of the spillway bridge have been conservatively apportioned, except for the reservations mentioned in the above paragraph.

c. Operating Records

No records are available but the spillway functions satisfactorily as an uncontrolled weir. The crest roadway surface run-off is a continual maintenance problem but the various corrective measures are, for the most part, satisfactory in preventing serious erosion of the slopes. As previously stated, there are no records at the Division of Water Resources that the dam has been inspected in recent times.

d. Post Construction Changes

There is no evidence of any post-1936 construction changes except highway guardrail has been installed each side of the bridge parapets.

e. Seismic Stability

This dam is located in Seismic Zone 1 and experience indicates that low dams of the Barneqet Lake type will have adequate stability under earthquake dynamic loading conditions if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection procedures stipulated by the Corps of Engineers, the Barnegat Lake Dam is adjudged to be in an adequately sound overall structural condition, although the spillway is incapable of transmitting the SDF without overtopping. No detrimental findings were revealed except those recommended to be corrected by the remedial items stipulated below. The structural stability of the spillway against severe breaching or undercutting remains questionable but is viewed as being satisfactory as long as the embankment fill remains in place.

The spillway capacity is "inadequate" and does not meet the requirements of the Recommended Guidelines for Safety Inspection of Dams, being able to accommodate only 16 percent of the ½ PMF design flood as calculated by Corps of Engineers criteria. However, the conditions are such that failure from overtopping would not significantly increase the hazard to loss of life downstream from that which would exist just before overtopping failure occurs. Due to the very flat terrain, overtopping flows would spread out into surrounding residential areas and effectively engulf a flood plain almost one-half mile wide. This would diminish any further rise in flood levels and although the downstream dam would probably be overtopped, the overall condition would not increase the danger to human life.

b. Adequacy of Information

The information obtained for the Phase I inspection is deemed to be adequate and it is believed that little else is available. Performance data is non-existent. Therefore, in view of the

hazard classification and downstream conditions, the information is considered adequate for the assessment.

c. Urgency

A collapse of the spillway could endanger the downstream dam and culvert at Route 9. However, in view of the overall site conditions, it is recommended that the remedial measures set forth below be taken under advisement in the future.

d. Necessity for Further Study

Further structural studies regarding the dam itself are believed to be unnecessary but additional hydraulic/hydrologic studies are recommended as dictated by Corps of Engineers criteria.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. Recommendations

The deteriorated areas of the exposed concrete surfaces should be patched, especially on the top of the curved crest of the spillway. Also the tops of all joints should be cleaned out and caulked.

Other remedial measures include:

- Regrade all slopes of embankment and reseed.
- Replace the scoured cavities along the upstream face with stone riprap or other heavy shore protection material.
- Install roadway curbs and drains on each side of the spillway bridge to channelize the surface run-off away from the structure.

b. O&M Maintenance and Procedures

No additional procedures other than those presently in effect are warranted. However, it is recommended that Ocean County and Lacey Township develop a checklist of periodic maintenance inspections so records of conditions and repairs can be maintained. It is also suggested that the division of responsibility be clarified by all involved parties.

