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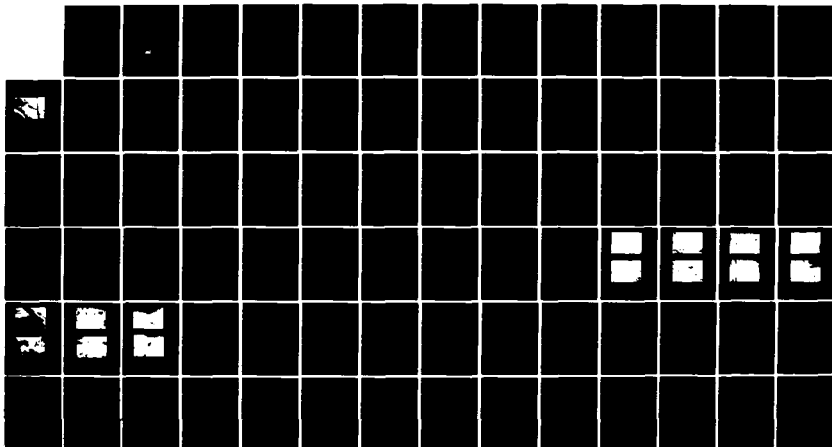
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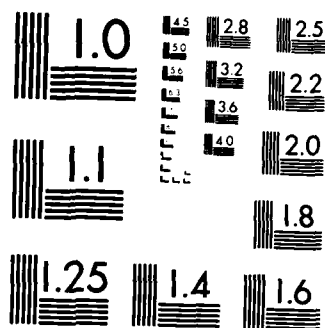
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CONNECTICUT RIVER BASIN
LEBANON, NEW HAMPSHIRE

GLEN ROAD DAM
NH 00159

STATE NO 134.12

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

FEBRUARY 1979

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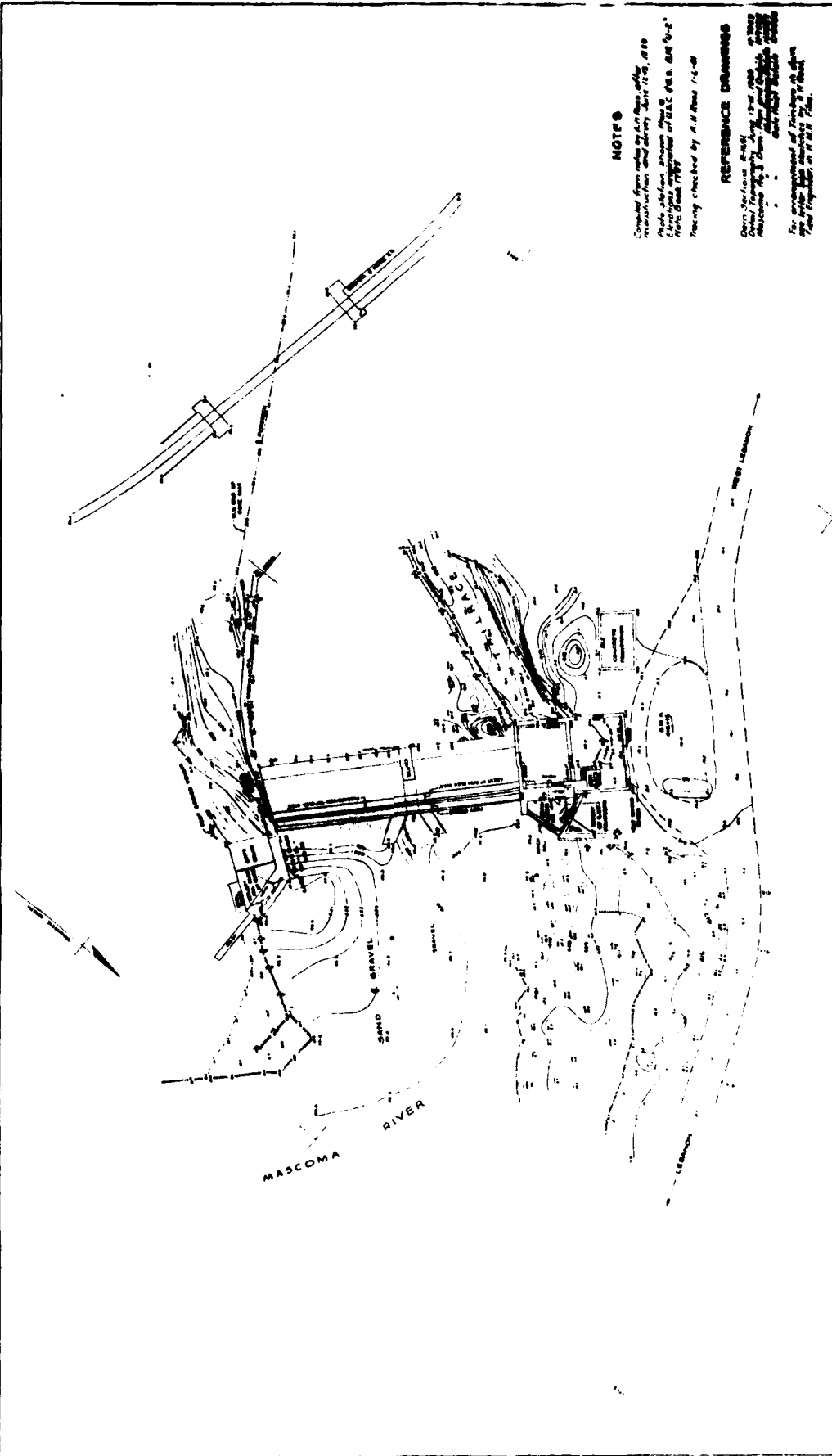
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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00159	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Glen Road Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS		8. CONTRACT OR GRANT NUMBER(s)
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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18. SUPPLEMENTARY NOTES Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Connecticut River Basin Lebanon, New Hampshire Mascoma River		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam has a hydraulic height of 22 ft. with a length of 175 ft. The dam is in poor condition and there are various major concerns which must be corrected. It is small in size with a significant hazard potential classification.		

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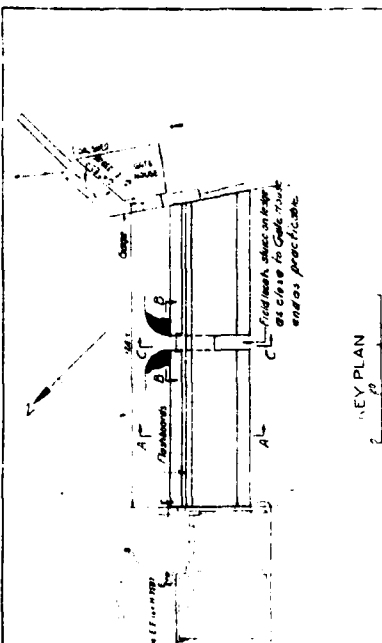
NOTES

Completed from notes by A.H. Shaw, after
reconstruction, and dated June 14, 1910.
Paved abutment shown. Dam No. 3
Lebanon Dam, 1910.
Drawing checked by A.H. Shaw 1-1-10

REFERENCE DRAWINGS

Gen. Section, Dam
Gen. Elevation, July 1910
Mascoma No. 3 Dam
Mascoma No. 3 Dam
For arrangement of drawings of dam
see before plan showing by A.H. Shaw
and prepared by A.H. Shaw

NEW ENGLAND POWER SERVICE COMPANY INCORPORATED IN MASSACHUSETTS
MASCOMA RIVER DAM NO. 3 LEBANON, N.H.
SEALING M. L. LAFITTE, CIVIL ENGINEER

[illegible]

KEY PLAN

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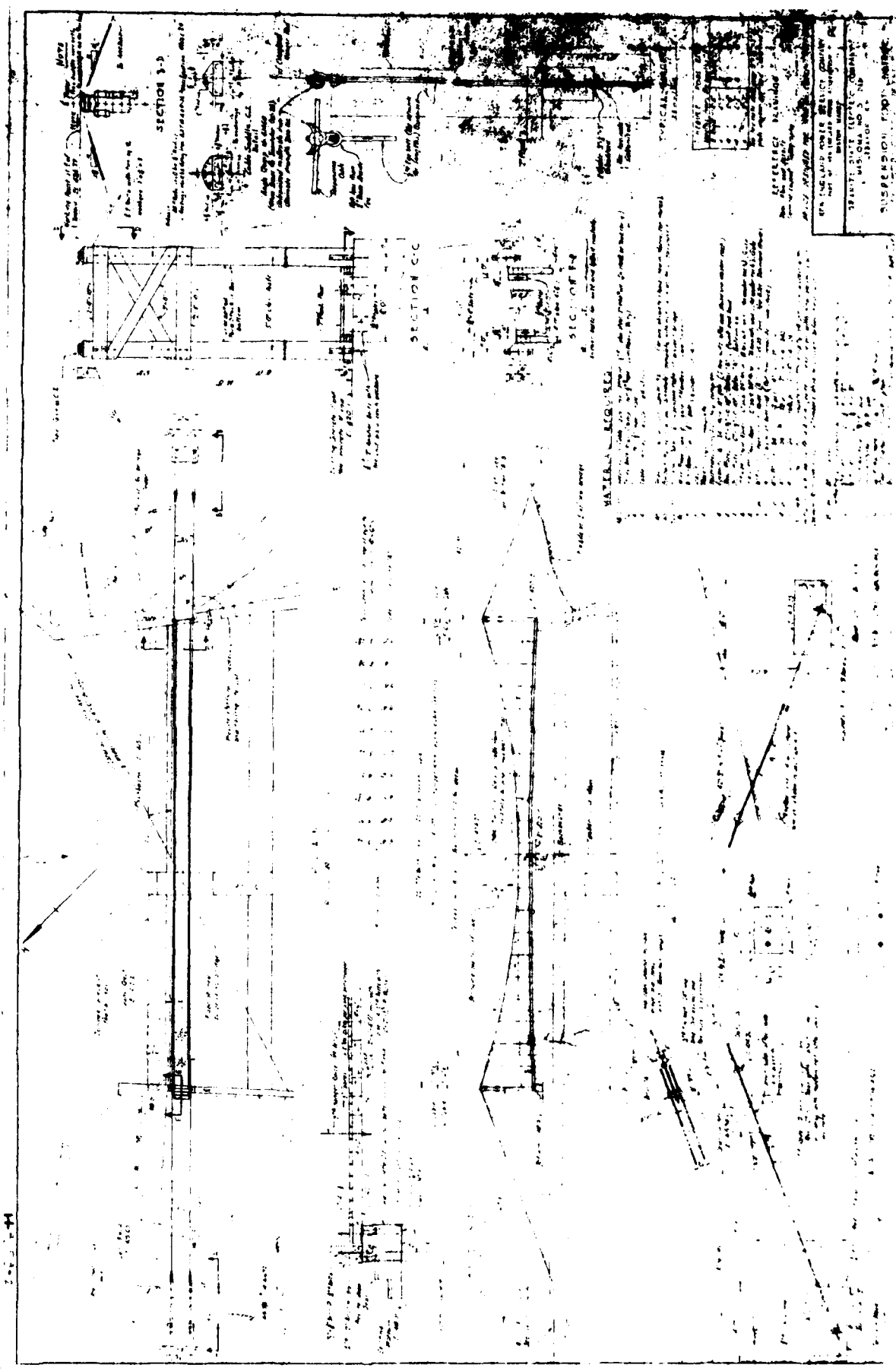
Notes

1. The first of these is the fact that the
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 3. growth in the United States, and this
 4. was reflected in the increase in the
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 6. in the manufacturing sector. This was
 7. due to a number of factors, including
 8. the fact that the United States was
 9. the only major industrial power in
 10. the world at the time, and the fact
 11. that the United States was the only
 12. major industrial power in the world
 13. that was not a member of the British
 14. Commonwealth. This was due to the
 15. fact that the United States was the
 16. only major industrial power in the
 17. world that was not a member of the
 18. British Commonwealth. This was due
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A ... FUEL AND POWER SERVICES COMPANY

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SUSPENSION FOOT BRIDGE
 DRAWING NO. 1
 DATE 10/1/50
 BY J. H. B.

100

2. **THE STATE OF TEXAS, COUNTY OF DALLAS, ss. I, _____, a Notary Public in and for said County and State, do hereby certify that the foregoing is a true and correct copy of the original of the same as the same appears from the records of said County.**



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Distribution For	
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Dear Governor Gallen:

I am forwarding to you a copy of the Glen Road Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, City of Lebanon, 51 North Park, Engineering Department, Lebanon, New Hampshire 03766.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Water Resources Board for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: NH00159
Name of Dam: Glen Road Dam
City: City of Lebanon
County and State: Grafton County, New Hampshire
River: Mascoma River
Date of Inspection: November 9, 1978

BRIEF ASSESSMENT

Glen Road Dam, also known as Mascoma Dam No. 3, has a hydraulic height of 22 feet, is 175 feet in length, and 5 feet wide at the crest. It is a run-of-the-river timber-crib dam, with crest faced on upstream and downstream sides with plank decking. The northwest abutment consists of two gated 6'5" diameter conduits with operable lift mechanisms. A 6-foot low-flow sluiceway, centrally located in the spillway, has had the gate lift mechanism removed. The southeast abutment gatehouse is inoperable. The dam spans a reach of the Mascoma River, and is located in west-central New Hampshire. Maximum storage capacity is about 60 acre-feet. The pond is 0.2 miles in length with a surface area of about 3.5 acres.

The dam is in poor condition. Major concerns are: the deteriorated planking on the upstream face and crest, and absence of much of the decking downstream; absence of and the deteriorated condition of structural timbers; eroded or displaced rockfill on downstream side; large leakage and/or seepage along downstream toe, around sluiceway, and between spillway and gate structure; and silt accumulation upstream of and on the dam.

Based on small size and significant hazard potential classifications in accordance with Corps guidelines, the test flood is $\frac{1}{2}$ Probable Maximum Flood (PMF). A test flood outflow of 15,825 cfs (82 csm) would overtop the dam by 2.8 feet (9.7 feet over spillway crest). The spillway, if it remained in place, would pass 8,470 cfs or about 54 percent of the test flood. A major breach at top of dam would probably result in the loss of no lives but could conceivably cause significant property damage.

The owner, the City of Lebanon, should implement the results of the recommendations and remedial measures given in Sections 7.2 and 7.3 respectively, within one year after receipt of this Phase I inspection report.

Warren A. Guinan
Warren A. Guinan
Project Manager
N.H. P.E. 2339

This Phase I Inspection Report on Glen Road Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

Joseph W. Finegan
JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian
CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy
JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar
JOE B. FRYAR
Chief, Engineering Division

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. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

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. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide 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.

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Figure 1 - Overview of Glen Road Dam.



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Anderson-Nichols & Co., Inc.		U.S. ARMY ENGINEER DIV. NEW ENGLAND	
CONCORD		CORPS OF ENGINEERS	
NEW HAMPSHIRE		WALTHAM, MASS.	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
GLEN ROAD DAM			
LOCATION MAP			
MASCOMA RIVER		NEW HAMPSHIRE	
			SCALE: SEE BAR SCALE
			DATE: FEBRUARY 1979

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
GLEN ROAD DAM

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 New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0009 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) To perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) To encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) To update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Glen Road Dam (Mascoma Dam No. 3) is located in the City of Lebanon, New Hampshire. The dam is a run-of-the-river dam spanning the Mascoma River, a major tributary of the Connecticut River. After discharging over the dam, the Mascoma River flows south then westerly for a distance of 1.5 miles before becoming confluent with the Connecticut River. The dam is shown on U.S.G.S. Quadrangle, Hanover, Vermont - New Hampshire with coordinates approximately at N 43° 38' 06", W 72° 18' 18", Grafton County, New Hampshire. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Glen Road Dam is a rock-filled timber-crib run-of-the-river dam, with a hydraulic height of 22 feet, and 175 feet long. The spillway is 123 feet long placed between two concrete abutments. As originally constructed, the dam has a plank facing on the upstream face, crest, and downstream face. The northwest abutment structure served as the foundation to a power plant. Two headgates control two 6'5" diameter conduits that discharge into the former tailrace. The gates are manually operated with control mechanisms located directly above each gate. The southeast abutment structure served as the inlet works to a penstock to supply a power plant farther downstream. The gates are manually operated with control mechanisms located directly above each gate, but are now inoperable. Access to the gatehouse on the southeast side of the dam from Glen Road is by a suspension foot bridge above the spillway of the dam. At the center of the dam there is a 6-foot sluiceway with discharge controlled by a 6.5'W x 8.5'H timber gate. The lifting mechanism for this gate has been removed.

c. Size Classification. Small (hydraulic height - 22 feet; storage - 60 acre-feet) based on storage (≥ 50 to < 1000 acre-feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant Hazard. A major breach in the dam would probably result in no loss of life but could cause appreciable property damage. (See Section 5.1 f.)

e. Ownership. The earliest recorded ownership was the Grafton County Electric Light and Power Company, in 1930. Ownership was transferred to the Granite State Electric Company between 1935 and 1937 and then transferred again to the City of Lebanon sometime after 1963.

f. Operator. The current owner and operator of the dam is the City of Lebanon, New Hampshire, Engineering Department, 51 North Park. Phone: (603) 448-4220.

g. Purpose of Dam. The dam was originally constructed to provide storage to produce electricity from a power plant located at the dam. This use was discontinued prior to 1930. From that time on the dam provided water for plant No. 4 which was located about one mile downstream. A penstock led directly to the No. 4 plant. The dam and penstock is now abandoned.

h. Design and Construction History. The original dam was constructed prior to 1930. It was reconstructed in 1940 by the New England Power Service Company for the Granite State Electric Company. A full set of plans of the new dam

were found on file at the New Hampshire Water Resources Board (NHWRB). (See Appendix C.)

i. Normal Operational Procedures. No operational procedures or maintenance are being done at this time.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 193 square miles (123,520 acres) of predominantly wooded terrain.

b. Discharge at Damsite

(1) Outlet Works (conduits) - Two 6'5" diameter conduits @ invert elevation 402' MSL. Combined capacity at top of dam - 1540 cfs @ 419' MSL. Sluice gate not operable. Penstock at gatehouse on southeast abutment not operable.

