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AD-A155 397

CONNECTICUT RIVER BASIN
MONSON, MASSACHUSETTS

ZERO MANUFACTURING COMPANY DAM
MA 00551

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This dam is a 150 ft. long stone masonry-concrete dam with a height of 18.2 ft. There are deficiencies which must be corrected to assure the continual performance of the dam. Generally the dam is in fair condition. Seepage at the base of the wall directly below the low-level outlet was observed. The dam is classified as small in size having a high hazard potential.		



DEPARTMENT OF THE ARMY
 NEW ENGLAND DIVISION, CORPS OF ENGINEERS
 424 TRAPELO ROAD
 WALTHAM, MASSACHUSETTS 02254

REPLY TO
 ATTENTION OF:
 NEDED

SEP 09 1981

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

Dear Governor King:

Inclosed is a copy of the Zero Manufacturing Company Dam (MA-00551) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. This report is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. I approve 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 vitally important.

Copies of this report have been forwarded to the Department of Environmental Quality Engineering, and to the owner, Zero Corporation, Monson, MA. Copies will be available to the public in thirty days.

I wish to thank you and the Department of Environmental Quality Engineering for your cooperation in this program.

Sincerely,

C. E. EDGAR, III
 Colonel, Corps of Engineers
 Division Engineer

Incl
 As stated

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ZERO MANUFACTURING COMPANY DAM

MA 00551

CONNECTICUT RIVER BASIN
MONSON, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
BRIEF ASSESSMENT

Identification No.: MA00551

Name of Dam: Zero Manufacturing Company Dam

Town: Monson

County and State: Hampden County, Massachusetts

Stream: Chicopee Brook, tributary of the Connecticut River

Date of Inspection: December 2, 1980

Zero Manufacturing Company Dam, also known as Ellis Mills Upper Dam is a 150-foot long stone masonry-concrete dam built in 1900. The dam has a maximum height of 18.2 feet. The top of the dam is at Elevation (El) 434.6, (National Geodetic Vertical Datum of 1929). The spillway is a narrow crested weir, 76 feet long, with the crest at El 427.0. Flashboards have been added to raise the pond an additional 1.85 feet to El 428.85. The outlet conduit is a 2.5 foot square box sluiceway and is controlled by a slide gate. The outlet works are located at an intake area to the right of the spillway. There are three additional outlets in the intake area. One of these outlets which is always open controls flow into a 16-inch diameter pipeline, that supplies water to a downstream power plant for heating the buildings at the dam. None of the outlets have been operated since 1962 and are considered to be inoperable.

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 and a review of the available data. Generally the dam is in fair condition.

The following deficiencies were observed at the site: heavy siltation upstream of the dam resulting in blocking the low-level outlet; displaced stone blocks at the toe of the spillway; inoperable outlets; seepage at the base of the wall directly below the low-level outlet; leakage through one of the outlets; severely spalled and eroded concrete along the upstream walls of the intake area; and a growth of saplings through the masonry walls at the abutments of the spillway.

ZERO MANUFACTURING COMPANY DAM

Based on Corps of Engineers' guidelines, the dam has been classified in the small size and high hazard categories. A test flood equal to one-half the probable maximum flood (PMF) was used to evaluate the capacity of the spillway. The test flood inflow is calculated to be 5,760 cubic feet per second (cfs). The test flood outflow with flashboards on the spillway is 5,730 cfs, resulting in a pond level at El 437.2. The test flood would overtop the dam by 2.6 feet. Hydraulic analyses indicate that the spillway with flashboards can discharge 3,600 cfs, or 62 percent of the test flood outflow before the dam is overtopped. Without flashboards, the pond would rise to El 436.7 and the spillway would discharge 4,250 cfs or 74 percent of the test flood outflow before the dam is overtopped.

It is recommended that the Owner employ a qualified registered professional engineer to determine the limits of dredging required upstream of the dam in the vicinity of the low-level outlet; investigate the source of leakage downstream of one of the outlets; investigate the seepage noted at the base of the spillway; investigate the extent of the deterioration of the concrete walls of the intake area; and establish a procedure for removing trees from the spillway abutments. In addition, the Owner should repair the deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of annual technical inspections, a plan for surveillance of the dam during and after periods of heavy rainfall, and a plan for notifying downstream residents in the event of an emergency at the dam.

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



A handwritten signature in cursive script, appearing to read "Edward M. Greco".

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

Massachusetts Registration
No. 29800

Approved by:

A handwritten signature in cursive script, appearing to read "Stephen L. Bishop".

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

Massachusetts Registration
No. 19703



This Phase I Inspection Report on Zero Manufacturing Company Dam (MA-00551) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

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

Aramast Mahtesian

ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering 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 will 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.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

ZERO MANUFACTURING COMPANY DAM

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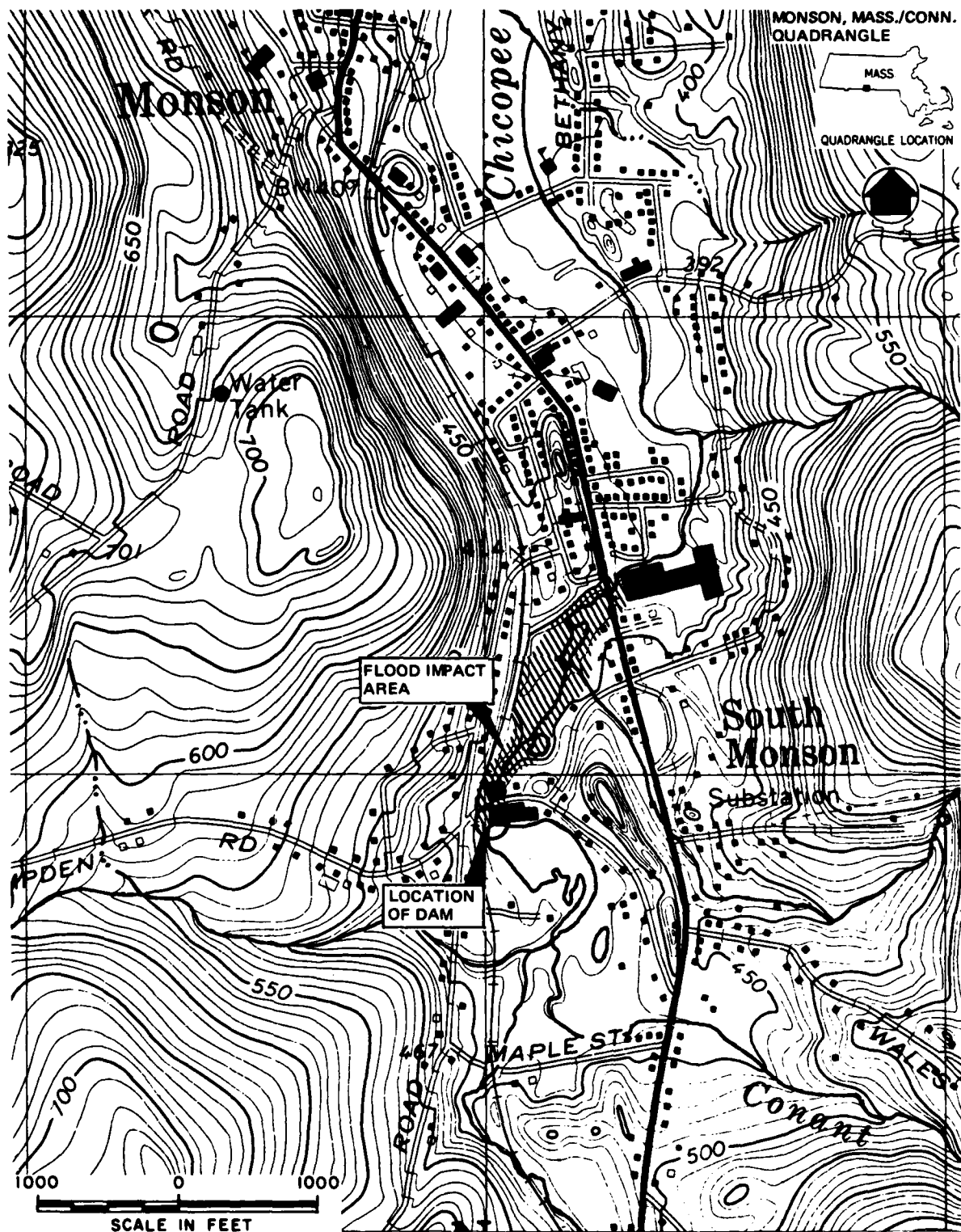
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**OVERVIEW
ZERO MFG. CO. DAM
MONSON, MASSACHUSETTS**





LOCATION MAP - ZERO MFG. CO. DAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

ZERO MANUFACTURING COMPANY DAM

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. 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 33-80-C-0054, dated April 18, 1980, 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 quickly initiate effective dam safety programs for non-Federal dams.
- (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. The dam is located on the Chicopee Brook in the Town of Monson, Hampden County, Massachusetts and in the Connecticut River Basin. The coordinates of this location are Latitude 42 deg. 5.3 min. north and Longitude 72 deg. 18.8 min. west. The Chicopee Brook joins the Chicopee River 6 miles downstream of the dam.

ZERO MANUFACTURING COMPANY DAM

b. Description of Dam and Appurtenances

Zero Manufacturing Company Dam consists primarily of a stone masonry spillway and an intake area with vertical concrete walls on the upstream face and stone masonry walls on the downstream face. The area between these two walls contains earthfill. The dam and spillway are approximately 150 feet long and the crest width varies from 9 to 22 feet, with a maximum height of 18.2 feet (see plan of Dam and Sections in Appendix B and photographs in Appendix C). The top of the dam (concrete walls in intake area) varies between El 434.6 and 434.7. The spillway is a 76 foot long narrow crested weir with a downstream slope of 6V to 1H (vertical to horizontal). The slope of the upstream face could not be determined due to its submerged condition and siltation of the pond to within 1 foot of the spillway crest. Wooden flashboards 1.85 feet high are mounted with steel pipes on the crest of the spillway. The crest of the spillway is at El 427 and the top of the flashboards is at El 428.8. At the center of the spillway, there is a 6 foot wide by 0.6 foot deep notch in the flashboards. Directly below this notch there is a 6 foot wide by 4 foot deep opening in the stone masonry with stoplogs in place. The top of the stoplogs is at the spillway crest (El 427).

The discharge channel between the dam and the bridge has cut-stone masonry side walls. Approximately 25 feet downstream of the dam, the stream passes beneath a factory building with an opening 80 feet wide by 4.5 feet high. There are approximately 10 building support columns founded on piers which obstruct flow in the channel. Beneath this structure, the channel narrows to a width of 26 feet at which point it passes beneath a bridge with a 29 foot wide by 9 foot high concrete opening. Downstream from the bridge, the channel is adjacent to and partially beneath a second building with flow partially obstructed by a 3 foot wide pier. This results in a channel width of 22 feet. The concrete side walls adjacent to this structure are 10 feet high. Approximately 230 feet downstream of the dam the stream returns to its natural unlined earth channel and has a width of 80 feet. The floor of the stream is the natural streambed and slopes at 5 percent.

The low level outlet (Outlet No. 1 as shown in Figure B-1) for the dam is a 2-1/2 foot square, stone box sluiceway with a 4 foot square slide gate on the upstream end controlled by a hand wheel operator. The downstream invert of this outlet is at El 422.9 and if operable could discharge at a flow of 58.5 cfs into the spillway channel. Reportedly Outlet No. 1 is inoperable.

