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NATIONAL DAM SAFETY PROGRAM. CRYSTAL LAKE DAM, NJ-00169, PASSAI--ETC(U)
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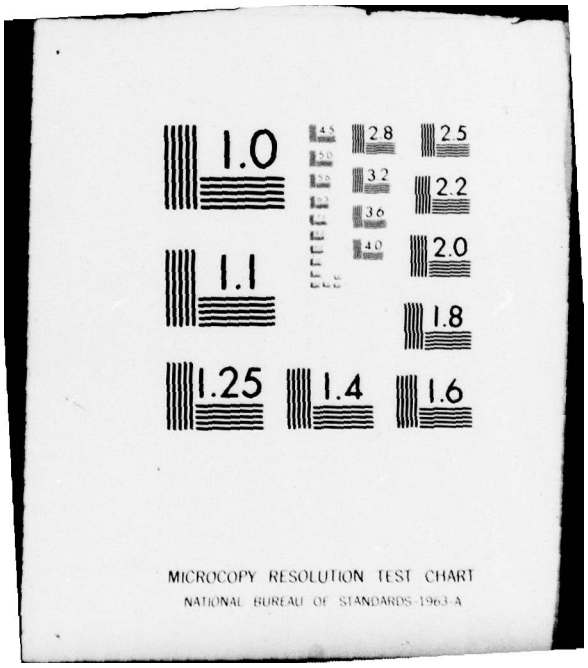
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PASSAIC RIVER BASIN
TROY BROOK, MORRIS COUNTY
NEW JERSEY

LEVEL II

CRYSTAL LAKE DAM
NJ 00169

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Crystal Lake Dam, NJ-00169.
Passaic River Basin. Troy Brook,
Morris County, New Jersey.
Phase I Inspection Report.

(9) Final rept.,
(12) 72 p.

(10) Warren H. /Guinan

(15) DACW61-79-C-0011

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

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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7. AUTHOR(s) Guinan, Warren H. P.E.		8. CONTRACT OR GRANT NUMBER(s) DACW61-79-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS Anderson-Nichols 6 Louden Rd. Concord, NH 03301		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, Pennsylvania 19106		12. REPORT DATE August, 1979 13. NUMBER OF PAGES 30
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16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	Structural analysis
Crystal Lake Dam, N.J.	Safety
Spillways	Visual inspection
Seepage	National Dam Inspection Act report

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 - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

SEP 1979

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

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Crystal 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, Crystal Lake Dam, a high hazard potential structure, is judged to be in poor overall condition. The spillway is considered seriously inadequate since 15 percent of the Probable Maximum Flood (PMF) would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard of loss of life downstream from the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended.

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

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to:

(1) Investigate the seepage at the downstream toe of the dam and downstream toe of the dike and design and implement appropriate remedial measures.

(2) Specify and supervise procedures for removal of the trees, their roots, and brush on the downstream slope of the dam.

(3) Specify and implement appropriate remedial measures for the erosion on the downstream slope of the dam.

(4) Design and install adequate means to drain the reservoir in case of emergency.

c. Within one year from the date of approval of this report, engage a professional engineer qualified in the design and inspection of dams to make a comprehensive technical inspection of the dam once every two years.

d. Within thirty days from the date of approval of this report, a program should be initiated to check the condition of the dam periodically and monitor the seepage until remedial measures are effected.

e. The following actions should be completed within three months from the date of approval of this report:

(1) Initiate a program to control trespassing on the downstream face of the dam.

(2) Remove several of the spillway stoplogs to provide additional storage capacity in the reservoir until additional hydrologic and hydraulic analyses can be performed and permanent mitigating measures implemented.

f. Within one year from the date of approval of this report, the owners should establish a ground cover and maintain the dam, free of brush.

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 Congresswoman Millicent Fenwick of the Fifth 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.

NAPEN-D
Honorable Brendan T. Byrne

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

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

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

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

CRYSTAL LAKE DAM (NJ00169)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 16 May 1979 by Anderson-Nichols and Company, Inc. under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Crystal Lake Dam, a high hazard potential structure, is judged to be in poor overall condition. The spillway is considered seriously inadequate since 15 percent of the Probable Maximum Flood (PMF) would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE classification applied for a structural deficiency. It does mean, however, that based on an initial screening, and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam would take place, significantly increasing the hazard of loss of life downstream from the dam. To insure adequacy of the structure, the following actions, as a minimum, are recommended.

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

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to:

(1) Investigate the seepage at the downstream toe of the dam and downstream toe of the dike and design and implement appropriate remedial measures.

(2) Specify and supervise procedures for removal of the trees, their roots, and brush on the downstream slope of the dam.

(3) Specify and implement appropriate remedial measures for the erosion on the downstream slope of the dam.

(4) Design and install adequate means to drain the reservoir in case of emergency.

c. Within one year from the date of approval of this report, engage a professional engineer qualified in the design and inspection of dams to make a comprehensive technical inspection of the dam once every two years.

d. Within thirty days from the date of approval of this report, a program should be initiated to check the condition of the dam periodically and monitor the seepage until remedial measures are effected.

e. The following actions should be completed within three months from the date of approval of this report:

(1) Initiate a program to control trespassing on the downstream face of the dam.

(2) Remove several of the spillway stoplogs to provide additional storage capacity in the reservoir until additional hydrologic and hydraulic analyses can be performed and permanent mitigating measures implemented.

f. Within one year from the date of approval of this report, the owners should establish a ground cover and maintain the dam, free of brush.

APPROVED: Joel Kelleher LTC
for JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 14 September 1977

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

IN REPLY REFER TO
NAPEN-D

11 SEP 1979

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

Dear Governor Byrne:

This is in reference to our ongoing National Program for Inspection of Non-Federal Dams within the State of New Jersey. Crystal Lake Dam (Federal I.D. No. NJ00169), a high hazard potential structure has recently been inspected. The dam is owned by the Borough of Mountain Lakes and is located on Troy Brook approximately two miles upstream from Mountain Lakes.

Using Corps of Engineers screening criteria, it has been determined that the dam's spillway is seriously inadequate since approximately 15 percent of the Probable Maximum Flood would overtop the dam. The seriously inadequate spillway is assessed as an UNSAFE, non-emergency condition, until more detailed studies prove otherwise, or corrective measures are completed. The classification of UNSAFE applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with an UNSAFE unclassification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations, there appears to be a serious deficiency in spillway capacity so that if a severe storm were to occur, overtopping and failure of the dam could take place, significantly increasing the hazard potential to loss of life downstream from the dam. As a result of this UNSAFE determination, it is recommended that the dam's owner take the following measures within 30 days of the date of this letter:

a. Engage the services of a qualified professional consultant to more accurately determine the spillway adequacy by using more detailed and sophisticated hydrologic and hydraulic analyses, and to recommend any remedial measures required to prevent overtopping of the dam.

b. In the interim, a detailed emergency operation plan and downstream warning system should be developed. Also, round-the-clock surveillance should be provided during periods of unusally heavy precipitation.

A final report on this Phase I Inspection will be forwarded to you within two months.

Sincerely,

for Roy A. Tiritani
JAMES G. TON
Colonel, Corps of Engineers
District Engineer

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

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

UNSAFE DAM
NATIONAL PROGRAM OF INSPECTION OF DAMS

a. NAME: Crystal Lake Dam

b. ID NO.: NJ00169

c. LOCATION State: New Jersey. County: Morris.
River or Stream: Troy Brook.
Nearest D/S City or Town: Mountain Lakes

d. HEIGHT: 16 feet.

e. MAXIMUM IMPOUNDMENT CAPACITY: 135 ac ft.

f. TYPE: Earthfill.

g. OWNER: Borough of Mountain Lakes.

h. DATE GOVERNOR NOTIFIED OF UNSAFE CONDITIONS: 11 Sep 79.

i. CONDITION OF DAM RESULTING IN UNSAFE ASSESSMENT Preliminary report calculations indicate of 15% PMF would overtop the dam.

l. URGENCY CATEGORY: UNSAFE, Non-Emergency.

m. EMERGENCY ACTIONS TAKEN:
Gov. notified of this condition by District Engineer's letter of 11 Sep 79.

j. DESCRIPTION OF DANGER INVOLVED:
Overtopping and failure of the dam would significantly increase hazard potential to loss of life and property downstream of dam.

h. REMEDIAL ACTIONS TAKEN:
N.J.D.E.P. will notify dam's owner upon receipt of our letter.

k. RECOMMENDATIONS GIVEN TO GOVERNOR:
Within 30 days of date of District Engineer letter the owner to do the following:
a. Engage the services of a qualified professional consultant to more accurately determine the spillway adequacy by using more detailed and sophisticated hydrologic and hydraulic analyses, and to recommend any remedial measures required to prevent overtoppoing of the dam.
b.In the interim, a detailed emergency operation plan and downstream warning system should be developed. Also, around-the-clock surveillance should be provided during periods of unusually heavy precipitation.

o. REMARKS: Final report, to be issued within six weeks, will have WHITE cover.

W. H. ZINK, Coordinator
Dam Inspection Program
U.S.A.E.D., Philadelphia

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Crystal Lake Dam
ID Number:	ID No. NJ00169
State Located:	New Jersey
County Located:	Morris
Stream:	Troy Brook
River Basin:	Passaic
Date of Inspection:	May 16, 1979

ASSESSMENT OF GENERAL CONDITIONS

Crystal Lake Dam is an old dam of undetermined age and is in poor overall condition. It is small in size and is classified as High Hazard. A large rust colored seepage, estimated as 5 gpm, was observed at the toe of the dam. Trees and brush are growing on the upstream slope, downstream slope, and the crest of the dam. Undermining and erosion around the concrete spillway chute was noted. Erosion caused by trespassing is present on the downstream face and crest of the dam. There is seepage and a small pool of water immediately downstream of the dike located near the left abutment of the dam. The spillway is capable of passing 14 percent of the PMF without causing the dam to overtop. Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream over the non-failure condition. Thus the spillway is judged to be seriously inadequate.

We recommend that the owner, in the near future, retain the services of a professional engineer, qualified in the design and inspection of dams, to accomplish the following: further evaluate the hydrology and hydraulic capacity of the watershed, reservoir and dam; and determine, design and implement mitigating measures determined necessary to provide the dam with the ability to withstand high discharges; investigate the seepage at the downstream toe of the dam, and downstream of the dike near the left abutment, and design and supervise the implementation of appropriate remedial measures; specify and supervise procedures for removing trees, their roots, and brush from the slopes and crest of the dam; specify and implement appropriate remedial measures for the erosion on the downstream slope of the dam; and, in the future, design and install adequate means to drain the reservoir in case of emergency.

We further recommend that as a part of operating and maintenance procedures, the owner check the condition of the dam once each month and monitor the seepage until remedial measures are effected. This should be started immediately. Control trespassing on the downstream face of the dam. This should be started very soon. Establish a ground cover and maintain the dam free of brush. This should be done in the future. Remove several of the spillway stoplogs to provide additional storage capacity in the reservoir until additional hydrologic and hydraulic analyses can be performed and permanent mitigating measures implemented. This should be done very soon. Establish a surveillance program for use during and immediately following periods of heavy rainfall, and also a warning program to follow in case of floodflow conditions or imminent dam failure. This should be done soon. Engage a professional engineer, qualified in the design and inspection of dams, to make a comprehensive technical inspection of the dam once every two years. This should be started in the future.

Warren A. Guinan

Warren A. Guinan, P.E.
Project Manager
New Jersey No. 16848

16 MAY 1979

OVERVIEW
CRYSTAL LAKE DAM

CONTENTS
PHASE I INSPECTION REPORT
CRYSTAL LAKE DAM N.J. NO. 25-69 FED ID NO. NJ00169

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

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

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Authority to perform the Phase I Safety Inspection of Crystal Lake Dam was received from the State of New Jersey, Department of Environmental Protection, Division of Water Resources by letter dated 4 April 1979 under Contract No. FPM-39 dated 28 June 1978. This Authority was given pursuant to the National Dam Inspection Act, Public Law 92-367 and by agreement between the State and the U.S. Army Engineers District, Philadelphia. The inspection discussed herein was performed by Anderson-Nichols & Company, Inc. on 16 May 1979.

b. Purpose. The purpose of the Phase I Investigation is to develop an assessment of the general conditions with respect to safety of Crystal Lake Dam and appurtenances based upon available data and visual inspection, and, determine any need for emergency measures and conclude if additional studies, investigations and analyses are necessary and warranted.

