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CONNECTICUT RIVER BASIN
SOUTH BARRE, MASSACHUSETTS



SOUTH BARRE MILL POND DAM
MA 00091

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

AUGUST 1978

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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 South Barre, Massachusetts | | |
| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The South Barre Mill Pond Dam is a small dam consisting of two adjacent concrete spillways, a short earth embankment on the right side and an outlet works to a penstock at the left abutment. The dam is in fair to good condition. Based on the size and hazard classification, the spillway design flood falls between 1/2 the PMF and the PMF. | | |



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

REPLY TO
ATTENTION OF:
NEDED-E

JUL 11 1973

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts

Dear Governor King:

I am forwarding for your use a copy of the South Barre Mill Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment which emphasizes the inadequacy of the project spillway under test flood conditions is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the South Barre Mill Pond Dam would likely be exceeded by floods greater than 35 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Screening criteria for initial review of spillway adequacy specifies that this class of dam, having insufficient spillway capacity to discharge fifty (50) percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations there appears to be a serious deficiency in spillway capacity. This could render the dam unsafe in the event of a severe storm which would likely cause overtopping and possible failure of the dam, significantly increasing the hazard potential for loss of life downstream from the dam.

NEDED-E

Honorable Edward J. King

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy precipitation, round-the-clock surveillance should be provided.

I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. This report has also been furnished to the owner of the project, Barre Wool Combing Company, Vernon Street, South Barre, Massachusetts 01074.

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

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for the cooperation extended in carrying out this program.

Sincerely yours,


MAX B. SCHEIDER

Colonel, Corps of Engineers
Division Engineer

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SOUTH BARRE MILL POND
MA 00091



CONNECTICUT RIVER BASIN
SOUTH BARRE, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM

Identification No.: MA 00091
Name of Dam: South Barre Mill Pond
Town: South Barre
County: Worcester
State: Massachusetts
Stream: Ware River
Date of Site Visit: 11 May 1978

The South Barre Mill Pond dam is a small dam consisting of two adjacent concrete ogee spillways, a short earth embankment on the right side and an outlet works to a penstock at the left abutment. The present dam, constructed about 1904, was extensively damaged in the floods of 1936 and 1938 and has been reconstructed on several occasions, the latest work in 1944.

The dam is in fair to good condition. There are no obvious signs of failure or conditions which would warrant urgent remedial treatment.

Based on the size and hazard classification in accordance with the Corps of Engineers guidelines, the spillway design flood falls between one-half the probable maximum flood and the probable maximum flood. Hydraulic analyses indicate that the spillway will not pass one-half the probable maximum flood and the spillway is considered inadequate.

Recommendations for remedial work include repair of concrete at the left training wall and right spillway weir and restoration of gates to good operating condition.

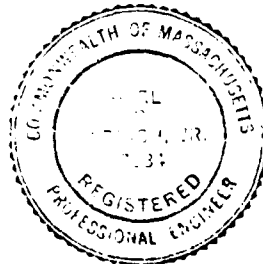
Additional investigation of the right spillway weir is recommended, since no data are available concerning this portion of the structure.

HALEY & ALDRICH, INC.

by:



Harl Aldrich
President



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

Charles G. Tiersch

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

Fred J. Ravens, Jr.

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

Saul Cooper

SAUL COOPER, Member
Chief, Water Control 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 investigations and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of 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 investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood referred to in this report as the spillway design flood, is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm runoff), or fraction thereof. Because of the magnitude and rarity

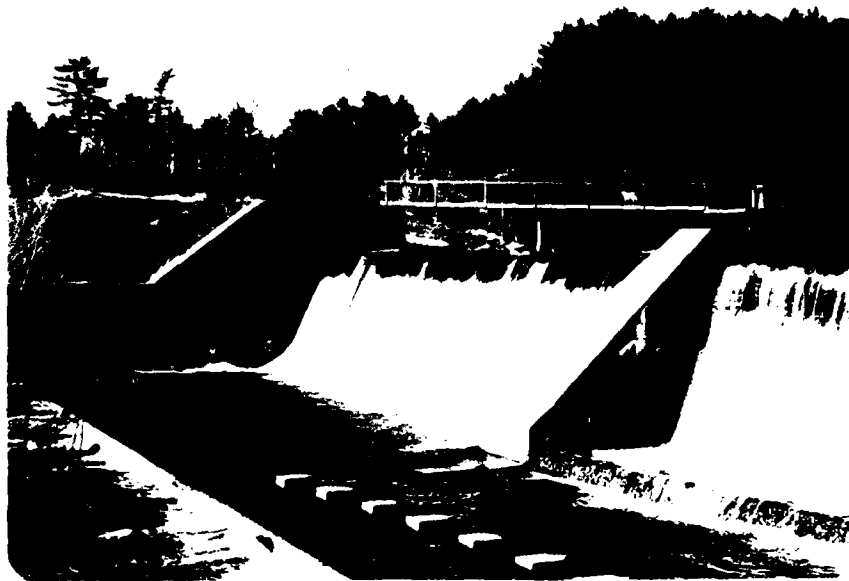
of such storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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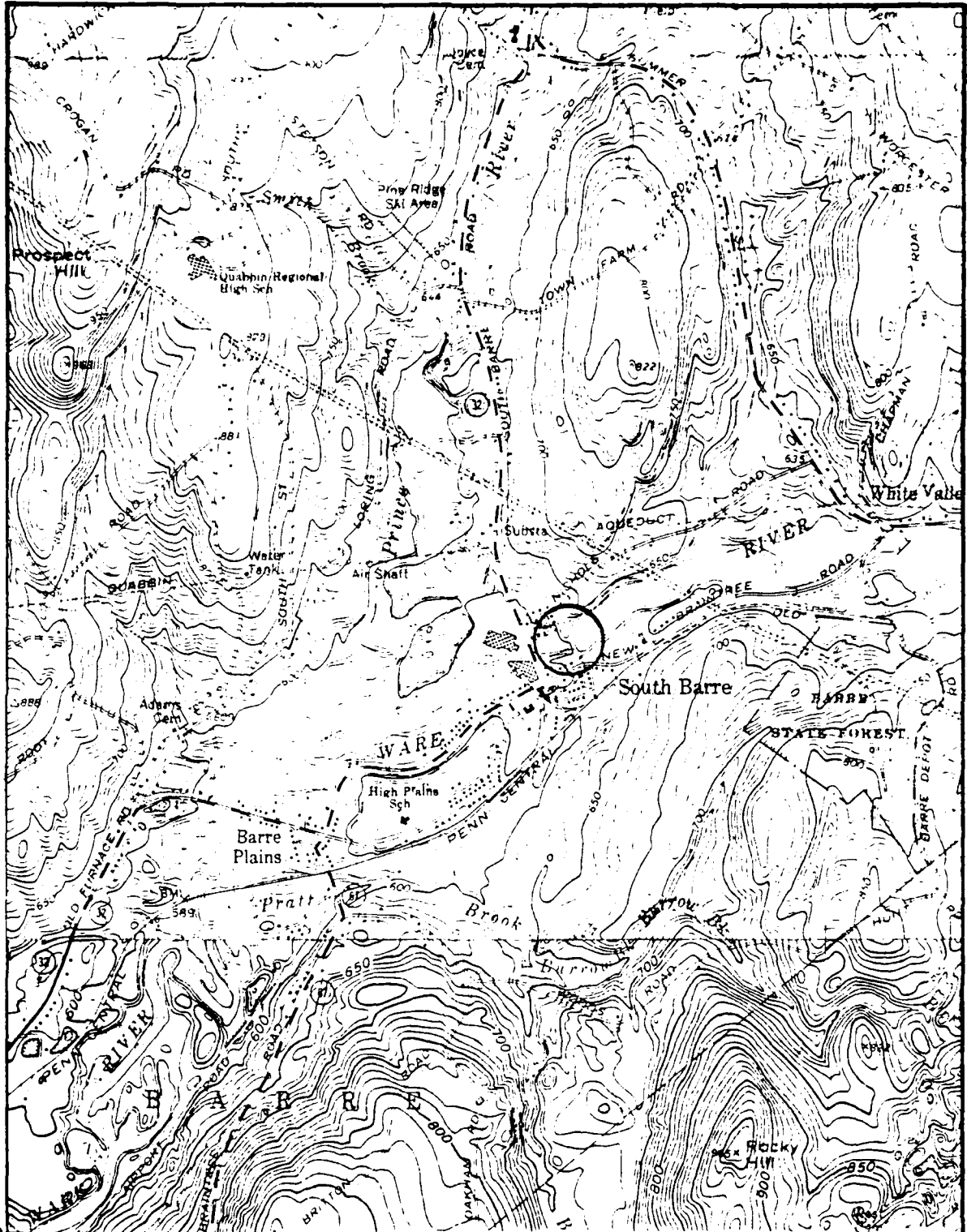
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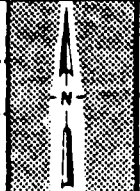
1. Overview of Spillway and Right Embankment



FILE NO. 4160

DAM: South Barre Mill Pond

IDENTIFICATION NO. MA 00091



LOCATION MAP
USGS QUADRANGLE
BARRE, MA.

APPROX. SCALE: 1" = 2000'

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM
SOUTH BARRE MILL POND DAM
MA 00091

I. PROJECT INFORMATION

1.1 GENERAL

A. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National 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.

Haley & Aldrich, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Haley & Aldrich, Inc. under a letter dated 26 April 1978 from Colonel Ralph T. Garver, Corps of Engineers. Contract No. DACW33-78-C-0301 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/hydrologic aspects of the investigation.

B. Purpose. The primary purposes of the National Dam Inspection Program are to:

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

2. Encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

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

1.2 PROJECT DESCRIPTION

A. Location. The dam is located on the Ware River,

in the town of South Barre, Massachusetts, as indicated on the Location Map, page vi.

B. Dam and Appurtenances. The main portion of the dam is formed by two ungated concrete spillways separated by a center pier, as shown on the drawings in Appendix B-1 and Appendix C-1. An earth embankment is located right of the spillway and an outlet works, once used to power mill equipment, is located at the left abutment.

A broad earth embankment, approximately 20 ft. high, extends a short distance from the spillway to the right abutment. The top of the abutment is more than 30 ft. wide except where it joins the right training wall. An apparent concrete core wall, the top of which is flush with the ground, extends from the spillway training wall for a distance of at least 120 ft. The dimensions and depth of this wall are unknown. The embankment is shown in Photos No. 3 and 4.

The concrete ogee spillways are approximately 180 ft. long and 18 ft. high. The right and left spillway crest elevations are 615.0 and 611.0, respectively. However, flashboards about 4 ft. high at the left spillway bring the normal operating levels to about El. 615, approximately 7 ft. below the top of training walls at the spillway abutments. Spillways are shown in several photos in Appendix C.

An outlet works with two slide gates is located on the left side. Water formerly discharged through a 10 ft. diameter penstock to power mill equipment. The outlet works and gates appear in Photos No. 11 and 12.

A bridge extends from the right end of the spillway to a platform and gate mechanism which controls the reservoir drain. Water flows through the right spillway into a sluiceway on the apron, Photos No. 5 and 6.

C. Size Classification. The storage to the top of the dam is estimated to be 389 acre-feet, and the height of the dam is approximately 20 ft. Storage of less than 1000 acre-feet and height of less than 40 ft. classifies South Barre Mill Pond Dam in the "small" category

according to guidelines established by the Corps of Engineers.

D. Hazard Classification. The dam is currently classified as having a "high" hazard potential in the Corps of Engineers National Inventory of Dams. Based on the potential loss of life and economic loss to residential, commercial and industrial properties as determined by performing a dam failure analysis, Appendix D, it is recommended that this classification be retained.

E. Ownership. The dam has been owned by the Barre Wool Combing Company since about 1901. The owner's address is: Barre Wool Combing Company, Vernon Street, South Barre, MA 01074 (phone: 617/355-2921). The owner was represented by Mr. John Gould during the course of this investigation.

F. Operator. Mr. John Gould is assigned responsibility for operation of the dam.

G. Purpose of the Dam. The dam was originally constructed to create a water supply for driving mill equipment. Presently, the dam serves no specific purpose since the mill has been closed, except for recreation.