(2) The maximum discharge at damsite - a U.S.G.S. gaging station with a drainage area of 153 square miles is located on the Mascoma River near Mascoma, New Hampshire. A maximum discharge of 5840 cfs was recorded at this gaging station during the March 1936 flood. Using this figure, the maximum discharge at damsite can be interpolated to be about 6,950 cfs.

(3) Ungated spillway capacity @ top of dam - 8,470 cfs @ 419.0' MSL

(4) Ungated spillway capacity @ test flood elevation - 14,120 cfs @ 421.8' MSL

(5) Gated spillway capacity @ top of dam elevation - not applicable

(6) Gated spillway capacity @ test flood elevation - not applicable

(7) Total spillway capacity @ test flood elevation - 14,120 cfs @ 421.8' MSL

(8) Total project discharge @ test flood elevation - 15,825 cfs @ 421.8' MSL

c. Elevation (feet above MSL based on elevation from dam plans on southeast abutment at elevation 420.11' MSL.)

(1) Streambed at centerline of dam - 396.8 (at downstream toe)

(2) Maximum tailwater - with an estimated maximum discharge of 6,950 cfs during the March 1936 flood, maximum tailwater could be estimated to have been 403' MSL.

- (3) Upstream invert low-level outlets - 402.0
- (4) Recreation pool - not applicable
- (5) Full flood control pool - not applicable
- (6) Spillway crest - 412.1
- (7) Design surcharge (Original Design) - unknown
- (8) Top of dam - 419.0
- (9) Test flood pool - 421.8

d. Reservoir (miles)

- (1) Length of maximum pool - 0.4
- (2) Length of pool at spillway crest - 0.2
- (3) Length of flood control pool - not applicable

e. Storage (acre-feet)

- (1) Recreation pool - not applicable
- (2) Flood control pool - not applicable
- (3) Spillway crest pool - 30 (approximate)
- (4) Top of dam - 60 (approximate)
- (5) Test flood pool - 76 (approximate)

f. Reservoir Surface (acres)

- (1) Recreation pool - not applicable
- (2) Flood control pool - not applicable
- (3) Spillway crest - 3.5 (approximate)
- (4) Test flood pool - 6.5 (approximate)
- (5) Top of dam - 5.6 (approximate)

g. Dam

(1) Type - rock-filled timber crib between two vertical concrete walls; available records indicate that dam is founded partly on "ledge" and partly on "gravel".

(2) Length - 175'

(3) Height - 23' (structural height)

(4) Topwidth - 5'

(5) Zoning - not applicable

(6) Impervious core - not applicable

(7) Cutoff - unknown

(8) Grout curtain - unknown

h. Diversion and Regulating Tunnel. Not applicable.
(See j. below)

i. Spillway

(1) Type - timber-crib run-of-the-river

(2) Length of weir - 123'

(3) Crest elevation - 412.1' MSL

(4) Gates - One 6.5' x 8.5' sluice gate at the center of the spillway which controls discharge into a 6-foot sluiceway. The lifting mechanism has been removed and the gate is in the closed position. The only discharge through the sluice is leakage.

(5) U/S Channel - Mascoma River - The channel bottom upstream is covered with silt. The south bank of the channel is heavily covered with trees. The north bank of the channel immediately upstream is lightly covered with brush.

(6) D/S Channel - The channel downstream of the dam is generally wide and unobstructed. The channel bottom is in bedrock and contains many large boulders. A railroad bridge, with no center pier and with abutments well back onto the sides of the valley, is located a few hundred feet downstream of the dam. The Mascoma River discharges into the Connecticut River slightly over 1.5 miles downstream of Glen Road Dam. Located along this reach is a large shopping mall.

(7) General - 4-foot wide suspension access bridge over spillway.

j. Regulating Outlets. No gates are in operation at the present time. The two gates at the southeast abutment gatehouse are closed and the lifting devices are inoperable. These gates were the inlets to a surge tank for a penstock to power station No. 4. At the northwest abutment one of the two gates which controls two 6-foot, 5-inch diameter conduits is partially open but both are jammed with timber and other debris. The lifting mechanisms appear to be operable.

SECTION 2
ENGINEERING DATA

2.1 Design

No engineering design data were disclosed for Glen Road Dam.

2.2 Construction

The reconstruction plans of Glen Road Dam in 1940 by the New England Power Service Company for the Granite State Electric Company are the only construction data that were available.

2.3 Operation

No engineering operational data were disclosed.

2.4 Evaluation

a. Availability. A search of the files of the NHWRB and contact with the owner revealed only a limited amount of recorded information. Reconstruction plans were found in the files of the NHWRB.

b. Adequacy. The final assessments and recommendations of this investigation are based on the visual inspection and the hydrologic and hydraulic calculations in conjunction with the available 1940 reconstruction plans.

c. Validity. The dimensions on the existing plans were consistent with what was seen at the time of the inspection.

SECTION 3. VISUAL INSPECTION

3.1 Findings

a. General. Glen Road Dam is a low, run-of-the-river dam which impounds a reservoir of small size. At the time of the inspection, the water level in the reservoir was about 2 feet below the crest of the dam, and the entire flow of the river was leaking through the dam and gates. The downstream face of the dam was dry and accessible for inspection. Both abutments were also accessible for inspection.

b. Dam. Glen Road Dam is a rock-filled timber-crib structure, about 23 feet high, 5 feet wide at the crest, and 175 feet long. (See Appendix C - Figure 2.) As originally constructed, the dam had a plank facing on the upstream face, crest, and downstream face. The plank facing which is visible above water level on the upstream face is badly deteriorated. (See Appendix C - Figures 3 and 4.) At one location there is a small whirlpool, which is presumably evidence of a large concentrated leak through the upstream plank facing. The planks on the crest of the dam are also badly deteriorated. Most of the plank facing on the downstream face is missing, and a few remnants are very badly deteriorated. Several pieces of the timber-crib structure are also missing, and the remnants that are still in place and visible are badly deteriorated. Significant quantities of the rockfill have also been washed out from the downstream side of the crib. (See Appendix C - Figures 5 and 6.) The individual pieces of rockfill are about 1 to 2 feet in size.

Substantial quantities of leakage and/or seepage are discharging from the downstream toe of the dam along its entire length. At some locations the noise of water cascading down through the rockfill can be heard. The greatest concentration of leakage is adjacent to the low-level, gated sluice near the center of the dam. (See Appendix C - Figures 2 and 5.) It was not possible to determine from the visual inspection whether the leakage at the sluice was taking place primarily through the gate itself or through the zone immediately around the sluice. There are also concentrations of leakage, but of much smaller magnitude, adjacent to each of the gate structures at the ends of the dam.

The northwest end of the dam appears to be founded on bedrock which is visible at the downstream toe of the dam. At the southeast end of the dam, sand, gravel, and boulders are visible at the downstream toe. These observations are

consistent with the comment in a questionnaire dated June 12, 1935 (prior to renovation of the dam in 1940) to the effect that the dam was founded on "ledge at north end, probably gravel at the south end."

A number of logs have washed over the dam and are lodged on the downstream face near the north abutment. (See Appendix C - Figure 6.)

A large amount of debris is lodged against the intake structure on the northwest end of the dam substantially restricting the flow. (See Appendix C - Figure 7.) Silt has accumulated in the reservoir to an elevation several feet below the crest of the dam.

A concrete gate structure is located at either end of the dam. (See Appendix C - Figures 8 and 9.) No evidence of seepage through the abutments was noted around the ends of the concrete gate structures, although as mentioned above, evidence of concentrated leakage was visible at the contacts between the dam and the two gate structures.

c. Appurtenant Structures

(1) Northwest Abutment Gate Structure. The existing northwest abutment gate structure served as the foundation for a power plant. Visual inspection of the existing concrete structure indicates that the concrete is deteriorated. (See Appendix C - Figure 10.) Numerous areas have spalled and the downstream face of the structure shows efflorescence. The concrete training walls have numerous cracks and general areas of spalling. The visible portion of the wooden gates is deteriorated and the downstream ends of the steel draft tubes are badly corroded. (See Appendix C - Figure 11.) The remaining mechanical gate operating mechanisms appear in fair condition with minimal deterioration. (See Appendix C - Figure 12.) Although the two gates are in the open position, wood and other debris has collected in front of the gate openings and substantially obstructs flow.

(2) Southeast Abutment Gate Structure. The existing southeast abutment gate structure served as the inlet works to a penstock supplying a power plant farther downstream. (See Appendix C - Figure 9.) Visual inspection of the structure revealed the concrete below the first floor level is spalled and cracked in numerous areas. The upstream face of the concrete and gates has been silted to within two feet of the dam crest. The wood-frame building has also deteriorated and has been vandalized.

The interior of the structure was not inspected because of the presence of septic sewage odors. The hand operated gate mechanism which is still intact is in fair condition. The exposed portion of the concrete penstock downstream of the gate structure was observed to be in fair condition with limited surface spalling.

(3) Service Bridge. The cable-suspended walk bridge over the dam was observed to be fair condition. (See Appendix C - Figure 13.) The main suspension cable was observed to be corroded on the surface. The deck of the walkway is constructed of treated wood plank. Some evidence of deterioration was observed in the wood decking. It was also noted that the south end of the suspension bridge deck was loose from the bearing pad. At the time of inspection, entrance to the bridge from the northwest abutment was boarded up, preventing free access to the bridge.

d. Reservoir Area. The drainage area above the dam is rolling terrain. The lower elevations are generally clear and the higher elevations are generally forested. Upstream of Glen Road Dam are several dams; the nearest one is about one-half mile upstream. The reservoir is silted up to about 2 feet below the crest of the dam on the southeast side; siltation is much lower on the northwest side. (See Appendix C - Figure 14.)

e. Downstream Channel. The channel downstream of the dam is generally broad and unobstructed. (See Appendix C - Figure 15.) The channel bottom consists primarily of bedrock and boulders, with some sand and gravel. A railroad bridge, with no center pier and with abutments well back onto the sides of the valley, is located a few hundred feet downstream of the dam. The Mascoma River discharges into the Connecticut River slightly over 1.5 miles downstream of Glen Road Dam.

3.2 Evaluation

Based on the visual inspection, Glen Road Dam is considered to be in poor condition. The timber-crib and the rockfill in the crib are so badly deteriorated and eroded that the dam could wash out under floodflow conditions. If the dam does wash out, the quantity of water that will be released is relatively small, because of the silt in the reservoir. A large volume of silt might be carried downstream over a period of months or years. The silt itself may contain pollutants, if any were dumped in the river in years past. Pollutants could cause environmental damage downstream if the dam were breached, either accidentally or deliberately.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

No operational procedures have been followed for the Glen Road Dam as it has essentially been abandoned.

4.2 Maintenance of Dam

The City of Lebanon is responsible for the maintenance of Glen Road Dam. At the present time nothing is being done to maintain the dam.

4.3 Maintenance of Operating Facilities

At the present time no maintenance is being performed on the operating facilities.

4.4 Description of Any Warning System in Effect

No warning system was disclosed for the Glen Road Dam.

4.5 Evaluation

Because of the poor condition of the dam, the present assessment reflects major problems that are not amenable to simple operating and maintenance procedures.

SECTION 5.
HYDROLOGY AND HYDRAULIC ANALYSIS

5.1 Evaluation of Features

a. Design Data. No original hydrologic and hydraulic design data were found for the Glen Road Dam.

b. Experience Data. No information regarding past overtopping failure was found.

c. Visual Observations. At the time of inspection, visible evidence of damage to the dam was noted. The damage appears to have occurred over a long period of time by the normal flow conditions throughout the years and probably not by excessive discharges.

d. Test Flood Analysis. Glen Road Dam is classified as being small in size having a maximum storage of 60 acre-feet and a hydraulic height of 22 feet. Using the Recommended Guidelines for Safety Inspection of Dams, the test flood was determined to be $\frac{1}{2}$ the Probable Maximum Flood (PMF). Using $\frac{1}{2}$ PMF, the test flood discharge for Glen Road Dam, having a drainage area of 193 square miles, was determined to be 15,826 cfs. The overtopping analysis indicates that the dam during the test flood would be overtopped by 2.7 feet (9.7 feet over the spillway crest). The spillway capacity at top of dam is 8,470 cfs which is 54 percent of the test flood discharge.

e. Dam Failure Analysis. To determine the hazard classification for the Glen Road Dam the impact of failure of the dam at normal pool was assessed using Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered the reach extending from the dam to the shopping center, a distance of approximately 1.0 mile. A breach at Glen Road Dam under normal flow conditions would result in an increase in stage of about 1 foot at this shopping center above the 2-foot antecedent stage. An increase in water depth and a release of channel clogging debris consisting of timbers and rock from the dam, would probably not cause loss of life, but could result in significant property damage to the shopping center, Boston and Maine Railroad bridge and Route 12A bridge. As a result of this analysis, Glen Road Dam was classified - Significant Hazard.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The following visual observations indicate Glen Road Dam is not in stable condition:

- (1) Deterioration of planking on upstream face and crest of dam.
- (2) Presence of a small whirlpool above the upstream face, which indicates a large concentrated leak through the plank facing.
- (3) Absence of plank facing over most of the downstream face and severe deterioration of the plank facing that remains.
- (4) Absence of several timbers from the timber-crib structure and severe deterioration of the timbers that are exposed on the downstream face.
- (5) Erosion of rockfill on downstream side of dam.
- (6) Large leakage and/or seepage discharge along the downstream toe of the dam, with a large concentration of flow adjacent to the low-level sluice outlet near the center of the dam, and minor concentrations of flow at the ends of the dam adjacent to the gate structures.

In addition, a large amount of debris has accumulated behind the trash racks in the gate structure at the northwest abutment, and both of the gates at the northwest abutment are plugged with logs and other debris.

b. Design and Construction Data. Drawings are available showing the layout of the dam and the cross-section of the rock-filled timber-crib. The following statement was found in available records: "Where the new cribbing is to be laid on bedrock the holes will be drilled in the ledge to provide a means of pinning the cribbing." No other design and construction data are available.

c. Operating Records. Available records indicate that the reservoir was drained and the area immediately upstream of the dam was dredged in 1960. No other operating records pertinent to the structural stability of the dam were disclosed.

d. Post-Construction Changes. No records were disclosed of changes to the dam after its reconstruction in 1940.

e. Seismic Stability. This dam is in Seismic Zone 2 and in accordance with recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS & REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Glen Road Dam is in poor condition. The principal concerns with respect to the integrity of the dam are:

- (1) Deterioration of plank facing on upstream face and crest of dam.
- (2) Presence of a small whirlpool above the upstream face, which indicates a large concentrated leak through the plank facing.
- (3) Absence of plank facing over most of the downstream face and severe deterioration of the plank facing that remains.
- (4) Absence of several timbers from the timber-crib structure and severe deterioration of the timbers that are exposed on the downstream face.
- (5) Erosion of rockfill on downstream side of dam.
- (6) Large leakage and/or seepage discharge along the downstream toe of the dam, with a large concentration of flow adjacent to the low-level sluice outlet near the center of the dam, and minor concentrations of flow at the ends of the dam adjacent to the gate structures.

Also, the silt that has accumulated in the reservoir below the crest of the dam may or may not contain pollutants that would cause environmental damage downstream if the dam failed. The southeast abutment gatehouse is open to trespass and is potentially hazardous.

b. Adequacy of Information. The information available is such that the assessment of the dam must be based primarily on the visual inspection. The visual inspection is adequate to determine the condition of the dam.

c. Urgency. The recommendations and remedial measures made in 7.2 and 7.3 below should be carried out within one year after receipt of this Phase I inspection report.

d. Need for Addiitonal Investigation. No need exists for additional investigation other than that required to carry out the recommendations made in 7.2 below.

7.2 Recommendations

It is recommended that Glen Road Dam be removed within one year. A Registered Professional Engineer should be engaged to develop a procedure for removing the dam in such a way as to avoid damage downstream. Attention should be given to the silt that has accumulated in the reservoir and to its potential for causing environmental damage downstream. Consideration should also be given to demolishing the gate structures and service bridge.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. Because it is recommended that this dam be removed, there is no need to implement specific operating and maintenance procedures. It is recommended that a surveillance and warning system be established for use in the event of emergency conditions. The debris behind the northwest abutment gate openings should be removed to provide fullflow openings until the dam is removed.