1.2 Project Description

a. Description of Dam and Appurtenances. Crystal Lake Dam is an old (construction date unknown) earthfill dam approximately 160 feet long. The average topwidth of the crest is 12 feet. The structural height is 16.3 feet and the hydraulic height is 14.2 feet. The upstream face is of undetermined slope. The downstream face has a vertical dry stone retaining wall just downstream of the crest that varies from 2 to 5 feet in height. Below the wall the downstream slope averages 3H:1V to Sunset Lake.

A concrete inlet box with a 3.0 foot high by 2.25 foot wide opening, gated with wood stoplogs, is located in the center of the dam. Concrete wingwalls seven feet long and at 30 degree angles contract the flow to the inlet box. The wingwalls are covered with a plywood sheet and the inlet box is covered with steel plate which determines the minimum elevation of the dam (536 feet MSL). The elevation of stoplogs at the time of the inspection was 535.1 feet MSL. This limited the inlet opening to .9 feet by 2.25 feet. From the inlet box, flow is discharged through 10-inch diameter, 2-foot long AC pipe onto the concrete discharge chute, which carries the flow to Sunset Lake. The discharge chute is 3 feet wide and 19 feet long. The slope of the chute steepens about halfway down the face of the dam. A dry stone dike extends for approximately 100-feet at the left end of the dam. Essential features of the dam are shown in Figure 2.

The watershed above the reservoir is gently sloping and wooded. There are some houses on the shore of the lake.

b. Location. The dam and reservoir are located in the Borough of Mountain Lakes, Morris County, New Jersey on Troy Brook immediately downstream of the Birchwood Lake Dam. Its coordinates are: north latitude 40° 53.4' and west longitude 74° 27.2'. A location map is shown in Figure 1.

c. Size Classification. Crystal Lake Dam is classified as being small in size, as defined in the Recommended Guidelines for Safety Inspection of Dams, on the basis of its structural height of 16.3 feet, which is less than 40 feet and its storage volume of 135 acre-feet which is less than 1000 acre-feet, but more than 50 acre-feet.

d. Hazard Classification. Visual inspection of the downstream area indicates that a breach of Crystal Lake Dam would likely cause breaching of Sunset Lake Dam. Approximately 10 residences are located immediately below Sunset Lake Dam, some with first floor elevations below the normal pool level of the lake. A breach of Crystal Lake would, therefore, likely cause excessive property damage and place up to 20 lives in jeopardy. Crystal Lake Dam is thus classified as High Hazard.

e. Ownership. Crystal Lake Dam is owned by the Borough of Mountain Lakes. Mr. Carl Danser, Superintendent of Public Works (334-3131) was contacted for information and was present during the inspection.

f. Purpose of Dam. The dam was originally constructed to impound an ice pond. Currently the reservoir is used for recreational purposes.

g. Design and Construction History. No plans, hydraulic or hydrologic data for the original construction were disclosed. Reference data on file at the N.J.D.E.P. dated 7 November 1928 indicates that the dam is old and was constructed by Mountain Ice Company. This is the oldest disclosed record regarding the dam.

h. Normal Operational Procedures. No formal operating procedures were disclosed.

1.3 Pertinent Data

a. Drainage Areas. - 0.29 square mile

b. Discharge at Damsite (cfs)

Maximum flood at damsite - unknown

Gated spillway capacity at pool elevation with stoplogs in place (as during inspection) - .5±

Gated spillway capacity at maximum pool (top of dam) elevation with stoplogs removed (controlled by pipe capacity) - 7

Total spillway capacity at maximum pool elevation - 7

c. Elevation (ft. above MSL)

Top Dam - 536.0

Maximum pool-design surcharge (½ PMF) - 536.9

Recreation pool (at time of inspection) - 535.2

Stoplog sill - 533

Spillway crest (stoplogs) - 535.1

Streambed at centerline of dam - 521.8

Maximum tailwater (estimated) - 524

d. Reservoir

Length of maximum pool - 2100 ft. ±

Length of recreation pool - 2000 ft. ±

Length of flood control pool - 2100 ft. ±

e. Storage (acre-feet)

Recreation pool - 118

Design surcharge (½PMF) - 153

Top of dam - 135

f. Reservoir Surface (acres)

Top Dam - 19.5

Maximum pool (½ PMF) - 19.7

Recreation pool - 19.3

Spillway crest - 19.3

g. Dam

Type - earthfill

Length - 160 ft. ±

Height - hydraulic - 14.2 ft.
structural - 16.3 ft.

Top width - 12 ft. ±

Side slopes - upstream - not visible
downstream - 2H:1V

Zoning - unknown

Impervious core - unknown

Cutoff - unknown

Grout curtain - unknown

h. Spillway

Type - stoplog

Length of weir - 2.25 ft.

Crest elevation - sill 533.
- with stoplogs in place (as during inspection) 535.1

Gates - rough cut 2 x 4-inch by 2.25 ft. long stoplogs

U/S Channel - Crystal Lake

D/S Channel - Sunset Lake

SECTION 2
ENGINEERING DATA

2.1 Design

No original engineering design data or plans were disclosed.

2.2 Construction

No original construction data were disclosed.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. A search of New Jersey Department of Environmental Protection files and contact with community officials, revealed a very limited amount of information.

b. Adequacy. The information available was such that the evaluation of this dam was based solely on visual observations.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. Dam. Seepage estimated at 5 gpm was observed at the downstream toe of the dam. Brush and trees up to 2 feet in diameter are growing on the upstream slope, downstream slope, and part of the width of the crest. No riprap was observed. Extensive trespassing and erosion on the downstream slope of the dam, particularly in the vicinity of the spillway was noted. The erosion has resulted in local undermining of the concrete chute in which water from the spillway flows down the downstream slope of the dam.

b. Appurtenant Structures. There is seepage and a small pool of water immediately downstream of the dike which is located near the left abutment of the dam.

c. Reservoir Area. The watershed above the reservoir is gently sloping and wooded. Slopes adjacent to the reservoir appear stable. There are some houses on the shore of the lake. Crystal Lake backs up to the toe of Birchwood Lake Dam.

d. Downstream Channel. Sunset Lake backs up to the downstream toe of the dam.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No formal operating procedures were disclosed.

4.2 Maintenance of Dam

No formal maintenance procedures for the dam were disclosed.

4.3 Maintenance of Operating Facilities

No formal maintenance procedures for the operating facilities were disclosed.

4.4 Warning System

No description of any warning system was disclosed.

4.5 Evaluation of Operational Adequacy

Because of the lack of operation and maintenance procedures the remedial measures described in Section 7.2 should be implemented as prescribed.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. Design Data. No hydrologic or hydraulic design data were disclosed.

b. Experience Data. No experience data were disclosed.

c. Visual Observation. No visible evidence of damage to the structure caused by overtopping was observed. A rust colored seepage was discharging at an estimated 5 gpm from the downstream toe of the dam. There was also seepage and a small pool of water immediately downstream of the east dike. At the time of inspection about 1 inch of water was flowing over the stoplogs.

d. Overtopping Potential. The hydraulic/hydrologic evaluation for Crystal Lake Dam is based on a Spillway Design Flood (SDF) equal to one-half the Probable Maximum Flood (PMF) in accordance with the range of test floods given in the evaluation guidelines for dams classified as high hazard and small size. The PMF has been determined by application of the SCS dimensionless unit hydrograph procedures to a 6-hour PMP storm of 25.5 inches. The inflow hydrograph from the intermediate drainage area was added to outflow from Birchwood Lake Dam to develop the inflow hydrograph. Hydrologic computations are given in Appendix 3. The routed half-PMF peak discharge for the subject watershed is 386 cfs.

The minimum elevation of the dam allows 0.9 foot of depth above the stoplogs, as in place during the inspection, before overtopping begins. Under this head the spillway discharge pipe capacity is 7 cfs.

Routing calculations indicate that Crystal Lake Dam will be overtopped for more than 5 hours to a maximum depth of 0.9 foot under half-PMF conditions. It is estimated that the spillway can pass approximately 14 percent of the PMF without overtopping the dam because the spillway can pass less than 50 percent of the PMF, the dam is classified as High Hazard, and dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from that which would exist just before overtopping failure, the spillway for Crystal Lake Dam is judged to be seriously inadequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. Seepage at the downstream toe of the dam and at the downstream toe of the dike could lead to future instability of the dam. Trespassing and erosion on the crest and downstream slope of the dam, especially in the vicinity of the spillway, could result in breaching of the dam, if not corrected. Trees growing on the dam may blow over and pull out their roots, or, if the trees die or are cut, their roots may rot. In either case, serious erosion or seepage problems may result. No evidence of bulging or other signs of slope instability were observed.

b. Design and Construction Data. No design and construction data pertinent to the structural stability of the dam were disclosed.

c. Operating Records. No operating records pertinent to the structural stability of the dam were disclosed.

d. Post-Construction Changes. No record of post-construction changes was disclosed.

e. Seismic Stability. Crystal Lake Dam is in Seismic Zone 1 and in accordance with the recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Crystal Lake Dam is an old dam of undetermined age and is in poor overall condition.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based solely on the results of the visual inspection.

c. Urgency. The recommendations made in Section 7.2 a. and the operating and maintenance procedures in 7.2 c. should be implemented by the owner as prescribed below.

d. Necessity for Additional Data/Evaluation. The information available from the visual inspection is adequate to identify the potential problems that are listed in Sections 5 and 6. These problems require the attention of a professional engineer qualified in the design and inspection of dams who will have to make additional engineering studies to design or specify remedial measures. If left unattended, the problems could lead to instability of the structure. Because the spillway is judged to be seriously inadequate, additional evaluation of the hydrology and the hydraulics of the dam, using more detailed methods, is necessary.

7.2 Recommendations/Remedial Measures

a. Recommendations. The owner should retain the services of a professional engineer qualified in the design and inspection of dams to accomplish the following in the near future:

(1) Conduct a more detailed investigation of the hydrology and hydraulics of the watershed, reservoir, dam and spillway; and determine, design, and implement the necessary mitigating measures to provide the dam with the ability to withstand high discharges.

(2) Investigate the seepage at the downstream toe of the dam and downstream toe of the dike and design and implement appropriate remedial measures.

(3) Specify and supervise procedures for removal of the trees, their roots, and brush on the downstream slope of the dam.

(4) Specify and implement appropriate remedial measures for the erosion on the downstream slope of the dam.

(5) Design and install adequate means to drain the reservoir in case of emergency.

b. Operating and Maintenance Procedures. The owner should:

(1) Check the condition of the dam periodically and monitor the seepage until remedial measures are effected. This should be started immediately.

(2) Control trespassing on the downstream face of the dam. This should be started very soon.

(3) Establish a ground cover and maintain the dam, free of brush after completion of a.(3) above in the future.

(4) Remove several of the spillway stoplogs to provide additional storage capacity in the reservoir until additional hydrologic and hydraulic analyses can be performed and permanent mitigating measures implemented. This should be done very soon.

(5) Establish a surveillance program for use during and immediately following periods of heavy rainfall, and also a warning program to follow in case of floodflow conditions or imminent dam failure. This should be done soon.

(6) Engage a professional engineer qualified in the design and inspection of dams to make a comprehensive technical inspection of the dam once every two years. This should be started in the future.

