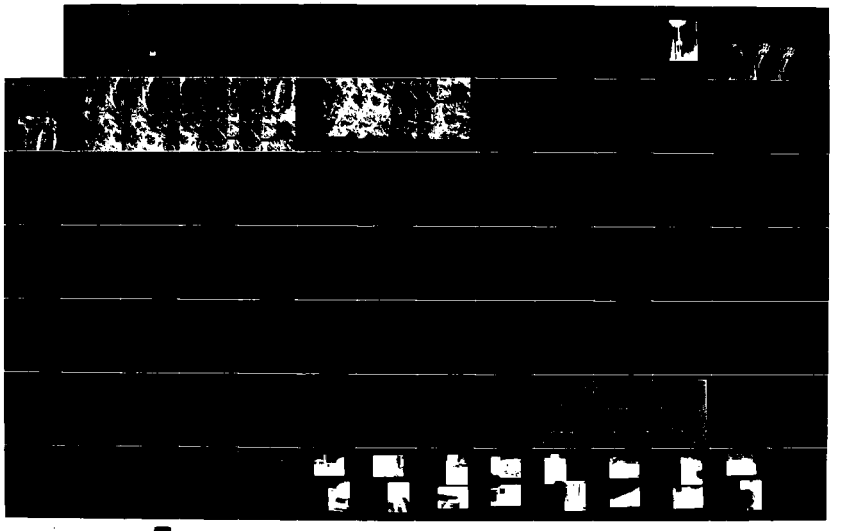
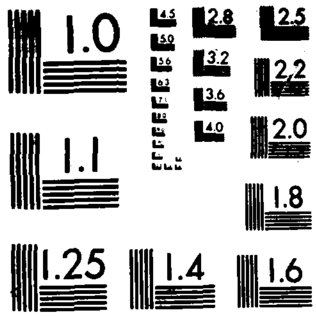
AD-A156 000 NATIONAL DAM INSPECTION PROGRAM MASCOMA LAKE DAM (NH00153) CONNECTICUT RIVER BASIN LEBANON NEW HAMPSHIRE (U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV MAY 79 1/2

UNCLASSIFIED F/G 13/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CONNECTICUT RIVER BASIN

LEBANON, NEW HAMPSHIRE

MASCOMA LAKE DAM

NH 00153

NHWRB 134.01

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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

MAY 1979

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NH 00153	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Mascoma Lake Dam NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS		5. TYPE OF REPORT & PERIOD COVERED INSPECTION REPORT 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPT. OF THE ARMY, CORPS OF ENGINEERS NEW ENGLAND DIVISION, NEDED 424 TRAPELO ROAD, WALTHAM, MA. 02254		12. REPORT DATE May 1979 13. NUMBER OF PAGES 98
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVAL FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

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

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 is of timber and stone crib with earth dikes as wingwalls. THe maximum height of the dam is about 18 ft. and is about 575 ft. long. The dam is judged to be in fair condition. It is intermediate in size with a high hazard potential classification. The project will pass about 13 percent of the test flood peak outflow without overtopping the earth dike.There are various remedial measures which should be implemented.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

MASCOMA LAKE DAM

NH 00153

NHWRB 134.01

CONNECTICUT RIVER BASIN
LEBANON, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	NH 00153
Name of Dam:	Mascoma Lake Dam
Town:	Lebanon
County & State:	Grafton, New Hampshire
Stream:	Mascoma River
Date of Inspection:	June 8, 1978

BRIEF ASSESSMENT

The existing dam is of timber and stone crib with earth dikes as wingwalls. The maximum height of dam is about 18 feet and is approximately 575 feet long. The outflow structures consist of a 112-foot flashboard section, a 36-foot stanchion log board section, and a 16-foot sluice opening. The spillway is equipped with pin-type flashboards designed to fail in successive portions as the lake level rises. The sluice opening is divided into four bays, each 4 feet by 4 feet, and controlled by four gates.

Based on visual inspection, the dam is judged to be in fair condition. The soil adjacent to the northwest corner of the gate house has settled. The lower 6 feet of the northern wing wall on the downstream side have settled 6 inches and apparently tilted. The wooden planks on the flashboard section were observed to be in poor condition. Continuance of this classification depends on proper operations and maintenance of the dam.

This dam falls under the category of high hazard potential, and it is intermediate in size. The estimated test flood peak inflow is equal to the probable maximum flood, 156,000 cfs, and the test flood outflow is about 124,000 cfs after routing through lake storage. Hydraulic analysis indicates that, with such a flood, the maximum pool elevation would be about 776.4 feet msl, overtopping the earth dike section of the dam by about 17.4 feet. Under test flood conditions, the spillway would likely no longer function as a hydraulic control as it would be submerged by downstream tailwater, and the downstream flooding would be the same whether or not the dam exists across the outlet of Mascoma Lake.

The project will pass approximately 13 per cent of the test flood peak outflow without overtopping the earth dike. The Mascoma Lake Dam was intentionally designed with a relatively low earth dike section to prevent a large hydraulic head buildup in the event of a major flood and the spillway was designed with sufficient capacity to produce a tailwater elevation approximately equal to headwater at time of dam overtopping, thus preventing a significant flood surge in the

event of overtopping and resulting breaking of the dam. Detailed hydraulic analysis was beyond the scope of this Phase I study but it was concluded that high tailwater conditions would be likely at this project in the event of a major flood flow with indications that differential head at the dam would likely not exceed about 6 feet at the dam during a major flood.

Within one year after receipt of this Phase I report, the New Hampshire Water Resources Board should implement the remedial measures resulting from studies made to determine the cause of settlement and movement of the lower portion of the northern wingwall on the downstream side.

The following remedial measures, as stated in Section 7.3, should also be implemented:

(1) All concrete surfaces should be repaired and the wooden planks on the flashboard section should be replaced.

(2) Proper grades of the settled area at the northwest corner of the gate house should be reestablished, and a program be prepared and initiated to repair the slope protection as it becomes necessary.

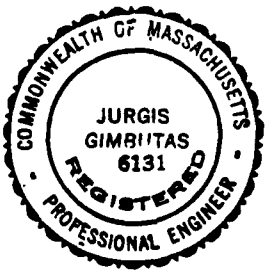
(3) All vegetation should be removed from the dike embankment and the riprap on the dikes be completed.

(4) Observation for scour around downstream steel sheet piling should be made under adverse conditions.

(5) A program of regular maintenance should be established and the owner should develop a formal warning system.

(6) The technical annual periodic inspections being performed by the engineering staff should be continued.

FAY, SPOFFORD & THORNDIKE, INC.
By



Jurgis Gimbutas, P.E.
Project Engineer

Richard W. Albrecht, P.E.
Vice President

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.

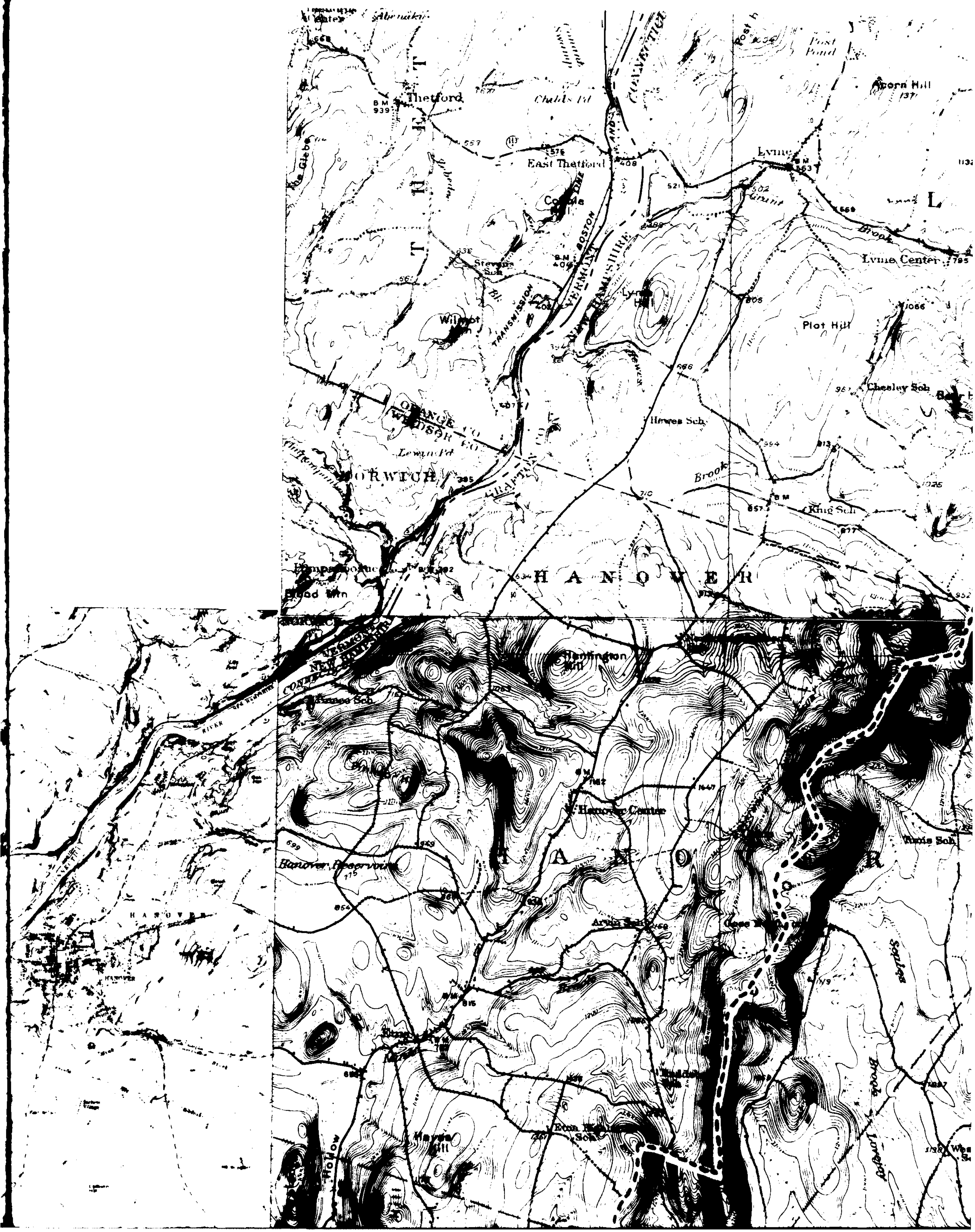
It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the 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 reasonable 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.

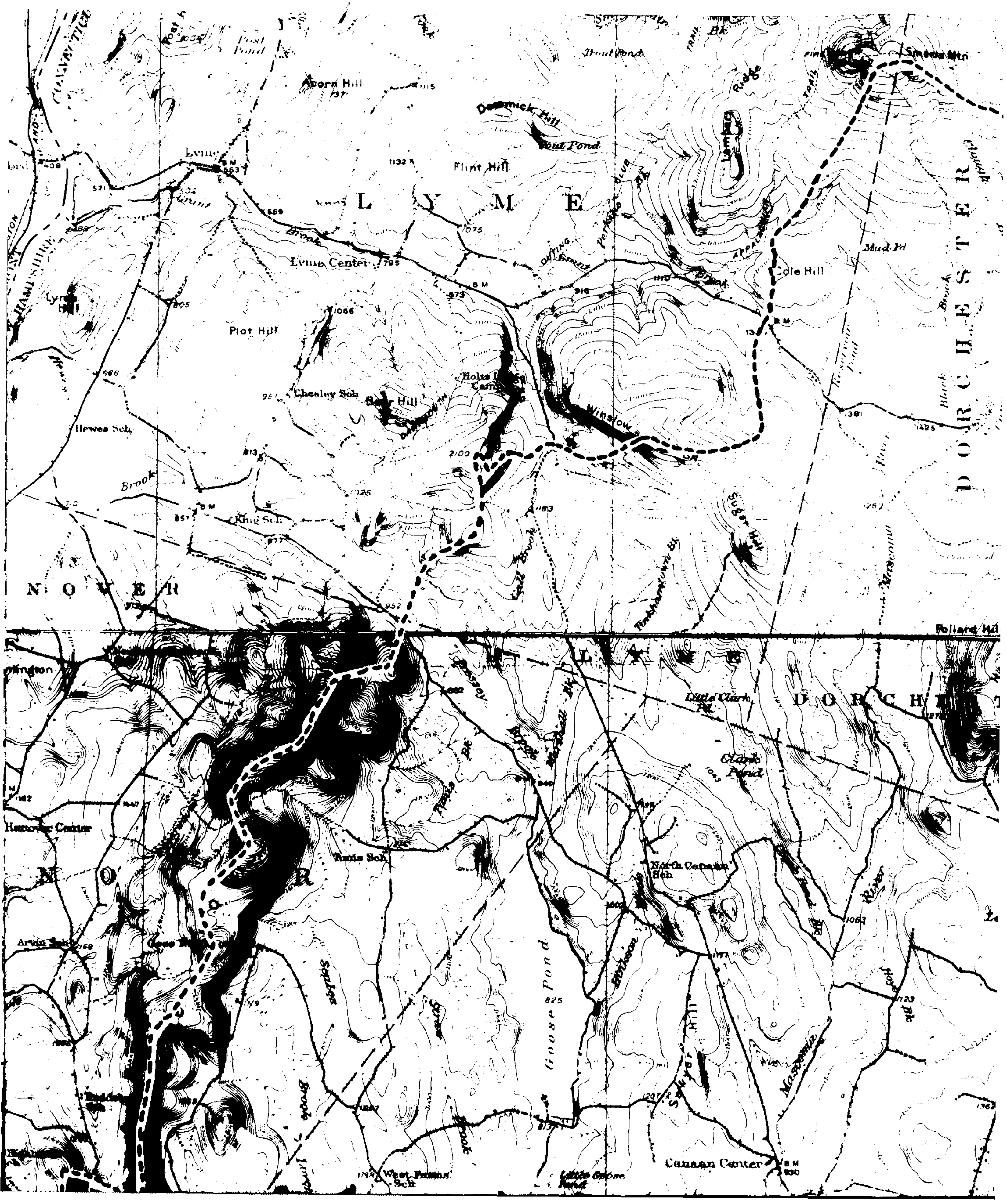
TABLE OF CONTENTS

OVERVIEW PHOTOGRAPH

MASCOMA LAKE DAM, LOOKING UPSTREAM
Negative No. 7-31A



Thetford
East Thetford
Lyme
Lyme Center
Acorn Hill
Post Pond
Plot Hill
Chesley Sch
Hewes Sch
King Sch
Stevens Sch
Wilmot Hill
Lyme Hill
Childs Pd
Brook
NORWICH
ORANGE CO
WINDSOR CO
VERMONT
NEW HAMPSHIRE
BOSTON
TRANSMISSION
H A N O V E R
Huntington Hill
Hanover Center
Hanover Reservoir
H A N O V E R
Tunis Sch



Smarts Mtn
Trout Pond
Acorn Hill
Post Pond
Flint Hill
Lyme
L Y M E
Lyme Center
Brook
Cole Hill
Mud Pd
D O R C H E S T E R
Plot Hill
Lyme Hill
Chesley Sch
Hewes Sch
Winslow
King Sch
Pollard Hill
Little Clark Pd
Clark Pond
Hanover Center
Tunis Sch
North Canaan Sch
Goose Pond
River
Canaan Center
West Farms Sch
Little Goose Pond

1.3 Pertinent Data

a. Drainage Area

Mascoma Lake as shown on the U.S.G.S. Quadrangle Sheet is located on the headwaters of Mascoma River. It has a total drainage area of 153 square miles. The watershed is highly wooded and is of mountainous topography.

b. Discharge at Dam Site

(1) Outlet works: four gated waste sluices, size 4 feet by 4 feet each.

556 cfs at spillway crest Elevation 749 (all four gates fully open).

1,190 cfs at top of dam Elevation 759.0 (estimated) (all four gates fully open).

(2) Maximum known flood at dam site - flood of March, 1936, and the corresponding flow was 5,800 cfs.

(3) Ungated spillway capacity at top of dam - 15,700 cfs - at Elevation 759.0.

(4) Ungated spillway capacity at test flood maximum pool - discharge unknown at Elevation 776.4.

c. Elevation (Feet above MSL)

(1) Top dam - 759.0

(2) Test flood maximum pool - 776.4.

(3) Full flood control pool - not applicable.

(4) Recreation pool - 751.0.

(5) Spillway crest - 749.0.

(6) Stream bed at centerline of dam - 742.0 (estimated).

(7) Maximum tail water - 774.0 (estimated).

d. Reservoir

(1) Length of maximum pool - 4.5 miles (estimated).

18-, 20-, and 56-foot sections. With the cooperation of USGS, a new recording water level gauge was installed during the latter part of 1953. A separate shed to house the instruments was built near the north end of the upstream slope of the dam. All these improvements were made by the New England Power Service Company. The New England Power Service Company prepared a new four-page operating guide, dated October 20, 1953. This guide included detailed instructions for the attendant of the dam. A telephone was also installed at the gatehouse on the dam.

In 1960, an automated gaging system was installed and is still in operation. In 1968, the New Hampshire Water Resources Board engineers revised the 15-year old operating guide.

In February, 1978, the New Hampshire Water Resources Board prepared plans for improvements of the gates in the dam, which included four stainless steel gate items and new and larger timber gates, 5 feet 10 inches by 4 feet 5 inches and 6 inches thick. A letter dated February 22, 1978, stated the reason for these improvements as "parts of existing system have failed."

i. Normal Operational Procedure

The water level at the dam site is read at least once a day by use of a telemark gage, which is connected to the office of the New Hampshire Water Resources Board in Concord. Under normal conditions, this dam is checked weekly by personnel of the New Hampshire Water Resources Board using their established procedures. A log book is kept at the dam site and entries, including gate operations, needle beam, pin board failure, and gage readings, as well as general comments of value for the record, are made by date and time.

In accordance with the operating guide, Mascoma Lake is drawn down during the winter and early spring by removing logs from the stanchion board section of the dam. The crest of the stanchion board section can be lowered to a minimum elevation of 747.3. After the peak runoff passes and before June 1, the stop logs in the stanchion board sections are replaced to a maximum elevation of 751.0. With the advent of snow melt and precipitation, the level of the lake is controlled by operating the gates to an elevation not exceeding 751.0. If the inflow should suddenly increase during other periods of the year, the lake level is controlled to an elevation not exceeding 751.0 by operation of the gates and the lowering of the stop log crest by removal of the logs. When the inflow during any season is excessive and the pond elevation cannot be controlled at Elevation 751.0 by means of the gates and the stop logs, the lake will rise and spill over the flashboards. For operational procedures for lake levels above Elevation 751.0, see operating guide dated 1968 in Appendix B.

feet, as the total fall from Mascoma Lake to the Connecticut River was 425 feet within a 10 3/4-mile length.

The oldest technical description of Mascoma Lake Dam can be found on an USGS inventory card dated 1927. This dam was described as an 8-foot high timber dam with a 150-foot long spillway and a drainage area of 145.6 square miles. Extensive repairs had been made to this dam in 1918.

At the end of 1934, New England Power Engineering and Service Corporation, Boston, Massachusetts, completed extensive repairs to the dam. The height of the dam remained the same, but the abutment and the earth embankments were raised 2 feet to an elevation of 758.0. The old wooden crib was rebuilt using 8-inch by 10-inch hemlock or spruce, and the deck sheeting was replaced with 4-inch thick hemlock. The new apron sheeting was 4 inches thick. The four gates at the north abutment were not changed. The spillway was 158 feet long. After the 1936 flood, this dam was partially rebuilt.

In 1948 the new owner, Granite State Electric Company made extensive repairs to the dam and engaged New England Power Service Company of Boston (formerly called the New England Power Engineering and Service Corporation) to do the work. The reconstruction consisted of replacing the old timber dam and flashboards with a new timber dam approximately 9 feet high. The new spillway was made of two sections: one 36 feet long with stanchion stop logs 6.5 feet high, and the other 112 feet long with 3-foot high pin-type flashboards for a normal pond level at Elevation 752.0. The old gate structure and the house on it was not affected by the reconstruction. The entire flow was diverted through the gates near the north abutment. A steel footbridge with creosoted planking was built over the stop log section of the dam. A timber pier was built between the two sections of the spillway. New gate and hoist installations, gate house lighting, and conduit layout were done.

The design called for 2 feet of riprap on the downstream slope of both embamkments at the ends of the dam, and 1 foot of riprap on the top and the upstream side. The only riprap observed was on the upstream slope.

The pin-type flashboards were designed to fail when the water surface of the lake reached a predetermined elevation. This occurred during the March 1953 flood, and some buildings on the lower part of Lebanon were flooded without warning.

The criticism of the operation and the design of Mascoma Lake, following the 1953 spring flood, resulted in improvements. The flashboard pins were redesigned to give definite stepped failures in

d. Hazard Classification

In the event of failure of this dam, the city of Lebanon, which is at a distance of approximately 3 miles downstream from the dam, will be in danger of being flooded. The depth of water at the damage impact area, as shown in Appendix D, is estimated. It is also estimated that more than a few lives could be lost and excessive property damage could probably occur in the event of the failure of this dam. Therefore, on the basis of Table 2, Hazard Potential Classification, in the "Recommended Guidelines for Safety Inspection of Dams," furnished by the Corps of Engineers, this dam falls in the category of high hazard potential.

e. Ownership

Mascoma River Improvement Company of Lebanon, New Hampshire, has been the owner of this dam from approximately 1917 until 1948. In 1948, the Granite State Electric Company of Lebanon, New Hampshire obtained ownership of the dam.

In 1969, the water rights, land, and buildings connected therewith in Lebanon and Enfield for Mascoma Lake Dam were acquired by the New Hampshire Water Resources Board for the benefit of the state being exempt from taxation.

f. Operator

The operator of Mascoma Lake Dam is the owner, New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire, telephone (617) 271-3406. The chief engineer is Vernon A. Knowlton. When necessary, the water plant of the city of Lebanon provides assistance in operation.

g. Purpose of Dam

The dam has to fulfill three objectives: supply water to the City of Lebanon (minimum 40 cfs); maintain a comfortable recreational level of the lake; and prevent the water from rising in case of a large runoff. Each spring the dam releases enough "white water" for downstream racing. In an emergency, the water supply needs would have priority.

h. Design and Construction History

The profile of Mascoma River, surveyed by C.A. & A.B. Downs of Lebanon, New Hampshire, and dated 1881, indicated a dam at the Mascoma Lake outlet. At that time, the dam at the lake had a head of 7

b. Description of Dam

This dam consists of three different sections: a rock-filled timber crib, 156 feet long; a concrete abutment, containing sluice gates, 27 feet long; and two earth embankments at each end, approximately 392 feet long. The total length is approximately 575 feet.

Sheet piling was provided over the entire 156-foot long timber section. At the toe 10-foot deep steel sheet piling and at the heel, 5 foot wooden sheet piling was provided.

Near the south abutment, which is a rock-filled timber crib, there is a 112-foot long timber crested spillway with 3-foot high flashboards that are supported by steel pins. To the north, there is a timber pier. Adjacent to the pier is a 36-foot long stop log control outlet with steel stanchions. The top of the stop logs is at a maximum elevation of 752.0. The top of the flashboards of the spillway is at Elevation 752.0 (Photographs No. 1, 2 and 4, Appendix C).

At the north end of the dam, the right bank of Mascoma River, there is a reinforced concrete gate house with four gates, each 4 feet by 4 feet. At the time of our inspection, three gates were electrically operated and one manually operated. There is a steel frame footbridge from the gate structure to the pier at the spillway (Photographs No. 3 and 10, Appendix C).

The structural height of the dam at the spillway is 9 feet from the stream bed to the top of the flashboards. The height of the concrete gate structure is approximately 18 feet. The dam is 27 feet wide near the river bed.

The earth embankments have upstream slopes of 1 vertical to 2 horizontal, and the downstream slopes of 1 vertical to 1 1/2 horizontal. The top of the embankment is at Elevation 759, which is 7 feet higher than the top of the spillway (Photographs No. 7, 8, and 15, Appendix C).

c. Size Classification

The storage capacity at the level of the full pond or the top of the boards is 9,600 acre-feet, which falls in the range $\geq$ 1,000 and $<$ 50,000 acre-feet. Therefore, on the basis of Table 1, Size Classification, in the "Recommended Guidelines for Safety Inspection of Dams," furnished by the Corps of Engineers, the dam is classified as intermediate in size .

MASCOMA LAKE 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. Fay, Spofford & Thorndike, Inc., Engineers, have 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 was issued to Fay, Spofford & Thorndike, Inc., under a letter of May 3, 1978, from Mr. Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0308 has been assigned by the Corps of Engineers for this work.

b. Purpose

(1) 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) 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

Mascoma Lake Dam is located in the central eastern part of the State of New Hampshire and about 10 miles above the mouth of the Mascoma River, which is a tributary of the Connecticut River. The dam site is 3 miles upstream from the city of Lebanon and the small village of Mascoma is situated near the dam.

NEW HAMPSHIRE - VERMONT

HANOVER QUADRANGLE 1957
AMS 6571 III NE SERIES V813

MASCOMA QUADRANGLE 1927
MT. CUBE QUADRANGLE 1931

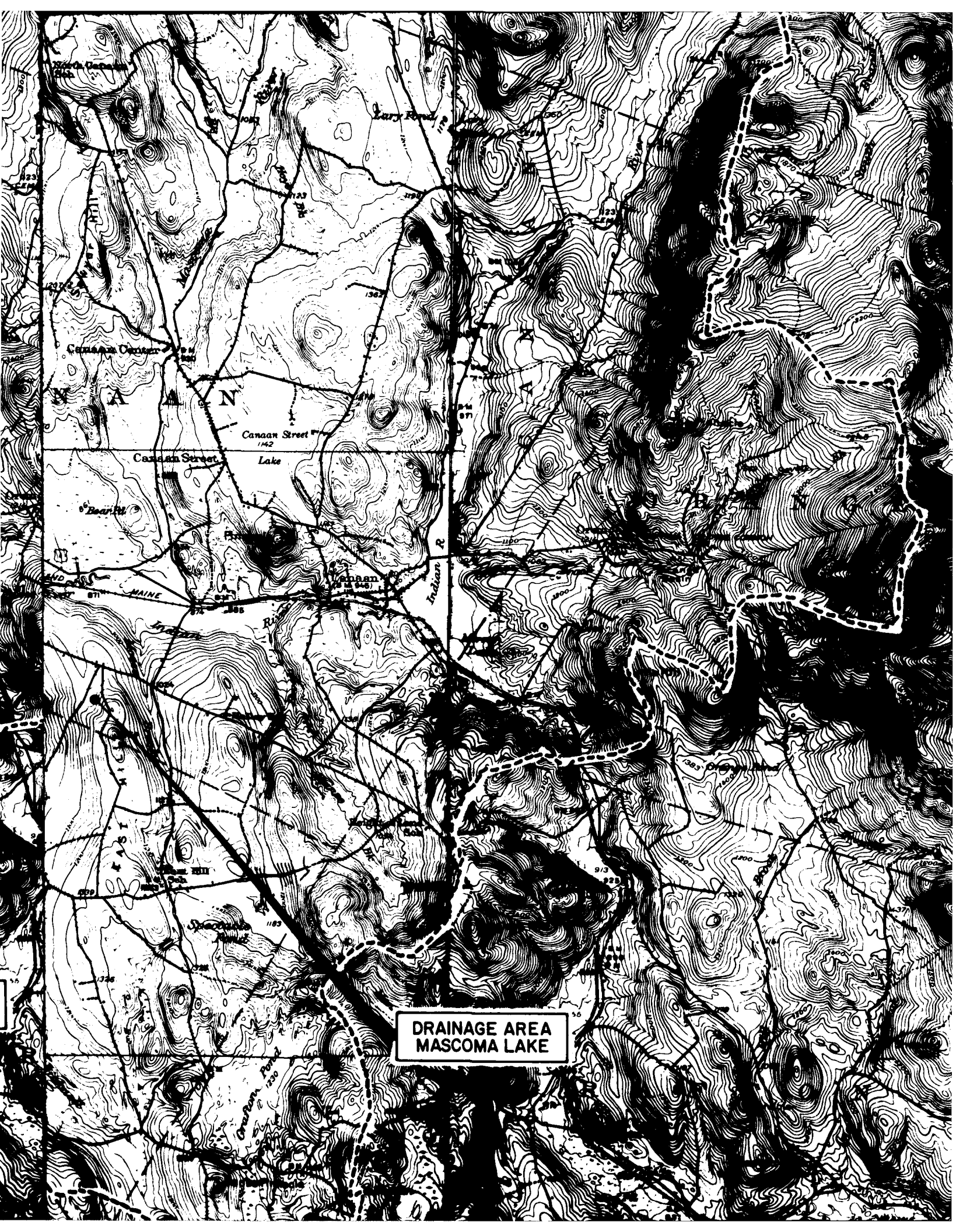
NEW HAMPSHIRE

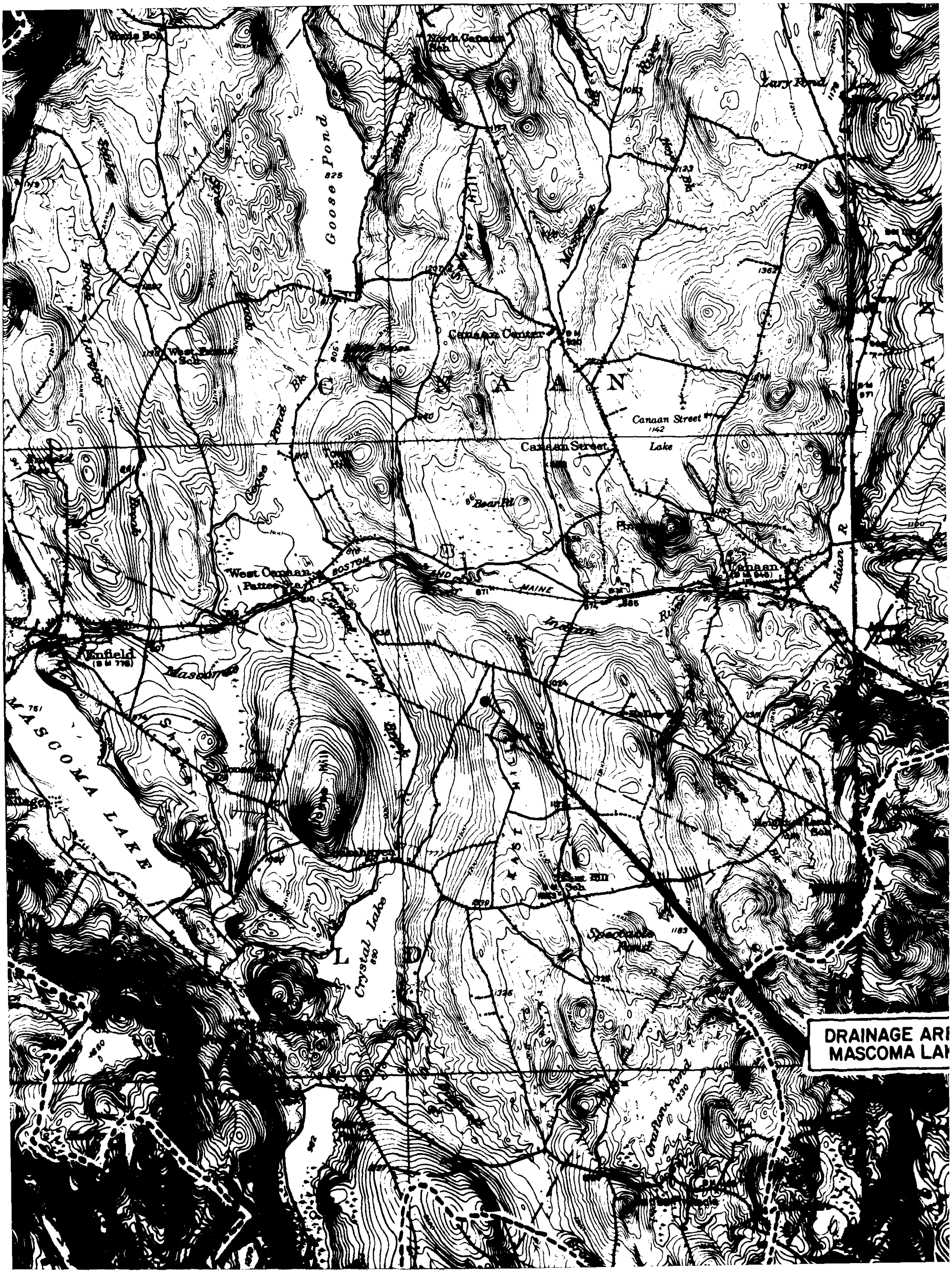
CARDIGAN QUADRANGLE 1956
AMS 6671 III-SERIES V712

