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NASHUA RIVER BASIN  
FITCHBURG, MASSACHUSETTS

AD-A155 702

McTAGGARTS POND DAM  
MA 00879

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



DTIC  
JUN 24 1985  
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DEPARTMENT OF THE ARMY  
NEW ENGLAND DIVISION, CORPS OF ENGINEERS  
WALTHAM, MASS. 02154

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DECEMBER 1979

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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 Edward J. King  
 Governor of the Commonwealth of  
 Massachusetts  
 State House  
 Boston, Massachusetts 02133

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AUG 11 1980



Dear Governor King:

Inclosed is a copy of the McTaggart's Pond 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 Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Crocker Technical Paper Company, 431 Westminster Street, Fitchburg, Massachusetts 01420.

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 Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely,

*Max B. Scheider*  
 MAX B. SCHEIDER

Colonel, Corps of Engineers  
 Division Engineer

Incl  
 As stated

McTaggart's Pond Dam  
MA 00879

Nashua River Drainage Basin  
Fitchburg, Massachusetts

Phase 1 Inspection Report  
National Dam Inspection  
Program

National Dam Inspection  
Program

Phase I Inspection Report  
Brief Assessment

Identification No: MA 00879

Name of Dam: McTaggarts Pond

Town: Fitchburg

County and State: Worcester County, Massachusetts

Stream: Phillips Brook

Date of Inspection: November 28, 1979

The impounding facility at McTaggarts Pond is a 458-foot long, 23 foot high stone-earthfill structure with upstream and downstream concrete retaining walls. The date of construction of the original dam is unknown but it was substantially reconstructed in 1928 and repaired in 1956. The spillway which is a 158 foot long ungated broad crested weir has a crest at elevation (El) 636.0. The outlet structure, located adjacent to the spillway includes a discharge pipe to a mill downstream and a low level outlet.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on the visual inspection of the site, a review of available data, and a review of operating and maintenance procedures. Generally, the dam is in fair condition.

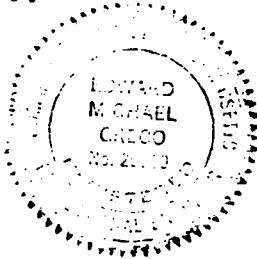
The following deficiencies were observed at the dam: Seepage at the toe of the downstream retaining wall; seepage through the joints in the concrete at the outlet structure; severe spalling of the concrete on the spillway side walls; bulging of a downstream retaining wall; displaced riprap and brush growing through the riprap; erosion on the top of the right (west) embankment section; and rubble, boulders and debris in the downstream channel.

MCTAGGARTS POND DAM

Based on the Corps of Engineers' guidelines, the dam has been classified in the "small" size and in the "high" hazard categories. The drainage area is 15 square miles. A test flood equal to 1/2 the probable maximum flood (PMF), was used for this analysis. The peak test flood inflow is estimated to be 8,060 cubic feet per second (cfs). The peak test flood outflow of 8,010 cfs with the pond at El 642.1 will overtop the dam by a maximum of 0.5 feet. Hydraulic analyses indicate that the spillway can discharge 6,910 cfs at El 641.6 which is the low point on the top of the dam. The spillway can discharge 86 percent of the test flood before the dam is overtopped.

It is recommended that the Owner employ the services of a qualified registered engineer to investigate the seepage at the outlet structure and at the toe of the downstream retaining wall and the bulging of the downstream retaining wall. The Owner should implement the recommendations by the consultant. In addition, the Owner should repair the deficiencies listed above and as described in Section 7.3. Also, the Owner should institute a technical inspection program and a written definite plan for the surveillance and warning system during periods of unusually heavy rains and/or runoff.

The measures outlined above and in Section 7 should be implemented by the Owner within a period of one year after the receipt of this Phase 1 Inspection Report.



Edward M. Greco, P.E.  
Project Manager  
Metcalf & Eddy, Inc.

Massachusetts Registration  
No. 29800

Approved by:

Stephen L. Bishop, P.E.  
Vice President  
Metcalf & Eddy, Inc.

Massachusetts Registration  
No. 19703



MCTAGGARTS POND DAM

This Phase I Inspection Report on McTaggart's 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.

Aramast Mahtesian

ARAMAST MAHTESIAN, MEMBER  
Geotechnical Engineering Branch  
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER  
Design Branch  
Engineering Division

Richard J. DiBuono

RICHARD DIBUONO, CHAIRMAN  
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 Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. 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 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 conditions and the downstream damage potential.

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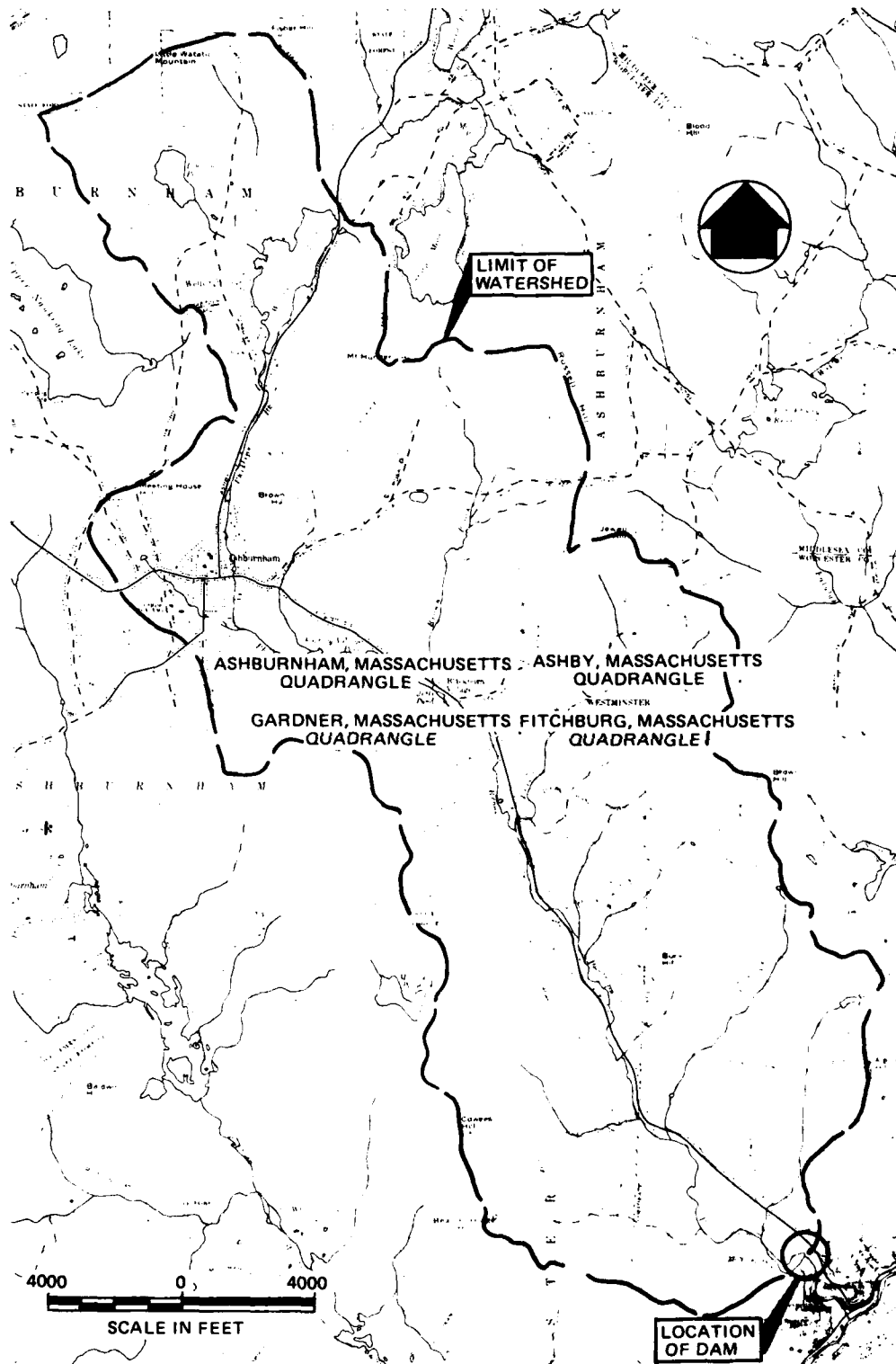
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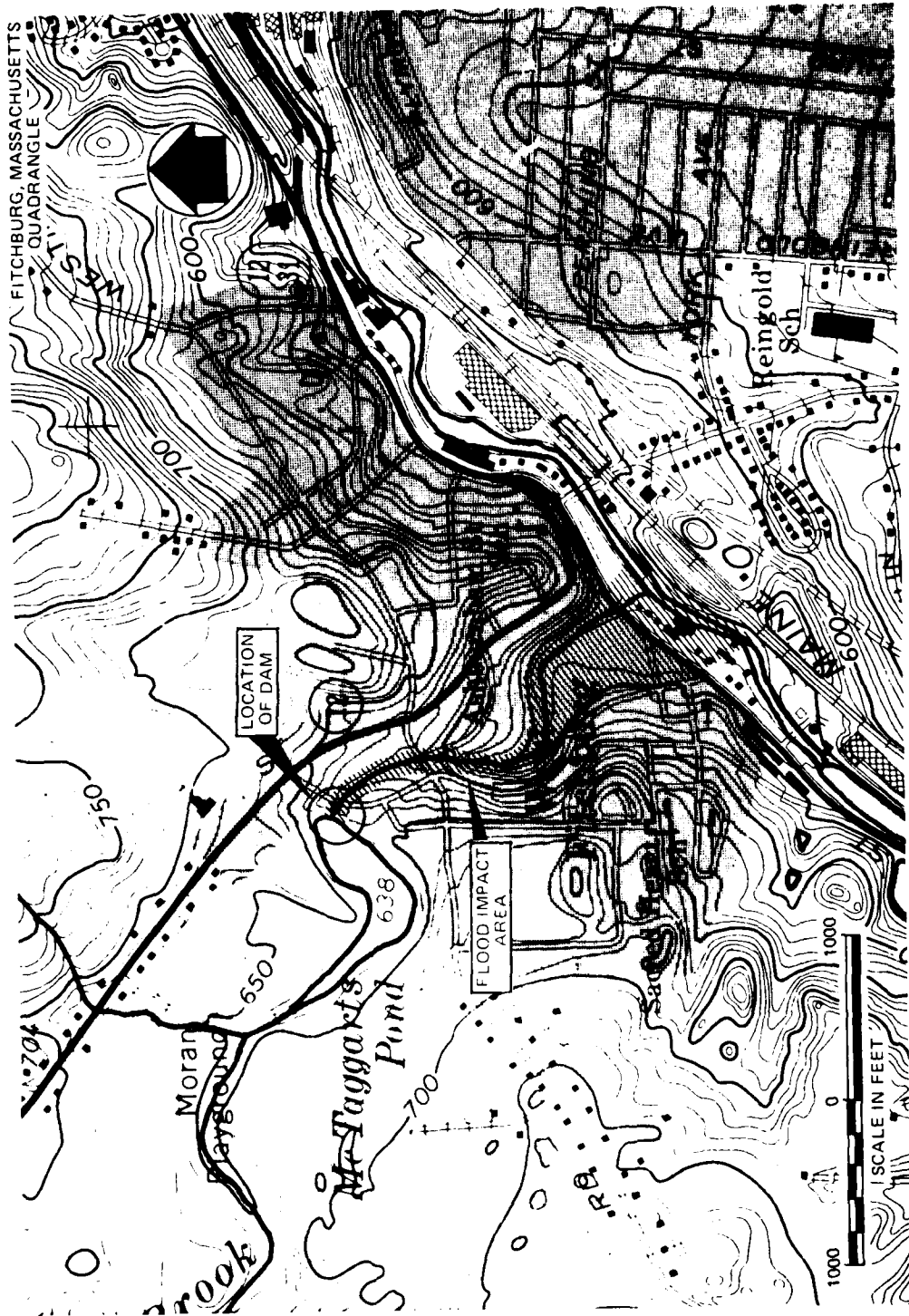
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**OVERVIEW  
McTAGGARTS POND DAM  
FITCHBURG, MASSACHUSETTS**





**LOCATION MAP - McTAGGARTS POND DAM**



FLOOD IMPACT AREA — McTAGGARTS POND DAM

NATIONAL DAM INSPECTION  
PROGRAM

PHASE I INSPECTION REPORT

MCTAGGARTS POND DAM

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, dated 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. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-79-C-0054, dated March 27, 1979, has been assigned by the Corps of Engineers for this work.
- b. Purpose:
- (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
  - (2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.
  - (3) Update, verify and complete the National Inventory of Dams.

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## 1.2 Description of Project

- a. Location. The dam is located on Phillips Brook, a tributary of the Nashua River (see Location Map) and lies entirely within the City of Fitchburg, Worcester County, Massachusetts. The coordinates of this location are latitude 42 deg. 34.7 min. north and longitude 71 deg. 50.6 min. west.
- b. Description of Dam and Appurtenances. The impounding facility at McTaggarts Pond Dam is a stone-earthfill structure with upstream and downstream concrete retaining walls. The dam is 458 feet long and a maximum of 23 feet high (see Appendix B, Figures B-1 through B-3 and Overview Photograph). The dam is comprised of an east and west embankment section on either side of a concrete spillway. The west (right) section, which is separated from the spillway by a gated concrete outlet structure, is approximately 230 feet long and 30 feet wide. The east (left) section is approximately 70 feet long and 17 feet wide. The upstream slopes of both embankments are protected with riprap. The downstream concrete retaining walls are battered at 1:7 (horizontal to vertical). The tops of the embankment sections are covered with grass. The maximum elevation of the west section is 641.7 feet and that of the east section is also 641.7 feet. Downstream of the west embankment is a 39-foot long stone masonry retaining wall. This wall, which is 10 feet high, is perpendicular to the dam axis. The wall has bulged outward at the top. Seepage was flowing at about 2 gallons per minute at the toe (see photographs No. 7 and No. 8 in Appendix C).