Anderson-Nichols & Co., Inc. BOSTON MASSACHUSETTS	U.S. ARMY ENGINEER DIST. PHILADELPHIA CORPS OF ENGINEERS PHILADELPHIA, PA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

CRYSTAL LAKE DAM
LOCATION MAP

TROY BROOK NEW JERSEY

SCALE: SEE BAR SCALE

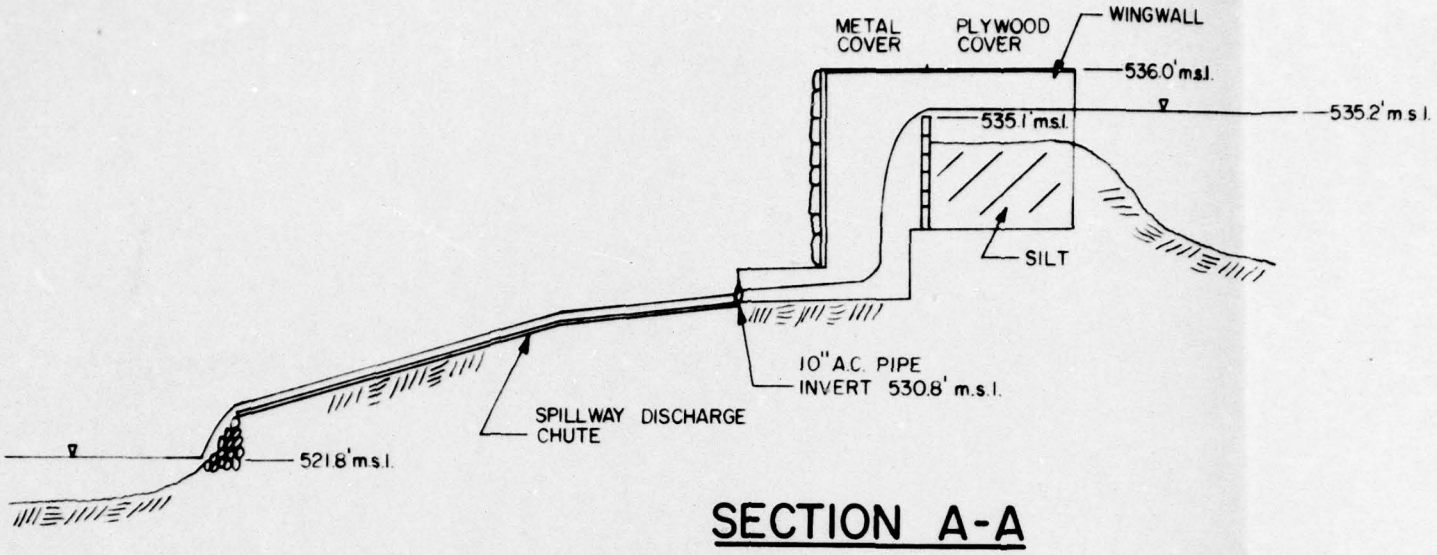
DATE: AUGUST 1979

SCALE IN MILES

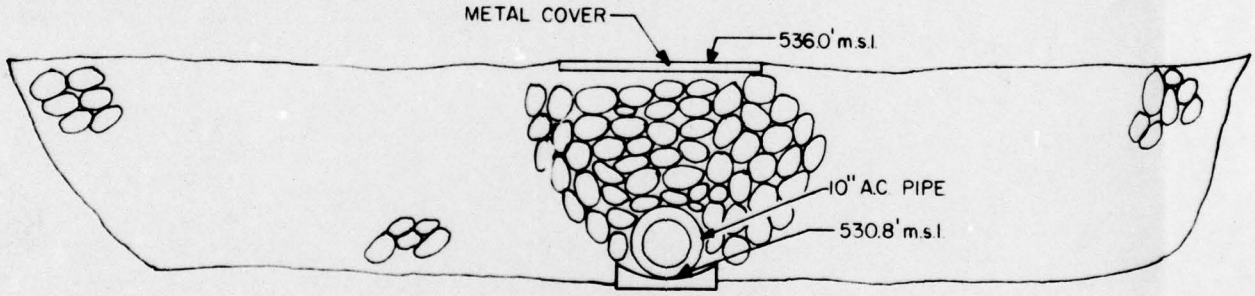
0 5 10

MAP BASED ON STATE OF NEW JERSEY OFFICIAL HIGHWAY MAP AND GUIDE.

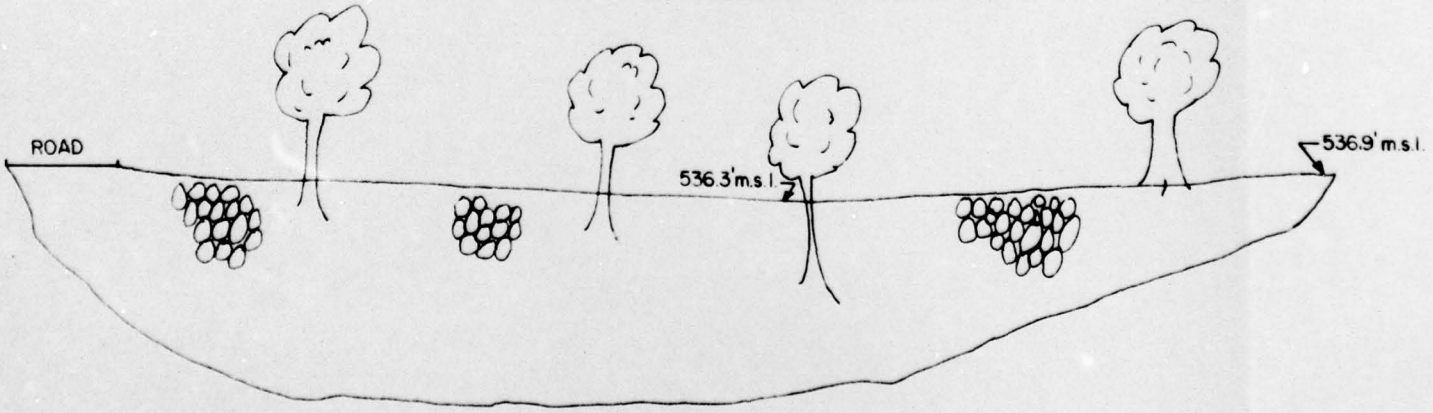
FIGURE 1



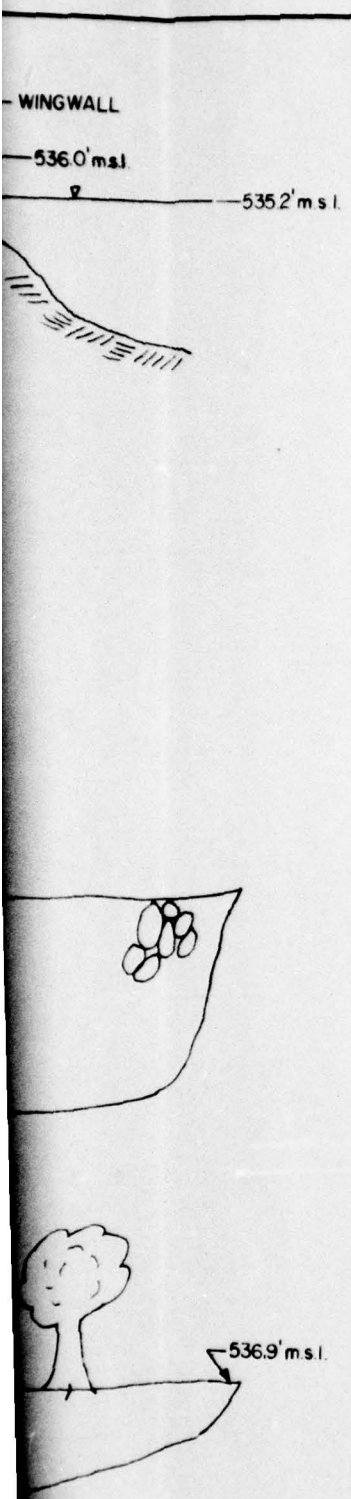
SECTION A-A

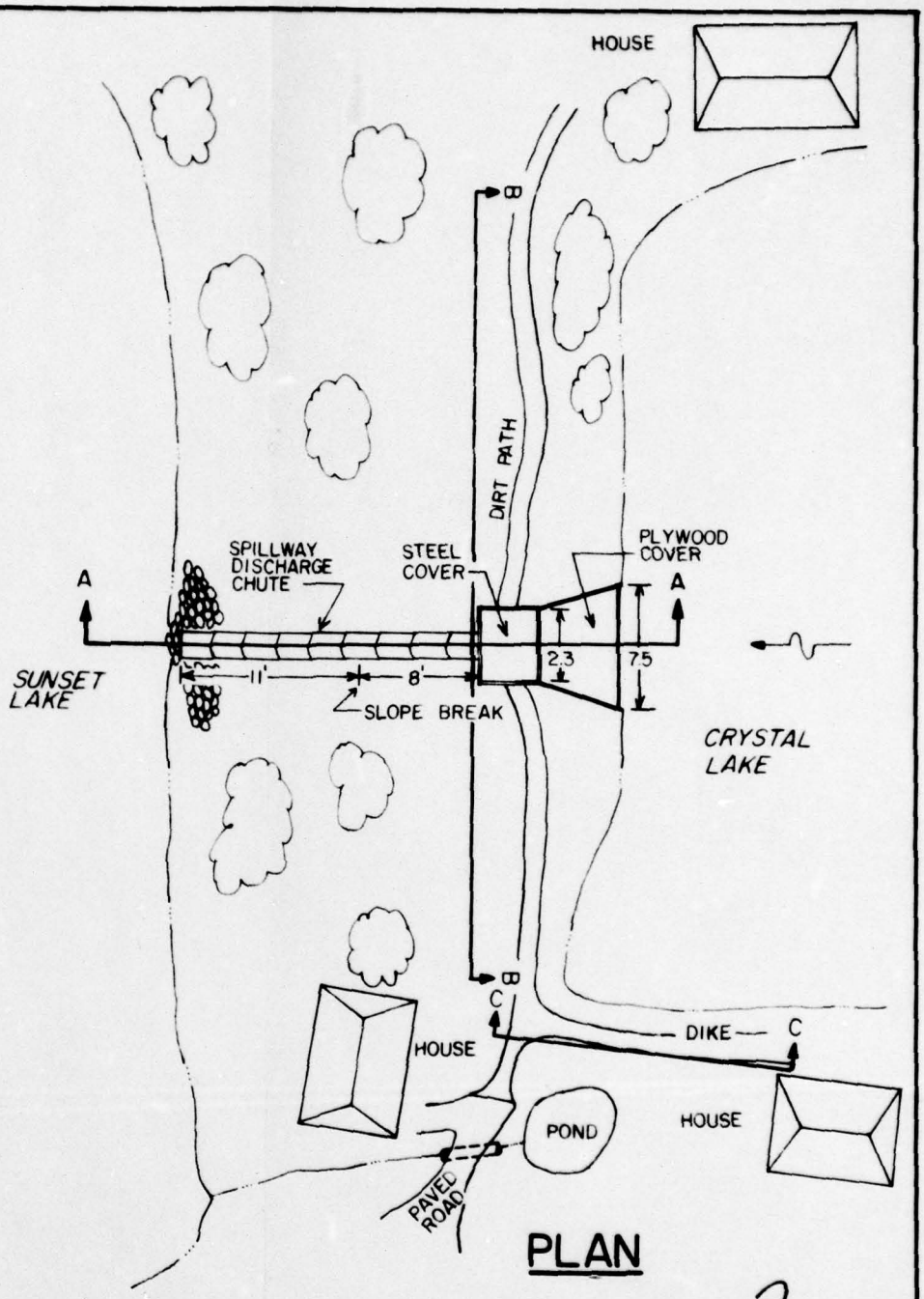


ELEVATION B-B



ELEVATION C-C





PLAN

2

Data from field inspection May 16, 1979

Anderson-Nichols & Co., Inc.	U.S. ARMY ENGINEER DIST. PHILADELPHIA
BOSTON MASSACHUSETTS	CORPS OF ENGINEERS PHILADELPHIA, PA

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

CRYSTAL LAKE DAM

TROY BROOK NEW JERSEY

			SCALE NOT TO SCALE
			DATE AUGUST, 1979

FIGURE 2

APPENDIX 1

CHECKLIST

VISUAL INSPECTION

CRYSTAL LAKE DAM

Check List
Visual Inspection
Phase 1

Name Dam Crystal Lake Dam County Morris State New Jersey Coordinators NJDEP

Date(s) Inspection May 16, 1979 Weather Sunny Temperature 70°

Pool Elevation at Time of Inspection 535.2 MSL Tailwater at Time of Inspection 521.8 MSL

