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RICE RESERVOIR DAM (N.. (U) CORPS OF ENGINEERS WALTHAM
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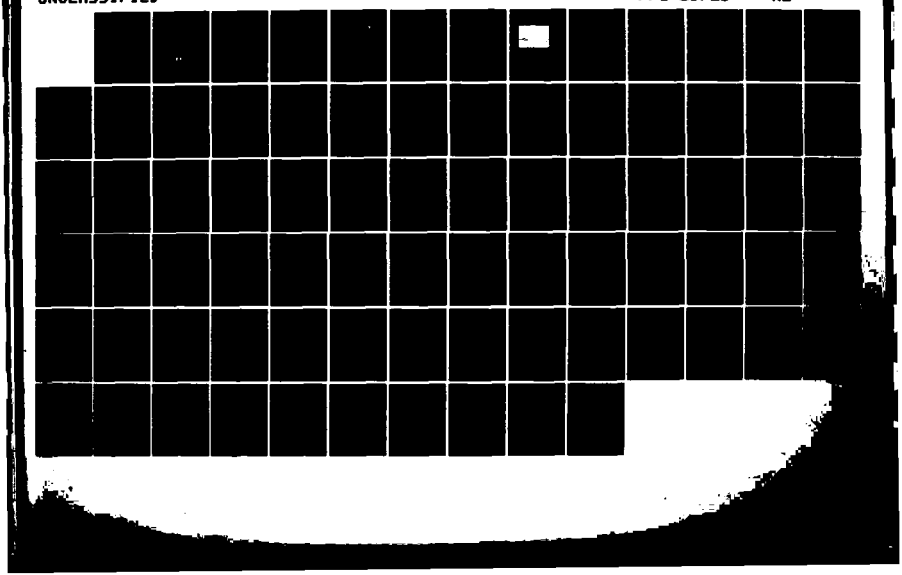

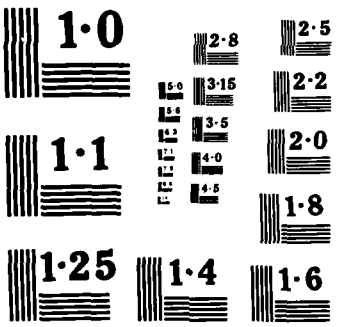

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

CONNECTICUT RIVER BASIN

CLAREMONT, NEW HAMPSHIRE

RICE RESERVOIR DAM
N H 00141

STATE NO 47.14

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

JULY 1979

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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
Claremont, New Hampshire
Stevens Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam has a hydraulic height if 48 ft. and is 980 ft. long. It is an earthen embankment dam. The dam is in fair condition. It is intermediate in size with a significant hazard potential. There are various concerns which must be corrected.

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NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: NH00141
Name of Dam: Rice Reservoir Dam
City: Claremont
County and State: Sullivan, New Hampshire
Stream: Stevens Brook
Date of Inspection: May 8, 1979

BRIEF ASSESSMENT

Rice Reservoir Dam has a hydraulic height of 48 ~~feet~~, is 12 ~~feet~~ wide, and is 980 ~~feet~~ long. It is an earthen embankment dam, having a reinforced concrete core and a small chute-type spillway. The dam spans the uppermost reach of Stevens Brook and is located in west-central New Hampshire. The dam contains runoff from a 0.11 square mile drainage area and has a maximum storage capacity of about 152 acre-feet. Rice Reservoir Dam is used for water supply storage for the City of Claremont. The pond is about 1,000 feet in length with a surface area of about 11 acres.

The dam is in fair condition. Concerns are: the cracked and spalled condition of the concrete chute spillway, the incompleted spillway discharge channel, seepage at the downstream toe of the dam at the deepest part of the valley and several soft wet areas near the downstream toe.

Based on intermediate size and significant hazard classification in accordance with Corps guidelines, the test flood is the full Probable Maximum Flood (PMF). A test flood outflow of 260 cfs (2,500 csm) would overtop the dam by about 0.2 feet (3.4 feet over spillway crest with flashboard removed). The spillway (with flashboard removed) will pass 124 cfs or about 48 percent of the test flood. A major breach at top of dam could result in the loss of 4-6 lives and appreciable property damage.

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

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

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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May, 1979

Figure 1 - Overview of Rice Reservoir Dam.

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SCALE IN MILES

0 5 10

MAP BASED ON STATE OF NEW HAMPSHIRE OFFICIAL HIGHWAY MAP.

Anderson-Nichols & Co., Inc. CONCORD NEW HAMPSHIRE	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

RICE RESERVOIR DAM LOCATION MAP

RICE RESERVOIR NEW HAMPSHIRE

			SCALE: SEE BAR SCALE
			DATE: JULY, 1979

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
RICE RESERVOIR DAM

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Anderson-Nichols & Company, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed were issued to Anderson-Nichols under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0009 has been assigned by the Corps of Engineers for this work.

b. Purpose

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

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

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

1.2 Description of Project

a. Location. Rice Reservoir Dam, also known as Stevens Reservoir Dam, is located in the City of Claremont, New Hampshire. The dam spans the headwaters of Stevens Brook. Stevens Brook flows southwest for a distance of about 3 miles to its confluence with the Sugar River. The Sugar River then flows west-northwest for about 3 miles to its confluence with the Connecticut River. Rice Reservoir Dam is shown on U.S.G.S. Quadrangle, Claremont, N.H. - Vt. with approximate coordinates of N 43° 25' 10", W 72° 19' 45", Sullivan County, New Hampshire. (See Location Map page vii.)

b. Description of Dam and Appurtenances. Rice Reservoir Dam is an earthen embankment with a concrete core wall and a concrete chute-type spillway. The spillway is 8' long and 3' deep

at the crest. It narrows slightly and becomes more shallow as it curves to the northwest down to the toe of the dam. The earthen embankment dam section is about 310' long at the crest and has upstream and downstream slopes of about 2.5H:1V. The downstream slope and the crest are covered with well maintained grass. A dike embankment, contiguous with the dam, stretches northeast to southwest upstream of the dam embankment. The crest and slopes of the 670-foot long dike embankment are identical to those of the dam embankment.

c. Size Classification. Intermediate (hydraulic height - 48 feet; storage - 152 acre-feet) based on height ($\geq$ 40 to $<$ 100 feet) as given in Recommended Guidelines for Safety Inspection of Dams.

d. Hazard Classification. Significant Hazard. a major breach could result in the loss of 4-6 lives and appreciable property damage. (See Section 5.1 f.)

e. Ownership. Rice Reservoir Dam has been owned by Claremont Water Works since its construction was completed in 1935.

f. Operator. The current owner and operator of Rice Reservoir Dam is Claremont Water Works, City Hall, Claremont, New Hampshire 03743; phone: (603) 542-6691.

g. Purpose of Dam. Rice Reservoir Dam was designed to form a water supply storage reservoir for Claremont, New Hampshire.

h. Design and Construction History. The dam was designed in 1934 by E. Worthington, Civil and Consulting Engineer, Water Supply and Sewerage, Dedham, Massachusetts. Plans consisting of sheets 2 of 5 through 5 of 5, dated September 21, 1934 and drawn by E. Worthington, were obtained from the New Hampshire Water Resources Board (NHWRB) files. Also found in these files were the "Specifications for Construction of Dam and Dyke" and a "Brief Statement of the Concrete Core Wall Reinforcement Design and the Overflow," dated 1934 and signed by E. Worthington. Charles W. Easter, Superintendent of Claremont Water Works, supervised construction of the dam which was completed in 1935. Subsequent to original construction, no records indicating modifications or repairs were disclosed.

i. Normal Operating Procedures. Water is diverted 1½ miles from Whitewater Brook to Rice Reservoir through a 12-inch diameter, cast iron pipe. This pipeline is controlled by gates so that Rice Reservoir may receive water for storage during dry weather conditions. The maximum discharge capacity of the pipe is reported to be about 2.5 cfs. A second regulating reservoir, known as Dole Reservoir is located along the continuation of the pipeline downstream of Rice Reservoir. Dole Reservoir furnishes the hydraulic

head for the Claremont area. Therefore, an increase in the pool elevation of Rice Reservoir means added reserve storage, available to be drawn into Dole Reservoir as needed.

1.3 Pertinent Data

a. Drainage Area. The drainage area consists of 0.11 square miles (70 acres) of steeply sloped, wooded terrain. Because of the dike embankment, which forms the northwest shore of the reservoir, the drainage area is located entirely on the southeast side of the reservoir. The normal level of Rice Reservoir has a surface area of 11 acres, which constitutes 16 percent of the watershed.

b. Discharge at Damsite.

(1) Outlet works - Design plans call for a 16" diameter drain pipe to discharge at the downstream toe. No pipe was found during the inspection. However, some discolored discharge was found near the supposed drain outlet location.

(2) The maximum discharge at the damsite is unknown.

(3) Ungated spillway capacity (without flashboard) at top of dam - 124 cfs @ 823.2' MSL

(4) Ungated spillway capacity (without flashboard) @ test flood elevation - 135 cfs @ 823.4' MSL

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

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

(7) Total spillway capacity (without flashboard) @ test flood elevation - 135 cfs @ 823.4' MSL

(8) Total project discharge @ test flood elevation - 260 cfs @ 823.4' MSL

c. Elevation (feet above MSL; see (6) below)

(1) Streambed at centerline of dam - 775.6 (at downstream toe)

(2) Maximum tailwater - unknown

(3) Upstream portal invert diversion tunnel - not applicable

(4) Recreation pool - not applicable

(5) Full flood control pool - not applicable

(6) Spillway crest - 820.0 (assumed spillway elevation without flashboard taken from U.S.G.S. Quadrangle sheet)

(7) Design surcharge (original design) - unknown

(8) Top of dam - 823.2

(9) Test flood pool - 823.4

d. Reservoir (feet)

(1) Length of maximum pool - 1050

(2) Length of recreation pool - not applicable

(3) Length of flood control pool - not applicable

(4) Length of pool at spillway crest - 1000

e. Storage (acre-feet)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest pool - 117

(4) Top of dam - 152

(5) Test flood pool - 154

f. Reservoir Surface (acres)

(1) Recreation pool - not applicable

(2) Flood control pool - not applicable

(3) Spillway crest - 11

(4) Test flood pool - 11

(5) Top of dam - 11

g. Dam

(1) Type - earth embankment with concrete core

(2) Length - 980' (dam 310' plus contiguous dike 670')

(3) Height - 48' (structural height)

(4) Top width - varied

(5) Side slopes - 2.5H:1V; grass covered downstream, upstream covered with riprap.

(6) Zoning - Design plans indicate a 10-foot wide zone of puddled earth on the upstream side of the core wall.

(7) Impervious core - Design plans indicate a reinforced concrete core, 2' wide @ crest, 6' wide @ base, extending approximately 304'.

(8) Cutoff - No cutoff trench; design plans indicate cutoff (antiseep collars) on drain and supply piping that are about 6' square by 18" thick.

(9) Grout curtain - not applicable

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

i. Spillway

(1) Type - concrete chute-type spillway

(2) Length of weir - 8'

(3) Crest elevation - 820.0' MSL

(4) Gates - none

(5) U/S Channel - The approach channel consists of Rice Reservoir, the headwaters of Stevens Brook, which ranges from 100 to 300 feet in width. The east bank is heavily wooded and slopes steeply. The west bank is an earthen dike, about 10 feet wide at the crest, covered with well maintained grass. The upstream slope near the waterline is riprapped.

(6) D/S Channel - The channel immediately downstream of the dam, Stevens Brook, is about 5 feet wide. Some rocks, branches, and scattered logs litter the channel. Small trees and brush cover both overbanks. Stevens Brook crosses under Winter Street and State Route #120 before turning to the south. The brook then follows State Route #120, crossing under the road five times within the 4,200-foot downstream hazard reach. There are four inhabited structures along this reach.

j. Regulating Outlets. A valve controlling a 10-inch diameter cast iron pipeline is located near the toe of the dam. This line utilizes storage from Rice Reservoir to affect the level of Dole Reservoir, the principal water supply impoundment for the City of Claremont.

SECTION 2
ENGINEERING DATA

2.1 Design

A "Brief Statement of the Concrete Core Wall Reinforcement Design and the Overflow" by E. Worthington, Engineer for Claremont Water Works, is included in Appendix B. Also obtained were the design plans consisting of sheets 2 of 5 through 5 of 5, dated September 21, 1934 and drawn by E. Worthington, Civil and Consulting Engineer.

2.2 Construction

"Specifications for Construction of Dam and Dike", by E. Worthington, are also included in Appendix B. Other construction data include concrete test forms and construction progress photographs.

2.3 Operation

No operational data were disclosed.

