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NATIONAL DAM SAFETY PROGRAM. OPENAKA LAKE DAM (NJ00780), PASSAI--ETC(U)
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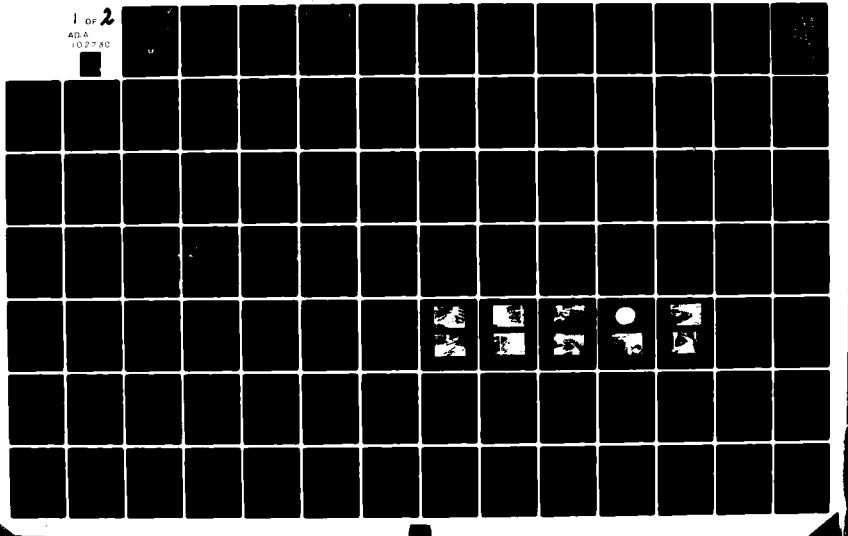

PASSAIC RIVER BASIN
DEN BROOK, MORRIS COUNTY
NEW JERSEY

OPENAKA LAKE DAM
NJ 00780

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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

MAY 1981

REPT. NO. DAEN/NAP-53842/NJ00780-81/05

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Structural Analysis
Seepage
National Dam Safety Program
Openaka Lake Dam, NJ
Passaic River Basin, NJ
Gabions
Den Brook, NJ
Morris County, NJ

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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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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

IN REPLY REFER TO
NAPEN-N

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

28 JUL 1981

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Openaka Lake Dam in Morris 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, Openaka Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 14 percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure 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. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within six months of the date of approval of this report, a qualified professional consultant, engaged by the owner should investigate the following:

(1) The stability of the terraced gabions on the downstream side of the embankment.

(2) The observed evidence of seepage should be monitored on a periodic basis in order to detect any changes in condition.

Within three months of the consultants findings, remedial measures should be determined and implemented.

c. Within six months from the date of approval of this report the following remedial actions should be initiated:

(1) The outlet works should be investigated with respect to operational adequacy and then restored to proper operational condition.

(2) Sloughing of the downstream side of the embankment on the right side of the spillway should be corrected.

(3) The large board collecting debris in the stilling basin should be removed.

(4) Cracked concrete on the spillway crest and right abutment should be repaired.

(5) The deteriorated chain link fence at each end of the spillway should be repaired to prevent access to the spillway area.

(6) Trees and adverse vegetation on the embankments should be removed and the embankment surfaces properly stabilized.

d. The owner should, within one year from the date of approval of this report, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

e. The owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

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 Courter of the Thirteenth 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-N
Honorable Brendan T. Byrne

An important aspect of the Dam Inspection 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,

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and 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 Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

OPENAKA LAKE DAM (NJ00780)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 24 December 1980 and 2 March 1981 by Storch Engineers, 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.

Openaka Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to 14 percent of the One Hundred Year Flood would cause the dam to be overtopped. To ensure 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. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within six months of the date of approval of this report, a qualified professional consultant, engaged by the owner should investigate the following:

(1) The stability of the terraced gabions on the downstream side of the embankment.

(2) The current evidence of seepage should be monitored on a periodic basis in order to detect any changes in condition.

Within three months of the consultants findings, remedial measures should be determined and implemented.

c. Within six months from the date of approval of this report the following remedial actions should be initiated:

(1) The outlet works should be investigated with respect to operational adequacy and then restored to proper operational condition.

(2) Sloughing of the downstream side of the embankment on the right side of the spillway should be corrected.

(3) The large board collecting debris in the stilling basin should be removed.

(4) Cracked concrete on the spillway crest and right abutment should be repaired.

(5) The deteriorated chain link fence at each end of the spillway should be repaired to prevent access to the spillway area.

removed and the embankment surfaces properly stabilized.

d. The owner should, within one year from the date of approval of this report, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

e. The owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam within one year from the date of approval of this report.

APPROVED: Roger L. Baldwin

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

DATE: 29 July 81

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Openaka Lake Dam, I.D. NJ00780
State Located:	New Jersey
County Located:	Morris
Drainage Basin:	Passaic River
Stream:	Den Brook
Dates of Inspection:	December 24, 1980 March 2, 1981

Assessment of General Condition of Dam

Based on visual inspections, past operational performance and Phase I engineering analyses, Openaka Lake Dam is assessed as being in fair overall condition.

Based on investigations of the downstream flood plain made in connection with this report, it is recommended that the hazard potential classification be downgraded from high to significant hazard.

Hydraulic and hydrologic analyses indicate that the spillway is inadequate. Discharge from the spillway is not sufficient to pass the designated spillway design flood (100-year storm) without an overtopping of the dam. The spillway is capable of passing approximately 13 percent of the SDF. Therefore, the owner should engage a professional engineer experienced in the design and construction of dams in the near future to perform more accurate hydraulic and hydrologic analyses relating to the spillway capacity. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken

by the operator to minimize downstream effects of an emergency at the dam.

In the future, the stability of the terraced gabions on the downstream side of the embankment should be investigated by a professional engineer experienced in the design and construction of dams.

The observed evidence of seepage should be monitored on a periodic basis by a professional engineer experienced in the design and construction of dams in order to detect any changes in condition.

In addition, it is recommended that the following remedial measures be undertaken in the near future:

1) The outlet works should be investigated with respect to operational adequacy and then restored to proper operational condition.

2) Sloughing of the downstream side of the embankment on the right side of the spillway should be corrected.

3) The large board collecting debris in the stilling basin should be removed.

4) Cracked concrete on the spillway crest and right abutment should be repaired.

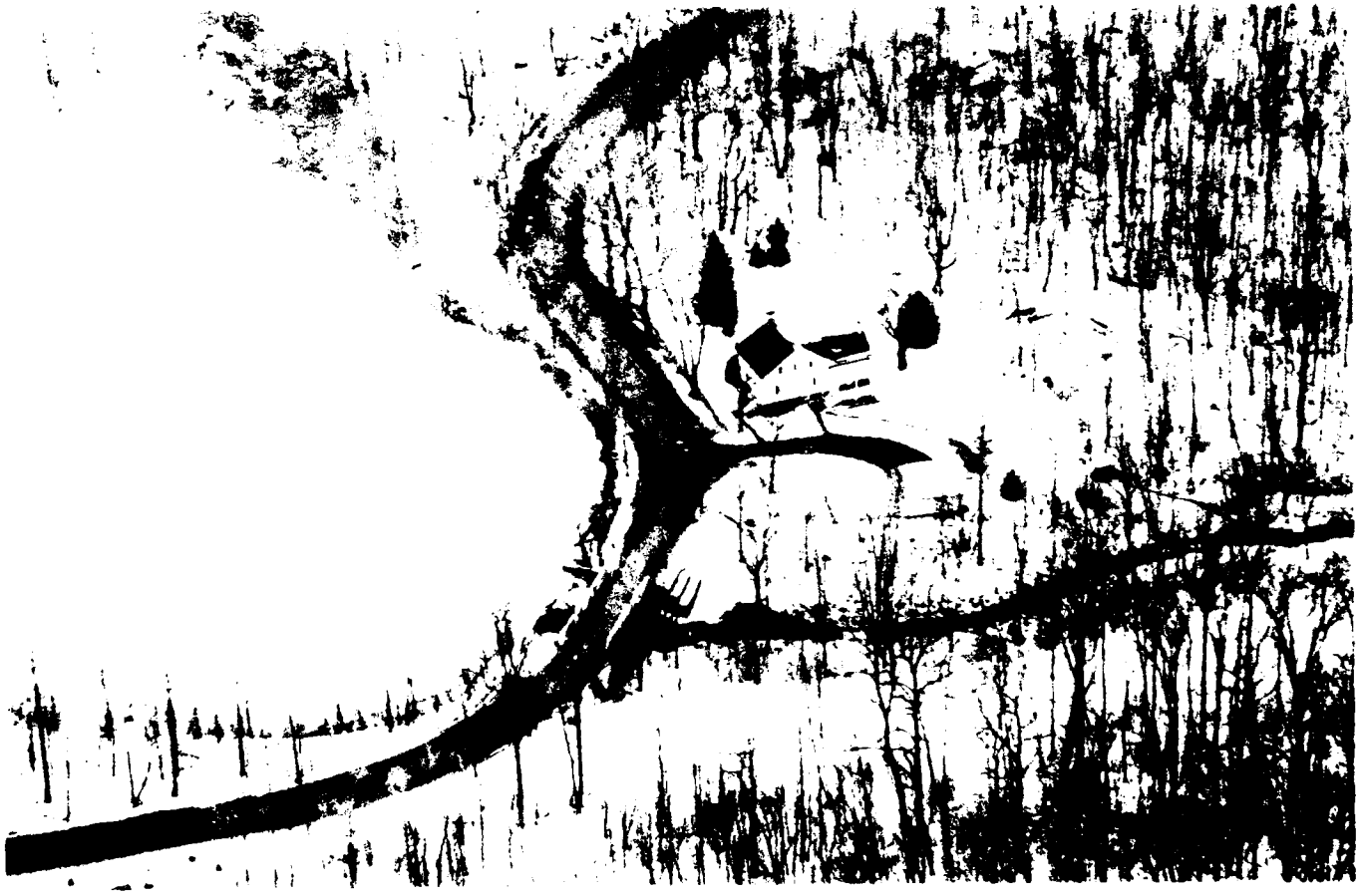
5) The deteriorated chain link fence at each end of the spillway should be repaired to prevent access to the spillway area.

6) Trees and adverse vegetation on the embankments should be removed and the embankment surfaces properly stabilized.

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.



OVERVIEW - OPENAKA LAKE DAM

20 JANUARY 1981

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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 a 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 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 the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydraulic and hydrologic 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 hydraulic and hydrologic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

OPENAKA LAKE DAM, I.D. NJ00780

SECTION 1: PROJECT INFORMATION

1.1 General

a. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspections of Openaka Lake Dam was made on December 24, 1980 and March 2, 1981. The purpose of the inspections was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description of Dam and Appurtenances

Openaka Lake Dam consists of a stone masonry spillway section with earth embankments at each end. The spillway section comprising about one-third the length of the dam is constructed with a concrete cap on its top. Immediately downstream from the spillway section is a steel roadbridge. A paved roadway runs along the crest of the embankments and over the steel bridge. A low level outlet transversely penetrates the center of the spillway and discharges downstream from the dam just to the right of the downstream channel.

With an overall crest length of 190 feet, the dam has crest elevations ranging from 679.9 National Geodetic Vertical Datum (N.G.V.D.) at the center, to 681.5 at the ends. The spillway crest width is 6.0 feet and the slope of the downstream face is 1 horizontal to 1 vertical.

The downstream side of the right embankment is formed by a stone masonry wall for most of its length with a stone rubble wall near its right end. The upstream side of the right embankment consists of a stone rubble wall.

The downstream side of the left embankment is composed of terraced gabions for about one-half its length. The gabions contain stones ranging up to 8 inches in diameter. Beyond the gabions for a distance of about 10 feet to the left, the downstream slope is riprapped with stones of approximately the same size as those in the gabions. The remainder of the downstream face is unprotected soil. The upstream side of the left embankment consists of a concrete wall.

The spillway consists of a cut stone block structure with a stepped downstream face and concrete cap. Stone masonry abutments are located at each end. The upper portion of the abutments are concrete. The stone masonry abutments extend downstream from the spillway and serve also as abutments for the road bridge. The length of the spillway is 56 feet and its crest elevation is 678.0.

The low level outlet pipe conists of a 24-inch steel pipe. A steel standpipe is located in the lake at the apparent upstream end of the outlet and a concrete gate housing is located on the right bank of the downstream channel at the downstream end of the outlet.

b. Location

Openaka Lake Dam is located in the Township of Denville, Morris County, New Jersey. It impounds a recreational lake located along Openaka Road. Discharge from the spillway flows into Den Brook.

c. Size and Hazard Classification

The dam is classified in accordance with criteria presented in "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers. Size categories consist of Small, Intermediate and Large while hazard categories are designated as Low, Significant and High.

Size Classification: Openaka Lake Dam is classified as "Small" size since its maximum storage volume is 59 acre-feet (which is less than 1000 acre-feet) and its height is 15.5 feet (which is less than 40 feet).

Hazard Classification: Visual inspection of the downstream flood plain of the dam together with breach analysis indicate that failure of the dam would not inundate the dwellings located downstream from the dam. Damage could possibly be sustained by the steel road bridge at the dam as well as two road bridges located downstream from the dam. Accordingly, Openaka Lake Dam is classified as "Significant" hazard.

d. Ownership

Openaka Lake Dam is owned and operated by Mr. Robert Price, R.D. No. 1, Dover, N.J. 07801. The dam embankment traversed by Openaka Road is owned by Morris County, Department of Public Works, Courthouse (Ann Street), Morristown, N.J. 07960.

e. Purpose of Dam

The purpose of the dam is the impoundment of a lake used for recreation.

f. Design and Construction History

Openaka Lake Dam reportedly was constructed in the mid 1700's. Those responsible for the construction of the dam are unknown.

g. Normal Operational Procedures

The dam and appurtenances are maintained by the owner, Mr. Robert Price. There is no fixed schedule of maintenance; repairs are made as the need arises.

The lake was last lowered in 1978-1979 when the County repaired bridge piles. The water level was lowered 2 feet at that time.

