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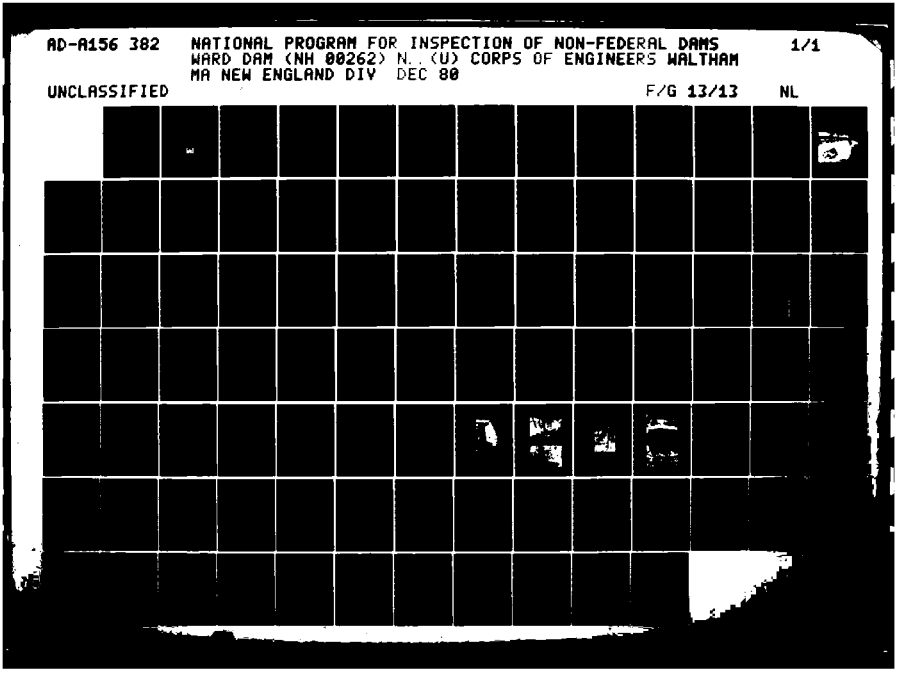

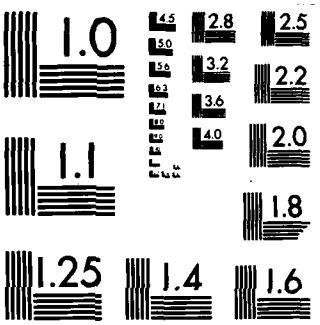

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MERRIMACK RIVER BASIN
WEST WILTON, NEW HAMPSHIRE

WARD DAM

NH 00262

NHWRB 254.18

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

DECEMBER 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

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

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin,
West WIlton, New Hampshire,
Blood Brook, a tributary of the Souhegan River.

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

The dam is a gravity arch structure constructed of rubble stone and split stone masonry founded on bedrock. It is about 260 ft. long and 18 ft. high. The dam is small in size with a significant hazard potential. The dam is in poor condition at the present time. It is recommended that the owner undertake remedial measures within one year of receipts of the Phase I report.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

MAY 0 8 1981

REPLY TO
ATTENTION OF:
NEDED

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

Dear Governor Gallen:

Inclosed is a copy of the Ward Dam (NH-00262) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Mr. Richard Clattenberg, West Wilton, New Hampshire 03086.

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

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

Sincerely,

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION

PHASE I INSPECTION REPORT

Identification No.:	NH 00262
NHWRB No.:	254.18
Name of Dam:	Ward Dam
Town:	Wilton
County and State:	Hillsboro, New Hampshire
Stream:	Blood Brook, a tributary of the Souhegan River
Date of Inspection:	October 17, 1980

BRIEF ASSESSMENT

Ward Dam is located on Blood Brook approximately one quarter mile upstream of the village of West Wilton, New Hampshire. It can be reached from a town road which intersects State Route 101 in Wilton, New Hampshire.

The dam is a gravity arch structure constructed of rubble stone and split stone masonry, founded on bedrock. It is approximately 260 feet long and 18 feet high. For the purposes of this report, the top of the dam has been taken to be the top of the training wall at the right abutment. The overflow type spillway has a crest length of 29 feet and is 14.5 feet above the streambed. There is a rectangular, stonelined, box culvert passing through the spillway which is controlled by a vertical slide gate. An abandoned sluiceway at the left bank leads to an old mill building downstream which has been converted to a residence. This sluiceway is apparently silted up but leaking somewhat, according to the resident.

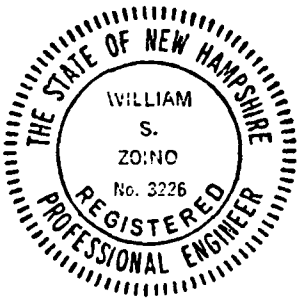
The dam was apparently constructed in 1840 to provide power for a saw mill but presently is only used for recreation. The drainage area for this dam consists of approximately 6.6 square miles of rolling terrain which is mostly forested with some minor development. Approximately 4.9 square miles of this area is controlled by the Souhegan River Watershed Dam No. 26 which is the subject of a separate Dam Safety Inspection Report.

The dam is SMALL in size and its hazard potential classification is SIGNIFICANT since appreciable economic loss and possible loss of a few lives could result in the event of a dam failure. The appropriate Test Flood for a dam classified SMALL in size with a SIGNIFICANT hazard potential would be between 100-year

flood and one half the probable maximum flood (PMF). Since the risk downstream in the event of dam failure is on the low side of SIGNIFICANT, the 100-year flood has been adopted as the appropriate Test Flood.

The analysis in Appendix D shows a peak 100-year inflow of 328 cfs for the dam. Attenuation due to storage in the reservoir is negligible and the Peak Test Flood routed outflow is 328 cfs, with the water surface at 727.2 feet (NGVD), which is 2.2 feet above the principal spillway. The spillway is capable of passing the Peak Test Flood routed outflow with 1.1 feet of freeboard at the training wall right abutment. The left abutment would be overtopped but this would not threaten the integrity of the dam because the abutment is solid bedrock.

The dam is in POOR condition at the present time. It is recommended that the owner retain the services of a qualified registered professional engineer to inspect the upstream side of the dam and make recommendations for the repair of all deficiencies, to investigate the bulging of the downstream face of the spillway and its structural stability, to investigate the operability of the sluice gate and make recommedations for its rehabilitation, and to investigate the condition of the sluiceway and penstock and make recommendations for its removal or rehabilitation. Remedial measures to be undertaken by the owner include implementing annual maintenance and inspection programs and developing a formal written report system for warning downstream residents and officials in the event of an emergency. These engineering studies and remedial measures should be implemented by the owner within one year of receipts of this Phase I Inspection Report.



William S Zoino

William S. Zoino
NH Registration No. 3226

Nicholas A. Campagna, Jr.

Nicholas A. Campagna, Jr.
California Registration No. 21006

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This Phase I Inspection Report on Ward Dam (NH-00262) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

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

ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering 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 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.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

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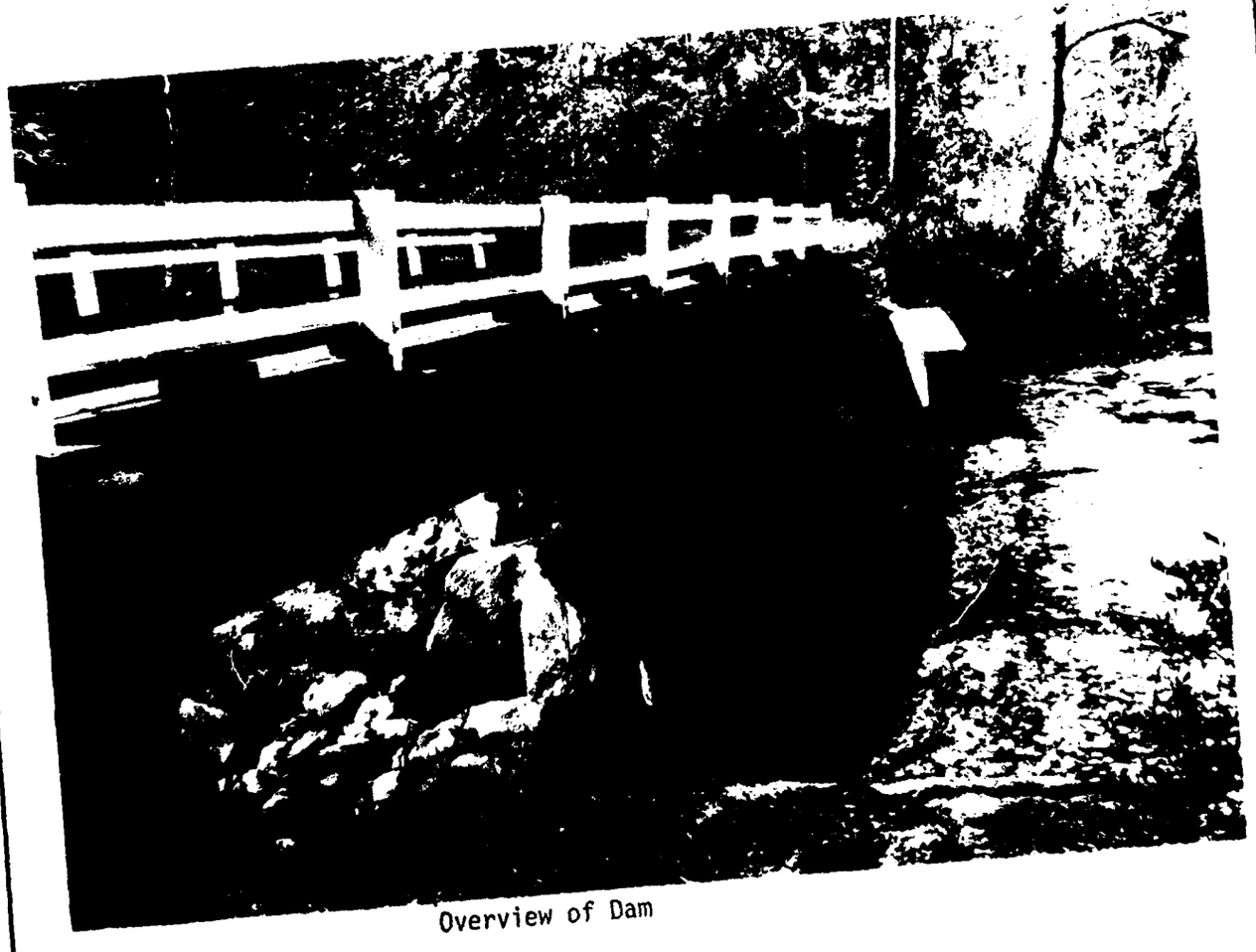
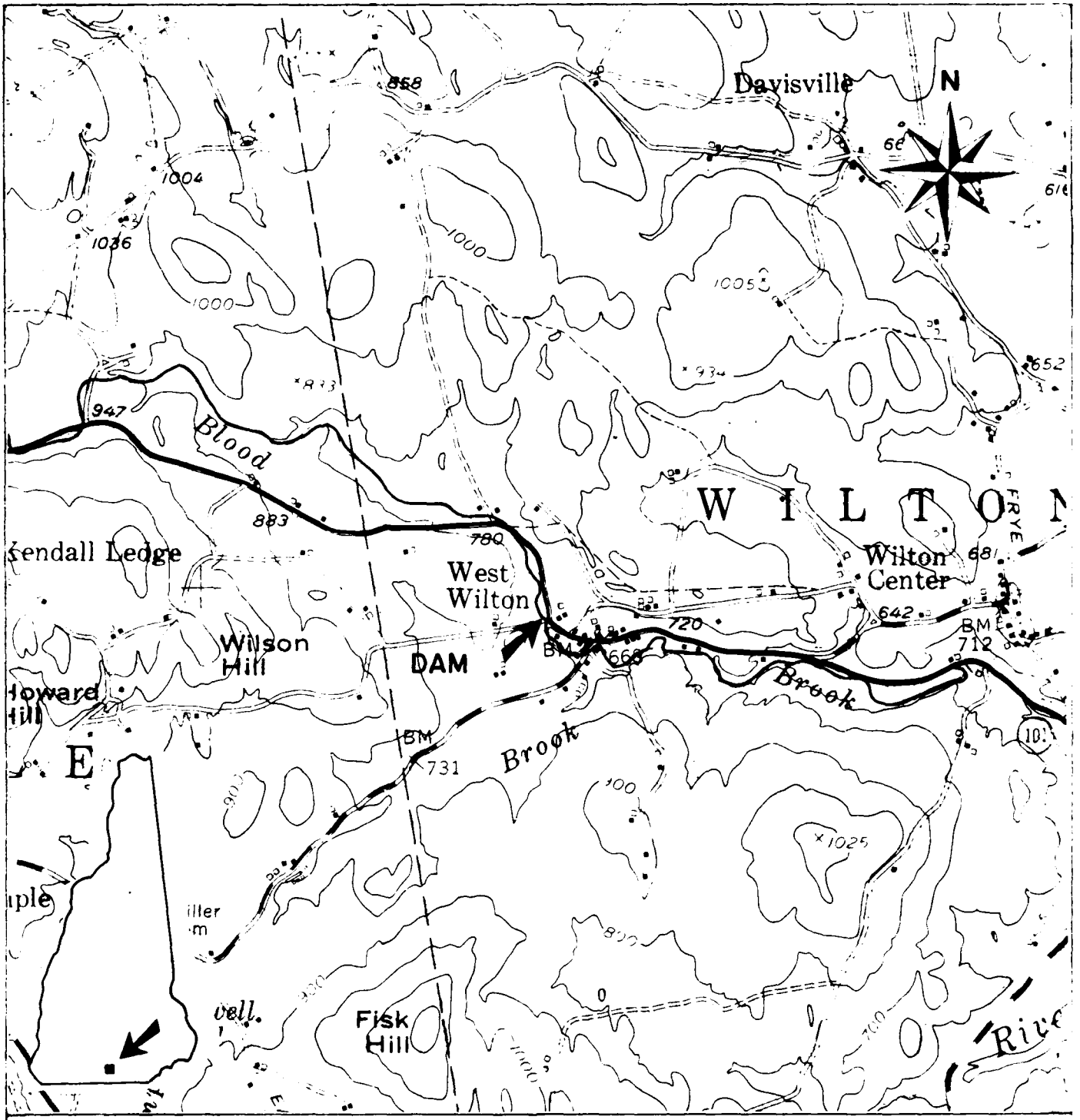
APPENDICES



Overview of Dam



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FROM USGS PETERBOROUGH - N H
QUADRANGLE MAP

GOLDBERG ZOINO & ASSOCIATES, INC GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS, MASSACHUSETTS	US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCATION PLAN

FILE No 2605

WARD DAM WILTON, NEW HAMPSHIRE

SCALE AS SHOWN

DATE OCT 1980

National Dam Inspection Program

Phase I Inspection Report

Ward Dam

Section I: 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 Progam 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 & Associates, Inc. (GZA) 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 GZA under a letter of September 23, 1980 from Colonel William E. Hodgson, Jr., Corps of Engineers. Contract NO. DACW 33-80-C-0055 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.

