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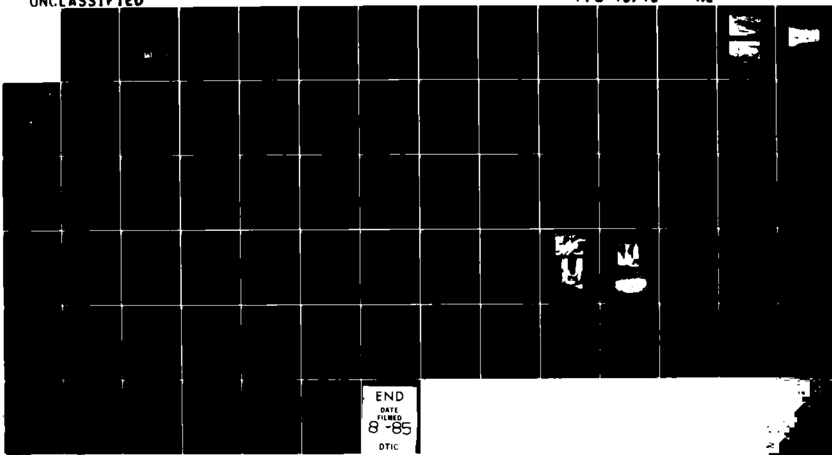

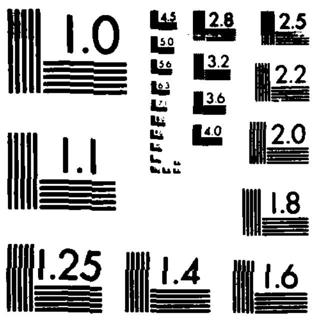
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AD-A156 372

CONNECTICUT RIVER BASIN
SPRINGFIELD, NEW HAMPSHIRE

BOG BROOK DAM

NH 00189

NHWRB 220.12

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

NOVEMBER 1978

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Springfield, New Hampshire
Bog Brook

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

The dam is a 289 ft. long earthfill structure which incorporates 71 ft. of free everfall spillway and two 4 ft. wide sluiceways with stoplogs. It is intermediate in size with a low hazard potential. The dam is in good condition at the present time. Only minor operations and maintenance type procedures are required to correct the deficiencies.

BOG BROOK DAM
NH 00189

CONNECTICUT RIVER BASIN
SPRINGFIELD, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT

Identification No.:	NH 00189
NHWRB No.:	220.12
Name of Dam:	BOG BROOK DAM
Town:	Springfield
County and State:	Sullivan County, New Hampshire
Stream:	Bog Brook
Date of Inspection:	September 20, 1978

BRIEF ASSESSMENT

Bog Brook Dam is a 289 foot long earthfill structure which incorporates 71 feet of free overfall spillway and two 4 foot wide sluiceways with stoplogs. The embankment portions of the dam are approximately 7 feet high and contain a concrete core wall. The gravity concrete spillway and sluiceway section is founded on bedrock and has a maximum height of approximately 13.5 feet. The dam was constructed in 1957 by the New Hampshire Fish and Game Department for wildlife management purposes.

The dam lies on Bog Brook and receives runoff from 12.1 square miles of steeply sloping, heavy forest. The dam's maximum impoundment of 2500 acre-feet places it in the INTERMEDIATE size category, while the absence of any downstream hazard for a distance of at least 3 miles indicates a LOW hazard potential classification.

Based on the size and hazard potential ratings and in accordance with the Corps' guidelines, the Test Flood (TF) is in the range of the 100 year flood to one half the Probable Maximum Flood (PMF). An inflow TF of 5000 cfs yields a maximum discharge at the dam of approximately 3100 cfs, which would result in overtopping on the order of 0.5 feet. The maximum discharge capacity of the dam without overtopping is approximately 2840 cfs. Thus, it is recommended that further hydrologic studies of the spillway adequacy be made.

The dam is in GOOD condition at the present time. Only minor operations and maintenance type procedures are required to correct the deficiencies noted.

Included in these tasks are monitoring of a wet spot on the toe of the embankment, increased brush clearing and the repair of rodent holes, repair of some eroded concrete joints, removal of debris and overhanging trees from the downstream channel, removal of debris and sediment from behind the dam, installation of a gage and the provision of a device for securing stoplogs in place.

The above recommendations and remedial measures should be implemented within two years of receipt of this report by the owner. Based on the dam's GOOD condition, periodic technical inspections should be scheduled every two years.

William S. Zoino
New Hampshire Registration 3226

Robert Minutoli
Massachusetts Registration 29165

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

CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division

SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

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

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

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

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the 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 aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

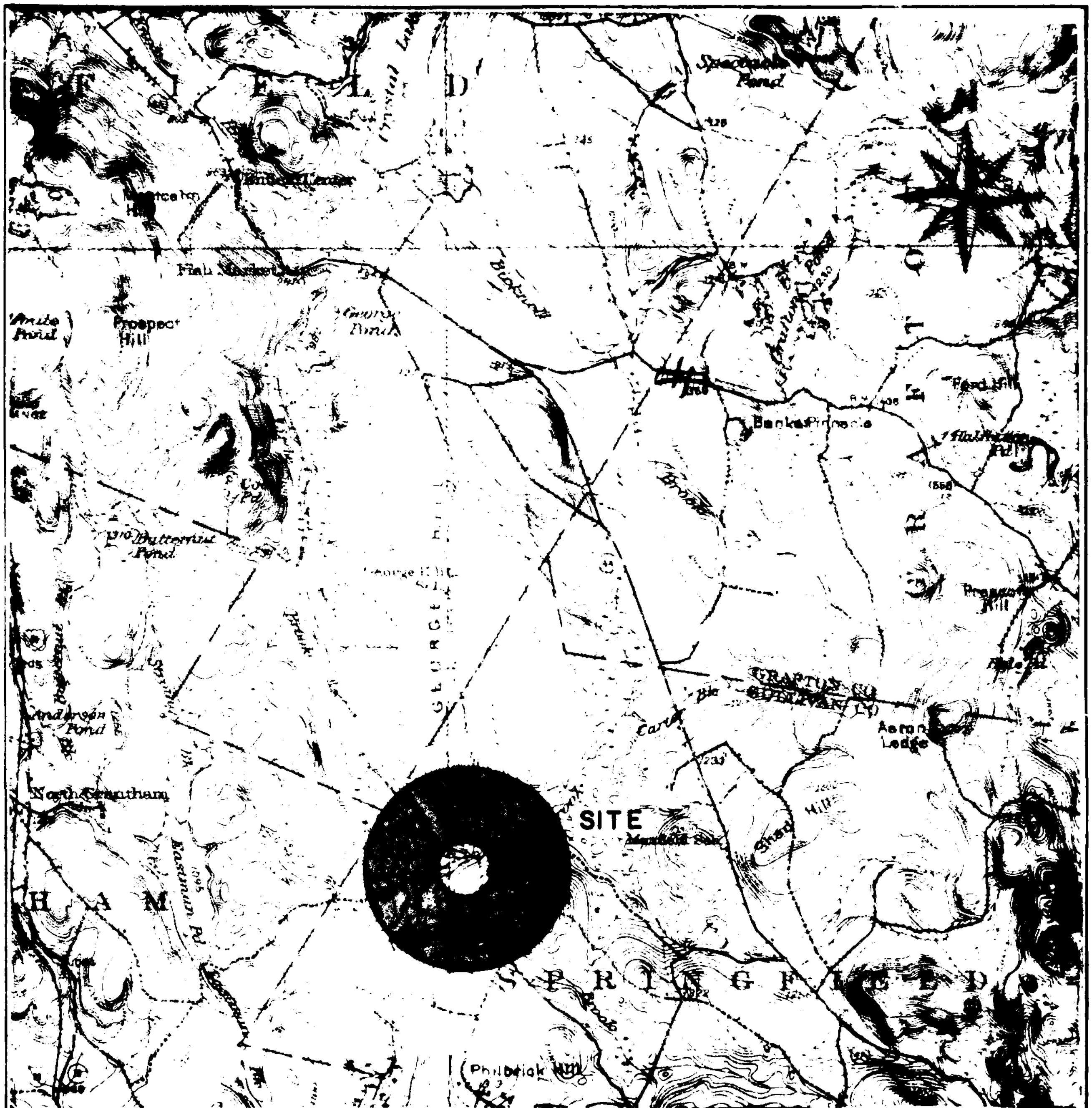
TABLE OF CONTENTS

Table of Contents - Cont. Page

Overview of dam from left abutment

Overview of dam from left spillway endwall

Overview of dam from upstream right side



- SCALE -

0 1/2 1 2 miles

FROM: USGS MASCOMA, N.H. QUADRANGLE MAP

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

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

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCUS PLAN

FILE No. 2067

BOG BROOK DAM — NEW HAMPSHIRE

SCALE AS NOTED

DATE SEPT 1978

PHASE I INSPECTION REPORT

BOG BROOK 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. Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) 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 was issued to GZD under a letter of August 22, 1978 from Colonel Ralph T. Garver, Corps of Engineers. Contract No. DACW 33-78-C-0303 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) Update, verify and complete the National Inventory of Dams.

(c) Scope

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dam.

1.2 Description of Project

(a) Location

The Bog Brook Dam is located on George Hill Road at the intersection designated Washburn Corner. This point is 4.2 miles south of the junction of George Hill Road and Route 4A, which, in turn, is 1.5 miles south of Enfield Center on Route 4A and 5.5 miles south of the town of Mascoma at the intersection of Routes 4 and 4A. The portion of the USGS Mascoma, NH quadrangle on page ix shows this locus. Figure 1 of Appendix B presents a site plan developed from the map and the site inspection.

(b) Description of Dam and Appurtenances

This dam is basically a 289 foot long earthfill structure incorporating two 4 foot wide sluiceways with stoplogs and 71 feet of free overfall spillway (Pg. B-3). The embankment portions of the dam, 77 feet long on the right side and 130 feet long on the left side, are approximately 7 feet high and contain a concrete core wall to a height approximately 2 feet above the permanent spillway crest (Pg. B-4).

Beginning at the right side, the concrete portion of the dam consists of a concrete endwall extending up and downstream, a 4 foot wide sluiceway structure with provision for stoplogs and an invert 2 feet below the spillway crest, a 20.5 foot section of gravity concrete spillway, another sluiceway identical to the previous one but with an invert 7.2 feet below the spillway crest, a 50.5 foot section of spillway with a V configuration and an endwall on the left side. The endwalls are approximately 4.3 feet higher than the spillway crest. The entire gravity concrete structure is founded on hard, generally competent schist and has a maximum height of approximately 13.5 feet above the streambed.

(c) Size Classification

The dam's maximum impoundment of 2500 acre-feet falls within the 1000 to 50,000 acre-feet range which defines INTERMEDIATE size category as defined in the "Recommended Guidelines."

(d) Hazard Potential Classification

The dam is located in a sparsely populated area and is at least 3 miles upstream of the nearest population center. These facts, when combined with the structure's fairly broad downstream channel, indicate a LOW hazard potential classification.

(e) Ownership

The New Hampshire Fish and Game Department (NHFGD), 34 Bridge Street, Concord, New Hampshire owns the dam. The Department's phone number is (603) 271-3421.

(f) Operator

The Engineering Section of the NHFGD controls the operation of the dam. Mr. Stephen A. Virgin is the Department's responsible engineer and he can be reached at the phone number given above.

(g) Purpose of Dam

The dam was constructed for the purpose of wildlife management.

(h) Design and Construction History

Construction of the dam was completed in 1957. The Fish and Game Department designed the dam and constructed it by force account.

(i) Normal Operational Procedures

Day to day operation of the dam rests with local conservation officers who adjust the water level as necessary to accomplish wildlife management goals. Operation for any other purpose would be directed by the chief engineer and accomplished by the local conservation officer; no operations of this nature are on record or can be recalled by the Engineering Section.

1.3 Pertinent Data

(a) Drainage Area

The pond impounded by Bog Brook Dam receives runoff from 12.1 square miles of steeply sloping, heavily forested terrain. Bog Brook and several smaller streams carry runoff into the impoundment. There is no development around the shores of the pond.

(b) Discharge at Damsite

(1) Outlet Works

The dam's only outlets are the two 4 foot wide sluiceways. The sluiceway at the right end of the spillway has its invert at El. 1092.7, while the invert of the other sluiceway is at El. 1087.5.

(2) Maximum known flood at damsite

No data on experienced peak flood flows or pond levels are available for this dam.