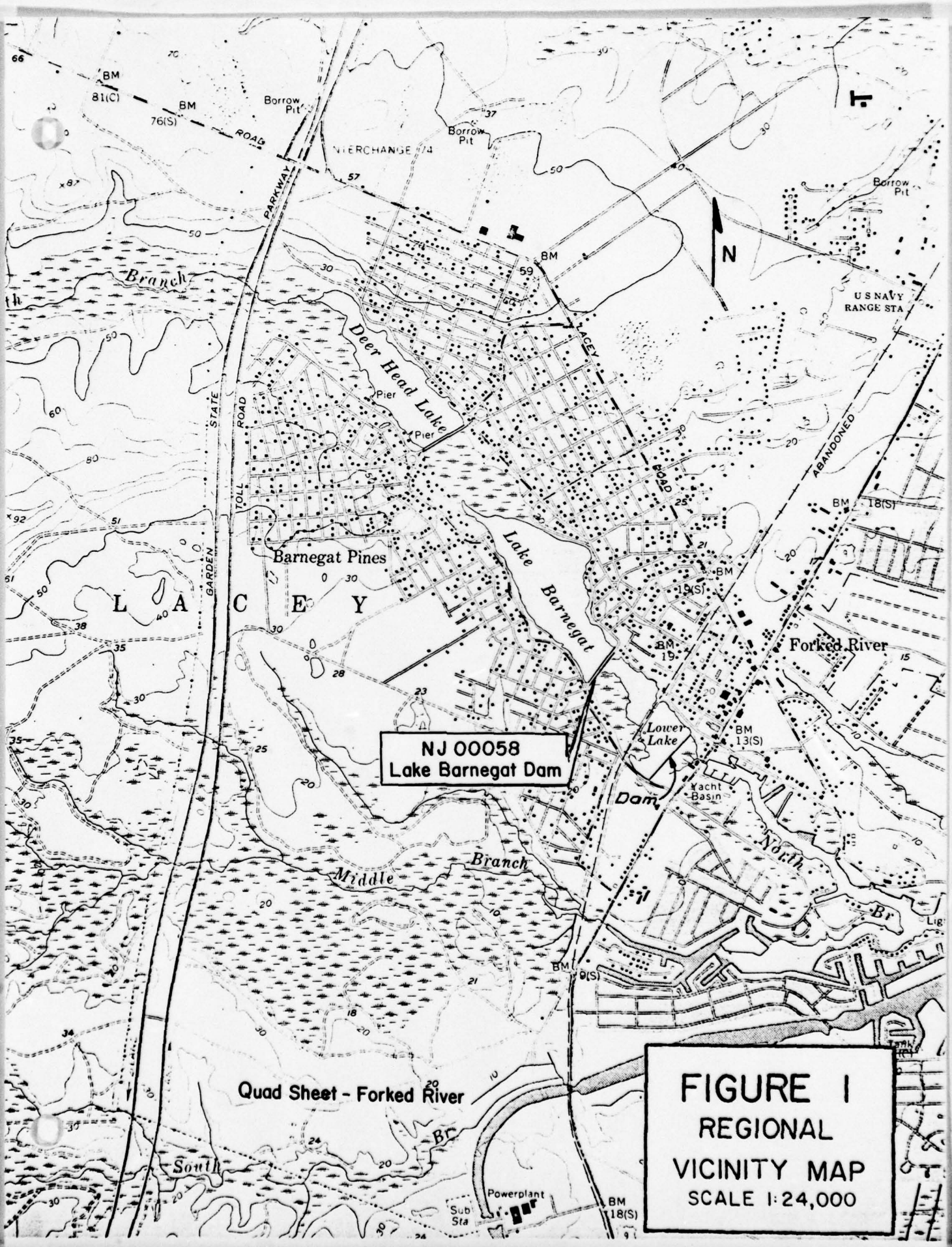


FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24,000

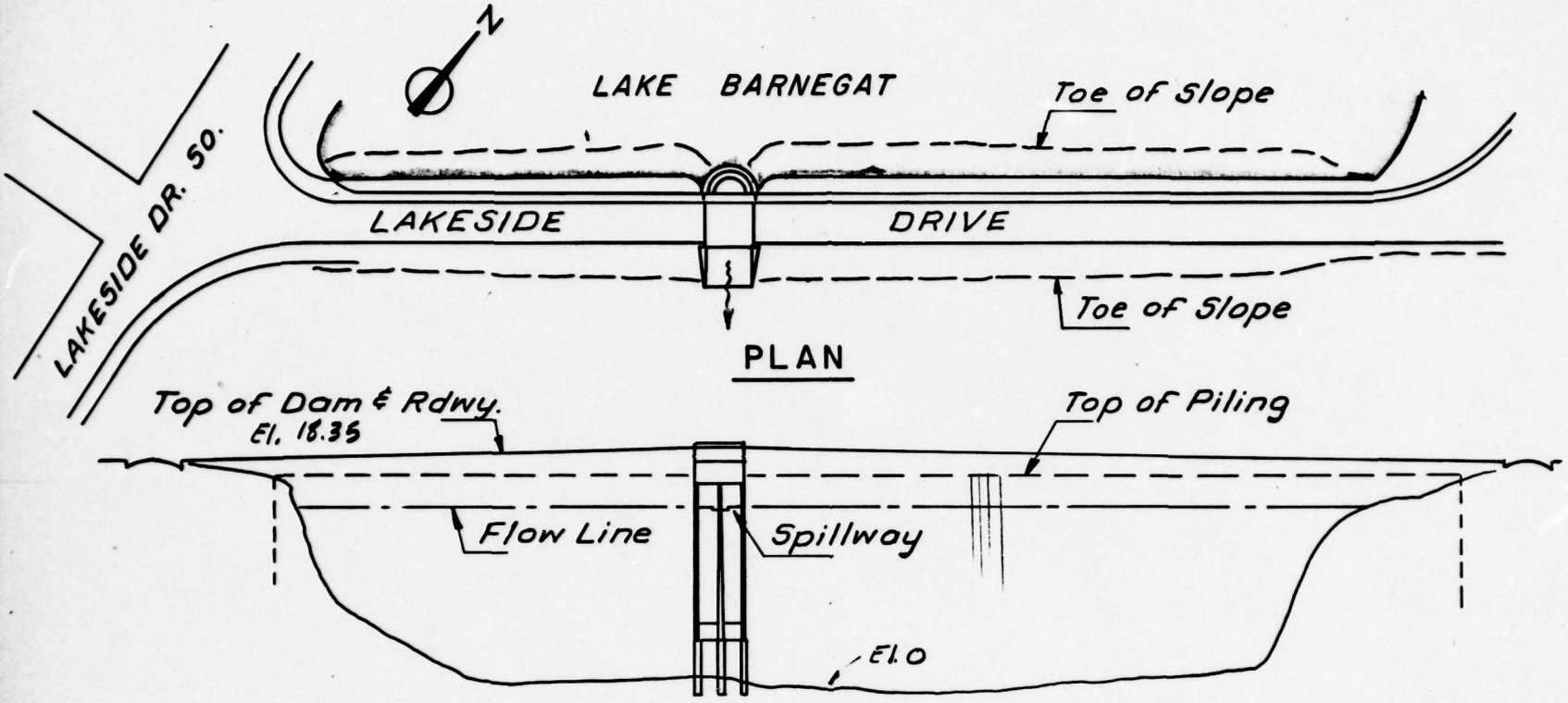
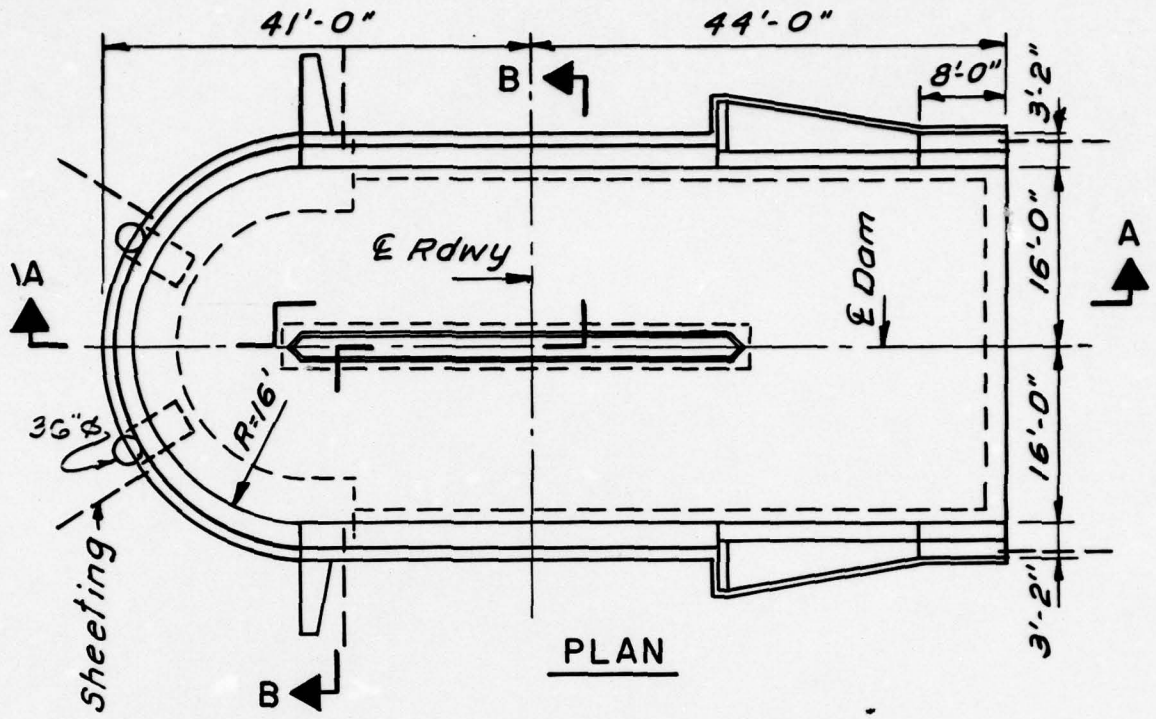
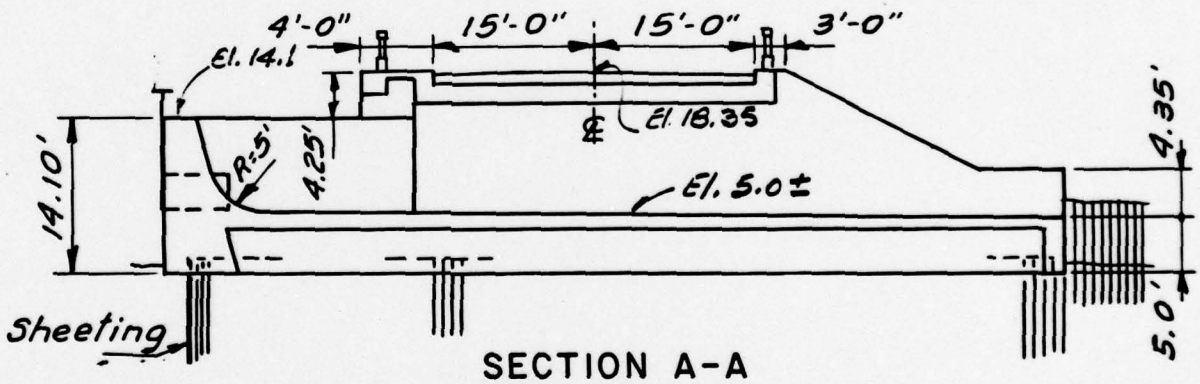
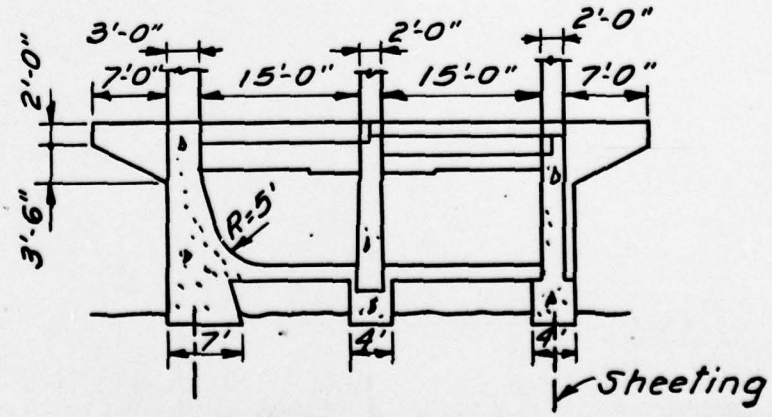

