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NATIONAL DAM SAFETY PROGRAM, INDIAN LAKE DAM (NJ00188), DELAWARE-ETC(U)
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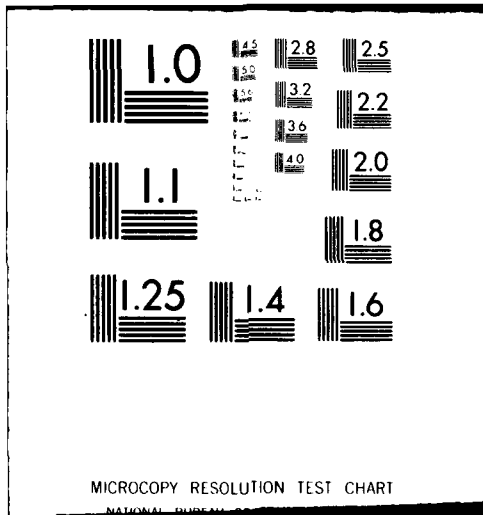
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DELAWARE RIVER BASIN
INDIAN RUN, MONMOUTH COUNTY
NEW JERSEY

INDIAN LAKE DAM

NJ 00188

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PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



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PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
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PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-N

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

24 JUL 1980

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Indian Lake Dam in Monmouth 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, Indian Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to sixty percent of the Spillway Design Flood--SDF - would cause the dam to be overtopped. (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 from overtopping would not significantly increase the hazard to loss of life downstream from that which would exist just before overtopping failure. 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. The owner should, within six months 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.

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

(1) The gaps adjacent to the bridge wingwalls should be suitably repaired and the embankment slope stability in that area investigated and repaired as required.

NAPFN-N

Honorable Brendan T. Byrne

(2) The spillway structure and outlet works should be thoroughly inspected with the lake drawn down and then renovated as required.

(3) All trees and bushes on the embankment should be removed.

(4) Animal holes in the embankment should be filled.

(5) The deteriorated guide rail should be repaired or replaced.


d. The owner 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 Thompson of the Fourth 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.

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,


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 Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

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INDIAN LAKE DAM (NJ00188)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 20 November 1979 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.

Indian Lake Dam, a high hazard potential structure, is judged to be in fair overall condition. The dam's spillway is considered inadequate because a flow equivalent to sixty percent of the Spillway Design Flood--SDF - would cause the dam to be overtopped. (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 from overtopping would not significantly increase the hazard to loss of life downstream from that which would exist just before overtopping failure. 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. The owner should, within six months 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.

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

(1) The gaps adjacent to the bridge wingwalls should be suitably repaired and the embankment slope stability in that area investigated and repaired as required.

(2) The spillway structure and outlet works should be thoroughly inspected with the lake drawn down and then renovated as required.


(3) All trees and bushes on the embankment should be removed.

(4) Animal holes in the embankment should be filled.

(5) The deteriorated guide rail should be repaired or replaced.

d. The owner 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:


JAMES G. TON

Colonel, Corps of Engineers
District Engineer

DATE:

12 Aug 80

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Indian Lake Dam, I.D. NJ00188
State Located: New Jersey
County Located: Monmouth
Drainage Basin: Delaware River
Stream: Indian Run
Date of Inspection: November 20, 1979

Assessment of General Condition of Dam

Based on visual inspection, past operational performance and Phase I engineering analyses, the dam is assessed as being in fair overall condition.


Hydraulic and hydrologic analyses indicate that the spillway is not sufficient to pass the designated spillway design flood (SDF) without an overtopping of the dam. (The SDF for Indian Lake Dam is equal to one-half the probable maximum flood.) The spillway is capable of passing approximately 30 percent of the probable maximum flood or 60 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. Based on the findings of the analyses, the need for and type of remedial measures should be determined and then implemented.

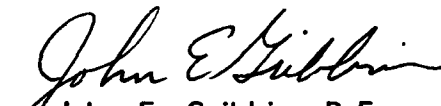
The owner should, in the near future, develop an emergency action plan together with an effective warning system outlining actions to be taken by the operator to minimize downstream effects of an emergency at the dam.

It is further recommended that the following remedial measures be undertaken by the owner in the near future:

- 1) The gaps adjacent to the bridge wingwalls should be suitably repaired and the embankment filled and stabilized.
- 2) The spillway structure and outlet works should be thoroughly inspected with the lake drawn down and then renovated as required.
- 3) All trees and bushes on the embankment should be removed.
- 4) Animal holes in the embankment should be filled.
- 5) The deteriorated guide rail should be repaired or replaced.

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


Richard J. McDermott, P.E.


John E. Gribbin, P.E.

be lowered at least once every five years at which time the normally submerged portions of the dam and outlet works should be inspected and repaired.


Richard J. McDermott, P.E.


John E. Gribbin, P.E.



OVERVIEW - INDIAN LAKE DAM

29 NOVEMBER 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 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 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 SAFETY PROGRAM

INDIAN LAKE DAM, I.D. NJ00188

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

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 inspection of Indian Lake Dam was made on November 20, 1979. The purpose of the inspection 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

Indian Lake Dam is an earthfill embankment with a concrete free overflow spillway. The spillway is located at the upstream end of a concrete bridge, the abutments of which form the spillway discharge channel.

The northern half of the upstream side of the dam consists of a timber wall while the southern half, including the upstream side of the spillway, consists of steel sheet piles with a concrete cap. Part of this concrete cap forms a pedestal for the outlet works control stem.

A building housing waterworks facilities is located on the downstream face of dam at its approximate center. Steel sheet piling forms the downstream face for approximately 10 feet on each side of the bridge wingwalls. Steel sheet piling also forms a cut-off along the downstream end of the bridge.

The spillway crest appears to be a modified ogee shape with a two-staged crest having an overall length of 33.8 feet and primary crest elevation of 76.8 (N.G.V.D.). The elevation of the crest of dam is 82.1 while that of the downstream channel bottom is 65.0. The height of dam is 17.1 feet. The overall length of the dam is 270 feet. The top width is 42 feet and the upstream and downstream slopes are vertical and 1.5 horizontal to 1 vertical, respectively.

b. Location

Indian Lake Dam is located in the Borough of Allentown, Monmouth County, New Jersey. Constructed across Indian Run, the dam impounds Indian Lake. The dam is readily accessible by Route 526 which traverses its crest.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams," published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

	<u>Impoundment</u>	
	<u>Storage (Ac-ft)</u>	<u>Height (Ft.)</u>
Small	< 1000 and \geq 50	< 40 and \geq 25
Intermediate	\geq 1000 and < 50,000	\geq 40 and < 100
Large	\geq 50,000	\geq 100

HAZARD POTENTIAL CLASSIFICATION

<u>Category</u>	<u>Loss of Life</u> (Extent of Development)	<u>Economic Loss</u> (Extent of Development)
Low	None expected (no permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than a small number	Excessive (Extensive community, industry or agriculture)

The following data relating to size and downstream hazard for Indian Lake Dam have been obtained for this Phase I assessment:

Storage: 118 Acre-feet

Height: 17.1 feet

Potential Loss of Life:

Waterworks building and facilities are located immediately downstream of dam. The building is normally occupied for eight hours per day by one operator. Failure of the dam could possibly cause loss of life.

Potential Economic Loss:

Damage could be sustained by the waterworks building and facilities as a result of dam failure, resulting in disruption of public water supply.

Therefore, Indian Lake Dam is classified as "Small" size and "High" hazard potential.

d. Ownership

Indian Lake Dam is owned by the County of Monmouth, Hall of Records, Main Street, Freehold, New Jersey 07728.

e. Purpose of Dam

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

f. Design and Construction History

According to records in the NJDEP file, Indian Lake Dam was designed by John E. Hogan of Red Bank, N.J. in 1937. It was constructed jointly by Monmouth County and Allentown Borough in the same year to replace an old timber dam. Inspections by the State of New Jersey recorded in the NJDEP file indicated that construction conformed to the plans and final inspection was made on October 29, 1937.

g. Normal Operational Procedures

The dam, spillway and outlet works are operated and maintained by the Borough of Allentown. Repairs are reportedly made on an "as needed" basis. The bridge and road are maintained by the County of Monmouth.

It is reported by the Department of Public Works of Allentown that the dam has never been overtopped and, therefore, the outlet gate is not opened at times of intense rain to attenuate flooding conditions.

1.3 Pertinent Data

a. Drainage Area	1.7 square miles
b. Discharge at Damsite	
Maximum flood at damsite	Not known
Outlet works at normal pool elevation	40 c.f.s.
Spillway capacity (pool elevation at top of dam)	1472 c.f.s.

c. Elevation (N.G.V.D.)

Top of dam	82.1
Maximum pool-design surcharge	83.2
Normal pool	77.3
Spillway crest - Primary	76.8
- Secondary	77.0
Stream bed at centerline of dam	65.0
Maximum tailwater	70 (Estimated)

d. Reservoir

Length of maximum pool	3000 feet
Length of normal pool	1050 feet (scaled)

e. Storage (Acre-feet)

Normal pool	10 Acre-feet
Design surcharge	170 acre-feet
Top of dam	118 acre-feet

f. Reservoir Surface (Acres)

Top of dam	50.2 acres (Estimated)
Maximum pool	62.8 acres (Estimated)
Normal pool	4.6 acres
Spillway crest	4.6 acres

g. Dam

Type	Earthfill
Length	270 feet
Height	17.1 feet

j. Regulating Outlets

24-inch CIP with gate valve on downstream side of spillway weir.

SECTION 2: ENGINEERING DATA

2.1 Design

Plans of reconstruction of the dam are available in NJDEP files. Construction drawings titled: "Bridge No. U-18 and Dam on Indian Run, Allentown, New Jersey" (3 sheets) prepared by John E. Hogan and approved by State Water Policy Commission - 1937 include the following:

- 1) Location Map
- 2) Sections
- 3) Details

In addition, brief hydraulic analyses are available in the NJDEP files.

2.2 Construction

Inspection reports during and after construction by State of New Jersey indicated that construction was acceptable and in conformance with the approved drawings.

2.3 Operation

According to correspondence in the NJDEP file, on one occasion during a major rainstorm, tailwater at Indian Lake Dam rose over the retaining wall adjacent to the waterworks. The cause of the high tailwater was attributed to the alteration of a downstream dam. No information on overtopping of Indian Lake Dam can be found.

2.4 Evaluation

a. Availability

Available engineering information is limited to that which is on file at the New Jersey Department of Environmental Protection (NJDEP), Division of Water Resources, P.O. Box CN-029, Trenton, N.J. 08625.

b. Adequacy

Available engineering data pertaining to Indian Lake Dam is of limited assistance to the performance of a Phase I evaluation. A list of absent information is included in paragraph 7.1.b.

c. Validity

Most engineering data that could be verified was found to be accurate within a reasonable allowance for error.

Hydraulic and hydrologic computations indicate that the spillway was designed to pass 570 c.f.s. with water level 3.0 feet over the spillway crest. The design flow was based on the Central Jersey curve. This design criterion is inadequate in relation to criteria currently used for Phase I evaluations.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspection of Indian Lake Dam was performed on November 20, 1979 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix I.

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) Depths of water were measured at various locations in the lake.

b. Dam

The crest of dam appeared to be level and uniform in width and the paved road was in good condition. The downstream face, north of the waterworks, was uniformly graded and covered with a uniform stand of grass. The downstream face, south of the waterworks, was covered with ground cover, weeds and small trees.

Gaps were noted between the downstream wingwalls of the bridge and the steel sheet piling on the downstream side of the dam. The gap in the right, or north, junction was the

more severe of the two and had a maximum width of approximately 1 foot. Considerable material had eroded through the gap and a void was noted in the embankment above the gap. The void appeared to have been caused by loss of soil.

The timber wall on the upstream side of the dam appeared to be in satisfactory condition. The steel sheet piling was also in satisfactory condition. The concrete cap north of the spillway was severely spalled.

The guide rail located on the upstream side of the roadway was in a generally collapsed and deteriorated condition. Animal holes were noted on the upstream side of the embankment.

c. Appurtenant Structures

The spillway structure appeared to be structurally sound. Concrete surfaces were eroded with some spalling and exposed aggregate observed. The spalling was most pronounced near the crest.

Concrete surfaces of the bridge were generally good. However, one vertical crack was noted in the south abutment and two in the north abutment. The cracks were near the center and were approximately 1/8 inch wide.

