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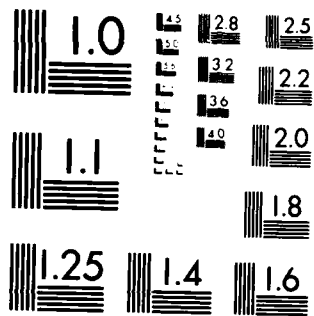
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
CURTIS PONDS DAM (MA..(U) CORPS OF ENGINEERS WALTHAM MA
NEW ENGLAND DIV OCT 78

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BLACKSTONE RIVER BASIN
WORCESTER, MASSACHUSETTS



CURTIS PONDS DAM
MA 00140

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

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Curtis Ponds Dam is a 420 foot long, 14 foot high earthfill dam. The dam is in fair condition. It has been placed in "significant" hazard category for the classification of hazard potential. The spillway can discharge 27 percent of the outflow test flood (½ the PMF) which is 9,500 cfs with a pond level at EL 481.0.		



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

Dear Governor King:

I am forwarding to you a copy of the Curtis Ponds 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, Massachusetts Electric Company, 939 Southbridge Street, Worcester, Massachusetts 01610, ATTN: Mr. Barry Huston, District Superintendent.

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 yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00140

Name of Dam: Curtis Ponds

Town: Worcester

County and State: Worcester County, Massachusetts

Stream: Middle River - Tributary of the Blackstone
River

Date of Inspection: September 18, 1978

Curtis Ponds Dam is a 420-foot long, 14-foot high earthfill dam built in 1837. The dam has vertical upstream and downstream walls, portions of which are made of concrete and portions are dry-stone masonry. The area immediately downstream of the dam has been filled in nearly to the crest. The spillway is an 80-foot long, broad crested weir with a stepped stone cascade at the southeast abutment of the dam and has a crest at elevation (El) 472.0. There is an abandoned steel framework across the crest which formerly supported a walkway and flashboards. The downstream discharge channel is 70 feet wide and has vertical concrete sidewalls 9 to 13 feet high. At 150 feet downstream of the spillway, the channel intersects a second channel which is 4.6 feet wide and has vertical concrete sidewalls about 6.5 feet high. There is no regulating outlet at the dam. There is a partly demolished gate house and about 12 abandoned and rubble filled intake openings located upstream of the dam near the southeast abutment.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based upon the visual inspection at the site, the lack of engineering data, and limited operational and maintenance information. Generally, the dam is in fair condition. It has been placed in the

CURTIS PONDS DAM

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"significant" hazard category according to the Corps of Engineers guidelines for the classification of hazard potential.

The dam is considered to be a potential hazard because of the lack of a regulating outlet as well as the signs of distress which were observed at the site: erosion of a large area on the crest and downstream of the dam, the steel framework across the crest of the spillway, and debris on the crest of the spillway and in the downstream channel.

Hydraulic analyses indicate that the spillway can discharge a flow of 2,575 cfs (cubic feet per second) when the pond level is at El 477.3, which is the low point on the crest of the dam. The spillway can discharge 27 percent of the outflow test flood (half the probable maximum flood) which is 9,500 cfs with a pond level at El 481.0. The above test flood pool elevation would be modified by a high tailwater and general flooding.

It is recommended that the Owner employ the services of a qualified consultant to design a regulating outlet for the dam. In addition, the Owner should accomplish the following: backfill the eroded area downstream of the dam, remove the steel framework across the crest of the spillway, and clear debris from the spillway and downstream channel. The Owner should also implement a systematic program of inspection and maintenance.

The recommendation and remedial measures outlined above and in Section 7 should be implemented by the Owner within a period of two years after receipt of this Phase I Inspection Report. An alternative to these recommendations would be to drain the pond and breach or remove the dam.



Edward M. Greco

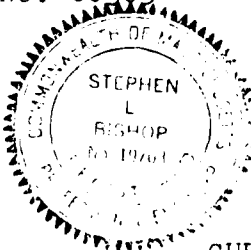
Edward M. Greco, P.E.
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Approved by:

Stephen L. Bishop

Stephen L. Bishop, P.E.
Vice President
Metcalf & Eddy, Inc.
Massachusetts Registration
No. 19703



CURTIS PONDS DAM

This Phase I Inspection Report on Curtis Ponds 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.

Richard F. Doherty

RICHARD F. DOHERTY, MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials 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.

CURTIS PONDS DAM

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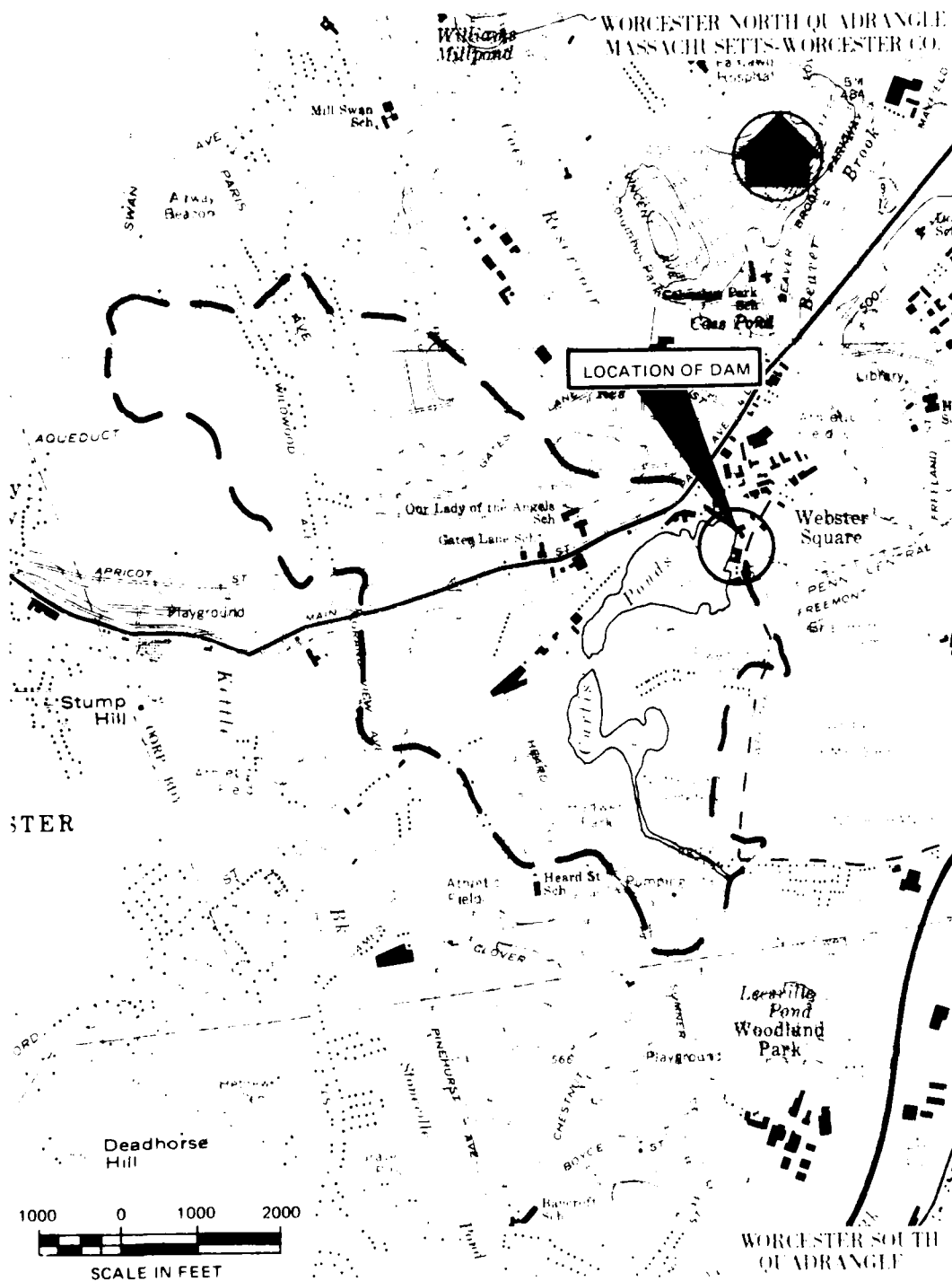
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OVERVIEW
CURTIS PONDS
WORCESTER, MASSACHUSETTS



VIEW OF UPSTREAM FACE OF DAM

Location and Direction of Photographs
Shown on Figure in Appendix B



LOCATION MAP - CURTIS PONDS DAM

NATIONAL DAM INSPECTION
PROGRAM

PHASE I INSPECTION REPORT

CURTIS PONDS

SECTION 1

PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection the 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. Authorization and notice to proceed was issued to Metcalf & Eddy, Inc. under a letter of July 28, 1978, from Ralph T. Garver, Colonel, Corps of Engineers. Contract No. DACW 33-78-C-0306 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) To update, verify and complete the National Inventory of Dams.

CURTIS PONDS DAM

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1.2 Description of Project

- a. Location. The dam is located on Middle River, a tributary of the Blackstone River, in the City of Worcester, Worcester County, Massachusetts (see Location Map).
- b. Description of Dam and Appurtenances. Curtis Ponds Dam is an earthfill dam with vertical walls on the upstream and downstream faces, portions of which are made of concrete and portions are dry-stone masonry (see Figure B-1). The dam has a maximum height of 14 feet and is about 420 feet long, including a stone cascade spillway at the southeast abutment. The crest of the dam is about 22 feet wide, but is obscured by filling of the area downstream of the dam for use as a coal yard. The crest varies from El 477.3 to 480.0. The axis of the embankment forms a bend at about 125 feet northwest of the spillway. The upstream face of the dam is a vertical concrete wall from the spillway for a distance of 175 feet and is a vertical dry-stone wall for an additional 165 feet to the northwest abutment. Most of the downstream face of the dam is not visible due to subsequent filling of the area. One section which is visible is a vertical, dry-stone masonry wall.