N
LAKE BARNEGAT
Toe of Slope
LAKESIDE DR. 50'
LAKESIDE
DRIVE
Toe of Slope
PLAN
Top of Dam & Rdwy.
El. 18.35
Top of Piling
Flow Line
Spillway
El. 0
LONG. SECTION
Not to Scale
7'
15'
15'
3'
1:1
2:1
3:1
Timber Piling
O.G.
SECTION THRU DAM

FIGURE 2





Not to Scale



SPILLWAY DETAILS
FIGURE 3

Check List
Visual Inspection
Phase 1

Name Dam Lake Barnegat County Ocean State New Jersey Coordinators NJDEP

Date(s) Inspection 2 May 79 Weather Clear Temperature 60°F

Pool Elevation at Time of Inspection 14.6 M.S.L. Tailwater at Time of Inspection 9.35 M.S.L.

Inspection Personnel:

K. Jolls

L. Baines

K. Greenfield

L. Baines Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed. Pavement in good condition.	Asphalt-paved 2-lane roadway.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed at downstream slopes. Upstream slope being undercut by wave action.	Recommend added protection.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Some erosion at downstream toe. Approximately 2:1 downstream slopes.	Very irregular slopes. Backslopes should be regraded in eroded areas.
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Satisfactory. Roadway runoff is damaging backslopes.	Roadway (50 $\pm$) Very level. Asphalt paved. Guard rail at bridge.
RIPRAP FAILURES	No riprap except at downstream wingwalls.	Suggest additional riprap on upstream slopes.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
Excessive Shrub Growth, Trees, etc.	Secondary growth of pines on downstream slopes.	O.G. to right of main spillway 6'-8' below dam crest.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Satisfactory	Abutment areas are at street intersections.
ANY NOTICEABLE SEEPAGE	None observed	Lower lake extends up to downstream toe.
STAFF GAGE AND RECORDER	None	
DRAINS	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Numerous heavy cracks, especially in downstream wingwalls.	Bridge built in 1936.
INTAKE STRUCTURE	Circular weir; crest in good condition.	Water about 2' deep in front of spillway wall.
OUTLET STRUCTURE	None. Center bridge pier spalled and deteriorated.	Spillway discharges into Lower Lake.
OUTLET CHANNEL	Clear of debris; shallow short channel area clear. (50± wide).	
EMERGENCY GATE	2 gates in sillway. Wheels missing.	Submerged. Could not be observed.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Narrow-crested circular weir.	
APPROACH CHANNEL	Main reservoir.	
DISCHARGE CHANNEL	See previous page.	
BRIDGE AND PIERS	See previous page.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Very flat	Recreation beach on north shore.
SEDIMENTATION	Minor, clear sand bottom.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Lower Barnegat Lake immediately below dam. Township recreation facilities. New timber spillway and bridge. Numerous utility manholes.	
SLOPES	Very flat, 3-5 feet above normal lake elevation.	
APPROXIMATE NO. OF HOMES AND POPULATION	Most homes 3'-4' above lake level. (Same approximate elevation as dam crest.)	Number of homes in influence area: 10-15.