Three weep holes were noted in each abutment. Two weep holes, as well as the vertical crack, in the south abutment exhibited orange deposits and the upstream weep hole was discharging a trickle of clear water. The downstream weep hole in the north abutment exhibited heavy orange deposits and was discharging a trickle of clear water. The center weep hole in the north abutment exhibited rust colored deposits and was not discharging water.

Most of the low level outlet was submerged and not observed. However, the lift gate on the downstream side of the spillway appeared to be in satisfactory condition. The operating stem appeared to be severely rusted near the gate. The outlet works was not operated at the time of inspection.

d. Reservoir Area

Indian Lake is 1050 feet long and the width varies from 100 to 300 feet. The north bank of the lake is adjacent to open meadows while the south bank is generally wooded and adjacent to a residential area.

Soundings in the lake in the vicinity of the spillway indicated sediment accumulation of as much as 4 feet.

e. Downstream Channel

The spillway discharges into Indian Run which enters Doctor's Creek about 4000 feet downstream. A road bridge is located about 2800 feet downstream from the dam.

A retaining wall at the bank of the waterworks was severely cracked and was tilted in the direction of the stream. Other banks of the stream were generally wooded and steep with an average slope of approximately 2 horizontal to 1 vertical.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Indian Lake is regulated naturally by discharge over the spillway.

According to Allentown Public Works personnel, the gate is not opened during heavy storms. Reportedly, the gate was last opened about 6 to 8 years ago.

4.2 Maintenance of the Dam

Reportedly, no maintenance of the dam has been performed in the recent past by the Borough of Allentown. Usual maintenance consists of road and bridge maintenance performed by Monmouth County.

4.3 Maintenance of Operating Facilities

No maintenance is performed on the operating facilities.

4.4 Description of Warning System

No warning system for the dam is currently in use.

4.5 Evaluation of Operational Adequacy

The operation of the dam has been successful to the extent that the dam reportedly has never been overtopped.

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

- 1) Spalls and deterioration on the spillway not repaired.
- 2) Loss of soil on the downstream embankment slope not properly filled.
- 3) Trees and bushes on the embankment not removed.
- 4) Animal holes on the embankment not filled.
- 5) Guide rail not repaired or replaced.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The intensity 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 intensity, 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 classification. According to the "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers, the SDF for Indian Lake Dam falls in a range of 1/2 PMF to PMF. In this case the low end of the range 1/2 PMF is chosen since the factors used to select size and hazard classification are on the low side of their respective ranges.

The SDF peak inflow computed for Indian Lake Dam is 3053 c.f.s. This value is derived from the 1/2 PMF flood hydrograph computed by the use of the HEC-1-DB Flood Hydrograph Computer Program using the SCS triangular hydrograph with the 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 for the configuration of the structure. The combined primary and secondary spillway discharge with lake level equal to the top of dam was computed to be 1472 c.f.s. The SDF was routed through the dam by use of the HEC-1-DB 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 1.1 feet. A dam breach would not significantly increase the hazard potential for loss of life downstream due to dam failure from overtopping over that which exists without failure. The high hazard classification is based on the presence of a public utility and not on loss of life. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

According to the Allentown Department of Public Works the dam has never been overtopped. The NJDEP files indicate that on one occasion backwater in the downstream channel rose to a height over the retaining wall adjacent to waterworks property. The high backwater was apparently caused by a dam located on the downstream channel.

c. Visual Observation

No indication of overtopping of the dam was evident at the time of inspection.

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 1.1 feet over the crest of dam. The spillway is capable of passing approximately 60 percent of the SDF with lake level equal to the top of dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The dam appeared, at the time of inspection to be outwardly structurally sound. However, some evidence of possible distress was noted. Orange deposits from weep holes may indicate transport of embankment material by seepage. Three vertical cracks of approximately 1/8 inch width were observed at the abutment walls. Significant loss of soil was noted on the downstream side of the embankment adjacent to the north wingwall of the bridge.

b. Generalized Soils Description

The generalized soils description of the dam site consists of recent alluvium, composed of stratified materials deposited by streams, overlying a discontinuous mantle of stratified, alluvial material deposited during the Quaternary period, known as the Pensauken Formation. The Quaternary deposits consist of sand, silty sand and sandy silt. The underlying formations are consolidated Cretaceous sediments known as Magothy and Raritan Formations.

c. Design and Construction Data

The analyses of structural stability and construction data for the embankment are not available.

d. Operating Records

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

e. **Post-Construction Changes**

No records of post-construction changes are available.

f. **Seismic Stability**

Indian 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. Indian Lake Dam appeared to be outwardly 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 Indian Lake Dam is assessed as being inadequate. The spillway is not able to pass the SDF without an overtopping of the dam.

The embankment appeared, at the time of inspection to be outwardly stable. The structural integrity of the dam is considered adequate based on visual inspection. The observed evidence of possible distress is not considered to be an indication of immediate instability.

b. Adequacy of Information

Information sources for this report include 1) field inspection, 2) USGS quadrangle, 3) aerial photograph from Monmouth County, 4) consultation with Borough of Allentown maintenance personnel, 5) NJDEP file. 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) Description of fill material for embankment.
- 2) Structural design computations and reports.
- 3) Maintenance documentation.

c. Necessity for Additional Data/Evaluation

Although some data pertaining to Indian 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. 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.

It is further recommended that the following remedial measures be undertaken by the owner in the near future:

- 1) The gaps adjacent to the bridge wingwalls should be suitably repaired and the embankment filled and stabilized.
- 2) The spillway structure and outlet works should be thoroughly inspected with the lake drawn down and then renovated as required.

- 3) All trees and bushes on the embankment should be removed.
- 4) Animal holes in the embankment should be filled.
- 5) The deteriorated guide rail should be repaired or replaced.

b. Maintenance

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

PLATES

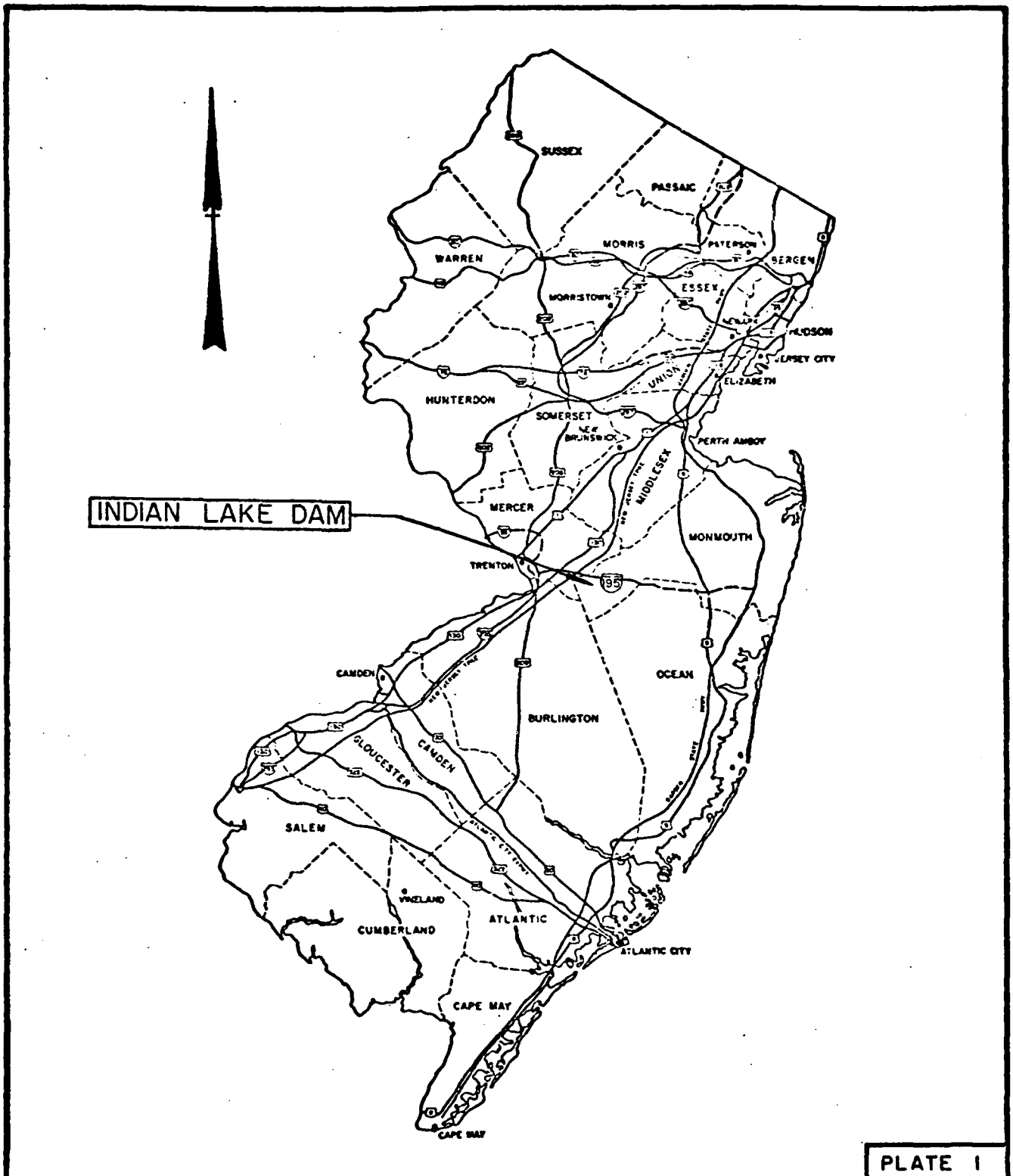
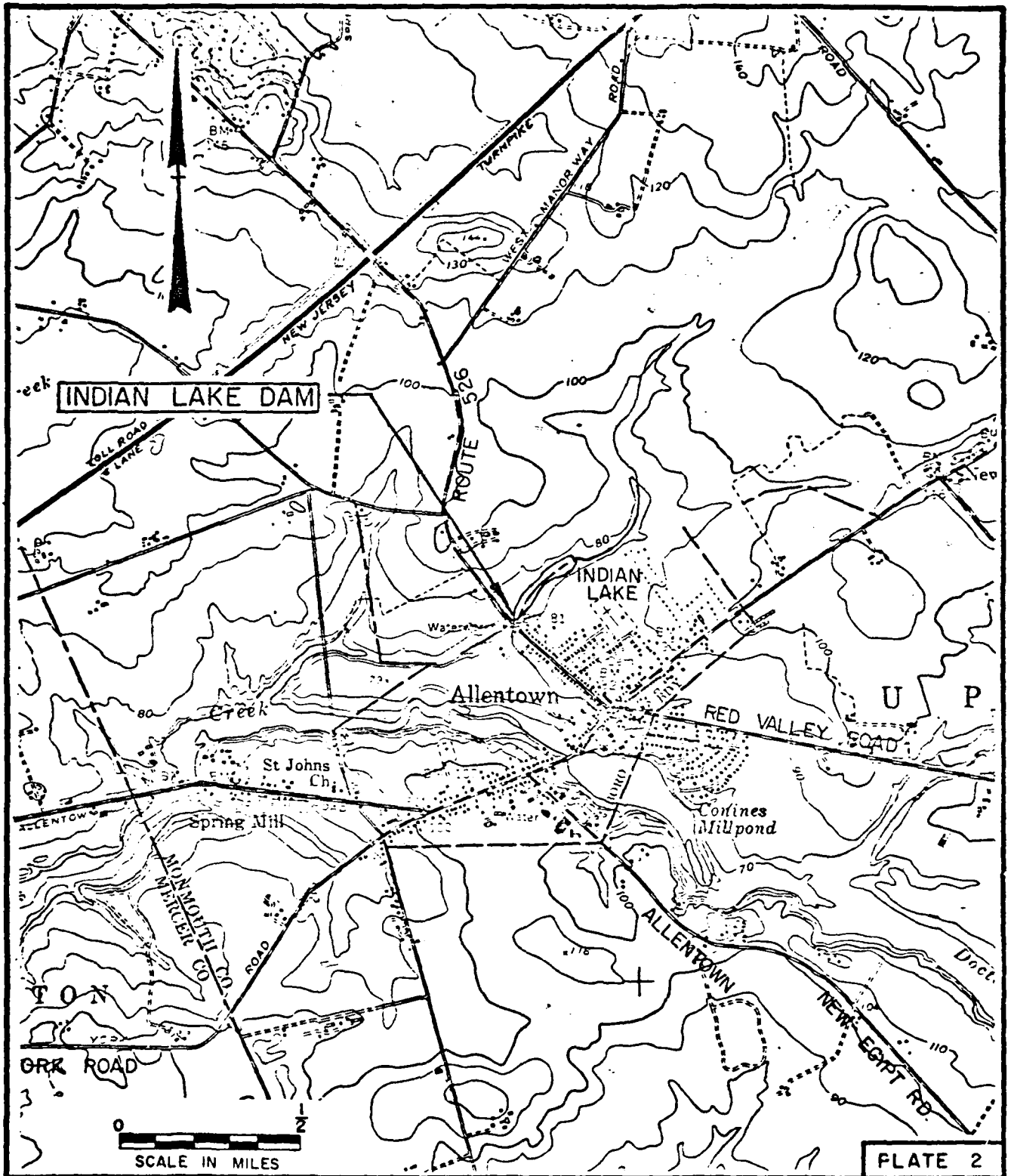