RUMNEY QUADRANGLE 1928

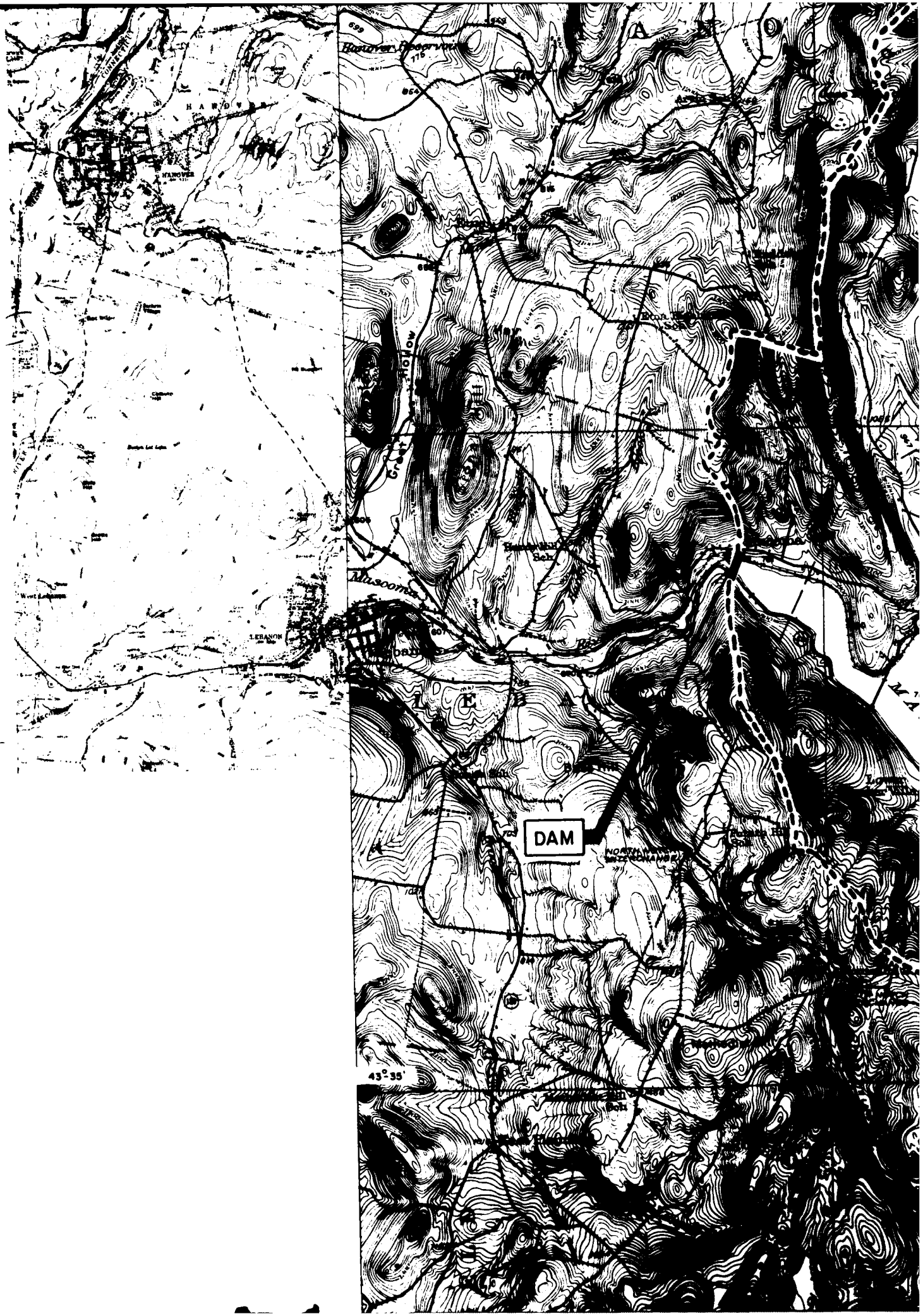
SCALE 1:62500(ACTUAL)

UNITED STATES
DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY


DRAINAGE AREA
MASCOMA LAKE


DRAINAGE ARE
MASCOMA LAK
Goose Pond
Lary Pond
Canaan Center
C A N A A N
Canaan Street
Lake
Bear Hill
West Canaan
BOSTON
MAINE
Canaan
Indian R
Enfield
MASCOMA LAKE
Crystal Lake
Spectacle Pond
Grafton Pond


Hanover Center
Goose Pond
825
West Canaan
Enfield
MASCOMA LAKE
751
DAM
Crystal Lake
BOSTON


DAM
43°-35'


DORCHESTER
Line Pond
Mud Pd
Cole Hill
Black Brook
Cummings Pd
DOG CAMP
Mud Pond
Dorchester
Clark Pond
Lary Pond
N

(2) Length of recreation pool - 4 miles.

(3) Length of flood control pool - not applicable.

e. Storage (Acre-Feet)

(1) Top of dam - 18,300 acre-feet.

(2) Test flood pool elevation - 40,000 acre-feet.

(3) Flood control pool - not applicable.

(4) Recreation pool or conservation pool - 8,332 acre-feet.

(5) Spillway crest - 6,166 acre-feet.

f. Reservoir Surface (Acres)

(1) Top of dam - 1,244 acres.

(2) Test flood maximum pool - 1,445 acres.

(3) Flood control pool - not applicable.

(4) Recreation pool - 1,155 acres.

(5) Spillway crest - 1,128 acres.

g. Dam

(1)	Type	Wooden crib and earth dikes.
(2)	Length	575 feet.
(3)	Height	18 feet.
(4)	Top width	Dike - 10 feet; flashboard section - 5 feet.
(5)	Side slopes - Dike	
(1)	Upstream	1 vertical to 2 horizontal.
(2)	Downstream	1 vertical to 1.5 horizontal.

(6) Zoning	Not applicable.
(7) Impervious core	Not applicable.
(8) Cutoff	Concrete core wall extending some 25 feet from the concrete gate structure into the dike.
h. Spillway	
(1) Type	Spillway consists of two sections: one section consists of pin-type flashboards; second section consists of stanchion boards.
(2) Length of weir	Stanchion section is 36 feet long divided into seven bays. Flashboard sections is 112 feet long divided into four bays. The total length is 156 feet.
(3) Crest elevation	Sill elevation in stanchion section is 745.54. Sill elevation in flashboard section is 749.03.
(4) Control mechanism	3-foot high flashboards in flashboard section; 6.5-foot high stanchion log boards.
(5) U/S Channel	Lake.
i. Regulating Outlets	
(1) Invert	743.2.
(2) Size	16 feet long and divided into four bays, each 4 feet by 4 feet.
(3) Description	Wooden gates.

(4) Control mechanism	Four gates - three gates operated by an electrically driven motor, and one gate temporarily operated manually.

SECTION 2 - ENGINEERING DATA

2.1 Design

Drawings indicating plans, elevations and sections of the dam and appurtenant structures, including the details of the discharge facilities, such as outlet works, limited service and emergency spillways, flashboards, fuse plugs, and operation equipment, are available from project records. Selected drawings are included in Appendix B.

2.2 Construction

No engineering data are available on the construction of this dam.

2.3 Operation

The records of operation of this dam are available at the New Hampshire Water Resources Board office. Extensive repairs to the original dam were made in 1918. Subsequently, extensive damage was done to the dam in 1936, and repairs were made in 1937. In 1948, the dam, as now existing, was reconstructed. During the flood of 1953, significant flood damage occurred in the town of Lebanon. In 1953, a recording gage was installed and an operating guide was prepared. After the New Hampshire Water Resources Board obtained ownership in 1968, a telemetered recording gage was installed at the U.S.G.S. Stream Gaging Station in West Canon. Repairs to all four gates in the sluiceway had been proposed in February, 1978.

2.4 Evaluation

a. Availability

Pertinent structural, geotechnical, hydrologic, and hydraulic data, which formed the basis of the design of the dam, are available on a limited basis from the project records.

b. Adequacy

Sufficient engineering data are available for a Phase I inspection.

c. Validity

The available engineering data is considered valid on the basis of the results of the visual inspection.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

The Phase I inspection of the Mascoma Lake Dam was performed on June 8, 1978. A copy of the inspection check list is included in Appendix A.

a. General

In general, the soil features are in fair condition. The concrete was observed to be in poor condition, see subparagraph c.

b. Dam and Dikes

The timber dam, consisting of rockfill for a length of 112 feet covered with wooden planks on both the upstream and the downstream faces, is in poor condition. No evidence of vertical or horizontal misalignment was observed.

The rock slope protection on the upstream slopes of both dikes is in fair condition. Vegetation, consisting of grass and weeds, was noted on both the upstream and downstream slopes and on the top of the dike. Small bushes and trees were observed on the downstream slope. The condition of the riprap was probably due to lack of continued maintenance. There is no indication of sloughing, bulging or movement of the slopes. No evidence of seepage or piping was observed.

The soil adjacent to the northwest corner of the gate house has settled. Observations indicate that this was probably caused by erosion.

c. Appurtenant Structures

The concrete of the gate house wingwalls is in poor condition. Joint alignment is generally good, but both horizontal and vertical cracks were observed. No cavitation was noted but several areas of spalling were observed. The bottom 6 feet of the northern wingwall on the downstream side has settled 6 inches and apparently has tilted. Water is flowing behind the wingwall and eroding the adjacent soil. Observations indicated that the fill behind the lower 6 feet of the wingwall consisted of boulders. The slope above this wingwall has been protected with a thin layer of lean concrete (Photographs No. 11 and 12, Appendix C).

Field observations indicate that the gate house is a wooden framed small building on a concrete substructure. This building is well maintained and houses the gate operating equipment. The concrete substructure, which contains the sluice openings, is in poor condition. Both horizontal and vertical cracks show areas of erosion. (Photographs No. 5 and 9, Appendix C). Joint alignment is generally good and no cavitation was noted.

The building housing the telemark gage is approximately 50 feet north of the gate house. The slope of this gage house has been protected with a thin layer of lean concrete. Cracks were observed in the lower portion of the slope, which indicated that the existing slopes are too steep (Photographs No. 13 and 14, Appendix C).

The wooden footbridge connecting the gate house to the spillway is in good condition except for the loose steps at the south end. The railing for the footbridge is also in good condition.

d. Reservoir Area

Mascoma Lake is located at the headwaters of Mascoma River between the towns of Enfield and Lebanon. There are three conservation reservoirs draining into Mascoma Lake, namely, Goose, Grafton, and Crystal Lakes. Mascoma Lake has a full pond area of 1,155 acres, a length of about 4 miles, a maximum width of 1 mile, and a shoreline of about 8 miles. There are several cottages and docks around the shore of the lake. The shoreline of Mascoma Lake is heavily wooded.

e. Downstream Channel

The downstream channel and side slopes are in good condition. Approximately 1,000 feet downstream from the dam, there is a highway bridge across the Mascoma River, which is a restriction in case of flood (Photograph No. 16, Appendix C).

3.2 Evaluation

The observed condition of the dam is fair. The potential problems observed during the visual inspection are:

a. Settlement of the area adjacent to the northwest corner of the gatehouse.

b. Settlement and movement of the lower portion of the northern wingwall on the downstream side.

c. Poor condition of the wooden planks on the upstream and downstream face of the flashboard section.

d. Concrete erosion.

e. Potential for overtopping.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

The New Hampshire Water Resources Board has operated the Mascoma Lake Dam since 1969. The lake level is maintained by a flashboard section and a stanchion log board section. The flow is controlled by manually operated stanchion log boards. The flashboard section is equipped with pin-type flashboards designed to fail in successive portions as the lake level rises. Draw down is accomplished by opening the four sluice gates. Three of the four gates are operated by an electrically driven motor and one is operated manually on a temporary basis. See Section 1.2.i for further details.

4.2 Maintenance of Dam

The maintenance of Mascoma Lake Dam is the responsibility of the New Hampshire Water Resources Board. This Board plans to reconstruct the flashboard section of the dam and to replace the existing gates.

4.3 Maintenance of Operating Facilities

Maintenance of the gate operating facilities, which control the opening of the undersluice in the old concrete section, is good. Throughout the year, the dam is visited on a weekly basis by the New Hampshire Water Resources Board personnel.

4.4 Description of any Warning System in Effect

A flood warning system is in existence with the aid of a continuously monitored telemetered gage.

4.5 Evaluation

The operation and maintenance procedures for Mascoma Lake Dam, consisting of a weekly program of inspection, should ensure that all problems encountered can be remedied within a reasonable period of time. A detailed check list of items to be looked at by the operator or by the inspector has been prepared by the New Hampshire Water Resources Board.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

(1) This dam falls under the category of high hazard potential, and it is intermediate in size. Using the "Recommended Guidelines for Safety Inspection of Dams," the recommended spillway test flood peak inflow is equal to the probable maximum flood. The spillway test flood inflow hydrograph, estimated, furnished in Appendix D. The adopted spillway test flood peak inflow is 156,825 cfs.

(2) The estimated maximum peak outflow is 124,440 cfs, corresponding to the routed spillway test flood peak inflow through the lake.

(3) The lake storage capacity versus the elevation, an estimated capacity curve is included in Appendix D.

(4) The computed rating curve for the spillway is furnished in Appendix D.

(5) The computed composite discharge rating curve (for flashboard section, stanchion section, and gate section) is furnished in Appendix D.

(6) The composite discharge rating curve for pool levels above the top of the dam (assuming the dam or earth dikes remain intact) is furnished in Appendix D.

(7) The tailwater rating curve immediately below the dam site is furnished in Appendix D.

(8) The hydrologic map of the watershed above the dam site, including reservoir area and watercourse, is included in Appendix D.

b. Experience Data

The peak of the actual design inflow hydrograph adopted for the project was 19,205 cfs. When the design inflow hydrograph was routed through Mascoma Lake when the lake was full, with all the gates open, flashboards off, and needle beams out, the project design flood would cause the lake level to rise approximately to elevation 761.8

msl or 2.8 feet above the top of the earth dike. The peak of the tailwater elevation just below the dam would rise to 761.3. There might be considerable damage at the highway and railroad bridges immediately below the dam, should a flood of the same magnitude as the project design flood occur. The above design data has been taken from the Granite Lake Company; report, "Hydraulic Design, Mascoma Lake Dam," which is inclulded in Appendix B.

There are records of several damaging floods which resulted in rebuilding (as in 1936) or extensive repairs of the dam, as in 1953. Maximum known flood at dam site occurred in March, 1936, and it produced a corresponding flow of 5,800 cfs.

c. Visual Observations

The crest of the non-overflow section is about 7 feet above the crest of the spillway. At the time of the inspection, water was observed flowing over the stanchion log board and through the sluices. Downstream of the dam, there is a deep still pool of water serving as an effective energy dissipator. The downstream channel is narrow and deep. The highway and railroad bridges immediately below the dam constrict the flow in the downstream channel. The back water could be so high during a major flood that there would be a very little drop available at the dam.

d. Overtopping Potential

The spillway test flood peak inflow is 156,825 cfs. When the test flood peak inflow is routed through the Mascoma Lake (assuming the earth dam remains intact after being overtopped), it is found that the maximum pool elevation behind the dam would be 776.4. Therefore, the earth dam would be overtopped by 17.4 feet. The corresponding test flood peak outflow would be 124,440 cfs. The spillway can pass about 13% of the test flood peak outflow without overtopping the earth dike.

The elevation corresponding to the test flood peak outflow could not be found from the tailwater rating curve immediately below the dam site, therefore, the channel below the dam does not have the conveyance capacity required to accommodate the computed peak outflow without overtopping its banks. Substantial portion of the peak outflow would have to be accommodated in the flood plain on both sides of the downstream river. In other words, the spillway no longer functions as a hydraulic control as it would be submerged. The downstream flooding under test flood conditions would be the same whether or not the dam exists across the outlet of Mascoma Lake.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

At the time of our inspection, the water surface was at Elevation 749.48, 6.55 on the telemark gage. The upstream and downstream slopes of the rockfilled timber crib could not be observed due to the fact that it was under water. The slopes of the dike embankment do not show any erosion or other weak areas. The visual inspection revealed the following evidence of possible stability problems.

(1) Settlement of the area adjacent to the northwest corner of the gate house.

(2) Settlement and movement of the lower portion of the northern wingwall on the downstream side.

b. Design and Construction Data

No design computations are available, but drawings dated 1934 and 1948, were obtained from the project records.

c. Operating Records

Except for memorandums and correspondence listed in Appendix B, other operating records apparently are not available at the office of the New Hampshire Water Resources Board office.

d. Post-Construction Changes

According to available data, improvements have not been made since 1948.

e. Seismic Stability

The dam is located 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

Examination of available documents and visual inspection of Mascoma Lake Dam and its appurtenant structures did not reveal any defects which would render the project inadequate from the standpoint of structural stability and the dam is judged to be in fair condition.

b. Adequacy of Information

An adequate assessment of the dam consistent with the scope of a Phase I investigation has been made based upon the visual inspection and available information.

c. Urgency

The recommendations enumerated in Section 7.2 and 7.3 should be implemented within 1 year of receipt of this Phase I report by the owner.

d. Need for Additional Investigation

The information available from the visual inspection is adequate to identify the potential problems which are: overtopping, and the settlement and movement of the lower portion of the north wingwall. These problems require the attention of a competent engineer who will have to make additional engineering studies to design and specify remedial measures to rectify the problems. If left unattended, the problem could lead to instability of the structure.

7.2 Recommendations

It is recommended that the New Hampshire Water Resources Board undertake more detailed hydraulic studies to evaluate the extent of damage to life and property in Lebanon in the event of dam failure at Mascoma under either normal flow and flood flow conditions. Also, studies should be made to determine the cause of the settlement and movement of the lower portion of the northern wingwall on the downstream side.

7.3 Remedial Measures

It is considered important that the following operating and maintenance procedures be attended to as early as practical:

a. All concrete surfaces should be repaired, as continuous deterioration could develop into a serious problem.

b. Proper grades of the settled area at the northwest corner of the gate house should be reestablished.

c. Vegetation should be removed from the dike embankment, and riprap placed on the downstream slopes as indicated on the 1948 plans.

d. Program should be prepared and initiated to repair the slope protection as it becomes necessary.

e. The wooden planks on the flashboard section should be replaced as continued deterioration could develop into a serious problem.

f. Observations for scour around downstream steel sheet piling should be made under adverse conditions.

g. A program of regular maintenance should be established.

h. The technical annual periodic inspection being performed by the engineering staff should be continue.

i. The owner should develop a formal warning system.

7.4 Alternatives

None recommended.

APPENDIX A

VISUAL INSPECTION CHECK LISTS

APPENDIX B

1. Listing of Design, Construction and Maintenance Records

The files, No. 134.01, of the New Hampshire Water Resources Board contain seven folders of memorandums, correspondence, technic·· and hydrological data related to Mascoma Lake, River, and Dam.

(1) The oldest document is the profile of Mascoma River at Lebanon, New Hampshire made by C. A. & A. B. Downs of Lebanon, in 1881. It covers the whole length of the river from Mascoma Lake to the Connecticut River, almost eleven miles. There is a three-page typewritten description of this profile and of the dams, which is stamped "Received June 20, 1920, New Hampshire Public Service Commission."

(2) October 1, 1934. A four page questionnaire statement, written by the New England Power Engineering & Service Corp. of Boston, explaining the proposed repairs of the Mascoma Lake Dam. There is a copy of Order No. 2749, dated October 9, 1934, by the New Hampshire Public Service Commission authorizing these repairs.

(3) May 24, 1978. An application for reconstruction and raising the dam by the owner, Granite State Electric Co. of Lebanon. It contains a brief description of work proposed.

(4) August, 1948. A set of 8-inch by 10-inch photographs showing the reconstruction in progress.

(5) After the March 1953 flood in the town of Lebanon, there were many letters, newspaper clippings, studies, and recommendations for improvements that were written and filed.

(6) Fall, 1953. Memorandums and letters concerning a new lake level recording gage installation.

(7) October 20, 1953. Mascoma Lake Dam Operating Guide, written by Mr. E. Mosley of the New England Power Service Co., Hydraulic Department, including a sketch of the flashboard pin arrangement. This guide was revised in 1968.

(8) Instructions for installing and operating the new telemark lake level gage, purchased March 9, 1960, from Leopold & Stevens Instruments, Inc., Portland, Oregon (Telemark Type T-4, Serial No. 29427).

APPENDIX B

EXISTING AVAILABLE INFORMATION

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE Footbridge

DISCIPLINE Structures NAME [illegible]

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - FOOTBRIDGE	
a. Superstructure	
Bearings	Good condition (steel plates)
Anchor Bolts	Good condition
Longitudinal Members	Good condition (steel beams)
Deck	Sound condition (wooden planks)
Drainage System	None
Railings	Good condition

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE Stanchion Board Section

DISCIPLINE Structures NAME [illegible]

PROJECT FEATURE Approach Channel

DISCIPLINE Soils & Foundations NAME [illegible]

DISCIPLINE Hydraulics & Hydrology NAME [illegible]

AREA EVALUATED	CONDITION
c. Discharge Channel	
General Condition	Good
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	None observed
Floor of Channel	Could not be observed
Other Obstructions	None observed

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE Stanchion Board Section

DISCIPLINE Structures NAME

PROJECT FEATURE Approach Channel

DISCIPLINE Soils & Foundations NAME

DISCIPLINE Hydraulics & Hydrology NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - STANCHION BOARD SECTION, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	None observed
Floor of Approach Channel	Water at Elevation 749.48; bottom could not be observed
b. Stanchion Board Section	
General Condition	Good
Stop Logs	Good condition

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE Gate House

DISCIPLINE Structures & Concrete NAME E. A. Di...ta.

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
b. Mechanical and Electrical	
Air Vents	None
Float Wells	None
Crane Hoist	None
Elevator	None
Hydraulic System	None
Service Gates	Four gates - three gates operated electrically; and one gate temporarily manually operated
Emergency Gates	None
Lightning Protection System	None
Emergency Power System	None
Wiring and Lighting System	Apparently in good condition

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE Gate House

DISCIPLINE Structures & Concrete NAME [illegible]

PROJECT FEATURE

DISCIPLINE NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - GATE HOUSE	
a. Concrete and Structural	
General Condition	Poor
Condition of Joints	Good
Spalling	Yes (see Section 3)
Visible Reinforcing	None observed
Rusting or Staining of Concrete	None observed
Any Seepage or Efflorescence	None observed
Joint Alignment	Good
Unusual Seepage or Leaks in Gate Chamber	None
Cracks	Yes (see Section 3)
Rusting or Corrosion of Steel	None observed

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE South Dike Embankment

DISCIPLINE Soils & Foundations NAME Henry H. Stoller

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	None apparent
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	Fair condition
Unusual Movement or Cracking at or Near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE South Dike Embankment

DISCIPLINE Soils & Foundations NAME Henry M. Hall

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
SOUTH DIKE EMBANKMENT	
Crest Elevation	759.0
Current Pool Elevation	749.48
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	None
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	No visual vertical misalignment
Horizontal Alignment	No visual horizontal misalignment
Condition at Abutment and at Concrete Structures	Normal

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE North Dike Embankment

DISCIPLINE Soils & Foundations NAME Henry N. Hall

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
Indications of Movement of Structural Items on Slopes	Lower portion of downstream wingwall has apparently tilted
Trespassing on Slopes	None apparent
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	Fair condition
Unusual Movement or Cracking at or Near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE North Dike Embankment

DISCIPLINE Soils & Foundations NAME Henry M. Stiller

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
NORTH DIKE EMBANKMENT	
Crest Elevation	759.0
Current Pool Elevation	749.48
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	None
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	No visual vertical misalignment
Horizontal Alignment	No visual horizontal misalignment
Condition at Abutment and at Concrete Structures	Erosion at the northwest corner of gate house

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE Flashboard Section

DISCIPLINE Soils & Foundations NAME Henry H. Stell

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	None observed
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection - Riprap Failures	None
Unusual Movement or Cracking at or Near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	None
Toe Drains	None
Instrumentation System	None

PERIODIC INSPECTION CHECK LIST

PROJECT Mascoma Lake Dam DATE June 8, 1978

PROJECT FEATURE Flashboard Section

DISCIPLINE Soils & Foundations NAME [signature]

PROJECT FEATURE _____

DISCIPLINE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
FLASHBOARD SECTION	
Crest Elevation	Top of boards 752.0
Current Pool Elevation	749.48
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	None
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	No visual vertical misalignment
Horizontal Alignment	No visual horizontal misalignment
Condition at Abutment and at Concrete Structures	Normal

APPENDIX A

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Mascoma Lake Dam DATE June 8, 1978

TIME 900 - 1230

WEATHER Cloudy & Intermittent Rain

W.S. ELEV. 749.48 U.S. _____ DN.S.

PARTY:

1. Jurgis Gimbutas, P.E.	Team Captain - Structural and Concrete
2. Harvey H. Stoller, P.E.	Soils, Geology, & Foundations
3. V. Rao Maddineni, P.E.	Hydraulics & Hydrology

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Flashboard Section	H. H. Stoller	Fair
2. North Dike Embankment	H. H. Stoller	Fair
3. South Dike Embankment	H. H. Stoller	Fair
4. Gate House	J. Gimbutas	Poor
5. Stanchion Board Section	J. Gimbutas	Good
6. Approach and Discharge Channels	H. H. Stoller V. R. Maddineni	Good
7. Footbridge	J. Gimbutas	Good
8. Reservoir and Downstream Channel	V. R. Maddineni	Good

(9) May 20, 1968. Description of properties to be deeded to the State of New Hampshire, prepared by Granite State Electric Co. in Lebanon (two pages and a marked-up U.S.G.S. map). Subsequently, there is a copy of "An Act to Authorize the Water Resources Board to Acquire, etc.," the dam, water rights, land and any buildings connected therewith at Mascoma Lake, dated, 1969, by the General Court of New Hampshire.

(10) June 10, 1971. Request and authorization for the installation of a remote stage recording instrument on the Mascoma River at West Canaan, upstream of Mascoma Lake.

(11) March 9, 1972. Memorandum to the New Hampshire Water Resource Board, written by Mr. Vernon A. Knowlton, Water Resources Engineer. It explains the operation and the purpose of the dam. There are several letters regarding the operation of Mascoma Lake in 1973 and 1974.

(12) March 22, 1974. Four photographs taken for the Army Corps of Engineers' Dam Inventory Program.

(13) July 1976. Two letters regarding vandalism at the dam structure.

(14) February 22, 1978. Request for additional quotations for new gate stems and other hardware for gates. There are drawings by Rodney Hunt Co., Orange, Massachusetts, including three 11-inch by 17-inch sheets, approved by the New Hampshire Water Resources Board on April 6, 1978.

In addition, there are numerous data on the hydrology of Mascoma Lake and hydraulic calculations for the dam. Summary of such data is as follows:

(1) Detailed history of floods from 1925-1953 by excerpts from local press, seven pages.

(2) FIA Flood Hazard Boundary Maps for Town of Lebanon, dated September 20, 1974.

(3) Hydraulic Design - Mascoma Lake Dam, dated March 22, 1949, by H. M. Nelson of Granite State Electric Co., seven pages and four plates of curves.

(4) Mascoma Lake hydrographs 1950-1953.

(5) Discharge computations following the March 1953 flood by F. C. Moore, Civil Engineer, of the New Hampshire Water Resources Board. Also various discharge rating curves made by the Hydraulic Dept. of New England Power Service Co., dated May 1953.

(6) Hydrological data summaries in 1959 and 1960, numerous sheets including graphs.

(7) Comparison of watersheds and storage capacities and a plan of operation for the Mascoma River storage system (no date) and a plan of the Mascoma Lake drainage area (in 1953).

(8) Mascoma Lake storage data sheets - 1961-1970.

Drawings, mostly blueprints, are stored in the files of the New Hampshire Water Resources Board under State Nos. 134.01 and 134.12. In chronological order, these drawings are:

(1) 1918-1919 - Drawings made by the Mascoma River Improvement Co., Engineering Department, Turner Falls office, Sheets No. LS-22, F-2292, C-695 to C-698, showing topography, gate structure, and details of this dam.

(2) March, - September, 1926 - Drawings made by the New England Power Construction Co., Engineers, in Worcester, Mass., Sheets No. D-780, H-1884, H-1886, showing intake structure, Dam No. 1 and topography of the dam.

(3) October, 136 - Sheets No. D-1927* and H-10321, showing detailed topography in vicinity of dam at outlet of Mascoma Lake near Enfield, New Hampshire.

(4) 1941 drawings - Sheet R-1828 1/2, showing aerial survey.

(5) January, 1944 - Drawing No. D-3741, made by the Mascoma River Improvement Co., showing Mascoma Lake property and dam.

(6) May, - December, 1948 - Drawings made by the New England Power Service Co. of Boston, Mass. - Sheets Nos. LS-2572, H-5929, H-10932, H-10993*, H-10988, H-11197, ML-11238 and five sheets without numbers showimg general plans, sections, and installations for the reconstruction of the Mascoma Lake Dam.

*Reduced copies of drawings included in this report.

(7) March, 1949 - Elevation of the dam looking upstream which shows dimensions.

(8) There are two drawings without dates, namely, Sheet No. C-699, showing Mascoma Lake drainage area (flow of drainage into downstream towns), and Sheet No. E-4874, showing Mascoma Lake Dam field dimensions.

2. Copies of Past Inspection Reports Included in This Report

(1) September 9, 1937, by the New Hampshire Water Resources Board, inventory page and one page of the sketches.

(2) January 3, 1939, by the New Hampshire Water Control Commission, tabulated by AAN & RLT, two pages of data.

(3) December 31, 1960, Data Sheet No. 210 without signature.

3. Copies of Other Documents Included in This Report

(1) Hydraulic Design - Mascoma Lake Dam, dated March 22, 1949, by H.M. Nelson of Granite State Electric Co., seven pages and four plates of curves.

(2) October 20, 1953. Mascoma Lake Dam Operating Guide, written by Mr. E. Mosley of the New England Power Service Co., Hydraulic Department, including a sketch of the flashboard pin arrangement. This guide was revised in 1968.