Note: Marina - east of Route 9.
Downstream dam at Lacey Township Rec. Area.
Railroad track occasionally used for atomic power plant.

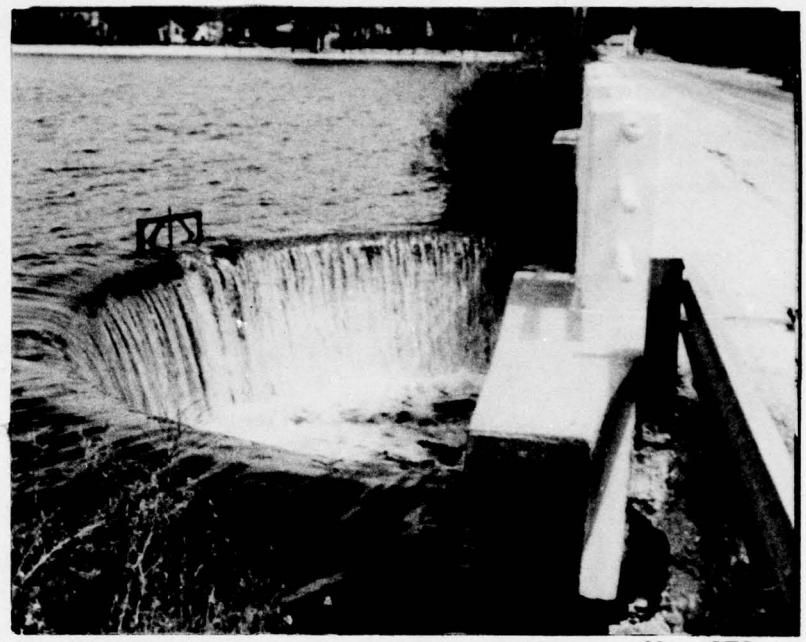
CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	Available (NJDEP - Div. Water Resources, Bureau Flood Plain Management
REGIONAL VICINITY MAP	Available (U.S.G.S. Quadrangle - Forked River)
CONSTRUCTION HISTORY	Some available (NJDEP)
TYPICAL SECTIONS OF DAM	Available (NJDEP)
HYDROLOGIC/HYDRAULIC DATA	Some available (NJDEP)
OUTLETS - PLAN	Available (NJDEP)
- DETAILS	Available (NJDEP)
-CONSTRAINTS	Not available
-DISCHARGE RATINGS	Not available
RAINFALL/RESERVOIR RECORDS	Not available

ITEM	REMARKS
SPILLWAY PLAN	Available (NJDEP)
SECTIONS	Available (NJDEP)
DETAILS	Available (NJDEP)
OPERATING EQUIPMENT PLANS & DETAILS	Some available (NJDEP)

ITEM	REMARKS
DESIGN REPORTS	Some available (NJDEP)
GEOLOGY REPORTS	None available
DESIGN COMPUTATIONS	None available
HYDROLOGY & HYDRAULICS	Some available
DAM STABILITY	None available
SEEPAGE STUDIES	None available
MATERIALS INVESTIGATIONS	None available
BORING RECORDS	None available
LABORATORY	None available
FIELD	None available
POST-CONSTRUCTION SURVEYS OF DAM	Unknown
BORROW SOURCES	Unknown

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	None available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Unknown
MAINTENANCE OPERATION RECORDS	None available