The spillway is an 80-foot long, ungated weir with a stone cascade on the downstream face. The crest is at El 472.0. The vertical, concrete sidewalls are 5.2 feet (north side) to 7.4 feet (south side) high. A steel frame is mounted on the weir and formerly supported a walkway and flashboards. The downstream face is a five-step cascade made of cut stone blocks. The channel below the spillway is about 150 feet long, 70 feet wide, and has vertical, concrete sidewalls about 9 to 13 feet high. Four concrete piers are located in the floor of the channel and formerly supported a railroad trestle. The downstream end of the channel intersects another channel carrying flow from Beaver and Tatnuck Brooks. The second channel is 46 feet wide with vertical, concrete sidewalls about 6.5 feet high. This channel continues southerly and

CURTIS PONDS DAM

under a bridge for Webster Street, then on through commercial and industrial areas of Worcester.

A partly demolished gate house is located upstream of the dam near the southeast abutment. It has a concrete deck and foundation with five openings which formerly served as intakes for cooling water for a power plant. Some slide gates are missing, and some intake openings are filled with concrete and building debris. The intakes and slide gates are inoperable. Between the gate house and the spillway is a vertical concrete wall along the pond. The wall has a gate opening leading to remnants of a flume made of steel sheet piling. This reportedly served to return warm water to the pond. Upstream of the gate house, a vertical concrete wall continues along the pond. This wall contains five more abandoned intake openings, some with wooden slide gates in place, but no operating mechanisms.

- c. Size Classification. Curtis Ponds Dam is classified in the "small" category since it has a maximum height of 14 feet and a maximum storage capacity of 512 acre-feet.
- d. Hazard Classification. Directly downstream of the dam is a heavily developed commercial area of Worcester known as Webster Square. Also, a firehouse is located about 200 feet downstream of the dam immediately east of the Webster Street bridge. Commercial and industrial development also occurs near the abutments of the dam. Two towers for power transmission lines are located at the site, one on the northwest abutment of the dam and one on the filled area downstream of the dam. This power line leads to a nearby downstream substation. However, in the event of failure of the dam, few lives could be lost although excessive property and utility damage could occur. Accordingly, the dam has been placed in the "significant" hazard category.
- e. Ownership. The dam is presently owned by Massachusetts Electric Company, 939 Southbridge Street, Worcester, Massachusetts 01610.

CURTIS PONDS DAM

Mr. Barry Huston, District Superintendent (617-791-8511), granted permission to enter the property and inspect the dam.

- f. Operator. Since there are no operable facilities at this dam, there are no known operators.
- g. Purpose of Dam. The dam was originally built to provide cooling water for a fossil fuel power plant. The plant was removed about 10 years ago, and the pond is no longer being used. The site is fenced off to prevent trespassing.
- h. Design and Construction History. Curtis Ponds Dam was built in 1837. The dam was originally constructed with a stone wall on the upstream face. A letter from the Owner to the Worcester County Commissioners in 1923 states that the abutments of the spillway are constructed of stone on each side with wood sheeting in the center, then filled with earth. Removable flashboards supported by a steel walkway over the spillway were in use by 1923. The downstream side of the dam was filled and used for a coal yard. In 1923, a flume was constructed for returning water to the pond. The flume cuts through the south wing wall near the right abutment of the dam. By 1938, a concrete wall on the upstream face of the dam had been constructed. In 1955, the dam was overtopped and damaged by flooding. Repairs consisted of gravel fill up to 20 inches thick placed on the crest of the dam directly behind the concrete wall. In 1973, slight spalling was observed on the concrete wall on the south side of the spillway. By 1976, the supports of the steel walkway had become eroded, and it was recommended by the Owner's maintenance personnel to remove the flashboards and abandon the walkway.
- i. Normal Operating Procedures. There are no operable structures and no operating procedures at this dam.

CURTIS PONDS DAM

1.3 Pertinent Data

- a. Drainage Area. Curtis Ponds has a drainage area of approximately 21,327 acres (33.3 square miles). This area includes the drainage basins of Ramshorn Brook, Dark Brook and Kettle Brook (see Watershed Plan, Figure D-1). About 15 dams are located upstream of Curtis Ponds, including five water supply reservoirs. In 1959, a flood control dam and diversion tunnel were constructed about 2.5 miles upstream on Kettle Brook. The tunnel has an overflow intake at El 487 and is designed to carry a maximum flow of 6,000 cfs. This facility is known as the Worcester Diversion.

The drainage area is about 50 percent rural and 50 percent urban. Rural areas are sparsely developed, mostly wooded, and have moderate slopes. Urban areas are thickly developed, mostly paved or grassed, and have flat to moderate slopes.

- b. Discharge. Normal discharge is over an ungated, broad crested spillway which is 80 feet long with the crest at El 472.0. Water then drops about 8 feet down a steep stone cascade and into the downstream channel. The channel is about 70 feet wide and 150 feet long, with vertical side walls 9 to 13 feet high. The gradient of the channel is 0.004 (0.4 percent). Water then flows into a second channel which flows southeastward to Tatnuck and Beaver Brooks. Below this intersection, the flow in the channel is called Middle River. The second channel is 46 feet wide and about 6.5 feet deep with vertical concrete sidewalls. At 135 feet downstream of the intersection, there is an arched culvert 7.5 feet high and 46 feet wide with an invert at El 463.0. The channel continues downstream through industrial areas of Worcester.

The maximum flood recorded at the site was during the 1955 hurricane, when the pond level was at about El 480, and the peak flow at Kettle Brook gage, a mile upstream, was

CURTIS PONDS DAM

recorded as 3,970 cfs. Since that time, the Worcester Diversion tunnel was constructed upstream to divert up to 6,000 cfs from Kettle Brook to the Blackstone River south of Worcester. Hydraulic analyses indicate that the spillway can discharge a flow of 2,575 cfs when the pond level is at El 477.3 which is the low point on the crest of the dam. An outflow test flood, which assumes a diversion of 6,000 cfs, of 9,800 cfs will overtop the dam by a maximum of 3.7 feet.

c. Elevation (feet above Mean Sea Level (MSL)).

A benchmark at El 472.0 was established at the crest of the spillway. This elevation was taken from a United States Geological Survey (U.S.G.S.) topographic map.

- (1) Top dam: 477.3 to 480.0
- (2) Test flood pool: 481.0
- (3) Design surcharge (original design):
unknown
- (4) Full flood control pool: Not Applicable
(N/A)
- (5) Recreation pool: 472.0
- (6) Spillway crest (ungated): 472.0
- (7) Upstream portal invert diversion tunnel:
487.0 Worcester Diversion Tunnel
- (8) Streambed at centerline of dam: 463.5
floor of channel below spillway
- (9) Tailwater: 463.9 water surface in
channel below spillway

d. Reservoir

- (1) Length of maximum pool: 4,200 feet
- (2) Length of recreation pool: 4,200 feet
- (3) Length of flood control pool: N/A

CURTIS PONDS DAM

e. Storage (acre feet)

- (1) Test flood surcharge (net): 715 at El 481
- (2) Top of dam: 512
- (3) Flood control pool: N/A
- (4) Recreation pool: 220 (Approximate)
- (5) Spillway crest: 220

f. Reservoir Surface (acres)

- * (1) Top dam: 55
- * (2) Maximum pool: 55
- (3) Flood-control pool: N/A
- (4) Recreation pool: 55
- (5) Spillway crest: 55

g. Dam

- (1) Type: earthfill with stone walls
- (2) Length: 420 feet
- (3) Height: maximum 14 feet
- (4) Top width: 22 feet
- (5) Side slopes: vertical upstream and downstream
- (6) Zoning: Unknown
- (7) Impervious core: timber sheeting near abutments to spillway
- (8) Cutoff: Unknown
- (9) Grout curtain: Unknown

*Based on the assumption that the surface area will not significantly increase with changes in reservoir elevation from 472.0 to 477.3.

CURTIS PONDS DAM

i. Spillway

- (1) Type: broad crest
- (2) Length of weir: 80 feet
- (3) Crest elevation: 472.0
- (4) Gates: None
- (5) Upstream Channel: None
- (6) Downstream Channel: 70 feet wide and 150 feet long with vertical sidewalls 9 to 13 feet high; leads to second channel 46 feet wide with vertical sidewalls 6.5 feet high

j. Regulating Outlets. There is no regulating outlet at this dam.

SECTION 2

ENGINEERING DATA

- 2.1 General. There are no plans, specifications, or computations available from the Owner, State, or County offices relative to the design and construction of this dam. The only data available for this evaluation were visual observations made during inspection, review of previous inspection reports, and conversations with local residents, and State and County agencies.

We acknowledge the assistance and cooperation of personnel of the Massachusetts Department of Public Works: Messrs. Willis Regan and Raymond Rochford, and of the Massachusetts Department of Environmental Quality Engineering, Division of Waterways: Messrs. John J. Hannon and Joseph Iagallo.

Also, we acknowledge the cooperation and assistance of personnel from the Worcester County Engineer's Office: Messrs. John O'Toole and Joseph Brazauskas.

In addition, we thank Mr. Barry Huston of Massachusetts Electric Company, who granted permission to enter the property and inspect the dam.