1.3 Pertinent Data

a.	Drainage Area	4.09 square miles
b.	Discharge at Damsite	
	Maximum flood at damsite	Unknown
	Outlet Works at pool elevation	55 cfs.
	Spillway capacity at top of dam	389 cfs
c.	Elevation (N.G.V.D.)	
	Top of Dam	679.9
	Maximum pool-design surcharge	683.0
	Recreation pool	678.0
	Spillway crest	678.0
	Stream bed at centerline of dam	664.4
	Maximum tailwater	671 (Estimated)
d.	Reservoir	
	Length of maximum pool	600 feet (Estimated)
	Length of recreation pool	500 feet (Scaled)
e.	Storage (Acre-feet)	
	Recreation pool	46 acre-feet
	Design surcharge	91 acre-feet
	Top of dam	59 acre-feet
f.	Reservoir Surface (acres)	
	Top of dam	9.2 acres (Estimated)
	Maximum pool - design surcharge	9.4 acres (Estimated)
	Recreation pool	2.2 acres

g. Dam

Type	Earthfill
Length	190 feet
Height	15.5 feet
Sideslopes - Upstream	2 horiz. to 1 vert.
- Downstream	2 horiz. to 1 vert.
Zoning	Unknown
Impervious core	Unknown
Cutoff	Unkown
Grout curtain	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Concrete Weir
Length of weir	56.0 feet
Crest elevation	678.0
Gates	N.A.
Upstream channel	N.A.
Downstream channel	Natural stream

j. Regulating Outlet

24" diameter steel pipe, low-level outlet works with gate at downsteam end (Non-Operable).

SECTION 2: ENGINEERING DATA

2.1 Design

No plans or calculations pertaining to the original construction of the dam could be obtained.

2.2 Construction

No data or reports pertaining to the construction of the dam are available.

2.3 Operation

Correspondence in the NJDEP, Division of Water Resources files refers to NJDEP order on March 2, 1973 to dewater the lake. Further correspondence indicates subsequent non-compliance. The problem was apparently not resolved.

2.4 Evaluation

a. Availability

Data or reports pertaining to the operations of the dam are limited to those contained in the NJDEP file.

b. Adequacy

Available engineering data pertaining to Openaka Lake Dam is not adequate to be of significant assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

c. Validity

The validity of engineering data cannot be assessed due to the general absence of data.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspections of Openaka Lake Dam were performed on December 24, 1980 and March 2, 1981 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inspection:

1) The embankment of the dam, appurtenant structures and adjacent areas were examined.
2) The embankment and accessible appurtenant structures were measured and key elevations determined by surveyor's level.
3) The embankment, appurtenant structures and adjacent areas were photographed.
4) The downstream flood plain was toured to evaluate downstream development and restricting structures.

b. Embankments

The right and left embankments were overgrown with trees and bushes on their upstream side. The trees ranged in size from 2 inches to 12 inches. The roadway pavement was patched but appeared to be in satisfactory condition. Near the right end of the stone rubble wall on the downstream side right embankment where the wall is about 3 feet high, the wall was bulging out approximately 1 foot due to sloughing of the embankment. The wall however, was not undermined at its base. The remainder of the wall which is composed of grouted stone appeared to be in generally satisfactory condition. An 8-inch deep depression in the soil approximately 4 feet to the right of the spillway

was observed. An assessment of possible material loss could not be made. Also, two holes in the soil about 2 feet upstream of downstream wall along the right embankment were observed. The holes were about 10 inches deep and 4 inches in diameter.

The walls forming the upstream sides of the embankments appeared to be in fair condition. The concrete wall on the upstream side of the left embankment appeared to be stable.

The gabions forming a portion of downstream side of the left embankment appeared to be stable and in good condition. The downstream side adjacent to the gabions for a length of about 10 feet was covered with riprap which appeared to provide adequate slope protection. The remainder of the downstream side consisted of unprotected soil containing no vegetation.

c. Appurtenant Structures

The condition of the stone masonry abutments for the spillway and bridge appeared to be sound, although their surfaces were slightly irregular. At the base of the abutments, concrete foundations were noted to be in satisfactory condition. The stones forming the spillway structure appeared to be sound although their condition could not be accurately determined because they were obscured by overflow. Immediately downstream of the spillway structure was a stilling basin which had a bottom lined with small boulders and extended downstream to the center of the bridge. If the downstream toe of the spillway was undermined it could not be determined by the inspections. A large board collecting debris was lodged in the stilling basin. The junctions or interfaces between the spillway and the right and left abutments appeared to be generally sound. Cracking of the concrete cap and right concrete abutment was also observed. The cracking of the concrete cap appeared to have

caused a hole in the concrete measuring about 2 feet by 1 foot by 4 inches deep. The hole was adjacent to the cracked concrete abutment.

The steel bridge appeared to be sound, although its structural members appeared to be relatively light weight. The bridge load was restricted (by sign) to 5 tons. A chain link fence located along the upstream side of the roadway was deteriorated at each end of the spillway allowing access to the spillway area. This condition was considered potentially hazardous.

The low level outlet pipe emerged from the rocks in the channel bed just downstream from the bridge. The pipe was extremely deteriorated with large holes rusted through. The concrete gate housing was in fair condition with spalled and broken concrete surfaces. A circular plate was observed on top with a stem protruding through the plate. The stem was severely rusted and the gate operating mechanism appeared to be inoperable.

d. Seepage

Orange stains were noted on several of the rocks in the bed of the downstream channel. These stains could be rust stains from the low level outlet pipe which was severely rusted. Orange stains were also noted on the rocks and in the bed of the downstream channel on its left bank approximately 20 feet downstream from the downstream toe of the dam. These orange deposits did not appear to be rust stains, but could have been related to seepage.

d. Downstream Channel

The downstream channel is a meandering natural stream lined with small boulders in its bed and on its banks and wooded to the waterline. The banks are about 4 to 5 feet high with a

small flood plain extending about 50 feet on either side with steeper terrain beyond. There are no significant obstructions in the channel within five hundred feet of the dam. A dwelling was located adjacent to the channel immediately downstream from the dam. An abandoned, breached stone masonry dam was located on the channel 2500 feet from the dam. Three dwellings were observed adjacent to the channel about one mile from the dam. Two additional dwellings were located about 5700 feet from the dam. All dwellings were at least 8 feet above the stream. Road bridges were located 5400 feet and 6000 feet from the dam.

e. Reservoir Area

The reservoir shores were wooded with steep slopes ranging from 25 percent to 100 percent. A few homesites were observed on the shore slopes. One dwelling was about 8 feet above the water level, whereas the remaining dwellings were significantly higher.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Openaka Lake is regulated by discharge over the stone masonry spillway. At present the outlet works of the dam cannot be used to drain the lake or to augment the discharge capacity of the spillway.

The most recent drawdown of the lake occurred in 1978-1979 when the County drew the lake down two feet in order to repair bridge piles.

4.2 Maintenance of the Dam

Reportedly, maintenance is performed only on an "as needed" basis.

4.3 Maintenance of Operating Facilities

Reportedly, regular maintenance of the operating facilities consists of repairing of spalled or cracked concrete.

4.4. Descrption of Warning System

Reportedly, no warning system is currently in use for the dam.

4.5 Evaluation of Operational Adequacy

The operation of the dam has been unsuccessful to the extent that the dam reportedly has been overtopped in the past.

Maintenance is inadequate and maintenance documentation is poor. Areas of maintenance that have not been adequately performed are:

1) Trees and brush on embankment not removed.
2) Debris at spillway discharge channel not removed.

3) Sloughed area of the downstream face of right embankment not repaired.
4) Deteriorated outlet works not repaired.
5) Cracks in concrete cap and concrete abutment at right end of spillway not repaired.
6) Deteriorated fence on embankments in the area of the spillway not repaired.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to handle is based on the size and hazard classification of the dam. This runoff quantity called the spillway design flood (SDF), is described in terms of return frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers, the SDF for Openaka Lake Dam falls in a range of 100-year frequency to 1/2 PMF. In this case, the low end of the range, 100-year frequency, is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The SDF peak computed for Openaka Lake Dam is 3072 c.f.s. This value is derived from the 100-year flood hydrograph computed by the use of the HEC-1-DAM Flood Hydrograph Computer Program using the Soil Conservation Service triangular unit hydrograph with curvilinear transformation. Hydrologic computations and computer output are contained in Appendix 4.

The spillway discharge rates were computed by the use of a weir formula appropriate to the configuration of the spillway structure. The total spillway discharge with lake level equal to the top of the dam was computed to be 389 c.f.s. The SDF was routed through the dam by use of the HEC-1-DAM computer program using the modified Puls Method. In routing the SDF, it was found that the dam crest would be overtopped by a depth of 3.1 feet. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

A dam breach analysis was then performed using a trapezoidal breach section with bottom length of 50 feet and sideslopes of 1 horizontal to 1 vertical. The breach peak outflow was computed to be 3344 c.f.s. Dam breach computations are contained in Appendix 4.

The breach analysis indicates that dam failure from over topping would not cause inundation of the dwellings located downstream from the dam.

b. Experience Data

Reportedly, the dam was last overtopped during the winter of 1978 when the lake was completely frozen over. During this heavy rainfall severe flooding was reported in Denville, located approximately 5 miles downstream. However, estimates of the extent of inundation and property damage could not be obtained.

c. Visual Observation

No evidence was found at the time of inspection that would indicate that the dam had been overtopped.

d. Overtopping Potential

As indicated in paragraph 5.1.a. a storm of magnitude equal to the SDF would cause overtopping of the dam to a height of 3.1 feet over the crest of the dam. The spillway is capable of passing approximately 13 percent of the SDF with the lake level equal to the top of dam.

e. Drawdown Time

At the time of inspection, the low-level outlet works were not operational. However, drawdown of the lake was designed to be accomplished by opening the gated 24-inch outlet pipe. Total time for drawdown is estimated to be 16.8 hours (See Appendix 4).

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The embankments and spillway section appeared generally stable at the times of inspection. Sloughing observed at the downstream embankment to the right of the spillway and cracks on the spillway crest are not considered to be indications of immediate instability.

b. Generalized Soils Description

The generalized soils description of the dam site consists of recent alluvium, composed of unstratified materials deposited by streams, largely gravel and sand, overlying glacial ground moraine.

c. Design and Construction Data

Analysis of structural stability and construction data for the embankments are not available.

d. Operating Records

No operating records are available for the dam. The water level of Openaka Lake is not monitored.

e. Post-Construction Changes

Reportedly, it is not known whether or not there have been any post-construction changes. Possible post-construction changes could be the addition of the steel bridge, the addition of the gabion slope protection and widening of the embankments to facilitate the construction of Openaka Road.

f. Seismic Stability

Openaka Lake Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if they have adequate stability under static loading conditions. Openaka Lake Dam appeared to be generally stable under static loading conditions at the time of inspection.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses outlined in Section 5 and Appendix 4, the spillway of Openaka Lake Dam is assessed as being inadequate. The spillway is not able to pass the SDF without an overtopping of the dam.

The embankments and spillway structure appeared to be generally stable. Observed sloughing of the right embankment and cracks on the spillway crest are not considered to be indications of immediate instability.

b. Adequacy of Information

Information sources for this report include 1) field inspections, 2) USGS quadrangle, 3) reference data and correspondence in the NJDEP files, and 4) consultation with the owner, Mr. Robert Price. The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1. Construction and as-built drawings.
2. Description of fill material for embankment.
3. Design computations and reports.
4. Soils report for the site.

c. Necessity for Additional Data/Evaluation

Although some data pertaining to Openaka Lake Dam are not available, additional data are not considered imperative for this Phase I evaluation.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a, the spillway is considered to be inadequate. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to perform more accurate hydraulic and hydrologic analyses relating to spillway capacity. Based on the findings of these analyses, the need for and type of remedial measures should be determined and then implemented.

The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

In the future, the stability of the terraced gabions on the downstream side of the embankment should be investigated by a professional engineer experienced in the design and construction of dams.

In addition, it is recommended that the following remedial measures be undertaken in the near future:

1) The outlet works should be investigated with respect to operational adequacy and then restored to proper operational condition.

2) Sloughing of the downstream side of the embankment on the right side of the spillway should be corrected.

3) The large board collecting debris in the stilling basin should be removed.

4) Cracked concrete on the spillway crest and right abutment should be repaired.

5) The deteriorated chain link fence at each end of the spillway should be repaired to prevent access to the spillway area.

6) Trees and adverse vegetation on the embankments should be removed and the embankment surfaces properly stabilized.

b. Maintenance

In the future, the owner of the dam should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam.

c. Additional Studies

The observed evidence of seepage should be monitored on a periodic basis by a professional engineer experienced in the design and construction dams in order to detect any changes in condition.