1.2 Description of Dam

(a) Location

The Ward Dam is located on Blood Brook in Wilton, New Hampshire approximately one quarter mile upstream of the village of West Wilton. It can be reached from a town road which intersects State Route 101 in Wilton, New Hampshire. The dam is shown on USGS Peterborough, New Hampshire quadrangle at approximate coordinates N4249.9, W7148.6 (see location map on Page vi). Page B-2 of Appendix B is a site plan for this dam.

(b) Description of Dam and Appurtenances

The dam is a gravity arch structure of split stone masonry, and concrete with a 3 foot by 2 foot waste gate, a 29 foot wide spillway, and a separate sluiceway leading to a former mill building. The dam is founded on bedrock and is a total of 260 feet long and 18 feet high.

1) Left Abutment

The left abutment is bedrock.

2) Principal Spillway

The spillway is constructed of rubble stone capped with split stone masonry and concrete. The concrete is approximately 1.5 feet high. The spillway is a broad crested weir 29 feet wide and the crest is 13.5 feet above the streambed. There is a rectangular, stone lined box culvert through this section. The invert of the conduit is 7.5 feet below the spillway crest. No operating mechanism was available for this outlet.

3) Sluiceway

The concrete faced sluiceway to the left of the dam is controlled by stoplogs. The upstream opening is approximately 18 inches wide. This sluiceway leads to a former mill building downstream which once housed a sawmill.

4) Right Abutment

The right abutment is constructed on bedrock and consists of split stone masonry wing walls with earth and stone fill. A concrete training wall approximately 3.3 feet high extends across the right abutment to the spillway section.

(c) Size Classification

The dam's maximum impoundment of 19 acre-feet and height of 18 feet place it in the SMALL size category according to the Corps of Engineer's Recommended Guidelines.

(d) Hazard Potential Classification

The hazard potential classification for this dam is SIGNIFICANT because of the appreciable economic losses and potential for loss of a few lives downstream in the event of dam failure. Section 5 of this report presents more detailed discussion of the hazard potential.

(e) Ownership

The dam is presently owned by Mr. Richard Clattenberg, West Wilton, New Hampshire. He can be reached by telephone at (603) 654-9881.

(f) Operator

The operation of the dam is controlled by Mr. Richard Clattenberg of West Wilton, New Hampshire. He can be reached by telephone at (603) 654-9881.

(g) Purpose of the Dam

The purpose of the dam is to impound water for recreational purposes. At one time, the dam was used for hydropower for a sawmill.

(h) Design and Construction History

The original design and date of construction are unknown. The records of the New Hampshire Water Resources Board indicate that the dam was constructed in 1840 to provide power for a sawmill. The mill building has since been converted to a house and the water wheels have been removed.

(i) Normal Operating Procedure

No formal procedures exist for this dam. There is no viable means of operating the sluicegate at the spillway, and the outlet sluiceway is apparently silted closed.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for this dam covers 6.6 square miles. It is made up of rolling terrain which is primarily forest with some minor development. Approximately 4.9 square miles of this area is controlled by the Souhegan River Watershed Dam No. 26 which is the subject of a separate Dam Safety Inspection Report.

(b) Discharge at Dam Site

1) Outlet Works

There is an 18 inch wide sluiceway in the left bank leading to an abandoned mill downstream. This sluiceway is plugged. There is a 3 foot by 2 foot waste gate in the center of the dam with an invert elevation of 715.1 feet (NGVD). This gate appears to be inoperable.

2) Maximum Known Flood

There is no data available for the Maximum Known Flood at this dam site.

3) Ungated Spillway Capacity at Top of Dam

The capacity of the spillway with the reservoir at top of dam elevation (728.3 feet NGVD) is 616 cfs.

4) Ungated Spillway Capacity at Test Flood

The capacity of the spillway with the reservoir at Test Flood elevation (727.2 feet NGVD) is 327 cfs.

5) Gated Spillway Capacity at Normal Pool

There are no gated spillways.

6) Gated Spillway Capacity at Test Flood

There are no gated spillways.

7) Total Spillway Capacity at Test Flood

The total spillway capacity at Test Flood elevation (727.2 feet NGVD) is 327 cfs.

8) Total Project Discharge at Top of Dam

The total project discharge at top of dam elevation (728.3 feet NGVD) is 616 cfs.

9) Total Project Discharge at Test Flood Elevation

The total project discharge at Test Flood elevation (727.2 feet NGVD) is 327 cfs.

(c) Elevation (feet above NGVD)

1) Streambed at toe of dam: Approximately 710.5

2) Bottom of cutoff: Unknown

3) Maximum tailwater: Unknown

4) Recreation Pool: Approximately 725.0

5) Full flood control pool: Not applicable

6) Spillway crest: Approximately 725.0

7) Design surcharge: Unknown

8) Top of dam: 728.3 (right abutment)

9) Test flood surcharge: 727.2

(d) Reservior (length in feet)

1) Normal Pool: 1000

2) Flood Control Pool: Not applicable

3) Spillway Crest Pool: 1000

4) Top of Dam: 1000 @728.3 (right abutment)

5) Test Flood Pool: 1000

(e) Storage (acre-feet)

1) Normal Pool: 9.8

2) Flood Control Pool: Not applicable

3) Spillway Crest Pool: 9.8

4) Top of Dam Pool: 18.8

5) Test Flood Pool: 16.4

(f) Reservoir Surface (acres)

1) Normal Pool: 3

2) Flood Control Pool: not applicable

3) Spillway Crest: 3

4) Test Flood Pool: 3

5) Top of Dam: 3

(g) Dam

1) Type: Gravity, overflow, split stone masonry arch

2) Length: Approximately 260 feet

3) Height: Approximately 18 feet

4) Top width: Approximately 4 feet, variable

5) Side slopes: Not applicable

6) Zoning: Not applicable.

7) Impervious Core: Not applicable

8) Cutoff: Unknown

9) Grout curtain: Unknown

(h) Diversion and Regulating Tunnel

Not applicable

(i) Spillway

1) Type: Masonry, broad crested weir

2) Length of weir: 29 feet

3) Crest elevation: 725.0 feet (NGVD)

4) Gates: Spillways not equipped with gates

5) Upstream channel: Reservoir

6) Downstream channel: Blood Brook, steep rocky channel

(j) Regulating Outlets

The regulating outlet is a rectangular, stonelined, box culvert through the spillway which is controlled by a vertical slide gate. The gate is 3 feet by 2 feet with an invert elevation of 715.5 feet (NGVD). It appears to be inoperable.

Section 2: Engineering Data

2.1 Design Data

None of the original design drawings or calculations are available for this dam. Lacking is data concerning the construction of the sluiceway to the mill building.

2.2 Construction Records

No construction records are available for this dam.

2.3 Operational Records

No operational records are available for this dam.

2.4 Evaluation of Data

a) Availability

There is no detailed design or construction data available for evaluation.

(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 of the dam is 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 records of the New Hampshire Water Resources Board, a satisfactory evaluation for validity is indicated.

Section 3: Visual Inspection

3.1 Findings

(a) General

The Ward Dam is in POOR condition at the present time.

(b) Dam

(1) Spillway (See Photo 1,2, and overview)

This stone masonry structure was constructed as an arch. A tunnel outlet is located near the center of the structure. The tunnel walls and roof consist of granite, and have been reinforced with steel plates. An inclined, steel, sluice gate was observed at the upstream end of the tunnel. A pressure relief gate is mounted on the steel gate, and is approximately 8 inches in diameter. Minor seepage was observed flowing through the tunnel. The gate operating equipment is either submerged or has been removed from the site.

The rubble stone masonry spillway is founded on bedrock at its left end, and either bedrock or massive boulder at its right end. The abutments of the bridge immmediately downstream form the end walls of the spillway. There are numerous unravelled boulders at the base of the structure. At one location at the left end of the spillway, stones have been displaced over an area 3 feet long, 2 feet high, and 2 feet deep. Stones above this area have bulged outward over a 10 foot square area. Ravelling has also occurred approximately 5 feet to the right of the tunnel outlet. This ravelling is in the range of 2 feet square, and 2 feet deep. This damage can be attributed to ice action. The concrete cap has been subjected to minor surface erosion which can be attributed to ice damage.

A concrete gravity training wall was constructed over 20 feet of the right end of the spillway. This wall is 3 feet 4 inches high and is in good condition with no evidence of spalls, cracks, or efflorescence.

(2) Sluiceway (see photo 5)

This structure could not be observed due to its submerged condition. The outlet consists of a penstock controlled by stoplogs. The opening is approximately 18 inches wide. There is a considerable degree of silting in front of this structure which precluded inspection. The penstock outlets in the basement of a downstream mill building which has been converted to a residence. Minor seepage flow can be seen exiting the basement of the dwelling through an outlet channel.

(c) Reservoir Area

The shore of the reservoir area is generally shallow to medium sloping woodland. It appears to be stable and in good condtion.

(d) Downstream Channel (see photo 6)

The downstream channel is steep and rocky, and consists primarily of exposed bedrock. It appears stable and in good condition.

3.2 Evaluation

The dam and its appurtenant structures are generally in poor condition. The problem areas noted during the visual inspection are listed as follows:

a) Stones have been dislodged from the downstream base of the spillway.

b) The downstream face of the spillway is bulging.

c) Operating equipment for the waste gate was not observed.

d) The condition of the sluiceway or penstock plug is unknown.

Section 4: Operational and Maintenance Procedures

4.1 Operational Procedures

(a) General

No written operational procedures exist for this dam. The dam is normally self regulating. The operability of the outlet works for this dam is unknown.

(b) Description of any Warning System in Effect

There is no warning system in effect at this dam.

4.2 Maintenance Procedures

(a) General

No formal maintenance program exists for the dam, and maintenance is performed infrequently.

(b) Operating Facilities

No formal maintenance program exists, and maintenance is performed infrequently.

4.3 Evaluation

Emphasis on routine maintenance will assist the owner in assuring the long-term safety of the dam and operating facilities. A formal, written, downstream emergency warning system should be developed for this dam.

Section 5: Evaluation of Hydraulic/Hydrologic Features

5.1 General

Ward Dam is a masonry dam on Blood Brook, a tributary of the Souhegan River, which is a tributary of the Merrimack River. The dam is located about 1000 feet upstream of West Wilton, New Hampshire.

Ward Dam is about 260 feet long and 18 feet high. Part of the dam embankment is formed by a small road which crosses Blood Brook on a bridge just downstream of the dam. The reservoir behind the dam has a surface area of about three acres at normal pool. The resevoir stores about 19 acre-feet at the dam crest.

The principal spillway is a 29 foot granite masonry weir with a concrete cap and its crest at about 725 feet NGVD. There is a 3' x 2' gate in the spillway with its invert at 715.5 feet NGVD, and a sluiceway in the left embankment with its invert at 722.5 feet NGVD. Both outlets were closed at the time of the inspection and neither appeared to be operable.

The right abutment is a concrete training wall at 728.3 feet NGVD running for 20 feet before the grade climbs to the roadway just downstream of the spillway. To the left of the spillway is natural ledge at 726.3 feet NGVD. The ledge runs 7 feet before climbing to the roadway. The top of the dam has been taken as the training wall at the right abutment (elevation 728.3 NGVD).

Downstream of the dam, Blood Brook runs for about 1,000 feet as a steep, mountain stream in a steep-sided channel. The only development in the reach is one house well above the stream.

About 1,000 feet downstream of Ward Dam, Blood Brook passes under a road leading from West Wilton to Temple, New Hampshire. The bridge has two granite arch masonry openings, one 12' x 7' and one 19' x 7'. The roadway surface is 10 feet above the stream. There are two houses upstream of the bridge - one with a cellar 4 feet above the stream and first floor at the roadway level, and the other well above the stream. Downstream of the bridge there is one house 2 to 3 feet below the roadway and one at roadway level.

About 700 feet downstream of this bridge, Blood Brook is joined by Temple Brook. There is one house in this reach (besides the two already discussed), about 8 to 10 feet above the stream channel. Blood Brook runs 2,000 feet from the junction with Temple Brook to a restaurant, and a house at the downstream end of West Wilton. In this reach, there are 3 houses 10 to 15 feet above the stream channel, and the restaurant and house 12 feet up.

Downstream of West Wilton, Blood Brook runs about 2 miles to the Souhegan River. The only structures in the reach are a house 2,000 feet downstream of West Wilton, and the Route 31 bridge, just 800 feet upstream of the Souhegan River. The following sections provide a detailed hydraulic/hydrologic discussion of the dam.

5.2 Design Data

Data sources available for Ward Dam include a 1936 sketch of the dam; the New Hampshire Water Resources Board's August 28, 1936 "Inventory of Dams and Water Power Developments," the Public Service Commission of New Hampshire's September 3, 1936 "Dam Record," the New Hampshire Water Control Commission's undated "Record of Dam No. 254-18", and September 26, 1939 "Data on Dams in New Hampshire." Also available, were inspection reports dated June 10, 1940; July 16, 1951; and July 24, 1975 and a record of flooding during the September 1938 flood (record dated October 14, 1938). The original hydraulic calculations were not available for this dam.

5.3 Experience Data

No records of flow or stage are known to be available for Ward Dam or the area immediately downstream.

5.4 Test Flood Analysis

The hydrologic conditions of interest in this Phase I Investigation are those required to assess the dam's overtopping potential, and its ability to safely allow an appropriately large flood to pass. This requires use of the discharge and a storage characteristics of the structure to evaluate the impact of an appropriately sized Test Flood. The original hydraulic and hydrologic design analyses are not available for this dam.

Guidelines for establishing a recommended Test Flood based on the size and hazard classification of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. The impoundment of less than 1,000 acre-feet and the height of less than 40 feet classify this dam as a SMALL structure.

The appropriate hazard classification for this dam is SIGNIFICANT because of the significant economic and small potential for loss of a few lives downstream in the event of failure of the dam. As shown in the Dam Failure Analysis section, the increase in flooding caused by failure would cause property damage in West Wilton, 1,000 feet downstream of the dam.

As shown in Table 3 of the "Recommended Guidelines", the appropriate Test Flood for a dam classified as SMALL in size with a SIGNIFICANT hazard potential would be between the 100-year flood and one-half the probable maximum flood (PMF). Since the risk downstream in the event of dam failure is on the low side of SIGNIFICANT, the 100-year flood is the appropriate Test Flood.

The drainage area upstream of Ward Dam is 6.58 square miles. However, 4.9 square miles of this area is controlled by the Soil Conservation Services's Souhegan River Watershed Dam No. 26. The SCS Design notes for this dam give a peak outflow of 144 cfs.

The 100-year inflow for Ward Dam was estimated as the peak discharge of 184 cfs from the uncontrolled drainage area of 1.68 square miles, added to the peak 100 year outflow rate from S.R.W.D. #26 which is given by the S.C.S. as 144 cfs. Using this methodology, the Peak Test Flood inflow was 328 cfs, about 50 csm for the 6.58 square mile drainage area.

Attenuation due to storage in the reservoir is negligible and the Test Flood routed peak outflow is 328 cfs, with the reservoir water surface at 727.2 feet NGVD. This is 2.2 feet above the principal spillway crest and 1.05 feet below the top of the dam. The spillway capacity is 190 percent of the Test Flood routed outflow.

