CONNECTICUT RIVER BASIN
BATH, NEW HAMPSHIRE

AMMONOOSUC RIVER DAM
NH 00061
NHWRB NO. 17.02

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

JUNE 1980
**Ammonoosuc River Dam**

**National Program for Inspection of Non-Federal Dams**

The dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The dam is considered to be in poor condition. There are various major concerns which should be corrected to assure the continued performance of the dam. It is small in size with a significant hazard potential.
DISCLAIMER NOTICE

THIS DOCUMENT IS BEST QUALITY PRACTICABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.
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 Ammonoosuc River Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, New Hampshire Wood Products Corp., Bath, NH.

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

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

Sincerely,

Max B. Scheider  
Colonel, Corps of Engineers  
Division Engineer
AMMONOOSUC RIVER DAM
NH 00061
NHW RB 17.02

CONNECTICUT RIVER BASIN
BATH, NEW HAMPSHIRE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NATIONAL DAM INSPECTION PROGRAM
PHASE I - INSPECTION REPORT
BRIEF ASSESSMENT

Identification No: NH 00061
Name of Dam: Ammonoosuc River Dam
Town: Bath
County and State: Grafton, New Hampshire
Stream: Ammonoosuc River
Date of Inspection: April 30, 1980

The Ammonoosuc River Dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The maximum height of the dam is approximately 25 feet from the top of the gate operator platform to the lowest point of the ledge foundation of the overflow section. The overall length of the dam is approximately 365 feet between abutments. The total length of the man-made structures is about 273 feet. Located at the left abutment of the dam is the intake structure for a 26 feet wide by 9 feet high concrete penstock. Flow through the penstock is controlled by three 5.6 feet wide by 7.3 feet high penstock gates with lifting mechanisms and a bar rack. Located immediately to the right of the penstock gates is a waste gate opening which is also 5.6 feet wide and 7.3 feet high.

The dam impounds water from the Ammonoosuc River which, after passing over the spillway, flows in a southerly direction through the center of the town of Bath. The dam was apparently originally constructed to provide water power and later hydroelectric power to a mill at the site, but has been abandoned for that purpose since the adjoining mill was closed in 1969 and destroyed by fire in 1976. The generating equipment is currently not in use but is intact and the present owner has immediate plans to revitalize the electrical generating capability. The pool behind the dam is normally 0.63 miles in length with a surface area of about 24 acres. The maximum storage capacity at top of dam is about 520 acre-feet.

As a result of the visual inspection of this facility, the dam is considered to be in POOR condition. Major concerns are: the apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length; the rotting wood in the penstock gates with 3 feet of silt built up behind them, the leakage through the gates, the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations and the heavy rust on the lifting mechanisms; the removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations and the inoperability of the lifting mechanism.
This dam is classified as SMALL in size and a SIGNIFICANT hazard structure in accordance with the recommended guidelines established by the Corps of Engineers. The test flood for this dam, therefore, ranges from the 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). The 100-year flood was selected for this hydrologic analysis since the dam falls about midway in the range of storages given for the small size classification. The test flood inflow was estimated to be 50,800 cfs and resulted in a routed test flood outflow equal to 50,500 cfs which would overtop the dam crest by about 0.6 foot. The capacity of the man-made overflow sections with the water surface at the dam crest was estimated to be about 40,000 cfs, which is about 79 percent of the routed test flood outflow. An assumed breach with the water surface at the crest of the overflow sections would increase the stage along the immediate downstream channel to an elevation of about 488 feet (NGVD). The discharge resulting from this failure would approach the sill level of the mill located on the left bank a short distance downstream from the dam, possibly resulting in an economic loss to the owner. The potential for loss of less than a few lives of employees at the mill would exist.

It is recommended that the owner engage a qualified registered engineer to inspect the downstream face of the overflow sections under no flow conditions, to design and specify repairs for the erosion and spalling of the concrete overflow sections and the concrete intake structure, and to design and specify repairs to the penstock gates and to the waste gate.

The recommendations and remedial measures are described in Section 7 and should be addressed by the owner within one year after receipt of this Phase I Inspection Report.

Kenneth M. Stewart
Project Manager
N.H.P.E. 3531

S E A Consultants Inc.
Rochester, New Hampshire
This Phase I Inspection Report on Ammonoosuc River 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.

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, 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, 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 trespassing 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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SECTION 5
EVALUATION OF HYDROLOGIC/HYDRAULIC FEATURES

5.1 General. Ammonoosuc River Dam is a series of concrete gravity overflow sections founded on ledge and extending between ledge outcroppings in the river channel. The overall length of the dam is about 365 feet, while the man-made portion of the dam is about 273 feet long. The overflow section of the dam has a maximum structural height of approximately 16 feet as measured from the crest of the overflow section to the ledge foundation. Adjacent to the left abutment is an inlet structure which has four sluice gates. Three of the gates lead to the penstock, while the fourth (waste gate) bypasses the penstock and discharges to the river channel at the toe of the dam. At the time of inspection, the waste gate by-passing the penstock was not in place, and water was discharging through the gate opening to the river channel. The penstock gates were all in place and closed.

The drainage area above Ammonoosuc River Dam is quite large and consists of hilly and mountainous terrain with numerous streams that feed the Ammonoosuc River. Ammonoosuc River Dam is a run of the river structure with a maximum storage of approximately 520 acre-feet.

5.2 Design Data. No hydrological or hydraulic design data were disclosed.

5.3 Experience Data. Data relating to known flood discharges and projected flood flows and elevations have been published in Flood Plain Information, Ammonoosuc River, Bath, New Hampshire, prepared by the Department of the Army, New England Division, Corps of Engineers, Waltham, Massachusetts, May, 1978. Data from this report indicated that the high water mark at the Ammonoosuc River Dam for the "March, 1936 Flood" was approximately 500.8 feet (NGVD) with an estimated discharge of about 24,000 cfs.

5.4 Test Flood Analysis. Due to the absence of detailed design and operational information, the hydrologic evaluation was performed utilizing data gathered during field inspection, watershed size and an estimated test flood determined from the Corps of Engineers guide curves. For this dam (small size and significant hazard), the test flood ranges from a 100-year flood to one-half the Probable Maximum Flood (1/2 PMF). The 100-year flood was selected for this analysis since the dam falls about midway in the range of storages given for the small size classification. Since the drainage area consists of a combination of hilly and mountainous terrain and the time of concentration is long due to the size of the watershed, the "rolling" curve from the Corps of Engineers set of guide curves, was used to estimate the maximum probable peak flow rate. The water surface behind the dam was assumed to be at an elevation of 494 feet prior to the test flood routing.

Based on an estimated maximum probable flood peak flow rate of 625 cfs per square mile and a drainage area of 325 square miles, the test flood inflow was estimated to be 50,800 cfs. The test flood was routed through the reservoir in accordance with the Corps of Engineers procedure for Estimating Effect of Surcharge Storage on Maximum Probable Discharge. The routed test flood outflow was estimated to be 50,500 cfs. This analysis indicated that the dam crest (top
SECTION 4
OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures
   a. General. The Ammonoosuc River Dam is used primarily to impound water from the Ammonoosuc River. There are no written or routine operational procedures.

   b. Description of Any Warning System in Effect. No written warning system exists for the dam.

4.2 Maintenance Procedures
   a. General. The owner, New Hampshire Wood Products Corporation, Charles Diamond, Owner, is responsible for the maintenance of the dam. No formal maintenance plan exists.

   b. Operating Facilities. No formal plan for maintenance of operating facilities was disclosed, although the owner has made some minor repairs to the penstock gates and indicated that repairs to the entire dam would begin late this summer to revitalize the hydroelectric production capabilities to be on line by 1983.

4.3 Evaluation
   The current maintenance procedures for the Ammonoosuc River Dam are inadequate to insure that all problems encountered can be remedied within a reasonable period of time. The owner should establish a written operation and maintenance procedure, as well as establish a warning system to follow in event of flood flow conditions or imminent dam failure.
d. Reservoir Area. There are no signs of instability of the banks of the river channel upstream of the dam, although there is minor erosion of the bank immediately upstream of the bridge pier on the left abutment. Trees are growing on the steep left bank of the channel some distance upstream of the dam. The right side of the valley consists of a low, flat floodplain which is cultivated and generally free of trees and brush (See Photo No. 1).

e. Downstream Channel. The channel downstream of the dam is generally wide and unobstructed, although a mill building is located on the floodplain just downstream from the dam (See Photo No. 12). Immediately downstream of the dam, the channel bottom appears to be bedrock. Farther downstream the channel bottom appears to consist of sand, gravel, and boulders, and there appear to be no bedrock exposures.

3.2 Evaluation

On the basis of the visual inspection, Ammonoosuc River Dam appears to be in poor condition.

The apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length are signs of serious structural problems and instability, and if allowed to continue, will cause a progressive lowering of the crest.

The rotting wood in the penstock gates with 3 feet of silt build-up behind them, making the gates inoperable; the leakage through the gates, the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations; and the heavy rust on the lifting mechanisms are all signs of considerable deterioration of the gates and surrounding structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the penstock gates and surrounding structure.

The removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations, and the inoperability of the lifting mechanism are all signs of considerable deterioration of the gate structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the waste gate structure.
The central portion of the man-made overflow section is about 10 feet high and is constructed between two ledge outcroppings in a "dog leg" configuration approximately 96 feet long (See Photo No. 2). A section of the top of the dam about 40 feet long and from 1 to 2 feet deep in the center of this portion of the man-made overflow section appears to have broken free. As seen beneath the flowing water, it appears that the entire crest of this portion of the dam is cracked and severely spalled.

