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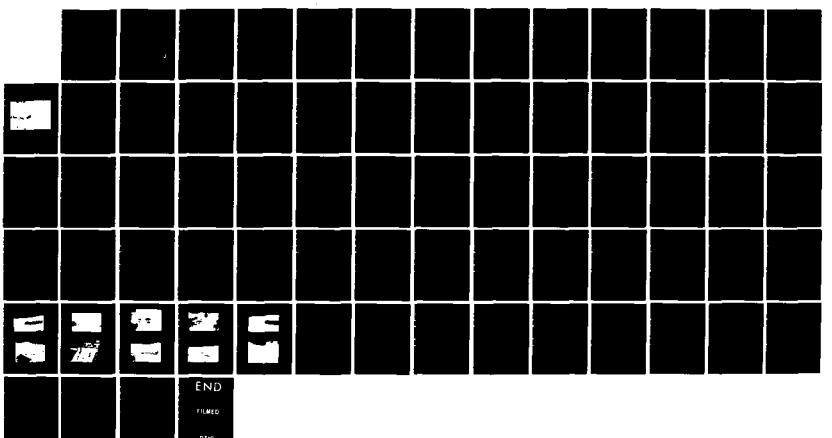

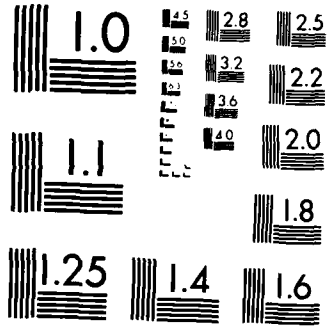

CONNECTICUT RIVER BASIN
GROVETON, NEW HAMPSHIRE

UPPER GROVETON DAM
N.H. 00148

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

FEBRUARY 1979

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

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Groveton, New Hampshire
Upper Ammonoosuc River

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

The dam is a run of the river, timber crib stone fill dam with concrete abutment and flood gates. It is 120 ft. long and 21 ft. high. It is small in size with a low hazard classification. The dam was found to be in good overall condition based on the limited visual inspection. There are some indications of a flow of water downstream and beneath the right abutment.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

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

JUN 18 1979

Dear Governor Gallen:

I am forwarding to you a copy of the Upper Groveton 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, Mr. Michael LeDuc, Plant Engineer, Groveton Paper Company, Groveton, New Hampshire 03582.

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 yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

UPPER GROVETON DAM

NH 00148

NORTHUMBERLAND, NEW HAMPSHIRE

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No:	NH00148
Name of Dam:	Upper Groveton Dam
Town:	Northumberland
County and State:	Coos, New Hampshire
Stream:	Upper Ammonoosuc River
Date of Inspection:	November 16, 1978

BRIEF ASSESSMENT

The Upper Groveton Dam is a run-of-the-river, timber crib stone fill dam with concrete abutments and flood gates. The length of the dam is 120 feet and it is 21 feet high. Flood gates and a former power house form the left abutment. The dam is currently used to provide process water to the Groveton Papers Company. Under normal conditions the dam impounds approximately 200 acre-feet and has a drainage area of 243 square miles.

The dam is classified as small and has a low hazard potential in the event of a dam failure. Based on size and hazard classifications, a 100-year flood of 13,100 CFS was used as the test flood. Because of the limited storage capacity, the test flood outflow is equal to the test flood inflow. The total spillway capacity, including the gates, is 14,150 CFS which is 108 percent of the test flood.

The dam was found to be in good overall condition based on the limited visual inspection. The following significant findings were determined during the investigation:

1. There are some indications of a flow of water downstream and beneath the right abutment.

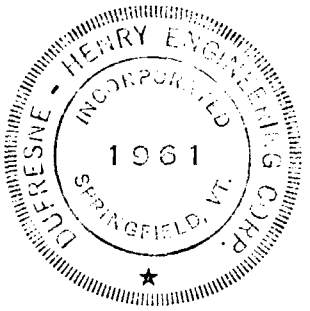
2. Recent repairs reported by the Groveton Papers Company indicate that there may be some problems with the upstream dam face and foundation material.

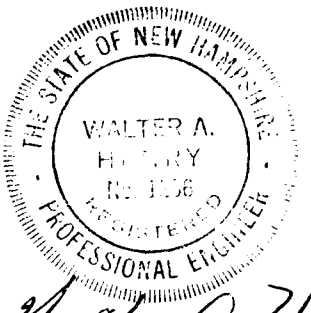
Although the dam appears to be in good condition, the following actions are recommended to be instituted under the guidance of a qualified engineer within two years of the receipt of this report:

1. Inspect the upstream face of the dam and foundation with the reservoir dewatered.

2. Establish a procedure for the operation of the flood gates in the event of a major storm.

3. Institute a program of biennial periodic technical inspections.





Walter A. Henry

This Phase I Inspection Report on Upper Groveton 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.

Joseph W. Finegan

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

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, CHAIRMAN
Chief, Structural Section
Design Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

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 aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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APPENDICES

through the gates would pass through the power house and discharge into the tailrace channel. The discharge openings are, at the present time, covered with break-away partitions to control the temperature inside the building (see Photo 5). An additional flood gate is located in the intake channel wall which would divert water from the intake channel directly to the downstream side of the dam (see Photo 3).

The structural concrete of the power house and intake channel is in fair condition. There are some large spalled areas, especially on the downstream wall (see Photo 5) and leakage is occurring at several locations (see Photo 3). The leakage and efflorescence appears to be associated with the original construction jointing.

(2) Gate Works

The gate works consist of five gates with concrete training walls. Four of the gates are flood or waste gates and the fifth has a concrete sluiceway which was used to jam logs to the lower river (see Photo 4).

The four waste gates are seven feet wide and are equipped with electrical lifting devices. The fifth gate is only five feet wide and is operated by block and tackle.

The gate works are in good overall condition. Spalling concrete has been patched and the entire service platform has received a new concrete cap. All of the equipment, hand rails, steps, ladders, etc., are in sound structural condition and have recently been painted.

(3) Intake Structure (right side)

The intake structure located at the right abutment is a reinforced concrete and wood chamber with a bar screen. A 30-inch steel penstock carries the intake water to the processing area of the plant (see Photo 6).

d. Reservoir Area

The right bank of the reservoir area is presently occupied by a railroad and storage yard. This is the area where the washout occurred in 1953 and as a result, the embankment is now protected by a sheet pile coffer dam.

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General

The on-site inspection of the Upper Groveton Dam was performed on November 16, 1978. Water was flowing over the dam during the inspection, preventing visual observation of a good portion of the timber crib spillway structure. No emergency conditions were observed on the day of the inspection.

b. Dam

The timber crib dam structure was found to be in good condition, based on a limited visual inspection. All sections of the dam were intact and the vertical and horizontal alignments were good. The nonfailing flashboards were in place and there was no bulging or settlement observed (see Photos 1 and 2).

Water was flowing over all portions of the dam during the inspection. This prevented a more detailed inspection of the structure. As mentioned in Section 1.2, some repair work was recently performed on the dam. The nature of these repairs indicates that problem areas may exist in the upstream crib structure and the foundation material. Based on this information, a more in-depth inspection of the dam appears justified.

Turbulence of the water was observed immediately downstream of the dam next to the right abutment. It could not be ascertained whether it was the result of seepage through the foundation or abutment soils or of the flow of water over the spillway.

c. Appurtenant Structures

(1) Existing Power House (left abutment)

The structural portions, building and foundation, of the old power house are still intact. The power generation equipment has been removed and the building is presently being used as a maintenance shop. The intake channel and head gate facilities are reported to be in good operational condition with electrical lifting mechanisms on all three gates. Under normal operating conditions the gates are closed. Any water passing

b. Adequacy

The lack of in-depth engineering data does not allow for a definitive review. Therefore, the adequacy of the dam, structurally and hydraulically, cannot be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history and sound hydrologic and hydraulic engineering judgment.

c. Validity

Not applicable.

SECTION 2 - ENGINEERING DATA

2.1 Design

A timber or log crib dam is made of wood members bolted into cribs and filled with rock. This type of dam usually leaks considerably and its resistance against sliding is reduced by buoyant forces which decrease the effective weight of the dam. A relatively long sloping approach apron is also utilized to increase the resistance to sliding and reduce leakage. The life span of a timber crib dam varies between 10 and 40 years depending upon climatic conditions, amount of maintenance performed and type of timber used. Cedar, redwood and cypress are the most durable timbers.

The Upper Groveton Dam has been modified, rebuilt and repaired several times since its original construction in the early 1900s. The present configuration bears little resemblance to the dam shown in sketches and photographs in 1936. All past design data which may have existed has either been destroyed or cannot be located by the Groveton Papers Company.

2.2 Construction

The present dam is a timber crib and stone spillway with concrete abutments and gate works. Those portions of the spillway which were visible are covered with wood plank. The foundation crib work is reinforced with steel railroad rails which also provide protection to the lower apron from ice and logs flowing over the spillway. The plans found in Appendix B were drawn, based on visual observations and descriptions in the records and approximate the existing physical construction of the dam.

2.3 Operation

The flow of water to the plant is controlled at the plant. Therefore, there is no physical operation at the dam during normal flow conditions. Flood gates are operated on an as-needed basis to suit higher flow conditions.

2.4 Evaluation

a. Availability

The design and construction records for this dam are not available.

j. Regulating Outlets

In addition to the 30-inch penstock, there are a total of nine gates which may be used to regulate the flow at the dam. There are five waste gates located adjacent to the spillway. Four of these gates are 7' x 17' with an invert of 81.8. The fifth gate is a smaller 5' x 9.5' with an invert of 89.3. It is believed that the smaller gate was used to jam logs to the lower river. The four large gates are equipped with electric operating mechanisms while the smaller gate is lifted by block and tackle.

The sixth waste gate is located in the intake channel wall just upstream of the power house. The gate is 9' x 9' with an invert of 84±. This gate is also equipped with an electric operator.

The old power house includes three head gates. The power house was not completely accessible during the inspection and the dimensions and inverts of these gates could not be obtained. These gates were also equipped with electric lifting mechanisms and are reported to be operational.

(5) Side Slopes

Not applicable.

(6) Zoning

None known.

(7) Impervious Core

Not applicable.

(8) Cutoff

Not applicable.

(9) Grout Curtain

Not applicable.

h. Diversion and Regulating Tunnel

Not applicable.

i. Spillway

(1) Type

Timber crib with 2.5-foot flashboards.

(2) Length

120 feet.

(3) Crest Elevation

Top of flashboards - 93.5
Permanent spillway - 91.0

(4) Gates

Six waste gates - varying sizes. Three head gates at power house.