PLATES

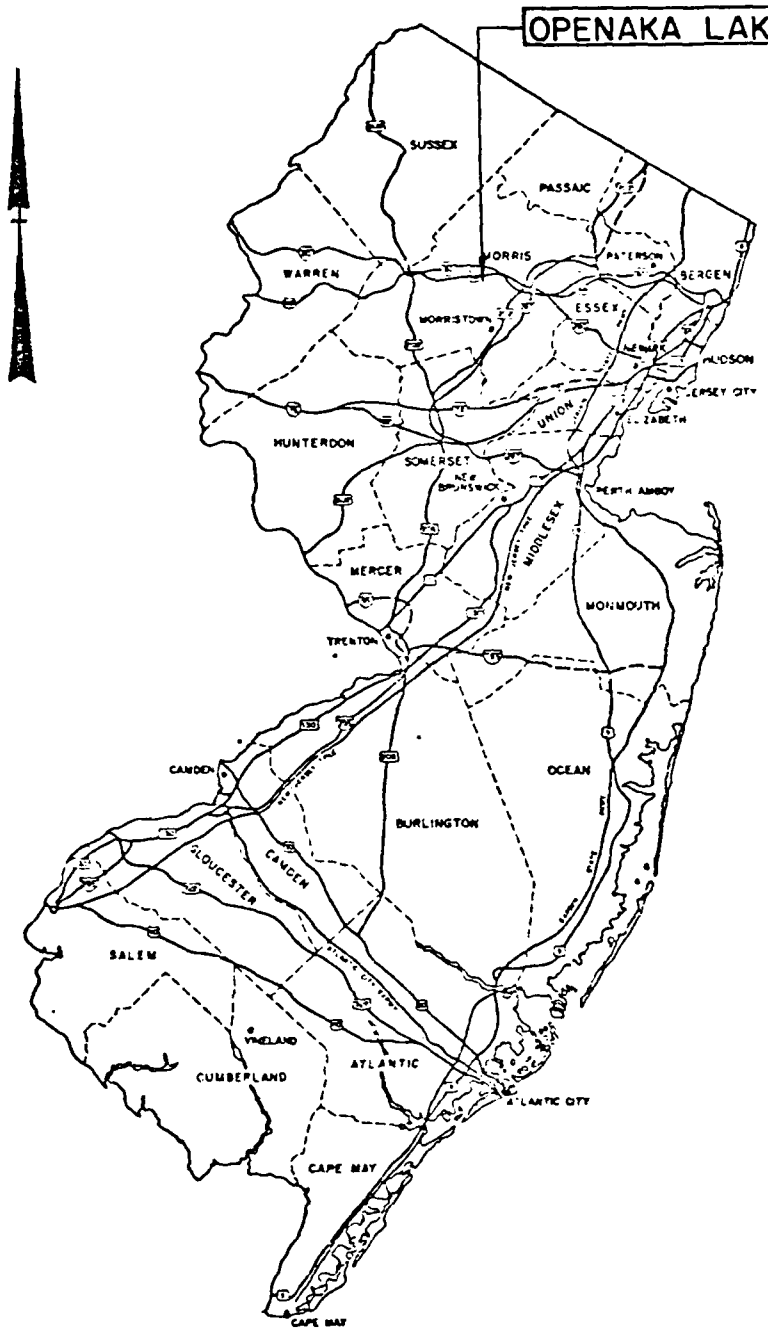
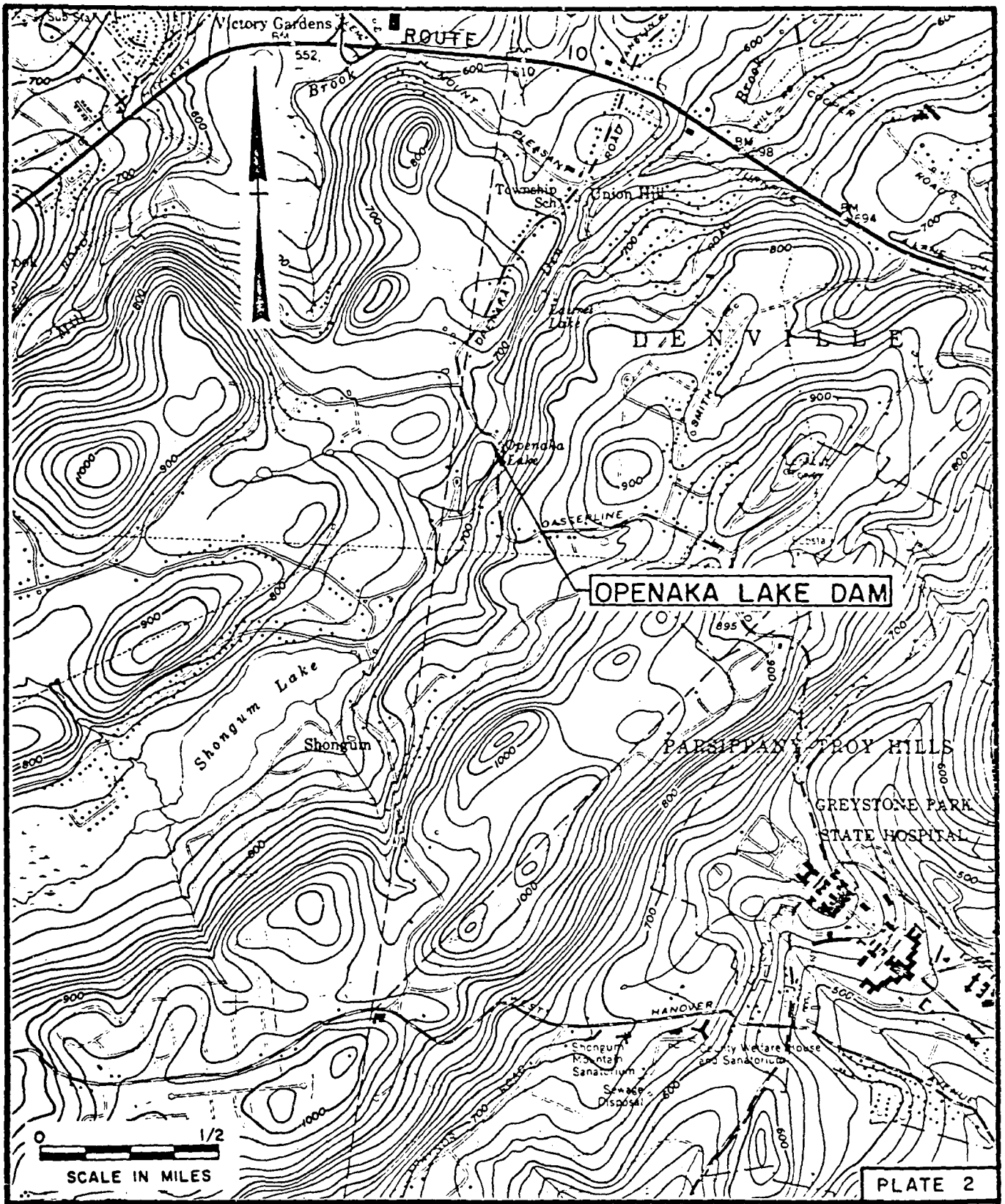
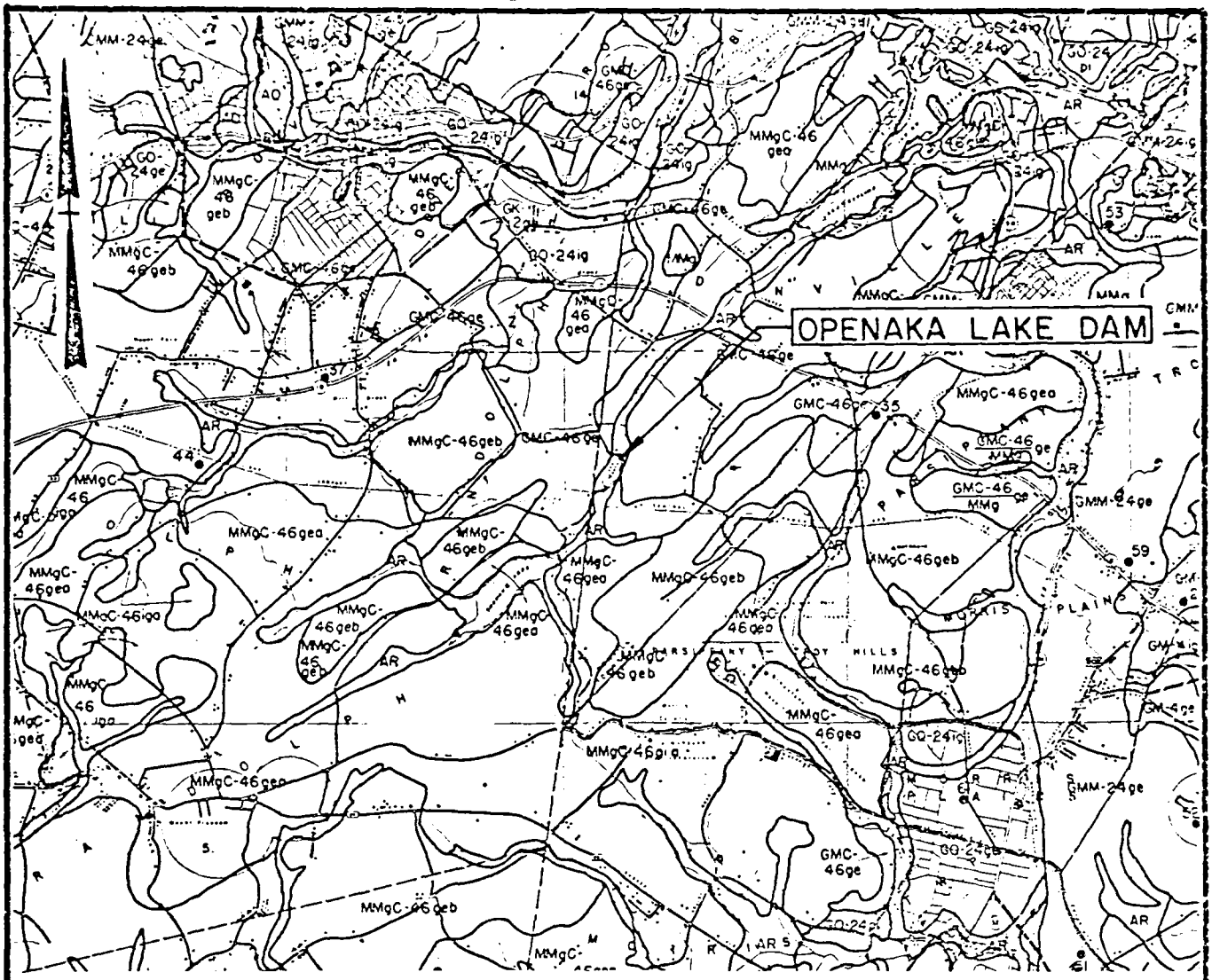


PLATE 1

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS KEY MAP OPENAKA LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	SCALE: NONE DATE: FEB. 1981



STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS **VICINITY MAP** OPENAKA LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	SCALE: AS SHOWN DATE: FEB. 1981



Legend

AR	Recent alluvium, composed of stratified materials by streams.
GMC-46	Glacial ground moraine; composed of unstratified mat

Note: Information taken from: Rutgers University Engineeri. _ Soil Survey of New Jersey, Report No. 9, Morris County, November 1953 and Geologic Map of New Jersey prepared by J. V. Lewis and H. Kummel 1910-1912, revised by H. B. Kummel 1931 and M. Johnson 1950.

PLATE 3

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY.