7.4 Alternatives

If a dam is needed at this site, a new one should be designed and built.

APPENDIX A
VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Glen Road Dam, NH

DATE November 10, 1978

TIME A.M.

WEATHER Cool, partly cloudy

W.S. ELEV.	U.S.	DN.S.
	<u>710.4</u>	<u>396.8</u>

PARTY:

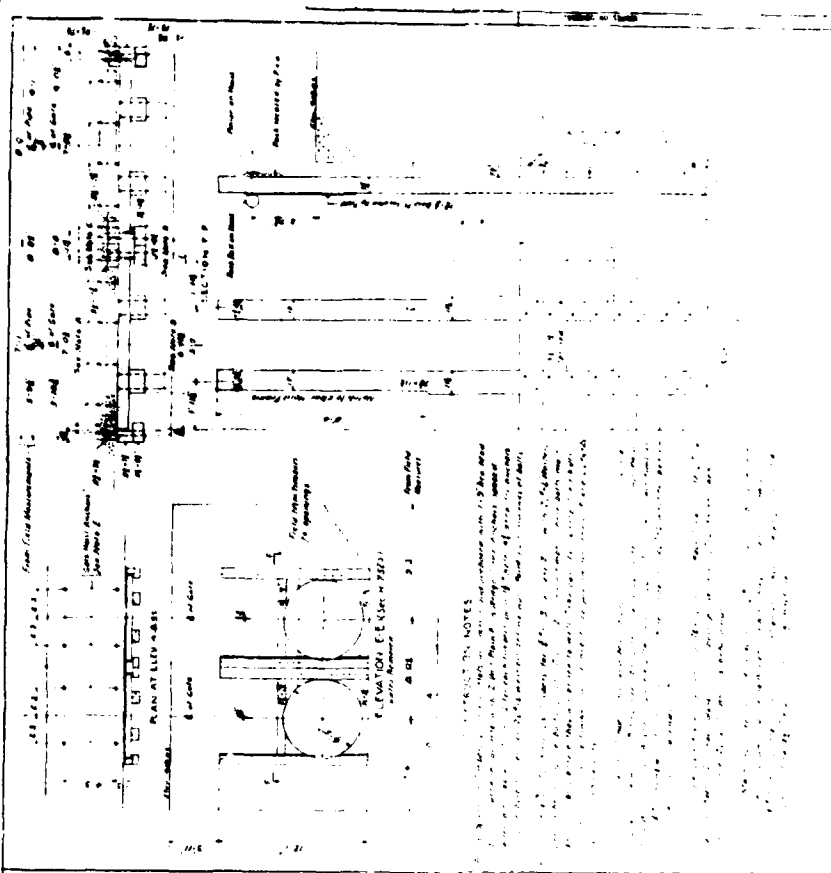
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|--------------------------|---------------------------------------|
| 1. <u>Robert Langen</u> | 6. <u>Ronald Hirschfeld</u> |
| 2. <u>Stephen Gilman</u> | 7. <u>Warren H. Guinan (11/15/78)</u> |
| 3. <u>David Deane</u> | 8. _____ |
| 4. <u>Douglas Ford</u> | 9. _____ |
| 5. <u>Robert Ojendyk</u> | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Hydrology/Hydraulics</u>	<u>W. Guinan/D. Ford/R. Langen</u>	
2. <u>Soils & Geology</u>	<u>R. Hirschfeld</u>	
3. <u>Structural Stability</u>	<u>S. Gilman</u>	
4. _____	_____	_____
5. _____	_____	_____
6. _____	_____	_____
7. _____	_____	_____
8. _____	_____	_____
9. _____	_____	_____
10. _____	_____	_____

PERIODIC INSPECTION CHECKLIST

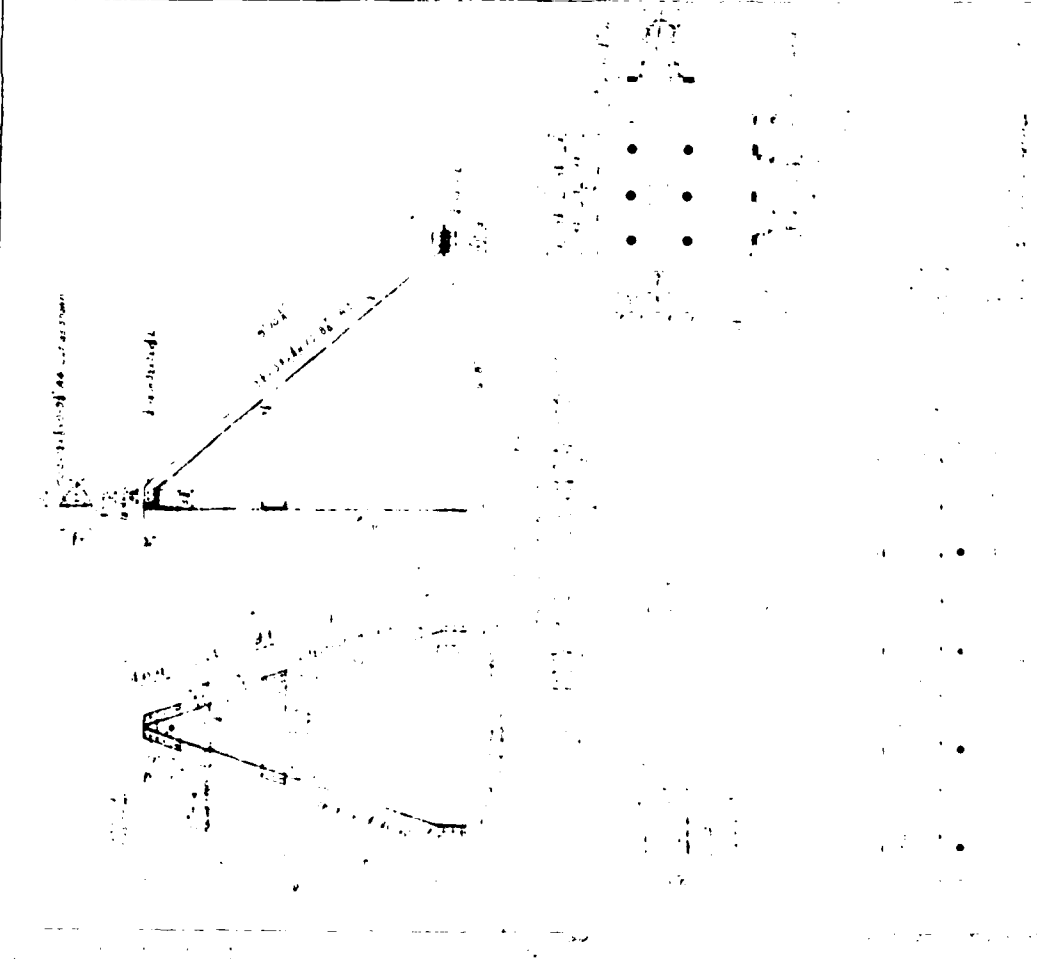
PROJECT Glen Road Dam, NH DATE November 10, 1978
 PROJECT FEATURE Dam Embankment NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>DAM EMBANKMENT</u>	Dam consists of rock-filled timber crib.
Crest Elevation	
Current Pool Elevation	710.4' MSL
Maximum Impoundment to Date	Unknown
Surface Cracks	Not applicable
Pavement Condition	Not applicable
Movement or Settlement of Crest	Crest alignment deviates a few inches horizontally and vertically from a straight line near rockfill washouts close to each end.
Lateral Movement	See "Movement...of Crest," above.
Vertical Alignment	See "Movement...of Crest," above.
Horizontal Alignment	See "Mvoement...of Crest," above.
Condition at Abutment and at Concrete Structures	Poor. No indication of instability.
Indications of Movement of Structural Items on Slopes	None visible. Several parts of timber crib are decayed, other parts have washed away.
Trespassing on Slopes	Not applicable
Sloughing or Erosion of Slopes or Abutments	Not applicable
Rock Slope Protection - Riprap Failures	Not applicable
Unusual Movement or Cracking at or Near Toe	Not applicable
Unusual Embankment or Downstream Seepage	Seepage discharging at toe of rockfill along entire length of dam, especially severe near sluice at center of dam and near abutments.
Piping or Boils	Hole eroded backward from toe next to downstream training wall at southeast abutment.
Foundation Drainage Features	None apparent
Toe Drains	Not applicable
Instrumentation System	Not applicable
Vegetation	None



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PERIODIC INSPECTION CHECKLIST

PROJECT Glen Road Dam, NH DATE Nov. 10, 1978
Outlet Works - Intake Channel
 PROJECT FEATURE and Intake Structure NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	Outlet works at northwest abutment
a. Approach Channel	
Slope Conditions	Vertical concrete
Bottom Conditions	Not visible
Rock Slides or Falls	None
Log Boom	None
Debris	Clogged with debris
Condition of Concrete Lining	Poor, extensive spalling
Drains or Weep Holes	None apparent
b. Intake Structure	
Condition of Concrete	Concrete faced stone - extensive spalling
Stop Logs and Slots	Rotted

PERIODIC INSPECTION CHECKLIST

PROJECT Glen Road Dam, NH DATE November 10, 1978
Outlet Works -
 PROJECT FEATURE Control Tower NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - CONTROL TOWER</u>	Northwest Abutment - old power-house foundation.
a. Concrete and Structural	
General Condition	Fair, mass of structure sound.
Condition of Joints	No indication of movement.
Spalling	Face of concrete spalling showing stone masonry behind.
Visible Reinforcing	None
Rusting or Staining of Concrete	Limited to area adjacent to embedded iron.
Any Seepage or Efflorescence	Significant
Joint Alignment	No indication of movement.
Unusual Seepage or Leaks in Gate Chamber	
Cracks	Extensive alligator cracking.
Rusting or Corrosion of Steel	None visible
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	Wood in deteriorated condition.
Emergency Gates	Gate in open position but blocked with wood and debris. Operating mechanism is in fair condition.
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIOD INSPECTION CHECKLIST

PROJECT Glen Road Dam, NH DATE November 10, 1978

Outlet Works - Transition

PROJECT FEATURE and Conduits NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	
General Condition of Concrete	Not applicable
Rust or Staining on Concrete	Steel penstock - 28' long 5' Ø steel is rusted.
Spalling	Not applicable
Erosion or Cavitation	None visible
Cracking	Surrounding concrete is cracked and spalled.
Alignment of Monoliths	Not applicable
Alignment of Joints	No indications of movement.
Numbering of Monoliths	Not applicable

PERIODIC INSPECTION CHECKLIST

PROJECT Glen Road Dam, NH DATE November 10, 1978
 PROJECT FEATURE Outlet Structure and Outlet Channel NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	Poor
Rust or Staining	Some around penstock
Spalling	Substantial where concrete in contact with water.
Erosion or Cavitation	
Visible Reinforcing	None
Any Seepage or Efflorescence	Yes
Condition at Joints	
Drain holes	None apparent
Channel	
Loose Rock or Trees Overhanging Channel	Some trees, but channel is wide.
Condition of Discharge Channel	Bedrock with boulders - fair

PERIODIC INSPECTION CHECKLIST

PROJECT Glen Road Dam, NH DATE November 10, 1978
Outlet Works - Spillway Weir,
 PROJECT FEATURE Approach & Discharge NAME _____
Channels
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	Sluiceway at center of dam.
a. Approach Channel	
General Condition	Heavy silting against upstream face of dam.
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Silt
b. Weir and Training Walls	
General Condition of Concrete	Poor - extensive cracking & spalling on training walls.
Rust or Staining	None visible
Spalling	Yes
Any Visible Reinforcing	None visible
Any Seepage or Efflorescence	Efflorescence of alligator cracks.
Drain Holes	None apparent
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Trees overhanging channel; channel is wide.
Floor of Channel	Bedrock and boulders.
Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

PROJECT Glen Road Dam, NH DATE November 10, 1978
 PROJECT FEATURE Outlet Works - Service Bridge NAME _____
 DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SERVICE BRIDGE</u>	
a. Super Structure	Concrete and wood suspension
Bearings	Concrete - good
Anchor Bolts	Fair - southeast end of suspension bridge loose from bearing.
Bridge Seat	
Longitudinal Members	Treated 4" x 6" - fair
Underside of Deck	Good
Secondary Bracing	Cables at tower are rusted.
Deck	Treated wood, fair condition.
Drainage System	Not applicable
Railings	None
Expansion Joints	None
Paint	None
b. Abutment & Piers	
General Condition of Concrete	Good
Alignment of Abutment	Good
Approach to Bridge	Good
Condition of Seat & Backwall	Good
Towers - treated wood	Good condition
Cables	Rusted - fair

PROJECT Glen Road Dam, NH

DATE November 10, 1978

PROJECT FEATURE Reservoir

NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Major
Changes in Watershed Runoff Potential	Some (highway)
Upstream Hazards	Railroad bridge
Downstream Hazards	Railroad bridge
Alert Facilities	None
Hydrometeorological Gages	None at site - U.S.G.S. gage upstream 8.4 miles
Operational & Maintenance Regulations	None

APPENDIX B
ENGINEERING DATA

NEW HAMPSHIRE WATER RESOURCES BOARD
QUESTIONNAIRE
WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

Electric
Granite State Power Co.
Lebanon, N.H.

Gentlemen:

We maintain in this office a list of the water power installations in New Hampshire and are frequently receiving inquiries concerning these installations. We are, therefore, bringing this information up to date, and request your cooperation by filling in the questionnaire below with data on your development and return it to us in the enclosed stamped envelope.

If the ownership has changed, will you please forward this questionnaire to the present owners.

Very truly yours,

Walter G. White
Acting Chairman

Dam No. 13412 Location Lebanon Brook
River at Timberline

1. Will you please check or correct:

Dam #3

	Our Data	Your Corrections
Head - feet	73	
Capacity		
Wheel - H.P.	2840	2440
Generator - K.W.	1300	

2. Is the power plant in operation? Yes
3. If not, is the equipment in operable condition? Yes
4. Is the dam in good repair? Yes

Signed: *W. G. White*
PRES.

Date 2-2-48

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION
Town Lebanon County Grafton AT DAM NO. 134.12
Stream Mascoma River
Basin-Primary Conn. R. Secondary Mascoma R.
Local Name

GENERAL DATA

Head-Max. 75 ft.: Min. 75 ft.: Ave. 75 ft.
Date of Construction 1939 Use of Power Public Utility
Pondage 0 ac. ft.: Storage 0 ac. ft.

DESCRIPTION

Racks

Size of Rack Opening
Size of Bar 1/2" Material Steel
Area: Gross 0 Sq. Ft.: Net 0 sq. ft.

Head Gates

Type Vertical
Number 3 Size 33" ft. high x 22 1/2" ft. wide
Elevation of Invert 100 Total Area 0 sq. ft.
Hoist

Penstock

Number 3 Material Steel
Size 33" Length 1240

Turbines

3 S Morgan Smith Ver.
22 1/2 Morgan Smith Vertical
Number 3 Makers
Rating HP. per unit 2-800 H.P. 1-1240 H.P. Total Capacity 2840 HP.
Max. Dement C.F.S., per unit 0 Total 0 cfs.

Drive

Type Vertical

Generator

Number 3
Make 2. G.E. 2300 V 157 A 514 R.P.M. 1-GE 2300 V 251 A 360 R.P.M.
Rating KW., per unit 2. 500 1. 600 Total Capacity 1300 K.W.

Exciter

Number 3 Make GE
Rating-per unit 0 Total Capacity 0 K.W.

OUTPUT—KWHRS

19.....	19.....
19.....	19.....
19.....	19.....
19.....	19.....
19.....	19.....

OWNER Granite State Electric Co

Tabulation By A.A.N. & R.L.T. Date Jan. 3, 1939

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 134.12
Town Lebanon : County Crafton
Stream Mascoma River
Basin-Primary Conn. R. : Secondary Mascoma R.
Local Name Plant No. 4
Coordinates—Lat. 43° 40' - 118.00 : Long. 72° 20' - 76.00
GENERAL DATA
Drainage area: Controlled.....Sq. Mi.: Uncontrolled.....Sq. Mi.: Total 194 Sq. Mi.
Overall length of dam 175 ft.: Date of Construction
Height: Stream bed to highest elevation 21.5 ft.: Max. Structure 13.5 ft.
Cost—Dam : Reservoir
DESCRIPTION Log Crib— Wood— Stone— Concrete
Waste Gates
Type
Number : Size ft. high x ft. wide
Elevation Invert : Total Area sq. ft.
Hoist
Waste Gates Conduit
Number : Materials
Size ft.: Length ft.: Area sq. ft.
Embankment
Type
Height—Max. ft.: Min. ft.
Top—Width ft.: Elev. ft.
Slopes—Upstream on : Downstream on
Length—Right of Spillway : Left of Spillway
Spillway
Materials of Construction
Length—Total ft.: Net 123 ft.
Height of permanent section—Max. ft.: Min. ft.
Flashboards—Type : Height 2.5 ft.
Elevation—Permanent Crest 411.7 : Top of Flashboard
Flood Capacity 10,455 cfs.: 5+ cfs/sq. mi.
Abutments
Materials: Concrete
Freeboard: Max. 9.0 ft.: Min. ft.
Headworks to Power Devel.—(See "Data on Power Development")
OWNER Granite State Electric Co
REMARKS Hydro Electric Power for Public Utility

Tabulation By A. A. N. & R. L. T. Date Jan 3, 1929
BAC1254

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire
October 14, 1938.