Inspection Personnel:

Warren Guinan	Ronald Hirschfeld
Stephen Gilman	
David Deane	

Gilman & Hirschfeld Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None apparent.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None apparent.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Considerable erosion of downstream slope adjacent to spillway chute	Repair erosion. Provide appropriate slope protection.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Good.	
RIPRAP FAILURES	No riprap.	Provide appropriate slope protection.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RAILINGS		
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Considerable erosion adjacent to and under spillway chute.	Repair erosion.
ANY NOTICEABLE SEEPAGE	Large seepage at downstream toe between spillway and left abutment.	Investigate seepage. Design and implement appropriate remedial measures.
STAFF GAGE AND RECORDER	None apparent.	
DRAINS	None apparent.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Concrete stoplog box - good condition - only surface laitance eroded away wood stoplog - weathered - fair condition An 8" pipe enters at invert of stoplog box - source unknown	
APPROACH CHANNEL	Wide and unobstructed.	
DISCHARGE CHANNEL	Trees and brush overhanging channel, which widens directly into Sunset Lake.	Clear trees and brush on both sides of spillway channel from dam to Sunset Lake which is immediately downstream.
BRIDGE AND PIERS	Wood deck over stoplog - painted - good condition Steel plate - good condition - surface rust	
GATES AND OPERATION EQUIPMENT	Rough cut 2 x 4-inch by 2.25 foot-long stoplogs	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	No original plans were disclosed. Plans for this report were developed from visual inspection.
REGIONAL VICINITY MAP	Prepared for this report.
CONSTRUCTION HISTORY	None disclosed.
TYPICAL SECTIONS OF DAM	Prepared for this report from visual inspection.
HYDROLOGIC/HYDRAULIC DATA	None disclosed.
OUTLETS - PLAN	None disclosed.
- DETAILS	None disclosed.
- CONSTRAINTS	None disclosed.
- DISCHARGE RATINGS	None disclosed.
RAINFALL/RESERVOIR RECORDS	None disclosed.

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

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

ITEM	REMARKS
SPILLWAY PLAN	No original plans were disclosed.
SECTIONS	Cross-section for this report was prepared from visual inspection.
DETAILS	
OPERATING EQUIPMENT	None.
PLANS & DETAILS	

CRYSTAL LAKE
CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 0.29 square mile, hilly, wooded

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 535.2 ft. MSL (118 ac-ft)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not applicable

ELEVATION MAXIMUM DESIGN POOL: 537.7 ft. MSL

ELEVATION TOP DAM: 536

CREST: Stoplog section

a. Elevation 535.1

b. Type Stoplog

c. Width 2 inches

d. Length 2.25 feet

e. Location Spillover Approximate center of dam

f. Number and Type of Gates 6 Stoplogs in place during inspection

OUTLET WORKS: None

a. Type

b. Location

c. Entrance Inverts

d. Exit Inverts

e. Emergency Draindown Facilities

HYDROMETEORLOGICAL GAGES: None

a. Type

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 7 cfs

APPENDIX 2

PHOTOGRAPHS

CRYSTAL LAKE DAM

16 MAY 1979

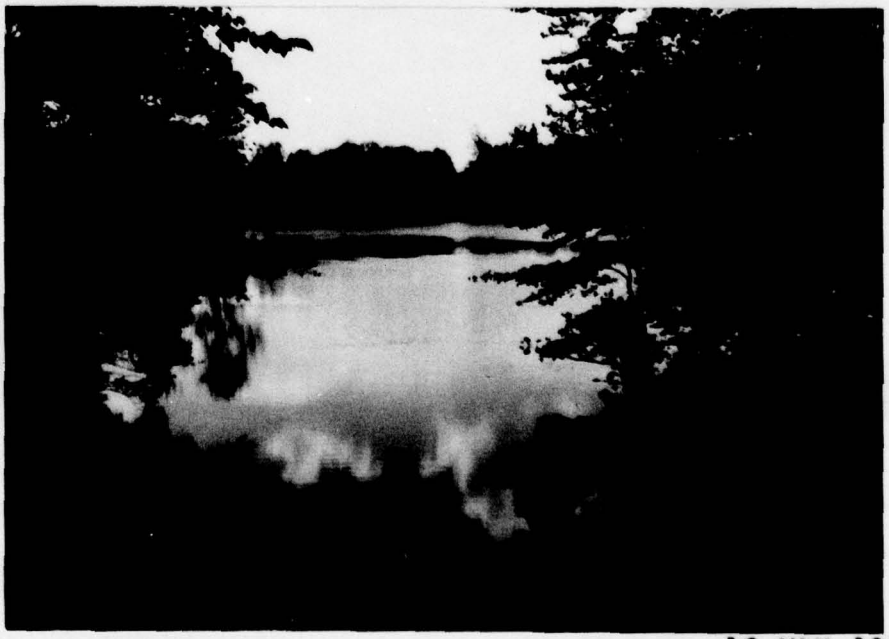
VIEW FROM THE CENTER OF DAM LOOKING EAST

16 MAY 1979

VIEW FROM THE CENTER OF DAM LOOKING WEST

16 MAY 1979

VIEW OF RESERVOIR LOOKING NORTH FROM CREST



16 MAY 1979

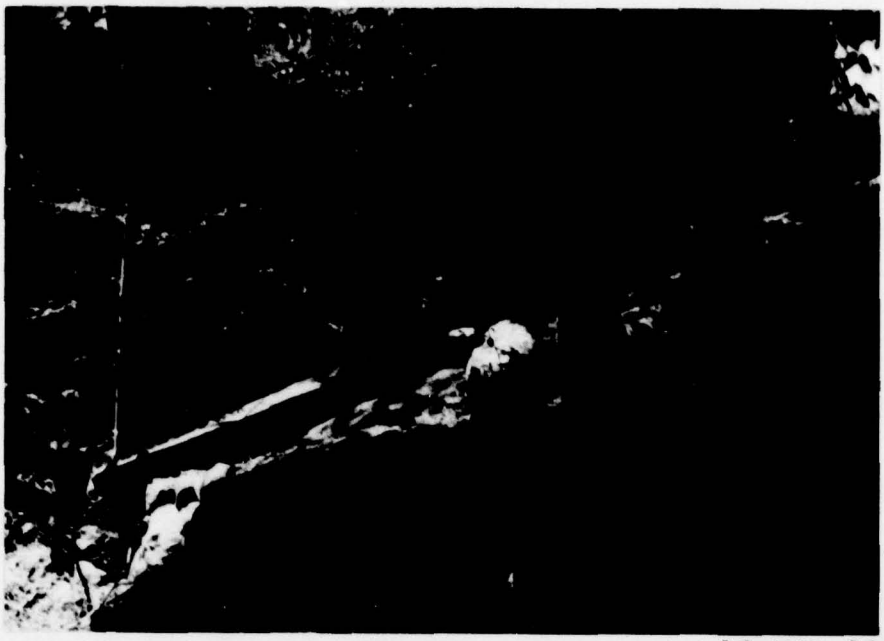
VIEW OF SUNSET LAKE LOOKING DOWNSTREAM FROM TOE AT SPILLWAY OUTLET

16 MAY 1979

VIEW INSIDE DROP BOX OF SPILLWAY STRUCTURE

16 MAY 1979

DOWNSTREAM END OF SPILLWAY STRUCTURE

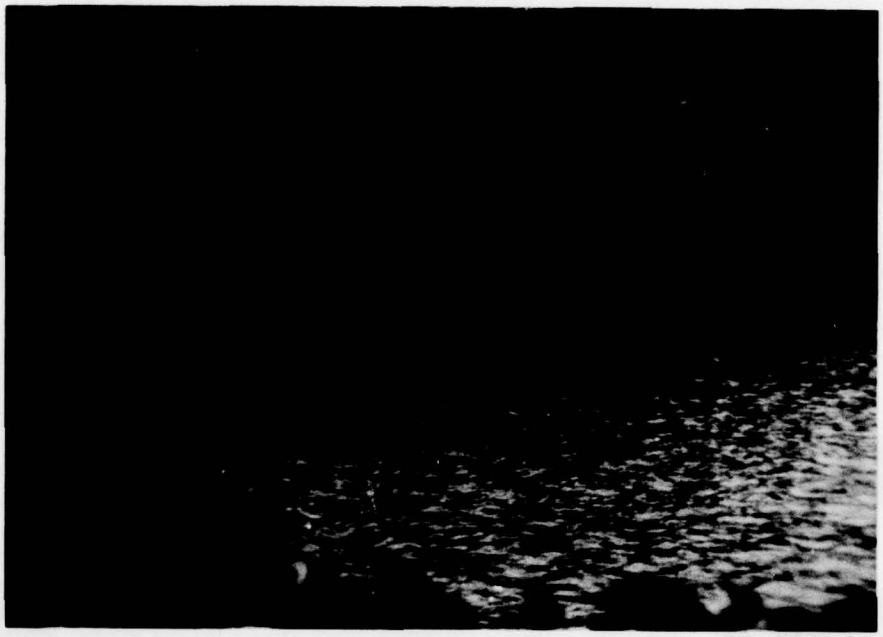


16 MAY 1979

VIEW ACROSS DOWNSTREAM SLOPE OF DAM

16 MAY 1979

SEEPAGE DISCHARGE (RUST STAINED) AT DOWNSTREAM TOE EAST OF SPILLWAY STRUCTURE



16 MAY 1979

VIEW OF UPSTREAM FACE LOOKING SOUTH FROM RESERVOIR

16 MAY 1979

DOWNSTREAM FACE OF THE SPILLWAY STRUCTURE

16 MAY 1979

VIEW OF THE EAST DIKE LOOKING SOUTH TOWARD DAM

16 MAY 1979

DOWNSTREAM FACE OF EAST DIKE

16 MAY 1979

BOULDER WALL OF DOWNSTREAM FACE OF DAM JUST WEST OF SPILLWAY STRUCTURE

APPENDIX 3

HYDROLOGIC COMPUTATIONS

CRYSTAL LAKE DAM

Anderson-Nichols & Company, Inc.

Subject: H-H

Sheet No. 1 of 12
Date 01-23-75
Computed [illegible]
Checked [illegible]

JOB NO. 2290-01

SQUARES 1/4 IN. SCALE

HYDROLOGIC COMPUTATIONS

CRYSTAL LAKE DAM

LOCATION: MORRIS COUNTY, N.J.

DRAINAGE AREA: 0.29 SQ. MILE

EVALUATION CRITERIA: SIZE - SMALL
HAZARD - HIGH

Anderson-Nichols & Company, Inc.

Subject H'D

Sheet No. 2 of 12
Date 7/21/77
Computed [illegible]
Checked [illegible]

JOB NO. 3290-04

SQUARES 1/4 IN. SCALE

CRYSTAL LAKE

OVERLAND FLOW L - 1300' H - 175' S - .1346

Tc - TIME OF CONCENTRATION

① BY KIRPICH NOMOGRAPH Tc - 4.1 MINUTES

② BY IZZARD FORMULA

$$Tc = \frac{L^{1.15}}{7700\,H^{.38}} = \frac{1300^{1.15}}{7700 \cdot 175^{.38}} = 3.2 \text{ MINS}$$

③ BY EQUATION - CALIFORNIA CULVERT p. 71 DESIGN of SMALL DAM

$$Tc = \left(\frac{11.9 \cdot L^3\,[\text{mile}]}{H\,[\text{ft}]}\right)^{.385} = \left(\frac{11.9 \cdot .246^3}{175}\right)^{.385} = 4.2 \text{ MINS}$$

④ WESTON FORMULA

$$Tc = \frac{L}{3600\,V} = \frac{1200}{3600 \cdot 4\ \text{ft/sec}} = 5.4 \text{ MINS}$$

AVERAGE Tc ≈ 4.5 MINUTES

Anderson-Nichols & Company, Inc.

Subject H.S.A.