5.5 Dam Failure Analysis

The downstream flows that would result from the failure of Ward Dam are estimated using the procedure suggested in "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs." The failure is assumed to occur with the water surface elevation at the level of the left abutment, 728.3 feet msl. The outflow prior to dam failure would be 616 cfs, creating a tailwater of about 2 feet in the channel downstream of the dam.

For an assumed breach width equal to 40 percent of the dam width at the half-height, the gap in the dam due to failure would be about 20 feet. The resulting peak failure outflow would be 3,130 cfs given the 17.8 foot dam height, increasing tailwater to 4 feet. This would easily pass under the bridge just downstream of the dam.

The peak flow resulting from dam failure would be attenuated to 2,450 cfs at the bridge 1,000 feet downstream of the dam, resulting in an increase in stage from 4 feet before failure to 10 to 11 feet, about 1/2 foot over the roadway surface. This flow would cause flooding to several feet in the cellar and 0 to 1 feet in the first floor at one house upstream of the bridge, minor flooding at another house downstream, and 1 to 3 feet of flooding at the bridge which might well damage or destroy the bridge. There is only a slight chance of loss of life in this area, since the flooding would be backwater flooding, and flow rates would be low.

The next reach of Blood Brook, 2,700 feet to the downstream end of West Wilton, includes the juncture with Temple Brook. This reach has one house 8 to 10 feet above the stream near the upstream end, 3 houses 10 to 15 feet up, and a restaurant and house 12 feet up.

The prefailure flow of 616 cfs would cause a stage of 4.1 feet in Blood Brook. The peak dam failure flow of 2,450 cfs would cause a stage of 8.4 feet at the upstream end of the reach. This would attenuate significantly through West Wilton due to the storage provided by the stream. The only structure which might receive minor (less than 0.5 feet) flooding in this reach is the lowest house.

Downstream of West Wilton, Blood Brook runs about 2 miles to the Souhegan River. The dam failure flood flow would attenuate a great deal in this reach, and would probably not threaten any of the structures in the reach. The flow resulting from the failure of Ward Dam would probably cause no damage along the Souhegan River.

The chart on the next page summarizes the downstream effects of the failure of Ward Dam.

Location # (see Map)	Location	Distance Downstream from Dam (feet)	# of Structures	Level above Stream (ft)	Flow & Stage Before failure	Flow & Stage After failure	Comments
-	Just D/S of Ward Dam	-	1 bridge	18 ft.	616 cfs 1.8 ft.	3130 cfs 4.1 ft.	Little danger to bridge
1	Bridge on road to Temple	1000 ±	1 house 2 houses 1 house 1 house 1 bridge	8 ft. 10 ft. 15 ft. cellar 4 1st floor 10 10 ft.	616 cfs 4.1 ft.	2450 cfs 10.6 ft.	slight danger of loss of life, minor flooding a one house, significant flooding at 2 others - about 1/2 ft. flow over road.
	house before Temple Brook	1400	1 house	8 ft.	616 cfs 4.1 ft.	2450 cfs <8.4 ft.	possible minor flooding. Flow attenuates downstream - no further flooding likely.

Section 6: Structural Stability

6.1 Evaluation of Structural Stability

(a) Visual Observations

1) General

Ward Dam is in poor condition at the present time.

2) Spillway

The investigation revealed that stones have been dislodged, and the face of the spillway near the left abutment is bulging outward.

3) Sluiceway

This structure is heavily silted, and plugged. Some seepage is flowing through the penstock.

(b) Design and Construction Records

No plans or calculations of value to a stabililty assessment are available for this dam.

6.2 Design and Construction Data

No records of structural stability analyses are available for this dam.

6.3 Post Construction Changes

The sluiceway at the left abutment has been filled in with silt and debris.

6.4 Seismic Stability

The dam is located in seismic zone No. 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

Ward Dam is in POOR condition at the present time. The dislodged stones at the base of the spillway, and the bulging of the face of the spillway should be arrested and repaired.

(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 based primarily on the visual inspection, past performance, and sound engineering judgement.

(c) Urgency

The Engineering studies and improvement described herein should be implemented by the owner within one year of receipt of this Phase 1 Inspection Report.

7.2 Recommendations

It is recommended that the services of a qualified registered professional engineer be retained to:

(a) Draw down the impoundment pool, inspect the upstream side of the dam, and make recommendations for the repair of all deficiencies.

(b) Investigate the structural stability of the spillway with attention given to the bulging of the face and the heavy ice loading noted at this dam.

(c) Investigate the operability of the sluice gate, and make recommmendations for its rehabilitation, if necessary.

(d) Investigate the condition of the sluiceway and penstock, and make recommendations for its rehabilitation or removal, as appropriate.

The owner should implement the findings of these investigations.

7.3 Remedial Measures

It is recommended that the following remedial measures be undertaken by the owner:

(a) Implement a program of annual technical inspections of the dam and its appurtenances including operation of all outlet works.

(b) Develop a plan for surveillance of the dam during and immediately after periods of heavy rainfall and a formal warning system for alerting downstream residents and officials in the event of an emergency.

(c) Implement and intensify a program of diligent and periodic maintenance.

7.4 Alternatives

There are no meaningful alternatives to the above recommendations.

APPENDIX A

VISUAL CHECKLIST WITH COMMENTS

Inspection Team Organization

DATE: October 17, 1980

PROJECT: NH00262
Ward Dam
Wilton, New Hampshire
NHWRB 254.18

WEATHER: Clear, warm

INSPECTION TEAM:

Nicholas A. Campagna	Goldberg-Zoino & Assoc.	Team Captain
William S. Zoino	GZA	Soils
Jeffrey M. Hardin	GZA	Soils
Andrew Christo	Andrew Christo Engineers	Structures
Paul Razgha	ACE	Structures
Carl Razgha	ACE	Structures

NHWRB Representative Present - Gary Kerr

NOTE: Tom Gooch and Richard Laramie of Resource Analysis Inc., performed the hydrologic inspection of this dam on October 3,1980.

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
GENERAL		
Crest Elevation	JMH	728.3 feet NGVD
Current Pool Elevation	JMH	725.0 feet NGVD
Maximum Impoundment to Date		Unknown
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS		
a. Approach Channel		
Loose Rock Overhanging Channel	NAC	None
Trees Overhanging Channel	NAC	Minor
Floor of Approach Channel	NAC	Submerged, appears to be heavily silted.
b. Spillway		
General Condition	AC	Stones have become dislodged at base of spillway, and over an area 3' long x 2' high x 2' deep adjacent to left abutment. Ten square foot area of displaced stones located above unravelled stones. Unravelled stones 2' x 2' x 2', five feet to right of tunnel outlet. Unravelling caused by ice damage.
Seepage		None noted except minor seepage through outlet gate
c. Training Wall		
General Condition of Concrete		Good
Rust or Staining	AC	None

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
Spalling	AC	None noted
Any Visible Reinforcing		None noted
Any Seepage or Efflorescence		None noted
Drain Holes	AC	None noted
d. Discharge Channel		
General Condition	JMH	Good
Loose Rock Overhanging Channel		None
Trees Overhanging Channel		Minor
Floor of Channel		Bedrock
Other Obstructions	JMH	Two fish weirs downstream would not restrict large flows.
OUTLET WORKS - WASTEGATE AND BOX CULVERT		
General Condition	PK	Fair, no operating mechanism was observed.
Condition of Joints		Good
Spalling		None noted
Visible Reinforcing		None
Rusting or Staining of Concrete		Some rust staining due to seepage
Any Seepage or Efflorescence		Some minor seepage past gate.
Cracks		None
Rusting or Corrosion of Steel	PK	Minor rusting of gate

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE		
a. Approach Channel		
Slope Conditions	JMH	Good
Bottom Conditions		Silted up
Rock Slides or Falls		None
Log Boom		None
Debris		Heavily silted and blocked with leaves.
Condition of Concrete Lining		Not observed
Drains or Weep Holes	JMH	None observed
b. Intake Structure		
Condition of Concrete	AC	Good
Stop Logs and Slots		None in place, slots good.
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL		
General Condition		Poor, penstock is apparently plugged with silt and there is some seepage. Structure was not observed.
Rust or Staining		Unknown
Spalling		Unknown
Erosion or Cavitation		Unknown
Visible Reinforcing		Unknown
Any Seepage or Efflorescence	AC	Some seepage observed at outlet

CHECKLIST FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITIONS AND REMARKS
Condition at Joints	AC	Unknown
Drain Holes		Unknown
Channel		
Loose Rock or Trees Overhanging	NAC	Minor
Condition of Discharge Channel	NAC	Good

APPENDIX B

ENGINEERING DATA

State of New Hampshire

WATER RESOURCES BOARD

37 Pleasant St.
CONCORD 03301

February 26, 1976

Mr. Richard Clattenberg
West Wilton
New Hampshire

Dear Mr. Clattenberg:

Under the provisions of RSA-Chapter 482, Sections 8 through 15, the New Hampshire Water Resources Board is authorized to inspect all dams in the state which by reason of their physical condition, height, and location may be a menace to the public safety.

The dam structure (Dam # 254.18) located on your property in Wilton , N.H. was inspected on 7/24/75 and as a result of this inspection no discrepancies were found at the time of the inspection which would require any corrective measures.

This letter is provided for your information only. If you have any questions, please feel free to call or write.

Sincerely,

George M. McGee, Sr.

George M. McGee, Sr.
Chairman

GMM/SCB:L

cc: Board of Selectmen
Wilton

N. H. WATER RESOURCES BOARD
Concord, N. H. 03301

DAM SAFETY INSPECTION REPORT FORM

Town: Wilton Dam Number: 254.13

Inspected by: S Bunnith Date: 24 July 19 75

Local name of dam or water body: _____

Owner: Richard Clattenberg Address: _____

Owner was/was not interviewed during inspection.

Drainage Area: 5.5± sq. mi. Stream: Blood Brook

Pond Area: 1 Acre, Storage 2 Ac-Ft. Max. Head 11.5 Ft.

Foundation: Type Ledge, Seepage present at toe - Yes/(No)

Spillway: Type Overflow, Freeboard over perm. crest: 3',
Width 29'±, Flashboard height 0,
Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover _____ Width _____,
Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type Conc, Condition: (Good), Fair, Poor

Gates or Pond Drain: Size _____ Capacity _____ Type _____
Lifting apparatus _____

Changes since construction or last inspection: _____

_____

_____

Downstream development: _____

This dam would/would not be a menace if it failed.

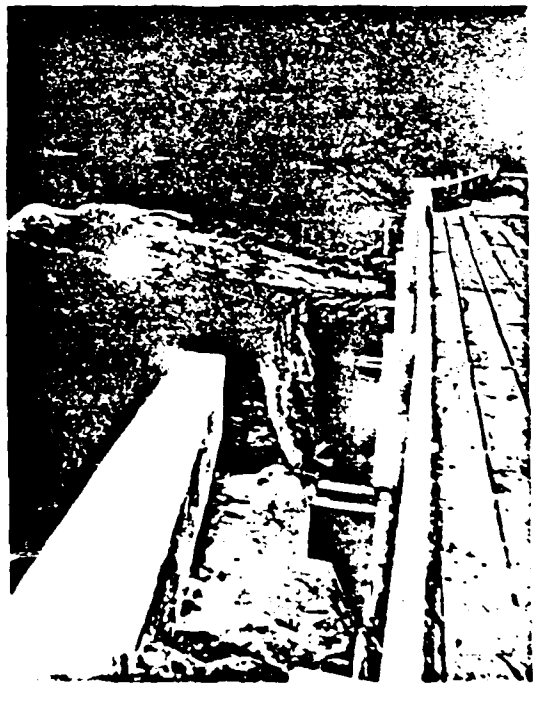
Suggested reinspection date: _____

Remarks: _____

_____

_____

_____



NEW HAMPSHIRE
WATER RESOURCES BOARD

SITE EVALUATION DATA

OWNER: Richard Clattenberg TELEPHONE NO. _____

MAILING ADDRESS: _____

SITE LOCATION (TOWN OR CITY) _____

NAME OF STREAM OR WATERBODY: _____

QUADRANGLE: Peterboro LOCATION up 5.75" Lt 3.08"

HEIGHT OF (PROPOSED, EXISTING) DAM 11.5 LENGTH 200

TYPE OF (PROPOSED, EXISTING) STRUCTURE Conc Cap Split stone Bo

DRAINAGE AREA 5.5 ±Sm POND AREA 1

AVAILABLE ARTIFICIAL STORAGE: PERMANENT: _____ TEMPORARY: _____ TOTAL 2

EXISTING DEVELOPMENT DOWNSTREAM OF (PROPOSED, EXISTING) STRUCTURE

Town Road & Bridge 50' Down

Homes

POTENTIAL DEVELOPMENT DOWNSTREAM OF (PROPOSED, EXISTING) STRUCTURE _____

POTENTIAL DAMAGE DOWNSTREAM OF STRUCTURE (EXPLAIN IN DETAIL AND INCLUDE ANY POTENTIAL LOSS OF LIFE ESTIMATE) _____

OTHER COMMENTS: _____

CLASS OF STRUCTURE -- NON MENACE: MENACE A B C DAM # 254.18

DATE OF INSPECTION: 24 July 75

SIGNED S Burritt

SIGNATURE

DATE:

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Wilton DAM NO. 25/8 STREAM Flood Brook

OWNER Daniel Needham ADDRESS West Wilton, N.H.

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on 7/16/51 accompanied by

NOTES ON PHYSICAL CONDITION

Abutments Excellent

Spillway Excellent

Gates Typewhile

Other

CHANGES SINCE LAST INSPECTION Rt. abutment raised 3'-2" - top width 18" at spillway & 30" at right abutment - 3½' bottom width - Concrete. Built on right half of old Conover spillway.

FUTURE INSPECTIONS Yes

This dam (is) ~~(is not)~~ a menace because of highway below.

REMARKS Water just spilling.
Low retaining wall.
Bridge just below rebuilt this year.

Copy to Owner	Date

Francis C. Moore
INSPECTOR

(Additional Notes Over)

C/58-1

September 17, 1940

Mr. Louis C. Aimini
Wilton
New Hampshire

Dear Sir:

As requested in your letter of September 5, Mr. Colman of this office visited Mr. Ward's dam and also the water hole on Blood Brook directly downstream.

He found that Mr. Ward had constructed the dam in a satisfactory manner so as not to become a public menace. He also found that Mr. Ward had a breeder's permit from the Fish and Game Department which permits him to install screens in the Brook. This he is doing in cooperation with the Fish and Game Department.

It is my understanding that the water hole was filled with water at the time of Mr. Colman's visit and it would appear that once the fire hole is filled, conditions will be similar to what they were before the flashboards were replaced by concrete. Mr. Ward, however, has indicated his willingness to cooperate whenever necessary in letting down enough water to keep the fire pool full.

This, I believe, was what you were primarily interested in and I therefore hope that this settlement will meet with your approval. We are now considering the case closed.

Very truly yours,

Richard S. Holmgren
Chief Engineer

RSH:LP.