MA STATION

Granite State Elec Co.,
Lebanon N H

RE: Granite State Dam N. C. C. No. 134.12

Gentlemen:

In order that we may determine the magnitude and extent of the flood of September 21-24 just passed, we are requesting the various dam owners in the State to supply us with the following information:

1. Was this dam injured? Ans. NO
2. If so, to what extent? Ans. -
3. Did all flashboards go out? Ans. PRACTICALLY ALL
4. What was the maximum height of water over the permanent crest of spillway? Ans. APPROX. 6 FT.
5. At what day and hour did the maximum flood height reach your dam? Ans. APPROX. 11 P.M., SEPT. 21

6. Any other interesting information regarding the flood or rain fall may be given on the back of this sheet, or attach sheets.

Will you please return this letter with as much information as you can give us as promptly as possible. A self-addressed envelope is attached hereto.

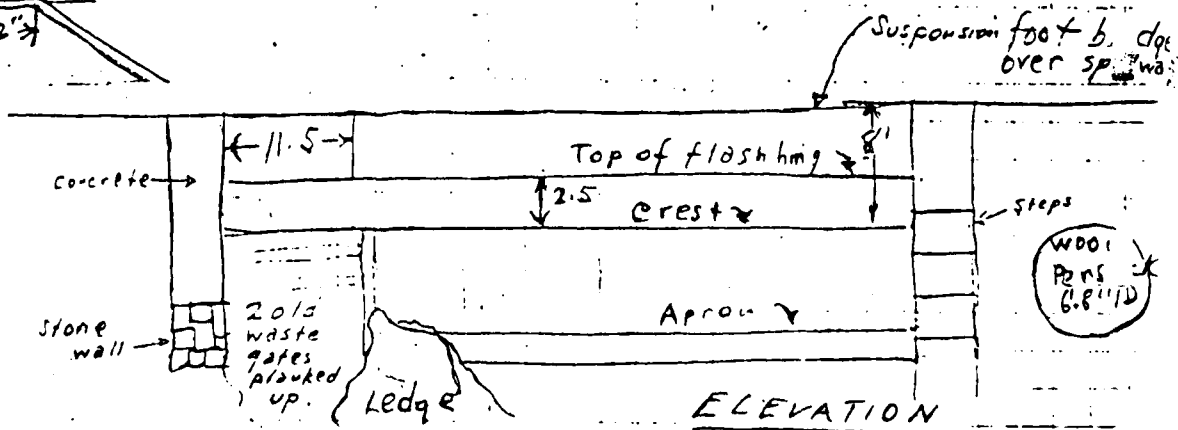
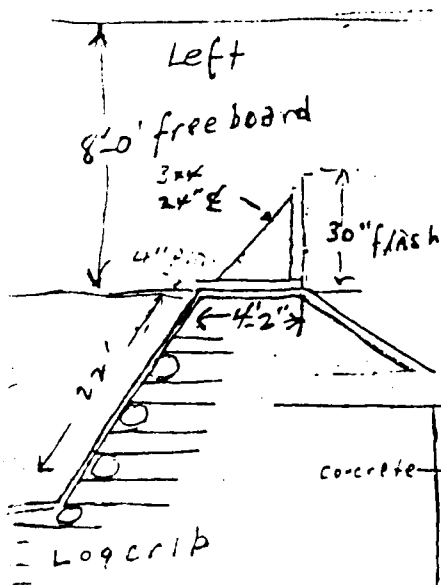
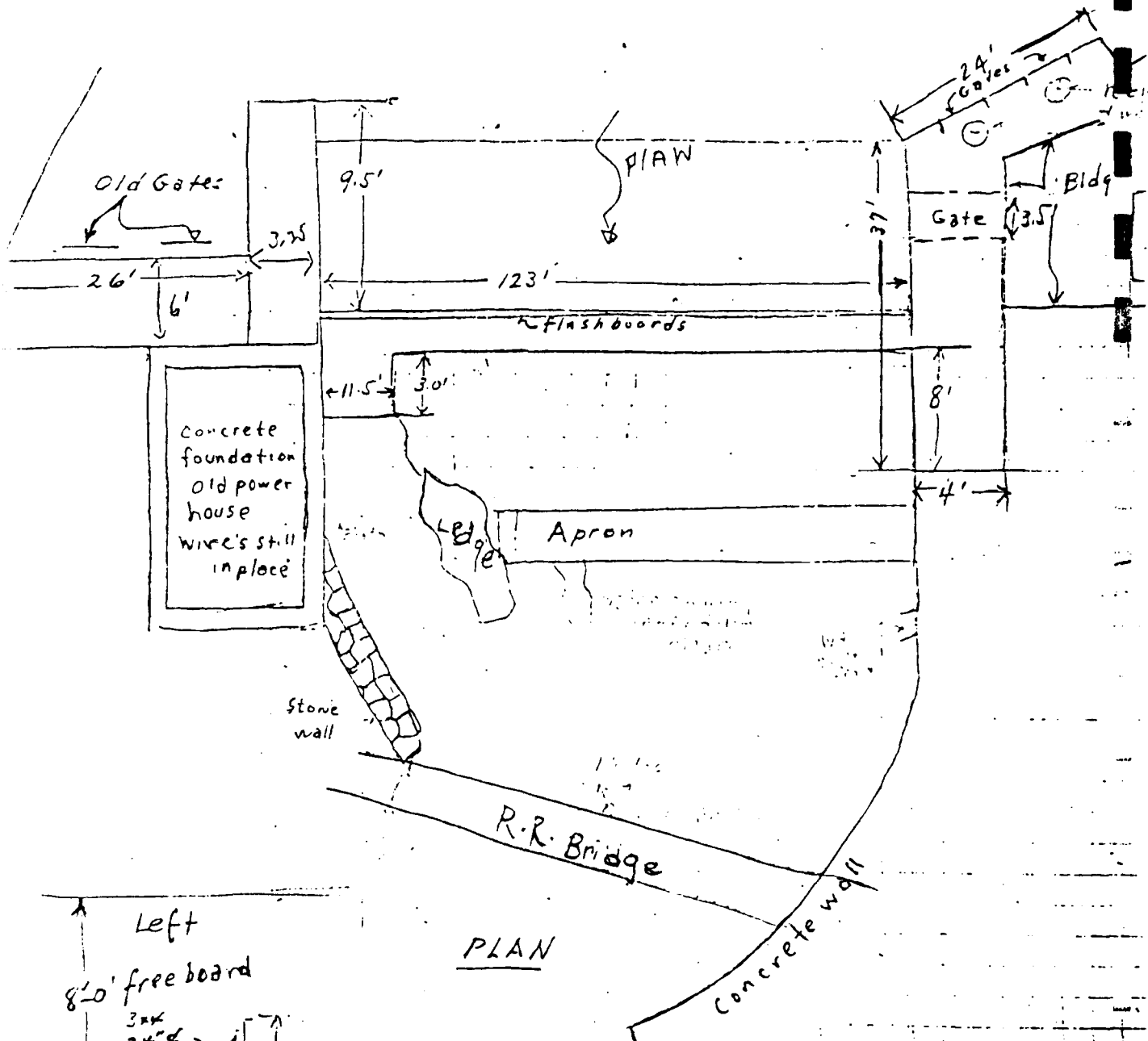
We thank you for your cooperation.

Very truly yours,

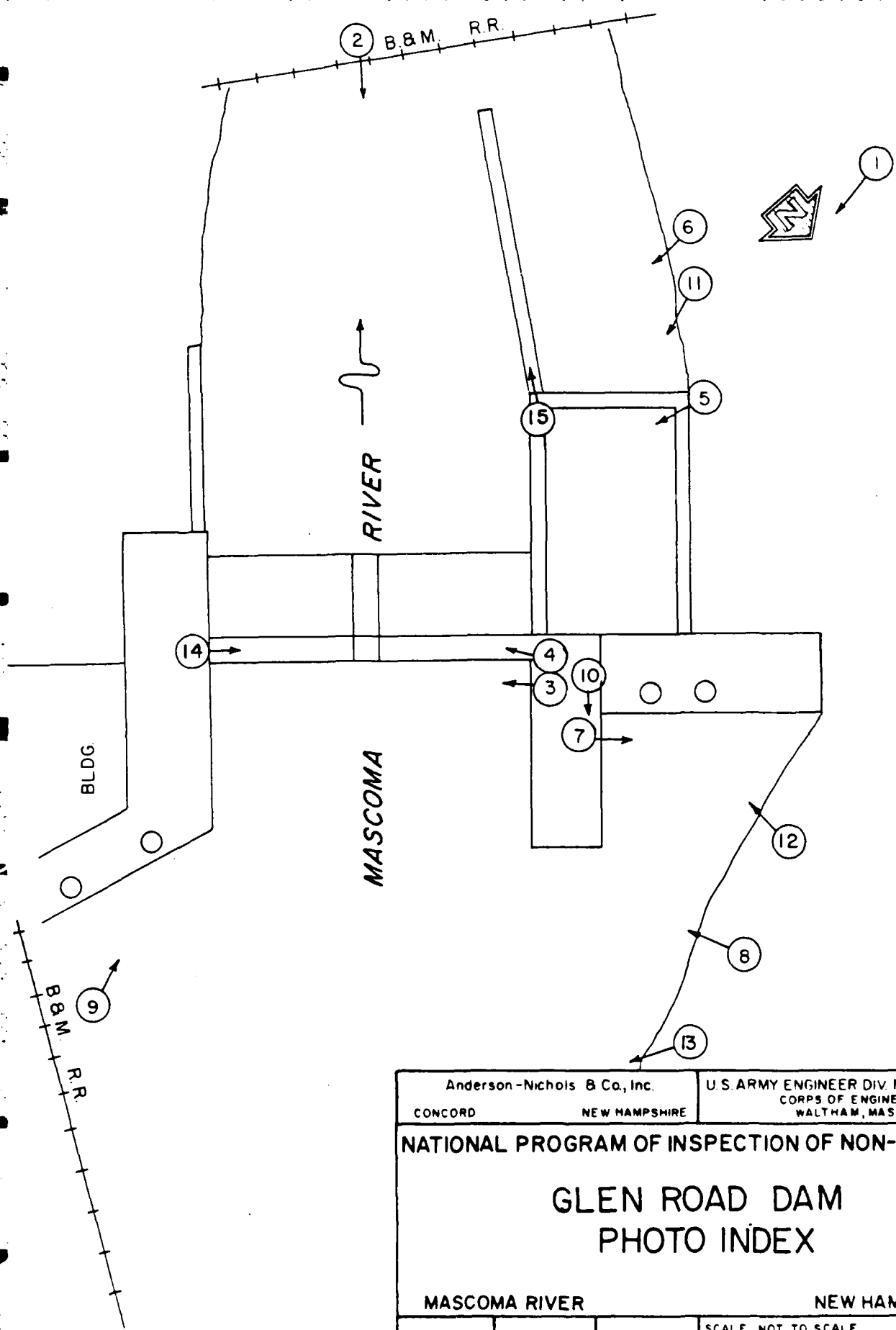
Richard C. Holmgren

Richard C. Holmgren
Chief Engineer

SDC:SLB
Enc.



APPENDIX C
PHOTOGRAPHS



Anderson-Nichols & Co., Inc.		U.S. ARMY ENGINEER DIV. NEW ENGLAND	
CONCORD		CORPS OF ENGINEERS	
NEW HAMPSHIRE		WALTHAM, MASS	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
GLEN ROAD DAM			
PHOTO INDEX			
MASCOMA RIVER		NEW HAMPSHIRE	
		SCALE NOT TO SCALE	
		DATE FEBRUARY 1979	



Figure 2 - Looking at the downstream face of the dam.

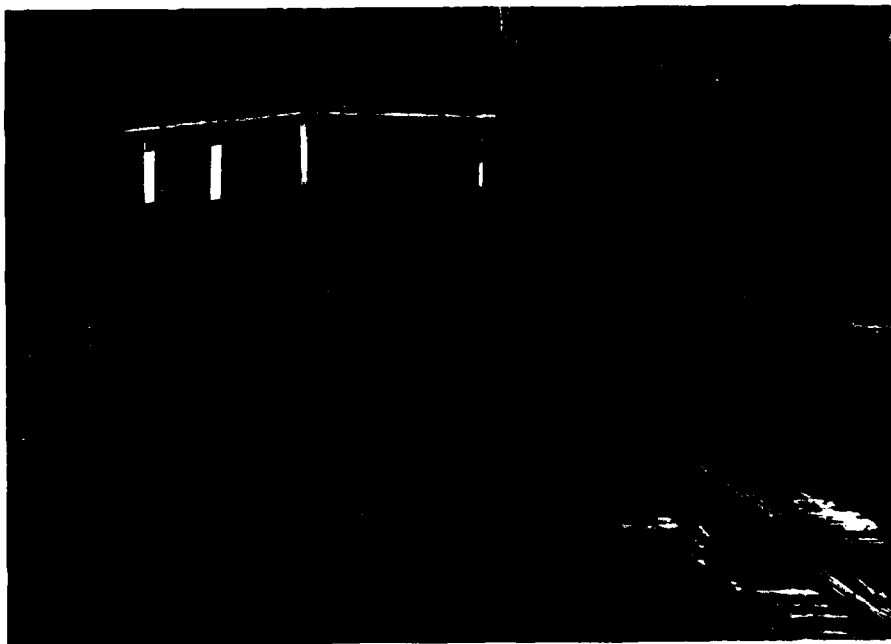


Figure 3 - Looking across upstream face of crest of the dam at the gatehouse.

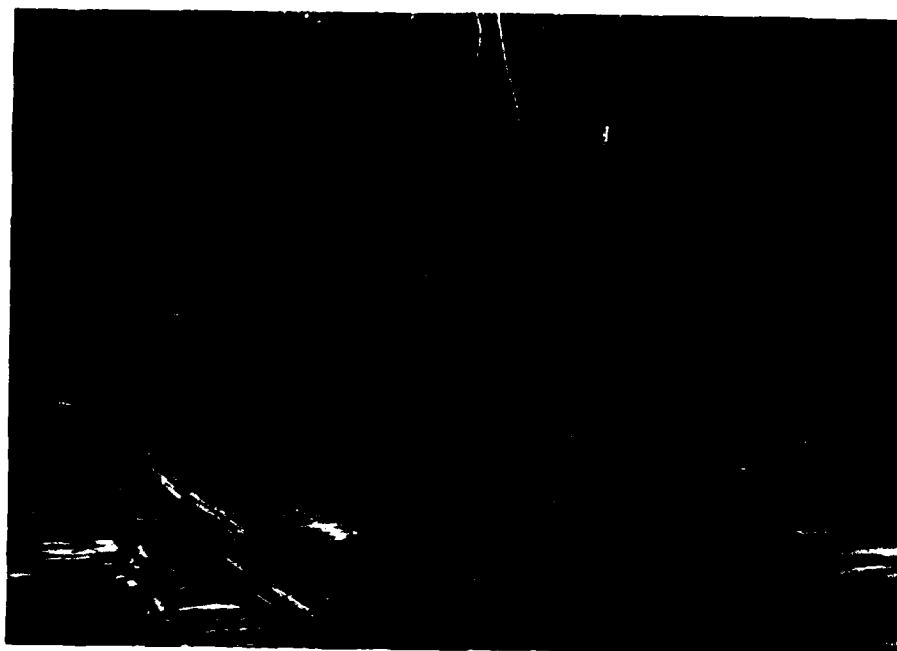


Figure 4 - Looking across the crest of the dam.



Figure 5 - Looking across the downstream face of the dam.



Figure 6 - Looking at northwest end of the dam.



Figure 7 - Closeup view of debris in front of gates to old powerhouse at the northwest abutment of the dam.

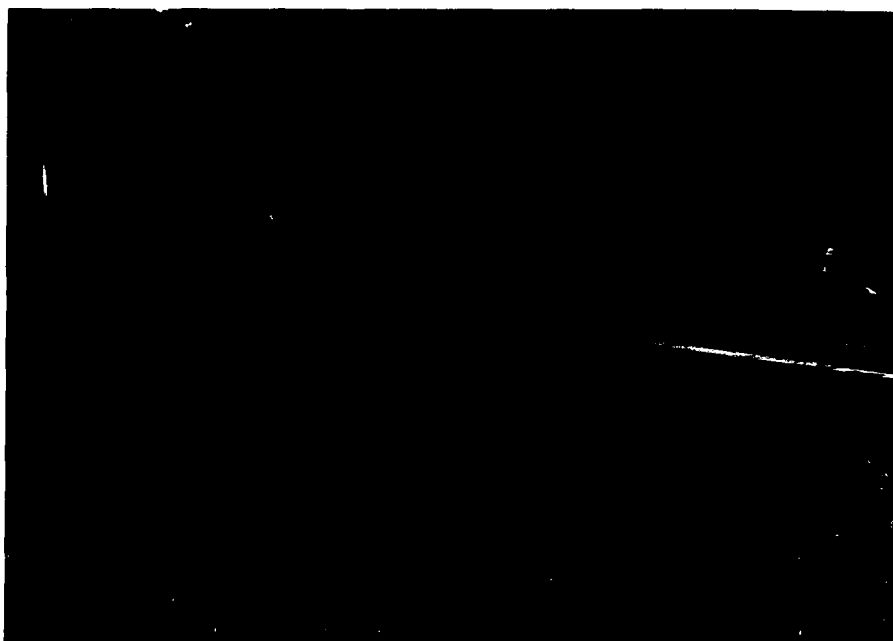


Figure 8 - Looking at gate structures and upstream face of the dam.