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN *Connecticut* NO. ~~[illegible]~~ *1* *134.01* *151.5 NE* *145.6 PSC*
RIVER *Mascoma Lake* MILES FROM MOUTH *10.2* D.A.SQ.MI *153 AE*
TOWN *Lebanon* OWNER *Mascoma River Improvement Co.*
LOCAL NAME OF DAM
BUILT *Rebuilt 1936.* DESCRIPTION *Wood Crib, concrete abutment + gate struct. right end. Log crib abutment left. Earth wing walls*
POND AREA-ACRES *1114.90 PB* *1115 WRB* DRAWDOWN FT. *8.0* *7 WRB.* POND CAPACITY-ACRE FT. *11,400*
HEIGHT-TOP TO BED OF STREAM-FT. *8* MAX. MIN.
OVERALL LENGTH OF DAM-FT. *150* *220* MAX.FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV.U.S.G.S. *751.5* LOCAL GAGE
TAILWATER ELEV.U.S.G.S. *—* LOCAL GAGE
SPILLWAY LENGTHS-FT. ~~*150 PSC*~~ *156* FREEBOARD-FT. *6'10"*
FLASHBOARDS-TYPE,HEIGHT ABOVE CREST *0.7 ft.*

WASTE GATES-NO.	WIDTH	MAX.OPENING	DEPTH SILL BELOW CREST
4	*4*	*x4*	*8*

REMARKS *Top Elevation 745.0 Max high water 756.2*
3G. Condition Good, practically rebuilt after 1936 flood.
into Mascoma River, Connecticut River

POWER DEVELOPMENT

UNITS NO.	RATED HP	HEAD FEET	C.F.S. FULL GATE	KW	MAKE

USE *Storage*

REMARKS *Talked to A.C. Benfes, Mgr. Granite State Elec. Co. in Lebanon Office. S. I. Topper showed us this dam.*

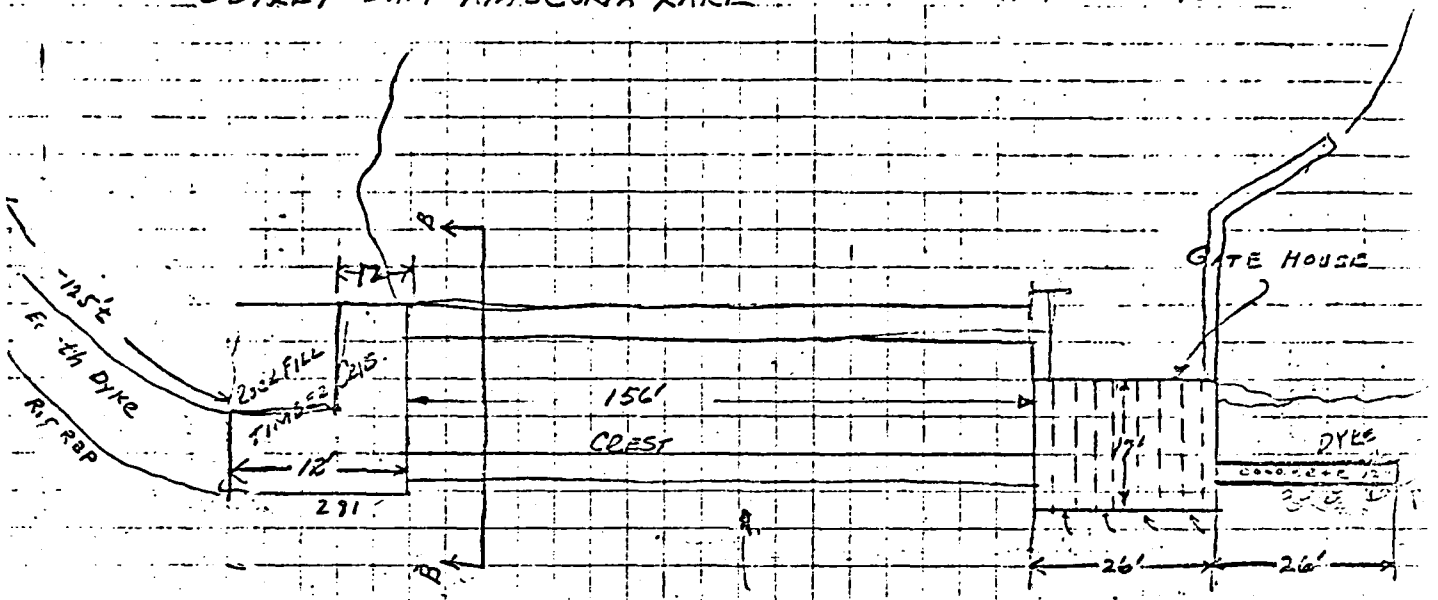
DATE *1977 PSC 1981 AE*
9/9/37 *[illegible] 1 J.H.S.*

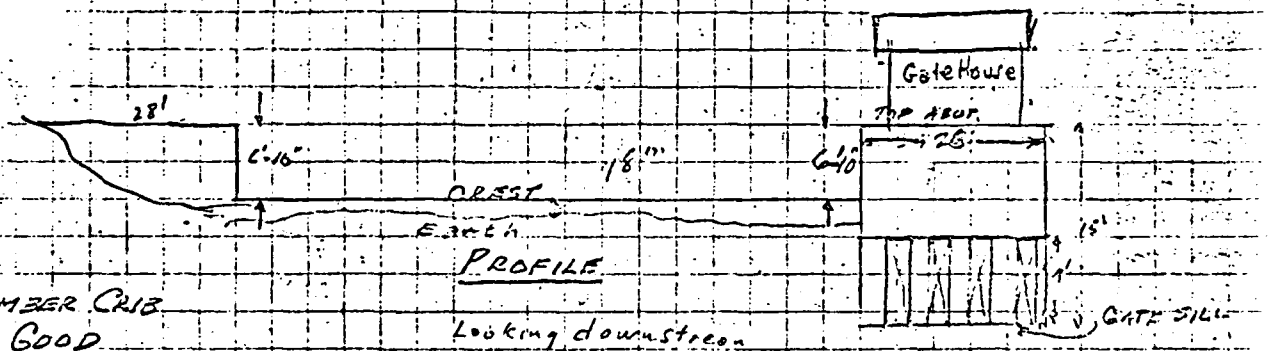
[illegible]

MASCOMA LAKE DAM 134.01

9/9/37

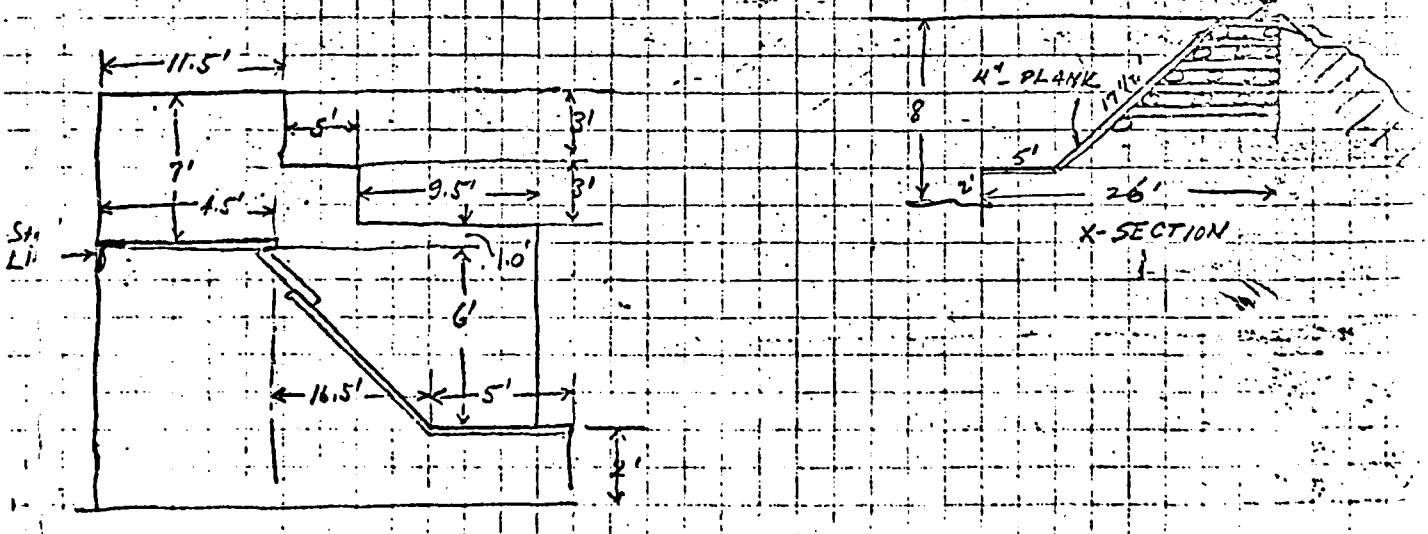
OUTLET DAM - MASCOMA LAKE PHOTO #11-#12





TYPE - TIMBER CRIB

CONDITION - GOOD



Section B-B
Left (Crib) abutment.

NEW HAMPSHIRE WATER CONTROL COMMISSION

DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 134.01

Town Lebanon ✓ : County Grafton

Stream Mascoma Lake ✓

Basin-Primary Conn R. ✓ : Secondary Mascoma R ✓

Local Name

Coordinates—Lat. 43°-40'-6400 : Long. 72° 10' +7100

GENERAL DATA

Drainage area: Controlled Sq. Mi. Uncontrolled Sq. Mi.: Total 151.5 Sq. Mi. 153 ✓

Overall length of dam 220 ✓ ft.: Date of Construction 1936

Height: Stream bed to highest elev. 8 ✓ ft.: Max. Structure 1' 2" ✓ ft.

Cost—Dam : Reservoir

DESCRIPTION Timber Crib— Wood Stone & Concrete ✓

Waste Gates

Type

Number 4 ✓ : Size 4 ✓ ft. high x 4 ✓ ft. wide

Elevation Invert 8 ✓ : Total Area 64 ✓ sq. ft.

Hoist

Waste Gates Conduit

Number : Materials

Size ft.: Length ft.: Area sq. ft.

Embankment

Type

Height—Max. ft.: Min. ft.

Top—Width : Elev. ft.

Slopes—Upstream on : Downstream on

Length—Right of Spillway : Left of Spillway

Spillway

Materials of Construction

Length—Total ft.: Net 156 ✓ ft.

Height of permanent section—Max. 1' 2" ft.: Min. ft.

Flashboards—Type ? : Height 0.7 ✓ ft.

Elevation—Permanent Crest 751.5 : Top of Flashboard

Flood Capacity 1800 cfs.: cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 6' 10" ✓ ft.: Min. ft.

Headworks to Power Devel.—(See "Data on Power Development")

OWNER Mascoma River Improvement Co ✓

REMARKS Use— Storage Condition Good

Tabulation By A A N & R L T Date January 3 1939

7208

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON RESERVOIRS & PONDS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 134.01

Town Lebanon : County Grafton

Stream Mascoma Lake

Basin—Primary Conn R. : Secondary Mascoma R

Local Name

DRAINAGE AREA

Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 151.5 Sq. Mi.

ELEVATION vs. WATER SURFACE AREA vs. VOLUME

Point	Head Feet	Surface Area Acres	Volume Acre Ft.
(1) Max. Flood Height			
(2) Top of Flashboards			
(3) Permanent Crest			
(4) Normal Drawdown	7	1115	10,300
(5) Max. Drawdown			
(6) Original Pond			

Base Used .....: Coef. to change to U.S.G.S. Base .....

RESERVOIR CAPACITY

	Total Volume	Useable Volume
Drawdown	ft.	ft.
Volume	ac. ft.	ac. ft.
Acre ft. per sq. mi.		
Inches per sq. mi.		

USE OF WATER Storage

OWNER Mascoma River Improvement Co

REMARKS

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

OPERATING COMPANY Granite State Electric Company

LOCATION & DRAINAGE AREA

A) TOWN Lebanon and Enfield (B) POST OFFICE Lebanon, N.H.

C) COUNTY Grafton (D) STATE New Hampshire

E) RIVER Mascoma (F) MILES ABOVE MOUTH (DAM) 9.7

G) GROSS DRAINAGE AREA 153 SQ.MI. (H) NET DRAINAGE AREA 124.1 SQ.MI.

HYDRAULIC DATA

ELEVATIONS

A) TOP OF DAM 16.07 (B) TOP OF BOARDS 9.07 (C) NORMAL FULL 9.07 (D) CREST (SEE ITEM III e) 6.10 2.61

E) MINIMUM NORMAL 2.2 (F) MINIMUM USABLE 2.2 (G) MINIMUM POSSIBLE 0.2

Note: ELEVATIONS ARE ON Local DATUM; ZERO = 742.93 above M.S.L.

STORAGE

H) FULL POND AREA 1155 ACRES

I) MAX. NORMAL DRAWDOWN 6.9 FT.; VOLUME 7744 ACRE-FEET; .337 BCF 1.17 INS. ON 124.1 SQ.MI. (1)

J) MAX. USABLE DRAWDOWN 6.9 FT.; VOLUME 7744 ACRE-FEET

K) MAX. POSSIBLE DRAWDOWN 8.9 FT.; VOLUME 9909 ACRE-FEET .432 BCF

(1) EQUIVALENT TO 429,800 KWH ON THE FOLLOWING PLANTS: No. 4

EQUIVALENT TO 2.52 BILLION GALLONS

STORAGE RESERVOIRS ABOVE

M) LOCATION	Grafton Pond	GROSS DRAINAGE AREA	3.3 SQ.MI.;	USABLE VOLUME	3,300 ACRE-FEET
O) LOCATION	Crystal Lake	GROSS DRAINAGE AREA	13.2 SQ.MI.;	USABLE VOLUME	1,725 ACRE-FEET
P) LOCATION	Goose Pond	GROSS DRAINAGE AREA	15.7 SQ.MI.;	USABLE VOLUME	11,688 ACRE-FEET
Q) LOCATION		GROSS DRAINAGE AREA	SQ.MI.;	USABLE VOLUME	ACRE-FEET

II DAM

A) MATERIAL Earth & Timber (B) TYPE Crib (C) OVERALL LENGTH 580 FT. (D) MAX. HT. 15 (A) FT.

E) SPILLWAY 112' @ GH 6.10 and 36' @ GH 2.61

F) FLASHBOARDS 112' Pin Type @ 2.97' and 36' Stantion Type @ 6.46'

G) GATES 4 - 4' x 4' Gates Sill @ GH 0.05 (Four hoists oper. by 4 - one half HP Elec. Motors and 4 - Gear Ratio Drives.)

IV WATERWAYS & MISC.

NOTES

(A) = APPROXIMATE ONLY

(NA) = NOT AVAILABLE

DATA AS OF 12/31/60

FORM 646-B.1 4-48

MEMORANDUM

To A. C. Benjes | Lebanon, New Hampshire (COMPANY OR LOCATION) | March 30, 1949

Fr M. H. M. Nelson | Boston (COMPANY OR LOCATION) | FILE

SUBJECT MASCOMA LAKE DAM

Gave Topper 1 copy

Attached hereto are two copies of a report entitled "Granite State Electric Company, Hydraulic Design, Mascoma Lake Dam," dated March 22, 1949.

You will note that the peak inflow used in our design flood is only 126 cu. ft. per second per square mile. If you will look on plate 4 on which are plotted floods which have already been experienced in New York and New England, you will see that 126 cu. ft. per second per square mile is far below the maximum which has been experienced.

Harry M. Nelson

HMN:GCL

Add Plate V folded

GRANITE STATE ELECTRIC CO.

HYDRAULIC DESI

MASCOMA [illegible] 2A

H. M. Nelson March 22, 1949 [illegible]

HYDRAULIC DESIGN MASCOMA LAKE DAM

In the early part of 1948 a study was made of the flood capacity required at Mascoma Lake dam. This study was undertaken due to the fact that the timber spillway section of the old dam was in such a state of decay that it could no longer be repaired, and a new spillway section was indicated.

The study indicated that due to the topography at the dam site and below, it would be impossible to design a practical dam at this location which could pass through gates and spillway a design flood which we based on runoff from eight tenths of the maximum possible precipitation for a drainage area of this size, as worked out by the United States Weather Bureau forces, without raising the water in the lake so high that it might cause a great amount of damage.

The river is restricted below the dam by a highway bridge and a railroad bridge. These limitations, together with the natural slope and configuration of the channel, would cause a backwater condition at the dam which would practically drown it out during the period of maximum discharge of any flood approaching the design flood in magnitude.

In order to pass the design flood through the dam, it would be necessary to lower the crest below that of the present dam and, in addition, raise the dikes at either end of the dam. The increased height of the dikes would add a restriction to the passage of water from the lake to the channel below and thus cause a higher lake level, which would in turn increase the discharge of water along the Boston & Maine railroad through the highway overpass just north of the dam. Damage to cottages and docks around the lake might be caused also by raising the dikes.

It was decided to recommend no change in the concrete gate structure at the north end of the dam and no change in elevation of the present

dikes except to add some stone rip rap to them for protection in case of inundation.

The elevation of the crest of the timber section of the old dam, which was 156 feet long, was about 751.25 and some low braced flashboards used had a top elevation of 752.0. It was decided to recommend for the new timber section 36 feet of crest at elevation 745.0 with needle beams provided with stop logs to carry the water to elevation 752. To support the bridge to which the tops of the needle beams were to be anchored, it was found necessary to introduce a timber crib pier 8 feet wide at the south end of the 36 foot bay. South of the crib pier 112 feet of crest at elevation 749.0 provided with pipe supported flashboards with top elevation of 752.0, designed to fail in two sections at different pond elevations were also recommended. The location of the face of the south abutment was to remain unchanged.

With the above described arrangement the gates should be opened, flashboards should be allowed to fail and needle beams should be released as necessary to control the elevation of the Lake at or below elevation 756 as long as possible during periods of high discharge. The maximum discharge which can be passed at pond elevation 756 with all gates open, all flashboards off and all needle beams out is about 9000 c.f.s.

A design storm precipitation of 13.32 inches occurring in 36 hours which produced a maximum inflow at Mascoma Lake of 19200 cubic feet per second and a total runoff of 10.44 inches on the drainage area in a period of 146 hours was used in the study calculations.

The spillway section was built substantially as recommended and new gates and motor drives for the gates were installed during the fall of ~~this~~ the 1942 year. The only deviations were some changes which resulted in making the needle beam bay slightly smaller than it was originally planned to be. It

was found necessary to shorten it by pouring a facing on the south end of the concrete gate structure and due to the top elevation of foundation timbers in the old dam which were found to be sound the floor of the low bay was raised to elevation 745.5 instead of 745.0.

If a flood of the order of the design flood should occur when the pond is full or nearly full the elevation of the pond surface would rise to above elevation 758.0 and the entire structure except the superstructure of the gate house would be inundated. The backwater would be so high that there would be very little drop at the dam at such a time.

It is felt that the stone protection placed over the entire surface of the dikes will prevent any serious loss of material from them and that when the flood waters recede very little serious damage to the dam will be found.

It seems likely that should a flood of the order of the design flood occur, there might be considerable damage at the highway and railroad bridges immediately below the dam.

For general plan and section of the Mascoma Lake dam as rebuilt in 1948, see Plan H-10993 as revised.

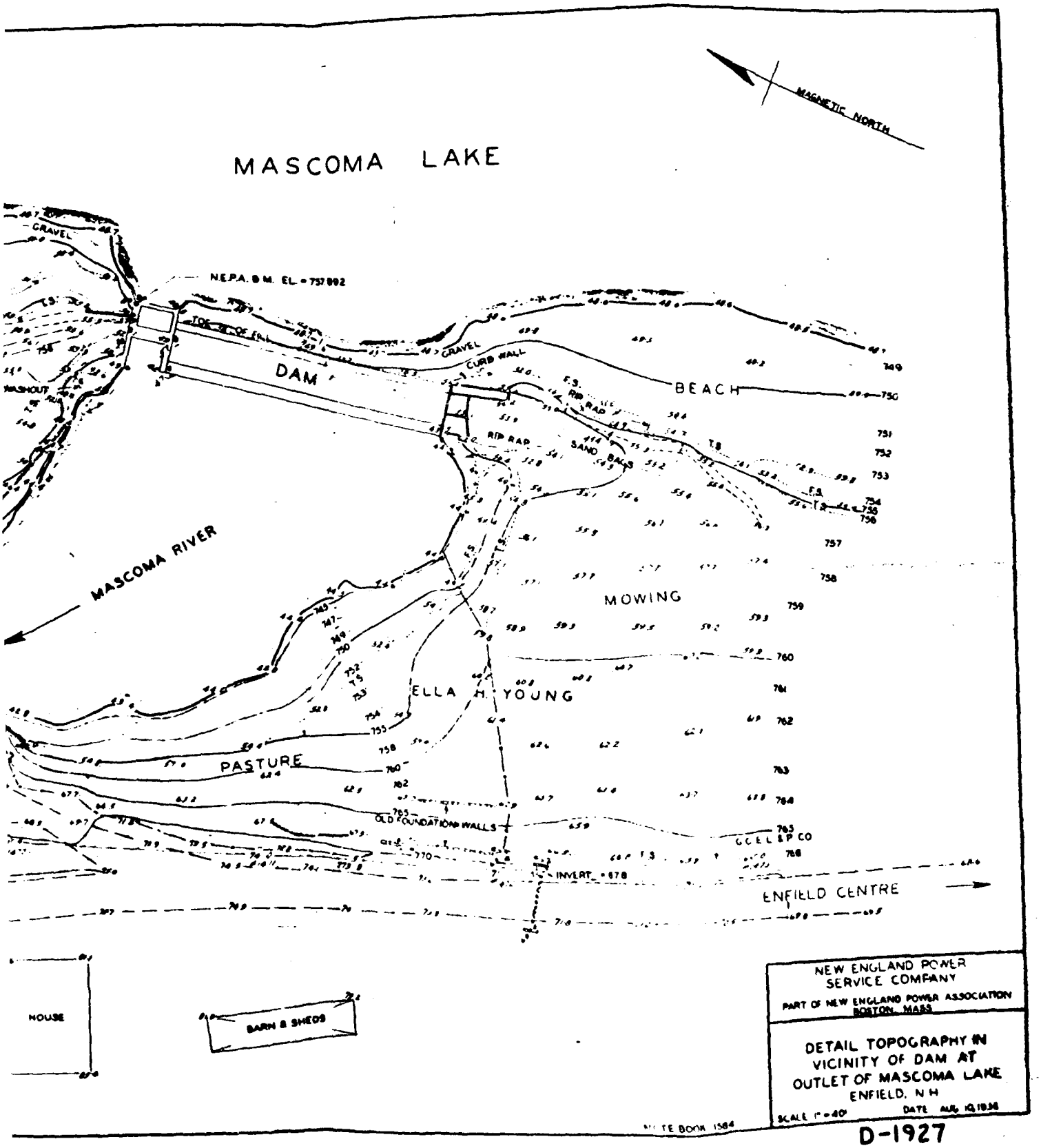
3/22/49 Harry M Nelson

DESIGN STORM AND RESULTANT INFLOW HYDROGRAPH

The precipitation during 36 hours of the storm of November 2 - 4, 1927, at the Harriman reservoir as determined from the average of six precipitation stations weighted for drainage area was 7.62 inches. The design storm precipitation for Mascoma Lake dam was obtained by multiplying the Harriman precipitation for the November, 1927, storm by 1.75. This gave a precipitation total of 13.32 inches for the design storm. This happens to be slightly less than eight tenths of the maximum possible precipitation for this area as developed in the Ompompanoosuc River report of March 1940 by the U.S. Weather Bureau. An infiltration rate of .08 inches per hour was then subtracted giving a total runoff of 10.44 inches. The details of this are shown in the table in the upper right-hand corner of Plate I.

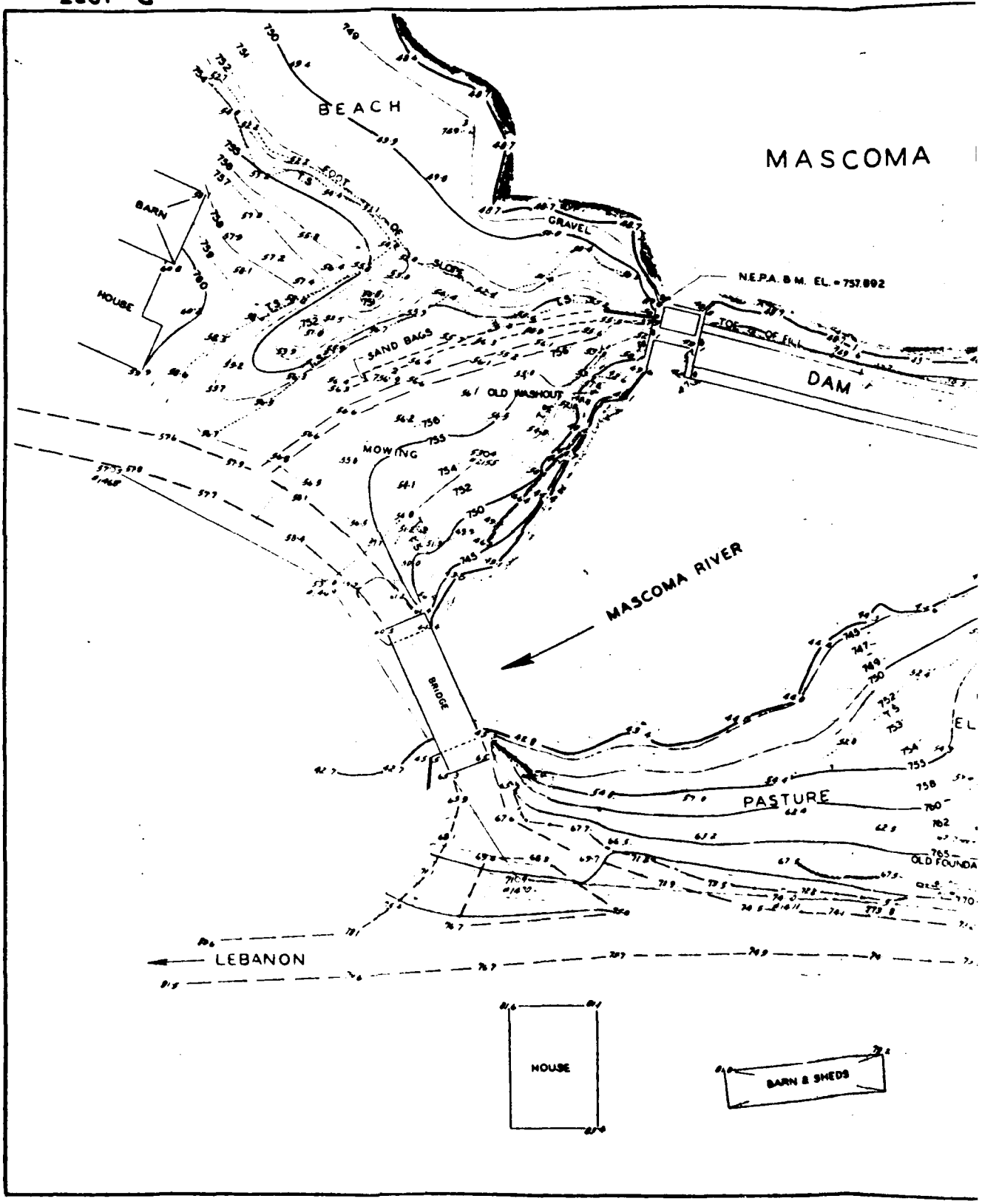
The inflow hydrograph shown on Plate I was built up from a distribution graph of the U. S. G. S. gaging station just below Mascoma Lake dam given in Fig. 4 of the paper, "The Unit Hydrograph and Flood Routing," by Gerald F. McCarthy for presentation at the conference of the North Atlantic Division, U. S. Engineer Dept. at New London, Connecticut, on June 24, 1938. From the distribution graph a unit hydrograph was developed. Using this, hydrographs for the precipitation for each six-hour period were developed, and these were then combined to develop the inflow hydrograph shown on Plate I.

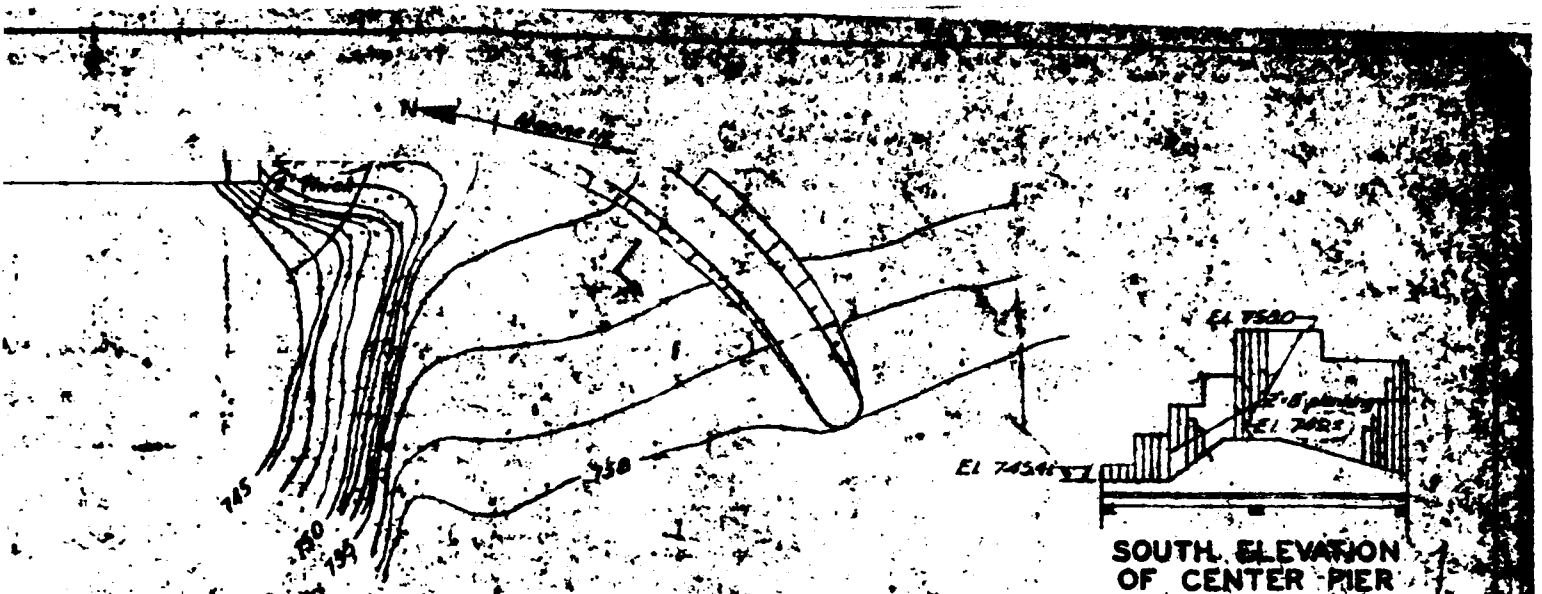
The peak inflow for the design flood on the 153-square-mile drainage area at Mascoma Lake dam as shown on Plate I is 126 cubic feet per second per square mile. The peak inflow experienced for the 154-square-mile drainage area at Harriman reservoir during the flood of September, 1938, was 288 cubic feet per second per square mile. No information is available from which a short time peak during the flood of November, 1927, can be computed for the Harriman reservoir, but from information available we find that


MAGNETIC NORTH
MASCOMA LAKE
GRAVEL
N.E.P.A. B.M. EL. = 757.992
DAM
CURB WALL
BEACH
RIP RAP
SAND BALLS
MASCOMA RIVER
MOWING
ELLA H. YOUNG
PASTURE
OLD FOUNDATION WALLS
G.C.E.L. & P. CO
INVERT = 678
ENFIELD CENTRE
HOUSE
BARN & SHEDS
NEW ENGLAND POWER SERVICE COMPANY
PART OF NEW ENGLAND POWER ASSOCIATION
BOSTON, MASS.
DETAIL TOPOGRAPHY IN VICINITY OF DAM AT OUTLET OF MASCOMA LAKE
ENFIELD, N.H.
SCALE 1" = 40'
DATE AUG. 10, 1938
NOTE BOOK 1584

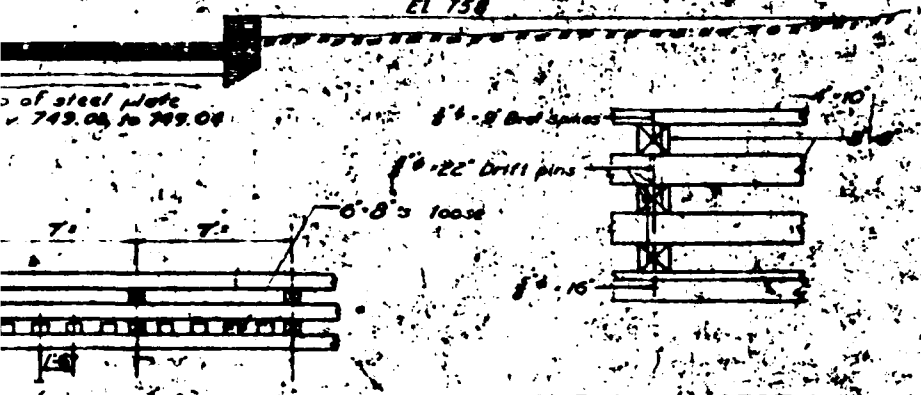
D-1927

D-1927


MASCOMA
BEACH
GRAVEL
BARN
HOUSE
SAND BAGS
OLD WASHOUT
MOWING
N.E.P.A. B.M. EL. = 757.892
DAM
MASCOMA RIVER
BRIDGE
PASTURE
LEBANON
HOUSE
BARN & SHEDS



SOUTH ELEVATION OF CENTER PIER



TYPICAL SECTION

SECTION E-E

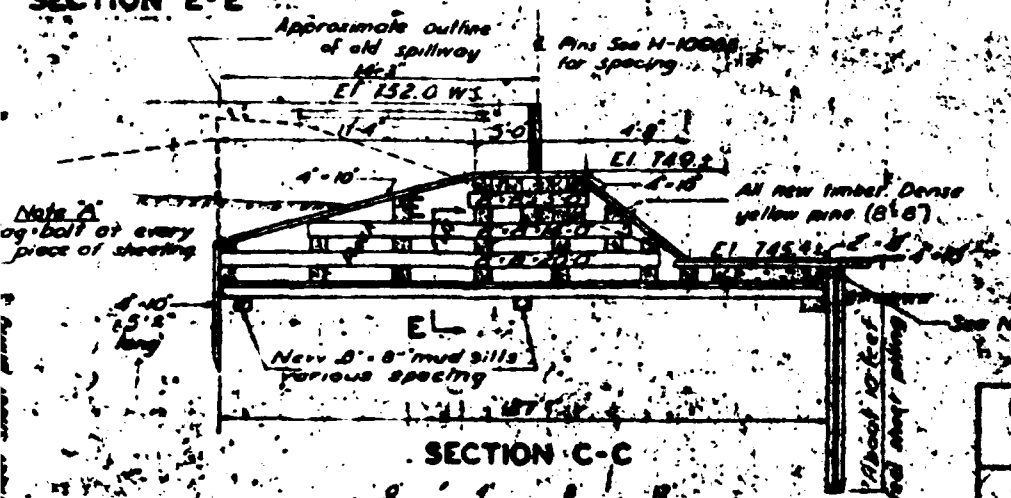
GENERAL NOTES

Timbers in pier to be dense yellow pine pressure creosoted.
All other timber to be dense yellow pine.