(3) Spillway capacity at maximum pool elevation:

2110 cfs at El. 1099

(4) Sluiceway capacity at normal pool elevation:

295 cfs at El. 1094.7

(5) Sluiceway capacity at maximum pool elevation:

730 cfs at El. 1099

(6) Total discharge capacity at maximum pool elevation:

2840 cfs at El. 1099

(c) Elevation (feet above MSL based upon New Hampshire Department of Public Works and Highway Bench Mark 4190020 located on crest of dam)

(1) Top of dam: 1099.0 ±

(2) Maximum pool: 1099.0 ±

(3) Recreational pool: 1094.7 ±

(4) Spillway crest: 1094.7 ±

(5) Streambed at centerline of dam: 1085.5 ±

(6) Maximum tailwater: Unknown

(d) Reservoir

(1) Length of recreational pool: 2 miles ±

(2) Storage - recreational pool: 1000
- maximum pool: 2500 acre-feet ±

(3) Surface area - recreational pool: 330 acres ±

(e) Dam

(1) Type: Earth embankment with concrete gravity spillway

(2) Length: 289 feet

(3) Height: 7 feet ±

(4) Top Width: 8 feet ±

(5) Side slopes - U/S 3:1
- D/S 2:1

(6) Impervious Core: 1 foot thick concrete core wall from ledge to El. 1096.5

(7) Zoning, cutoff and grout curtain: Unknown

(f) Spillway

(1) Type: Concrete gravity, free overfall

(2) Length of weir: 71 feet

(3) Crest elevation: 1094.7 feet ±

(4) U/S channel: Shallow approach from pond

(5) D/S channel: Broad and rocky

(g) <u>Regulating outlets</u>

As mentioned previously, the dam's only regulating outlets are the two 4 foot wide sluiceways with manually installed and removed stoplogs. The sluiceway at the right end, which has its invert at El. 1092.7 can accommodate 2 feet of stoplogs. The second sluiceway, with invert at 1087.5, provides for installation of up to 7.2 feet of stoplogs.

SECTION 2 - ENGINEERING DATA

2.1 Engineering Records

The design of this dam is quite simple and incorporates no unusual features. No original design drawings or calculations are available.

2.2 Construction Records

Plans for the construction of the dam are included in Appendix B. Page B-3, which presents a plan of the dam, was altered to reflect the as-built configuration of the structure.

2.3 Operational Records

The owner operates the dam in a manner consistent with its intended purpose and engineering features.

2.4 Evaluation of Data

(a) Availability

The absence of design drawings and calculations is a significant shortcoming, but is somewhat mitigated by the availability of the construction plans. An overall marginal assessment for availability is, therefore, warranted.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is thus based primarily on the visual inspection, past performance and sound engineering judgement.

(c) Validity

Since the observations of the inspection team generally confirm the information contained in the construction drawings, with modification, a satisfactory evaluation for validity is indicated.

SECTION 3 - VISUAL OBSERVATIONS

3.1 Findings

(a) General

The Bog Brook Dam is in GOOD condition at the present time and requires only minor routine maintenance for continued safe operation.

(b) Dam

(1) Embankment

The dam's embankment is divided into two sections, one 130 feet long and one 77 feet long, by the spillway and sluiceways. Both sections are approximately 7 feet high and tie into high ground on either side of the dam. The internal construction of the embankments is not know, but existing plans do show a concrete core wall on both sides of the spillway from ledge to El. 1096.5. The core walls tie into the spillway endwalls and into naturally rising ground at the dam's abutments.

Inspection of the embankments revealed no evidence of vertical or horizontal movement. No deficiencies were noted at the junctions with the spillway endwalls or with the natural slopes at either side. The embankments are covered with a thick, low brush which appears to have been recently trimmed. There was no evidence of any sloughing, erosion or cracking of the earthfill. Several small rodent holes were noted, however.

There are no obvious signs of active seepage along either of the embankments. However, at a distance of 95 feet from the left spillway endwall, a wet area approximately 10 feet by 20 feet in plan and 3 to 6 inches deep was noted at the toe of the left embankment some 40 feet from the centerline. There was no evidence of flow or of turbidity, although the water was discolored. Based upon the topography of the area, this location could be a natural ponding point for storm runoff. No obvious deficiencies in the earthfill were noted in this area.

(2) Spillway

The gravity concrete spillway is founded on bedrock which appears to be a hard, generally competent schist. While there is some nearly vertical jointing in the rock at essentially right angles to the dam centerline, the low head behind the dam indicates that these joints are not a significant concern.

Observations of the spillway crest revealed no evidence of erosion, spalling, cracking or efflourescence of the concrete. Similar observations apply to the two concrete endwalls.

(3) Sluiceways

Both sluiceways show evidence of erosion along the construction joints between their sidewalls and the buttress supports on the spillway sides of these structures. Efflourescence and fine random cracking is evident along the same joint on the inside face of both sluiceways. Minor erosion was observed on the concrete sill in the sluiceway located at the right spillway endwall. The stoplogs in place in the sluiceways are in good condition.

(c) Appurtenant Structures

This dam has no appurtenant structures.

(d) Reservoir

Observation of the reservoir shore revealed no evidence of movement or other instability. A small amount of sedimentation was noted behind the spillway. Examination of the surrounding area revealed no work in progress or recently completed which might increase the flow of sediment into the pond. Additionally, there were no changes to the surrounding watershed which might adversely affect the runoff characteristics of the basin.

(e) Downstream Channel

The immediately downstream channel is very rocky and has many overhanging trees.

Some trees are also growing in the channel itself. Additionally, there is a large, corrugated metal arch culvert under the road some 100 feet downstream of the dam which could create a hydraulic constriction in the event of the Test Flood. Since the dam has only limited operational features, these obstructions do not limit the operation of the dam. They could, however, create flow restrictions at a time when such a situation is least tolerable.

3.2 Evaluation

Because most of the dam's key features are readily accessible for observation, the visual inspection provided a satisfactory basis upon which to assign a GOOD evaluation for the majority of those items which affect the safety of the structure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

Based upon information provided by Mr. Virgin of the Fish and Game Department, the water level in the reservoir does not vary much during the year and little manipulation of stoplogs has been necessary for as long as he can remember. Local conservation officers could make adjustments if their periodic inspections deemed such action necessary.

4.2 Maintenance of Dam

The local conservation officers visit the site periodically and report any observed deficiencies back to the Department. Additionally, an engineer from the Department inspects the dam semiannually and upon notification of a problem by the local conservation officers. The engineer then initiates any necessary maintenance activity.

4.3 Maintenance of Operating Facilities

The stoplogs require no maintenance other than periodic inspection and replacement, if necessary.

4.4 Description of Any Warning System in Effect

There is no warning system in effect for this dam.

4.5 Evaluation

The established operational procedures are adequate for Bog Brook Dam. The good condition of the dam reflects well on the Department's maintenance program. Due to the absence of nearby downstream development, the lack of a formal warning system is not a significant concern.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features

(a) Design Data

The only data sources available for Bog Brook Dam are two construction drawings dated January 1956 and some associated hydraulic calculations. These data have been checked and updated by information acquired in the field. Changes to the original design include the addition of a 4 foot wide stoplog weir on the right end of the spillway and a change in the configuration of the left portion of the spillway. The original spillway capacity calculations are only of value as an approximate check of present calculations, since the dam as actually built differs appreciably from the original design.

(b) Experience Data

No data on experienced peak flood flows or lake levels is available for Bog Brook Pond.

(c) Visual Observations

Bog Brook Dam is an earth embankment and core wall structure built on ledge and with concrete gravity outlet works. The dam has an overall crest length of about 289 feet at El. 1099. The top width of the dam averages 8 feet with two to one and three to one slopes on the embankments.

The dam's control features consist of a 71 foot long broad-crested spillway at elevation 1094.7 and two adjustable four-foot long stoplog weirs. One of the weirs has a permanent concrete base 2.0 feet below the spillway crest, while the permanent base of the other is 7.2 feet below the spillway. At the time of the inspection, both stoplog weirs were set at the same height as the spillway and the pond was at approximately the same level, resulting in only a trickle of flow through the outlet.

Just downstream of the dam is a constricted channel section due to a high roadway embankment with a crest about 2.8 feet higher than the spillway crest. The stream at this location passes through a large 18 foot by 11.5 foot elliptical, corrugated metal culvert. Beyond the culvert, the stream resumes a normal channel and passes through an area having very little, if any, development.

(d) Overtopping Potential

The hydrologic conditions of interest in this Phase I investigation are those required to assess the overtopping potential of the dam and its ability to safety allow an appropriately large flood to pass. This requires using the discharge and storage characteristics of the structure to evaluate the impact of an appropriately-sized Test Flood.

Guidelines for establishing a recommended Test Flood based on the size and hazard potential classifications of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. As shown in these Guidelines, the appropriate Test Flood for a dam classified as INTERMEDIATE in size with a LOW hazard potential would be between the 100-year frequency flood and one-half of the Probable Maximum Flood (PMF).

The magnitude of the 100-year peak inflow to Bog Brook Pond is estimated using a regression relationship provided by the USGS in Water Resources Investigations 78-47, "Progress Report on Hydrologic Investigations of Small Drainage Areas in New Hampshire." This equation, which uses the drainage area, main channel slope and the 24-hour, 2-year frequency precipitation to estimate peak inflow, yields a 100-year peak flood flow of 1560 cfs for the Bog Brook Dam basin. A check of the spillway capacity by the New Hampshire Water Resources Board in 1957 derived a 100-year flood flow of 2000 cfs.

The chart of "Maximum Probable Peak Flow Rates" obtained from the Corps of Engineers, New England Division is used to determine the PMF. For the 12.1 square mile drainage area above Bog Brook Dam, which has a hilly topography, the curve for "rolling" terrain gives a PMF flow of 1600 cfs per square mile. This results in a total PMF of 19,400 cfs or a one-half PMF flow of 9,700 cfs.

The "Guidelines" further suggest that if a range of values is indicated for the Test Flood, the magnitude most closely related to the involved risk should be selected. Since the risk is towards the lower end of the LOW category, a Test Flood of 5000 cfs is used as inflow to the Bog Brook impoundment.

The attenuation of the peak, due to storage, is estimated using the procedure suggested by the Corps of Engineers, New England Division for "Estimating the Effect of Surcharge Storage on Maximum Probable Discharges."

The Storage-Stage Curve used for these calculations is developed assuming that the surcharge storage available in a pond is equal to the surface area of the pond times the depth of surcharge. No spreading or increase in surface area with increasing depth is considered. Use of the recommended procedure shows that the pond storage does have a significant attenuating effect on the magnitude of the peak flow, since the calculations result in a corrected Test Flood flow of about 3100 cfs, or a thirty-eight percent reduction in the pond inflow.

The Stage-Discharge Curve is developed by defining discharge as the sum of the flows over the spillway and stoplogs, flow over the dam crest, and the flow over the slopes at the ends of the dam. Since it is possible that stoplogs might not be pulled in the event of the Test Flood, these calculations assume that stoplogs remain in place throughout the flood at spillway level. Thus, the sluiceways are assumed to act as weirs. Paragraph 1.3 presents the discharge capacities assuming that stoplogs were removed.

5.2 Hydrologic/Hydraulic Evaluation

The results of the hydrologic and hydraulic calculations indicate that the outlet capacity of Bog Brook Dam is insufficient to pass the applicable Test Flood of 3100 cfs without overtopping the dam crest. Flow over this portion of the dam is not desirable since the crest is formed by a simple earthen embankment and is not intended to carry flow. Even if it were possible to remove all stoplogs in the event of a major storm, the capacity of the existing outlet works would be only 2800 cfs with the water level at the dam crest. Thus, additional outlet capacity, possibly in the form of an emergency spillway, would be required to safely pass the recommended Test Flood flow.

5.3 Downstream Dam Failure Hazard Estimates

The flood hazards in downstream areas resulting from a failure of Bog Brook Dam are estimated using the procedure suggested in the Corps of Engineers, New England Division's "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." This procedure accounts for the attenuation of dam failure hydrographs in computing flows and flooding depths for downstream reaches.

For these calculations, failure is assumed to occur as soon as the dam crest is overtopped at a pond elevation of 1099.0 feet. This corresponds to a height of 13.5 feet above the stream bed. If the breach width is assumed to be thirty feet, the resultant peak discharge due to dam failure is 2400 cfs.

Downstream of the dam the stream may be considered in four reaches for these calculations. Below these four reaches is a swamp and pond that would dampen out the effects of any dam failure flows.

The first reach covers the region between the dam and a highway bridge about 100 feet downstream. Due to its short length and well defined channel, this reach passes the peak discharge downstream with no attenuation. At the bottom of this reach, an 18' by 11.5' corrugated metal culvert beneath the roadway controls the discharge passing on to Reach 2.