Figure 9 - Looking at gatehouse and intake structure for inoperative penstock.

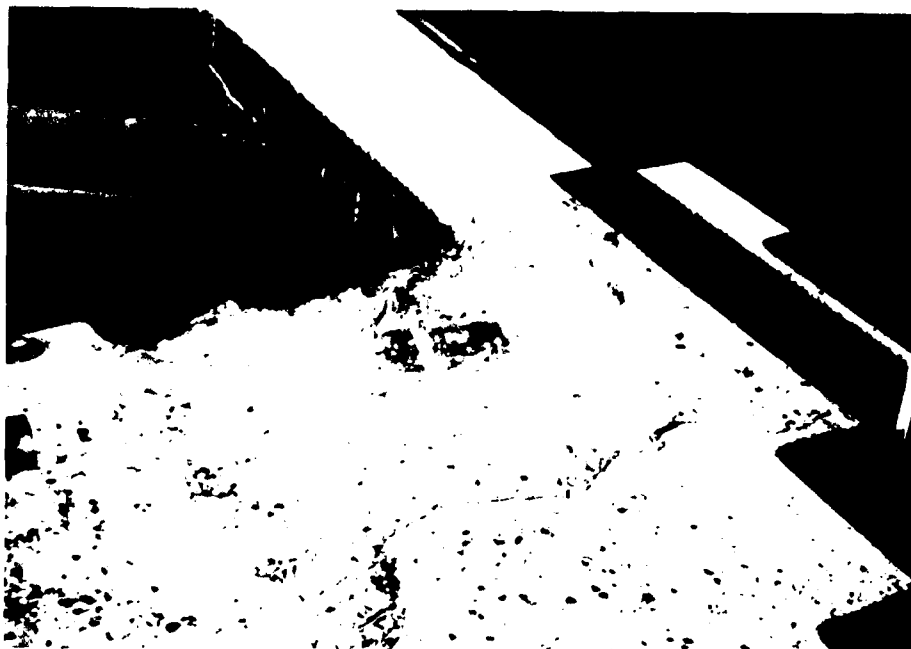


Figure 10 - Closeup view of spalling concrete on northwest abutment gate structure.



Figure 11 - Looking at penstocks to old powerhouse at the northwest end of dam.



Figure 12 - Gate controls for old powerhouse at the northwest abutment of the dam.



Figure 13 - Looking across the gatehouse service bridge from the southeast abutment.

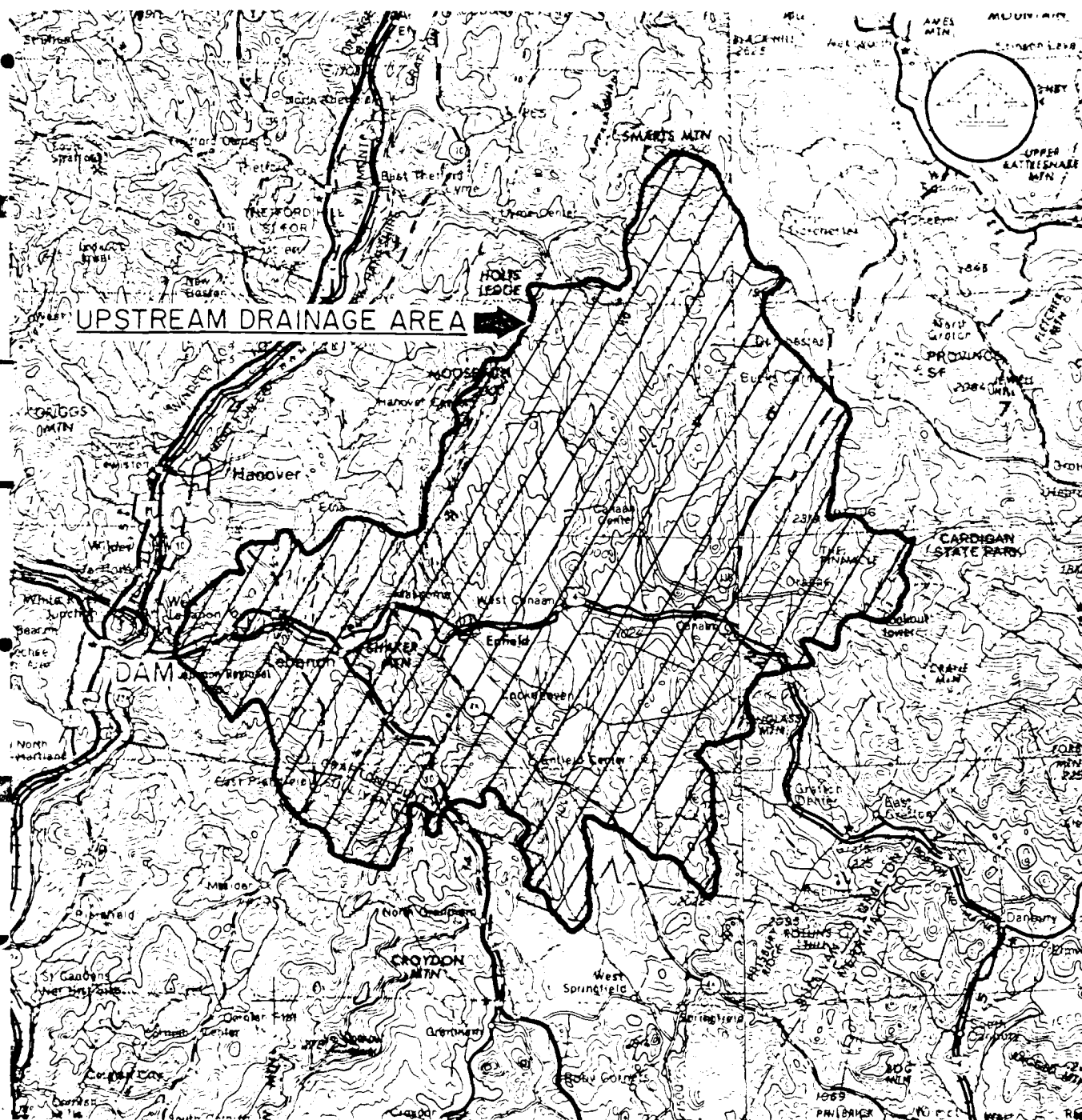


Figure 14 - Looking upstream from the northwest river bank.



Figure 15 - Looking downstream from the northwest abutment.

APPENDIX D
HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION
OF NON-FED. DAMS
GLEN ROAD DAM

LEBANON, NEW HAMPSHIRE

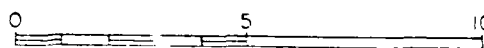
REGIONAL VICINITY MAP

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

ANALYST: N. H. B. B. B. B.

CONCORD, NH

SCALE IN MILES



MAP BASED ON U.S.G.S. 1:250,000 SERIES
TOPOGRAPHIC MAPPING. GLENS FALLS, N.Y.,
VT., N.H. 1956 REVISED 1972, AND PORTLAND,
ME., N.H. 1956 REVISED 1972.

APPENDIX D
HYDROLOGY & HYDRAULICS

GLEN ROAD DAM (MASCOMA DAM No. 3)
OVERTOPPING ANALYSIS

$$A = 193 \text{ MI}^2$$

SIZE CLASSIFICATION = SMALL

HAZARD CLASSIFICATION = LOW

TEST FLOOD = $\frac{1}{4}$ PMF

CALCULATE PMF USING "PRELIMINARY GUIDANCE FOR ESTIMATING MAXIMUM PROBABLE DISCHARGES IN PHASE I DAM SAFETY INVESTIGATIONS, MARCH 1975."

AVERAGE SLOPE OF THE WATERSHED IS 29 FT/MI. DUE TO MASCOMA LAKE, LOCATED APPROXIMATELY 9 MILES UPSTREAM OF THE DAM AND OTHER STORAGE AREAS FURTHER UPSTREAM THE 'FLAT & CONSTAL' CURVE WILL BE USED TO COMPUTE THE PMF.

$$\text{PMF} = 193 \text{ MI}^2 \times 328 \text{ CSM} = 63,304 \text{ CFS}$$

$$\frac{1}{4} \text{ PMF} = \frac{63,304}{4} = 15,826 \text{ CFS}$$

TEST FLOOD DISCHARGE = 15,826 CFS

REFER TO RATING CURVE: (P. 3)

WITH A DISCHARGE OF 15,826 CFS AN ELEVATION OF 421.3' MSL IS READ. SPILLWAY CREST = 421.1' MSL.

∴ THE SPILLWAY WILL BE OVERTOPPED BY APPROXIMATELY 0.2 FEET DURING THE TEST FLOOD ($\frac{1}{4}$ FLOOD MAXIMUM FLOOD)

DETERMINE DISCHARGE RATING CURVE FOR THE DAM
 USING THE WEIR EQUATION $Q = CLH^{3/2}$, WHERE THE
 'C' FOR THE DAM SPILLWAY CREST IS 3.8, 'C' OVER
 ABUTMENTS AND OVERTOPPING IS 2.6.

TRIAL #1 @ 412.1 SPILLWAY CREST
 $Q = 0$ CFS

TRIAL #2 @ 413.0
 $Q = 3.8(123)(0.9)^{3/2} = 399$ CFS

TRIAL #3 @ 415.0
 $Q = 3.8(123)(2.9)^{3/2} = 2308$ CFS

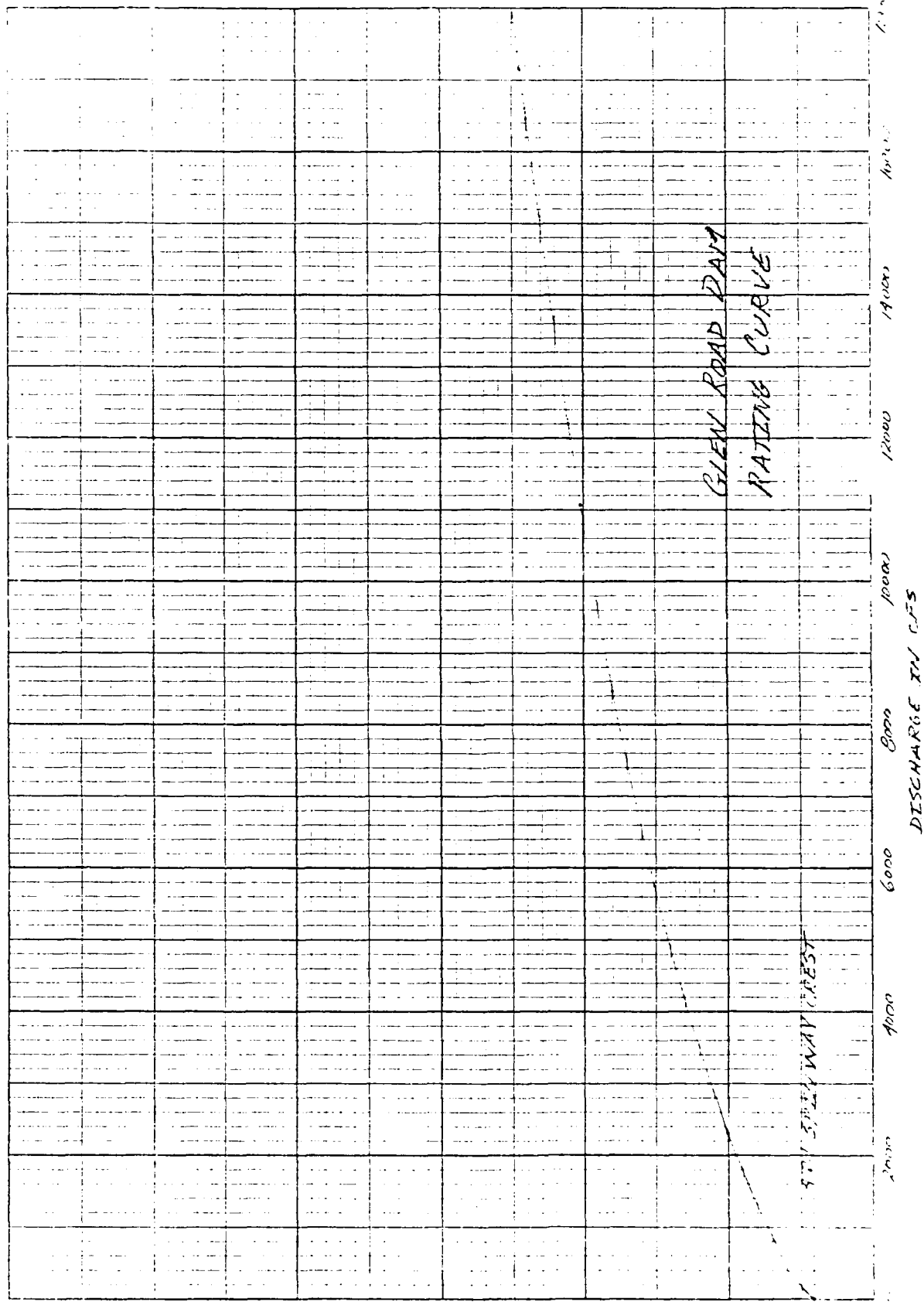
TRIAL #4 @ 419.0 MAXIMUM POOL (RIGHT ABUT.)
 $Q = 3.8(123)(6.9)^{3/2} = 8472$ CFS

TRIAL #5 @ 420.1 LEFT ABUT.
 $Q = 3.8(123)(8)^{3/2} + 2.6(55)(1.1)^{3/2}$
 $+ 2.6(61)(1.6)^{3/2} = 11,062$ CFS

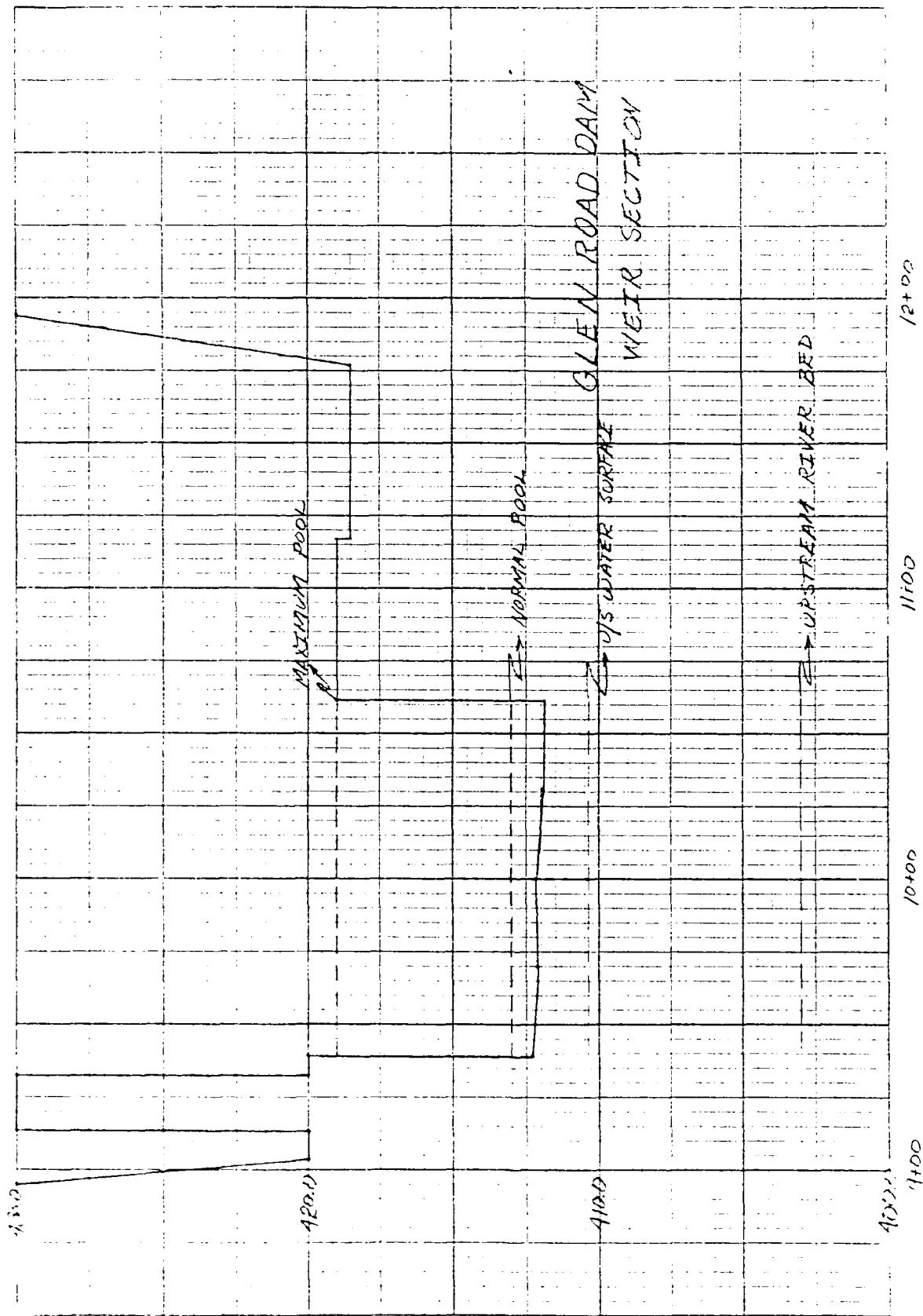
TRIAL #6 @ 422.0
 $Q = 3.8(123)(9.9)^{3/2} + 2.6(55)(3)^{3/2} + 2.6(61)(3.5)^{3/2}$
 $+ 2.6(17)(2.0)^{3/2} = 16,466$ CFS

TRIAL #7 @ 427.0
 $Q = 3.8(123)(14.9)^{3/2} + 2.6(55)(8.0)^{3/2} + 2.6(61)(9.5)^{3/2}$
 $+ 2.6(17)(7.0)^{3/2} = 34,867$ CFS

USE THE ABOVE TRIALS TO DEVELOP A DISCHARGE
 RATING CURVE FOR THE GLEN ROAD DAM.