Joints in sheeting to be covered by boards or battens as directed in the field.

Bore for drift pins with auger size ⅛" smaller than pin.

Crib fill to consist of selected stone plus make-up stone and coarse gravel intermingled.



SECTION C-C

REFERENCE DRAWINGS

1948 Repairs - Spillway Details
Topography of Dam

NEW ENGLAND POWER SERVICE COMPANY

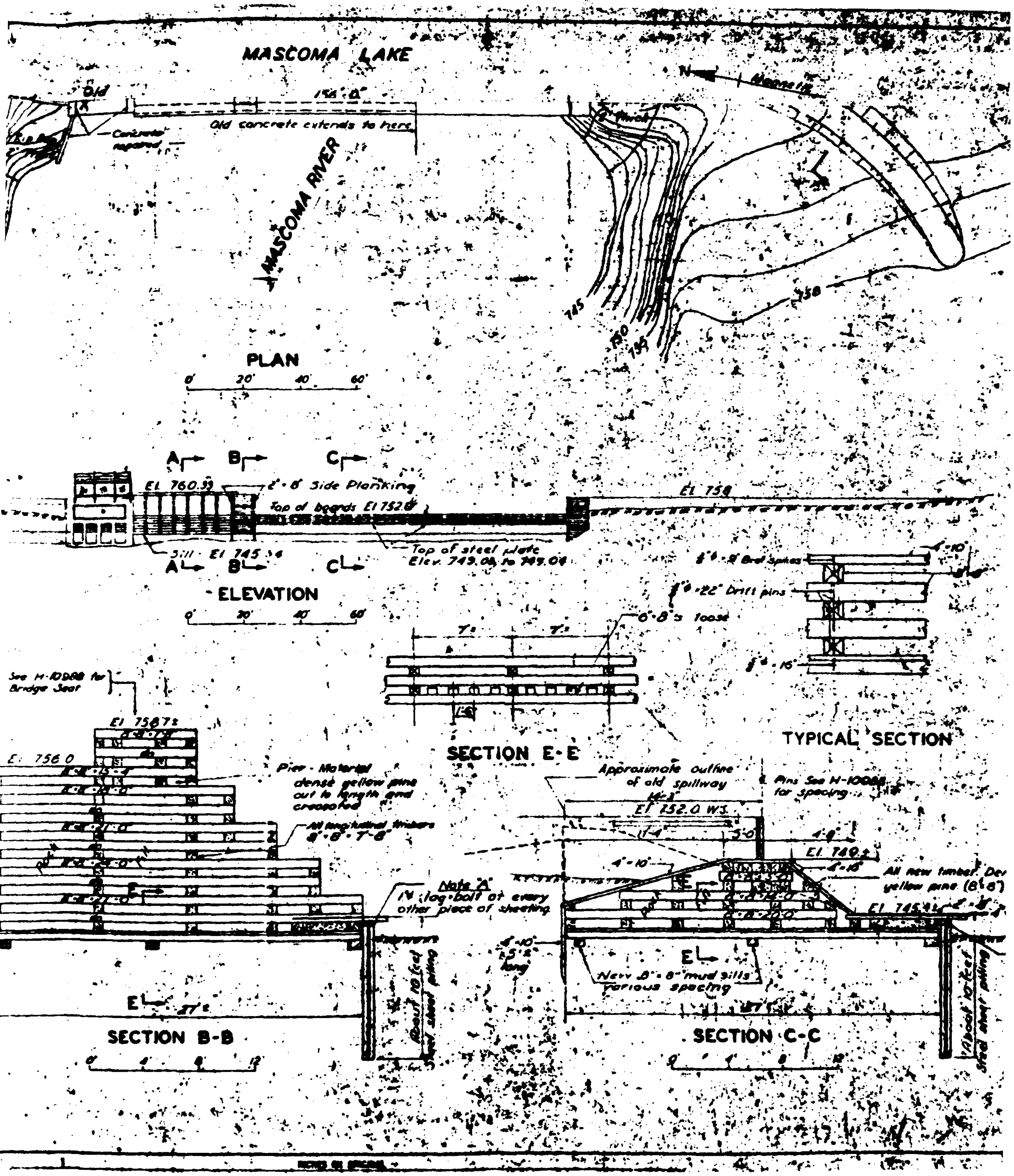
GRANITE STATE ELECTRIC COMPANY

MASCOMA LAKE DAM

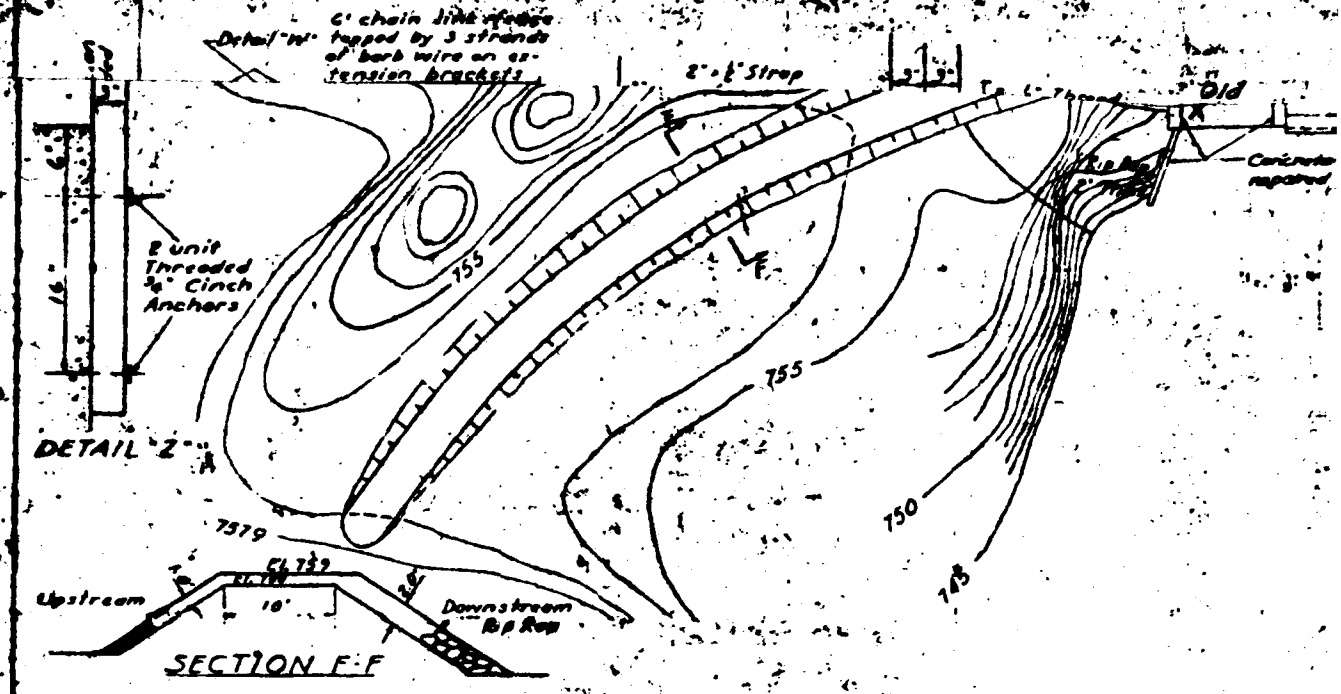
AS BUILT 1948

TIMBER DETAILS

H-10003-5


MASCOMA LAKE
Old
156'-0"
Concrete repaired
Old concrete extends to here
MASCOMA RIVER
N
Magnetic
745
750
755
758
PLAN
0' 20' 40' 60'
A B C
EL 760.39
2" x 8" Side Planking
Top of boards El 752.0
EL 758
Sill - El 745.34
Top of steel plate Elev. 749.04 to 749.04
ELEVATION
0' 20' 40' 60'
4'-10"
Brad Spikes
22" Drift pins
8" x 8"s loose
7'±
7'±
SECTION E-E
TYPICAL SECTION
See H-10988 for Bridge Seat
El 758.7±
El 756.0
Pier - Material dense yellow pine cut to length and creosoted
All longitudinal timbers 8" x 8" - 7'-8"
Note "A"
1¼" log bolt at every other piece of sheeting
About 10 feet Steel sheet piling
E
27'±
SECTION B-B
0 4 8 12
Approximate outline of old spillway
El 752.0 W.S.
Pins See H-10988 for spacing
5'-0"
4'-0"
El 749.±
4'-10"
All new timber Dense yellow pine (8" x 8")
El 745.4±
4'-10"
New 8" x 8" mud sills various spacing
27'±
About 10 feet Steel sheet piling
SECTION C-C
0 4 8 12

REVISIONS



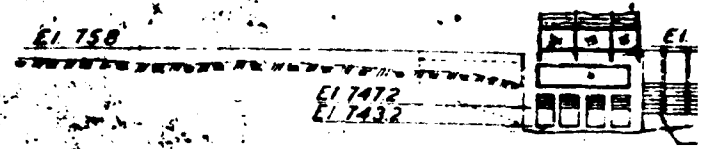
Rip rap is to be placed on top of the present north and south embankments as indicated on Section F-F.

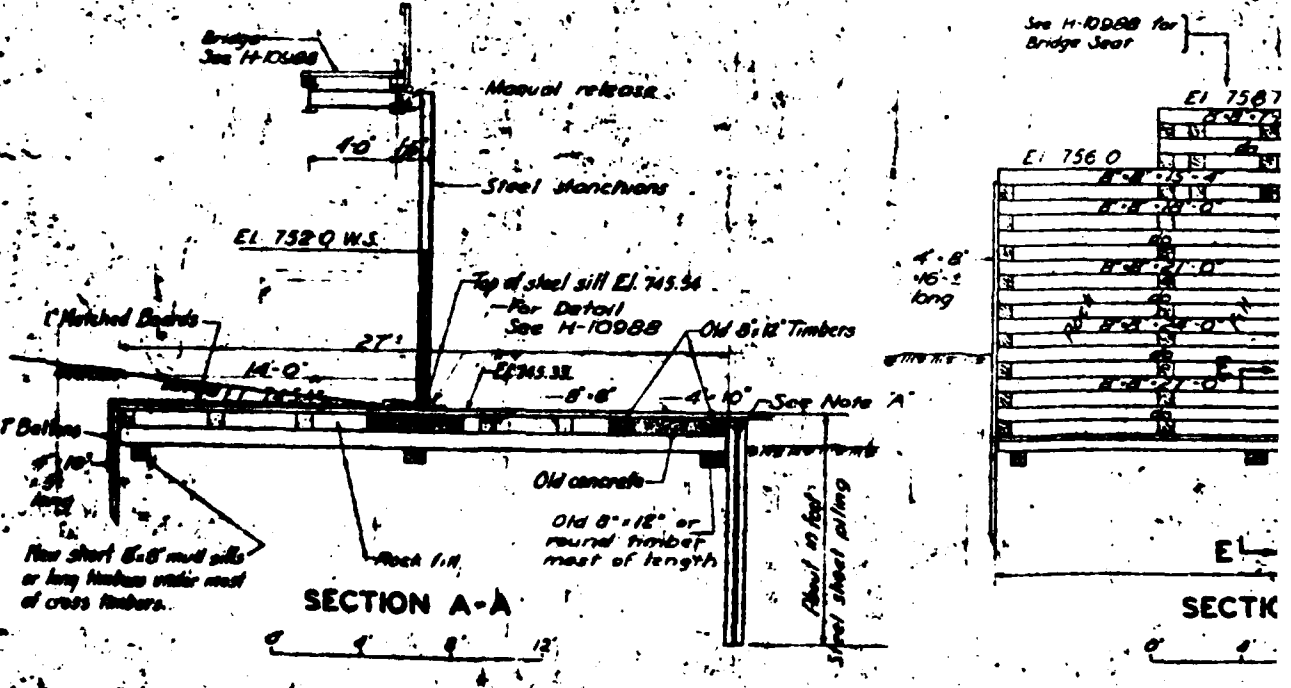
Field stones or quarry stones may be used for the embankment rip rap. The stones shall range in maximum thickness from [illegible] thickness of the area in which they are laid to a minimum diameter of two inches.

40 percent or more of the stones shall have a minimum thickness of one half the thickness of the area in which they are laid.

After the rip rap is placed the voids in it shall be filled with gravel.

This rip rap is not yet placed - as of 10-3-56





occur gates should be closed promptly to compensate for the added discharge through the failed portion of the flashboards. This will necessitate closure of approximately 13' of gate to hold a steady lake elevation. The gates will then be gradually reopened to hold the lake at Elev. 753.11 until all gates are opened wide.

Item 7.

If the inflow continues to increase, the lake level will gradually rise above Elev. 753.11 and at or slightly below Elev. 754.37 (G.H. 11.42) failure of the 1-1/4" std. pins should occur. The pond should then be controlled at this elevation as long as possible by gate operation as in item 6 above. Approximately 10' to 11' of gate closure will be required to compensate for the additional discharge through the failed section.

Item 8.

If the inflow continues to increase, the lake level will gradually rise above Elev. 754.37 and at approximately Elev. 755.86 (G.H. 12.96) failure of the 1-1/2" std. pins should occur. When failure occurs, the pond should then be controlled by gate operation as in items 6 and 7 above. Approximately 14' of gate closure will be required for compensation.

Item 9.

If the inflow continues to increase, the lake level will gradually rise above Elev. 755.86 and at approximately Elev. 757.32 (G.H. 14.42) failure of the 1-1/2" E.H. pins should occur. When this last failure occurs all gates should be opened full.

Item 10.

After the peak of the run off has passed, the dam should be redressed, replacing pin and flashboards as soon as the water on the crest is low enough to permit safe working conditions. The stop logs in stanchion board section can be dropped into place at the same time, using gates to pass inflow.

Vt. Water Resources Board

MASCOMA LAKE DAM - OPERATING GUIDE

or Elev. 747.33, because of scour along the upstream edge of the dam with logs at lower elevations. After peak of run off passes, stop logs in stanchion board sections are replaced to a maximum G.H. of 8.1 or Elev. 751.0 before June 1.

Item 3.

With the advent of snow melt and precipitation the lake should be controlled to an elevation not to exceed 751.0 or G.H. 8.1 by operation of the gates. Other than Spring Run off.

Item 3-A.

If during other periods of the year the inflow should suddenly increase due to heavy precipitation or snow melt or both, the lake should be controlled to an elevation not to exceed 751.0 or G.H. 8.1 by operation of the gates and lowering of the stop log crest by removal of the logs. This lowering of the crest to be carried to a minimum G.H. of 4.43 or Elev. 747.33.

Item 4.

When the inflow in any season has become so great that the pond elevation cannot be controlled at Elev. 751.0 by means of the gates and the lowered stop logs in the stanchion board section, the lake will rise and spill over the flashboards.

Item 5.

In preparation for gate operation during board failures an attendant should be permanently stationed at the dam as soon as conditions described under item 4 above prevail. Indications of the inflow trend to be anticipated at Mascoma Dam from 12 to 36 hours later can be obtained by noting the plot of the chart of the U.S.G.S. gage at West Canaan.

Item 6.

As the lake elevation reaches 753.11 (G.H. 10.16) the failure of the 1" E.H. pins should occur, possibly at an elevation slightly lower. When failure does

MASCOMA LAKE

Mascoma Lake has been operated as a storage reservoir for hydroelectric purposes through a continuous period of about 50 years. Unrestricted use of the lake's storage volume for primary benefit to downstream hydroelectric power plants is an essential element in providing reliable power at the lowest possible cost for the customers of the company.

Subject to the above-named primary function, the following operating guide has been developed for the purpose of assisting the operator of the dam during periods of flood conditions on the Mascoma River:

MASCOMA LAKE DAM - OPERATING GUIDE

The prime purpose of this operating guide is to allow the passage of flood waters past the dam with as little variation in pond level and volume of discharge as can be practicably attained with the present facilities. This operating guide prepared principally for the spring run off period is to be applied at other times during the year when unusually high inflows are expected. The dressing of the dam as shown on H10993-5 and/or H10988-5, is corrected as follows:

About 1/4 of the crest with 1" E.H. pins, about 1/4 with 1-1/4" std. pins, about 1/4 with 1-1/2" std. pins and 1/4 with 1-1/2" E.H. pins.

Item 1.

A log book is maintained at the dam into which entries will be made by date and time as to gate operation, needle beam and stop log removal and replacement, pin board failures and head and tail water observations, as well as her general comments of value for the record.

Item 2.

As the lake is drawn down during the winter and early spring, the water surface elevation will be followed by the crest of the stanchion board section by removing logs. This lowering of the crest to be carried to a minimum G.H. of 4.43

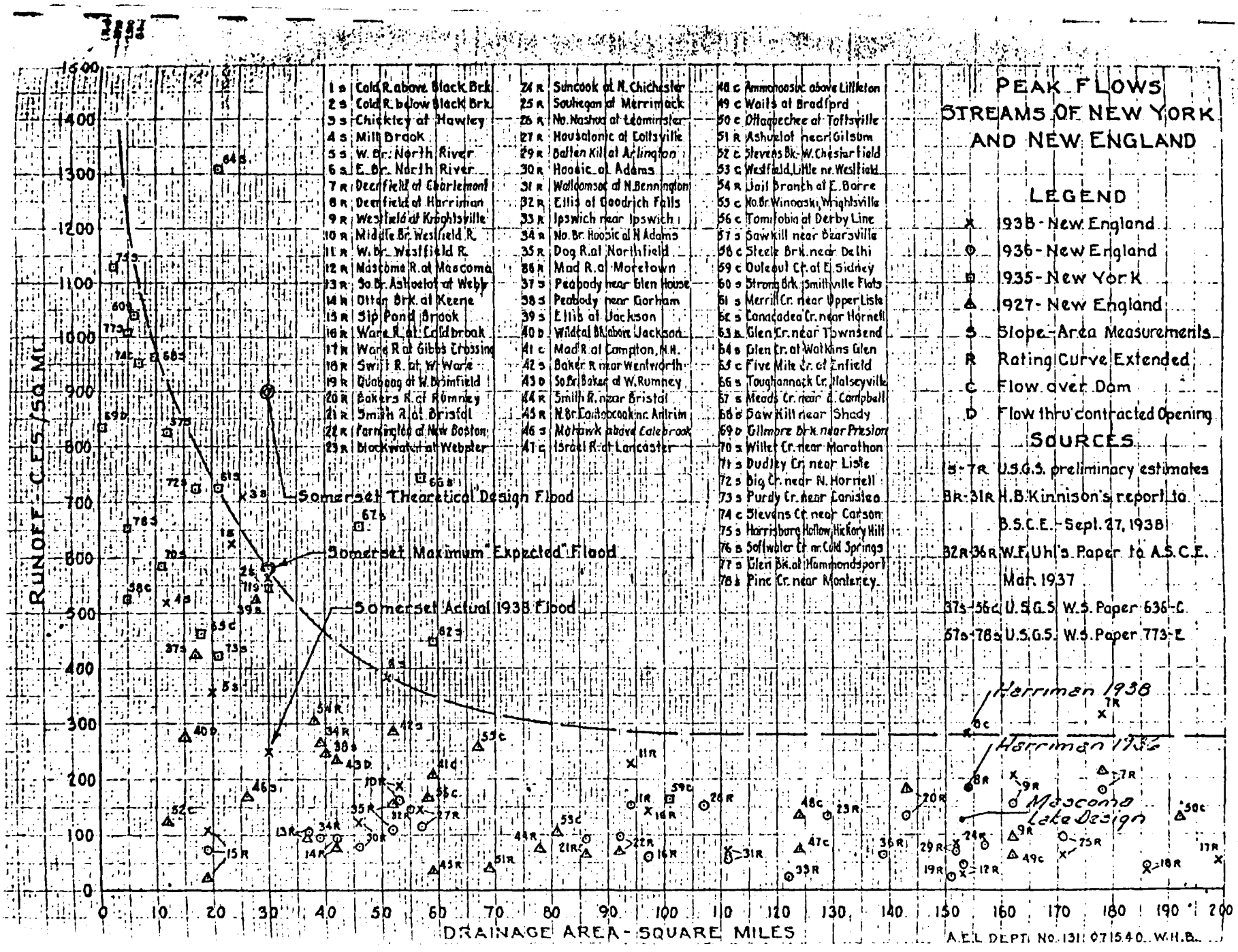

PEAK FLOWS
STREAMS OF NEW YORK
AND NEW ENGLAND
LEGEND
X 1938 - New England
O 1936 - New England
□ 1935 - New York
△ 1927 - New England
S Slope-Area Measurements
R Rating Curve Extended
C Flow over Dam
D Flow thru contracted Opening
SOURCES
5-7R U.S.G.S. preliminary estimates
8R-31R H.B. Kinnison's report to
B.S.C.E. - Sept. 27, 1938
32R-36R W.F. Uhl's Paper to A.S.C.E.
Mar. 1937
37s-56c U.S.G.S. W.S. Paper 636-C
67s-78s U.S.G.S. W.S. Paper 773-E
1 s Cold R. above Black Brk.
2 s Cold R. below Black Brk.
3 s Chickley at Hawley
4 s Mill Brook
5 s W. Br. North River
6 s E. Br. North River
7 R Deerfield at Charlemont
8 R Deerfield at Harriman
9 R Westfield at Knightsville
10 R Middle Br. Westfield R.
11 R W. br. Westfield R.
12 R Mascoma R. at Mascoma
13 R So. Br. Ashuelot at Webb
14 R Otter Brk. at Keene
15 R Slip Pond Brook
16 R Ware R. at Coldbrook
17 R Ware R. at Gibbs Crossing
18 R Swift R. at W. Ware
19 R Quaboag at W. Brimfield
20 R Bakers R. at Rumney
21 R Smith R. at Bristol
22 R Farmington at New Boston
23 R Blackwater at Webster
24 R Suncook at N. Chichester
25 R Souhegan at Merrimack
26 R No. Nashua at Leominster
27 R Housatonic at Coltsville
29 R Batten Kill at Arlington
30 R Hoosic at Adams
31 R Wallomsac at N. Bennington
32 R Ellis at Goodrich Falls
33 R Ipswich near Ipswich
34 R No. Br. Hoosic at N. Adams
35 R Dog R. at Northfield
36 R Mad R. at Moretown
37 S Peabody near Glen House
38 S Peabody near Gorham
39 S Ellis at Jackson
40 D Wildcat Br. above Jackson
41 C Mad R. at Compton, N.H.
42 S Baker R. near Wentworth
43 D So. Br. Baker at W. Rumney
44 R Smith R. near Bristol
45 R N. Br. Contoocook nr. Antrim
46 S Mohawk above Colebrook
47 C Israel R. at Lancaster
48 C Ammonoosuc above Littleton
49 C Waits at Bradford
50 C Ottaquechee at Toftsville
51 R Ashuelot near Gilsum
52 C Stevens Bk. W. Chesterfield
53 C Westfield, Little nr. Westfield
54 R Dail Branch at E. Barre
55 C No. Br. Winooski, Wrightsville
56 C Tomifobia at Derby Line
57 S Sawkill near Dearsville
58 C Steele Brk. near Delhi
59 C Outcout Cr. at E. Sidney
60 S Strong Brk. Smithville Flats
61 S Merrill Cr. near Upper Lisle
62 S Canaqadea Cr. near Hornell
63 S Glen Cr. near Townsend
64 S Glen Cr. at Watkins Glen
65 S Five Mile Cr. at Enfield
66 S Toughannock Cr. Halseyville
67 S Meads Cr. near E. Campbell
68 S Saw Kill near Shady
69 D Gilmore Brk. near Preston
70 S Willet Cr. near Marathon
71 S Dudley Cr. near Lisle
72 S Big Cr. near N. Harpell
73 S Purdy Cr. near Lanisboro
74 C Stevens Cr. near Carson
75 S Harrisburg Hollow, Hickory Hill
76 S Softwater Cr. nr. Cold Springs
77 S Glen Brk. at Hammondsport
78 S Pine Cr. near Monterey
Somerset Theoretical Design Flood
Somerset Maximum "Expected" Flood
Somerset Actual 1938 Flood
Harriman 1938
Harriman 1936
Mascoma Lake Design
RUNOFF - CFS/SQ MI
DRAINAGE AREA - SQUARE MILES
A.E.L. DEPT. No. 131 071540. W.H.B.