- 2.2 Construction Records. There are no construction records available.
- 2.3 Operating Records. No operating records are available, and there is no daily record kept of the elevation of the pool or rainfall at the dam site.
- 2.4 Evaluation
- a. Availability. Due to the age of this dam, there is no engineering data available.
 - b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.

CURTIS PONDS DAM

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c. Validity. The limited engineering data available is valid.

CURTIS PONDS DAM

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I inspection of the dam at Curtis Ponds was performed on September 18, 1978. A copy of the inspection checklist is included in Appendix A. Previous inspections of this dam have been conducted by others since 1925. A partial listing of these inspections is in Appendix B. An inspection was made in 1973 by personnel from the Massachusetts Department of Public Works. A copy of their report is included in Appendix E.

- b. Dam. Curtis Ponds Dam is an earthfill dam with vertical, concrete or stone walls on the upstream and downstream faces. The dam is generally in fair condition. No seepage from the embankment was observed, although the area immediately downstream of the dam has been filled in nearly to the crest, which prohibits inspection of the downstream face. The crest of the dam is covered with miscellaneous fill including soil, coal, and some grass. Several signs of distress were observed at the site. There is a large eroded depression which extends from the edge of the spillway channel along the downstream edge of the dam for a distance of about 130 feet (see Figure B-1). The depression is up to 90 feet wide and 6 feet deep. It appears to be due to erosion by surface runoff. There is a moderate growth of brush at the bottom of the upstream wall of the dam, from the bend to the northwest abutment. There is minor cracking of the concrete portion of the wall, and slight staining and spalling along the water line.

- c. Appurtenant Structures. The spillway is an ungated, 80-foot long, broad crested weir with a stepped stone cascade on the downstream face. A steel frame is mounted on the crest of the spillway and formerly supported a walkway and flashboards. The framework is rusted and

CURTIS PONDS DAM

eroded at the base and is an obstruction to flow over the spillway. Wood debris is scattered on the crest and down the cascade. There is minor cracking and staining of the sidewalls.

There is no operable outlet at this dam. The remnants of a gate house, about 12 intake gates and a flume to return water to the pond are located just upstream of the spillway. These structures have not been used for about 10 years. Some are missing slide gates, some are filled with debris from building demolition, and all are missing operating mechanisms.

- d. Reservoir Area. The lower half of the area around Curtis Ponds is thickly developed with commercial and industrial buildings. The area around the upstream half of the pond is occupied by a park and a cemetery. It is unlikely that much more development could occur in the future. The area is cleared and paved or grassed with slopes of 5 to 20 percent.
- e. Downstream Channel. Discharge from the spillway flows into a 70-foot wide channel with vertical concrete sidewalls. This channel intersects a second channel at 150 feet downstream, and flow is directed southerly beneath Webster Street. The channel below the spillway contains four concrete piers which formerly supported a railroad trestle. The channel bottom contains scattered debris, mostly at the toe of the spillway. Farther downstream, soil has been deposited in the bottom, and a thick growth of grass covers about half of the channel bottom. The sidewalls are cracked in places and slight staining and spalling occurs along the water line. The channel downstream of the spillway is in good condition, except for a thick growth of grass along the bottom of the southwest sidewall.

- 3.2 Evaluation. The above findings indicate that the dam is in fair condition, and there are several deficiencies which require attention. It is evident that the dam is not adequately maintained. Recommended measures to improve these conditions are stated in Section 7.3.

CURTIS PONDS DAM

SECTION 4
OPERATING PROCEDURES

- 4.1 Procedures. There are no operating procedures at this dam. The property around the dam is fenced off, and the gate is kept locked.
- 4.2 Maintenance of Dam. The dam is not adequately maintained. There is a large depression eroded downstream of the crest, and brush is growing at the bottom of the upstream wall on the northwest half of the dam. Debris is scattered on the crest and downstream face of the spillway. The steel walkway on the crest of the spillway is deteriorating and forms an obstruction to flow.
- The most recent maintenance reported at the dam was removal of flashboards and the deck for the walkway over the spillway in about 1976. The last major repair was filling of the crest of the dam with up to 20 inches of gravel after the flooding in 1955.
- 4.3 Maintenance of Operating Facilities. There is no outlet at this dam to draw down the pond in an emergency. The abandoned gate house and intake structures are partly demolished and inoperable.
- 4.4 Description of Any Warning Systems in Effect. There is no warning system in effect at this dam.
- 4.5 Evaluation. There is no regular program of maintenance or warning system in effect at Curtis Ponds Dam. This is undesirable considering the dam is in the "significant" hazard category. A program of inspection and maintenance and a surveillance system for this dam should be implemented as recommended in Section 7.3

CURTIS PONDS DAM

SECTION 5

HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

- a. Design Data. Curtis Ponds Dam is about 6,000 feet downstream of Leesville Dam. As part of the Worcester Diversion Studies by the U.S. Army Corps of Engineers, a Probable Maximum Flood (PMF) rate under the M.P.F. was established for Leesville. This value was adjusted for increased drainage area and used for Curtis Ponds Dam. The PMF rate was determined to be 950 cfs per square mile. Applying one-half the PMF to the 33.3 square miles of drainage area results in a calculated peak flood flow of 15,822 cfs. Since the diversion tunnel above Leesville Dam removes 6,000 cfs, a peak flood flow of 9,800 cfs was established as the inflow test flood. By adjusting the inflow test flood for surcharge storage, the maximum discharge rate was established as 9,500 cfs (285 cfs per square mile), with a water surface at El 481.0.

Flow over the crest of the dam during the test flood is predicted to be 2,800 cfs. Flow through the spillway would be 5,700 cfs. The maximum depth over the crest of the dam would be 3.7 feet with a discharge of 19.0 cfs per foot of width. Depth at critical flow would be at 2.3 feet with a velocity of 8.5 feet per second.

Hydraulic analyses indicate that the existing spillway can discharge 2,575 cfs when the pond level is at El 477.3, which is the low point on the crest of the dam.

- b. Experience Data. Hydraulic records are not available for this dam. The dam was, however, overtopped in the 1955 hurricane. It was reported that the pond level was about 4 feet above the crest of the dam (El 481), which corresponds closely with topographic maps of the flooded area which show a pond level at about El 480. Since that event, however, the diversion tunnel was built upstream, which will decrease the quantity of flow in the future.

CURTIS PONDS DAM

- c. Visual Observations. Discharge from Curtis Ponds is over an ungated, broad crested weir and down a stepped masonry cascade. The spillway is crossed by a steel structure which formerly supported a walkway and flashtboards. This structure could be blocked by trash which could impede flows. A more detailed record of observation is included in Section 3 Visual Inspection.

- d. Overtopping Potential. Overtopping of the dam by about 3.7 feet is expected under the cut-flow test flood of 9,500 cfs. In the event of overtopping, complete failure of the dam could occur, although backwater from the downstream channels will minimize this possibility.

Failure of the dam, combined with spillway discharge at El 477.3, would produce a peak flow of 5,375 cfs. The tailwater depth would increase from 5.0 feet to 9.0 feet.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

- a. Visual Observations. The elevation of the structural stability of Curtis Ponds Dam is based on the visual inspection conducted on September 18, 1978. As discussed in Section 3, Visual Inspection, the dam is in fair condition. There is a large area of erosion immediately downstream of the dam, and brush is growing on the northwest half of the upstream wall. The concrete on the upstream wall and sidewalls of the spillway is cracked and spalled.

Although no seepage or unusual settlement was observed at the site, the dam is considered to be a potential hazard because of the lack of a regulating outlet, the deficiencies noted above and the abandoned steel walkway structure.

- b. Design and Construction Data. The dam at Curtis Ponds was built in 1837. There are no plans, specifications or computations available from the Owner, County or State offices on the design, construction or repair of this dam. A letter from the Owner to the Worcester County Commissioners dated 1923 states that "the dam proper is made of stone" and "the abutments or wing walls are stone on each side with plank piling in the center, then filled with dirt." Information does not appear to exist on the type, shear strength and permeability of the soil and/or rock materials of the embankment.
- c. Operating Records. There is no evidence that instrumentation of any type was ever installed in Curtis Ponds Dam. The performance of this dam under prior loading can only be inferred by physical evidence at the site.
- d. Post-Construction Changes. There are no as-built drawings available for Curtis Ponds Dam. Information on construction changes is derived from previous inspection reports. Sometime between

CURTIS PONDS DAM

1923 and 1938, the concrete wall on the upstream face of the dam was constructed. It appears in the field that the original dry-stone wall was removed to about El 472, and the concrete wall was added on top.

The dam was overtopped by about 4 feet during the hurricane of 1955. Soon afterward, erosion of the crest was repaired by placing up to 20 inches of gravel fill along the upstream concrete wall.

- e. Seismic Stability. The dam is located in Seismic Zone No. 2 and in accordance with Phase I "Recommended Guidelines" does not warrant seismic analyses.

CURTIS PONDS DAM

SECTION 7

ASSESSMENT, RECOMMENDATION, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. Curtis Ponds Dam was neither designed nor constructed according to current state-of-the-art procedures. Based upon the visual inspection of the site, the lack of engineering data, and limited operational or maintenance information, there are deficiencies which must be corrected to assure the continued performance of this dam. Generally, the dam is considered to be in fair condition. There is no regulating outlet for the dam. There are also several conditions which require repair at the site: erosion of a large area below the downstream wall of the dam, an abandoned steel structure across the crest of the spillway which collects debris and obstructs flow, and wood and debris scattered on the crest of the spillway and in the downstream channel.

Hydraulic analyses indicate that the spillway can discharge a flow of 2,575 cfs when the pond level is at El 477.3, which is the low point on the crest of the dam. The spillway can discharge 27 percent of the test flood outflow of 9,500 cfs.