H. Design and Construction History. The best available account of the history of the dam is contained in a technical paper "Repairs to Dam at South Barre, Massachusetts" by Howard M. Turner, published in the Journal of the Boston Society of Civil Engineers, October 1947. This paper describes the history of the dam through 1944, when the last major repair work was performed. The following discussion is quoted from the Howard Turner paper:

"The present dam at Barre was built about 1904. It was certainly the second dam at the site and may be the third or fourth. It

consisted of a spillway of stone filled timber crib about 95 ft. long with non-overflow section on the north end of stone masonry with fill upstream 200 ft. long. The dam is not on ledge. In 1935, this old dam was entirely rebuilt. A concrete ogee spillway section was placed just below the timber crib dam, the concrete being poured right against the timber and then carried over the top raising the level 3 ft. Part of the non-overflow section was also made into a spillway by means of a concrete ogee section both downstream from the masonry and over its top, the elevation of this portion being 4 ft. higher than the other part of the new spillway. Stone paving was placed below the spillway toe. New abutments were built on each side to a height of 7 ft. above the north half of the dam and 11 ft. above the south half. A heavy fill was put in extending approximately 50 ft. upstream from the dam with its elevation sloping gently down from the crest. On the south end there is a head gate and intake structure built in 1914 for a 10 ft. penstock which leads down to a hydro-electric station. Process water for the mill is taken from this penstock.

The 1936 flood did some damage below the dam requiring some repairs. A new concrete apron was put in the dam extending downstream 30 ft. from the toe and the walls on each side were extended downstream. The 1938 flood undermined these walls and washed out holes below the new apron which required its reconstruction. The holes below the apron were filled in with a heavy paving. It was proposed at that time that the apron should later be extended downstream but this work was never done.

In the summer of 1944 when the water was drawn down below the crest of the dam it was

apparent that there were leaks through the upstream fill, mostly about 6 or 7 ft. back from the concrete crest. These were of sufficient size in some cases so that, when the water was pulled down nearly to the level where the leak occurred, a small whirlpool could be seen. At other places it was not so evident but the appearance of the top of the gravel fill showed that water had been seeping through. Various attempts were made during that season to stop these leaks but without apparent success. It was decided, however, not to attempt under existing conditions to do more than try and locate the worst leaks and fill them in. After the winter, however, it was found that conditions were becoming much worse and water was beginning to appear bubbling up downstream from the concrete toe of the dam in the joint between the dam and the apron. Further explorations were made to try and trace the leaks to see if they could be stopped but, as this was apparently not going to yield any success, it was decided to do a real repair job on this portion of the dam. It was pretty clear that the planking of the old timber dam which gave the structure its main water tightness was failing.

The plan adopted consisted of the removal of enough of the timber dam so that adequate width of river bottom would be exposed to provide a suitable cut-off and allow the construction of a sufficient block of concrete behind the original concrete portion of the dam to create a stable concrete dam. The final plan adopted is shown in [Appendix B, Figure I] which gives a typical cross section. Borings showed the existence of hardpan below the dam at a distance within reach. The new section was carried down to this hardpan. A concrete cut-off was at first proposed but it was found that steel sheet piling could be driven to sufficient depth to provide an adequate cut-off. No attempt was made to drive this piling below a depth of more than 6 ft. but

most of it was successfully driven to that depth. As the old dam was exposed it was found that it was in very bad condition and there was no question but what anything less than complete repairs would have been ineffective.

There was some question before the bottom of the old dam was finally reached as to just what was under the upstream portion of the original concrete part. Inquiries from people who had been there during construction were conflicting. It was finally found, however, as far as could be determined from the upstream side, that this concrete rested on a stone filled timber crib which presumably formed an apron below the original dam. It was decided to leave this crib in on the basis that the timbers would always be wet. The new concrete was allowed to run in among the timbers as far as possible.

In computing the stability of this design it was assumed that for the water seeping under the dam, head was lost lineally with the length of flow, the path of flow being taken from the top of the earth fill around the clay fill and the cut-off to the log crib under the dam. On this basis the resultant, with maximum water over the crest, came at about the center of the distance between the upstream heel of the new concrete and the downstream toe of the old concrete section. Actaually the timber crib below the dam underneath the old concrete section almost certainly acts as a drain to relieve upward pressure from that point downstream. This was shown by the necessity of pumping downstream from the old dam through holes excavated in the concrete apron to prevent backwater flow into the construction. The appearance of some of these holes seemed to show that in places during the time when the leaks were coming out below the toe of the dam, some fine material had been washed from the gravel on which the concrete was placed. In order to consolidate this gravel without interfering with its drainage possibilities, five

piers were constructed of concrete below the toe of the old dam down to the hardpan foundation. These piers were approximately 3 ft. square at the bottom and were filled with concrete which was allowed to run into the surrounding gravel. They were spaced about 18.5 ft. It was not intended that these should take all the load but that they should reinforce possible weak spots in the gravel foundation under the dam above the hardpan.

The work was done during the summer of 1945. The water above the dam was drawn down by the sluice gate on the north half of the dam. A coffer dam was built across in front of the head gates which were closed, process water being taken into the penstock through a 24-in. pipe which extended through the coffer dam into the pond above. The two ends of the dam required some special measures, particularly the south end where it was necessary to get an adequate tight connection of the new concrete with the headgate structure. This necessitated underpinning the abutment.

It was clear from past experience that precautions against erosion at the toe during floods were required. The Ware River at Barre has a drainage area of about 104 sq. mi. The Metropolitan District Commission's diversion at Coldbrook where the drainage area is 96.8 sq. mi. is only 2 miles above this point. This diversion takes the "flood" waters in excess of about 131 c.f.s., but the maximum it can take is limited to about 3,000 c.f.s. which is not a very large proportion of a large flood so that it cannot be considered in any way as flood control. The 1936 flood had a peak of 6,800 c.f.s., 65 c.f.s. per sq. mi. The 1938 flood had a peak of 15,000 c.f.s., 144 c.f.s. per sq. mi. Both of these came after the diversion at Coldbrook. The proposed Barre Falls flood control reservoir controlling 57 sq. mi. when built, will reduce the floods at this dam.

The concrete apron extending 30 ft. below the dam, which was put in to replace the stone paving washed out by the 1936 flood, was badly damaged in the 1938 flood. It was replaced and a heavy toe wall was built all the way across the river. It was proposed at that time this apron should be carried downstream an additional 90 ft. to the end of the abutment wall on the south bank. Instead of this, heavy stone paving was put in immediately below the new wall. Experience during the years after this work was done showed that successive floods even of moderate size would wash out this stone paving. The question of what to do to prevent this erosion of the toe of this dam became a part of the design.

A study was made of the possibility of obtaining a hydraulic jump on the apron or immediately below the apron. Experiments were conducted for this purpose at the Alden Hydraulic Laboratory at Worcester. The final design consists of a slight kick-up bucket at the bottom of the spillway which throws the water up into the air and a series of baffle piers placed on the apron at the point where the stream of water from this kick-up again hits the apron. There is also a slight lift to the apron at its very downstream edge."

I. Operation. There is no established routine for operation of the dam.

1.3 PERTINENT DATA

Elevations given in this report are those appearing on the drawing in Appendix B-1. Although the datum for these elevations is unknown, it appears to be 6.5 ft. below National Geodetic Vertical Datum (NGVD) since the crest elevation reported by the USGS in their 1960 publication "Floods of August-October 1955, New England to North Carolina", Water Supply Paper 1420 is 608.5 NGVD versus El. 615 used herein.

A. Drainage Area. The drainage area above the dam is approximately 100.2 square miles of which 55 square miles is controlled by the Corps of Engineers Barre Falls flood control dam which was constructed in 1958.

B. Discharge of Dam Site. No significant floods have occurred in the watershed since the construction of the Barre Falls flood control dam.

1. The maximum known flood at the dam site occurred during the September 1938 flood and was estimated to be 15,000 cfs at an estimated headwater of El. 615.3.
2. The maximum spillway capacity with the flashboards in place is 13,100 cfs at pool El. 622.0, the top of the adjacent training wall.
3. The maximum spillway capacity with the flashboards removed is 17,400 cfs at a pool El. 622.0.

C. Elevation. (Note: elevations taken from Turner Plans).

- | | | |
|----|--|-----------------------------|
| 1. | Top Dam. | .622.0 |
| 2. | Maximum Pool-Design surcharge (1/2 PMF). | .622.0 |
| 3. | Full flood control pool. | N/A |
| 4. | Recreation pool. | .615.0 |
| 5. | Spillway crest | |
| | Right spillway | .615.0 |
| | Left spillway. | .611.0 |
| | | (615.0 with flashboards) |
| 6. | Upstream portal invert diversion tunnel | N/A |
| 7. | Streambed at centerline of dam | .597.0 (Est.) |
| 8. | Maximum tailwater. | Unknown |

D. Reservoir.

1. Length of maximum pool0.7 miles (Est.)

A. Drainage Area. The drainage area above the dam is approximately 100.2 square miles of which 55 square miles is controlled by the Corps of Engineers Barre Falls flood control dam which was constructed in 1958.

B. Discharge of Dam Site. No significant floods have occurred in the watershed since the construction of the Barre Falls flood control dam.

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3. The maximum spillway capacity with the flashboards removed is 17,400 cfs at a pool El. 622.0.

C. Elevation. (Note: elevations taken from Turner Plans).

1. Top Dam. 622.0
2. Maximum Pool-Design surcharge (1/2 PMF). 622.0
3. Full flood control pool. N/A
4. Recreation pool. 615.0
5. Spillway crest
 - Right spillway 615.0
 - Left spillway. 611.0
(615.0 with flashboards)
6. Upstream portal invert diversion tunnel N/A
7. Streambed at centerline of dam 597.0 (Est.)
8. Maximum tailwater. Unknown

D. Reservoir.

1. Length of maximum pool . . . 0.7 miles (Est.)

- 2. Length of recreational pool0.7 miles (Est.)
- 3. Length of flood control pool0.7 miles (Est.)

E. Storage. (acre-feet)

- 1. Recreational pool.135.0 (Est.)
- 2. Flood control poolN/A
- 3. Design surcharge pool (1/2 PMF)485.0 (Est.)
- 4. Top of dam389.0 (Est.)

F. Reservoir Surface (acres)

- 1. Top dam.50 (Est.)
- 2. Maximum pool48 (Est.)
- 3. Flood control poolN/A
- 4. Recreation pool.22.5 (Est.)
- 5. Spillway crest22.5 (Est.)

G. Dam (embankment, right abutment)

- 1. TypeEarth fill
- 2. LengthApprox. 100 ft.
- 3. HeightApprox. 20 ft.
- 4. Top Width.Approx. 30 to 50 feet (variable)
- 5. Side Slopes.Approx. 4:1 U/S or flatter, 2:1 D/S
- 6. ZoningUnknown
- 7. Impervious CurveUnknown, possibly concrete core wall
- 8. CutoffUnknown
- 9. Grout curtain.Unknown
- 10. Other.Unknown

H. Spillway

- 1. TypeUngated concrete ogee weir
- 2. Length of Weir and Crest Elevation.90.5 ft. at El. 611 with flashboards

- | | |
|-------------------------|---|
| | to El. 615 plus 87 feet fixed at El. 615 |
| 3. U/S Channel. | N/A |
| 4. D/S Channel. | .(Less than 5 percent) |
| 5. General. | .The upstream approach is the submerged remains of a crib-earth dam |

I. Regulating Outlets. There are two hand operated sluice gates at the left embankment of unknown size feeding a 10 ft. steel penstock. The gate operators appear to be in operating condition. They are marked HM Company, Style A, 0.4169. The invert elevation is unknown.

The reservoir drain is operated from a platform over the reservoir and appears to be operable. Access to the platform is by a bridge from the right abutment. The drain, estimated to be 4 to 5 ft. in diameter, discharges into a sluiceway in the apron below the right spillway. The operator is labeled with the number 3012 and 580, the gear box on the operator has the number G.470 present. There is a second operator present on the platform which controls flow into a pipe estimated to be 24 inches in diameter. The outlet of the pipe is unknown. The valve operator for this pipe is a Rodney Hunt Operator labeled with the numbers 2500 and 534. Invert elevations for the pipes are unknown.

It has been determined that both regulating outlets and reservoir drain are operable and maintained. Both can be used to reduce flood flows over the spillway without detrimental effect to the Barre Wool Combing Co. downstream.

II. ENGINEERING DATA

2.1 DESIGN RECORDS

In addition to the data published in the 1947 BSCE paper, a number of drawings and sketches were located relating to the design of repair work that was completed in 1944. A copy of a drawing prepared by Howard M. Turner which summarizes the 1944 repairs is included in Appendix B-1.

A drawing titled "Details of Head Gate Wall Showing Changes and Additions" prepared by Lockwood, Greene & Co. and dated 20 October 1914 was also available for review. No records of earlier designs were located.

2.2 CONSTRUCTION RECORDS

The only available construction records, other than the information published in 1947, consists of a copy of "Specifications on Repairs to Dam" prepared by Howard M. Turner and 9 black and white photographs taken of the 1944 repair work.

2.3 OPERATION RECORDS

No operational records are available.

2.4 EVALUATION

A. Availability. Available design and construction records are located at the Barre Wool Combing Co., South Barre, Massachusetts.