(5) Upstream Channel

Upper Ammonoosuc River.

(6) Downstream Channel

Upper Ammonoosuc River.

Maximum Tailwater	Variable
Upstream Portal Invert	Not Applicable
Recreation Pool	93.5
Full Flood Control Pool	99.4
Spillway Crest (Top of Flashboards)	93.5
Design Surcharge	99.4
Top of Dam	99.4
Test Flood Surcharge	98.5

d. Reservoir — Feet*

Length of Maximum Pool	4200
Length of Recreation Pool	3200
Length of Flood Control Pool	4200

e. Storage — Acre-Feet*

Recreation Pool	66
Flood Control Pool	216
Test Flood Pool	216
Spillway Crest Pool	66

f. Reservoir Surface — Acres*

Top of Dam	24
Test Flood Pool	24
Flood Control Pool	24
Recreation Pool	16
Spillway Crest	16

g. Dam

(1) Type

Timber crib and stone with concrete abutments, run-of-the river dam.

(2) Length

325 feet overall.
120 feet spillway.

(3) Height

21 feet.

(4) Top Width

Not applicable (flashboards).

*Estimated, based on USGS topographic maps and visual observations.

steel penstock carries river water to the plant processing area. The maximum capacity of the penstock is estimated at approximately 20 CFS. The penstock is not equipped with a gated control mechanism and any flow which is not required for process water is bypassed to the river at the filter plant.

(2) Maximum Known Flood at Dam Site

The maximum recorded flood flow at the Upper Ammonoosuc gauging station, located approximately 3 miles upstream of Groveton, occurred on May 20, 1969. This flood flow of 24,100 CFS was the result of a failure of the Nash Bog Pond dam located on Nash Stream, a tributary to the Upper Ammonoosuc River. This flow is equivalent to a gauge height of 12.01 feet. The maximum known storm related flow occurred in March 1936, but was not recorded on the Upper Ammonoosuc because the gauge was not installed until 1940. Based on water marks from that storm compared to the existing gauge, the March 1936 flow was approximately 12,000 CFS. This storm is believed to have caused extensive damage to the Upper Groveton Dam, requiring the repairs referenced in the August 1936 State inspection. Another major storm occurred on March 27, 1953 with an estimated storm flow of 9,950 CFS causing a major breach around the right abutment. The breach caused a shut-down of the Groveton Papers Company and extensive repairs including a steel sheet pile coffer dam along the right embankment.

(3) Spillway Capacity

The spillway has 2.5 feet high flashboards which are apparently not designed to fail in case of flood. The spillway has a capacity of approximately 3950 CFS with the flashboards in place. If all six flood gates are open, an additional 8590 CFS will be added for a total capacity of 12,540 CFS. Since the operation of the dam is essential to the Groveton Papers Company, it was reported that these gates will be operated in the event of major storm flow. Additional capacity can also be obtained by opening the old power house head gates and allowing water to flow through the old power house. Since the internal constrictions of the old power house were not determined, the flow capacity could not be determined.

c. Elevations

(Based on an assumed bench mark of 100.0 on the power house intake channel retaining wall - see plan for exact location.)

Streambed at Centerline of Dam	77.0(estimated)

The last inspection took place on October 27, 1972. During that inspection the condition of the concrete abutments and training walls was rated as fair to poor because of excessive spalling. As a result of this inspection, remedial action was taken in 1975. The spalling concrete was repaired and a new concrete surface was placed on the service platform.

In the summer of 1978 an underwater inspection of the dam revealed some minor deterioration of the upstream face and a significant cavity under the timber crib foundation. A reinforcing fiber cloth was applied to the upstream face of the dam and the cavity was filled with approximately 18 cubic yards of concrete.

i. Normal Operating Procedures

Under normal operating conditions all gates are closed and the water level is controlled by the spillway (with flashboards) and the water flowing to the Groveton Papers plant. The dam and gate works are under 24-hour surveillance by the plant's maintenance and security forces. In the event of high river flows, the appropriate personnel are contacted to operate the gates.

The flow of water through the penstock does not have a gated control mechanism. The penstock water flows to a filter plant before becoming process water. Water which is not required for processing is bypassed to the river at the filter plant.

1.3 Pertinent Data

a. Drainage Area

The drainage area above the Upper Groveton Dam contains approximately 243 square miles of rolling hills and mountainous terrain. Approximately 50 percent of the basin, south of the Upper Ammonoosuc River is within the White Mountain National Forest. The Upper Ammonoosuc River has a length of approximately 32 miles with an average slope of 87 feet per mile. Elevations vary from 1000 feet along the river to 4000 feet at the ridge of the Pilot Mountain range in the White Mountain National Forest. The soils are predominantly glacial till overlying bedrock and hardpan within 3 feet of the surface.

b. Discharge at Dam Site

(1) Outlet Works

Outlet works, consisting of a trash screen and intake box are located at the right abutment. A 30" diameter

The dam was used previously for power generation. The power house, intake facilities and discharge channel, located at the left embankment, are intact. All mechanical power generation equipment has been removed and the power house is presently being used as a maintenance shop. The electrically operated head gates are reported to be in good operating condition.

h. Design and Construction History

Very little information is available on the original construction of the dam and power house. Design drawings and operating records have been either destroyed or could not be located by the Groveton Papers Company.

The original dam was constructed in the early 1900s. Several inspections, on file with the New Hampshire Water Resources Board, indicate that the dam has been partially or completely reconstructed several times since the original construction and it is not known if any of the existing dam dates back to the original.

The present dam is a timber crib and stone dam with concrete abutments. The timber cribbing is completely covered with planking and appears to be in good condition. The base of the dam is reinforced with steel rails which protect the lower apron section from damage due to ice flowing over the dam.

An inspection of the dam performed on August 10, 1936, noted that the dam was in poor condition and being repaired. Also two additional waste gates were being constructed. The photos and sketches accompanying that inspection report show that the original dam included three waste gates and a log sluiceway with log crib training walls. These log crib structures have since been replaced with concrete training walls and a concrete service platform.

The next correspondence on file with the New Hampshire Water Resources Board is a newspaper article and several pictures concerning a washout of the dam which took place in late March 1953. The information indicates that the washout occurred around the right abutment, in the area presently occupied by the railroad and storage yards. Repairs to the dam included the installation of sheet piling along the right upstream bank which can be seen in Photos 2 and 7. The article also indicates that some damage was sustained by the dam itself although details of the damage were not given. A photo of the dam does not show any major structural damage other than the washout around the right embankment.

embankment includes an intake and screen chamber for a 30-inch diameter penstock which supplies process water to the Groveton Paper Mill. Under normal conditions, all gates are closed and the water level is controlled by the spillway.

c. Size Classification

The Upper Groveton Dam has a maximum height of 21 feet and an estimated maximum storage volume of 380 acre-feet. The USCE Guidelines place dams with maximum heights between 25 and 40 feet and maximum storage between 50 and 1000 acre-feet in the small category. Therefore the size category of the Upper Groveton Dam is small.

d. Hazard Classification

A failure of the Upper Groveton Dam would release a flood wave into the lower river channel. The river channel below the dam is wide and well defined. If the dam were to fail, the lower channel has adequate capacity to handle the flood wave without overbank flow. Therefore the hazard category is low.

e. Ownership

The present owner of the Upper Groveton Dam is:

Groveton Papers Company
Groveton, New Hampshire 03582

f. Operator

The operation and maintenance of the dam is under the supervision of:

Mr. Michael LeDuc, Plant Engineer
Groveton Papers Company
Groveton, New Hampshire 03582

Telephone: 603-636-1154

g. Purpose

The present purpose of the Upper Groveton Dam is to provide process water to the Groveton Papers Company. The Upper Dam is one of two dams intended to impound and divert water to the plant's processing facilities. Water is conveyed to the plant via a 30-inch diameter penstock which begins at the intake chamber located at the right abutment.

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
NAME OF DAM: UPPER GROVETON

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Dufresne-Henry Engineering Corporation 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 Dufresne-Henry Engineering Corporation under a letter of November 20, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. DACW33-79-C-0010 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 nonfederal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for nonfederal dams.

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

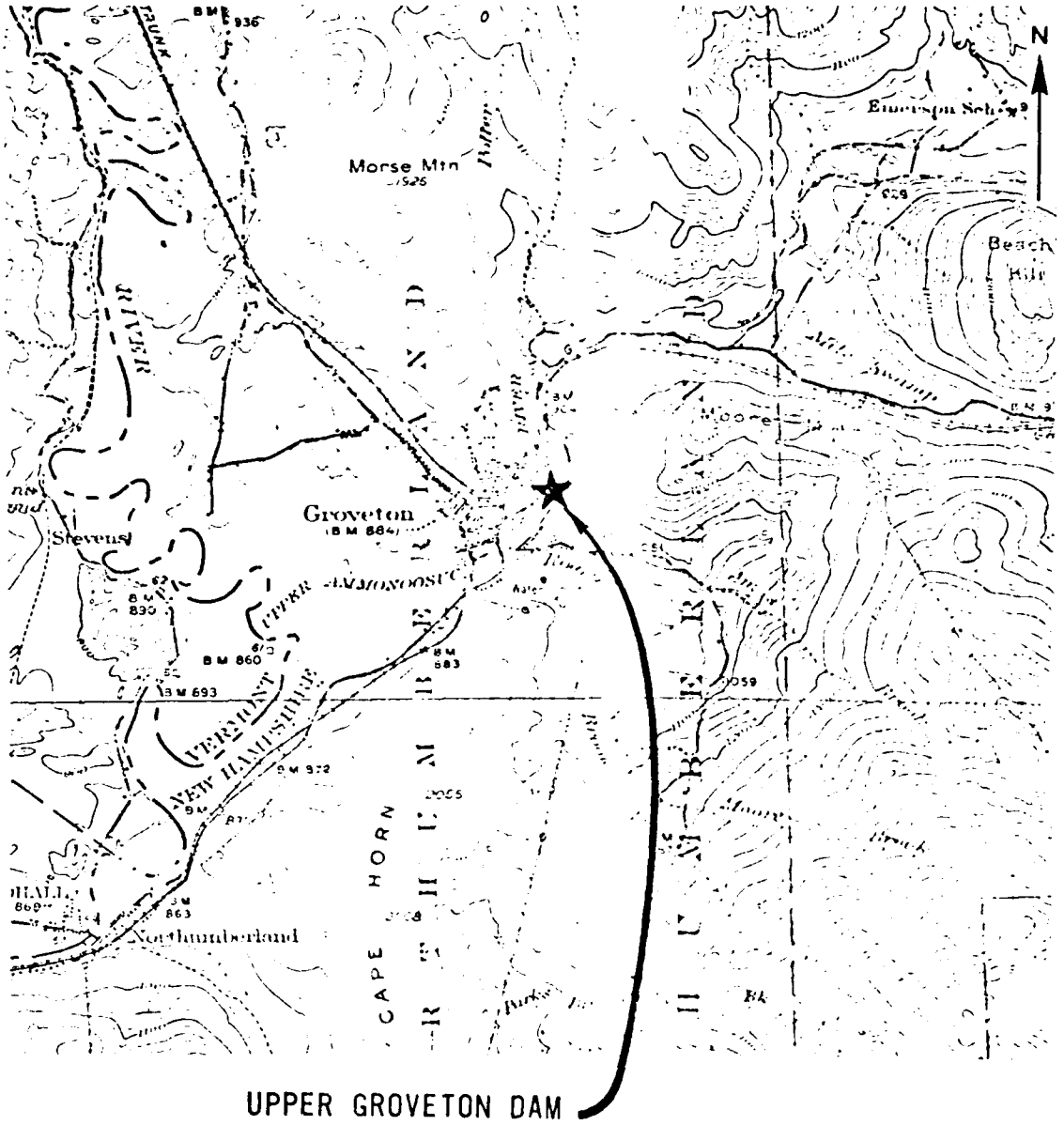
1.2 Description of Project

a. Location

The Upper Groveton Dam is located in northern New Hampshire in the Town of Groveton, Coos County. The dam is on the Upper Ammonoosuc River, approximately 1.5 miles upstream from its confluence with the Connecticut River.