- b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and engineering judgment.
- c. Urgency. The recommendation and remedial measures outlined below should be implemented by the Owner within two years after receipt of this Phase I Inspection Report.
- d. Need for Additional Investigation. Additional investigations to further assess the adequacy of the dam are outlined below in Section 7.2.

CURTIS PONDS DAM

- 7.2 Recommendation. In view of the concerns over the continued performance of the dam, it is recommended that the Owner employ a qualified consultant to design a regulating outlet for the dam.

The recommendations on repairs and maintenance procedures are outlined below under Section 7.3, Remedial Measures.

7.3 Remedial Measures

- a. Operating and Maintenance Procedures. The dam and appurtenant structures are not adequately maintained. It is recommended that the Owner accomplish the following:
- (1) backfill the large depression eroded along the downstream wall of the dam,
 - (2) remove the steel framework across the crest of the spillway,
 - (3) clear wood and trash from the spillway and downstream channel,
 - (4) implement a systematic program of maintenance inspections. As a minimum, the 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 all applicable State regulations,
 - (5) institute a definite plan for surveillance and a warning system during periods of unusually heavy rains and/or runoff,
 - (6) conduct technical inspections of this dam on an annual basis.

- 7.4 Alternatives. An alternative to implementing the recommendations and remedial measures listed above would be to drain the pond and breach or remove the dam.

CURTIS POND'S DAM

APPENDIX A
PERIODIC INSPECTION CHECKLIST

CURTIS PONDS DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Curtis Ponds Dam

DATE Sept. 18, 1976

TIME 1:00 - 5:00 PM

WEATHER overcast, 65° F

W.S. ELEV. 472.0* 463.9*
*based on assumed benchmark EI 472.0
on crest of spillway

PARTY:

- | | |
|-------------------------|----------------------|
| 1. <u>Ed Greco</u> | 6. <u>Henry Lord</u> |
| 2. <u>Carol Sweet</u> | 7. _____ |
| 3. <u>Lyle Branagan</u> | 8. _____ |
| 4. <u>Dave Cole</u> | 9. _____ |
| 5. <u>Frank Sviokla</u> | 10. _____ |

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>dam</u>	<u>Ed Greco / Carol Sweet</u>	
2. <u>spillway</u>	<u>Lyle Branagan / Ed Greco</u>	
3. _____		
4. _____		
5. _____		
6. _____		
7. _____		
8. _____		
9. _____		
10. _____		

PERIODIC INSPECTION CHECK LIST

PROJECT Curtis Ponds Dam DATE Sept. 18, 1978
 PROJECT FEATURE dam embankment NAME Ed Greco
 DISCIPLINE geotechnical NAME Carol Sweet

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	varies from 477.3 to 480.0
Current Pool Elevation	472.1
Maximum Impoundment to Date	approx. El 480 - August 1955
Surface Cracks	gullies eroded in fill downstream of dam
Pavement Condition	not applicable
Movement or Settlement of Crest	crest irregular
Lateral Movement	none visible
Vertical Alignment	slightly irregular
Horizontal Alignment	bends upstream at about 125 feet northwest of spillway
Condition at Abutment and at Concrete Structures	left abutment lies into natural ground right abutment is concrete wall
Indications of Movement of Structural Items on Slopes	none visible
Overlapping on Slopes	not apparent
Scouring or Erosion of Slopes or Abutments	severe erosion of depression downstream of dam
Rock Slope Protection - Riprap Failures	concrete wall on upstream slope, stone wall on downstream slope
Unusual Movement or Cracking at or near Toes	none visible - area downstream of dam filled in nearly to crest
Unusual Embankment or Downstream Seepage	none visible - area covered with fill
Piping or Boils	none visible
Foundation Drainage Features	weep holes in walls of downstream channel
Toe Drains	none visible
Instrumentation System	none visible

PERIODIC INSPECTION CHECK LIST

PROJECT Curtis Ponds Dam DATE Sept. 18, 1978
 PROJECT FEATURE spillway NAME Lyle Branagan
 DISCIPLINE geotechnical NAME Ed Greco

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	natural stream bed - 2 wooden piers in bottom
General Condition	some debris - fair
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	none
Floor of Approach Channel	shallow - some debris
b. Weir and Training Walls	vertical concrete walls - steel framework across crest
General Condition of Concrete	fair to good - erosion at water line, cracks in left wall
Rust or Staining	minor - steel framework corroded at bottom
Spalling	minor
Any Visible Reinforcing	none
Any Seepage or Efflorescence	none
Drain Holes	none
c. Discharge Channel	5-step cascade below spillway - discharge channel w/vertical concrete walls
General Condition	fair
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	none
Floor of Channel	scattered debris - grass growing on half of floor
Other Obstructions	4 abandoned concrete piers formerly supported railroad

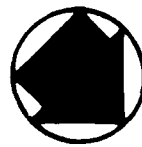
APPENDIX B
PLAN OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam	B-1
Figure B-2, Sections of Dam	B-2
Previous Inspections (Partial Listing)	B-3
Inspection Reports by Massachusetts Department of Public Works, dated January 26, 1973	B-4

CURTIS PONDS

NS 472.1

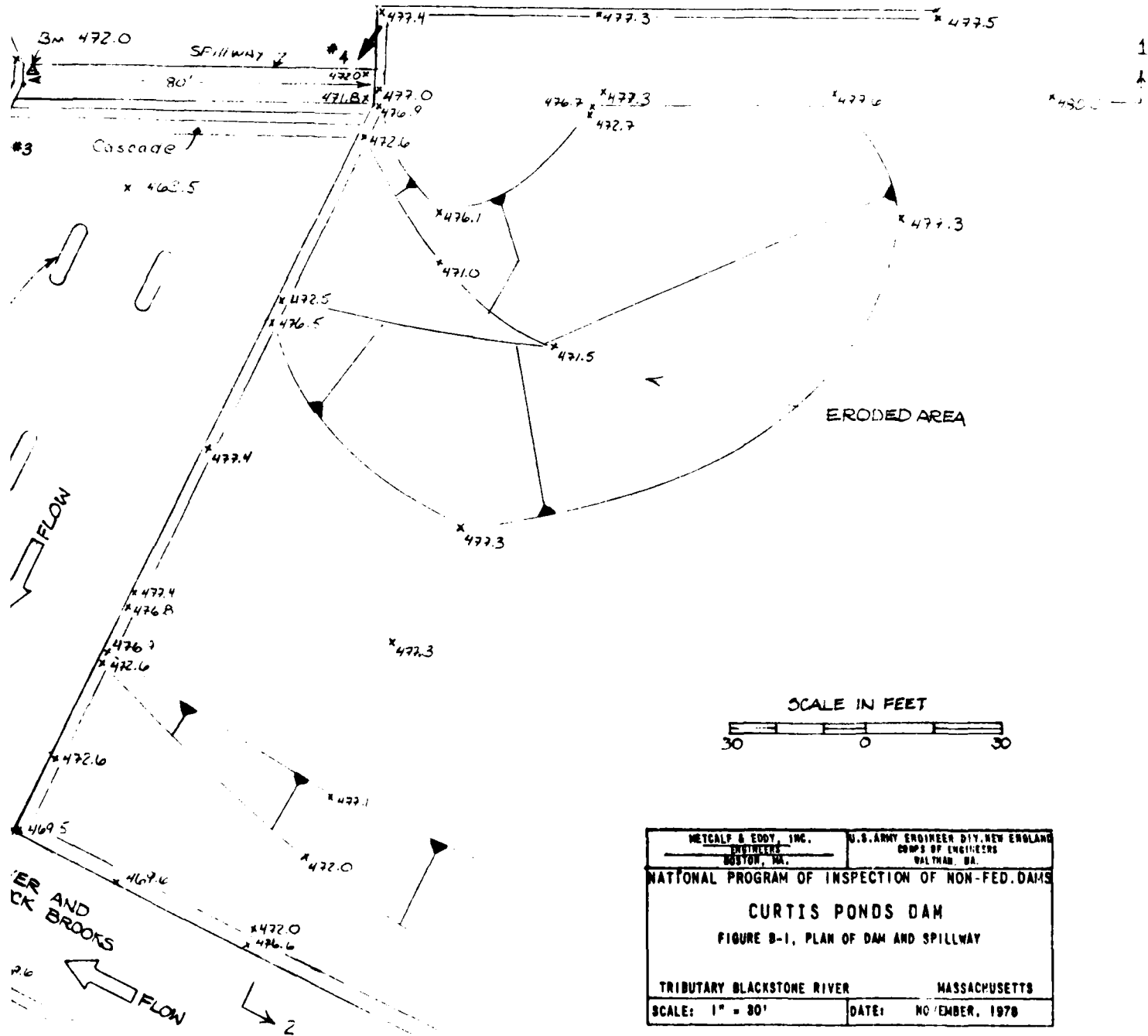
2
01 ←



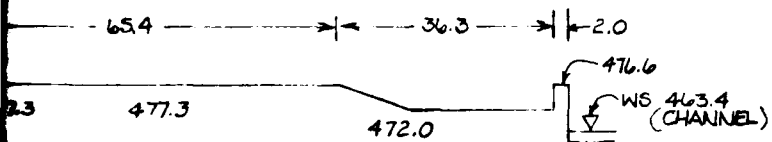
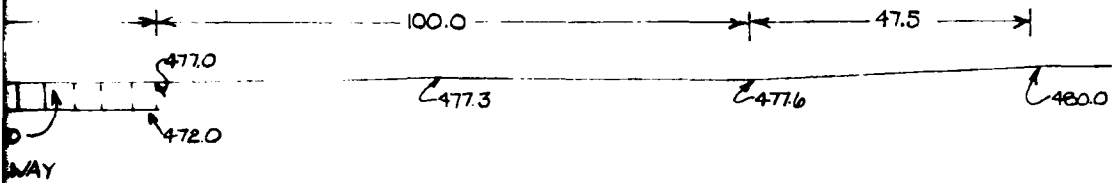
END OF DAM
ABOUT 200 FT. NORTHWEST