B. Validity. There is no reason to doubt the validity of the available data.

C. Adequacy. While the available records provide useful information, the evaluation of the dam for the purposes of this investigation must be based primarily on the visual examinations described in the following section.

III. VISUAL EXAMINATION

3.1 FINDINGS

A. General. The Phase I visual examination of the South Barre Mill Pond dam was conducted on 11 May 1978. A supplemental visit to the site was made on 29 June 1978.

In general, the earth embankment, spillways and outlet structures were observed to be in fair to good condition. On 11 May, observation of the spillways was obscured by water but on 29 June the right spillway was "dry".

Visual inspection checklists for both site visits are included in Appendix A and selected photographs are given in Appendix C.

B. Dam (embankment at right abutment). The earth embankment located right of the spillways is in good condition. No indications of settlement, lateral movements, seepage or other serious defects were observed.

The embankment is generally grass-covered. Some erosion from rainfall, foot traffic, and boat launching operations was noted on the upstream and downstream slopes, especially at the spillway end. These conditions are shown by Photos No. 3 and 4.

The upstream slope is only partially protected by riprap, Photo No. 4. However, no evidence of significant erosion by wave action was apparent and little would be anticipated.

C. Appurtenant Structures. The view of the spillway weir and apron was obscured by flowing water during the May inspection, the left side wall appeared to be in fair condition with erosion present at areas of contact with flowing water. Concrete spalls and deterioration of concrete are present in the downstream region of the foundation, Photo No. 10. The right side wall appeared to be in good condition, the surface having been given

a parge coat in recent times. However, some deterioration was noted near the water surface at the downstream edge and some erosion was noted in the region of flowing water adjacent to the weir, Photos No. 7 and 8.

A supplemental inspection was made in June at that time no water was flowing over the right weir, Photo No. 5. The parge coat was found to be in fair condition in the lower region adjacent to the weir and apron. One section approximately 4 ft. long has spalled off exposing the reinforcing mesh. The entire length of the parge coat at the junction of the apron has been undercut. Three drains outlet at the base of the right wall, Photo No. 7. The upstream drain has a small flow of water, the center one was dry and the downstream drain has two plugged pipes just beneath it. Rusty water is seeping from the plugged pipes, Photo No. 8.

The right weir exhibited considerable surface deterioration in the lower region. Several spalled areas are present and the general area appeared to be loose when sounded with a hammer. Two vertical cracks are present. One rises from the main reservoir drain outlet to approximately mid-height of the weir, Photo No. 6. The second is several feet to the left of the first and starts approximately at the elevation of the crown of the outlet pipe and rises vertically to the top of the weir.

The center buttress of the spillways has been undercut by flowing water as well at the the left training wall. The right apron is in good condition but undercutting is taking place in the outlet channel for the reservoir drain. It is quite evident on the left side of the channel near the weir. The downstream riprap adjacent to the right apron appears to have been placed to form a smooth channel bottom. However, the stones have been materially displaced.

The outlet works structure concrete is in poor condition with spalls, efflorescence, cracks, projecting reinforcement and loose concrete noted. The gates, Photo No. 12, appeared to be operable although they were not tried during the inspection. They were said to be operable.

The service bridge to the reservoir drains is in good condition. Railing protection in the bridge and platform are below normal minimum standards. The gate was opened two years ago to lower the pond level for repairs to flashboards.

D. Reservoir Area. The area around South Barre Mill Pond is generally developed and side slopes are relatively flat. There is no possibility that landslides into the pond would cause waves which would overtop the dam. No conditions which might result in a sudden increase in sediment load into the pond were apparent.

E. Downstream Channel. The channel immediately downstream of the spillways is in satisfactory condition. The floor of the channel is generally covered with cobbles, boulders and broken concrete and the side slopes are paved with large boulders. Islands in the channel floor and side slopes are lightly wooded. These conditions are shown in Photos No. 2, 3 and 9.

3.2 EVALUATION

Based on visual observations during the site examination, the general condition of the project is satisfactory. Although concrete surfaces, especially at the left training wall and right spillway weir have experienced considerable deterioration, their present condition should not have any serious effect on the performance of the dam.

IV. OPERATIONAL PROCEDURES

4.1 PROCEDURES

In general, there is no established routine for operation of the dam.

4.2 MAINTENANCE OF EMBANKMENT

The earth embankment receives little maintenance except for occasional mowing.

4.3 MAINTENANCE OF OPERATING FACILITIES

Portions of the outlets to the mill have been plugged. It is questionable how effective they would be if utilized to control the water level in the reservoir. However the gates appear to have received minimum maintenance.

The reservoir drains also appear to have received minimum maintenance. It is recommended that the drains be operated at least once a year.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no established warning system or emergency preparedness plan in effect for this structure.

4.5 EVALUATION

With the closing of the Barre Wool Combing Co., the dam no longer serves a useful purpose and can be expected to be given only minor attention.

V. HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

A. Design Data. No hydrologic or hydraulic data was found for the original dam. Repair work to the south half of the dam was engineered by Howard M. Turner in 1944 and is summarized in a report of spillway modeling by the Alden Hydraulic Laboratory of Worcester, Massachusetts, dated 5 September 1944, and in a paper presented on 7 May 1947 to the BSCE by H.M. Turner. These sources indicate that the Flood of Record (September 1938) had a peak discharge of 15,000 cfs, at a head of 10.8 feet on the spillway or pool elevation of 615.3 National Geodetic Vertical Datum (NGVD) and a tailwater elevation of 599.9 NGVD.

1. A recurrence of the hurricane of September 1938 would not result in as high a peak discharge due to the protection afforded by the Barre Falls Dam and Reservoir located upstream, which was completed in 1958.
2. The recommended spillway design flood for the size (small) and hazard potential (high) classification of this dam is a range of 1/2 PMF to PMF (probable maximum flood).

B. Experience Data. The PMF was determined by using the peak inflow rate of 1,109 cfs/sq.mi. as determined by the New England Division, Corps of Engineers for the Barre Falls Dam which is also on the Ware River, upstream of the South Barre Mill Dam. The PMF was determined on the basis of the drainage area downstream of the Barre Falls Dam (45.2 sq.mi.). The upstream drainage area was excluded as the downstream drainage area will have passed its peak before the peak outflow from the Barre Falls Dam reaches this dam. It was assumed that the releases from the Barre Falls Dam would be diverted at the Coldbrook intake. On the basis of the foregoing assumptions, the PMF was calculated to be 50,000 cfs.

C. Visual Observations. At some time after repairs were made in 1944 as recommended by H.M. Turner, 4 feet of flashboards were added to the south half making its crest elevation the same as the north half (608.5 NGVD). The flashboards are held in place by a series of metal rods, each of which is supported by a metal cable which runs back to a main cable that spans the river upstream of the crest. The system appears to be designed so that the flashboards can be quickly released by cutting the main cable.

The repairs made in 1944 to the apron downstream of the spillway appear to be in good condition.

D. Overtopping Potential. The maximum spillway capacity, assuming that the flashboards are released or washed out and the head on the spillway (south half) is 11.0 feet or pool elevation of 615.5 NGVD (top of dam), was determined to be 17,400 cfs. However, it is noted that a visual inspection shows that the banks of the pool are below elevation 615.5 on the south half at the end of the headwall for the penstock. Since the SDF is between 25,000 cfs and 50,000 cfs, the spillway is considered inadequate.

E. Evaluation. In the event of an occurrence of a peak discharge of 1/2 PMF (25,000 cfs), the estimated depth of flow over the top of dam would be between 1.5 and 2.0 ft. Immediately downstream of the dam, in the path of such overtopping, are both single and multifamily housing. As previously mentioned, there exists a low spot on the south side of the dam located at the end of the concrete wall. In the event of the dam being overtopped, this low are could rapidly erode, thus increasing the flood hazard to housing on the south side of the river. At the same time, the portion of the dam on the north side, which is protecting the multifamily housing at the foot of the dam, would be most susceptible to failure since this portion is beyond the limits of the apparent concrete "core" wall.

A dam failure analysis indicates that no significant damage would result if the dam failed in the area of the spillway. However, if the dam failed on the right side, above the multifamily housing, the potential for loss of life would be severe.

In conclusion, the spillway is inadequate to pass the SDF range of 1/2 to 1 PMF and should the dam be overtopped, the two weakest portions are immediately above residential housing.

VI. STRUCTURAL STABILITY

6.1 EVALUATION OF EMBANKMENT STRUCTURAL STABILITY

A. Visual Observations. No visual evidence of instability in the earth embankment located right of the spillways was noted during the site examinations on 11 May 1978. The embankment has a cross-section considerably broader than a typical embankment section. Although the downstream slope is typical, resembling a man-made embankment, the top width and upstream slope are broad and flat, respectively. Therefore, a failure of the embankment is not likely under static loading conditions.

B. Design and Construction Data. There were no design and construction data relative to the embankment.

C. Operating Records. Not applicable.

D. Post-Construction Changes. No major post-construction changes in the earth embankment are known to have been performed.

E. Seismic Stability. Since the South Barre Mill Pond Dam is located in Seismic Zone 2, the scope of work has not included a study of stability during earthquake events. However, a failure of the embankment is not considered likely in the event of an earthquake.

6.2 EVALUATION OF SPILLWAY STRUCTURAL STABILITY

A. Visual Observation. There was no evidence that movement or distress in the spillway concrete has taken place. However, the left spillway was obscured by flowing water.

B. Design and Construction Data. Design data in the form of construction plans and a publication on the reconstruction and model testing are available on the left spillway. No design or construction data are available for the right spillway. An analysis of the left spillway indicates that the spillway is stable for the PMF flooding. There is some indication that the right spillway may have been constructed against and

utilized part of an existing old timber crib dam. Therefore, it would not be prudent with the information available to estimate its stability.

C. Operating Records. No operating records are known to exist for the spillway.

D. Post-Construction Changes. The present dam, built about 1904, was definitely the second dam at the site and possibly the fourth. The dam was entirely rebuilt in 1935. The spillway was repaired in 1939 and the left spillway was modified in 1945.

E. Seismic Stability. The left spillway is deemed adequate for seismic stability in that it is in a Zone 2 area and structurally stable for normal loading conditions. It is not possible to comment on the seismic stability of the right spillway due to the lack of data on the structure.

VII. ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

A. Condition. The visual examination of the earth embankment and spillway reveal that the South Barre Mill Pond dam is in fair to good condition. There are no visual signs of failure or conditions which would warrant urgent remedial treatment.

The investigation has indicated that the left spillway is adequate for the usual force applied to structures of this type, the safety of the right spillway cannot be determined with the information currently available.

The spillways cannot pass a spillway design flood in the range of 1/2 PMF to PMF (25,000 to 50,000 cfs) without overtopping the embankment. The maximum capacity of the spillway is estimated to be 17,400 cfs. However, before the dam would overtop, water would discharge around the concrete wall at the left abutment where existing grade is about 2 ft. lower than the embankment right of the spillways. A stairway at this location is shown in the upper left corner of Photo No. 11.

B. Adequacy of Information. While there is sufficient information available for analysis of the left spillway, there is insufficient information on the right spillway.

C. Urgency. The recommendations for additional investigations and remedial measures outlined in Sections 7.2 and 7.3, respectively, should be undertaken by the Owner as soon as practical.

D. Need for Additional Investigation. Additional investigations should be performed by the Owner as outlined in the following section.

7.2 RECOMMENDATIONS FOR ADDITIONAL INVESTIGATIONS

It is recommended that the Barre Wool Combing Company

engage a registered professional engineer to undertake the following investigations:

1. An investigation of the right spillway to determine the structural stability of this portion of the dam.
2. Hydrologic studies to determine what alternative measures are required to significantly increase the discharge capabilities at the dam. These alternatives may include the use of properly maintained sluice gates in the dam and a predetermined emergency operation procedure.

7.3 REMEDIAL MEASURES

A. Alternatives. Not applicable.

B. Operation and Maintenance and Procedures. It is recommended that the following remedial work be undertaken by the Barre Wool Combing Company:

1. Repair concrete surfaces on the left spillway training wall and the downstream face of the right spillway weir, to prevent continued deterioration of these structures in the future. Loose weak concrete should be removed and the surface restored by application of concrete mortar, shotcrete or by other methods.
2. Maintain both the gates to the outlet works and the gate which controls flow to the reservoir drain through the right spillway, and operate these gates at least once a year, to provide a means for lowering the pond level in the event of an emergency.

Due to the "high" hazard potential classification, surveillance of the dam should be provided by the Owner during and following periods of unusually heavy precipitation. The Owner should also develop a formal emergency procedures plan and warning system, in cooperation with local officials in downstream communities.