PLATE II

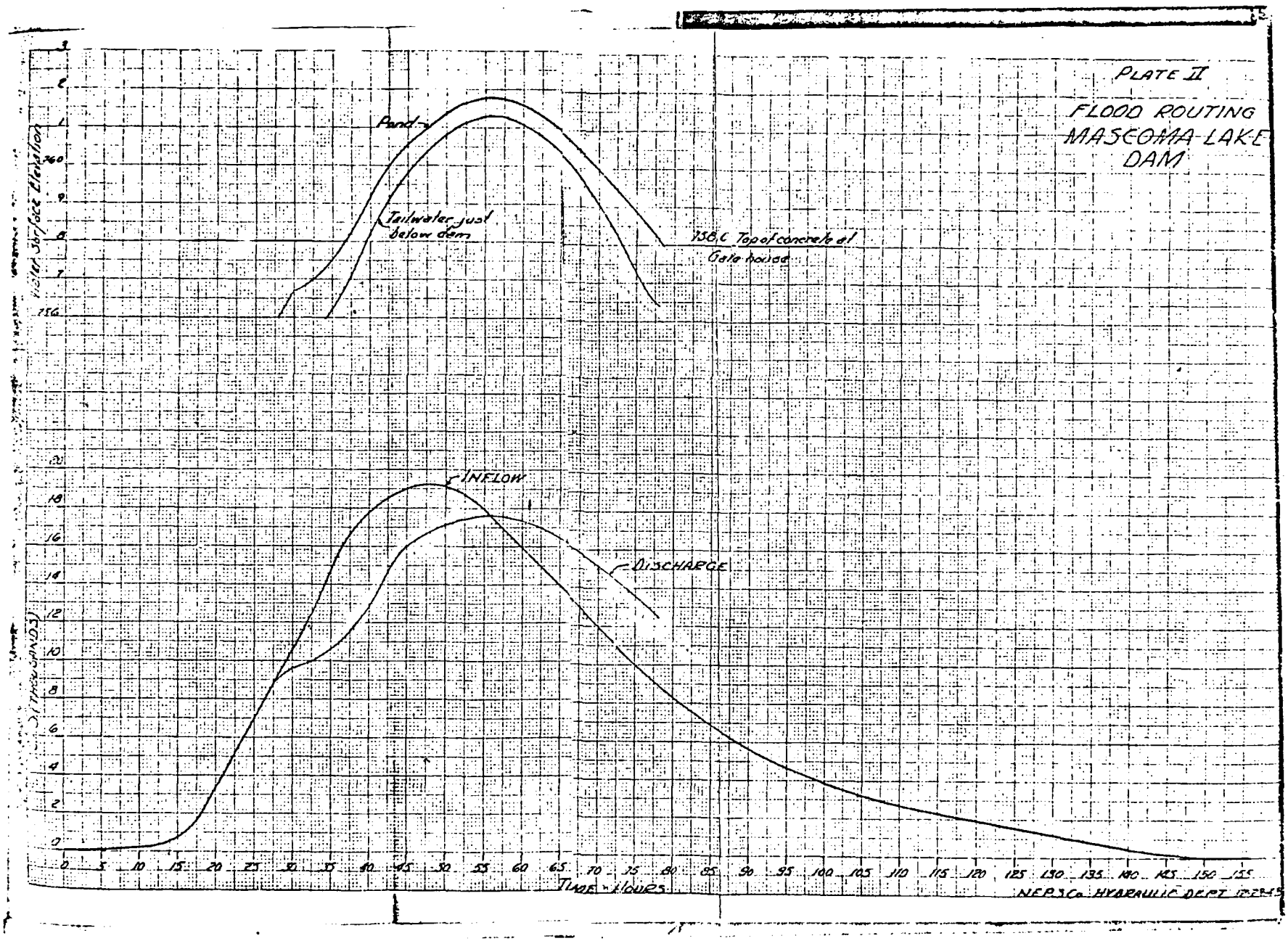
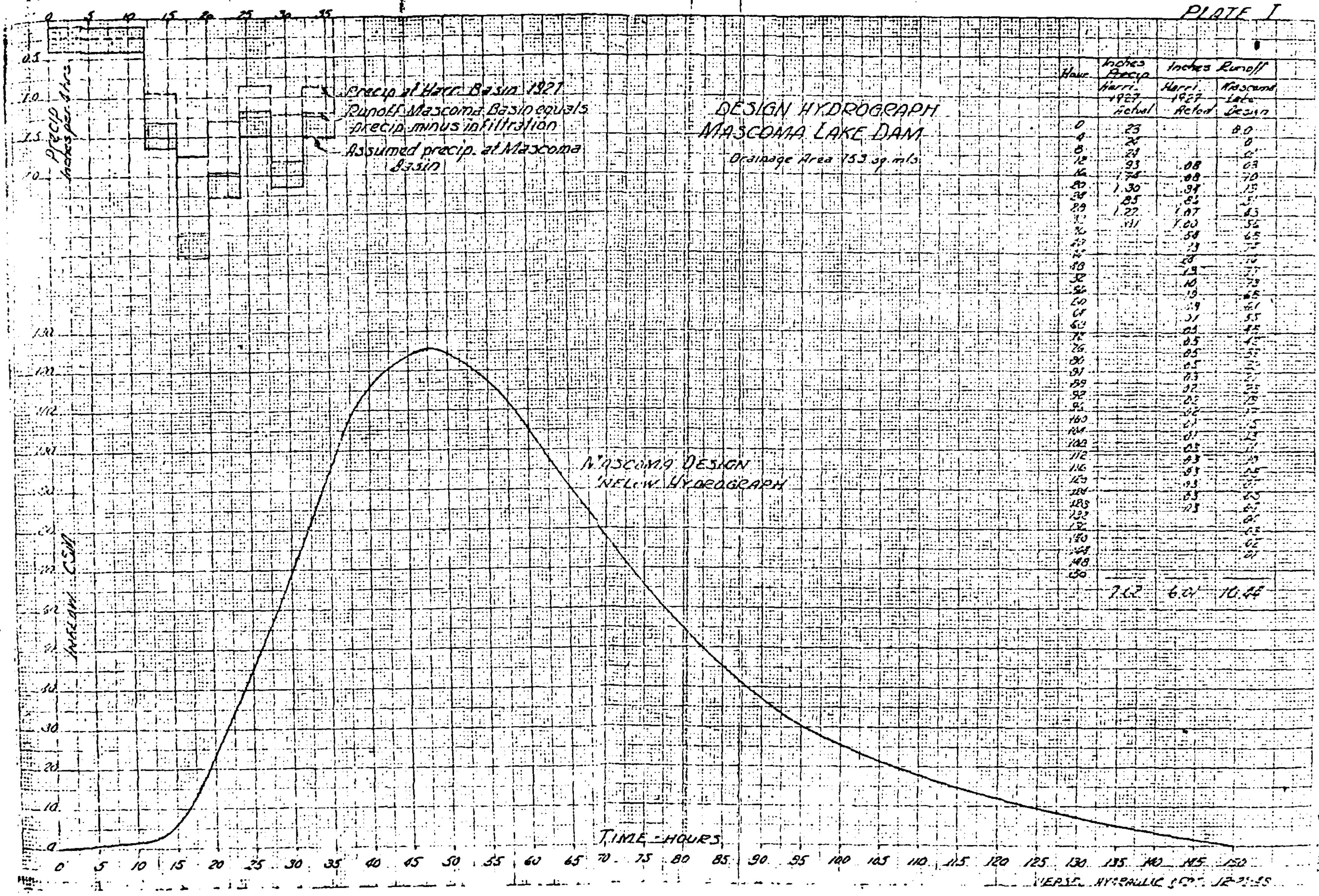


PLATE II
FLOOD ROUTING
MASCOMA LAKE
DAM
Pond
Tailwater just
below dam
738.6 Top of concrete of
Gate house
INFLOW
DISCHARGE
HIGH WATER SURFACE ELEVATION
THOUSANDS OF CUBIC FEET PER SECOND
TIME - HOURS
NEPSCo HYDRAULIC DEPT



Hour	Inches Precip Harri. 1927 Actual	Inches Runoff Harri. 1927 Actual	Inches Runoff Mascoma Lake Design
0	.23		0.0
4	.25		0
8	.24		.01
12	.93	.08	.03
16	1.75	.08	.70
20	1.30	.34	.15
24	.85	.81	.51
28	1.22	1.07	.43
32	.41	1.00	.56
36		.58	.65
40		.23	.75
44		.20	.70
48		.19	.77
52		.10	.73
56		.19	.65
60		.19	.61
64		.31	.55
68		.05	.45
72		.05	.45
76		.05	.37
80		.05	[illegible]
84		.03	[illegible]
88		.02	.25
92		.02	.19
96		.02	[illegible]
100		.01	.15
104		.01	.13
108		.03	.11
112		.03	.10
116		.03	.05
120		.03	.07
124		.03	.05
128		.03	.05
132			.06
136			.03
140			.02
144			.01
148			
150			
	7.62	6.24	10.44

VERST. HYDRAULIC SECT. 12-21-55

DAM AND BASIN DATA

Basin Data

1. Drainage area above site sq. mi. Gross - 154, Net - 124.1
2. Storage above site

Name	D.A.Sq.Mls. Gross	Net.	Elev.	Full Pond Area Acres	Vol. Acre Ft.	Inches on Net D.A.	Inches on 153 sq. mi.
Grafton Pond	3.3	3.3	16.0	321	3300.	18.7	.40
Crystal Lake	13.2	9.9	8.8	378	1725.	3.27	.21
Goose Pond	15.7	15.7	106.5	668	11688.	13.96	1.43
Nascoma Lake	153.0	124.1	752.0	1155	7744.	1.17	.94
Total							2.98

(Storage Volumes are usable)

3. Percent of D.A. above lake partially controlled - 19

Reservoir Data

1. Elevation, top of dike	759.0
2. " " " boards	752.0
3. Area full pond, top of boards, acres	1155
4. Capacity full pond above 745.15 acre feet (Usable)	7744
" " " " 745.15 inches on 124.1 Sq. Mi.(Usable)	1.17
Capacity inches on 124.1 Sq. Mi. for one foot rise at full pond	0.175

Spillway Data (Timber Dam)

1. Present Gates (4), 4' x 4'	Invert Elev.		743.2
2. 1-56' Bay pinboards, top at El. 752; fail at El. 753.0	Crest El.		749.03
1-56' " " " " " 752.0 " " " 754.4	"	"	749.03
3. 1-36' Bay stanchions top at El. 752	Sill El.		745.48

Design Storm

Harriman storm of Nov., 1927, multiplied by 1.75, with .05" per hour infiltration subtracted, applied to unit hydrograph of Nascoma R. at Nascoma, by Army Engrs. (See paper dated June 24, 1938 by G. E. McCarthy).

1.	Inches precip. Harriman	7.62
2.	" " Design	13.32
3.	" runoff (i.e. ex. infiltration) under hydrograph	10.44
4.	" " to maximum discharge	5.31
5.	(a) Max. inflow c.f.s.	19205
	(b) " " c.s.m. gross D.A. 153	126
6.	(a) " discharge c.f.s.	17600
	(b) " " c.s.m. gross D.A. = 153	115
7.	Max. pond elevation	761.8
8.	" T.W. "	761.30
9.	Total hours precip.	36
10.	" " runoff	140

PREDICTED RESULTS OF DESIGN FLOOD AT AND BELOW THE MASCOMA LAKE DAM

Plate II shows the design inflow hydrograph expressed in cubic feet per second and the corresponding discharge curve for the dam as rebuilt, with all gates open, flashboards off, and needle beams out. With this condition, the design storm would cause the lake level to rise above the dikes at each end of the dam, which have a top elevation of about 759.0. The pond elevation-time curve is shown in the upper part of the sheet with a maximum of 761.8.

The curve of computed backwater time-elevation immediately below the dam is also shown in the upper part of the sheet. It was assumed that the north approach to the highway bridge over the river would be washed out soon after the tailwater elevation reached 759.0. The lowest controlling point in the road at this location is at elevation 757.6.

The maximum pond elevation of 761.8 or 2.8 feet over the top of the dikes, as shown by the calculations, is approximate only as the exact changes or time of changes in the channel below the dam should a flood of the order of the design flood occur, cannot be accurately predicted.

Obviously, if a dam had been built with abutments and dikes high enough to prevent overtopping by the design flood, the lake level would rise considerably higher and cause additional damage to shores, cottages, and docks, which might be the subject of damage suits against the Power Company.

The rebuilt dam has greater discharge capacity than the old dam for all stages of flood because the additional waterway area of the lowered spillway crest exceeds the area reduction by the added rip rap and stanchion bay bridge with its supporting wooden pier.

Plate III shows area and storage curves for Mascoma Lake from elevation 744.0 to 762.0.

H. M. N.

12-29-48

there was an average inflow of 200 cubic feet per second per square mile for three hours at this reservoir.

The design flood peak discharge at Mascoma Lake dam is below the experienced discharge for both the 1927 and the 1938 floods at Harriman because of the difference in the topography of the contributing drainage areas. The Harriman drainage area has relatively steep slopes while there are considerable areas of relatively flat land in the Mascoma Lake drainage area and, in addition, in excess of one fifth of the drainage area is tributary to ponds which store water during flood periods.

APPENDIX C

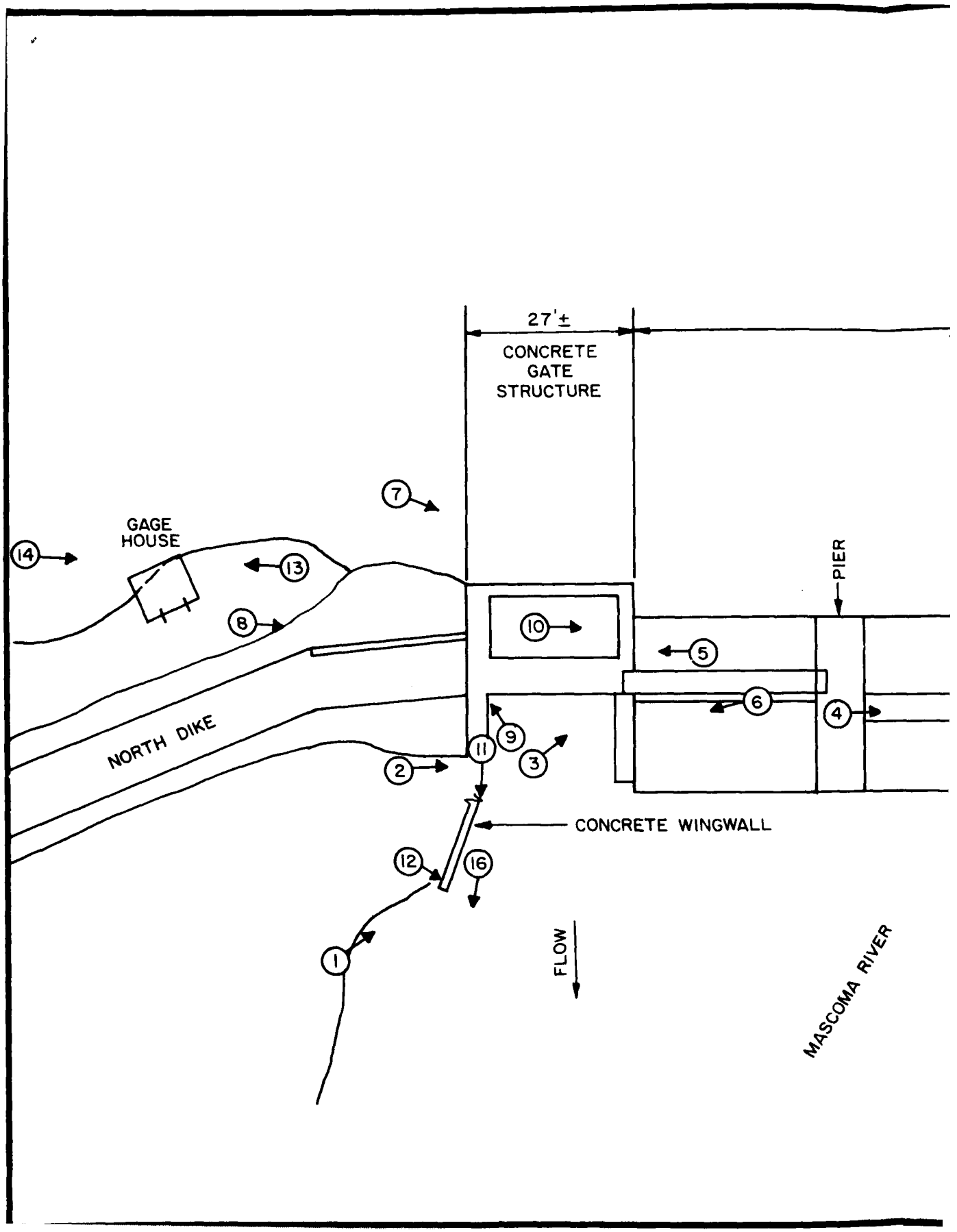
PHOTOGRAPHS

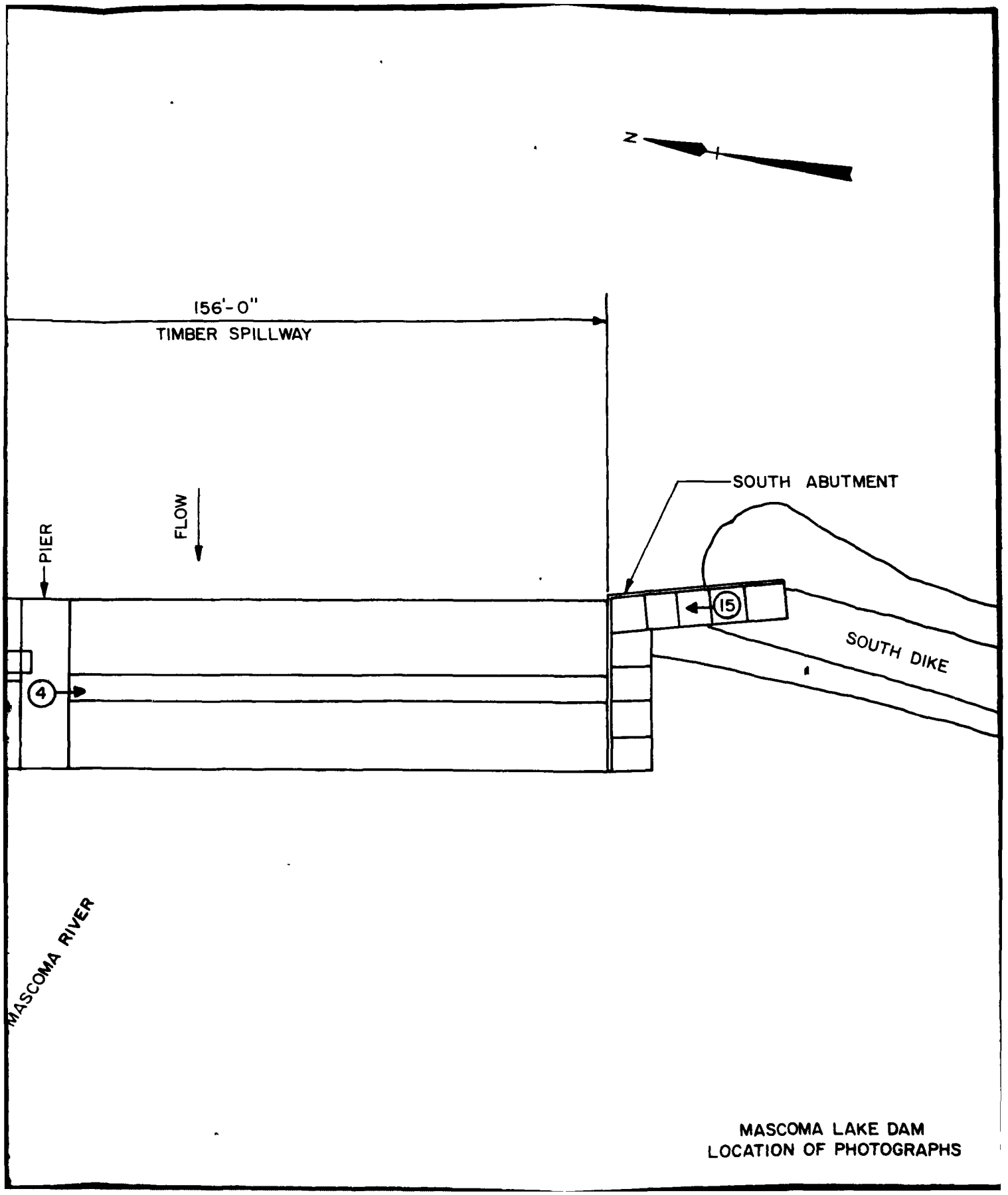
APPENDIX C

REPRESENTATIVE PHOTOGRAPHS OF PROJECT

y. Total hours precip. 136
10. " " runoff 140

No.		Negative No.	Page
10.	Inside of gate house, showing operating gear in partially open position.	7-28	C-8
11.	Downstream wingwall near the gate house outlet, showing misalignment and concrete erosion.	7-21	C-9
12.	Lower end of same wingwall, showing washout of adjacent soil.	7-22	C-9
13.	Telemark gage house near the right abutment of dam.	7-25	C-10
14.	Concrete covered rip-rap cracked near the right abutment of dam.	7-27	C-10
15.	Left bank abutment, stone-filled, wooden crib.	7-34	C-11
16.	Downstream channel and bridge, looking from right abutment of dam.	7-23A	C-11


27'±
CONCRETE
GATE
STRUCTURE
GAGE
HOUSE
PIER
NORTH DIKE
CONCRETE WINGWALL
FLOW
MASCOMA RIVER
1
2
3
4
5
6
7
8
9
10
11
12
13
14
16



MASCOMA LAKE DAM
LOCATION OF PHOTOGRAPHS

1. Mascoma Lake Dam: Gate House, Stop Log Section and Spillway. Footbridge from Gate House to Spillway.

2. Stop Log Stanchions and Outlet. Wooden Spillway in Background.

3. Downstream Side of Intake Structure Under the Gate House.

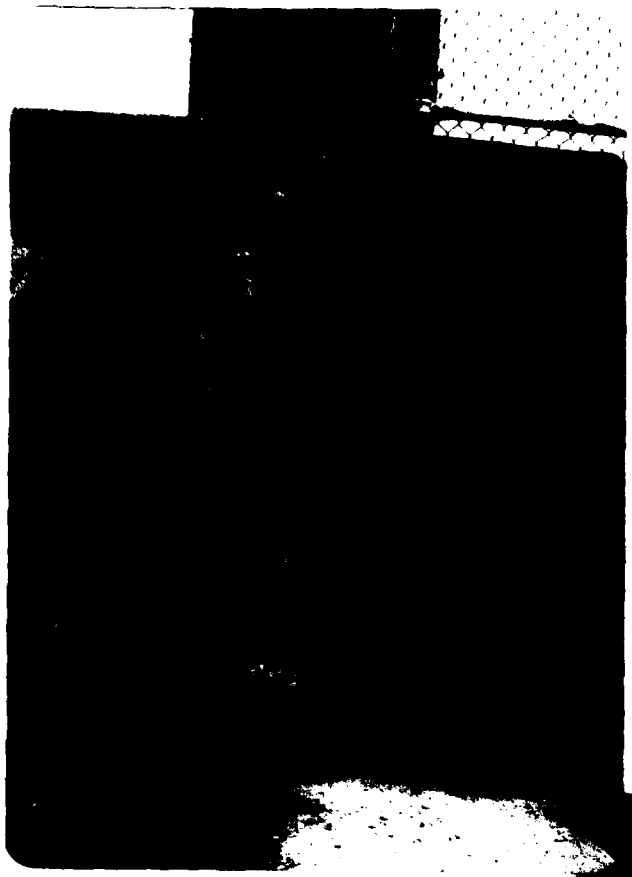
4. Spillway with Flashboards, Looking from the Footbridge. Left Abutment in the Background.

5. Intake Structure Looking from Footbridge Over Stop Log Section. Note Concrete Erosion and Surface Cracks.

6. Outlets of Stop Log Section and of Gate House. Showing Right Side Wingwall in Background.

7. The Upstream Side of the Intake Structure and Gate House.

8. The Right Abutment and the Gate House.

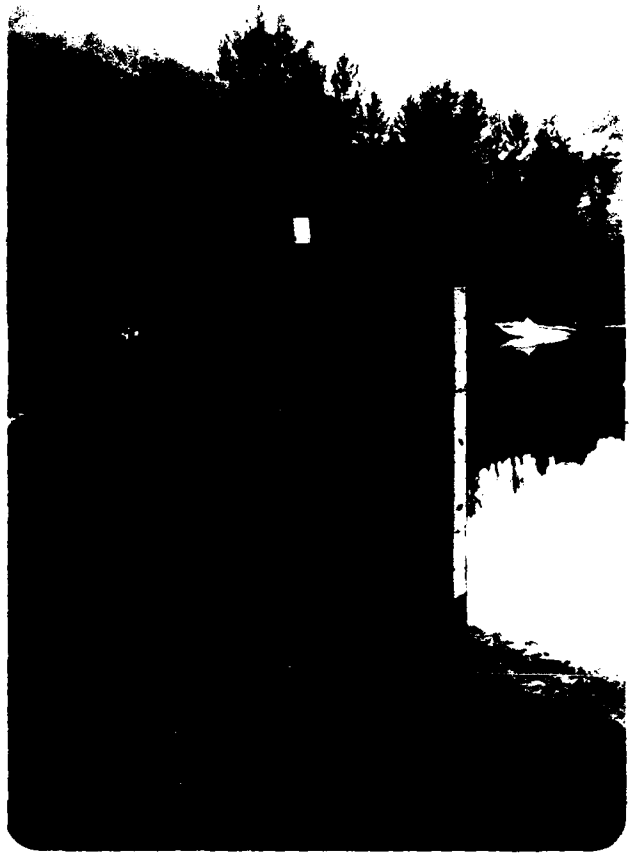


9. Open Joint Between Gate House and Right Abutment, Looking Upstream. Showing Concrete Erosion.

10. Inside of Gate House, Showing Operating Gear in Partially Open Position.

11. Downstream Wingwall Near the Gate House Outlet, Showing Misalignment and Concrete Erosion.

12. Lower End of Same Wingwall, Showing Washout of Adjacent Soil.



13. Telemark Gage House Near the Right Abutment of Dam.

14. Concrete Covered Rip-Rap, Cracked Near the Right Abutment of Dam.

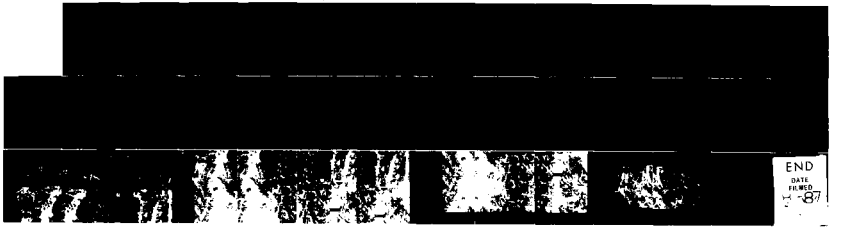
15. Left Bank Abutment, Stone-Filled Wooden Crib.

16. Downstream Channel and Bridge, Looking From Right Abutment of Dam.

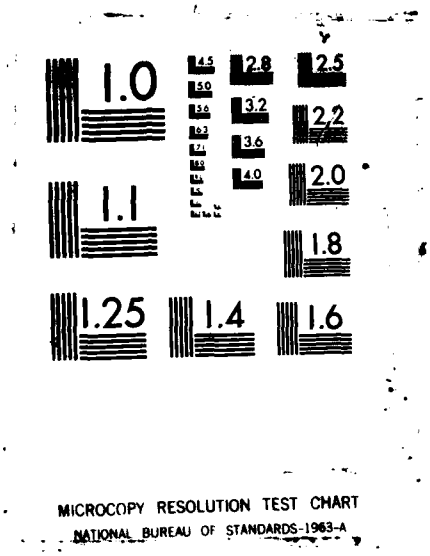
APPENDIX D

HYDROLOGIC & HYDRAULIC COMPUTATIONS

AD-A156 000 NATIONAL DAM INSPECTION PROGRAM MASCOMA LAKE DAM 2/2
(NH00153) CONNECTICUT RIVER BASIN LEBANON NEW HAMPSHIRE
(U) CORPS OF ENGINEERS WALTHAM MA NEW ENGLAND DIV
UNCLASSIFIED MAY 79 F/G 13/2 NL



END
DATE FILMED
6-85


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-606(5)

FILE NUMBER EN-606
SHEET NUMBER 6F
DATE 8-18-1978
COMPUTED BY LEM
CHECKED BY

SUBJECT NATIONAL DAM INSP. PROGRAM
MASCOMA LAKE DAM

total drainage area of Mascoma Lake = 153.0 sq. miles

The drainage area of Mascoma Lake is characterized by mountainous topography. Therefore, from guide curves, furnished by the Corps of Engineers, it is found that

Probable maximum flood Peak Inflow = 1025 x 153
= 156,825 cfs.

According to size classification as given in TABLE 1, in "Recommended Guidelines for Safety Inspection of Dams", Mascoma Lake dam is intermediate in size.
According to Hazard Potential classification as given in TABLE 2, it falls under the category of high hazard dam.

∴ According to Hydrologic Evaluation Guidelines as given in TABLE 3,

Test Flood Peak Inflow = 156,825 cfs.

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006 (5)

FILE NUMBER E-1-006
SHEET NUMBER 2 OF
DATE 9-12-78
COMPUTED BY
CHECKED BY

SUBJECT MASCOMA LAKE DAM

SPILLWAY TEST FLOOD INFLOW HYDROGRAPH
(BASED ON SCS DIMENSIONLESS UNIT HYDROGRAPH)

Total length of travel from farthest point to outlet = 122,000 ft.

Difference in elevation = 2480 ft.

$$\therefore T_c = \frac{(122{,}000)^{1.15}}{7700 \times (2480)^{0.38}}$$

$$= \frac{706828.6477}{7700 \times 19.49}$$

$$= 4.7098 \text{ hrs.}$$

$$\simeq 4.75 \text{ hrs (say)}$$

PMF = 156,825 cfs.

$\therefore$ SDF = PMF = 156,825 cfs.

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006(5)

FILE NUMBER EN-006
SHEET NUMBER 3 OF
DATE 8-16-1978
COMPUTED BY JRM
CHECKED BY

SUBJECT WASHINGTON LAKE DAM.

SPILLWAY TEST FLOOD INFLOW HYDROGRAPH
(BASED ON SCS DIMENSIONLESS UNIT HYDROGRAPH).

$T_c = 4.75$ hrs.

$Q_p = 156,825$ cfs.

T (hrs)	T/T_c	Q/Q_p	Q (cfs)
1.18	0.25	0.05	7841
2.38	0.50	0.18	28228
3.56	0.75	0.73	114482.0
4.75	1.00	1.00	156,825.0
5.94	1.25	0.80	125460.0
7.13	1.50	0.40	62730.0
8.31	1.75	0.25	39206.0
9.50	2.00	0.17	26660.0
13.06	2.75	0.06	9410.0
16.625	3.50	0.02	3136.5
19.00	4.00	0.01	1568.0

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT SAFETY EVALUATION OF NON-FEDERAL DAMS

FILE NUMBER EN-006
SHEET NUMBER 4
DATE 10/16/78
COMPUTED BY G. G. L
CHECKED BY

SUBJECT MASCOMA LAKE DAM

DISCHARGE RATING TABLE FOR SPILLWAY, STANCHION SECTION, AND GATE SECTION.

ELEVATION	DISCHARGE (CFS) SPILLWAY Q_1	STANCHION SECTION * Q_2	GATE SECTION Q_3 **	TOTAL $Q = Q_1 + Q_2 + Q_3$
749.00	0	690 (621)	556 (550)	1,246 (1177)
750.00	380	1000 (850)	664	2044 (1894)
751.00	1080	1360 (1075)	744	3,184 (2899)
752.00	1960 (1820)	1750 (1313)	812	4,522 (3945)
753.00	3000 (2630)	2150 (1559)	876	6,026 (5065)
754.00	4200 (3490)	2550 (1810)	928	7,678 (6178)
755.00	5500 (4760)	2950 (2360)†	980	9,430 (8120)
756.00	6800 (6120)	3350 (2846)†	1032	11,182 (10,000)
757.00	8000 (7460)	3750 (3275)†	1084	12,834 (11,919)
758.00	9200 (8800)	4150 (3943)†	1136	14,486 (13,879)

REFER TO FIGURES:

* ALL SIX STANCHION OUT, DISCHARGE OF STANCHION BAY

** ALL FOUR GATES ARE WIDE OPEN; TAILWATER ELEV. IS BELOW THE GATE SILL ELEV.; AND EL. 749 ≈ 5.5 FT GAGE.

*** THE NUMBERS IN PARENTHESES INDICATE THE DISCHARGE IS AFFECTED BY TAILWATER. THE TAILWATER ELEV. IS ASSUMED TO BE 2 FT LESS THAN THE HEADWATER BUT NOT EXCEED ELEV 752.

† ASSUMED TAILWATER EL. IS 752 AND % ADJUSTMENT RANGED FROM 80 to 95

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006(5)

FILE NUMBER EN-1.4
SHEET NUMBER 5 OF
DATE 10-23-1978
COMPUTED BY VEH
CHECKED BY

SUBJECT MASCOMA LAKE DAM

DISCHARGE RATING TABLE FOR DIKES

FOR POOL LEVELS ABOVE TOP OF DAM.

Total length of earth dam = 392.0 ft.

$$Q = 2.6 \times 392 \times H^{3/2} =$$
$$= 1019.2\, H^{3/2}$$

ELEV.	H (ft)	Q (cfs)
759.0	0	0
760.0	1	1019.0
761.0	2	2883.0
762.0	3	5296.0
763.0	4	8154.0
764.0	5	11395.0
765.0	6	14979.0
766.0	7	18876.0
767.0	8	23062.0
768.0	9	27518.0
769.0	10	32230.0
770.0	11	37183.0
771.0	12	42367.0
772.0	13	47772.0
773.0	14	53388.0
775.0	16	65229.0
779.0	20	91160.0
780.0		

FAY, SPOFFORD & THORNDIKE, INC.
ENGINEERS
BOSTON

PROJECT EN-006 (5)

FILE NUMBER EN-006
SHEET NUMBER 6 OF
DATE 10-26-78
COMPUTED BY VRM
CHECKED BY

SUBJECT MASCOMA LAKE DAM.

COMPOSITE DISCHARGE RATING TABLE

ELEV	FLOW THRU SPILLWAY, STANCHIONS AND GATES	FLOW OVER EARTH DAM	TOTAL DISCHARGE Q
749	1,177		
750	1,894		
751	2,899		
752	3,495		
753	5,065		
754	6,178		
755	8,120		
756	10,000		
757	11,919		
758	13,879		
759	15,500	0	
760	17,600	1,019	18,619
761	19,400	2,883	22,283
762	21,400	5,296	26,696
763	23,500	8,154	31,654
764	25,300	11,395	36,695
765	27,300	14,979	42,279
766	29,300	18,876	48,176
767	31,200	23,062	54,262
768	33,500	27,518	61,018
769	35,100	32,230	67,330
770	37,500	37,183	74,683
771	39,500	42,367	81,867
772	41,600	47,772	89,372
773	43,600	53,388	96,988
775	47,900	65,229	113,129
779	56,300	91,160	147,460
780	58,500		

REFER TO FIGURES:

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006(2)

FILE NUMBER EN-006
SHEET NUMBER 7
DATE 10-11-78
COMPUTED BY P.M.M.
CHECKED BY

SUBJECT NATIONAL DAM INSP. PROGRAM - MASCOMA DAM - DEVELOPMENT OF TAILWATER RATING CURVE (APPROXIMATE METHOD)

$n = .045$ to 4' depth $\qquad$ $n = .050$ (over 4' depth)

$C = \frac{1.486}{.045} = 33.02$ $\qquad$ $C = \frac{1.486}{.050} = 29.72$

S_b = mean bed slope = 0.0025, $S_b^{1/2} = 0.050$

ELEV.	DEPTH	a	P	r	$r^{2/3}$	C	K_d	$S_b^{1/2}$	Q
742	0	0	0	—	—	—			
744	2	250	205	1.22	1.14	33.02	9,411	.05	470
746	4	678	220	3.08	2.12	33.02	47,462	.05	2,370
748	6	1,130	232	4.87	2.87	29.72	96,385	.05	4,820
750	8	1,604	244	6.57	3.51	29.72	167,325	.05	8,370
752	10	2,096	250	8.38	4.13	29.72	257,271	.05	12,860
754	12	2,600	256	10.16	4.69	29.72	362,406	.05	18,120
756	14	3,154	322	9.79	4.58	29.72	429,315	.05	21,470
758	16	4,042	480	8.42	4.14	29.72	497,331	.05	24,870
760	18	5,192	654	7.94	3.98	29.72	614,139	.05	30,710

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006(5)

FILE NUMBER EN-006
SHEET NUMBER 8 OF
DATE 11-1-1978
COMPUTED BY VEH
CHECKED BY

SUBJECT MASCOMA LAKE DAM.
TO DETERMINE PEAK OUTFLOW.