b. Description of Dam and Appurtenances

Upper Groveton Dam consists of a 120-foot long timber crib, stone and concrete spillway. A power house, intake channel and gate works are located on the left embankment. The right



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DUFFERIN-HENRY ENGINEERING CORP.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION MAP
UPPER GROVETON DAM

GROVETON NEW HAMPSHIRE
CLIENT NO. 04-0084 1" = 1 MILE
ENGR. JAC

OVERVIEW OF
UPPER GROVETON DAM
NORTHUMBERLAND, NEW HAMPSHIRE

The only other significant feature of the reservoir area is a floating log boom located approximately 200 feet upstream of the dam. The log boom intercepts floating debris, preventing it from damaging or plugging the dam and gate works.

e. Downstream Channel

The channel below the dam is the natural river channel of the Upper Ammonoosuc River. The Groveton Papers Company is located along the right bank which has been filled and riprapped to reduce erosion and possible damage to the Paper Company buildings (see Photos 9 and 10). The left bank is a well vegetated natural river bank which shows no sign of recent erosion.

A cable suspension pedestrian bridge is located approximately 150 feet downstream of the dam. The right concrete pier and cable tower are within the river channel and have been subject to erosion. At present, the concrete pier appears to be resting on top of the stream bed, without any horizontal support. The pier may be subject to horizontal displacement during high river flow.

3.2 Evaluation

The Upper Groveton Dam appears to be in good condition based on a superficial visual inspection. Water flowing over the dam prevented a detailed inspection of the structural crib work. The repairs performed on the dam during the summer has resulted in some question as to the actual condition of the upstream face of the dam and the foundation material. A possible seep may exist at the right abutment as evidenced from some turbulence of the tailwater. These questionable features of the dam should be verified by a complete inspection during low flow conditions.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

The 30-inch penstock carries water to a filter plant before entering the main plant. Water that is not required for process water is returned to the river at the filter plant. There is no means of controlling the flow of water through the penstock with the exception of lowering the reservoir level.

The dam and gate works receive 24-hour surveillance by maintenance and security forces. In the event of rising river flows, appropriate personnel are notified to operate the gates.

4.2 Maintenance of Dam

The Groveton Papers Company has recently instituted a semiannual inspection of the timber crib dam. An inspection uncovered several deficiencies which were repaired in the summer of 1978.

The concrete abutments, service platform railings, etc., are maintained on a regular basis, with periodic painting and repairs to spalling concrete.

4.3 Maintenance of Operating Facilities

The electrical gate lifting mechanisms are maintained on a regular basis which includes test running of electric drives and lubrication of gears.

4.4 Description of Warning System

None exists for this dam.

4.5 Evaluation

The operation and maintenance of the Upper Groveton Dam is adequate to maintain a safe and workable facility.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General

The Upper Groveton Dam is a run-of-the-river type dam, designed as a spillway for its entire length. Originally the dual purpose structure was used for both power generation and water supply, but the power house has been inactive for some time.

b. Design Data

No design data for the dam were available.

c. Experience Data

The maximum known flood on the Upper Ammonoosuc River occurred in March of 1969 and was caused by the failure of the Nash Bog Dam, resulting in a 24,100 CFS flow at the Groveton gauge. No record data could be found for any damage to the Upper Groveton Dam.

Reports of extensive damage were found for flood flows occurring in March 1936 (12,000 CFS, estimated) and March 1953 (9,950 CFS, recorded at the gauge). Since the operational configuration of the dam and flood gates during these events is not known, a hydraulic evaluation could not be made.

d. Visual Observation

The dam and appurtenant facilities appear to be in good condition. A total of six flood gates appear to be in excellent working condition. In addition, the power house head gates could be opened to increase the total flood flow capacity.

e. Test Flood Analysis

The dam is classified to be small size with a low hazard classification. Since the hazard classification is low, a test flood of 100-year exceedance interval has been selected as a criterion for this study.

Record flow data was analyzed for USGS gauge 01130000, located approximately 2.8 miles upstream of the Upper Groveton Dam. The flow data was processed by computer in accordance with the "United States Water Resources Council Guidelines" (Bulletin 17). The results of the gauge analysis were adjusted to suit conditions at the dam by the ratio of their drainage areas to the three quarters power. This resulted

in a 100-year test flood flow of 13,100 CFS. Because of the limited storage, the test flood outflow was assumed equal to the test flood inflow.

Since the integrity of the dam is essential to the operation of the Groveton Papers Company, it was reported that the flood gates will be operated effectively during a major flood. Therefore, the capacity of the gates is included in the total capacity of the dam, with flashboards in place, of 12,040 CFS (at elevation 98). Overbank flow will not result until the water elevation exceeds the top of the sheet pile coffer dam at elevation 99.4. The estimated capacity at this elevation is 14,150 CFS, or 1,050 CFS more than the 100-year test flood. The test flood would result in a flow elevation of 98.5. The total spillway capacity represents 108 percent of the test flood.

Additional capacity is available by opening the power house head gates and passing flow through the old structure. Since the internal constrictions are not known, the hydraulic capacity was not calculated.

f. Dam Failure Analysis

Since the Upper Groveton Dam is a run-of-the-river dam, the storage is relatively small. During high flow conditions the dam would be partially backwatered by the high river flow and any failure during these conditions would produce a relatively small flood wave. The remaining storage in the downstream channel would be adequate to contain the flood wave without overbank flow.

Using the procedures outlined in the Guidelines, the estimated maximum dam failure flow is 16,200 CFS assuming a maximum reservoir level and no downstream backwater. This flow would quickly dissipate due to the downstream channel size and limited upstream storage.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

Based on a visual inspection alone, one cannot evaluate the structural stability of this dam. However, there are no signs of stability problems and the dam appears to be in good condition.

b. Design and Construction Data

There are no design and construction data available for this dam.

c. Operating Records

There are no formal operating records available for this dam. Data on file with the New Hampshire Water Resources Board from past inspections indicates that the dam sustained extensive damage as a result of floods in March 1936 and March 1953. No information as to the type or extent of the damage was available.

d. Post-Construction Changes

The original dam was constructed in the early 1900s. Several inspections and record data on file with the New Hampshire Water Resources Board indicate that the dam has been partially or completely reconstructed several times since the original construction and it is not known if any of the existing dam dates back to the original.

The first reconstruction was referenced in an inspection report dated August 10, 1936. It is assumed that the damage and repairs were a result of the severe storm flow of March 1936. During this reconstruction new flood gates were added and log sluice structures were replaced with concrete.

The next correspondence on file with the New Hampshire Water Resources Board is a newspaper article and several pictures concerning a washout of the dam which took place in late March 1953. The information indicates that the washout occurred around the right abutment, in the area presently occupied by the railroad and storage yards. Repairs to the dam included the installation of sheet piling along the right upstream bank which can be seen in Photos 2 and 7. The article also indicates that some damage was sustained

by the dam itself, although details of the damage were not given. A photo of the dam does not show any major structural damage other than the washout around the right embankment.

e. Seismic Stability

The dam is in seismic zone 2 and in accordance with recommended Phase I Guidelines, does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/ REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition

Based on the records and the visual inspection performed on November 16, 1978, this dam appears to be in good condition. The repairs performed during the summer of 1978 indicate that some problems may exist which could not be observed during the inspection because of the water flowing over the dam. A final evaluation of the dam cannot be made until additional information is obtained and an inspection is performed of the upstream portions of the dam and of the downstream toe.

b. Adequacy of Information

The lack of in-depth engineering data does not allow for a definitive review. Therefore, the evaluation of this dam, structurally and hydraulically, cannot be assessed from the standpoint of review of design calculations, but must be based primarily on the visual inspection, past performance history and sound hydrologic and hydraulic engineering judgment.

c. Urgency

The recommendations listed in 7.2 and 7.3 should be carried out within two years of the receipt of this report.

d. Need for Additional Investigation

The additional investigations described in Section 7.2 should be carried out.

7.2 Recommendations

As mentioned above, the dam appears to be in good condition and does not require any remedial action at this time. However, the following items should be addressed within two years of the receipt of this report:

1. Perform a thorough inspection by a qualified professional engineer, of the dam under low flow conditions with the reservoir dewatered, noting: the condition of the crib wall, condition of the foundation soils at the downstream toe for possible erosion or piping, and seepage through the foundation soils particularly next to the right abutment.

7.3 Remedial Measures

1. Repair spalled concrete on the power house foundation.

2. Develop an exact regulation scheme for operating the waste gates during major storm events.

3. Institute a program of biennial periodic technical inspections.

7.4 Alternatives

None.

APPENDIX A

VISUAL INSPECTION CHECK LIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT UPPER GROVETON DAM

DATE November 16, 1978

TIME 7:50 - 10:05 AM

WEATHER Partly cloudy, cool

W.S. ELEV. _____ U.S. ____ DN.S.