ZERO MANUFACTURING COMPANY DAM

There are three additional outlets at the dam. Outlet No. 2 controlled flow to a 16-inch diameter pipeline which was cut and sealed downstream of the dam at Hampden Road during sewer construction in 1977. Outlet No. 3 controls flow to a second 16-inch diameter pipeline and is protected upstream by a steel trash rack and screen. The outlet is used to provide water for boilers at a downstream heating plant and the gate is always kept open. Outlet No. 4 is a slide gate which at one time controlled flow to a water wheel that powered machinery at the factory. Outlet Nos. 2 and 4 are reportedly inoperable.

- c. Size Classification. For a dam to be classified as small it must have a height between 25 feet and 40 feet and a maximum storage capacity between 50 acre-feet and 1,000 acre-feet. Zero Manufacturing Company Dam has been classified as "small" on the basis of its storage capacity of 70 acre-feet.
- d. Hazard Classification. Immediately downstream of the dam there are 2 factory buildings located directly above the stream channel beginning approximately 25 feet downstream of the dam (see Flood Impact Area shown on the Location Map). The foundations of these structures are partially founded on the floor of the channel. The sill of the first building downstream is 4.5 feet above the streambed and an assumed failure of the dam under dry weather conditions with the pond level at the top of the flashboards would result in a flood wave 11 feet high or 6.5 above the floor of the building causing a potential for building failure. It is possible that more than a few lives could be lost and a significant amount of property damage could occur. Accordingly, the dam has been placed in the "high" hazard category.
- e. Ownership. The dam is owned by Zero Corporation, 288 Main Street, Monson, Massachusetts 01057. Mr. Hess, General Manager, (telephone 617-267-5561) granted permission to enter the property and inspect the dam.
- f. Operator. The dam is operated by personnel from Zero Corporation.
- g. Purpose of the Dam. The water in the pond is supplied to boilers for heating purposes by the Zero Corporation. The original purpose of the dam was to provide water for heating and also power generation for the mill located at the dam.

- h. Design and Construction. Construction of Zero Manufacturing Company Dam was completed in 1900. There are no drawings or specifications available.

Previous inspection reports indicate that for the past 12 years, the dam has been in fair condition. The only known repairs made in the last 20 years were the replacing of the flashboards in 1975.

- i. Normal Operating Procedures. There are no operating procedures for the dam. The only maintenance work performed is to periodically clean the trash racks and screens at the intake to the 16 inch supply pipe. None of the hand wheel operator mechanisms have reportedly been operated or maintained for the past 18 years.

1.3 Pertinent Data

- a. Drainage Area. The drainage area is approximately 9,500 acres (14.8 square mile) and consists of flat and gently rolling land (see Figure D-1 in Appendix). The watershed ranges from El 1,150 to El 427. The drainage area includes drainage from Norcross Pond Numbers 1 through 4, Vinica, Squire, Duck, Calkins and Smith Ponds, Conant Brook Dam, and Chicopee and Conant Brooks. Conant Brook Dam, located 1.6 miles upstream from Zero Manufacturing Company Dam, was designed for flood control within a 7.8 square mile drainage area by the New England Division of the Corps of Engineers. The dam was designed to retain 9 inches of rainfall (spillway level) on the watershed. About 2.7 percent of the drainage area is ponds and swamps. In general, the undeveloped portions of the drainage area consist of 80 percent woodland, and 20 percent open fields. Light residential and commercial development occurs in the area.
- b. Discharge. Discharge from Zero Manufacturing Company Dam flows over the flashboards on the spillway and into an unlined stream where it passes beneath a factory approximately 25 feet downstream of the spillway. Water also discharges from the outlet into the spillway discharge channel.
- (1) Outlet: Size - 2-1/2 foot square opening. Invert El. - 422.9.
Discharge Capacity - 58.5 cfs at El 427.
 - (2) Maximum known flood at damsite: El 437+ (1955)
 - (3) Ungated spillway capacity at top of dam
3600 cfs at El 434.6 (with flashboards)
4250 cfs at El 434.6 (without flashboards)

ZERO MANUFACTURING COMPANY DAM

- (4) Ungated spillway capacity at test flood elevation:
5260 cfs at El 437.2 (with flashboards)
5530 cfs at El 436.7 (without flashboards)
- (5) Gated spillway capacity at normal pool elevation:
Not applicable.
- (6) Gated spillway capacity at test flood elevation:
Not applicable.
- (7) Total spillway capacity at test flood elevation:
5260 cfs at El 437.2 (with flashboards)
5530 cfs at El 436.7 (without flashboards)
- (8) Total project discharge at top of dam:
3600 cfs at El 434.6 (with flashboards)
4250 cfs at El 434.6 (without flashboards)
- (9) Total project discharge at test flood elevation:
5730 cfs at El 437.2 (with flashboards)
5760 cfs at El 436.7 (without flashboards)

c. Elevation (feet above National Geodetic Vertical Datum of 1929 (NGVD)). A benchmark was established at El 427 at the crest of the spillway. This elevation was estimated from a United States Geological Survey (U.S.G.S.) topographic map.

- (1) Streambed at toe of dam: 416.4
- (2) Bottom of cutoff: unknown
- (3) Maximum tailwater: unknown
- (4) Normal pool (without flashboards): 427.0
(with flashboards): 428.85
- (5) Full flood control pool: N/A
- (6) Spillway crest: 427.0
- (7) Design surcharge (Original design): unknown
- (8) Top of dam: 434.6
- (9) Test flood surcharge: 436.7 (without flashboards)
437.2 (with flashboards)

d. Reservoir (Length in feet)

- (1) Normal pool: 1,200
- (2) Flood control pool: N/A
- (3) Spillway crest pool: 1,200
- (4) Top of dam: 1,200
- (5) Test flood pool: 1,200

e. Storage (acre-feet)

- (1) Normal Pool (with flashboards): 70
- (2) Flood control pool: not applicable
- (3) Spillway crest pool (without flashboards): 50
- (4) Top of dam: 156
- (5) Test flood pool: 182

f. Reservoir surface (acres)

- (1) Normal pool: 13
- (2) Flood-control pool: N/A
- (3) Spillway crest: 13
- * (4) Test flood pool: 13
- * (5) Top of dam: 13

g. Dam

- (1) Type: stone masonry and concrete
- (2) Length: 150 feet
- (3) Height: 18.2 ft.

*Based on the assumption that the surface area will not significantly increase with changes in pool elevation from 427 to 437.7.

- (4) Top width: intake area varies between 22 feet and 9 feet; spillway - unknown
- (5) Side slopes: intake area - upstream - vertical
downstream 6V:1H
spillway - upstream - unknown
downstream 6V:1H
- (6) Zoning: unknown
- (7) Impervious core: unknown
- (8) Cutoff: unknown
- (9) Grout curtain: unknown
- (10) Other: N/A

h. Diversion and Regulating Tunnel Not Applicable

i. Spillway

- (1) Type: Narrow Crested Weir
- (2) Length of weir: 76 feet
- (3) Crest elevation with flashboards: 428.85
without flashboards: 427.0
- (4) Gates: N/A
- (5) Upstream channel: floor of sand and gravel
- (6) Downstream channel: natural streambed 85 feet wide channel flows beneath structure 25 feet downstream of dam. Channel narrows to 26 feet approximately 80 feet downstream of dam where it passes beneath bridge. At second structure the channel is obstructed by 3 feet wide pier.
- (7) General: At center of spillway 6 ft. wide by 4 ft. deep notch in stone masonry wall with stop logs in place.

j. Regulating Outlets

- (1) Invert El: 422.9.
- (2) Size: 2 1/2' x 2 1/2'

- (3) Description: 2 1/2' square stone masonry box
sluice way opening into spillway channel
- (4) Control mechanism: hand wheel operator for slide
gate (inoperable)
- (5) Other: N/A

ZERO MANUFACTURING COMPANY DAM

SECTION 2

ENGINEERING DATA

- 2.1 General. There was limited engineering data available for this Phase I inspection. There are no drawings, specifications, or computations available from the Owner, State, or County agencies. A copy of a previous inspection report dated October 1969, prepared by Tighe and Bond Consulting Engineers is included in Appendix B. The most recent inspection was conducted in 1972 by the Massachusetts Department of Public Works. A copy of that report is also given in Appendix B.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Department of Public Works; and the Hampden County Engineers Office. In addition, we acknowledge the assistance of Mr. William Cormier, Zero Corporation, who provided information on the history and operation of the dam.

- 2.2 Construction Records. There are no construction records or as-built drawings available for the dam or appurtenances.
- 2.3 Operator Records. No operating records are available, and there is no record kept of the elevation of the pool 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 hydraulic, structural and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on the visual inspection, past performance history, and engineering judgment.
 - c. Validity. The information obtained during the field survey is valid for the Phase I inspection.

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I Inspection of Zero Manufacturing Corporation Dam was performed on December 2, 1980. A copy of the inspection checklist is included in Appendix A. Previous inspections were conducted in 1969 for the Hampden County Board of County Commissioners, and by the Massachusetts Department of Public Works in 1972. Copies of those reports are given in Appendix B. Selected photographs taken during our Visual Inspection are included in Appendix C.
- b. Dam. The dam consists of a stone masonry spillway with a concrete cap (see Photos No. 3, 4), a nearly vertical downstream face, and four outlets contained within the intake area portion of the dam (see Photos No. 5 and 6). The intake area of the dam consists of vertical concrete walls on the upstream face, while the downstream walls are stone masonry (see Photos No. 1, 3). The area between the upstream and downstream walls is earthfilled and ranges in width between 9 feet and 22 feet. There is a low area within the intake area located directly above the low level outlet (see Photo No. 8). At the base of the wall, directly below the low level outlet, two clear seeps were flowing at approximately 4 and 8 gpm (see Photo No. 7). The concrete along the splash zone of the upstream walls in the intake area was severely eroded and spalled (Photos No. 5, 6).

The spillway has a concrete cap over the stone masonry and is in good condition. At the base of the spillway approximately 8 of the masonry blocks used as erosion protection have been displaced (see Photos No. 3, 4).

The stone masonry wall which is the downstream face of the spillway is in good condition. There is grass and some small trees growing between the joints of the stone masonry at the right abutment of the spillway and along both the left and right downstream masonry training walls (Photos No. 3 and 4). Trees up to 12 inches in diameter are growing near the left spillway abutment.

- c. Appurtenant Structures. The spillway, which encompasses approximately one-half of the dam is a narrow crested weir 76 feet long and 11 feet high (see Photos No. 3 and 4).

ZERO MANUFACTURING COMPANY DAM

Flashboards 1.85 feet high are located along the entire length of the spillway crest. There is a notch in the flashboards, 6 feet long by 0.6 feet deep located at the center of the spillway. Directly below this notch is a 6 foot wide by 4 foot deep opening in the stone masonry with stop logs in place. There is no access walkway to the flashboards or stoplogs which would permit their removal during periods of high flow. There is a major accumulation of soil and vegetation growth within the pond and along the spillway crest (see Photos No. 3 and 4). The condition of the upstream face of the spillway could not be determined because of siltation.

At the time of the inspection, water was discharging over the spillway, so the weir, stoplogs and flashboards and downstream toe could not be examined.

There are four outlets along the intake portion of the dam (see Figure B-1 and Photos No. 5 and 6). None of the outlets have been operated since 1962 and are considered to be inoperable. Three of the outlets are controlled by hand wheel operators located along the upstream face of the intake area. The first hand wheel operator (Outlet No. 1) controls flow to the low-level outlet located within the stone masonry. A thick accumulation of silt is blocking the upstream end of the outlet and the surrounding area. It is unlikely that this outlet could be opened and flow maintained in an emergency. The discharge end of the outlet is clogged with debris.