(75% F. TESTED) 10/10/54



SHEET 4 OF 14

BREACH ANALYSIS - TO DETERMINE DOWNTREAM
HAZARD CLASSIFICATION

1. NORMAL POOL (USING MEAN ANNUAL FLOW): USING
WATER RESOURCES DATA FOR NEW HAMPSHIRE AND
VERMONT, WATER YEAR 1976, U.S. GEOLOGICAL SURVEY
DATA REPORT NH-VT-76-1, AUGUST 1977:

AT GAGE STATIONS ON MASCOMA RIVER

DA = 80.5 MI² - MEAN ANNUAL FLOW = 167 CFS = 2.07 CSM

DA = 153.0 MI² - MEAN ANNUAL FLOW = 323 CFS = 2.11 CSM

DU TO THE UPSTREAM STORAGE OF MASCOMA LAKE, A
2.11 CSM VALUE IS APPLIED TO DA @ CUMMINGS DAM.
(DA = 193 MI²) $\therefore$ MEAN ANNUAL FLOW = $193 \times 2.11 = 407$ CFS
THIS GIVES ABOUT 0.9 FOOT DEPTH OVER THE SPILLWAY.

$$Q_p = 8/27 W_b \sqrt{g} y_p^{3/2}$$

W_b = BREACH WIDTH

$$g = 32.2 \text{ FT/SEC}^2$$

y_p = POOL ELEV - U/S RIVER BED

413.0' MSL OR 0.9' OVER SPILLWAY CREST. UPSTREAM
RIVER BED SHOWN ON PLANS $\approx$ 403' ON THE DAY
OF INSPECTION SEDIMENTATION WAS OBSERVED.
SOME OF THIS SEDIMENTATION MAY BE CON-
SOLIDATED HOWEVER THE MOST CONSERVATIVE y_p
WILL BE USED.

2. GIVEN POOL DAM

$$W_b = 123' \times 0.90 = 110 \text{ FT}$$

$$y_p = 413.0 - 403.0 = 10 \text{ FT}$$

FROM EQUATION: $Q = 2605$ CFS

Q OVER DAM OTHER THAN BREACHED AREA: $Q = 23.74 (0.9)^{3/2} = 140$ CFS

$$\text{TOTAL BREACH } Q_1 = 2005 + 240 = \underline{2245 \text{ CFS}}$$

FOR MAXIMUM POOL: MAXIMUM POOL ELEVATION = 419.0'

3. E. EN. ROAD DAM

$$L_d = 40 \text{ FT}$$

$$H_d = 419 - 403 = 16 \text{ FT}$$

FROM EQUATION: $Q = 5273 \text{ CFS}$

$$Q \text{ OVER DAM OTHER THAN BREACHED AREA: } 3.9(74)(6.9)^{3/2} = 5070 \text{ CFS}$$

$$\text{TOTAL BREACH } Q_2 = 5273 + 507 = \underline{10,370 \text{ CFS}}$$

REACH #1

USE A TYPICAL CROSS SECTION ALONG THE DOWN-
STREAM REACH FROM THE DAM TO THE SECTION
1200 FT DOWNSTREAM.

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

n = COMPOSITE "n" VALUE

A = AREA OF SECTION

R = A/P (WETTED PERIMETER)

S = SLOPE OF REACH

LENGTH OF REACH = 1200 FT

ELEVATION @ T/S TOE = 402

ELEVATION @ END OF REACH = 390

SLOPE = 0.01

COMPOSITE "n" = 0.075

TRAIL #1 STAGE = 1.0'

$$Q = \frac{1.49}{0.075} \cdot 92 \cdot (42.5)^{2/3} (0.01)^{1/2} = 180 \text{ CFS}$$

TRIAL #2 STAGE = 3.0'

$$Q = 1.49 / 0.075 \cdot 289 \cdot \left(\frac{289}{103.5} \right)^{2/3} \cdot (0.01)^{1/2} = 1152 \text{ cfs}$$

TRIAL #3 STAGE = 5.0'

$$Q = 1.49 / 0.075 \cdot 500 \cdot \left(\frac{500}{112.5} \right)^{2/3} \cdot (0.01)^{1/2} = 2695 \text{ cfs}$$

TRIAL #4 STAGE = 7.0'

$$Q = 1.49 / 0.075 \cdot 776 \cdot \left(\frac{776}{169.5} \right)^{2/3} \cdot (0.01)^{1/2} = 4267 \text{ cfs}$$

TRIAL #5 STAGE = 10.0'

$$Q = 1.49 / 0.075 \cdot 1400 \cdot \left(\frac{1400}{253} \right)^{2/3} \cdot (0.01)^{1/2} = 8701 \text{ cfs}$$

TRIAL #6 STAGE = 12.0'

$$Q = 1.49 / 0.075 \cdot 1956 \cdot \left(\frac{1956}{309} \right)^{2/3} \cdot (0.01)^{1/2} = 13277 \text{ cfs}$$

USE THE ABOVE TRIALS TO ESTABLISH A
DOWNSTREAM 1-SECTION RATING CURVE.

FOR NORMAL POOL:

BREACH $Q_{p1} = 2895 \text{ cfs} \rightarrow \text{STAGE} = 5.4'$

$W/\text{STAGE} = 5.4' \quad \text{VOLUME} = 11 \text{ AC-FT}$

BREACH $Q_{p2} (\text{TRIAL}) = 2895 \left(1 - \frac{11}{30} \right) = 1502 \text{ cfs} \rightarrow \text{STAGE} = 4.0'$

$W/\text{STAGE} = 4.0' \quad \text{VOLUME} = 7 \text{ AC-FT}$

BREACH $Q_{p2} = 2895 \left(1 - \frac{(11+7)/2}{30} \right) = 1992 \text{ cfs} \rightarrow \text{STAGE} = 4.2'$

ANTECEDENT $Q = 407 \text{ cfs} \rightarrow \text{STAGE} = 1.5'$

$\therefore$ THE INCREASE IN STAGE CAUSED BY A
BREACH AT NORMAL POOL WOULD BE ≈ 2.7 FEET.

FOR MAXIMUM POOL:

BREACH $Q_{P1} = 10,370 \text{ cfs} \rightarrow \text{STAGE} = 10.8'$

$W/\text{STAGE} = 10.8' \quad \text{VOLUME} = 7 \text{ AC-FT}$

BREACH $Q_{P2} (\text{TRIAL}) = 10,370 \left(1 - \frac{7}{60}\right) = 9,160 \text{ cfs} \rightarrow \text{STAGE} = 10.2'$

$W/\text{STAGE} = 10.2' \quad \text{VOLUME} = 5 \text{ AC-FT}$

BREACH $Q_{P2} = 10,370 \left(1 - \frac{(7+5)/2}{60}\right) = 9,505 \text{ cfs} \rightarrow \text{STAGE} = 10.4'$

ANTECEDENT $Q = 8,472 \text{ cfs} \rightarrow \text{STAGE} = 9.8'$

$\therefore$ THE INCREASE IN STAGE CAUSED BY A BREACH AT MAXIMUM POOL WOULD BE ≈ 0.6 FEET.

REACH #2

USE A TYPICAL CROSS SECTION ALONG THE DOWN-STREAM REACH FROM THE DAM TO THE SECTION 2800' DOWNSTREAM.

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

LENGTH OF REACH = 1600 FT (2800 - 1200)

ELEVATION @ BEGINNING OF REACH = 390

ELEVATION @ END OF REACH = 370

SLOPE = 0.0125

COMPOSITE 'n' = 0.075

TRIAL #1 STAGE = 1.0'

$$Q = \frac{1.49}{0.075} \cdot 89 \cdot \left(\frac{89}{99}\right)^{2/3} \cdot (0.0125)^{1/2} = 1,970 \text{ cfs}$$

TRIAL #2 STAGE = 3'

$$Q = 1.49 / 0.075 \cdot 276 \cdot \left(\frac{276}{105} \right)^{2/3} \cdot (0.0125)^{1/2} = 1160 \text{ CFS}$$

TRIAL #3 STAGE = 5'

$$Q = 1.49 / 0.075 \cdot 500 \cdot \left(\frac{500}{121} \right)^{2/3} \cdot (0.0125)^{1/2} = 2300 \text{ CFS}$$

TRIAL #4 STAGE = 7'

$$Q = 1.49 / 0.075 \cdot 760 \cdot \left(\frac{760}{161} \right)^{2/3} \cdot (0.0125)^{1/2} = 4750 \text{ CFS}$$

TRIAL #5 STAGE = 10'

$$Q = 1.49 / 0.075 \cdot 1300 \cdot \left(\frac{1300}{261} \right)^{2/3} \cdot (0.0125)^{1/2} = 8900 \text{ CFS}$$

TRIAL #6 STAGE = 12'

$$Q = 1.49 / 0.075 \cdot 1760 \cdot \left(\frac{1760}{302} \right)^{2/3} \cdot (0.0125)^{1/2} = 12100 \text{ CFS}$$

USE THE ABOVE TRIALS TO ESTABLISH A DOWN-
STREAM V-S-ECTION RATING CURVE.

FOR NORMAL POOL:

BREACH $Q_{P2} = 1992 \text{ CFS} \rightarrow \text{STAGE} = 4.0'$

$W/\text{STAGE} = 4.0'$

VOLUME = 9.0 AC-FT

BREACH $Q_{P3} (\text{TRIAL}) = 1992 \left(1 - \frac{9}{30-9} \right) = 1138 \text{ CFS} \rightarrow \text{STAGE} = 3.0'$

$W/\text{STAGE} = 3.0'$

VOLUME = 5.0 AC-FT

BREACH $Q_{P3} = 1992 \left(1 - \frac{(9+5)/2}{30-9} \right) = 1328 \text{ CFS} \rightarrow \text{STAGE} = 3.2'$

ANTECEDENT $Q = 407 \text{ CFS} \rightarrow \text{STAGE} = 1.6'$

$\therefore$ THE INCREASE IN STAGE CAUSED BY A
BREACH AT NORMAL POOL WOULD BE ≈ 1.6 FEET.

FOR MAXIMUM POOL:

REACH $Q_1 = 9505 \text{ cfs} \rightarrow \text{STAGE} = 10.6$

$W/\text{STAGE} = 10.6' \quad \text{VOLUME} = 51111$

REACH $Q_2 (\text{TOP}) = 9505 \left(1 - \frac{5}{10.6}\right) = 8640 \text{ cfs} \rightarrow \text{STAGE} = 10.1$

$W/\text{STAGE} = 10.1' \quad \text{VOLUME} = 14611$

REACH $Q_3 = 9505 \left(1 - \frac{(5-1)10}{10.6-10.1}\right) = 3997 \text{ cfs} \rightarrow \text{STAGE} = 10.3$

ANTECEDENT $Q = 8412 \text{ cfs} \rightarrow \text{STAGE} = 10.0'$

$\therefore$ THE INCREASE IN STAGE CAUSED BY A BRIST
AT MAXIMUM POOL WOULD BE ≈ 0.3 FEET

REACH #3

USE A TYPICAL CROSS SECTION ALONG THE
DOWNSTREAM REACH FROM THE DAM TO THE
SECTION 4300' DOWNSTREAM

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

LENGTH OF REACH = 1500 FT (4300 - 2800)

ELEVATION @ BEGINNING OF REACH = 370

ELEVATION @ END OF REACH = 353

SLOPE = 0.0133

COEFFICIENT $n = 0.075$

TYPICAL n STAGE = 1'

$$Q = \frac{1.49}{0.075} \cdot 101 \cdot \left(\frac{10}{0.0133}\right)^{2/3} \cdot (0.0133)^{1/2} = 229 \text{ cfs}$$

TRIAL #2 STAGE = 2'

$$Q = 1.49 / 0.075 \cdot 204 \cdot (204/106)^{2/3} \cdot (0.0133)^{1/2} = 723 \text{ cfs}$$

TRIAL #3 STAGE = 3.5'

$$Q = 1.49 / 0.075 \cdot 362 \cdot (362/110)^{2/3} \cdot (0.0133)^{1/2} = 1255 \text{ cfs}$$

TRIAL #4 STAGE = 5'

$$Q = 1.49 / 0.075 \cdot 824 \cdot (824/389)^{2/3} \cdot (0.0133)^{1/2} = 3140 \text{ cfs}$$

TRIAL #5 STAGE = 10'

$$Q = 1.49 / 0.075 \cdot 2150 \cdot (2150/689)^{2/3} \cdot (0.0133)^{1/2} = 10,583 \text{ cfs}$$

USE THE ABOVE TRIALS TO ESTABLISH A DOWN-STREAM X-SEC RATING CURVE.

FOR NORMAL POOL:

BREACH $Q_p = 1328 \text{ cfs} \rightarrow \text{STAGE} = 2.9'$

$V/\text{STAGE} = 2.9'$ VOLUME = 5 AC-FT

BREACH $Q_{p1} (\text{TRIAL}) = 1328 (1 - \frac{5}{30-9.7}) = 859 \text{ cfs} \rightarrow \text{STAGE} = 2.2'$

$V/\text{STAGE} = 2.2'$ VOLUME = 3 AC-FT

BREACH $Q_{p2} = 1328 (1 - \frac{(5+3)/2}{30-9.7}) = 949 \text{ cfs} \rightarrow \text{STAGE} = 2.3'$

ANTECEDENT $Q = 407 \text{ cfs} \rightarrow \text{STAGE} = 1.9'$

$\therefore$ THE INCREASE IN STAGE CAUSED BY A BREACH AT NORMAL POOL WOULD BE ≈ 0.9 FEET.

FOR MAXIMUM POOL:

BREACH $Q_p = 5997 \text{ cfs} \rightarrow \text{STAGE} = 7.2'$

$V/\text{STAGE} = 7.2'$ VOLUME = 2 AC-FT

BREACH $Q_{p1} (\text{TRIAL}) = 5997 (1 - \frac{2}{60-5.5}) = 854 \text{ cfs} \rightarrow \text{STAGE} = 7.2'$

$V/\text{STAGE} = 7.2'$ VOLUME = 2 AC-FT

BREACH $Q_{p2} = 5997 (1 - \frac{(2+2)/2}{60-5.5}) = 9511 \rightarrow \text{STAGE} = 7.2'$

UNDEVELOPED $Q = 9972 \text{ cfs} \rightarrow \text{STAGE} = 7.1$

$\therefore$ THE INCREASE IN STAGE CAUSED BY A BREACH AT MAXIMUM POOL WOULD BE ≈ 0.1 FEET.

NOTE: THE EFFECTS OF A BREACH AT MAXIMUM POOL HAVE BEEN ATTENUATED.

REACH #4

USE A TYPICAL CROSS SECTION ALONG THE DOWNSTREAM REACH FROM THE DAM TO THE SECTION 5300' DOWNSTREAM AT THE SHOPPING CENTER.

$$Q = 1.49/n AR^{2/3} S^{1/2}$$

LENGTH OF REACH = 1000 FT (5300 - 4300)

ELEVATION @ BEGINNING OF REACH = 353

ELEVATION @ END OF REACH = 395

SLOPE = 0.008

MASSITE $n = 0.075$

TRIAL #1 STAGE = 1'

$$Q = \frac{1.49}{0.075} \cdot 82 \left(\frac{82}{99.5} \right)^{2/3} (0.008)^{1/2} = 143 \text{ cfs}$$

TRIAL #2 STAGE = 3'

$$Q = \frac{1.49}{0.075} \cdot 250 \left(\frac{250}{99.5} \right)^{2/3} (0.008)^{1/2} = 302 \text{ cfs}$$

TRIAL #3 STAGE = 5'
 $Q = 1.49 / 0.015 \cdot 400 \cdot (1.49 / 0.015)^{2/3} \cdot (0.015)^{1/2} = 2.44 \text{ cfs}$

TRIAL #4 STAGE = 7'
 $Q = 1.49 / 0.015 \cdot 755 \cdot (1.49 / 0.015)^{2/3} \cdot (0.015)^{1/2} = 3590 \text{ cfs}$

TRIAL #5 STAGE = 10'
 $Q = 1.49 / 0.015 \cdot 2756 \cdot (1.49 / 0.015)^{2/3} \cdot (0.015)^{1/2} = 12,220 \text{ cfs}$

USE THE ABOVE TRIALS TO ESTABLISH A DOWN-STREAM X-SEC RATING CURVE.