PARTY:

1. Jim Maynes D-H
2. Jim Dohrman D-H
3. Sherward Farnsworth D-H
4. Gonzalo Castro GEI
5. Ken Stern, New Hampshire Water Resources Board
6. _____
7. _____
8. _____
9. _____
10. _____

PROJECT FEATURE	INSPECTED BY	REMARKS
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM DATE November 16, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
DAM EMBANKMENT - LOG CRIB	*Water flowing over entire dam.
Crest Elevation	Permanent spillway 877.2 (USCS)
Current Pool Elevation	Same.
Maximum Impoundment to Date	380 acre-feet (estimated)
Surface Cracks	Not observed (water covered).
Pavement Condition	None.
Movement or Settlement of Crest	None observed (under water).
Lateral Movement	None observed.
Vertical Alignment	Good*
Horizontal Alignment	Good*
Condition at Abutment and at Concrete Structures	Fair*
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes	N/A (Spillway)
Sloughing or Erosion of Slopes or Abutments	N/A
Rock Slope Protection - Riprap Failures	N/A
Unusual Movement or Cracking at or near Toes	N/A
Unusual Embankment or Downstream Seepage	None observed through dam; some indication of seepage at right embankment.
Piping or Boils	None observable.
Foundation Drainage Features	N/A
Toe Drains	N/A
Instrumentation System	None known.
Vegetation	N/A

PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM DATE November 16, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - GATE CONTROL PLATFORM	
a. Concrete and Structural	
General Condition	Good.
Condition of Joints	Good.
Spalling	Minor - recent concrete cap.
Visible Reinforcing	None.
Rusting or Staining of Concrete	None.
Any Seepage or Efflorescence	None observed.
Joint Alignment	Good.
Unusual Seepage or Leaks in Gate Chamber	Minor.
Cracks	None.
Rusting or Corrosion of Steel	None.
b. Mechanical and Electrical	
Air Vents	N/A
Float Wells	N/A
Crane Hoist	None.
Elevator	None.
Hydraulic System	None.
Service Gates	Electrical lifting mechanism on all gates.
Emergency Gates	Electrical lifting mechanism on all gates.
Lightning Portection System	None known.
Emergency Power System	None known.
Wiring and Lighting System in Gate Chamber	Outside lighting is provided for all gate mechanisms.

PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM DATE November 16, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - CONDUIT	30" Process water for mill.
General Condition of Concrete	Good at intake chamber.
Rust or Staining on Concrete	None observed.
Spalling	None.
Erosion or Cavitation	None.
Cracking	None.
Alignment of Monoliths	N/A
Alignment of Joints	None observed.
Numbering of Monoliths	N/A
	Screen chamber (wood) leaking at base.

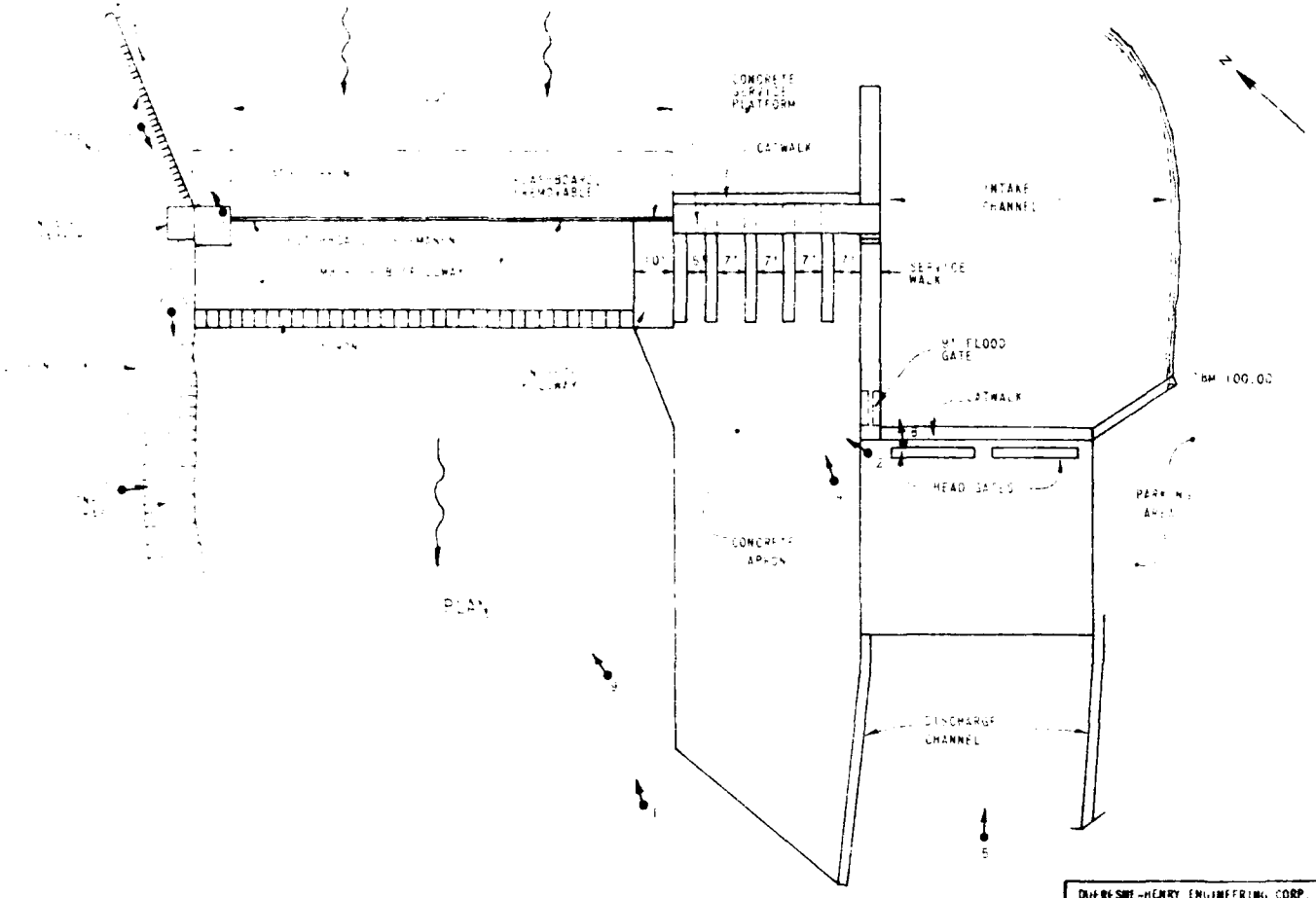
PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM DATE November 16, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	NONE
General Condition of Concrete	
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain Holes	
Channel	
Loose Rock or Trees Overhanging Channel	
Condition of Discharge Channel	



DUFRESNE-HENRY ENGINEERING CORP.