The spillway is a flat, broad crested weir constructed of concrete over stone-earth fill. The crest is 158 feet long and at El 636. The available drawings for the spillway show provisions for the installation of flashboards. However, the pipe sockets were not visible during the inspection and conversations with the representatives of the owner indicated that flashboards have not been used. The east (left) sidewall of the weir is

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concrete about 17 feet long and one foot thick. The west side wall which separates the spillway from the outlet channel is also concrete and is 18 feet long and 1 foot thick. Discharge is over the weir, down the face, and into a stream bed. Boulders, rubble, and debris have been deposited against the downstream spillway wall at roughly the center of the spillway. This fill extends halfway up the wall (see photograph No. 6).

There is a concrete intake structure located west of the spillway (see Figures B-2 and B-3 for details). A 29 foot long spillway training wall extends around the end of the dam embankment such that it also serves as an upstream retaining wall for the dam. A steel bar rack is located at the entrance to the intake channel (see photograph No. 5). The stream bed at the intake is at El 625.5 and the floor of the intake channel is at El 627. The intake channel as shown on the 1956 drawing (Figure B-3), has a 4.75 by 5.5 foot wooden slide gate that is operated by a rack and pinion mechanism. This mechanism is presently housed in a steel shed on a concrete slab above the outlet channel. The gate is reportedly operable. The invert of the slide gate in the outlet channel is at El 627. The opening at the slide gate is 5.0 feet wide and 4.6 feet high but it necks down to a 3.5 foot diameter discharge pipe at the outlet just 3.5 feet downstream of the gate. The 3.5 foot diameter pipe transitions to a 12-inch diameter pipe just downstream of the dam. This 12-inch pipe carries water to the Crocker Technical Paper Company mill further downstream. (see photograph No. 2). Approximately 1.5 feet east of the intake channel is the entrance of the low level outlet. The invert of the upstream low level outlet, which is 2.0 feet square, is at El 625.5. The downstream opening which is 2.79 feet high by 2.0 feet wide is at El 624.75. Flow from the low level outlet is directed by a low stone wall into Phillips Brook immediately downstream of the dam. The wooden gate for the low level

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outlet is equipped with a hook for lifting the gate. The gate was reportedly last opened in 1956 when repairs were made to the upstream face of the dam. Access to the slide gate, to the discharge pipe and the low level outlet is by a footpath along the western dam section.

- c. Size Classification. McTaggarts Pond Dam is classified in the "small" category since it has a maximum height of 25 feet and a maximum storage capacity of 112 acre-feet.
- d. Hazard Classification. The valley downstream of the dam is steep and in places the stream is incised into bedrock. The width of the valley varies from 140 feet at the dam to as little as 25 feet further downstream. In addition to the restriction imposed by the Sanborn Street bridge, there is a mill 700 feet downstream that spans the channel and restricts flow through an arched culvert.

Failure of the dam with the pond at El 636.0 would produce a backwater 26 feet high at the mill culvert. It is likely that this flood could result in significant property damage and possible loss of more than a few lives. Accordingly the dam has been placed in the "high" hazard category.

- e. Ownership. The dam is presently owned by the Crocker Technical Paper Company, 431 Westminster Street, Fitchburg, Massachusetts 01420. Mr. Gordon Cleveland (617-345-7771) granted permission to enter the property and inspect the dam.
- f. Operator. The dam is operated by personnel from the Crocker Technical Paper Company.
- g. Purpose of Dam. Water from McTaggarts Pond is used as process water in the manufacture of paper at the Crocker Mill located one half mile downstream. There is an abandoned generating station located on the bank of Phillips Brook adjacent to the Crocker Mill. This station was reportedly built in the late 1920's to supply electricity to the mill. It was abandoned in the late 50's or early 60's.

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Water to power this generator was drawn from the McTaggarts Pond by a cast iron discharge pipe line through a T-connection and valve at the mill. The valve was operated during the visual inspection by employees of the mill.

- h. Design and Construction History. The original dam at the site, which was built sometime before 1924, consisted of earthfill contained by upstream and downstream stone masonry retaining walls. The spillway had a sloping concrete face upstream and a vertical stone masonry wall downstream. According to an early inspection report there were two 3 foot by 5 foot discharge gates located in the outlet structure at the west end of the spillway. The inspection report of 1924, which is the first available, lists the owner as the American Woolen Company and states that the dam was abandoned.

In 1925 the Worcester County Commissioners acting through the County Engineers Office inspected the dam and subsequently ordered repairs to be made. These repairs are listed in the inspection reports of 1925 and 1926 when a follow-up inspection was completed (Figures B-11 and B-12).

The dam changed owners sometime between 1926 and 1928 after which the dam was reconstructed by the new owner, Crocker Burbank and Company. The details of the reconstruction are shown on Figure B-2.

Inspections of the dam were made periodically between 1928 and 1941 and describe the dam as in good condition. In 1943 a 3-inch layer of gunite was applied to the crest of the spillway. A new trash rack was installed a year later. Gunite was again applied to the dam in 1949, this time to the inside face of the eastern-most spillway section.

The 1955 inspection report (Figure B-13) noted that during a storm on October, 15, 1955, the eastern spillway abutment was above water

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whereas the western abutment was under water. Based on this information the Worcester County Engineer ordered the owners to raise the abutments and earth embankments 2.6 feet. Until these changes were implemented the owners were ordered to sand bag the embankments. The following year, the dam was repaired as ordered. A construction drawing detailing the work performed is included as Figure B-3 in Appendix B.

In 1961 the spillway crest was repaired using a 3-inch thick layer of gunite. The gunite was placed starting from a point 3 feet upstream of the crest and extending over the crest onto the downstream face by about 1 foot.

In 1975 the Massachusetts Department of Public Works inspected the dam and recommended repairs consisting of the investigation of seepage downstream of the gate house, repair of spalling side walls, repair of the downstream stone masonry retaining wall, and removal of brush and debris around the dam. The Phase I Inspection revealed that the brush had been removed but the debris downstream of the spillway was still there. The other recommendations have not been carried out.

- i. Normal Operational Procedures. The outlet gate to the discharge pipe just west of the spillway is reportedly operable. It is reportedly closed once a year to allow the line to be drained when the paper mill is shutdown for the Christmas holidays. The spillway is ungated and has no flashboards. The low level outlet was reportedly last used in 1956.

### 1.3 Pertinent Data

- a. Drainage Area. The drainage area for McTaggart's Pond is approximately 9,600 acres (15 square miles). Of this, 1,408 acres (2.2 square miles) are directly tributary to Winnekeag Lake at the head of the basin. Below Winnekeag Lake, Phillips Brook has an average slope of 1 percent. The drainage basin contains the town of Ashburnham but otherwise consists of hilly woodland that is sparsely inhabited.

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Only about 4 percent of the total drainage area is ponds and swamps.

- b. Discharge at the Dam Site. The outlet structure contains both the main outlet to the Crocker Mill and the low level outlet. Whereas the main outlet is closed once a year, the low level outlet was reportedly last used in 1956 while the dam was undergoing repairs. The entrance to the main outlet is 5.0 feet wide and 4.6 feet high but transitions down to a 3.5 foot diameter pipe with an invert at El 627.0. A 12-inch diameter pipe is connected to this pipe immediately downstream of the dam (see photograph No. 2) and transmits water to the Crocker Mill. At the entrance to the outlet structure, the low level outlet is 2 feet square. Thereafter, the bottom of the low level outlet slopes downward such that the outlet dimensions are 2.79 feet high and 2.0 feet wide (see Figure B-2). The low level outlet can discharge 58 cfs with the pond at El. 635.5.

Normal discharge at the dam site flows over the ungated 158-foot long spillway into the Phillips Brook stream channel (see Photograph No. 9). Flows have not been recorded at this site and therefore the maximum flood discharge is unknown. However, hydraulic calculations indicate the spillway can discharge 6,910 cfs when the water level is at El 641.6 which is the low point on the dam. During the test flood (1/2-PMF), the peak discharge would be 8,010 cfs with the pond at El. 642.1 which means the dam will be overtopped by 0.5 feet.

- c. Elevation (feet above National Geodetic Vertical Datum (NGVD)). A benchmark was established at El 636 on the crest of the spillway. This elevation was estimated from a 1956 construction drawing.

- (1) Top dam: 641.7
- (2) Test flood pool: 642.1

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- (3) Design surcharge (original design):  
Unknown
- (4) Full flood control pool: Not applicable  
(N/A)
- (5) Recreation pool: N/A
- (6) Spillway crest: 636.0
- (7) Upstream portal invert diversion tunnel:  
N/A
- (8) Stream bed at centerline of dam 618.0
- (9) Tailwater: 621.5

d. Reservoir

- (1) Length of maximum pool: 1,300 feet
- (2) Length of recreation pool: N/A
- (3) Length of flood control pool: N/A

e. Storage (acre-feet)

- (1) Test flood surcharge (total): 116 at El  
642.1
- (2) Top of dam: 112
- (3) Flood control pool: N/A
- (4) Recreation pool: N/A
- (5) Spillway crest: 69

F. Reservoir Surface (acres)

- \*(1) Top dam: 7.7
- \*(2) Maximum pool: 7.7
- (3) Flood-control pool: N/A
- (4) Recreation pool: N/A
- \*(5) Spillway crest: 7.7

\*Based on the assumption that the surface area will not significantly increase with changes in reservoir elevation from 636 to 642.1. 8

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g. Dam

- (1) Type: stone-earthfill with upstream and downstream concrete retaining walls
- (2) Length: West Section: 230 feet  
East Section: 70 feet
- (3) Height: 23 feet
- (4) Top width: West Section: 30 feet  
East Section: 17 feet
- (5) Side slopes: Upstream: 1 1/2:1  
Downstream: vertical  
(concrete wall)
- (6) Zoning: Unknown
- (7) Impervious core: Unknown
- (8) Cutoff: None shown
- (9) Grout curtain: Unknown

i. Spillway

- (1) Type: Broad crested weir - no flashboards
- (2) Length of weir: 158 feet
- (3) Crest elevation: 636.0
- (4) Gates: None
- (5) Upstream channel: concrete floor and sidewalls
- (6) Downstream channel: Downstream face of weir concrete. Below this is stone rubble over a natural stream bed.

- j. Regulating Outlets. The outlet to the discharge pipe at the dam is a 4.75 by 5.5 foot wooden slide gate located adjacent to the west end of the spillway. The outlet necks down to

MCTAGGARTS POND DAM

a 3.5 foot diameter stub conduit. From this stub a pipeline of varying sizes transmits the water to the plant (see Overview Photograph and photograph No. 2). The gate is reportedly used every winter. Also located in the outlet structure is a 2 x 2 foot low level outlet which has a wooden slide gate and an attached lifting ring. Reportedly this outlet was last used in 1956 (see photograph No. 5).

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## SECTION 2

### ENGINEERING DATA

2.1 General. Several drawings and previous inspection reports are available for McTaggart's Pond Dam. A drawing (Figure B-2) dated 1928 details the reconstruction of the dam to the previous dam. A 1943 drawing shows the concrete cap for the spillway. A drawing dated 1956 and a Technical Specification dated 1955 (Figures B-3 and B-4) detail how the abutment walls and embankments were to be raised. The remaining data available for this evaluation were visual observations made during inspection, review of previous inspection reports, and conversations with representatives of the owner.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Division of Waterways, the Worcester County Engineers Office, Mr. Gordan Cleveland and Mr. Donald Crocker of the Crocker Technical Paper Company.

2.2 Construction Records. The only construction records are the specifications and drawings referred to in Section 2.1 and included in Appendix B. There are no as-built drawings for the dam or appurtenant structures.

2.3 Operating Records. No operating records are available for the dam. No daily record is kept of pool elevation or rainfall at the dam site.

#### 2.4 Evaluation

- a. Availability. There is limited engineering data available for this dam.
- b. Adequacy. The lack of detailed structural data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on the review of available drawings and reports, review of past inspection reports, visual inspection, past performance history, and engineering judgment.

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- c. Validity. Comparison of the available drawings with the field survey conducted during the Phase 1 inspection indicates that the available information is valid. The elevations given on the drawings compare favorably with the elevations obtained during the Phase 1 inspection.

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## SECTION 3

### VISUAL INSPECTION

#### 3.1 Findings

- a. General. The Phase 1 Inspection of the dam at McTaggarts Pond was performed on November 28, 1979. A copy of the checklist is included in Appendix A. Previous inspections were conducted periodically by the Worcester County Engineers from the first recorded inspection in 1924 to 1964 after which the Massachusetts Department of Public Works took over the inspections. These inspection reports are given in Appendix B (see pages B-8 through B-15).
- b. Dam. The dam is in fair condition. There is minor spalling evident, with generally less than 1/4-inch penetration on most of the concrete wall surfaces which are located on the downstream side of the embankment sections. Heavy efflorescence was visible on the western downstream wall adjacent to the gate structure and at this location spalling had penetrated 1/2-inch into the face (see photograph No. 2).

The upstream slope of the dam is covered with riprap that has been displaced at the water line. Growing through the riprap are many small bushes that have been cut back but not removed (see photograph No. 1).