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

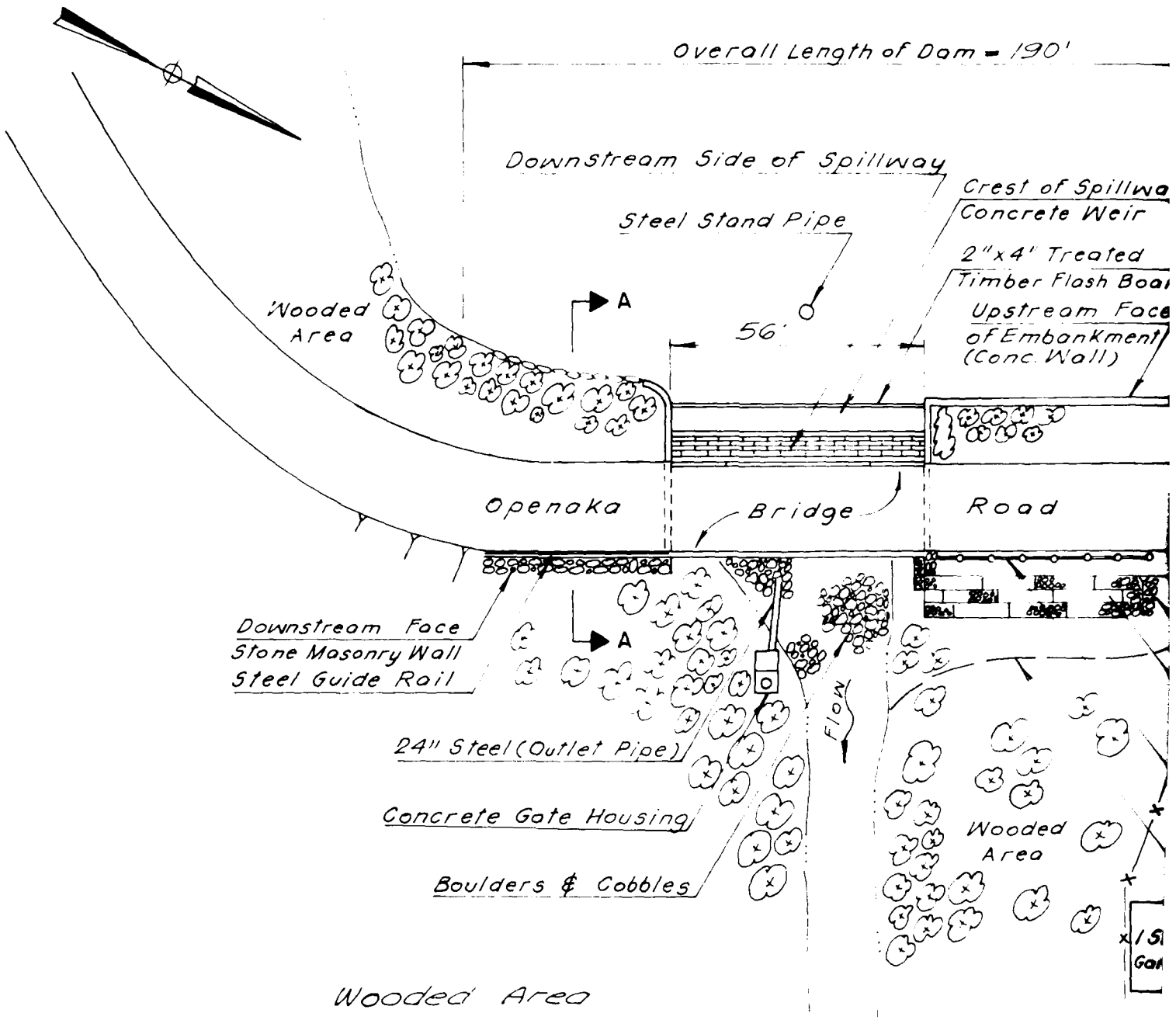
INSPECTION AND EVALUATION OF DAMS

SOIL MAP

OPENAKA LAKE DAM

SCALE: NONE

DATE: FEB. 1981



Note:
Information taken from field inspection December 24, 1980

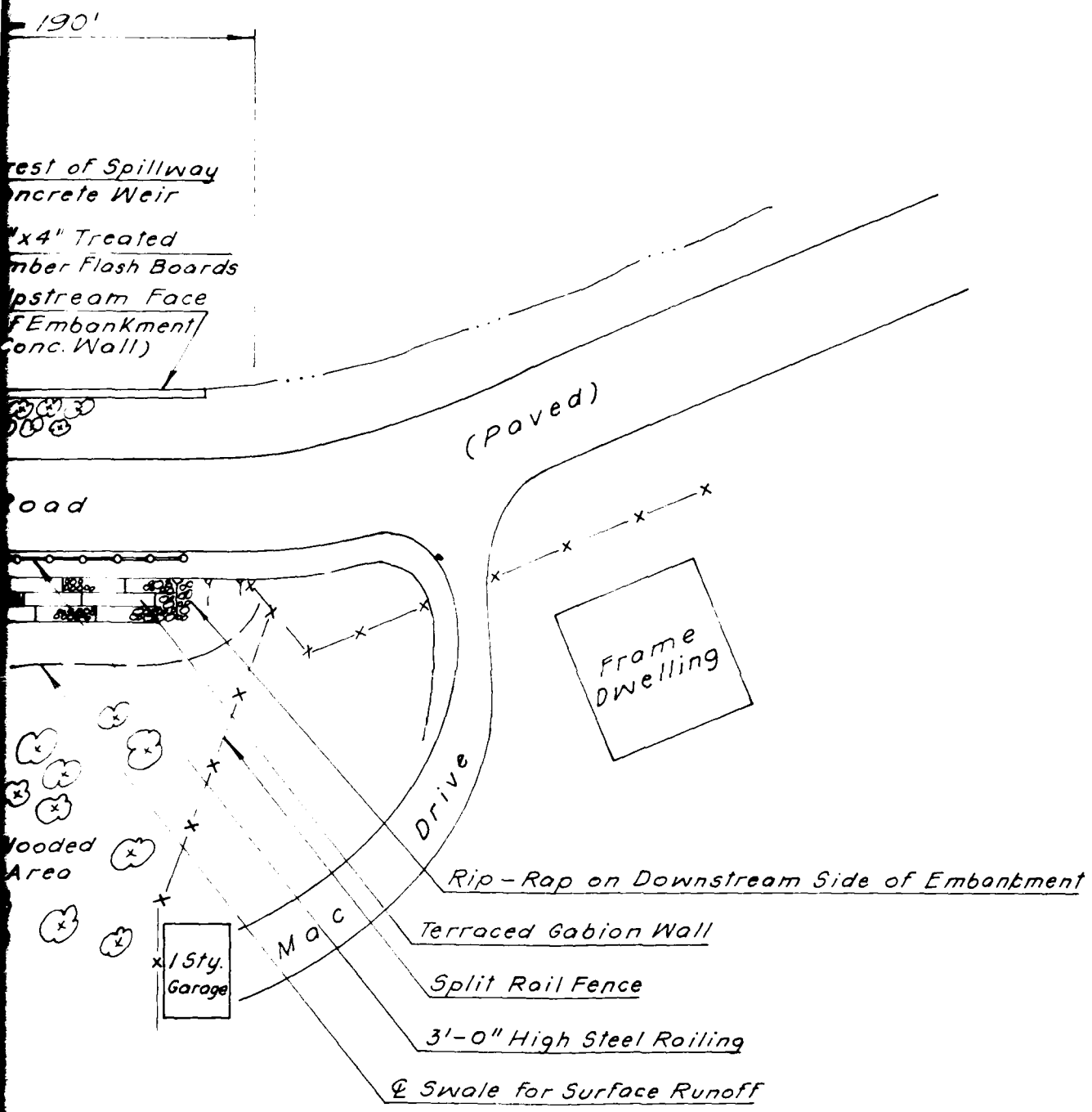


PLATE 4

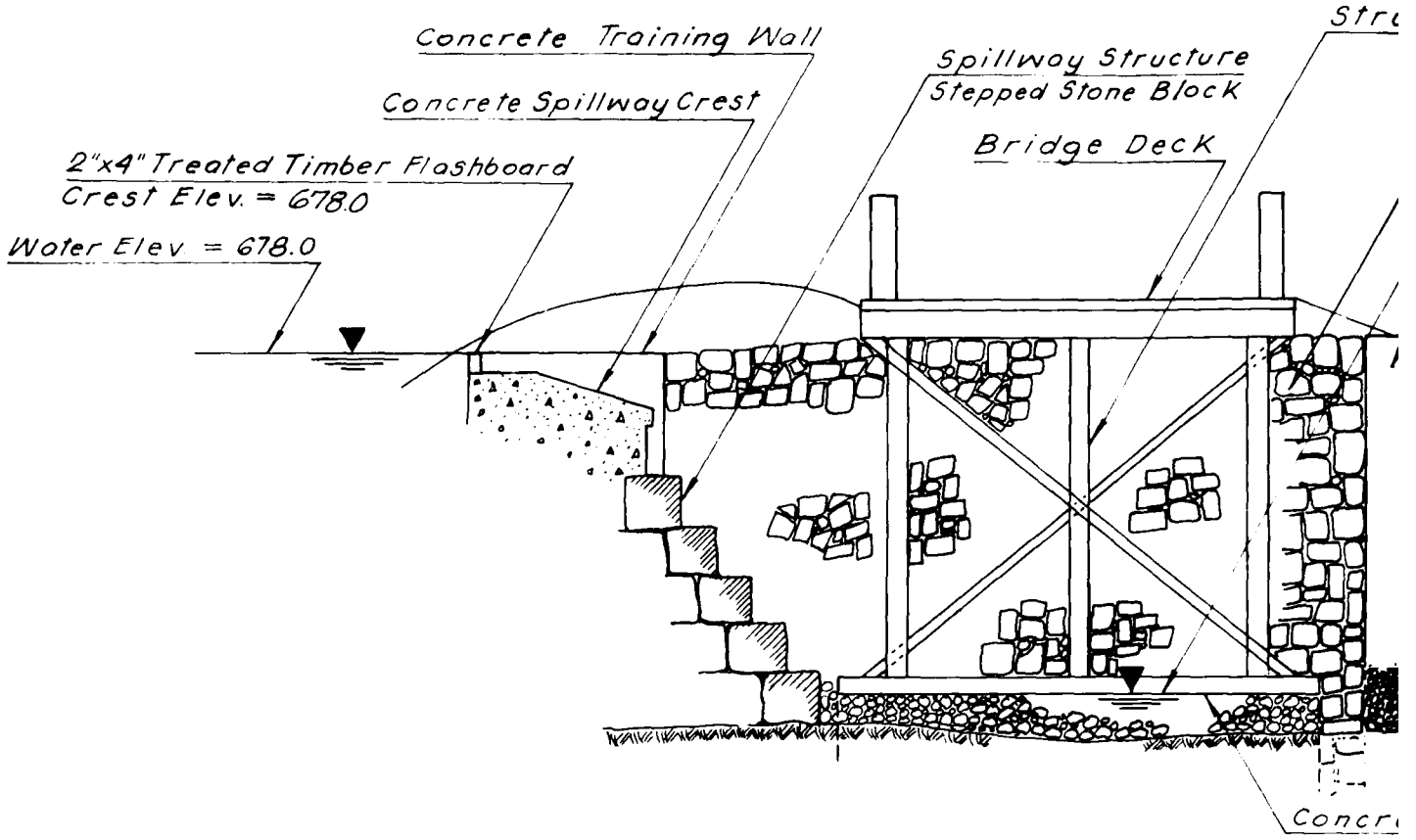
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

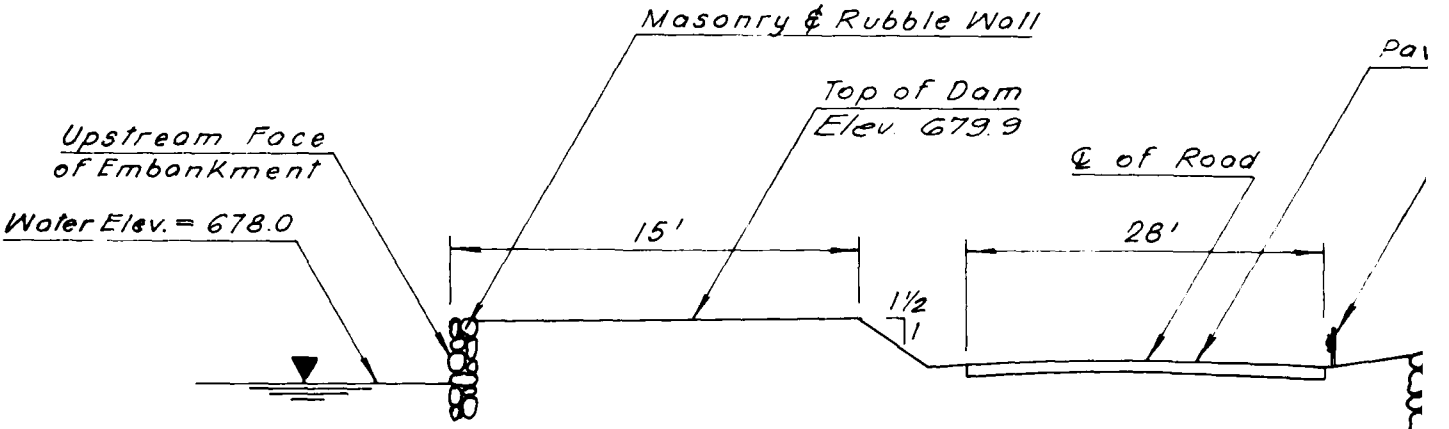
GENERAL PLAN

OPENAKA LAKE DAM

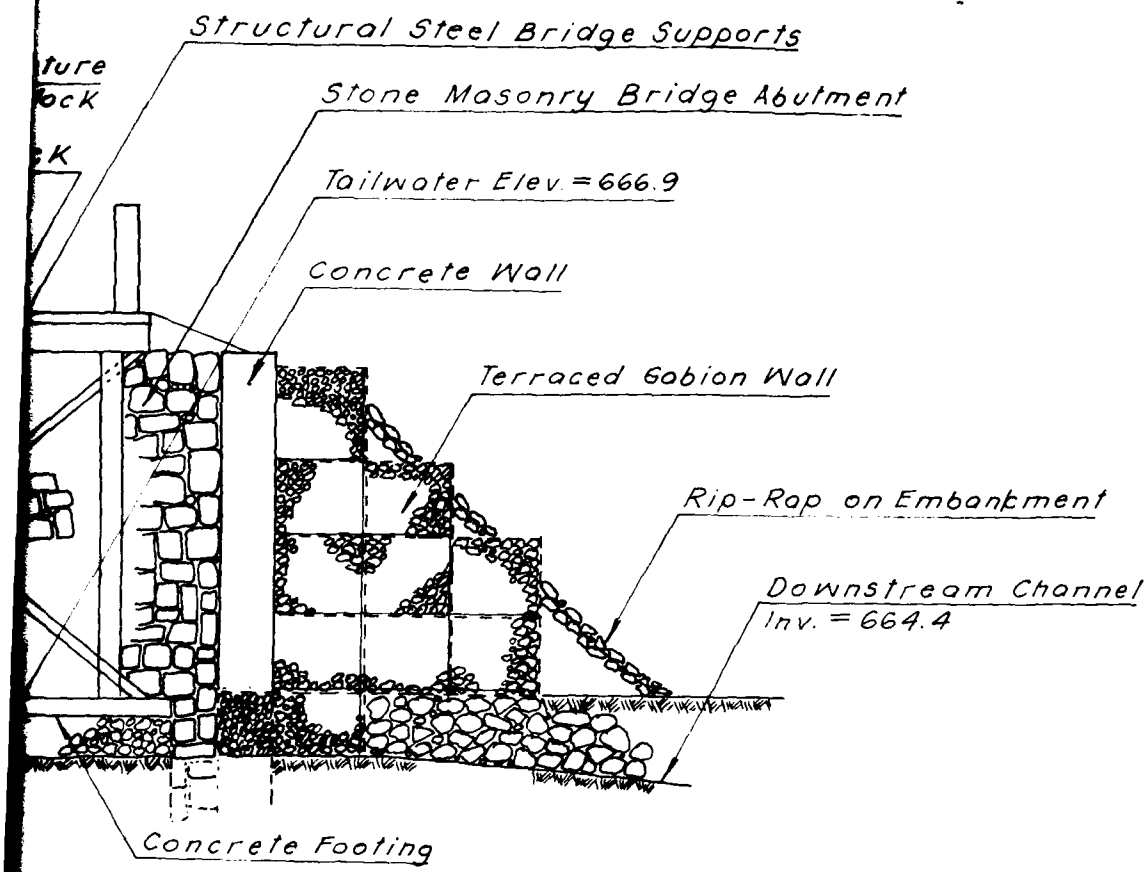
I.D. N.J. 00780	SCALE: NOT TO SCALE
	DATE: FEB. 1981



SPILLWAY SECTION



SECTION A–A



CTION

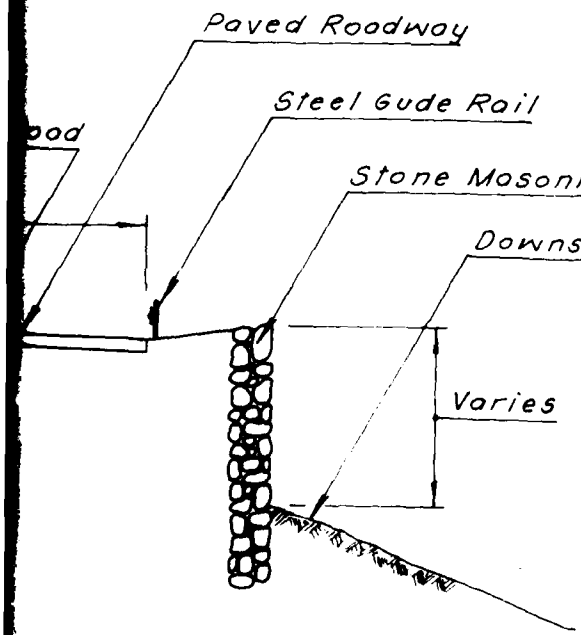


PLATE 5

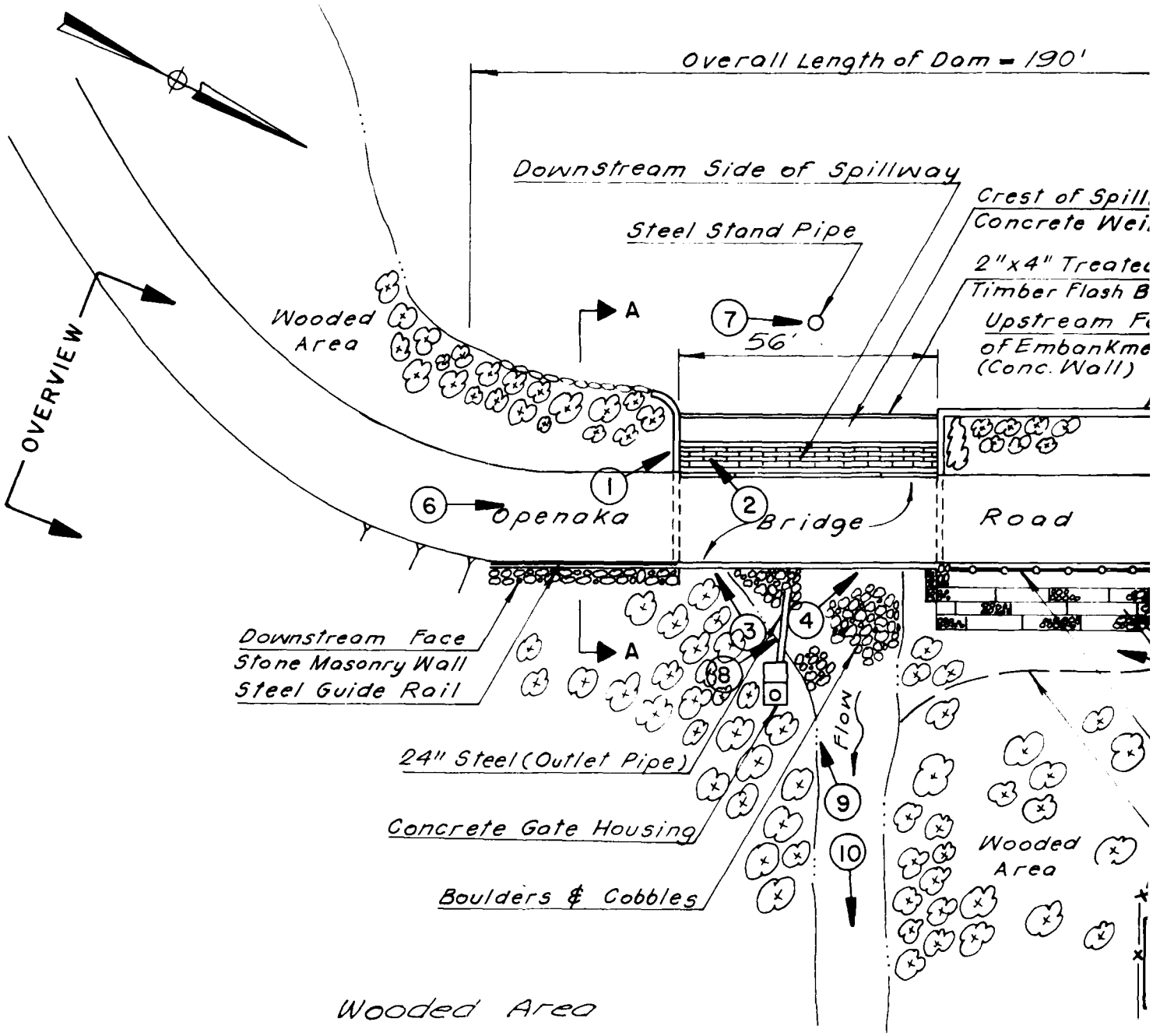
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