ENT. 170.1

172.1



METCALF & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DISTRICT NEW ENGLAND CORPS OF ENGINEERS DALTHAM, MA.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
CURTIS PONDS DAM	
FIGURE B-1, PLAN OF DAM AND SPILLWAY	
TRIBUTARY BLACKSTONE RIVER	MASSACHUSETTS
SCALE: 1" = 80'	DATE: NOVEMBER, 1978



WISALE & EDDY, INC. ENGINEERS BOSTON, MA.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS BALTIMORE, MD.
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS	
CURTIS PONDS DAM	
FIGURE B-2, SECTIONS THROUGH DAM	
TRIBUTARY BLACKSTONE RIVER	MASSACHUSETTS
SCALE: 1" = 30'	DATE: NOVEMBER, 1970

2

(M.M.) PLAN NO. 1111 DAM NO. 67-05
 C.C. DOCKET NO. 348

TOWN OR CITY *Worcester* DECREE NO.
 LOCATION *Curtis Pond - Webster St.*

DESCRIPTION OF DAM
Stone Abts. plank pile, earth fill wall
 El. top 109
 El. base 108

DESCRIPTION OF RESERVOIR & WATERSHED
 Name of Main Stream *Tatnuck brook*
 " " any other Streams *From Leesville Pond, etc.*
 Length of Watershed .
 Width " "
 Is Watershed Cultivated
 Percent in Forests
 Steepness of Slope
 Kind of Soil *Rocky*
 No. of Acres in Watershed *32.38 S & M*
 " " " Reservoir *52.*
 " " " Reservoir
 Width " "
 Max Flow Cu. Ft. per Sec.
 Head of Flashboards-Low Water
 " " " High "

Type *Stone Abts*
 Length
 Height
 Thickness top *Abt. 24"*
 " bottom
 Downstream Slope
 Upstream " "
 Length of Spillway
 Size of Gates *2-5.9' x 6'-9" - 1-10' x 7'*
 Location of Gates *South end Dam*
 Flashboards used *Yes supported on steel structure.*
 Width Flashboards or Gates
 Dam designed by
 " constructed by
 Year constructed *1837*

GENERAL REMARKS
Owned by Worcester Electric Lt. Co. - Mass Elec Co.
 Inspected: *Aug. 15, 1925 L.O. Marden*
 " *Oct. 27, 1928 "*
 " *Mar. 7, 1929 "*
 " *Dec. 17, 1931 "*
 " *Nov. 17, 1938 L. H. Spofford*
 " *Dec. 9, 1940 "*
 " *Dec. 7, 1942 L.O.M.-J.F.C.*

2. (Rev. 1) Bureau 10-97760

PREVIOUS INSPECTIONS (PARTIAL LISTING)
 COPY OF INSPECTION CARD ON FILE AT THE MASSACHUSETTS
 DEPARTMENT OF PUBLIC WORKS, DISTRICT OFFICE, WORCESTER.

PREVIOUS PAGE IS BLANK

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: City/Town WORCESTER Dam No. 3-14-348-5
Name of Dam CURTIS POND DAM Inspected by H. J. [unclear]
Date of Inspection 1-20-73

2. Owner/s: per: Assessors _____ Prev. Inspection
Reg. of Deeds _____ Pers. Contact _____

1. MASS. ELEC CO. 939 SUMNER ST WORCESTER
Name St. & No. City/Town State Tel. No.
2. _____
Name St. & No. City/Town State Tel. No.
3. _____
Name St. & No. City/Town State Tel. No.

3. Caretaker (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.
Name: _____ St. & No.: _____
City/Town: _____ State: _____ Tel. No.: _____

4. No. of Pictures taken NONE

5. Degree of Hazard: (if dam should fail completely)*
1. Minor _____ 2. Moderate
3. Severe _____ 4. Disastrous _____

* This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual
Operative _____ yes; _____ No.

Comments:

7. Upstream Face of Dam: Condition:
1. Good 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

8. Downstream Face of Dam:

Condition: 1. Good ✓ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

9. Emergency Spillway:

Condition: 1. Good _____ 2. Minor Repairs _____
3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

10. Water Level at time of inspection: 5 ft. above _____ below ✓
top of dam ✓ principal spillway _____
other _____

11. Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment _____
Animal Burrows and Washouts NONE
Damage to slopes or top of dam NONE
Cracked or Damaged Masonry RETAINING WALL HAS SLIGHT SPALLING
Evidence of Seepage NONE
Evidence of Piping NONE
Erosion NONE
Leaks NONE
Trash and/or debris impeding flow NO
Clogged or blocked spillway NO
Other _____

12. Remarks & Recommendations: (Fully Explain)

THE DAM AND SPILLWAY ARE IN GOOD CONDITION. THERE IS SOME SPALLING OF A SMALL SECTION OF THE CONCRETE RETAINING WALL ON THE RIGHT SIDE OF THE DAM. THE DAM HAS BEEN USED BY THE MASS ELEC. CO. AS A WATER SOURCE FOR COOLING PURPOSES. THE COMPANY IS MOVING THIS OPERATION AND NO MORE WILL THIS DAM SERVE FOR INDUSTRIAL PURPOSE

13. Overall Conditions:

- 1. Safe _____
- 2. Minor repairs needed _____
- 3. Conditionally safe - major repairs needed _____
- 4. Unsafe _____
- 5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

DESCRIPTION OF DAM

Submitted by F. HULLMAN
R. DUNHAM District 3
Date 1-26-73 Dam No. 3-14-348-05
City/Town Worcester
Name of Dam CURTIS POND DAM

1. Location: Topo Sheet No. ~~210~~ 21B

Provide 8 1/2" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: _____ Year/s of subsequent repairs _____

3. Purpose of Dam: Water Supply Recreational _____
Irrigation _____ Other INDUSTRIAL

4. Drainage Area: 32.30 sq. mi. _____ acres

5. Normal Ponding Area: 52 acres; Ave. depth _____
Impoundment: _____ gals.; _____ acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir
POWER PLANT
BRICK BUILDING i.e. summer homes, etc. _____

7. Dimensions of Dam: Length 600 ± Max. Height 12

Slopes: Upstream Face VERT

Downstream Face VERT

Width across top VARIES 50 - 200

8. Classification of Dam by Material:
Earth Conc. Masonry Stone Masonry
Timber _____ Rockfill _____ Other _____

9. A. Description of present land usage downstream of dam:
_____ % rural; 100 % urban.

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? yes _____ no _____

DAM NO. 3-11-345-05-

10. Risk to life and property in event of complete failure.

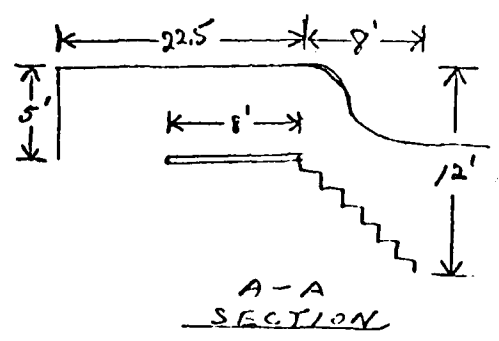
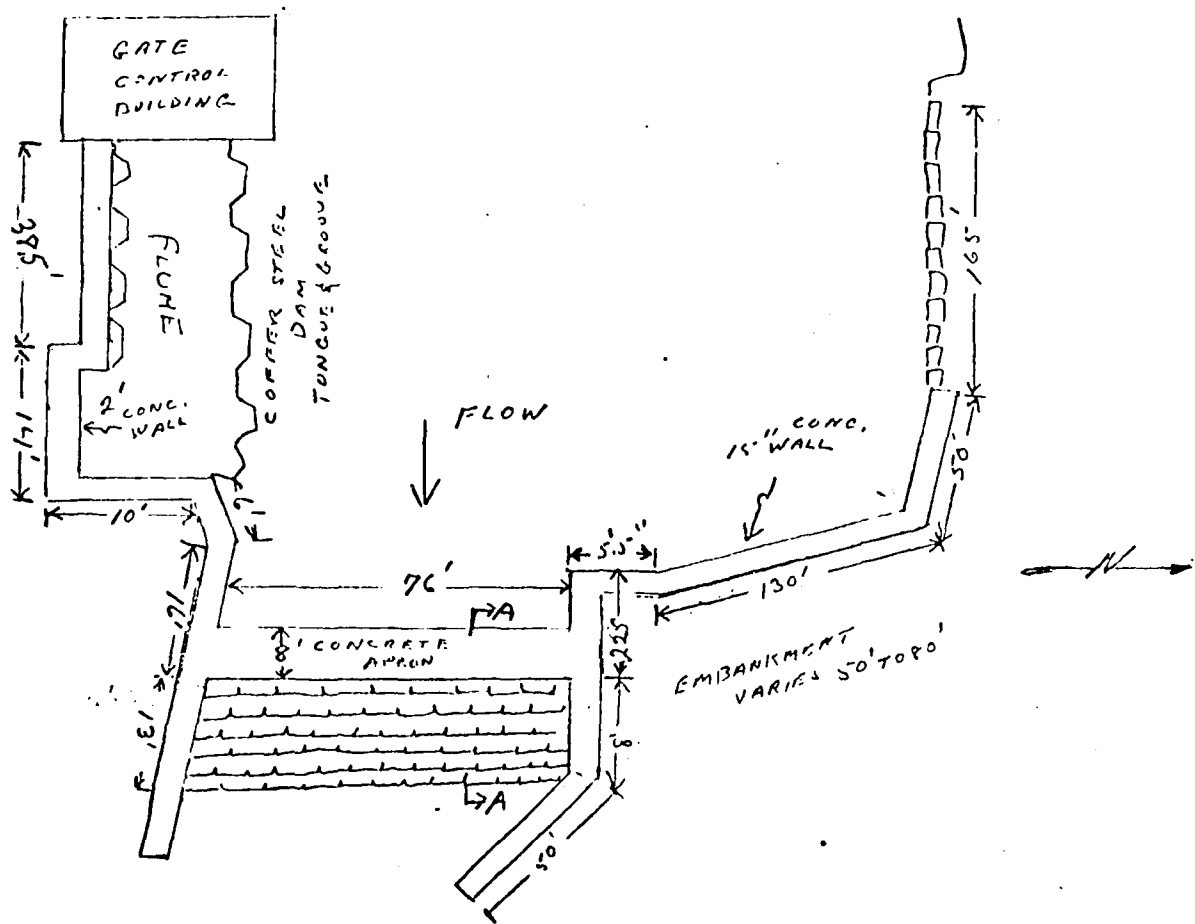
No. of people 50± .
No. of homes 6 .
No. of Businesses 12 .
No. of industries 1 . Type _____
No. of utilities 1 . Type ELEC PUMP
Railroads 1 .
Other dams NONE .
Other _____ .