2.4 Evaluation

a. Availability. Only brief narratives of design and construction of Rice Reservoir Dam were disclosed.

b. Adequacy. The data obtained are sufficient to illustrate a fairly good picture of the dam; however, specific details are lacking.

c. Validity. Design plans call for a 2-foot high ogee spillway, 75 feet long, 15 feet wide at the crest, tapering to 10 feet wide, with wasteway steps at the end to act as energy dissipators. The spillway, as seen on the visual inspection, consists of a concrete chute-type spillway 8 feet wide at the crest tapering to 7 feet wide. Rocks have been randomly placed at the end of the spillway chute to act as energy dissipators. The visible portions of the dam embankment and dike were constructed according to specifications.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Rice Reservoir Dam, intermediate in height, impounds a reservoir having a small storage capacity. The watershed above the reservoir is rolling and heavily wooded. The downstream area is wooded and open land.

b. Dam. Rice Reservoir Dam is an earth embankment having a hydraulic height of 48 feet, 310 feet long, and 12 feet wide at the crest. Available drawings indicate that the dam has a concrete core wall, but the core wall was not visible. A dike, constructed contiguously with the dam, forms a dog leg on the right (west) side.

The portion of the upstream slope that was visible above the reservoir surface has a slope of 2.5H:1V. Riprap is visible from about one foot below the crest to the maximum depth that is visible beneath the reservoir surface. There is erosion between the top of the riprap and the crest of the dam. (See Appendix C - Figure 2.) Small trees (less than 3 feet high) are growing near the top of the upstream slope. (See Appendix C - Figure 3.) The crest of the dam is covered with grass, which appears to have been mowed regularly.

The downstream slope of the dam has a slope of 2.5H:1V. It is covered with grass and a few coarse weeds, and appears to have been mowed at least once during the summer prior to the inspection. (See Appendix C - Figure 4.) Five animal burrows were observed on the downstream slope. Seepage is discharging from the toe of the dam at the deepest part of the valley. The seepage has deposited rust colored precipitate in the flow area, but otherwise the water is clear. (See Appendix C - Figure 5.) The toe of the slope at the deepest part of the valley is covered with boulders. This may be a toe drain or merely surface riprap. Two soft, wet areas were also noted about 50 feet downstream of the toe of the dam near the break in alignment of the crest. No visible discharge of water was observed in either of these two areas. These soft, wet areas may be the result of seepage from the reservoir or they may be the result of a generally high water table in the low, flat area downstream of the dam. In addition, one slightly soft, wet area close to the downstream toe of the dam was observed between the break in alignment and the right abutment of the dike.

c. Appurtenant Structures. A concrete spillway 8 feet long with the crest 3.2 feet below the crest of the dam is located on the east end of the embankment. A concrete chute spillway 7 feet wide and 1.5 feet deep channels the discharge flow down the face of the embankment and outlets into the brook at the toe of the dam. (See Appendix C - Figure 6.)

The vertical wall on the east side of the spillway is cracked in at least three places. One crack and one spalled area upstream of the flashboards was observed to have been partially repaired with mortar; however, an inclined crack immediately downstream was discharging water, presumable entering the wall from upstream. (See Appendix C - Figure 7.) The bottom of the spillway was observed to be in good condition with surface erosion limited to loss of surface laitance.

The concrete box discharge chute, constructed in approximately eight sections, has deteriorated. Of particular concern is the longitudinal movement observed between first and second sections and the tilted vertical walls of the third and fourth box sections. (See Appendix C - Figure 6.) Numerous hairline cracks with efflorescence and small areas of spalling were observed in the spillway box walls. (See Appendix C - Figure 8.)

Water was observed flowing into the transverse joint in the floor between the first and second box section (See Appendix C - Figure 9) and discharging from the horizontal joint between the wall and the floor approximately three feet downstream of the transverse joint. Open joints which permit water to pass through them expose the subsurface material to erosion. Erosion under or along the side of the box culvert would seriously jeopardize the integrity of the embankment.

The last section of spillway was never completed. Rocks appear to have been placed in this area and a significant amount of debris has collected here. (See Appendix C - Figure 10.) During high spillway discharges, this area would be susceptible to erosion and may effect the stability of the dam embankment.

d. Reservoir Area. The watershed above the reservoir is rolling and heavily wooded. No camps or other structures were noted on the shore of the reservoir. (See Appendix C - Figure 11.) No visible evidence of significant sedimentation in the reservoir was noted.

e. Downstream Channel. The valley downstream of the dam is broad and has gentle slopes. The bottom of the channel consists of boulders, sand, and pieces of brush in the channel. (See Appendix C - Figure 12.) Located just downstream of the toe of the dam is an inhabited trailer.

3.2 Evaluation

Based on the visual inspection, Rice Reservoir Dam appears to be in fair condition. The small trees that appear to have been planted near the top of the upstream slope could become a potential problem several decades from now if they blow over and pull their roots, or if they die and their roots rot, which could lead to seepage or erosion problems. Seepage from the toe of the dam at the deepest section and the presence of soft, wet areas near the downstream toe may develop into problems over the long term if not controlled or remedied. Minor erosion between the crest of the

dam and the top of the riprap on the upstream slope could result in a problem if not controlled. Animal burrows on the downstream face of the dam could lead to seepage problems.

The 16" diameter drain pipe called for on the design plans was not found. However, discolored seepage was found near the supposed location.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures

Water is diverted 1½ miles from Whitewater Brook to Rice Reservoir through a 12-inch diameter cast iron pipe. This pipeline is controlled by valves so that Rice Reservoir may receive water for storage during dry weather conditions. The maximum discharge capacity of the pipe is about 2.5 cfs. A second reservoir, known as Dole Reservoir, is located along the continuation of the pipeline downstream of Rice Reservoir. Dole Reservoir furnishes the hydraulic head for the Claremont area. Therefore, an increase in the pool elevation of Rice Reservoir means added reserve storage, available to be drawn through a 10-inch diameter pipeline into Dole Reservoir as needed. Water may also be diverted directly from Whitewater Brook to Dole Reservoir through a Rice Reservoir by-pass line. However, because Rice Reservoir also serves as a particulate matter settling pond, this line is usually used only during high demand periods.

4.2 Maintenance of Dam

Claremont Water Works is responsible for maintenance of Rice Reservoir Dam.

4.3 Maintenance of Operating Facilities

Periodic maintenance is performed on diversion piping and valves.

4.4 Description of Any Warning System in Effect

No written warning system was disclosed for Rice Reservoir Dam.

4.5 Evaluation

The operational and maintenance procedures followed, though not written, appear to be generally satisfactory.

SECTION 5
HYDROLOGIC/HYDRAULIC

5.1 Evaluation of Features

a. General. Rice Reservoir Dam is an earthen embankment which impounds a reservoir of small size. It has a hydraulic height of 48 feet and a crest length of about 310 feet. The western side of the dam is extended by an earthen dike having a crest length and width of about 670 feet and 10 feet, respectively. A small chute-type spillway, 8 feet long by 3 feet deep, is located at the eastern end of the dam embankment.

b. Design Data. A "Brief Statement of the Concrete Core Wall Reinforcement Design and the Overflow" by E. Worthington, Engineer for Claremont Water Works, is included in Appendix B. The latter part of this statement provides some hydrologic/hydraulic design data. The original design called for a 15 foot long spillway. Unfortunately the provided spillway is only 8 feet in length.

c. Experience Data. No data were disclosed concerning flood heights, flood damage, or maximum discharges at the dam.

d. Visual Observations. The chute-type spillway is in some disrepair. The spillway channel near the toe of the dam is filled with rocks, logs, and branches. Flashboards approximately 8 inches high were located on the spillway crest.

e. Test Flood Analysis. Rice Reservoir Dam is classified an intermediate dam, having a hydraulic height of 48 feet and a maximum storage capacity of 152 acre-feet. The significant hazard dam impounds a reservoir of small size, containing runoff from a 0.11 square mile drainage area characterized by mountainous, forested terrain, as well as the diverted water from Whitewater Brook. Using a csm value of 2,500, a Probable Maximum Flood (PMF) of 275 cfs was obtained. The Recommended Guidelines for Safety Inspection of Dams and the possible loss of life if the dam failed dictated the use of the full PMF as the test flood. The PMF discharge after routing was determined to be 260 cfs (2364 csm). Using the calculated test flood discharge of 260 cfs, the dam embankment would be overtopped by 0.2 foot. The maximum spillway capacity at top of dam is 124 cfs or 48% of the test flood.

f. Dam Failure Analysis. The impact of a breach at top of dam was assessed using the Guidance for Estimating Downstream Dam Failure Hydrographs issued by the Corps of Engineers. The analysis covered a reach extending downstream 4200 feet from the toe of the dam, along which five inhabited structures are located. There are five houses with elevations above stream water surface ranging from

7 to 13 feet, and one house with elevation of 0.8 feet. A breach at top of dam would increase the stage by 9.1 feet above the already high 4.2 feet antecedent stage, damaging the four downstream structures as well as State Route 120 and Winter Street. The potential for loss of life is significant (4-6 lives). Considerable property damage could occur as neither the channel nor the five culvert crossings under Route 120, are adequately sized for the volume of discharge.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The visual examination indicates the following evidence of potential problems:

(1) Seepage at the downstream toe of the dam in the deepest part of the valley.

(2) Soft, wet areas at several locations near and downstream of the downstream toe of the dam.

(3) Cracked and spalled concrete in the concrete chute spillway with some leakage; could develop serious erosion if left uncorrected.

(4) The incompleted spillway discharge channel could lead to serious erosion problems if left uncorrected.

(5) Minor erosion above the top of the riprap on the upstream slope of the dam.

(6) Small trees growing on the top of the upstream slope.

(7) Animal burrows on the downstream slope.

In addition, there are a number of small trees overhanging the discharge channel downstream of the dam.

b. Design and Construction Data. Design sketches dated 8/13/34 indicate that the cross section of the dam includes a vertical concrete core wall two feet wide at the crest and six feet wide at the base; a 10-foot wide zone of puddled earth on the upstream side of the core wall, with the remainder of the upstream shell consisting of earth fill; a gravel layer about 15 feet thick on the downstream side of the core, with the remainder of the downstream shell consisting of selected material from clearing the reservoir bottom; a "paved" upstream slope; and a "seeded" downstream slope. Specifications for construction of the dam were also available.

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

d. Post-Construction Changes. No records of post-construction changes were disclosed.

e. Seismic Stability. Rice Reservoir Dam is located in Seismic Zone 2 and in accordance with the Recommended Phase I Guidelines does not warrant seismic analysis.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual inspection indicates that the Rice Reservoir Dam is in fair condition. The principal concerns with respect to the condition of the dam are:

(1) Seepage at the downstream toe of the dam in the deepest part of the valley.

(2) Soft, wet areas at several locations near and downstream of the downstream toe of the dam.

(3) Incompleted spillway discharge channel.

(4) Cracked and spalled concrete in the chute spillway.

(5) Minor erosion above the top of the riprap on the upstream slope of the dam.

(6) Lack of emergency drawdown facility.

(7) Trees growing on the upstream slope of the dam and dike.

(8) Animal burrows on the downstream slope.

In addition, there are a number of small trees overhanging the discharge channel downstream of the dam.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection. The visual inspection is adequate to identify the potential problems listed in 7.1 a.

c. Urgency. The recommendations made in 7.2 and 7.3 below should be implemented by the owner within one year after receipt of this Phase I report.

d. Need for Additional Information. Investigate whether 16" outlet pipe was in fact installed and buried.

7.2 Recommendations

The owner should engage a Registered Professional Engineer to:

(1) Investigate the seepage and wet areas at and near the downstream toe of the dam, and to design remedial or control measures if needed.

(2) Design repairs for the erosion above the top of the riprap on the upstream face of the dam.

(3) Design completion of the spillway discharge channel.

(4) Investigate whether or not the low-level discharge pipe exists and make it operable if it is found.

The owner should carry out the recommendations made by the Engineer.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Repair the cracked and spalled portions of the concrete chute spillway.

(2) Repair the spillway discharge channel.

(3) Remove the small trees growing on the upstream slope of the dam and dike.

(4) Visually inspect the dam and appurtenant structures once each month.

(5) Engage a Registered Professional Engineer to make a comprehensive technical inspection of the dam once every year.

(6) Establish a surveillance program for use during and immediately following periods of heavy rainfall and also a warning program to follow in case of emergency conditions.

(7) Remove debris from spillway discharge channel and fill in animal burrows.

(8) Remove stoplogs and steel bar supports from spillway and keep them removed until spillway is increased.

7.4 Alternatives

No alternatives are recommended.