APPENDIX A
INSPECTION TEAM ORGANIZATION AND CHECK LIST

| | <u>Page No.</u> |
|--|-----------------|
| <u>VISUAL INSPECTION PARTY ORGANIZATION</u> | 1 |
| <u>VISUAL INSPECTION CHECK LIST</u> | |
| Dam Embankment | 2 |
| Outlet Works (Left Abutment) | 3 |
| Outlet Works-Spillway Weir, Approach and Discharge Channels | 3 |
| Reservoir Drain-Service Bridge and Platform | 4 |
| Reservoir Drain-Gates | 4 |
| <u>SUPPLEMENTAL VISUAL INSPECTION</u> | |
| Party Organization | 5 |
| Visual Inspection Checklist | 6 |

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

Dam: South Barre Mill Pond

Date: 11 May 1978

Time: 0805-1700

Weather: Clear and Warm (70's F.)

Water Surface Elevation Upstream: El. 615.6 (Datum
uncertain)

Stream Flow: 125 MGD on 11 May 1978
(M.D.C. Records)

Inspection Party:

Harl P. Aldrich, Jr. - Soils/Geology
Haley & Aldrich, Inc.

Roger H. Wood - Structural/
Camp, Dresser & McKee, Inc. Mechanical

Present During Inspection:

John M. Gould, Barre Wool Combing Co.

**VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM**

DAM: South Barre Mill Pond DATE: 11 May 78

| AREA EVALUATED | CONDITION |
|---|---|
| <u>DAM EMBANKMENT</u> (Right Abutment) | |
| Crest Elevation | Approximately El. 622.0 (Ground beyond end of wall at left abutment is about 2 ft. lower) |
| Current Pool Elevation | El. 615.6 |
| Maximum Impoundment to Date | Not known |
| Surface Cracks | None observed |
| Pavement Condition | No pavement |
| Movement or Settlement of Crest | None observed |
| Lateral Movement | None observed |
| Vertical Alignment | Top of concrete "core" wall in good alignment |
| Horizontal Alignment | Good |
| Condition at Abutment and at Concrete Structures | Some erosion noted near spillway training wall |
| Indications of Movement of Structural Items on Slopes | No structures on embankment |
| Trespassing on Slopes | Frequent, no restrictions to vehicles or persons |
| Animal Burrows in Embankment | None observed |
| Vegetation on Embankment | Grass (no trees) |
| Sloughing or Erosion of Slopes or Abutments | Some erosion and loss of material from foot traffic on paths near concrete wall at right abutment of spillway |
| Rock Slope Protection - Riprap Failures | Minor blocks of concrete riprap near water level. Upper part of upstream slope has no riprap. (See Photo) |
| Unusual Movement or Cracking at or near Toes | None observed |
| Unusual Embankment or Downstream Seepage | None observed |
| Piping or Boils | None observed |
| Foundation Drainage Features | None |
| Toe Drains | None |
| Instrumentation Systems | None |

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX A-2

**VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM**

DAM: South Barre Mill Pond

DATE: 11 May 78

| AREA EVALUATED | CONDITION |
|--|--|
| <u>OUTLET WORKS (Left Abutment)</u> | |
| <u>a. Structure</u> | |
| General Condition of Concrete Spalling | Poor condition |
| Visible Reinforcing | Downstream side, at cracks and joints and upstream side |
| Any Seepage or Efflorescence | At downstream edge of slab |
| Railing | General efflorescence, particularly at air vent |
| Walkways at stop logs | Loose and incomplete One plank missing. Some deterioration of wood |
| <u>b. Mechanical and Electrical</u> | |
| Air Vents | (No Electrical facilities) |
| Lifting Devices | Operable |
| Bar racks | Appear to be in operable condition (not tried) |
| Stop log guides | Good condition |
| Service Gates | Concrete broken down near water surface at left stop log area Not observable |
| <u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u> | |
| <u>a. Approach Channel</u> | |
| General Condition | Not applicable - spillway fronts on reservoir |
| <u>b. Weir and Training Walls</u> | |
| General Condition of Concrete | Weir not visible (flowing water) fair left side, good right side, surface parged, spalling observed at pier |
| Rust or Staining | None observed |
| Spalling | Particularly at water surface left side, and downstream of weir at wall foundation |

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

**VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM**

DAM: South Barre Mill Pond DATE: 11 May 78

| AREA EVALUATED | CONDITION |
|---|--|
| Any Visible Reinforcing Any Seepage or Efflorescence Drain Holes c. <u>Discharge Channel</u> (below apron) General Condition Loose Rock Overhanging Channel Trees Overhanging Channel Floor of Channel Other Obstructions | None observed At cracks particularly at left side some at right side walls Possibly at bottom of weir-view obstructed Good, channel is natural bed of river; side slopes immediately downstream of spillway training walls paved with large blocks of broken concrete and boulders None Banks of river and islands are wooded Cobbles, boulders, broken concrete None observed |
| <p><u>RESERVOIR DRAIN - SERVICE BRIDGE AND PLATFORM</u></p> | |
| Superstructure and Foundation Bearings Anchor Bolts Foundation Longitudinal Members Under Side of Deck Deck Railings Paint | Concrete and steel in good condition Frozen by parging of right abutment OK Steel tubes - some rust spots Steel - some rust spots OK Good - some surface deterioration Single rail one side only Steel needs painting |
| <p><u>RESERVOIR DRAIN - GATES</u></p> | |
| Gate Operators | No handles present; 1 of 3 operators has no shaft present; one has shaft cover (pipe) bent |

FILE NO. 4160

**VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM**

DAM: South Barre Mill Pond DATE: 11 May 78

| AREA EVALUATED | CONDITION |
|---|--|
| <p>Any Visible Reinforcing Any Seepage or Efflorescence Drain Holes</p> <p>c. <u>Discharge Channel</u> (below apron)</p> <p>General Condition</p> <p>Loose Rock Overhanging Channel Trees Overhanging Channel Floor of Channel Other Obstructions</p> <p><u>RESERVOIR DRAIN - SERVICE BRIDGE AND PLATFORM</u></p> <p>Superstructure and Foundation Bearings Anchor Bolts Foundation Longitudinal Members Under Side of Deck Deck Railings Paint</p> <p><u>RESERVOIR DRAIN - GATES</u></p> <p>Gate Operators</p> | <p>None observed At cracks particularly at left side some at right side walls Possibly at bottom of weir-view obstructed</p> <p>Good, channel is natural bed of river; side slopes immediately downstream of spillway training walls paved with large blocks of broken concrete and boulders</p> <p>None</p> <p>Banks of river and islands are wooded Cobbles, boulders, broken concrete None observed</p> <p>Concrete and steel in good condition</p> <p>Frozen by parging of right abutment OK Steel tubes - some rust spots Steel - some rust spots OK Good - some surface deterioration Single rail one side only Steel needs painting</p> <p>No handles present; 1 of 3 operators has no shaft present; one has shaft cover (pipe) bent</p> |

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

SUPPLEMENTAL VISUAL INSPECTION
NATIONAL DAM INSPECTION PROGRAM

Dam: South Barre Mill Pond

Date: 29 June 1978

Time: 1700

Weather: Clear; Temperature 75⁺°F.

Water Surface Elevation Upstream: El. 615

Stream Flow: Unknown

Inspection Party:

| | |
|--|--------------|
| Roger H. Wood Camp, Dresser & McKee, Inc. | - Structural |
| Charles E. Fuller Camp, Dresser & McKee, Inc. | - Hydraulics |

**VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM**

DAM: South Barre Mill Pond DATE: 29 June 78

| AREA EVALUATED | CONDITION |
|--|---|
| <u>SUPPLEMENTAL</u> | <u>VISUAL INSPECTION</u> |
| <p><u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u></p> <p>a. Approach Channel</p> <p>b. Weir and Training Walls</p> | <p>- See 11 May 1978 Inspection</p> <p>- Left weir not visible due to flow</p> <p>- Right weir has loose surface concrete and spalled areas in lower portion of weir. There are two vertical cracks, one starts at the center drain and rises to mid-height of the weir, the other is about 3 feet to the south and starts just above the drain and rises to the top of the weir.</p> <p>- Right training wall is undercut, has lost a four foot area of the parge coat near the weir exposing the surface reinforcing mesh. There are three drains at the bottom of the wall. The upstream one has a small amount of flow present, the second drain is dry and the downstream one has rusty water seeping from two plugged pipes just beneath the drain.</p> <p>- Center buttress shows undercut at apron.</p> <p>- Left wall is undercut at apron.</p> <p>- Right apron appears to be in good condition. Reinforcing steel projects downstream at each side of drain channel. Apron is undercut by flow in drain channel on left side of the channel near the weir.</p> <p>- Left apron not visible for inspection due to flow of water.</p> <p>- Row boat debris present during first inspection has been partially removed and relocated.</p> <p>- Riprap downstream of right apron appears to have been placed to form</p> |

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: South Barre Mill Pond

DATE: 29 June 78

| AREA EVALUATED | CONDITION |
|----------------|--|
| | <p>a smooth bottom during original construction but very little remains in place.</p> <ul style="list-style-type: none">- Splitter blocks in left apron appear to be in good structural condition. |

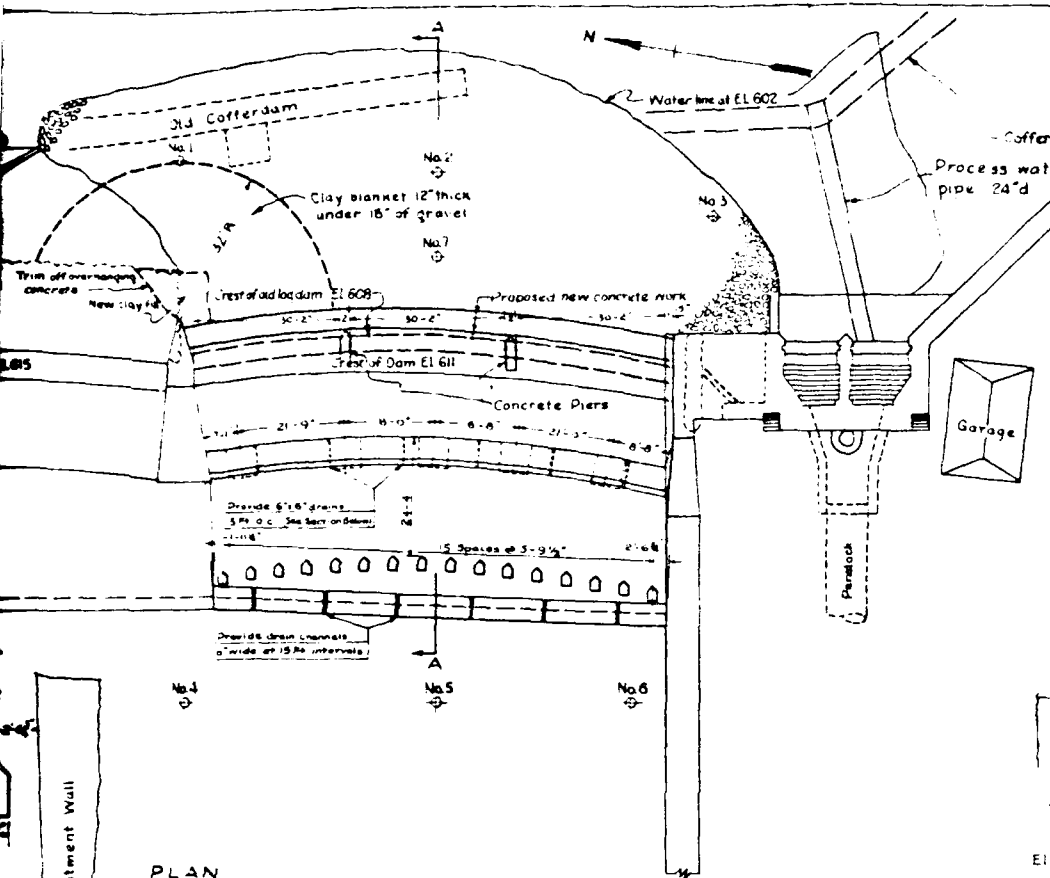
FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

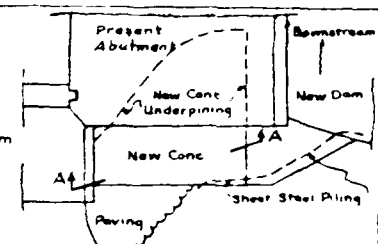
APPENDIX A-7

APPENDIX B
LIST OF AVAILABLE DOCUMENTS AND
PRIOR INSPECTION REPORTS

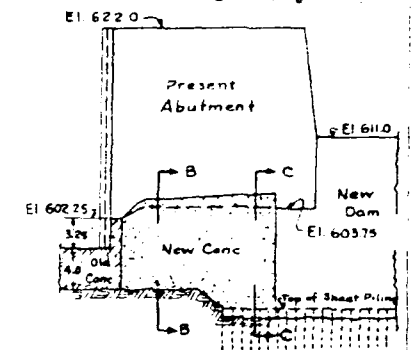
| | <u>Page No.</u> |
|--|------------------|
| "Repairs to Dam", Howard M. Turner, 14 September 1944 | 1 |
| <u>LIST OF AVAILABLE DOCUMENTS</u> | 2 |
| <u>PRIOR INSPECTION REPORTS</u> | (none available) |