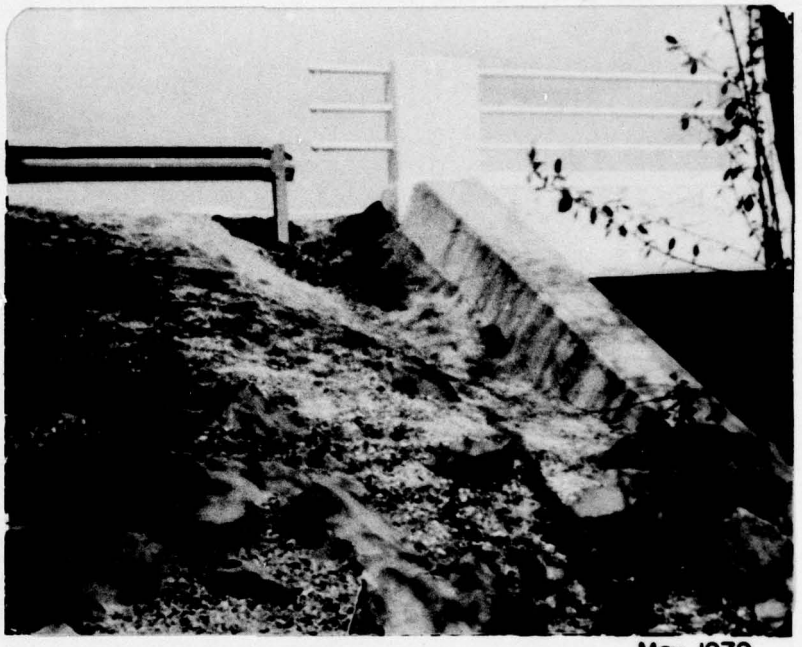


May, 1979

View of Spillway

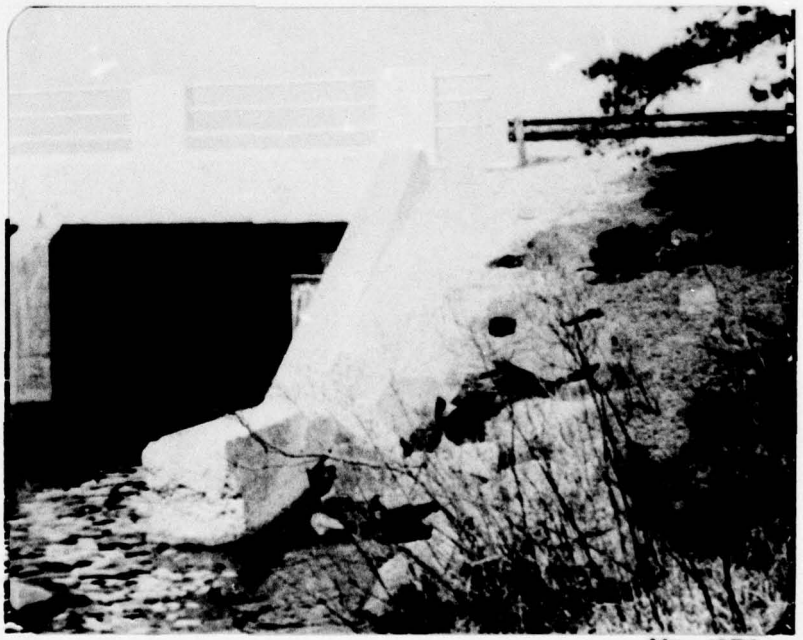
May, 1979

View of Spillway Outlet



May, 1979

View of Erosion - Right Wingwall



May, 1979

View of Erosion - Left Wingwall

May, 1979

View of Erosion

May, 1979

View of Crest Looking Northeast

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 15.0 Square miles

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 14.1 M.S.L. (230 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N/A

ELEVATION MAXIMUM DESIGN POOL:

ELEVATION TOP DAM: 18.35 M.S.L. (570 acre-feet)

CREST: Main Spillway

a. Elevation 14.1 M.S.L.
b. Type Concrete semi-circular weir
c. Width 3 feet
d. Length 50 feet
e. Location Spillover 340 feet from right abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type
b. Location
c. Entrance inverts
d. Exit inverts
e. Emergency draindown facilities 2-36" Ø low level pipes

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 1440 cfs

BY. D. J. M. DATE 6-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A1 OF.
CHKD. BY. DATE LAKE BARNEGAT DAM PROJECT C234
SUBJECT

Time of concentration: (Drainage area = 15 square miles)

length along longest water course to drainage divide = 8.8 miles
= 46,464 ft

ΔH = 156 feet $\therefore$ Slope $= \frac{156 \times 100}{46,464} = 0.34\%$

Assume a velocity of 2.0 ft s^{-1}

$\therefore t_c = \frac{46,464}{2.0 \times 3600} = 6.5$ hours

By California Culverts Method:

$$t_c = \left(\frac{11.9 \times 8.8^3}{156}\right)^{0.385} = 4.6 \text{ hours}$$

take an average value of $t_c = \frac{4.6 + 6.5}{2}$

$\therefore$

$= 5.55$ hours

$t_p = \frac{1}{2} + 0.6 \times 5.55 = 3.83$ hours

$Q_p = \frac{256 \times 15}{3.83} = 1003$ cfs

BY D.J.M. DATE 9-79
CHKD. BY _____ DATE _____
SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.
LAKE BARNEGAT DAM

SHEET NO. A2
PROJECT C23

Unitgraph

Time	T/Tp	Dimensionless Ordinate (DO)	Q (cfs) = Qp × DO
1	0.26	0.20	201
2	0.52	0.49	491
3	0.78	0.90	902
4	1.04	0.99	993
5	1.31	0.92	922
6	1.57	0.80	802
7	1.83	0.66	682
8	2.09	0.56	561
9	2.35	0.49	491
10	2.61	0.43	431
11	2.87	0.38	381
12	3.13	0.33	331
13	3.39	0.29	291
14	3.66	0.25	251
15	3.92	0.22	221
16	4.18	0.20	201
17	4.44	0.19	190
18	4.70	0.18	180
19	4.96	0.16	160
20	5.22	0.15	150
21	5.48	0.14	140
22	5.74	0.12	120
23	6.01	0.11	110
24	6.27	0.10	100
25	6.53	0.08	80
26	6.79	0.07	70
27	7.05	0.06	60
28	7.31	0.05	50
29	7.57	0.04	40
30	7.83	0.035	35
31	8.09	0.03	30

BY D J M DATE 9-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A2A OF ___

CHKD. BY ___ DATE ___ LAKE RARITAN PROJECT C234

SUBJECT ___

PRECIPITATION:

Probable Maximum Precipitation for 200 square miles - 24 hours (in inches) = 23.8"

Maximum	6 hour percentage	= 110%
Maximum	12 hour percentage	= 120%
Maximum	24 hour percentage	= 129%