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

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

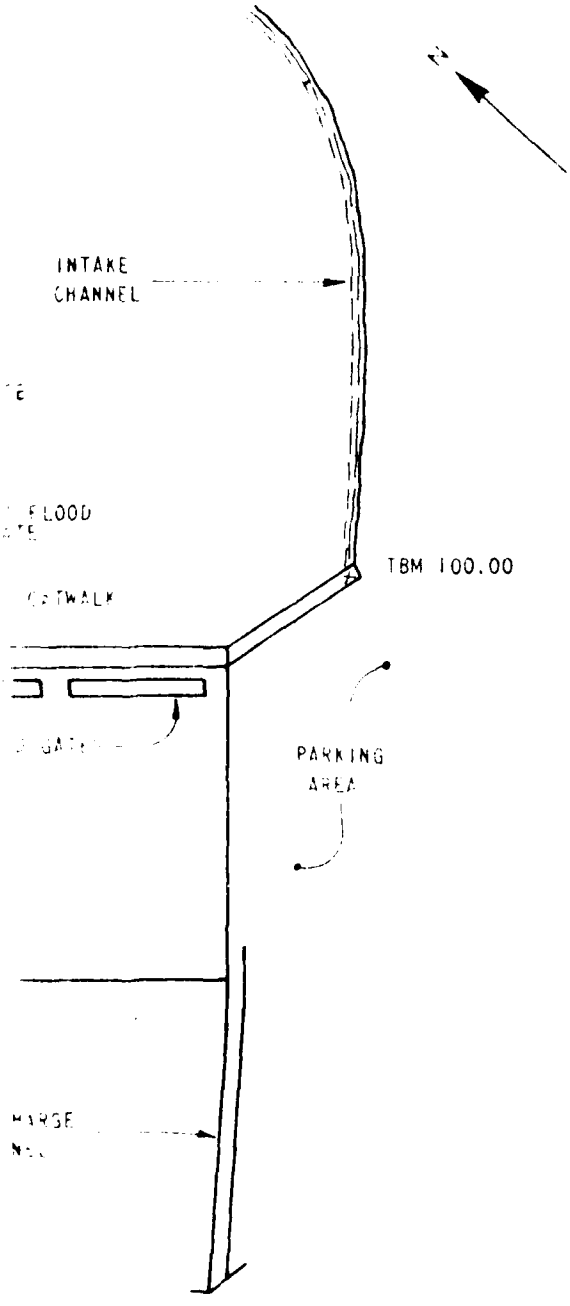
UPPER GROVETON DAM

PHOTOGRAPH LOCATION PLAN

GROVETON NEW HAMPSHIRE

APPENDIX C

PHOTOGRAPHS



DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

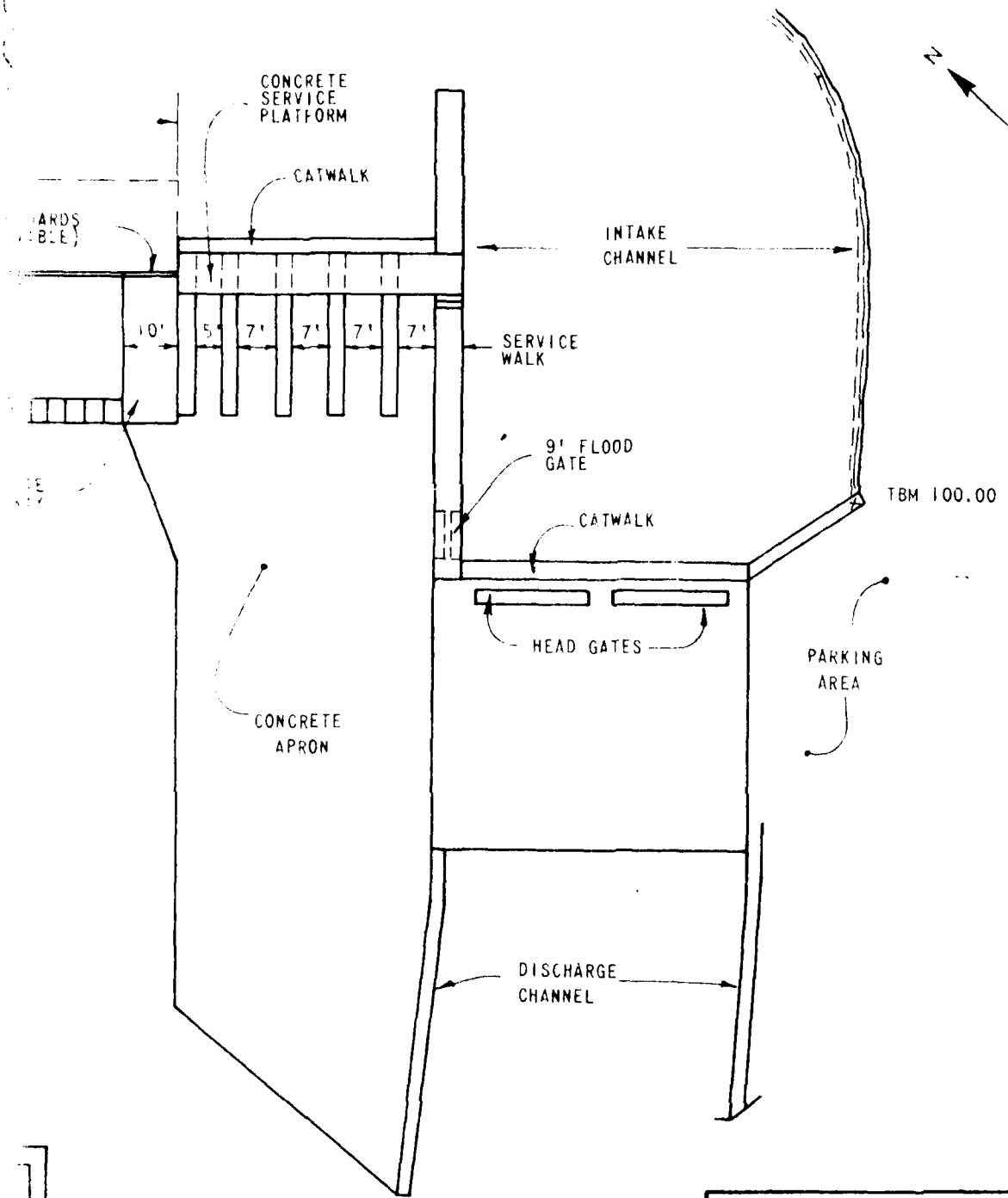
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

UPPER GROVETON DAM

PLAN - ELEVATION

GROVETON NEW HAMPSHIRE

CLIENT NO.	04-0084	SCALE	N.T.S.
ENGR.	JAD	DATE	1-22-79



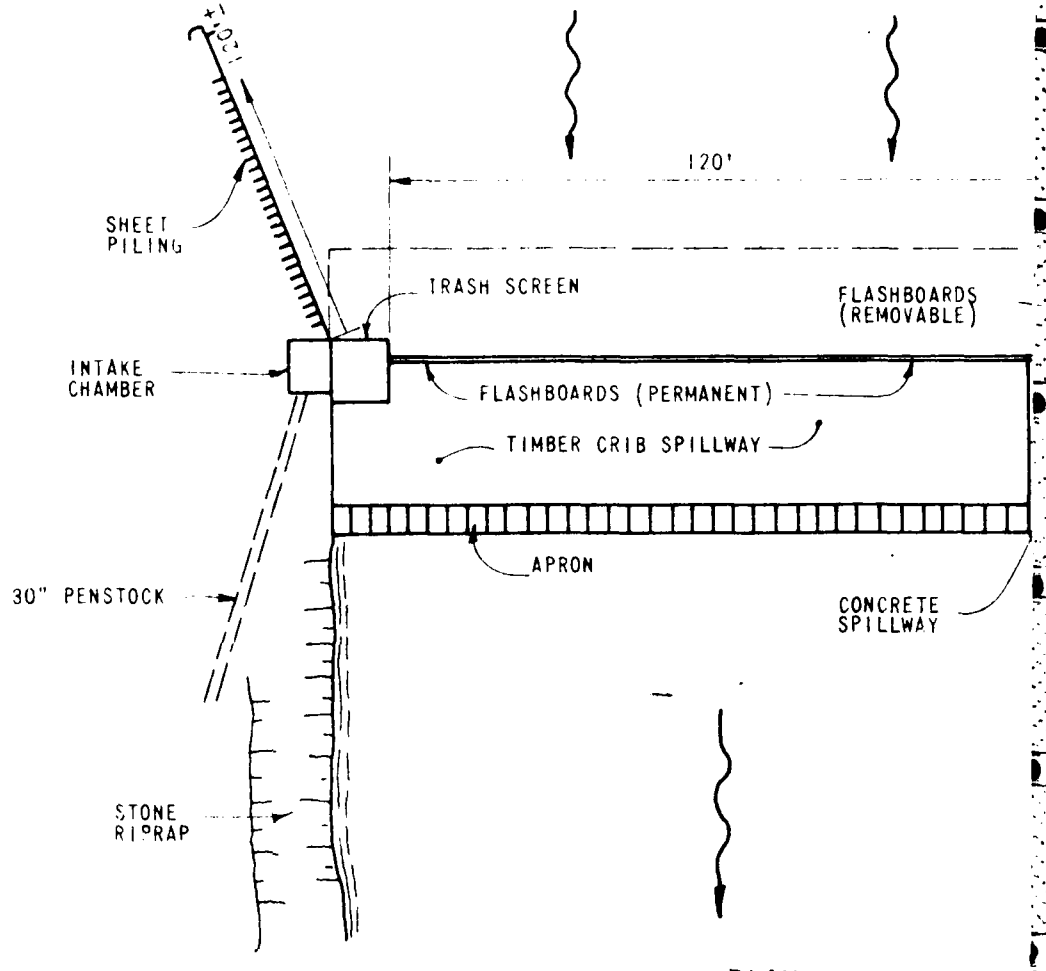
DUFRESNE-HENRY ENGINEERING CORP. ARCHITECT-ENGINEER	U.S. ARMY ENGINEER D CORPS OF EN WALTHAM,

NATIONAL PROGRAM OF INSPECTION OF NON-I

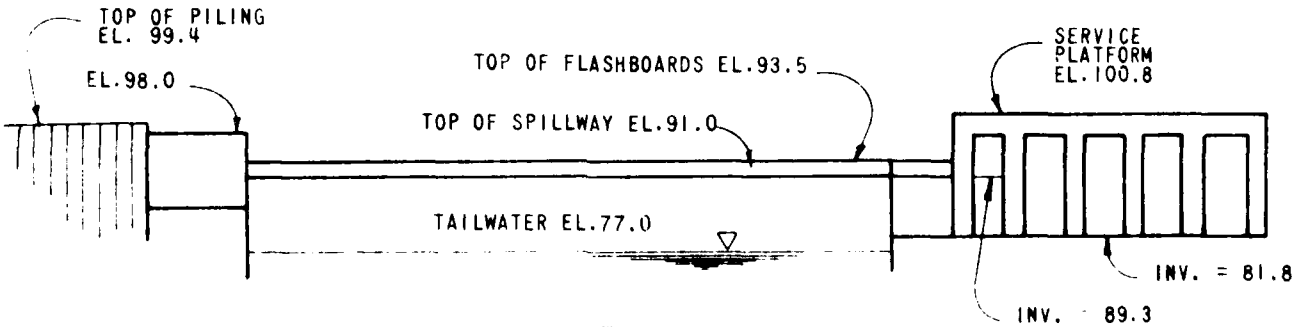
UPPER GROVETON DAM

PLAN - ELEVATION

GROVETON			
CLIENT NO.	04-0084	SCALE	N.T.S.
ENGR.	JAD	DATE	1-22-79



PLAN



ELEVATION

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

DAM SAFETY INSPECTION REPORT FORM

Town: Northumberland Dam Number: 182.03

Inspected by: Robert B. Chamberlin Date: Oct. 27 1972

Local name of dam or water body: _____

Owner: Groveton Paper Address: Groveton, N.H.

Owner was/was not interviewed during inspection.

Drainage Area: 263 sq. mi. Stream: Upper Ammonoosuc River

Pond Area: 25+ Acre, Storage 75 Ac-Ft. Max. Head 12.5 (15.5) Ft.

Foundation: Type Earth, Seepage present at toe - Yes/No, _____

Spillway: Type Timber crib, Freeboard over perm. crest: 6,

Width 120, Flashboard height 3.5',

Max. Capacity _____ c.f.s.

Embankment: Type _____, Cover _____ Width _____,

Upstream slope _____ to 1; Downstream slope _____ to 1

Abutments: Type Concrete, Condition: Good, Fair, Poor

Gates or Pond Drain: Size 4-7'x full depth Capacity _____ Type _____

Lifting apparatus _____ Operational condition Good

Changes since construction or last inspection: Power house on left abutment is now a maintenance shop. Exit sluices covered, intake trash rack on right abutment indicates plant using water.

Downstream development: Dam No. 182.02

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

Suggested reinspection date: _____

Remarks: Concrete on gate abutments eroding to show pipe casings for railing. Railing was just painted.

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON DAMS IN NEW HAMPSHIRE

OK

LOCATION STATE NO. 182.03

Town Northumberland /: County Coos /

Stream Upper Ammonoosuc /

Basin-Primary Connecticut: Secondary Upper Ammonoosuc /

Local Name

Coordinates—Lat. 44° 35' 1" 7800: Long. 71° 30' 4" 3200

GENERAL DATA

Drainage area: Controlled Sq. Mi.: Uncontrolled Sq. Mi.: Total 349 / Sq. Mi.

Overall length of dam 325 / ft.: Date of Construction

Height: Stream bed to highest elev. 20 / ft.: Max. Structure 14 / ft.

Cost—Dam: Reservoir

DESCRIPTION Crib timber and stone concrete /

Waste Gates

Type Foundation earth /

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

Length—Total 120 /ft.: Net ft.

Height of permanent section—Max. 14' ft.: Min. Stop planks ft.

Flashboards—Type Fixed 1 section 8' removable /: Height 3½ / ft.

Elevation—Permanent Crest: Top of Flashboard

Flood Capacity 6550 cfs.: 26.4 cfs/sq. mi.

Abutments

Materials:

Freeboard: Max. 6 / ft.: Min. ft.

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

OWNER Groveton Paper Co. /

REMARKS Clearance yes Condition poor being repaired and addition 1 / gate built

Subject to inspection

1206

NEW HAMPSHIRE WATER CONTROL COMMISSION
DATA ON WATER POWER DEVELOPMENTS IN NEW HAMPSHIRE

LOCATION AT DAM NO. 182.03

Town Northumberland: County Coos

Stream Upper Ammonoosuc

Basin-Primary Connecticut: Secondary Upper Ammonoosuc

Local Name

GENERAL DATA

Head-Max. ft.: Min. ft.: Ave. 9 ft.