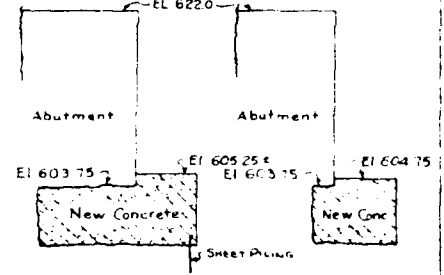
PLAN
Scale 1"=160'



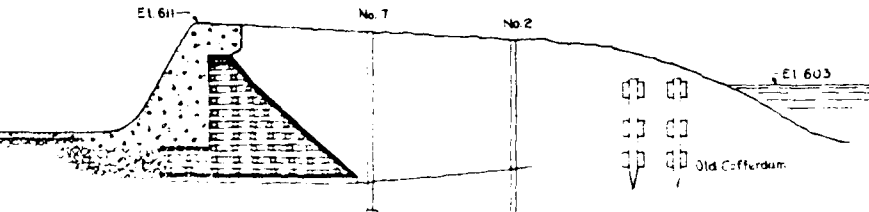
PLAN OF SOUTH ABUTMENT
SCALE 1/8"=1'-0"



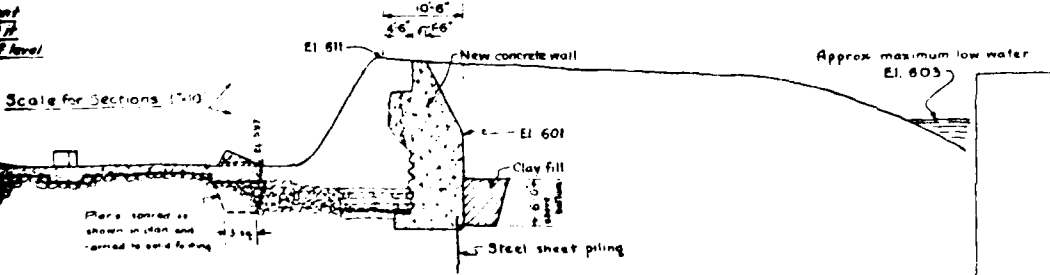
ELEVATION & SECTION ON LINE A-A ABOVE
Scale 1/4"=1'-0"



SECTION C-C SECTION B-B
Scale 1/4"=1'-0"



SECTION A-A "PRESENT DAM"



SECTION SHOWING PROPOSED NEW WORK

Note

Location of borings shown thus No 3

Revised April 26 1945
 Revised April 25 1945
 Revised Feb 19 1945
 Revised Nov 11 1944
 Revised Oct 11 1944
 Revised Sept 25 1944

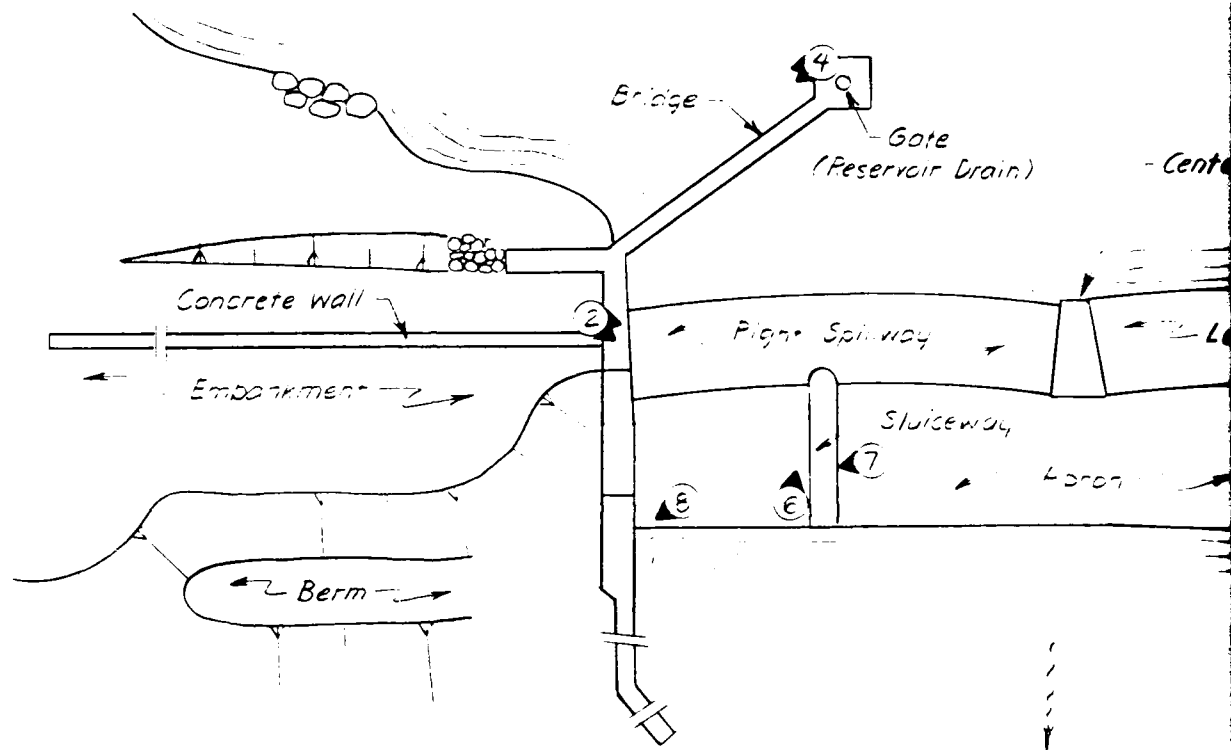
REPAIRS TO DAM
 50 BARRE, MASS.
 BARRE WOOL COMBING CO
 BARRE, MASS.

HOWARD M. TURNER
 CONSULTING ENGINEER
 BOSTON

SCALE AS NOTED
 DRAWN BY H. R. G. J.
 CHECKED BY J. H. G.
 APPROVED H. M. T.

SEPT 14, 1944
 NO 1067-1

SOUTH BARRE MILL P



NOTES:

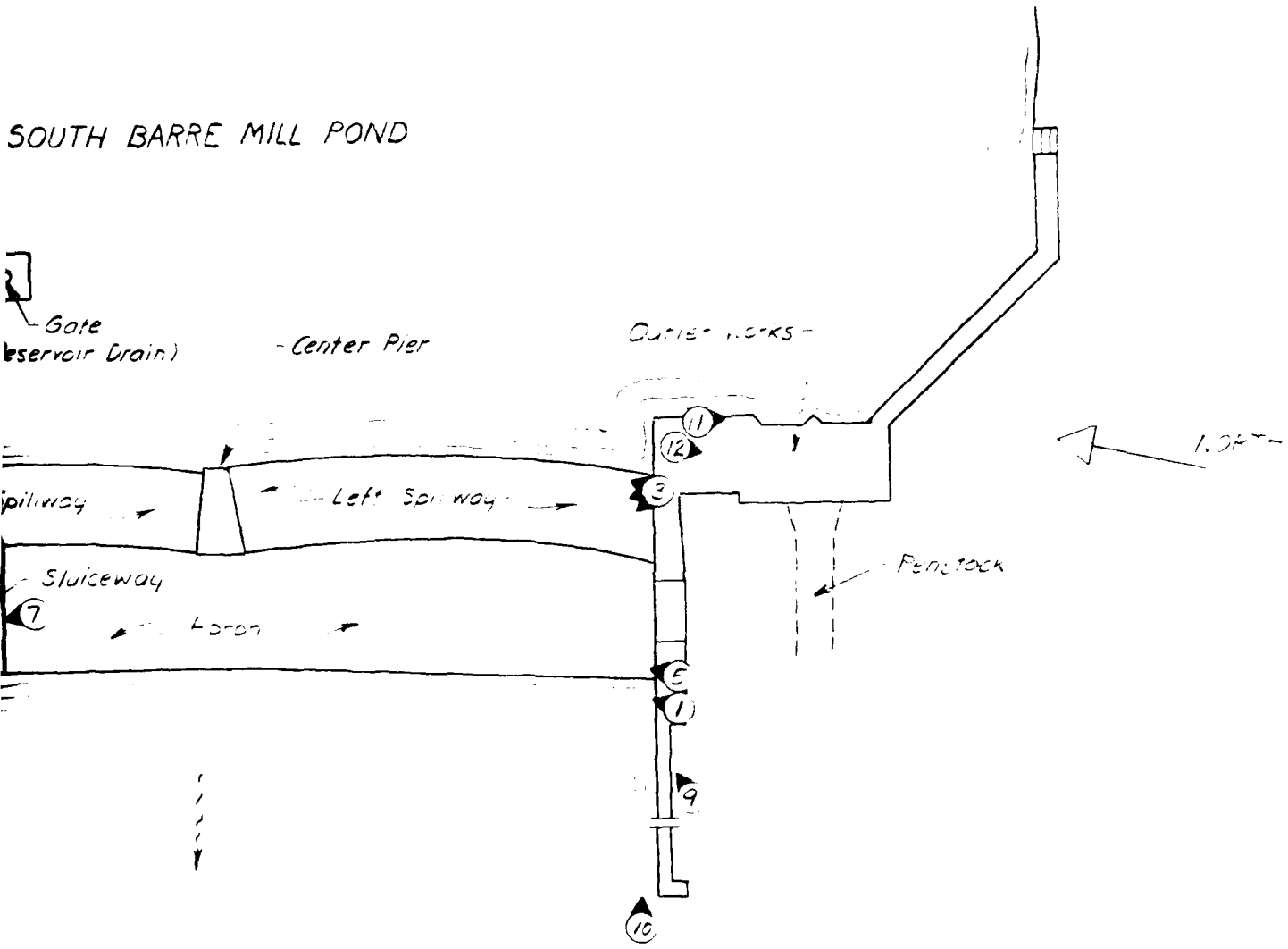
1. Plan sketch developed from 1944 drawing by H.M. Turner (Fig. 2) and from Haley & Aldrich, Inc. field observations.
2. See Appendix B-1 for more detailed plan and sections.

LEGEND:

③ Photograph number and direction of view.

FILE 4160 83

SOUTH BARRE MILL POND



Photograph number and direction of view.