FOR NORMAL POOL:

BREACH $Q_{P4} = 949 \text{ cfs} \rightarrow \text{STAGE} = 3.1'$

W/STAGE = 3.1' VOLUME = 2 AC-FT

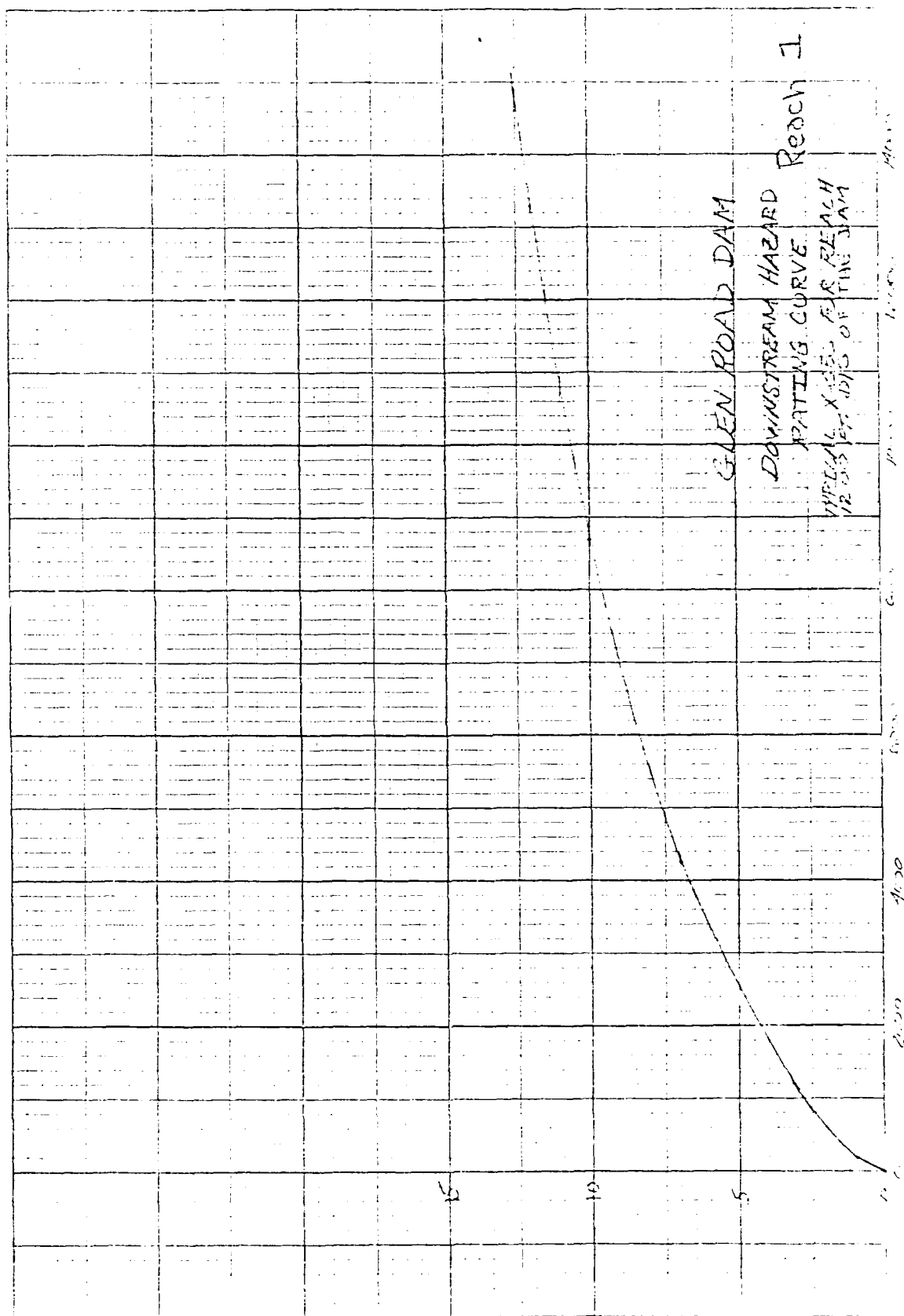
BREACH $Q_{P5} \text{ (TRIAL)} = 949 \left(1 - \frac{2}{30-2.7-4}\right) = 759 \text{ cfs} \rightarrow \text{STAGE} = 2.7'$

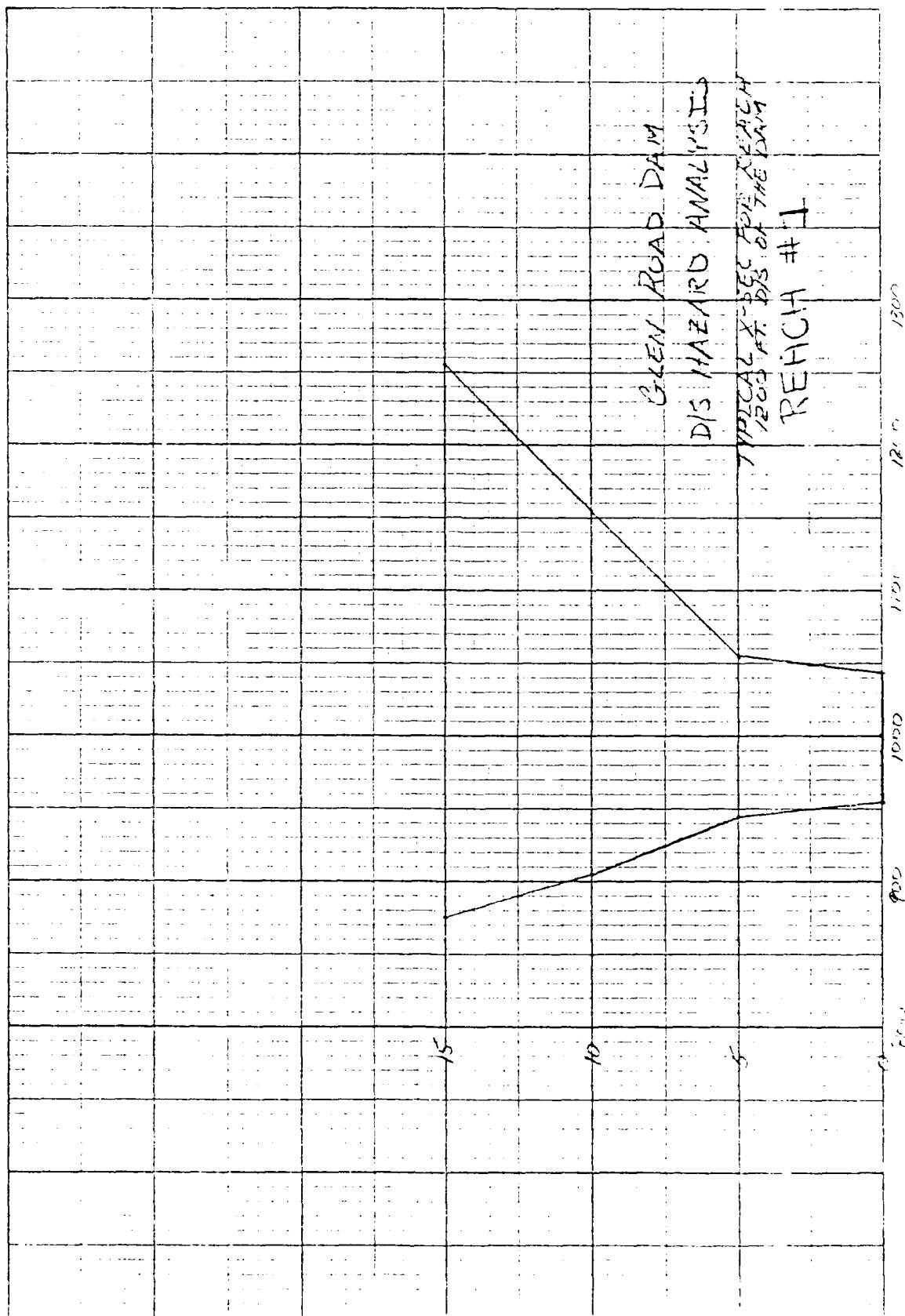
W/STAGE = 2.7' VOLUME = 1.5 AC-FT

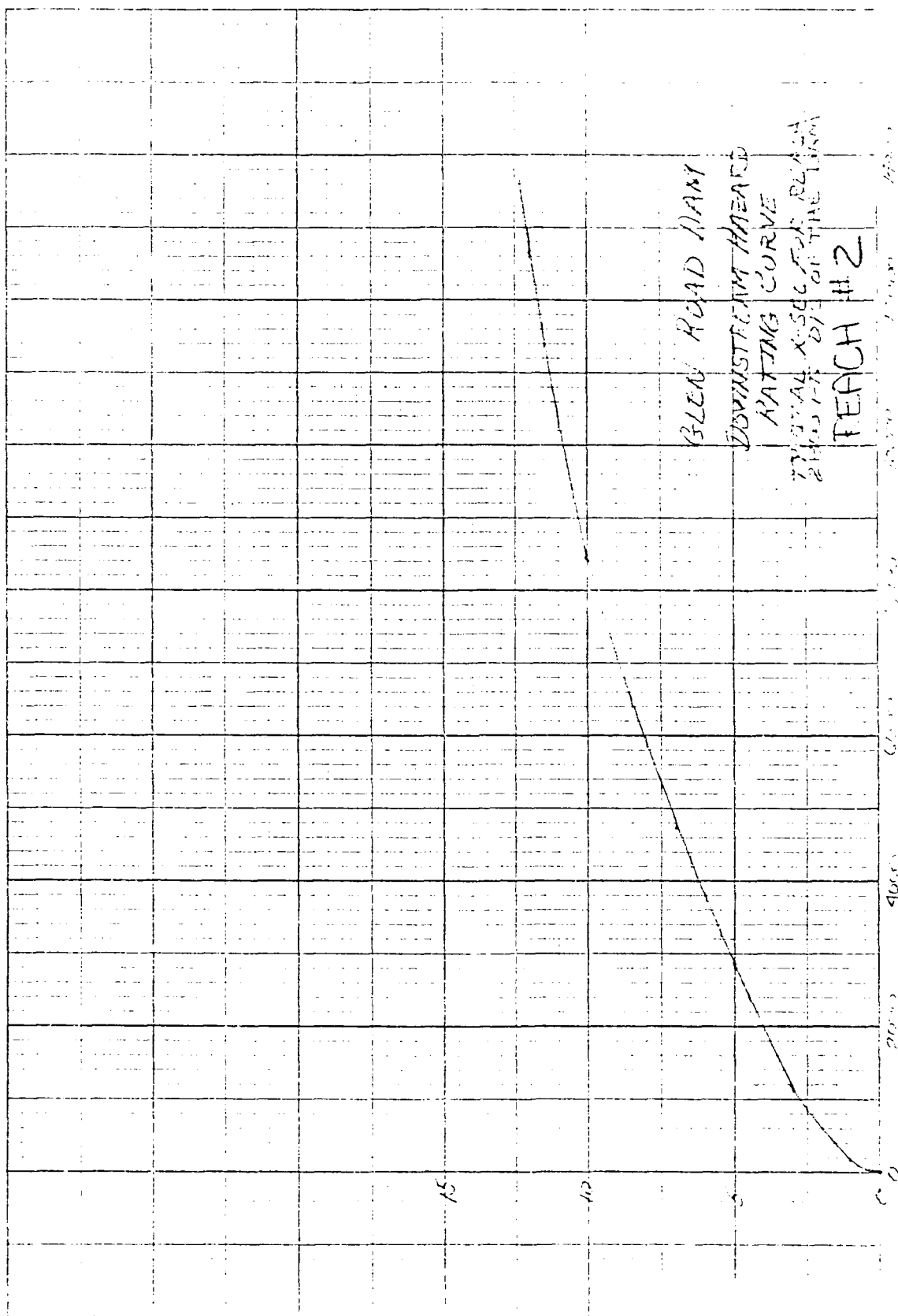
BREACH $Q_{P5} = 949 \left(1 - \frac{(2+1.5)/2}{30-2.7-4}\right) = 783 \text{ cfs} \rightarrow \text{STAGE} = 2.9'$

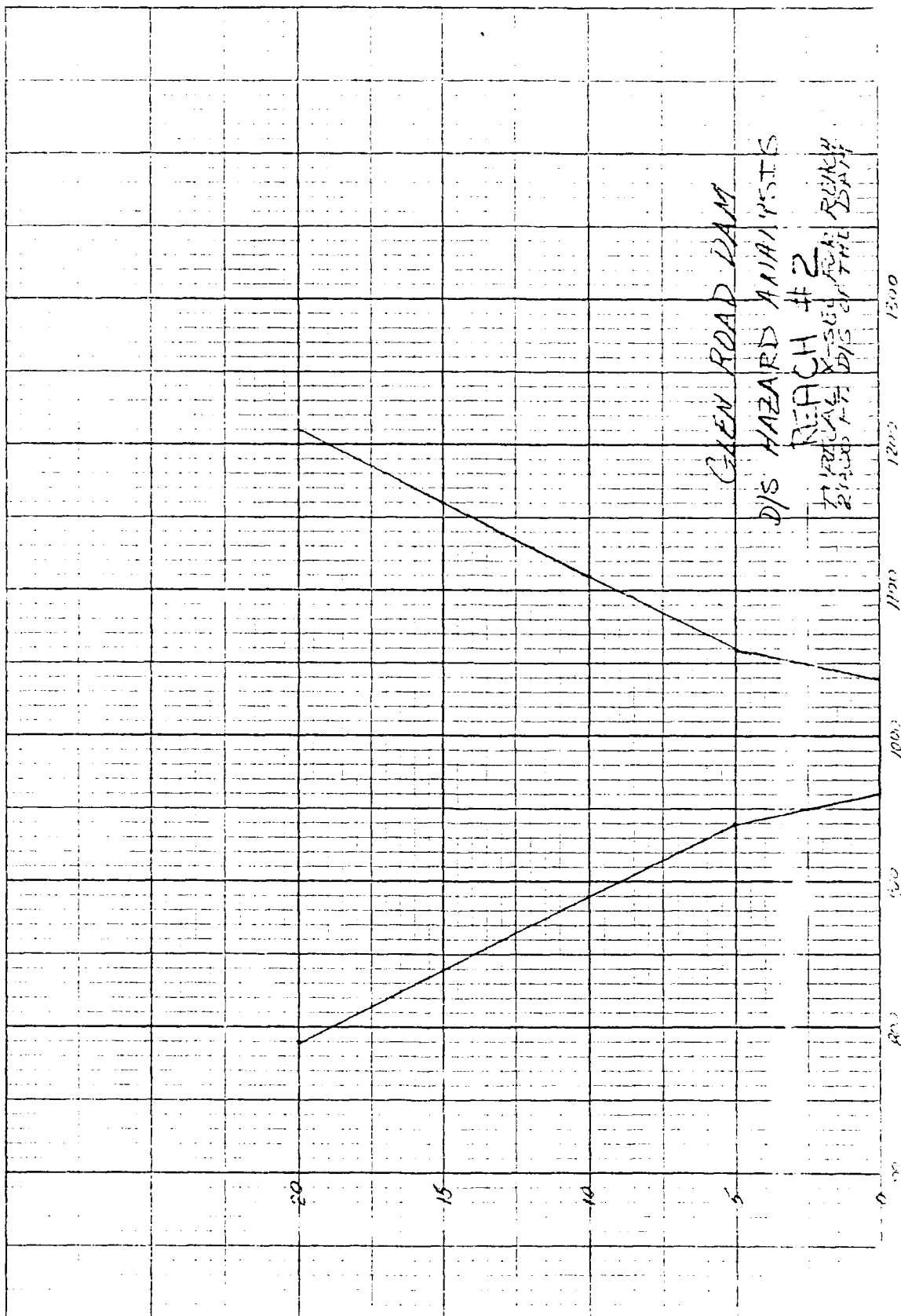
ANTECEDENT $Q = 407 \text{ cfs} \rightarrow \text{STAGE} = 1.9'$