Date of Construction: Use of Power Industrial

Pondage ac. ft.: Storage ac. ft.

DESCRIPTION

Racks

Size of Rack Opening

Size of Bar: Material

Area: Gross Sq. Ft.: Net sq. ft.

Head Gates

Type

Number 1: Size 9' ft. high x 4' ft. wide

Elevation of Invert: Total Area sq. ft.

Hoist

Penstock

Number: Material

Size: Length

Turbines

Number 2: Makers 38" vertical

Rating HP. per unit: Total Capacity 800 HP.

Max. Dement C.F.S., per unit: Total cfs

Drive

Type

Generator

Number 2

Make

Rating KW., per unit 300 each; Total Capacity K. W.

Exciter

Number: Make

Rating-per unit: Total Capacity K. W

OUTPUT—KWHRS

19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	
19.....	:	19.....	

Form 1

PUBLIC SERVICE COMMISSION OF NEW HAMPSHIRE—DAM RECORD

I-5427

TOWN	NORTHUMBERLAND	TOWN NO. 3	STATE NO. 172
RIVER STREAM	Upper Amonoosuc		
DRAINAGE AREA		POND AREA	
DAM TYPE	Crib	FOUNDATION NATURE OF	Earth
MATERIALS OF CONSTRUCTION	Timber, Stone, Concrete		
PURPOSE OF DAM	POWER—CONSERVATION—DOMESTIC—RECREATION—TRANSPORTATION—PUBLIC UTILITY		
HEIGHTS, TOP OF DAM TO BED OF STREAM	Approx. 20'	TOP OF DAM TO SPILLWAY CRESTS	Approx. 6'
SPILLWAYS, LENGTHS DEPTHS BELOW TOP OF DAM	Approx. 120'	LENGTH OF DAM	Approx.
FLASHBOARDS TYPE, HEIGHT ABOVE CREST	Fixed – 1 section 8' removable stop planks 3½'		
OPERATING HEAD CREST TO N. T. W.	9'	TOP OF FLASHBOARDS TO N. T. W.	12'-6"
WHEELS, NUMBER KINDS & H. P.	2-36" Vertical		
GENERATORS, NUMBER KINDS & K. W.	2 – 200 KW		
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: Groveton Paper Co.

CONDITION: Poor – Being repaired & additional gates built

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. 10, 1936, according to notification to owner dated Aug. 5, 1936, and bill for same is enclosed.

D. Waldo White
Chief Engineer

Aug. 10, 1936
Copy to Owner

APPENDIX B

PROJECT RECORDS AND PLANS

A. Listing of Design, Construction and Maintenance Records.

None.

B. Copies of Past Inspection Reports.

1. "Inspection by New Hampshire Water Resources Board, August 10, 1936."

2. "Inspection by New Hampshire Water Resources Board, October 27, 1972."

C. Listing of Plans

Figure 1 - Upper Groveton Dam

Plan - Elevation

PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM **DATE** November 16, 1978

PROJECT FEATURE _____ **NAME** _____

DISCIPLINE _____ **NAME** _____

AREA EVALUATED	CONDITION
RESERVOIR	
Stability of Shoreline	Good - riprap.
Sedimentation	Not known (could not measure).
Changes in Watershed Runoff Potential	None known.
Upstream Hazards	Log boom, floating logs.
Downstream Hazards	None.
Alert Facilities	None known.
Hydrometeorological Gages	None known.
Operational and Maintenance Regulations	Well maintained. Dam inspected during past 6 months. Repairs made to up stream face, 18 cubic yards of concrete placed in cavity under dam. Concrete spalling is patched regularly.

PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM DATE November 16, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE TO GATES	
a. Super Structure	
Bearings	Good.
Anchor Bolts	Good.
Bridge Seat	Good.
Longitudinal Members	Good.
Under Side of Deck	Good.
Secondary Bracing	Good.
Deck	Good.
Drainage System	N/A
Railings	Good.
Expansion Joints	Good.
Paint	Good.
b. Abutment and Piers	
General Condition of Concrete	Good.
Alignment of Abutment	Good.
Approach to Bridge	Good.
Condition of Seat and Backwall	Good.

PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM DATE November 16, 1978

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	NONE
a. Approach Channel	
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECK LIST

PROJECT UPPER GROVETON DAM DATE November 16, 1978

PROJECT FEATURE _____ NAME _____

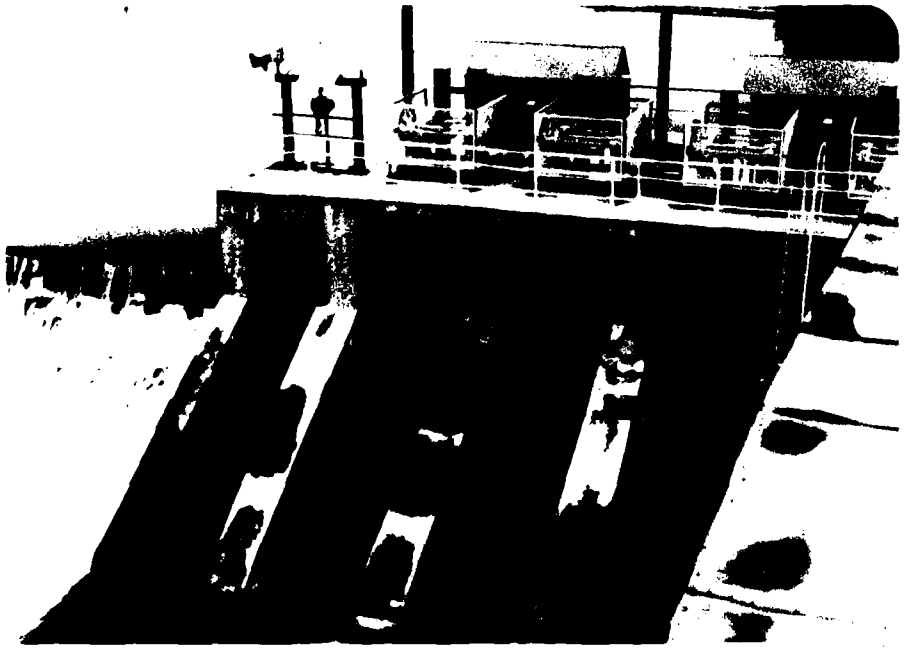
DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET GATES - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	Log Boom Upstream
a. Approach Channel	To old power house
General Condition	Fair to good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Approach Channel	Not observable.
b. Weir and Training Walls	
General Condition of Concrete	Fair to good.
Rust or Staining	None.
Spalling	Yes - many patches generally good conditions - spalling at single gate.
Any Visible Reinforcing	None observed.
Any Seepage or Effloresence	Minimal through gates.
Drain Holes	None observed.
c. Discharge Channels	
General Condition	Good except downstream of power house.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Channel	Not observable
Other Obstructions	

#1. OVERALL VIEW OF SPILLWAY

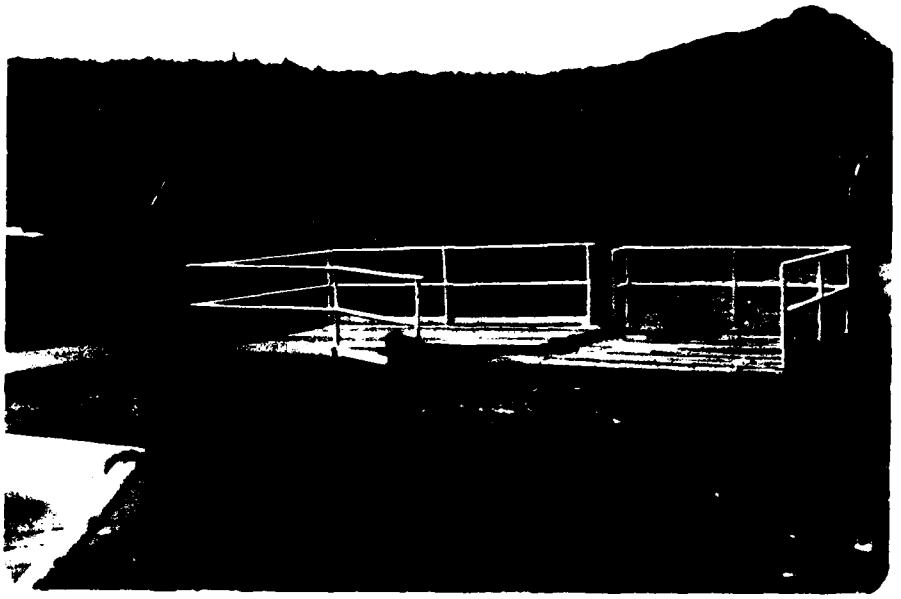
#2. VIEW OF SPILLWAY AND SHEET PILE COFFER DAM

#3. VIEW OF GATE WORKS AND POWER HOUSE



#4. VIEW OF GATE WORKS

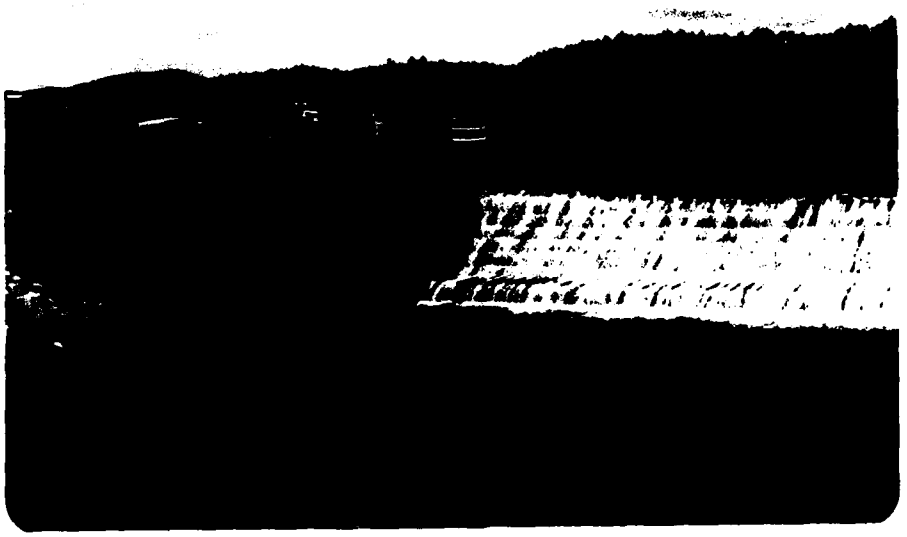
#5. VIEW OF DOWNSTREAM WALL OF POWER HOUSE



#6. VIEW OF INTAKE CHAMBER AND BAR SCREEN

#7. VIEW OF RIGHT BANK SHOWING SHEET PILE COFFER DAM

#8. VIEW OF UPSTREAM IMPOUNDMENT SHOWING LOG BOOM



#9. VIEW OF DOWNSTREAM RIGHT RIVER BANK

#10. VIEW OF RIGHT RIVER BANK AND PEDESTRIAN BRIDGE

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

DUFRESNE-HENRY ENGINEERING CORPORATION

BY JAD SUBJECT UPPER GROVETON DAM SHEET NO. ____ OF ____
DATE 3-30-79 SURFACE - STORAGE ESTIMATES JOB NO. ____

LENGTH 4200' TO UPSTREAM DAM
3200' NORMAL POOL (ESTIMATED)
4200' MAXIMUM POOL

WIDTH 225' AVERAGE
250' MAX. POOL

DEPTH 4' - AVERAGE
9' - MAX POOL

NORMAL POOL

SURFACE = 3200 x 225 = 720,000 = 16 ACRES

STORAGE = 16 x 4 = 66 AC-FT.