SECTIONS

OPENAKA LAKE DAM

I.D. N J. 00780	SCALE: NOT TO SCALE
	DATE: FEB. 1981



Note:
Information taken from field inspection December 24, 1980

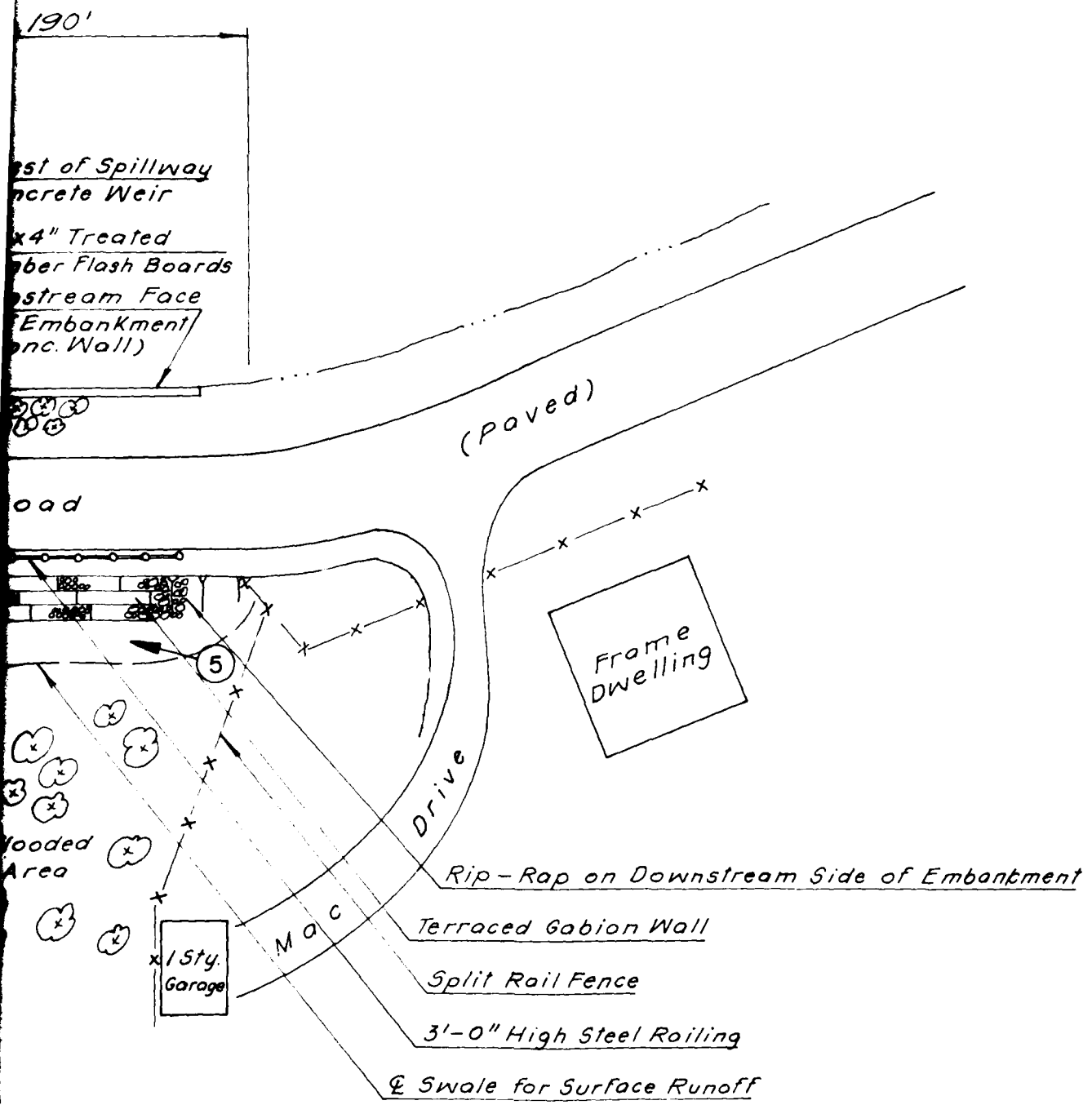


PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN
OPENAKA LAKE DAM

I.D. N.J. 00780	SCALE: NOT TO SCALE
	DATE: FEB. 1981

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List

Visual Inspection

Phase I

Name of Dam Openaka Lake Dam County Morris State N.J. Coordinators NJDEP

Date(s) Inspection 12/24/80, 3/2/80 Weather Cloudy Temperature 30°F

Pool Elevation at time of Inspection 678.0 M.S.L. Tailwater at Time of Inspection 666.9 M.S.L.

Inspection Personnel:

John Gribbin — Mark Brady

Charles Osterkorn — Richard McDermott

Daniel Buckelew

John Gribbin Recorder

Owner not present.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Stepped, cut stone downstream face in generally satisfactory condition.	Downstream face obscured by ice accumulation and overflow.
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Junctions with stone masonry abutments appeared sound. Cracks observed in concrete at top of right abutment, see SPILLWAY.	
DRAINS	None observed	
WATER PASSAGES	None observed	
APRON	Apron obscured by stilling basin water immediately downstream from toe.	
VERTICAL AND HORIZONTAL ALIGNMENT	Vertical: level Horizontal: straight	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Cracks observed at right end of crest and abutment, see SPILLWAY.	
STRUCTURAL CRACKING	None observed	
CONSTRUCTION JOINTS	None observed	
MONOLITH JOINTS	N.A.	
LEAKAGE	Could not be assessed due to accumulation of ice, overflow and presence of stilling basin.	
SEEPAGE	Orange stains observed on rocks in downstream channel on left and right sides.	Some coloring could be due to rust from deteriorated outlet pipe. However, stains on left side could be related to seepage. Seepage should be monitored on a periodic basis.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	Upstream side of crest of left and right embankments overgrown with trees and bushes. Trees range in size from 1 inch to 12 inches. Paved roadway on crest patched but in satisfactory condition. Conc. wall forming upstream face of left embankment in fair condition, generally stable.	Trees and adverse vegetation should be removed. Deteriorated chain link fences at each end of spillway should be repaired to prevent access to spillway area.
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Junctions at stone spillway section appeared generally sound. Cracks observed in spillway crest. Possible relation to junction distress could not be assessed.	
ANY NOTICEABLE SEEPAGE	Orange deposits observed at left bank of downstream channel approximately 20 feet downstream from toe of dam.	Evidence of seepage should be monitored.
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None observed.	

EMBANKMENT

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None observed.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Stone rubble wall forming downstream face near right end bulging away from embankment approx. 1 foot. Remaining embankment faces appeared sound. Two holes (4" dia) in embankment above downstream wall right side-possibly due to subsidence of embankment material.	Bulging wall could be due to embankment sloughing. Wall approx. 3 feet high in area of bulge. Wall should be repaired.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical: varies approx. 2 feet. Horizontal: Curved.	
RIPRAP	None observed on upstream face. Riprap observed on downstream face near left end, immediately adjacent to gabions. Coverage appeared satisfactory.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit severely deteriorated. Section of pipe exposed between dam toe and gate housing at downstream end. Areas of exposed section rusted through.	Outlet conduit composed of riveted steel pipe. Outlet works should be investigated to determine need for drawdown capability. Outlet works should be repaired, in accordance with results of investigation.
INTAKE STRUCTURE	Standpipe located at apparent upstream end of outlet works leaking extensively near its top.	Standpipe opened at top and protruding above water level approx. 0.2 feet. Function of standpipe unknown.
OUTLET STRUCTURE	Outlet appeared to be located at downstream gate housing (see below)	
OUTLET CHANNEL	Outlet discharges directly into downstream channel.	
GATE AND GATE HOUSING	Concrete gate housing at downstream end of outlet pipe appeared to be deteriorated. Steel plate on top of housing could not be removed. Stem protruding through plate severely rusted. Downstream gate appeared inoperable. Downstream end of housing discharging approx. 2 gal./min. (3/2/81)	

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	Timber flashboards appeared to be in satisfactory condition. Conc. cap on top of spillway structure in generally satisfactory condition with cracks and open area at right end. Opening in conc. approx. 2' x 1' x 4" deep.	Conc. cap and abutment at right end should be repaired.
ABUTMENTS	Conc. abutment at left end in satisfactory condition. Cracks observed in right conc. abutment.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	Formed by stone masonry abutments for bridge. Bottom lined with boulders and cobbles. Portion from spillway toe and center of bridge serves as stilling basin-water approx. 2.5 feet deep. Debris noted in stilling basin.	Debris should be removed.
BRIDGE	Steel bridge spans discharge channel. Structure appeared sound, although structural steel members were relatively light weight. Bridge load restricted to 5 tons	

INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Shores wooded with steep slopes ranging from 25% to 100%.	
SEDIMENTATION	Unknown.	
STRUCTURES ALONG BANKS	A few homesites noted along shore slopes. One homesite observed near waterline on left side of lake approx. 8 ft. above water level.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTION, DEBRIS, ETC.)	Meandering natural stream with bed and banks lined with small boulders. No obstructions noted within 500 feet of dam. Banks wooded to waterline.	
SLOPES	Banks about 4' to 5' high with flat flood plain extending about 50' on either side, then the terrain slopes up at moderate grade beyond.	
STRUCTURES ALONG BANKS	Dwelling located immediately downstream from dam. Abandoned, breached dam located on stream 2500' from dam. Three dwellings located about 5000' from dam. Road bridge located 5400' from dam. Two dwellings located 5700' from dam. Highway bridge (Route 10) located 6000' from dam. All dwellings greater than 8 feet above stream.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM			REMARKS
DAM	-	PLAN	Not Available
		SECTIONS	
SPILLWAY	-	PLAN	Not Available
		SECTIONS	
		DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS			Not Available
OUTLETS	-	PLAN	Not Available
		DETAILS	
		CONSTRAINTS	
		DISCHARGE RATINGS	
HYDRAULIC/HYDROLOGIC DATA			Not Available
RAINFALL/RESERVOIR RECORDS			Not Available
CONSTRUCTION HISTORY			Not Available
LOCATION MAP			Available in NJDEP file - NJDEP, Division of Water Resources, P.O. Box CN-029, Trenton, N.J. 08625

ITEM	REMARKS
DESIGN REPORTS	Not Available
GEOLOGY REPORTS	Not Available
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM INSTABILITY SEEPAGE STUDIES	Not Available
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available
POST-CONSTRUCTION SURVEYS OF DAM	Not Available
BORROW SOURCES	Not Available

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Not Available
HIGH POOL RECORDS	Not Available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Inspection by State of N.J. on Sept. 22, 1972 indicated presence of flashboards which were apparently installed without proper State approval - in NJDEP file.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	"Reference Data" in NJDEP file refers to overtopping of "right wing" on July 23, 1919. Overtopping caused undermining of highway bridge abutment.
MAINTENANCE OPERATION RECORDS	Correspondence in NJDEP file refers to NJDEP order on March 2, 1973 to dewater the lake.