The downstream retaining wall located perpendicular to the right (west) embankment section has bulged at the top and is 4 feet out of plumb. It is braced in the area of the bulge with a rotting log (see photograph No. 7). At the bottom of this wall seepage is flowing at an estimated rate of less than 1 gpm. There was no evidence of piping or boils.

- c. Appurtenant Structures. Discharge from the pond is over a 158 foot long concrete spillway. There were no flashboards on the spillway. The crest of the spillway adjacent to

MCTAGGARTS POND DAM

the sidewalls appeared to be smooth with a minimum of spalling. However, at the spillway abutments there was severe efflorescence and spalling of concrete from the sidewalls along the waterline upstream of the crest and on the downstream face of the sidewalls. Spalling had penetrated over two inches in places but no steel reinforcing was visible. (see photographs No. 3 and No. 4). The downstream face of the spillway was not visible due to flow and because of boulders stacked against the wall. The boulders appear to have been dumped at the site however the reason for this is unknown. These boulders contained branches and other wood debris washed over the spillway (see photograph No. 6).

The outlet structure is located between the right (west) embankment section and the spillway. This structure can discharge water to the crocker Technical Paper Company mill via a pipe of varying materials and diameters. It also contains the low level outlet.

The entrance to the outlet has a steel slat trash rack that is slightly rusted. On the deck above the outlet, the channel is covered with a metal grate and a heavy steel plate. The upstream side of the deck is protected by a metal hand rail. Adjacent to the trash rack is the operating mechanism for the low level outlet. Only the section above the water line was visible and consisted of a board held in place by a metal guide attached to the concrete. The top of the board was equipped with a metal ring for lifting. The board was severely weathered and both the metal guide and ring were rusted (see photograph No. 5). The operating mechanism for the main outlet is housed in a metal shed that is bolted to the concrete deck. The operating mechanism is a hand operated ring and pinion gear mechanism that is rusted but reportedly operable.

On the downstream face of the outlet structure are several joints in the concrete from which a small amount of water is seeping. There is

MCTAGGARTS POND DAM

a minor amount of efflorescence associated with the seepage. Seepage is also emanating from the low level outlet and is flowing at approximately 1 to 2 gpm.

- d. Reservoir Area. The area around McTaggart's Pond consists of wooded hillsides that are sparsely developed with single family housing. Land on the both sides slopes down to the pond at about 9 percent.
- e. Downstream Channel. The channel is approximately 140 feet wide at the downstream edge of the spillway and narrows to about 42 feet at the Sanborn Street bridge located 85 feet downstream. The bottom and east bank of the discharge channel below the spillway are unlined. The west (right) bank is protected by a 3 1/2 foot high dry stone masonry wall down to the Sanborn Street bridge. This wall also serves to direct flow from the low level outlet into the stream channel. The bed of the drainage channel is partly covered with grass. The east and west banks support a modest growth of brush and small trees (see photograph No. 9).

Flow under the Sanborn Street bridge is through a divided opening which has a total area of 471 square feet. downstream of the bridge approximately 700 feet, the stream flows under a mill building and Westminster Hill road (see photographs No. 10 and No. 11). Under the mill is a concrete box culvert 16.5 feet wide and 11.5 feet high which changes to arched stone beneath the road. From there the water flows approximately 1,000 feet to the Nashua River.

- 3.2 Evaluation. The above findings indicate that the dam is in fair condition and that there are several deficiencies which require attention. Recommended measures to improve these conditions are stated in Section 7.3.

MCTAGGARTS POND DAN

## SECTION 4

### OPERATING PROCEDURES

- 4.1 Procedures. Personnel from the Crocker Technical Paper Company reportedly visit the dam daily. Normal operating procedures at the dam consist of leaving the slide gate open at the outlet structure and regulating flow to the mill by valves located downstream. Reportedly the slide gate is closed and opened at least once each year. The low level outlet was last used during reconstruction of the dam in 1956.
- 4.2 Maintenance of Dam. The dam was reconstructed in 1928 and received extensive repair work in 1956. Since then there has been deterioration of the concrete at the spillway sidewalls (see photographs No. 3 and No. 4) and an overall deterioration of the downstream retaining wall (see photograph No. 7). Generally the dam is not well maintained. However, the embankments are kept free of brush and the reservoir and downstream area of the spillway are cleared of debris twice a year. There is an extensive accumulation of boulders, rubble, and debris in the discharge channel immediately downstream of the spillway. Also, a few small trees and a moderate growth of brush have been allowed to grow on the banks of the downstream channel (photograph No. 9).
- 4.3 Maintenance of Operating Facilities. Only the downstream end of the outlet conduits, the slide gate operating mechanism, and the pulling ring and beam for the low level outlet were visible at the time of the inspection. The discharge pipe appears to be in good condition. The slide gate operating mechanism is slightly rusted but is reportedly operable. The low level outlet pulling ring and beam is heavily weathered wood with a steel loop bolted to the top. This outlet has not been used since 1956 (see photograph No. 5).
- 4.4 Description of Any Warning System in Effect. There is reportedly an informal warning system in effect at the dam. However, there are no written procedures for this warning system. We understand, through oral discussion, that the dam is

visited daily and more frequently during inclement weather. In the event of an emergency, the inspector would notify officials at the mill who would notify local officials.

- 4.5 Evaluation. Although personnel from the mill visit the dam regularly, the maintenance program is not adequate. There is no regular program of technical inspection or a written warning system posted at the mill. This is undesirable considering the dam is in the "high" hazard category. These programs should be implemented by the Owner, as recommended in Section 7.3.

## SECTION 5

### HYDRAULIC/HYDROLOGIC

#### 5.1 Evaluation of Features

- a. General McTaggarts Pond has a 15-square mile drainage area, 2.2 square miles of which are associated with Winnekeag Lake located upstream. Below Winnekeag Lake only 1 percent of the area is ponds and swamps (see Figure D-1, Drainage Area Map). The land is hilly, wooded and mostly undeveloped.

McTaggarts Pond Dam is a 23-foot high stone-earthfill dam with upstream and downstream concrete retaining walls. The dam was reconstructed in 1928 and repaired in 1956. The spillway is a 158-foot long, ungated, broad crested weir.

The low level outlet is a wooden slide gate adjacent to the west end of the spillway. The maximum opening provided by the slide gate is 2 feet wide and 2 feet high. This opening can discharge a flow of 58 cfs when the pond is at El 636.0, the elevation of the spillway. With the pond at El 636.0 and assuming no inflow, the outlet can lower the pond by 1 foot in about 2 hours.

- b. Design Data. There are no hydraulic or hydrologic computations available for the design of the spillway.
- c. Experience Data. Detailed hydraulic records are not kept for this dam. There are no records available for the storms in 1938 or 1955 and there is no record of the highest water level to date.
- d. Visual Observation. The dam consists of a spillway flanked by two embankments that extend into natural ground. Both the spillway and low level outlet discharge into the

MCTAGGARTS POND DAM

unlined stream channel of Phillips Brook. Discharge from the main outlet is through the discharge pipe to the mill and is controlled by a wooden slide gate.

- e. Test Flood Analysis. McTaggarts Pond Dam has been placed in the "small" size category and in the "high" hazard category. According to the Corps of Engineers' guidelines, a spillway design flood ranging between the one-half probable maximum flood (PMF) and the full PMF should be used to evaluate the spillway. In the following analysis the one-half PMF was used.

The PMF was selected as 1,150 cfs per square mile (CSM) for the section below Winnekeag Lake. This calculation is based upon the average slope of the drainage area of 1.2 percent, the pond-plus-swamp area to drainage area ratio of 1 percent, and the US Army Corp of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). A point between "Rolling" and "Flat and Coastal" was used to determine the peak flow rate. Applying the 1/2 PMF rate storm to the 13 miles of drainage area below Winnekeag Lake results in a calculated peak flood flow of 7,400 cfs as the inflow test flood. In addition, flow is contributed from Winnekeag Lake located upstream approximately 8 miles. In the test flood analysis there is a 1.9 hour time delay before water flowing over the spillway from Winnekeag Lake reaches McTaggarts Pond. At that time it will contribute 660 cfs additional flow for a total test flood inflow to McTaggarts Pond of 8,060 cfs. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 8,010 cfs with a water surface at 642.1.

During the test flood, the dam would be overtopped by a maximum of 0.5 feet with discharge over the crest at 0.9 cfs per foot. The depth at critical flow would be 0.3 feet, with a velocity of 3.1 feet per second. Total crest flow would be over 190 cfs.

MCTAGGARTS POND DAM

f. Dam Failure Analysis. Hydraulic calculations indicate the spillway can discharge 6,910 cfs with the pond at El. 641.6 which is the low point on the top of the dam. This amount of flow would produce a backwater 15.3 high behind the Sanborn Street bridge and 31.6 feet high at the Mill culvert. Failure of the dam at maximum flow would produce a flow of 9,500 cfs and would cause the backwater to rise an additional 1.4 feet at the Sanborn Street bridge and 3.8 feet at the culvert under the factory.

In either case the bridge and mill would be inundated resulting in severe damage and possible loss of life. For this reason the dam has been placed in the "high" hazard category.

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## SECTION 6

### STRUCTURAL STABILITY

#### 6.1 Evaluation of Structural Stability

- a. Visual Observations. The evaluation of the structural stability of McTaggart's Pond Dam is based on a review of available drawings, a review of previous inspection reports, and the visual inspection conducted on November 28, 1979.

As discussed in Section 3, Visual Inspection, the dam is considered to be in fair condition due to seepage at the downstream retaining wall and at the outlet structure, the bulging of the downstream retaining wall, and the severe spalling of concrete at the spillway side walls.

- b. Design and Construction Data. A drawing for the reconstruction of McTaggart's Pond Dam was approved in 1928 and the work was completed in October of that year. The drawing indicates that the original dam section consisted of earthfill between vertical upstream and downstream stone walls. The crest of the dam was also covered with stone. The spillway section had a vertical downstream stone wall and a sloping upstream wall made of stone but covered with concrete. An earlier low level outlet was located near the center of the spillway. There is little information available on the design of the original outlet structure.

The 1928 reconstruction included concrete walls placed against the existing stone walls at both the embankment sections and the spillway. According to the drawing (Figure B-2 Appendix B) the foundation was to be "carried to ledge, hardpan, or other good material". Fill was placed between the walls at the abutments and new concrete was placed on the crest of the spillway. The outlet structure was modified and refurbished including

MCTAGGARTS POND DAM

relocating the low level outlet from the spillway to the outlet structure. In addition, riprap was placed against the upstream slopes of the abutments.

In 1956, at the direction of the Worcester County Engineers, the dam was raised an additional 2.5 feet by adding concrete cap walls on to the existing walls and placing new fill in between. A plan for this work is shown as Figure B-3 in Appendix B.

- c. Operating Records. There is no evidence of instrumentation of any type in McTaggart's Pond Dam, and there is nothing to indicate that any instrumentation was ever installed at this dam. The performance of this dam under prior loading can only be inferred from physical evidence at the site.
- d. Post-Construction Changes. Since the reconstruction in 1928 there have been periodic repairs to the concrete on the spillway crest. In 1944 the trash rack was replaced. In 1956, at the direction of the Worcester County Engineers, the dam was raised an additional 2.5 feet by adding concrete cap walls on to the existing walls and placing new fill in between. A plan for this work is shown as Figure B-3 in Appendix B.
- e. Seismic Stability. The dam is located in Seismic Zone 2 and does not warrant further seismic analysis at this time.

## SECTION 7

### ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

#### 7.1 Dam Assessment

- a. Condition. Based upon a review of available data, the visual inspection of the site, and limited operational or maintenance information, there are deficiencies which must be corrected to assure the continued performance of the dam. Seepage was observed both at the bottom of the downstream retaining wall and through several joints in the concrete at the outlet structure (see photographs No. 3 and No. 4). Heavy efflorescence was noted on the downstream wall of the western abutment immediately adjacent to the outlet structure (see photograph No. 2). The riprap has been displaced and in some areas on the western embankment it has slumped.

Hydraulic analyses indicate that the spillway can discharge an estimated flow of 6,910 cfs with the reservoir at El 641.6 which is the low point on the top of the dam. An outflow test flood of 8,010 cfs 1/2-PMF will overtop the dam by 0.5 feet. The spillway can discharge 86 percent of the test flood before the dam is overtopped.

- b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on a review of the available data, the visual inspection, past performance and engineering judgment.
- c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within one year after receipt of this Phase 1 Inspection Report.
- d. Need for Additional Investigation. Additional investigations to further assess the adequacy of the dam and spillway are outlined below in Section 7.2, Recommendations.

MCTAGGARTS POND DAM

7.2 Recommendations. It is recommended that the Owner employ a qualified registered engineer to:

- a. Investigate the seepage at the outlet structure and at the toe of the downstream retaining wall.
- b. Investigate the bulging of the downstream retaining wall.
- c. Inspect the dam and spillway under no flow conditions.
- d. Investigate the boulders at the downstream toe of the spillway.

The Owner should implement the recommendations of the consultant.

7.3 Remedial Measures

a. Operating and Maintenance Procedures

It is recommended that the owner accomplish the following:

- (1) Repair the spalled concrete on the spillway sidewalls.
- (2) Maintain the low level gate in operating condition and provide a channel from the outlet to the stream channel.
- (3) Remove all brush and debris from the spillway discharge channel.
- (4) Replace missing or dislodged riprap from the upstream face of the dam.
- (5) Remove all brush from the dam and backfill any excavations with selected material.
- (6) Institute a written definite plan for the surveillance and warning system during periods of unusually heavy rains and/or runoff.

- (7) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances, supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in accordance with applicable State regulations.
- (8) Conduct periodic technical inspections of this dam on an annual basis.