BY D.J.M. DATE 6-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A3 OF

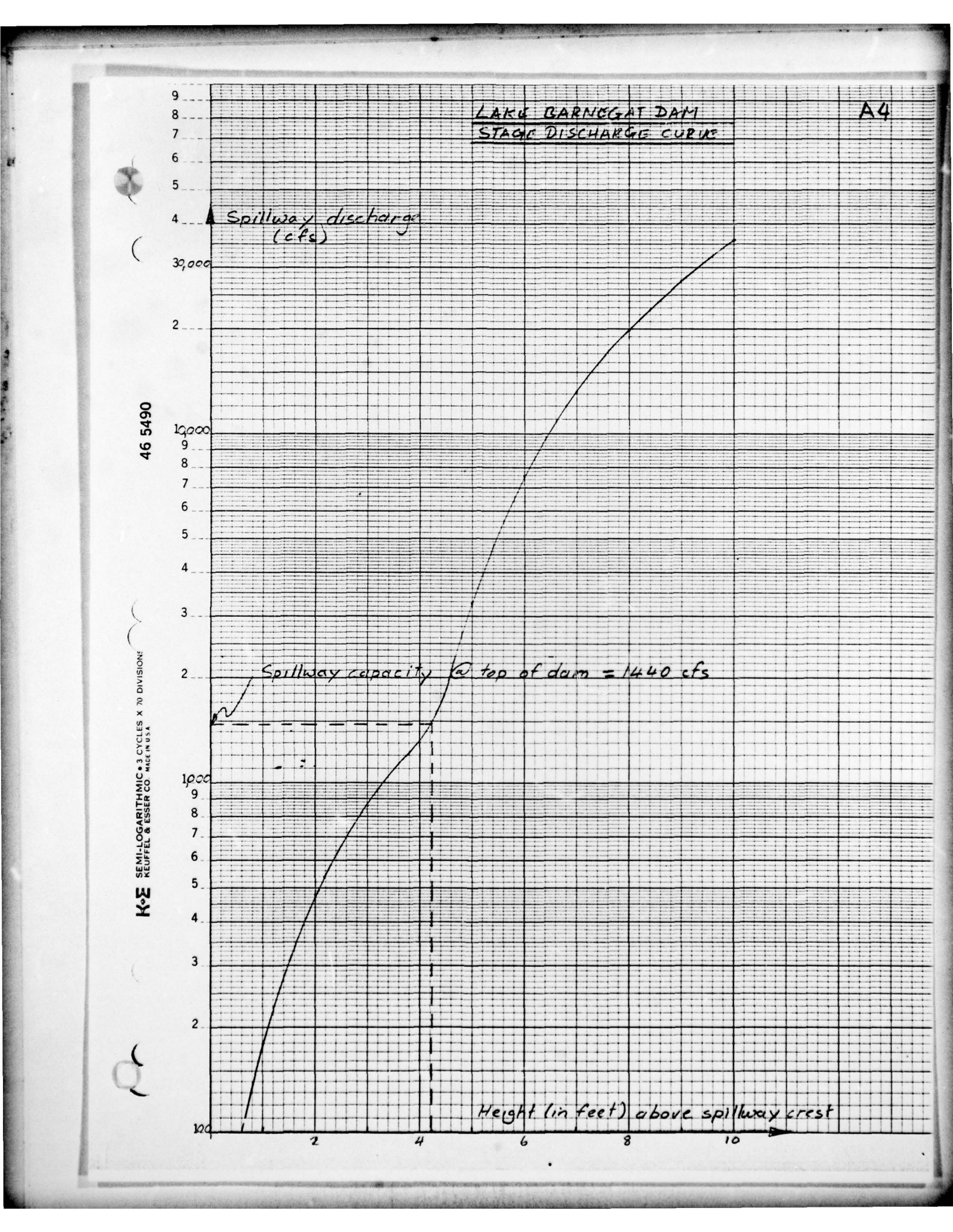
CHKD. BY DATE LAKE BARNEGAT DAM PROJECT C234

SUBJECT Spillway discharge capacity

Spillway discharge:

flow over crest L = 38'			flow over notch L=12'			flow over dam L≈800'			ΣQ cfs
H	C	Q	H	C	Q	H	C	Q	
0	3.2	0	0.3	3.2	6				6
1	3.2	122	1.3	3.2	57				179
2	3.2	344	2.3	3.2	134				478
3	3.2	632	3.3	3.2	230				862
4	3.2	973	4.3	3.2	342				1,315
5	3.2	1360	5.3	3.2	469	0.75	2.8	1,455	3,284
6	3.2	1787	6.3	3.2	607	1.75	2.8	5,186	7,580
7	3.2	2252	7.3	3.2	757	2.75	2.8	10,215	13,224
8	3.2	2751	8.3	3.2	918	3.75	2.8	16,267	19,936
9	3.2	3283	9.3	3.2	1089	4.75	2.8	23,189	27,561
10	3.2	3845	10.3	3.2	1269	5.75	2.8	30,885	35,999

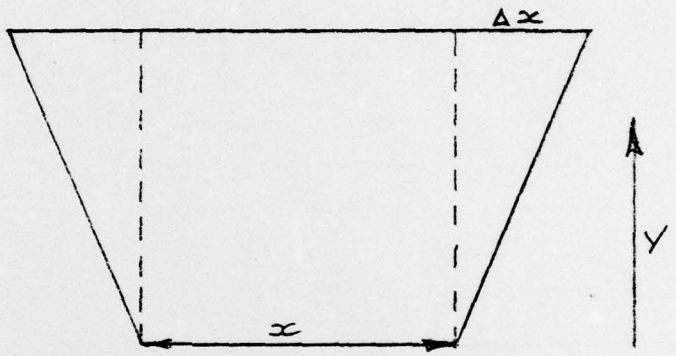
The above discharge calculations do not include the two 36" pipes. As there is no guarantee that they will be open under flood conditions


LAKE BARNEGAT DAM
STAGE DISCHARGE CURVE
A4
Spillway discharge (cfs)
30,000
10,000
1,000
100
Spillway capacity @ top of dam = 1440 cfs
Height (in feet) above spillway crest
2
4
6
8
10
46 5490
K+E SEMI-LOGARITHMIC • 3 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

BY D J M DATE 6-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A5 OF
CHKD. BY DATE LAKE BARNEGAT DAM PROJECT C234
SUBJECT