South Barre Mill Pond
South Barre, Massachusetts

SITE PLAN SKETCH

No scale

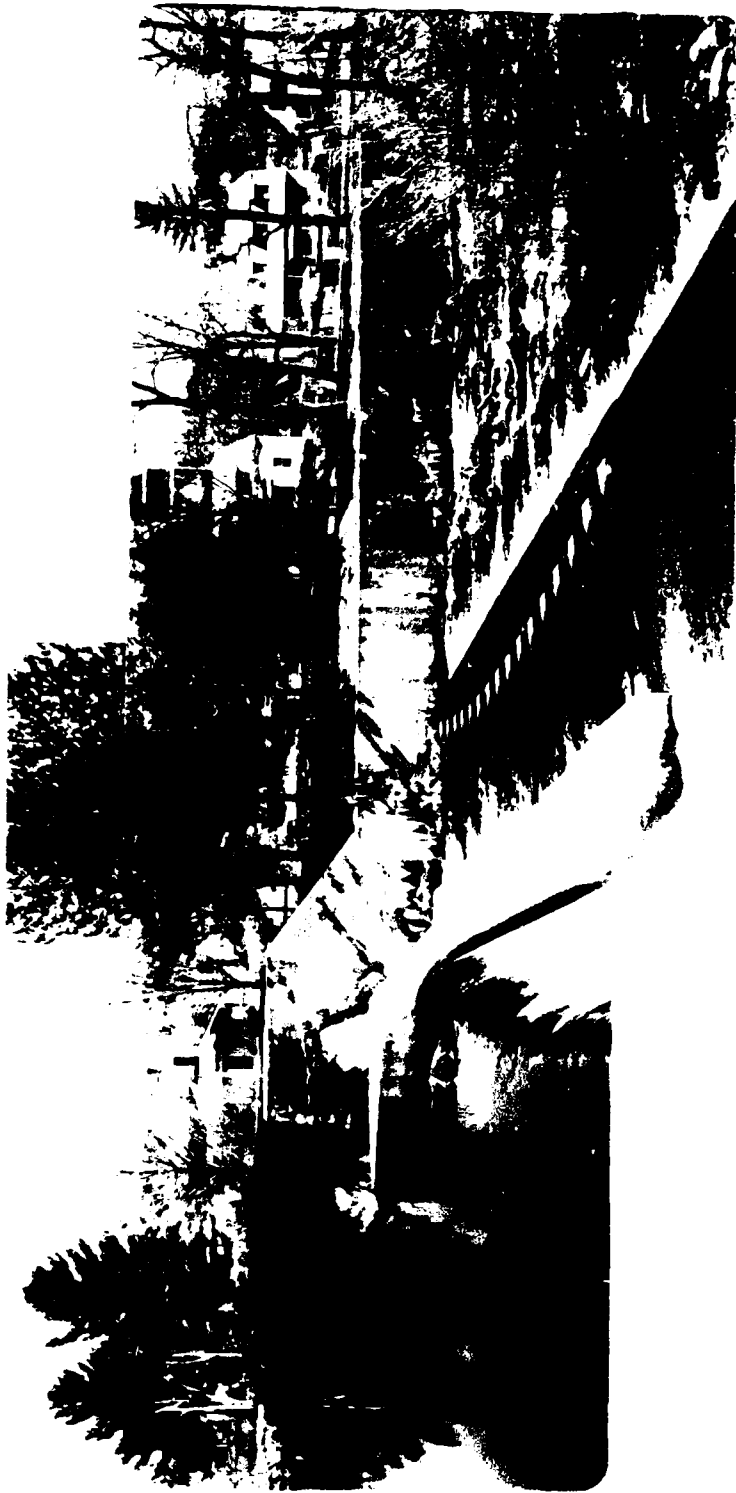
July 1978

SOUTH BARRE MILL POND
LIST OF AVAILABLE DOCUMENTS

| <u>DOCUMENT</u> | <u>CONTENTS</u> | <u>LOCATION</u> |
|--|--|---------------------------------------|
| "Details of Head Gate Wall Showing Changes and Additions", by Lockwood, Greene & Co., Boston, MA, 20 October 1914. | Blue Print showing mechanical and structural details. | Barre Wool Combing Co. |
| "Cross-Section of Mill Pond Dam", by M.J. Wyrwal, 29 July 1944. | Pencil drawing of section taken 21 ft. from south abutment. | Barre Wool Combing Co. |
| "Repairs to Dam", by H.M. Turner, 14 September 1944. | Original drawing of 1944 repair details. | Barre Wool Combing Co. (Appendix B-1) |
| "Specifications on Repairs to Dam", by H.M. Turner, undated. | Construction specifications for 1944 repairs, with 9 photos taken during construction. | Barre Wool Combing Co. |
| "Repairs to Dam at South Barre, Mass." by H.M. Turner, Journal of the Boston Society of Civil Engineers, October 1947. | Technical paper. (see text) | Published document. |
| Miscellaneous sketches, by H.M. Turner, undated. | Five pencil sketches of construction details. | Barre Wool Combing Co. |

APPENDIX C
SELECTED PHOTOGRAPHS OF PROJECT

| | | | | <u>Page No.</u> |
|----------------------|--|-------------|--------------|-----------------|
| <u>LOCATION PLAN</u> | | | | |
| Site Plan Sketch | | | | 1 |
| <u>PHOTOGRAPHS</u> | | | | |
| <u>No.</u> | <u>Title</u> | <u>Roll</u> | <u>Frame</u> | <u>Page No.</u> |
| 1. | Overview of Spillway and Right Embankment | 6 | 10 | v |
| 2. | Overview of Left Abutment | 6 | 11,12 | 2 |
| 3. | Overview of Right Abutment Showing Dam Embankment and Reservoir Drain | 6 | 1,2,3 | 3 |
| 4. | Upstream Side of Embankment Viewed from Reservoir Drain Platform | 6 | 13,14 | 4 |
| 5. | Right and Left Spillway Weirs Showing Center Pier | C11 | 9A | 5 |
| 6. | Reservoir Drain Outlet at Base of Right Spillway | C11 | 12A | 5 |
| 7. | Right Training Wall and Spillway Apron | C11 | 14A | 6 |
| 8. | Drain Pipe at Base of Right Training Wall, Sluiceway in Foreground (Pipe also shown at left side of Photo 7) | C11 | 16A | 6 |
| 9. | Left Spillway Weir | 6 | 8A | 7 |
| 10. | Downstream End of Left Training Wall | 6 | 7 | 7 |
| 11. | Intake for Outlet Works to Penstock and Concrete Wall Left of Intake | C5 | 18 | 8 |
| 12. | Gates for Outlet Works | C5 | 17 | 8 |



2. Overview of Left Abutment



3. Overview of Right Abutment Showing Dam Embankment and Reservoir Beach

30943 018 7-0

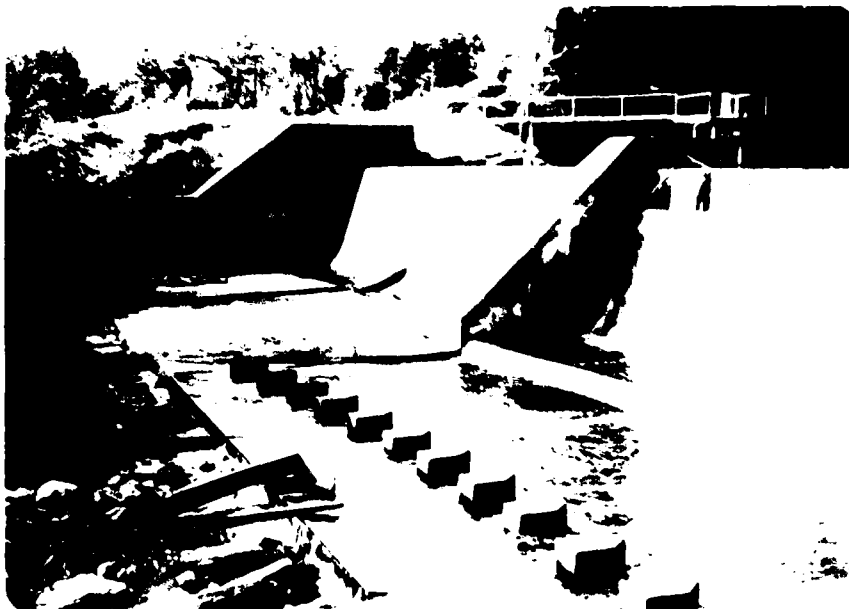


3. OVERVIEW OF RIGHT ABUTMENT SHOWING

APPENDIX 2-3



4. Upstream Side of Embankment Viewed from Reservoir Drain Platform



5. Right and Left Spillway Weirs Showing Center Pier



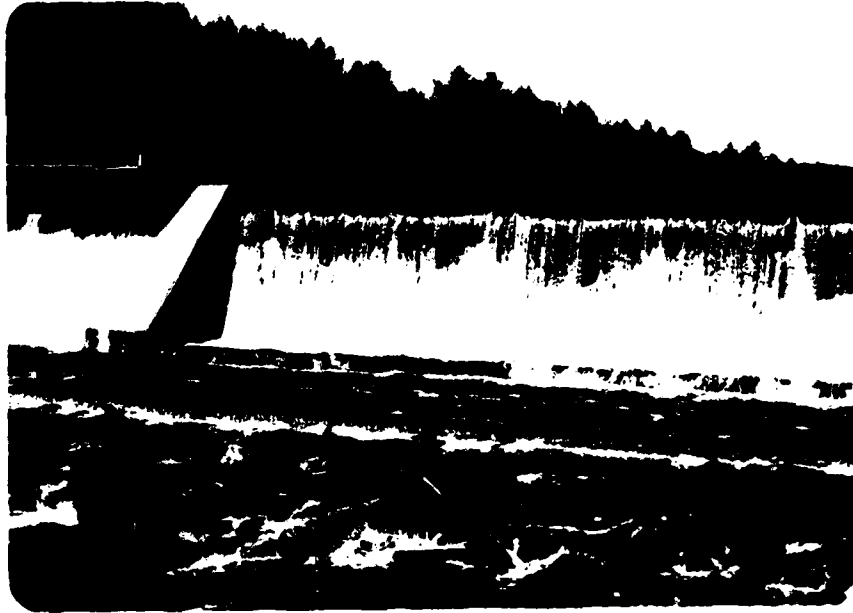
6. Reservoir Drain Outlet at Base of Right Spillway



7. Right Training Wall and Spillway Apron



8. Drain Pipe at Base of Right Training Wall,
Sluiceway in Foreground (Pipe also shown
at left side of Photo 7)



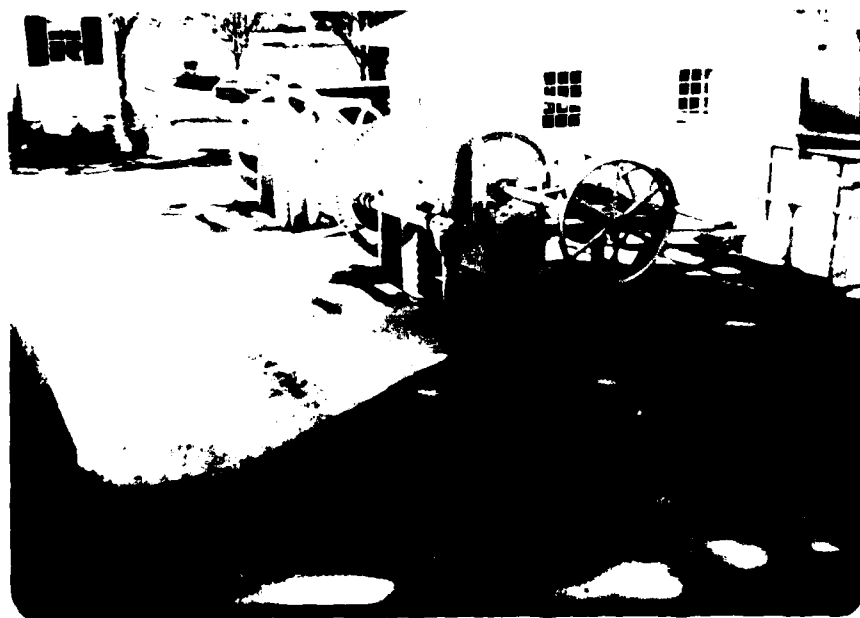
9. Left Spillway Weir



10. Downstream End of Left Training Wall



11. Intake for Outlet Works to Penstock and
Concrete Wall Left of Intake



12. Gates for Outlet Works

APPENDIX D
OUTLINE OF DRAINAGE AREA AND
HYDRAULIC COMPUTATIONS

Page No.

COMPUTATIONS

| | |
|---------------------------|---|
| Size Classification | 1 |
| Hazard Classification | 1 |
| Spillway Design Floods | 1 |
| Drainage Area | 1 |
| Maximum Probable Flood | 1 |
| Historical Floods | 1 |
| Stage-Discharge Relations | 2 |
| Reservoir Storage Map | 4 |
| Flood Routing | 5 |
| Hydrologic Data | 6 |
| Elevation Equivalents | 7 |
| Dam Failure Analysis | 8 |

OUTLINE OF DRAINAGE AREA

| | |
|-------------------|---|
| Drainage Area Map | 9 |
|-------------------|---|

SIZE CLASSIFICATION:

Height < 40 ft }
Storage < 1000 acre-ft } ∴ Category is SMALL

HAZARD POTENTIAL CLASSIFICATION:

Development is significant downstream of dam.
Economic loss due to dam failure would be considerable
high in terms of structural damage to housing
& industry
∴ Category is HIGH

SPILLWAY DESIGN FLOODS:

Hazard HIGH & Size SMALL → 1/2 PMF to PMF

Since the risk of loss of life is quite high due to
the closeness of downstream housing, the
Probable Maximum Flood will be used.

DRAINAGE AREA:

From RHW comp's: 64170 acres = 100.2 sq. mi.

MAXIMUM PROBABLE FLOOD:

Corps uses 60,000 cfs at Rate Falls Dam; D.A. = 85 sq. mi.
then 60,000 / 85 acres = 1,109 cfs/mi²

If same cfs/area applied, MPF at Rate Falls Dam would be
MPF = 100.2 mi² × 1,109 cfs/mi² = 111,222 cfs
however this is not valid since the Corps Flood Curve
will reduce the MPF.

Discussion w/ the Engineer of Corps suggests reduction
D.A. upstream of Rate Falls Dam.

Then MPF = (100.2 - 85) × 1,109 cfs/mi² = 50,125 cfs
then 30,000

HISTORICAL FLOODS (From BCE Report by H. Turner dated 10/15/57)

1936 Flood - 6,800 cfs - crest = 2.7 ft
1938 Flood - 15,300 cfs - crest = 2.5 ft

DAMP CRESSER & MCKEE
Environmental Engineers
Boston, Mass.