7.4 Alternatives. There are no recommended alternatives.

APPENDIX A  
PERIODIC INSPECTION  
CHECKLIST

MCTAGGARTS POND DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT McTaggarts

DATE 11/28/79

TIME AM

WEATHER clear 60's

W.S. ELEV. 636.1\* U.S. 621.5\* DN.S.

PARTY:

\*Based on benchmark at El.636 located on crest of spillway at west abutment

- 1. M. Larson
- 2. S. Nagel
- 3. W. Checchi
- 4. L. Taverna
- 5. \_\_\_\_\_

- 6. \_\_\_\_\_
- 7. \_\_\_\_\_
- 8. \_\_\_\_\_
- 9. \_\_\_\_\_
- 10. \_\_\_\_\_

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Dam Embankment</u>	<u>Larson/Nagel</u>	
2. <u>Spillway</u>	<u>Larson/Nagel</u>	
3. <u>Intake and Outlet Works</u>	<u>Larson/Nagel</u>	
4. _____		
5. _____		
6. _____		
7. _____		
8. _____		
9. _____		
10. _____		

PERIODIC INSPECTION CHECK LIST

PROJECT McTaggart's Pond DATE 11/28/79

PROJECT FEATURE Dam NAME M. Larson

DISCIPLINE NAME S. Nagel

L/S = Left Side U/S = Upstream  
R/S = Right Side D/S = Downstream

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	636.0
Current Pool Elevation	636.1
Maximum Impoundment to Date	Unknown
Surface Cracks	none visible in soil-some rutting of soil
Pavement Condition	unpaved top of dam - path worn on top of dam right side by foot & vehicle traffic
Movement or Settlement of Crest	L/S none visible R/S none visible
Lateral Movement	L/S none visible R/S none visible
Vertical Alignment	L/S slopes gently toward spillway R/S very slightly undulating
Horizontal Alignment	L/S straight R/S constructed with d/s bend
Condition at Abutment and at Concrete Structures	L/S ties into natural ground R/S ties into d/s stone masonry wall
Indications of Movement of Structural Items on Slopes	Link fence on left abutment in poor condition R/S none visible
Trespassing on Slopes	L/S some light trespassing on slopes-R/S rutting from foot & vehicle traffic on crest
Sloughing or Erosion of Slopes or Abutments	some erosion on R/S from foot traffic along U/S face & crest
Rock Slope Protection - Riprap Failures	L/S riprap in place-brush growing through-seepage from hillside below abutment-R/S sloughing of riprap throughout slope brush growing in riprap trimmed back
Unusual Movement or Cracking at or near Toes	none visible
Unusual Embankment or Downstream Seepage	some seepage at L. abutment apparently from hillside. Heavy seepage at R. abutment below D/S stone masonry retaining wall
Piping or Boils	none visible
Foundation Drainage Features	none visible
Toe Drains	none visible
Instrumentation System	none

PERIODIC INSPECTION CHECK LIST

PROJECT McTaggarts DATE 11/28/79

PROJECT FEATURE Outlet Channel NAME M. Larson

DISCIPLINE \_\_\_\_\_ NAME S. Nagel

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL</u>	
General Condition of Concrete	Good
Rust or Staining	Only adjacent to steel structures
Spalling	Very minor
Erosion or Cavitation	None visible
Visible Reinforcing	None
Any Seepage or Efflorescence	None visible on top slight seepage below-grass growing on ledge where <del>seepage occurs</del>
Condition at Joints	Good on top some spalling & cracking d/s face
Drain Holes	None visible
Channel	Pipe main outlet low level filled with trash & debris
Loose Rock or Trees Over- hanging Channel	Some brush
Condition of Discharge Channel	Stone wall d/s deteriorated brush, logs, debris in channel

PERIODIC INSPECTION CHECK LIST

PROJECT McTaggarts Pond DATE 11/28/79

PROJECT FEATURE Intake Channel NAME M. Larson

DISCIPLINE \_\_\_\_\_ NAME S. Nagel

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u> a. Approach Channel	
Slope Conditions	vertical concrete angle wall on right side
Bottom Conditions	submerged
Rock Slides or Falls	N/A
Log Boom	N/A trash rack of vertical steel plates slightly rusted - rotting wood frame
Debris	slight amount in front of rack and inside rack
Condition of Concrete Lining	good - only slight amount of spalling
Drains or Weep Holes	N/A
b. Intake Structure	Vert. concr. side walls w/rounded corner protected by metal plate & grating
Condition of Concrete	Good - minor spalling
Stop Logs and Slots	Slots for stoplogs but no stoplogs

PERIODIC INSPECTION CHECK LIST

PROJECT McTaggarts Pond DATE 11/28/79  
 PROJECT FEATURE Spillway Weir NAME M. Larson  
 DISCIPLINE \_\_\_\_\_ NAME S. Nagel

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	Concrete training walls-concrete spillway.
General Condition	Submerged
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Leftside U/S some small trees on shoreline.
Floor of Approach Channel	Submerged
b. Weir and Training Walls	
General Condition of Concrete	*L/S heavy spalling at water line and at corners. R/S heavy spalling at corners
Rust or Staining	L/S from fence posts in concrete R/S none
Spalling	Left training wall heavy spalling along water line
Any Visible Reinforcing	Reinforcing exposed in L/S and R/S walls in areas of heavy spalling.
Any Seepage or Efflorescence	Adjacent to spillway on R/S D/S wall
Drain Holes	None visible
c. Discharge Channel	
General Condition	Fair
Loose Rock Overhanging Channel	loose stone from D/S wall along edges but not overhanging channel
Trees Overhanging Channel	some trees on L/S 6 to 12 inches
Floor of Channel	grass and brush growing in channel
Other Obstructions	some logs

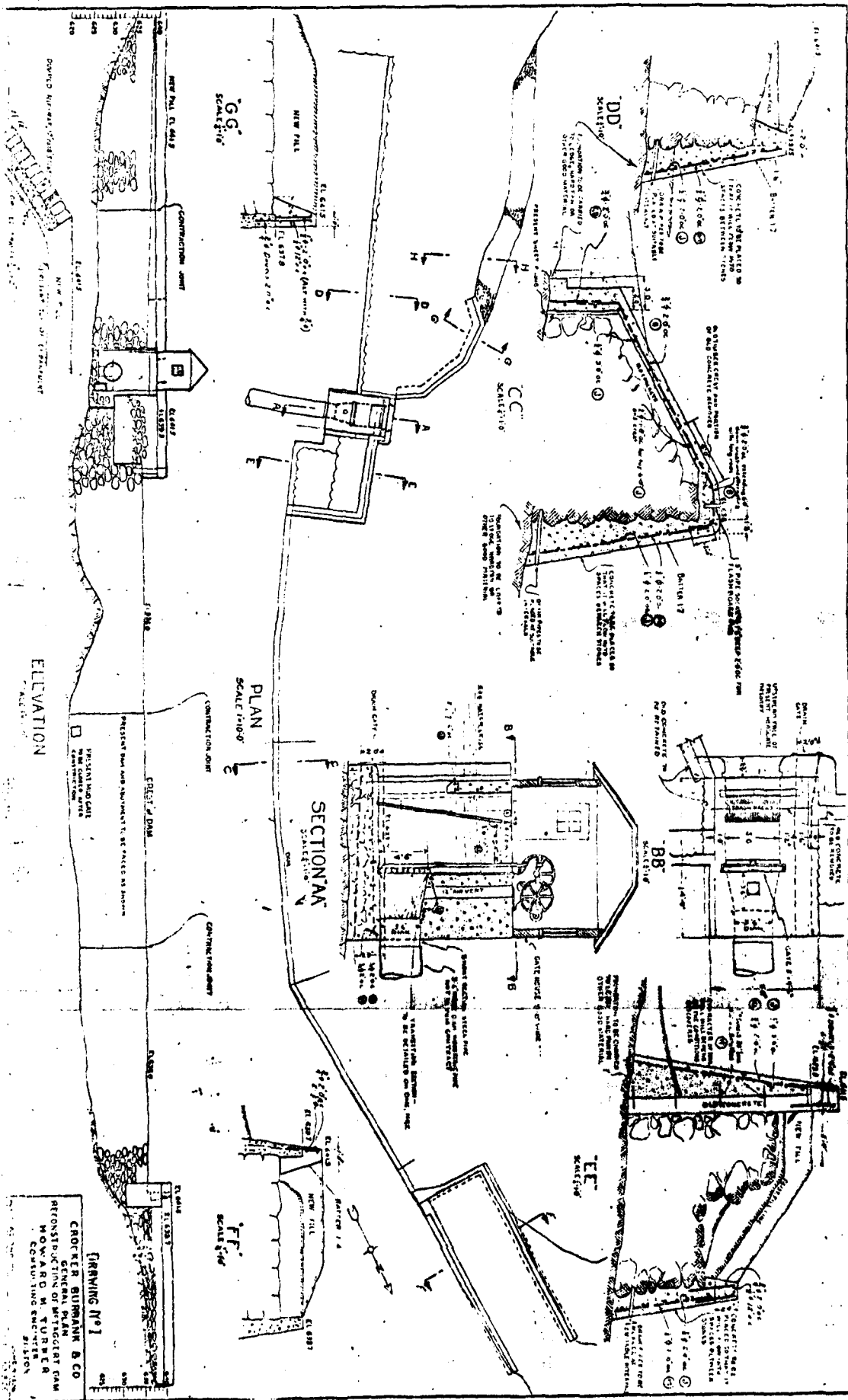
\*Spalling of d/s weir face widespread.

APPENDIX B  
PLANS OF DAM AND PREVIOUS  
INSPECTION REPORTS

	<u>Page</u>
Figure B-1 Plan of Dam	B-1
Figure B-2 1928 Reconstruction Drawing	B-2
Figure B-3 1956 Repair Drawing	B-3
Figure B-4 Technical Specification for 1956 Repair Work	B-4
Figure B-5 Previous Inspections (Partial Listing)	B-7

MCTAGGARTS POND DAM





[DRAWING No. 1]  
 GROFFER, GUINMAN & CO.  
 ARCHITECTS  
 REVISION OF MITCHELL PLAN  
 HOWARD M. TURNER  
 CONSULTING ENGINEER  
 DIVISION



January 11, 1956

CROCKER, BURBANK & CO. ASSCN.

SPECIFICATIONS

FOR REPAIRS

McTAGGART DAM AT FITCHBURG

These specifications cover various repairs on the McTaggart Dam by the Crocker, Burbank & Co., Asscn., Fitchburg, Massachusetts. This generally consists of the following:

1. On the south abutment, raise the upstream and river abutment walls and the additional fill behind them up to their new level.
2. On the north abutment, raise the abutment wall with a new concrete wall and fill behind it up to the level shown. Raise the embankment north of this north abutment wall and provide rip-rap on the river face of it.
3. On the small abutment south of the gate house, raise the walls on both the river and downstream sides and fill as shown.

All work is to be done in accordance with these specifications and the plans prepared by Howard M. Turner, Consulting Engineer of Boston. The plans and specifications and construction of the dam are subject to the approval of the County Commissioners of Worcester County or their appointed engineer, as provided in Chapter 253 of the General Laws. The County Commissioners of Worcester County are to be notified before work is commenced. All work is subject to inspection and approval by the County Engineer of Worcester County.

These specifications are intended to describe the character of the work to be done. The nature of the work is such that the construction required may have to be decided upon during the progress of the work, and the work shall be done in accordance with instructions and such further plans which will be furnished as required to illustrate the work during its progress.

Fill

Filling on the downstream side of the north abutment near the gate house shall be a fine sand. The remainder of the fill shall be sand or gravel. Before placing fill, existing turf shall be removed. Fill is to be placed in level layers not over 1 ft. in thickness. Top of fill is to be loamed and seeded.

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### Rip-Rap

Under the new rip-rap on the north embankment, there shall be placed a layer of gravel 1 ft. thick. The rip-rap will be dumped in, and the line smoothed out by hand.

### Concrete

The various concrete walls shall be constructed of ready-mixed concrete furnished by an accredited dealer. All concrete shall be 3,000-lb. classification.

### Placing

All concreting shall be done in the dry and the water shall be excluded from the area where work is in progress by means of cofferdams, or other approved methods.

The surface of the wet concrete in the forms shall be kept approximately level at all times. Care shall be taken that no pockets of stone without mortar exist. The concrete shall be spaded back from the surface of the forms to bring the finer material to the surface and it shall be so placed that where it comes in contact with masonry it shall flow into and fill the spaces between the stones.

Great care shall be taken in the placing of concrete that the scum or "laitance" from the cement shall not be mixed with the concrete but is removed or allowed to collect in one place and not become a part of the concrete.

Where concrete is placed on top of other concrete already set, the top of the old concrete shall be thoroughly cleaned of all dirt, loose material and scum or "laitance". All smooth places shall be roughened up and the whole surface washed and brushed. It shall be thoroughly wet before new concrete is placed on it.

The tops of the walls and of the dam shall be carefully screeded to grade and troweled smooth with a steel trowel.

All forms shall be carefully built true to line and grade and tight enough so that the water does not leak out while the concrete is being poured. They shall be watched during concreting to see that they are not displaced.

All forms are to be of lumber dressed on the inside where used on exposed surfaces. Lumber that is in good condition may be used more than once but if used on exposed surfaces it shall be carefully cleaned before being again erected. All roughness shall be removed so that the form will present a smooth and even surface. Forms shall not be removed until the concrete has thoroughly set.

Concrete from which the form has been removed shall be kept wet from 3 to 6 days. After removal of forms, all stone pockets in the concrete shall be dug out and refilled with good concrete or mortar the same day.