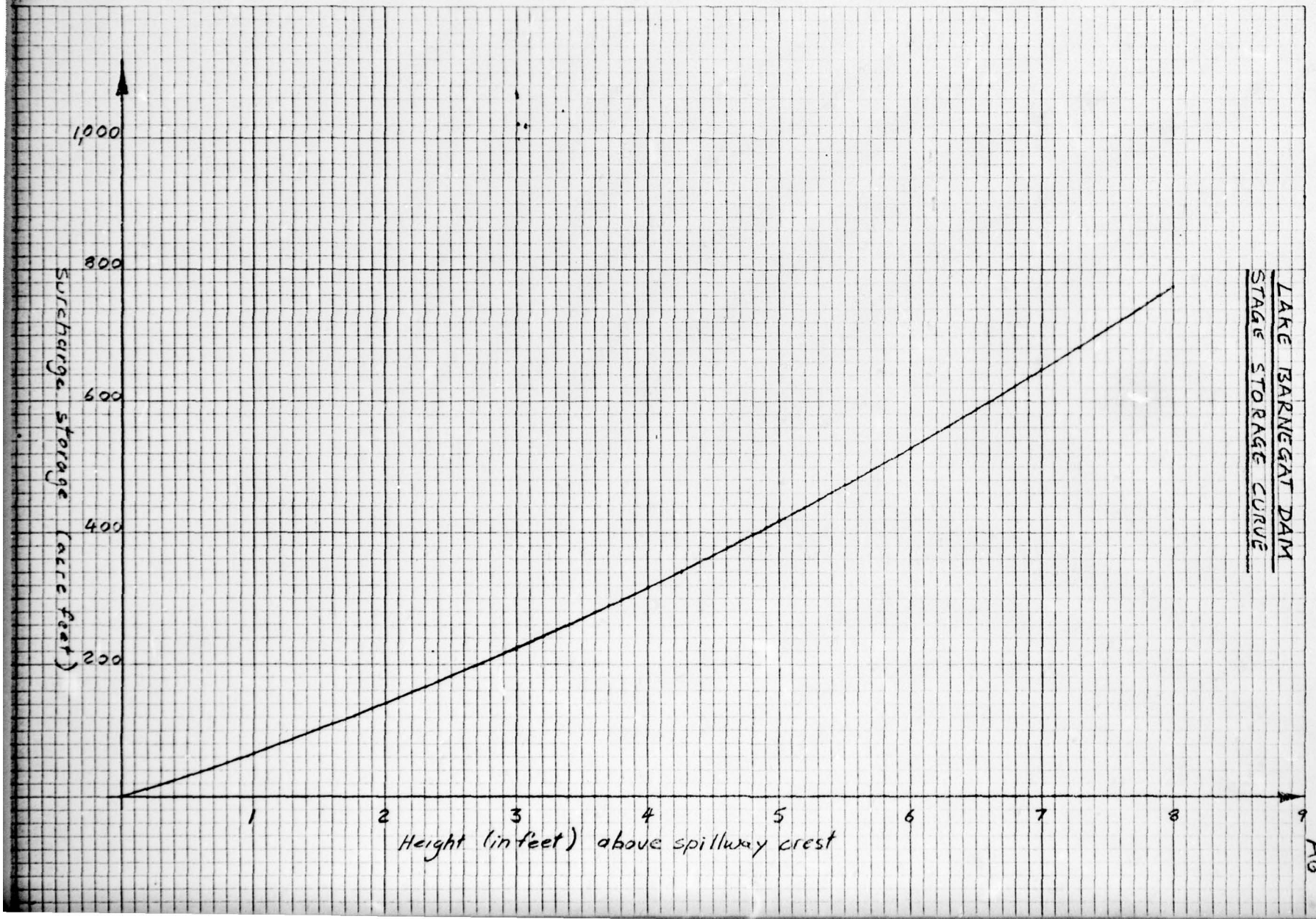
Surcharge storage:

Area of lake @ El. 14.1 = 61.5 acres
@ top of dam = 99.1 acres
Area of 20' contour = 113.7 acres



Increment in volume $\Delta v = (x + \Delta x)Y$

Height in feet above spillway crest.	Surcharge storage (acre feet)
0	0
1	66
2	141
3	224
4	317
5	418
6	528
7	647
8	775
9	912
10	1057



A6

BY D J M DATE 6-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A7 OF.
CHKD. BY ____ DATE ____ LAKE BARNEGAT DAM PROJECT C234
SUBJECT ____

GENERAL SUMMARY OF APPENDIX :

length of dam = 850'
Effective length of spillway = 50' @ El. 14.1

Total spillway capacity @ top of dam = 1440 cfs

Surcharge storage @ top of dam = 340 acre feet
storage @ normal pool = 230 acre feet

∴ Total storage @ top of dam = 570 acre feet

Lake area @ normal pool = 61.5 acres
Lake area @ top of dam = 99.1 acres

- Drainage area used = 15 square miles

BY D.J.M. DATE 7-79
CHKD. BY ____ DATE ____
SUBJECT ____

LOUIS BERGER & ASSOCIATES INC.
LAKE BARNEGAT DAM

SHEET NO. A8 OF
PROJECT C 234

Available head ≈ 6.5′ on two 36" pipes

Storage @ normal pool ≈ 230 acre feet

Assume drawdown in two equal stages and an inflow of 1 cfs / sq mile (≈ 15 cfs). No tailwater

Stage 1)

$H = 4.9'$

$Q = 138.0 - 15 = 123$ cfs

$$\therefore \text{time} \approx \frac{230 \times 43560}{2 \times 123 \times 3600}$$

$$= 11.3 \text{ hours}$$

Stage 2)

$H = 1.6'$

$\therefore \quad Q = 79 - 15 = 64$ cfs

$$\therefore \text{time} \approx \frac{230 \times 43560}{2 \times 64 \times 3600}$$

$$= 21.74 \text{ hours}$$

$$\Sigma \text{ time} \approx (21.74 + 11.3)/24$$

$$= 1.38 \text{ days}$$

Say 1 ½ days

Where $Q = 0.55 \times A \times \sqrt{2gH}$

LAKE BARNEGAT DAM
BY D.J.M.
JUNE 21 1979

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	1	0	0	0	0	0	0	0	0

JOPER	NWT
3	0

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	-1	15.00	0.0	15.00	0.0	0.500	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.0	23.80	110.00	120.00	129.00	0.0	0.0	0.0

TRSPC COMPUTED BY THE PROGRAM IS 0.814

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

GIVEN UNIT GRAPH, NUHGG= 31

201.	491.	902.	993.	922.	802.	682.	561.	491.	431.
381.	331.	291.	251.	221.	201.	190.	180.	160.	150.
140.	120.	110.	100.	80.	70.	60.	50.	40.	35.
30.									

UNIT GRAPH TOTALS 9667. CFS OR 1.00 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.12	0.00	0.
2	0.12	0.00	0.
3	0.12	0.00	0.
4	0.12	0.00	0.
5	0.12	0.01	2.
6	0.12	0.02	9.
7	0.32	0.22	63.
8	0.32	0.22	180.
9	0.32	0.22	362.
10	0.32	0.22	600.

BY D.J.M. DATE
CHKD. BY DATE
SUBJECT LAKE BARNEGAT DAM

LOUIS BERGER & ASSOCIATES INC.

SHEET NO. 49 OF
PROJECT C-2334

72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.
81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.
89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
SUM	24.97	22.48	217668.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	18427.	16024.	8375.	3023.	217666.
INCHES		9.94	20.78	22.50	22.50
AC-FT		7950.	16620.	17998.	17998.