APPENDIX A

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT Rice Reservoir Dam, N.H. DATE Nov. 22, 1978 (May 8,'79)

TIME 1030

WEATHER Cold, snowing

W.S. ELEV. U.S. 820 D/S. 775.6

PARTY:

1. Warren Guinan
2. Setphen Gilman
3. Robert Ojendyk
4. Gerry Blanchette (5/8/79)
5. John Regan (5/8/79)
6. Ronald Hirschfeld
7. Leslie Williams (11/22/78)
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Hydraulics	W. Guinan/L. Williams	
2.	Structural Stability	S. Gilman/G. Blanchette	
3.	Soils and Geology	R. Hirschfeld	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Rice Reservoir Dam, NH DATE May 8, 1979

PROJECT FEATURE Dam NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	823.2' MSL
Current Pool Elevation	820.0' MSL
Maximum Impoundment to Date	
Surface Cracks	None apparent.
Pavement Condition	Not paved.
Movement or Settlement of Crest	None apparent.
Lateral Movement	None apparent.
Vertical Alignment	Good.
Horizontal Alignment	Good.
Condition at Abutment and at Concrete Structures	Good. Spillway walls at top have ripped in 1".
Indications of Movement of Structural Items on Slopes	3rd and 4th Sections of vertical concrete wall of chute spillway tilted inward, approximately 8".
Trespassing on Slopes	None apparent
Sloughing or Erosion of Slopes or Abutments	Slight erosion above top of riprap on upstream slope.
Rock Slope Protection - Riprap Failures	Riprap on upstream slope in good condition. See "Sloughing..." above.
Unusual Movement or Cracking at or Near Toe	None apparent.
Unusual Embankment or Downstream Seepage	Large area that is soft and has standing water near toe at deepest section of valley. Minor soft spots but no standing water at downstream toe of north section. Flowing water at headwall where there may be low-level outlets or toe drains; water is very rusty.
Piping or Boils	None apparent.
Foundation Drainage Features	None apparent.
Toe Drains	None apparent, but see "Unusual..."above.
Instrumentation System	Three open casings near downstream toe. Purpose and details unknown.
Vegetation	Grass on crest. Grass on upstream slope above riprap; grass and weeds on downstream slope.

PERIODIC INSPECTION CHECKLIST

PROJECT Rice Reservoir Dam, NH DATE May 8, 1979

PROJECT FEATURE Dike NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	670' Dike continuous with dam.
Crest Elevation	
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	See "Sloughing..." for Dam Embankment.
Rock Slope Protection - Riprap Failures	See "Rock Slope..." for Dam Embankment. Small trees planted on upstream face.
Unusual Movement or Cracking at or Near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	
Vegetation	Grass on downstream face and crest. Small trees planted on upstream face above riprap.

PERIODIC INSPECTION CHECKLIST

PROJECT Rice Reservoir Dam, NH DATE May 8, 1979

PROJECT FEATURE Outlet Works NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	Shown on design plans, not visible in field inspection.
General Condition of Concrete	Large seepage in deepest part of valley may be discharge from a toe drain or low-level outlet.
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	

PERIODIC INSPECTION CHECKLIST

PROJECT Rice Reservoir Dam, NH DATE May 8, 1979

PROJECT FEATURE Spillway NAME

DISCIPLINE NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Chute spillway, one 8" flashboard
a. Approach Channel	Rice Reservoir
General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Riprapped
b. Weir and Training Walls	
General Condition of Concrete	Fair
Rust or Staining	Rust visible at flashboard pipes.
Spalling	Some spalling at cracks in walls.
Any Visible Reinforcing	No
Any Seepage or Efflorescence	Seepage discharging from downstream of flashboards on the left side.
Drain Holes	None
c. Discharge Channel	Incompleted; large boulders randomly placed at end of spillway chute.
General Condition	Fair, two sections of vertical concrete wall on side of chute spillway leaning in.
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None over chute, trees do overhang channel downstream of chute.
Floor of Channel	Concrete over most of length, boulders near discharge end.
Other Obstructions	Large boulders and other debris in discharge channel.

PROJECT Rice Reservoir Dam, NH

DATE May 8, 1979

PROJECT FEATURE Reservoir

NAME R. Langen

AREA EVALUATED	REMARKS
Stability of Shoreline	Good
Sedimentation	Not significant.
Changes in Watershed Runoff Potential	None
Upstream Hazards	None
Downstream Hazards	5 Inhabited structures and State Route 120.
Alert Facilities	None
Hydrometeorological Gages	None
Operational & Maintenance Regulations	None posted.

APPENDIX B

ENGINEERING DATA

NEW HAMPSHIRE WATER RESOURCES BOARD CONCORD, N. H.

PROJECT

SUBJECT PINE RIVER DAM — TAMWORTH — CENTER SUGAR RIVER — BARNSTEAD WATER WORKS

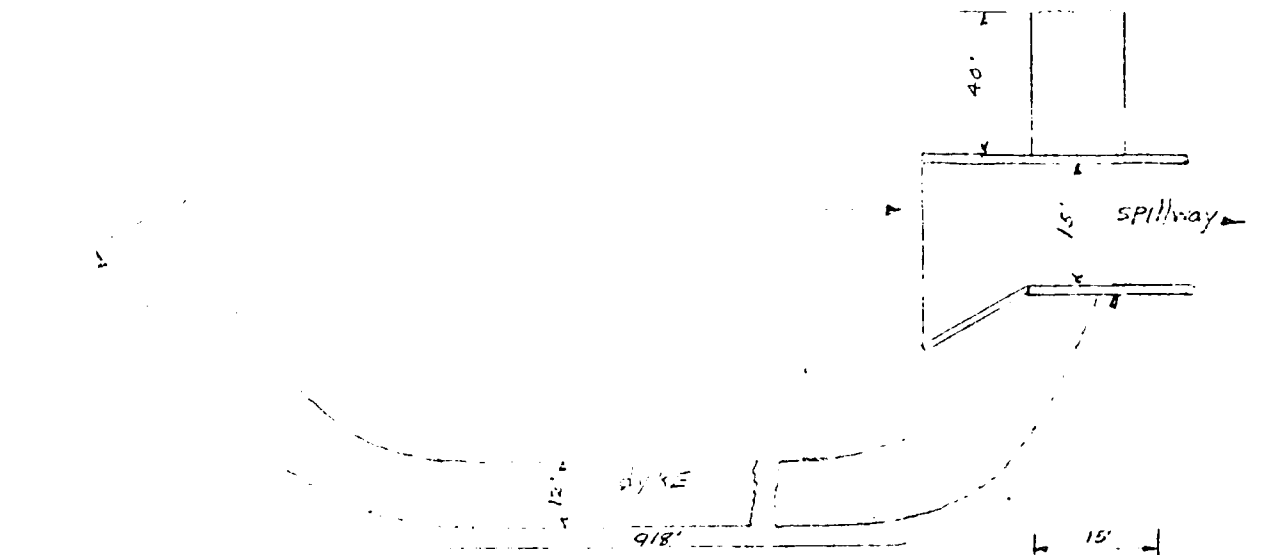
FILE 47.19

ACC.

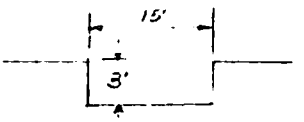
COMPUTER G.S.W. CHECKER

CONT. FROM ACC. CONT. ON ACC. SUMMARY ON ACC.

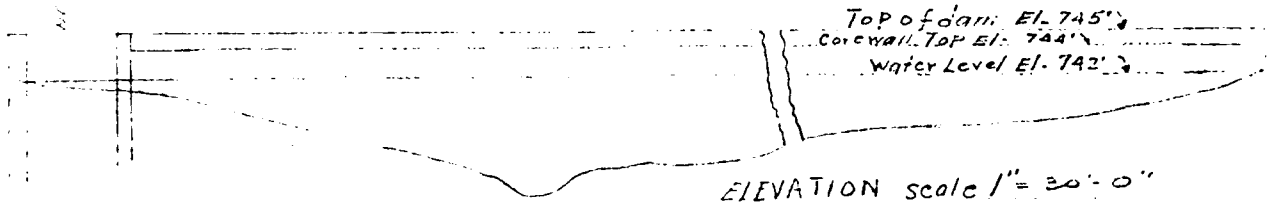
DATE 9/24/62



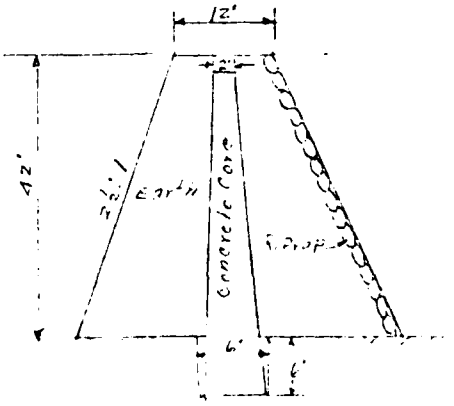
PLAN



X-SECTION SPILLWAY



ELEVATION scale 1" = 20'-0"



X-SECTION OF DAM

7204

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 47.1

Town [illegible]: County [illegible]

Stream [illegible]

Basin-Primary [illegible]: Secondary [illegible]

Local Name

Coordinates—Lat. [illegible]: Long. [illegible]

43° 25' - 6200

GENERAL DATA

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 0.7 E Sq. Mi.

Overall length of dam 970' ft.: Date of Construction 1935

Height: Stream bed to highest elev. 46' ft.: Max. Structure 43' ft.

Cost—Dam ..... : Reservoir .....

DESCRIPTION Earth- Concrete- Cone- Wall

Waste Gates

Type .....

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

Elevation Invert ..... : Total Area ..... sq. ft.

Hoist .....

Waste Gates Conduit

Number ..... : Materials .....

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

Embankment

Type .....

Height—Max. ..... ft.: Min. ..... ft.

Top—Width ..... : Elev. ..... ft.

Slopes—Upstream ..... on ..... : Downstream ..... on .....

Length—Right of Spillway ..... : Left of Spillway .....

Spillway

Materials of Construction Concrete- Earth- Stone

Length—Total ..... ft.: Net 151' ft.

Height of permanent section—max. 43' ft.: Min. ..... ft.

Flashboards—Type ..... : Height 10" ft.

Elevation—Permanent Crest 743.4 (743.4) : Top of Flashboard .....

Flood Capacity 210 cfs.: ..... cfs/sq. mi.

Abutments

Materials: .....

Freeboard: Max. 3.0 ft.: Min. ..... ft.

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

OWNER Claremont Power Works Claremont N H

REMARKS Condition Good

Tabulation By W. A. L. C. Date November 8, 1938.

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire
October 13, 1955.

Claremont Water Works,
Claremont N H

Re: Rice Res. Dam. N. C. C. #8.14

Gentlemen:

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

1. Was this dam injured? Ans. No

2. If so, to what extent? Ans.

3. Did all flashboards go out? Ans. No

4. What was the maximum height of water over the permanent crest of spillway? Ans. Do not know

5. At what day and hour did the maximum flood height reach your dam? Ans.

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

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

We thank you for your cooperation.

Very truly yours,

Richard S. Holmgren

Richard S. Holmgren
Chief Engineer

CDC:GMB
Enc.

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN *Connecticut* NO. *14* *47.14*

RIVER *Rice Reservoir* MILES FROM MOUTH D.A.SQ.MI

TOWN *Claremont* OWNER *Claremont Water Works*

LOCAL NAME OF DAM

BUILT *1935* DESCRIPTION *Concrete ... [illegible]*

[illegible]

POND AREA-ACRES *10.77* DRAWDOWN FT. *25* POND CAPACITY-ACRE FT. *117*

HEIGHT-TOP TO BED OF STREAM-FT. *46 [illegible]* MAX. MIN.

OVERALL LENGTH OF DAM-FT. *970 [illegible]* MAX.FLOOD HEIGHT ABOVE CREST-FT.

PERMANENT CREST ELEV.U.S.G.S. *743.4* LOCAL GAGE

TAILWATER ELEV.U.S.G.S. LOCAL GAGE

SPILLWAY LENGTHS-FT. *10* *15 [illegible]* FREEBOARD-FT. *3*

FLASHBOARDS-TYPE,HEIGHT ABOVE CREST *-10"*

WASTE GATES-NO. WIDTH MAX.OPENING DEPTH SILL BELOW CREST

REMARKS *Water diverted from Whitewater Brook at No 11, 1½ mi thru 12" C.I. pipe to this reservoir, thence thru 10" [illegible] mi to Dole Reservoir, a distribution Reservoir at sufficient elevation to serve City.*

ZH.

[illegible] Brook? *Condition good.*

El. top. [illegible]

POWER DEVELOPMENT

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

USE *Water Supply*

REMARKS *Information from Supt. Claremont Water Works*

Capacity Rice Reservoir 38,100,000 gal. In addition to dam there is a dike 638 ± long. Spillway overflow carried 75 ft. from dam

[illegible] E [illegible] Engr. Slopes [illegible]

Shown by Chas Easter Supt.

Area El 743.4 469 088 sq.ft.

[illegible] 4,678 565 gal.

" [illegible] 18,225 151 "

DATE *6/15/37 [illegible]*

10 [illegible]

[illegible] YES.

47.00 ✓

CLAREMONT WATER WORKS

~~JAMES L. RICE, SUPERINTENDENT~~

CLAREMONT, NEW HAMPSHIRE

CHARLES W. EASTER, SUPT.

June 15,1937

New Hamp.Water Recourses Board
Concord, New Hampshire.
Mr. Richard S. Holmgren.

Dear Mr. Holmgren:

We are pleased to comply with your request of June 4th, but, as we have no engineer, we will give you such data as we have.

Under separate cover, you will receive a map with our Reservoirs located very clearly, with lines drawn, showing you the way the Reservoirs are connected and the size of the pipe lines: from the Straw Reservoir there is a 12" cement pipe to the Town, and from the Dole Reservoir a 20" cast iron pipe to the Town also: these two reservoirs are on the same level.

The draw down of these Reservoirs are so varied different years that it is rather difficult to comment: last year, being exceptionally dry, they were nearly empty, and other years they remain nearly full.