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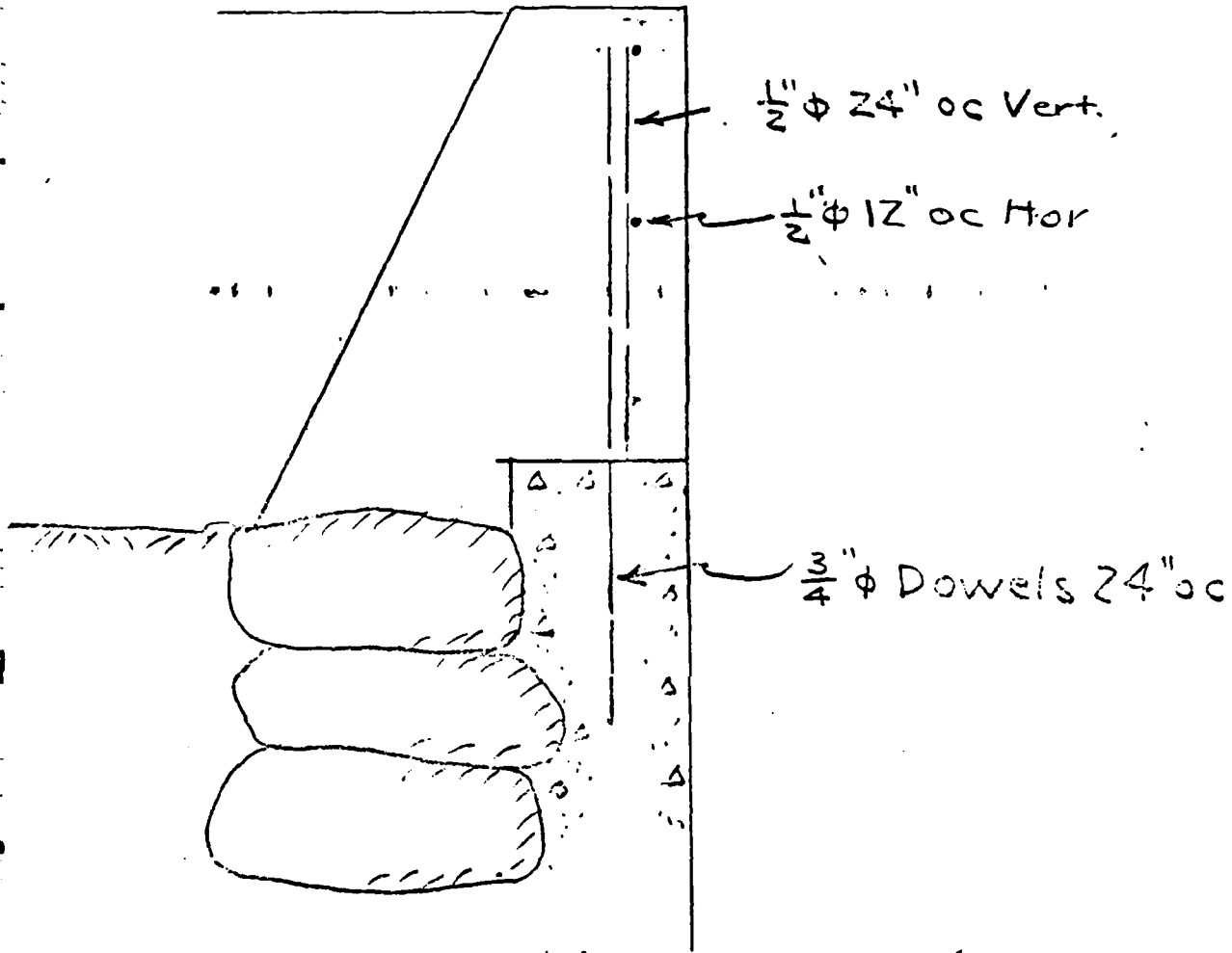
### Reinforcing Steel

Where shown on the plans steel reinforcement shall be furnished by the Contractor and embedded in the concrete as shown. This reinforcement is to consist of deformed bars which shall fulfill the requirements for the intermediate or structural grade of the Standard Specifications of the American Society of Testing Materials for Billet Steel Concrete Reinforcement Bars, Serial Designation A-15-30. It shall be bent as shown and securely wired to prevent displacement during concreting. All rust scales shall be removed before the steel is placed in the forms.

The lap of reinforcing bars shall be long enough to develop the full working strength of the bar at 100 lbs. per square inch adhesion and in no case shall the length of the lap be less than forty diameters.

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D. M. TURNER  
CONSULTING ENGINEER  
10 BEACON STREET  
BOSTON 8, MASS.



WALL EXTENSION REINFORCING  
McTAGGERT DAM  
N.T.S.      OCT. 1955

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TOWN OR CITY	DECREE NO.	PLAN NO.	DAM NO.
<b>Fitchburg</b>			<b>10-22</b>
<b>Sanborn St. above #5 Mill (McTaggart's Dam.)</b>			<b>C. C. DOCKET NO.</b>
<b>DESCRIPTION OF DAM</b>		<b>DESCRIPTION OF RESERVOIR &amp; WATERSHED</b>	
Type <b>Earth Stone Spillway. Conc. upstream. El. 100</b>		Name of Main Stream <b>Ashburnham Br. (Nookages River)</b>	
Length <b>308'±</b>		" " any other Streams	
Height <b>14'±</b>		Length of Watershed	
Thickness top <b>18'±</b>		Width " "	
" bottom <b>Prob. 30'±</b>		Is Watershed Cultivated	
Downstream Slope <b>Earth 1 1/2:1</b>		Percent In Forests	
Upstream " <b>Vert. Spillway walls</b>		Steepness of Slope	
Length of Spillway <b>130'± El. Crest - 99.0</b>		Kind of Soil	<b>Rocky - Hard Pan.</b>
Size of Gates <b>2 - 3' x 5' Concrete El. 89.0</b>		No. of Acres in Watershed	<b>15.2± 20 M</b>
Location of Gates <b>To West Spillway.</b>		" " " Reservoir	
Flashboards used <b>None.</b>		Length of Reservoir	
Width Flashboards or Gates		Width " "	
Dam designed by		Max Flow Cu. Ft per Sec. <b>1500. cfs per sq. mi.?</b>	
" constructed by		Head or Flashboards-Low Water	
Year constructed		" " " -High "	
<b>GENERAL REMARKS</b>		<b>GENERAL REMARKS</b>	
<b>Owner: Crocker Burbank &amp; Co. Assn. - 1928</b>		<b>Inspected: Oct. 19, 1924 - L. O. Marden</b>	
<b>American Woolen Co.</b>		<b>Dec. 14, 1926 - " "</b>	
<b>INSPECTED - JAN 17, 1945 - L. O. M. - S. F. S.</b>		<b>July 26, 1927 - " "</b>	
<b>" " MAR 15, 1951 - "</b>		<b>Sept. 26, 1928 - " "</b>	<b>*(Reservoir)</b>
<b>El. top Spillway - 633.8</b>		<b>Oct. 31, 1928 - " "</b>	<b>*(Completed)</b>
<b>1926 Flood El. - 637.2</b>		<b>Jan. 15, 1934 - " "</b>	
<b>1939 Flood El. - 635.8</b>		<b>Dec. 8, 1937 - " "</b>	
<b>Tracing checked: L. O. M. 3-9-40</b>		<b>Oct. 7, 1938 - E. C. Corcoran</b>	
		<b>Measured: Mar. 27, 1939 - J. C. Powers - J. A. Tuttle</b>	
		<b>INSPECTED: DEC 3, 1941 - L. O. M.</b>	<b>U. S. Library Bureau 10-58500</b>

McTAGGARTS POND DAM

COUNTY OF WORCESTER, MASSACHUSETTS  
OFFICE OF COUNTY ENGINEER

Neg. Nos.

INSPECTION OF DAMS, RESERVOIR DAMS AND RESERVOIRS

Town Fitchburg Date Oct. 10, 1924 Dam No.  
Location Sanborn St. above #5 Name of Pond or Stream Ashburbham Branch  
Inspected by L.O. Marden Taggart Pond  
Owner American Woolen Co. Use Ice Pond

MATERIAL & TYPE Earth dam - stone faced spillway conc. upstream  
face to embankment  
Elevations in feet: above (+) or below (-) full pond or reservoir level.

FOR DAM Bed of stream below 86 top of spillway 99

FOR RESERVOIR

top of dam 100 top of flashboards none ground surface below 93  
level of overflow pipe 89 length in feet  
width top in feet 18 width bottom in feet size pipe to mill none  
inches length spillway in feet 130 head in feet

Size of wheel H. P. developed

Size of gates 2-3x5 conc. location of gates to west spillway section

Foundation and details of construction Rocky - hardpan

condition of embankment fair

Constructed by date

Designed by location

Recent repairs and date

Evidence of leakage

Condition stones face embankment falling in - wall bulging

Topography of country below #5 mill pond below

Nature of buildings and roads below dam Sanborn St.

No. Acres in watershed No. Acres in pond

Plans secured Percent watershed in cultivation

Percent in forests Note: Cross out word not applicable

abandoned - wall spillway section not so bad

McTAGGARTS POND DAM

County of Worcester

CVT

OFFICE OF COUNTY ENGINEER

Court House, Worcester, Mass.

L. O. Marden  
County Engineer

1925.

Town Fitchburg

Dam no. 16.22

Location Sawborn St above mill #5

American Woolen Co.,  
Fitchburg Mass.

The County Commissioners of Worcester County, acting under Chapter 253, General Laws, as amended by Chapter 178 of the Acts of 1924, said section being headed "Safety of Dams and Reservoirs", have ordered an inspection of your dam. The above Acts states in part regarding the inspection of dams,--

"The county commissioners shall as often as once in two years cause a thorough examination to be made of every reservoir, reservoir dam and mill dam by the breaking of which loss of life or damage to a road or bridge is likely to be caused,--

The commissioners shall cause every examination to be made by a competent engineer who shall report in detail and the work or the changes required for safety and the public good." The County Commissioners hereby order that the following repairs be made to your dam:-- (Note:-- Repairs to be made are marked with a cross.)

- 1. Repair down stream wall..... **X**
  - 2. " up " " ..... **X**
  - 3. " walls to spillway section..... **X**
  - 4. " " canal or flume..... **X**
  - 5. " concrete walls .....
  - 6. " apron to spillway.....
  - 7. " Leaks at .....
  - 8. Renew planks and timbers.....
  - 9. Clean out waste gate pipe or flume.....
  - 10. " canal to mill.....
  - 11. Provide new waste pipe or flume.....
  - 12. " pipe to mill thru embankment.....
  - 13. Remove flashboards .....
  - 14. Lower " .....
  - 15. Construct spillway section..... spillway to be..... feet long and..... feet deep..... at .....
  - 16. Cut off brush and trees from embankment .....
  - 17. Fill up holes and regrade embankment..... **X**
- Repair embankment and wall bulging

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Kindly notify us either in person or by letter after you have made these repairs.

Yours very truly,

McTAGGARTS POND DAM

COUNTY OF WORCESTER, MASSACHUSETTS  
OFFICE OF COUNTY ENGINEER

SECOND INSPECTION Neg. Nos.  
INSPECTION OF DAMS, RESERVOIR DAMS AND RESERVOIRS

Town Fitchburg Date Dec. 14, 1926 Dam No. 16-22  
Location Sanborn St. Name of Pond or Stream Nookage River  
Inspected by L.O. Marden  
Owner American Woolen Co. Use

MATERIAL & TYPE See first inspection sheet

Elevations in feet: above (+) or below (-) full pond or reservoir level.

FOR DAM Bed of stream below top of spillway

FOR RESERVOIR

top of dam top of flashboards ground surface below

level of overflow pipe length in feet

width top in feet width bottom in feet size pipe to mill

inches length spillway in feet head in feet

Size of wheel H. P. developed

Size of gates location of gates

Foundation and details of construction

condition of embankment

Constructed by date

Designed by location

Recent repairs and date none ✓

Evidence of leakage thru concrete at gates. ✓

Condition Downstream rubble wall is bulging. ✓

Topography of country below

Nature of buildings and roads below dam

No. Acres in watershed No. Acres in pond

Plans secured Percent watershed in cultivation

Percent in forests Note: Cross out word not applicable

Repairs to be made -- Bulge to be taken out of all rubble  
walls- a concrete wall to be constructed in line with downstream  
face across waste gates to the west bulkhead of spillway. The  
space between the 2 walls at gate to have either pipe or concrete  
box put across and filled with good clay filling and stone, any  
holes in the spillway section to be filled. ✓

MCTAGGARTS POND DAM

COUNTY OF WORCESTER MASSACHUSETTS  
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by F. C. Gorcoran Date 10/7/37 Dam No. 16-22

Town Fitchburg Mass <sup>Mr Foss</sup> Location M<sup>rs</sup> Taggart's Pond  
Owner Cresker Burbank Co Use Yes (Paper Making)  
Material and Type reinforced concrete dam

Dam Designed by Turner Boston Mass Constructed by C. B. ... Year 1927

SPILLWAY water 2' crest during flood None at present  
El. top Abutment 638.0 El. Crest 636.0 El. Apron          El. Streambed 318.0  
Width top Abutment 2.0 Width top Crest 2.0 Width bottom Spillway           
Width Flashboards carried None Kind Flashboards None  
El. Flowline Cleanout Pipe 627.0 Size and Kind Cleanout Pipe 2 x 2 opening  
Kind of Foundation under Spillway Ledge  
Condition Good