The flow capacity of the culvert was determined using a nomograph shown in the Handbook of Steel Drainage and Highway Construction Products (American Iron and Steel Institute, 1971). The capacity was computed for a 13.5 foot depth in the reach to be 2200 cfs.

Reach 2 covers a section of stream about 2300 feet long in a well defined channel. This reach would experience a 4.3 foot stage increase while offering little or no attenuation in the peak discharge. The flow passed to Reach 3 is 2190 cfs.

In Reach 3, which covers the next 3500 feet of stream, the channel is wider and flatter than the first reaches, and would develop a flood flow depth of about 5.3 feet. In passing through this reach, the peak flow would be reduced to about 2140 cfs. Reach 4 is a wide, flat swampy area about 8000 feet long that would experience a flow depth of about 5.8 feet, while attenuating the peak flow to about 2000 cfs.

There is no development along any of these four reaches that would be affected by the computed depths of flooding.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

(a) Visual Observations

The field investigation revealed no significant displacements or distress which warrant the preparation of structural stability calculations based on assumed sectional properties and engineering factors.

(b) Design and Construction Data

While no design drawings or calculations are available, the construction drawings would be of considerable value to a stability analyses were one deemed necessary.

(c) Operating Records

There are no formal operating records for this dam. Thus, no information concerning the stability of the dam during periods of high flow is available.

(d) Post-Construction Changes

There have been no post-construction changes as of the date of this report.

(e) Seismic Stability

The dam is located in Seismic Zone No. 2 and, in accordance with recommended Phase I guidelines, does not warrant seismic analyses.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

(a) Condition

The Bog Brook Dam is in GOOD condition at the present time.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is thus based primarily on the visual inspection, past performance and sound engineering judgement.

(c) Urgency

The remedial measures recommended below should be accomplished within two years of receipt of the Phase I Inspection Report by the owner.

(d) Need for Additional Investigation

No additional investigations are indicated at this time.

7.2 Recommendations

Since the discharge capacity of the dam is insufficient to pass the selected Test Flood, it is therefore recommended that further hydrologic studies of the spillway adequacy be made.

7.3 Remedial Measures

The Bog Brook Dam requires the following operating and maintenance improvements:

(1) Monitor the wet area at the downstream toe of the left embankment to determine the source of the water. If the water is seepage through the embankment, institute appropriate measures to protect the toe of the fill from erosion.

(2) Fill all rodent holes in the embankment.

(3) Conduct a more vigorous program of brush clearing on the embankments, as the vegetation appears to grow rapidly.

(4) Rake out eroded construction joints and pack the joints with high strength mortar.

(5) Remove all debris and sediment from behind the dam.

(6) Clear all vegetation and debris from the downstream channel and trim or remove all trees overhanging the channel.

(7) Install a gage at the dam and institute a program of regularly recorded readings to provide some historical performance data for the dam.

(8) Provide a method of securing stoplogs in place to preclude unauthorized removal.

(9) Perform a technical inspection of the dam every two years.

7.4 Alternatives

There are no viable alternatives to the accomplishment of the following operations and maintenance tasks.

APPENDIX A

VISUAL INSPECTION CHECKLIST

INSPECTION TEAM ORGANIZATION

Date: September 20, 1978

NH 00189
BOG BROOK DAM
Springfield, New Hampshire
Bog Brook
NHWRB 220.12

Weather: Sunny and warm

INSPECTION TEAM

Robert Minutoli	Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD)	Team Captain
William S. Zoino	GZD	Soils
Nicholas Campagna	GZD	Soils
Andrew Christo	Andrew Christo Engineers (ACE)	Structural
Paul Razgha	ACE	Structural
Richard Laramie	Resource Analysis, Inc.	Hydrology

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
EMBANKMENT		
Vertical alignment and movement	[illegible]	No deficiencies noted
Horizontal alignment and movement		No deficiencies noted; top width variable
Condition at abutments		No deficiencies noted
Trespassing on slopes		No evidence
Sloughing or erosion of slopes or abutments		None noted; thick, recently trimmed growth over entire embankment; some small rodent holes
Rock slope protection		None
Unusual movement or cracking at or near toe		None noted
Unusual downstream seepage		Wet area 10' x 20' in plan 95 feet along crest from left spillway endwall and 40 feet downstream of centerline; water is 3-6 inches deep, appears stagnant and shows no evidence of turbidity; no flow noted; based on local topography, could be ponding, area for storm runoff; no other significant observations
Piping or boils		None noted
Foundation drainage features	[illegible]	Unknown, but none shown on drawings and unlikely

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	**BY**	**CONDITION & REMARKS**
OUTLET WORKS		
a. Approach Channel		
Slope conditions	PLC	Broad approach from pond with very low banks
Bottom conditions		Some siltation behind dam
Rock slides or falls		No rock in vicinity
Log boom		None
Control of debris		Small amount of debris submerged behind dam
Trees overhanging channel	PLC	None
b. Spillway		
Condition of concrete		
General condition		Good
Erosion or cavitation		None noted
Spalling		None noted
Cracking		None noted
Condition of joints		No deficiencies noted
Rusting or staining		None noted
Visible reinforcing		None noted
Seepage or efflourescence	PC	None noted

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
Foundation conditions		Spillway founded on bedrock which appears to be hard, generally competent schist; near vertical jointing at right angles to centerline of dam
c. Sluiceways		
Condition of concrete		
General condition		Good
Erosion or cavitation		Some erosion of construction joints between sidewalls and buttress supports on the spillway sides of the sluiceways; minor erosion on concrete sill in sluiceway adjacent to right abutment
Spalling		None noted
Cracking		Fine random cracking along the construction joints mentioned above on the inside face of both sluiceways
Condition of joints		Good except as mentioned above
Rusting or staining		None noted
Visible reinforcing		None noted
Seepage or efflourescence		Some efflourescence along construction joints mentioned above
Condition of stoplogs		Good

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
Adequately secured (tamperproof)	PP	Stoplogs not locked in place
d. Spillway Endwalls		
Condition of concrete		
General condition		Good
Erosion or cavitation		None noted
Spalling		None noted
Cracking		None noted
Condition of joints		No deficiencies noted
Rusting or staining		None noted
Visible reinforcing		None noted
Seepage or efflour-escence	TL	None noted
d. Outlet Channel (immediate area)		
Slope conditions	NaC	Downstream area generally gently sloping bedrock; low banks with heavy overgrowth
Rockslides or falls		None noted
Control of debris		Small amount of debris in channel
Trees overhanging channel	NaC	Heavy overgrowth on both sides which does extend over channel; some small trees growing in channel

Bog Brook Dam
Springfield, New Hampshire

September 20, 1978
NH 00189

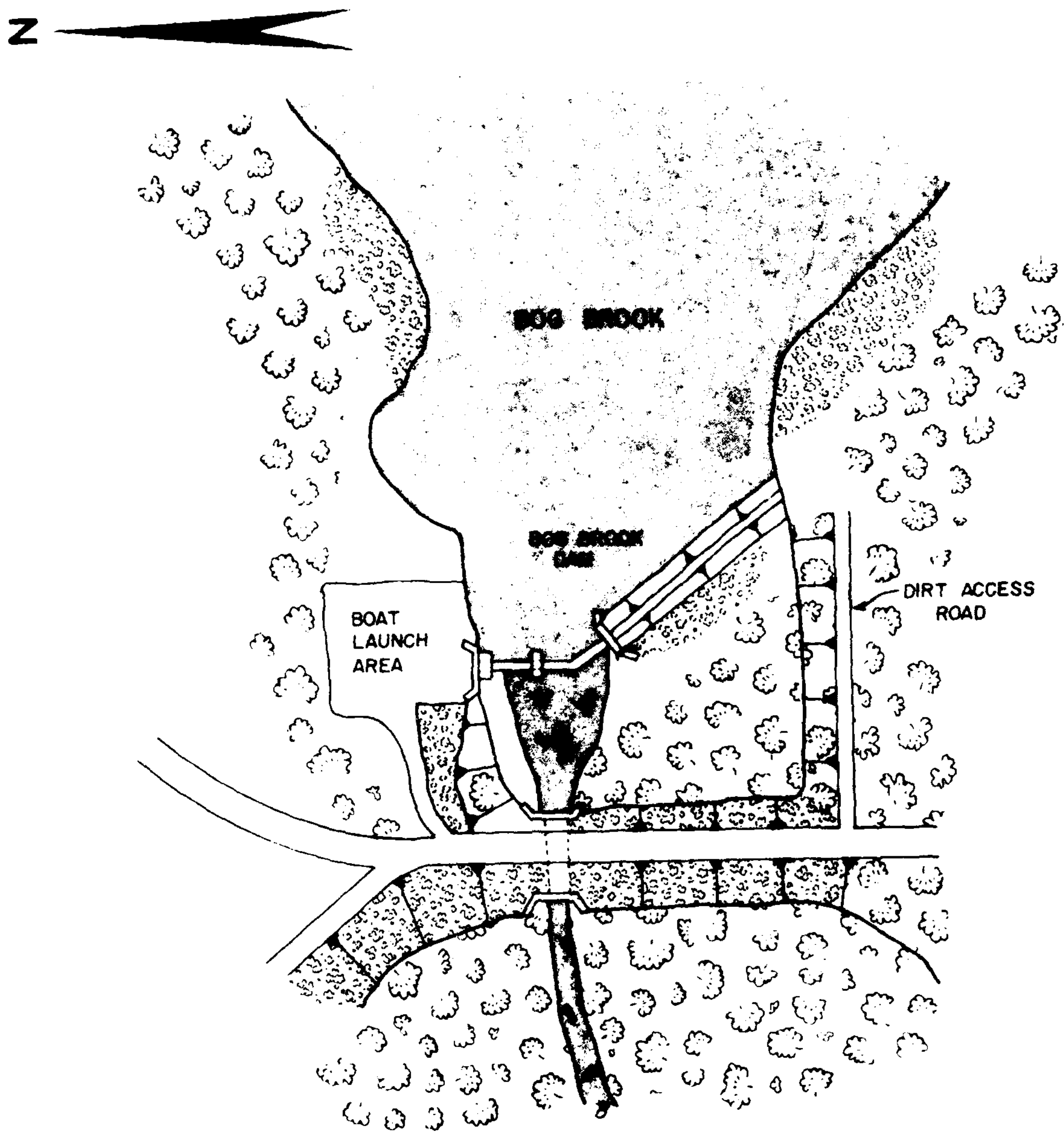
CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
Other obstructions	MLC	Large corrugated metal, multiplate arch under road 100 feet downstream of dam
c. Existence of gages		None at dam
RESERVOIR		
a. Shoreline		
Evidence of slides		None noted
Potential for slides		Shoreline stable
b. Sedimentation		Some noted immediately behind dam
c. Upstream hazard areas in the event of backflooding		None
d. Changes in nature of watershed (agriculture, logging, construction, etc.)	MLC	None noted
DOWNSTREAM CHANNEL		
Restraints on dam operation	[illegible]	None given dam's limited operational capacity
Potential flooded area	[illegible]	No development within 3 miles of dam

Bog Brook Dam
Springfield, New Hampshire

September 20, 1978
NH 00189

CHECK LISTS FOR VISUAL INSPECTION		
AREA EVALUATED	BY	CONDITION & REMARKS
OPERATION AND MAINTENANCE FEATURES		
a. Reservoir regulation plan		
Normal procedure	RJC	Maintain water level for wildlife management; little or no manipulation of stop-logs required
Emergency procedures		No emergency situation ever encountered since construction; local conservation officer could pull logs if necessary
Compliance with designated plan		Satisfactory
b. Maintenance		
Quality		No O & M type deficiencies noted
Adequacy	RJC	Dam inspected semi-annually by engineers; no problems with maintenance evident

APPENDIX B



GOLDBERG, ZOINO, DUNNICLIFF & ASSOC, INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