The right portion of the man-made overflow section is about 2.5 feet high and begins at a high point in the ledge outcropping and extends approximately 54 feet in a "dog leg" configuration to a concrete wall at the right abutment (See Photo No. 6). This wall acts as a training wall for the dam and a retaining wall for the Boston and Maine Railroad line at the right abutment. As seen beneath the flowing water, it appears that the entire crest of this portion of the dam is cracked and spalled (See Photo No. 7). The concrete training wall is also spalled in a few locations with signs of efflorescence (See Photo No. 8). It cannot be determined on the basis of the visual inspection alone whether this wall is founded on soil or bedrock, or whether the right abutment of the concrete gravity section is soil or bedrock.

The left abutment immediately upstream from the dam consists of soil, but it cannot be determined on the basis of the visual inspection alone whether the left abutment of the concrete gravity section is soil or bedrock.

c. Appurtenant Structures. Located at the left abutment of the dam is the concrete intake structure (See Plans and Details in Appendix A and Photo No. 9). Three 5.6 feet wide by 7.3 feet high gates in this structure discharge to a 26 feet wide by 9 feet high concrete penstock. A bar rack is located just downstream from the penstock gates at the mouth of the penstock. The penstock extends from these gates, underneath the foundation of an old burned out mill, to a generator room. The penstock and generating facilities have not been in use since 1969. The penstock gates are closed and the lifting mechanisms are heavily rusted. Portions of the wooden gates are rotted, although some sections of wood planking have recently been replaced. All three gates are leaking slightly, and there is about 3 feet of silt on the penstock floor between the gates and the bar rack making the gates inoperable (See Photo No. 11). The entire concrete intake structure is severely spalled, with visible reinforcement at many locations (See Photo No. 10). A railing around the top of the intake structure, operator platform for the gates, is heavily rusted and some sections are missing (See Photo No. 10).

Located immediately to the right of the penstock gates is a waste gate opening which is also 5.6 feet wide and 7.3 feet high (See Photo Nos. 9 and 10). The wood gate has been removed and, according to the owner, lies on the floor of the river immediately upstream of the gate opening. The lifting mechanism is inoperable and the surrounding concrete is severely spalled with visible reinforcement at several locations (See Photo No. 10).
SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. Ammonoosuc River Dam is a run-of-river dam and, consequently, impounds a pond of small size. The drainage area is quite large, and consists of hilly and mountainous terrain. The majority of the drainage basin is heavily wooded. Development in the area is quite variable ranging from large sections of undeveloped land in White Mountain National Forest to more extensively developed portions around towns and tourist areas. The flood plain downstream from the dam is generally undeveloped.

The field inspection of Ammonoosuc River Dam was made on April 30, 1980. The inspection team consisted of personnel from SEA Consultants Inc. and Geotechnical Engineers, Inc. Inspection checklists, completed during the visual inspection, are included in Appendix A. At the time of inspection, water was passing over the entire length of the overflow section. The pool elevation was at approximately 495.5 NGVD. The upstream face of the dam could only be inspected above this water level. Inspection of the downstream face was not possible due to the discharge of water over the dam.

b. Dam. Ammonoosuc River Dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The maximum height of the dam is approximately 25 feet from the top of the gate operator platform to the lowest point of the ledge foundation of the overflow section. The overall length of the dam is approximately 365 feet between abutments. The total length of the man-made structures is about 273 feet. The upstream face of the overflow section is vertical, and the downstream face has a slope approximately 4 feet vertical to 1 foot horizontal (4:1). The crest width is about 2 feet. Because water was flowing over the dam at the time of the inspection, it was not possible to make a detailed examination of the concrete in the dam or of the foundation. However, it appears that the dam is founded on bedrock since there are bedrock outcrops along the axis of the dam and immediately downstream of the dam.

The left portion of the man-made overflow section is about 16 feet high and begins at the penstock intake structure and extends approximately 82 feet toward the right abutment, terminating at a high point in the ledge outcropping (See Photo No. 4). At this point, there is one of three dry stone masonry piers constructed on the ledge that supports a covered bridge which spans the river immediately upstream from the dam. This portion of the dam is badly deteriorated and it appears that a section about 50 feet long and as much as 5 feet deep has broken free (See Plans and Details in Appendix A and Photo No. 4). As seen beneath the flowing water, it appears that the entire crest of this portion of the dam is cracked and severely spalled.
SECTION 2
ENGINEERING DATA

2.1 Design
No design data were found for the Ammonoosuc River Dam.

2.2 Construction
No construction records were found.

2.3 Operation
No engineering operational data were found.

2.4 Evaluation
   a. Availability. No engineering data were available for the Ammonoosuc River Dam. A search of the files of the New Hampshire Water Resources Board and direct contact with the owner, revealed a limited amount of recorded information.

   b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgment.

   c. Validity. No engineering data were found to validate.
h. **Diversion and Regulating Tunnel**

Not applicable (see Section j below)

i. **Spillway**

1. Type - concrete overflow section with concrete and ledge outcrop training walls

2. Length of weir - 273 feet (entire overflow section)

3. Crest elevation - 489.5 (minimum elevation of deteriorated overflow section)
   - 495 (approximate original elevation of right portion of overflow section)
   - 494 (approximate original elevation of left portion of overflow section)

4. Gates - N/A

5. U/S Channel - The banks upstream from the dam appear to be stable, although there is minor erosion of the bank immediately upstream from the bridge pier on the left abutment. Trees are growing on the steep left bank of the channel some distance upstream from the dam. The right side of the valley consists of a low, flat flood plain which is cultivated and generally free of trees and brush.

6. D/S Channel - The channel downstream from the dam is generally wide and unobstructed. Immediately downstream from the dam the channel appears to be ledge (bedrock). Further downstream the channel bottom appears to consist of sand, gravel and boulders, and there appear to be no ledge exposures.

j. **Regulating Outlets**

1. Invert - Four sluice gates - 488.6 (bottom of gate opening)

2. Size - Four sluice gates - 5.8 feet wide x 7.3 feet high opening

3. Description
   
   a. Penstock gates - Three gates constructed of 2-inch thick by 8-inch wide wood planks bolted together to form gate. One gate was missing two or three planks, but opening covered with plywood.

   b. Waste gate - Gate was missing.

4. Control Mechanism
   
   a. Penstock gates - Manual crank lifting mechanisms, rusted but otherwise appear to be intact. Gates appear to be inoperable due to silt build-up behind gates.

   b. Waste gate - Manual crank lifting mechanism, which appears to have been vandalized and consequently missing mechanical hardware.
e. **Storage** (acre-feet)
   (1) Normal pool - 100
   (2) Flood control pool - N/A
   (3) Spillway crest pool - 77.7
   (4) Top of dam - 520
   (5) Test flood pool - 570

f. **Reservoir Surface** (acres)
   (1) Normal pool - 24
   (2) Flood control pool - N/A
   (3) Spillway crest - 18 (minimum elevation original crest - 494 feet)
   (4) Test flood pool - 155
   (5) Top of dam - 139

g. **Dam**
   (1) Type - concrete gravity overflow structure
   (2) Length - 365 feet (total length between abutments)
      273 feet (length of man-made portion)
   (3) Height - 25 feet maximum
   (4) Top Width - 2 feet
   (5) Side Slopes - vertical (upstream face)
      4.0V to 1.0H (downstream face)
   (6) Zoning - unknown
   (7) Impervious core - unknown
   (8) Cutoff - unknown
   (9) Grout curtain - none
   (10) Other - none
(8) The total project discharge (including flow over the railroad track at the right abutment) with the water surface at the top of the dam (Elev. 503.5 feet) was estimated to be 44,000 cfs (with the sluice gates closed) and 46,640 cfs (with the sluice gates open).

(9) The total project discharge with the water surface at the test flood elevation (Elev. 504.1 feet) was estimated to be 50,500 cfs.

c. Elevation (feet, NGVD) based on U.S.G.S. bench mark located near the dam (MAC No. 10, 1925, Elev. 505.02)

(1) Streambed at toe of dam - 479 (toe of man-made structure) 468 (toe of ledge)

(2) Bottom of cutoff - unknown

(3) Maximum tailwater - unknown

(4) Normal pool - 495

(5) Full flood control pool - N/A

(6) Spillway crest - 495 (approximate original elevation of right portion of overflow section)
- 494 (approximate original elevation of left portion of overflow section)
- 489.5 (minimum elevation of deteriorated overflow section)

(7) Design surcharge (Original Design) - unknown

(8) Top of dam - 503.5 (top of gate operator platform) 498.8 (top of right training wall)

(9) Test flood surcharge - 504.1

d. Reservoir (length in feet)

(1) Normal pool - 3300

(2) Flood control pool - N/A

(3) Spillway crest pool - 2970 (minimum elevation original crest - 494 feet)

(4) Top of dam - 7070

(5) Test flood pool - 7,400
i. Normal Operating Procedures. The Ammonoosuc River Dam at present is used primarily to retain the water of the Ammonoosuc River for conservational purposes. There is no normal operating procedure for this dam.

1.3 Pertinent Data

a. Drainage Area. The drainage area above Ammonoosuc River Dam covers approximately 325 square miles (208,000 acres), consisting of hilly and mountainous terrain. Numerous streams transecting the area feed the Ammonoosuc River. The topography in the drainage basin ranges from 6288 feet NGVD on top of Mount Washington to approximately 478 feet NGVD at the base of the dam. The majority of the basin is heavily wooded. Development in the drainage basin is quite variable ranging from large sections of undeveloped land in White Mountain National Forest to more extensively developed portions around towns and tourist areas.

b. Discharge at Damsite. Discharge at the damssite normally occurs over the concrete overflow sections, which provide a total weir length of 273 feet. Due to deterioration of the concrete, the elevation of the crest of the overflow sections varies considerably (See Plans and Details in Appendix B). A total of four sluice gates are located at the intake structure, three penstock gates which feed the penstock and one waste gate which discharges directly to the downstream river channel. The invert elevation of all four gates is approximately 488.6 feet (NGVD). At the time of inspection, the three penstock gates were in place and closed, and the waste gate was missing. The owner reported that the waste gate had been removed to increase project discharge.