EMBANKMENT

El. Top 637.25 El. Natural Ground 626.0 Width Top 21.0 - 1'  
Width of Bottom 3.5' Upstream Slope 3.5' Downstream Slope conc. wall  
Kind of Corewall          Riprap           
Material in Embankment Earth - back by retaining wall Foundation Hardpan  
Condition Very Good

GATES 1 Location           
Size 42" Kind Panstock Gate El. Flowline           
Condition Good

WHEEL Kind S. Morgan Smith Size 22" Rated H. P.           
Location \* 5 Mill Ave. Head           
Evidence of Leaks in Structure None

Recent Repairs and Date         

Topography of Country below Dam Ledge

Nature of Buildings and Roads below Dam Brick Buildings + Tar Roads

Number Acres in Pond          Drainage Area in Square Miles

TOWN Fitchburg  
LOCATION \_\_\_\_\_

Heavy Rain  
Nashua River very high  
3" below bottom Crider R.R. Bridge

DAM NO. 16-22  
STREAM Nookagee

WORCESTER COUNTY ENGINEERING DEPARTMENT  
WORCESTER, MASSACHUSETTS  
**DAM INSPECTION REPORT**

OWNED BY Crocker-Buchank Co PLACE Fitchburg USE Storage  
INSPECTED BY LOM-J Fall DATE Oct. 15, 1955  
TYPE OF DAM \_\_\_\_\_ CONDITION \_\_\_\_\_

**SPILLWAY**

FLASHBOARDS IN PLACE None RECENT REPAIRS None  
CONDITION East Concrete Spill Abut - above water - west abut wall  
under water.  
REPAIRS NEEDED Raise abut walls to spillway 2'6"

**EMBANKMENT**

RECENT REPAIRS None  
CONDITION Raise West embankment at least 2'6"  
REPAIRS NEEDED " East " " " 2'6"

ORDERED BOTH Embankments Soid Urged watch level  
dwn

**GATES**

RECENT REPAIRS Could not examine  
CONDITION \_\_\_\_\_  
REPAIRS NEEDED \_\_\_\_\_

**LEAKS**

HOW SERIOUS \_\_\_\_\_

DATE \_\_\_\_\_

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May 13, 1975

Factory Village Pond-Dam #3-14-11-25

Repairs are needed. The following conditions were noted that require attention:

1. The northerly end of the downstream wall has collapsed and some erosion was noted. The southerly abutment wall is convex. These areas should be rebuilt.
2. Remove the growth of trees and brush from the embankment of the dam.
3. There are areas of erosion which require backfill with suitable material, properly compacted and graded.

The overall appearance of these dams is that of deterioration from neglect for the lack of any on-going maintenance program. At this time it is recommended that you obtain the services of a Registered Professional Civil Engineer experienced in the design, maintenance, and construction of dams. He can best advise you what course of action to take. Mr. Corwell of the corporation has been in contact with this office and, by virtue of the information forwarded to him under cover of our letter dated, May 10, 1974, is fully cognizant of the responsibilities in this matter. If we may be of assistance, please do not hesitate to contact us. With any correspondence, please include the number/s of the dam/s as indicated above.

Very truly yours,

*Norman L. Diegoli*

NORMAN L. DIEGOLI, P.E.  
Acting Deputy Chief Engineer

*LEH:jap*

cc Richard J. Corwell, Vice Pres.,  
Technical Director, Pittsburg

J. J. Lyons  
W. Regan

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APPENDIX C

PHOTOGRAPHS

(For location and direction of view of photographs,  
see Figure B-1 in Appendix B.)

MCTAGGARTS POND DAM



**NO. 1 VIEW OF WEST ABUTMENT**



**NO. 2 DOWNSTREAM VIEW OF WEST ABUTMENT,  
OUTLET STRUCTURE AND SPILLWAY WEIR**

**McTAGGARTS POND DAM**



NO. 3 DOWNSTREAM VIEW OF SPALLING  
CONCRETE ON WEST SPILLWAY SIDEWALL

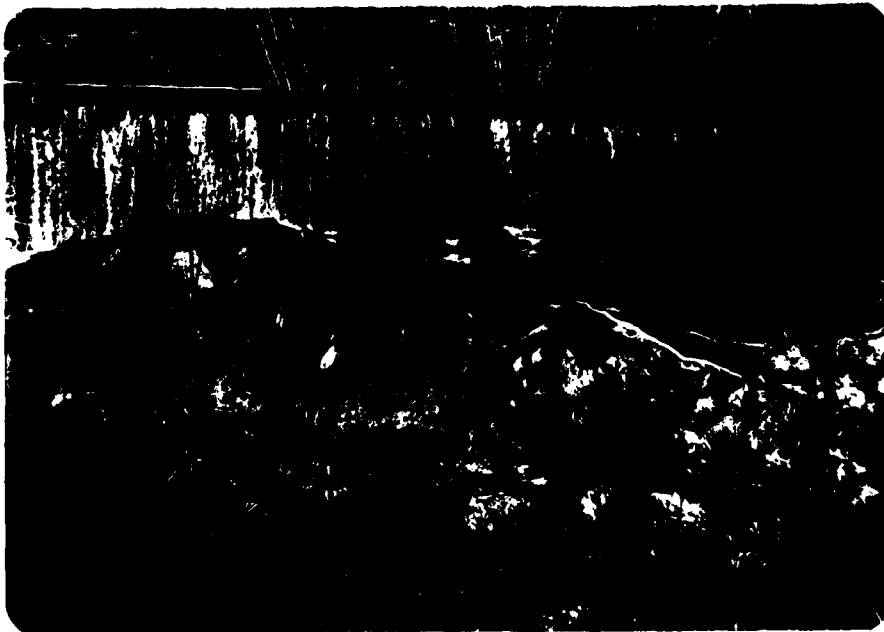


NO. 4 DOWNSTREAM VIEW OF SPALLING  
CONCRETE ON EAST SPILLWAY SIDEWALL

McTAGGARTS POND DAM



**NO. 5 VIEW OF LOW LEVEL OUTLET  
CONTROL AND MAIN INTAKE TRASH RACK**



**NO. 6 DOWNSTREAM VIEW OF SPILLWAY**

**McTAGGARTS POND DAM**



**NO. 7 VIEW OF RETAINING  
WALL DOWNSTREAM OF  
WEST ABUTMENT**



**NO. 8 SEEPAGE  
BELOW RETAINING  
WALL**



**NO. 9 VIEW OF DOWNSTREAM CHANNEL**



**NO. 10 VIEW OF DOWNSTREAM CHANNEL RESTRICTION BENEATH MILL**

**McTAGGARTS POND DAM**



**NO. 11 UPSTREAM VIEW OF SANBORN STREET BRIDGE**



**NO. 12 UPSTREAM VIEW OF CHANNEL RESTRICTION BENEATH MILL**

McTAGGARTS POND DAM

APPENDIX D  
HYDROLOGIC AND HYDRAULIC  
COMPUTATIONS

MCTAGGARTS POND DAM

Winnekeag  
Lake Inflow

**I** Test Flood, Storage & Storage Functions

1- Total Drainage Area - 2.2 mi<sup>2</sup>

2- Pond(s) Area: 0.06 mi<sup>2</sup>  
 Swamp(s) Area:  $0.19 + .04 + .05 = 0.28$   
 Total Area Ponds & Swamps: 0.34

% Ponds & Swamps =  $\frac{0.34}{2.2} = 15\%$

3-  $\frac{1500 - 1120}{7800} = .0479$  } Say Ave Slope = 4.5%

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be between "rolling and Flat & Coastal" and taken at 1650 cfs./mi<sup>2</sup>

Size Class:     ; Hazard Pot.:     ; Spill. Des. Flood:     

Use: Test Flood =  $\frac{1}{2}$  PMF storm based on McTaggart Pond Dam

5- Test Flood Inflow =  $\frac{1}{2}(1650)2.2 = 1820$  cfs.

6- Pond Storage

The pond area is 0.18 sq. mi. at elev.      map  
 Based on a const. area, storage increases at 115.2 ac. feet per foot of depth increase.

7- Spillway crest elev. is (N/A)

8- Storage Functions are based on  $Q_{out} = Q_{in} [1 - \frac{S_{out}}{R}]$

$S_{out}$  = Storage Vol. in Reservoir related to final  $Q_{out}$  in terms of inches of rain over the drainage area.

$S$  (in Inches) =  $12 D (\frac{0.18}{2.2}) = 0.98 D$ ;  $R = 6$  hr rain of storm.

$D$  = Storage depth in feet above spillway crest in reservoir

9- Storage Functions: (Test Flood &  $\frac{1}{2}$  PMF - if needed)

$F'_{TF} = 1820$	$- 189.5$	$S = 1820 - 186$	$D$
$F'_{\frac{1}{2}PMF} = F'_{TF}$	$-$	$S =$	$D$

II Winnekeag Lake - Discharge Relations

A. Spillway

Length = ± 30', 5' ± freeboard above flashboards

$$Q_A = 30 (3.3) H_A^{1.5} = 99 H_A^{1.5};$$

$H_A = \text{Depth}_A =$	2	4	5	6	8	7
$Q_A =$	280	790	1110	1450	2240	1830

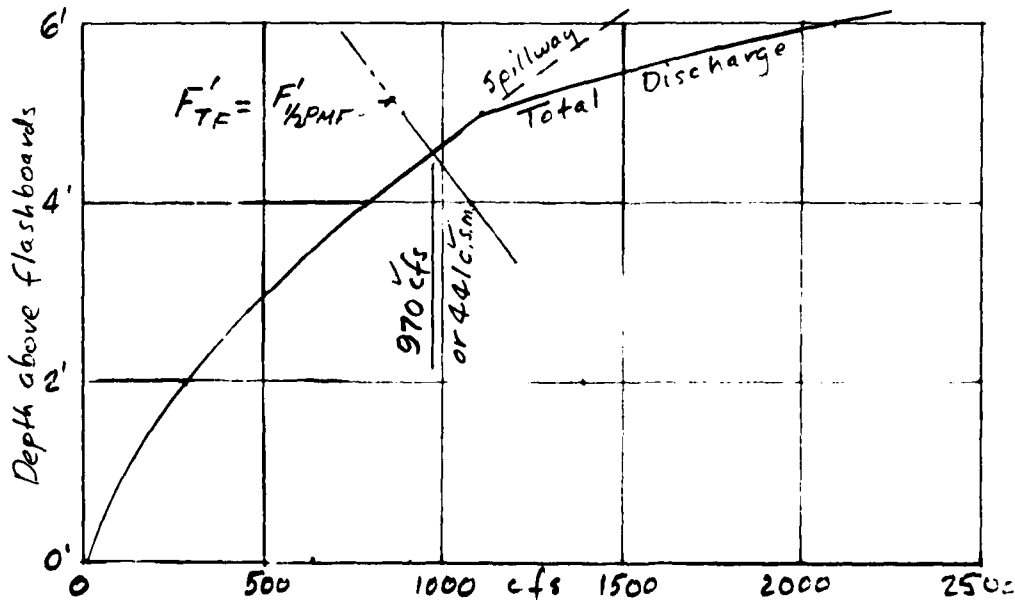
B. Crest

Length = ± 250',  $Q = 250 (2.55) H_B^{1.5} = 637.5 H_B^{1.5}$

$H_B = \text{Depth}_B =$	1	2	3
$Q_B =$	640	1800	3310

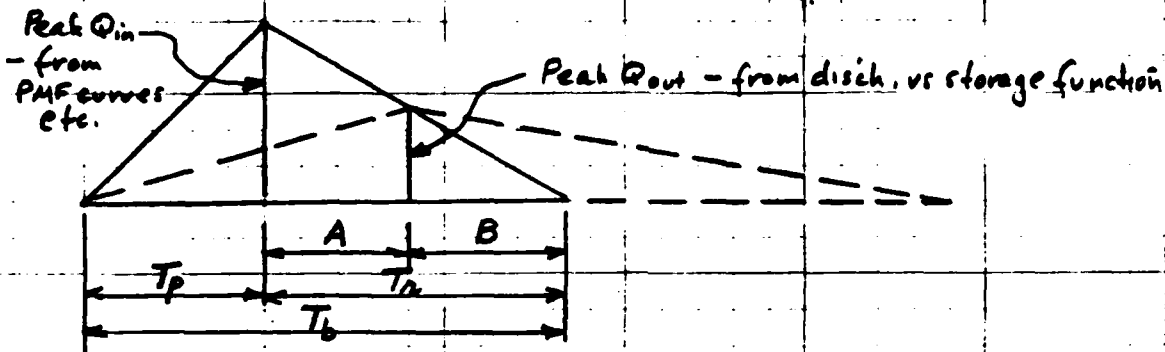
[Note:  $H_A = H_B + 5'$ ]

III Winnekeag Lake - Test Flood Discharge



**IV Storage Lag - for Winnekeag Lake**

Est. time lag between time of peak inflow rate and time of peak outflow rate due to reservoir/pond storage. Assume triangular inflow/outflow hydrographs.



$$\left(\frac{1}{2} \text{Peak } Q_{in}\right)(T_b) = \text{Volume Rain} = (\text{Depth rain})(\text{Drainage Area})$$

$$T_b = 1291 \left[ \frac{R(DA)}{Q_{in}} \right] \quad \begin{array}{l} R = \text{inches of rainfall excess} \\ DA = \text{drainage area in sq. miles} \\ Q_{in} = \text{peak } Q_{in} \text{ in cfs.} \end{array}$$

$$T_p = \frac{T_b}{2.67} \quad ; \quad T_n = 1.67(T_p) = 0.6255 T_b$$

$$B = T_n \left( \frac{Q_{out}}{Q_{in}} \right) \quad ; \quad A = T_n - B = T_n \left( 1 - \frac{Q_{out}}{Q_{in}} \right)$$

$$\therefore A = 807.3 (R)(D.A.) \left[ \frac{Q_{in} - Q_{out}}{Q_{in}^2} \right] \text{ — in hours}$$