FIGURE 1

SITE PLAN

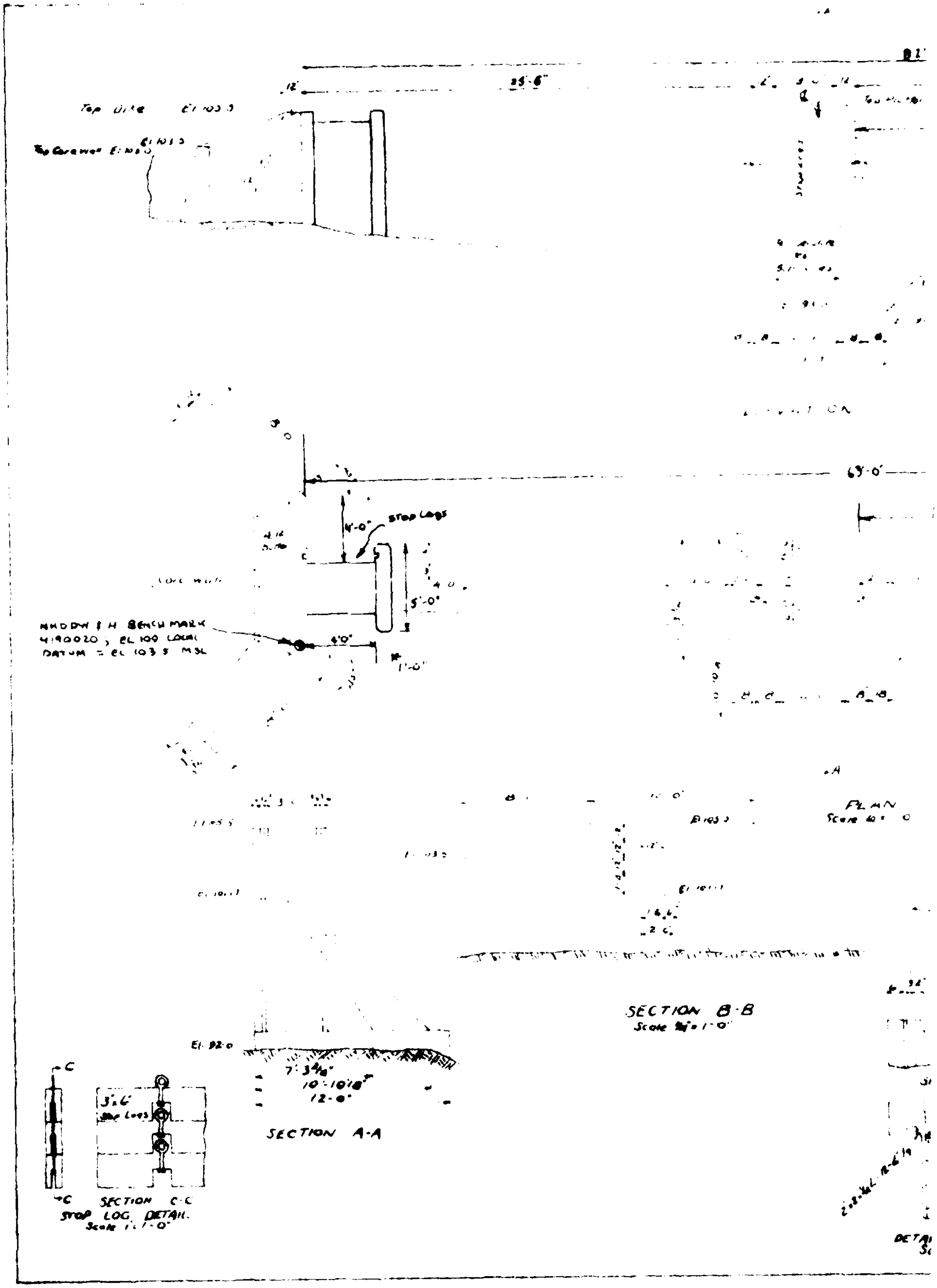
BOG BROOK DAM

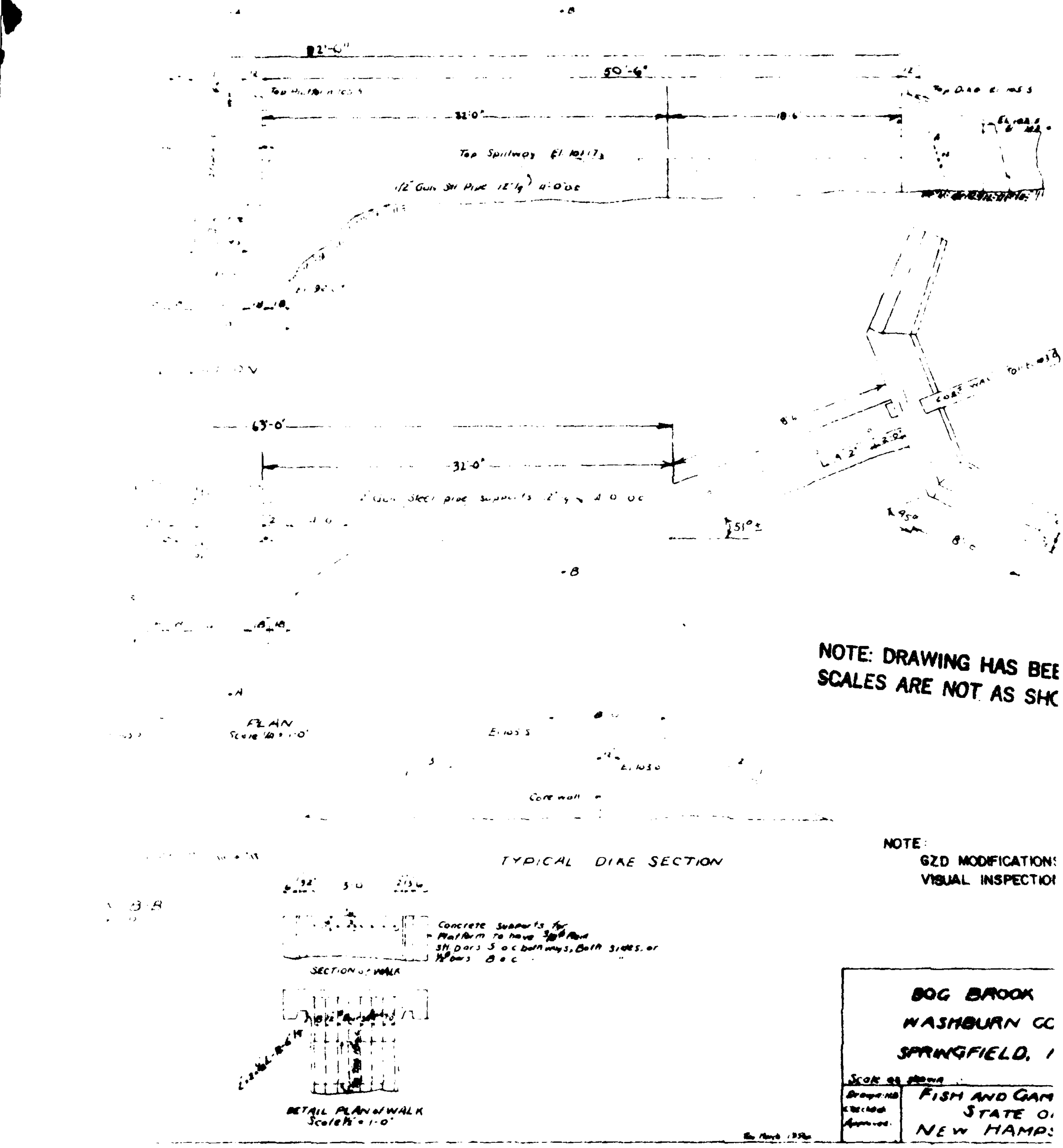
NEW HAMPSHIRE

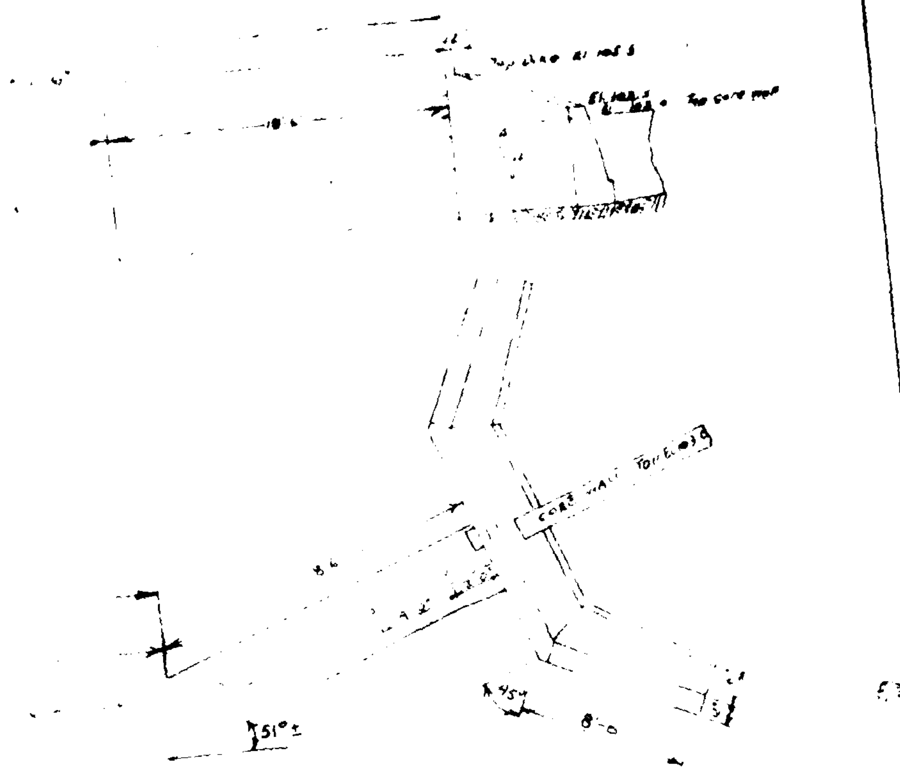
FILE No. 2067

SCALE NO SCALE

DATE NOV. 1978


35'-6"
Top Dike
Stop Logs
4'-0"
5'-0"
65'-0"
BENCH MARK
PLAN
SECTION B-B
El 92.0
7'-3 3/4"
10'-10 1/8"
12'-0"
SECTION A-A
3"x6"
Stop Logs
SECTION C-C
STOP LOG DETAIL


50'-6"
32'-0"
18'-6"
Top Spillway El. 101.7
1/2" Galv. Stl Pipe 12' lg @ 4'-0" oc
63'-0"
32'-0"
51°±
PLAN
TYPICAL DIKE SECTION
Core wall
Concrete supports for Platform to have 3/8" Round Stl bars 5" o c both ways, Both sides, or 1/2" bars 8" o c
SECTION of WALK
DETAIL PLAN of WALK
NOTE: DRAWING HAS BEE
SCALES ARE NOT AS SHO
NOTE:
GZD MODIFICATIONS
VISUAL INSPECTIO
BOG BROOK
WASHBURN CO
SPRINGFIELD,
Scale as shown
FISH AND GAM
STATE O
NEW HAMPS



NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN

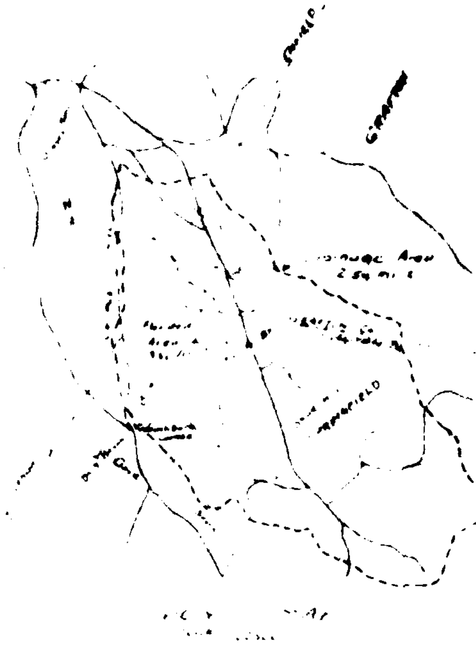
DIKE SECTION

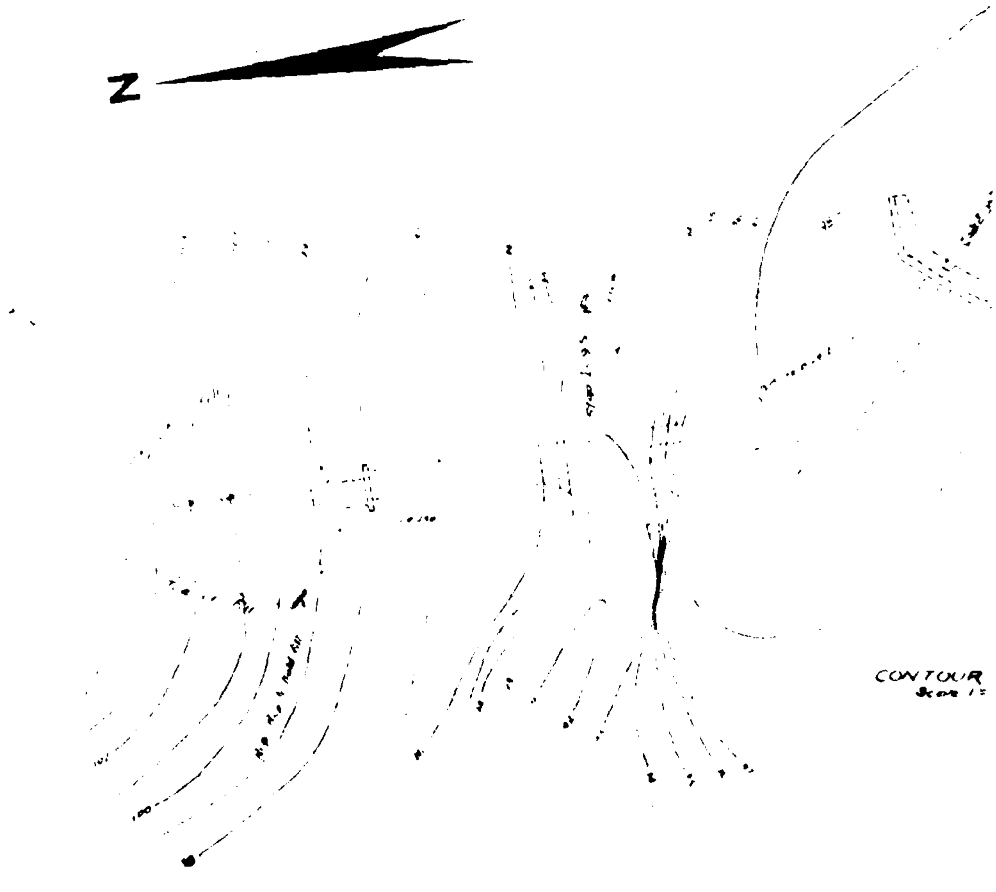
NOTE:
GZD MODIFICATIONS BASED ON VISUAL INSPECTION; NOT TO SCALE.