DOLE RESERVOIR	37,000,000 gallons-	DAM 475'	long-	OVERFLOW 15'wide.	
JOHNSON "	24,000,000 "	- DAM 300'	" -	" " 50'lg.10'wide	
PHELPS "	3,500,000 "	- DAM 250'	" -	" " 10'wide	
✓ RICE "	38,109,000 "	- DAM 304'	"-DYKE 638'long	OVERFLOW (10'wide,75'lon	
STRAW "	3,500,000 "	- DAM 150'	"	-OVERFLOW 2-16"pipes.	

The Dole,Rice and Straw Reservoirs have a very small watershed;only a few acres: as you will see by the Map, water is conducted to them through pipe lines: the water from the Johnson Reservoir flows to the Phelps Reservoir in a brook controlled by a valve at the lower side of the Johnson dam.
You will note the map is marked WHITE WATER BROOK INTAKE: this is a cement dam about 90' long and 10' in height, which has a valve and screen chamber connected to same: water flows from here in a cast iron pipe 1½ miles to the Rice Reservoir,thence to the Dole Reservoir.

Hoping this report will answer your request,we are,

Yours very truly,

Chas. W. Easter ....Supt.

MR

CLAREMONT WATER WORKS

Information transferred to dam work & summary sheets dam survey 6/16/37 by Hossire

[illegible]

B-5

4714 ✓

CLAREMONT WATER WORKS

CHARLES W. EASTER, Superintendent

CLAREMONT, NEW HAMPSHIRE

October 2, 1935

Mr. Lord.
N.H.Pub.Serv.Comm.
Concord, N.H.

Dear sir:

I am sending you, under separate cover, a countour print of the Rice Reservoir, as it is to be known, and you will find enclosed, photos of the rip rap while under construction, which, I think, will interest you; the rip rap will be completed today, and I feel that we have done a fine job.

The stones were laid edgewise or endwise at right angles to the slope, 18" thick.

The grading is nearly done; then we will finish the stripping at the upper end.

I feel somewhat proud of the job, and trust that it will meet with your approval.

Yours truly,
Charles W. Easter, Supt.
Claremont Water Works

MR

17.14 J

September 24, 1934.

Mr. Charles W. Easter
Supt. of Water Works
Claremont, N.H.

Dear Mr. Easter:

I send you with this in separate enclosure, four sets of plans and specifications for the Stevens Reservoir Dam.

One set you are sending to Mr. Fraiser of the New Hampshire State Board of Health, I understand.

The State of Massachusetts requires that all dams be approved in plan by the County Commissioners of the County in which the dam is located as a measure of proper safety to the public.

I do not know what the requirements are in New Hampshire, but you can ascertain if the filing of the plans with the State Board of Health answers the requirements.

The plans are prepared with this in view.

Please note especially that when the pipes are laid through the dam they must be thoroughly supported by concrete supports as shown on the plan and details. Also that every other support is made a cut off wall to prevent the leakage of water along the pipe and through the dam. A smooth pipe is frequently the way for water to follow the line.

Also the pipe must be thoroughly supported to prevent settlement due to possible insecure foundation and also the weight of the fill over the pipe. A leaky joint may cause disaster and your pipes will always be fille You cannot get at a joint to repair it after it is enclosed in the dam.

The core wall is also important to start not only on firm foundation but also below the point which will have impervious material to prevent leakage underneath the wall. For this reason the wall is to be carried not only down to this impervious strata but into it so as to seal off the point of contact. In ledge we cut out a channal to hard rock at least a foot or more deep into the solid rock.

This may seem to be unnecessary at times, but the cost of such precautions is not great and means everything sometimes.

The dam is a structure to hold water and be safe from any strains that may be put upon it. The time to make it so is when it is built as after construction it is difficult and expensive to remedy defects.

The dam foundations are perhaps the most important feature and should be secure for both support and leakage.

For the above reasons the stripping on the dam location as covered by the filling should be thoroughly cleaned down to the subsoil of all loam and vegetable matter down to the firm subsoil. You do not want a porous strata at base of fill.

I am emphasizing these features because while you doubtless realize them, it is no harm to keep in mind.

The plans and specifications are practically complete including details for building the dam.

The specifications are not in complete shape for a contract job. They are for description purposes largely to show how work is to be done.

It is essential, I think, to have the work inspected at frequent intervals particulary in foundations and starting work.

I am leaving to you the times when you wish me to come up for this purpose and also to give you layouts. You can get me at a days notice.

Yours truly,

4114

RECEIVED
SEP 13 1984
N.H. Public Service Commission

New Hampshire Public Service Commission

QUESTIONNAIRE - STATEMENT

Concerning Mills and their repairs, Dams and Flowage

Chapter 218, Public Laws of New Hampshire

LOCATION

1. In what town? Claremont

2. On what stream? Stevens Brook seldom water except in spring

3. Give location definite as possible by description and by indication on plan or map Centerline on map about one half mile north shed

ERECTION:

4. Is it proposed to erect a new dam on a new location? Yes.

5. Is it proposed to erect a new dam on a location previously occupied? No

REPAIRS:

6. Is it proposed to make minor repairs (repairs that can be made without lowering the pond level, diverting flow and interfering with operation)? X

RECONSTRUCTION:

7. Is it proposed to make major repairs, (requiring a lowering of pond level, diverting flow and interfering with operation)? X

8. Is it proposed to increase the height of the dam permanently?

9. Is it proposed to increase the height of the dam by flashboards? No

47.19

10. Is it proposed to increase the height of the dam by increasing the height of the original flashboards?

No

OWNERSHIP:

11. Who will or does own the dam and appurtenances?

Name Claremont Water Works

Address 7 Sullivan St Claremont

12. Who owns the premises upon which the dam is or will be built?

Name Claremont Water Works

Address 7 Sullivan St Claremont

13. Who owns the premises flowed by the dam or will be when built?

Name Claremont Water Works

Address

14. Who will or does maintain the dam?

Name Claremont Water Works

Address

15. Who will or does operate the dam?

Name Claremont Water Works.

Address

16. Has the consent of the owners of the land upon which the dam is to be built, been obtained? By order of town

17. Has the consent of the owners of the land that will be flowed by the dam been obtained? Yes

PURPOSE:

(Check opposite the designation under which this dam is) (or will be classed.)

18. Conservation ( )

19. Domestic (X)

47.14 J

20. Power (|)

21. Recreation

(a) Private (|)

(b) Commercial (|)

22. Transportation (|)

DIMENSIONS:

23. What is or will be the area of the pond created by the dam? About 14 acres

24. What is or will be the length of the pond from the dam upstream? 2057'

25. What is or will be the length of the dam? 300'

26. What is or will be the height of the dam above the bed of the stream? 40'

27. What is or will be the length and depth of the spillway?

28. What is or will be the number and size of openings? One

MATERIALS:

29. Of what materials is the dam constructed?

30. Of what materials will the dam be constructed? Cement core with earth either side

31. What is the nature of the foundation where or upon which the dam is or will be built? (Ledge - hardpan - sand gravel - clay - etc. and extent)? X X Some ledge mostly hardpan. (Some ledge - mostly hardpan)

TIME:

32. When will the job be begun? Started to clear ground May 25th

33. When will the job be completed? Wish to complete this year

47.14

PL[illegible] AND SPECIFICATIONS:

34. Submit plans (plan, elevations, cross sections) of dam, giving information as to foundations, showing dimensions, etc.
I have sent you plans a made by a Mr Harris we have changes the location to a lower elevations and

PERSONNEL: Mr Worthington has them nearly ready the lower elevations shortens the dam about 10 feet will send you his plans soon

35. Who will be Engineer? C

Name C. Worthington

Address Needham Mass

36. Who will be contractor or constructor?

Name The Superintendent

Address 2 Sullivan St Claremont

REMARKS. We are very short of water lower than [illegible] in this part ten years and beg for your approval. This reservoir will be filled from a 10" pipe line that now runs through the proposed reservoir

Dated: Sept. 14 1934

Signed: Thos. H. Carter Supt.

CLAREMONT WATER WORKS

CLAREMONT, NEW HAMPSHIRE
CHARLES W. EASTER, SUPT.

Sept.7,1934.

New Hampshire Public Service Commission.

Gentlemen:

On September 5th, Claremont held a special Town Meeting and voted to instruct the Water Commissioners to build a new storage reservoir to be known as the Stevens Brook Reservoir.

The site is about three miles from town on the Cornish Road: the brook is but a spring brook: the Reservoir will be filled from a pipe line from White Water Brook.

I am sending you plans for same, and beg your approval.

Since this plan was drawn, the board has decided to build about 400 feet lower down the basin and thus shorten the dam to 300 feet in length and 40 feet high: otherwise the dam will be built the same as the enclosed plan.

If we may be permitted to build this dam, will you please mail the permit to us as soon as possible?

We are very short of water and do not care to experience such conditions in years to come.

This dam will impound about 55,000,000 gallons.

Hoping to hear from you soon, we remain,

Yours truly,

Claremont Water Works.

M.R. Chas. W. Easter Supt.

B-13

CLAREMONT WATER WORKS

CLAREMONT, N. H.

STEVENS RESERVOIR DAM

1934.

Brief Statement of the concrete core wall reinforcement design and the overflow

---

REINFORCEMENT STEEL FOR CORE WALL

The primary object of the core wall is to prevent seepage through the earthen dam so far as possible. The core must be guarded against shrinkage cracks in setting. Temperature conditions are not met as in retaining walls or exposed concrete structures. The core wall is embedded in the earth fill and not subject to sudden or extreme temperature changes. The condition of construction due to unequal pressures on opposite sides is largely compensated by carrying the fill on both sides up stimultaneously.

Some allowance may be made for different conditions occasioned by possible saturation of water side to some extent.

The reinforcement in a concrete core wall is largely a matter of opinion as to its size and placing. The size selected was largely based on an opinion derived from the stresses due to temperature and shrinkage stresses in a long continuous wall where there is a chance of some side thrust due to unequal settling of the fill on either side

A steel percentage of from 0.1% to 0.2% is very common in concrete core walls. I have used 0.1% in this core wall and I doubt if this should be cut to any extent. According to the considerably theoretical formula of stability as used by Parker in the "Control of Water" the unbalanced shear due to a saturated upstream full and unsaturated downstream side would give a shear of about 80,000 lbs per lineal foot at 40 feet down. This will be about 95 lbs. per square inch on the concrete. This makes assumptions of

he hydraulic gradient through the dam which are probably not true, but is higher than likely to occur in this dam.

The steel used by me in the concrete is closely the same as that used in the U.S. Reclamation Tieton Dam in Washington built about 1925 which had an additional small hydraulic core on the upstream side but in which both upstream and down stream sides were filled at the same time.

The Phelps Brook reservoir of the Hartford, Conn. Water Supply (of about the same height as Claremont) used expansion joints every thirty feet and a section about like the one at Claremont but expansion joints in a core wall do not appeal to me as being as good as making a continuous reinforced core unless carefully designed for tightness.

The steel in the Claremont Dam is not placed in the most effective way but is placed to conform to simple methods of handling in view of the labor conditions. I would prefer to make this ½ inch square steel 8 inches on center both ways at a depth from the surface of about 4 to 6 inches. This requires handling many more pieces of steel than the 1 inch rounds at 24 inch centers both ways.

The depth of placing of part of the steel 12" in from face in lower section, while lowering the beam strength does give greater protection to the steel. The 24 inch each way spacing should not allow cracks to develop which would allow leakage.

Personally, in view of the small amount of cost of the steel designed for Claremont, I can see little use in lowering the percentage. There is only about 30,000 lbs in the entire core wall and at 3½¢ per lb. this is a little over $1000.00

OVERFLOW DESIGN.

The Stevens Reservoir is designed to form a storage reservoir for water diverted into it from a brook about 3500 feet away which brook does not drain through the Reservoir. The water is brought into the natural basin by a controlled pipe line which can be cut off by gates so as to be available only when desired to fill the basin for storage during dry weather conditions.

This pipe line now in consists of about 3000 feet of 12" pipe and 500 feet of 10" pipe. The head or fall is about 21 feet in this distance. The discharge of this pipe line is computed to be at a maximum rate of 2.5 cubic feet per second. There is another storage Reservoir on this same pipe line about 2 miles nearer the distribution area known as the Dole Reservoir which is kept filled so far as possible by this pipe line. The Dole Reservoir has a storage capacity of about 21,000,000 gallons and furnishes the head for the Claremont area. The Stevens Reservoir would increase the reserve to be in turn drawn into the Dole Reservoir as needed.

The Stevens Reservoir is in a small natural depression with no water collecting therein except at certain periods of wet seasons. It has a small drainage area tributary to it of about 100 acres,(0.15 sq. miles) wholly on one side. This area is a fairly steep slope heavily wooded, largely white pine. The overflow would become operative if a rainfall would be heavy enough to fill up the pondage in reservoir sufficiently to flow over the crest of the spillway.

The data on the overflow requirements

It is evident that in all cases the effect of the Reservior Storage must be taken into account. The 15 foot spillway will in itself take care of 290 cubic feet per second or 2.9 inches per hour before the dam is topped. The Reservoir itself will take care of 5.5 inches of rainfall above the spillway before topping the embankment.