MEMORANDUM

TO: Richard S. Holmgren, Chief Engineer

RE: Complaint by Mr. Aimini of West Wilton

In regard to this matter, I have asked Mr. Carpenter Director of the Fish and Game Department to request that Mr. Proctor the Conservation Officer of that district, look into the matter. Attached hereto is a copy of Mr. Proctor's letter to the Fish and Game Commission which explains the situation.

I also visited Mr. Ward's dam and found that the work that he did consisted of constructing a cement weir on top of an old spillway to the height of an old flashboard. At one time the stone work extended to this height but was removed and flashboards installed. These were found to be unsatisfactory due to leakage so Mr. Ward put the structure back into its original shape. I talked with a couple of property owners adjacent to the fire pool which was built by Mr. Smith and the Town and their only concern was that in dry weather, Mr. Ward might not let down enough water to keep the fire pool full.

However, Mr. Ward assured me that any time in the summer that the town pool needs water, he would be very willing to cooperate by letting down water, which information when I conveyed to the people concerned, seemed to adjust their feelings.

Mr. Proctor will keep an eye on the affair so that the normal flow of the stream is let down. This is in the province of the Fish and Game Department to maintain the fish life in the streams. The fire pool now is completely filled since the last rain and I believe the matter has been adjusted to the satisfaction of all concerned.

Respectfully submitted,

Charles D. Colman
Assistant Engineer

CDC:LR.
9/14/40

STATE OF NEW HAMPSHIRE

INTER-DEPARTMENT COMMUNICATION

DATE Sept. 12, 1940.

FROM Proctor - **AT (OFFICE)**

SUBJECT Aimini Complaint - Wilton N.H.-

TO Chairman Water Control Commission.

My Dear Sir .-

I have at hand a letter from the Fish and Game Dept of which I am a Conservation Officer . This pertains to the building of dams and screening of brooks .

This is a SPITE case pure and simple .

If one of your men come to Wilton I would like to go with him and tell him the story. I dont think Mr Ward is on town just now and it would be unfair to him not to hear both sides of this argument .-

Mr Ward is a good sport and has spent a good many thousands of dollars in this town and pays a big tax . I want your Commission to get my side of the story and then get Mr Aimini side . You will find its a case of spite .

Yours very truly.-

Geo S Proctor -

Conservation Officer
Dist No 2
Fish and Game Dept .-

P.S. Let me know when your man comes to town and I will make it a point to meet him . It must be this week for next week I go to Springfield to the Eastern States Exposition to represent the F and G Dept .-

I will be home again Sept . 23rd .-

I have written to Director Carpenter giving him the facts as I see them . Hope I am right .-

STATE OF NEW HAMPSHIRE
FISH AND GAME DEPARTMENT
CONCORD

ADDRESS ALL CORRESPONDENCE TO
DIRECTOR

September 13, 1940

Mr. C. D. Colman
Water Control Commission
Concord, N. H.

Dear Mr. Colman:

We asked Conservation Officer George S. Proctor of Wilton to investigate the Blood Brook proposition as outlined in Mr. Louis C. Aimini's letter of September 5 to you and the following is his report:

"Your letter of the 11th in regard to the Ward dams at hand. This Mr. Aimini has nothing to do with this matter in any way, shape nor manner. It is a neighborhood scrap and I find those things are well to be out of. A few years ago Mr. Ward applied to the State Dept. for a permit to screen this Blood Brook. Two men from the Fish and Game Dept. came down and O.K.'d it and he went at big expense to dam and screen the brook. Every year he buys from 1500 to 2000 ten inch trout and puts them into the lower pool. In the fall he sends for me and with his man we transplant to the big pond above also owned by Mr. Ward (which is open to fishing) all the trout left in the pools that he has kept them all summer. This he has done now for the past few years. Last March the town appropriated $200 for a water hole where an old dam went out farther down the brook from Mr. Ward. Prof. A. F. Smith who owns a summer home nearby put up a like sum and a shovel was put in and dug out quite a space. It being a dry year the water did not come down as fast that they wanted to fill up the pond so Mr. Smith and some men went up and pried up the blank and let down the water. Mr. Ward caught them in the act and I guess he told them a few things. Here is where Mr. Aimini enters the scene. He wants to make himself a big fellow in that little burg. If I told you his history it would not look well in print so I will defer that until I see you personally. This man Ward is a successful business man and has rubber farms all over the world. He has a business in Brookline, Mass. and factories all over Mass. He knows his stuff and would not break a law on his life. He told me sometime ago that an agent of the Water Control Commission came down and inspected his dams and O.K.'d them. Mr. Ward has a breeder's permit to keep the trout. This man has done a lot to help stock the brooks of this town at his own expense. They are sore because they think he is holding back the water but he is filling

his pond. When the pond is full they get the water that runs over the dam. This whole matter is a case of spite. Why didn't they make a complaint years ago when the dams were first built and the screens put in. This recent 18 inches of cement on the old dam is just putting the old dam where its been or was before the flood for one hundred years."

It would seem that this is more or less of a spite case and as far as this department is concerned, I would say that Mr. Ward was within his rights as he has a breeder's permit and apparently he benefits the fishing in that section by placing his large trout in the lower pool which is open to the public to fishing.

I trust that this answers your inquiry in regard to the matter.

Sincerely yours

Ralph G. Carpenter, 2nd

Ralph G. Carpenter, 2nd
Director

RGC:EMC

West Wilton N. H Sept 5th. 1940

Water Resource Board
Concord N. H

C. D. COLMAN
WATER CONT. COMM.

Sirs:-

I wish to bring to your attention a condition existing in Blood Brook, at West Wilton N. H- which we trust you will investigate, at once.

Here's the Story:-

At Town meeting, last Spring, it was voted to raise $200.00. to build a water hole in Blood Brook in the rear of Professor Archibald Smith's premises-

Professor Smith contributed $560.00 in cash and time, to develop the water Hole into a place of recreation for the

Citizens of West Milton.

To achieve his end was necessary for him to build a dam the permit for which was issued from your office three days ago - on the hill above Professor Smith's on land owned by Mrs Delia Ward - Mr Ward has seen fit to remove flash boards from his dam and fill in with cement which cannot be raised or lowered, above the water line - Thus nullifying all effort and expense put out by the Town and Professor Smith - Also preventing the formation of the Water Hole as planned -

Another thing directly in the rear of Mr Ward's premises he has constructed two dams and enclosed by wire two pools wherein he has impounded all the fish above him.

He, further, has erected a gate closing the brook to all fishermen.

Please send a man to West Milton to investigate this matter at once and advise the writer when you will do so -

If he will call on the writer at his home in West Milton he would be glad to go over the subject with him.

The writer is entering this complaint in the interests of other residents of West Milton as well as his own -

If you should desire references as to the integrity of the writer he would refer you to the Wilton Selectmen

The writer is a resident and taxpayer of West Wilton

Very sincerely

Louis C. Aimini

MEMORANDUM

Case No. C158-I

TO: Richard S. Holmgren, Chief Engineer

RE: Blood Brook in W. Wilton.

Two of the Selectmen of Wilton called at the office Monday afternoon, September 30, 1940 in reference to the Ward Dam in West Wilton. Mr. Durgin who I have always done business with in Wilton was present.

It seems that they have received complaints from property owners concerning the raising of the spillway at the Ward Dam. Mr. Ward originally had flashboards in the spillway of the dam to a height of about 18 inches. He has replaced these flashboards with a concrete slab of approximately the same height. The Selectmen felt that there might be some question of water going over the abutments in high water but were more worried about their bridge which is directly below the dam. What worried them here was the fact that perhaps the bridge was not high enough under existing conditions to carry off the water.

I suggested to them that they get in contact with Mr. White, Division Engineer for the Highway Department and have him visit the site with them and give them what advise he could. I personally do not believe that the dam is a menace as constructed and possibly the only trouble that could ensue would be water over the abutment upon which the bridge rests.

The situation all started due to fishermen in the area being alarmed over the fact that Mr. Ward has screened the brook for rearing pools and they were not able to fish in this area. However, Mr. Ward has permission from the Fish and Game Department and that is not within our jurisdiction. The Selectmen were aware of the fact that Mr. Ward had repaired his dam without permission from the Commission.

The Selectmen seem to realize that the affair is more or less out of our jurisdiction but suggested that they might request me to attend a conference with Mr. Ward to work the matter out.

I told them I would do anything possible but felt that Mr. White would be the man to see.

Respectfully submitted,

Charles D. Colman
Assistant Engineer

CDC:LR.
10/2/40

Time: 1:30 P. M.

NEW HAMPSHIRE WATER CONTROL COMMISSION

REPORT ON DAM INSPECTION

TOWN Wilton DAM NO. 254.18 STREAM Blood Brook

OWNER S. P. Ward ADDRESS Wilton, N. H.

In accordance with Section 20 of Chapter 133, Laws of 1937, the above dam was inspected by me on June 10, 1940 accompanied by _____

NOTES ON PHYSICAL CONDITION

Abutments _____

Spillway _____

Gates _____

Other _____

CHANGES SINCE LAST INSPECTION _____

FUTURE INSPECTIONS _____

This dam (is) (is not) a menace because _____

REMARKS _____

Copy to Owner	Date

_____
INSPECTOR

B-17

(Additional Notes Over)

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

LOCATION STATE NO. 254.18 ✓

Town Wilton ✓ : County Hillsboro ✓

Stream Blood Brook ✓

Basin-Primary Merrimack R. ✓ : Secondary Souhegan R. ✓

Local Name Ward Dam ✓

Coordinates—Lat. 42°50'-600ft : Long. 71°50'-6,400ft.

GENERAL DATA

Drainage area: Controlled ..... Sq. Mi.: Uncontrolled ..... Sq. Mi.: Total 5½ ± Sq. Mi.

Overall length of dam 200 ✓ ft.: Date of Construction 1840 present Dam 1920 ✓

Height: Stream bed to highest elev. 18 ✓ ft.: Max. Structure 11.5 ✓ ft.

Cost—Dam ..... : Reservoir .....

DESCRIPTION Gravity-Stone, concrete on ledge ✓

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 stone&concrete

Length—Total 24.917 ✓ ft.: Net ..... ft.

Height of permanent section—Max. 11.5 ✓ ft.: Min. ..... ft.

Flashboards—Type Fixed ✓ : Height o 1.583 ft.

Elevation—Permanent Crest ..... : Top of Flashboard .....

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

Abutments

Materials: .....

Freeboard: Max. 6.5 ✓ ft.: Min. ..... ft.

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

OWNER S.B.Ward ✓

REMARKS Dam is Menace. Use is Storage for Industrial use, Recreational

Dam in good condition ✓

B-19

Tabulation By RLT Date 9/26/39

Rec'd 10/15/38

Jacobson	
Holmgren	✓
Colman	
Return to	
Filed	
File No.	

WATER CONTROL COMMISSION

STATE OF NEW HAMPSHIRE

Concord, New Hampshire

October 14, 1938.

S B Ward,
Wilton N H

254.18

RE: Blood Brook Dam. W. C. C. No. 254.~~18~~

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. 3 feet

5. At what day and hour did the maximum flood height reach your dam? Ans. Was not here at the time so do not know.

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

Yours truly
S B Ward

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.

3-10

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD I-5519

TOWN	WILTON	TOWN NO. 18	STATE NO.
RIVER STREAM	Blood Brook		
DRAINAGE AREA		POND AREA	
DAM TYPE	Gravity	FOUNDATION NATURE OF	Ledge
MATERIALS OF CONSTRUCTION	Stone, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	18'	TOP OF DAM TO SPILLWAY CRESTS	6½'
SPILLWAYS, LENGTHS / DEPTHS BELOW TOP OF DAM	24'-11" / 6½"		LENGTH OF DAM Approx. 20
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	Fixed 19"		
OPERATING HEAD CREST TO N. T. W.		TOP OF FLASHBOARDS TO N. T. W.	
WHEELS, NUMBER KINDS & H. P.			
GENERATORS, NUMBER KINDS & K. W.			
H. P. 90 P. C. TIME 100 P. C. EFF.		H. P. 75 P. C. TIME 100 P. C. EFF.	
REFERENCES, CASES, PLANS, INSPECTIONS			

REMARKS

OWNER: S. B. Ward

CONDITION: Good

MENACE: Yes. Will be subject to periodic inspection.

To the Public Service Commission:

The foregoing memorandum on the above dam is submitted covering inspection made Aug. 27, 1936, according to notification to owner dated Aug. 14, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Sept. 3, 1936
Copy to Owner

Co. .....

No. .....

CALCULATION SHEET

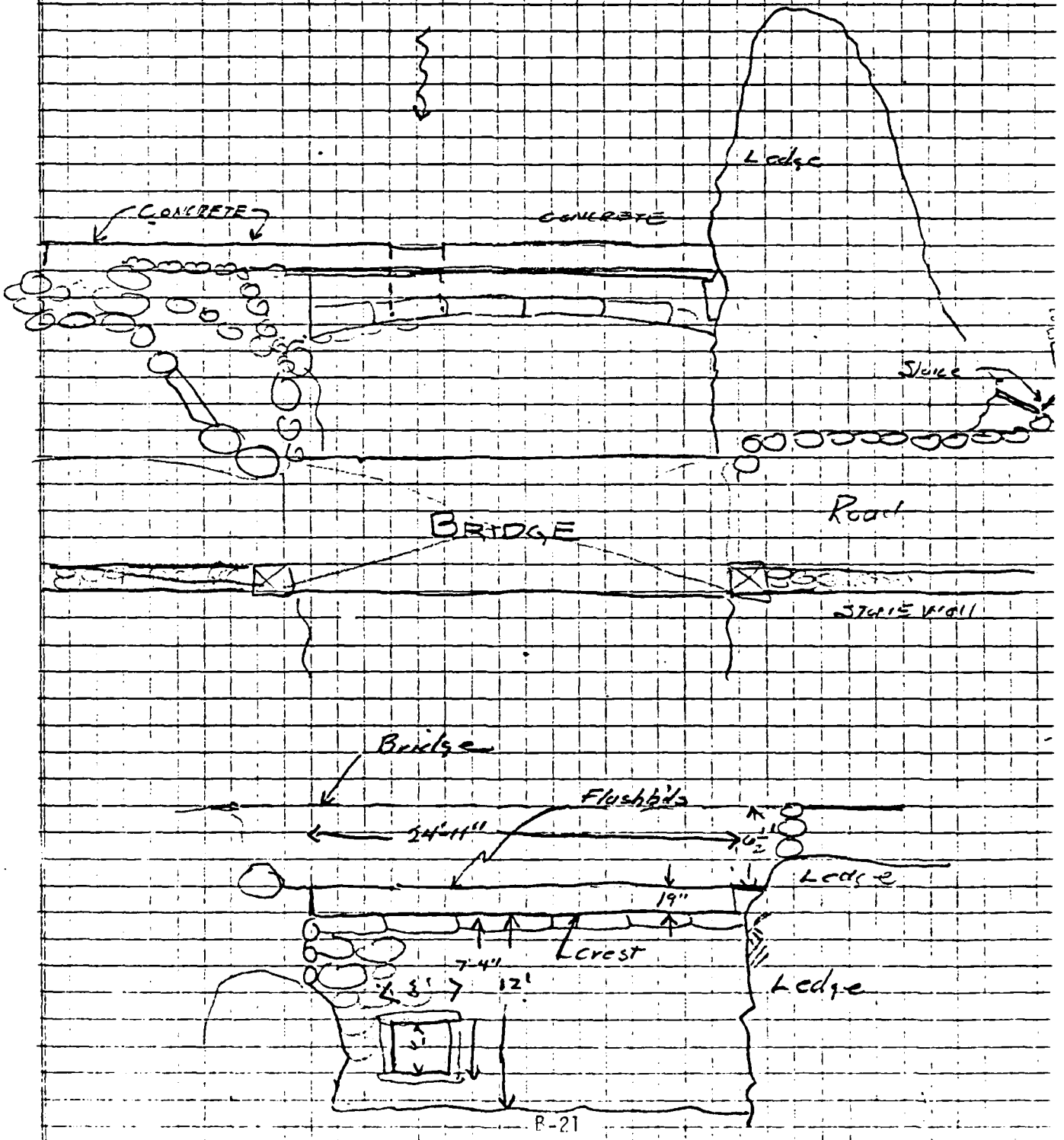
Date ..... Aug. 27, 1936 .....