PLATE 1

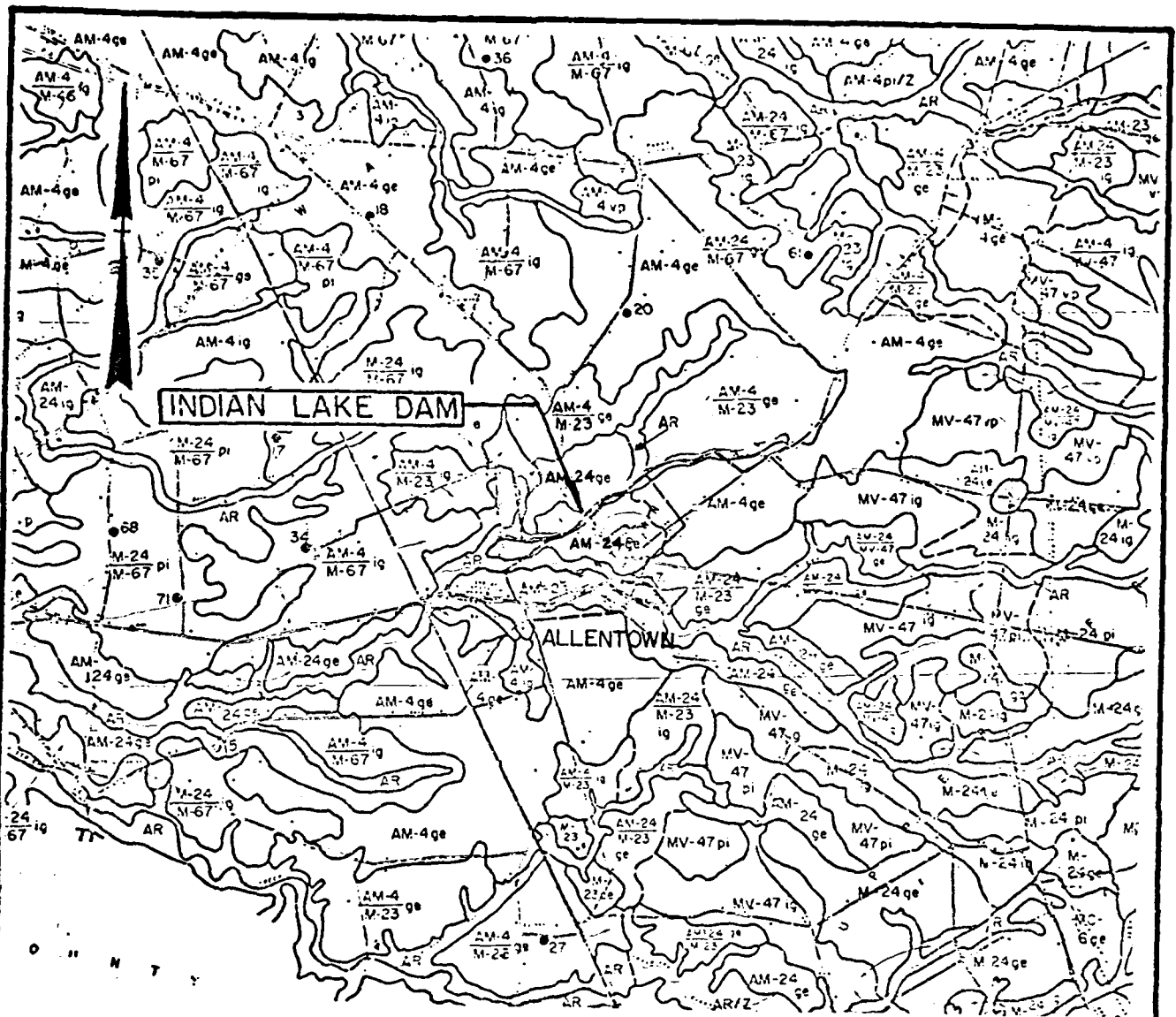
<p>STORCH ENGINEERS FLORHAM PARK, NEW JERSEY</p>	<p>INSPECTION AND EVALUATION OF DAMS KEY MAP INDIAN LAKE DAM</p>	
<p>DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY</p>	<p>I.D.N.J.00188</p>	<p>SCALE: NONE DATE: NOV., 1979</p>



STORCH ENGINEERS
 FLORHAM PARK, NEW JERSEY

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

INSPECTION AND EVALUATION OF DAMS
VICINITY MAP
 INDIAN LAKE DAM
 I. D. N. J. 00188
 SCALE: AS SHOWN
 DATE: NOV., 1979



Legend

AR Recent alluvium composed of stratified materials deposited by streams.

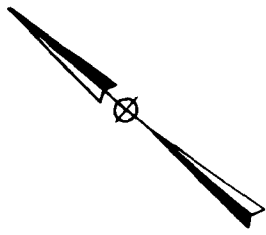
AM-24 Sand, silty sand and sandy silt deposited during the Quaternary period. (Pensauken Formation).

NOTE Information taken from Rutgers University Soil Survey of New Jersey, Report No. 19 Monmouth County, and Geological Map of New Jersey prepared by Lewis and Kummel.

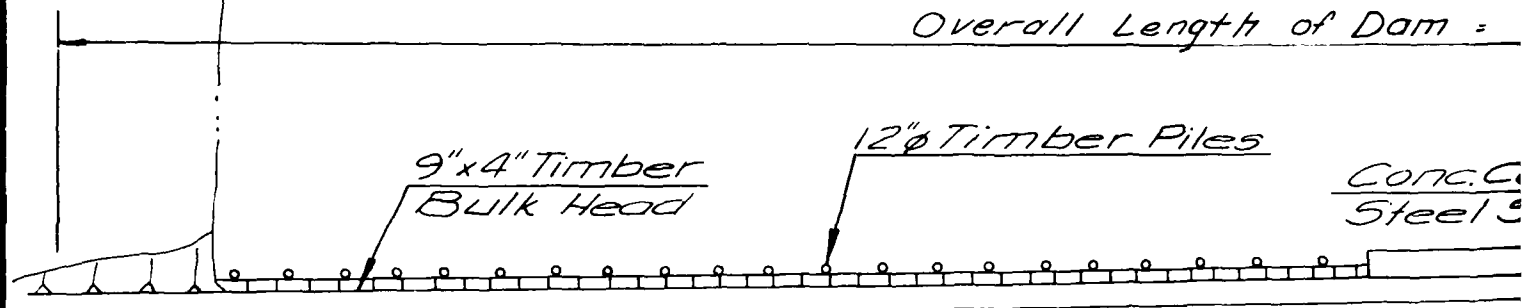
PLATE 3

<p>STORCH ENGINEERS FLORHAM PARK, NEW JERSEY</p>	<p>INSPECTION AND EVALUATION OF DAMS SOIL MAP INDIAN LAKE DAM</p>	
<p>DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY</p>	<p>I.D. NJ00188</p>	<p>SCALE: NONE DATE: NOV., 1979</p>

INDIAN LAKE

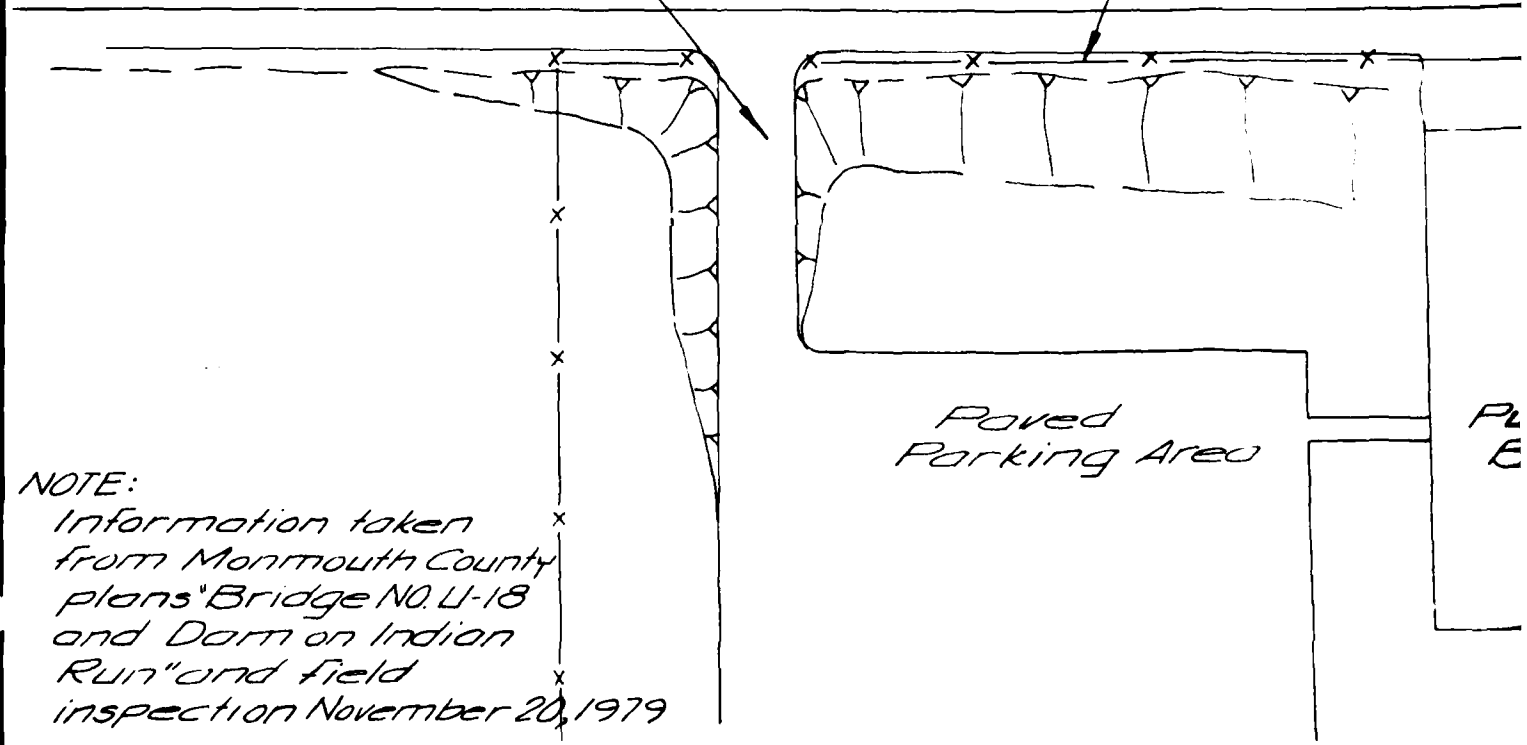


Overall Length of Dam =



Driveway

Chain Link Fence



NOTE:
Information taken
from Monmouth County
plans "Bridge NO. U-18
and Dam on Indian
Run" and field
inspection November 20, 1979

AN LAKE

Conc. Retaining Wall

Length of Dam = 270'