TABLE OF DATA (APPROXIMATE)

1. Watershed----------4,300,000 sq.ft.
2. 1 inch of runoff---------- 360,000 cu.ft.
3. 1 inch runoff per hour---------- 100 c.f.p.s.
4. Pondage---------- 16 acres
5. Pondage for 3 ft. overflow depth----------2,000,000 cu.ft.
6. Inches runoff collected for 3 ft. over spillway elevation 5.5 in.
7. Width of spillway ---------- 15 feet.
8. Depth of spillway---------- 3 feet.
9. Capacity of Spillway---------- 290 c.f.p.s.
(Rolled top section)@ C. = 3.7

The report of the Boston Society of Civil Engineers Committee on the 1927 Flood (September 1930) Page 345 etc. would indicate that no long continued storm is likely to reach an average of 2.9 inches per hour and Houk (Engineering News, June 29, 1922, Page 1072) quotes no storms in North Eastern United States of cloudburst intensity which would top the Stevens Dam with a 15 foot spillway with 90 percent runoff allowance. It does seem as if a 90 percent runoff is amply large for cloudburst conditions. (See also Talbot, Meade, Meyer, Miami etc.)

The period of time for the maximum flood is much the most important item in this small, steep drainage basin when dealing with high flows. The peak would be of short duration in hours. The peak flow of the proposed Committee Report (page 406) allows for $Q = 1000 \times \sqrt{0.156} \times 8 = 3150$ c.f.p.s. which corresponds to a flood flow of about 20,000 c.f.p.s. per square mile which is not at all reasonable in these conditions. The formula which gives an infinitely large rate for an infinitely small area is not suitable for water sheds which are not in conformance with its derivation and I have discarded it in favor of a more rational method of length of duration of intense

precipitation based on Houk's cloudburst records and a consideration of the reservoir storage between the spillway crest and the top of the dam. This again has been compared with the probable run off rate caused by a maximum storm of longer duration.

The reservoir will itself take care of a flood rise of 5.5 inches of runoff and the spillway itself will take care of a constant run off of 2.9 inches per hour.

The spillway might have been designed as a circular inlet flowing into a pipe through the dam. This would have probably involved less expense. An available head of 40 feet with a pipe or culvert length of 250 feet would require a 36 inch pipe to deliver 290 c.f.p.s. A throat could be constructed to give proper spillway but with the possible ice conditions and the ease of clearing of an open overflow with the difficulty of approach if in the reservoir, I believe that the open canal and spillway is the safest method of treating the flood water.

After the water has left the proposed spillway the cheapest plan may be to run the overflow into a pipe with a suitable concrete funnel intake into a 36 inch cast iron pipe to conduct it outside of the dam and to a point below the dam. This has a disadvantage in clearing in case of stoppages from logs or other detritus. It is believed that the open channel is safest under all conditions which might arise.

E. Worthington C.E.

Engineer for Claremont Water Works

Dedham, Mass. October 5, 1934.

CLAREMONT WATER WORKS

CLAREMONT, N.H.

STEVEN'S RESERVOIR, 1934.

SPECIFICATIONS FOR CONSTRUCTION OF

DAM AND DYKE

GENERAL DIMENSIONS:

The dam is to be 304 feet long on top which is placed at assumed elevation of 745.00

All elevations are relative to this assumed base.

The lowest point of dam below this top is 705.00 or 40 feet lower.

The water level in basin when full is at elevation 742 or 3 feet below the top.

The top of core wall is 744 or 1 foot below top of dam.

The dyke on northwest side is 638 feet long and from 0 to 10 in elevation above the present surface.

PLANS.

Accompanying these specifications is a set of plans showing the location and construction of the dam and dyke with details of certain features.

These plans are as follows:

1. Outline of Dam and Dyke, Scale 1" = ~~50~~ 100
   Contour Plan of Dam location, Scale 1" = 20'

2. Plan of dam and Profile showing location of details
   Scales 1" = 20' Horizontal
   1" = 10' Vertical

3. Plan of Dyke and Profile, Scales same as for Dam.

4. Detail Sheet.
   Core wall with reinforcement.
   Cut off walls and supports for pipes
   Screen box and grating for pipe inlets
   Section of dam to show pipe location and construction.

5. Wasteway sections with profile.

These plans are a part of these specifications and are referred to for dimensions and details.

CLEARING SITE.

The areas occupied by the dam and dyke are to be cut off from trees and brush. The stumps are to be pulled and removed.

STRIPPING.

The site of both dam and dyke are to be cleaned of top soil and all matter to the subsoil of clay or gravel.

All stripping material is to be stacked outside the outer slope lines of both dam and dyke to be graded later when slopes are finished. The loam to be kept separate for top spreading.

CORE WALL.

The core wall is to be of concrete mixed one of cement, two of sand and four parts of crushed stone. The dimensions of this core wall are shown on the plan and the reinforcement is shown on the details and schedule of quantities annexed hereto.

The core wall foundations are to be carried down to rock or impervious material especially in lower portion of the dam. The general dimensions are 6 feet wide at lowest point. The batter of the core wall is one half foot in each 10 feet or the wall starting at top will be 2 feet wide and for each 10 feet below increase one foot. The details of this are shown on the plans.

This core wall starts at elevation 744 or one foot below the top of dam except at the overflow where it is at high water mark or elevation 742.

The cement used is to be fresh ground cement of standard fixed by Americ Standard of Testing materials. The sand to be of clean sharp pit sand free from loam, clay or foreign matter.

The broken stone of sound hard stone from ½ inch to 2 inches in any diameter for use in reinforcement work. In mass concrete small clean stone of not over 6 inches in diameter may be used on center of core wall for fill

if separated so as to have layer of concrete surrounding each stone. The concrete shall be thoroughly spaded in forms so as to flush faces to forms without spaces or voids. If on removal of forms the concrete shows voids they shall be filled with cement mortar mixed one part cement to two parts sand. The faces shall be coated with cement wash applied with a brush after forms are removed.

EARTH FILLINGS. The filling of earth to form body of dam and dyke shall be composed of selected earth from borrow pits. Such material shall be clay hard pan for the water side of dam with all stone over 6 inches in any diamete removed. The outer slope may have a mixture of gravel if such material is encountered in borrow pits. All porous material or waste is to be deposited below dam and outside dyke for grading after dam is completed. All filling shall be deposited in layers not over 2 feet thick in horizontal layers and thoroughly wet with water and rolled so as to compact the material. The fill shall be carried full to outer slope and kept higher on outer edges to keep puddling water in dam fill. After the filling is complete the sides shall be trimmed to lines for rip rap paving on water side and loaming on top and lower side of fills.

PIPING

The 16 inch drain pipe is to be laid in cast iron water pipe on line an grade as given with 16 inch valve at lower end and grated concrete box at upper end as shown on the detail plans.

The 10 inch discharge pipe is to be cut into main running through reservoir to the Dole Reservoir below with Y and bend. Three 10 inch gates are to be set at such connection for controls. At the upper end of this discharge pipe is to be set a concrete screen box with screen cover as sho on detail plan.

CUT OFF WALLS.

On the pipes extending through the dam there are to be cut off walls

and supports of concrete as shown in details. The supports and cut off walls alternate every 12 feet or each pipe joint so to form a firm foundation for these pipes and guard against settlements which may break joints or leakage along the pipes.

All details of these cut off walls and supports are shown with other detail on detail sheet.

All details are to be in accordance with the plans therefor which accompany these specifications.

OVERFLOW:

An overflow channel and wasteway is to be provided at easterly end of the dam as shown in the plans.

This overflow will have its crest at high water mark and be 15 feet wide at such points.

The walls and channel of overflow will be of reinforced concrete as per plan. Outside the dam on the slope and to the brook channel below the dam the wasteway will be 10 feet wide with walls and bottom of reinforced concrete. These details are shown on the plan.

RIP RAP ON WATER SIDE OF DAM AND DYKE.

The surface of the slope on water sides of dam and dyke after trimming will be paved with stone rip rap laid to line and grade with face. This rip rap is to be of as large stone as practical to form a paving at least 12 inches thick. The stone shall be laid by hand and bedded in screened gravel with all spaces in face chinked with stone or gravel. The rip rap shall be rammed in place as laid to give firm bed.

GRADING.

All surplus material outside the outer slope shall be graded to meet slope and then all such grading and the outer slope and top of dam and dyke shall be covered with loam 12 inches thick on slopes and top, raked smooth and seeded.

CLEARING UP SITE

On completion of the work all material shall be disposed of and the work left in neat and workmanlike manner.

GENERAL CONDITION

All lines, grades, and directions as given by Engineer, from time to time shall be carefully followed and special care taken to preserve all marks and benches.

To prevent misunderstandings and loss of markings the work should be visited from time to time by the Engineer to examine the work and make the necessary layout with directions.

Dedham, Mass.
September 17, 1934.

E. Worthington, Engineer.

Claremont Water Works. 8-13-'34.
Notes on proposed dam at Stevens Brook.

Watershed of Stevens Brook, above damsite, probably less than one half square mile; in addition to flood flow from this watershed there may be entering the reservoir some 2,000,000 gallons per day from the White Water Brook. Spillway must provide for this.

For present economy we omit gatehouse and gates on upper ends of proposed service and waste pipes and show simple bulkheads with screens and trash racks. This being a long narrow pond there should be but a small amount of leaves or other trash to cause trouble and if pond is emptied frequently the screens can be cleaned; in an emergency a diver can be employed to do this.

Excavate for foundation and core trench as directed by the Engineer. Concrete to be 1-2 1/2- 5 (or proportions may be modified by order of the Engineer) and to this mixture add one part of Hydrated lime to each ten parts of cement.

Material for puddled core should contain sufficient clay or "hardpan" to make a compact and, as nearly as possible, an impervious core.
Use plenty of water in trench so material deposited will be immediately submerged. Spread material for core by shovels as no dumping will be be allowed within ten feet of concrete.

The upstream slope to be of gravel, loamy gravel or "hardpan" not too rich in clay, deposited in layers, kept moist at all times and rolled or compacted by tractors.

Adjacent to the core wall, on the lower side, fill to be of gravel place in layers, as above.

The lower slope, below the gravel, may be of selected material moved in cleaning bed of reservoir; stumps, logs and other large pieces of wood will not be allowed but small roots and other vegetable matter need not be entirely excluded.

Slope paving, on the upper slope, to be of large stone to lay, generally, 18 inches thick, carefully placed to grade with their longest dimension perpendicular to the slope and voids filled with fine gravel.

All pipes to be laid on a firm foundation to avoid any possibility of settlement and breaking by the fill above. Construct two thin concrete ~~xxbfxxxxix~~ cut off walls around each pipe, including the present service pipe, above the concrete core wall. Puddle all material surrounding these pipes for their whole length.

Work to be at all times open to inspection by the Board of Water Commissioners, their Engineer and such other inspection as may legally be required.

Town No. 13 Town Claremont No.

Data by LWB File

Owner Town of Claremont

River or Stream Straw Reservoir

Public Utility Yes Drainage area sq. mi.

Wheel Capacity H. P. { Primary H. P. / 90% time }

Type of Construction Concrete and Stone

Height 25 ft. Operating Head Storage ft.

Length 200 ft. Spillway Length (No. 1) ft. (No. 2) ft.

Would Failure of Dam do Harm? Possibly

Present Condition Good Date 1925

7374

RICE RESERVOIR

Town No. 14 Town Claremont No.

Data by LWB File

Owner Town of Claremont

River or Stream Diversion dam, keep water going into reservoir formed by dam No. 13.

Public Utility No Drainage area sq. mi.

Wheel Capacity H. P. { Primary H. P. / 90% time }

Type of Construction Earth

Height 10 ft. Operating Head Storage ft.

Length [illegible] ft. Spillway Length (No. 1) ft. (No. 2) ft.

Would Failure of Dam do Harm? Yes

Present Condition Good Date 1925

7374

7208

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

LOCATION AT DAM NO. 47.14

Town ...Unity...: County ...Sullivan...

Stream ...Sugar River...

Basin—Primary ...Connecticut R....: Secondary ...Sugar R....

Local Name .....

DRAINAGE AREA

Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total ..... 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	25	10.77	117
(5) Max. Drawdown	.....	.....	.....
(6) Original Pond	U.S.G.S. Sh	.....	.....

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 ...Water Supply...

OWNER ...Claremont Water Works... ...Claremont N H...

REMARKS

Tabulation By ...A.A.N. & R.L.T.... Date ...November 9, 1938...

47.14

E. WORTHINGTON
Civil and Consulting Engineer
WATER SUPPLY AND SEWERAGE
INSURANCE BUILDING
DEDHAM - MASS.

TELEPHONE, DEDHAM 0120

DEDHAM, MASS., October 4, 1934

Mr. S. J. Lord
Public Service Commission
State House,
Concord, N. H.

Dear Sir:

I am sending you in separate enclosure a set of blue prints for the dam at Stevens Reservoir, Claremont, N. H.

This is the same as the set given you at Claremont September 25th with the addition of sheet 5 containing overflow details. Mr. Easter was to send you a duplicate copy of sheet 5 for your first set.