Spillway Test flood Peak Inflow = 156,825 cfs.

TRIAL #1:

Assume inflow volume = 19" of runoff from D.A.

Available Surcharge Storage upto top of dam

$$= \frac{1186 \times 10}{153 \times 140} \times 12$$

= 1.453 inches of runoff from D.A.

$$\frac{\text{Lake Surcharge Storage}}{\text{Inflow runoff Volume}} = \frac{1.453}{19}$$

$$= 0.076$$

Referring to Figure 17-11 in SCS NEH, Section 4

$$\frac{\text{Outflow Peak Rate}}{\text{Inflow Peak Rate}} = 0.98$$

∴ Outflow Peak Rate = 0.98 × 156,825

= 153,688 cfs.

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006(5)

FILE NUMBER EN-006
SHEET NUMBER 1 OF
DATE 11-1-1978
COMPUTED BY VRM
CHECKED BY

SUBJECT MASCOMA LAKE DAM.
TO DETERMINE PEAK OUTFLOW.

TRIAL #2:

From the composite rating curve, the above outflow peak rate corresponds to ELEV. 779.6

i.e. surcharge height above the spillway crest
30.6 feet

∴ Vol. of surcharge storage (STOR$_1$)

$$= \frac{1186 \times 30.6}{153 \times 640} \times 12$$

$$= 4.45 \text{ inches of runoff from D.A.}$$

∴ Peak outflow $Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR_1}{19}\right)$

$$= 156,825\left(1 - \frac{4.45}{19}\right)$$

$$= 156,825\left(1 - 0.234\right)$$

$$= 156,825 \times 0.766$$

$$= 120,128 \text{ cfs}$$

FAY, SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006(5)

FILE NUMBER EN-006
SHEET NUMBER 10 OF
DATE 11-1-1978
COMPUTED BY VRM
CHECKED BY

SUBJECT MASCOMA LAKE DAM
TO DETERMINE PEAK OUTFLOW

TRIAL #3:

From the composite rating curve, the above outflow peak rate corresponds to ELEV. 775.60

i.e. Surcharge height above the spillway crest
= 26.60 feet.

∴ Vol. of Surcharge Storage (STOR$_2$)

$$= \frac{1186 \times 26.60}{153 \times 640} \times 12$$

= 3.87 inches of runoff from D.A.

∴ Peak outflow $Q_{P_2} = 156,825 \left(1 - \frac{3.87}{19}\right)$

$= 156,825 (1 - 0.204)$

$= 156,825 \times 0.796$

= 124 832 cfs.

FAY SPOFFORD & THORNDIKE INC
ENGINEERS
BOSTON

PROJECT EM-006(5)

FILE NUMBER EM-006
SHEET NUMBER 11 3F
DATE 11-1-1978
COMPUTED BY VEM
CHECKED BY

SUBJECT MASCOMA LAKE DAM
TO DETERMINE PEAK OUTFLOW

TRIAL #4:

From the composite rating curve, the above outflow peak rate corresponds to ELEV. 776.40

i.e. surcharge height above the spillway crest
= 27.40 feet

∴ Vol. of surcharge storage ($STOR_2$)

$$= \frac{1186 \times 27.40}{153 \times 640} \times 12$$

= 3.98 inches of runoff from D.A.

Peak outflow $Q_{P_2} = 156,825 \left(1 - \frac{3.98}{19}\right)$

$= 156,825 \left(1 - 0.209\right)$

$= 156,825 \times 0.791$

$= 124,048$ cfs.

FAY SPOFFORD & THORNDIKE, INC
ENGINEERS
BOSTON

PROJECT EN-006(5)

FILE NUMBER EN-006
SHEET NUMBER 12 OF
DATE 11-1-1978
COMPUTED BY VRM
CHECKED BY

SUBJECT BIASCONA LAKE DAM
TO DETERMINE PEAK OUTFLOW

Average of $STOR_1$ and $STOR_2$

$$= \frac{3.87 + 3.98}{2}$$

$$= 3.925 \text{ inches of runoff from A}$$

$$\therefore \text{Peak outflow} = 156,825 \left(1 - \frac{3.925}{19}\right)$$

$$= 156,825 \times (1 - 0.2065)$$

$$= 156,825 \times 0.7935$$

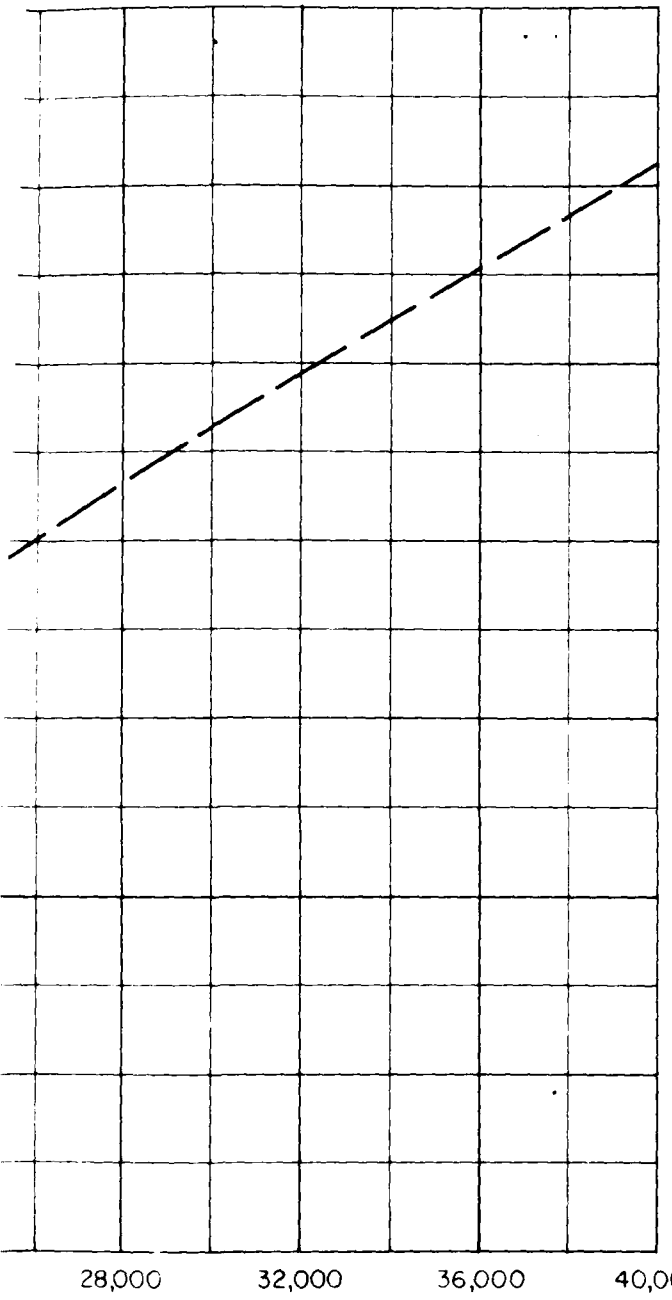
$$= 124,440 \text{ cfs.}$$

The corresponding maximum pool Elevation
$= 776.40$

$\therefore$ Maximum surcharge height $= 27.40$ feet.

Earth dam (assuming they remain intact after being overtopped) would be overtopped by
17.40 feet.

Spillway (Flashboard section, stanchion section, and Gate section) can pass without overtopping the dam 15,700 cfs.



CURVE

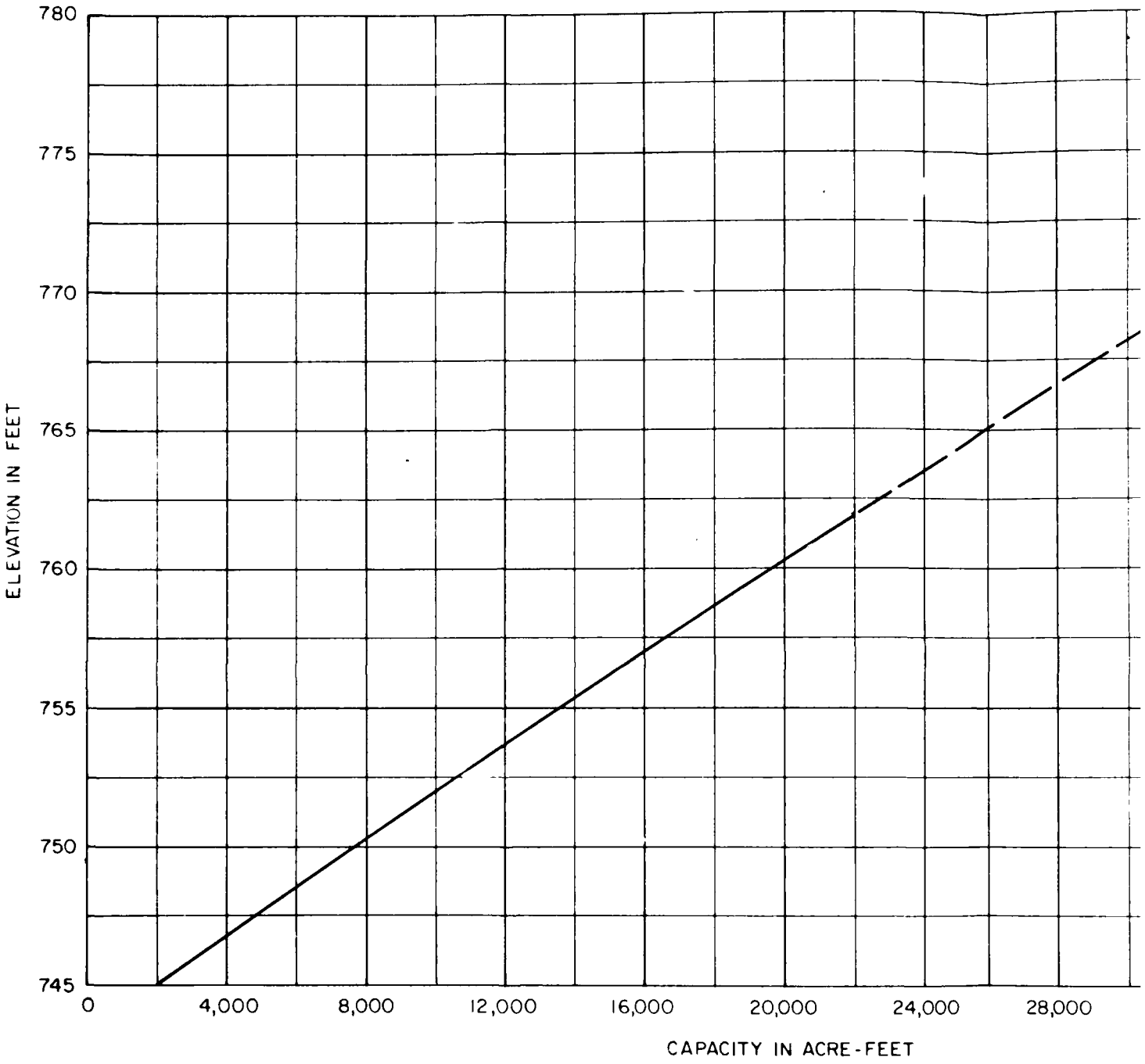
FAY, SPOFFORD & THORNDIKE, INC ENGINEERS BOSTON, MASS	U S ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

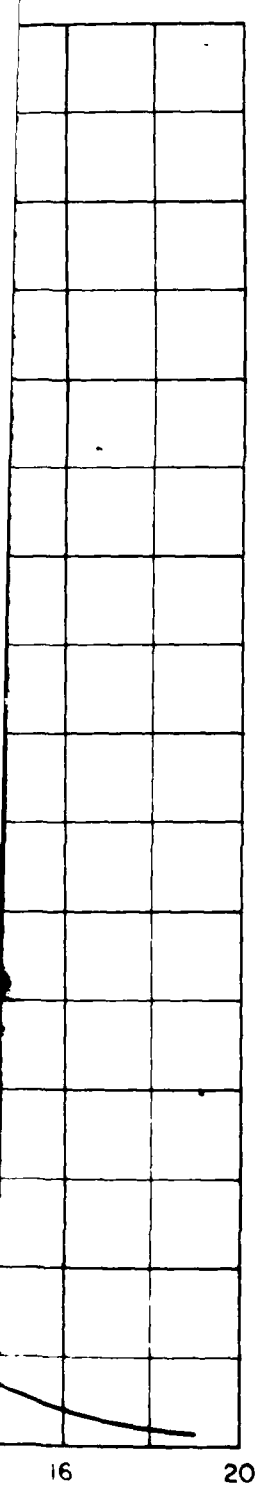
MASCOMA LAKE DAM

MASCOMA RIVER — NEW HAMPSHIRE

SCALE	AS SHOWN
DATE	AUGUST, 1978



STORAGE CAPACITY – ELEVATION CURVE



DROGRAPH

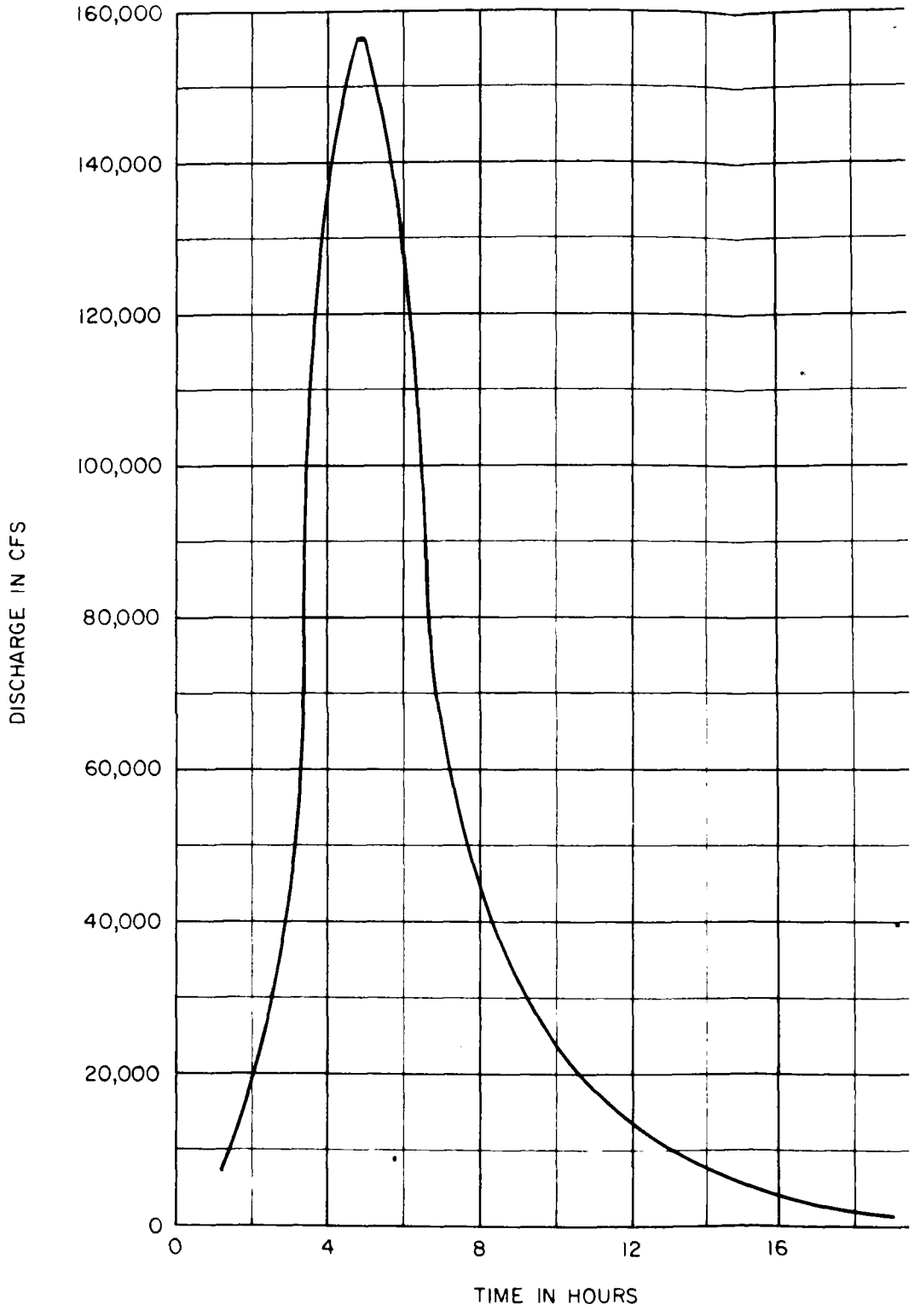
FAY, SPOFFORD & THORNDIKE, INC. ENGINEERS BOSTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

MASCOMA LAKE DAM

MASCOMA RIVER — NEW HAMPSHIRE

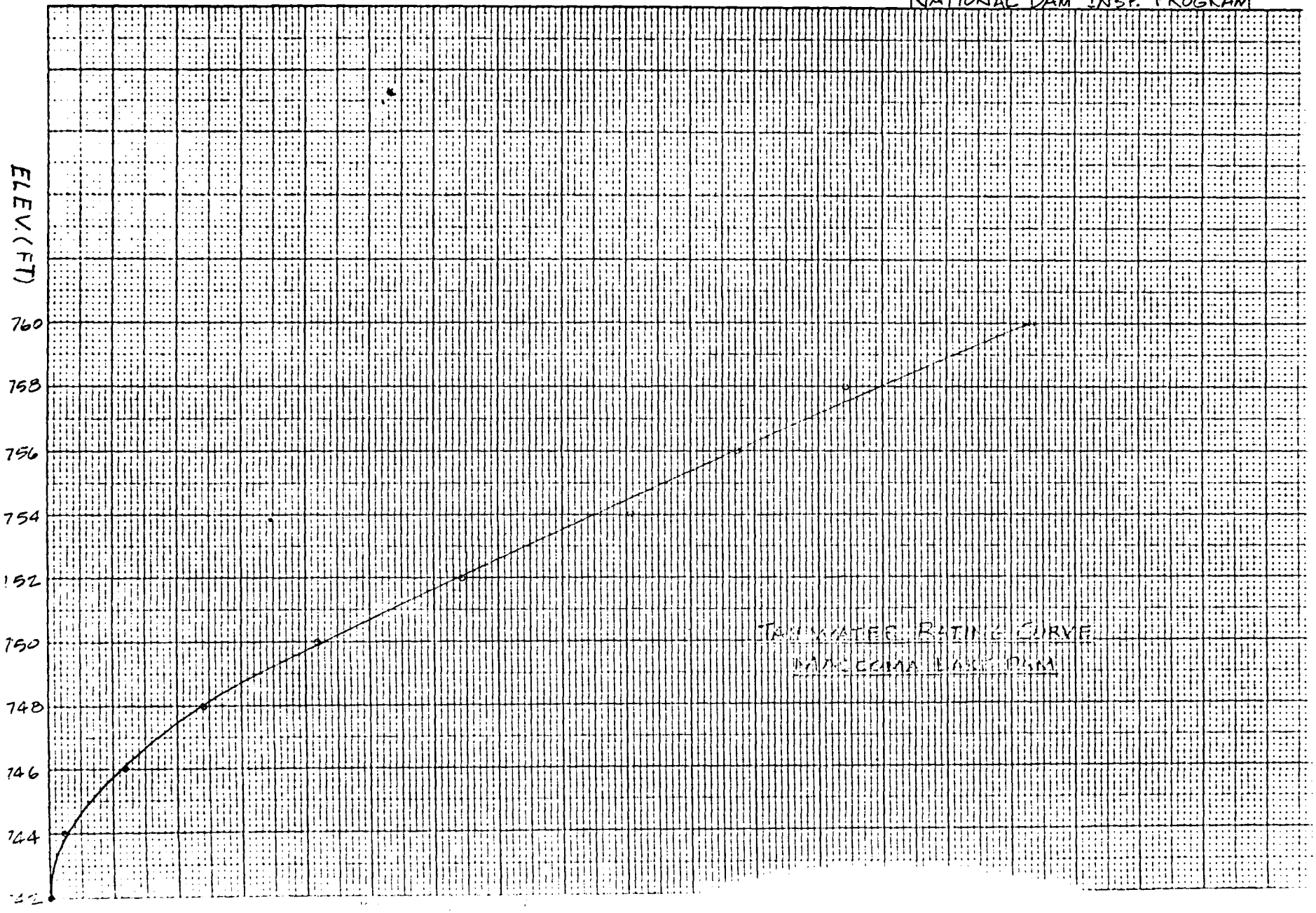
SCALE	AS SHOWN
DATE	AUGUST, 1978



SPILLWAY TEST FLOOD INFLOW HYDROGRAPH

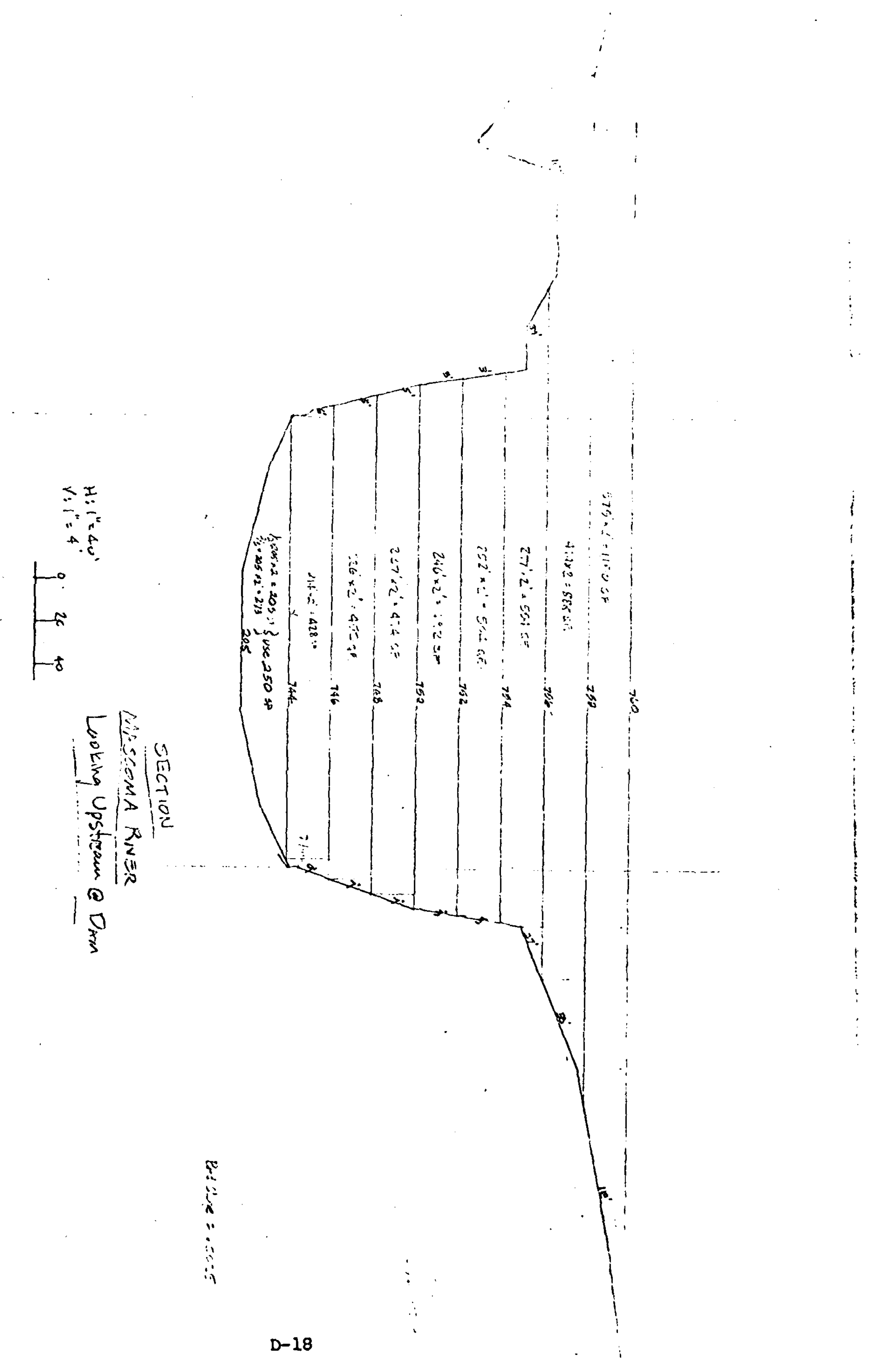
APPENDIX D

NATIONAL DAM INSP. PROGRAM



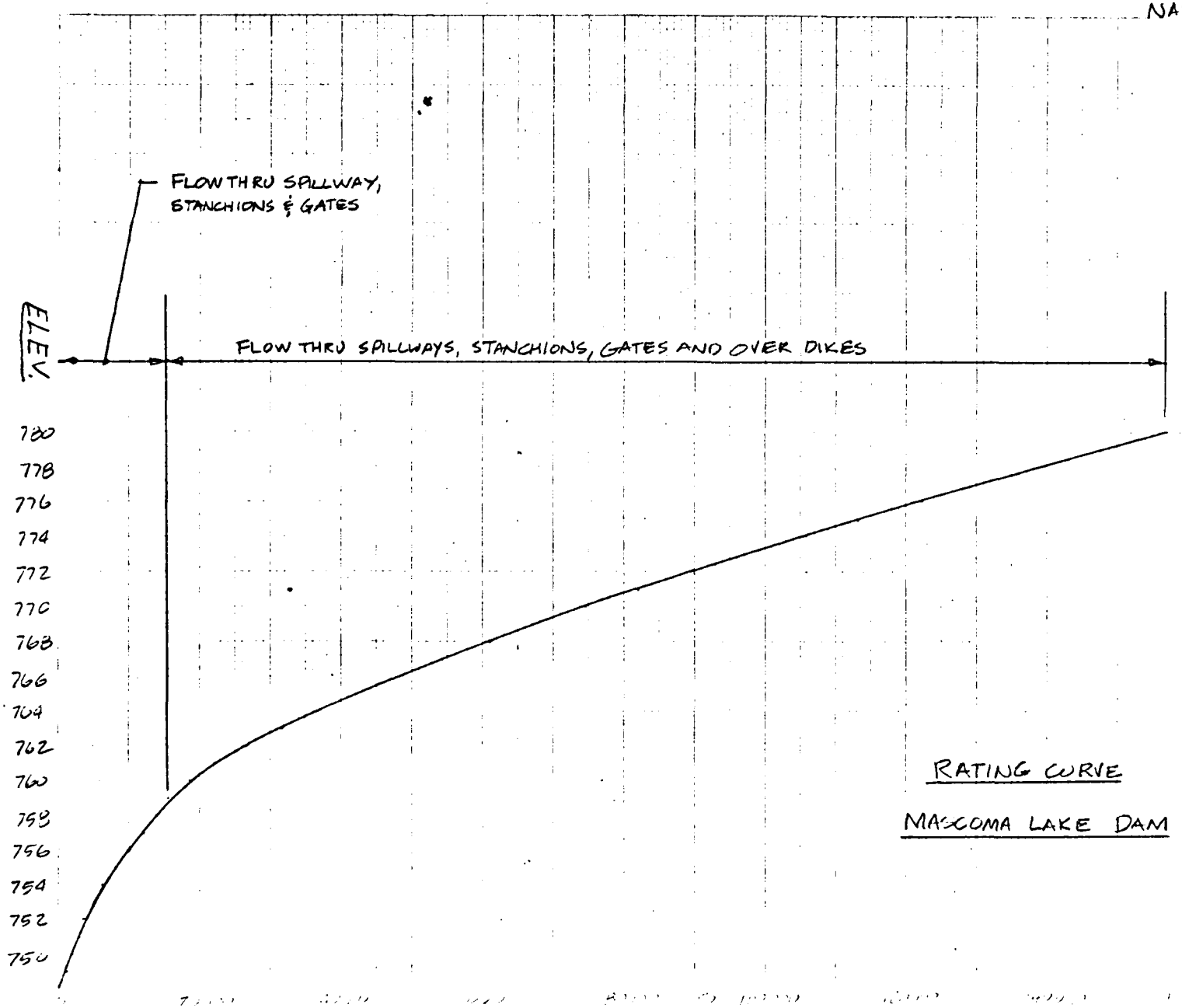
TAILWATER RATING CURVE

DAM NO. CCMA 1 DAM


SECTION
Looking Upstream @ Dam
H: 1"=40'
V: 1"=4'

APPENDIX D

NATIONAL DAM INSP. PROGR.