Refers to.....

Made By ..... EEB .....

2544

S. BWARD



State of New Hampshire
PUBLIC SERVICE COMMISSION

COPY

August 14, 1936

S. B. Ward
Milton, N. H.

Dear Sir:

Pursuant to the duty imposed upon it by Chapter 218 of the Public Laws of New Hampshire, the Public Service Commission will inspect the dams in the vicinity of Milton, New Hampshire on August 27, 1936.

Town Records indicate that you are the owner of one dam in the Town of Milton, New Hampshire, which will be inspected on the above mentioned date. We should be pleased to have you or your representative present during this inspection if you so desire.

Under the statute all dams in your vicinity will be inspected to determine whether or not they would be a menace to the public safety if improperly maintained. Dams which would not be a menace to the public safety will not be subject to a later periodic inspection. It is our intention to inspect dams which would be a menace to the public safety if improperly maintained about once every five years.

There will be a nominal charge for such dams as would be a menace to the public safety if not constructed and maintained properly. We hope you will be present when our inspector views your dam so that you may avail yourself of his services.

Very truly yours,

N. H. PUBLIC SERVICE COMMISSION

D Waldo White

D. Waldo White
Chief Engineer

THE OLD RED MILL
1840
West Wilton, New Hampshire

August 30, 1936

E. D. Waldo White
Public Servic Com.
Concord N.H.

Dear Mr. White.

I was very sorry to be away on August 27 when, according to your letter of the 14th, my dam was to be inspected. Will you, therefore, advise me of the conditions of the dam as reported by your inspector.

Yours truly
S. B. Ward

NEW HAMPSHIRE WATER RESOURCES BOARD

INVENTORY OF DAMS AND WATER POWER DEVELOPMENTS

DAM

BASIN Merrimack NO. 18 — — I-5519
RIVER Blood Brook MILES FROM MOUTH D.A.SQ.MI.
TOWN Wilton OWNER S. B. Ward, Wilton
LOCAL NAME OF DAM Ward Dam
BUILT 1840 DESCRIPTION Gravity — Stone & Concrete on ledge
present dam 1920

POND AREA-ACRES DRAWDOWN FT. POND CAPACITY-ACRE FT.
HEIGHT-TOP TO BED OF STREAM-FT. 18 MAX. MIN.
OVERALL LENGTH OF DAM-FT. 200± MAX. FLOOD HEIGHT ABOVE CREST-FT.
PERMANENT CREST ELEV. U.S.G.S. LOCAL GAGE
TAILWATER ELEV. U.S.G.S. LOCAL GAGE
SPILLWAY LENGTHS-FT. 24.917 FREEBOARD-FT. 6.5
FLASHBOARDS-TYPE, HEIGHT ABOVE CREST 1.583 Fixed
WASTE GATES-NO. WIDTH MAX. OPENING DEPTH SILL BELOW CREST

REMARKS Condition Good

4-1 mi to Souhegan R

Co-ordinates from AG
42° 50' — 600 ft
71° 50' — 6,400 ft.

POWER DEVELOPMENT

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

USE Recreation

REMARKS Source water rights owned by Sherman B. Ward.
Replaced old wood dam used to store water for dam #17 down stream which operated saw mill.
A.E. got information from Leslie R. Frye, West Wilton

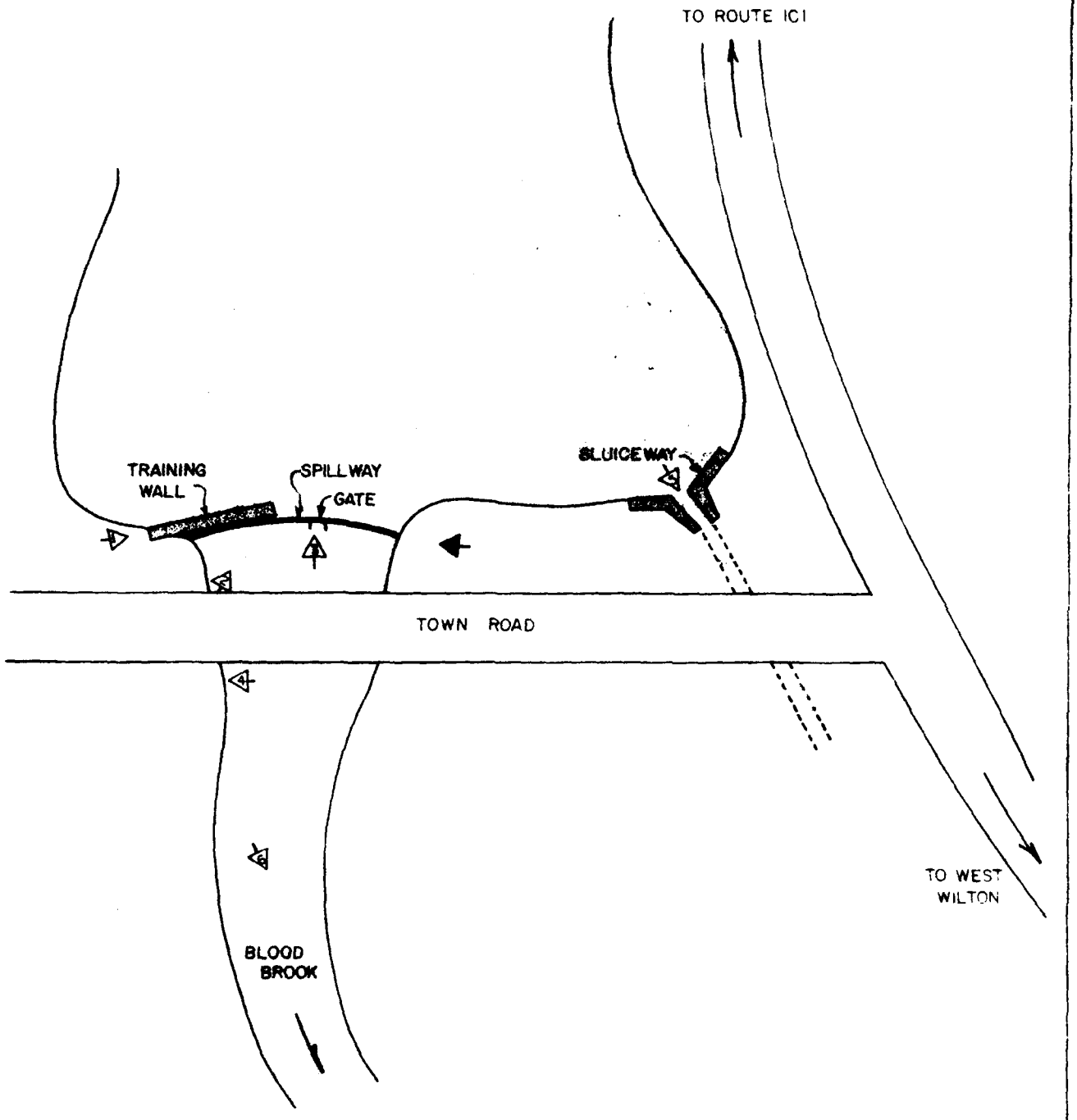
Photo D-55

5/28/36 AE

DATE 5/28/36

APPENDIX C

PHOTOGRAPHS



OVERVIEW PHOTO

APPENDIX C PHOTO

GOLDBERG ZOINO & ASSOCIATES, INC GEOTECHNICAL-GEOHYDROLOGICAL CONSULTANTS NEWTON UPPER FALLS, MASSACHUSETTS	US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

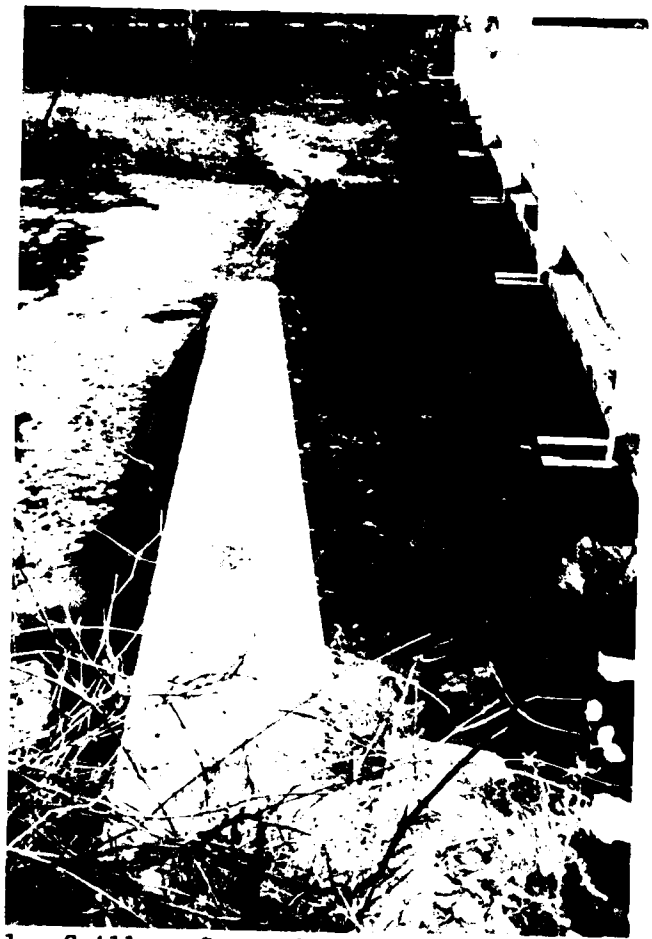
PHOTO LOCATION PLAN

FILE No. 2605

WARD DAM — WILTON, NEW HAMPSHIRE

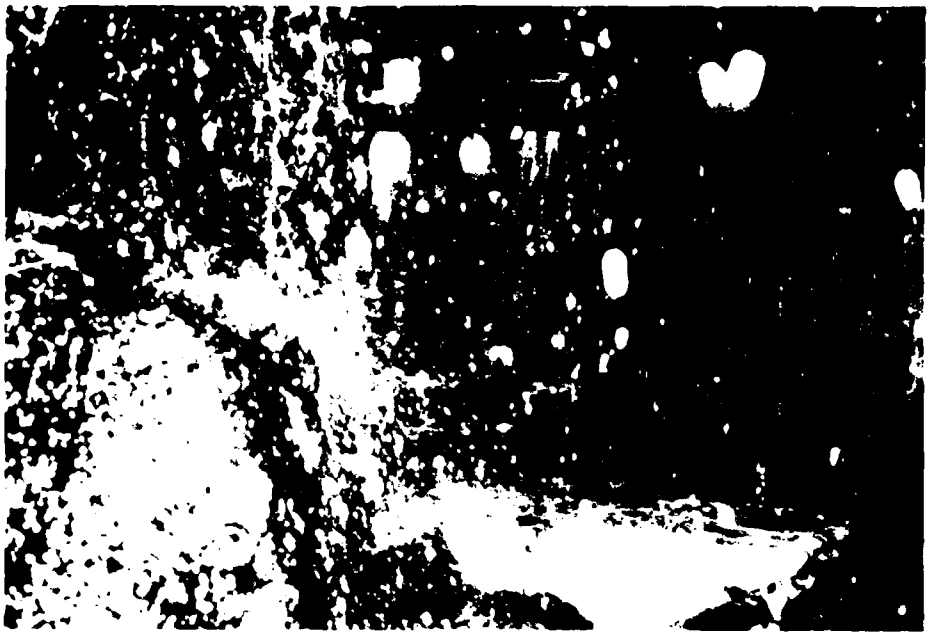
SCALE SCHEMATIC

DATE OCT 1980



1. Spillway Crest From Right Abutement

2. Spillway From Downstream Right Side - Note Box Culvert Near Center of Photo



3. Interior of Box Culvert Looking Upstream

4. Downstream Side of Right Abutment

5. Concrete Inlet to Penstock at Left Abutment

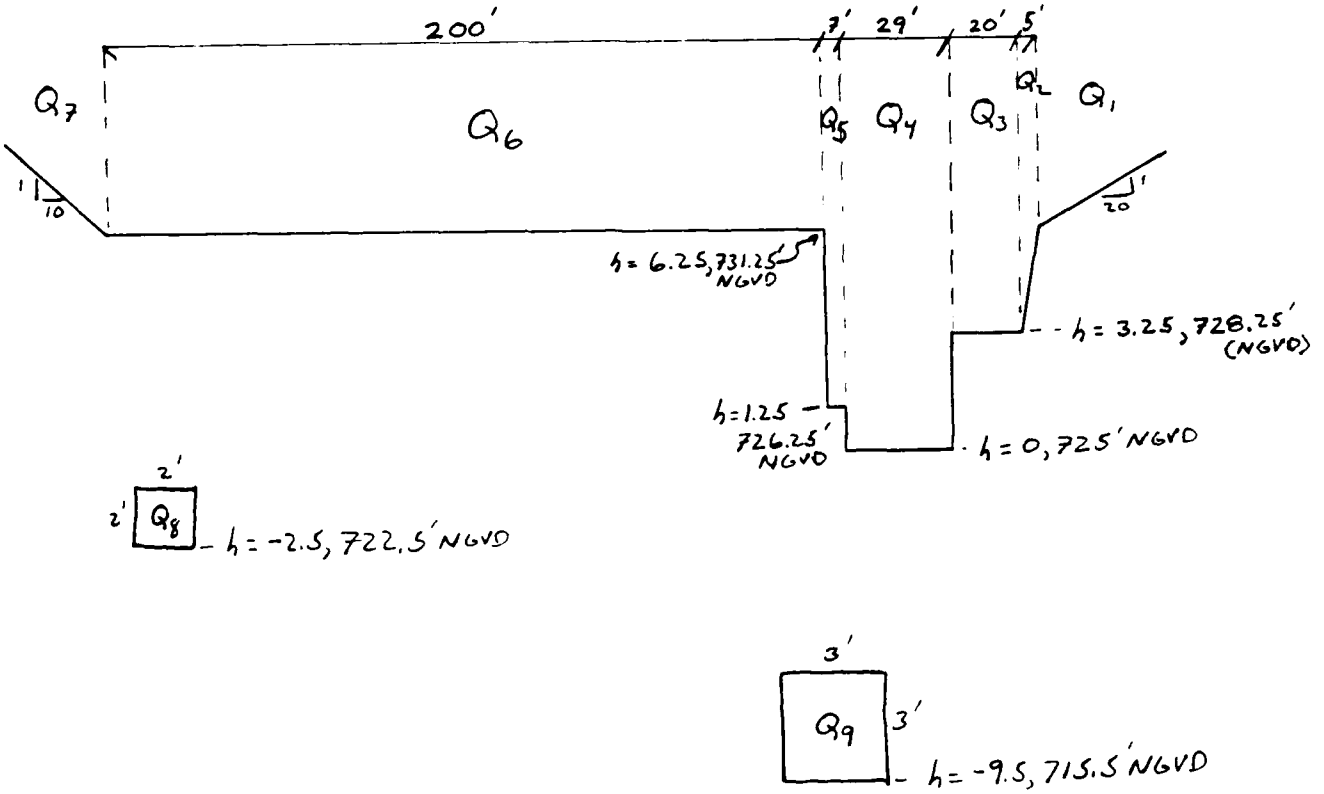
6. Downstream Channel

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Ward Dam

The elevation schematic of Ward Dam given below is based on field notes and USGS topo information. The elevations above mean sea level are based on an assumed spillway elevation of 725 ft. msl, which was estimated from the USGS Quad.