CLIENT NEW BEDFORD
PROJECT SOUTH SIDE DAM
DETAIL _____

JOB NO. _____
DATE CHECKED _____
CHECKED BY _____

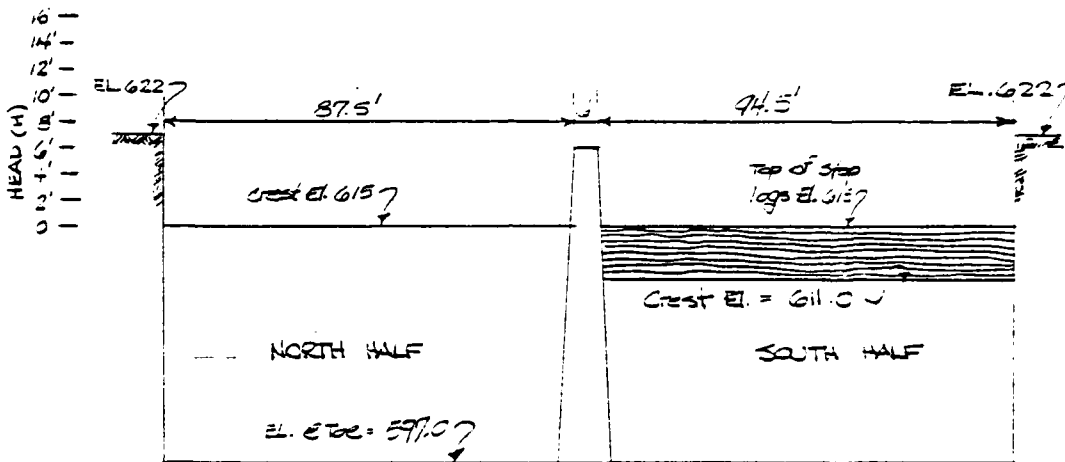
PAGE 2 OF 5
DATE 1/22/78
COMPUTED BY _____

NORTH OVERBANK

Assume 115 ft \pm EL. 622
 \pm C = 2.50

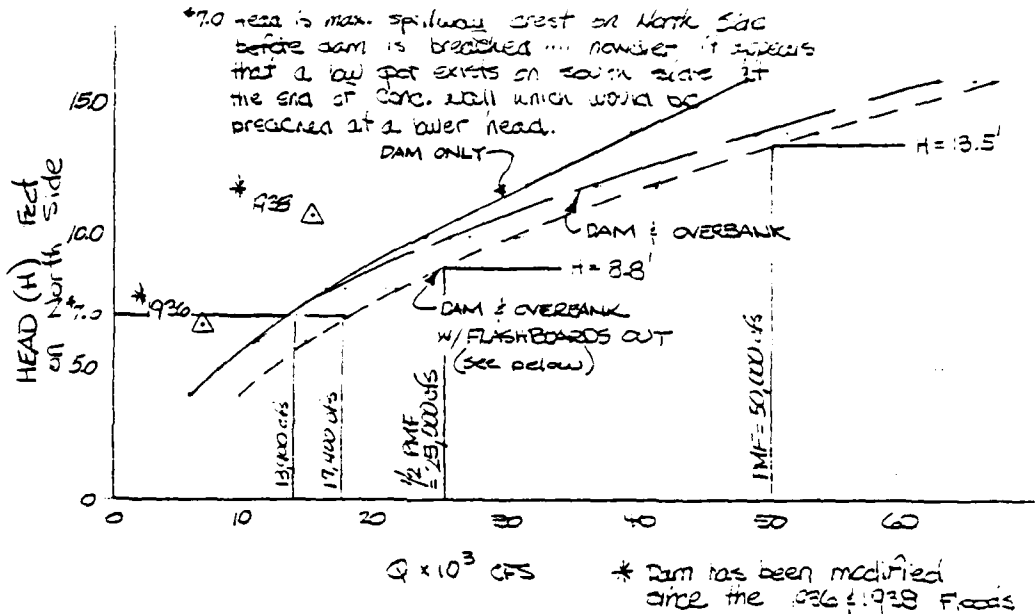
SOUTH OVERBANK

Assume 125 ft \pm EL. 622
 \pm C = 2.80



$Q = CLH^{3/2}$; North Half - Broad Crested, let $C = 3.40$
South Half - Sharp Crested, $n/p = 12/4 = 3$; $C = 4.1$

| W.S. CREST ELEV | H | DAM ONLY | | | DAM & OVERBANKS | | |
|-----------------|-------|----------|---------|---------|-----------------|---------|---------|
| | | North Q | South Q | TOTAL Q | North Q | South Q | TOTAL Q |
| 619.0 | 4.0' | 2,380 | 3,100 | 5,480 | | | |
| 621.0 | 6.0' | 4,372 | 5,694 | 10,066 | | | |
| 622.0 | 7.0' | 5,700 | 7,405 | 13,105 | | | |
| 623.0 | 8.0' | 6,964 | 9,045 | 16,009 | 7,252 | 9,395 | 16,647 |
| 625.0 | 10.0' | 9,730 | 12,643 | 22,373 | 11,224 | 14,462 | 25,686 |
| 627.0 | 12.0' | 12,790 | 16,617 | 29,407 | 16,000 | 20,530 | 36,530 |
| 629.0 | 14.0' | 16,118 | 20,940 | 37,058 | 21,443 | 27,423 | 48,866 |
| 631.0 | 16.0' | 19,673 | 25,554 | 45,227 | 27,756 | 35,034 | 62,790 |

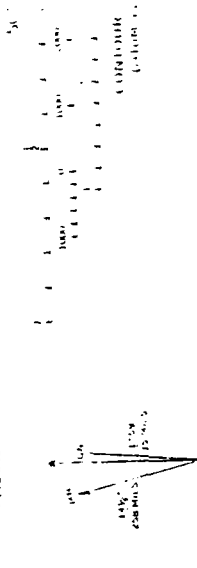
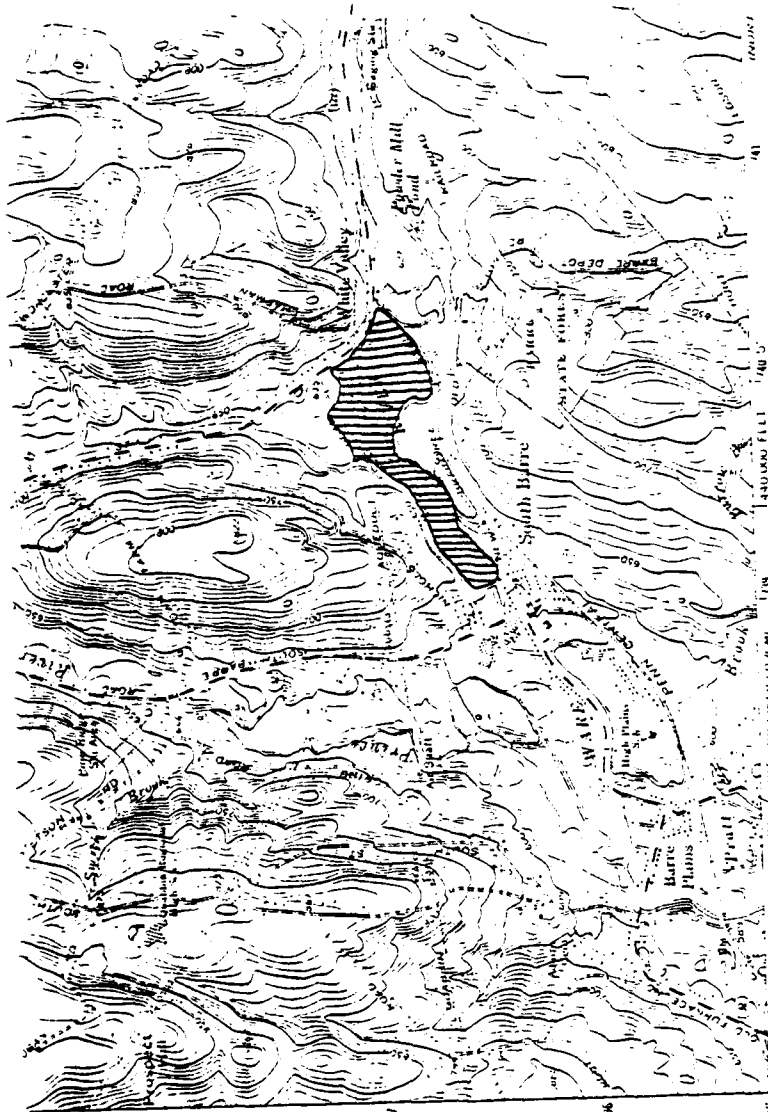


Note:

A+ PMS (50,000 cfs) Crest Elev. = 13.8 ft. above crest of dam and 6.5 ft. above overbank water embankment. Substantial flooding of dwelling units immediately downstream of dam will occur on both banks as a result of this over-topping of the coxks.

Assume stop logs are removed or washed out when $Q > 10,000$ cfs
'C' for South Half assumed as 3.40

| W.S. CREST ELEV. | HEAD (ft) | | North Q | South Q | TOTAL Q |
|------------------|-----------|-------|---------|---------|------------|
| | North | South | | | |
| 619.0 | 4' | 3' | 2350 | 7270 | 9650 cfs |
| 621.0 | 6' | 10' | 5372 | 15,160 | 20,532 cfs |
| 622.0 | 7' | 11' | 5700 | 17,000 | 22,700 cfs |
| 623.0 | 8' | 12' | 7252 | 14,130 | 21,382 cfs |
| 625.0 | 10' | 14' | 11,220 | 15,180 | 30,450 cfs |
| 627.0 | 12' | 16' | 16,500 | 25,120 | 41,620 cfs |
| 629.0 | 14' | 18' | 21,440 | 31,700 | 53,140 cfs |
| 631.0 | 16' | 20' | 27,450 | 39,100 | 66,550 cfs |



THIS MAP COMPRISES WITH
FOR SALE BY U.S. GEOLOGICAL
A FOLDER OF AERIAL PHOTOGRAPHS

Mapped, edited, and published by the Geological Survey
Control by U.S.G.S. 1886, 1885, and Massachusetts Geologic Survey
Topography by plane-table surveys 1943 and 1944. Revised from
aerial photographs taken 1963. Field checked 1969
Polyconic projection. 1927 North American datum.
10,000 foot grid based on Massachusetts coordinate system.
mountain zone
1000 meter Universal Transverse Mercator grid ticks.
Zone 18 shown in blue.
Fine red dashed lines indicate selected fence and field lines where
generally visible on aerial photographs. This information is uncheckd
Area covered by dashed light blue pattern is subject
to controlled inundation.

CREST ELEV. = 608.5 USGS

$$\text{SURCHARGE HT. @ PMF} = \frac{13.3'}{322.3 \text{ USGS}} \rightarrow \frac{4.7' \frac{1}{2} \text{ PMF}}{63.2 \text{ USGS}}$$
 SURFACE AREA @ ELEV. 620 = 72.5 ACRES
 STORAGE VOL. = 72.5 ACRES x 3.5 FT. = 1000 ACRES-FT.

+ 41

FLOOD ROUTING (USING CORPS Δ METHOD)

SURCHARGE STORAGE FOR PMF (50,000 CFS)

STEP 1: Peak Inflow (Q_{p1}) = 50,000 cfs

STEP 2a: Surcharge Height to Pass Q_{p1} = 13.5 ft.

2b: Volume of Storage (STOR₁) = 1,000 acre-ft. (AF)
 $1000 \text{ AF} / 53.3 \times 45.2 \text{ mi}^2 = 0.4 \text{ inches}$

2c: $Q_{p2} = Q_{p1} \times (1 - 0.4/19) = 50,000 \times .98 = 49,000 \text{ cfs}$

STEP 3a: Surcharge Height to Pass Q_{p2} = 13.7 ft.
STOR₂ = 1,000 acre-ft. = 0.4 inches

3b: $(\text{STOR}_1 + \text{STOR}_2) / 2 = 1000 \text{ AF}$
 $\therefore Q_{p3} = (50,000 + 49,000) / 2 = 49,500 \text{ cfs}$

SURCHARGE STORAGE FOR 1/2 PMF (25,000 CFS)

STEP 1: $Q_{p1} = 25,000 \text{ cfs}$

STEP 2a: Surcharge Ht. = 9.7'

STEP 2b: STOR₁ = 1000 acre-ft. = 0.4 inches

STEP 2c: $Q_{p2} = 25,000 \times .98 = 24,500 \text{ cfs}$

STEPS 3a & b: $Q_{p3} = (25,000 + 24,500) / 2 = 24,750 \text{ cfs}$

CONCLUSION:

Storage behind dam is insignificant in reducing
floods > 1/2 PMF

HYDROLOGIC DATA FROM LOGS: SEPT 1950 R.