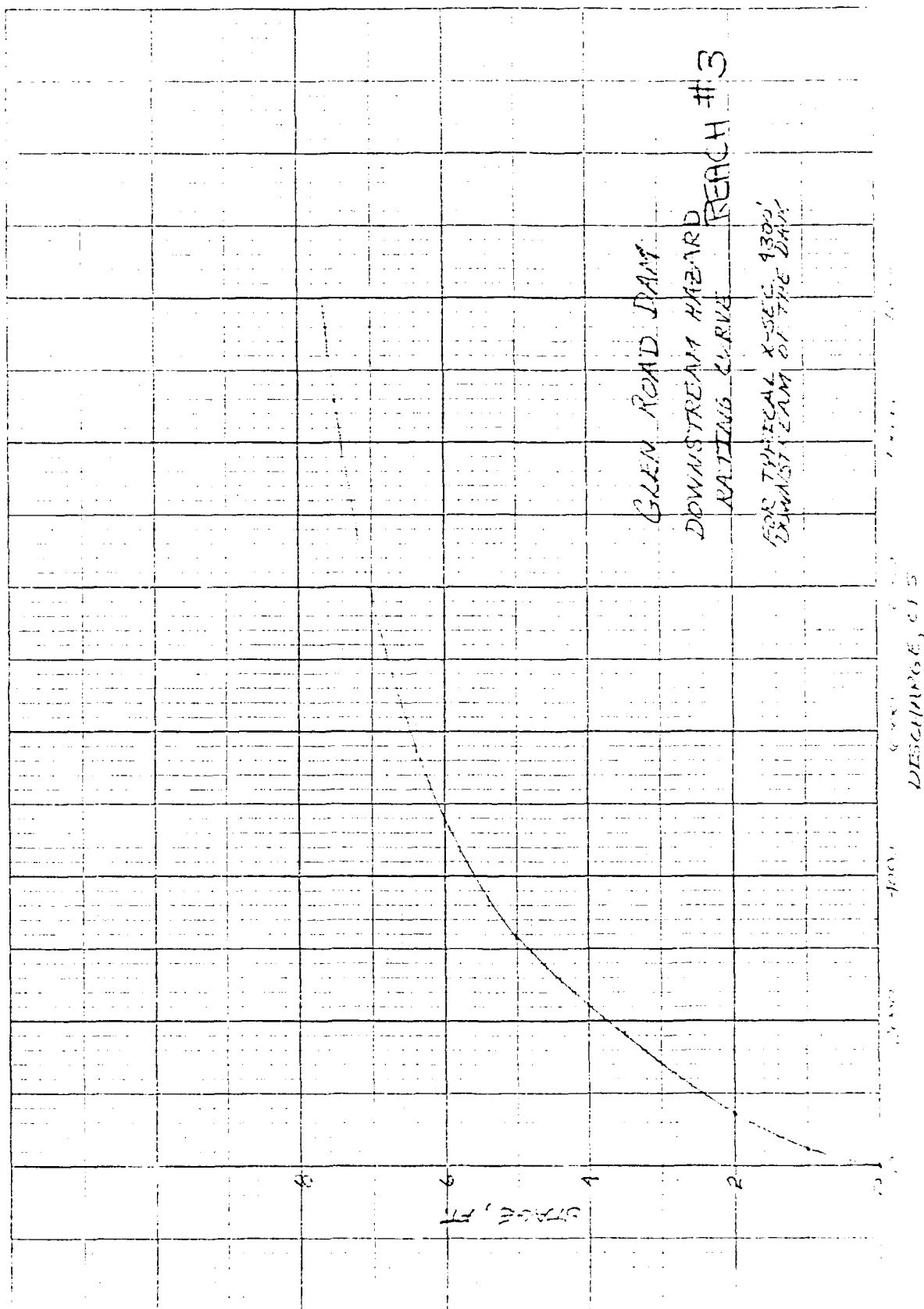
$\therefore$ THE INCREASE IN STAGE CAUSED BY A BREACH AT NORMAL POOL WOULD BE ≈ 0.9 FEET.

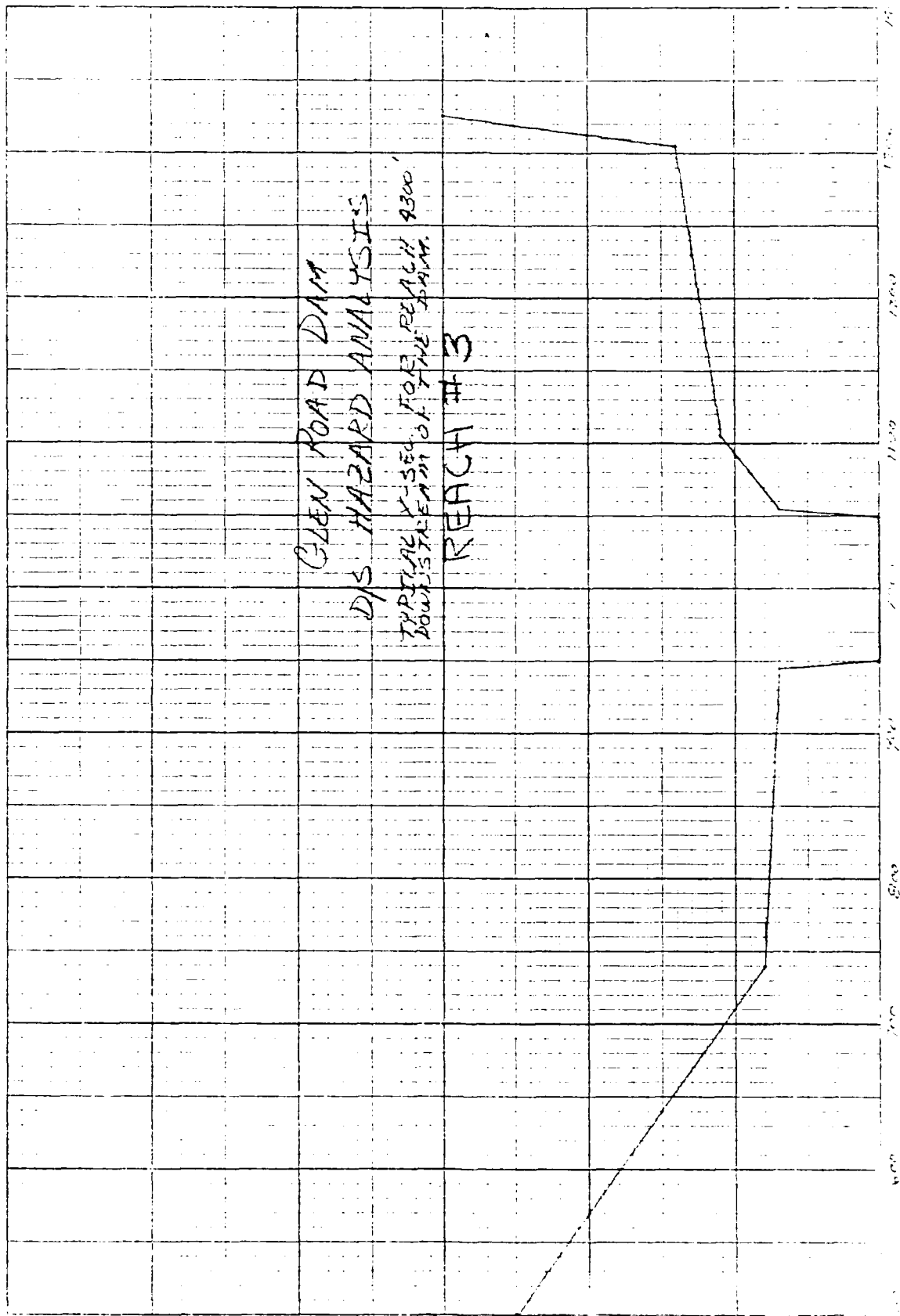








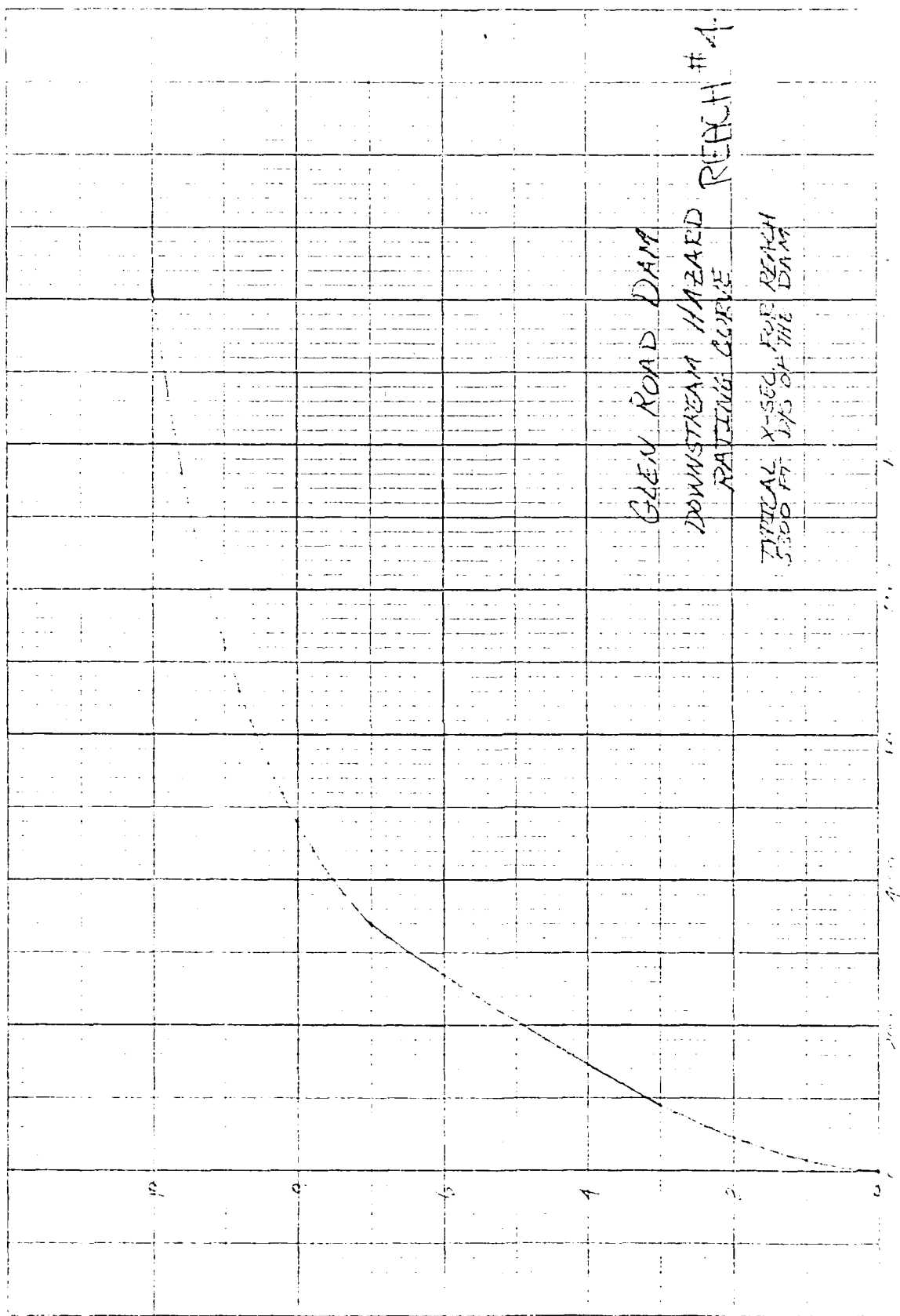


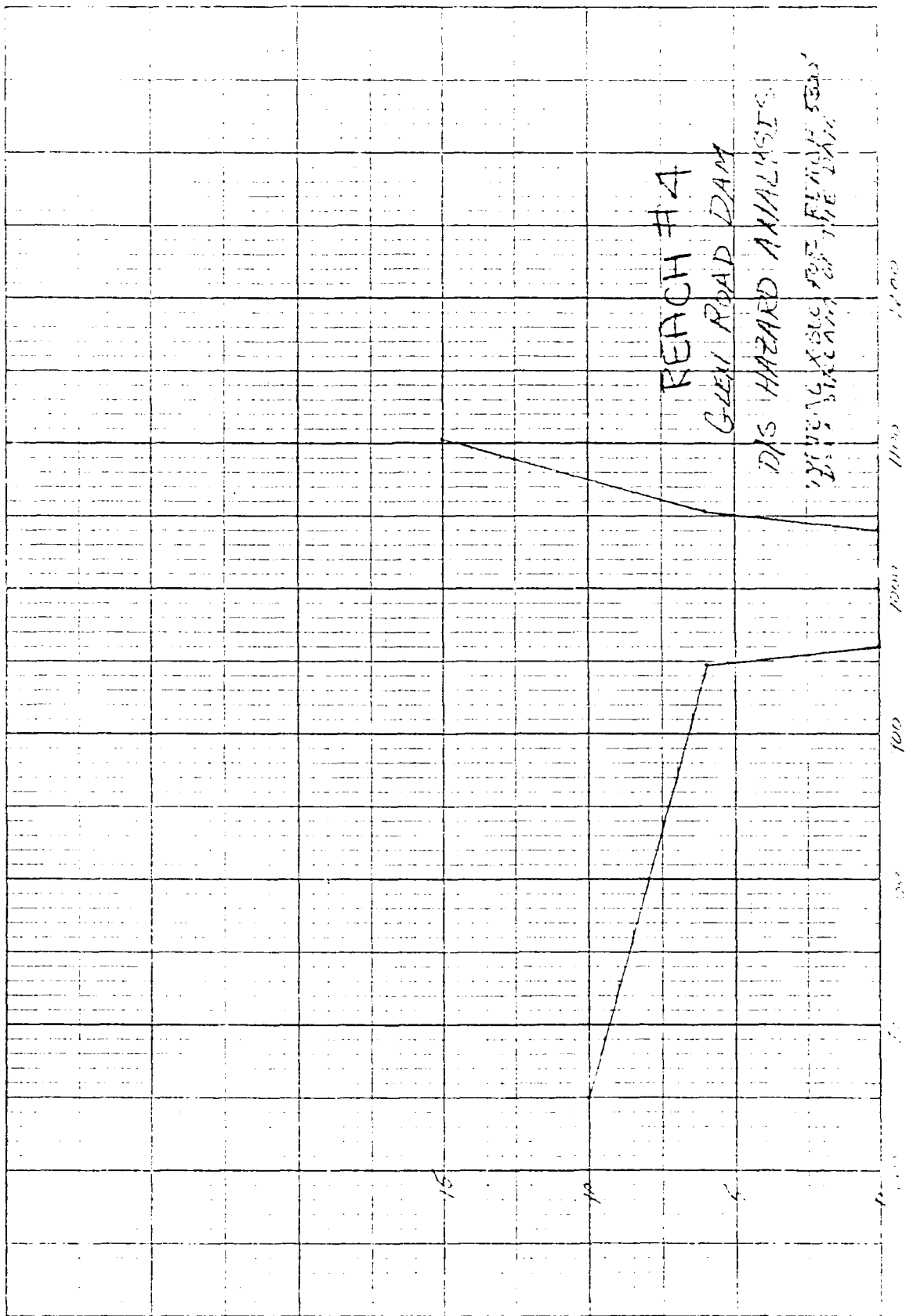


GLEN ROAD DAM
DIS HAZARD ANALYSIS

THREE V-SEC. FOR REACH 9300'
DOWNSTREAM OF THE DAM

REACH #3





Top Pass Dam

Determine approximate gate capacity
for two (2) 6'5" diameter openings

Calculate capacity of top dam 418' msl
using the orifice equation $Q = CA\sqrt{2gh}$
where $C = 0.8$ and $A = 405.2 \text{ sq. ft.}$

$$Q = (0.8)(405.2)\sqrt{2(32.2)(13.8)} \\ = 771.3 \text{ say } 770 \text{ cfs}$$

Total combined capacity of both
gates would be 1540 cfs

APPENDIX E

INFORMATION AS
CONTAINED IN THE NATIONAL
INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(g)				(h)		(i)	
COUNTY	STATE	COUNTY DIST.	COUNTY	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
ALABAMA	AL	1	ALABAMA	ALABAMA	33° 17' N	88° 51' W	1 SEP 1979

REGULAR NAME	NAME OF FOUNDMENT
WASLEY FIVE	

(1)	(2)	(3)	(4)	(5)
PERSONS	RIVER OR STREAM	NEAREST DOWNSTREAM CITY - TOWN - VILLAGE	DIST FROM DAM (MI.)	POPULATION
1	WASCO RIVER	LEAVENWORTH	0	9725

(1)	(2)	(3)	(4)	(5)	(6)	(7)
TYPE OF DAM	YEAR COMPLETED	PURPOSES	STORAGE CAPACITY (A.C.F.)	HYDRAULIC HEIGHT (F.T.)	MAXIMUM CAPACITY (A.C.F.)	EXISTING NORMAL CAPACITY (A.C.F.)
1. Concrete Gravity	1953	"	25	22	60	30

[illegible]

		NAVIGATION LOOKS									
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	POWER CAPACITY										
2	INSTALLED										
3	PRODUCED										
4	INW										
5	VOLUME										
6	CLAS										
7	SPILLWAY										
8	NAVRONT										
9	ORCHARGE										
10	IT										
11	TYPE										
12	NO.										
13	TYPE										
14	NO.										
15	TYPE										
16	NO.										
17	TYPE										
18	NO.										
19	TYPE										
20	NO.										
21	TYPE										
22	NO.										
23	TYPE										
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95	TYPE										
96	NO.										
97	TYPE										
98	NO.										
99	TYPE										
100	NO.										

OWNER	ENGINEERING BY	CONSTRUCTION BY
	(1)	

DESIGN	CONSTRUCTION	REGULATORY AGENCY	OPERATION	MAINTENANCE

INSPECTION BY	INSPECTION DATE		AUTHORITY FOR INSPECTION
	DAY	MO YR	

NAME	DATE	REMARKS

END

FILMED

8-85

DTIC