RUNOFF MULTIPLIED BY 0.50

0.	0.	0.	0.	1.	4.	31.	90.	191.	300.
401.	489.	745.	1294.	2332.	4118.	6182.	8348.	9214.	9049.
8167.	7112.	6100.	5319.	4666.	4125.	3620.	3183.	2798.	2494.
2253.	2075.	1925.	1753.	1608.	1465.	1301.	1159.	1019.	867.
741.	625.	526.	413.	320.	233.	97.	46.	11.	8.
6.	4.	2.	1.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9214.	8012.	4188.	1512.	108832.
INCHES		4.97	10.39	11.25	11.25
AC-FT		3975.	8310.	8999.	8999.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

11	0.32	0.22	803.
12	0.32	0.22	978.
13	2.13	2.03	1491.
14	2.56	2.46	2587.
15	3.20	3.10	4663.
16	8.10	8.00	8236.
17	2.98	2.88	12365.
18	2.34	2.24	16696.
19	0.17	0.07	18427.
20	0.17	0.07	18099.
21	0.17	0.07	16334.
22	0.17	0.07	14223.
23	0.17	0.07	12201.
24	0.17	0.07	10638.
25	0.0	0.0	9332.
26	0.0	0.0	8251.
27	0.0	0.0	7240.
28	0.0	0.0	6366.
29	0.0	0.0	5595.
30	0.0	0.0	4988.
31	0.0	0.0	4505.
32	0.0	0.0	4151.
33	0.0	0.0	3849.
34	0.0	0.0	3507.
35	0.0	0.0	3217.
36	0.0	0.0	2930.
37	0.0	0.0	2601.
38	0.0	0.0	2318.
39	0.0	0.0	2038.
40	0.0	0.0	1734.
41	0.0	0.0	1483.
42	0.0	0.0	1250.
43	0.0	0.0	1053.
44	0.0	0.0	827.
45	0.0	0.0	640.
46	0.0	0.0	465.
47	0.0	0.0	195.
48	0.0	0.0	92.
49	0.0	0.0	21.
50	0.0	0.0	16.
51	0.0	0.0	12.
52	0.0	0.0	8.
53	0.0	0.0	5.
54	0.0	0.0	2.
55	0.0	0.0	0.
56	0.0	0.0	0.
57	0.0	0.0	0.
58	0.0	0.0	0.
59	0.0	0.0	0.
60	0.0	0.0	0.
61	0.0	0.0	0.
62	0.0	0.0	0.
63	0.0	0.0	0.
64	0.0	0.0	0.
65	0.0	0.0	0.
66	0.0	0.0	0.
67	0.0	0.0	0.
68	0.0	0.0	0.
69	0.0	0.0	0.
70	0.0	0.0	0.
71	0.0	0.0	0.

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

LAKE BARNEGAT DAM

SHEET NO. A12 OF

PROJECT C-824

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
11	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	141.	324.	317.	418.	528.	647.	775.	912.	1057.
OUTFLOW=	0.	478.	862.	1315.	3284.	7580.	13224.	19936.	27561.	35999.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	0.	0.
5	0.	1.	0.
6	0.	3.	1.
7	1.	18.	5.
8	6.	61.	19.
9	14.	140.	49.
10	29.	246.	97.
11	47.	351.	159.
12	68.	445.	230.
13	96.	617.	325.
14	146.	1019.	501.
15	237.	1813.	925.
16	369.	3225.	2328.
17	473.	5150.	5446.
18	531.	7265.	7700.
19	561.	8781.	9131.
20	561.	9132.	9132.
21	546.	8608.	8439.
22	523.	7639.	7394.
23	498.	6606.	6421.
24	476.	5710.	5543.
25	458.	4993.	4863.
26	444.	4396.	4286.
27	431.	3873.	3776.
28	419.	3401.	3314.
29	404.	2990.	3017.
30	387.	2646.	2686.
31	373.	2373.	2407.
32	362.	2164.	2190.
33	353.	2000.	2021.
34	345.	1839.	1859.
35	337.	1681.	1700.
36	329.	1537.	1554.
37	321.	1385.	1401.
38	312.	1230.	1290.
39	298.	1089.	1223.
40	279.	943.	1129.
41	256.	804.	1020.
42	233.	683.	907.
43	210.	576.	799.
44	188.	470.	693.
45	165.	367.	588.
46	143.	276.	488.
47	120.	165.	406.
48	96.	72.	324.

49	74.	28.	251.
50	57.	9.	192.
51	43.	7.	146.
52	33.	5.	112.
53	25.	3.	85.
54	19.	2.	65.
55	14.	1.	49.
56	11.	0.	37.
57	8.	0.	28.
58	6.	0.	21.
59	5.	0.	16.
60	4.	0.	12.
61	3.	0.	9.
62	2.	0.	7.
63	2.	0.	5.
64	1.	0.	4.
65	1.	0.	3.
66	1.	0.	2.
67	0.	0.	2.
68	0.	0.	1.
69	0.	0.	1.
70	0.	0.	1.
71	0.	0.	1.
72	0.	0.	0.
73	0.	0.	0.
74	0.	0.	0.
75	0.	0.	0.
76	0.	0.	0.
77	0.	0.	0.
78	0.	0.	0.
79	0.	0.	0.
80	0.	0.	0.
81	0.	0.	0.
82	0.	0.	0.
83	0.	0.	0.
84	0.	0.	0.
85	0.	0.	0.
86	0.	0.	0.
87	0.	0.	0.
88	0.	0.	0.
89	0.	0.	0.
90	0.	0.	0.
91	0.	0.	0.
92	0.	0.	0.
93	0.	0.	0.
94	0.	0.	0.
95	0.	0.	0.
96	0.	0.	0.
97	0.	0.	0.
98	0.	0.	0.
99	0.	0.	0.
100	0.	0.	0.
SUM			108831.	

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	9132.	8036.	4130.	1512.	108831.
INCHES		4.98	10.24	11.25	11.25
AC-FT		3987.	8196.	8999.	8999.

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	9214.	8012.	4188.	1512.	15.00
ROUTED TO	11	9132.	8036.	4130.	1512.	15.00