Outlets Nos. 2 and 3 each control flow to 16 inch diameter pipelines which were used to transmit water to boilers at separate heating plants. The pipe controlled by the second hand wheel operator (Outlet No. 2) was reportedly cut and sealed downstream of the dam. The third hand wheel operator (Outlet No. 3) is used to provide water to boilers for Zero Corporation's Main Street heating plant and is continuously open. Outlet No. 3 has a trash rack and screen at the upstream end. The rack consists of vertical steel slats that are heavily rusted and the steel screen, which is immediately downstream of the trash rack, is also heavily rusted. The trash rack and screen at Outlet No. 3 are cleaned periodically.

A fourth outlet (Outlet No. 4), located to the right of the three hand wheel operators (see Photo No. 6), is a wooden slide gate 5-1/2 feet wide which was used to regulate flow to a water wheel to power machinery at the Old Ellis Mill. The height of the slide gate could not be determined due to siltation in front of it.

The hand wheel operators and lifting mechanism for the slide gate have not been operated or maintained since Zero Corporation purchased the dam in 1962.

- d. Pond Area. The pond area is lightly developed. The Town of Monson is located downstream of the Pond. Residential development is located on the upstream side of the reservoir. Most of the land is wooded with gentle slopes. There is a slight potential that future development will occur in the pond area.
- e. Downstream Channel. Both the spillway and outlet discharge into the downstream channel. The stone masonry and concrete walls that form the walls of the channel are in good condition (see Photos No. 3 and 4). Portions of the left side of the channel are earth slopes which have been slightly eroded by runoff to the extent that the grass cover has been removed. The floor of the channel is the natural streambed. There is a slight accumulation of debris in the floor of the channel (see Photos No. 2 and 7). Several trees are growing on the sides of the channel (see Photos No. 3 and 5). About 25 feet downstream of the dam, the channel passes beneath a factory building (see Photo No. 2). The upstream opening is approximately 85 feet wide by 4.5 feet high. There are 10 building support columns founded on piers which obstruct flow within the channel. The channel at the downstream end of the building narrows to a width of 25 feet and increases to a height of 8 feet. Approximately 6 feet downstream of the building, the stream passes beneath a bridge with a 29 foot wide by 9 foot high opening. Approximately 12 feet downstream of the bridge the channel is partially obstructed by a 3 foot wide pier for support columns of a second factory building. The channel side walls adjacent to this building are 10 feet high. Approximately 230 feet downstream of the dam the stream returns to the natural channel width of 80 feet.

There is a second discharge channel for Outlet No. 4. The channel passes beneath the two factory buildings and joins the main discharge channel approximately 210 feet downstream of the dam. The side walls of the channel are vertical and constructed of stone masonry. Although Outlet No. 4 is kept closed, there was a moderate amount of flow in the channel. The source of this leakage is unknown. The floor of the channel is gravel with a moderate amount of debris.

- 3.2 Evaluation. The visual inspection indicates that the dam is in fair condition. The stated deficiencies which must be corrected to assure the continued performance of this dam and measure to improve these conditions are outlined in Section 7.

The following conditions could affect the long term performance of the dam.

1. Heavy siltation upstream of the dam resulting in blocking the low-level outlet.
2. Displaced stone blocks at the toe of the spillway.
3. Inoperable outlets.
4. Seepage at the base of the wall directly below the low level outlet.
5. Leakage downstream of Outlet No. 4.
6. Severely spalled and eroded concrete along the upstream walls of the intake area.
7. A growth of saplings through the masonry walls at the abutments of the spillway.

SECTION 4
OPERATING AND MAINTENANCE
PROCEDURES

4.1 Operating Procedures

- a. General. There are no operating facilities and no regular operating procedures for this dam.
- b. Warning System. There is no warning system in effect at this dam.

4.2 Maintenance Procedures

- a. General. The dam is not adequately maintained. Zero Corporation is responsible for maintenance of the facility.
- b. Operating Facilities. There is no maintenance of the operating facilities at the dam.

- 4.3 Evaluation. There are no regular programs of maintenance or technical inspections at the dam. There are also no plans for surveillance of the dam during periods of heavy rainfall, or for warning people in downstream areas in the event of an emergency at the dam. The lack of standard operating and maintenance procedures is undesirable, considering that the dam is in the "high" hazard category. These programs should be implemented as recommended in Section 7.3.

SECTION 5

EVALUATION OF HYDRAULIC/ HYDROLOGIC FEATURES

- 5.1 General. Zero Manufacturing Company Dam has a drainage area of 14.8 square miles of which 2.7 percent is ponds and swamps (see Figure D-1, Drainage Area Map). The land is gently rolling and lightly developed.

There is a flood control dam located on Conant Brook which was constructed to provide additional storage within the watershed.

The pond has a surface area of approximately 13 acres, and a maximum storage capacity of 156 acre-feet at El 434.6.

The low-level outlet can discharge a flow of 58.5 cfs when the pond is at El 427 which is the crest of the spillway. At this pond elevation and with no additional inflow, the outlet can lower the pond by 1 foot in about 3 hours.

- 5.2 Design Data. There are no hydraulic or hydrologic computations available for the design of the spillway at Zero Manufacturing Company Dam.
- 5.3 Experience Data. A previous inspection report from 1972 indicated the dam was overtopped during the 1955 hurricane. The flood waters were reported, in that inspection report, to have been approximately 10.5 to 11.5 feet above the spillway crest. Water was reportedly flowing through the second floor windows of the factory 25 feet downstream of the dam.
- 5.4 Test Flood Analysis. Zero Manufacturing Company Dam has been classified in the "small" size and "high" hazard categories. According to the Corps of Engineers guidelines, a test flood ranging from one-half the PMF (Probable Maximum Flood) to the full PMF should be used to evaluate the capacity of the spillway. The one-half PMF was chosen on the basis of the size of the dam and the small storage capacity.

The drainage area is made up of the watershed above the Conant Brook Dam (7.8 square miles) and the watershed of the Conant and Chicopee Brooks (7.0 square miles) below the Conant Brook Dam. The PMF rate for the entire 14.8 square miles of drainage area for Zero Manufacturing Company Dam was calculated to be 1,180 cfs per square mile. This calculation is based on an average slope of 2 percent in the drainage area, the pond-plus-swamp area to drainage area ratio of 2.7 percent, and the US Army Corps of Engineers'

guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). For this analysis the peak flow rate was determined to be between the curves for rolling and flat and coastal topography. Applying the one-half PMF rate to the 14.8 square mile drainage area (Conant Brook and Chicopee Brook watersheds) resulted in a peak test flood inflow of 8,730 cfs. Considering the storage effects of the Corps of Engineers flood control dam on Conant Brook, the test flood inflow for Zero Manufacturing Company Dam was reduced. First, the PMF rate was calculated for the watershed below Conant Brook Dam (7.0 square miles) and was determined to be 1,580 cfs per square mile of the drainage area. Applying the one-half PMF rate to the Chicopee Brook watershed alone resulted in a peak test inflow of 5,530 cfs. Secondly, due to storage effects at the Conant Brook Reservoir Dam, the coincident flow from the Conant Brook watershed would be 225 cfs. The resulting combined inflow was therefore a peak test flood inflow of 5,760 cfs. With the flashboards on the spillway, the peak test flood outflow was calculated to be 5,730 cfs (387 cfs per square mile). With flashboards, the pond level would rise to El 437.2. Without flashboards, the peak outflow would be 5,760 cfs and the pond would rise to El 436.7.

Hydraulic analyses indicate that the spillway with flashboards can discharge 3,600 cfs or 62 percent of the test flood outflow with the pond at El 434.6 which is the low point on the top of the dam. Without flashboards, the spillway could discharge 4,250 cfs, or 74 percent of the outflow before the dam is overtopped.

Approximately 25 feet downstream of the spillway, the channel passes beneath a building with an opening 4.5 feet high. Beneath this structure the channel narrows from 85 feet to 26 feet. This constriction would result in a tailwater at the toe of the dam of El 434.7.

- 5.5 Dam Failure Analysis. Due to the high tailwater effect during the test flood, the peak discharge rate due to failure of the dam was calculated under "Dry Weather" conditions to be 2,235 cfs with the pond at El 428.85. This calculation is based on a maximum head of 12.5 feet and an assumed 30-foot wide breach occurring in the center of the spillway. Failure of the dam would produce a downstream flood wave 11 feet deep as compared to no channel flow prior to failure. This would result in a flood 6.5 feet deep in the first floor of the building straddling the stream immediately downstream of the dam.

TABLE 5-1.

	Flashboards in place	Flashboards removed
Maximum height of water above dam, ft:	2.6	2.1
Maximum height of water above low area (El 435.5) west of left abutment, ft:	1.7	1.2
Discharge over spillway and dam, cfs:	5,360	5,540
Discharge over low area west of left abutment cfs: cfs:	370	220
Depth at critical flow, ft:	1.5	1.2
Velocity at critical flow, fps:	7.0	6.3

There are two factory buildings and a bridge located above the channel between 25 and 125 feet downstream of the dam. The support columns of these structures are founded on piers which are located within the floor of the channel and partially obstruct the flow. Due to the configuration of the channel, little attenuation of the flood flow is expected. An assumed failure of the dam would result in a flood wave that would rise above the channel opening beneath the factory causing the flooding of the first floor. Severe damage to the building could result in the possible loss of more than a few lives and an excessive amount of property damage. Accordingly, the dam has been placed in the "high" hazard category.

SECTION 6
STRUCTURAL STABILITY

- 6.1 Visual Observations. The evaluation of the structural stability of Zero Manufacturing Company Dam is based on a review of previous inspection reports and the visual inspection conducted on December 2, 1980.

Based on the visual observation detailed in Section 3, Zero Manufacturing Company Dam is in fair condition. In the event the soil is removed upstream of the spillway, an unstable condition could result. An analysis to determine the limits of dredging should be performed so that the stability and impermeability of the dam is unimpaired.

As was discussed in Section 3, seepage was observed along the base of the spillway directly below the low level outlet (Outlet No. 1). There is a low area directly above this outlet within the intake area's vertical walls and there is a growth of saplings. Also, there are several saplings growing out of the vertical masonry wall of the spillway in the area of the low level outlet. Several of the stone blocks used for erosion protection at the downstream toe of the spillway have been displaced by water action creating a potential for undermining at the toe of the spillway.

- 6.2 Design and Construction Data. Construction of Zero Manufacturing Company Dam was completed in 1900. Computations for design of the dam, spillway and outlet are not available.

Drawings showing the proposed or as-built construction of the dam are not available.

Specifications for construction of the dam are not available.

- 6.3 Post-Construction Changes. Since the original construction of the dam, the only known repairs made in the past 20 years were the replacing of the flashboards in 1975.

- 6.4 Seismic Stability. The dam is located in Seismic Zone No. 2, and in accordance with Corps of Engineers' guidelines does not warrant further seismic analysis at this time.

SECTION 7
ASSESSMENT, RECOMMENDATIONS, AND
REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. As a result of the visual inspection, the review of available data, and limited information on operation and maintenance, the dam is considered to be in fair condition. The following deficiencies must be corrected to assure the continued performance of this dam: heavy siltation upstream of the dam blocking the low-level outlet; inoperable outlets; seepage at the base of the spillway directly below the low level outlet; leakage downstream of Outlet No. 4; severely spalled and eroded concrete along the upstream walls of the intake area; a growth of saplings through the masonry walls at the abutments of the spillway; and displaced masonry blocks along the toe of the spillway.