BOG BROOK DAM
WASHBURN CORNER
SPRINGFIELD, N. H.

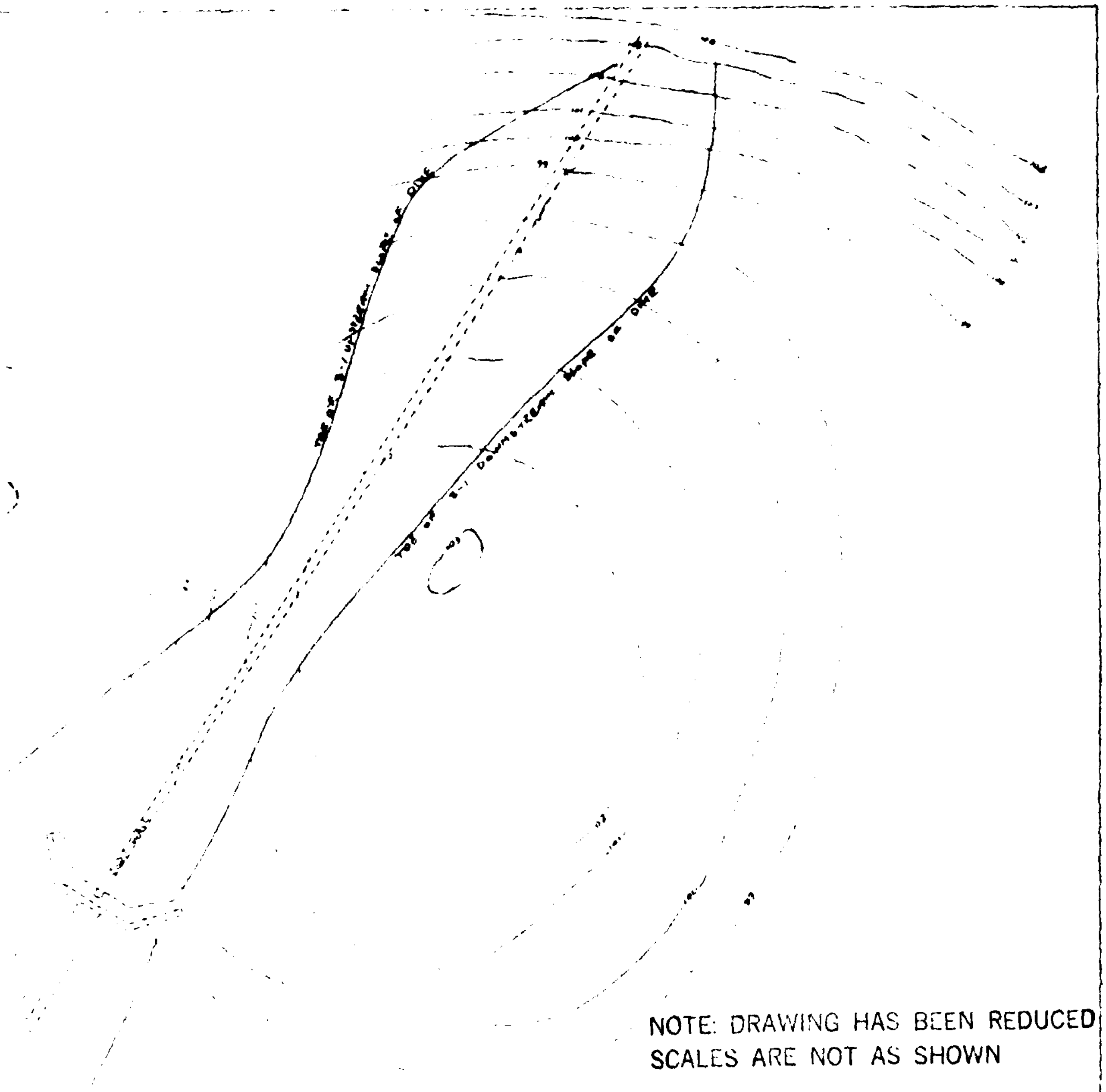
Date: Jan. 1956

Scale as shown		Sht. No.
Drawn: Checked: Approved:	FISH AND GAME DEPT. STATE OF NEW HAMPSHIRE	1





1112



NOTE: DRAWING HAS BEEN REDUCED
SCALES ARE NOT AS SHOWN

NOTE:
GZD MODIFICATIONS BASED ON VISUAL INSPECTION; NOT TO SCALE.

CONTOUR MAP
Scale 1:10'0"

BOG BROOK DAM
WASHBURN CORNER
SPRINGFIELD, N. H.

Scale as shown — Date-Jun 1966

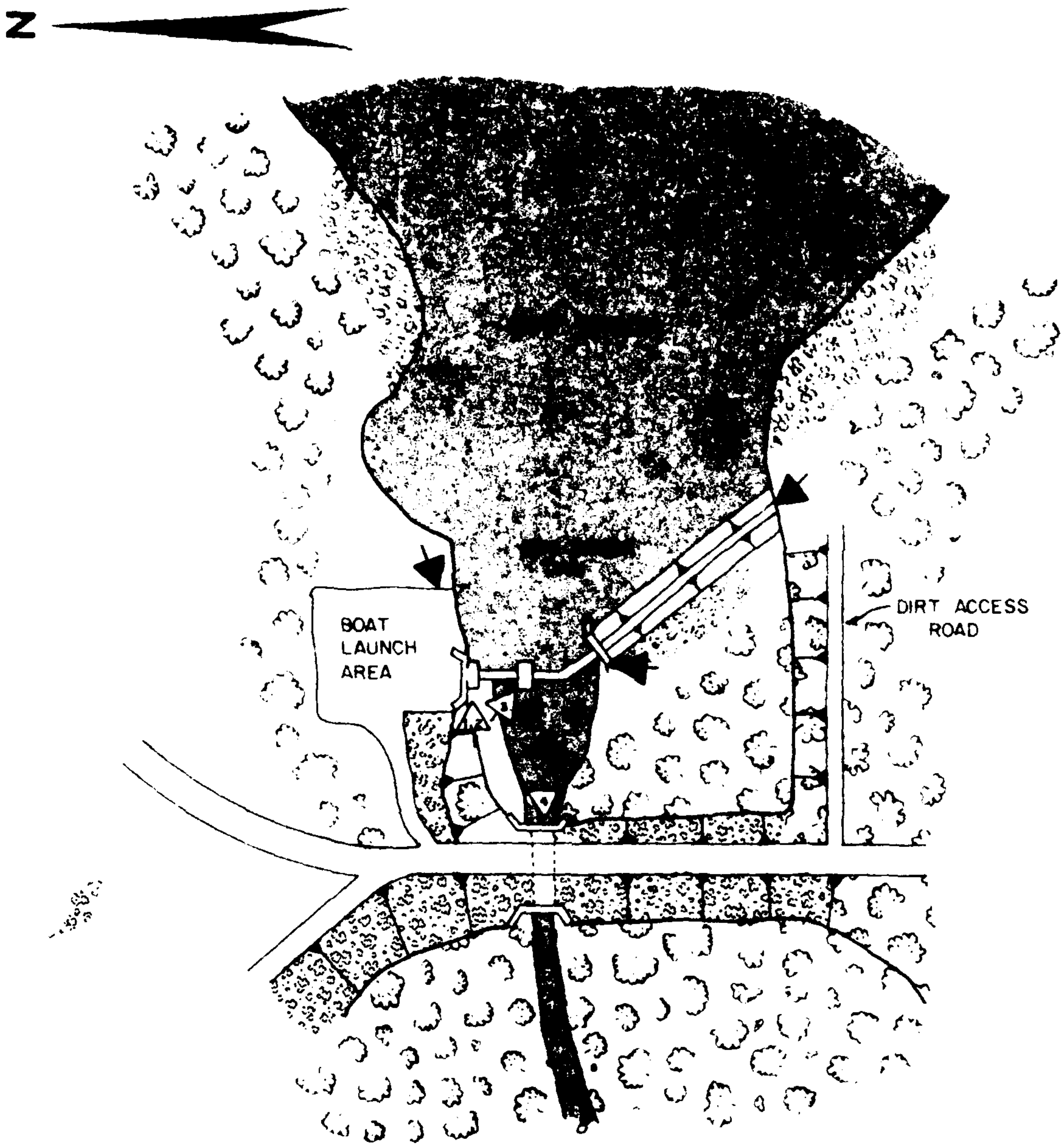
Drawn by / Checked / Approved — FISH AND GAME DEPT STATE OF NEW HAMPSHIRE — Sht. No. 2

The New Hampshire Water Resources Board, 37 Pleasant Street, Concord, New Hampshire has in its files two pages of hydraulic calculations dated September 3, 1957. The Board may be reached at phone number (603) 271-3406.

The New Hampshire Fish and Game Department maintains records concerning the construction of the dam, including the change order directing the angling of the spillway and the additional sluiceway. The Department's address and phone number are presented in subparagraph 1.2(e).

APPENDIX C

SELECTED PHOTOGRAPHS



OVERVIEW PHOTOS

APPENDIX C PHOTOS

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC, INC
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND ORIENTATION OF PHOTOS

BOG BROOK DAM — NEW HAMPSHIRE

FILE No. 2067

SCALE: NO SCALE
DATE: NOV 1978

1. View of right sluiceway showing bedrock foundation under concrete portions of dam

2. Detail of Photo 1 showing erosion of construction joint between sluiceway sidewall and spillway buttress support

3. View of center sluiceway showing erosion between sluiceway sidewalls and spillway buttress supports

4. View from channel between dam and road showing bridge culvert

APPENDIX D

HYDROLOGIC/HYDRAULIC COMPUTATIONS

RE Job no. 148 Dam Safety RJH 10/13/78 1 of 20

Boe Brook Dam

Initial assumptions = - water level at USGS el. 1094.67'
(local elev. 100' = 1093.5' USGS)

- water level at spillway crest
(from ...)

→ - spillway crest is at USGS el. 1094.67'

Size classification = Intermediate

Hazard classification = Low

Test Flood equals 100-yr frequency flood to ½ PMF.

Using the regression equation introduced by Dean LeBlanc in USGS Water Resources Investigation 78-47, the 100-yr freq flood is:

$$P_{100} = 0.55\, A^{1.05} S^{0.56} I^{2.72}$$

A = drainage area = 12.1 sq. mi.
S = main channel slope = 110 ft/mi.
I = max. 24-hr precip., 2-yr freq. = 2.7 in.