Sheet No. 3 of 12

Date

Computed

Checked EDD

JOB NO. 2292-04

SQUARES 1/4 IN. SCALE

CRYSTAL LAKE DAM

OUTFLOW FROM BIRCHWOOD LAKE TOWARD CRYSTAL LAKE

ELEV. [MSL]	Q [cfs]
551.6	3.2
551.7	4.0
.8	5.0
.9	5.2
552.0	5.5
.1	5.6
.2	5.7
.3	5.7
.4	5.7
.5	5.8
.6	6.2
.7	7.0
.8	10.5
.9	22.0
553.0	38.3
.1	58.0
.2	84.0
.3	115.0
.4	150.0
.5	189.9
.6	250.0
.7	310.0
.8	380.0
.9	470.0
554.	565.8
.1	680.
.2	790.

Anderson-Nichols & Company, Inc.

Subject W & H

Sheet No. 4 of 12

Date

Computed

Checked

JOB NO. 3290-04

SQUARES 1/4 IN. SCALE 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29

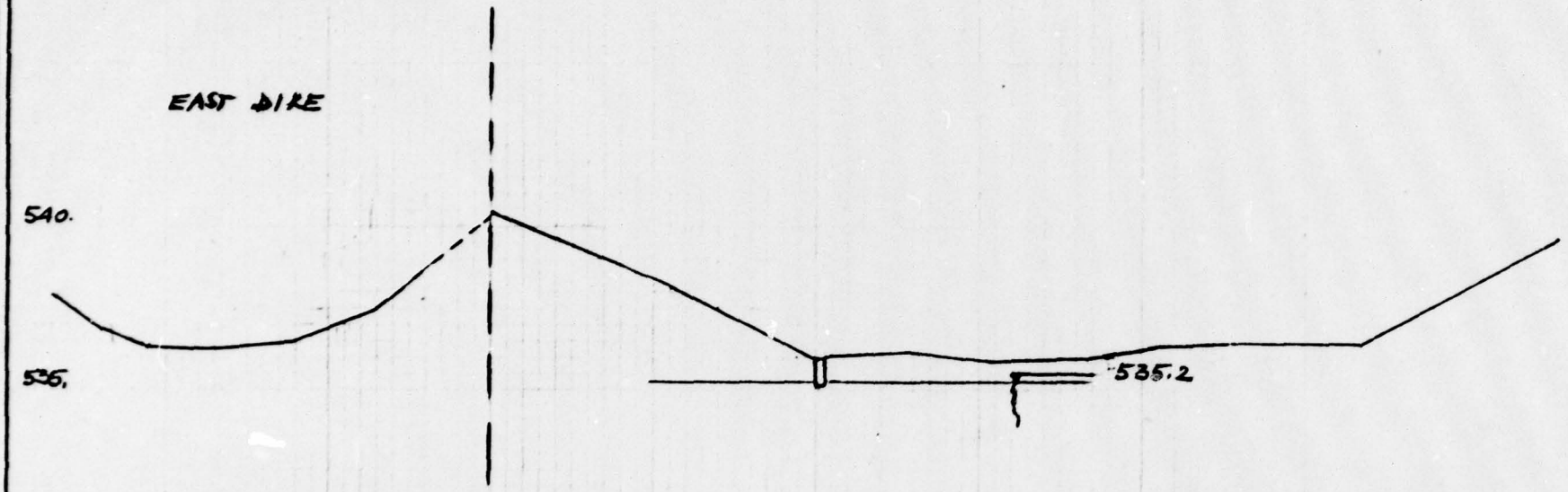
CRYSTAL LAKE DAM

PMF OUTFLOW HYDROGRAPH FROM BIRCHWOOD LAKE
CONTAINING FLOW ONLY TOWARD CRYSTAL LAKE

0.	0.	0.	0.	0.	0.	0.	1.	2.	3.
3.	5.	5	6	6	6	6	6	7.	7.
10.	13	17	22	25	30	38	45	50.	58
60.	62	66.	69.	72.	74	76.	78	80.	82
84.	115.	310.	690.	740.	690.	470.	310.	220.	170
115.	90.	84	82.	80.	78	76	74.	72	70
68	66	64	60	56	52	48	44.	40.	36
32	28	24	22.	15.	10.	7.	6	6	6
6	6	6	6	6	6	6	6	6	6

JOB # 3290-04
07-12-79
COMP. BY: J.G.
CHK'D: FDD

CRYSTAL LAKE DAM - XSECTION ALONG THE DAM



SCALE:
HOR 1"-50'
VER 1"-5'

5/12

Anderson-Nichols & Company, Inc.

Subject KSU

Sheet No. 6 of 12

Date

Computed

Checked

JOB NO. 3290 - 04

SQUARES 1/4 IN. SCALE

CRYSTAL LAKE DAM - RATING CURVE COMPUTATION

DISCHARGE OVER THE STOP LOGS ONLY

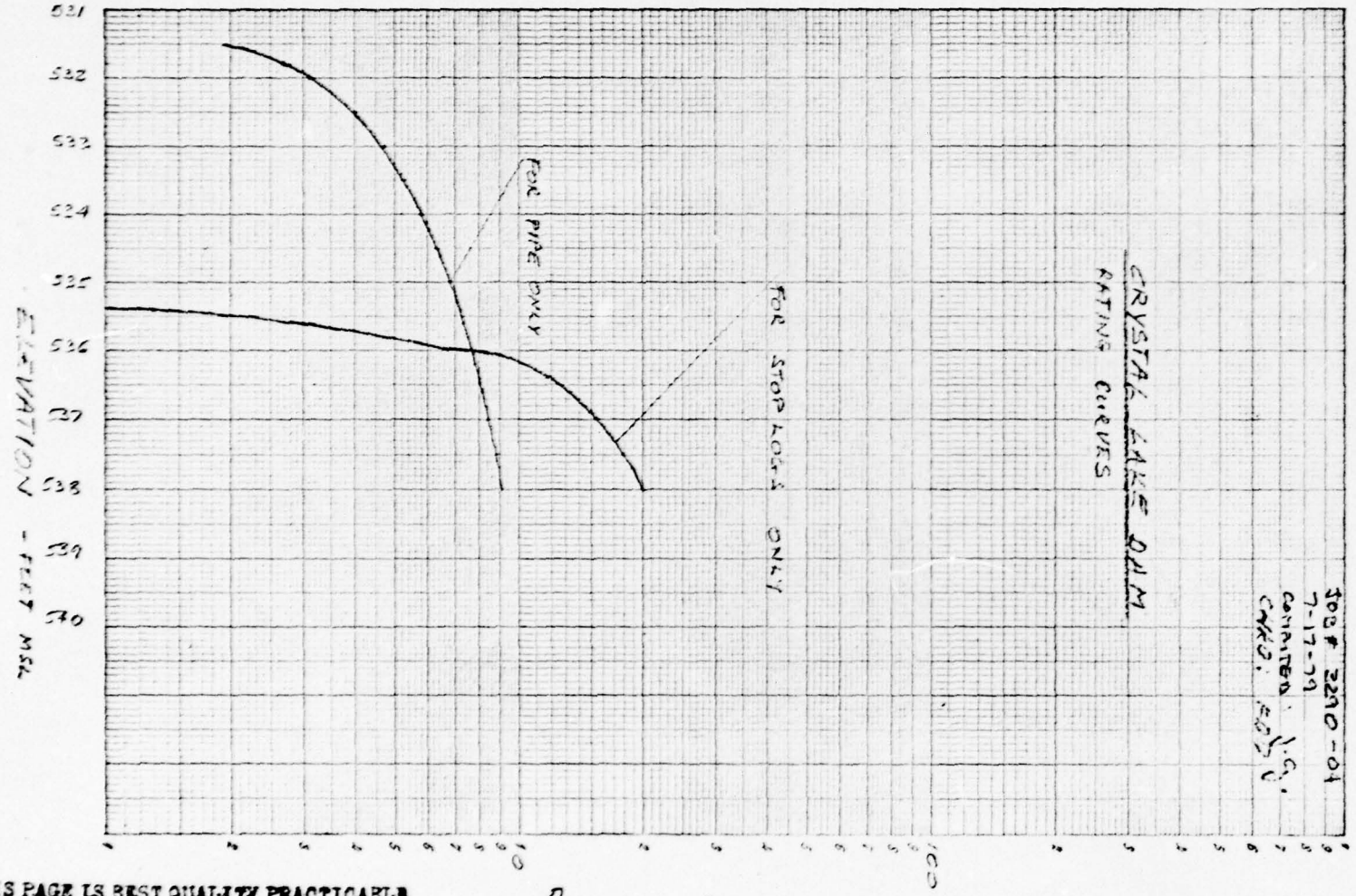
C = 2.5

ELEV. [MSL]	H. [FT]	L. [FT]	Q [CFS]
535.2	.1	2.25	.25
535.4	.3	2.25	1.30
535.6	.5	2.25	2.78
535.8	.7	2.25	4.61
536.0	.9	2.25	6.91

DISCHARGE THROUGH OPENING ABOVE THE STOP LOG ONLY

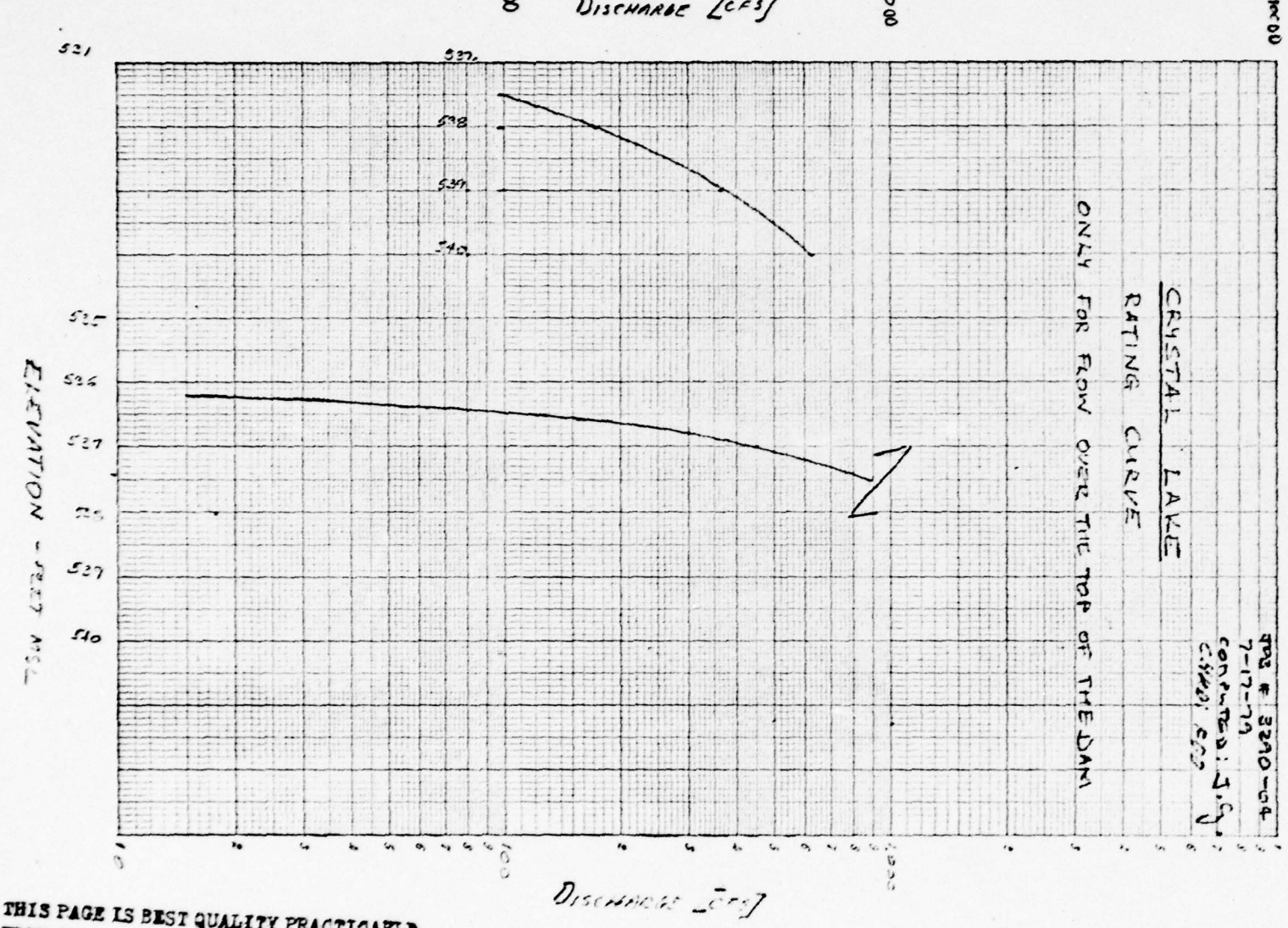
C = .8 A = 2. SQ. FT.