(1) The capacity of the sluice gates, with the water surface at the top of dam (Elev. 503.5 feet), was estimated to be

(a) Waste gate - 660 cfs
(b) Three penstock gates - 1980 cfs

(2) Maximum known flood at damsite - "March, 1936 Flood", high water mark at approximately 500.8 feet (NGVD) with an estimated discharge of about 24,000 cfs.

(3) The ungated spillway capacity (man-made portions of overflow section only) with the water surface at the top of the dam (Elev. 503.5 feet) was estimated to be 40,000 cfs.

(4) The ungated spillway capacity (man-made portions of overflow section only) with the water surface at the test flood elevation (Elev. 504.1 feet) was estimated to be 45,000 cfs.

(5) Gated spillway capacity at normal pool elevation - N/A

(6) Gated spillway capacity at test flood elevation - N/A

(7) The total spillway capacity with the water surface at the test flood elevation (Elev. 504.1 feet) was estimated to be 45,000 cfs.
The overall length of the dam is approximately 365 feet between abutments. The total length of the man-made structures is about 273 feet. The upstream face of the overflow section is vertical, and the downstream face has a slope approximately 4 feet vertical to 1 foot horizontal (4:1). The crest width is about 2 feet.

Located at the left abutment of the dam is the intake structure for a 26 feet wide by 9 feet high concrete penstock. Flow through the penstock is controlled by three 5.6 feet wide by 7.3 feet high penstock gates with lifting mechanisms and a bar rack. Located immediately to the right of the penstock gates is a waste gate opening which is also 5.6 feet wide and 7.3 feet high.

c. **Size Classification.** Small (height - 25 feet; storage - 520 acre-feet) based on storage (less than 1000 acre-feet and greater than or equal to 50 acre-feet) as given in the Recommended Guidelines for Safety Inspection of Dams.

d. **Hazard Classification.** Significant Hazard. An assumed breach in the Ammonoosuc River Dam would increase the stage along the immediate downstream channel by about 15 feet to an elevation of approximately 488 feet. The discharge resulting from this failure would approach the sill level of the mill located on the left bank a short distance downstream from the dam, possibly resulting in an economic loss to the owner. The potential for loss of less than a few lives of employees at the mill would exist. The stage of the failure discharge would decrease rapidly as it passes downstream.

e. **Ownership.** Several corporations have at one time or another owned the dam and adjoining mill complex; the present organization being New Hampshire Wood Products Corporation, Box A, Bath, New Hampshire 03740; Charles Diamond - owner. Telephone No. (603) 747-2202.

f. **Operator.** The dam is maintained and operated by Charles Diamond, owner, New Hampshire Wood Products Corporation, Box A, Bath, New Hampshire 03740. Telephone No. (603) 747-2202.

g. **Purpose of Dam.** The original purpose of the present structure was to provide water power and later electricity to the adjoining mill. At present, the mill is abandoned having been destroyed by fire. The penstock gates are closed, and the generating equipment is not in use, although the current owner has immediate plans to revitalize the electrical generating equipment.

h. **Design and Construction History.** Files at the state of New Hampshire Water Resources Board indicate a mill dam was in existence at this site as early as 1785. It is not known when the present structure was built, but according to records, was in existence by 1936. This structure provided water power to the mill to drive machinery, and by 1951, a small electric generator was added. The last reported use of hydro power for this dam was in 1969 when the mill was closed. A fire in 1976 destroyed the mill buildings, and there have been no changes to the dam since that time.
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. S E A Consultants Inc. has been retained by the New England Division to inspect and report on selected dams in the state of New Hampshire. Authorization and notice to proceed were issued to S E A Consultants Inc. under a letter of November 5, 1979 from William Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0008 has been assigned by the Corps of Engineers for this work.

b. Purpose

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

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

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

1.2 Description of Project

a. Location. The Ammonoosuc River Dam is located in the center of the town of Bath, New Hampshire, immediately downstream from the Pettyboro Road covered bridge. The dam impounds water from the Ammonoosuc River which, after passing over the spillway, flows in a southerly direction 4.85 miles to the confluence with the Connecticut River. The dam is shown on U.S.G.S. Quadrangle, Lisbon, New Hampshire, with coordinates approximately at N44°10'00", W71°58'33", Grafton County, New Hampshire (See Location Plan).

b. Description of Dam and Appurtenances. The Ammonoosuc River Dam is a concrete gravity overflow structure constructed between three depressions in a ledge outcropping that forms the bottom of the Ammonoosuc River Channel at this location. The maximum height of the dam is approximately 25 feet from the top of the gate operator platform to the lowest point of the ledge foundation of the overflow section. The top of the gate operator platform was taken as the top of dam despite the fact that the right training wall is set nearly 5 feet lower in elevation, because a short distance beyond the right training wall the embankment rises sharply and effectively confines the flow so that only the Boston and Maine Railroad tracks would be affected by flow overtopping the right training wall.
OVERVIEW PHOTO - AMMONOOSUC RIVER DAM
of sluice gate operator platform) would be overtopped by approximately 0.6 foot. The capacity of the man-made overflow sections with the water surface at the dam crest was estimated to be approximately 40,000 cfs, which is about 79 percent of the routed test flood outflow.

5.5 Dam Failure Analysis. The impact of dam failure was assessed utilizing the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs published by the Corps of Engineers. The analysis covered a reach extending a few hundred feet downstream. The prefailure flow with the water surface at the dam crest is significant. A cursory analysis of the downstream water surface elevations associated with the prefailure flow indicated that the mill building, which is located a short distance below the dam and is the only apparent hazard for this dam, would be inundated by the tailwater. Consequently, failure of the dam with the water surface at the top of dam would not increase the hazard potential of the dam. Therefore, the dam failure analysis was conducted with the water surface at the original overflow section crest. Based on this analysis, the Ammonoosuc River Dam has been classified as a significant hazard.

It was determined that the most probable location for an assumed breach to occur was in the overflow section between the left abutment and the ledge outcropping near the middle of the river. A failure length of 100 feet was used, which is about 37 percent of the total length of the man-made structures and represents the entire length of the aforementioned overflow section and a portion of the operator platform to which this overflow section is attached. Using a failure height of 16 feet the failure discharge was estimated to be approximately 10,800 cfs. Since a portion of the overflow section crest has broken away, there would be some discharge prior to failure. However, the prefailure discharge under these conditions is not significant, about 800 cfs, and therefore was not included with the dam failure calculations.

An assumed breach of the Ammonoosuc River Dam with the water surface at the crest of the overflow sections would increase the stage along the immediate downstream channel by about 15 feet to an elevation of approximately 488 feet (NGVD). The discharge resulting from this failure would approach the sill level of the mill located on the left bank a short distance downstream from the dam, possibly resulting in an economic loss to the owner. The potential for loss of less than a few lives of employees at the mill would exist. The stage of the failure discharge would decrease rapidly as it passes downstream.
SECTION 6
EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

The visual observations indicate the following potential structural problems:

(1) The apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length are signs of serious structural problems and instability, and if allowed to continue, will cause a progressive lowering of the crest.

(2) The rotting wood in the penstock gates with 3 feet of silt built up behind them, making the gates inoperable; the leakage through the gates; the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations; and the heavy rust on the lifting mechanisms are all signs of considerable deterioration of the gates and surrounding structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the penstock gates and surrounding structure.

(3) The removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations, and the inoperability of the lifting mechanism are all signs of considerable deterioration of the gate structure. If these problems are not corrected, they could lead to further deterioration and eventual failure of the waste gate structure.

Because water was flowing over the dam, it was not possible to make a detailed visual examination of the concrete in the dam or of the foundation.

6.2 Design and Construction Data. No information regarding the original design or construction of the dam was found, although it is known that a mill dam was in existence at this location by 1765. It is not known when the present structure was built, but according to the files at the state of New Hampshire Water Resources Board, it was in existence by 1936.

6.3 Post-Construction Changes. By 1951 a small electric generator was added to the existing water power facility. The hydro facilities were retired from use in 1969 when the mill closed. A fire in 1976 destroyed the mill buildings, and there have been no changes to the dam since that time.

6.4 Seismic Stability

This dam is located in Seismic Zone 2 and, in accordance with the Phase I guidelines, does not warrant seismic analysis.
SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. The visual examination indicates that Ammonoosuc River Dam is in poor condition. The major concerns with respect to the integrity of the dam are:

(1) The apparent erosion of the concrete overflow sections, including two large sections on the top of the dam that have broken free and the severe spalling and cracking on the crest of the dam over its entire length.

(2) The rotting wood in the penstock gates with 3 feet of silt built up behind them; the leakage through the gates; the severely spalled concrete of the penstock intake structure, with visible reinforcement at several locations; and the heavy rust on the lifting mechanisms.

(3) The removal of the waste gate, the severe spalling of the concrete gate structure with visible reinforcement in a few locations, and the inoperability of the lifting mechanism.

b. Adequacy of Information. The information available from the visual inspection is adequate to identify the problems mentioned in 7.2 and 7.3. However, because water was flowing over the crest of the dam at the time of the inspection, it was not possible to examine in detail the concrete in the dam or the foundation. The problems that have been identified will require the attention of a registered professional engineer qualified in the design and construction of dams who will have to make additional engineering studies to design or specify remedial measures. No additional information is needed for the purposes of this Phase I inspection.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report.