APPENDIX 2

Photographs

PHOTO 1

CREST OF SPILLWAY

PHOTO 2

CRACKS IN SPILLWAY CREST AND RIGHT ABUTMENT

OPENAKA LAKE DAM

24 DECEMBER 1980

PHOTO 3

RIGHT SPILLWAY ABUTMENT

PHOTO 4

LEFT SPILLWAY ABUTMENT

ODENAHA LAKE DAM

24 DECEMBER 1980

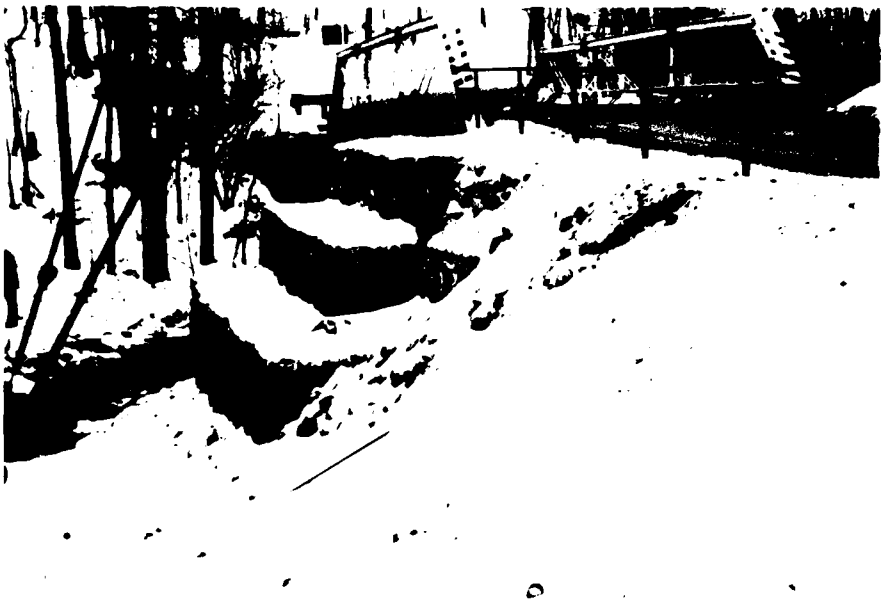


PHOTO 5

DOWNSTREAM SIDE OF DAM

PHOTO 6

CREST OF DAM

OPENAKA LAKE DAM

24 DECEMBER 1980

PHOTO 7

STEEL STANDPIPE-UPSTREAM END OF OUTLET WORKS

PHOTO 8

DETERIORATED OUTLET PIPE BEYOND TOE OF DAM

OPENAKA LAKE DAM

24 DECEMBER 1980

PHOTO 9

DOWNSTREAM FACE OF DAM AND SPILLWAY

SHOWING DOWNSTREAM END OF OUTLET WORKS

PHOTO 10

DOWNSTREAM CHANNEL

OPENAKA LAKE DAM

24 DECEMBER 1980

APPENDIX 3

Engineering Data

CHECK LIST

HYDROLOGIC AND HYDRAULIC DATA

ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Wooded and Residential

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 678.0 (46 Acre Feet)

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

ELEVATION MAXIMUM DESIGN POOL: 683.0

ELEVATION TOP DAM: 679.9

SPILLWAY CREST: Uncontrolled Weir

a. Elevation 678.0

b. Type Broad Crested Weir

c. Width 6.0 Feet

d. Length 56.0 Feet

e. Location Spillover Center of Dam

f. Number and Type of Gates Timber Flashboards Along Spillway Crest

OUTLET WORKS:

a. Type Low Level 24-inch Steel Pipe (Gate at Downstream End)

b. Location Center of Spillway Section

c. Entrance Invert Unknown

d. Exit Invert 664.2

e. Emergency Draindown Facilities: Outlet Inoperative

HYDOMETEOROLOGICAL GAGES: None

a. Type N.A.

b. Location N.A.

c. Records N.A.

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake Stage Equal to Top of Dam) 389 c.f.s.

APPENDIX 4

Hydraulic/Hydrologic Computations

STORCH ENGINEERS

Sheet 1 of 16.

Project OTERO #4 FLD DAM

Made By TLF Date 1-27-81

Chkd By JG Date 3/5/81

Hydrology

Hydrologic Analysis

Runoff hydrograph will be developed by HEC-1-DAM computer program using scs triangular hydrograph with the curvilinear transformation.

Drainage Area = 4.09 sq. mi.

Infiltration Data

Initial Infiltration	1.5 in.
Constant Infiltration	0.15 in./hr.

Time of Concentration (t_c) (Meth. 1 #1)

By SCS TR-55

Chart on Overland Flow and Channel Flow.

Overland Flow

L = 2300'

Δ ELEV. = 200'

S = 8.70 %

Time = 0.85 HR.

SCS TR-55 (Cont.)

Channel Flow

L = 2500'
S = 3.2%
V = 3.5 f.p.s.
Time = 0.20 HR.

L = 13000'
S = 0.31%
V = 1.3 f.p.s.
Time = 2.78 HR.
t_c = 3.83 HR.

Time of Concentration Method #2

by Kerby pg. 14-36 "Handbook of Applied Hydrology" Chow

$$t_c^{2.14} = 2/3 \frac{Ln}{\sqrt{S}}$$

t_c = Time of Concentration
L = Length of Flow
S = Slope
n = Roughness Coeff.

Overland Flow

L = 2300'
S = 0.0870
n = 0.40
Time = 0.59 Hr.

by Kerby (cont.)

Channel Flow
L = 2500'
S = 0.032
n = 0.10
Time = 0.88 Hr.

L = 13,000'
S = 0.0031
n = 0.10
Time = 1.52 Hr.
tc = 2.99 Hr.

Time of Concentration (method #3)

N.J. Highway Authority & D.E.P. Nomographs

Overland Flow:
L = 2300'
S = 8.70%
Average Grass
Time = 0.58 Hr.

Channel Flow:
L = 2500'
ΔELEV. = 30'
Time = 0.20 Hr.

N.J. Highway Authority & D.E.P. Nomographs (cont.)

Channel Flow:
L = 13,000'
ΔELEV = 40'
Time = 1.8 HR.
t_c = 2.58 HR.

Time of Concentration (Method #4)

By pg. 70 U.S. Dept. of Interior "Design of Small Dams" Texas Highway Dept. & Navdocks TP-PW-5

Overland Flow:
L = 2300'
S = 8.70%
V = 3.0 f.p.s.
Time = 0.21 HR.

Channel Flow:
L = 2500'
S = 3.2%
V = 3.0 f.p.s.
Time = 0.23 HR.

L = 13,000'
S = 0.31%
V = 1.0 f.p.s.
Time = 3.61 HR.
t_c = 4.05 HR.

STORCH ENGINEERS

Project OPENACA LAKE DAM

Sheet 5 of 16

Made By JLP Date 1-27-81

Chkd By JG Date 3/5/81

Time of Concentration and Lag Time

t_c use 3.36 HR.

$Lag = 0.6\ t_c = 2.02$ HR.

Precipitation

24 HOUR, 100-YEAR RAINSTORM DISTRIBUTION FOR OPENAKA LAKE DAM

TIME (HR.)	RAIN (INCHES)
1	0.075
2	0.075
3	0.075
4	0.075
5	0.075
6	0.075
7	0.075
8	0.075
9	0.075
10	0.075
11	0.075
12	0.075
13	0.15
14	0.15
15	0.15
16	0.33
17	0.65
18	3.00
19	0.65
20	0.33
21	0.33
22	0.15
23	0.15
24	0.15
	7.09 inches

ELEVATION - AREA TABLE

ELEV. (M.S.L)	AREA (AC.)
664.4	0
678.0	2.3
680.0	3.7
700.0	24.8

HEC-1-DAM Computer program will develop storage capacity from surface areas & elevations

Information taken from USGS Quadrangle Mendham, N.J.

HYDRAULICS

SPILLWAY STAGE DISCHARGE CALCULATIONS

Spillway Capacity

The spillway at Openaka Lake Dam is a broad crested weir with an effective length of 56.0'.

Discharge Q, can be calculated by:

$$Q = C l h^{3/2}$$

where: Q = discharge over spillway
C = discharge coefficient
l = effective length of spillway
h = total head on spillway

Values for the discharge coefficient "C" were taken from the "Handbook of Hydraulics" by King & Brater.

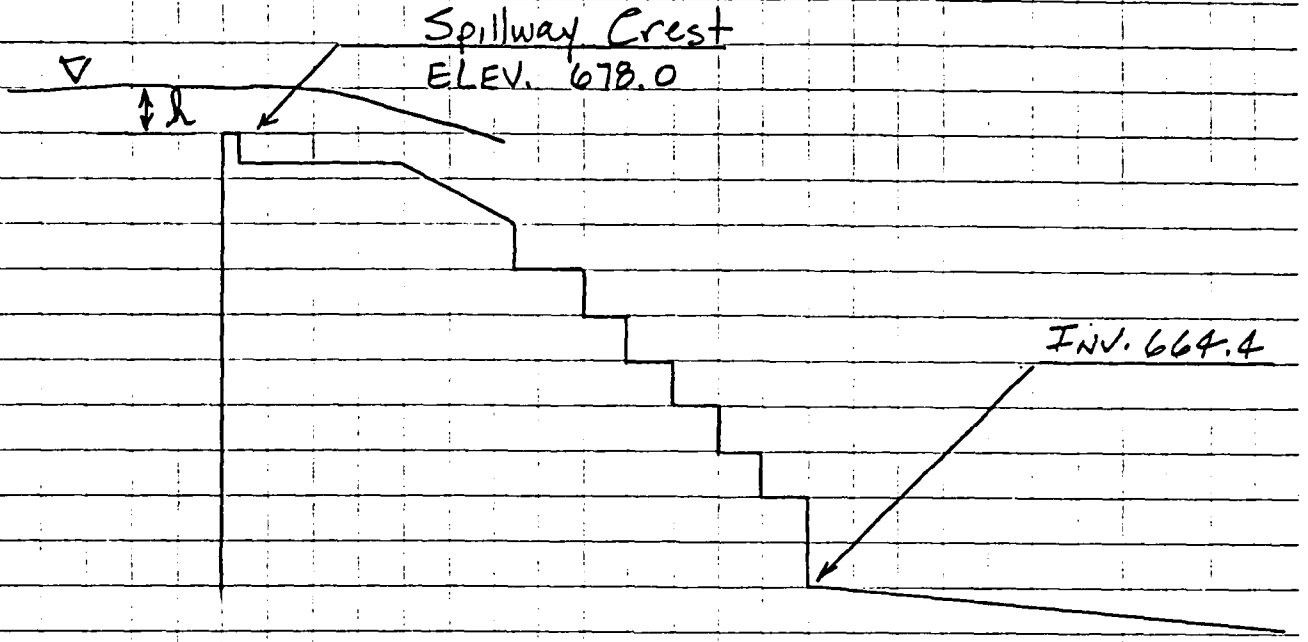
STORCH ENGINEERS

Project OPENAKA LAKE DAM

Sheet 9 of 16

Made By JLP Date 1-27-81

Chkd By JG Date 3/5/81



SPILLWAY SECTION

SPILLWAY STAGE DISCHARGE TABULATION

WATER SURFACE ELEVATION	HEAD (ft.)	COEFFICIENT "C"	DISCHARGE Q (cfs)
678.0	0	—	0
678.5	0.5	3.07	61
679.0	1.0	3.02	169
679.9	1.9	2.65	389
680.0	2.0	2.65	420
681.0	3.0	2.66	774
682.0	4.0	2.70	1210
683.0	5.0	2.79	1747
684.0	6.0	2.88	2370
685.0	7.0	3.02	3132