11. Attach Sketch of dam to this form showing section and plan on 8½" x 11" sheet.

12. How to locate:

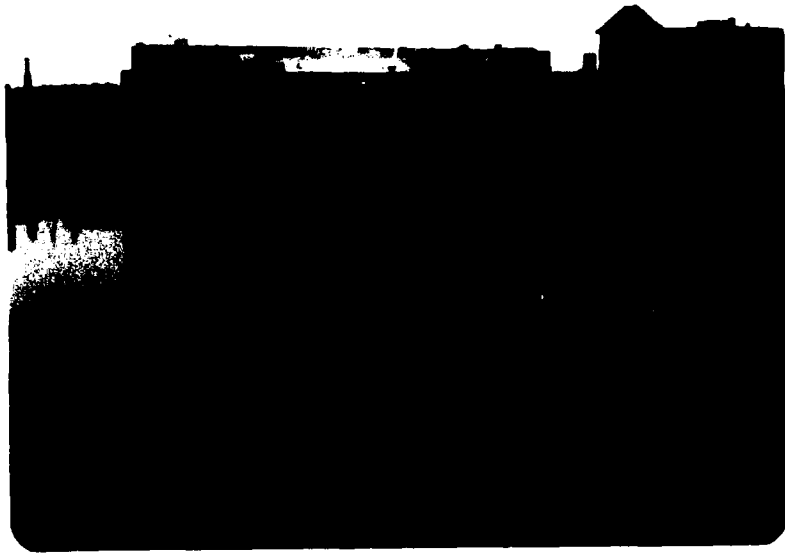
500± ON RIGHT SIDE OF WEBSTER ST
COMING FROM INTERSECTION OF WEBSTER &
CAMBRIDGE STREETS

CURTIS POND
DAM 3-14-24

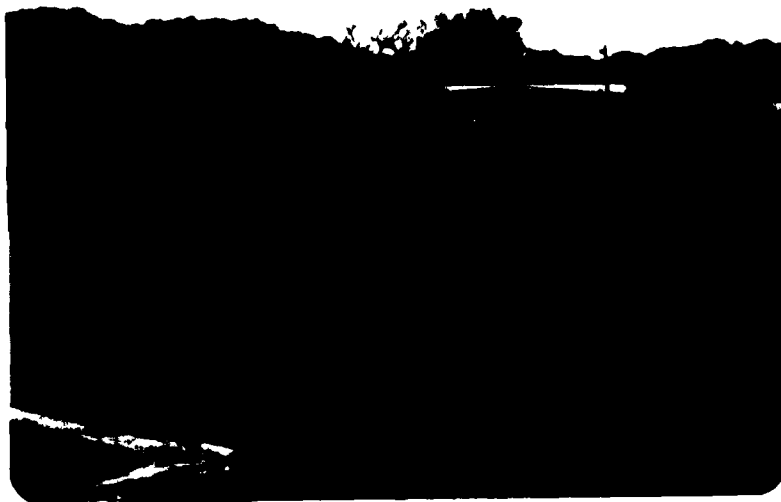


APPENDIX C
PHOTOGRAPHS

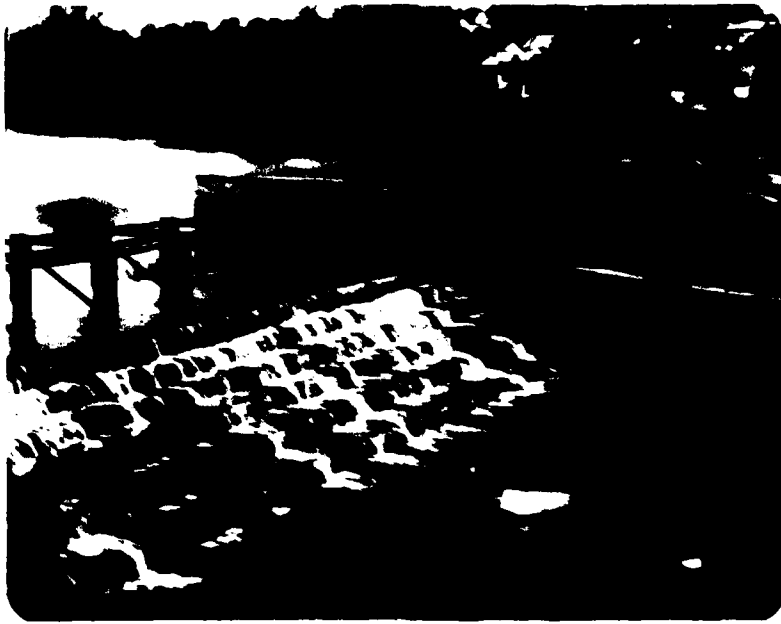
CURTIS PONDS DAM



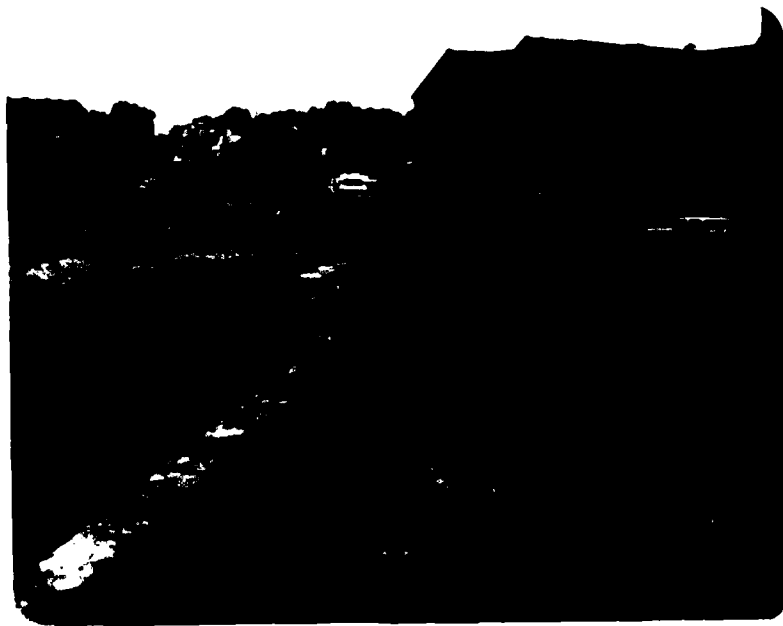
NO. 1 VIEW OF ABANDONED INTAKE STRUCTURES



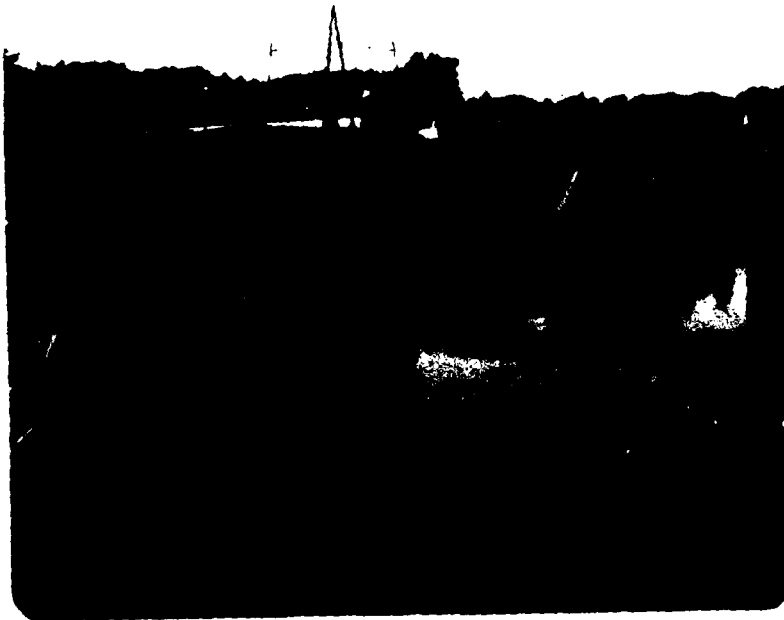
NO. 2 VIEW OF SPILLWAY AND NORTH ABUTMENT