7.2 Recommendations

The owner should retain a registered professional engineer qualified in the design and construction of dams to:

(1) Inspect the downstream face of the overflow sections under no flow conditions.

(2) Design and specify repairs for the erosion and spalling of the concrete overflow sections.
(3) Design and specify repairs to the penstock gates, lifting mechanisms, and for the erosion and spalling of the concrete penstock gate structure.

(4) Design and specify repairs to the waste gate, lifting mechanisms, and for the erosion and spalling of the concrete waste gate structure.

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

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Visually inspect the dam and appurtenant structures once a month.

(2) Engage a registered professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once a year.

(3) Establish a surveillance program for use during and immediately after periods of heavy rainfall, establish written procedures to be followed during flooding periods, and also establish a warning program to follow in case of emergency.

(4) Establish written maintenance and operating procedures.

7.4 Alternatives

There are no practical alternatives to the recommendations of Sections 7.2 and 7.3.
APPENDIX A
INSPECTION CHECKLIST
INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT: Ammonoosuc River Dam, NH

DATE: April 30, 1980
TIME: 11:00 a.m.
WEATHER: Sunny, warm
W.S. ELEV. 495.5 U.S. 479.4 (NGVD)

PARTY:
1. Kenneth Stewart, S E A
2. Robert Durfee, S E A
3. Bruce Pierstorff, S E A
4. Philip Upton, S E A
5. Ronald Hirschfeld, GEI

PROJECT FEATURE

1. Structural Stability
2. Hydrology/Hydraulics
3. Soils and Geology

INSPECTED BY

K. Stewart/R. Durfee
B. Pierstorff
R. Hirschfeld

A-1
**INSPECTION CHECK LIST**

**PROJECT:** Ammonoosuc River Dam, NH  
**DATE:** April 30, 1980

**PROJECT FEATURE:** Dam Embankment  
**NAME:**

**DISCIPLINE:**

**NAME:**

### AREA EVALUATED

<table>
<thead>
<tr>
<th><strong>CONDITIONS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DAM EMBANKMENT</strong></td>
</tr>
<tr>
<td>Crest Elevation</td>
</tr>
<tr>
<td>Current Pool Elevation</td>
</tr>
<tr>
<td>Maximum Impoundment to Date</td>
</tr>
<tr>
<td>Surface Cracks</td>
</tr>
<tr>
<td>Pavement Condition</td>
</tr>
<tr>
<td>Movement or Settlement of Crest</td>
</tr>
<tr>
<td>Lateral Movement</td>
</tr>
<tr>
<td>Vertical Alignment</td>
</tr>
<tr>
<td>Horizontal Alignment</td>
</tr>
<tr>
<td>Condition at Abutment and at Concrete Structures</td>
</tr>
<tr>
<td>Indications of Movement of Structural Items on Slopes</td>
</tr>
<tr>
<td>Trespassing on Slopes</td>
</tr>
<tr>
<td>Vegetation on Slopes</td>
</tr>
<tr>
<td>Sloughing or Erosion of Slopes or Abutments</td>
</tr>
<tr>
<td>Rock Slope Protection - Riprap Failures</td>
</tr>
<tr>
<td>Unusual Movement or Cracking at or near Toe</td>
</tr>
<tr>
<td>Unusual Embankment or Downstream Seepage</td>
</tr>
<tr>
<td>Piping or Boils</td>
</tr>
<tr>
<td>Foundation Drainage Features</td>
</tr>
<tr>
<td>Toe Drains</td>
</tr>
<tr>
<td>Instrumentation System</td>
</tr>
</tbody>
</table>

- 494.0 left overflow section
- 495.0 center and right overflow section
- 495.5
- Unknown
- Numerous throughout crest of dam
- No pavement
- Two large sections of crest broken free. Entire length of crest deteriorated.
- None observed
- Good
- Good
- Poor - concrete severely deteriorated at numerous locations.
- None observed
- None observed
- Some on slopes at abutments
- None observed
- No riprap
- Not observable - beneath water surface
- Not observable - beneath water surface
- N/A
- Not observable - beneath water surface
- Not observable - beneath water surface
- None
<table>
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<tr>
<th>AREA EVALUATED</th>
<th>CONDITIONS</th>
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<tr>
<td>DIKE EMBANKMENT</td>
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<tr>
<td>Crest Elevation</td>
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</tr>
<tr>
<td>Current Pool Elevation</td>
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</tr>
<tr>
<td>Maximum Impoundment to Date</td>
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</tr>
<tr>
<td>Surface Cracks</td>
<td></td>
</tr>
<tr>
<td>Pavement Condition</td>
<td></td>
</tr>
<tr>
<td>Movement or Settlement of Crest</td>
<td></td>
</tr>
<tr>
<td>Lateral Movement</td>
<td></td>
</tr>
<tr>
<td>Vertical Alignment</td>
<td></td>
</tr>
<tr>
<td>Horizontal Alignment</td>
<td></td>
</tr>
<tr>
<td>Condition at Abutment and at Concrete Structures</td>
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</tr>
<tr>
<td>Indications of Movement of Structural Items on Slopes</td>
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</tr>
<tr>
<td>Trespassing on Slopes</td>
<td></td>
</tr>
<tr>
<td>Vegetation on Slopes</td>
<td></td>
</tr>
<tr>
<td>Sloughing or Erosion of Slopes or Abutments</td>
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</tr>
<tr>
<td>Rock Slope Protection - Riprap Failures</td>
<td></td>
</tr>
<tr>
<td>Unusual Movement or Cracking at or near Toes</td>
<td></td>
</tr>
<tr>
<td>Unusual Embankment or Downstream Seepage</td>
<td></td>
</tr>
<tr>
<td>Piping or Boils</td>
<td></td>
</tr>
<tr>
<td>Foundation Drainage Features</td>
<td></td>
</tr>
<tr>
<td>Toe Drains</td>
<td></td>
</tr>
<tr>
<td>Instrumentation System</td>
<td></td>
</tr>
</tbody>
</table>
## INSPECTION CHECK LIST

**PROJECT:** Ammonoosuc River Dam, NH  
**DATE:** April 30, 1980  
**PROJECT FEATURE:** Intake Channel  
**DISCIPLINE:**  

### AREA EVALUATED

**OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE**

A. **Approach Channel**
- **Slope Conditions**: Some erosion of left river bank immediately upstream of outlet works
- **Bottom Conditions**: Not visible beneath water surface
- **Rock Slides or Falls**: None observed
- **Log Boom**: None
- **Debris**: Some debris at beginning of approach channel
- **Condition of Concrete Lining**: Considerable spalling above water surface elevation
- **Drains or Weep Holes**: None observed

B. **Intake Structure**
- **Condition of Concrete**: Considerable spalling above water surface elevation
- **Stop Logs and Slots**: None
<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTLET WORKS - CONTROL TOWER</td>
<td>Control works located on top of penstock intake structure</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Concrete and Structural</td>
<td></td>
</tr>
<tr>
<td>General Condition</td>
<td>Very poor</td>
</tr>
<tr>
<td>Condition of Joints</td>
<td>Not observed</td>
</tr>
<tr>
<td>Spalling</td>
<td>Several locations of severe spalling</td>
</tr>
<tr>
<td>Visible Reinforcing</td>
<td>Several locations of visible reinforcement</td>
</tr>
<tr>
<td>Rusting or Staining of Concrete</td>
<td>Staining of concrete below lifting mechanisms</td>
</tr>
<tr>
<td>Any Seepage or Efflorescence</td>
<td>None observed</td>
</tr>
<tr>
<td>Joint Alignment</td>
<td>Good</td>
</tr>
<tr>
<td>Unusual Seepage or Leaks in Gate Chamber</td>
<td>Minor leaks through penstock gates</td>
</tr>
<tr>
<td>Cracks</td>
<td>Minor</td>
</tr>
<tr>
<td>Rusting or Corrosion of Steel</td>
<td>Lifting mechanisms heavily rusted</td>
</tr>
<tr>
<td>b. Mechanical and Electrical</td>
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</tr>
<tr>
<td>Air Vents</td>
<td>None</td>
</tr>
<tr>
<td>Float Wells</td>
<td>None</td>
</tr>
<tr>
<td>Crane Hoist</td>
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</tr>
<tr>
<td>Elevator</td>
<td>None</td>
</tr>
<tr>
<td>Hydraulic System</td>
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</tr>
<tr>
<td>Service Gates, Emergency Gates</td>
<td>Waste gate removed, penstock gates(3) in place; fair condition</td>
</tr>
<tr>
<td>Lightning Protection System</td>
<td>None</td>
</tr>
<tr>
<td>Emergency Power System</td>
<td>None</td>
</tr>
<tr>
<td>Wiring and Lighting System</td>
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</table>
## INSPECTION CHECK LIST

**PROJECT:** Ammonoosuc River Dam, NH  
**DATE:** April 30, 1980  
**PROJECT FEATURE:** Transition and Conduit  
**DISCIPLINE:**  

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITIONS</th>
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</thead>
<tbody>
<tr>
<td>OUTLET WORKS - TRANSITION</td>
<td>26 feet wide by 9 feet high penstock</td>
</tr>
<tr>
<td>AND CONDUIT</td>
<td>Poor</td>
</tr>
<tr>
<td>General Condition of Concrete</td>
<td>Staining of concrete at bar rack</td>
</tr>
<tr>
<td>Rust or Staining on Concrete</td>
<td>Severe on inside lining</td>
</tr>
<tr>
<td>Spalling</td>
<td>Severe on inside lining</td>
</tr>
<tr>
<td>Erosion or Cavitation</td>
<td>Minor</td>
</tr>
<tr>
<td>Cracking</td>
<td>Good</td>
</tr>
<tr>
<td>Alignment of Monoliths</td>
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</tr>
<tr>
<td>Alignment of Joints</td>
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</tr>
<tr>
<td>Numbering of Monoliths</td>
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</tr>
</tbody>
</table>