The peak test flood (one-half PMF) outflow is estimated to be 5,730 cfs with the pond at El 437.2 assuming the flashboards are in place. The test flood would overtop the low point on the dam by 2.6 feet. Hydraulic analyses indicate that the spillway (with flashboards) can discharge 3,600 cfs or 62 percent of the test flood outflow before the dam (intake area) is overtopped.

- b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation 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 I Inspection Report.

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

- a. Determine the limits of dredging required upstream of the dam in the vicinity of the low-level outlet. The stability and impermeability of the dam and spillway should not be impaired by the dredging operation. In lieu of dredging, consideration could be given to providing an alternate means of lowering the reservoir.

- b. Conduct an investigation of the source of water flowing in the discharge channel downstream of Outlet No. 4 and design repairs, if necessary, to control the leakage.
- c. Conduct an investigation of the seepage at the base of the spillway directly below the low level outlet. This would include an evaluation of the dam stability.
- d. Determine the extent of the deterioration of the upstream concrete walls of the intake area and recommend necessary remedial repairs.
- e. Establish a procedure for removing trees, brush, and root systems from the stone masonry walls of the spillway abutments. Make recommendations for backfilling with suitable material.
- f. Inspect the downstream face of the spillway, especially the center section, under a no-flow condition.

The Owner should implement the recommendations of the Engineer.

7.3 Remedial Measures

- a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:
 - (1) Repair the operating mechanism on the low-level outlet and on Outlet No. 3 to restore them to working condition. Investigate a means of sealing Outlet No. 2 at the upstream end, so as to remove pressure in the conduit.
 - (2) Reset the dislodged stone blocks at the toe of the spillway to prevent overflowing water from washing out the downstream toe area.
 - (3) Remove all debris and loose stone in the floor of the spillway discharge channel.
 - (4) Institute a definite plan for surveillance of the dam and spillway during and after periods of heavy rainfall and a plan to warn people in downstream areas in the event of an emergency at the dam.
 - (5) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances, and be supplemented by additional inspections during and after severe storms. All

repairs and maintenance should be undertaken in compliance with all applicable State regulations. The maintenance program should include removal of any debris caught on the spillway weir to prevent clogging of the spillway.

- (6) Institute a program of annual technical inspections of this dam.

7.4 Alternatives. There are no practical alternatives.

APPENDIX A
PERIODIC INSPECTION CHECKLIST

ZERO MANUFACTURING COMPANY DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT ZERO MANUFACTURING CO. DAM

DATE Dec. 2. 1980

Abbreviations:

- D/S = Downstream
- U/S = Upstream
- N/A = Not Applicable

TIME 8 AM to 3 PM

WEATHER Cloudy-Cool

W.S. ELEV. 428.8 U.S. 415.8 DN.S.

PARTY:

1.	N. D'Agostino	Metcalf & Eddy	Geotechnical
2.	S. Nagel	Metcalf & Eddy	Geotechnical
3.	F. Gordon	Metcalf & Eddy	Geotechnical
4.	S. Pierce	Metcalf & Eddy	Geotechnical
5.	L. Branagan	Metcalf & Eddy	Hydraulics
6.	M. Mass	Bryant Associates, Inc.	Hydraulics
7.	W. Cloutier	Zero Corporation	
8.	E. Greco	Metcalf & Eddy	Geotechnical
9.			
10.			

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam	D'Agostino, Nagel, Branagan, Greco	
2.	Outlet Works - Spillway	D'Agostino, Nagel, Branagan, Greco	
3.	Outlet Works - Intake Area	D'Agostino, Branagan	
4.	Outlet Works - Low Level Outlets	D'Agostino, Nagel	
5.			
6.			

PERIODIC INSPECTION CHECK LIST

PROJECT ZERO MANUFACTURING CO. DAM DATE Dec. 2, 1980
 PROJECT FEATURE Dam NAME N. D'Agostino
 DISCIPLINE Geotechnical NAME S. Nagel

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	
Crest Elevation	434.6 at top of concrete wall intake area
Current Pool Elevation	428.8
Maximum Impoundment to Date	Unknown-reported by previous inspections to be 10.5 to 11.5' above top of spillway in 1955.
Surface Cracks	None visible-cut stone masonry dam-dry wall construction with conc. cap & vertical conc. wall at intake area.
Pavement Condition	N/A
Movement or Settlement of Crest	None visible
Lateral Movement	None visible
Vertical Alignment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Stone wall with conc. cap at left abutment of spillway. Conc. wall (part of foundation of brick building) at rt. abut. (training wall for old water wheel intake).
Indications of Movement of Structural Items on Slopes	None visible
Trespassing on Slopes	Minor along right abutment
Sloughing or Erosion of Slopes or Abutments	Spalling of concrete at abutments
Rock Slope Protection - Riprap Failures	N/A
Unusual Movement or Cracking at or near Toes	None visible
Unusual Embankment or Downstream Seepage	2 seeps along base at downstream rt. spillway abutment directly below box sluiceway. Approx. flow of 10 gpm.
Piping or Boils	None visible
Foundation Drainage Features	None visible
Toe Drains	None visible
Instrumentation System	None visible

Foundation walls & basement walls on Pond side of structures dry - reportedly never had seepage problem. page A-2 of 7

PERIODIC INSPECTION CHECK LIST

PROJECT ZERO MANUFACTURING CO. DAM DATE Dec. 2, 1980

PROJECT FEATURE Outlet Works - Spillway NAME N. D'Agostino

DISCIPLINE Geotechnical NAME S. Nagel

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
a. Approach Channel	
General Condition	Submerged - Silted in
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	No
Floor of Approach Channel	Submerged
b. Weir and Training Walls	Concrete wall on right
General Condition of Concrete	Stone wall with concrete cap on left fair.
Rust or Staining	No
Spalling	Severe-at angle point at juncture with outlet controls
Any Visible Reinforcing	No
Any Seepage or Efflorescence	Yes-efflorescence on right wall
Drain Holes	None
c. Discharge Channel	Structure over channel
General Condition	Debris in stream, downstream of Hampden Road
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Yes - downstream of Hampden Road
Floor of Channel	Gravel
Other Obstructions	5 piers and floor of structure.

PROJECT ZERO MANUFACTURING CO. DAM DATE Dec.2, 1981

PROJECT FEATURE Outlet Works Spillway NAME N. D'Agostino

DISCIPLINE Geotechnical/Hydraulics NAME L. Branagan

Spillway Weir (cont.)

Two inch thick flashboards in place on crest of spillway.
Approximately 1.85 feet high. Held in place by steel pipes.
At center of spillway one board removed to create six feet
wide by .62 feet deep notch. Directly below this notch is
a four feet deep by six feet wide opening in the stone masonry.
This opening has stop logs in place.

PERIODIC INSPECTION CHECK LIST

PROJECT ZERO MANUFACTURING CO. DAM DATE Dec. 2, 1980
 PROJECT FEATURE Intake Area NAME N. D'Agostino
 DISCIPLINE Geotechnical/Hydraulics NAME L. Branagan

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE</u>	
a. Approach Channel	Submerged
Slope Conditions	Vertical concrete wall
Bottom Conditions	Silted in
Rock Slides or Falls	N/A
Log Boom	Yes
Debris	None
Condition of Concrete Lining	N/A
Drains or Weep Holes	None
b. Intake Structure	
Condition of Concrete	Badly spalled at splash zone
Stop Logs and Slots	None

Intake Area-Pond Side vertical concrete walls. D/S portion stone masonry walls-earth filled area - small trees growing in area.

- Outlet--1. Left gate valve controls flow to low level outlet (30"x30" box sluiceway at D/S end) through 4'x4' gate inoperable--some movement of water observed in area of gate.
- Outlet--2. Middle gate valve which controls flow into a 16-inch diameter pipe which at one time flowed to structure (former power plant), downstream of Hampden Road. Pipe was cut and blocked at Hampden Road in 1979 during sewer line construction now, inoperable.
- Outlet--3. Right gate valve - controls flow into 16-inch diameter pipe to boilers at a power plant (approx. 1/2 mile D/S of dam) to produce steam for heating. Has trash rack and screens. Only maintenance performed is to clean screens. Provides 10,000 gpd to boilers. Intake always left open. Pressure regulated at Power Plant, excess water discharged back into Chicopee Brook.
- Outlet--4. Slide Gate-lifting mechanism for control of flow to a water wheel (removed) is inoperable. Slide Gate is wooden with steel slats. Opening approximately 5 1/2' wide. Height of gate could not be determined due to siltation of approach channel. Approach channel to outlet mechanisms for old water wheel (removed).

Right training wall spalled, cracked.
 Left training wall at corner spalling up to 6" deep
 at water line. (cont. on next page)

PROJECT ZERO MANUFACTURING CO. DAM DATE Dec. 2, 1980

PROJECT FEATURE Intake Area (cont.) NAME N. D'Agostino

DISCIPLINE Geotechnical/Hydraulics NAME L. Branagan

Intake Area (Cont.)

Discharge Channel - Old channel from which discharge from water wheel flows beneath Zero Corporation structures and exits from structure downstream of Hamden Road.

Water was observed to be flowing in this channel.

All outlet mechanisms have not been operated or maintained since Zero Corporation purchased property in 1962 from Ellis Mills Company. (original owners of dam.)

PERIODIC INSPECTION CHECK LIST

PROJECT ZERO MANUFACTURING CO. DAM DATE Dec. 2, 1980
 PROJECT FEATURE Outlet Works-Low Level NAME N. D'Agostino
Outlet
 DISCIPLINE Geotechnical NAME S. Nagel