STORCH ENGINEERS

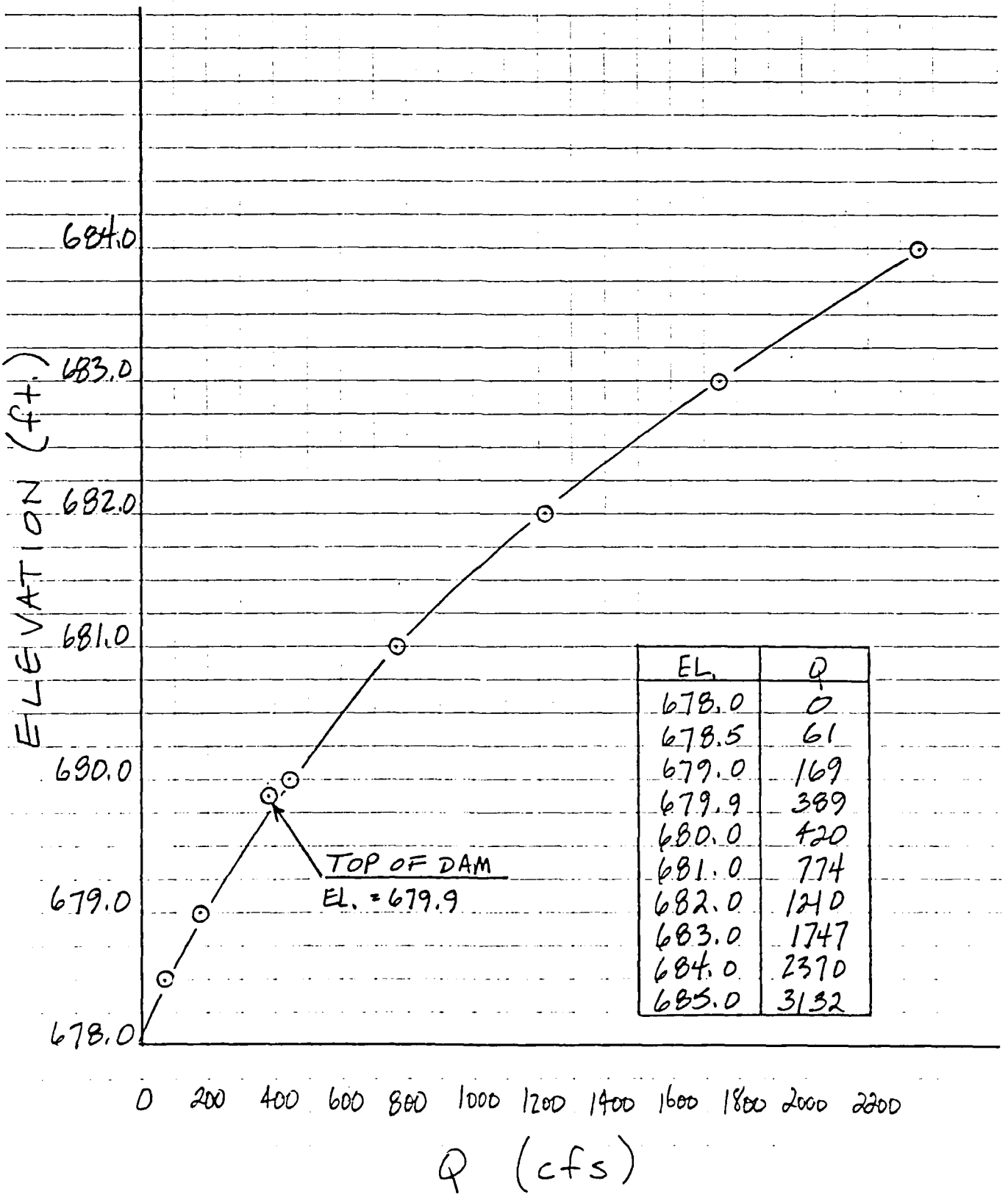
Project OPENAKA LAKE DAM

Sheet 11 of 16

Made By JLP Date 1-27-81

Chkd By JG Date 3/5/81

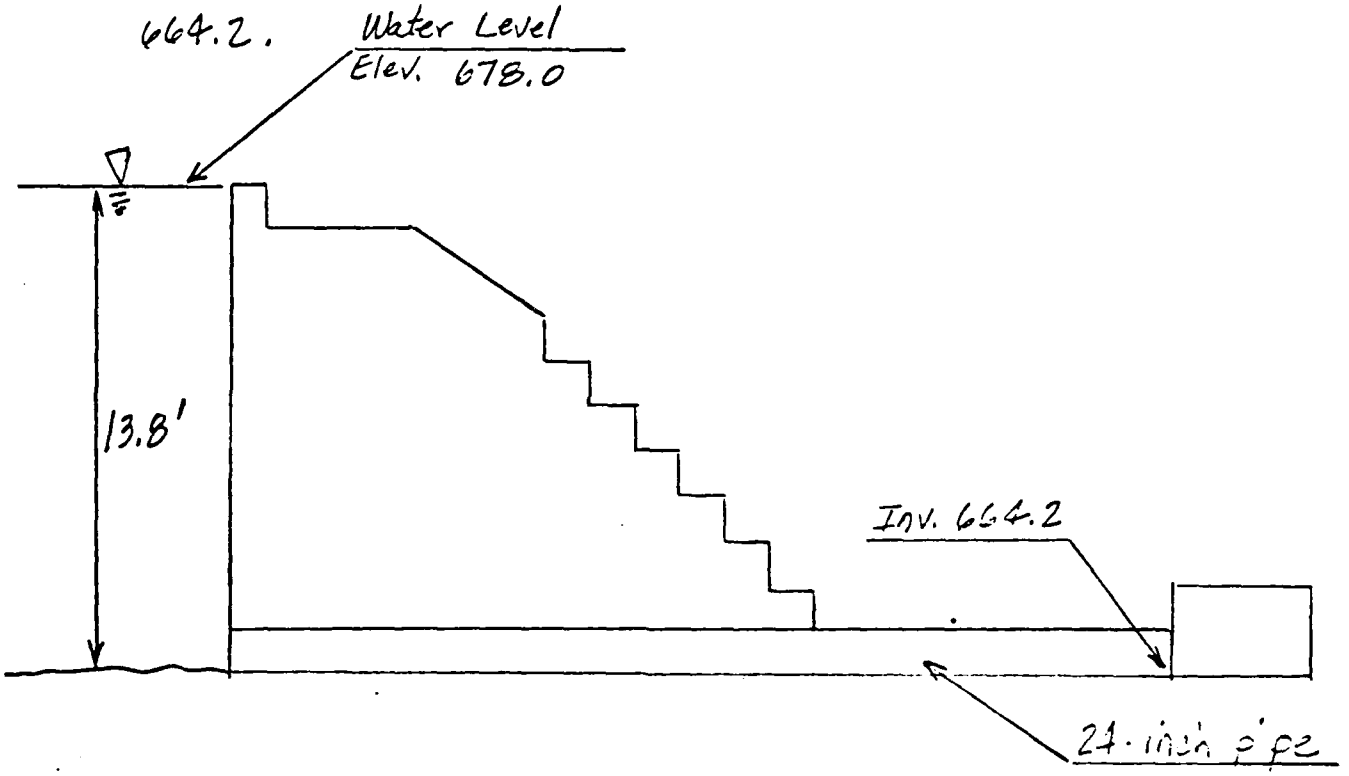
SPILLWAY STAGE DISCHARGE CURVE



EL.	Q
678.0	0
678.5	61
679.0	169
679.9	389
680.0	420
681.0	774
682.0	1210
683.0	1747
684.0	2370
685.0	3132

OUTLET WORKS CAPACITY

OUTLET WORKS FOR THE OPENAKA LAKE DAM CONSIST OF A 24"- RIVETED STEEL PIPE. OUTLET INVERT 664.2.



FROM "HYDRAULIC CHARTS FOR THE SELECTION OF HIGHWAY CULVERTS" BUREAU OF PUBLIC ROADS, 1963; INLET CONTROL CHART #2

MAXIMUM DISCHARGE; HW = 13.8'
Q = 55 C.F.S.

AVERAGE DISCHARGE; HW = 6.9'
Q = 37.0 C.F.S. DURING DRAWDOWN

DRAWDOWN

$$\text{DRAWDOWN} = \frac{\text{STORAGE AT SPILLWAY}}{\text{AVG. DISCHARGE - AVG. INFLOW}}$$

AVG. DISCHARGE = 37.0 CFS
AVG. INFLOW = 4.0 CFS based upon 1 CFS/Sq. Mi.

$$= \frac{46 \text{ acre-feet } (43560) \text{ SQ. FT/ACRE}}{(37-4) \text{ cfs } (3600) \text{ SEC./HR.}}$$

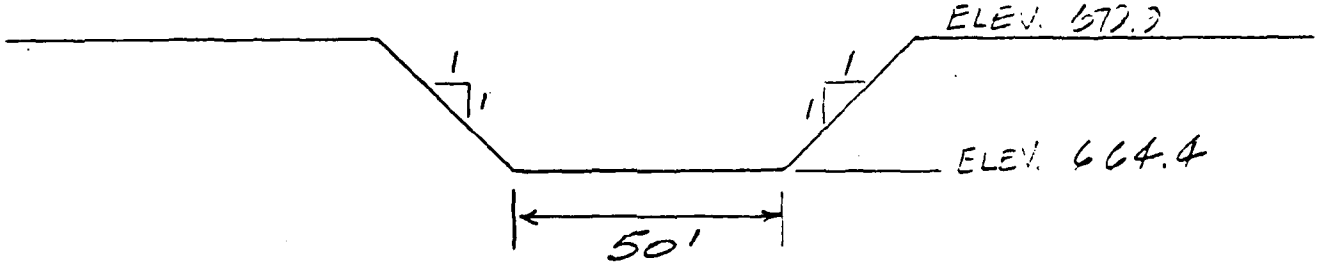
$$= 16.8 \text{ HOURS}$$

BREACH ANALYSIS

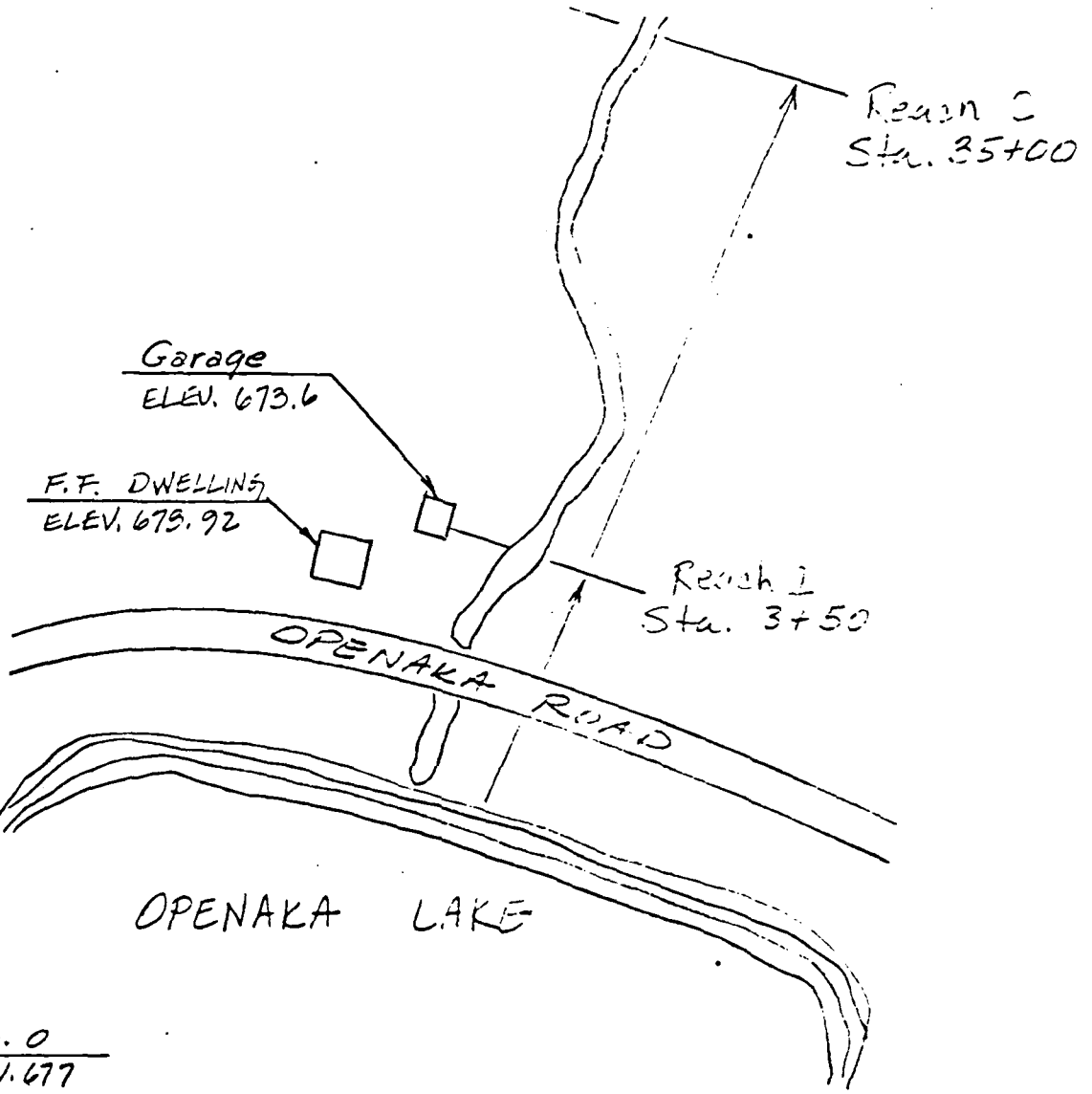
A BREACH HYDROGRAPH WILL BE COMPUTED BY THE HEC-1-DAM PROGRAM AND ROUTED THROUGH TWO DOWNSTREAM REACHES BY THE MODIFIED PULS METHOD.

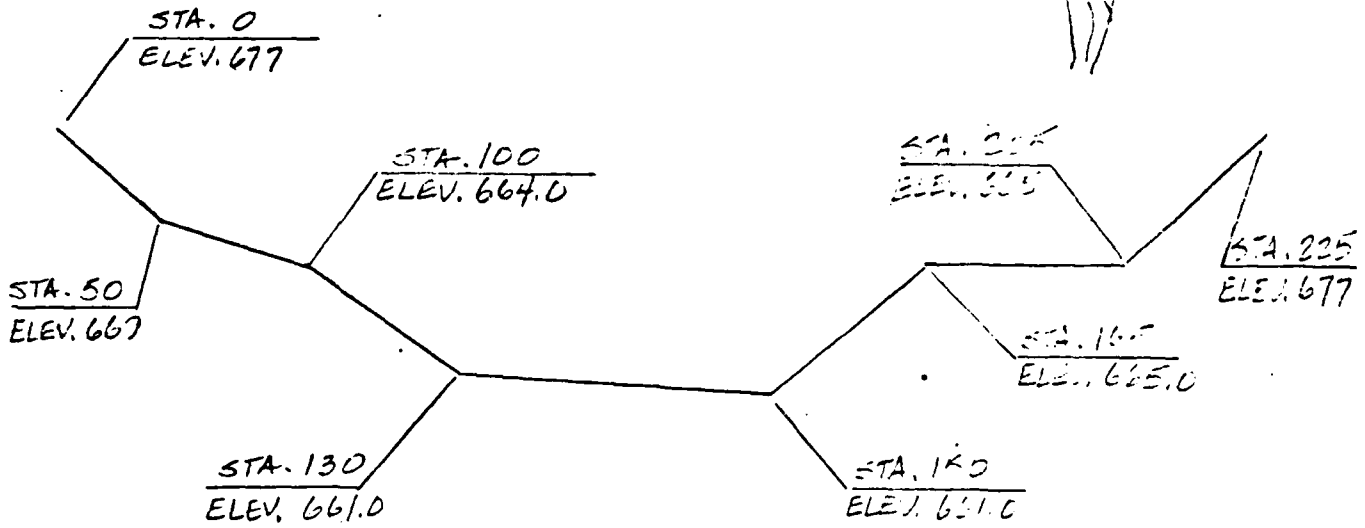
THE ASSUMED BREACH CONDITIONS ARE AS FOLLOWS:

1. THE BREACH BEGINS WHEN THE WATER SURFACE ELEVATION REACHES 679.9
2. TIME TO DEVELOP BREACH = 1.0 HR.
3. SECTION



FULLY DEVELOPED BREACH





CROSS SECTION END OF REACH 1
S = 0.0095

BREACH RESULTS:

1. Peak outflow = 3344 c.f.s.

2. Reach 1: Max Stage = 666.6
   5.6' above channel invert
   Dwelling not inundated.

3. Reach 2: Max. Stage = 642.5
   6.5' above channel invert
   Dwellings not inundated.

HEC - 1 - DAM PRINTOUT

Overtopping Analysis

```
1A1       NATIONAL DAM SAFETY PROGRAM
 A2       OPENAKA LAKE DAM, NEW JERSEY
 A3       100 YEAR STORM ROUTING
 B    300        0      30                                    0       0       3
 B1     5
 J      1        1       1
 J1     1
 K      0    LAKE                          0       0       1
 K1       INFLOW HYDROGRAPH TO OPENAKA LAKE DAM
 M      0        2    4.09              4.09       0                       1
 O     48
 O1 0.038    0.038   0.038   0.038   0.038   0.038   0.038   0.038   0.038   0.038
 O1 0.038    0.038   0.038   0.038   0.038   0.038   0.038   0.038   0.038   0.038
 O1 0.038    0.038   0.038   0.038   0.075   0.075   0.075   0.075   0.075   0.075
 O1 0.165    0.165   0.325   0.325   1.500   1.500   0.325   0.325   0.165   0.165
 O1 0.165    0.165   0.075   0.075   0.075   0.075   0.075   0.075
 T                                                   1.5    0.15
 W2           2.0
 X   -1.0    -0.05     2.0
 K      1      DAM
 K1       ROUTE DISCHARGE THROUGH DAM
 Y                                  1       1
 Y1     1                                        -678.0      -1
 Y4 678.0    678.5   679.0   679.9   680.0   681.0   682.0   683.0   684.0   685.0
 Y5     0       61     169     389     420     774    1210    1747    2370    3132
 $A     0      2.2     5.0     9.4    24.8
 $E 664.4    665.0   678.0   680.0   700.0
 $$ 678.0
 $D 679.9     2.63     1.5    86.5
 K      1       1                                       1
 K1       CHANNEL ROUTING REACH 1
 Y                                  1       1
 Y1     1
 Y6   0.1   0.035     0.1     661     677     350  0.0095
 Y7     0     677      50     669     100     664     130     661     150     661

 Y7   165     665     205     665     225     677
 K      1       2                                       1
 K1       CHANNEL ROUTING REACH 2
 Y                                  1       1
 Y1     1
 Y6   0.1   0.035     0.1     636     677    3500   0.008
 Y7     0     677      70     676     140     653     170     636     200     636
 Y7   220     641     260     651     365     677
 K     99
```

NATIONAL DAM SAFETY PROGRAM
OPENAKA LAKE DAM, NEW JERSEY
100 YEAR STORM ROUTING

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	30	0	0	0	0	0	3	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH TO OPENAKA LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	4.09	0.00	4.09	0.00	0.000	0	1	0

PRECIP DATA

NP	STORM	DAJ	DAK
48	0.00	0.00	0.00

PRECIP PATTERN

.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.08	.08	.08	.08	.08	.08
.17	.17	.33	.33	1.50	1.50	.33	.33	.17	.17
.17	.17	.08	.08	.08	.08	.08	.08		

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.50	.15	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= 2.00

RECESSION DATA
STRTQ= -1.00 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 22 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= 2.00 VOL= 1.00

105.	334.	672.	862.	862.	731.	538.	356.	246.	176.
121.	85.	59.	41.	29.	20.	14.	10.	7.	5.
3.	1.								