A-6
**INSPECTION CHECK LIST**

**OBJECT:** Ammonoosuc River Dam, NH

**DATE:** April 30, 1980

**OBJECT FEATURE:** Outlet Structure

**SCIPLINE:**

**NAME:**

---

<table>
<thead>
<tr>
<th>AREA EVALUATED</th>
<th>CONDITIONS</th>
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<tbody>
<tr>
<td><strong>OUTLET WORKS - OUTLET STRUCTURE</strong></td>
<td></td>
</tr>
<tr>
<td>General Condition of Concrete</td>
<td>Not visible - beneath mill foundation</td>
</tr>
<tr>
<td>Inst or Staining</td>
<td>Not visible - beneath mill foundation</td>
</tr>
<tr>
<td>Scaling</td>
<td>Not visible - beneath mill foundation</td>
</tr>
<tr>
<td>Erosion or Cavitation</td>
<td>Not visible - beneath mill foundation</td>
</tr>
<tr>
<td>Visible Reinforcing</td>
<td>Not visible - beneath mill foundation</td>
</tr>
<tr>
<td>Seepage or Efflorescence</td>
<td>Not visible - beneath mill foundation</td>
</tr>
<tr>
<td>Condition at Joints</td>
<td>Not visible - beneath mill foundation</td>
</tr>
<tr>
<td>Rain Holes</td>
<td>None observed</td>
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<tr>
<td>Channel</td>
<td>None observed</td>
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<tr>
<td>Loose Rock or Trees Overhanging Channel</td>
<td>None observed</td>
</tr>
<tr>
<td>Condition of Discharge Channel</td>
<td>Good</td>
</tr>
<tr>
<td></td>
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</tbody>
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A-7
## Inspection Check List

**Project:** Ammonoosuc River Dam, NH  
**Date:** April 30, 1980

**Area Evaluated**

### Approach Works - Spillway Weir, Approach and Discharge Channels

<table>
<thead>
<tr>
<th>Area</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approach Channel</strong></td>
<td></td>
</tr>
<tr>
<td>General Conditions</td>
<td>Good</td>
</tr>
<tr>
<td>Loose Rock Overhanging Channel</td>
<td>None</td>
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<tr>
<td>Trees Overhanging Channel</td>
<td>None</td>
</tr>
<tr>
<td>Floor of Approach Channel</td>
<td>Not visible beneath water surface</td>
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<tr>
<td><strong>Weir and Training Walls</strong></td>
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<tr>
<td>General Condition of Concrete</td>
<td>Very poor</td>
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<tr>
<td>Rust or Staining</td>
<td>Rusting at visible reinforcement</td>
</tr>
<tr>
<td>Spalling</td>
<td>Severe throughout structure</td>
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<tr>
<td>Any Visible Reinforcing</td>
<td>Visible reinforcement at several locations</td>
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<tr>
<td>Any Seepage or Efflorescence</td>
<td>Visible efflorescence at some locations</td>
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<tr>
<td>Drain Holes</td>
<td>None</td>
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<tr>
<td><strong>Discharge Channel</strong></td>
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<tr>
<td>General Condition</td>
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<tr>
<td>Loose Rock Overhanging Channel</td>
<td>None</td>
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<tr>
<td>Trees Overhanging Channel</td>
<td>Some trees overhanging channel</td>
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<tr>
<td>Floor of Channel</td>
<td>Not visible beneath water surface</td>
</tr>
<tr>
<td>Other Obstructions</td>
<td>None observed</td>
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<tr>
<td>AREA EVALUATED</td>
<td>CONDITIONS</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
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<tr>
<td>INLET WORKS - SERVICE BRIDGE</td>
<td>No service bridge</td>
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<tr>
<td>Super Structure</td>
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<td>Bearings</td>
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<td>Anchor Bolts</td>
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<td>Bridge Seat</td>
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<tr>
<td>Longitudinal Members</td>
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<tr>
<td>Under Side of Deck</td>
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<tr>
<td>Secondary Bracing</td>
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<td>Deck</td>
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<td>Drainage System</td>
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<td>Railings</td>
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<td>Expansion Joints</td>
<td></td>
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<td>Paint</td>
<td></td>
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<tr>
<td>Abutment &amp; Piers</td>
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<tr>
<td>General Condition of Concrete</td>
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<tr>
<td>Alignment of Abutment</td>
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<td>Approach to Bridge</td>
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<tr>
<td>Condition of Seat &amp; Backwall</td>
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</table>
### NEW HAMPSHIRE WATER CONTROL COMMISSION
### DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

| AT DAM NO. | 12,00 |
| County     | Grantham |
| County     | Grantham |

**DATA**

<table>
<thead>
<tr>
<th>x</th>
<th>ft.: Min</th>
<th>ft.: Ave</th>
<th>ft.: Max</th>
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<tbody>
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<td>13.8</td>
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**Construction**

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<th>Use of Power</th>
<th>Industrial</th>
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<th>ac.: ft: Storage</th>
<th>ac.: ft.</th>
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**Data**

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<th>Rack Opening</th>
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**Gross**

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<th>Sq. Ft.: Net</th>
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**er**

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<tr>
<th>Size</th>
<th>ft. high x ft. wide</th>
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**er**

| Material | |
|----------||

**er**

| Material | |
|----------||

**er**

| Length | |
|--------||

**er**

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<tr>
<th>Makers</th>
<th>1-25&quot; Leffel</th>
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**hp. per unit**

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<tr>
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<th></th>
<th>Total Capacity (500)</th>
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<td></td>
<td>24.0</td>
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**Demen C.F.S., per unit**

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<th>Total cfs.</th>
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**or**

<table>
<thead>
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<th></th>
<th>Total Capacity</th>
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**or**

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<tr>
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<th>g-per unit</th>
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**x Kw., per unit**

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<th>Total Capacity</th>
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**eper**

<table>
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<tr>
<th>Make</th>
<th>Total Capacity</th>
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**-KWHRS**

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<td>19.....</td>
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<td>19.....</td>
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</tbody>
</table>

**Quainton-Rhine Co, Batl N H**

**By** A.J. A.R.L. | Date October 13, 1938.
NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

<table>
<thead>
<tr>
<th>State No.</th>
<th>County</th>
<th>Name</th>
<th>Primary</th>
<th>Secondary</th>
<th>Lat.</th>
<th>Long.</th>
<th>Ctrl Area</th>
<th>Unctl Area</th>
<th>Total Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>27:22</td>
<td>Coos</td>
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</tbody>
</table>

**All Data**

- Age area: Controlled
- Sq. Mi.: Uncontrolled
- Sq. Mi.: Total

- Length of dam
- Ft.:
- Date of Construction

- Elevation
- Stream bed to highest elev.
- Ft.:

- Max. Structure
- Ft.

- Reservoir
- Gravity
- Type
- Length

**Gates**

- (Sluice, Slide)

- Size
- Ft.

- High x
- Ft.

- Wide
- Vlation
- Invert
- Ft.

- Total Area
- Sq. Ft.

**Gates Conduit**

- Number
- Materials
- Ft.

- Length
- Ft.

- Area
- Sq. Ft.

**Inkment**

- Feet
- Height
- Max.
- Ft.

- Min.
- Ft.

- Width
- Elev.
- Ft.

**Pipes**

- Upstream
- Ft.

- On
- Downstream
- On

**Right of Spillway**

- Length
- Right of Spillway
- Left of Spillway

**Materials of Construction**

- Concrete
- Total
- Ft.

- Net
- Ft.

- Height of permanent section
- Max.
- Ft.

- Min.
- Ft.

**Shadows**

- Type
- Height
- Ft.

**Flashboards**

- Permanent Crest
- Top of Flashboard
- Height

**Modified Capacity**

- Cfs.

- Cfs/sq. mi.

**Materials**

- Steel:
- Max.
- Ft.

- Min.
- Ft.

**Works to Power Devel.**

- See "Data on Power Development"

**RKS**

- A

- 33rd St.

**Signature**

- Date

- 1934

- 12/12/28

- B-12
Gentlemen:

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

1. Was this dam injured? Ans. _______ No ________

2. If so, to what extent? Ans. _______ X ________

3. Did all flashboards go out? Ans. _______ Half of them did. _______

4. What was the maximum height of water over the permanent crest of spillway? Ans. _______ About Nine (9) Feet _______

5. At what day and hour did the maximum flood height reach your dam? Ans. _______ Sept. 21, 7:30 P.M. _______

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

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

We thank you for your cooperation.

Very truly yours,

[Signature]

Richard S. Holmes
Chief Engineer

Enc.
NEW HAMPSHIRE WATER RESOURCES BOARD

QUESTIONNAIRE

WATER POWERS OF NEW HAMPSHIRE

Cushman Rankin Company
Bath
New Hampshire

Gentlemen:

We maintain in this office a list of the water power installations in New Hampshire. In recent months we have had several inquiries concerning the water power installations in the State and have found that our information is in some cases out of date.

We are, therefore, bringing this information up to date and request your cooperation by filling in the questionnaire below with data on your development, and return it to us in the enclosed stamped envelope.

Very truly yours,

[Signature]

Richard S. Holmgren
Chief Engineer

Encl.