Spillway

Outlet Works Pipe

Conc. Cap on Steel Sheet Piles

in Link
ce

Paved Road
Route 526

Conc. Railing

Conc. Apron

Steel Sheet Piling

Conc. Retaining Wall

Pump Station Building

PLATE 4

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

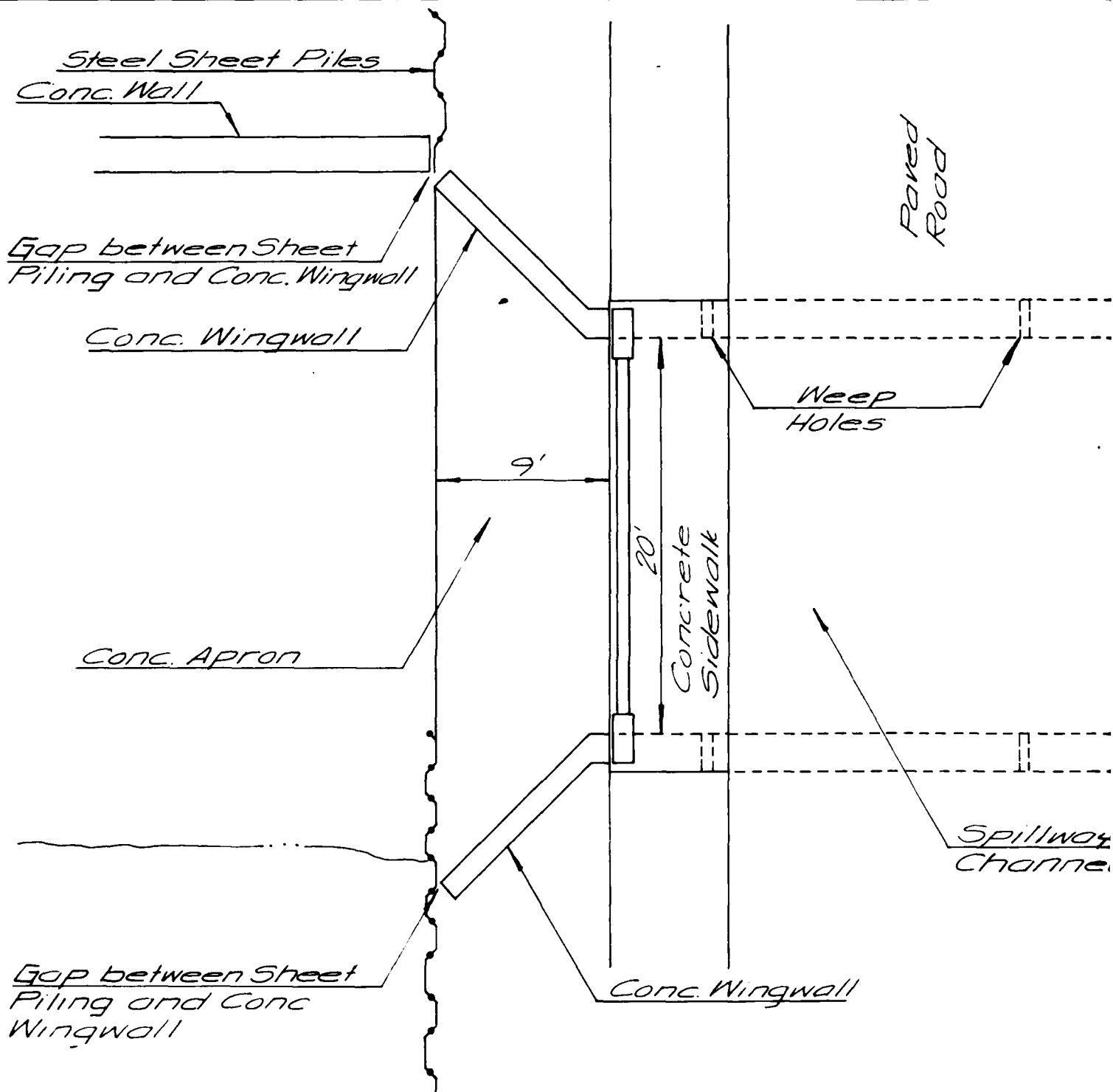
DIVISION OF WATER RESOURCE
N.J. DEPT. OF ENVIR. PROTECTIO
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS
GENERAL PLAN
INDIAN LAKE DAM

I.D.N.J. 00188

SCALE: NOT TO SCALE

DATE: DEC., 1979



NOTE:
 Information taken from Monmouth County plans "Bridge NO. U-18 and Dam on Indian Run" and field inspection November 20, 1979

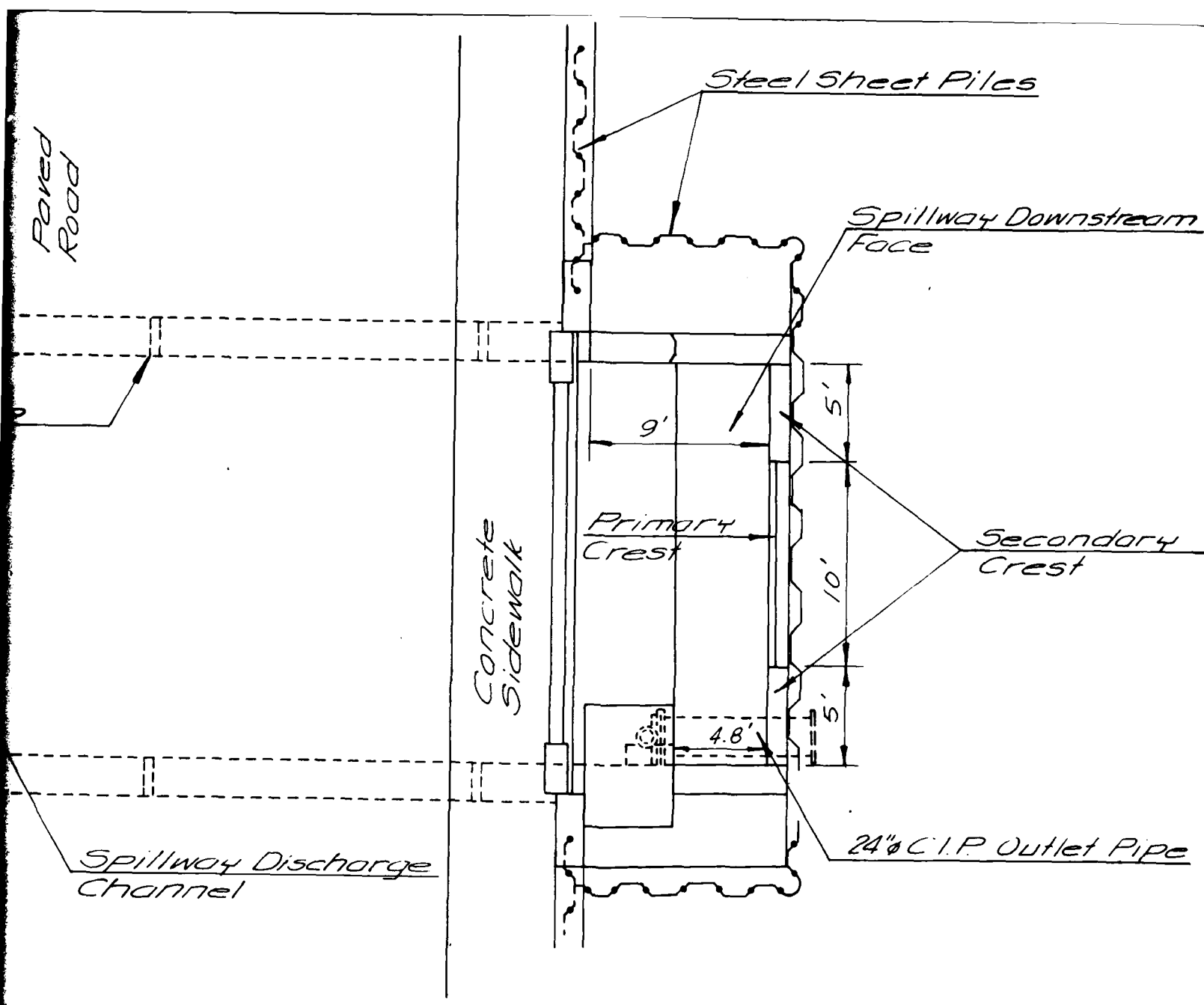
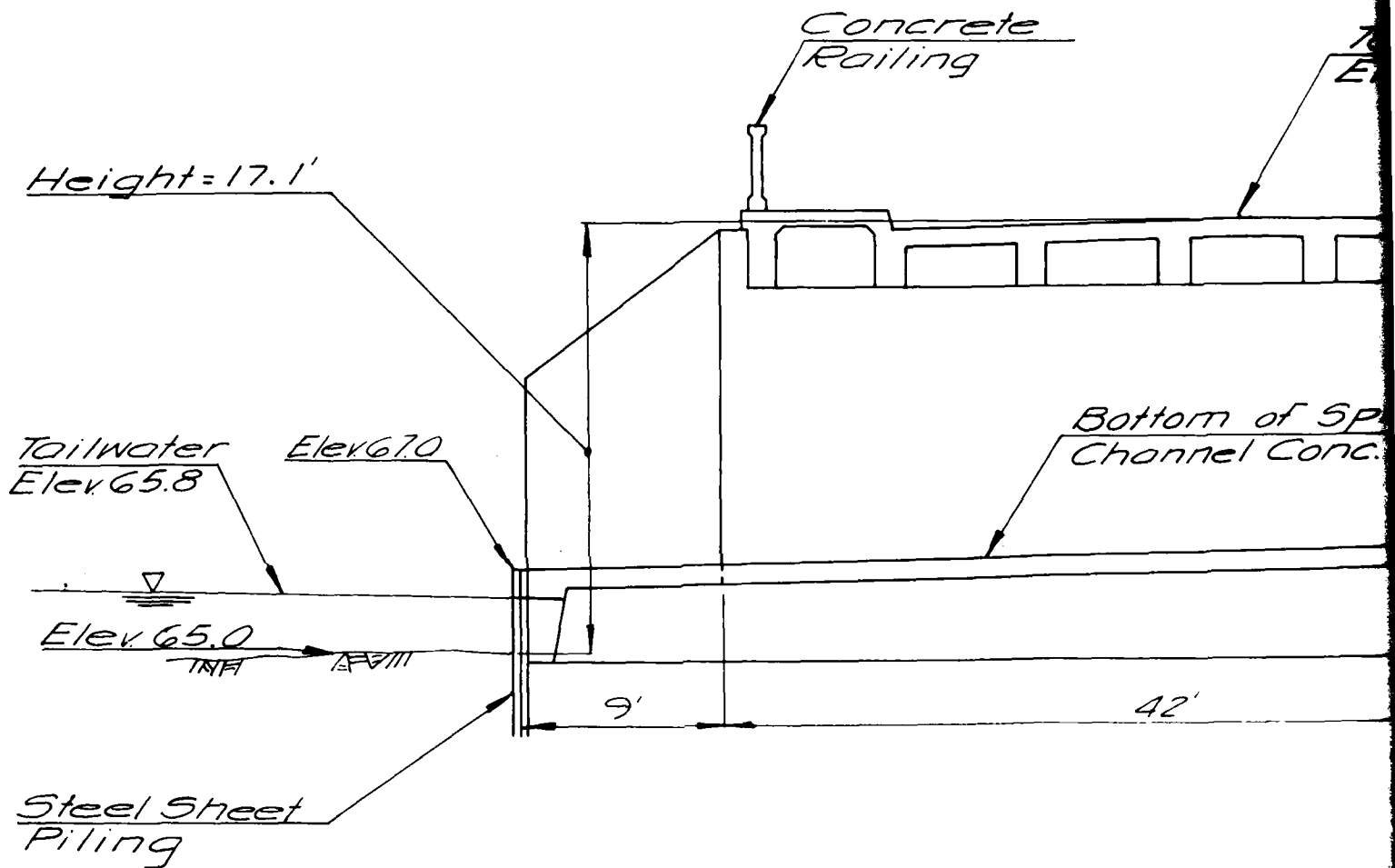


PLATE 1

<p>STORCH ENGINEERS FLORHAM PARK, NEW JERSEY</p>	<p>DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY</p>
<p>INSPECTION AND EVALUATION OF DAMS SPILLWAY PLAN INDIAN LAKE DAM</p>	
<p>I.D.N.J. 00188</p>	<p>SCALE: NOT TO SCALE</p>
<p>DATE: DEC. 1979</p>	



NOTES:

1. Information taken from Monmouth County plans "Bridge NO. U-18 and Dam on Indian Run" and Field inspection November 20, 1979
2. Elevations based on N.G.V.D. taken from Monmouth County plans.