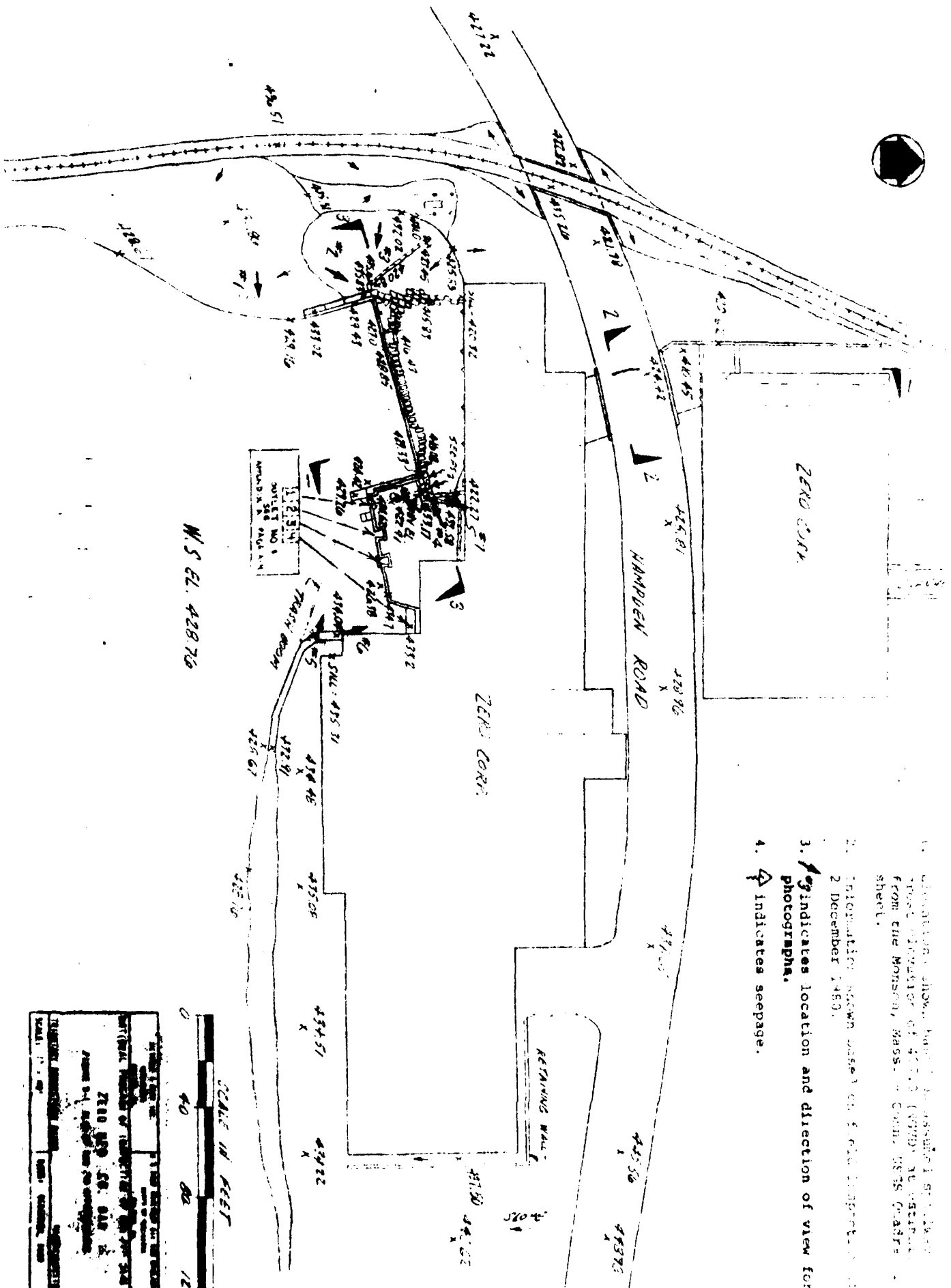
AREA EVALUATED	CONDITION
<u>OUTLET WORKS - TRANSITION AND CONDUIT</u>	
General Condition of Concrete	N/A
Rust or Staining on Concrete	N/A
Spalling	N/A
Erosion or Cavitation	N/A
Cracking	N/A
Alignment of Monoliths	N/A
Alignment of Joints	N/A
Numbering of Monoliths	N/A

16"-diameter ductile iron pipe follows stream channel to power plant on Main Street. Runs above ground. Valves have been installed to blowoff water to prevent freezing in pipe at critical points during low flows in pipe.

Sluiceway-Square 30" wide x 30" high opening in stone masonry portion of dam at downstream right abutment of spillway controlled by left gate valve has not been operated since 1962.

APPENDIX B
PLANS OF DAM AND PREVIOUS
INSPECTION REPORTS

	<u>Page</u>
Figure B-1, Plan of Dam	B-1
Figure B-2, Sections through Dam	B-2
Previous Inspection Reports	
Dated 1969 for the Hampden County Board of County Commissioners	B-3
Dated December 19, 1972 by Massachusetts Department of Public Works	B-4



W.S. 62. 42876

1. Information shown based on 1:50,000 scale map of the area, dated 1950.
2. Information shown based on 1:50,000 scale map of the area, dated 1950.
3. Indicates location and direction of view for photogrampha.
4. Indicates seepage.



UNITED STATES GOVERNMENT
 NATIONAL ARCHIVES OF THE UNIVERSITY OF MICROFILMS
 ZEDU 629 28 048 2
 FROM THE NATIONAL ARCHIVES OF THE UNIVERSITY OF MICROFILMS

GEORGE H. McDONNELL
PHILIP W. SHERIDAN
EDWARD J. BAYON

**TIGHE
& BOND**

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BOWERS AND PEOUOT STREETS
HOLYOKE, MASSACHUSETTS
TEL. JEFFERSON 3-3991

CD Monson
October 22, 1969

The Honorable the Board of County Commissioners
52 State Street
Springfield, Massachusetts

Gentlemen:

During the year 1969 inspections have been made from time to time of the various dams situated within the Town of Monson. Inspections recently completed have now concluded the inspection routine in Monson, and every dam located within that community, coming under County jurisdiction, has now been inspected at least once during the present calendar year. The following is a report on the general condition of each of the dams and dam sites situated within the Town of Monson.

D. Ellis Mills Upper Dam (Zero Manufacturing Dam)

The stone masonry forming this dam was found to be in satisfactory condition. The normal three flashboards were on the crest of the dam and water level in storage was at the top of the upper flashboard.

Abutment areas were okay. The flood training walls at both abutments were in satisfactory condition.

The toe area of the dam, in the bed of the stream, is satisfactory. Some of the large stone masonry blocks have been moved from the toe area at the left of the dam by flood flows. This condition does not appear to be causing any erosion in the bed of the stream. In the opinion of the undersigned this dam is safe.

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Locations: City/Town MONSON Dam No. 3-7-191-4
(ZERO MFG. DAM)
Name of Dam ELLIS MILLS UPPER DAM Inspected by M. KAMM D MAHAT

Date of Inspection 12-19-72

2. Owner/s: per: Assessors _____ Prev. Inspection _____

Reg. of Deeds _____ Pers. Contact

1. ZERO MFG. CO. 288 MAIN ST MONSON MA
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 2 one recvd @ Boston

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: 1 GATE IS KNOWN TO BE OPERATIVE

7. Upstream Face of Dam: Conditions

1. Good 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

8. Downstream Face of Dam:

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

Comments:

9. Emergency Spillway: 12-11-72

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

Comments:

12-11-72

10. Water Level at time of inspection: 2.8 ft. above below _____

top of dam _____ principal spillway
other _____ 2ft of which are flashboards

11. Summary of Deficiencies Noted:

- Growth (Trees and Brush) on Embankment NONE
- Animal Burrows and Washouts NONE
- Damage to slopes or top of dam NONE
- Cracked or Damaged Masonry YES
- Evidence of Seepage NONE
- Evidence of Piping NONE
- Erosion NONE
- Leaks NONE
- Trash and/or debris impeding flow NONE YES
- Clogged or blocked spillway NONE
- Other NONE

12. Remarks & Recommendations: (Fully Explain)

THIS DAM APPEARS TO BE IN GOOD CONDITION. IN CONVERSATION WITH THE ASST. PLANT SUPERINTENDANT IT WAS ESTABLISHED THAT THE DEGREE OF HAZARD & RISK TO LIFE & PROPERTY WOULD BE SEVERE SINCE IN THE FLOODS OF THE 1950'S THE WATER RAN SOME 2'-3' HIG ABOVE THE TOP OF THE DAM - THRU THE 2ND FLOOR OF THE FACTORY'S WINDOWS - CAUSING DAMAGE AS WELL TO THE RDWY. (BLISS ST.) & R.R. EMBANKMENT - IT APPEARS THAT THE CHANNEL UNDER THE FACTORY WILL NOT CARRY FLOOD FLOW WATERS - WHICH RESULTS IN A WALL OF WATER RUNNING THRU FACTORY WINDOWS ERODING DOWNSTREAM RDWY. & R.R. EMBANKMENTS.

AS PREVIOUSLY STATED THE DAM IS IN GOOD CONDITION AND THE CHANNEL (UNDER FACTORY & RDWY.) WILL ACCOMODATE NORMAL SPRING SEASONAL FLOWS.

THE DAMAGED MASONRY AMOUNTS TO EROSION OF CONC. FTG. AT THE GATE PEN (ON RT. OF SPILLWAY) ON UPSTREAM SIDE

THERE IS TRASH & DEBRIS AT THE FOOT OF THE SPILLWAY WHICH DOES IMPEDE FLOW & I WOULD ADVISE REMOVAL OF SAME.

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

DISTRICT 3

Submitted by M. KAHN & D. MARKT Dam No. 3-7-191-4

Date DEC. 19, 1972 City/Town MENSON

Name of Dam ELLIS MILLS UPPER DAM (ZERO MFG. DAM)

1. Locations: Topo Sheet No. 15 D

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 _____

4. Drainage Area: CHICPEET CONANT BROOK 2.0 sq. mi. _____ acres

5. Normal Ponding Area: 7.1 acres; Ave. depth _____

Impoundments: _____ gals.; _____ acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir

6 i.e. summer homes, etc. YEAR ROUND HOMES

7. Dimensions of Dam: Length 150' (EST.) Max. Height 20' ±

Slopes: Upstream Face 2:1

Downstream Face VERTICAL

Width across top VARIES 9'-20'

8. Classification of Dam by Material:

Earth Conc. Masonry Stone Masonry

Timber _____ Rockfill _____ Other _____

9. A. Description of present land usage downstream of dam:

80 % rural; 20 % urban.