Stage-Discharge Curve

Ward Dam is a gravity masonry dam with a concrete spillway cap. The spillway may be considered a sharp crested weir, with a concrete

wall to the right abutment and a natural ledge to the left. There are two gates associated with the dam - one 2' x 2' and one 3' x 3'. At the time of the inspection, neither appeared to be operable and the 3' x 3' gate was leaking a small amount of water. For the purposes of the stage-discharge calculations, both will be assumed to be closed. Therefore, for all h:

$$Q_8 = Q_9 = 0$$

for $0 \leq h \leq 1.25$

$$Q_1 = Q_2 = Q_3 = Q_5 = Q_6 = Q_7 = 0$$

$$Q_4 = 3.3(29)\ (h)^{3/2}$$

c = 3.3 for a sharp-crested weir

for $1.25 \leq h \leq 3.25$

$$Q_5 = 2.8(7)\ (h-1.25)^{3/2}$$

all others unchanged

c = 2.8 for a broad-crested earth weir

for $3.25 \leq h \leq 6.25$

$$Q_2 = 2.8\ (5/3)\ (h-3.25)\ (.5(h-3.25))^{3/2}$$

$$Q_3 = 3.0\ (20)\ (h-3.25)^{3/2}$$

all others unchanged

c = 3.0 for a broad-crested stone weir

for $h \leq 6.25$

$$Q_1 = 2.8\ (20)\ (h-6.25)\ (.5(h-6.25))^{3/2}$$

$$Q_2 = 2.8\ (5)\ (h-4.75)^{3/2}$$

$Q_6 = 2.8\ (200)\ (h\text{-}6.25)^{3/2}$

$Q_7 = 2.8\ (10(h\text{-}6.25))\ (.5(h\text{-}6.25))^{3/2}$

All others unchanged

The BASIC program which follows calculates a stage-discharge curve for Ward Dam.

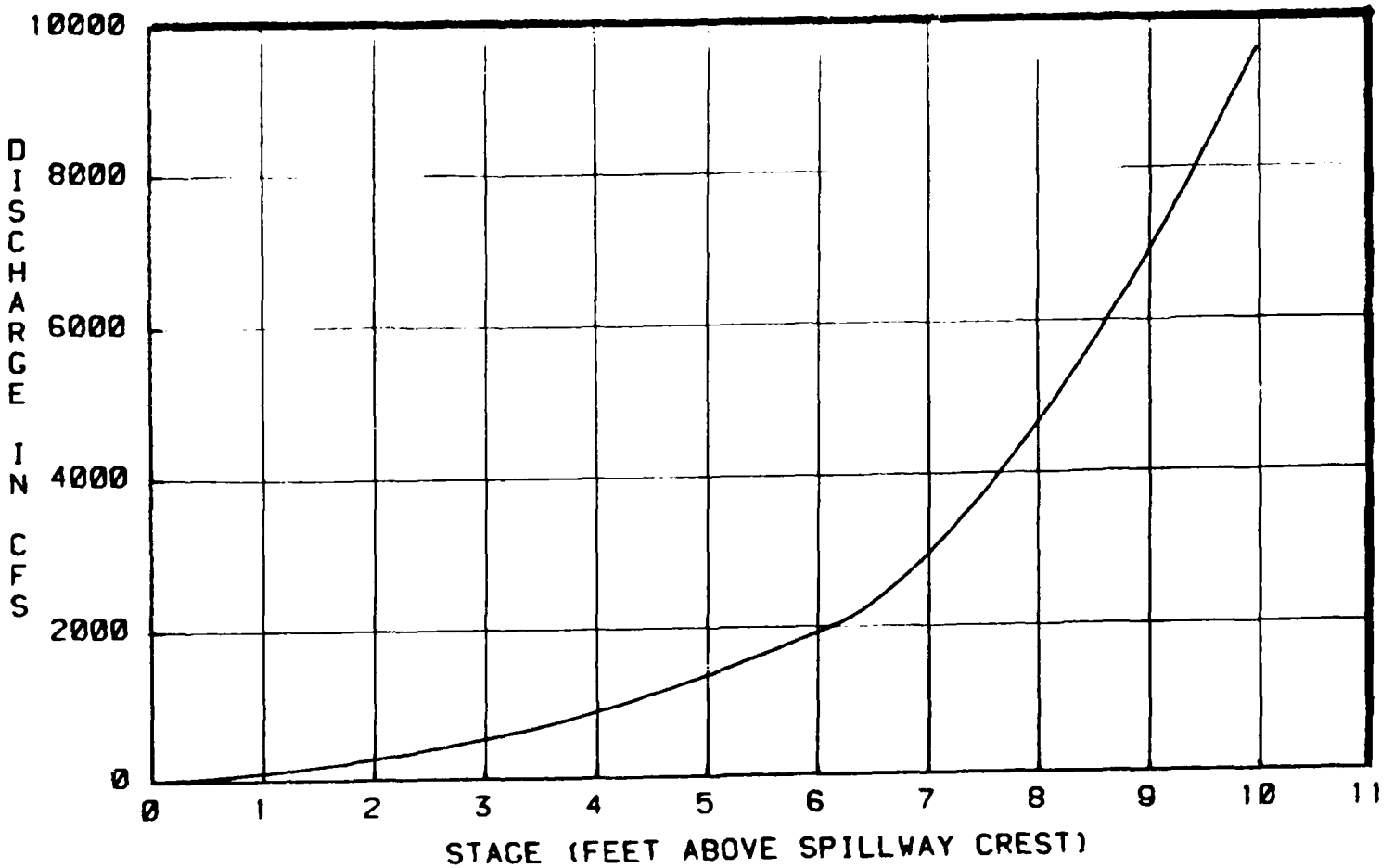
```
LIST
100 REM - STAGE/DISCHARGE CURVE FOR WARD DAM
110 REM - STORED ON TAPE B-1 FILE 15
120 PAGE
250 PRINT USING 260:
260 IMAGE 10T"STAGE VS. DISCHARGE RELATIONSHIP FOR WARD DAM          "
270 PRINT USING 280
280 IMAGE // 6T"HEAD"                    30T"DISCHARGE"
290 PRINT USING 300:
300 IMAGE 1T"(FT. ABOVE S/W)"32T"(CFS)"
310 PRINT USING 320:
320 IMAGE 19T "TOTAL      SPILLWAY      LEFT BANK      RIGHT BANK"
330 PRINT "   "
340 PRINT " "
350 FOR H=0 TO 17 STEP 0.5
355 01=0
360 02=0
370 03=0
380 04=0
390 05=0
400 06=0
410 07=0
440 04=3.3*29*H↑1.5
[illegible] IF H<1.25 THEN 700
[illegible] 05=2.8*7*(H-1.25)↑1.5
[illegible] IF H<3.25 THEN 700
[illegible] 05=3.20*(H-3.25)↑1.5
[illegible] 02=2.3*(5/3)*(H-3.25)*(0.5*(H-3.25))↑1.5
654 IF H<6.25 THEN 700
655 01=2.8*20*(H-6.25)*(0.5*(H-6.25))↑1.5
656 02=2.8*5*(H-4.75)↑1.5
657 06=2.8*200*(H-6.25)↑1.5
658 07=2.8*10*(H-6.25)*(0.5*(H-6.25))↑1.5
700 T1=01+02+03
710 T2=06+05+07
```

```
715 T3=04+T1+T2
720 PRINT USING 730:H,T3,04,T1,T2
730 IMAGE 6D.2D,14D,13D,13D,15D
740 NEXT H
750 END
```

STAGE VS DISCHARGE RELATIONSHIP FOR WARD DAM

HEAD (FT. ABOVE S/W)	DISCHARGE (CFS) TOTAL	SPILLWAY	LEFT BANK	RIGHT BANK
0.00	0	0	0	0
0.25	12	12	0	0
0.50	34	34	0	0
0.75	62	62	0	0
1.00	96	96	0	0
1.25	134	134	0	0
1.50	178	176	0	2
1.75	228	222	0	7
2.00	283	271	0	13
2.25	343	323	0	20
2.50	406	378	0	27
2.75	472	436	0	36
3.00	543	497	0	45
3.25	616	561	0	55
3.50	700	627	8	66
3.75	794	695	22	77
4.00	895	766	40	89
4.25	1002	838	62	102
4.50	1115	914	87	115
4.75	1234	991	115	128
5.00	1358	1070	146	142
5.25	1487	1151	179	157
5.50	1621	1234	215	172
5.75	1760	1320	253	187
6.00	1904	1406	294	203
6.25	2052	1495	337	219
6.50	2277	1586	385	306

STAGE-DISCHARGE CURVE AT WARD DAM



Stage-Storage Curve

The surface area of Ward Pond with the water surface at the spillway crest is about 3 acres. The pond is silted and shallow, with an average depth of about 3 feet. Thus, the storage at the spillway crest is (3) (3) = 9 acre feet.

Assuming a 3 acre surface area, and no spreading as the pond rises:

$$\text{Surcharge Storage} = 3\ h$$

$$\text{Total Storage} = 9 + 3\ h$$

For the drainage area of 6.58 square miles (4211 acres):

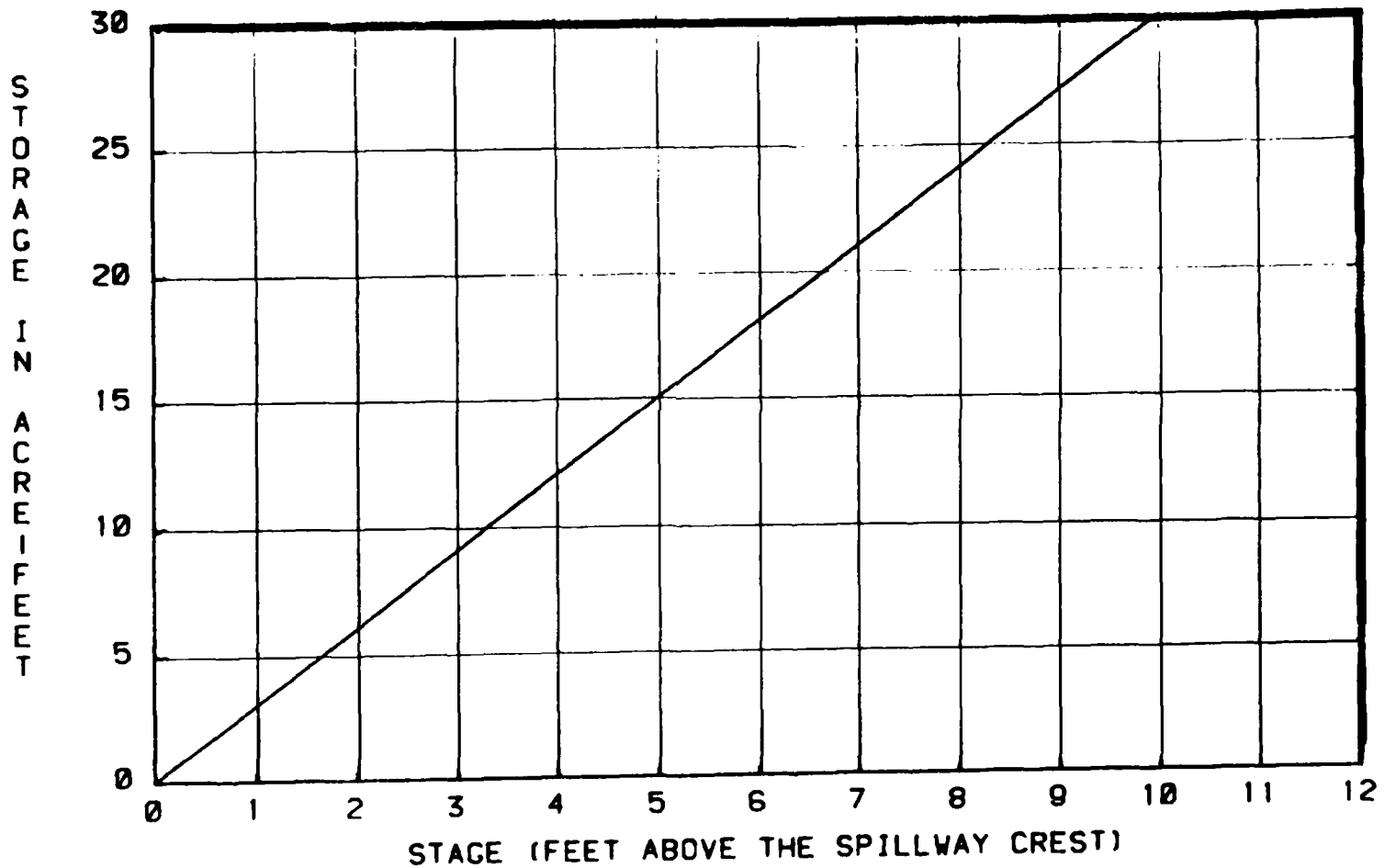
$$1\text{" of runoff} = \frac{4211\ \text{ac}(1")}{12"/\text{ft.}} = 350.9\ \text{acre-ft.}$$

$$1\ \text{acre-ft.} = \frac{1}{350.9} = 0.00285\text{" of runoff}$$

Surcharge storage to the top of the concrete wall to the right abutment = 3.25(3) = 9.75 acre-ft. = 0.28" of runoff. Total storage at the top of the wall = 9 + 9.75 = 18.75 acre-ft.

The stage - storage curve is given in the next page.

STAGE-SURCHARGE STORAGE CURVE FOR WARD POND



TCG 10/7/80

Dam Failure Analysis

Dam failure is assumed when the water overtops the concrete wall near the right abutment at h = 3.25, 728.25 ft. msl.