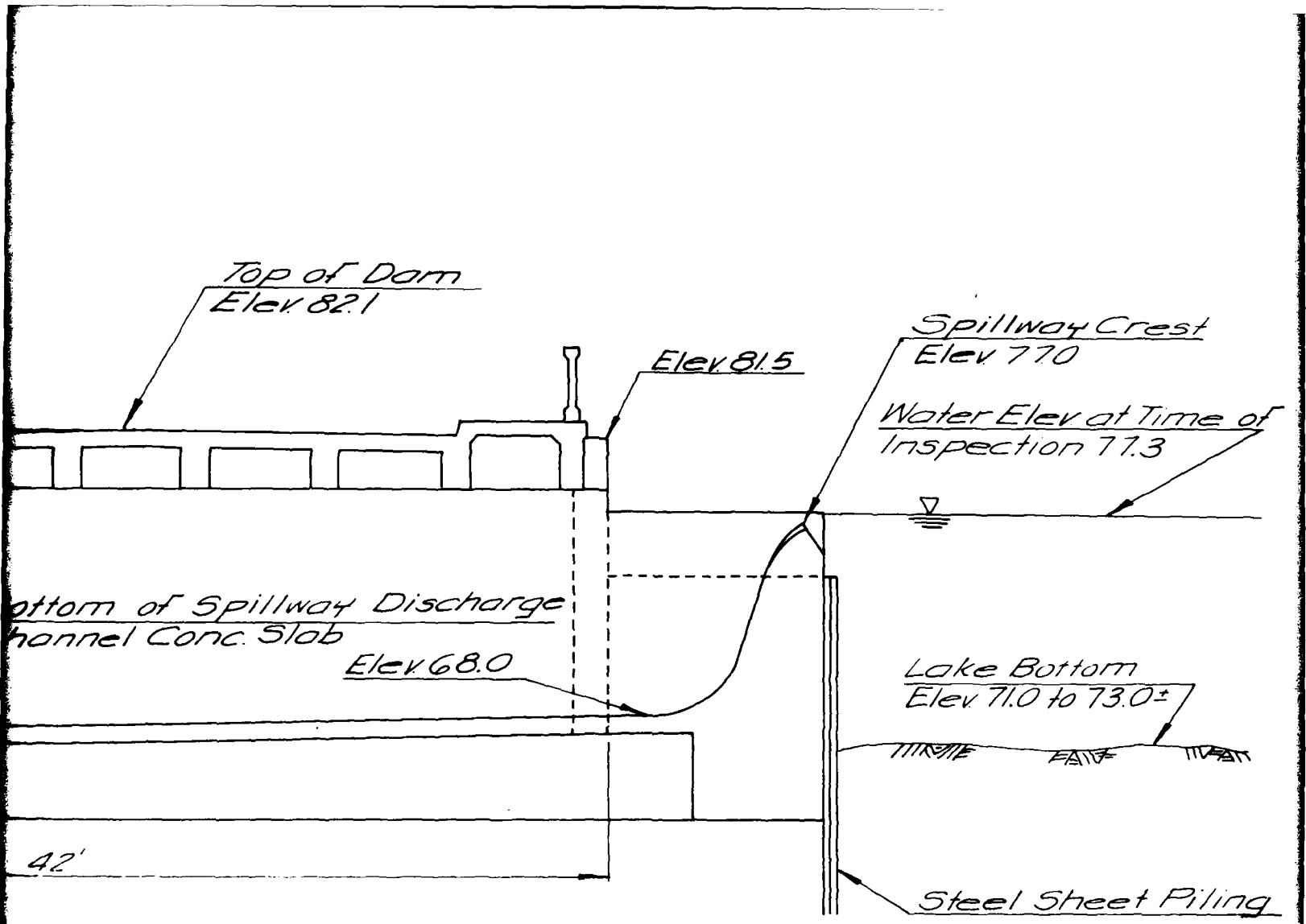
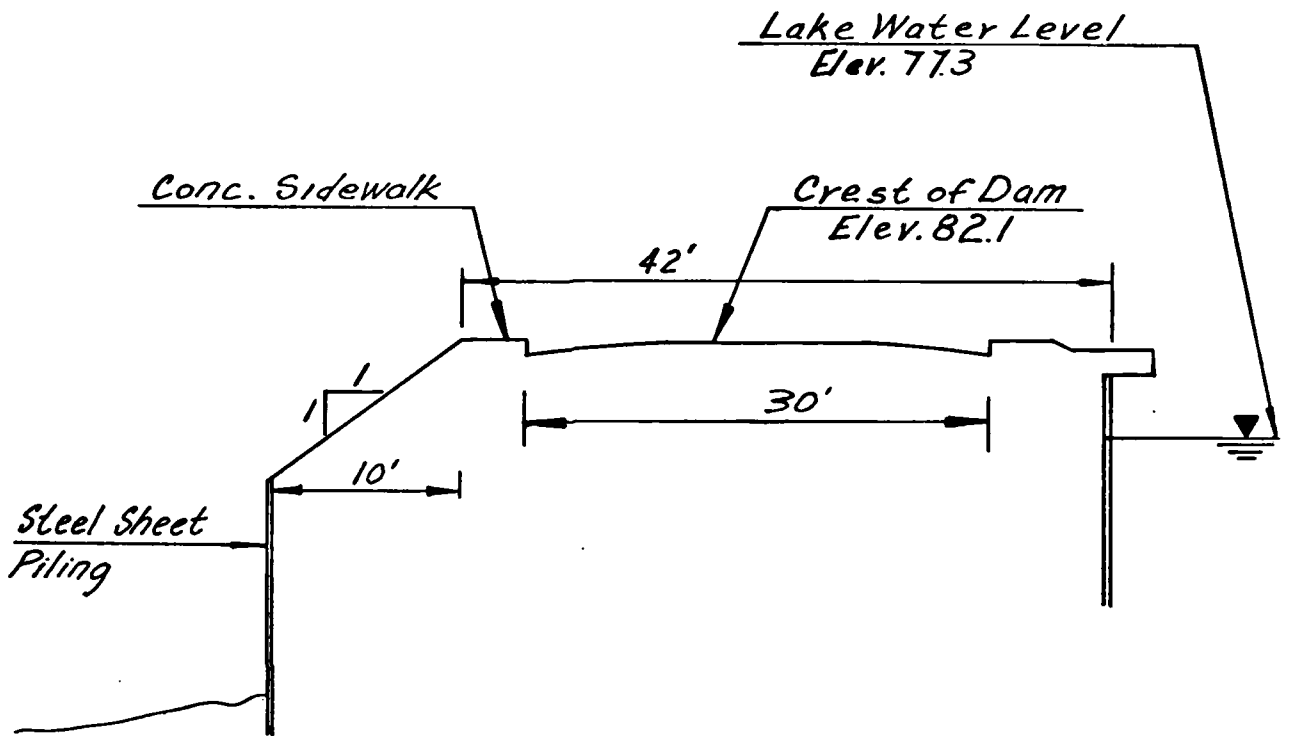


PLATE 6

<p>STORCH ENGINEERS FLORHAM PARK, NEW JERSEY</p>	<p>DIVISION OF WATER RESOURCE N.J. DEPT. OF ENVIR. PROTECTIO TRENTON, NEW JERSEY</p>
<p>INSPECTION AND EVALUATION OF DAMS SPILLWAY SECTION INDIAN LAKE DAM</p>	
<p>I.D.N.J. 00188</p>	<p>SCALE: NOT TO SCALE DATE: -</p>



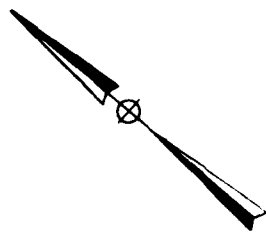
Notes:

1. Information taken from field inspection November 20, 1979.
2. Elevations based on N.G.V.D. taken from Monmouth County plans.

PLATE 7

<p style="text-align: center;">STORCH ENGINEERS FLORHAM PARK, NEW JERSEY</p>	<p>INSPECTION AND EVALUATION OF DAMS DAM SECTION INDIAN LAKE DAM</p>	
<p>DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY</p>	<p>I.D. N.J. 00188</p>	<p>SCALE: NOT TO SCALE DATE: DEC., 1979</p>

INDIAN LAKE



⑥ → 9"x4" Timber Bulk Head

12" Timber Piles

CONC. Steel S

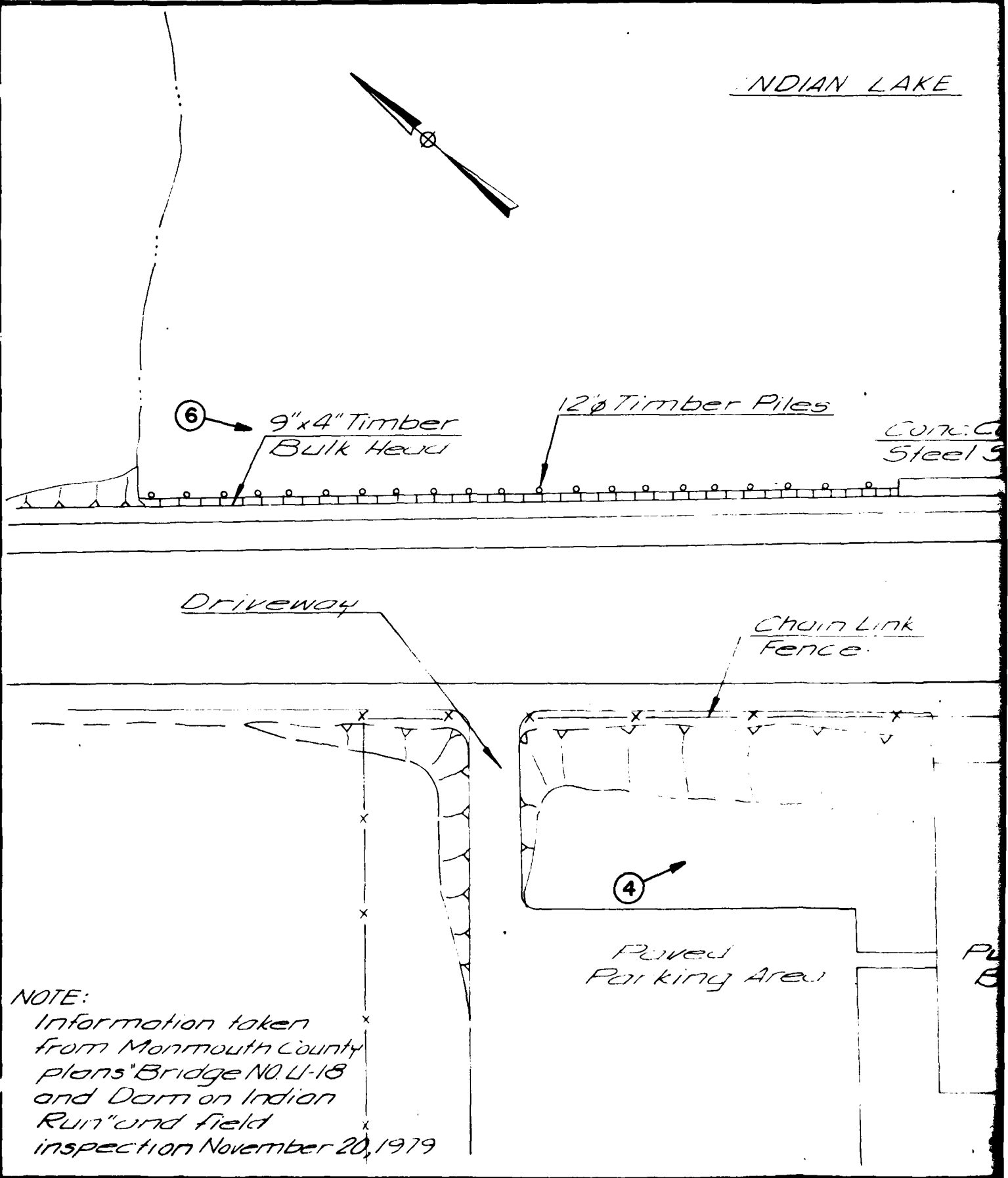
Driveway

Chain Link Fence

④ →

Paved Parking Area

NOTE:
Information taken
from Monmouth County
plans "Bridge NO. LI-18
and Dam on Indian
Run" and field
inspection November 20, 1979



N LAKE

OVERVIEW

Conc. Retaining Wall

SPILLWAY

Conc. Cap on Steel Sheet Piles

Outlet Works Pipe

1

5

3

9

n Link
ce

Paved Road Route 526

Conc. Retaining

2

Conc. Apron

Steel Sheet Piling

Conc. Retaining Wall

Pump Station Building

10

PLATE 8

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCE
N.J. DEPT. OF ENVIR. PROTECTIO
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

INDIAN LAKE DAM

I.D. N.J. 00188

SCALE: NOT TO SCALE

DATE DEC., 1979

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List
Visual Inspection
Phase I

Name of Dam Indian Lake Dam County Monmouth/Mercer State New Jersey Coordinators NJDEP

Date(s) Inspection 11/20/79 Weather Sunny Temperature 55°F

Pool Elevation at Time of Inspection 77.3 M.S.L. Tailwater at Time of Inspection 65.8 M.S.L.