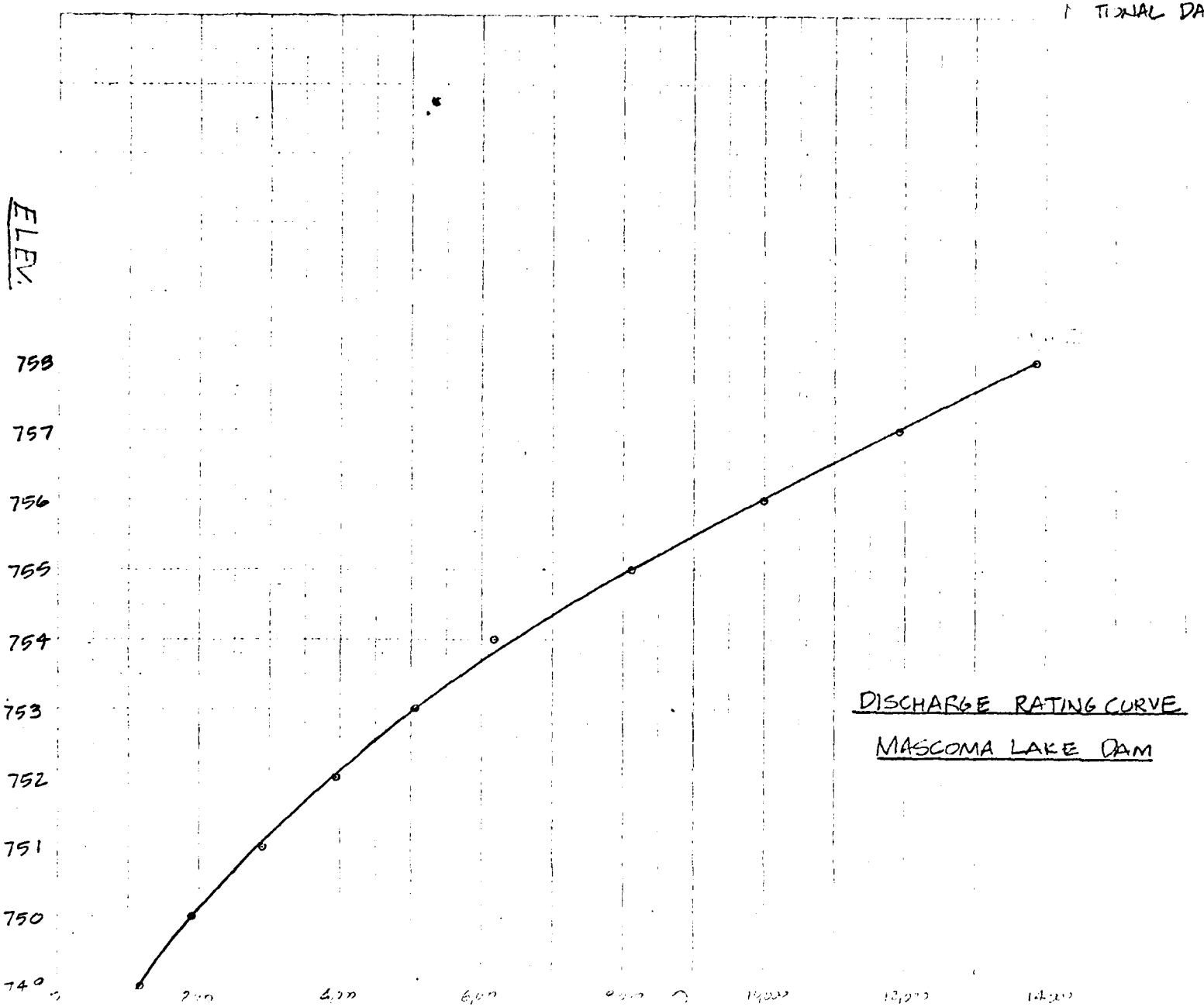


RATING CURVE

MASCOMA LAKE DAM

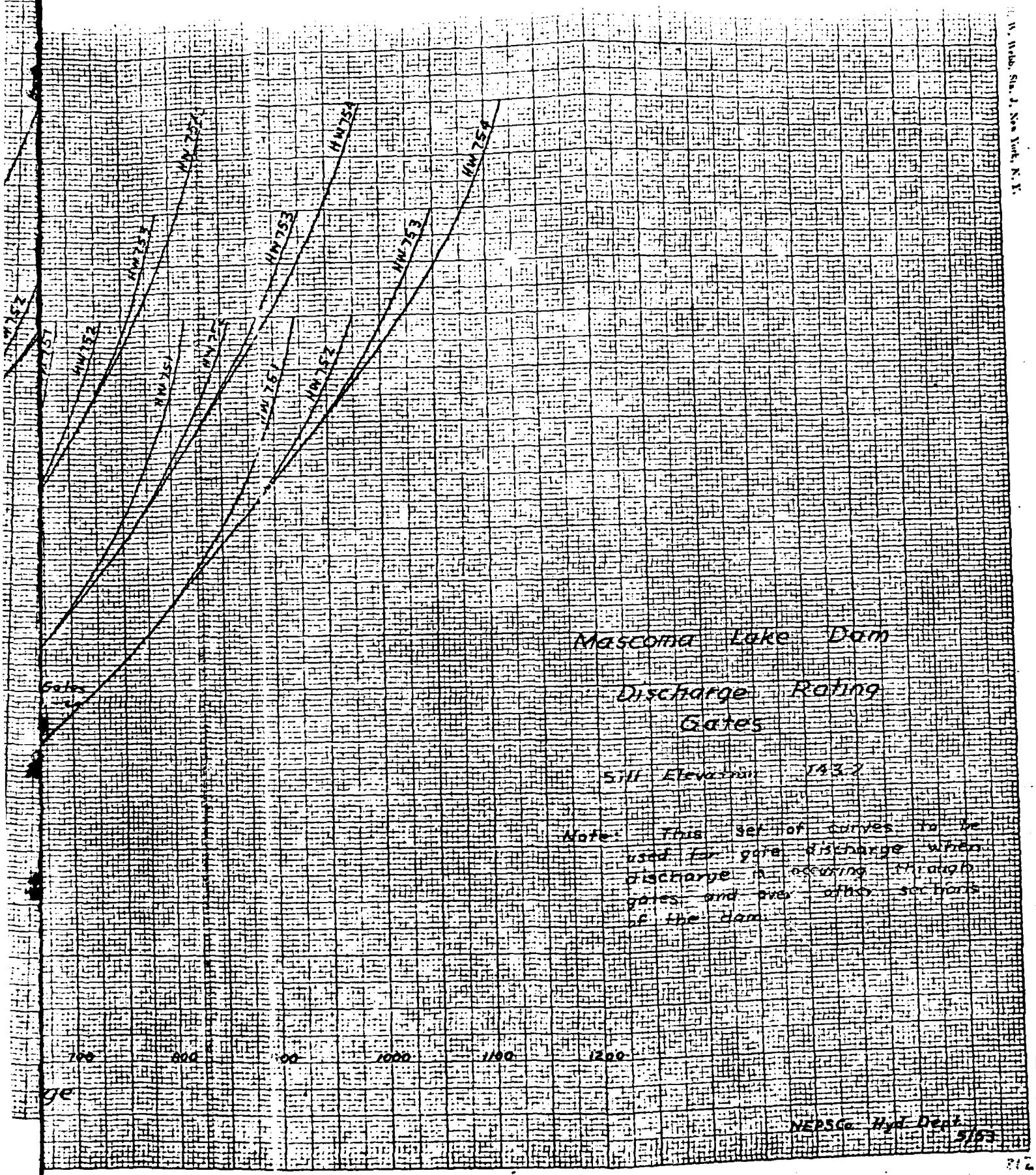
APPENDIX D

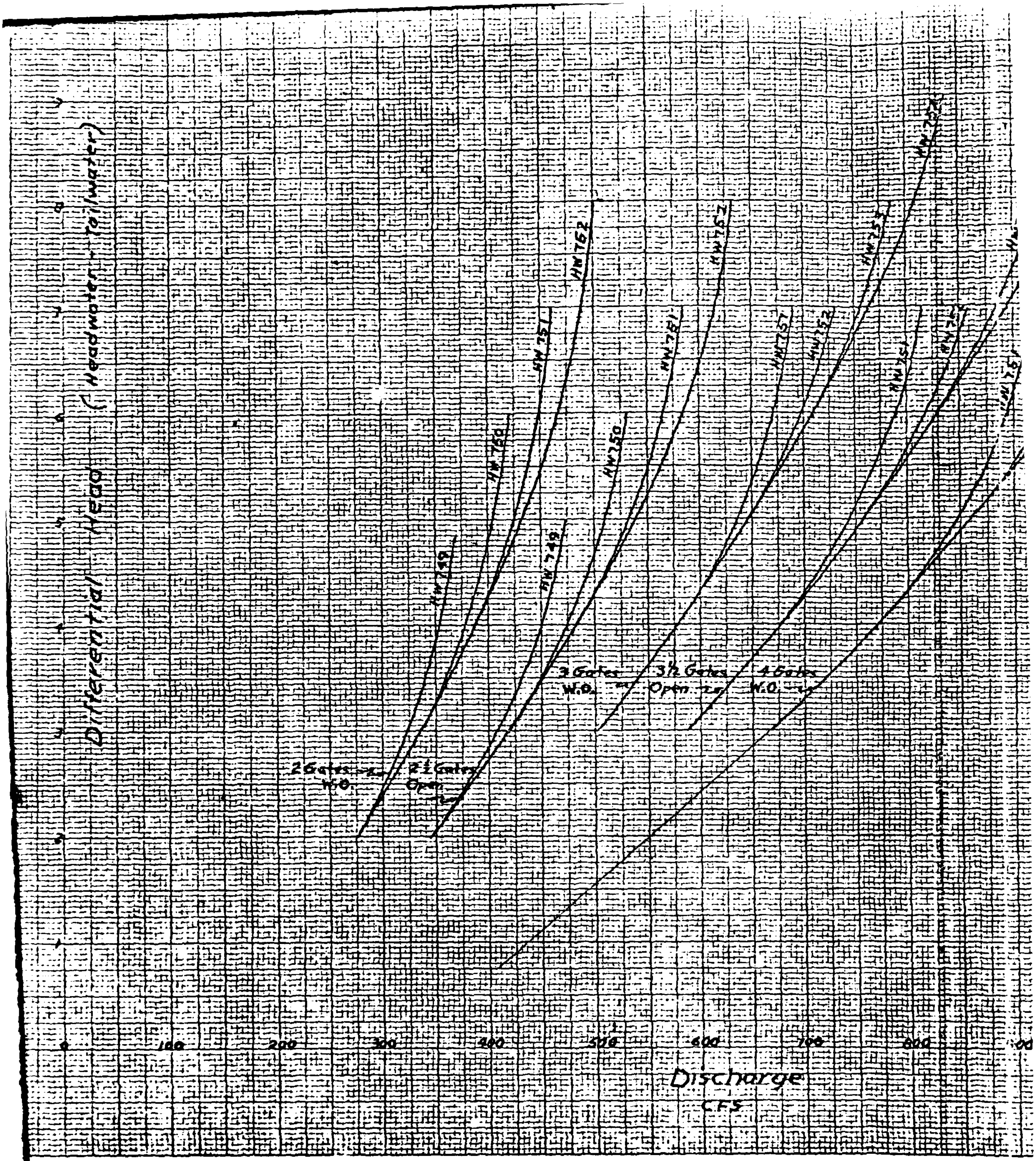
NATIONAL DAM INSP. PROGRAM

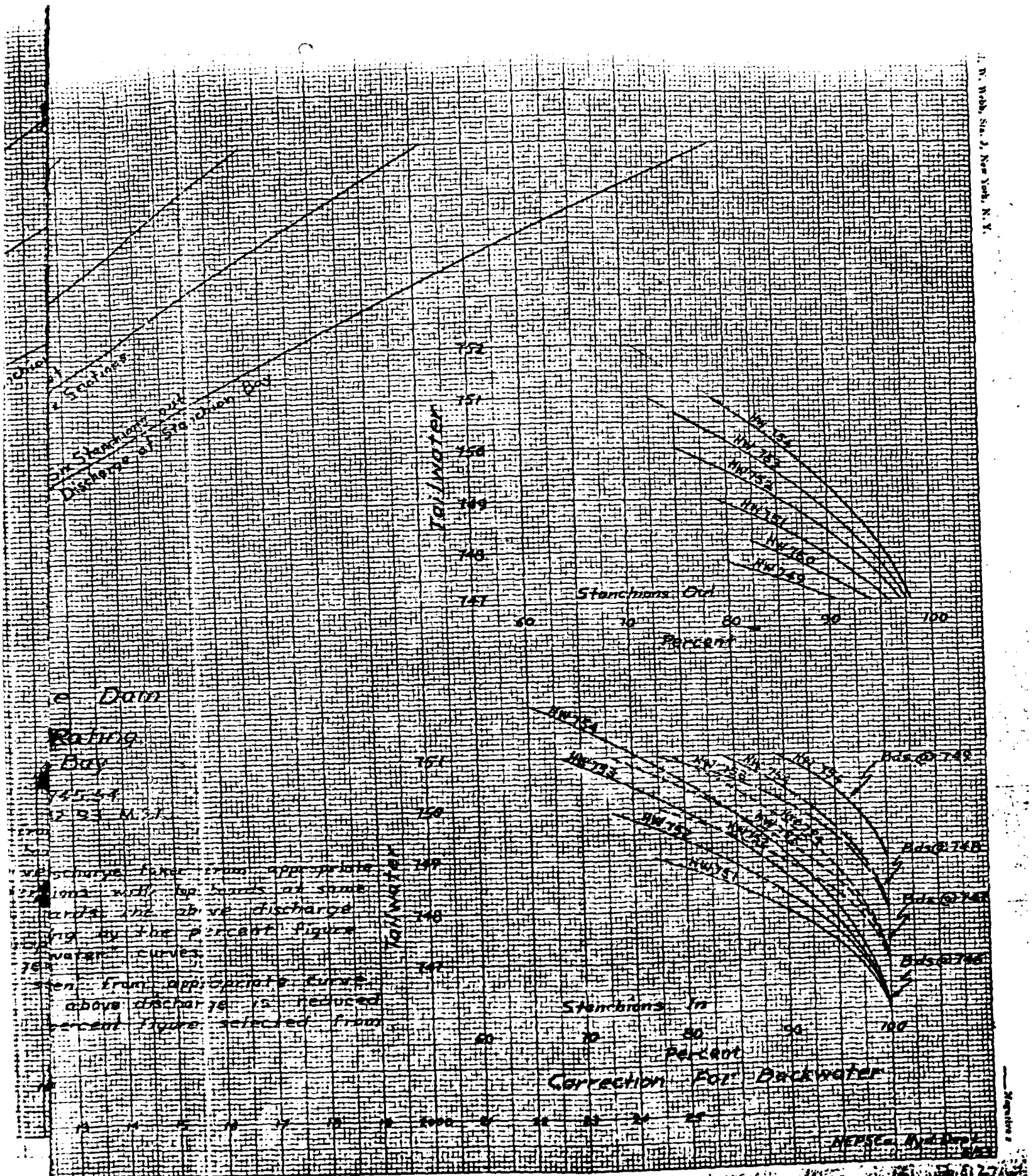


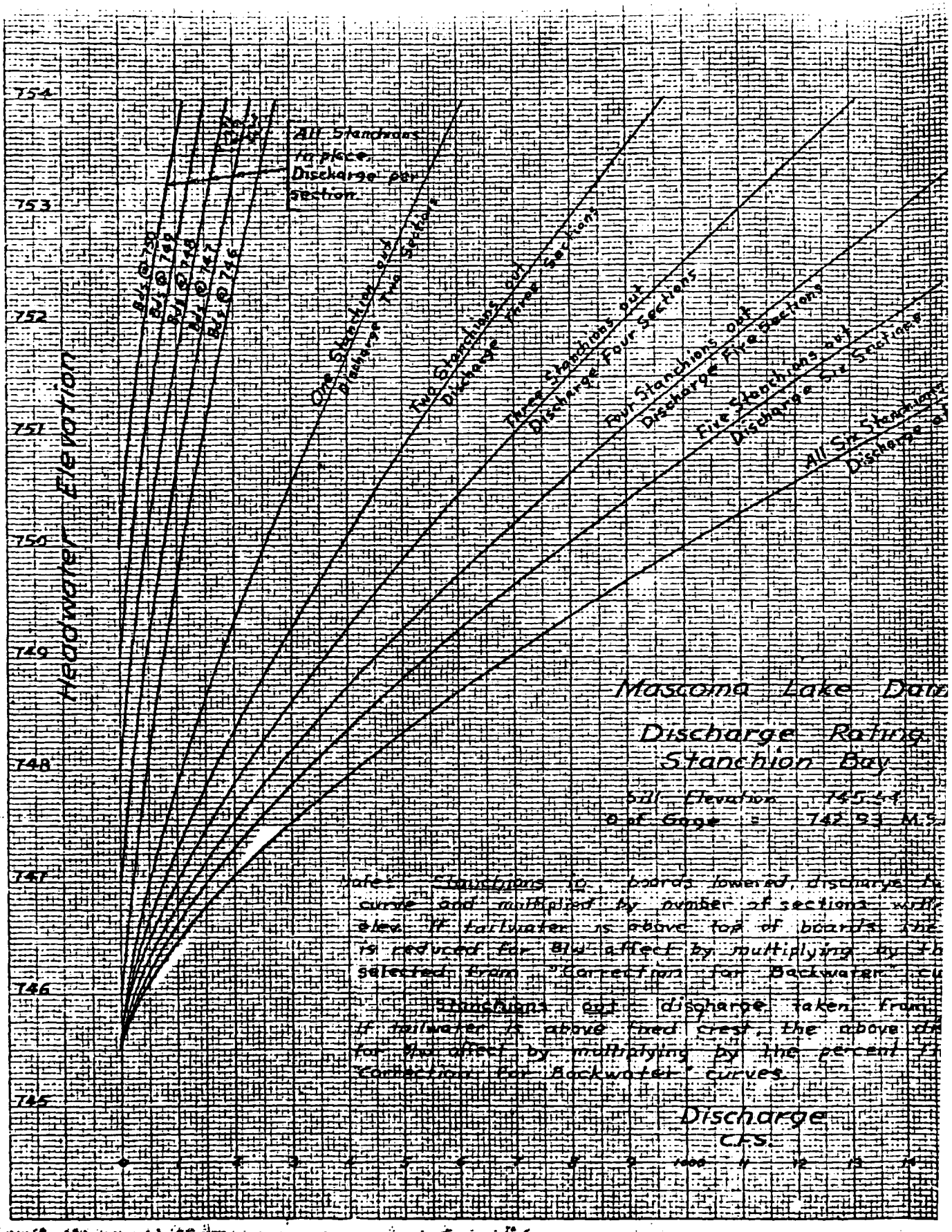
DISCHARGE RATING CURVE

MASCOMA LAKE DAM

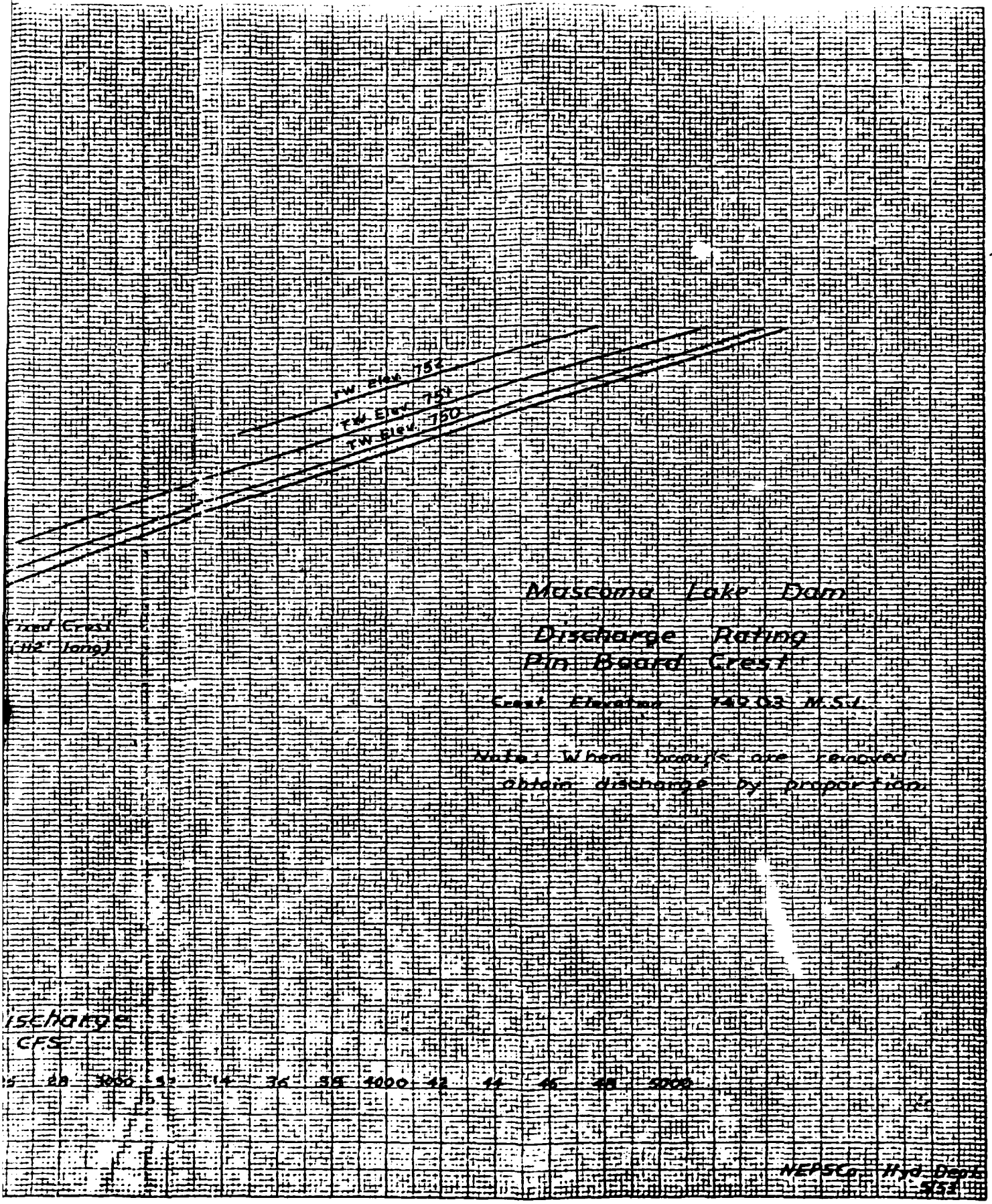

HW 754
HW 753
HW 752
HW 751
Mascoma Lake Dam
Discharge Rating
Gates
Still Elevation 1432
Note: This set of curves to be used for gate discharge when discharge is occuring through gates and over other sections of the dam.
NEPSCo Hyd Dept 5163


Differential Head (Headwater - Tailwater)
Discharge
C.F.S.
0
100
200
300
400
500
600
700
800
2 Gates W.O.
2½ Gates Open
3 Gates W.O.
3½ Gates Open
4 Gates W.O.
HW 749
HW 750
HW 751
HW 762
HW 752
HW 753


Tailwater
Stanchions Out
Percent
Stanchions In
Percent
Correction For Backwater
Bds @ 749
Bds @ 748
Bds @ 747
Bds @ 746
HW 754
HW 753
HW 752
HW 751
HW 750
HW 749
HW 748
HW 747
HW 746
HW 745
HW 744
HW 743
HW 742
HW 741
HW 740
HW 739
HW 738
HW 737
HW 736
HW 735
HW 734
HW 733
HW 732
HW 731
HW 730
HW 729
HW 728
HW 727
HW 726
HW 725
HW 724
HW 723
HW 722
HW 721
HW 720
HW 719
HW 718
HW 717
HW 716
HW 715
HW 714
HW 713
HW 712
HW 711
HW 710
HW 709
HW 708
HW 707
HW 706
HW 705
HW 704
HW 703
HW 702
HW 701
HW 700
HW 699
HW 698
HW 697
HW 696
HW 695
HW 694
HW 693
HW 692
HW 691
HW 690
HW 689
HW 688
HW 687
HW 686
HW 685
HW 684
HW 683
HW 682
HW 681
HW 680
HW 679
HW 678
HW 677
HW 676
HW 675
HW 674
HW 673
HW 672
HW 671
HW 670
HW 669
HW 668
HW 667
HW 666
HW 665
HW 664
HW 663
HW 662
HW 661
HW 660
HW 659
HW 658
HW 657
HW 656
HW 655
HW 654
HW 653
HW 652
HW 651
HW 650
HW 649
HW 648
HW 647
HW 646
HW 645
HW 644
HW 643
HW 642
HW 641
HW 640
HW 639
HW 638
HW 637
HW 636
HW 635
HW 634
HW 633
HW 632
HW 631
HW 630
HW 629
HW 628
HW 627
HW 626
HW 625
HW 624
HW 623
HW 622
HW 621
HW 620
HW 619
HW 618
HW 617
HW 616
HW 615
HW 614
HW 613
HW 612
HW 611
HW 610
HW 609
HW 608
HW 607
HW 606
HW 605
HW 604
HW 603
HW 602
HW 601
HW 600
HW 599
HW 598
HW 597
HW 596
HW 595
HW 594
HW 593
HW 592
HW 591
HW 590
HW 589
HW 588
HW 587
HW 586
HW 585
HW 584
HW 583
HW 582
HW 581
HW 580
HW 579
HW 578
HW 577
HW 576
HW 575
HW 574
HW 573
HW 572
HW 571
HW 570
HW 569
HW 568
HW 567
HW 566
HW 565
HW 564
HW 563
HW 562
HW 561
HW 560
HW 559
HW 558
HW 557
HW 556
HW 555
HW 554
HW 553
HW 552
HW 551
HW 550
HW 549
HW 548
HW 547
HW 546
HW 545
HW 544
HW 543
HW 542
HW 541
HW 540
HW 539
HW 538
HW 537
HW 536
HW 535
HW 534
HW 533
HW 532
HW 531
HW 530
HW 529
HW 528
HW 527
HW 526
HW 525
HW 524
HW 523
HW 522
HW 521
HW 520
HW 519
HW 518
HW 517
HW 516
HW 515
HW 514
HW 513
HW 512
HW 511
HW 510
HW 509
HW 508
HW 507
HW 506
HW 505
HW 504
HW 503
HW 502
HW 501
HW 500
HW 499
HW 498
HW 497
HW 496
HW 495
HW 494
HW 493
HW 492
HW 491
HW 490
HW 489
HW 488
HW 487
HW 486
HW 485
HW 484
HW 483
HW 482
HW 481
HW 480
HW 479
HW 478
HW 477
HW 476
HW 475
HW 474
HW 473
HW 472
HW 471
HW 470
HW 469
HW 468
HW 467
HW 466
HW 465
HW 464
HW 463
HW 462
HW 461
HW 460
HW 459
HW 458
HW 457
HW 456
HW 455
HW 454
HW 453
HW 452
HW 451
HW 450
HW 449
HW 448
HW 447
HW 446
HW 445
HW 444
HW 443
HW 442
HW 441
HW 440
HW 439
HW 438
HW 437
HW 436
HW 435
HW 434
HW 433
HW 432
HW 431
HW 430
HW 429
HW 428
HW 427
HW 426
HW 425
HW 424
HW 423
HW 422
HW 421
HW 420
HW 419
HW 418
HW 417
HW 416
HW 415
HW 414
HW 413
HW 412
HW 411
HW 410
HW 409
HW 408
HW 407
HW 406
HW 405
HW 404
HW 403
HW 402
HW 401
HW 400
HW 399
HW 398
HW 397
HW 396
HW 395
HW 394
HW 393
HW 392
HW 391
HW 390
HW 389
HW 388
HW 387
HW 386
HW 385
HW 384
HW 383
HW 382
HW 381
HW 380
HW 379
HW 378
HW 377
HW 376
HW 375
HW 374
HW 373
HW 372
HW 371
HW 370
HW 369
HW 368
HW 367
HW 366
HW 365
HW 364
HW 363
HW 362
HW 361
HW 360
HW 359
HW 358
HW 357
HW 356
HW 355
HW 354
HW 353
HW 352
HW 351
HW 350
HW 349
HW 348
HW 347
HW 346
HW 345
HW 344
HW 343
HW 342
HW 341
HW 340
HW 339
HW 338
HW 337
HW 336
HW 335
HW 334
HW 333
HW 332
HW 331
HW 330
HW 329
HW 328
HW 327
HW 326
HW 325
HW 324
HW 323
HW 322
HW 321
HW 320
HW 319
HW 318
HW 317
HW 316
HW 315
HW 314
HW 313
HW 312
HW 311
HW 310
HW 309
HW 308
HW 307
HW 306
HW 305
HW 304
HW 303
HW 302
HW 301
HW 300
HW 299
HW 298
HW 297
HW 296
HW 295
HW 294
HW 293
HW 292
HW 291
HW 290
HW 289
HW 288
HW 287
HW 286
HW 285
HW 284
HW 283
HW 282
HW 281
HW 280
HW 279
HW 278
HW 277
HW 276
HW 275
HW 274
HW 273
HW 272
HW 271
HW 270
HW 269
HW 268
HW 267
HW 266
HW 265
HW 264
HW 263
HW 262
HW 261
HW 260
HW 259
HW 258
HW 257
HW 256
HW 255
HW 254
HW 253
HW 252
HW 251
HW 250
HW 249
HW 248
HW 247
HW 246
HW 245
HW 244
HW 243
HW 242
HW 241
HW 240
HW 239
HW 238
HW 237
HW 236
HW 235
HW 234
HW 233
HW 232
HW 231
HW 230
HW 229
HW 228
HW 227
HW 226
HW 225
HW 224
HW 223
HW 222
HW 221
HW 220
HW 219
HW 218
HW 217
HW 216
HW 215
HW 214
HW 213
HW 212
HW 211
HW 210
HW 209
HW 208
HW 207
HW 206
HW 205
HW 204
HW 203
HW 202
HW 201
HW 200
HW 199
HW 198
HW 197
HW 196
HW 195
HW 194
HW 193
HW 192
HW 191
HW 190
HW 189
HW 188
HW 187
HW 186
HW 185
HW 184
HW 183
HW 182
HW 181
HW 180
HW 179
HW 178
HW 177
HW 176
HW 175
HW 174
HW 173
HW 172
HW 171
HW 170
HW 169
HW 168
HW 167
HW 166
HW 165
HW 164
HW 163
HW 162
HW 161
HW 160
HW 159
HW 158
HW 157
HW 156
HW 155
HW 154
HW 153
HW 152
HW 151
HW 150
HW 149
HW 148
HW 147
HW 146
HW 145
HW 144
HW 143
HW 142
HW 141
HW 140
HW 139
HW 138
HW 137
HW 136
HW 135
HW 134
HW 133
HW 132
HW 131
HW 130
HW 129
HW 128
HW 127
HW 126
HW 125
HW 124
HW 123
HW 122
HW 121
HW 120
HW 119
HW 118
HW 117
HW 116
HW 115
HW 114
HW 113
HW 112
HW 111
HW 110
HW 109
HW 108
HW 107
HW 106
HW 105
HW 104
HW 103
HW 102
HW 101
HW 100
HW 99
HW 98
HW 97
HW 96
HW 95
HW 94
HW 93
HW 92
HW 91
HW 90
HW 89
HW 88
HW 87
HW 86
HW 85
HW 84
HW 83
HW 82
HW 81
HW 80
HW 79
HW 78
HW 77
HW 76
HW 75
HW 74
HW 73
HW 72
HW 71
HW 70
HW 69
HW 68
HW 67
HW 66
HW 65
HW 64
HW 63
HW 62
HW 61
HW 60
HW 59
HW 58
HW 57
HW 56
HW 55
HW 54
HW 53
HW 52
HW 51
HW 50
HW 49
HW 48
HW 47
HW 46
HW 45
HW 44
HW 43
HW 42
HW 41
HW 40
HW 39
HW 38
HW 37
HW 36
HW 35
HW 34
HW 33
HW 32
HW 31
HW 30
HW 29
HW 28
HW 27
HW 26
HW 25
HW 24
HW 23
HW 22
HW 21
HW 20
HW 19
HW 18
HW 17
HW 16
HW 15
HW 14
HW 13
HW 12
HW 11
HW 10
HW 9
HW 8
HW 7
HW 6
HW 5
HW 4
HW 3
HW 2
HW 1
HW 0