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

DAM NO. 3-7-191-4

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

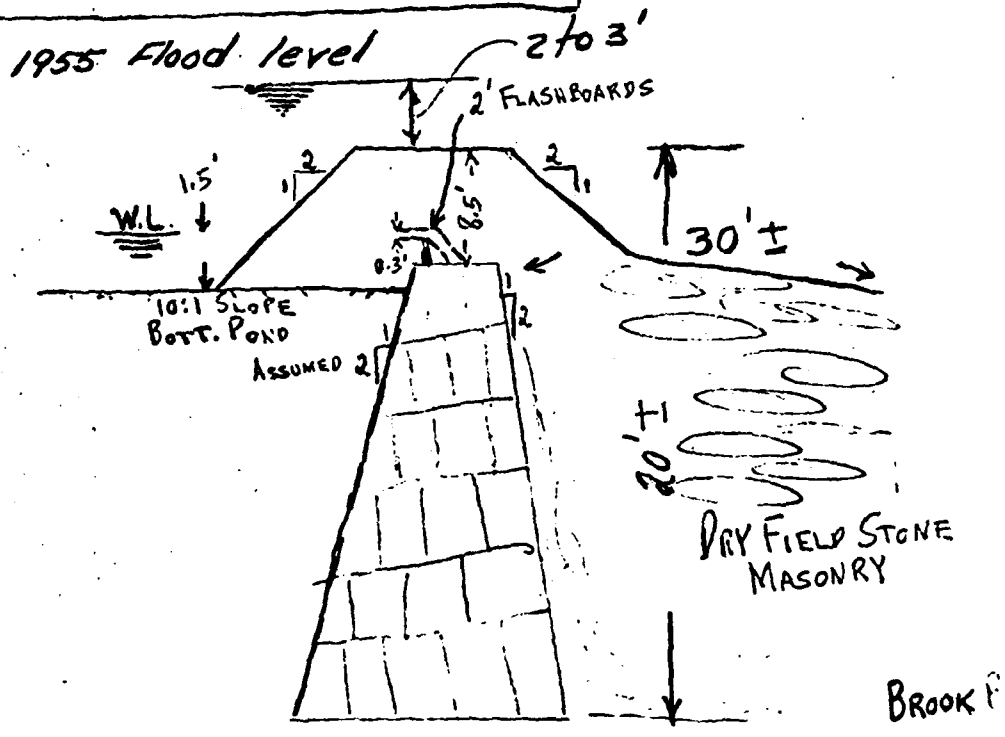
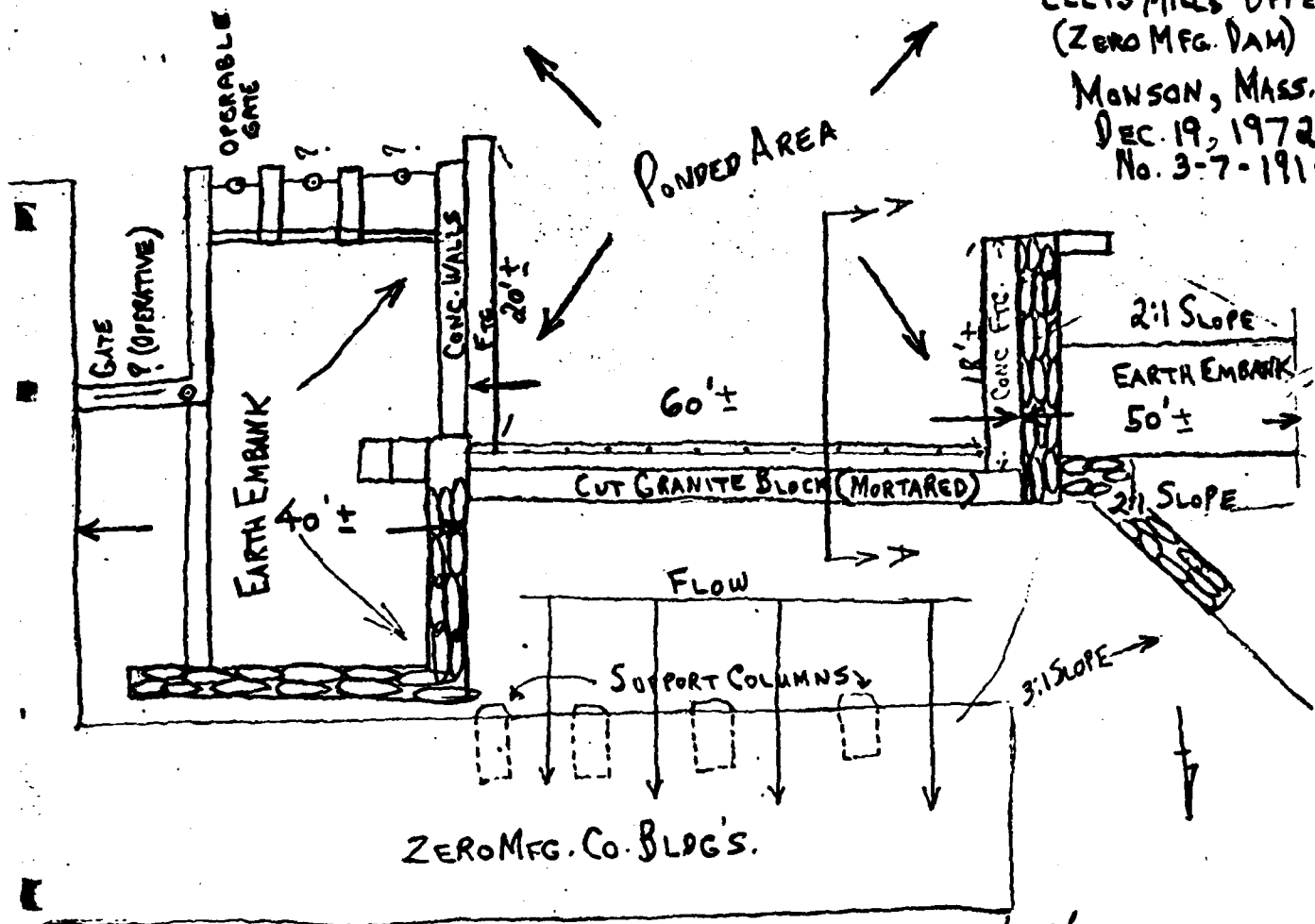
No. of people NONE (OTHER THAN EMPLOYEE'S)
No. of homes NONE
No. of Businesses NONE
No. of industries 1 Type MFG.
No. of utilities NONE Type _____
Railroads NONE
Other dams NONE
Other BLISS ST.

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

12. How to Locate:

CORNER OF ELM ST. & BLISS ST. (BEYOND ZERO MFG. ON BLISS ST.)
BETWEEN R.R. BRIDGE & MILL (ZERO MFG.)

ELLIS MILLS UPPER DAM
 (ZERO MFG. DAM)
 MONSON, MASS.
 DEC. 19, 1972
 No. 3-7-191-4



SECT. "AA"

February 6, 1973

Zero Manufacturing Company
288 Main Street
Monson Massachusetts

RE: Inspection-Dam #3-7-191-4
Monson
Ellis Mills Manufacturing Dam

Gentlemen:

An engineer from the Massachusetts Department of Public Works has inspected the above dam owned by the Zero Manufacturing Company.

The inspection was made in accordance with Chapter 253 of the Massachusetts General Laws, as amended by Chapter 595 of the Acts of 1970.

The results of the inspection indicate that this dam is safe; however it appears that the capacity of the outlet channel under the factory does not have the capacity to accommodate extreme flows thus causing local flooding problems. Several possibilities exist which may lessen this occurrence; the most notable being the removal of the two feet of flashboards along the crest of the dam as part of an overall emergency plan during peak flow periods. The outlet controls should be checked and made operative. Preventive maintenance should be exercised regularly. Other items which were noted that required your attention are the erosion of concrete near the spillway and the accumulation of trash and debris at the base of the spillway.

It is hoped that you recognize your responsibility and act on these matters promptly.

Very truly yours,

F. C. Schuelm
FRED C. SCHUELM, P.E.
Deputy Chief Engineer

J. L. B.
LRA/jac
cc G.E. Lybrand D.H.E.#3
A. Troiano Dist.#3

APPENDIX C

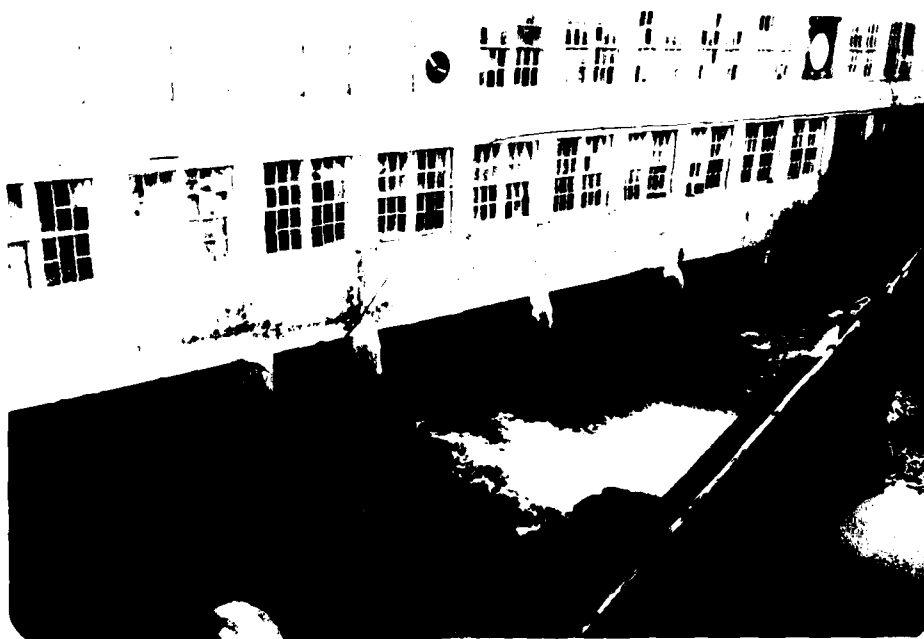
PHOTOGRAPHS

Note: Location and direction of photographs shown on
Figure B-1 in Appendix B.

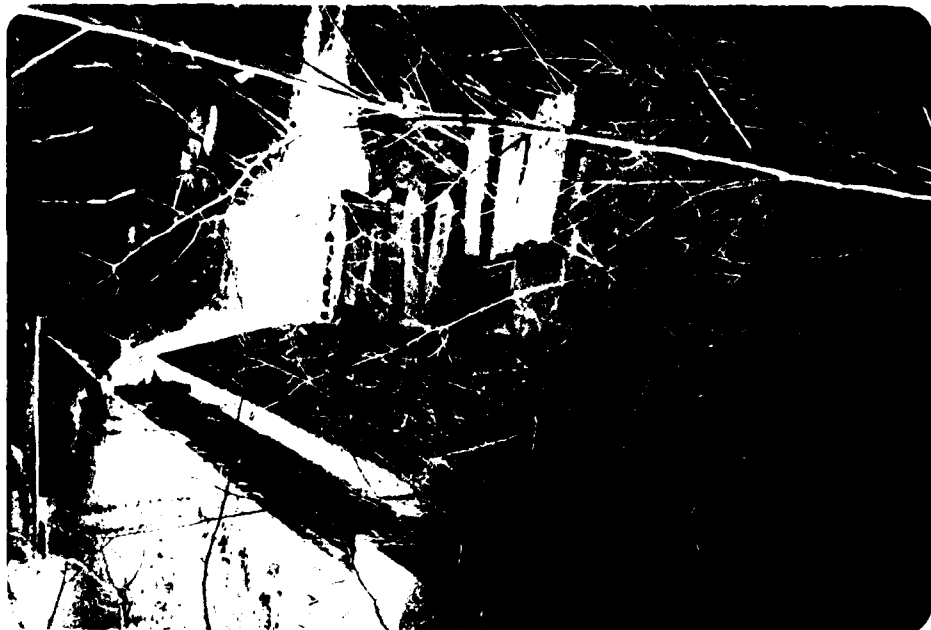
ZERO MANUFACTURING COMPANY DAM



NO. 1 TOP OF DAM AT INTAKE AREA



**NO. 2 STRUCTURE OVER CHICOPEE BROOK DOWNSTREAM
OF SPILLWAY**



NO. 4 DOWNSTREAM FACE OF SPILLWAY
FROM RIGHT ABUTMENT



NO. 3 DOWNSTREAM FACE OF SPILLWAY
FROM LEFT ABUTMENT



NO. 5 INTAKE AREA – HAND WHEEL OPERATORS FOR LOW LEVEL OUTLET AND WATER SUPPLY PIPES



NO. 6 INTAKE AREA – CONTROL MECHANISM FOR SLIDE GATE



**NO. 7 DOWNSTREAM END OF LOW LEVEL OUTLET ALONG
RIGHT ABUTMENT OF SPILLWAY**



NO. 8 LOW AREA ABOVE LOW LEVEL OUTLET

APPENDIX D

HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

	<u>Page</u>
Figure D-1, Drainage Area Map	D-1
Hydrologic and Hydraulic Computations	D-2