Normal outflow = 616 cfs

$$\text{Breach outflow} = Q_{pl} = 8/27 \sqrt{g} \; W_b \; Y_o^{3/2}$$

Y_o = the height of the water surface above the channel invert at dam failure = 14.5 + 3.25 ft = 17.75 ft.

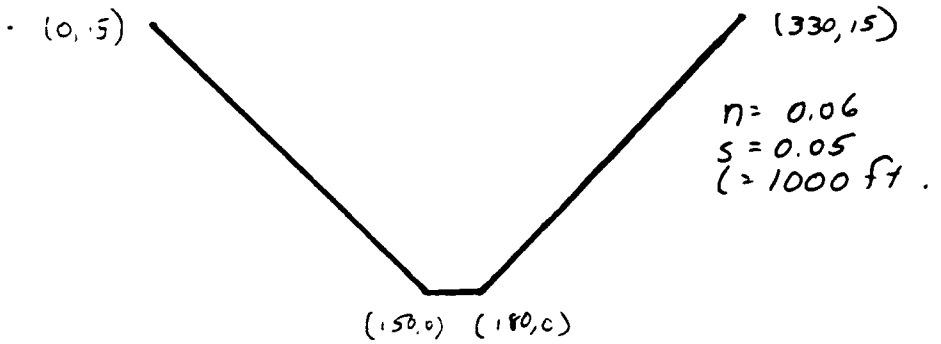
W_b = Width of breach = 40% of the dam width at 1/2 height. The dam width at 1/2 height is about 50 feet, so W_b = .4(50) = 20 ft.

$$Q_{pl} = 8/27 \sqrt{32.2} \; 20 \; (17.75)^{3/2} = 2515 \text{ cfs}$$

Peak failure outflow = 616 + 2515 = 3130 cfs

This flow would pass under the bridge just downstream of the dam and proceed downstream along Blood Brook. The bridge is 18' high and safely above flooding from failure.

A typical cross-section for Blood Brook just downstream of Ward Dam is as follows:



A stage-normal flood relationship for this reach is given on the next page. The pre-failure flow of 616 cfs would create a stage of slightly under 2 feet in this reach. Dam failure would increase this stage to 4.1 feet at the upstream end of the reach. Assuming a linear variation in stage in the reach, storage = $\frac{\text{storage U/S + Storage D/S}}{2}$ (length). The attenuation due to storage in this reach is calculated on p 12.

The attenuated peak dam failure flow at the downstream end of the reach would be 2450 cfs, creating a stage of 3.7 ft. The only development in the first 1000 feet downstream of the dam is one house well above the dam failure flood wave.

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.00	1.0	40.0	50.1	0.8	34.4	191.2
2.00	2.0	100.0	70.2	1.4	126.6	703.0
3.00	3.0	180.0	90.3	2.0	285.1	1583.2
4.00	4.0	280.0	110.4	2.5	520.7	2891.7
5.00	5.0	400.0	130.5	3.1	844.0	4687.0
6.00	6.0	540.0	150.6	3.6	1265.1	7025.0
7.00	7.0	700.0	170.7	4.1	1793.4	9959.0
8.00	8.0	880.0	190.8	4.6	2438.3	13540.4
9.00	9.0	1080.0	210.9	5.1	3208.7	17818.4
10.00	10.0	1300.0	231.0	5.6	4113.1	22840.9
11.00	11.0	1540.0	251.1	6.1	5159.9	28654.1
12.00	12.0	1800.0	271.2	6.6	6357.2	35303.0
13.00	13.0	2080.0	291.3	7.1	7712.9	42831.5
14.00	14.0	2380.0	311.4	7.6	9234.7	51282.4
15.00	15.0	2700.0	331.5	8.1	10930.1	60697.5

STAGE VERSUS NORMAL FLOW FOR FIRST 1000 FEET BELOW WARD DAM

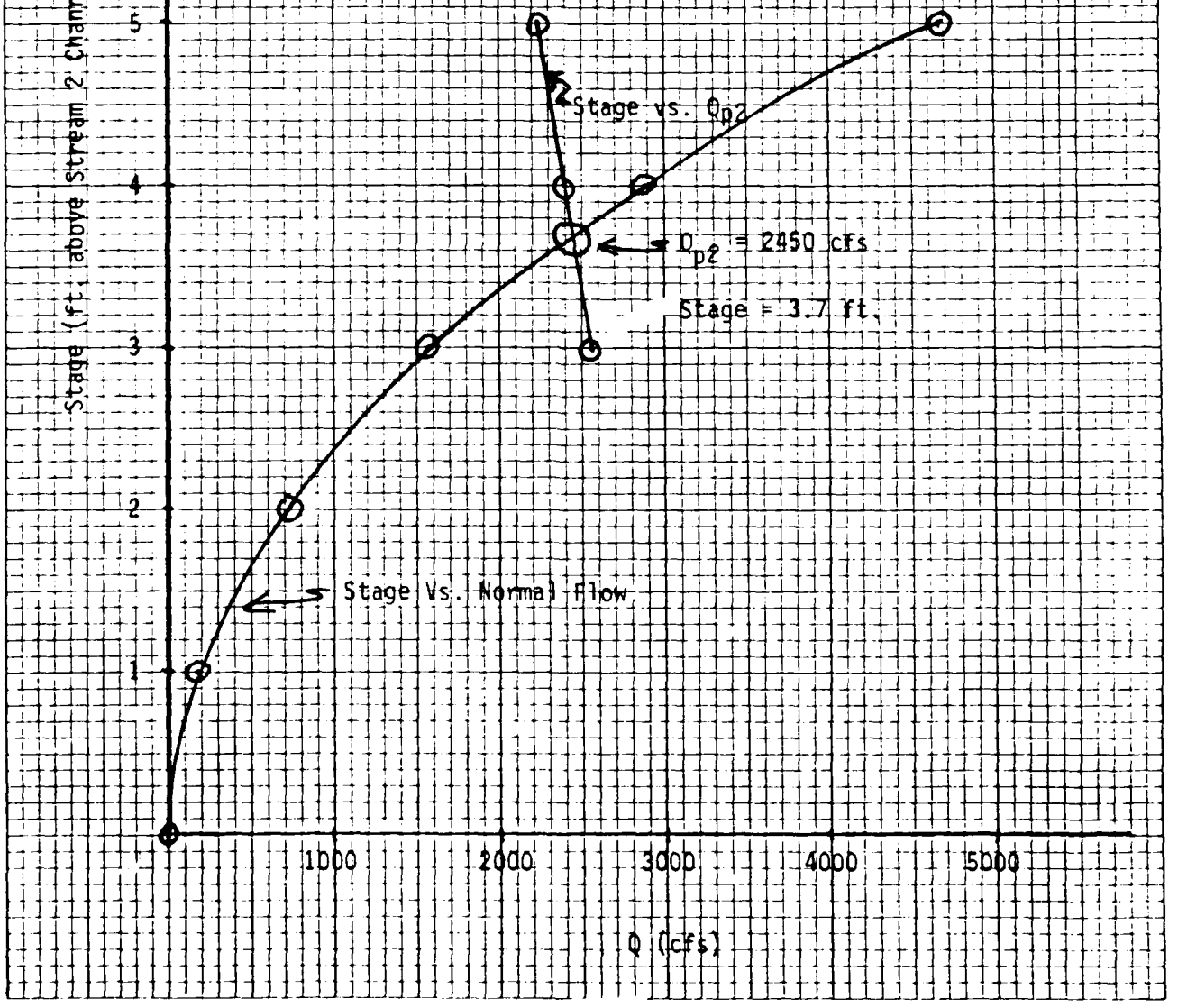
Attenuated Peak Dam Failure flow 1000 ft. Downstream of Ward Dam

$$Q_2 = \text{pre-failure flow} + Q_{p1}\left(1 - \frac{\text{Reach Storage}}{\text{Storage released by failure}}\right)$$

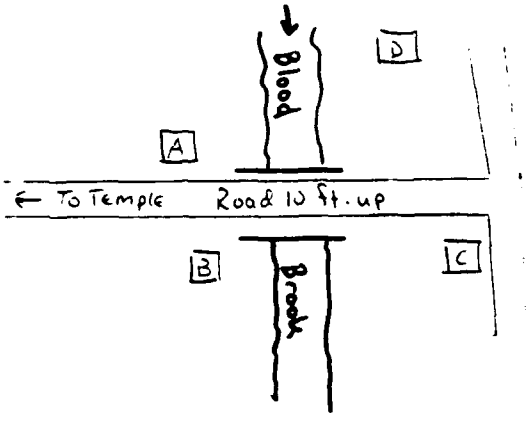
$$= 616 + 2515\left(1 - \frac{STOR}{18.75}\right) \quad .STOR = (\text{Average Flow Area} - \text{pre-failure area}) \times (\text{length})$$

$$+\left(\frac{292 + \text{Area D/S}}{2} - 50\right)(1000)\left(\frac{1}{43560}\right)$$

Stage (ft)	Area D.S. (Sq. ft.)	STOR (acre-ft.)	Q_{p2} (cfs)
3	180	4.27	2560
4	280	5.42	2400
5	400	6.80	2220

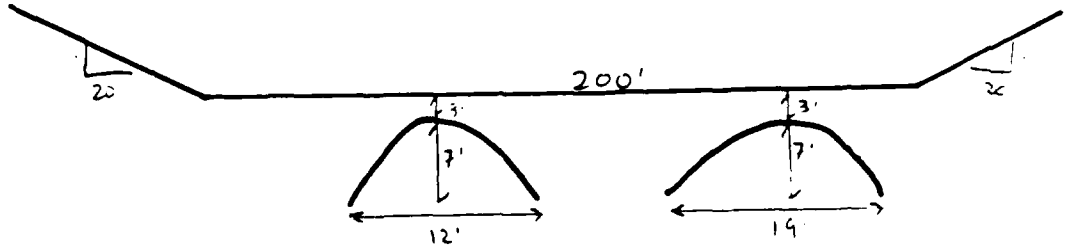


About 1000 feet downstream of Ward Dam, Blood Brook passes under a road leading to Temple, New Hampshire. There are houses downstream and upstream of the bridge as shown in the sketch below:



House	Description
A	Cellar 4 feet above stream. 1st floor at roadway level (10 ft. above stream).
B	1st floor 2-3 ft. below roadway level.
C	1st floor at roadway level.
D	Well above stream.

The bridge on which the road to Temple crosses the brook would control flow in this area. A sketch is shown below:



Not to Scale

The storage immediately upstream of this bridge is negligible, so that little attenuation of peak dam failure flows would occur here.

The stage-discharge relationship for the 12 x 7 arch was determined from the Federal Highway Administration's Hydraulic Engineering Circular 5, "Hydraulic Charts for the Selection of Highway Culverts," assuming inlet control. For these purposes the 12 x 7 arch was assumed to behave as a 11' - 5 " x 7' - 3" arch which is described in the Circular 5 monographs.

Discharge for the 19' x 7' arch assumed to be proportional to that of the 12' x 7' arch based on flow area. Assuming that both arches are ellipitical in shape:

$$\text{Area of } 12' \times 7' = \left(\frac{12}{2}\right)\left(\frac{7}{2}\right) = 65.97 \text{ sq. ft.}$$

$$\text{Area of } 19' \times 7' = \left(\frac{19}{2}\right)\left(\frac{7}{2}\right) = 104.46 \text{ sq. ft.}$$

$$\text{So } \frac{\text{Flow } 19 \times 17}{\text{Flow } 12 \times 17} = \frac{\text{Area } 19 \times 7}{\text{Area } 12 \times 7} = \frac{104.46}{65.97} = 1.58$$

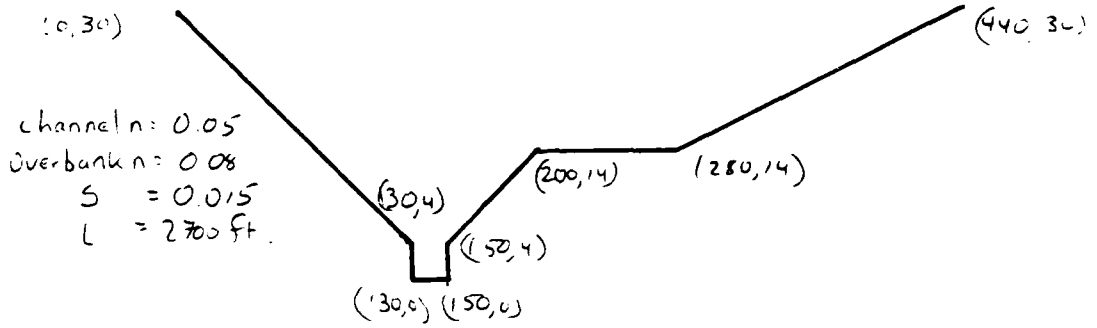
The flow over the roadway was calculated as simple weir flow:

$$Q_{road} = 2(2.8)\ (20)\ (h\text{-}10)\ (.5(h\text{-}10))^{3/2} + 2.8(200)\ (h\text{-}10)^{3/2}$$

Stage (ft.)	Headwater/ 7 ft.	Q_{12x17} (chart 6 HEC 5)	Q_{19x7} (1.58 x Q_{12x7}	Q_{Road}	Q_{Total}
4	0.57	225	355	0	580
5	0.71	325	515	0	840
6	0.86	425	670	0	1095
7	1.00	520	820	0	1340
8	1.14	605	955	0	1560
9	1.29	690	1090	0	1780
10	1.43	775	1225	0	2000
11	1.57	840	1330	600	2770
12	1.71	900	1420	1810	4130

The pre-failure flow of 616 cfs would create a stage of about 4.1 feet at the bridge. The peak dam failure flow of 2450 cfs would create a stage of about 10.6 feet, with about 0.6 feet of flow over the bridge. This flow would cause flooding to several feet in the cellar and 0-1 feet in the first floor at House "A", minor flooding at House "B", and 1-3 feet of flooding to House "C" as the flow returns to Blood Brook. The flow might well damage or destroy the bridge. There is only a slight chance of loss of life in this area, since the flooding would be backwater flooding, and flow rates would be low.

About 700 feet downstream of this bridge, Blood Brook is joined by Temple Brook. There is one house in this reach (besides the two already discussed), about 8-10 feet above the stream channel. Blood Brook runs 2000 feet from the conjunction with Temple Brook to a restaurant and a house at the downstream end of West Wilton. In this reach there are 3 houses 10-15 feet above the stream channel, and the restaurant and house 12 feet up. The following cross-section is typical of the reach from the bridge to the downstream end of West Wilton:



A stage-normal discharge relationship for this reach is given on the next page. The pre-failure flow of 616 cfs would cause a stage of 4.1 feet in Blood Brook. The peak dam failure flow of 2450 cfs would cause a stage of 8.4 feet at the upstream end of the reach. This would attenuate significantly through West Wilton due to the storage provided by the stream. The only structure which might receive minor (less than 0.5 feet) flooding in this reach is the lowest house.