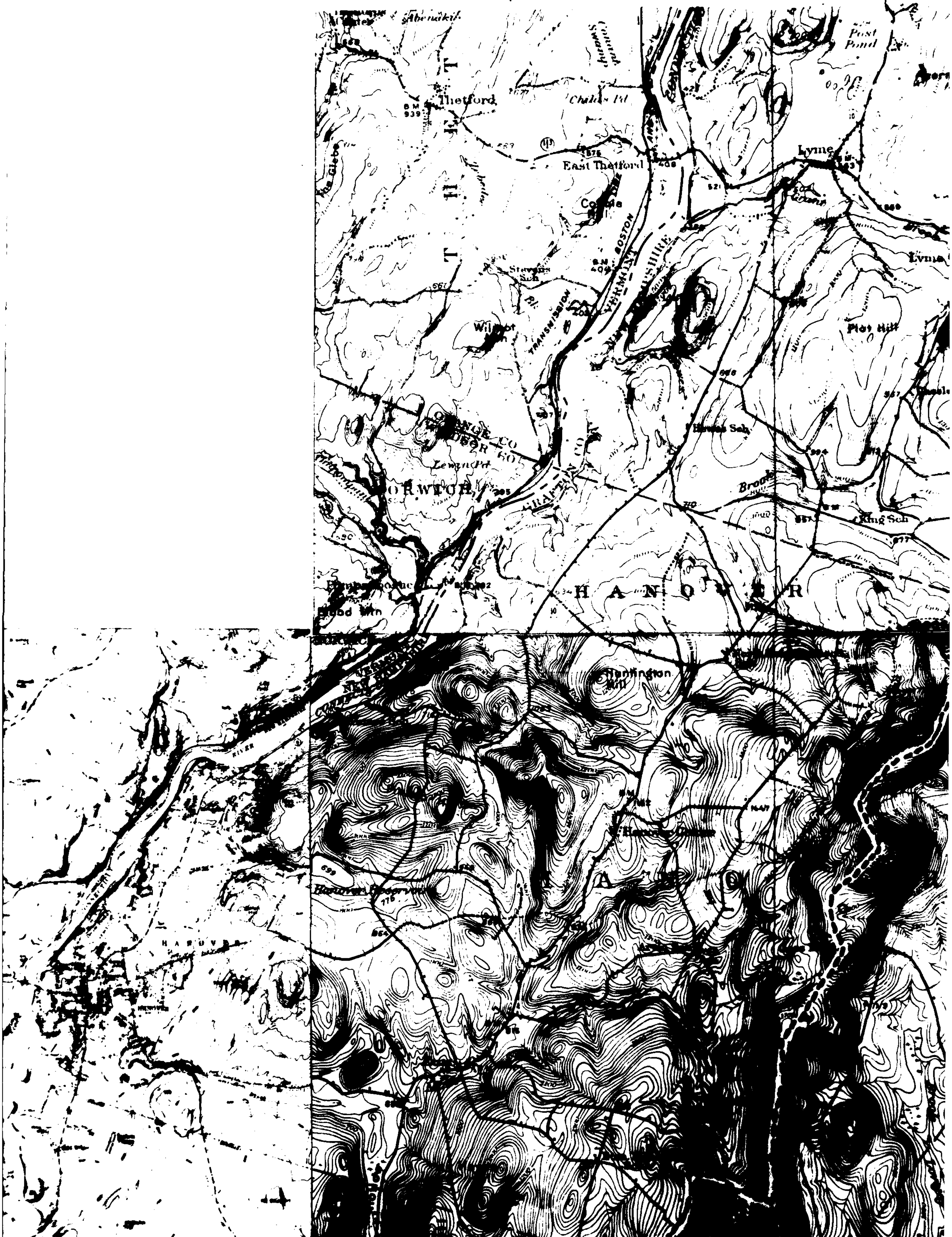

754
753
752
751
750
749
748
747
746
745
Headwater Elevation
All Stanchions in place. Discharge per section
Elev. 753.0
Elev. 752.0
Elev. 751.0
Elev. 750.0
Elev. 749.0
One Stanchion out Discharge Two Sections
Two Stanchions out Discharge Three Sections
Three Stanchions out Discharge Four Sections
Four Stanchions out Discharge Five Sections
Five Stanchions out Discharge Six Sections
All Six Stanchions
Discharge
Mascoma Lake Dam
Discharge Rating
Stanchion Boy
Sill Elevation 745.4
0 of Gage = 742.93 M.S.
Note: Stanchions in boards lowered, discharge
curve and multiplied by number of sections with
elev. If tailwater is above top of boards, the
is reduced for Blu affect by multiplying by th
selected from "Correction for Backwater cu
Stanchions out discharge taken from
if tailwater is above weir crest, the above dis
for blu affect by multiplying by the percent fr
Correction for Backwater curves
Discharge
C.F.S.
0
1000
11
12
13
14

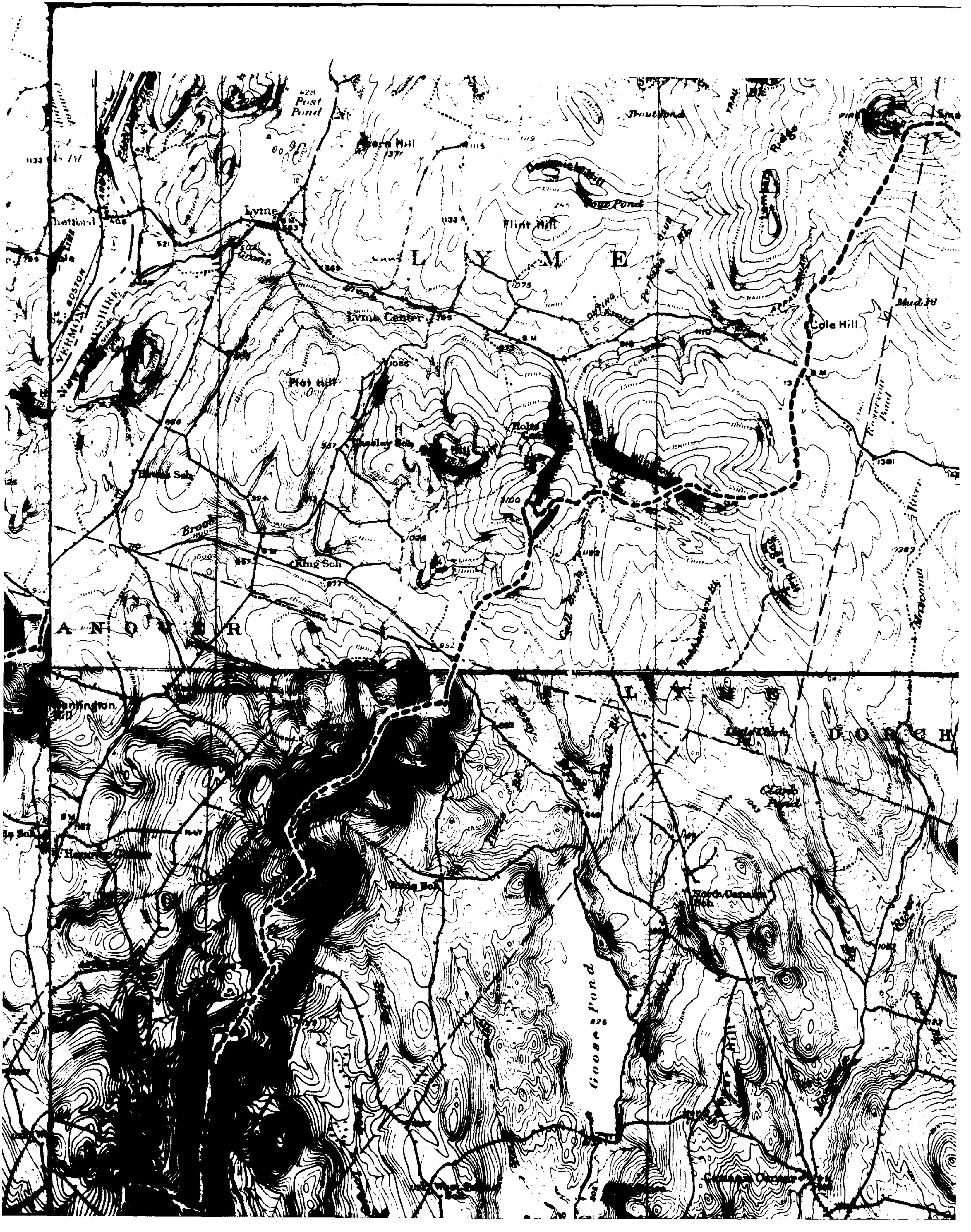
H. W. Webb, Sta. J, New York, N. Y.

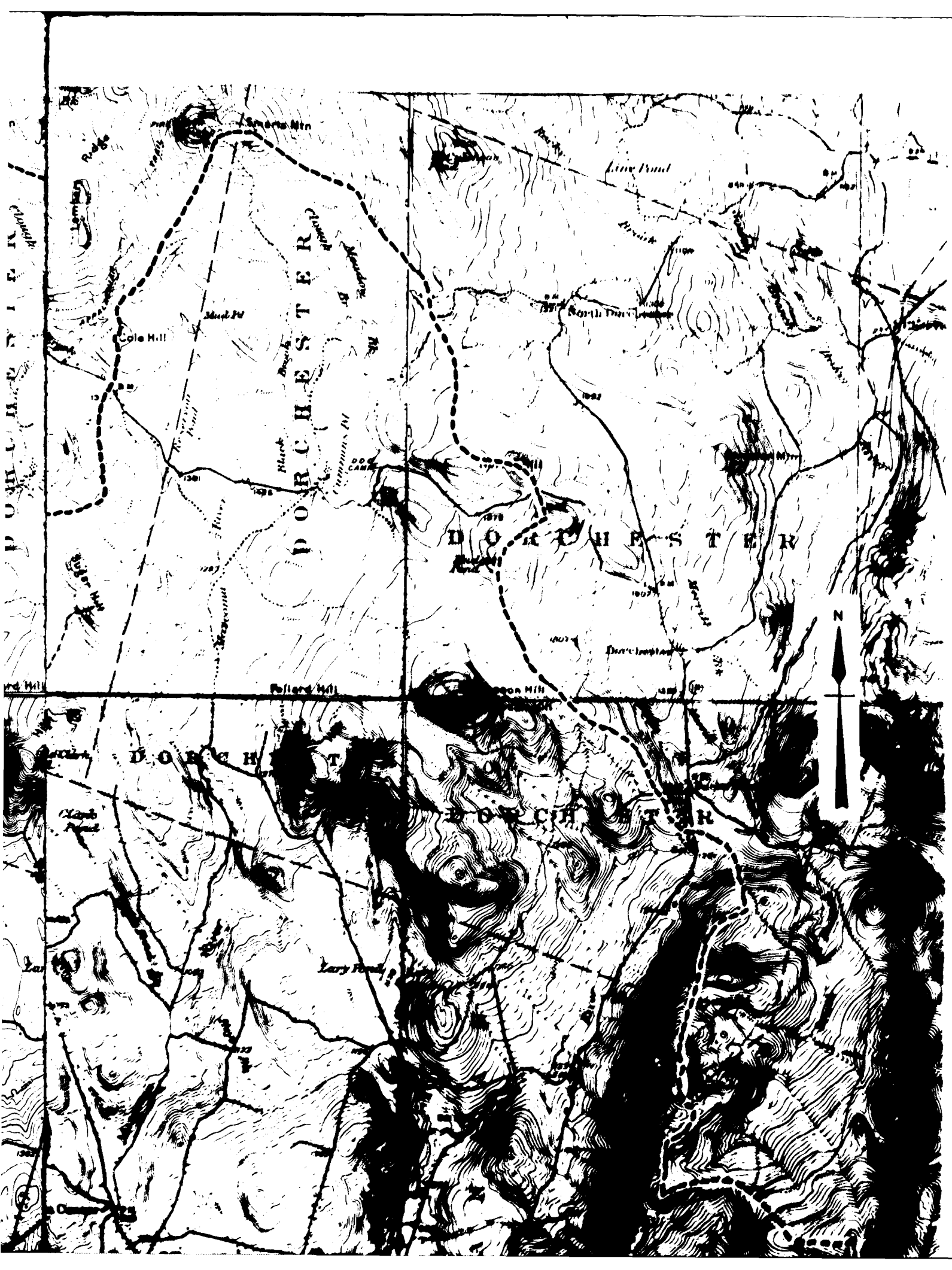


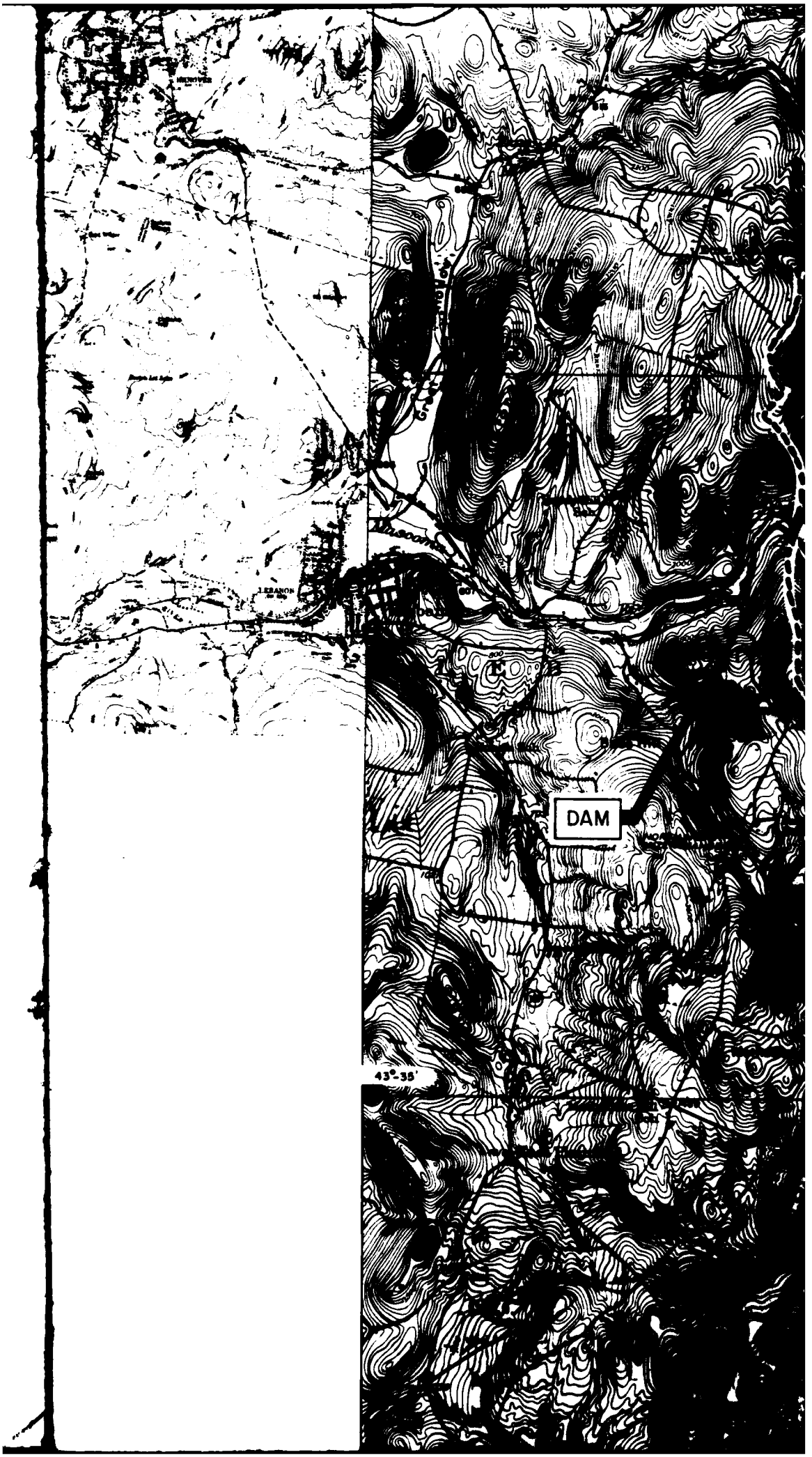
Negative 8

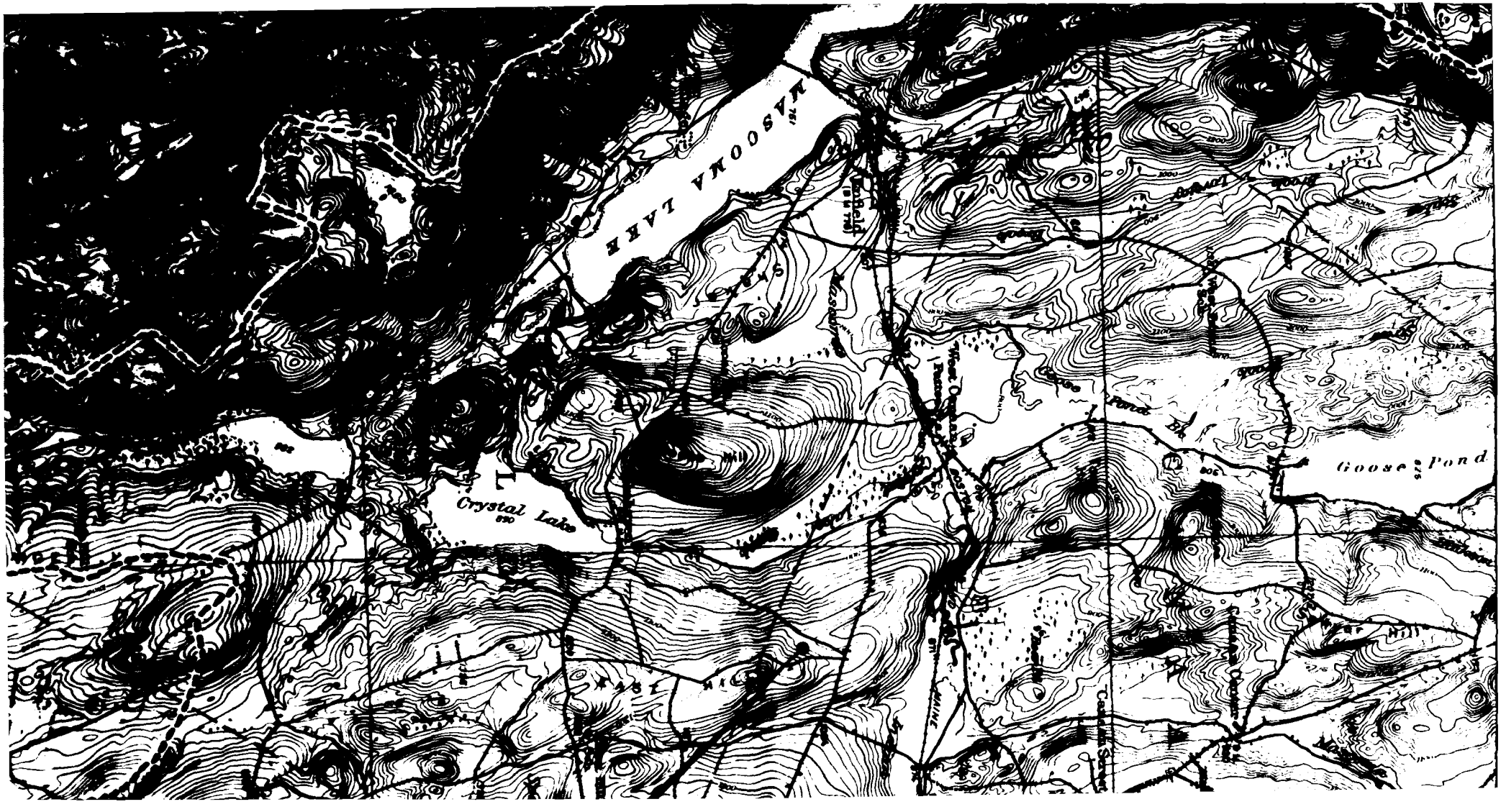

Head Water Elevation
755
754
753
752
751
750
749
Over Boards
(1/2" long)
Fixed
1/2"
0
2
4
6
8
1000
12
14
16
18
2000
22
24
26


Thetford
East Thetford
Childs Pd
Post Pond
Lyme
Plot Hill
BOSTON
TRANSMISSION
King Sch
Lewis Pd
H A N O V E R
Huntington Hill
HANOVER


Post Pond
Lyme
Thetford
VERMONT
NEW HAMPSHIRE
BOSTON
Flint Hill
L Y M E
Lyme Center
Trout Pond
Cole Hill
Mud Pd
Plot Hill
King Sch
A N O V E R
Goose Pond
Clark Pond
D O R C H

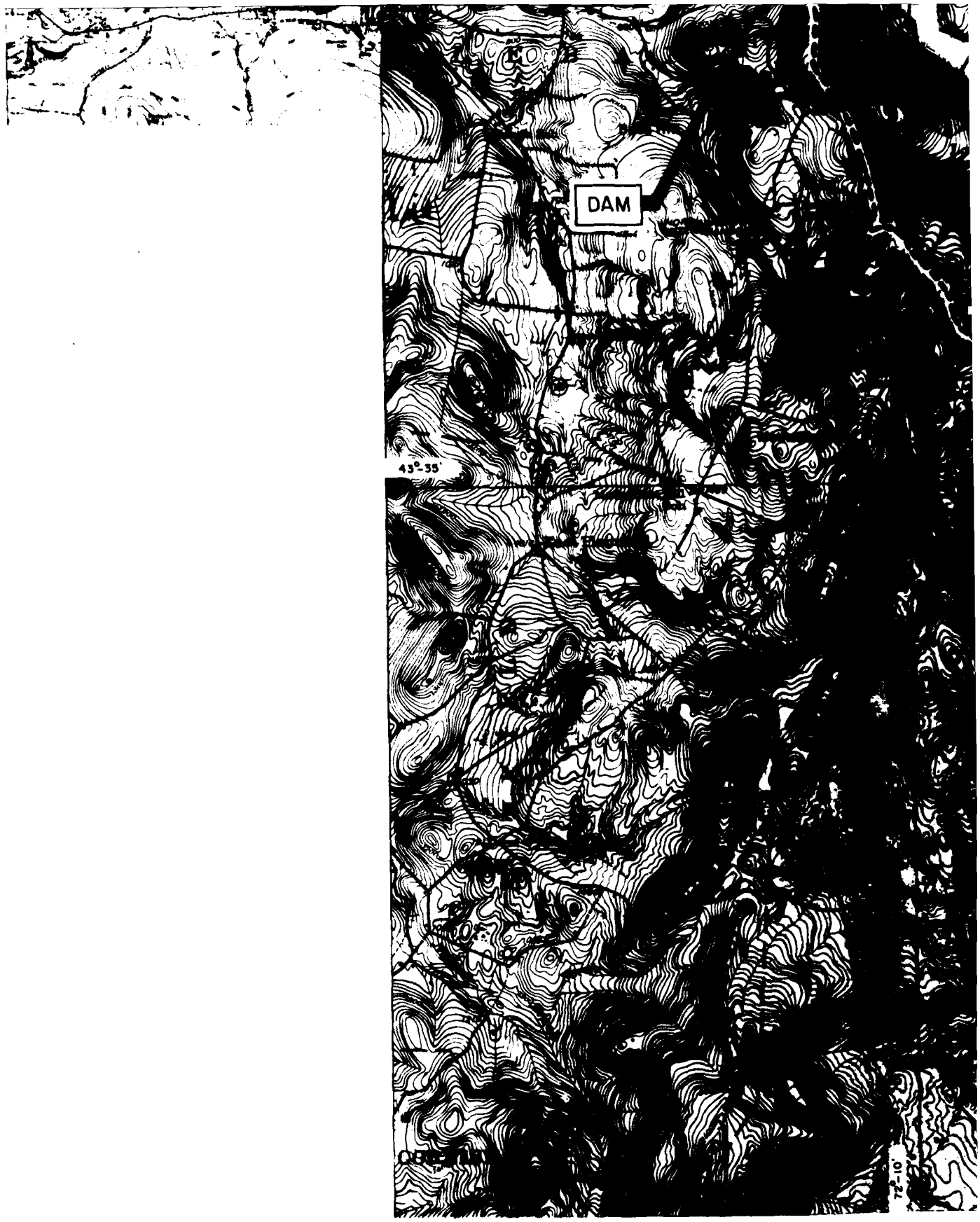

DORCHESTER
DORCHESTER
DORCHESTER
DORCHESTER
DORCHESTER
Cole Hill
Pollard Hill
Black
N


DAM
43°-35'


Crystal Lake
Goose Pond


Goose Pond
Canaan Center
Canaan Street
Canaan Street
Lake
West Canaan
MAINE
Crystal Lake
DRAINAGE AREA
MASCOMA LAKE


Canaan Street
1142
Canaan Street
Lake
MAINE



UNITED STATES
DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY

SCALE 1:62500 (ACTUAL)

NEW HAMPSH
HANOVER QUA
AMS 6571 III NI
MASCOMA QUA
MT. CUBE QU

NEW HAMPSHIRE – VERMONT

HANOVER QUADRANGLE 1957
AMS 6571 III NE SERIES V813

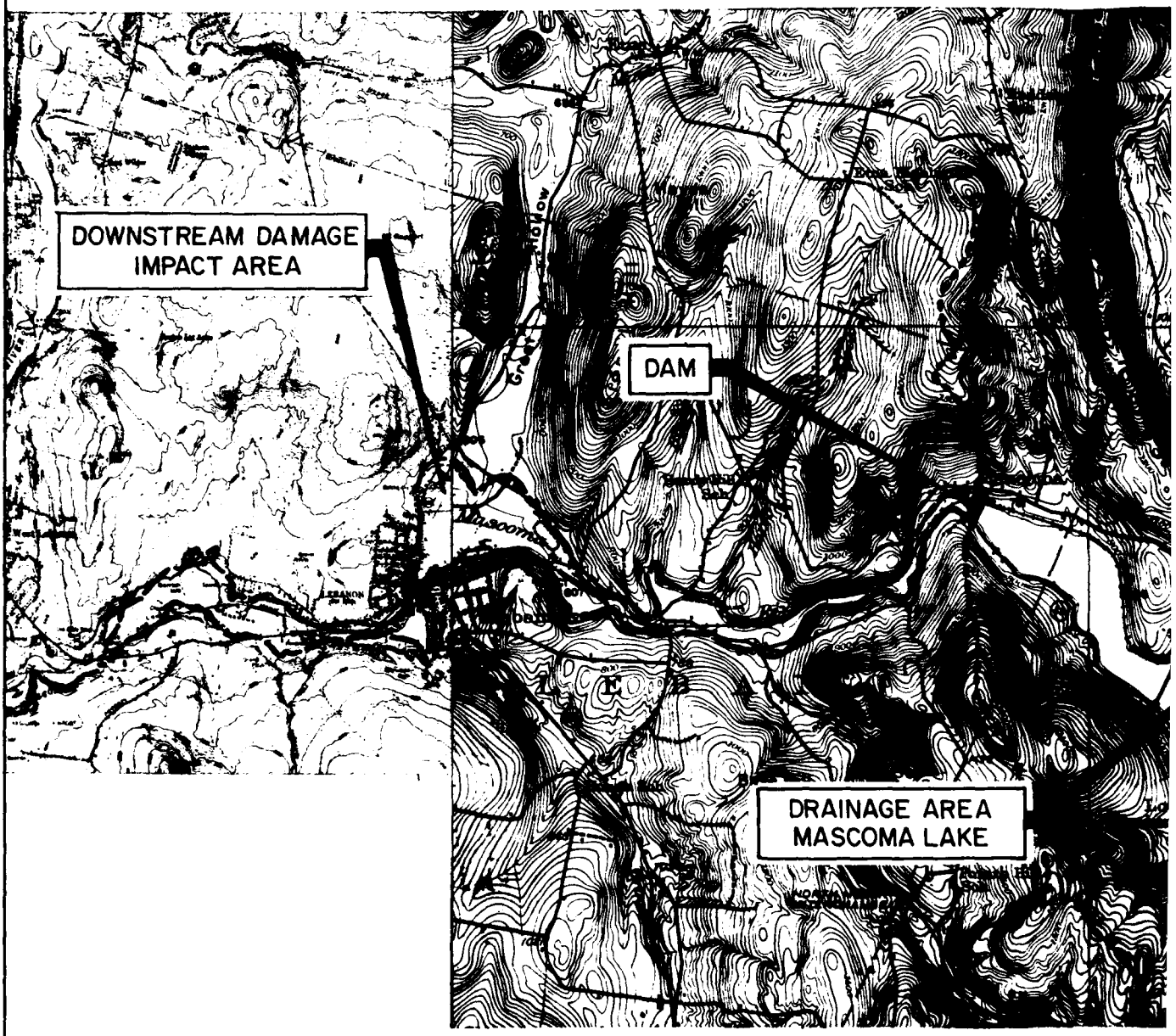
MASCOMA QUADRANGLE 1927

MT. CUBE QUADRANGLE 1931

NEW HAMPSHIRE

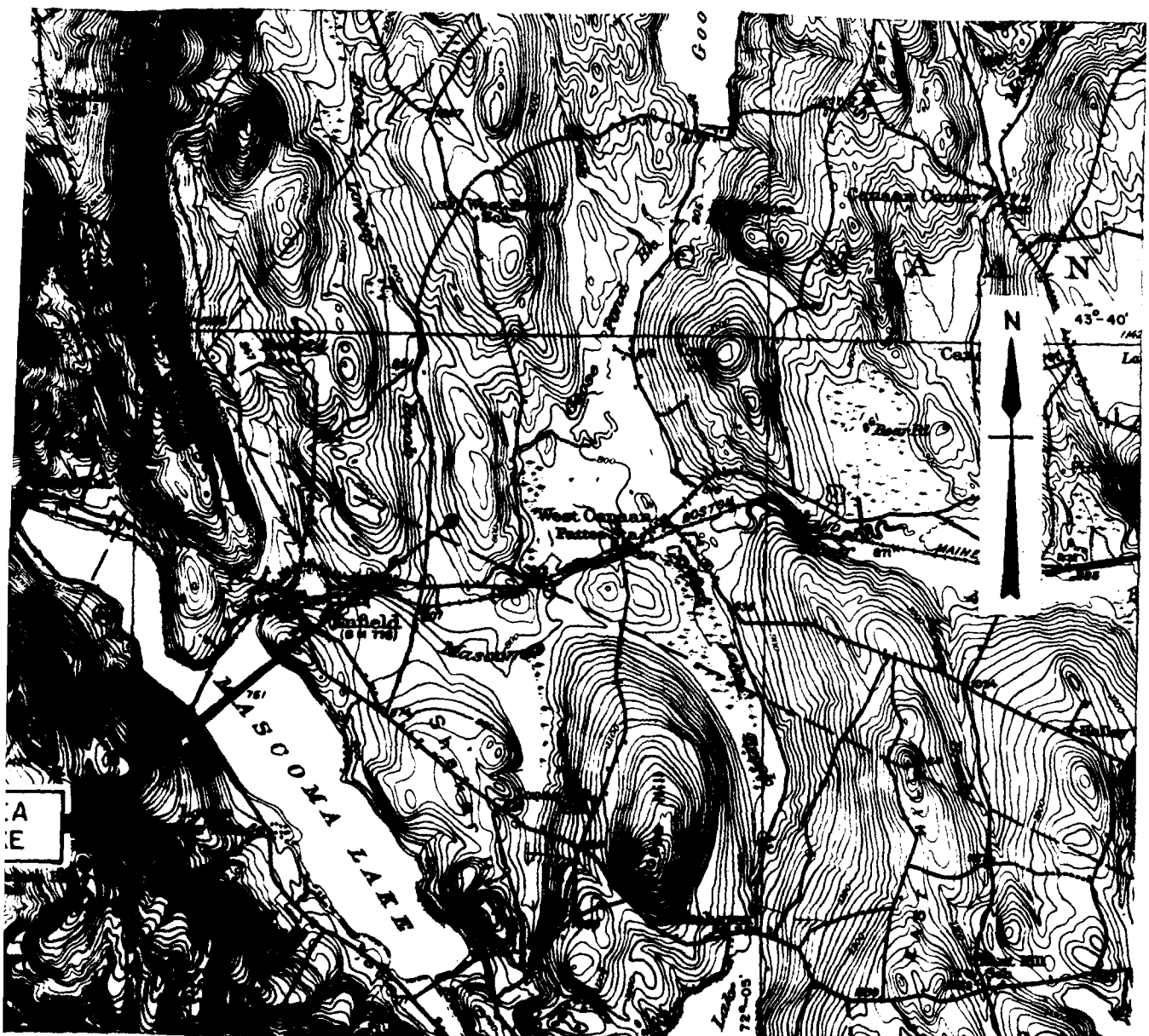
CARDIGAN QUADRANGLE 1956
AMS 6671 III–SERIES V712

RUMNEY QUADRANGLE 1928



SCALE 1: 62500 (ACTU

UNITED STATES
DEPARTMENT OF INTERIOR
GEOLOGICAL SURVEY



1: 62500 (ACTUAL)

NEW HAMPSHIRE - VERMONT
MASCOMA QUADRANGLE 1927
HANOVER QUADRANGLE 1957
AMS 6571 III NE - SERIES V813

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS


DATE:
ILME