Dam No. 17.02: Location: Ammonoosuc River at Bath

1. Will you please check or correct:

<table>
<thead>
<tr>
<th></th>
<th>Our Data</th>
<th>Your Corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Area - Sq.Mi.</td>
<td>327</td>
<td>7</td>
</tr>
<tr>
<td>Head - feet</td>
<td>16.5</td>
<td>16.0</td>
</tr>
<tr>
<td>Capacity (Total)</td>
<td>275</td>
<td>200</td>
</tr>
<tr>
<td>Wheel - H.P.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generator - K.W.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Is the power plant now in operation? Yes

3. If not, is the equipment in operable condition? Yes

4. Is the dam in good repair? Yes - Needed repairs

(Signed) [Signature]

Date July 15, 1944
December 4, 1961

The Cushman-Rankin Company
Bath, N.H.

Dear Sir:

To bring our records of hydro-electric power installations up to date, we are requesting you to furnish the following information on your generators in use at the present time:

[Blank]

reported as 11 KW in 1951

presently using None KW generators.

January 8, 1962

Gentlemen:

The Cushman-Rankin Company was liquidated in 1953 after a disastrous fire on July 1, 1952.

Yours very truly,

Francis C. Moore
Civil Engineer
WATER RESOURCES BOARD  
105 Loudon Rd.  
Concord, N. H.

Gentlemen:

We wish to report the following flood damage to the dam located below the covered wooden bridge at Bath, N. H. on June 30, 1973.

1. A section at the top of the dam approximately 100 ft. long and from two to five feet deep has broken free on the side closest to Route 302.

2. A section at the top of the dam approximately 20 feet long and one foot deep has broken free on the west side of the dam.

We would appreciate it if your department will make a record of the above damage, and inspect it as soon as possible.

Sincerely,

CHARLES M. DIAMOND

DIAMOND WOODWORKING CO.
MEMORANDUM

DATE: October 6, 1973
FROM: Pattu D. Kesavan, Water Resources Engineer
SUBJECT: Complaint from Diamond Woodworking Co. - Bath - #17.02

TO: Vernon A. Knowlton
    Chief Engineer, Water Resources Board

The Diamond Woodworking Company wrote a letter to this office regarding a flood damage to the dam which it claims to have occurred during June 30, 1973.

Peter Merkes has talked to the Bath Selectmen, who are of the opinion that the damage claimed by the Diamond Woodworking Company is not legitimate, and the dam was in that condition for several years. Also, as this is a private dam, the Corps of Engineers dam team did not prepare a DSR, and I assume that they informed this fact to the Diamond Woodworking Company.

I inspected the dam in October 3, 1973, accompanied by Mr. Charles Diamond. I was informed that Mr. Diamond bought the dam and the mill in April, 1973. The dam is situated across the Ammonoosuc River under the old covered bridge. (See photos).

I told Mr. Diamond that this is a privately owned dam, and there is little that the State or the Federal Disaster Assistance Program could do.

PDK: js
DATE: February 20, 1974

FROM: Francis C. Moore, Civil Engineer

SUBJECT: Diamond Woodworking Co. Dam - Bath - #17.02

TO: Vernon A. Knowlton, Chief Water Resources Engineer

On February 15, 1974, I inspected the results of ice jams above the Bath dam. There was negligible ice jamming in the power pool above this dam. By viewing the river above the power pool, there was considerable ice jamming of agricultural land. This caused some debris, trash and gravel buildup on agricultural land.

The flood gate at the Bath dam is only 3' x 5' from top of dam. This would pass about 160 cubic feet per second or 0.5 cubic feet per second per square mile. This would give negligible relief during floods.

I talked with Charles Diamond, owner, who said he was being granted a small Business Loan of $40,000 to rehabilitate the hydroelectric generator. This will include rebuilding of the intake structure. The flood gate is frozen in and a 10-ton hydraulic jack cannot at present open the gate. Upon rebuilding of the intake structure, this flood gate and a serious leak in the dam about fifty feet from the intake structure will be sealed off.

FCM: js
Diamond Woodworking Company  
Bath  
New Hampshire  

RE: REPAIRS NECESSARY TO YOUR DAM, BATH - #17.02  

1. Eroded concrete on spillway is to be repaired.
Diamond Woodworking Company
Bath, NH 03740

CERTIFIED MAIL

Dear

On October 3rd, 1974, an engineer of the New Hampshire Water Resources Board inspected your dam located on Ammonoosuc River in the Town of Bath.

This dam, #17.02 in the files of the New Hampshire Water Resources Board, is classified as a menace structure, and as such, must be maintained in a manner so that this structure would not endanger the public safety, nor become a "Dam in Disrepair".

As a result of this inspection, the several items noted on the attached sheet were found to be deficient and should be corrected immediately.

Under the provisions of Chapter 482:42-59, by petition from the selectmen of the town of mayor of any municipality or upon its own motion, the Board may conduct a public hearing for the determining of whether or not said dam is a "Dam in Disrepair". Should such a finding be determined, the owner would be requested to make the repairs within a specified time period. Upon failure to do so, the town, by the provisions of these statutes, may take the dam.

This office would appreciate receipt of your proposed schedule of these repairs, within 30 days receipt of this letter, and should no response be received within this time period, the Board may direct that a public hearing be conducted and a formal order be issued requiring that the necessary repairs be made or that this dam be breached.

If you have any questions regarding the above, please contact us at your convenience.

Very truly yours,

George W. McGee, Sr.
Chairman

George W. McGee, Sr.
Chairman

cc: Town Clerk

B-3
PAST INSPECTION REPORTS
AVAILABLE ENGINEERING DATA

Cross section information for the Ammonoosuc River Channel and top of dam generated for a flood plain information report for Bath, New Hampshire, prepared for the Army Corps of Engineers by Dubois & King in May of 1978 were obtained from the Army Corps of Engineers, New England Division, Waltham, Massachusetts.

Other than the cross section information mentioned above and records of past inspection reports on file at the State of New Hampshire, Water Resources Board, 37 Pleasant Street, Concord, New Hampshire 03301, no in-depth engineering calculations, as-built drawings, or specifications were found.
August 17, 1936

Mr. W. P. Rankin
The Cushman-Rankin Co.
Bath, New Hampshire

Dear Sir:

We are in receipt of your letter of August 12, 1936 regarding inspection of your dam in Bath.

In classifying your dam as being in fair condition, our Inspector based his report on the looks of the dam. This dam structurally is in first class condition, but as you have said the face is badly pitted. Also Mr. Blake said there was a little seepage in a ledge crevice which was probably due to the frost action on the ledge.

You are correct in saying we classified this dam a menace due to its height and location rather than its condition. We can offer no suggestions concerning the repair of your dam other than refacing, and at such time we will change our report of condition, fair, to condition, very good.

Yours very truly,

N. H. PUBLIC SERVICE COMMISSION

D. Waldo White
Chief Engineer
**PUBUC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD**

<table>
<thead>
<tr>
<th>TOWN</th>
<th>RIVER</th>
<th>STREAM</th>
<th>DRAINAGE</th>
<th>AREA</th>
<th>DAM</th>
<th>TYPE</th>
<th>MATERIALS OF CONSTRUCTION</th>
<th>PURPOSE OF DAM</th>
<th>HEIGHTS, TOP OF DAM TO BED OF STREAM</th>
<th>TOP OF DAM TO SPILLWAY CRESTS</th>
<th>SPILLWAYS, LENGTHS</th>
<th>DEPTHS BELOW TOP OF DAM</th>
<th>FLASHBOARDS</th>
<th>TYPE, HEIGHT ABOVE CREST</th>
<th>OPERATING HEAD CREST TO N. T. W.</th>
<th>WHEELS, NUMBER &amp; H. P.</th>
<th>GENERATORS, NUMBER &amp; H. P.</th>
<th>H. P. 90 P. C. TIME</th>
<th>100 P. C. EFF.</th>
<th>REFERENCES, CASES, PLANS, INSPECTIONS</th>
<th>REMARKS</th>
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**To the Public Service Commission:**

The foregoing memorandum on the above dam is submitted covering inspection made July 22, 1936, according to notification to owner dated July 14, 1936, and bill for same enclosed.

D. Waldo White
Chief Engineer

August 6, 1936
Copy to Owner
PLANS AND DETAILS
APPENDIX C

SELECTED PHOTOGRAPHS
AMMONOOSUC RIVER DAM PHOTO INDEX

BATH, NEW HAMPSHIRE

SCALE AS NIPPED
DATE JUNE 1980

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

R. R. CONSULTANT INC.
BATH, ME

U.S. ARMY ENGINEER DISS NEW ENGLAND
AGENCY OF ENGINEERING
WATERBURY, CT

ROAD

MILL ACCESS R.D.

PENSTOCK INLET STRUCTURE

BLDG.
Photo No. 1 - General view of upstream channel from bridge.

Photo No. 2 - View of left abutment and crest of dam from right abutment.
Photo No. 5 - Close-up of crest of central portion of overflow section.

Photo No. 6 - Downstream face of right portion of overflow section.
Photo No. 9 - Downstream face of intake structure.