NO. 3 VIEW OF SPILLWAY



NO. 4 VIEW OF DOWNSTREAM CHANNEL



**NO. 5 VIEW OF CONFLUENCE OF DOWNSTREAM
CHANNEL AND MIDDLE RIVER**

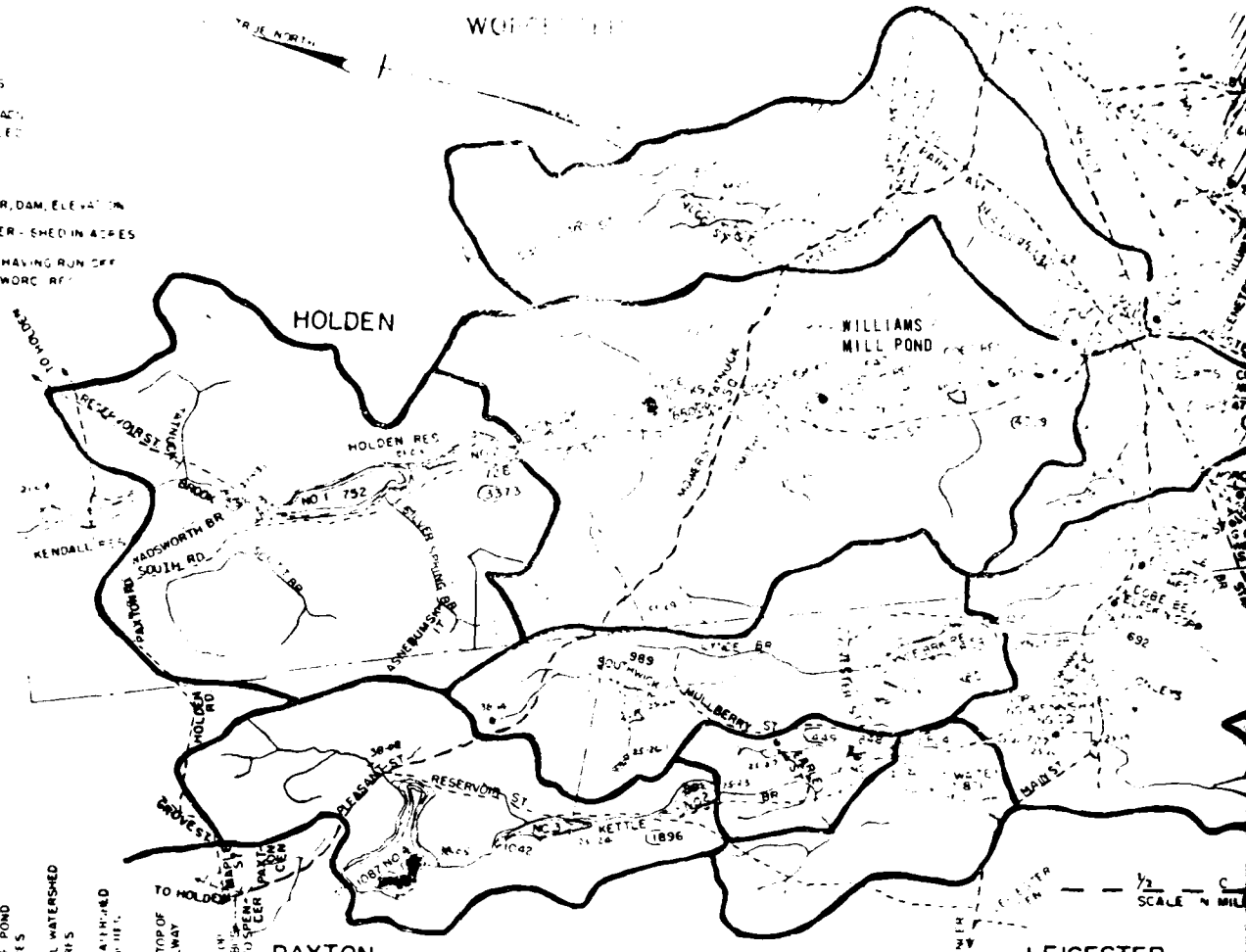


**NO. 6 VIEW OF WEBSTER STREET BRIDGE
OVER MIDDLE RIVER**

APPENDIX D
HYDROLOGIC AND HYDRAULIC COMPUTATIONS

	<u>Page</u>
Figure D-1, Watershed Plan	D-1
Hydrologic and Hydraulic Computations	D-2

- WATERSHED
- PRIMARY ROADS
- SECONDARY ROADS
- TRUCK RUTS
- RAILROADS
- TOWN LINES
- BODY OF WATER, DAM, ELEVATION
- AREA OF WATER-SHED IN ACRES
- WATER SHEDS HAVING RUN OFF UNPOUNCE BY WORC. REP.



POND NAME	CAPACITY OF POND IN MILLIONS OF GAL.	AREA OF POND IN ACRES	INDIVIDUAL WATERSHED IN ACRES	TOTAL WATERSHED IN ACRES	ELEV. OF TOP OF DAM SPILLWAY IN FT.	ELEV. OF HIGH WATER OF PLASHING IN FT.	YEAR BUILT	TYPE OF DAM	HIGH WATER MARK & WATER RIGHTS
							ORIGINAL PRESENT DAM		
01-02 CENTRAL WORCS	1.3	5.1			443.40		814	1899 EARTH MASONRY T. MBR. CORE PLAN B 77	ELEV. 443.47 COPPER BOLT TOP OF STONE BOUND. S. OF SPILLWAY WORCESTER. ELEV. 443.47 PLAN 1135. WAY FRSP. PLAN 8039
01-04 COES RESERVOIR		19							
01-05 CURTIS POND	62	62	893	6663					ELEV. 435.5 TWO FEET BELOW BOLT IN EARTH CONCRETE WALL. S. OF SPILLWAY WORCESTER. ELEV. 435.5 PLAN 1135. WAY FRSP. PLAN 8039. HIGH WATER MARK
1-01 MILTON POND	42	25.4	1147		96.56	28.38	1932	GATE IS SCREW STEM 24" PIPE EARTH WITH CONCRETE CORE WALL PLAN FOR CORE WALL 5682 CONCRETE SPILLWAY PLAN 1533	1959 REPAIRS
1-15 LEESVILLE POND	25		1522	1590					
01-05 MOSS RESERVOIR	256	158	699	699	1079	112.17	1921	1928 CONCRETE GRAVITY SECTION COVERED WITH EARTH GATE SCREW STEM 36" 30" BOX OUTLET	ELEV. 112.08 BRASS PLUG IN EDGE EAST SIDE OF POND. SOUTH OF SPILLWAY. PLAN 1135. WAY FRSP. PLAN 8039. HIGH WATER MARK
1-04 PONDVILLE POND	25	45	2639	4746				STONE MASONRY	
30-21 RAMSHORN POND	127	148	1527	1527	22.0	24.0	1873	1872-3 EARTH PUDDED WITH CHESTNUT CUTOFF WALL ALONG DAM	ELEV. 24.29 BOUND. IN LEDGE ON WESTERLY SHORE ELEV. OF N. TOP OF N.W. BRIDGE WIND WALL 22.00
30-21 RAMSHORN MEADOW POND	22	38	580				1916	GATE EARTH WITH CONCRETE CORE WALL CONCRETE SPILLWAY PLAN	PROPERTY MAP 8033
01-03 STILL WATER POND	35	30	608	2419					
1-02 STONEVILLE POND	45	4874	7478					BACK POND CONCRETE	PROPERTY MAP 8769 (1904)
1-02 STONEVILLE RESERVOIR	85	68	1772	1772					PROPERTY MAP 8769 (1904)
01-07 SOUTH GATE POND	5	15	83					GATE EARTH & STONE WALL 30" 30" OUTLET	FROM M. BONZEY 97 BK 123, P. 90
01-01 SOUTH WORKS POND	30	30	2472	43804	443.04		1921	FLOOD GATE BACK POND W/ TAKE GATE - SCREW STEM INSTALLED IN 1921. PLAN 3355. WAY FRSP. PLAN 8039	ELEV. 443.47 SAME AS CENTRAL WORCS. SOUTH OF SPILLWAY. PLAN 1135. WAY FRSP. PLAN 8039. HIGH WATER MARK

NOTE: THE INFORMATION SHOWN ON THIS PLAN IS DRAWN FROM EXISTING PLANS, & FROM FILES OF SURVEY & MAPPING. PARTICULARLY THE 1870-1875 REPORTS & 1874-1875 AND MOSS RESERVOIR DATA SUPPLIED BY ORIGINAL OWNERS OF CEDAR SWAMP.