ELEV. [MSL]	H [FT]	Q [CFS]
536.2	.65	10.35
536.4	.85	11.83
536.6	1.05	13.15
536.8	1.25	14.35
537.0	1.45	15.46
537.5	1.95	17.98
538.0	2.45	20.1



7/12

Discharge (cfs)



Anderson-Nichols & Company, Inc.

Subject H & H

Sheet No. 9 of 12
Date 07-17-79
Computed
Checked

JOB NO. 3290-04

SQUARES 1/4 IN. SCALE

CRYSTAL LAKE DAM - RATING CURVE COMPUTATION

DISCHARGE THROUGH THE PIPE ONLY

A = .525 SQ.FT C = .8

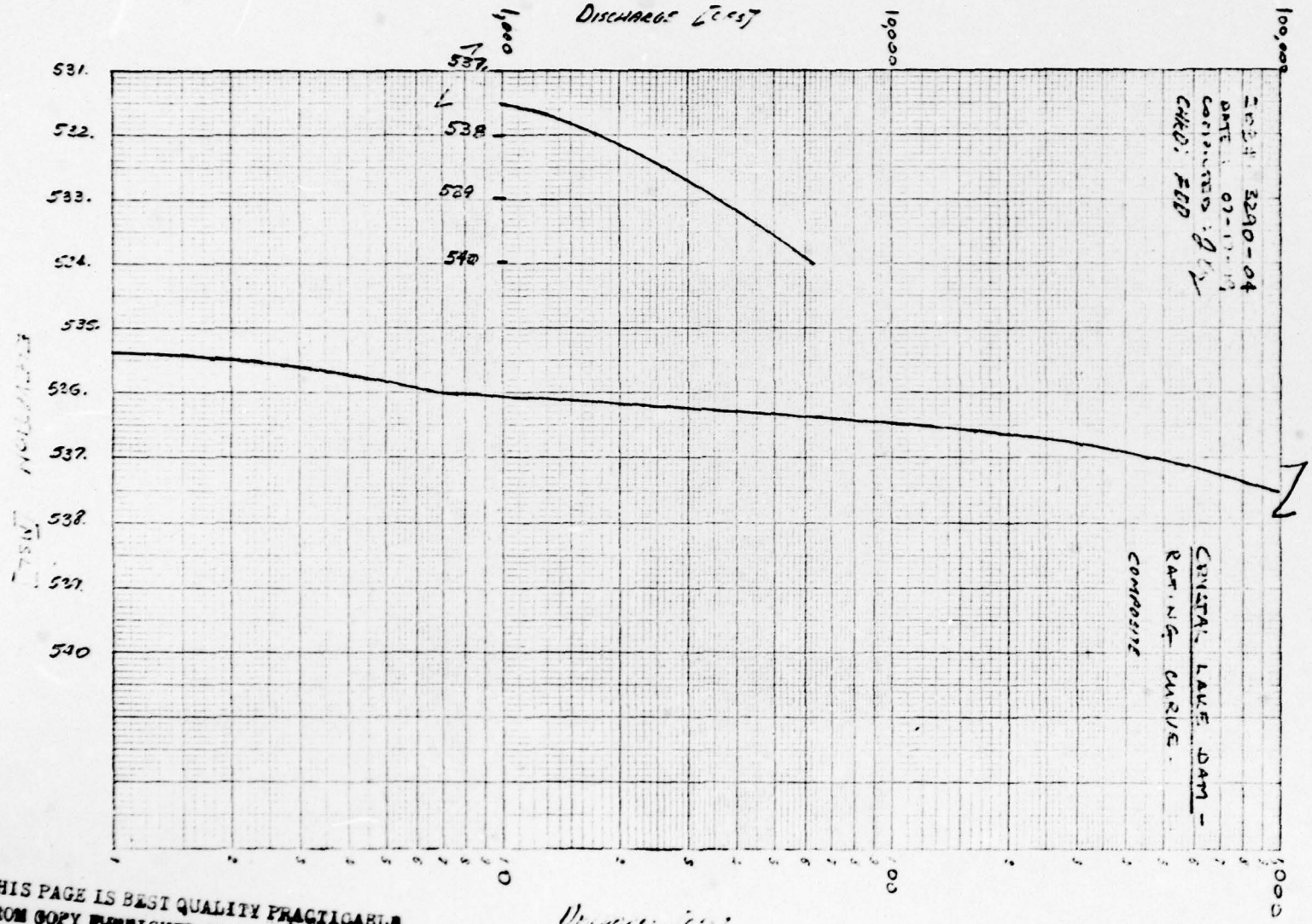
ELEV. [MSL]	H. [FT]	Q [cfs]
531.8	.6	2.7
532.0	.8	3.1
532.5	1.3	4.0
533.	1.8	4.7
533.5	2.3	5.3
534.0	2.8	5.8
534.5	3.3	6.3
535.0	3.8	6.8
535.2	4.0	7.0
535.4	4.2	7.2
535.6	4.4	7.3
535.8	4.6	7.5
536.0	4.8	7.7 ✓
536.2	5.0	7.8 ✓
536.4	5.2	8.0
536.6	5.4	8.1
536.8	5.6	8.3
537.0	5.8	8.4
537.5	6.3	8.5
538.0	6.8	9.1
539.0	7.8	9.8
540.0	8.8	10.4

DISCHARGE OVER THE TOP OF THE DAM ONLY (DIKE)

C = 2.8

~L [ft]	H [ft]	Q [cfs]	TOTAL [cfs]
60	.2	15.	~23.
90	.4	63.7	~72.
120	.6	156.2	~164.
150	.8	300.	~308.
160	1.0	448.	~456.
190	1.5	977.	~985.
220.	2.0	1742.	~1750.
250	3.0	3637.	~3650.
280.	4.0	6272.	~6280

NO. 3115-R. 20 DIVISIONS PER INCH (120 DIVISIONS) BY 3 2-INCH CYCLES RATIO RULING. codex GRAPH PAPER IN STOCK DIRECT FROM CODEX BOOK CO., NORWOOD, MASS. 02062 PRINTED IN U.S.A.



10/12

Anderson-Nichols & Company, Inc.