SEPT. 1955 FLOOD PEAKS

At site of Barre Falls Dam: 8,000 cfs → 7,900 cfs
* routed to Coldbrook
At Coldbrook ----- 6,200 cfs
14,200 cfs

15,000 cfs @ South Barre Mill Dam Report by H.M. Turner
then 15,000 / 14,000 = 1.0714

* routing yields 200 / 8,000 = 2.5% reduction

Had Barre Falls Dam been "in" - flow at S. Barre Mill Dam would have been 6,200 x 1.0714 = 6,630 cfs

AUG. 1955 FLOOD PEAKS

At site of Barre Falls Dam: 1,120 cfs → 1,110 cfs
routed
At Coldbrook ----- 500 cfs
1,910 cfs

At S. Barre Mill Dam = 1,910 x 1.0714 = 2,050 cfs

Had Barre Falls Dam been "in" - 800 cfs x 1.0714 = 860 cfs

STANDARD PROJECT FLOOD

At site of Barre Falls Dam: 17,300 → 16,300 cfs
routed
At Coldbrook ----- 7,500
23,800 cfs

At S. Barre Mill Dam w/ Barre Falls Dam "in"
9,300 x 1.0714 = 10,180 cfs

SUMMARY - PEAK DISCHARGES AT S. BARRE MILL DAM (Assumes Barre Falls Dam "in")

1955 FLOOD - 800 cfs
1958 FLOOD - 6,630 cfs
SPF - 10,180 cfs

1/2 PMF = 25,000 cfs
PMF = 50,000 cfs

DAMP DRESSER & MCKEE
 Environmental Engineers
 Boston, Mass.

CLIENT ALEX S. BURKE
 PROJECT See on Page 1
 DETAIL _____

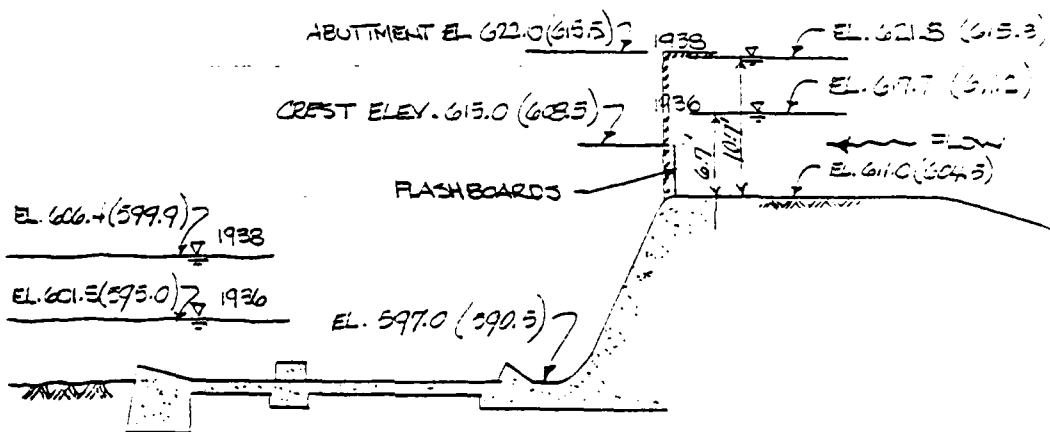
JOB NO. _____
 DATE CHECKED _____
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PAGE 7-3
 DATE 11-2-58
 COMPUTED BY ED

ELEVATION EQUIVALENTS

First number is as shown or reported by H.M. Turner - datum is unknown

Second number shown in () is USGS datum - derived from reported crest elev. of 608.5 in USGS's water supply paper 1420 "Floods of August - Oct. 1955 New England to North Carolina". This elev. assumed to be the upper crest (north half) as elev. contour 610 can be seen around pool. If 608.5 was lower crest (south half) then with 4' ft threshold $608.5 + 4 = 612.5 \rightarrow$ around 610.0 would not be seen.



NTS

DAMP DRESSER & MOKEE
Environmental Engineers
Boston, Mass

CLIENT WEST POINT
PROJECT DAM IMPROV
DETAIL SPILLWAY STUDY

JOB NO. DA-1987
DATE CHECKED _____
CHECKED BY _____

PLG# 5-11
DATE 7-2-78
COMPUTED BY ET

DAM FAILURE ANALYSIS

ESTIMATED STORAGE (S):

W.S. @ SPILLWAY EL. 615.0 SURFACE AREA = 1215 ACRES, DEPTH = 8'
VOL. = $\frac{1}{3} \times 1215 \times 8 = 3240 \text{ ACFT}$

W.S. @ TOP OF DAM EL. 622.0 SURFACE = 50 ACRES, DEPTH = 7'
VOL. = $\frac{1}{3} \times (22.5 + 50) \times 7 = 25 + 125 = 150 \text{ ACFT}$

W.S. @ 1/2 PMF EL. 623.5 SURFACE = 57 ACRES, DEPTH = 8'
VOL. = $\frac{1}{3} \times (50 + 97) \times 8 = 39 + 388 = 427 \text{ ACFT}$

PEAK FAILURE OUTFLOW (Q_p):

$$Q_p = 8/27 \times W_b \times (Y_0)^{3/2}$$

HEIGHT (Y_0) = 20 FT

LENGTH (RT. SIDE) = 100 FT, $W_b = 100 \times 40\% = 40'$

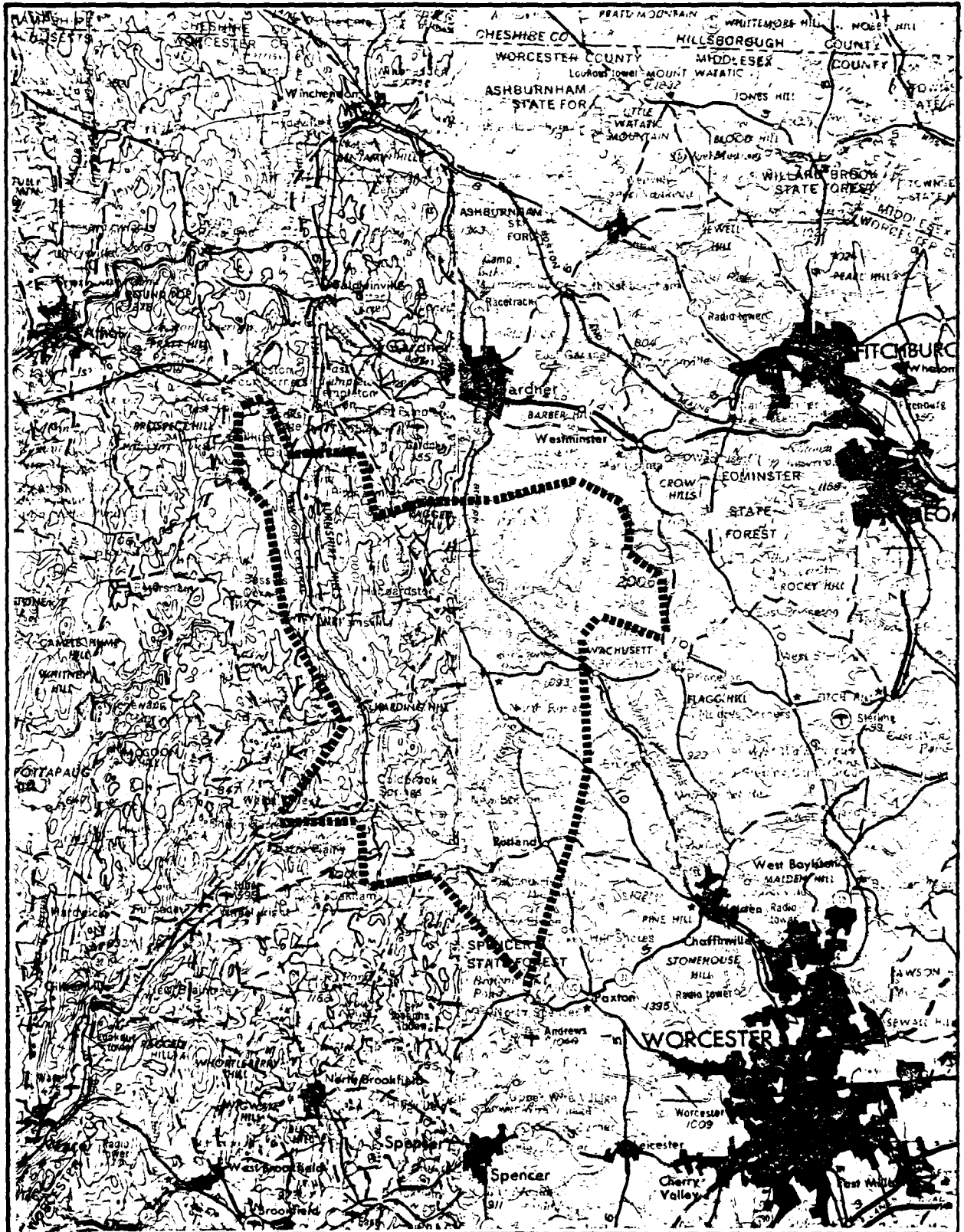
$$Q_p = 8/27 \times 40 \times (32.2)^{1/2} (20)^{3/2} = 4,000 \text{ CFS}$$

THE FLOOD OF MARCH 1936 WAS REPORTED TO HAVE BEEN
9,000 CFS AT A CREST EL. OF 617.7 AND A TAILWATER
ELEV. OF 601.5. SEPT. 1936 $Q_p = 15,000 \text{ CFS}$.

CONCLUSION:

IF THE DAM FAILED IN THE AREA OF THE SPILLWAY,
DOWNSTREAM FLOODING WOULD BE LESS THAN
THE HISTORICAL FLOODS OF 1936 & 1938 AND WOULD
NOT AFFECT THE HOUSING IMMEDIATELY DOWNSTREAM.

HOWEVER, SHOULD THE DAM FAIL ON THE RIGHT
SIDE, ABOVE THE MULTIFAMILY HOUSING, THE
POTENTIAL LOSS OF LIFE WOULD BE SEVERE.



CAMP DRESSER & McKEE Inc.
Consulting Engineers
Boston, Mass.



**SOUTH BARRE MILL DAM
 DRAINAGE AREA**

SCALE 1:250 000

APPENDIX D-9

APPENDIX E
INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

| | | | | | | |
|---------------------------|----------|--------|--------------|------------------|------------------|-------------|
| STATE | DIVISION | COUNTY | CONTRACT NO. | LATITUDE (NORTH) | LONGITUDE (WEST) | REPORT DATE |
| 4A | 91 NED | 02 | | 4223.2 | 7205.7 | 08SEP76 |
| NAME | | | | | | |
| SOUTH HARRE MILL POND DAM | | | | | | |

| | |
|--|------------------------------------|
| POPULAR NAME | NAME OF IMPOUNDMENT |
| SARRE MOOL POND | SOUTH HARRE MILL POND (HARE RIVER) |
| RIVER OR STREAM | |
| SOUTH HARRE | |
| NEAREST DOWNSTREAM CITY - TOWN - VILLAGE | POPULATION |
| SOUTH HARRE | 3983 |

| | | | | | | | | | | | | | | | |
|-------------|----------------|----------|--------|-----------|-----------------------|------|-----|-----|---|-----|-----|----|---|-----|---------|
| TYPE OF DAM | YEAR COMPLETED | PURPOSES | STATUS | HYDRAULIC | IMPOUNDING CAPACITIES | DIST | UN | FED | R | PRV | PED | SC | A | VER | DATE |
| RECTPG | 1904 | S | 25 | 18 | 369 | 135 | NED | N | N | N | N | N | N | N | 28AUG76 |

| |
|---------|
| REMARKS |
| |

| D/S | HAS | SPILLWAY | MAXIMUM DISCHARGE (CFS) | VOLUME OF DAM (CU FT) | POWER CAPACITY (KW) | INSTALLED | PROPOSED | NAVIGATION LOCKS |
|-----|-----|----------|-------------------------|-----------------------|---------------------|-----------|----------|------------------|
| 1 | 200 | C | 176 | 17400 | | | | |

| | | |
|-----------------------|----------------|-----------------|
| OWNER | ENGINEERING BY | CONSTRUCTION BY |
| SARRE MOOL CUMBING CO | M. N. TURNER | |

| | | | |
|--------|--------------|-----------|-------------|
| DESIGN | CONSTRUCTION | OPERATION | MAINTENANCE |
| NONE | NONE | NONE | NONE |

| | |
|-----------------------|--------------------------|
| INSPECTION BY | AUTHORITY FOR INSPECTION |
| MALEY & ALDRICH, INC. | PL 92-367 |

| |
|---------|
| REMARKS |
| |