Inspection Personnel:

John Gribbin Alan Volle
Ronald Lai Thomas Miller
Richard McDermott
J. Gribbin Recorder

Present: Vincent B. Johnson, Superintendent of Public Works, Borough of Allentown.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
GENERAL	<p>A paved road in good condition is located along the crest. The downstream face south of the water works building was covered with ground cover, weeds and small trees; north of the water works it is covered with a uniform stand of grass. Guide rail on upstream side of dam in collapsed and deteriorated condition. Animal holes noted on upstream side of embankment.</p>	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	<p>Gaps were noted between downstream bridge wingwalls and steel sheeting on downstream face of dam. The gap in the right, or north, junction is the more severe of the two (approx. 1 foot wide) and considerable material has eroded through. A hole was observed in the embankment face above the gap. The hole appeared to have been caused by loss of soil.</p>	<p>Recommend slope stability investigation and repair of slope and junction.</p>
ANY NOTICEABLE SEEPAGE	<p>None observed at embankment toe. Some discharge noted at bridge weep holes (see Drains below).</p>	
STAFF GAGE AND RECORDER	<p>None observed.</p>	
DRAINS	<p>Three weep holes noted in each abutment of bridge. Also two storm drains discharge through bridge abutments. Two weep holes in the south abutment exhibit orange deposits and the upstream hole was discharging a trickle of clear water. The downstream weep hole in the north abutment exhibited heavy orange deposits and was discharging a trickle of clear water.</p>	<p>The center weep hole in the north abutment exhibited rust colored deposits and was not discharging water.</p>

EMBANKMENT

VISUAL EXAMINATION OF	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	Loss of embankment material at downstream junction between bridge and embankment. (See "Junction" above).	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical: generally level Horizontal: Straight	
UPSTREAM FACE	Steel sheeting appeared to be anchored to embankment and was in satisfactory condition. Conc. cap north of the spillway was severely spalled. The timber wall was in generally satisfactory condition.	Upstream face consists of steel sheeting with conc. cap in vicinity of spillway and timber wall along north portion.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES IN OUTLET CONDUIT	N.A.	
INTAKE STRUCTURE	Submerged - not observed.	
OUTLET STRUCTURE	Portion of outlet pipe exposed on downstream side of spillway and gate at outlet end of pipe appeared to be in satisfactory condition. The operating stem appeared to be severely rusted.	
OUTLET CHANNEL	Same as spillway discharge channel.	
GATE AND GATE HOUSING	See "Outlet Structure" above.	

SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
WEIR	Spillway structure appeared to be structurally sound. Concrete surfaces were eroded with some spalling and exposed aggregate observed. The spalling was most pronounced near the crest.	
APPROACH CHANNEL	N.A.	
DISCHARGE CHANNEL	Discharge channel formed by concrete bridge abutments. Condition of concrete surfaces generally good. One vertical crack in the south abutment, two vertical cracks in the north abutment - the cracks are near the center of the abutments and are approx. 1/8" wide.	
BRIDGE	Concrete surfaces of the bridge are in generally good condition. Four pipelines are slung from the bottom of the bridge deck and span the discharge channel. One is cast iron and appears to have been patched.	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	N.A.	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Banks of the lake shore are approx. 3 feet high with generally flat terrain beyond. The south shore is generally wooded; the north shore is adjacent to open fields.	
SEDIMENTATION	Soundings in the lake in the vicinity of the spillway indicate a maximum depth of 6 feet, or sediment accumulation of as much as 4 feet.	
STRUCTURES ALONG BANKS	A few homes are located on the south side of the lake.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Downstream channel is natural stream. No obstructions were observed.	
SLOPES	Right bank consists of concrete wall in vicinity of water works. Other banks generally wooded and steep - average slope 2 horiz. to 1 vert.	
STRUCTURES ALONG BANKS	Waterworks building and facilities located immediately downstream from dam.	

**CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION**

ITEM	REMARKS
DAM - PLAN	Plans titled "Bridge No. U-18 And Dam on Indian Run" (3 sheets)
SECTIONS	Available in NJDEP Office, Trenton; New Jersey. Sections of dam not available.
SPILLWAY - PLAN	Available in above plans.
SECTIONS	
DETAILS	
OPERATING EQUIPMENT PLANS & DETAILS	Available in above plans.
OUTLETS - PLAN	Available in above plans.
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	Not Available
HYDRAULIC/HYDROLOGIC DATA	Limited (NJDEP file)
RAINFALL/RESERVOIR RECORDS	Not available.
CONSTRUCTION HISTORY	Limited (NJDEP file)
LOCATION MAP	Available in plans "Bridge No. U-18 And Dam on Indian Run" (See above)

ITEM

REMARKS

DESIGN REPORTS

Hydraulic report prepared by State of New Jersey available NJDEP file.

GEOLOGY REPORTS

Not available

**DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES**

Available - NJDEP file.
Not available
Not available

**MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY
FIELD**

Limited description in NJDEP file, Trenton Office, N. J.

POST-CONSTRUCTION SURVEYS OF DAM

Not available

BORROW SOURCES

Not available

ITEM

REMARKS

MONITORING SYSTEMS

Not available

MODIFICATIONS

Not available

HIGH POOL RECORDS

Not available

**POST CONSTRUCTION ENGINEERING
STUDIES AND REPORTS**

Not available

**PRIOR ACCIDENTS OR FAILURE OF DAM
DESCRIPTION
REPORTS**

Not available

**MAINTENANCE
OPERATION
RECORDS**

Not available

APPENDIX 2

Photographs

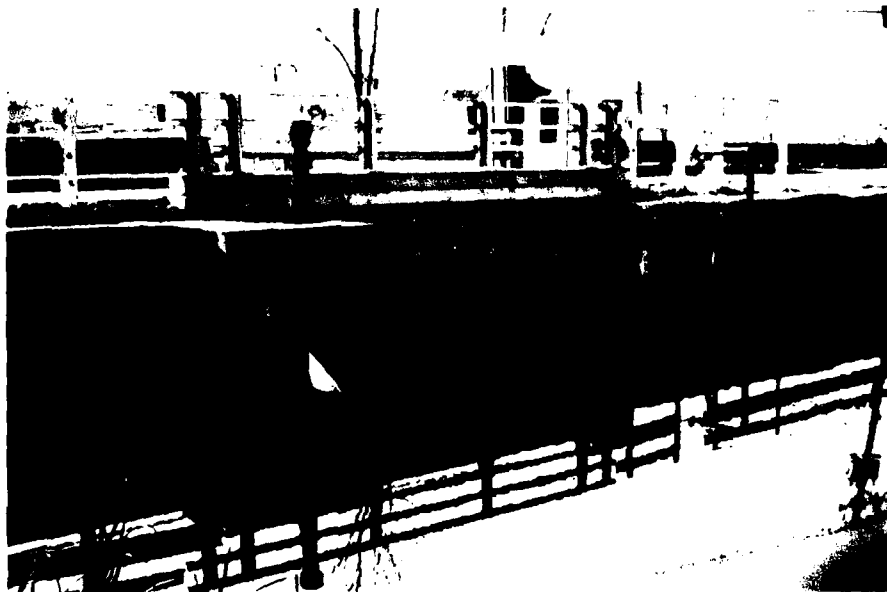


PHOTO 1
SPILLWAY

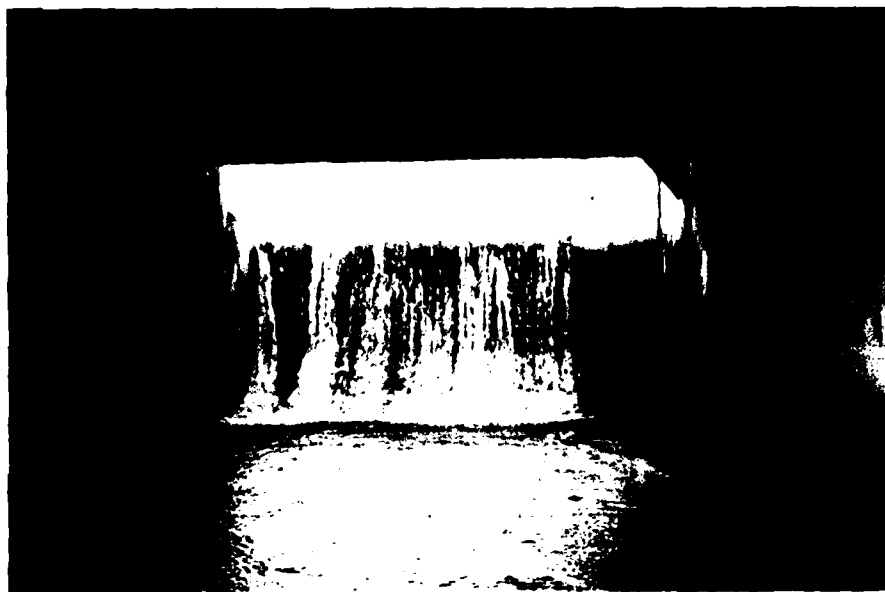


PHOTO 2
DOWNSTREAM FACE OF SPILLWAY AND DISCHARGE CHANNEL

INDIAN LAKE DAM
20 NOVEMBER 1979



PHOTO 3
OUTLET WORKS GATE AND STEM



PHOTO 4
DOWNSTREAM FACE OF DAM

INDIAN LAKE DAM
20 NOVEMBER 1979



PHOTO 5

UPSTREAM FACE OF DAM - LOOKING EAST



PHOTO 6

UPSTREAM FACE OF DAM - LOOKING WEST

INDIAN LAKE DAM
20 NOVEMBER 1979



PHOTO 7

STEEL SHEET PILING ON DOWNSTREAM SIDE OF DAM
SEPARATED FROM WEST WINGWALL



PHOTO 8

STEEL SHEET PILING ON DOWNSTREAM SIDE OF DAM
ADJACENT TO EAST WINGWALL

INDIAN LAKE DAM
20 NOVEMBER 1979



PHOTO 9

ORANGE DEPOSITS IN FLOW THROUGH CRACK AND WEEP HOLE IN
SPILLWAY DISCHARGE CHANNEL



PHOTO 10

DOWNSTREAM CHANNEL

INDIAN LAKE DAM
20 NOVEMBER 1979

APPENDIX 3

Engineering Data

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Fields and woods

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 77.3 (10 acre-feet)

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

ELEVATION MAXIMUM DESIGN POOL: 83.2

ELEVATION TOP DAM: 82.1

SPILLWAY CREST: Uncontrolled concrete weir

- a. Elevation 76.8 (primary), 77.0 (secondary)
- b. Type Modified Ogee
- c. Width 1.0 ft
- d. Length 10 ft. (primary), 23.8 ft. (secondary)
- e. Location Spillover Upstream side of dam
- f. Number and Type of Gates N.A.

OUTLET WORKS: 24-inch CIP

- a. Type Sluice with lift gate
- b. Location Left side of spillway structure
- c. Entrance inverts 68.0
- d. Exit inverts 68.0
- e. Emergency draindown facilities: Open gate

HYDROMETEOROLOGICAL 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) 1472 c.f.s.