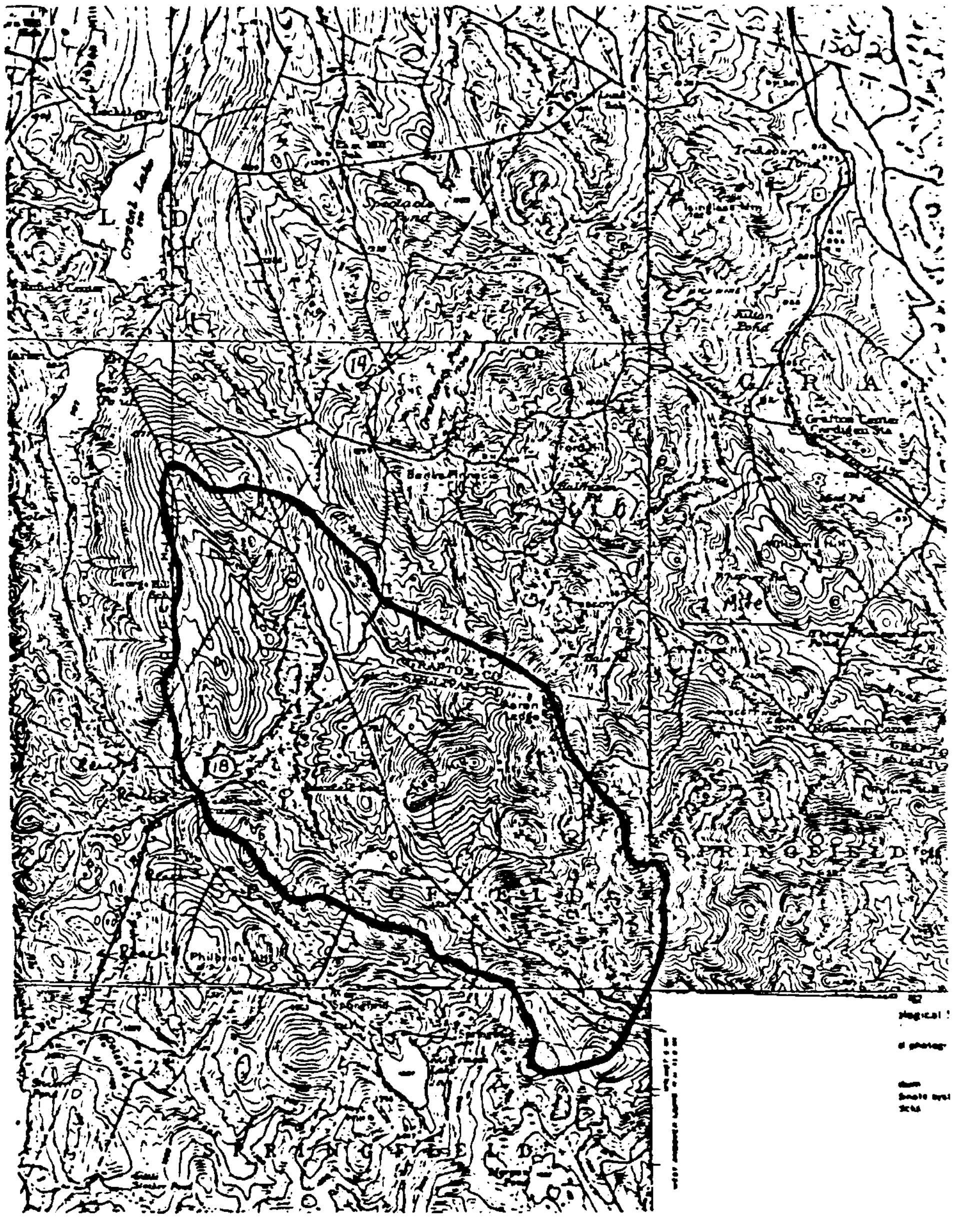
$$P_{100} = 0.55\,(12.1)^{1.05}(110)^{0.56}(2.7)^{2.72}$$
$$= \underline{1560\ cfs}$$

The PMF for this basin, (A = 12.1 sq. mi. and the topography = rolling) from the COE curve

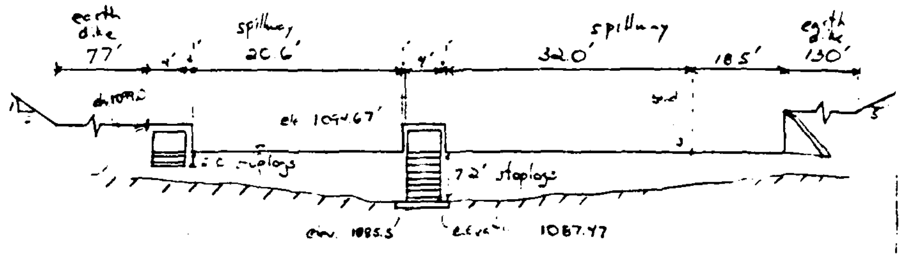
PMF = (1600 cfs/sq. mi.)(12.1 sq. mi.) = 19,400 cfs
so ½ PMF = 9700 cfs

Since this dam is about in the middle of the LOW hazard classification the test flood was chosen to be:

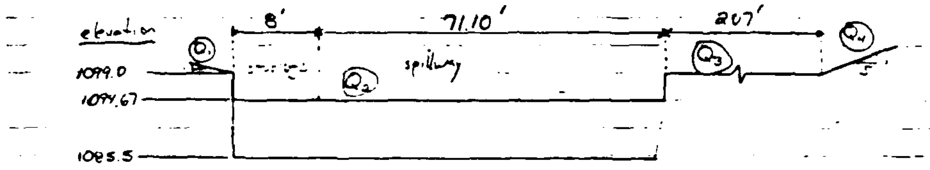
test flood = 5000 cfs



Bog Brook Dam



equivalent dam



For capacity computations, h=0 at the spillway crest

dam length (minus spillway) = 207.0'

spillway length – permanent = 71.10'
stoplogs = 8.0'
total = 79.10'

<u>Box Brook Dam</u>

Capacity calculations

for $h<0$, $Q_1 = Q_2 = Q_3 = Q_4 = 0$

for $0<h<4.3$, $Q_2 = 3.33(79.1')(h)^{1.5}$

$Q_1 = Q_3 = Q_4 = 0$

for $h>4.3$,

$Q_2 = 3.33\,(79.1')(h)^{1.5}$

$Q_3 = 2.8\,(207.0')(h-4.3)^{1.6}$

$Q_1 = 2.8\,(2(h-4.3))(0.5 * h-4.3))^{1.5}$

$Q_4 = 2.8\,(5\,(h-4.3))(0.5 * (h-4.3))^{1.5}$

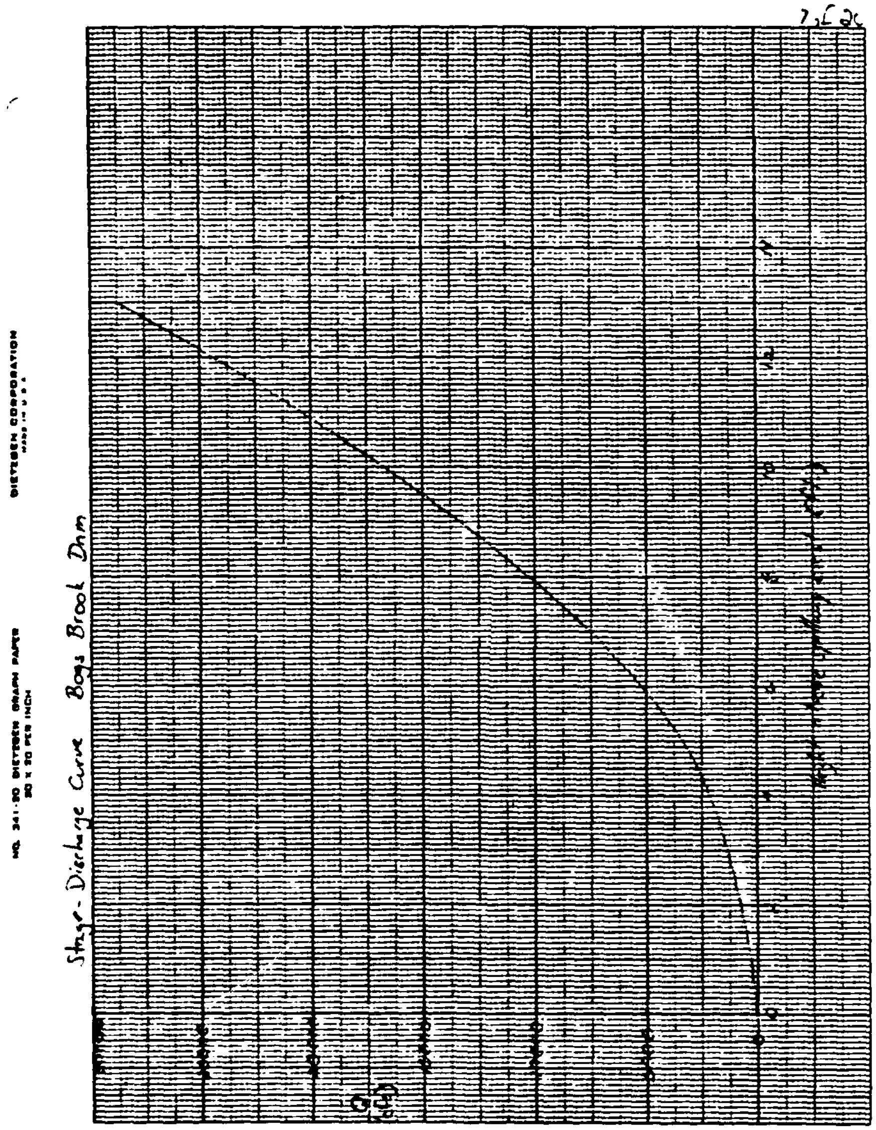
The next three pages list the program to compute these equations, its output and a plot of that output

```
100 REMARK: DISCHARGE CALCULATION FOR BOG BROOK DAM -
105 REMARK: STOPLOGS TO ELEVATION 1100.0
110 PAGE
120 E=1.5
130 PRINT "DISCHARGE FROM BOG BROOK DAM - STOPLOGS IN PLACE"
140 PRINT USING 150:
150 IMAGE // 2T"HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(FEET)"32T"(CFS)"
180 PRINT USING 190:
190 IMAGE 10T"TOTAL   SPILLWAY   DAM CREST   SIDE SLOPES"
194 PRINT " "
200 REMARK:      Q4 is flow over one side slope , Q3 is flow over the
210 REMARK: dam crest, Q2 is flow over the sharp crested spillway, and
220 REMARK: Q1 is the flow over the other side slope.
230 FOR H=0 TO 13 STEP 0.5
240 Q1=3*34*H↑E
250 Q2=3.33*79.1*H↑E
260 Q3=0
270 Q4=0
280 Q5=0
290 IF H<=4.5 THEN 330
300 Q4=2.8*(5*(H-4.3))*(0.5*(H-4.3))↑E
305 Q1=2.8*(2*(H-4.3))*(0.5*(H-4.3))↑E
310 Q4=Q4+Q1
320 Q3=2.8*207*(H-4.3)↑E
330 Q5=Q2+Q3+Q4
340 PRINT USING 350:H,Q5,Q2,Q3,Q4
350 IMAGE 1T,2D.2D,9D,10D,11D,13D
360 NEXT H
370 END
```

50! 20

DISCHARGE FROM BOG BROOK DAM - STOPLOGS IN PLACE

HEAD (FEET)	DISCHARGE (CFS) TOTAL	SPILLWAY	DAM CREST	SIDE SLOPES
0.00	0	0	0	0
0.50	93	93	0	0
1.00	263	263	0	0
1.50	484	484	0	0
2.00	745	745	0	0
2.50	1041	1041	0	0
3.00	1369	1369	0	0
3.50	1725	1725	0	0
4.00	2107	2107	0	0
4.50	2514	2514	0	0
5.00	3287	2945	339	3
5.50	4170	3398	762	11
6.00	5182	3871	1285	26
6.50	6306	4365	1891	50
7.00	7533	4878	2571	83
7.50	8855	5410	3318	127
8.00	10268	5960	4125	182
8.50	11767	6528	4989	251
9.00	13349	7112	5906	332
9.50	15013	7713	6873	427
10.00	16755	8330	7888	538
10.50	18573	8962	8948	663
11.00	20467	9610	10052	805
11.50	22434	10272	11198	964
12.00	24474	10949	12384	1140
12.50	26585	11641	13610	1334
13.00	28767	12346	14873	1547