In regard to the stresses and reinforcement of core wall concrete I am enclosing also a brief statement of the method of treating this subject in separate enclosure.

Also the question of the overflow in various designs. These I have made separate from this letter of transmittal as this may be easier for you to study.

I will add that if at anytime I can be of assistance to you in the matter I will be glad to do so.

The Claremont Water Board have not as yet engaged me or anyone to give Engineering supervision of this work and I am subject only to such calls as they may make.

I believe that they consider that all such details can be performed by Mr. Easter, their superintendent. Also they are purposing to carry out the work by local day labor.

This method will, I think, make the cost much greater than if contracted for with some reliable contractor equipped with suitable machinery and carried out under the supervision of an Engineer who has experienced with the class of work. The estimate of cost was made with this method in view.

What the result will be I cannot fortell but hope machinery can be used to expedite and cut the cost of the work.

I have emphasized the need of proper foundations for core wall and the stripping of site to be done to the firm subsoil.

I do not wish to assume responsibility unless done under my supervision.

Yours truly,

E. Worthington

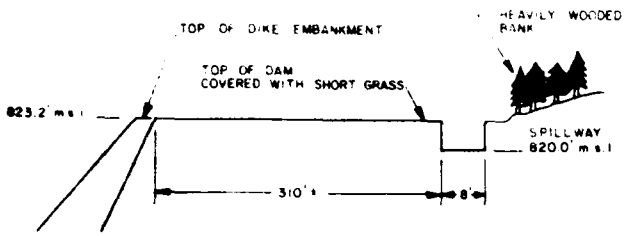
B-27

NEW HAMPSHIRE WATER CONTROL COMMISSION

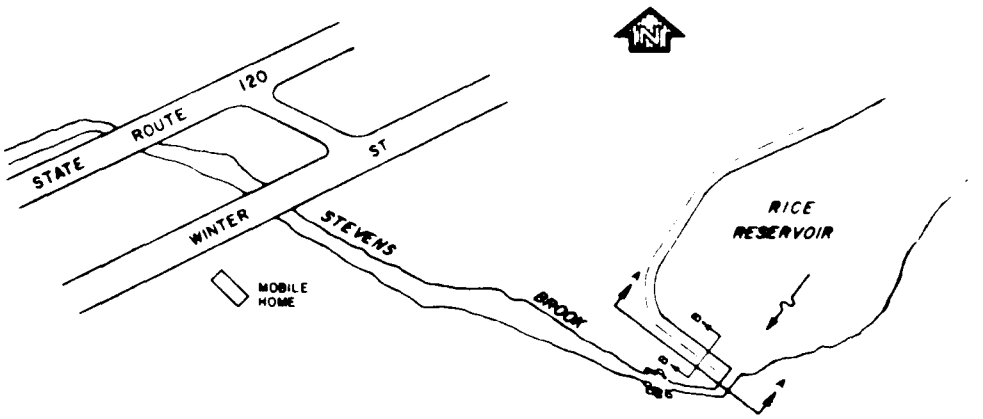
Dams on Which Information is Available in the

Town of Claremont

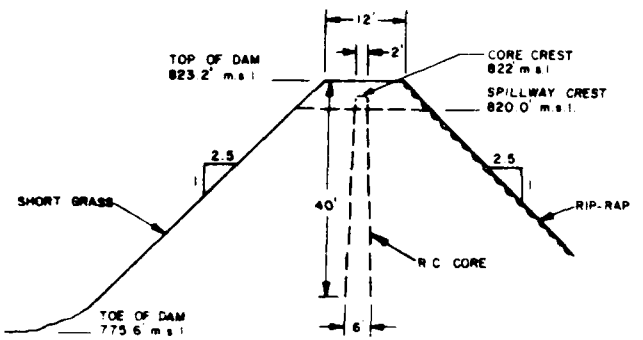
State No.	Location Stream	Name of Body of Water Created	Owner	Condition
47.01	Sugar River	---	Monadnock Mills	Ruin
47.02	" "	---	" "	Operable
47.03	" "	---	Sullivan Machinery Co.	Operable
47.04	" "	---	" " "	Operable
47.05	" "	---	(Claremont Waste Co. (Sugar R. Grist Mill	Operable
47.06	" "	---	Claremont Paper Co.	Operable
47.07	" "	---	Central Vt. Pub. Ser.	Operable
47.08	" "	---	Dartmouth Woolen Mills Inc.	Operable
47.09	" "	---	" " " "	Operable
47.10	" "	---	Coy Paper Co.	Operable
47.11	White Water Bk.	---	Claremont Water Works	Operable
47.12	Red Water Bk.	---	A. F. Gaffney	Operable
47.13	---	Straw Reservoir	Claremont Water Works	Operable
47.14	---	Rice Reservoir	" " "	Operable
47.15	Grandy Brook	Phelps Reservoir	" " "	Operable
47.16	Br. " "	Johnson Reservoir	" " "	Operable
47.17 & 47.17A	---	Dule Reservoir	" " "	Operable
47.18	Red Water Bk.	---	A. F. Gaffney	Operable
47.19	Bible Hill Bk.	Tyler Reservoir	Dr. Rowland G. Freeman	Operable
47.20	Stevens Brook	---	Isaac Walton League	"
47.21	Grandy Brook	---	A. Couture & Son	"



ELEVATION A-A



PLAN



SECTION B-B

Anderson-Nichols & Co., Inc.
CONCORD NEW HAMPSHIRE

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

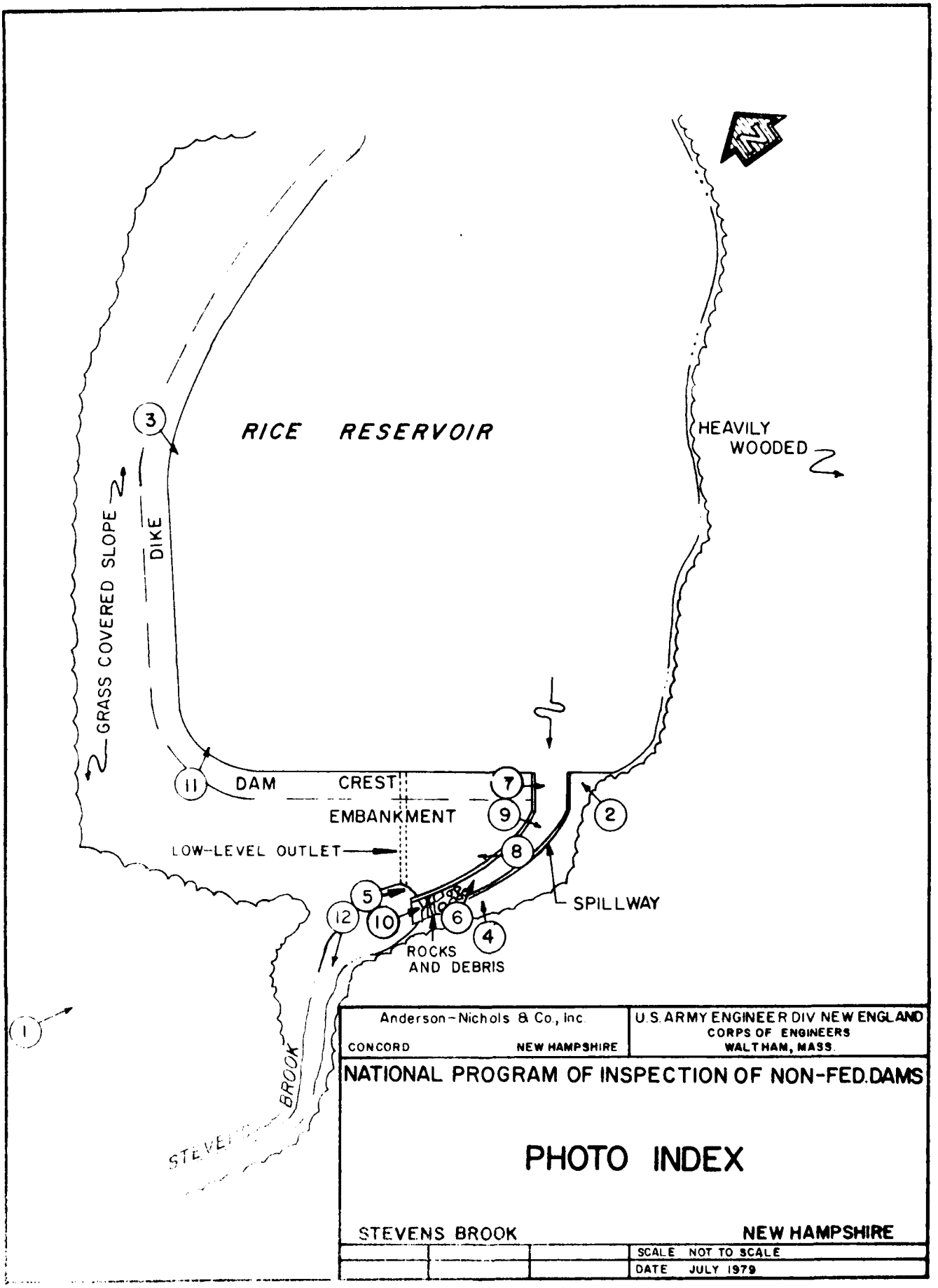
RICE RESERVOIR DAM

STEVENS BROOK NEW HAMPSHIRE

SCALE NOT TO SCALE
DATE JULY 1978

APPENDIX C

PHOTOGRAPHS



Anderson-Nichols & Co., Inc.
CONCORD NEW HAMPSHIRE

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PHOTO INDEX

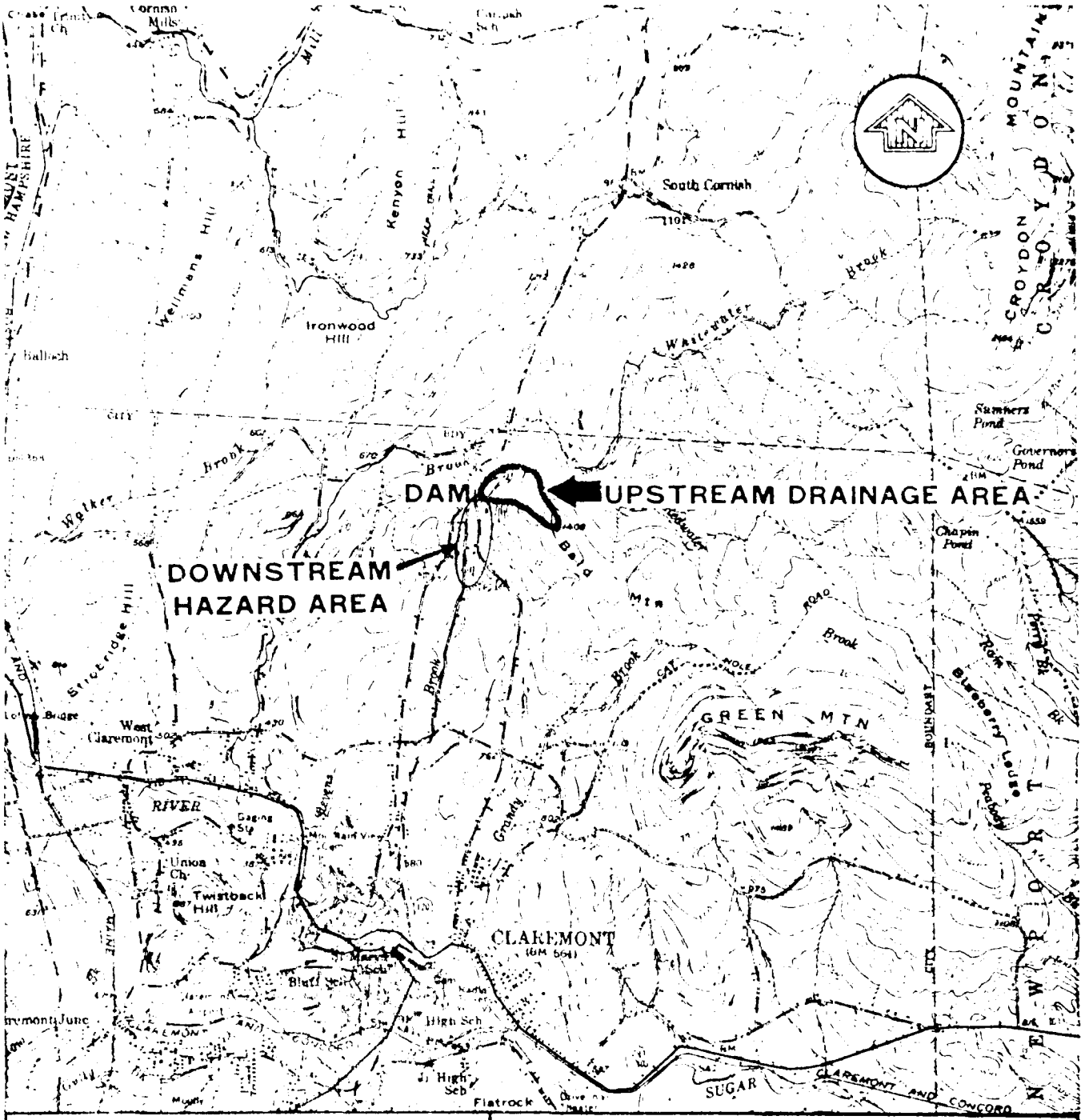
STEVENS BROOK NEW HAMPSHIRE

SCALE NOT TO SCALE

DATE JULY 1979

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

RICE RESERVOIR DAM
CLAREMONT, NEW HAMPSHIRE

REGIONAL VICINITY MAP

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

ANDERSON-NICHOLS & CO., INC. CONCORD, NH

SCALE IN MILES

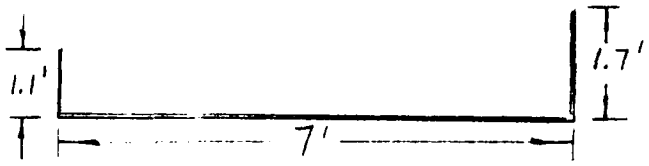
1 ½ 0 1 2

MAP BASED ON U.S.G.S. 15 MINUTE QUADRANGLE SHEET CLAREMONT, N.H. 1957

2/12
2 Jul 79

Use Manning's equation on a cross section through the downstream emergency spillway showing where water would first leave the channel (@ smallest "height of channel" found along the spillway).