JOB NO. 3290-04

Subject 11 & 12

Sheet No. 11 of 12
Date 07-12-7[illegible]
Computed
Checked EDD

SQUARES 1/4 IN. SCALE

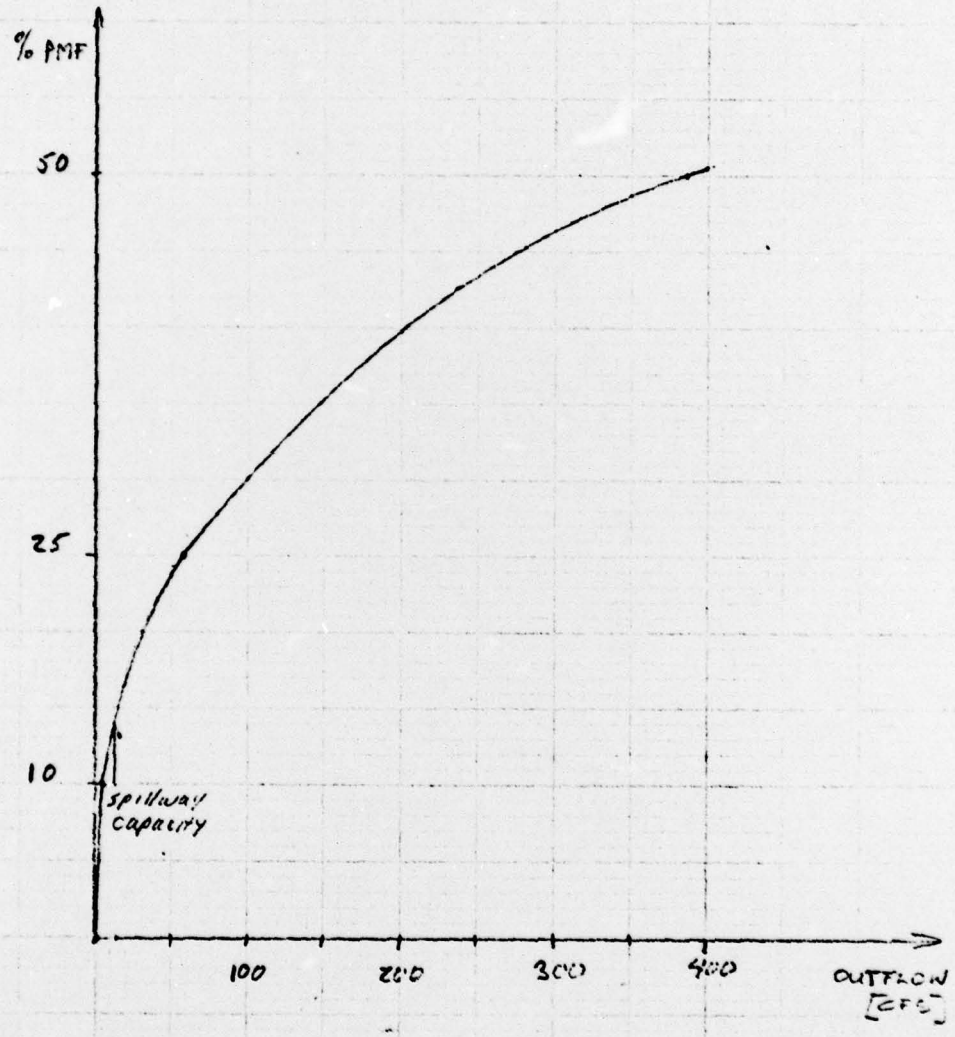
CRYSTAL LAKE DAM

STORAGE CALCULATION

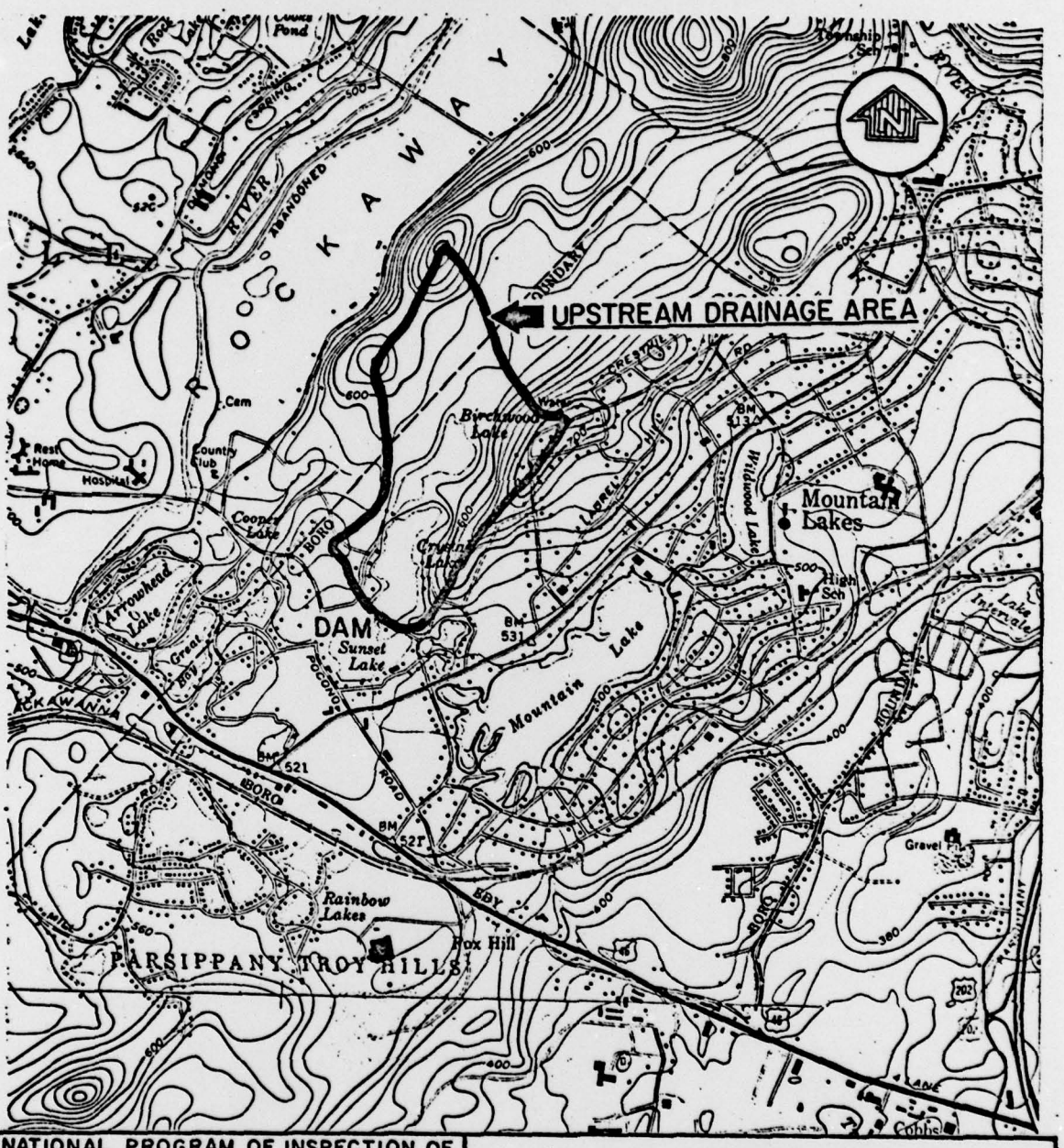
ELEV. [MSL]	AVERAGE H. [FT]	AVERAGE SURFACE [AC]	STORAGE [AC-FT]
535.1	6.	19.3	115.8
535.6	6.5	19.3	125.4
536.0	6.9	19.5	134.6
536.6	7.5	19.5	146.2
537.	8.0	19.6	156.8
537.5	8.5	19.7	167.5
538.	9.0	19.8	178.2
539.	10.0	19.9	199.
540.	11.0	20.0	211.

ANDERSON NICHOLS & CO. INC.
SUBJECT: H.H.
DATE: 07-31-79
COMPUTED BY: J.C.
CHECKED BY: FDD

CRYSTAL LAKE DAM JOB # 3290-C



DAM OVERTOPS AT APPROX. ELEVATION 536. FEET MSL
WITH Q = 7 CFS
∴ SPILLWAY CAN PASS ≥ 14. % of PMF



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

CRYSTAL LAKE DAM
BOROUGH OF MOUNTAIN LAKES

REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
PHILADELPHIA, PENNSYLVANIA

ANDERSON-NICHOLS & CO., INC. BOSTON, MA.

MAP BASED ON U.S.G.S. 7.5 MINUTE QUADRANGLE SHEETS. BOONTON, N.J., 1954, UPDATED 1970. MORRISTOWN, N.J., 1954, UPDATED 1970.