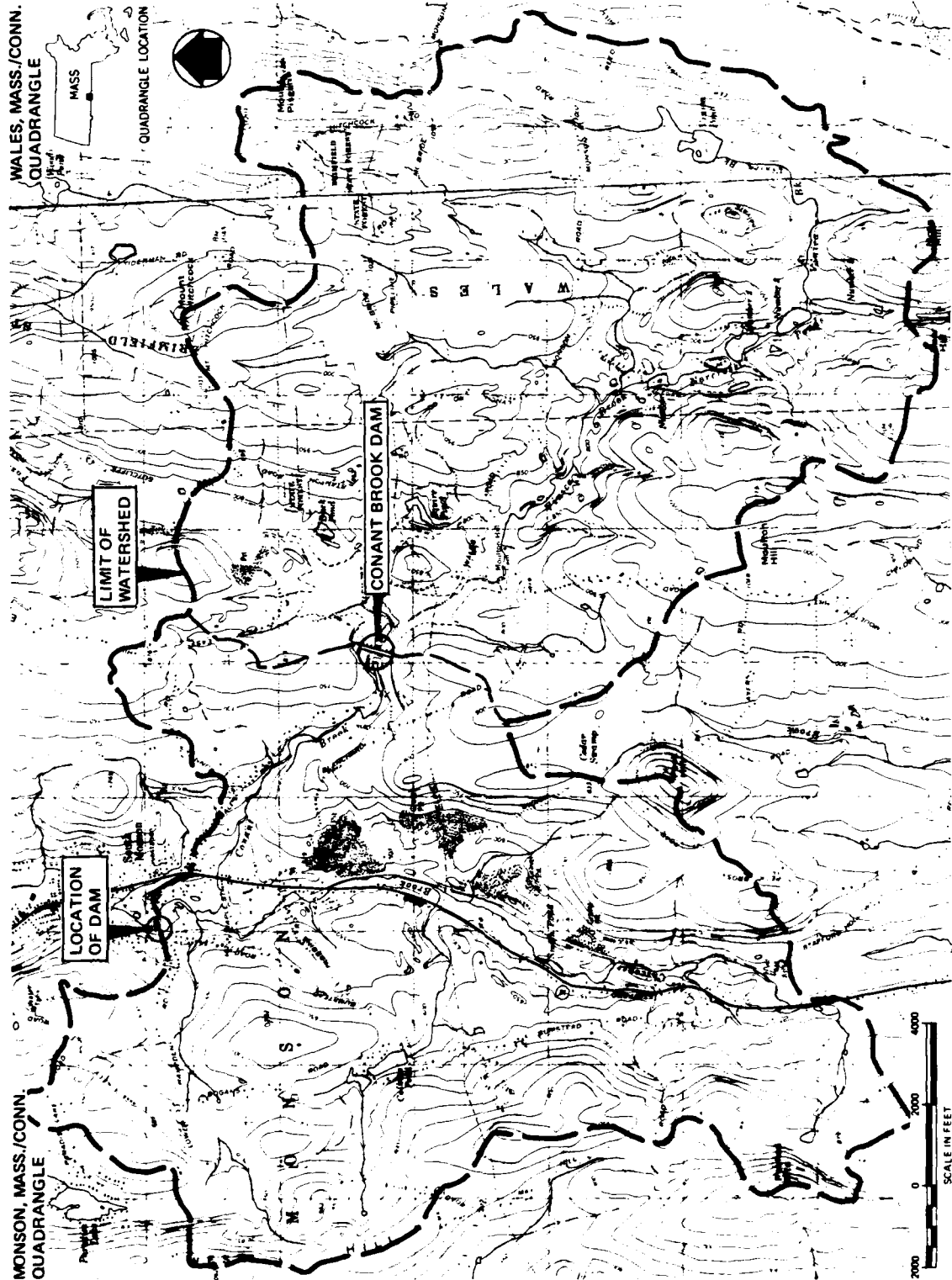


FIG. D-1 DRAINAGE AREA MAP

ZERO MFG. CO. DAM

I Conant Brook Res. Impact on Test Flood

Ref.: "Chicopee R. Watershed - Master Manual of Water Control - Appendix F" by C. of E. - Jan. 1979

The Zero Mfg. Dam has a drainage area of 14.8 mi². Some 7.0 mi² of this area supplies the C. of E. flood control structure; Conant Brook Res.

The 1/2 PMF Test Flood could be totally impounded relative to the Conant Br. Res and its drainage area. The peak T.F. flow at Zero would then be from the remaining 7.0 mi² - see **III**.

If Conant Br. was relatively full at the time of the Test Flood, then an appreciable flow would be additive to the peak from the 7.0 mi².

The peak test flood inflow to Zero Mfg. Dam would be from the remaining 7.0 mi² plus an additional 225 cfs from the low-level outlet at the Conant Brook Res.

- 1/2 PMF inflow (see III)	5530 cfs
- additional runoff	225 cfs
- peak 1/2 PMF to Zero Mfg Dam	5760 cfs

NONREPRODUCIBLE GRID FORM 145

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II Test Flood, Storage & Storage Function - Total Drainage Area

1- Total Drainage Area - 14.8 mi²

2- Pond(s) Area: $.02 + .02 + .03 = 0.07 \text{ mi}^2$
 Swamp(s) Area: $.10 + .05 + .02 + .07 + .05 + .04 = 0.33$
Total Area Ponds & Swamps: 0.40

% Ponds & Swamps = $\frac{0.40}{14.8} = 2.7\%$

3- $\frac{1203 - 427}{38900} = 0.01995$ } Say Ave Slope = 2.0%

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 1180 c.f.s./mi²
 Size Class: Small ; Hazard Pot.: High ; Spill. Des. Flood: 1/2 to Full PMF
 Use: Test Flood = 1/2 PMF

5- Test Flood Inflow = $\frac{1}{2}(1180)14.8 = 8730 \text{ c.f.s.}$

6- Pond Storage

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

7- Spillway crest elev. is

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.

$S(\text{in Inches}) = 12 D \left(\frac{S_{out}}{R} \right) = \text{ }$ D ; $R = 6 \text{ hr rain of storm}$

D = Storage depth in feet above spillway crest in reservoir

9- Storage Functions: (Test Flood & 1/2 PMF - if needed)

$F_{TF} = \text{ }$	$S = \text{ }$	$D = \text{ }$
$F_{1/2 PMF} = \text{ }$	$S = \text{ }$	$D = \text{ }$

III Test Flood, Storage & Storage Function - Partial Drainage Area

1- Total Drainage Area - 7.0 mi² - Area below Con. Br. Res.

2- Pond(s) Area: 0.02 = .02 mi²
Swamp(s) Area: .01+.01+.01+.01+.01+.01+.01+.03 = .10
Total Area Pond(s) & Swamp(s): .12

% Ponds & Swamps = $\frac{0.12}{7.0} = 1.71\%$

3- $\frac{1165 - 430}{27000} = .02722$ } Say Ave Slope = 2.7%

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be somewhat below "Rolling" and taken at 1580 c.f.s./mi²
 Size Class: Small; Hazard Pot.: High; Spill. Des. Flood: 1/2 to Full PMF
 Use: Test Flood = 1/2 PMF

5- Test Flood Inflow = 1/2 (1580) 7.0 = 5530 c.f.s.

6- Pond Storage
 The pond area is 0.02 sq. mi. at elev. ± 430
 Based on a const. area, storage increases at 13.0 ac. feet per foot of depth increase.

7- Spillway crest elev. is 427.0 - no fl. bds; 426.85 - with fl. bds

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.

$S(\text{in Inches}) = 12 D (\frac{0.02}{7.0}) = 0.034 D$; $R = 6\text{hr rain of storm}$
 D = Storage depth in feet above spillway crest in reservoir

9- Storage Functions: (Test Flood & 1/2 PMF - if needed)

$F_{TF} = 5530 - 582$	$S = 5530 - 20.0 D$
$F_{1/2 PMF} = F_{TF}$	$S = - D$

NONREPRODUCIBLE GRID FORM 149

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(VII) Discharge Relations

A - Spillway - no flashboards or tailwater*

Width - 76'± ; $Q = 76(3.33) H_A^{1.5}$; crest el. 427.0
 * 6' of width at el. 423.0. Add corrected flow from Item A' to this for full Q_A

Res El.	430	435	440	432	434	436	438	429.0
H_A	3	8	13	5	7	9	11	2
Q_A	1320	5730	11860	2830	4690	6830	9230	720
$Q_{A'}$	230	300	320	260	290	300	320	210
ΣQ_A	1550	6030	12180	3090	4980	7130	9550	930

B - Spillway - with exist. flashboards, no tailwater

Width - 6' @ el. 428.2 plus 70' @ el. 428.85

$Q_B = 6(3.33)(H_B + 0.65)^{1.5} + 70(3.33)(H_B)^{1.5}$

Res. El.	430	435	440	431	433	437	439
H_B	1.15	6.15	11.15	2.15	4.15	8.15	10.15
Q_1	50	350	810	90	210	520	710
Q_2	290	3560	8680	730	1970	5420	7540
Q_B	340	3910	9490	820	2180	5940	8250

C - Crest Flow - no tailwater**

± 65' left abut. @ ± el. 435.5 ; $Q_1 = 2.55(65) H_1^{1.5} = 165.75 H_1^{1.5}$
 ± 80' R.R. track @ ± el. 436.6 ; $Q_2 = 2.55(80) H_2^{1.5} = 204 H_2^{1.5}$

Res El.	436	437	438
Q_1	60	300	660
Q_2	-	50	340
ΣQ_c	60	350	1000

** Crest flow discharges around factory. Tailwater does not affect this for relevant flows. Add these to adjusted weir flows.

A' - Spill. - no flashbds or tailwater - Add to Item A above

Width 6', Crest el. 423.0, $Q_{A'} \approx 3(6') H_{A'}^{1.5} - 3.33(6') H_A^{1.5}$; $H_{A'} = H_A + 4'$

Res El.	430	435	440	432	434	436	438	429	427
$H_{A'}$	7	12	17	9	11	13	15	6	4
$Q_{A'}$	230	300	320	260	290	300	320	210	140

NONREPRODUCIBLE GRID FORM 143

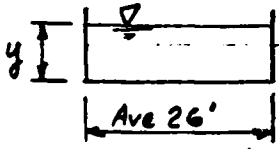
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(VII) Tailwater Levels

A - Lower Flows

Assume T.W. level at dam is a function of hydraulics of channel under factories & road.

$n = .045, S = \frac{9.28}{228}, R \approx y, V = \frac{1.49}{.045} (\frac{0.0407}{y})^{1/2} = 6.68 y^{2/3}$

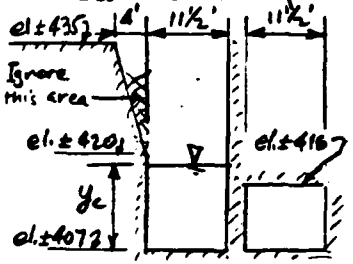


T.W. El. = 416.4 + y + h_v

y	A	V	Q	h _v	T.W. El.
1/2	52	10.6	550	1.7	420.1
4	104	16.8	1750	4.4	424.8
6	156	22.0	3440	7.6	430.0
8	208	26.7	5560	11.1	435.5

B - High Flows

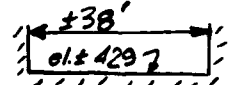
Assume "critical" flow at northwesterly end of northerly bldg, where channel is constricted, sets tailwater level, and level of flooding on street. Also assume flow around east end of northerly bldg controlled by street topography.