For Winnekeag Lake:

$$D.A. = 2.2 \text{ mi}^2, \quad R = 9.5, \quad \text{Max } Q_{in} = 1820 \text{ cfs}, \quad \text{Max } Q_{out} = 470$$

$$A = 807.3 (9.5) (2.2) \left[ \frac{1820 - 470}{(1820)^2} \right] = 4.3 \text{ hrs}$$

$$T_p = \frac{1291 \left[ \frac{9.5(2.2)}{1820} \right]}{2.67} = 5.6 \text{ hours} \quad ; \quad T_n = 9.4 \text{ hours}$$

$$\text{Downstream Area } T_p = 1291 \left( \frac{1}{2.67} \right) \left[ \frac{9.5(12.88)}{7400} \right] = 8.0 \text{ hours}$$

Travel Time Winnekeag to McTaggart - say 4 ft/coff @ 6 fps = 1.9 hours

$$\text{Winnekeag increment for McTaggart peak} = 970 \left( \frac{8.0}{2.3 + 5.6 + 1.9} \right) = 660 \text{ cfs}$$

**V** Test Flood, Storage & Storage Functions

1- Total Drainage Area - 12.88 mi<sup>2</sup> (below Winnekeag Lake)

2- Pond(s) Area:  $0.02 + 0.01 + 0.01 = 0.04$  mi<sup>2</sup>  
 Swamp(s) Area:  $0.09 = 0.09$   
Total Area Ponds & Swamps: 0.13

% Ponds & Swamps =  $\frac{0.13}{12.88} = 1.0\%$

3-  $\frac{1126 - 638}{41000} = 0.0119$  } Say Ave Slope = 1.2%

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be between "Rolling" and "Flat & Coastal" and taken at 1150 c.f.s./mi<sup>2</sup>  
 Size Class: Small ; Hazard Pot.: High ; Spill. Des. Flood:  $\frac{1}{2}$  to  $\frac{1}{4}$  PMF  
 Use: Test Flood =  $\frac{1}{2}$  PMF

5- Test Flood Inflow =  $\frac{1}{2}(1150)12.88 = 7400$  c.f.s. for area below Winnekeag L.  
Total Test Flood Inflow =  $7400 + 660 = 8060$  c.f.s.

6- Pond Storage  
 The pond area is 0.012 sq. mi. at elev. ± 636  
 Based on a const. area, storage increases at 7.8 ac. feet per foot of depth increase.

7- Spillway crest elev. is el. 636

8- Storage Functions are based on  $Q_{out} = Q_{in} [1 - \frac{S_{out}}{R}]$

$S_{out}$  = Storage Vol. in Reservoir related to final  $Q_{out}$  in terms of inches of rain over the drainage area.

$S(\text{in Inches}) = 12 D (\frac{0.012}{15.13}) = .0095 D$ ;  $R = 6\text{hr rain of storm}$

$D$  = Storage depth in feet above spillway crest in reservoir

9- Storage Functions: (Test Flood &  $\frac{1}{2}$  PMF. if needed)

$F_{TF} = 8060 - 848.4 S = 8060 - 8.1 D$
$F_{\frac{1}{2}PMF} = F_{TF}$ <span style="background-color: #cccccc; padding: 2px;">/</span> $S =$ <span style="background-color: #cccccc; padding: 2px;">/</span> $D$

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(VI) Discharge Relations

A - Spillway Crest

Length - 158 ±, Crest narrow w/ rounded edges, Elev. 636

$$Q_A = LCH^{1.5} = 158(3.3)H^{1.5} = 521.4H^{1.5} \text{ (no flashboards)}$$

Pond el.	638	640	641.6	642	644	643
Q <sub>A</sub>	1470	4170	6910	7660	11,800	9660

B - Dam Crest

Length ± 300', Elev. 641.7, Use  $q = 2.55H_B^{1.5}$

Pond el.	642	643	644	Q <sub>B</sub> = 300(2.55)H <sup>1.5</sup>
----------	-----	-----	-----	--

Q <sub>B</sub>	130	1130	2670
----------------	-----	------	------

(VII) Pond Lowering

Low level outlet - 2'x2' - @ el. 626.5 ± -  $Q = 0.6A\sqrt{2gh}$

Pond el. 635.5, h = 9', Ave Q = 58 cfs

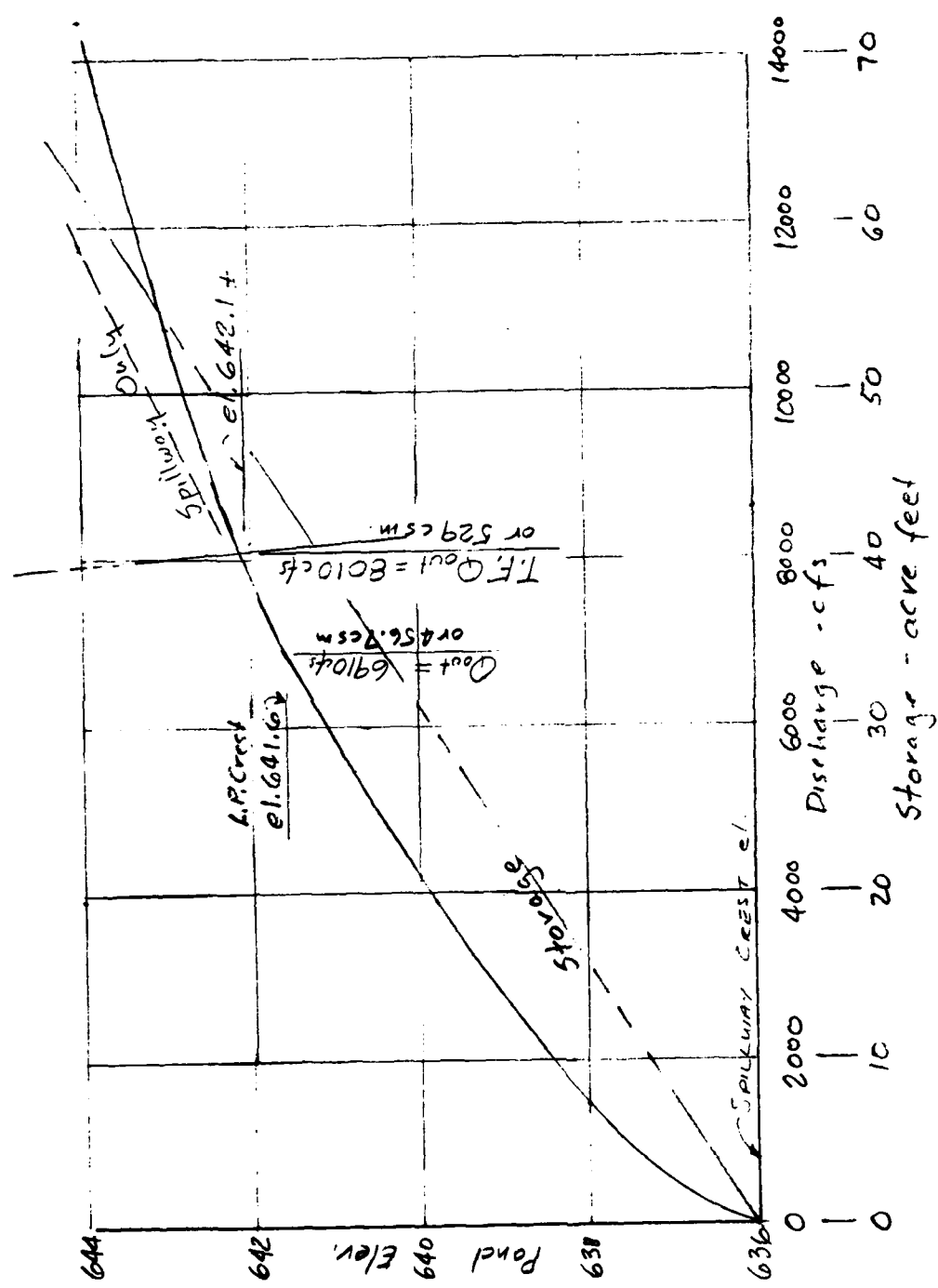
$$\text{Time to lower pond 12" from el. 636: } \frac{7.8(43560)}{58(3600)} = 1.6 \text{ hours} = 98 \text{ min}$$

(VIII) Crest Flow

Max T.F. Head = 642.1 - 641.6 = 0.5 ft.,  $q = 2.55(.5)^{1.5} = 0.90 \text{ cfs/ft}^2$

As Critical flow:  $y_c = 0.29 \text{ ft}$  ;  $V_c = 3.1 \text{ fps}$

(IX) Discharge, Storage & Storage Function vs Pond Elevation ✓



METCALF & EDDY ENGINEERS



## Failure of Dam - Dry Weather Failure

### Peak Failure Flow:

Pond Elevation - 636.0 - Spillway Crest

Toe Elevation - 618.5 ±

$$Y_0 = 17.5$$

Dam Length Subject to Breaching = ± 52' (betw. corners)

$$W_0 = 40\% (X) =$$

$$Q_p = 1.68 W_0 (Y_0)^{1.5} = 1.68 (52) (17.5)^{1.5} = \underline{6400 \text{ cfs}}$$

### Storage Volume Released:

Storage Above Spillway - None 0.0

Storage Below Spillway -  $\frac{1}{3} (7.8) 17.5 = 45.5 \text{ acft}$

S = Total Storage = 45.5 "

### Failure Hydraulics:

Dam failure assumed to initiate over a limited width of spillway length. The failure flow thru the dam causes the breach to widen at a rate related to the failure flow velocity, which decreases as the pond level is drawn down.

Based on  $Q_p$ , above, it takes only about 10 minutes to drain the pond - if the entire 52 feet of spillway is removed at once. Any appreciable time required to remove the dam lessens the peak failure rate for this case.

The spillway cross-section contains elements of reinforced concrete, plain concrete, and apparent stone work. The base width is about 1.4 times the height. It seems unlikely that 52 feet of spillway would be removed in a short time period.

An alternative peak discharge rate is estimated on Sheets 9 through 13.

### Time to Drain:

$$\frac{43560 (45.5)}{3600 (\frac{1}{2}) (6400)} = 0.17 \text{ Hours} = 10.3 \text{ Minutes}$$

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## Failure of Dam

Peak Failure Flow:

Pond Elevation - 641.6 L.P. Crest

Toe Elevation - 618.5 ± L.P. Toe of Spillway

$$Y_0 = 23.1$$

Dam Length Subject to Breaching = 52' (betw. contn. jts.)

$$W_0 = 40\% ( ) =$$

$$Q_R = 1.68 W_0 (Y_0)^{1.5} = 1.68 (52) (23.1)^{1.5} = 9700 \text{ cfs}$$

Remaining Spillway flow =  $\frac{106}{158} (6910) = 4640 \text{ cfs}$ ; Total 14340 cfs

Storage Volume Released:

Storage Above Spillway  $7.8 (5.6) = 43.7 \text{ ac. ft}$

Storage Below Spillway  $\frac{1}{3} (7.8) (17.5) = 45.5 \text{ "}$

S = Total Storage = 89.2 "

Channel Hydraulics:

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 permit fully legible reproduction

Time to Drain:

$$\frac{43560 (89.2)}{3600 (\frac{1}{2}) (9700)} = 0.22 \text{ Hours.} = 13.4 \text{ Minutes}^*$$

\* Time for 52' of spillway to totally fail would likely significantly increase this time.

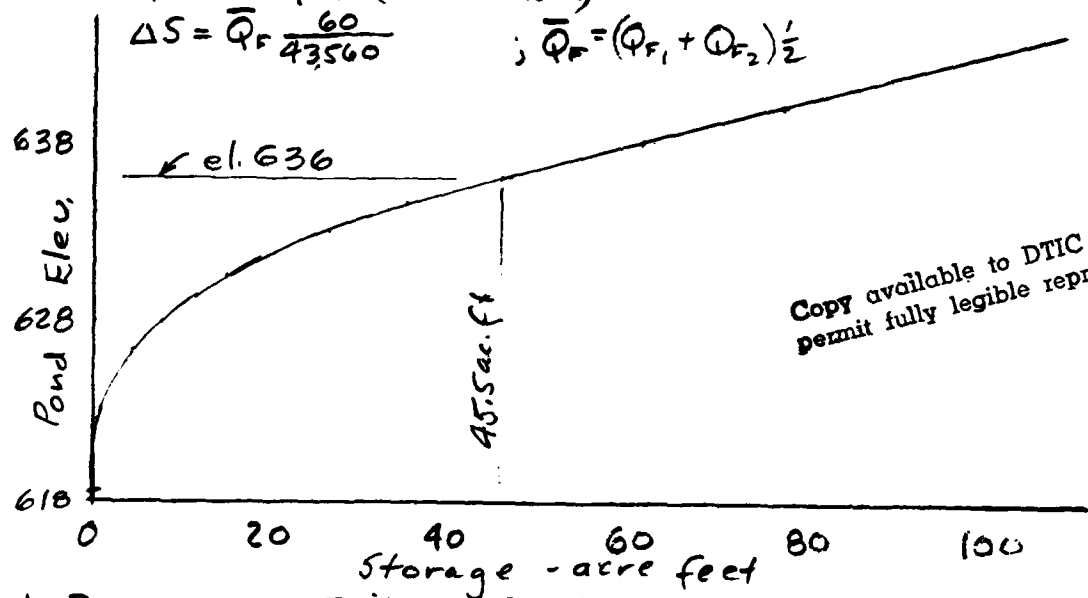
(XII) Alternative Failure of Dam

Assumptions & Procedure

Dam failure rate is 10 ft/min. along length of spillway.