Cross section:



$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ where $n \equiv$ channel roughness coeff.
$A \equiv$ area of cross section (ft^2)
$R \equiv$ hydraulic radius (ft)
$S \equiv$ slope of reach

$n = 0.015$
$A = 7(1.1) = 7.7\ ft^2$
$R = A/\text{wetted perimeter} = 7.7/9.2 = 0.84$ ft.
$S = 820 - 783 / 75 = 0.49$

$Q = \frac{1.49}{0.015}(7.7)(0.84)^{2/3}(0.49)^{1/2} = \underline{477\ cfs}$

From the above analysis, it is apparent that the control of flow in the spillway is at the entrance. Therefore, a discharge rating curve for the dam can be developed using the weir equation, $Q = CLH^{3/2}$, where 'C' for the spillway and embankment is 2.7.

Trial No.	Elevation	Discharge
1	820.0	0 cfs

3/12
TAC 245
23 Jul 79

Trial No.	Water Surface Elevation	Discharge
2	821.0	$Q = 2.7(8)(1.0)^{3/2} \doteq 22$ cfs
3	822.0	$Q = 2.7(8)(2.0)^{3/2} \doteq 61$ cfs
4	823.2	$Q = 2.7(8)(3.2)^{3/2} \doteq 124$ cfs
5	823.5	$Q = 2.7(10)(0.3)^{3/2} + 2.7(110)(0.3)^{3/2} + 2.7(8)(3.5)^{3/2} + 2.7(3)(0.5)^{3/2} \doteq 490$ cfs
6	824.0	$Q = 2.7(27)(0.8)^{3/2} + 2.7(770)(0.8)^{3/2} + 2.7(8)(4.0)^{3/2} + 2.7(4)(1.5)^{3/2} \doteq 1723$ cfs

Determine surcharge height to pass Q_{P_1} of 275 cfs. From the rating curve established using the above trials, a water surface elevation of 823.35 results from a flow of 275 cfs.

Determine volume of surcharge in inches of runoff:
Storage @ el. 820.0 (spillway crest) = 117 ac-ft.
Storage @ el. 823.2 (top of dam) = 152 ac-ft.
Reservoir surface area ≐ 11 acres
∴ storage @ 823.35 (Q_{P_1}) ≐ 154 ac-ft.
Surcharge storage = 154 − 117 = 37 ac-ft.

$$\frac{37 \text{ ac ft}}{(0.11 \text{ mi}^2)\left(\frac{1 \text{ mi}^2}{640 \text{ ac}}\right)\left(\frac{12 \text{ in.}}{\text{ft.}}\right)} \doteq 0.31 \text{ inches of runoff}$$

4/12
2 Jul 79

$Q_{P_2} = Q_{P_1}\left(1 - \frac{STOR_1}{19}\right) = 275\left(1 - \frac{6.31}{19}\right) \doteq 184$ cfs

Determine surcharge storage to pass Q_{P_2} ...
@ Q = 184 cfs, W.S. el. = 823.25
Storage @ 823.25 ≐ 153 ac-ft.
Surcharge storage = 153 - 117 = 36 ac-ft.

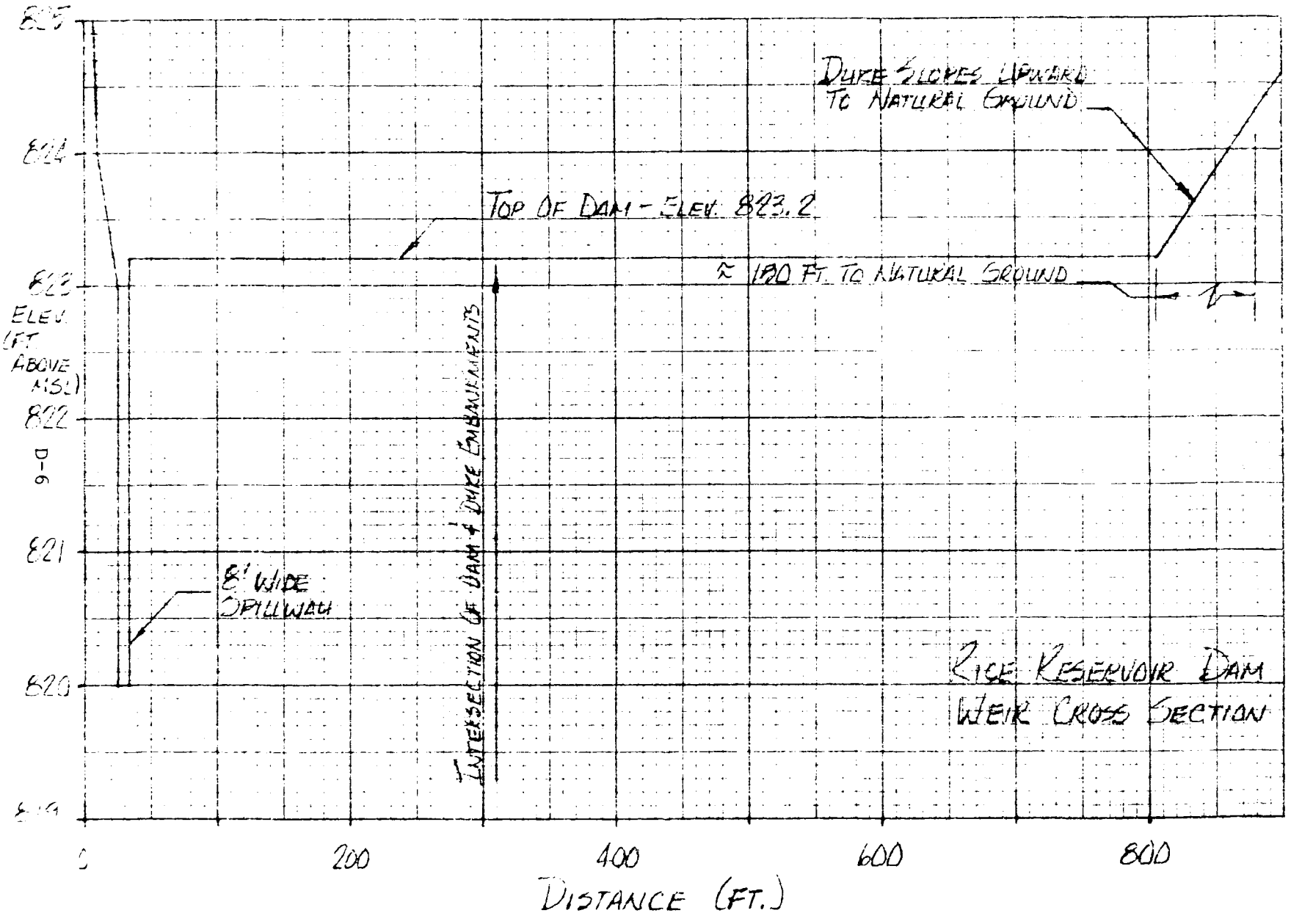
$36 \text{ ac-ft}\left(\frac{1}{0.11 \text{ mi}^2}\right)\left(\frac{1 \text{ mi}^2}{640 \text{ ac}}\right)\left(\frac{12 \text{ in}}{\text{ft}}\right) \doteq 6.14$ inches of runoff

Average runoff: $(6.31 + 6.14) \div 2 = 6.23$ in. = 0.52 ft.

$0.52 \text{ ft.}(0.11 \text{ mi}^2)\left(\frac{640 \text{ ac}}{1 \text{ mi}^2}\right) \doteq 37$ ac-ft.

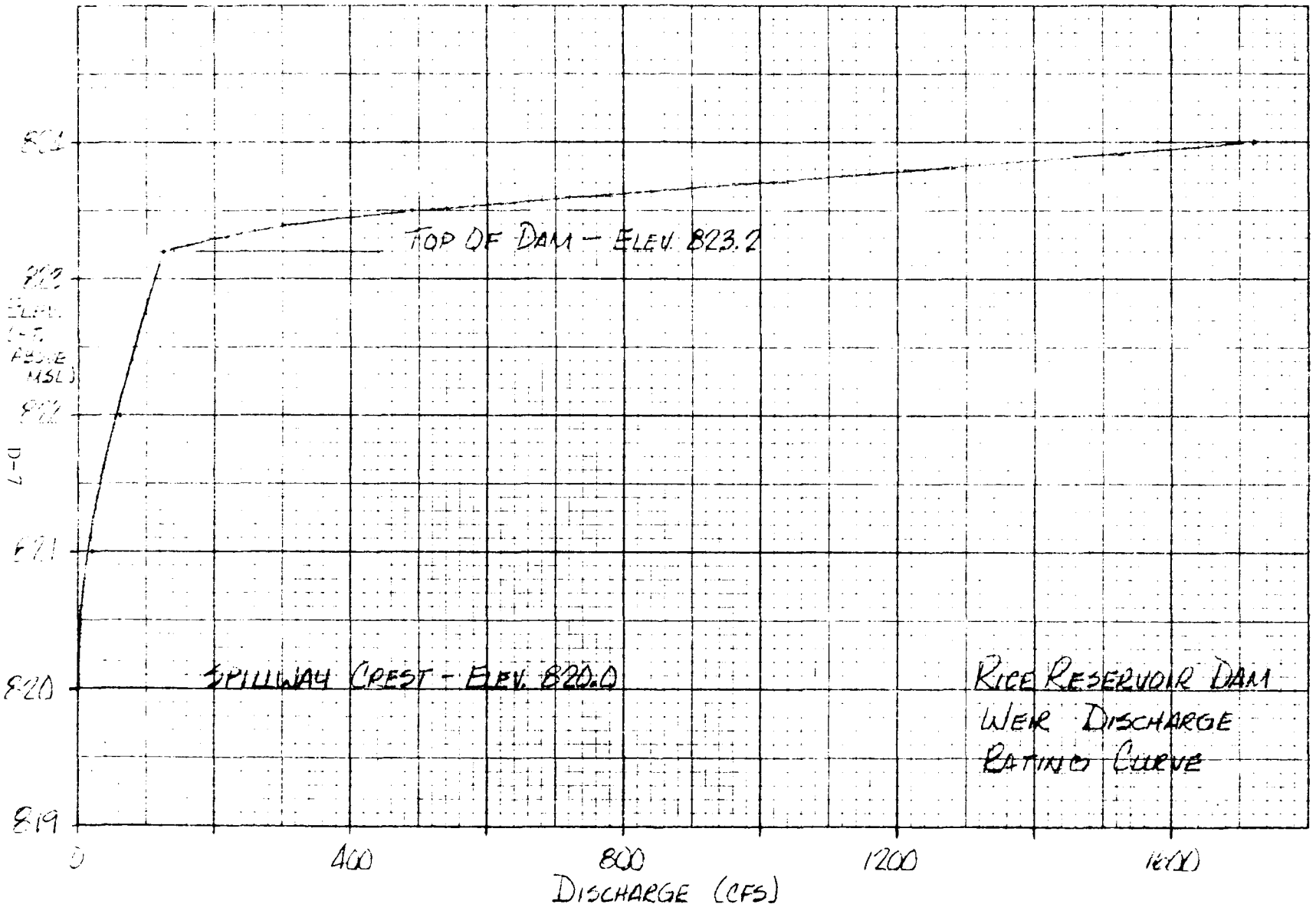
At 37 ac-ft of storage, water surface elevation = 823.35
From discharge rating curve, discharge = 260 cfs

∴ PMF outflow = 260 cfs @ el. 823.35' MSL (say 823.4)
Rice Reservoir dam will be overtopped by 0.2 ft. during the test flood.


825
824
823
822
821
820
ELEV (FT ABOVE MSL)
DUKE SLOPES UPWARD TO NATURAL GROUND
TOP OF DAM - ELEV. 823.2
≈ 180 FT. TO NATURAL GROUND
8' WIDE SPILLWAY
INTERSECTION OF DAM & DIKE EMBANKMENTS
0
200
400
600
800
DISTANCE (FT.)
RICE RESERVOIR DAM
WEIR CROSS SECTION

D-6

2 Jul 79



D-7

6/12
2 Jul 79

7/12
AB ZM
2 Jul 79

BREACH ANALYSIS

Purpose: Determine degree of downstream hazard.