I Test Flood, 100 year storm & Storage Functions

1- Total Drainage Area - 33.31 mi²

2- Pond(s) Area: 55 acres = 0.086 mi²
 Swamp(s) Area: N/A
 Total Area Pond(s) & Swamp(s): N/A

% Ponds & Swamps = N/A

3-

} Say Ave Slope = N/A

→ Use Leesville PFR based on studies for diversion tunnel

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be related to Leesville and taken at 950 c.f.s./mi²

Size Class: Small ; Hazard Pot.: Significant; Spill. Des. Flood: 100 yr to 1/2 PMF
 Use: Test Flood = 1/2 PMF - Dam very low - failure minor effect in flood

5- Test Flood Inflow = 1/2 (950) 33.31 - 6000 = 9800 cfs

* 6000 cfs removed due to diversion above Leesville

6- Pond Storage

The pond area is 0.086 sq. mi. at elev. 472.
 Based on a const. area, storage increases at 55 ac. feet per foot of depth increase.
 At pond elev. 477.3, 291 acre feet is stored above the spillway elevation

7- 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

$$S (\text{in Inches}) = 12 D \left(\frac{0.086}{33.31} \right) = .031 D; R = \text{shr rain in in.}$$

D = Storage Depth (above spillway) on reservoir, in feet

8- Storage Functions: (F_{TF}) ; D = 0 @ Pond El. 472

$$F_{TF} = 9800 - 1034 S = 9800 - 32 D$$

II Dam Discharge Ratings

A- Spillway (Assume flash board struct removed)

Broad Crest - 80' wide - say 79' side contr

$Q_s = 2.67 H^{1.5}$ [Ref. V.T. Chow - Open Channel Flow - p. 100]

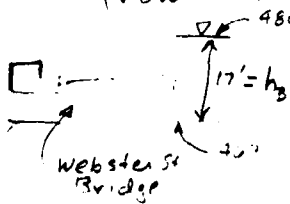
$\therefore Q_s = 211 H^{1.5}$, $H = 0 @ \text{Pond El. } 472$

Pond El.	473	474	475	476	477	478	479	480	481	482
Q_s	211	597	1092	1688	2359	3101	3908	4774	5697	6672



B- Downstream Control

- 1- In 1955 Kettle Brook Gage indicated 3970 c.f.s as its low during storm. Just below Curtis Ponds Dam a fire house has a flood marker at about elev. 480 for the same storm
- 2- Flow @ Curtis in 1955: $3970 \left(\frac{32.5 \text{ mi}^2}{31.3 \text{ mi}^2} \right) = 4150 \text{ c.f.s}$ (inst of 430)
- 3- Assume constriction downstream control pond elev. from about elev. 480 ±



$Q_c = K h_B^{1/2}$
 $4150 = K (17)^{1/2}$, $K = 1006$

This is $Q_c @ \text{Curtis}$ Relation assumes flow from Truck Bk, Beaver Brook, etc. is proportional to Q_c

h_B	15'	16'	17'	18'	19'	20'
Pond El.	478	479	480	481	482	483
Q_c	3900	4000	4150	4300	4400	4500

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II Dam Discharge Rating (Cont.)

C - Crest Flow

Assume all downstream "controls" removed.

Use $g = 2.67 H^{1.5}$ [Ref. V.T. Chow "Open Chan. Hydr." p. 53]

North of Spillway: 150' @ elev. 477.3 ±, $Q_{1c} = 400 H^{1.5}$
 South of Spillway: 200' @ elev. 479.3 ±, $Q_{2c} = 534 H^{1.5}$

Pond El.	478	479	480	481	482	483	484
Q_{1c}	234	887	1775	2846	4075		
Q_{2c}	—	—	313	1184	2369	3800	5441
Q_c	234	887	2088	4030	6444		
Add Q_s	310	3908	4774	5697	6672		
Q_{Tot}	3335	4795	6862	9727	13116		

III Summary

A - Crest Flow @ Min Crest Elev.

$g_{cr} = 2.67 (481 - 477.3)^{1.5} = 19 \text{ cfs/ft.}$

Where Critical:

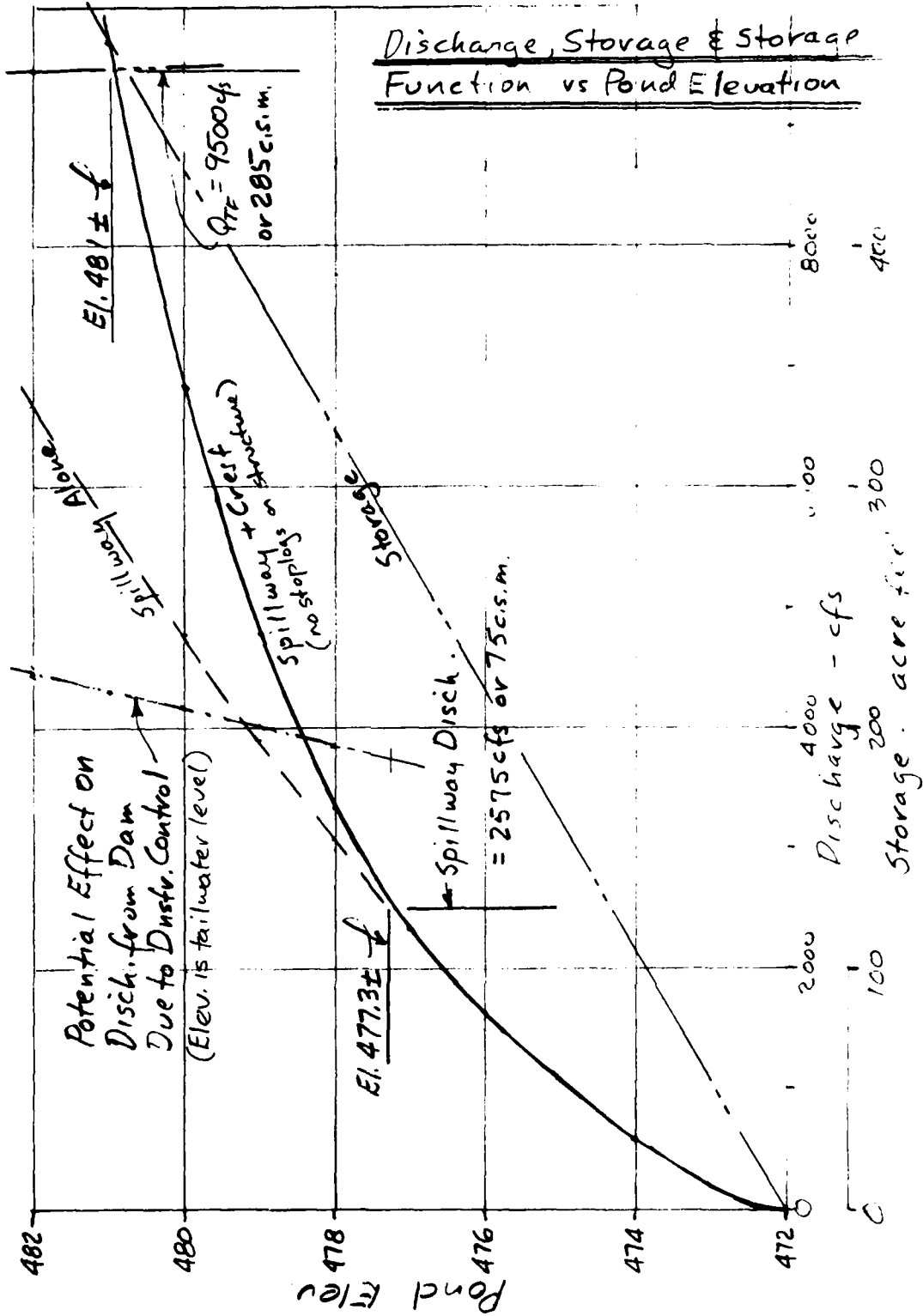
$y_c = 2.24'$, $V_c = 8.5 \text{ fps.}$

NON-PRODUCING GRID - 145

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(IV)

Discharge, Storage & Storage Function vs Pond Elevation



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Ⓟ Failure of Dam

Pond Elevation - 477.3 (Min. Crest Elev.)
 Toe Elevation - 463.5
 $Y_0 = 13.8$

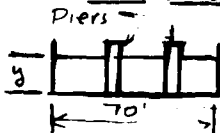
Dam Length Subject to Breaching = 80'
 $W_0 = 40\% (80') = 32'$

$Q_B = 1.68 W_0 (Y_0)^{1.5} = 1.68 (32') (13.8)^{1.5} = 2800 \text{ cfs}$

Storage Volume Released:

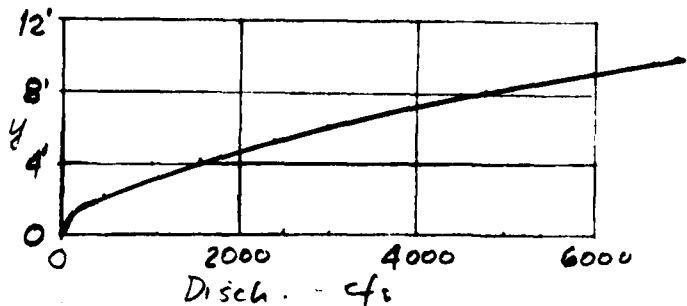
Storage Above Spillway: (@ elev. 477.3) 291 acre feet
 Storage Below Spillway: $\frac{1}{3} (8.5') (55) = 156$ " "
 $S = \text{Total Storage} = 447$ " "

Channel Hydraulics: (Use Channel Immediately dnstr. from dam)



$L = 70' - 2(5') = 60'$, $S = \frac{0.3}{170} = .00176$, $n = 0.025$
 $V = 2.5 R^{4/3}$, $R \approx y$

y	A	V	Q
2	120	4.0	480
4	240	6.3	1500
6	360	8.3	3000
8	480	10.0	4800
10	600	11.6	6962



Failure assumed to occur under peak spillway discharge of 2575 cfs, without crest flow. Dam failure added to this discharge produces total outflow 5375 cfs. Result is increase in depth of tailwater from 5' to 9', and vel. from 8 fps to 10 fps.

Time to Drain:

$\frac{43560 (447)}{3600 (\frac{1}{2}) (2800)} = 3.86 \text{ Hours, or } 232 \text{ Minutes}$

APPENDIX E
INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

CURTIS PONDS DAM