MAXIMUM POOL

SURFACE = 4200 x 250 = 105,000 = 24 ACRES

STORAGE = 24 x 9 = 216 AC-FT

DUFRESNE-HENRY ENGINEERING CORPORATION

BY J. DOHRMAN | SUBJECT UPPER GROVETON DAM HYD. CALCULATIONS | SHEET NO. 1 OF 7
DATE 2-20-79 | JOB NO. 04-0084

SPILLWAY CAPACITY

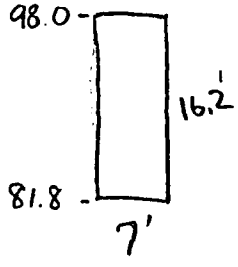
LENGTH = 120'
HEIGHT = 4.5' TO TOP OF RIGHT ABUTMENT ELEV 98.0
$C_w = 3.45$

$Q = C_w L H^{3/2} = (3.45)(120)(9.5^{4}) = 3949$ CFS. (WITH FLASH BOARDS)

$Q = (3.45)(120)(18.5) =$ 7,659 CFS (WITHOUT FLASH BOARDS)

GATES

4

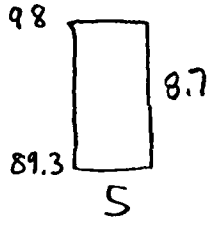


$\ell = 7'$
$H = 16.2$
$C = 3.30$

$Q = C_w L H^{3/2}$
$= (3.3)(7)(65.2) = 1506$ C.F.S.

$4 \times 1502 =$ 6025 C.F.S.

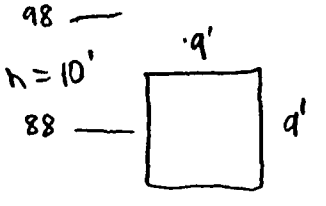
1



$L = 5$
$H = 8.7$
$C = 3.30$

$Q = (3.3)(5)(25.7) =$ 423 CFS

1



ORIFICE FLOW $Q = C_d A \sqrt{2gh} = 1644$ CFS
$C_d = .80$

TOTAL CAPACITY @ EL. 98.0 — TOTAL CAPACITY = **12,044 C.F.S.**

TEST FLOOD = 100 YEAR EXCEEDANCE INTERVAL

TEST FLOOD CALCULATED FOR GAUGE 01080101 IN GROVETON 2.8 MILES UPSTREAM OF DAM

DRAINAGE AREA TO GAUGE = 232 mi^2

DRAINAGE AREA TO DAM = 243

$\left(\frac{243}{232}\right)^{.75} = 1.03$

100 YEAR FLOOD AT GAUGE = 12,700 CFS (SEE ATTACHED)

100 YEAR FLOOD AT DAM = 1.03(12,700) = 13,100 CFS

(SEE COMPUTER PRINTOUT FOR TEST FLOOD CALCULATION)

STORAGE ROUTING

DRAINAGE AREA = 243 SQ. MI. = 155,520 ACRES

STORAGE AREA OF RESERVOIR = 35 ACRES (ESTIMATED)

STORAGE RATIO = $35/155,520 = .022\%$

ACCORDING TO U.S.D.A. SOIL CONSERVATION SERVICE PRACTICES, STORAGE RATIOS BELOW .20% HAVE INSIGNIFICANT EFFECTS ON FLOW REDUCTION.

STORAGE CAPACITIES

SINCE THE DAM IS A RUN OF THE RIVER DAM, STORAGE CAPACITIES WERE NOT CALCULATED.

FLOOD FLOW FREQUENCY COMPUTATION

01130000 UPPER AMMONOOSUC RIVER NEAR GROVETON, NEW HAMPSHIRE

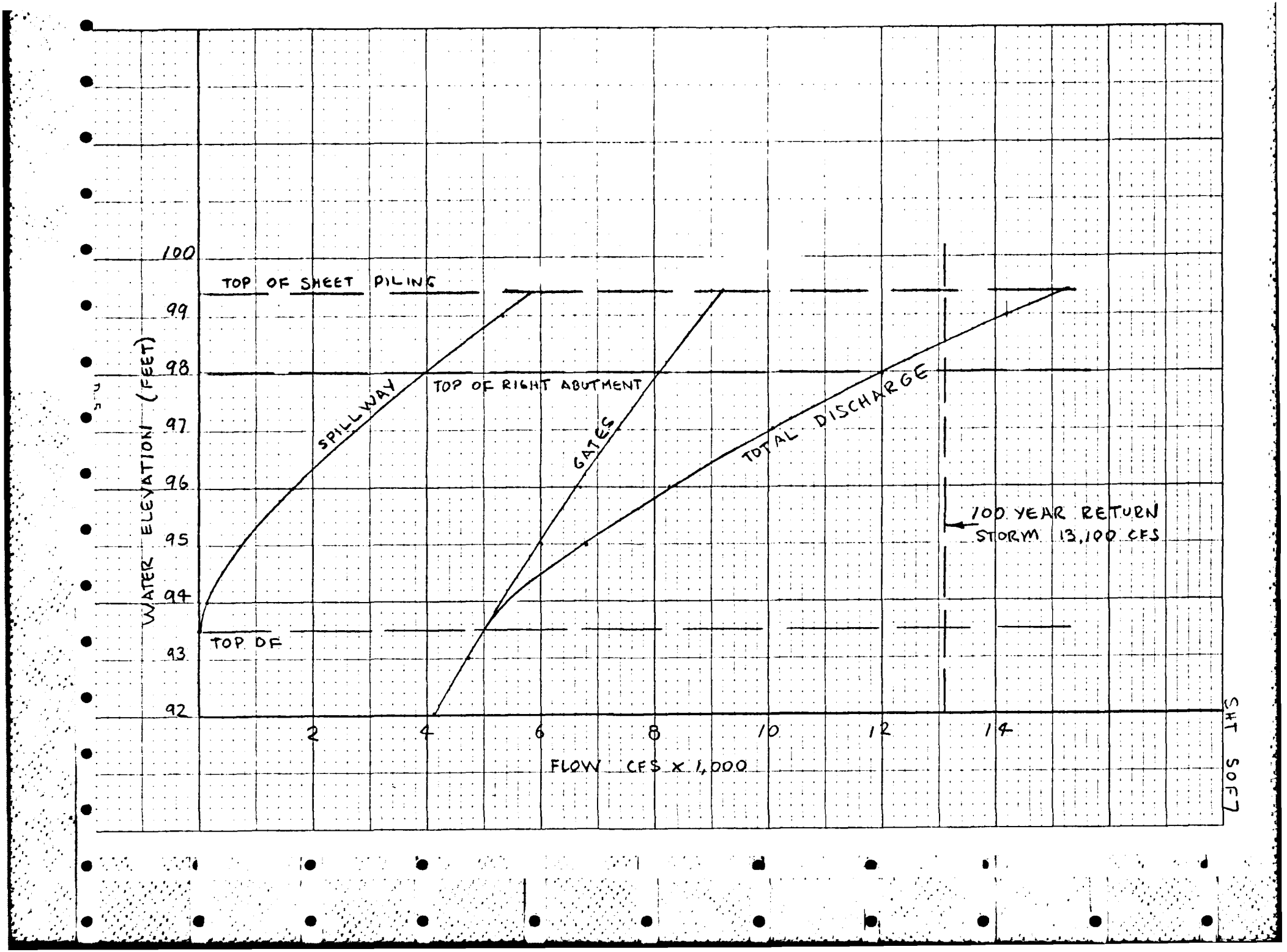
N	NOM	NOUTL	IYRA	IPLOT	IEXPP	SKEW	A	B	PRELM
37	0	0	1941	1	1	0.500	0.0	0.0	0.0

DAY	MONTH	YEAR	FLOW	ORDERED	RANK	PLOT POS
0	0	1941	5040.	9950.	1	0.0263
0	0	1942	5220.	8880.	2	0.0526
0	0	1943	4740.	7580.	3	0.0789
0	0	1944	6350.	7400.	4	0.1053
0	0	1945	6830.	6830.	5	0.1316
0	0	1946	2740.	6580.	6	0.1579
0	0	1947	7580.	6540.	7	0.1842
0	0	1948	3690.	6400.	8	0.2105
0	0	1949	3550.	6350.	9	0.2368
0	0	1950	4750.	6240.	10	0.2632
0	0	1951	5460.	5500.	11	0.2895
0	0	1952	4210.	5460.	12	0.3158
0	0	1953	9950.	5460.	13	0.3421
0	0	1954	8880.	5220.	14	0.3684
0	0	1955	6240.	5040.	15	0.3947
0	0	1956	3300.	4930.	16	0.4211
0	0	1957	3070.	4910.	17	0.4474
0	0	1958	6540.	4860.	18	0.4737
0	0	1959	2560.	4760.	19	0.5000
0	0	1960	6400.	4750.	20	0.5263
0	0	1961	3500.	4740.	21	0.5526
0	0	1962	4760.	4540.	22	0.5789
0	0	1963	4540.	4430.	23	0.6053
0	0	1964	4930.	4360.	24	0.6316
0	0	1965	1970.	4320.	25	0.6579
0	0	1966	2870.	3830.	26	0.6842
0	0	1967	3500.	3640.	27	0.7105
0	0	1968	3200.	3550.	28	0.7368
0	0	1969	5500.	3500.	29	0.7632
0	0	1970	6580.	3500.	30	0.7895
0	0	1971	4320.	3320.	31	0.8158
0	0	1972	7400.	3200.	32	0.8421
0	0	1973	4860.	3070.	33	0.8684
0	0	1974	5460.	2870.	34	0.8947
0	0	1975	3320.	2740.	35	0.9211
0	0	1976	4360.	2560.	36	0.9474
0	0	1977	4430.	1970.	37	0.9737

MEAN	3.6697
STD DEV	0.1553
COMPUTED SKEW	-0.1644
REGIONAL SKEW	0.5000
ADOPTED SKEW	0.3937

COMPUTED FLOW	EXPECTED-PROBABILITY FLOW	PROBABILITY	.05 LIMIT	.95 LIMIT
15530.	17519.	0.002	21129.	12536.
13389.	14626.	0.005	17622.	11044.
11889.	12714.	0.010	15245.	9973.
10680.	11006.	0.020	13080.	8943.
9150.	9461.	0.040	11103.	7945.
7983.	7617.	0.100	8738.	6648.
6254.	6314.	0.200	7101.	5645.
4566.	4566.	0.500	5034.	4133.
3443.	3420.	0.800	3821.	3029.
3008.	2973.	0.900	3376.	2590.
2709.	2659.	0.950	3073.	2288.
2258.	2161.	0.990	2619.	1840.