Photo No. 10 - Close-up of upstream face of intake structure.
c. Compute \( V_2 \) using \( Q_{PZ}(TRIAL) \)

From Figure 3 determine stage for \( Q_{PZ}(TRIAL) \)

\[
\text{Stage} = 483.0 \text{ feet}^4
\]

\[
\text{X-area} = 3,176 \text{ ft}^2 (\text{above Z}=473.2)
\]

\[
V_2 = \frac{(125 \text{ feet}) (3,176 \text{ ft}^2)}{43,560 + \frac{2}{4} \text{ acre}}
\]

\[
V_2 = 9.1 \text{ acre-feet}
\]

d. Average \( V_1 \) and \( V_2 \) and compute \( Q_{PZ} \)

1. \( V_{avg} = \frac{V_1 + V_2}{2} \)

\[
V_{avg} = \frac{9.5 \text{ acre-ft} + 9.1 \text{ acre-ft}}{2}
\]

\[
V_{avg} = 9.3 \text{ acre-feet}
\]

2. \( Q_{PZ} = Q_{P1} \left( 1 - \frac{V_{avg}}{S} \right) \)

\[
Q_{PZ} = \left( 10,900 \text{ cfs} \right) \left( 1 - \frac{9.3}{777} \right)
\]

\[
Q_{PZ} = 9,500 \text{ cfs}
\]
3. **STEP 3**: Prepare stage-discharge curve for Reach 1

a. Pertinent Data

   (1) Reach length = 125 feet

   (2) See discussion in Section V of the Hydrologic Calculations pertaining to stage-discharge curve

b. See Figure 3 for stage-discharge curve.

4. **STEP 4**: Estimate Reach Outflow

a. Determine stage for $Q_{p1} = 10,800 \, \text{cfs}$ from Figure 3 and find volume in reach

   (1) Stage = 488.6 feet

   (2) Volume in reach = (reach length) \(\frac{(\text{cross-sectional area of channel})}{\text{area of section}}\)

\[
\text{X-area} = 3.323 \, \text{ft}^2 \quad (\text{area of section} = 3.0)
\]

\[
\text{Volume} = V_1 = \frac{(125 \, \text{ft}) (3.323 \, \text{ft}^2)}{43.560 \, \text{ft}^2 / \text{acre}} = 9.5 \, \text{acre-ft}
\]

b. Determine $Q_{PZ(\text{TRIAL})}$

\[
Q_{PZ(\text{TRIAL})} = Q_{P1} \left(1 - \frac{V_1}{5}\right)
\]

\[
Q_{PZ(\text{TRIAL})} = \left(10,800 \, \text{cfs}\right) \left(1 - \frac{9.5}{74.7}\right)
\]

\[
Q_{PZ(\text{TRIAL})} = 9,470 \, \text{cfs}
\]
A Reach 1

1. **STEP 1**: Determine reservoir storage at time of failure

   from previous calcs storage = 77.7 acre-ft

2. **STEP 2**: Determine Peak Failure Discharge, \( Q_{p1} \)

   \[ Q_{p1} = (8/24) W_b \ 3^{1/2} \ Y_0 \]

   where: \( W_b = \) breach width (max 10% of length at dam)
   \[ = (0.40)(273 \text{ ft}) \]
   \[ = 109 \text{ ft}^3/\text{s} \]

   *109 ft/s of failure would resemble the failure of two separate portions of overflow section, used 100 ft/s which would include length of left portion of overflow section and part of center portion.

   \( Y_0 = \) Total height of man-made overflow section
   \[ \approx 16 \text{ ft} \]

   \[ Q_{p1} = (8/24)(100 \text{ ft}) (32.2)^{1/2} (16 \text{ ft})^{3/2} \]

   \[ Q_{p1} \approx 10,800 \text{ cfs} \]
the dam wall would be about 3 feet above the sill of the mill building. It is apparent that the relatively small amount of additional discharge resulting from failure of the dam under the aforementioned conditions would not increase the hazard to the mill building or any other structures further downstream. Consequently, the hazard classification for this dam should be based on failure of the dam with the water surface at the crest of the overflow section.

2. Since a portion of the overflow section has broken away, some prefailure discharge would result when the dam is failed at the approximate elevation of the original overflowing crest. However, this prefailure discharge is not significant when compared to the dam failure discharge and therefore has not been considered in subsequent calculations.

Using "Rule of Thumb" Guidance for Estimating Downstream Failure Hydrographs Examines the Impact of Dam Failure with the Water Surface at the Original Crest of the Overflow Section

1. Pertinent Data

2. Failure occurs with water surface at approximately elevation of original overflow section crest = 494 feet (NGVD)
Using "Rule of Thumb" Guidance for Estimating Downstream Failure Hydrographs Examine the Impact of Dam Failure with Water Surface at Crest of Dam

A. Pertinent Data

1. Failure occurs with water surface at crest of dam (Top of gate opener platform)

   elevation = 503.5 feet

2. Storage at crest of dam = 520 acre-feet

B. Since the overflow section extends almost the entire length of the dam, the tailwater resulting from discharge over the dam with water surface at the crest of dam will be significant. Therefore, the impact of the tailwater resulting from this discharge must be examined. If the hazard resulting from failure of the dam with the water surface at the crest of the dam is greater than the hazards from the pre-failing tailwater, then the hazard classification for the dam should be determined by failing the dam with the water surface at the spillway or overflow section crest.

1. From Figure 1, the discharge over the overflow section would be about 44,000 cfs with water surface at the crest of dam. Thus, discharge would result in a water surface elevation in the stream reach immediately downstream of...
b. determine \( \text{STOR}_2 \)

\[
\text{STOR}_2 = \frac{(570 \text{ ac-ft} - 77.7 \text{ ac-ft})(12''/ft)}{(325 \text{ sg.mi})(640 \text{ ac/sg.mi})}
\]

\[= 0.028 \text{ inches} \]

c. Average \( \text{STOR}_1 \) and \( \text{STOR}_2 \)

\[
\text{STOR}_{\text{avg}} = \frac{\text{STOR}_1 + \text{STOR}_2}{2}
\]

\[
\text{STOR}_{\text{avg}} = \frac{0.029 \text{ in} + 0.029 \text{ in}}{2}
\]

\[
\text{STOR}_{\text{avg}} = 0.0285 \text{ inches}
\]

\( \text{STOR}_2 \) and \( \text{STOR}_{\text{avg}} \) agree favorably. An uncorrected routed test flood outflow equal to 50,500 cfs at a surcharge elevation of +504.1 feet
(2) Subtract "dead storage" (below 494.0) from storage at surcharge elevation and insert in equation below.

\[ \text{STOR}_1 = \frac{\text{volume of storage (as acre-inches)}}{\text{drainage area}} \]

\[ \text{STOR}_1 = \frac{(580\text{ac-ft} - 77.7\text{ac-ft}) (12''/\text{ft})}{(325\text{ sq.mi})(640\text{ ac/sq.mi})} \]

\[ \text{STOR}_1 = 0.029 \text{ inches} \]

c. determine \( Q_{p2} \)

\[ Q_{p2} = Q_{p1} \left(1 - \frac{\text{STOR}_1}{9.5''}\right) \]

\[ Q_{p2} = \left(50,800 \text{ cfs}\right) \left(1 - \frac{0.029''}{4.75''}\right) \]

\[ Q_{p2} = 50,500 \text{ cfs} \]

STEP 3: Determine surcharge height and \( \text{STOR}_2 \) to pass \( Q_{p2} \) and \( Q_{p3} \)

a. Figure 1: determine surcharge height to pass \( Q_{p2} = 50,500 \text{ cfs} \)

Surcharge elevation \( \approx 504.1 \text{ ft} \)

Normal permanent crest level \( \approx 494.0 \text{ ft} \)

Surcharge height \( \approx 10.1 \text{ ft} \)

Storage at surcharge elevation \( \approx 570 \text{ ac-ft} \)
FIGURE 2

STORAGE vs ELEVATION
3. Effect of surcharge storage on max. prob. discharge

1. Pertinent Data
   a. Drainage area = 325 square miles
   b. Characteristics of basin - Combination of hilly and mountainous
   c. Test time = 100 yr or 1/4 PMF due to potential upstream storage
   d. Follow Army Corps' procedure

2. **STEP 1**: Determine Peak Inflow $Q_{p1}$ from Guide Curve
   a. the max. prob. discharge was estimated to be $625 \text{ cfs/sq. mi}$
   $$\text{PMF} = (325 \text{ sq. mi})(625 \text{ cfs/sq. mi})$$
   $$\approx 203,000 \text{ cfs}$$
   $$1/4 \text{ PMF } \approx 50,800 \text{ cfs}$$

3. **STEP 2**: Determine surcharge height to pass $Q_{p1}$, $\text{STOR}_1$
   a. from figure, determine surcharge height to pass $Q_{p1} = 50,800 \text{ cfs}$
      $$\text{Surcharge elevation } \approx 504.2'$$
      $$\text{Normal permanent crest elev } \approx 494.0'$$
      $$\text{Surcharge height } \approx 10.2'$$
   b. Determine volume of surcharge $\text{STOR}_1$ in inches of
      rain: $\text{STOR}_1 = 580 \text{ acre-ft}$

D-5
FIGURE 1

DISCHARGE vs ELEVATION
* Notes: (1) Elevations - NGVD
(2) Pond Surface Areas - Surface areas at 510', 500', and 494' determined from maps included in Flood Plain Information, Ammonoosuc River, Bath, N.H. prepared by Dept. of Army, NED, Corps of Engineers, May, 1976
(3) Storage - Utilized river cross-section data developed during preparation of the above referenced Flood Plain Information report to estimate storage at elevations 510, 500, and 494

C. Spillway Information

I. Discharge at the dam site occurs over various portions of the concrete overflow sections cast on and between lock structures in the river channel. The normal permanent crest elevation appears to have been at 494 feet. However, a relatively large segment of the overflow section adjacent to the penstock intake structure has broken out. The invert of this section is now at an elevation of approximately 499.5 feet.