APPENDIX 4

Hydraulic/Hydrologic Computations

HYDROLOGY

HYDROLOGIC ANALYSIS - RUNOFF HYDROGRAPH WILL
 BE DEVELOPED BY THE HEC-1-DB COMPUTER
 PROGRAM USING THE SCS TRIANGULAR UNIT
 HYDROGRAPH WITH CURVILINEAR TRANSFORMATION.
 DRAINAGE AREA = 1.7 SQUARE MILES

INFILTRATION DATA

INITIAL INFILTRATION = 1.5 INCHES

CONSTANT INFILTRATION = 0.15 INCHES/HOUR

TIME OF CONCENTRATION

BY SCS; TR-55 CHART ON OVERLAND FLOW

OVERLAND FLOW = 1500' ; 2% SLOPE

CHANNEL FLOW = 9400' 0.5% SLOPE

$$T_c = \left[\left(\frac{1500}{1.0} \right) + \left(\frac{9400'}{1.25} \right) \right] \frac{1}{3600} = 0.42 + 2.09$$

$$T_c = 2.5 \text{ HOURS}$$

OVERLAND TIME OF CONCENTRATION - BY KERISY

Ref: "HANDBOOK OF APPLIED HYDROLOGY"

BY CHOW

$$T_c^{2.14} = \frac{2}{3} \frac{L^n}{\sqrt{S}}$$

T_c = overland time of concentration (min)

L = length of overland flow (ft)

n = Manning's coefficient of roughness ($n=0.4$)

S = slope (ft/ft)

$$T_c^{2.14} = \frac{2}{3} \frac{(1500)(0.4)}{\sqrt{0.02}} \quad ; \quad \text{overland } T_c = 41 \text{ minutes}$$

channel $T_c = 125$ minutes
(from pg 1)

$$\begin{aligned} \text{Total } T_c &= 41 + 125 = 166 \text{ MINUTES} \\ &= 2.8 \text{ HOURS} \end{aligned}$$

TIME OF CONCENTRATION - BY CALIFORNIA CULVERTS PRACTICE

Ref: "DESIGN OF SMALL DAMS" Pg. 71

$$T_c = \left(\frac{11.9L^3}{H} \right)^{0.385}$$

T_c = time of concentration (hours)

L = length of watercourse (miles)

H = elevation difference (feet)

$L = 2.06$ MILES

$H = 75$ FEET

$$T_c = \left(\frac{11.9(2.06)^3}{75} \right)^{0.385}$$

$T_c = 1.13$ HOURS

TIME OF CONCENTRATION - BY SNYDER pg 135

ref "INTRODUCTION TO HYDROLOGY"

VISSMAN ET. AL.

$$t_t = C_t (LL_{ca})^{0.3} \quad \text{where:}$$

t_t = lag time (hours)

C_t = coefficient representing variations of watershed slopes & surfaces (ave $C_t = 2.0$)

L = length of main channel from outlet to divide (2.06 miles)

L_{ca} = length along main channel to a point opposite the watershed centroid (1.02 miles)

$$t_t = 2.0 (2.06 \times 1.02)^{0.3}$$

$$\text{LAG TIME } t_t = 2.5 \text{ HOURS}$$

BECAUSE SNYDER'S METHOD IS GENERALLY NOT APPLICABLE TO DRAINAGE BASINS LESS THAN 10 SQUARE MILES, LITTLE WEIGHT WILL BE GIVEN TO ITS LAG TIME CALCULATION FOR COMPUTER INPUT.

$$\text{LAG TIME USE } T_c = 2.1 \text{ HOURS} \quad \text{LAG} = 60\% T_c$$

$$\text{LAG TIME} = 1.26 \text{ HOURS}$$

PRECIPITATION (reference: "Design of Small Dams", USDI 1977; fig.15)

PROBABLE MAXIMUM PRECIPITATION = 26.4 INCHES
FOR 6 HOUR DURATION & 10 SQUARE MILE DA.

<u>DURATION</u>	<u>% PMP</u>
6 hrs	100
12	109
24	117

STORCH ENGINEERS

Sheet 4 of 9

Project INDIAN LAKE DAM

Made By STO Date 1/21/80

Chkd By RL Date 2/8/80

LAKE STORAGE VOLUME

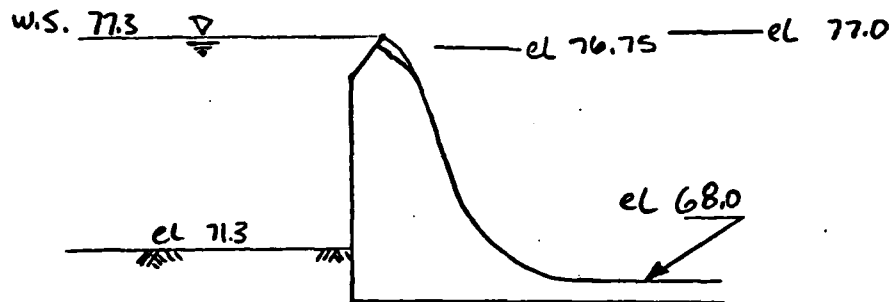
<u>WATER SURFACE ELEVATION</u>	<u>AREA (ACRES)</u>
71.0	0
77.3	4.6
80	26
90	141
100	315

HEC-1-DB COMPUTER PROGRAM WILL
DEVELOP STORAGE CAPACITY FROM SURFACE
AREAS & ELEVATIONS.

INFORMATION TAKEN FROM USGS QUADRANGLE

HYDRAULICS

THE SPILLWAY AT THE INDIAN LAKE DAM IS A TWO-STAGE, FREE OVERFLOW, CONCRETE WEIR, WITH A MODIFIED Ogee CROSS SECTION.



THE PRIMARY CREST IS AT ELEVATION 76.75 WITH AN EFFECTIVE LENGTH OF 10 FEET. THE SECONDARY CREST IS AT ELEVATION 77.0 WITH AN EFFECTIVE LENGTH OF 23.8 FEET. DISCHARGE WILL BE CALCULATED USING THE FORMULA; $Q = CLH^{3/2}$

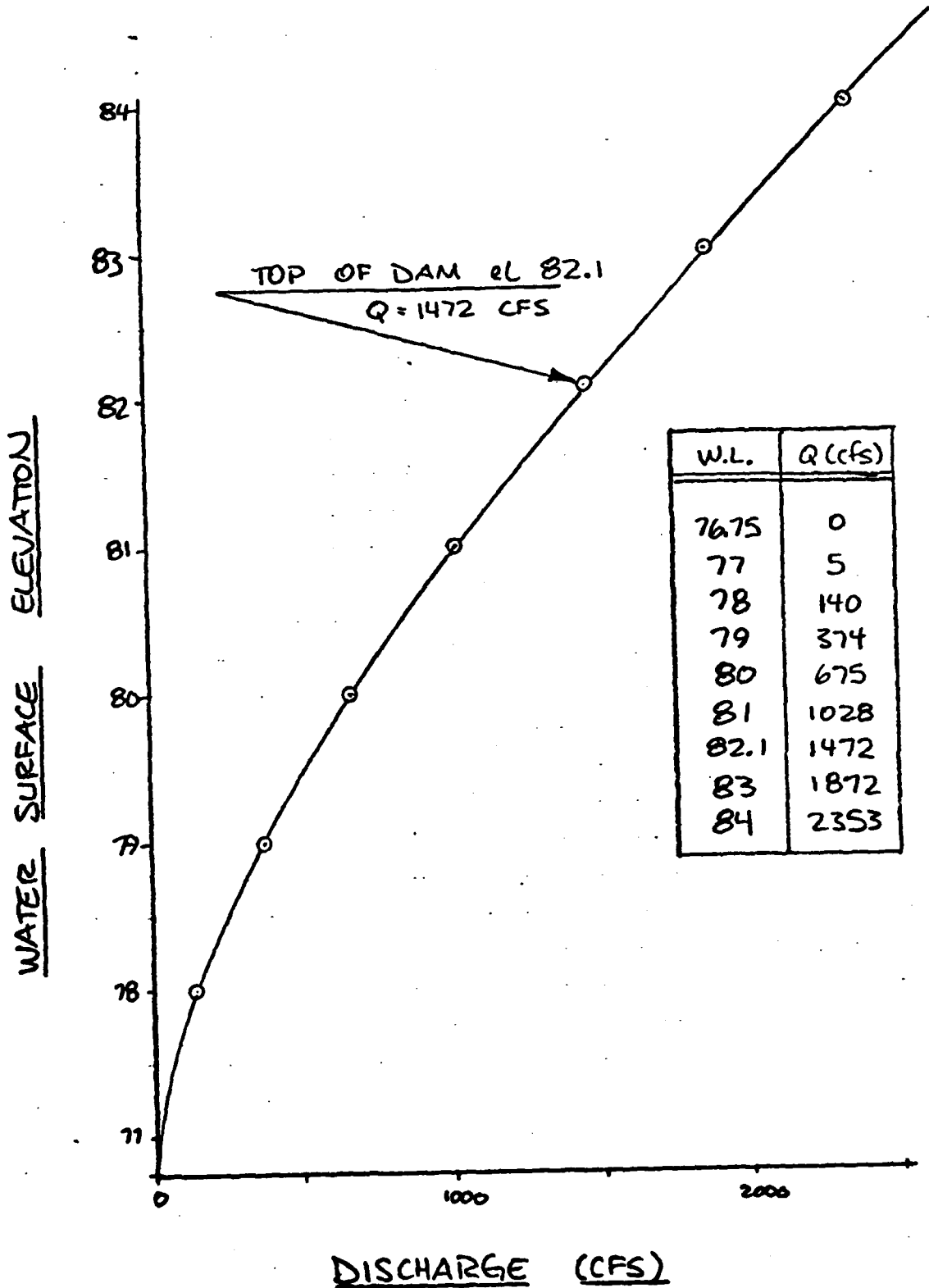
where Q = discharge
 C = coefficient of discharge
 L = effective length of spillway being overtopped
 H = total head on spillway.

NOTE: $C = 3.7$ FROM "DESIGN OF SMALL DAMS" USDI

STAGE DISCHARGE TABULATION

WATER ELEVATION	PRIMARY CREST EL 76.75 ; L=10'		SECONDARY CREST EL 77.0 ; L=23.8'		TOTAL DISCHARGE Q ₁ +Q ₂
	H ₁	Q ₁	H ₂	Q ₂	
76.75	0	0	0	0	0
77	0.25	5	0	0	5
78	1.25	52	1.0	88	140
79	2.25	125	2.0	249	374
80	3.25	217	3.0	458	675
81	4.25	324	4.0	704	1028
82.1	5.35	458	5.1	1014	1472
83	6.25	578	6.0	1294	1872
84	7.25	722	7.0	1631	2353
85	8.25	877	8.0	1993	2870

STAGE - DISCHARGE CURVE



OUTLET WORKS CAPACITY

THE OUTLET WORKS CONSIST OF A
24" DIAMETER CID APPROXIMATELY 10
FEET LONG. INLET INVERT IS 69.2

INLET CONTROLS FROM "HYDRAULIC CHARTS
FOR THE SELECTION OF HIGHWAY CULVERTS" (USDOT)