Downstream of West Wilton, Blood Brook runs about 2 miles to the Souhegan River. The dam failure flood flow would attenuate a great

===== DATA FOR THE COMBINED SYSTEM =====

DEPTH ft.	ELEV ft.	AREA ft↑2	WPER ft.	HYD-R ft.	AR2/3	Q cfs
0.00	0.0	0.0	0.0	0.0	0.0	0.0
1.00	1.0	20.0	22.0	0.9	18.8	68.6
2.00	2.0	40.1	24.0	1.7	56.5	206.1
3.00	3.0	60.2	26.0	2.3	105.4	384.8
4.00	4.0	80.4	28.0	2.9	162.4	592.8
5.00	5.0	105.6	38.2	2.8	208.0	868.4
6.00	6.0	140.8	48.4	2.9	286.9	1213.4
7.00	7.0	185.9	58.6	3.2	401.7	1644.5
8.00	8.0	241.1	68.7	3.5	556.5	2175.4
9.00	9.0	306.2	78.9	3.9	756.1	2818.5
10.00	10.0	381.4	89.1	4.3	1005.2	3585.3
11.00	11.0	466.5	99.3	4.7	1308.4	4486.7
12.00	12.0	561.6	109.5	5.1	1670.2	5532.8
13.00	13.0	666.6	119.7	5.6	2095.0	6733.6
14.00	14.0	781.7	129.8	6.0	2587.0	8098.6
15.00	15.0	989.3	225.0	4.4	2655.1	9230.9
16.00	16.0	1211.8	240.1	5.0	3565.3	11473.1
17.00	17.0	1449.4	255.3	5.7	4612.7	14057.5
18.00	18.0	1701.9	270.4	6.3	5801.4	16988.0
19.00	19.0	1969.5	285.6	6.9	7135.7	20271.0
20.00	20.0	2252.0	300.7	7.5	8620.1	23914.3
21.00	21.0	2549.5	315.9	8.1	10259.1	27926.3
22.00	22.0	2862.1	331.0	8.6	12057.2	32316.2
23.00	23.0	3189.6	346.2	9.2	14019.1	37093.5
24.00	24.0	3532.1	361.3	9.8	16149.3	42267.8
25.00	25.0	3889.7	376.4	10.3	18452.5	47848.9
26.00	26.0	4262.2	391.6	10.9	20933.1	53846.6
27.00	27.0	4649.7	406.7	11.4	23595.8	60270.9
28.00	28.0	5052.2	421.9	12.0	26445.1	67131.5
29.00	29.0	5469.7	437.0	12.5	29485.3	74438.3
30.00	30.0	5902.2	452.2	13.1	32721.0	82201.2

STAGE VERSUS MAXIMUM FLOW - [illegible]

deal in this reach, and would probably not threaten any of the structures in the reach - a house 2000 feet downstream of West Wilton and the Route 31 bridge just 800 feet upstream of the Souhegan River. The flow resulting from the failure of Ward Dam would probably cause no damage along the Souhegan River.

The chart on the next page summarizes the downstream effects of the failure of Ward Dam.

Location # (see Map)	Location	Distance Downstream from Dam (feet)	# of Structures	Level above Stream (ft)	Flow & Stage Before failure	Flow & Stage After failure	Comments
-	Just D/S of Ward Dam	-	1 bridge	18 ft.	616 cfs 1.8 ft.	3130 cfs 4.1 ft.	Little danger to bridge
1	Bridge on road to Temple	1000 ±	1 house 2 houses 1 house 1 house 1 bridge	8 ft. 10 ft. 15 ft. cellar 4 1st floor 10 10 ft.	616 cfs 4.1 ft.	2450 cfs 10.6 ft.	slight danger of loss of life, minor flooding a one house, significant flooding at 2 others - about 1/2 ft. flow over road.
-	house before Temple Brook	1400	1 house	8 ft.	616 cfs 4.1 ft.	2450 cfs <8.4 ft.	possible minor flooding. Flow attenuates downstream - no furthe flooding likely.

Test Flood Analysis

Size Classification: SMALL (height < 25 ft., storage < 1000 ac-ft.)

Hazard Classification: SIGNIFICANT based on the slight chance of loss of life and appreciable economic damages in the town of West Wilton downstream of the dam.

According to the "Recommended Guidelines" the hazard classification and dam size indicate a test flood between the 100 year flood and 1/2 of the Probable Maximum Flood (PMF). Since the hazard classification is on the low side of significant, we will use the 100 year flood.

The drainage area upstream of Ward Dam is 6.58 square miles. However, 4.9 square miles of this area is controlled by the Soil Conservation Service's Souhegan River Watershed Dam 26. The SCS Design notes for this dam give a peak 100 year storm stage of 922.9 ft. msl, yielding a peak outflow of 144 cfs.

To calculate the 100 year inflow for Ward Dam, we will estimate the peak inflow from the uncontrolled drainage area of 1.68 square miles, and make the conservative estimate that this peak concides with peak outflow from S.R.W.D. #26.

Peak Uncontrolled Flow:

Dennis R. LeBlanc's "Progress Report on Hydrologic Investigations of Small Drainage Areas in New Hampshire- Preliminary Relations for Estimating Peak Discharges on Rural, Unregulated Streams," USGS Water Resources

Investigations 78-47, gives this formula for a 100 year flow:

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

P_{100} = 100 year peak flow, cfs

A = drainage area, in square miles = 1.68

S = main channel slope, in feet/mile = 50

I = 2 year 24 hour rainfall, in inches = 3.1

$$P_{100} = 0.55(1.68)^{1.05}\ (50)^{0.56}\ (3.1)^{2.72} = 184 \text{ cfs}$$

Therefore 100 year flow = uncontrolled peak + SRWD #26 flow = 328 cfs

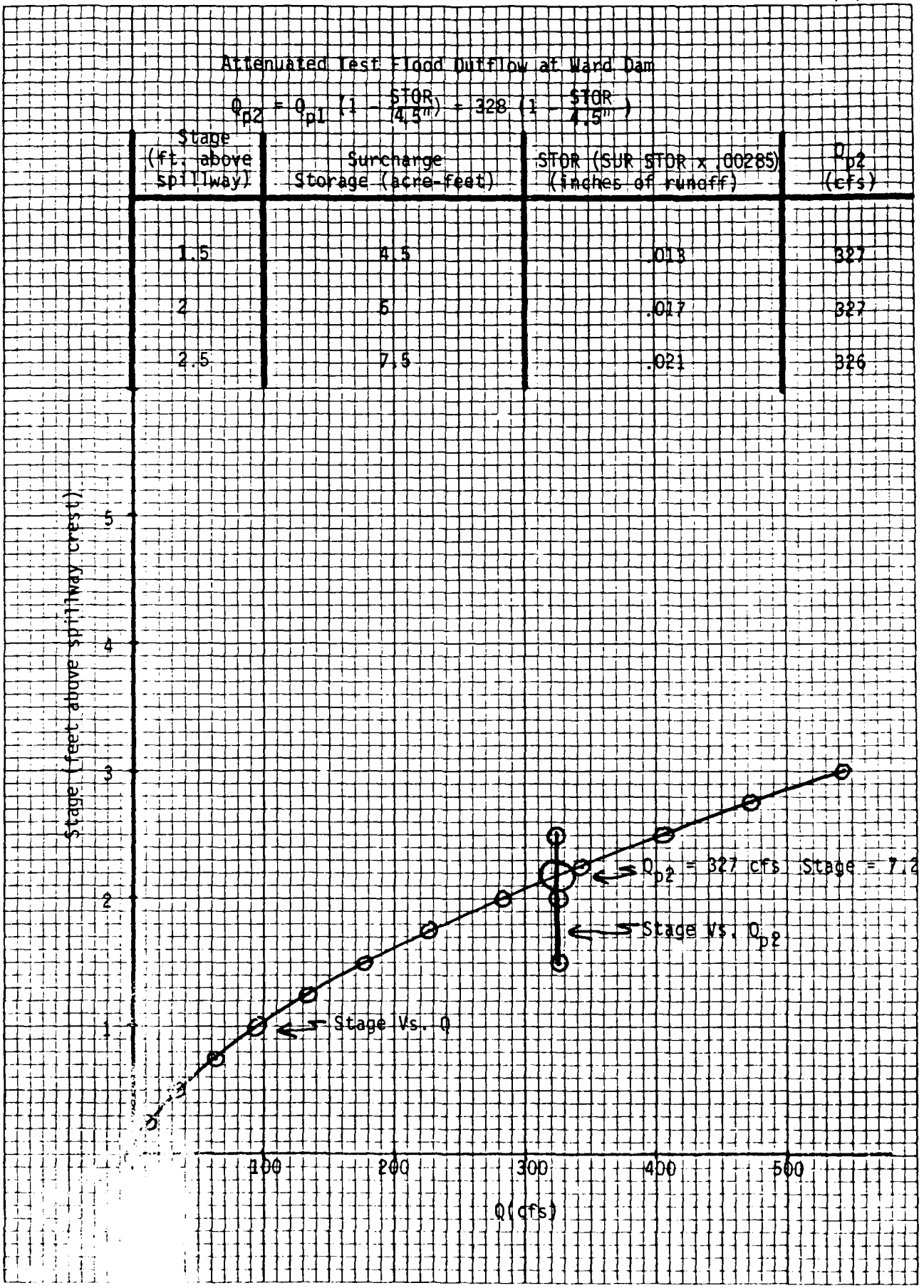
The attenuation of the test flood due to storage in the reservoir is calculated on the next page and is negligible. The 100-year inflow of 328 cfs has been adoped as the peak test flood routed outflow.

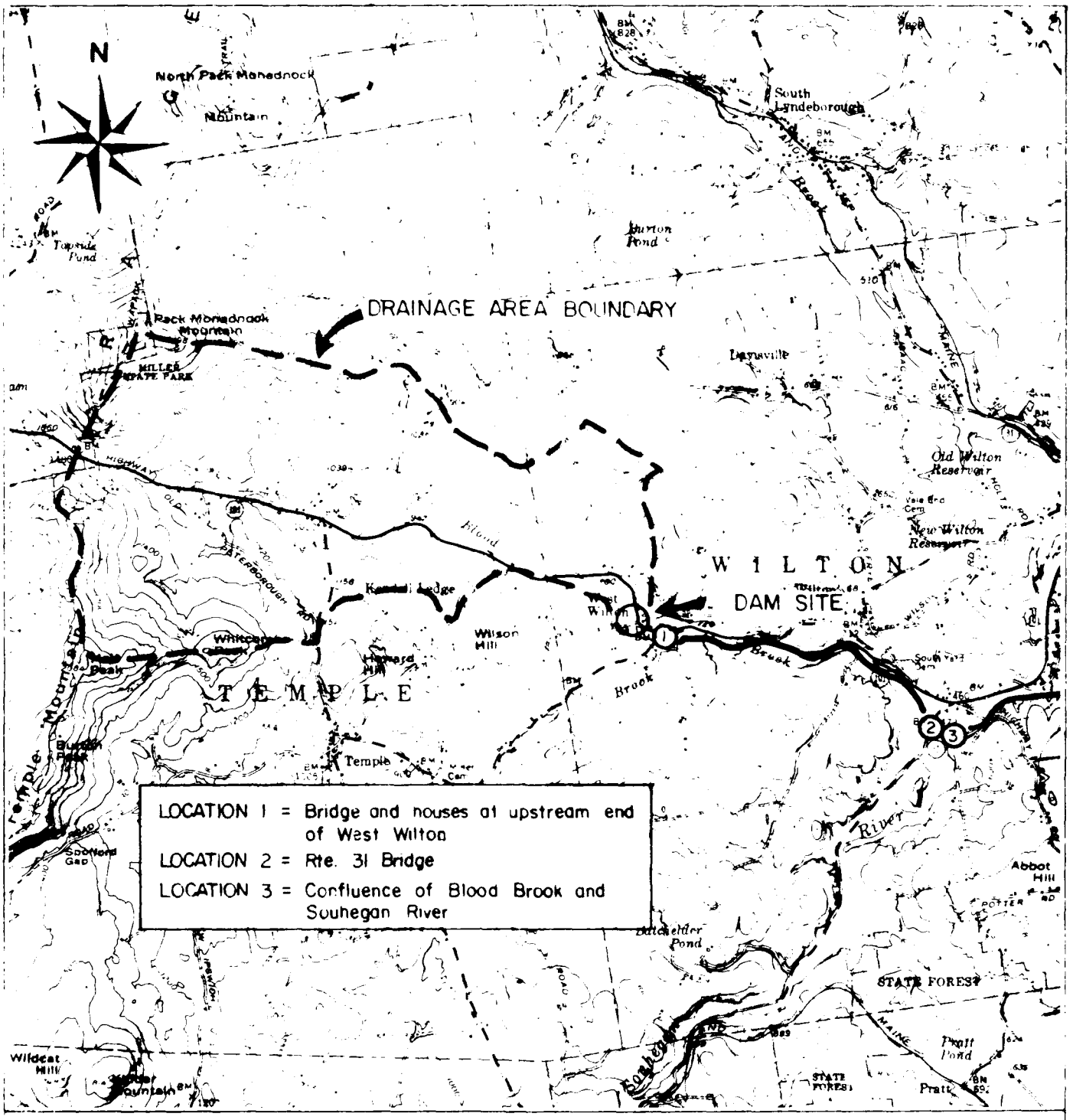
The peak test flood outflow of 328 cfs yields a stage of 2.2 feet (727.2 ft msl), 1.1 feet below the top of the concrete training wall, and 0.95 ft. over the natural ledge to the left.

Attenuated Test Flood Outflow at Ward Dam

$$Q_{p2} = Q_{p1}\left(1 - \frac{STOR}{4.5^{in}}\right) = 328\left(1 - \frac{STOR}{4.5^{in}}\right)$$

Stage (ft. above spillway)	Surcharge Storage (acre-feet)	STOR (SUR STOR x .00285) (inches of runoff)	Q_{p2} (cfs)
1.5	4.5	.013	327
2	6	.017	327
2.5	7.5	.021	326





SCALE

0 1/2 1 2 MILES

FROM USGS PETERBOROUGH, N.H. QUADRANGLE MAP

GOLDBERG ZOINO & ASSOCIATES, INC
GEOTECHNICAL - GEOHYDROLOGICAL CONSULTANTS
NEWTON UPPER FALLS, MASSACHUSETTS

U.S. ARMY ENGINEER DIV. NEW ENG. ARC
CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND DOWNSTREAM HAZARD MAP

26.5

WARE DAM

WILTON, NEW HAMPSHIRE

SCALE AS SHOWN

DATE OCT 1980

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	262	NED	NH	01	02				WARD DAM	42'49.9	71'48.6	10NOV80

POPULAR NAME	NAME OF IMPOUNDMENT
	BLOOD BROOK

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	06	BLOOD BROOK	WILTON	1.0	2276

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
AGOT	1800	R	18	18	19	10	NED	N	N	N	N	

REMARKS

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)	NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
Y	250	U	29	616												

OWNER	ENGINEERING BY	CONSTRUCTION BY
RICHARD CLATTENBERG	UNKNOWN	UNKNOWN

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NH WRB	NH WRB

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
GOLDBERG ZOINO & ASSOC INC	17OCT80	PL 92-367

REMARKS

END

FILMED

8-85

DTIC