Calculate conditions @ 1 min. intervals  
 Adjust head as storage is withdrawn  
 Storage Vol. below crest =  $\frac{1}{3}(7.0)17.5 = 45.5$  ac-ft.

$Q_F = 1.68 (H)^{4.5} (\text{Breach Width})$   
 $\Delta S = \bar{Q}_F \frac{60}{43560}$  ;  $\bar{Q}_F = (Q_{F1} + Q_{F2}) \frac{1}{2}$



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1- Dry Weather Failure - Pond @ el. 636

Time	Pond El.	Head	Breach width	$Q_F$	$\Delta S$	Storage Vol	Tailwater Depth
0	636	17.5	0'	0	0.8	45.5	0
1	636	17.5	10'	1230	2.5	44.7	
2	636	17.5	20'	2460	4.1	42.2	
3	635.5	17.0	30'	3530	5.5	38.1	8.5'±
4	635	16.5	40'	4500	6.6	32.6	11.5'±
5	634	15.5	50'	5130*	6.9	26.0	15.5'±
6	633	14.5	52'	4820	6.3	19.1	
7	632	13.5	52'	4330	5.2	12.8	
8	629.5	11.0	52'	3190	4.0	7.6	
9	628.0	9.5	52'	2560	3.0	3.4	
10	626.0	7.5	52'	1800	0.6	0.6	
11	618.5	0	52'	0	0.0	0.0	

\* Peak flow & subsequent flows reduced by high tailwater  
Peak  $Q_F \approx 5000$  cfs. - Dry Weather Failure

XIII Alternative Failure of Dam

2- Full Pond Failure - Pond @ el. 641.6

Before failure, crest flow = 6910 cfs or 43.73 cfs/ft.  
 Assume inflow = outflow before failure, an remaining spillway operates during failure.

$$\Delta S = (\Sigma \bar{Q}_{out} - 6910) \left( \frac{60}{43500} \right); Q_F = 1.68(L)(nh)^{1.5}$$

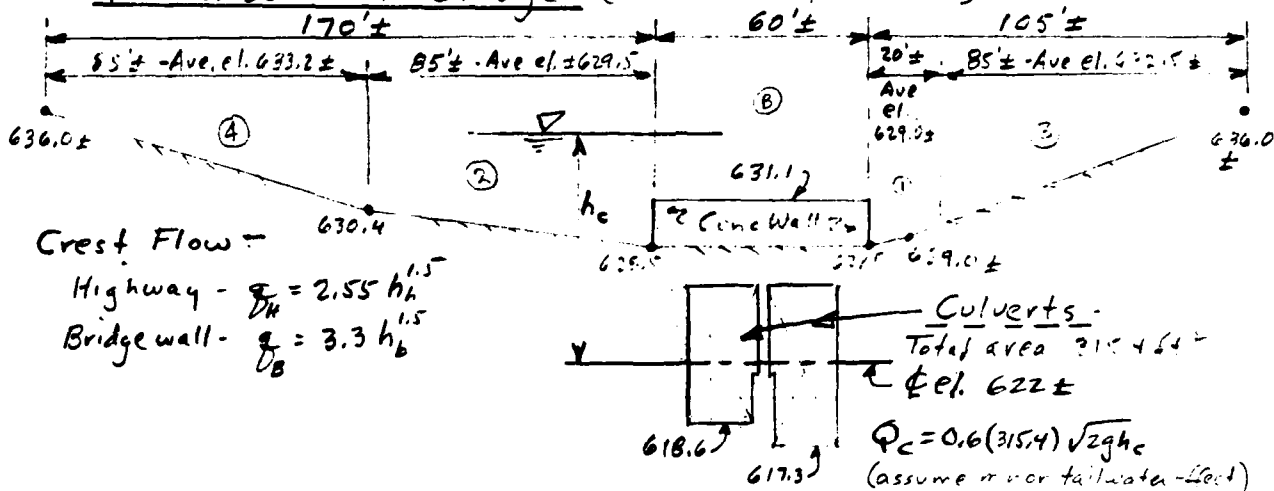
[Ref. for "Davis  
 Hnbk of Appl. Hydr."  
 2nd ed., Pg 1224, Table]

Time (Min.)	Pond Elev.	Head	Breach width	Q <sub>F</sub>	Q <sub>s</sub>	ΣQ	ΔS (acre) ft.	Storage Vol.	Tailwater Depth	n Reduct. Factor (for next step)
0	641.6	23.1	0	0	6910	6910	0	89.2	14.2	.839
1	641.6	23.1	10'	1430	6470	7900	0.7	88.5	14.8	.822
2	641.5	23.0	20'	2760	5880	8640	1.9	86.6	15.2	.808
3	641.3	22.8	30'	3980	5150	9130	2.7	83.9	15.4	.799
4	640.9	22.4	40'	5090	4220	9310	3.2	80.7	15.5	.784
5	640.5	22.0	50'	6020	3400	9420	3.4	77.3	15.5	.775
6	640.1	21.6	52	5980	2900	8880	3.1	74.2	15.3	.772
7	639.7	21.2	"	5780	2400	8270	2.3	71.9	15.0	.775
8	639.4	20.9	"	5690	2190	7880	1.6	70.3	14.8	

Say - Peak Total Failure Flow ≈ 9500 cfs.

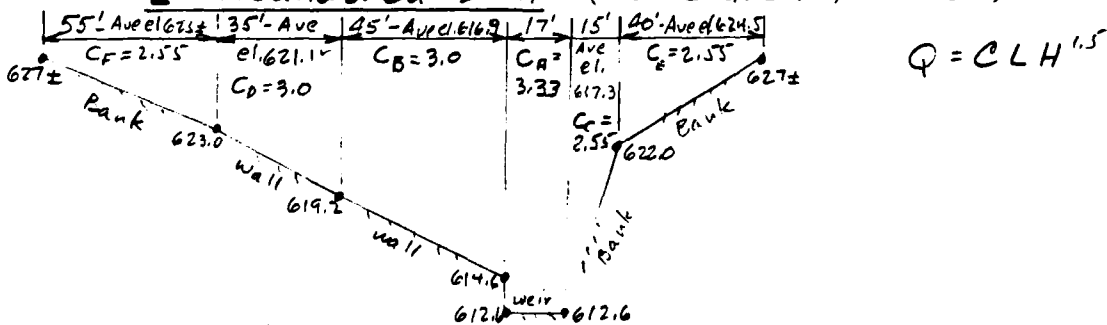
**XIV** Downstream Discharge Relations

1- Sanborn St. Bridge (100'± dustr. from McT.)



Upstr. Water El.	628	630	632	634	636	634.5	633
$Q_c$	3720	4300	4800	5260	5680	5370	5040
$Q_{H1}$	—	50	260	570	940	660	410
$Q_{H2}$	—	80	860	2070	3590	2420	1420
$Q_{H3}$	—	—	—	400	1420	610	80
$Q_{H4}$	—	—	—	160	1020	320	—
$Q_B$	—	—	170	980	2150	1240	520
$\Sigma Q_1$	3,720	4,430	6,090	9,440	14,800	10,620	7,470

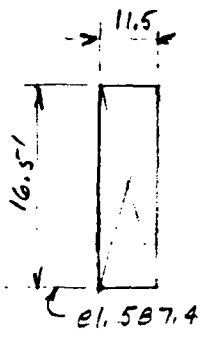
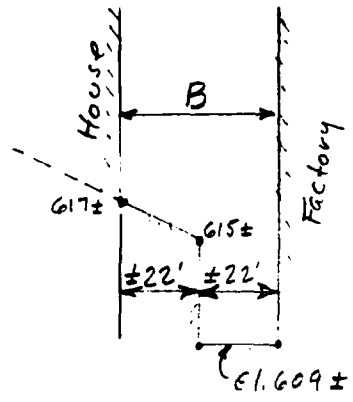
2- Abandoned Dam (300'± dustr. from McT.)



Upstr. Water El.	$Q_A$	$Q_B$	$Q_C$	$Q_D$	$Q_E$	$Q_F$	$\Sigma Q_2$
620	1130	740	170	—	—	—	2040
625	2450	3110	820	810	40	—	7230
626	2750	3710	980	1140	190	140	8910
627	3070	4330	1160	1500	400	400	10860

(XIV) Downstream Discharge Relations (Cont.)

3- Culvert at Factory (700' ± dnstr. from Mct.)



No flow around westerly end of factory for water el. < 625±

Assume critical flow at easterly side of factory due to dikes at Westminster Hill Rd. and beyond. Add velocity to water level at easterly side for water elev. at cut to culvert.

Easterly Side of Factory (near Westminster Hill Rd)

$$Q_{es} = \left[ \frac{A^3 g}{B} \right]^{1/2}$$

Culvert Entrance  
 el. ± 593

$$Q_c = 0.6(189.75) \sqrt{g h_c} = 913.6 \sqrt{h_c}$$

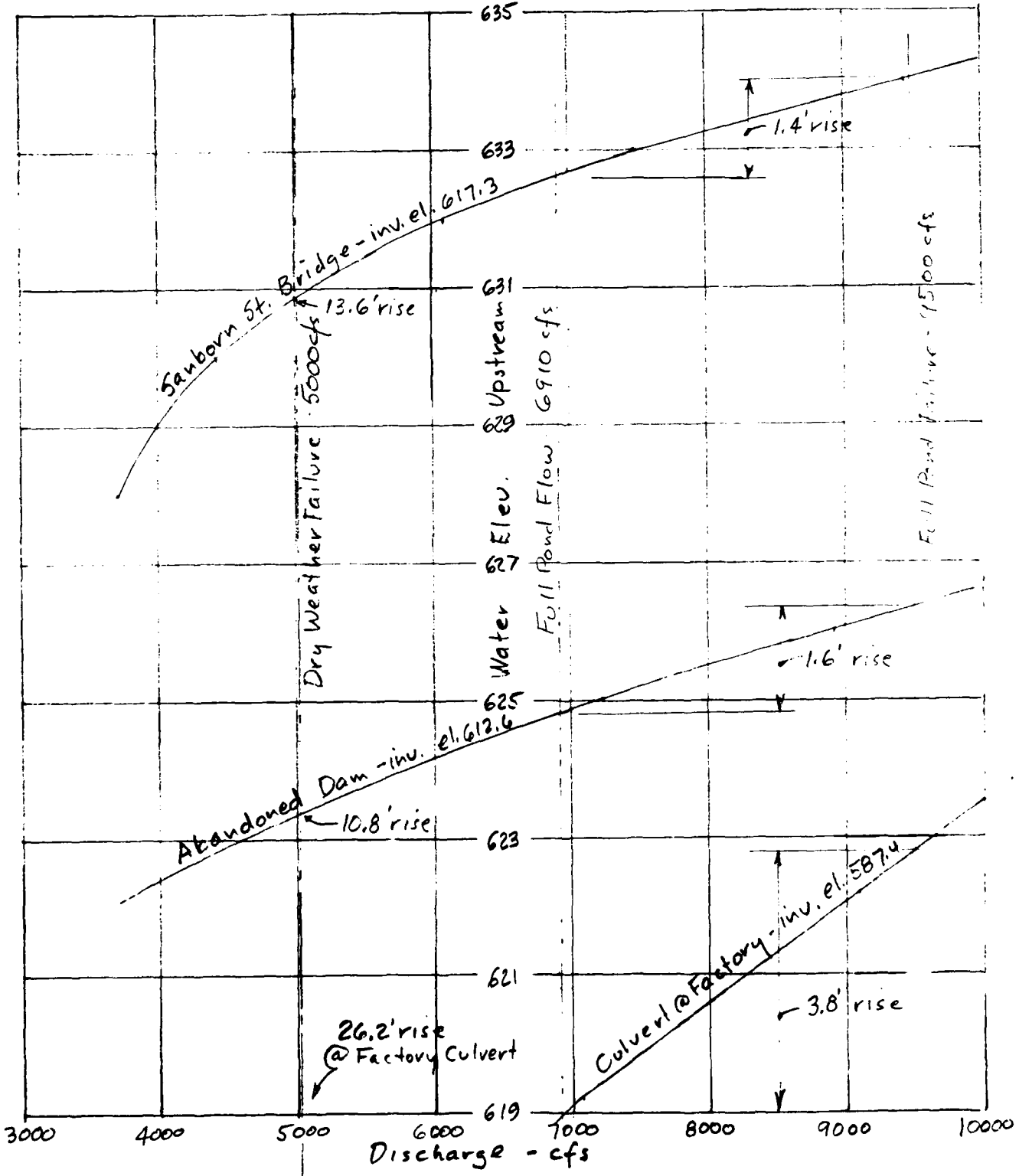
Water el. - easterly side	609	612	615	617	619	620
Area	0	66	132	198	256	330
B	0	22	22	44	44	44
Q <sub>es</sub>	0	650	1840	2380	3140	5130
h <sub>v</sub>	0	1.5	3.0	2.2	3.2	3.8
Water el. @ culvert	609	613.5	618	619.2	622.2	623.8
Q <sub>c</sub>	3650	4140	4570	4680	4940	5070
Σ Q <sub>3</sub>	3650	4790	6410	7360	9080	10200

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**XIV** Downstream Discharge Relations (Cont.)

4- Water Elev. vs Discharge



APPENDIX E  
INFORMATION AS CONTAINED IN  
THE NATIONAL INVENTORY  
OF DAMS

MCTAGGARTS POND DAM

NOT AVAILABLE AT THIS TIME

**END**

**FILMED**

7-85

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