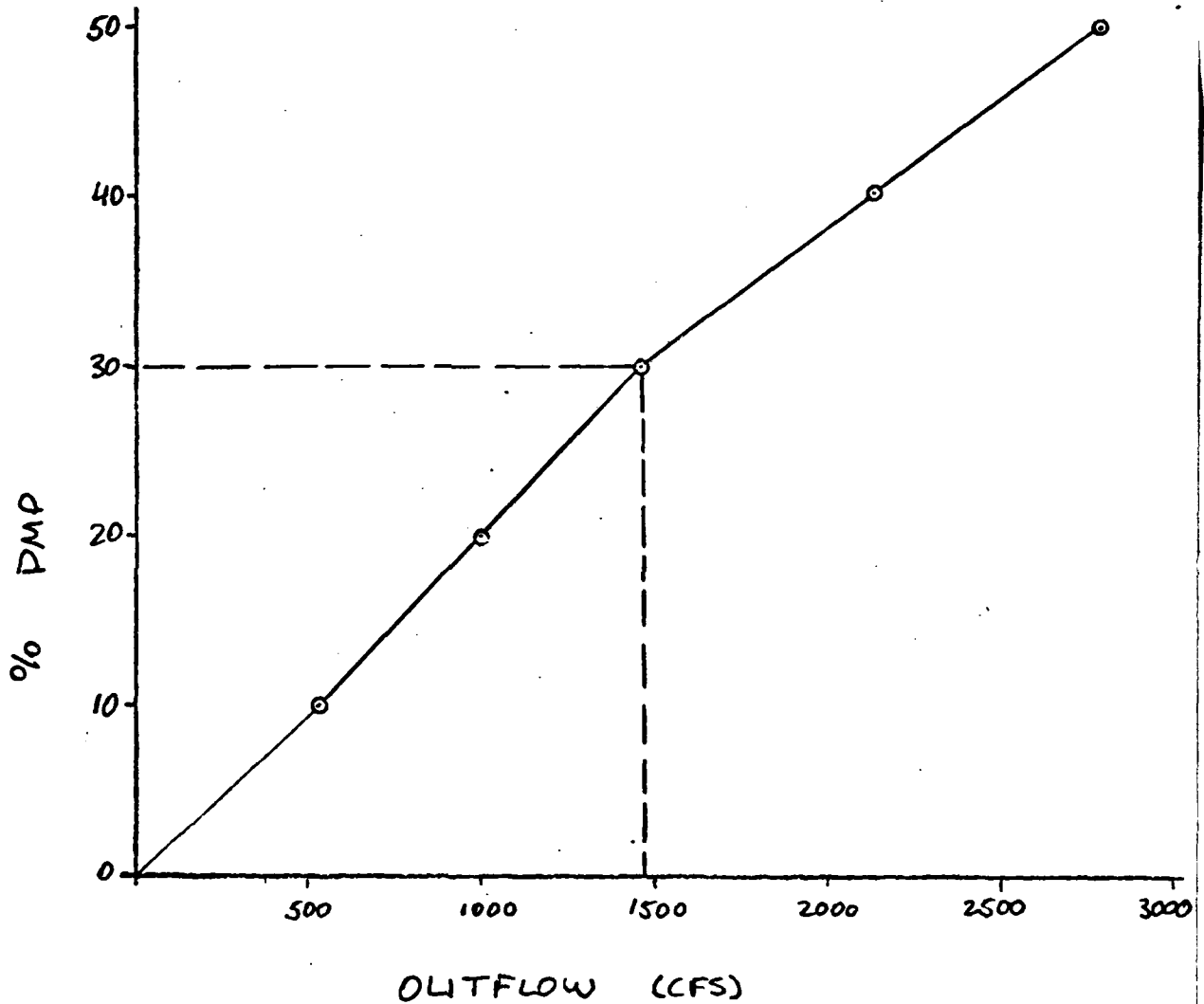
MAXIMUM DISCHARGE = 45 CFS $H_w = 8.1'$

AVERAGE DISCHARGE = 28 CFS $H_w = 4.0'$

DRAWDOWN

$$\begin{aligned}
 \text{DRAWDOWN} &= \frac{\text{STORAGE AT SPILLWAY}}{\text{AVE DISCHARGE} - \text{INFLOW}} \\
 &= \frac{7 \text{ AC-FT}}{28 \text{ CFS} - (1 \text{ CFS/SQ MI} \times 1.7 \text{ SQ MI})} \frac{43560 \text{ SF/AC}}{3600 \text{ SEC/HR}} \\
 &= 3.2 \text{ HOURS}
 \end{aligned}$$

OVERTOPPING POTENTIAL



OVERTOPPING OF THE DAM OCCURS AT
 ELEVATION 82.1 WITH $Q = 1472$ CFS \therefore DAM
 CAN PASS APPROXIMATELY 30% PMP
 OR 60% SDF

HEC-1-DB COMPUTATIONS

MO	DA	HR	MIN	PERIOD	RAIN	EXCS	LOSS	COMP	D
01	01			1	0	0	0	0	0
01	01			2	0	0	0	0	0
01	01			3	0	0	0	0	0
01	01			4	0	0	0	0	0
01	01			5	0	0	0	0	0
01	01			6	0	0	0	0	0
01	01			7	0	0	0	0	0
01	01			8	0	0	0	0	0
01	01			9	0	0	0	0	0
01	01			10	0	0	0	0	0
01	01			11	0	0	0	0	0
01	01			12	0	0	0	0	0
01	01			13	0	0	0	0	0
01	01			14	0	0	0	0	0
01	01			15	0	0	0	0	0
01	01			16	0	0	0	0	0
01	01			17	0	0	0	0	0
01	01			18	0	0	0	0	0
01	01			19	0	0	0	0	0
01	01			20	0	0	0	0	0
01	01			21	0	0	0	0	0
01	01			22	0	0	0	0	0
01	01			23	0	0	0	0	0
01	01			24	0	0	0	0	0
01	01			25	0	0	0	0	0
01	01			26	0	0	0	0	0
01	01			27	0	0	0	0	0
01	01			28	0	0	0	0	0
01	01			29	0	0	0	0	0
01	01			30	0	0	0	0	0
01	01			31	0	0	0	0	0
01	01			32	0	0	0	0	0
01	01			33	0	0	0	0	0
01	01			34	0	0	0	0	0
01	01			35	0	0	0	0	0
01	01			36	0	0	0	0	0
01	01			37	0	0	0	0	0
01	01			38	0	0	0	0	0
01	01			39	0	0	0	0	0
01	01			40	0	0	0	0	0
01	01			41	0	0	0	0	0
01	01			42	0	0	0	0	0
01	01			43	0	0	0	0	0
01	01			44	0	0	0	0	0
01	01			45	0	0	0	0	0
01	01			46	0	0	0	0	0
01	01			47	0	0	0	0	0
01	01			48	0	0	0	0	0
01	01			49	0	0	0	0	0
01	01			50	0	0	0	0	0
01	01			51	0	0	0	0	0
01	01			52	0	0	0	0	0
01	01			53	0	0	0	0	0
01	01			54	0	0	0	0	0
01	01			55	0	0	0	0	0
01	01			56	0	0	0	0	0
01	01			57	0	0	0	0	0
01	01			58	0	0	0	0	0
01	01			59	0	0	0	0	0
01	01			60	0	0	0	0	0
01	01			61	0	0	0	0	0
01	01			62	0	0	0	0	0
01	01			63	0	0	0	0	0
01	01			64	0	0	0	0	0
01	01			65	0	0	0	0	0
01	01			66	0	0	0	0	0
01	01			67	0	0	0	0	0
01	01			68	0	0	0	0	0
01	01			69	0	0	0	0	0
01	01			70	0	0	0	0	0
01	01			71	0	0	0	0	0
01	01			72	0	0	0	0	0
01	01			73	0	0	0	0	0
01	01			74	0	0	0	0	0
01	01			75	0	0	0	0	0
01	01			76	0	0	0	0	0
01	01			77	0	0	0	0	0
01	01			78	0	0	0	0	0
01	01			79	0	0	0	0	0
01	01			80	0	0	0	0	0
01	01			81	0	0	0	0	0
01	01			82	0	0	0	0	0
01	01			83	0	0	0	0	0
01	01			84	0	0	0	0	0
01	01			85	0	0	0	0	0
01	01			86	0	0	0	0	0
01	01			87	0	0	0	0	0
01	01			88	0	0	0	0	0
01	01			89	0	0	0	0	0
01	01			90	0	0	0	0	0
01	01			91	0	0	0	0	0
01	01			92	0	0	0	0	0
01	01			93	0	0	0	0	0
01	01			94	0	0	0	0	0
01	01			95	0	0	0	0	0
01	01			96	0	0	0	0	0
01	01			97	0	0	0	0	0
01	01			98	0	0	0	0	0
01	01			99	0	0	0	0	0
01	01			100	0	0	0	0	0

MO. DA	HR. MN	PERIOD	RAIN	EXCS	LOSS	COMP	D
1	01	101	.49	.47		61	5
1	01	102	.49	.47		61	5
1	01	103	.49	.47		61	5
1	01	104	.49	.47		61	5
1	01	105	.49	.47		61	5
1	01	106	.49	.47		61	5
1	01	107	.49	.47		61	5
1	01	108	.49	.47		61	5
1	01	109	.49	.47		61	5
1	01	110	.49	.47		61	5
1	01	111	.49	.47		61	5
1	01	112	.49	.47		61	5
1	01	113	.49	.47		61	5
1	01	114	.49	.47		61	5
1	01	115	.49	.47		61	5
1	01	116	.49	.47		61	5
1	01	117	.49	.47		61	5
1	01	118	.49	.47		61	5
1	01	119	.49	.47		61	5
1	01	120	.49	.47		61	5
1	01	121	.49	.47		61	5
1	01	122	.49	.47		61	5
1	01	123	.49	.47		61	5
1	01	124	.49	.47		61	5
1	01	125	.49	.47		61	5
1	01	126	.49	.47		61	5
1	01	127	.49	.47		61	5
1	01	128	.49	.47		61	5
1	01	129	.49	.47		61	5
1	01	130	.49	.47		61	5
1	01	131	.49	.47		61	5
1	01	132	.49	.47		61	5
1	01	133	.49	.47		61	5
1	01	134	.49	.47		61	5
1	01	135	.49	.47		61	5
1	01	136	.49	.47		61	5
1	01	137	.49	.47		61	5
1	01	138	.49	.47		61	5
1	01	139	.49	.47		61	5
1	01	140	.49	.47		61	5
1	01	141	.49	.47		61	5
1	01	142	.49	.47		61	5
1	01	143	.49	.47		61	5
1	01	144	.49	.47		61	5
1	01	145	.49	.47		61	5
1	01	146	.49	.47		61	5
1	01	147	.49	.47		61	5
1	01	148	.49	.47		61	5
1	01	149	.49	.47		61	5
1	01	150	.49	.47		61	5
1	01	151	.49	.47		61	5
1	01	152	.49	.47		61	5
1	01	153	.49	.47		61	5
1	01	154	.49	.47		61	5
1	01	155	.49	.47		61	5
1	01	156	.49	.47		61	5
1	01	157	.49	.47		61	5
1	01	158	.49	.47		61	5
1	01	159	.49	.47		61	5
1	01	160	.49	.47		61	5
1	01	161	.49	.47		61	5
1	01	162	.49	.47		61	5
1	01	163	.49	.47		61	5
1	01	164	.49	.47		61	5
1	01	165	.49	.47		61	5
1	01	166	.49	.47		61	5
1	01	167	.49	.47		61	5
1	01	168	.49	.47		61	5
1	01	169	.49	.47		61	5
1	01	170	.49	.47		61	5
1	01	171	.49	.47		61	5
1	01	172	.49	.47		61	5
1	01	173	.49	.47		61	5
1	01	174	.49	.47		61	5
1	01	175	.49	.47		61	5
1	01	176	.49	.47		61	5
1	01	177	.49	.47		61	5
1	01	178	.49	.47		61	5
1	01	179	.49	.47		61	5
1	01	180	.49	.47		61	5
1	01	181	.49	.47		61	5
1	01	182	.49	.47		61	5
1	01	183	.49	.47		61	5
1	01	184	.49	.47		61	5
1	01	185	.49	.47		61	5
1	01	186	.49	.47		61	5
1	01	187	.49	.47		61	5
1	01	188	.49	.47		61	5
1	01	189	.49	.47		61	5
1	01	190	.49	.47		61	5
1	01	191	.49	.47		61	5
1	01	192	.49	.47		61	5
1	01	193	.49	.47		61	5
1	01	194	.49	.47		61	5
1	01	195	.49	.47		61	5
1	01	196	.49	.47		61	5
1	01	197	.49	.47		61	5
1	01	198	.49	.47		61	5
1	01	199	.49	.47		61	5
1	01	200	.49	.47		61	5
		SUM	24.71	20.90	3.81	140.00	5
			628.00	531.00	97.00	396.00	5

***** HYDROGRAPH ROUTING *****

ROUTE DISCHARGE THROUGH DAM

ISTAT ICOMP IECON ITAPE JPLY JPRJ INAME ISTAGE IAUTO
 0 0 0 0 0 0 0 0 0 0 0 0
 ROUTING DATA
 CLOSS AVG IRES ISAME IOPI IPMP LSTR
 0.00 0.00 0.00 1 0 0 0
 NSTPS NSTDL LAG AMSKK Y ISK STORA ISPRAI
 1 0 0 0.000 0.000 0.000 0.000 0.000 -77%
 STAGE 76.75 77.00 78.00 79.00 80.00 81.00 82.10 83.00 84.00 85.00
 FLW 0.00 5.00 150.00 374.00 675.00 1028.00 1472.00 1872.00 2353.00 2870.00
 SURFACE AREA= 0. 5. 26. 141. 315.
 CAPACITY= 0. 10. 47. 806. 3028.
 ELEVATION= 71. 77. 80. 90. 100.

CREL SPWID COGN FXPU ELEV COGL CAREA EXPL
 76.8 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 TOPFL COGD EXPD DAMWID
 82.1 2.6 1.5 210.

CFS 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 3489 972 720 140016
 INCHES 18.71 21.28 21.27 2195.8
 AC-FT 47.825 540.46 540.57 540.57
 THOUS CU M 2091. 2378. 2379. 2379.

HYDROGRAPH AT STA LAKE FOR PLAN 1, RTIO 1

CFS 6-HOUR 24-HOUR 72-HOUR TOTAL VOLUME
 3753 486 350 70006
 INCHES 9.316 10.64 10.64 10.64
 AC-FT 237.63 270.23 270.29 270.29
 THOUS CU M 1066. 1189. 1189. 1189.

APPENDIX 5

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**DAT
FILM**