II. Estimate Effect of Surcharge Storage on Maximum Possible Discharge

A. Develop stage-discharge curve for outflow from dam complex

1. Data developed from computer analyses completed by the Army Corps for the above referenced Flood Plain Information report were used to prepare the stage-discharge curve. The appropriate data points are as follows: (see Figure 1)

<table>
<thead>
<tr>
<th>Storm Event</th>
<th>Water Surface Elevation, feet</th>
<th>Discharge, cfs</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-yr</td>
<td>499.55</td>
<td>17,700</td>
</tr>
<tr>
<td>50-yr</td>
<td>502.16</td>
<td>35,700</td>
</tr>
<tr>
<td>100-yr</td>
<td>503.60</td>
<td>44,600</td>
</tr>
<tr>
<td>500-yr</td>
<td>507.21</td>
<td>84,800</td>
</tr>
</tbody>
</table>
I. Basic Data

A. Drainage Area

1. 325 square miles - as defined on U.S.G.S. sheet and then planimetered

2. Drainage area has topography ranging from level to mountainous; use point midway between rolling and mountainous curve to estimate maximum probable flood peak flow rate

B. Dam and Storage Information

1. Size Classification: SMALL based on storage (≥ 50 acre-ft and < 1000 acre-ft)

   as indicated below - storage at crest of dam estimated to be 520 acre-feet

2. Hazard Potential: Significant

C. Storage Information

<table>
<thead>
<tr>
<th>Descriptive Information</th>
<th>Elevation * (feet)</th>
<th>Surface * (acre-feet)</th>
<th>Storage * (acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>510' Contour</td>
<td>510.0</td>
<td>300</td>
<td>1,500</td>
</tr>
<tr>
<td>Top of dam, gate operator platform</td>
<td>503.5</td>
<td>139</td>
<td>520</td>
</tr>
<tr>
<td>500' Contour</td>
<td>500.0</td>
<td>52</td>
<td>222</td>
</tr>
<tr>
<td>Min. elevation of original outflow section crest</td>
<td>494.0</td>
<td>18</td>
<td>7 7</td>
</tr>
</tbody>
</table>

D.2
APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS
3. Reach 2

1. **STEP 3**: Prepare stage-discharge curve for Reach 2

   a. Pertinent Data
      
      (1) Reach length = 750 feet
      
      (2) See discussion Section V of the Hydrologic Calculations pertaining to stage-discharge curves.

   b. See Figure 3 for stage-discharge curve

2. **STEP 4**: Estimate Reach Outflow

   a. Determine stage for \( Q_{p2} = 9,500 \text{ cfs} \) from Figure 3 and find volume in reach
      
      (1) Stage = 487.3 feet
      
      (2) Volume in reach = (reach length) \( \frac{(\text{cross-sectional area of channel})}{\text{area of channel}} \)

      \[
      X\text{-area} = 3,065 \text{ ft}^2
      \]

      \[
      \text{Volume} = V_1 = \frac{450 \text{ ft}}{43.56 \text{ ft}^2/\text{acre}} \left( \frac{3,065 \text{ ft}^2}{\text{acre}} \right)
      \]

      \[
      \text{Volume} = V_1 = 52.8 \text{ acre-ft}
      \]

   b. Determine \( Q_{P3'(\text{TRIAL})} \)

      \[
      Q_{P3'(\text{TRIAL})} = Q_{P2} \left( 1 - \frac{V_1}{S} \right)
      \]

      \[
      Q_{P3'(\text{TRIAL})} = (9,500 \text{ cfs}) \left( 1 - \frac{52.8}{43.56} \right)
      \]

      \[
      Q_{P3'(\text{TRIAL})} = 3,050
      \]

      \[
      Q_{P2(\text{TRIAL})} = 3,050
      \]
c. Compute $V_2$ using $Q_{P3}(TRIAL)$

From Figure 3 determine stage for $Q_{P3}(TRIAL)$

Stage $\approx 482.0$ feet

$X$-area $= 1615 \text{ ft}^2 \text{ (above ele. 473.0)}$

$$V_2 = \frac{(750 \text{ ft}) \cdot (1615 \text{ ft}^2)}{43,560 \text{ ft}^2/\text{acre}}$$

$$V_2 = 27.8 \text{ ac-ft}$$

d. Average $V_1$ and $V_2$ and compute $Q_{P3}$

$$(1) \quad V_{avg} = \frac{V_1 + V_2}{2}$$

$$V_{avg} = \frac{52.8 \text{ ac-ft} + 27.9 \text{ ac-ft}}{2}$$

$$V_{avg} = 40.3 \text{ acre-feet}$$

$$(2) \quad Q_{P3} = Q_{P2} \left(1 - \frac{V_{avg}}{S}\right)$$

$$Q_{P3} = (9,500 \text{ cfs}) \left(1 - \frac{40.3}{77.7}\right)$$

$$Q_{P3} = 4,570 \text{ cfs}$$
FIGURE 3

DISCHARGE vs ELEVATION

ELEVATION, feet (non-aided)

DISCHARGE, cfs

10 YR EVENT
50 YR EVENT
200 YR EVENT
500 YR EVENT

Reach 1
Reach 2
A. Information developed during the preparation of flood plain information, Ammonoosuc River, Bath, New Hampshire (Army Corps May, 1970) indicated the river channel has an adverse slope within the first 2800 feet below the dam. Consequently, estimate of discharge through this portion of the channel cannot be obtained utilizing Manning's Equation, with the assumption that the hydraulic gradient is essentially level to the bottom slope. Since cross-section data for various cross-sections below the dam and discharge for various cross-sections were made available to us by the Army Corps, we have utilized this information to develop stage-discharge curves for stream reaches below the dam.

1. The cross-section information was used to derive the three cross-sections shown in Figures 5, 6 & 7.

2. The discharge associated with various storm events (10-yr, 50-yr, 100-yr and 500-yr events) exceeded the dam failure discharge. Therefore, it was necessary to project below the 10-yr event to include the dam failure discharge in the range of flows caused by the stage-discharge curves. Discuss relevant to these projections follows.

a. It should be noted that due to the adverse channel bottom slope between the dam and river cross-section no. 24, a 2800 feet below the dam, a pool with average elevation about 173 feet (W.E.D.) will form below the dam under normal conditions. With reference to Figure 5, assume that all flow through river cross-section no. 26 occurs above elevation +173 feet (W.E.D.)
3. Estimate water surface elevation in X-section 26 resulting from dam failure discharge utilizing data from Army Corps computer analysis of Ammonoosuc River

1. Pertinent Data

a. Dam failure discharge = 10,000 cfs

b. Hydraulic gradient - will assume hydraulic gradient essentially equal to that computed for 10-year storm event with Army Corps water surface profile computer program = 0.0000642

c. Channel X-section shown in Figure 5 of these calculations - Note that above elevation 483.2 the channel side slopes are essentially vertical. Therefore, above this elevation the channel width changes very little and the length of the wetted perimeter (Wp) increases by a factor of twice-10 increase in depth of flow. Also, an average value for Wp can be estimated for an infinite range of water surface elevations. For the subsequent cals. a value of 260 ft was utilized

d. \( n = 0.06 \), based on information included with computer analysis

2. Utilizing the above information, Manning's Equation can be used to determine the channel cross-sectional area required to pass the failure discharge. The X-area can then be used to determine the water surface elevation.

\[
Q = A \frac{1.486}{n} R^{2/3} S^{1/2}
\]

\[
\text{where: } R = \frac{A}{Wp}
\]
10,800 cfs = A \left( \frac{1.486}{0.06} \right) \left( \frac{A}{260} \right)^{2/3} \left( 0.000642 \right)^{1/2}

10,800 cfs = 0.0154 A^{5/3}

A = 3218 \text{ ft}^2

3. Water Surface Elevation

a. X-area required for dam failure discharge = X-area between:  
   a. lower 483.2'  
   b. upper 473.0'

3218 ft² = 2000 ft² + (245 ft)(water depth above 483.2')

\text{water depth above 483.2'} \approx 5.0 \text{ feet}

b. Elevation of water surface = 483.2 feet + 5.0 feet

= 488.2 feet

C. This point has been plotted on Figure 3 and compared linearly with the assumed linear projection of the stage-discharge curve below the 10-yr event.
APPENDIX E

INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS
<table>
<thead>
<tr>
<th>STATE IDENTITY NUMBER</th>
<th>DIVISION</th>
<th>COUNTY CODE</th>
<th>COUNTY NAME</th>
<th>NAME</th>
<th>LATITUDE (NORTH)</th>
<th>LONGITUDE (WEST)</th>
<th>REPORT DATE</th>
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<tbody>
<tr>
<td>01</td>
<td>NEU</td>
<td>009</td>
<td>02</td>
<td>AMMONOUCIC MOUNT DAM</td>
<td>4410.0</td>
<td>7156.6</td>
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**POPULAR NAME**

**NAME OF IMPOUNDMENT**

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<tr>
<th>REGION</th>
<th>RIVER OR STREAM</th>
<th>NEAREST DOWNSTREAM CITY-TOWN-VILLAGE</th>
<th>DIRT ROAD (MI.)</th>
<th>POPULATION</th>
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<tr>
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<td>AMMONOUCIC MOUNT</td>
<td>BATH</td>
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**TYPE OF DAM**

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<th>PURPOSES</th>
<th>STATIC HEIGHT</th>
<th>HYDRAULIC HEIGHT</th>
<th>IMPOUNDING CAPACITIES</th>
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<td>M</td>
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<td>1b</td>
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**REMARKS**

20-1977 STATE CENSUS 21-CONCRETE

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<thead>
<tr>
<th>D/S/KAS</th>
<th>SPILLWAY</th>
<th>MAXIMUM DISCHARGE</th>
<th>VOLUME OF DAM</th>
<th>POWER CAPACITY</th>
<th>NAVIGATION LOCKS</th>
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**REGULATORY AGENCY**

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**INSPECTION BY**

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**AUTHORITY FOR INSPECTION**

PL 92-357

**REMARKS**