HEC-1 OUTPUT

CRYSTAL LAKE DAM

```
*
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
     1                    A1JOB 3290-04 CRYSTAL LAKE DAM  BOROUGH OF MOUNTAIN LAKES, N.J. NJ#25-69 US#169
     2                    A2OVERTOPPING ANALYSIS ANDERSON-NICHOLS & CO. INC. CONCORD,N.H.
     3                    A30.1,0.25,0.5 AND 1.0 MULTIPLE OF PMF FROM  6 HOUR PMP
     4                    B     90       0       5       0       0       0       0       0       0       0
     5                    B1     5
     6                    J      1       4       1
     7                    J1    .1      .25      .5     1.0
     8                    K                     A1                                      1
     9                    K1OUTFLOW HYDROGRAPH FROM BIRCHWOOD LAKE
    10                    M     -1                .20                     .8                      1
    11                    N      0       0       0       0       0       0       0       1       2       3
    12                    N      3       5       5       6       6       6       6       6       7       7
    13                    N     10      13      17      22      25      30      38      45      50      58
    14                    N     60      63      66      69      72      74      76      78      80      82
    15                    N     84     115     310     680     790     680     470     310     250     150
    16                    N    115      90      84      82      80      78      76      74      72      70
    17                    N     68      66      64      60      56      52      48      44      40      36
    18                    N     32      28      24      22      15      10       7       6       6       6
    19                    N      6       6       6       6       6       6       6       6       6       6
    20                    K                     A2                                      1
    21                    K1DEVELOP INFLOW HYDROGRAPH FOR CRYSTAL LAKE DAM
    22                    M                     2      .09                     .8                      1
    23                    O     72
    24                    O1   .213    .213    .213    .213    .213    .213    .213    .213    .213    .213
    25                    O1   .213    .213    .255    .255    .255    .255    .255    .255    .255    .255
    26                    O1   .255    .255    .255    .255    .319    .319    .319    .319    .319    .319
    27                    O1   .319    .319    .319    .319    .319    .319    .194    .388    .388    .581
    28                    O1   .678   1.647   2.713   1.066    .678    .581    .388    .388    .298    .298
    29                    O1   .298    .298    .298    .298    .298    .298    .298    .298    .298    .298
    30                    O1   .234    .234    .234    .234    .234    .234    .234    .234    .234    .234
    31                    O1   .234    .234
    32                    T                                                     1      .1
    33                    W2             .13
    34                    X     -3
    35                    K      2      A3                                      1
    36                    K1DEVELOP COMBINE INFLOW HYDROGRAPH FOR CRYSTAL LAKE  DAM
    37                    K      1      A4                                      1
    38                    K1 OVERTOPPING ANALYSIS
    39                    Y                             1       1
    40                    Y1                                                  -533.2      -1
    41                    Y4 535.1   535.2   535.4   535.6   535.8    536.   536.2   536.4   536.6   536.8
    42                    Y4  537.    537.5    538.    539.    540.
    43                    Y5     0      .25     1.3    2.78    4.61     6.7     23.     72.    164.    308.
    44                    Y5   456.    985.   1750.   3650.   6280.
    45                    $5 115.8   125.4   134.6   146.2   167.5   178.2    199.    211.
    46                    $E 535.1   535.6    536.   536.6   537.5    538.    539.    540.
    47                    $$ 535.1
    48                    $D  536.
    49                    K     99
1                              PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                  RUNOFF HYDROGRAPH AT          A1
                                  RUNOFF HYDROGRAPH AT          A2
                                  COMBINE 2 HYDROGRAPHS AT      A3
                                  ROUTE HYDROGRAPH TO           A4
                                  END OF NETWORK
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JOB 3290-04 CRYSTAL LAKE DAM BOROUGH OF MOUNTAIN LAKES, N.J. NJ#25-69 US#169
OVERTOPPING ANALYSIS ANDERSON-NICHOLS & CO. INC. CONCORD,N.H.
0.1,0.25,0.5 AND 1.0 MULTIPLE OF PMF FROM 6 HOUR PMP

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
90	0	5	0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1

RTIOS= .10 .25 .50 1.00

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SUB-AREA RUNOFF COMPUTATION

OUTFLOW HYDROGRAPH FROM BIRCHWOOD LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
-1	0	.20	0.00	.20	.80	0.000	0	1	0

INPUT HYDROGRAPH

0.	0.	0.	0.	0.	0.	0.	1.	2.	3.
5.	5.	5.	6.	6.	6.	6.	6.	7.	7.
10.	13.	17.	22.	25.	30.	38.	45.	50.	58.
60.	63.	66.	69.	72.	74.	76.	78.	80.	82.
84.	115.	310.	680.	790.	680.	470.	310.	250.	150.
115.	90.	84.	82.	80.	78.	76.	74.	72.	70.
68.	66.	64.	60.	56.	52.	48.	44.	40.	36.
32.	28.	24.	22.	15.	10.	7.	6.	6.	6.
6.	6.	6.	6.	6.	6.	6.	6.	6.	6.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	790.	90.	72.	72.	6498.
CMS	22.	3.	2.	2.	184.
INCHES		4.17	4.20	4.20	4.20
MM		105.87	106.62	106.62	106.62
AC-FT		44.	45.	45.	45.
THOUS CU M		55.	55.	55.	55.

HYDROGRAPH AT STA A1 FOR PLAN 1, RTIO 3

0.	0.	0.	0.	0.	0.	0.	1.	1.	2.
2.	3.	3.	3.	3.	3.	3.	3.	4.	4.
5.	7.	9.	11.	13.	15.	19.	23.	25.	29.
30.	32.	33.	35.	36.	37.	38.	39.	40.	41.
42.	58.	155.	340.	395.	340.	235.	155.	125.	75.
58.	45.	42.	41.	40.	39.	38.	37.	36.	35.
34.	33.	32.	30.	28.	26.	24.	22.	20.	18.
16.	14.	12.	11.	8.	5.	4.	3.	3.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	395.	45.	36.	36.	3249.
CMS	11.	1.	1.	1.	92.
INCHES		2.08	2.10	2.10	2.10
MM		52.93	53.31	53.31	53.31
AC-FT		22.	22.	22.	22.
THOUS CU M		27.	28.	28.	28.

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SUB-AREA RUNOFF COMPUTATION

DEVELOP INFLOW HYDROGRAPH FOR CRYSTAL LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A2	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	2	.09	0.00	.09	.80	0.000	0	1	0

PRECIP DATA

NP	STORM	DAJ	DAK
72	0.00	0.00	0.00

PRECIP PATTERN

.21	.21	.21	.21	.21	.21	.21	.21	.21	.21
.21	.21	.26	.26	.26	.26	.26	.26	.26	.26
.26	.26	.26	.26	.32	.32	.32	.32	.32	.32
.32	.32	.32	.32	.32	.32	.19	.39	.39	.58
.68	1.65	2.71	1.07	.68	.58	.39	.39	.30	.30
.30	.30	.30	.30	.30	.30	.30	.30	.30	.30
.23	.23	.23	.23	.23	.23	.23	.23	.23	.23
.23	.23								

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	1.00	.10	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .13

RECESSION DATA

STRTQ= -3.00 QRCSN= 0.00 RTIOR= 1.00

TIME INCREMENT TOO LARGE--(NHR IS GT LAG/2)

UNIT HYDROGRAPH to END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .13 VOL= 1.00

114.	254.	184.	79.	46.	16.	7.	3.	2.	0.

O ENDOF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.17	0.00	.17	0.	1.01	3.50	46	.46	.46	.01	575.
1.01	.10	2	.17	0.00	.17	0.	1.01	3.55	47	.31	.30	.01	421.
1.01	.15	3	.17	0.00	.17	0.	1.01	4.00	48	.31	.30	.01	316.
1.01	.20	4	.17	0.00	.17	0.	1.01	4.05	49	.24	.23	.01	250.
1.01	.25	5	.17	0.00	.17	0.	1.01	4.10	50	.24	.23	.01	208.
1.01	.30	6	.17	.02	.15	3.	1.01	4.15	51	.24	.23	.01	181.
1.01	.35	7	.17	.16	.01	24.	1.01	4.20	52	.24	.23	.01	169.
1.01	.40	8	.17	.16	.01	64.	1.01	4.25	53	.24	.23	.01	164.
1.01	.45	9	.17	.16	.01	91.	1.01	4.30	54	.24	.23	.01	162.
1.01	.50	10	.17	.16	.01	103.	1.01	4.35	55	.24	.23	.01	161.
1.01	.55	11	.17	.16	.01	109.	1.01	4.40	56	.24	.23	.01	161.
1.01	1.00	12	.17	.16	.01	111.	1.01	4.45	57	.24	.23	.01	161.
1.01	1.05	13	.20	.20	.01	116.	1.01	4.50	58	.24	.23	.01	161.
1.01	1.10	14	.20	.20	.01	125.	1.01	4.55	59	.24	.23	.01	161.
1.01	1.15	15	.20	.20	.01	132.	1.01	5.00	60	.24	.23	.01	161.
1.01	1.20	16	.20	.20	.01	134.	1.01	5.05	61	.19	.18	.01	155.
1.01	1.25	17	.20	.20	.01	136.	1.01	5.10	62	.19	.18	.01	142.
1.01	1.30	18	.20	.20	.01	136.	1.01	5.15	63	.19	.18	.01	132.
1.01	1.35	19	.20	.20	.01	136.	1.01	5.20	64	.19	.18	.01	128.
1.01	1.40	20	.20	.20	.01	137.	1.01	5.25	65	.19	.18	.01	126.
1.01	1.45	21	.20	.20	.01	137.	1.01	5.30	66	.19	.18	.01	126.
1.01	1.50	22	.20	.20	.01	137.	1.01	5.35	67	.19	.18	.01	125.
1.01	1.55	23	.20	.20	.01	137.	1.01	5.40	68	.19	.18	.01	125.
1.01	2.00	24	.20	.20	.01	137.	1.01	5.45	69	.19	.18	.01	125.
1.01	2.05	25	.26	.25	.01	142.	1.01	5.50	70	.19	.18	.01	125.
1.01	2.10	26	.26	.25	.01	155.	1.01	5.55	71	.19	.18	.01	125.
1.01	2.15	27	.26	.25	.01	165.	1.01	6.00	72	.19	.18	.01	125.
1.01	2.20	28	.26	.25	.01	169.	1.01	6.05	73	0.00	0.00	0.00	105.
1.01	2.25	29	.26	.25	.01	171.	1.01	6.10	74	0.00	0.00	0.00	59.
1.01	2.30	30	.26	.25	.01	172.	1.01	6.15	75	0.00	0.00	0.00	26.
1.01	2.35	31	.26	.25	.01	172.	1.01	6.20	76	0.00	0.00	0.00	12.
1.01	2.40	32	.26	.25	.01	172.	1.01	6.25	77	0.00	0.00	0.00	6.
1.01	2.45	33	.26	.25	.01	172.	1.01	6.30	78	0.00	0.00	0.00	3.
1.01	2.50	34	.26	.25	.01	172.	1.01	6.35	79	0.00	0.00	0.00	1.
1.01	2.55	35	.26	.25	.01	172.	1.01	6.40	80	0.00	0.00	0.00	1.
1.01	3.00	36	.26	.25	.01	172.	1.01	6.45	81	0.00	0.00	0.00	0.
1.01	3.05	37	.16	.15	.01	161.	1.01	6.50	82	0.00	0.00	0.00	0.
1.01	3.10	38	.31	.30	.01	153.	1.01	6.55	83	0.00	0.00	0.00	0.
1.01	3.15	39	.31	.30	.01	174.	1.01	7.00	84	0.00	0.00	0.00	0.
1.01	3.20	40	.46	.46	.01	212.	1.01	7.05	85	0.00	0.00	0.00	0.
1.01	3.25	41	.54	.53	.01	269.	1.01	7.10	86	0.00	0.00	0.00	0.
1.01	3.30	42	1.32	1.31	.01	410.	1.01	7.15	87	0.00	0.00	0.00	0.
1.01	3.35	43	2.17	2.16	.01	732.	1.01	7.20	88	0.00	0.00	0.00	0.
1.01	3.40	44	.85	.84	.01	954.	1.01	7.25	89	0.00	0.00	0.00	0.
1.01	3.45	45	.54	.53	.01	808.	1.01	7.30	90	0.00	0.00	0.00	0.
									SUM	20.41	18.86	1.55	13166.
										(519.)(	479.)(	39.)(	372.82)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	954.	183.	146.	146.	13164.
CMS	27.	5.	4.	4.	373.
INCHES		18.89	18.90	18.90	18.90
MM		479.70	480.00	480.00	480.00
AC-FT		91.	91.	91.	91.
THOUS CU M		112.	112.	112.	112.

HYDROGRAPH AT STA A2 FOR PLAN 1, RTIO 3

0.	0.	0.	0.	0.	1.	12.	32.	46.	52.
54.	56.	58.	63.	66.	67.	68.	68.	68.	68.
68.	68.	68.	68.	71.	78.	82.	84.	85.	86.
86.	86.	86.	86.	86.	86.	80.	77.	87.	106.
135.	205.	366.	477.	404.	288.	211.	158.	125.	103.
90.	84.	82.	81.	80.	80.	80.	80.	80.	80.
77.	71.	66.	64.	63.	63.	63.	62.	62.	62.
62.	62.	52.	30.	13.	6.	3.	1.	1.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	477.	91.	73.	73.	6582.
CMS	14.	3.	2.	2.	186.
INCHES		9.44	9.45	9.45	9.45
MM		239.85	240.00	240.00	240.00
AC-FT		45.	45.	45.	45.
THOUS CU M		56.	56.	56.	56.

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COMBINE HYDROGRAPHS

DEVELOP COMBINE INFLOW HYDROGRAPH FOR CRYSTAL LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A3	2	0	0	0	0	1	0	0

SUM OF 2 HYDROGRAPHS AT A3 PLAN 1 RTIO 1

0.	0.	0.	0.	0.	0.	2.	6.	9.	11.
11.	12.	12.	13.	14.	14.	14.	14.	14.	14.
15.	15.	15.	16.	17.	19.	20.	21.	22.	23.
23.	24.	24.	24.	24.	25.	24.	23.	25.	29.
35.	52.	104.	163.	160.	126.	89.	63.	50.	36.
30.	26.	25.	24.	24.	24.	24.	23.	23.	23.
22.	21.	20.	19.	18.	18.	17.	17.	16.	16.
16.	15.	13.	8.	4.	2.	1.	1.	1.	1.
1.	1.	1.	1.	1.	1.	1.	1.	1.	1.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	163.	27.	22.	22.	1966.
CMS	5.	1.	1.	1.	56.
INCHES		.87	.88	.88	.88
MM		22.16	22.25	22.25	22.25
AC-FT		13.	14.	14.	14.
THOUS CU M		17.	17.	17.	17.

SUM OF 2 HYDROGRAPHS AT A3 PLAN 1 RTIO 3

0.	0.	0.	0.	0.	1.	12.	32.	47.	53.
54.	58.	61.	64.	69.	70.	71.	71.	72.	72.
73.	75.	77.	79.	84.	93.	101.	107.	110.	113.
116.	118.	119.	121.	122.	123.	118.	116.	127.	147.
177.	262.	521.	817.	799.	628.	446.	313.	250.	178.
148.	129.	124.	122.	120.	119.	118.	117.	116.	115.
111.	104.	98.	94.	91.	89.	87.	84.	82.	80.
78.	76.	64.	41.	21.	11.	6.	4.	4.	3.
3.	3.	3.	3.	3.	3.	3.	3.	3.	3.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	817.	136.	109.	109.	9831.
CMS	23.	4.	3.	3.	278.
INCHES		4.36	4.38	4.38	4.38
MM		110.79	111.25	111.25	111.25
AC-FT		67.	68.	68.	68.
THOUS CU M		83.	84.	84.	84.

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HYDROGRAPH ROUTING

OVERTOPPING ANALYSIS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
A4	1	0	0	0	0	1	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	TSK	STORA	ISPRAT
0	0	0	0.000	0.000	0.000	-535.	-1

STAGE	535.10	535.20	535.40	535.60	535.80	536.00	536.20	536.40	536.60	536.80
	537.00	537.50	538.00	539.00	540.00					
FLOW	0.00	.25	1.30	2.78	4.61	6.70	23.00	72.00	164.00	308.00
	456.00	985.00	1750.00	3650.00	6280.00					
CAPACITY=	116.	125.	135.	146.	168.	178.	199.	211.		
ELEVATION=	535.	536.	536.	537.	538.	539.	539.	540.		

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
535.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
536.0	0.0	0.0	0.

STATION A4, PLAN 1, RATIO 3

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	1.	1.	2.	2.
2.	2.	2.	3.	3.	3.	3.	4.	4.	4.
4.	5.	5.	5.	6.	6.	7.	9.	12.	15.
20.	30.	60.	143.	264.	350.	386.	385.	365.	335.
302.	271.	244.	221.	202.	186.	174.	163.	157.	151.
145.	140.	134.	129.	123.	119.	114.	110.	106.	103.
99.	96.	92.	86.	78.	70.	65.	61.	56.	52.
48.	44.	41.	38.	35.	33.	30.	28.	26.	24.

STORAGE

118.	118.	118.	118.	118.	118.	118.	118.	118.	119.
119.	119.	120.	120.	121.	121.	121.	122.	122.	123.
123.	124.	124.	125.	125.	126.	127.	127.	128.	129.
130.	130.	131.	132.	133.	134.	134.	135.	136.	137.
138.	139.	141.	145.	149.	152.	153.	153.	153.	152.
151.	150.	149.	148.	147.	147.	147.	146.	146.	146.
145.	145.	145.	145.	144.	144.	144.	144.	144.	144.
143.	143.	143.	143.	143.	142.	142.	141.	141.	141.
140.	140.	140.	140.	139.	139.	139.	139.	139.	139.

STAGE

535.2	535.2	535.2	535.2	535.2	535.2	535.2	535.2	535.2	535.2
535.3	535.3	535.3	535.3	535.3	535.4	535.4	535.4	535.4	535.5
535.5	535.5	535.5	535.6	535.6	535.6	535.7	535.7	535.7	535.7
535.8	535.8	535.9	535.9	535.9	536.0	536.0	536.0	536.1	536.1
536.2	536.2	536.4	536.6	536.7	536.7	536.9	536.9	536.9	536.8
536.8	536.7	536.7	536.7	536.7	536.6	536.6	536.6	536.6	536.6
536.6	536.5	536.5	536.5	536.5	536.5	536.5	536.5	536.5	536.5
536.5	536.5	536.4	536.4	536.4	536.4	536.4	536.4	536.3	536.3
536.3	536.3	536.3	536.3	536.2	536.2	536.2	536.2	536.2	536.2

PEAK OUTFLOW IS 386. AT TIME 3.92 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	386.	95.	76.	76.	6840.
CMS	11.	3.	2.	2.	194.
INCHES		3.04	3.05	3.05	3.05
MM		77.28	77.40	77.40	77.40
AC-FT		47.	47.	47.	47.
THOUS CU M		58.	58.	58.	58.

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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .25	RATIO 3 .50	RATIO 4 1.00
HYDROGRAPH AT	A1	.20	1	79.	198.	395.	790.
		(.52)	(	2.24)(	5.59)(	11.19)(	22.37)(
HYDROGRAPH AT	A2	.09	1	95.	239.	477.	954.
		(.23)	(	2.70)(	6.75)(	13.51)(	27.02)(
2 COMBINED	A3	.29	1	163.	409.	817.	1634.
		(.75)	(	4.63)(	11.57)(	23.14)(	46.27)(
ROUTED TO	A4	.29	1	5.	59.	386.	1047.
		(.75)	(	.13)(	1.66)(	10.93)(	29.66)(

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	535.20	535.10	536.00
STORAGE	118.	116.	135.
OUTFLOW	0.	0.	7.

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
.10	535.80	0.00	130.	5.	0.00	6.25	0.00
.25	536.35	.35	141.	59.	3.83	4.83	0.00
.50	536.91	.91	153.	386.	4.42	3.92	0.00
1.00	537.54	1.54	168.	1047.	5.33	3.92	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
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APPENDIX 4

REFERENCES

CRYSTAL LAKE DAM

APPENDIX 4

REFERENCES

CRYSTAL LAKE DAM

1. U.S. Army Corps of Engineers, Hydrologic Engineering Center, "Flood Hydrograph Package (HEC-1) for Dam Safety Inspections - User's Manual," Davis, California, September 1978.

2. Brater, Ernest F. and King, Horace, Handbook of Hydraulics, Sixth Edition, McGraw-Hill, New York, 1976.

3. U.S. Bureau of Public Roads, "Design Charts for Open Channel Flow," October 1960.

4. Reference Data, Dams in New Jersey, No. 25-70 from New Jersey Department of Environmental Protection files, dated November 7, 1928.

5. Department of the Army, Philadelphia District, Corps of Engineers, Pennsylvania 19106. Birchwood Lake Dam - Phase I Inspection Report, National Dam Safety Program, August 1979.