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	.30	1	.50	4.	2.	46.	678.0
1.01	1.00	2	1.00	4.	3.	46.	678.0
1.01	1.30	3	1.50	3.	3.	46.	678.0
1.01	2.00	4	2.00	3.	3.	46.	678.0
1.01	2.30	5	2.50	3.	3.	46.	678.0
1.01	3.00	6	3.00	3.	3.	46.	678.0
1.01	3.30	7	3.50	3.	3.	46.	678.0
1.01	4.00	8	4.00	2.	3.	46.	678.0
1.01	4.30	9	4.50	2.	2.	46.	678.0
1.01	5.00	10	5.00	2.	2.	46.	678.0
1.01	5.30	11	5.50	2.	2.	46.	678.0
1.01	6.00	12	6.00	2.	2.	46.	678.0
1.01	6.30	13	6.50	2.	2.	46.	678.0
1.01	7.00	14	7.00	2.	2.	46.	678.0
1.01	7.30	15	7.50	1.	2.	46.	678.0
1.01	8.00	16	8.00	1.	1.	46.	678.0
1.01	8.30	17	8.50	1.	1.	46.	678.0
1.01	9.00	18	9.00	1.	1.	46.	678.0
1.01	9.30	19	9.50	1.	1.	46.	678.0
1.01	10.00	20	10.00	1.	1.	46.	678.0
1.01	10.30	21	10.50	1.	1.	46.	678.0
1.01	11.00	22	11.00	1.	1.	46.	678.0
1.01	11.30	23	11.50	1.	1.	46.	678.0
1.01	12.00	24	12.00	1.	1.	46.	678.0
1.01	12.30	25	12.50	1.	1.	46.	678.0
1.01	13.00	26	13.00	1.	1.	46.	678.0
1.01	13.30	27	13.50	1.	1.	46.	678.0
1.01	14.00	28	14.00	1.	1.	46.	678.0
1.01	14.30	29	14.50	1.	1.	46.	678.0
1.01	15.00	30	15.00	1.	1.	46.	678.0
1.01	15.30	31	15.50	2.	1.	46.	678.0
1.01	16.00	32	16.00	15.	6.	46.	678.0
1.01	16.30	33	16.50	67.	28.	47.	678.2
1.01	17.00	34	17.00	183.	98.	50.	678.7
1.01	17.30	35	17.50	492.	290.	56.	679.5
1.01	18.00	36	18.00	1099.	790.	66.	680.6
1.01	18.30	37	18.50	1966.	1710.	78.	681.8
1.01	19.00	38	19.00	2749.	2570.	87.	682.6
1.01	19.30	39	19.50	3072.	3031.	91.	683.0
1.01	20.00	40	20.00	2942.	2998.	91.	683.0
1.01	20.30	41	20.50	2507.	2628.	88.	682.7
1.01	21.00	42	21.00	1967.	2102.	82.	682.2
1.01	21.30	43	21.50	1503.	1622.	77.	681.7
1.01	22.00	44	22.00	1163.	1255.	73.	681.3
1.01	22.30	45	22.50	883.	968.	69.	680.9
1.01	23.00	46	23.00	651.	734.	65.	680.5
1.01	23.30	47	23.50	467.	539.	62.	680.2
1.02	0.00	48	24.00	326.	394.	59.	679.9
1.02	.30	49	24.50	225.	306.	56.	679.6
1.02	1.00	50	25.00	157.	217.	53.	679.2
1.02	1.30	51	25.50	144.	163.	52.	679.0
1.02	2.00	52	26.00	134.	144.	51.	678.9
1.02	2.30	53	26.50	125.	133.	51.	678.8
1.02	3.00	54	27.00	117.	124.	51.	678.8
1.02	3.30	55	27.50	109.	115.	50.	678.8
1.02	4.00	56	28.00	102.	107.	50.	678.7
1.02	4.30	57	28.50	95.	100.	50.	678.7
1.02	5.00	58	29.00	89.	93.	50.	678.7
1.02	5.30	59	29.50	83.	87.	49.	678.6
1.02	6.00	60	30.00	77.	81.	49.	678.6
1.02	6.30	61	30.50	72.	76.	49.	678.6
1.02	7.00	62	31.00	67.	71.	49.	678.5
1.02	7.30	63	31.50	63.	66.	49.	678.5
1.02	8.00	64	32.00	59.	61.	49.	678.5
1.02	8.30	65	32.50	55.	59.	49.	678.5
1.02	9.00	66	33.00	51.	55.	48.	678.5
1.02	9.30	67	33.50	48.	52.	48.	678.4
1.02	10.00	68	34.00	44.	48.	48.	678.4
1.02	10.30	69	34.50	41.	45.	48.	678.4
1.02	11.00	70	35.00	39.	42.	48.	678.3
1.02	11.30	71	35.50	36.	39.	48.	678.3
1.02	12.00	72	36.00	34.	37.	48.	678.3
1.02	12.30	73	36.50	31.	34.	47.	678.3
1.02	13.00	74	37.00	29.	32.	47.	678.3
1.02	13.30	75	37.50	27.	30.	47.	678.2

HYDROGRAPH ROUTING

ROUTE DISCHARGE THROUGH DAM

ISTAG	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM	1	0	0	0	0	0	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	ISK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-678.	-1

STAGE	678.00	678.50	679.00	679.90	680.00	681.00	682.00	683.00	684.00	685.00
FLOW	0.00	61.00	169.00	389.00	420.00	774.00	1210.00	1747.00	2370.00	3132.00
SURFACE AREA=	0.	2.	5.	9.	25.					
CAPACITY=	0.	0.	46.	60.	390.					
ELEVATION=	664.	665.	678.	680.	700.					

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
678.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
679.9	2.6	1.5	87.

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1
				1.00
HYDROGRAPH AT	LAKE	4.09	1	3072.
		(10.59)		(86.98)(
ROUTED TO	DAM	4.09	1	(3031)
		(10.59)		(85.81)(
ROUTED TO	1	4.09	1	3028.
		(10.59)		(85.75)(
ROUTED TO	2	4.09	1	3037.
		(10.59)		(86.01)(

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	678.00	678.00	679.90
STORAGE	46.	46.	59.
OUTFLOW	0.	0.	389.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	683.03	3.13	91.	3031.	6.50	19.50	0.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3028.	666.3	19.50

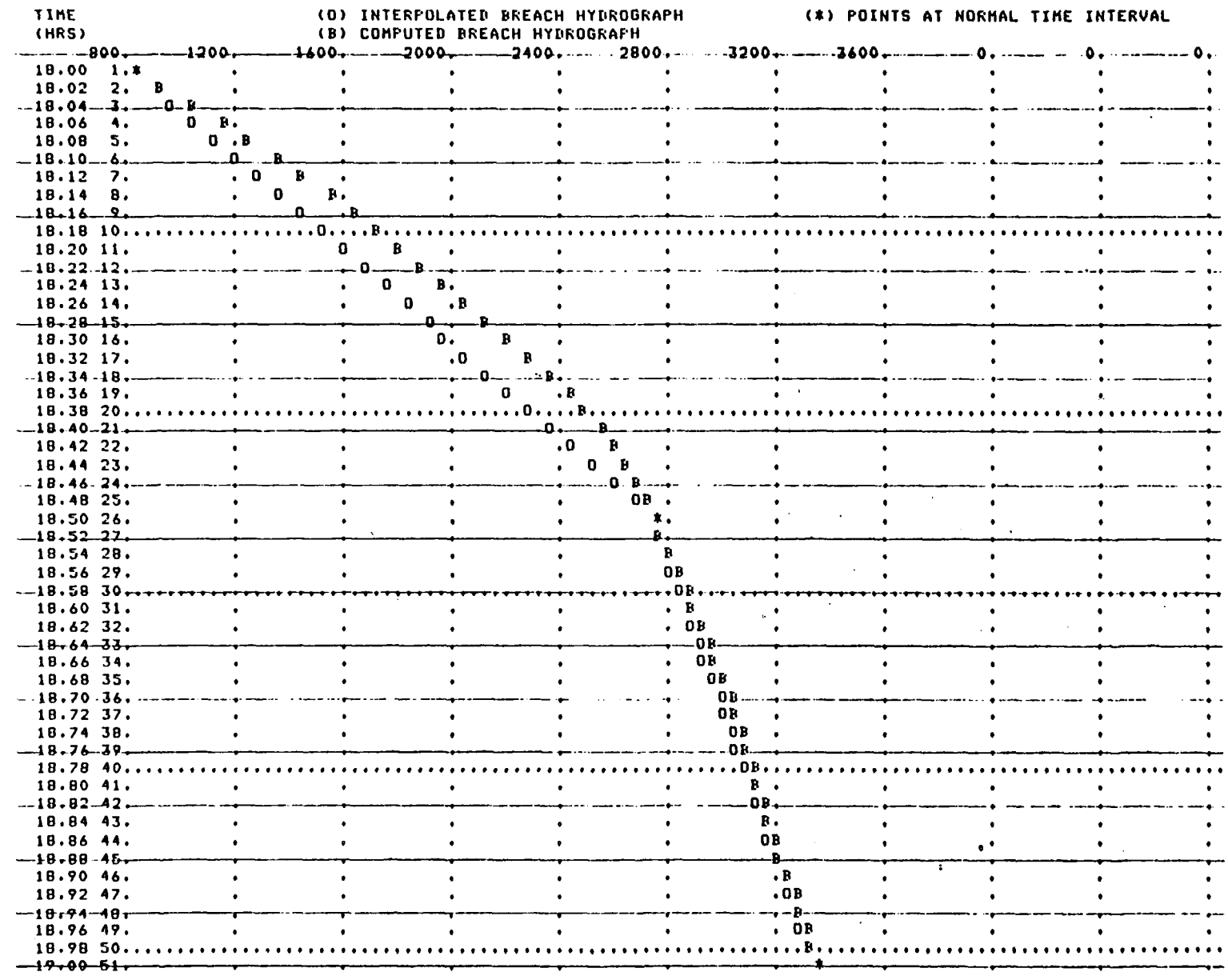
PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3037.	642.1	20.00

HEC - 1 - DAM PRINTOUT

Breach Analysis

```
1A1       NATIONAL DAM SAFETY PROGRAM
A2        OPENAKA LAKE DAM, NEW JERSEY
A3          100 YEAR STORM ROUTING
B     300         0        3(                                      0        0        3
R1      5
J       1         1        1
J1      1
K       0      LAKE                              0        0        1
K1        INFLOW HYDROGRAPH TO OPENAKA LAKE DAM
M       0         2     4.09              4.09        0                          1
B      48
O1 0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038
O1 0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038    0.038
O1 0.038    0.038    0.038    0.038    0.075    0.075    0.075    0.075    0.075    0.075
O1 0.165    0.165    0.325    0.325    1.500    1.500    0.325    0.325    0.165    0.165
O1 0.165    0.165    0.075    0.075    0.075    0.075    0.075    0.075
T                                                          1.5      0.15
W2              2.0
X    -1.0    -0.05      2.0
K       1      DAM
K1        ROUTE DISCHARGE THROUGH DAM
Y                                      1        1
Y1      1                                                 678.0       -1
Y4 678.0    678.5    679.0    679.9    680.0    681.0    682.0    683.0    684.0    685.0
Y5      0       61      169      389      420      774     1210     1747     2370     3132
$A      0      2.2      5.0      9.4     24.8
$E 664.4    665.0    678.0    680.0    700.0
$$ 678.0
$D 679.9     2.63      1.5     86.5
$B  50.0        1    664.4      1.0    678.0    679.9
K       1        1                                          1
K1      CHANNEL ROUTING REACH 1
Y                                      1        1
Y1      1
Y6    0.1    0.035      0.1      661      677      350   0.0095
Y7      0      677       50      669      100      664      130      661      150      661
Y7    165      665      205      665      225      677
K       1        2                                          1
K1      CHANNEL ROUTING REACH 2
Y                                      1        1
Y1      1
Y6    0.1    0.035      0.1      636      677     3500    0.008
Y7      0      677       70      676      140      653      170      636      200      636
Y7    220      641      260      661      365      677
K      99
A
```


TIME
(HRS)
(O) INTERPOLATED BREACH HYDROGRAPH
(B) COMPUTED BREACH HYDROGRAPH
(*) POINTS AT NORMAL TIME INTERVAL
800
1200
1600
2000
2400
2800
3200
3600
0
0
0

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1
				1.00
HYDROGRAPH AT	LAKE	4.09 (10.59)	1	3072. (86.98)(
ROUTED TO	DAM	4.09 (10.59)	1	3344. (94.68)(
ROUTED TO	1	4.09 (10.59)	1	3377. (95.63)(
ROUTED TO	2	4.09 (10.59)	1	3447. (97.61)(

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	678.00	678.00	679.90
	STORAGE	46.	46.	59.
	OUTFLOW	0.	0.	389.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	680.65	.75	66.	3344.	.82	19.00	18.00

PLAN 1 STATION 1

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3377.	666.6	19.00

PLAN 1 STATION 2

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	3447.	642.5	19.00

APPENDIX 5

Bibliography

AD-A102 730 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON --ETC F/G 4/2
NATIONAL DAM SAFETY PROGRAM. OPENAKA LAKE DAM (NJ00780), PASSAI--ETC(U)
MAY 81 R J MCDERMORR, J E GRIBBIN DACW61-79-C-0011
UNCLASSIFIED DAEN/NAP-53842/NJ00780-81/ NL

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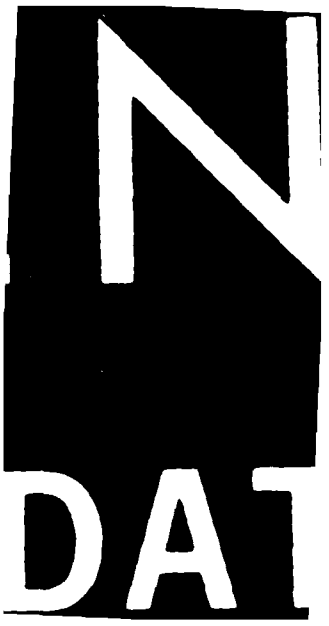
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