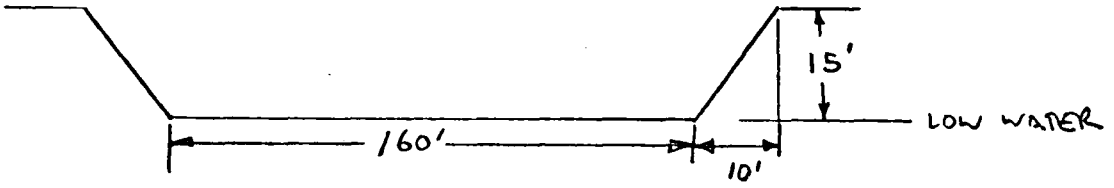
ELEV.	MAIN SPILLWAY		7' GATES (4)		5' GATE (1)		9' GATE (1)		TOTAL GATES	TOTAL FLOW
	h_w	Q	h_w	Q	h_w	Q	h_o	Q	Q	Q
92	0	0	10.2	3010	2.7	73	4	1040	4123	4123
93	0	0	11.2	3463	3.7	117	5	1162	4742	4742
94	.5	146	12.2	3937	4.7	168	6	1273	5378	5524
95	1.5	761	13.2	4431	5.7	224	7	1375	6030	6791
96	2.5	1636	14.2	4944	6.7	286	8	1471	6701	8337
97	3.5	2711	15.2	5476	7.7	352	9	1560	7388	10,099
98	4.5	3952	16.2	6025	8.7	423	10	1644	8092	12,044
99	5.5	5340	17.2	6591	9.7	498	11	1725	8814	14,154


WATER ELEVATION (FEET)
100
99
98
97
96
95
94
93
92
TOP OF SHEET PILING
TOP OF RIGHT ABUTMENT
TOP OF
SPILLWAY
GATES
TOTAL DISCHARGE
100 YEAR RETURN
STORM 13,100 CFS
2
4
6
8
10
12
14
FLOW CFS x 1,000
SHT 5 OF 7

...M FAILURE ANALYSIS

DAM HEIGHT = 20 FEET
LENGTH OF SPILLWAY = 120 FEET

APPROXIMATE X-SECTION OF RIVER BELOW DAM



$A = 170 \times 15 = 2550\ FT^2$

MAX STORAGE OF RESERVOIR = 380 ACRE-FEET
$= 16,552,800\ FT^3$

$16,552,800 / 2550 = 6491\ FT = 1.2$ MILES

...TE: BECAUSE OF THE HEIGHT TO LENGTH RATIO AND TYPE CONSTRUCTION IT IS HIGHLY UNLIKELY THAT AN INSTANTANEOUS FAILURE OF THE DAM WOULD OCCUR ALONG THE ENTIRE LENGTH OF THE DAM.

...W FLOW FAILURE

A DAM FAILURE UNDER LOW FLOW CONDITIONS WOULD RESULT IN A FLOOD WAVE APPROXIMATELY 10 FEET HIGH IMMEDIATELY DOWNSTREAM OF THE DAM. THE AVAILABLE STORAGE IN THE DOWN STREAM CHANNEL IS MORE THAN ADEQUATE TO DISSAPATE THE FLOOD FLOW WITHOUT OVERBANK FLOW.

...GH FLOW FAILURE

DURING HIGH FLOW CONDITIONS THE DAM WILL BE PARTIALLY BACKWATERED. THE ACTUAL DEPTH OF BACKWATER CANNOT BE DETERMINED

WITHOUT EXTENSIVE INVESTIGATION OF DOWNSTREAM CONDITIONS. THE BACK WATER WOULD REDUCE AVAILABLE STORAGE IN THE DOWN STREAM CHANNEL AND ALSO EFFECTIVELY REDUCE THE FLOOD WAVE SHOULD A FAILURE OCCURR. THESE TWO WOULD EFFECTIVELY CANCEL EACHOTHER AND ANY REDUCED FLOOD WAVE WOULD BE CONTAINED WITHIN THE RIVER CHANNEL.

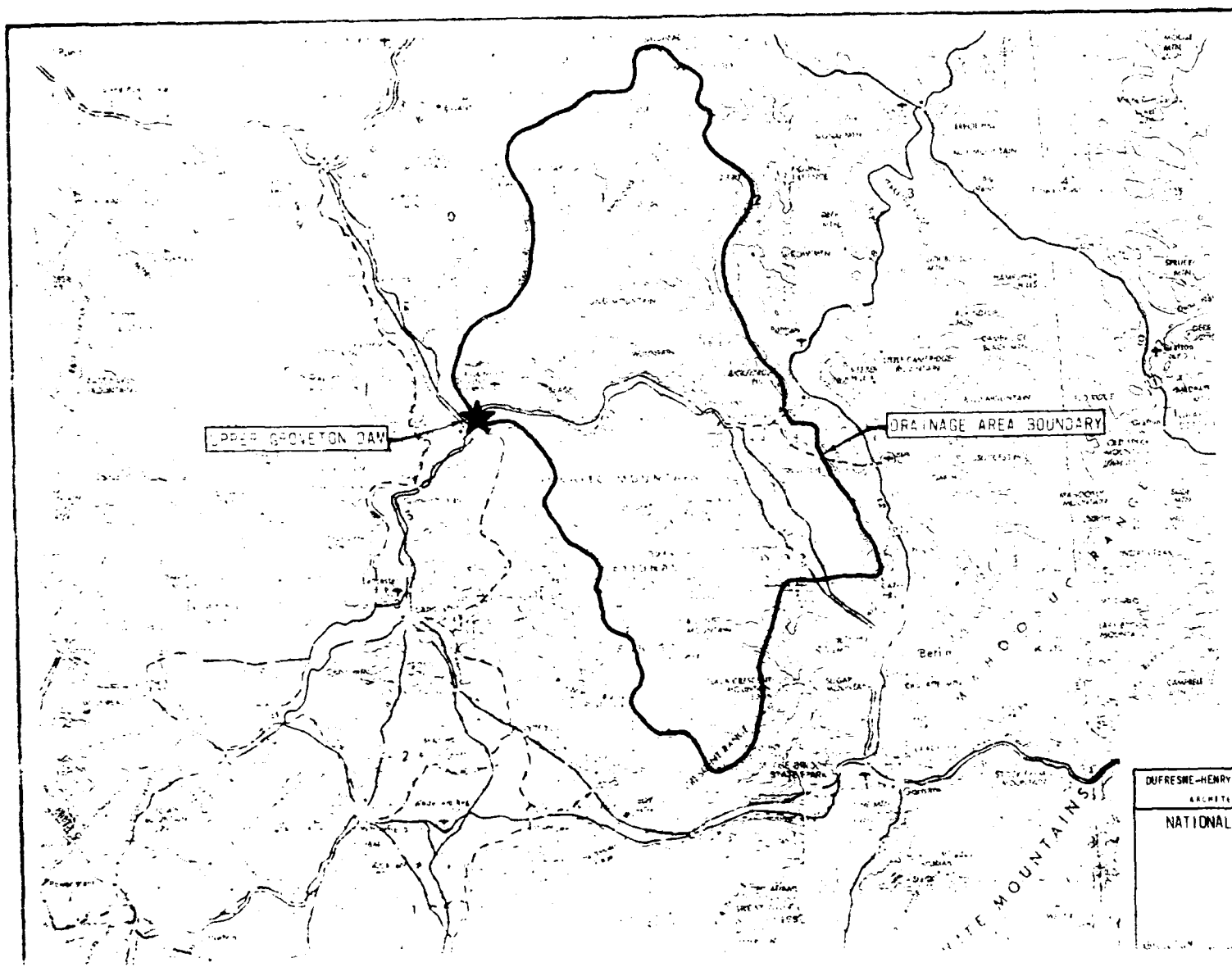
DAM FAILURE FLOW

$$Q = 8/27\, W_b \sqrt{g}\, Y_o^{3/2}$$

$W_b = .4\,(250) = 100$ FT.
$Y_o = 21$ FT

$$Q = 8/27\,(100)(5.67)(96.23) = 16{,}166 \text{ CFS}$$

SAY 16,200 CFS



SOURCE OF MAP
U.S. GEOLOGICAL SURVEY
LEWISTON QUADRANGLE
NEW HAMPSHIRE
SERIES V501
1:250 000. 1972

DUFRESNE-HENRY ENGINEERING CORP.	U.S. ARMY ENGINEER DIV. NEW ENGLAND

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
UPPER GROVETON DAM
DRAINAGE AREA

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	14M	NED	007	02					UPPER GROVETON DAM	4430.5	7130.5	01MAR79

POPULAR NAME	NAME OF IMPOUNDMENT
BROOKLYN DAM	UPPER AMONOOSUC RIVER

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	08	UPPER AMONOOSUC RIVER	NORTHUMBERLAND	0	2493

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
MASONRY	1920	S	21	21	216	66	NED	N	N	N	N	01MAR79

REMARKS

1=CH18203 21=TIMBER CRIB,STONE,CONC 22=APPROX,MAJ REPAIRS'36'53 23=INDL

D/S HAS	SPILLWAY CREST LENGTH	SPILLWAY TYPE	SPILLWAY WIDTH (FT.)	MAXIMUM DISCHARGE (CFS)	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	325	C	120	3950												

OWNER	ENGINEERING BY	CONSTRUCTION BY
GROVETON PAPERS CO		

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

INSPECTION BY	INSPECTION DATE DAY | MO | YR	AUTHORITY FOR INSPECTION
US CORPS OF ENGINEERS	16NOV78	PUBLIC LAW 92-367 8AUG1972

REMARKS

50=DA>2455M 51=FLASHBOARDS,GATES(6)

END

FILMED

8-85

DTIC