Stage-Discharge Curve Boys Brook Dam

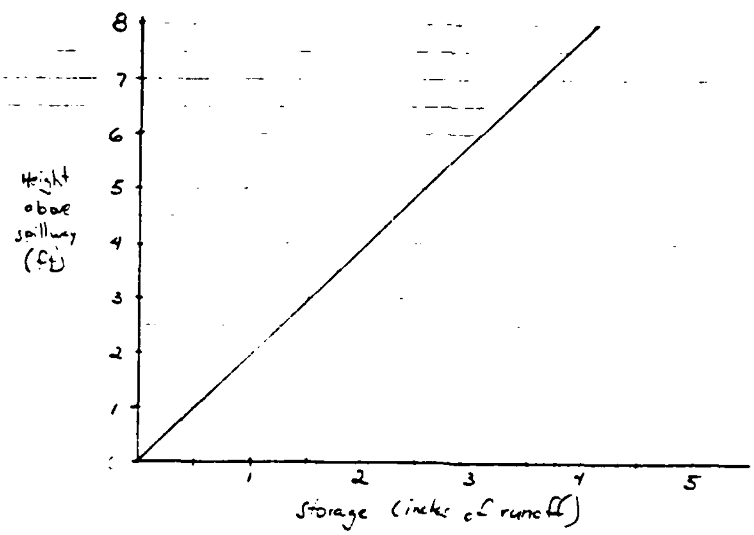
Storage Stage Relationship

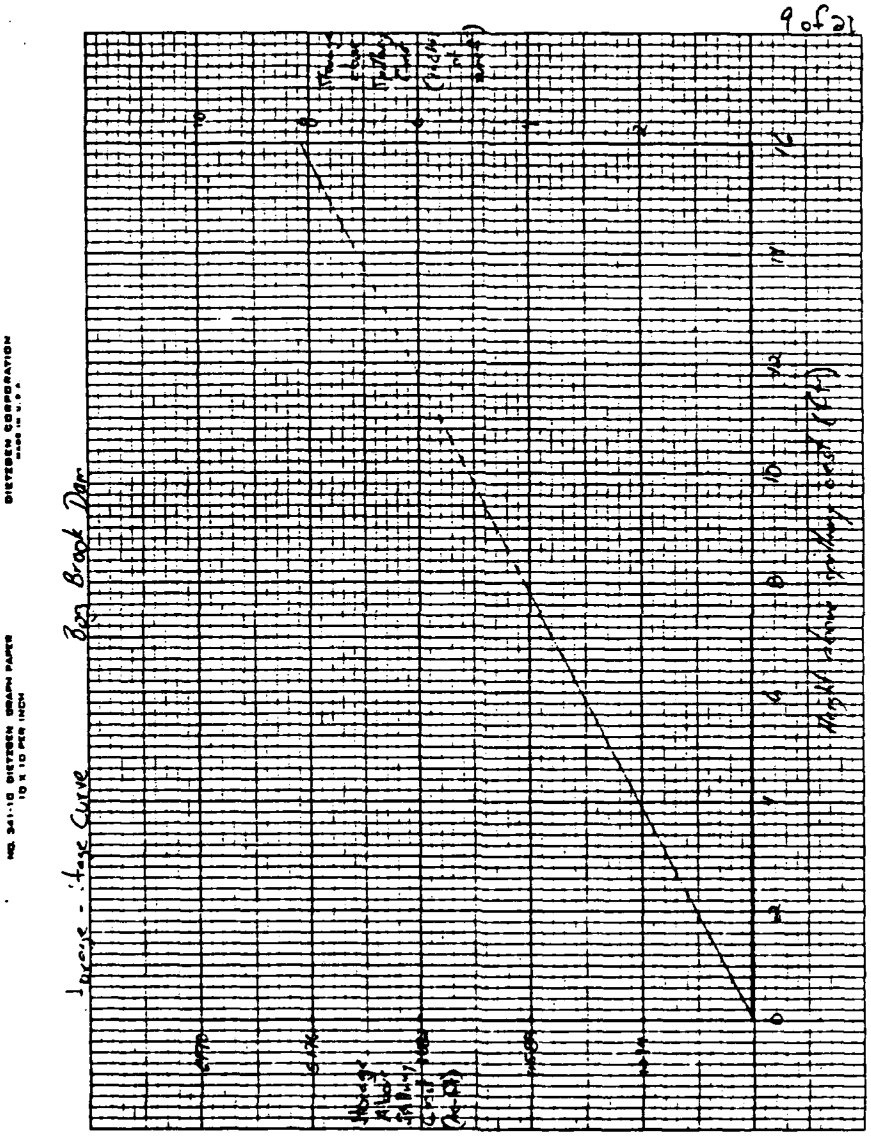
The surface level of the pond at its normal level is 330 acres and the drainage area above the dam is 12.1 sq. mi. So the relationship between runoff and stage of the pond is:

1" of runoff → yields → $\frac{1"(12.1 mi^2)(640 \frac{ac}{mi^2})}{330 \text{ acres}}$ = 23.47' rise in stage

If 1" of runoff yields ≈ 23.47" increase in water elevation then:

1' rise in water elevation is caused by → $\frac{12}{23.47}$ = .51" of runoff.




Storage - Stage Curve
Big Brook Dam
Height above spillway crest (Ft)
NO. 341-10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH
DIETZGEN CORPORATION
MADE IN U.S.A.

[illegible] 14E [illegible] [illegible] 10/14/78 [illegible]

[illegible] Brook Dam

[illegible] in flow due to storage:

Assume the total [illegible] volume = 6.5" (consistent with Test Flood)

Using the COE suggested methodology with [illegible]

$Q_{p_2} = Q_{p_1}(1 - \frac{[illegible]}{6.5})$

① [illegible] $h_1 = 5.9'$ [illegible]

[illegible] (5.9)(.51) = 3.01" of [illegible] storage

$Q_{p_2} = [illegible] (1 - \frac{3.01}{6.5}) = 2684.6$ cfs

② $Q_{p_2} = 2684.6$ cfs → yields $h_2 = 4.61'$ above the spillway crest

$h_2 = 4.61'$, yields (4.61)(.51) = 2.35" surcharge storage

$Q_{p_3} = 5000(1 - \frac{2.35}{6.5}) = 3192.5$ cfs

③ $Q_{p_3} = 3191.5$ → yields $h_3 = 4.94'$ [illegible]

$h_3 = 4.94'$ yields (4.94)(.51) = 2.52" surcharge storage

$Q_{p_4} = 5000(1 - \frac{2.52}{6.5}) = 3063.1$ cfs

④ $Q_{p_4} = 3063.1$ cfs → yields $h_4 = 4.86'$

$h_4 = 4.86'$, yields (4.86)(.51) = 2.48" surcharge storage

$Q_{p_5} = 5000(1 - \frac{2.48}{6.5}) = 3095.3$ cfs

⑤ $Q_{p_5} = 3095.3$ cfs → yields $h_5 = 4.88'$

$h_5 = 4.88'$ yields (4.88)(.51) = 2.49" surcharge storage

[illegible] = 5000 (1 - $\frac{[illegible]}{6.5}$)

[illegible] [illegible] KTH 10/14/75 [illegible]

[illegible]

[illegible] $h = 4.5'$ [illegible]
which is 0.54' above the dam crest.

Bog Brook Dam

Calculation of Estimated Downstream Dam Failure Flood Stages - Based on COE "Rule of thumb" Guidlines, April 1978.

Step 1 - Reservoir Storage at Time of Failure

Assume that the failure occurs when the dam is overtopped (4.33' above the spillway)

Storage = Normal + Surcharge = 1000 + 4.33(330) = 2430 A-ft.

Step 2 - Peak Failure Outflow

$Q_{P_1} = 8/27 \, W_b \sqrt{g} \, (Y_o)^{3/2}$

W_b < 40% width = .4(80±) ≈ 30 ft

Y_o = ft. above streambed = (1099.0 - 1085.5') = 13.5 ft

$Q_{P_1} = 8/27 (30) \sqrt{32.2} \, (13.5)^{3/2} = 2502$ cfs

Use 2500 cfs peak outflow

Step 3 - Develop Stage-Discharge Routing for Downstream Reaches

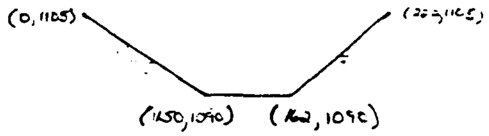
Assumed cross-sections for the downstream reaches, based on USGS topo and field data, are shown below

For these calculations the downstream brook (from the dam) is divided into 4 reaches.

Reach 1 is 100 feet long and is bordered downstream by a bridge. Reach 2 is 2300 feet long with a well defined channel both Reach 1 and 2 have a slope of 0.03. Reach 3 is a fairly flat, wide reach, about 3500 ft in length. Reach 4 is a flat, wide, swampy area 8000 ft long and 1500' wide. Both Reach 3 and 4 have an average slope of about 0.005.

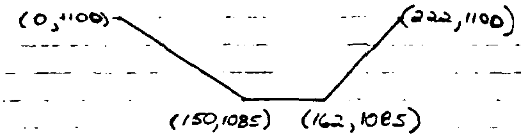
Reach 1 Bog Brook Dam to bridge

L= 100'
S= 0.03
n= 0.04



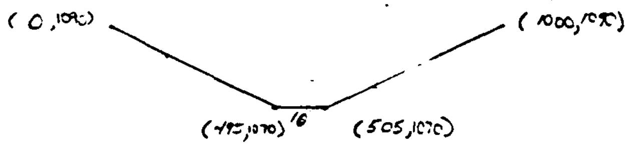
Reach 2 Bridge to valley

L= 2300'
S= 0.03
n= 0.04



Reach 3 First swampy reach

L= 3500'
S= 0.005
n= .07

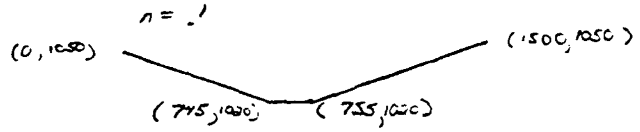


Job 148   Dam Safety   RJH   10/16/78   14 of 20

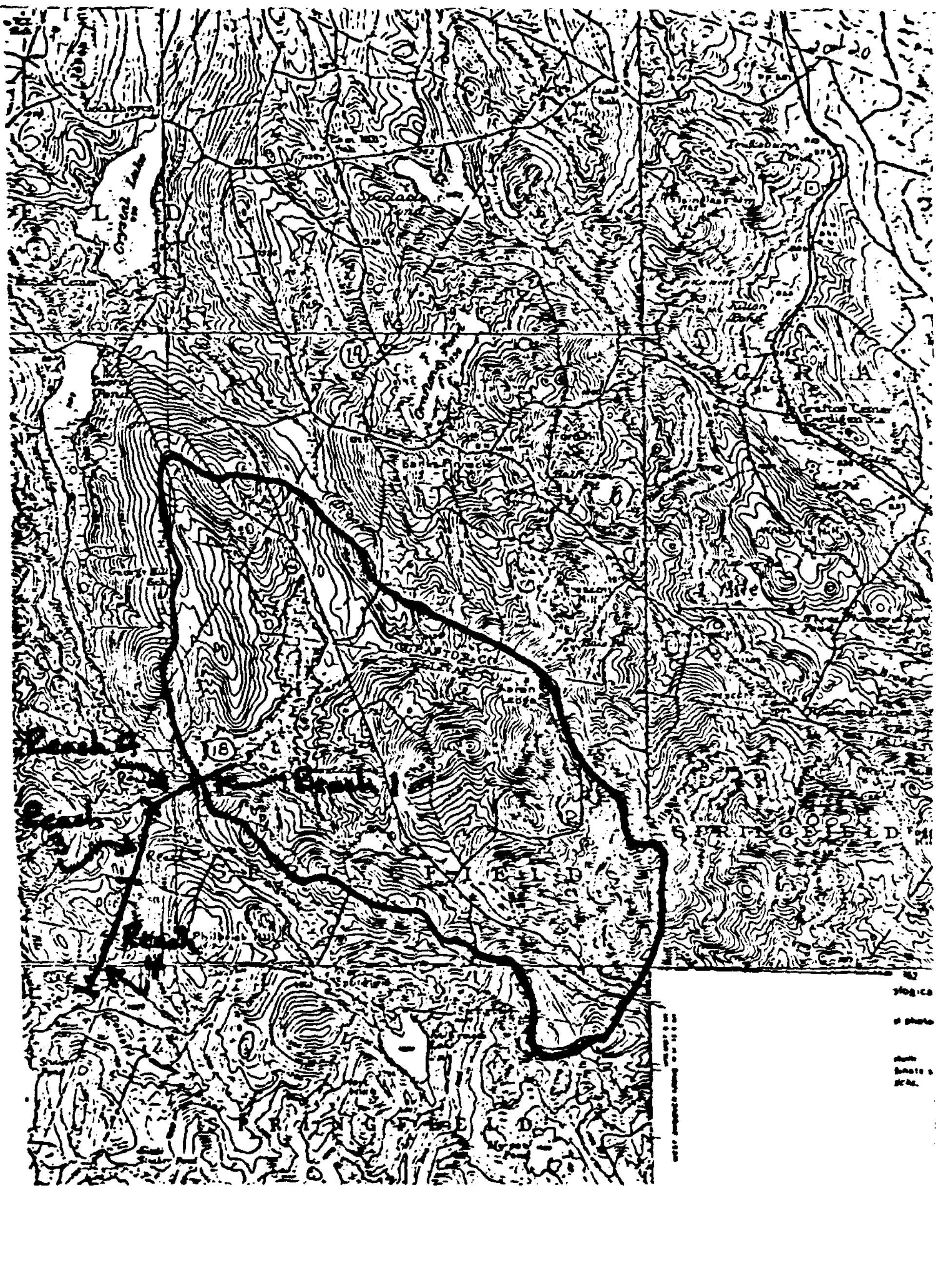
Bee Brook Dam

Reach 4   Swamp

L = 8000'
s = 0.005
n = .1



The following sheets contain the capacity computations for the cross-sections shown above



DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	1090.0	0.0	0.0	0.0	0.0	0.0
0.5	1090.5	7.8	19.1	0.4	4.2	27.4
1.0	1091.0	19.0	26.2	0.7	15.3	99.0
1.5	1091.5	33.8	33.3	1.0	34.1	219.9
2.0	1092.0	52.0	40.3	1.3	61.6	397.4
2.5	1092.5	73.8	47.4	1.6	99.0	638.7
3.0	1093.0	99.0	54.5	1.8	147.4	950.9
3.5	1093.5	127.8	61.6	2.1	207.8	1340.6
4.0	1094.0	160.0	68.7	2.3	281.2	1814.4
4.5	1094.5	195.8	75.8	2.6	368.6	2378.5
5.0	1095.0	235.0	82.9	2.8	471.0	3038.8
5.5	1095.5	277.8	90.0	3.1	589.2	3801.3
6.0	1096.0	324.0	97.0	3.3	724.1	4671.7
6.5	1096.5	373.8	104.1	3.6	876.6	5655.5
7.0	1097.0	427.0	111.2	3.8	1047.5	6758.2
7.5	1097.5	483.8	118.3	4.1	1237.6	7985.0
8.0	1098.0	544.0	125.4	4.3	1447.8	9341.2
8.5	1098.5	607.8	132.5	4.6	1678.9	10831.9
9.0	1099.0	675.0	139.6	4.8	1931.5	12462.0
9.5	1099.5	745.8	146.6	5.1	2206.6	14236.5
10.0	1100.0	820.0	153.7	5.3	2504.7	16160.2
10.5	1100.5	897.8	160.8	5.6	2826.8	18237.9
11.0	1101.0	979.0	167.9	5.8	3173.4	20474.3
11.5	1101.5	1063.8	175.0	6.1	3545.3	22873.9
12.0	1102.0	1152.0	182.1	6.3	3943.2	25441.3
12.5	1102.5	1243.8	189.2	6.6	4367.9	28181.1
13.0	1103.0	1339.0	196.2	6.8	4819.9	31097.7
13.5	1103.5	1437.8	203.3	7.1	5300.1	34195.4
14.0	1104.0	1540.0	210.4	7.3	5808.9	37478.5
14.5	1104.5	1645.8	217.5	7.6	6347.2	40951.4

REACHES ONE AND TWO

DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	1070.0	0.0	0.0	0.0	0.0	0.0
0.5	1070.5	11.2	34.8	0.3	5.3	7.9
1.0	1071.0	34.8	59.5	0.6	24.3	36.5
1.5	1071.5	70.7	84.3	0.8	62.8	94.6
2.0	1072.0	119.0	109.1	1.1	126.1	189.8
2.5	1072.5	179.7	133.9	1.3	218.7	329.2
3.0	1073.0	252.8	158.6	1.6	344.9	519.1
3.5	1073.5	338.2	183.4	1.8	508.7	765.6
4.0	1074.0	436.0	208.2	2.1	713.9	1074.5
4.5	1074.5	546.2	232.9	2.3	964.3	1451.4
5.0	1075.0	668.8	257.7	2.6	1263.3	1901.4
5.5	1075.5	803.7	282.5	2.8	1614.3	2429.7
6.0	1076.0	951.0	307.2	3.1	2020.6	3041.2
6.5	1076.5	1110.7	332.0	3.3	2485.4	3740.8
7.0	1077.0	1282.8	356.8	3.6	3011.8	4533.1
7.5	1077.5	1467.2	381.6	3.8	3602.8	5422.6
8.0	1078.0	1664.0	406.3	4.1	4261.3	6413.8
8.5	1078.5	1873.2	431.1	4.3	4990.4	7511.2
9.0	1079.0	2094.8	455.9	4.6	5792.7	8718.8
9.5	1079.5	2328.7	480.6	4.8	6671.2	10041.0
10.0	1080.0	2575.0	505.4	5.1	7628.5	11481.9
10.5	1080.5	2833.7	530.2	5.3	8667.3	13045.4
11.0	1081.0	3104.8	554.9	5.6	9790.3	14735.6
11.5	1081.5	3388.2	579.7	5.8	11000.0	16556.4
12.0	1082.0	3684.0	604.5	6.1	12299.0	18511.6
12.5	1082.5	3992.2	629.3	6.3	13689.9	20605.1
13.0	1083.0	4312.8	654.0	6.6	15175.2	22840.6
13.5	1083.5	4645.7	678.8	6.8	16757.2	25221.0
14.0	1084.0	4991.0	703.6	7.1	18438.5	27752.4
14.5	1084.5	5348.7	728.3	7.3	20221.5	30435.9

REACH 3

17-20

DEPTH	ELEV	AREA	WPER	HYD-R	AR2/3	Q
0.0	1020.0	0.0	0.0	0.0	0.0	0.0
1.0	1021.0	34.8	59.7	0.6	24.3	25.6
2.0	1022.0	119.3	109.4	1.1	126.4	133.2
3.0	1023.0	253.5	159.1	1.6	345.8	364.4
4.0	1024.0	437.3	208.8	2.1	716.0	754.4
5.0	1025.0	670.8	258.5	2.6	1267.1	1335.0
6.0	1026.0	954.0	308.2	3.1	2026.8	2135.4
7.0	1027.0	1286.8	357.9	3.6	3021.2	3183.1
8.0	1028.0	1669.3	407.7	4.1	4274.8	4503.9
9.0	1029.0	2101.5	457.4	4.6	5811.2	6122.6
10.0	1030.0	2583.3	507.1	5.1	7652.9	8063.0
11.0	1031.0	3114.8	556.8	5.6	9821.7	10348.0
12.0	1032.0	3696.0	606.5	6.1	12338.7	12999.9
13.0	1033.0	4326.8	656.2	6.6	15224.3	16040.1
14.0	1034.0	5007.3	705.9	7.1	18498.4	19489.7
15.0	1035.0	5737.5	755.6	7.6	22180.4	23369.0
16.0	1036.0	6517.3	805.3	8.1	26289.2	27698.0
17.0	1037.0	7346.8	855.0	8.6	30843.4	32496.2
18.0	1038.0	8226.0	904.7	9.1	35861.1	37782.8
19.0	1039.0	9154.8	954.4	9.6	41360.1	43576.5
20.0	1040.0	10133.3	1004.1	10.1	47357.9	49895.8
21.0	1041.0	11161.5	1053.8	10.6	53871.8	56758.7
22.0	1042.0	12239.3	1103.6	11.1	60918.5	64183.1
23.0	1043.0	13366.8	1153.3	11.6	68514.8	72186.4
24.0	1044.0	14544.0	1203.0	12.1	76677.0	80786.0
25.0	1045.0	15770.8	1252.7	12.6	85421.3	89998.9
26.0	1046.0	17047.3	1302.4	13.1	94763.5	99841.8
27.0	1047.0	18373.5	1352.1	13.6	104719.6	110331.4
28.0	1048.0	19749.3	1401.8	14.1	115304.9	121483.9
29.0	1049.0	21174.8	1451.5	14.6	126534.8	133315.6

REACH 4

Step 4: Calculate Downstream Attenuation

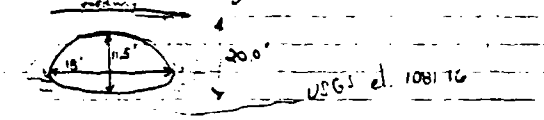
Reach 1 $Q_{P1} = 2500$ cfs → $h = 4.59'$
→ $A = 200$ ft^2

$$V_1 = \frac{100(200)}{43560} = 0.47 \text{ acre-ft}$$

$$Q_{P2T} = Q_{P1}\left(1 - \frac{.47}{2430}\right) = 2500 \text{ cfs}$$ no attenuation

There is no attenuation in the reach, by the standard calculations. However, in a reach of 100' with a culvert as its downstream terminus, the standard method of calculation does not apply, as the flow is controlled by the culvert capacity. To evaluate this culvert the nomographs from the Handbook of Steel Drainage and Highway Construction Products, (American Iron and Steel Institute, 1971) are used.

The culvert is made of corrugated steel with the pictured dimensions:



It is assumed, since the reach is so short, that the water level at the culvert is equal to the water level above the stream bed at time of failure, or 13.5 ft. With this depth the water depth to culvert height ratio is 1.17. Using the nomographs, the culvert size and this ratio, the culvert capacity is:

$$Q_c = 2200 \text{ cfs}$$

So 2200 cfs is the peak flow to Reach 2

Reach 2 $Q_{P1} = 2200$ cfs → $h = 4.34'$
→ $A = 185$ ft^2

$$V_1 = \frac{2300' \times 185 \text{ ft}^2}{43560 \text{ ft}^2/\text{acre}} = 9.8 \text{ acre-ft}$$

$$Q_{P2T} = 2200\left(1 - \frac{9.8}{2430}\right) = 2191 \text{ cfs}$$ → 4.33'
→ $A_2 = 184$

no attenuation

$$V_2 = \frac{2300 \times 184}{43560} = 9.7 \text{ acre-ft}$$

$$Q_{P2} = 2200\left(1 - \frac{9.75}{2430}\right) = 2191 \text{ cfs}$$

Job 148 Dam Safety RJH 10/17/78 20 of 30
Bog Brook Dam

Reach 3 - $Q_{p_1} = 2191$ cfs → $h_1 = 5.27'$, $A_1 = 743$ ft²

$V_1 = \frac{3500 \times 743}{43560} = 59.7$ acre-ft

$Q_{P_{2T}} = 2191 \text{ cfs} (1 - \frac{59.7}{2430}) = 2136$ cfs → $h_2 = 5.22'$, $A_2 = 729$ ft²

$V_2 = \frac{3500 \times 729}{43560} = 58.6$ acre-ft

$V_{avg} = \frac{59.7 + 58.6}{2} = 59.15$

$Q_{p_2} = 2191 (1 - \frac{59.15}{2430}) = \underline{2138 \text{ cfs}}$

Reach 4 - $Q_{p_1} = 2138$ cfs → $h_1 = 6.00'$, $A_1 = 955$ ft²

$V = \frac{8000 \text{ ft} \times 955 \text{ ft}^2}{43560 \text{ ft}^2/\text{ac}} = 175.4$ acre-ft

$Q_{P_{2T}} = 2138 (1 - \frac{175.4}{2430}) = 1984$ cfs → $h_2 = 5.81'$, $A_2 = 900$ ft²

$V_2 = \frac{8000 \times 900}{43560} = 165.4$ acre-ft

$V_{avg} = 170.4$ acre-ft

$Q_{p_2} = 2138 (1 - \frac{170.4}{2340}) = \underline{1982 \text{ cfs}}$

APPENDIX E

INFORMATION AS CONTAINED IN

THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
NH	189	NED	NH	019	02				BOG BROOK DAM	4331.5	7204.7	27NOV78

POPULAR NAME	NAME OF IMPOUNDMENT

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	BOG BROOK	GRANTHAM	4	375

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	IMPOUNDING CAPACITIES NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
REGTPG	1957	RO	14	14	2500	1000	NED	N	N		N	13DEC78

REMARKS
23-CONSERVATION

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NO	NAVIGATION LOCKS LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH	WIDTH
3	289	U	71	2110										

OWNER	ENGINEERING BY	CONSTRUCTION BY
NH FISH AND GAME DEPT	NH FISH AND GAME DEPT	NH FISH AND GAME DEPT

REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WAT RES BD	NH WAT RES BD	NH WAT RES BD	NH WAT RES BD

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
GOLDBERG ZOINO DUNNICLIFF + ASSOC	20SEP78	PUBLIC LAW 92-367

REMARKS

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-8