Assume: Pool elevation = 823.2
Upstream riverbed elevation = 808.0*

$Q_{P_1} = 8/27\, W_b \sqrt{g}\, y_0^{3/2}$ where
W_b = breach width
g = 32.2 ft/sec²
y_0 = pool elev. − u/s riverbed elev.

$W_b = 310(0.4) = 124$ ft.
$y_0 = 823.2 - 808.0 = 15.2$ ft.

$Q_{P_1} = 12{,}355$ cfs

Remaining flow going over spillway : $Q = CLH^{3/2}$
$C = 2.7^{\triangledown}$
$L = 8.0$
$H = 3.2$ $Q = 2.7(8)(3.2)^{3/2} = 124$ cfs

Total Breach Q = 12,355 + 124 = 12,480 cfs

say Q = 12,500 cfs

Use a typical cross section along a downstream reach beginning at the dam and continuing 0.8 miles (4200 feet) downstream. Along this reach, Stevens Brook crosses Route 120 five times. Field inspection has verified that, during high flows, the roadway itself would become the channel. Develop a stage-discharge rating curve using the Manning equation.

* Elevation at midheight.
$^{\triangledown}$ From King & Brater Hydraulics Handbook

B/½
(initials)
2 Jul 79

Breach Analysis (Cont.)

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

where n = composite channel roughness coefficient
A = area of section (ft²)
R = hydraulic radius (ft)
S = slope of reach

... length of reach = 4200 ft.
elevation @ d/s toe = 775.6
elevation @ end of reach = 680.0
slope = 0.02
composite n = 0.065 ; $K = \frac{1.49}{n} S^{1/2} = \frac{1.49}{0.065} (0.02)^{1/2} = 3.24$

The trials below refer to the downstream hazard cross section shown on page .

Trial No.	Stage (ft)	Discharge
1	5	$A = 5(6.5)(1/2) + 5(2) + 2(2) + 2^2(20)(1/2)$ $\doteq 70\ ft^2$ $WP = 8.2 + 2 + 3.6 + 40 = 53.8$ ft. $R = A/WP = 70/53.8 = 1.3$ ft. $Q = 3.24(70)(1.3)^{2/3} = 270$ cfs
2	7	$A = 70 + 2^2(5)(1/2) + 2(25) + 2(10.5)$ $+ 2(20) + 2^2(20)(1/2) = 231\ ft^2$ $WP = 2(5.1) + 25 + 53.8 + 2(20) = 129$ ft. $R = A/WP = 231/129 = 1.8$ ft $Q = 3.24(231)(1.8)^{2/3} = 1107$ cfs

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[illegible]
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BREACH ANALYSIS (CONT.)

Trial No.	Stage (ft)	Discharge
3	10	$A = 231 + 3^2(5)(1/2) + 3(10) + 3(25) + 3(10.5) + 4(20) + 3^2(20)(1/2) = 560 \text{ ft}^2$ $WP = 129 + 3(5.1) + 3(20) = 204 \text{ ft}$ $R = A/WP = 560/204 = 2.7 \text{ ft.}$ $Q = 3.24(560)(2.7)^{2/3} = 3518 \text{ cfs}$
4	12	$A = 560 + 2^2(5)(1/2) + 2(25) + 2(25) + 2(10.5) + 2(140) + 2^2(20)(1/2) = 1011 \text{ ft}^2$ $WP = 204 + 2(5.1) + 2(20) = 254 \text{ ft.}$ $R = A/WP = 1011/254 = 4.0 \text{ ft.}$ $Q = 3.24(1011)(4)^{2/3} = 8254 \text{ cfs}$
5	15	$A = 1011 + 3^2(5)(1/2) + 3(35) + 3(25) + 3(10.5) + 3(180) + 3^2(20)(1/2) = 1875 \text{ ft}^2$ $WP = 254 + 3(5.1) + 3(20) = 329 \text{ ft.}$ $R = A/WP = 1875/329 = 5.7 \text{ ft.}$ $Q = 3.24(1875)(5.7)^{2/3} = 19{,}385 \text{ cfs}$

Breach @ top of dam - elevation 823.2' MSL
Total breach Q = 12,500 cfs (see p. D-8).

Principal spillway Q = $2.7(8)(3.2)^{3/2} = 124$ cfs = outflow before dam breaches.

Stage @ toe of dam [illegible] Q = 13.3 ft.
Stage @ arrival of Q = 4.2 ft. (See [illegible] rating curve)

[illegible] in stage [illegible] = 13.3 - 4.2 = 9.1 ft.

K/R
[illegible]
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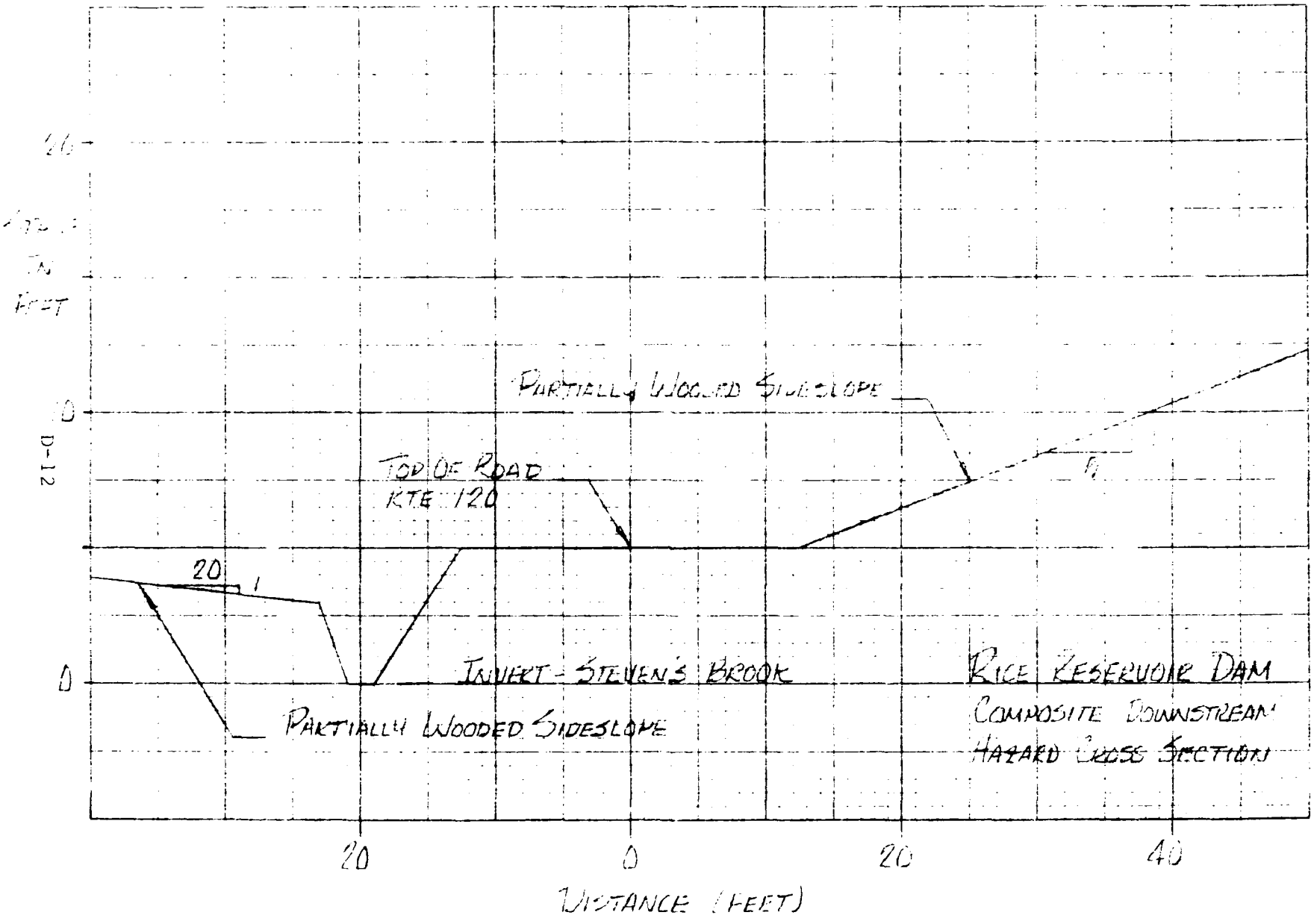
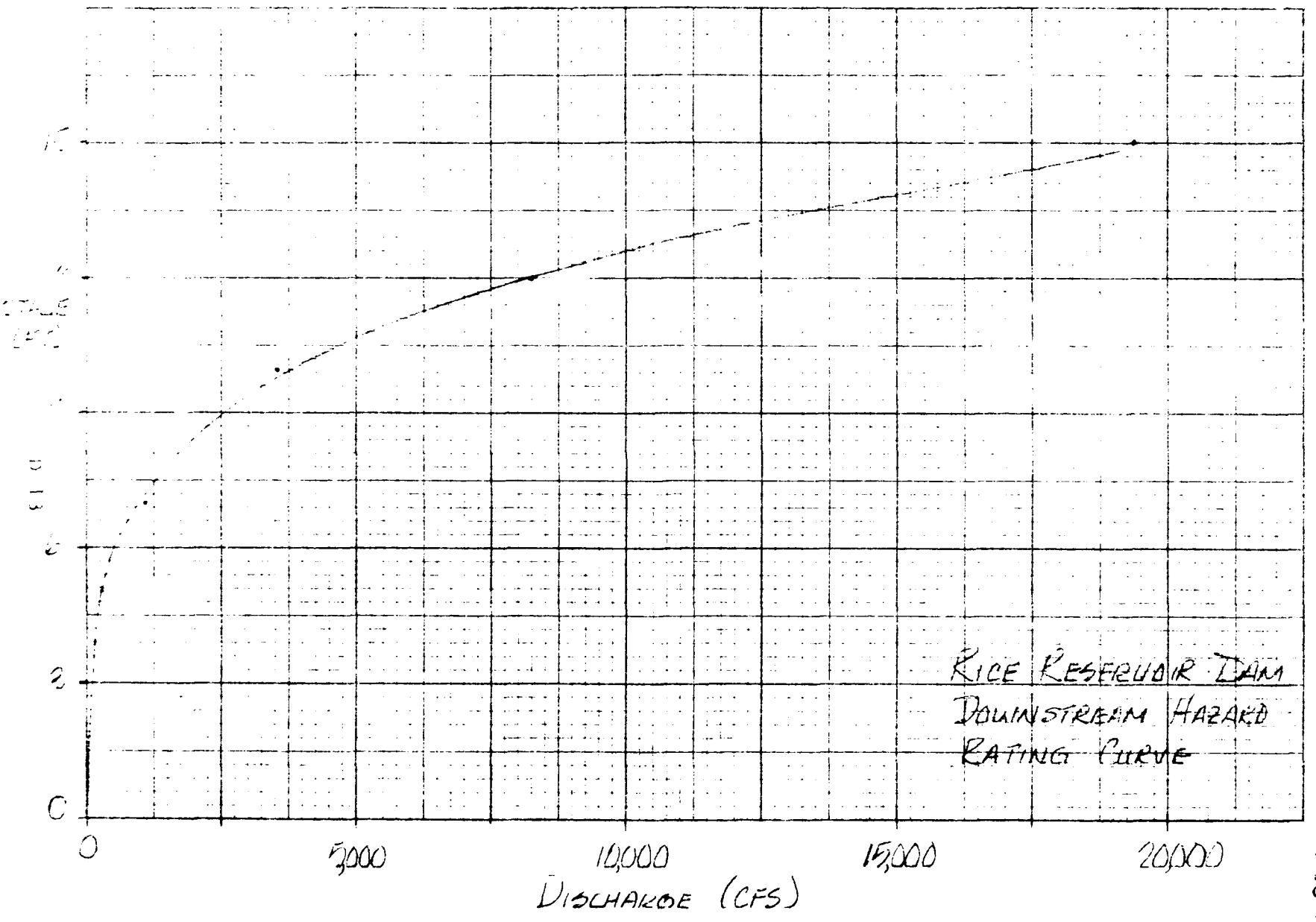
[illegible] - HAZARD CLASSIFICATION

[illegible] Dam is a significant hazard [illegible]. There [illegible] inhabited structures [illegible] [illegible] along the 1200-foot [illegible] of the dam. This [illegible] damaged in the event [illegible]. At least 4 lives would [illegible] endangered [illegible] breach occurred.


PARTIALLY WOODED SIDESLOPE
TOP OF ROAD
ELE 120
20
1
INVERT - STEVEN'S BROOK
PARTIALLY WOODED SIDESLOPE
RICE RESERVOIR DAM
COMPOSITE DOWNSTREAM
HAZARD CROSS SECTION
20
0
20
40
DISTANCE (FEET)
D-12


0
5,000
10,000
15,000
20,000
DISCHARGE (CFS)
RICE RESERVOIR DAM
DOWNSTREAM HAZARD
RATING CURVE

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

END

FILMED

8-85

DTIC