$V_c = \sqrt{g y_c}; E_c = y_c + \frac{V_c^2}{2g} \approx 1\frac{1}{2} y_c$

T.W. El. = 416.4 + E_c

Use T.W. El. to find H_s →



Street Section
 $Q_s = 3.0(38) H_s^{1.5}$

y _c	8	10	12	13	14
V	16.0	17.9	19.6	20.4	21.2
A	104	218.5	241.5	253	264.5
Q _c	2950	3910	4730	5160	5620
E _c	12	15	18	19.5	21
T.W. El.	428.4	431.4	434.4	435.9	437.4
H _s	0	2.4	5.4	6.9	8.4
Q _s	0	420	1430	2070	2780
EQ	2950	4330	6160	7230	8400

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JUN 68 DUCIM MID 143 NONREPRODUCIBLE GRID FORM 148

Rev. 2/27/81

(X) Reservoir Elev. w/ Tailwater Effects

Ref: Davis "Hbk of Appl. Hydr." pg 1224, Table 11
 Use Item **(Z)** for initial values

A - No Flashboards - $Q_{check} = 3.33(76)(nh)^{1.5}$

Q_{TW}	d	h	d/h	n	Q_{check}
<u>4000</u>	3.7	6.35	.583	.854	3196
"	"	7.12	.520	.894	3996
"	"	7.13	.519	.884	4005
Let h = 7.12 ; Pond El. 434.12					
<u>5000</u>	5.65	7.3	.774	.728	3100
"	"	8.8	.642	.823	4933
"	"	8.9	.635	.827	5054
Let h = 8.9 ; Pond El. 435.9					
<u>6000</u>	7.1	8.25	.861	.630	
"	"	10.3	.699	.795	5930
"	"	10.4	.683	.798	6051
Let h = 10.4 ; Res. El. 437.4					
<u>6500</u>	7.7	8.7			
"	"	11.0	0.7	.787	6446
"	"	11.1	0.694	.791	6584
Let h = 11.0 ; Res. El. 438.0					
<u>7000</u>	8.2	9.1			
"	"	11.7	0.701	.786	7058
"	"	11.6	0.707	.782	6914
Let h = 11.7 ; Res. El. 438.7					

B - With Flashboards

$Q = KL(nh_{TW})^{1.5} = KL(h_{TW})^{1.5} ; nh_{TW} = h_{TW}$

Q	d	h_{TW}	d/h	n	$h_{TW} (= \frac{h_{TW}}{n})$
4000	1.85	6.30	.294	.960	6.56
			.282	.963	6.54
			.283	.963	6.54
5000	3.10	7.30	.520	.884	8.26
			.460	.908	8.04
			.473	.903	8.08
			.470	.904	8.08
			} h = 8.1' Res. el. 436.95		

NON-REPRODUCIBLE GNU FORM 145

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Rev. 2/27/81

(X) Res. Elev. w/ Tailwater Effects - Cont.

B - With Flashboards - Cont.

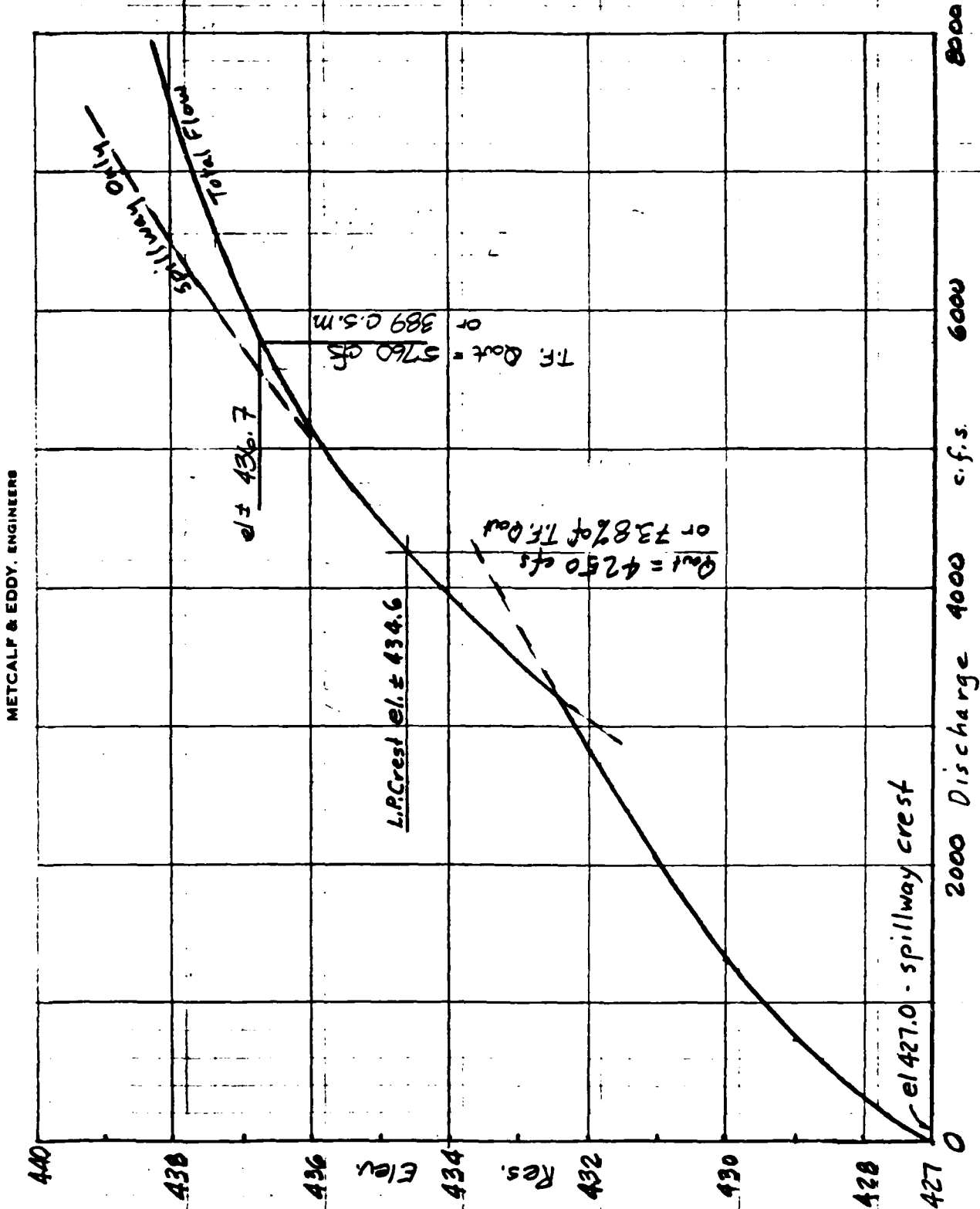
Q	d	h _{HW}	$\frac{d}{h}$	n	h _{TW} (= $\frac{h_{HW} n}{n}$)	
6000	5.25	8.20	.640	.824	9.95	} h = 9.4' Res. el. 438.25
			.520	.821	9.31	
			.564	.864	9.49	
			.553	.869	9.44	
			.556	.868	9.45	
6500	5.85	8.65	.676	.802	10.78	} h = 10.1' Res. el. 438.95
			.542	.874	9.90	
			.591	.851	10.16	
			.576	.858	10.08	
			.580	.856	10.10	
7000	6.35	9.00	.705	.783	11.49	} h = 10.0' Res. el. 439.45
			.552	.870	10.34	
			.600	.846	10.64	
			.597	.848	10.61	
			.598	.847	10.62	
			.598			

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NONREPRODUCIBLE GRID FORM 145

Project Nat. Review of Non-Fed. Dams Acct. No. 7252 Page 9 of 14
 Subject Hampden County, Mass Comptd. By LEB Date 1/19/81
 Detail ZERO MFG. DAM Ck'd. By MAN Date 3-3-81
 Rev. 2/27/81

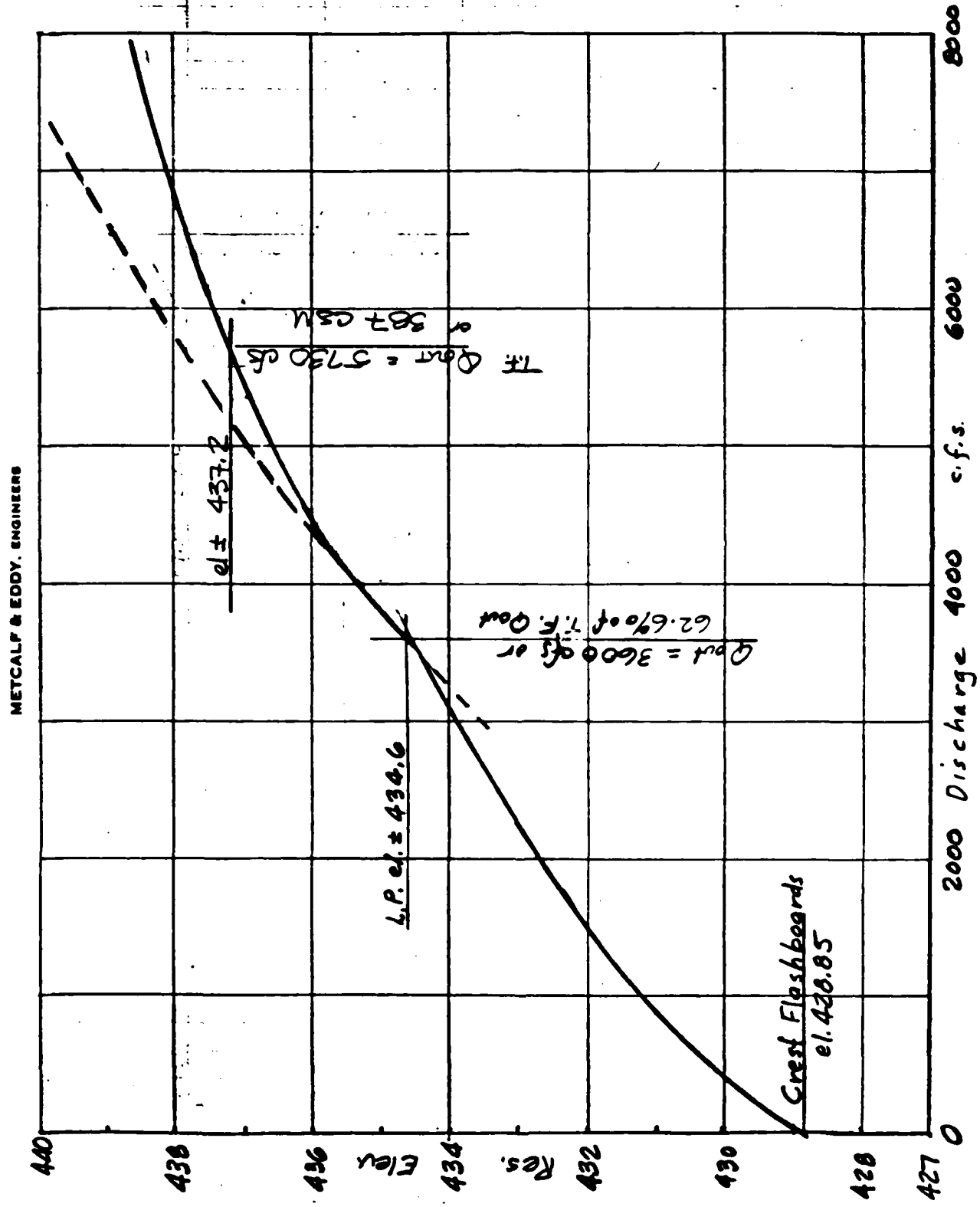
(XI) Discharge & Test Flood vs Res. Elev. - NO FLASHBOARDS



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NONREPRODUCIBLE GRID FORM 145

(III) Discharge & Test Flood vs Res. Elev. - WITH FLASHBOARDS



NON-REPRODUCIBLE GRID FORM 148

(XIII) Test Flood Crest Flow

A - No Flashboards

Test Flood Elev. - 436.7
 Low Pt. on Crest - 434.6
 Max. Head - 2.1 feet

Crest Flow - cfs/ft. = $q = 2.55(2.1)^{1.5} = 7.8 \text{ cfs/ft}$

Where flow is critical: $y_c = 1.24 \text{ ft.}; V_c = 6.3 \text{ fps}$

B - With Flashboards

Test Flood Elev. - 437.2
 Low Pt on Crest - 434.6
 Max. Head - 2.6 feet

Crest Flow $q = 2.55(2.6)^{1.5} = 10.7 \text{ cfs/ft}$

Where flow is critical: $y_c = 1.53 \text{ ft.}; V_c = 7.0 \text{ fps}$

Note: Assume "Crest Flow" not affected by high tailwater

(XIV) Low Level Outlet

Description: 30" sq. cond., 23' long, outlet el. 424.16, $R = \frac{6.25}{10} = .625$
 $H = \frac{V^2}{2g} \left(0.5 + 1.0 + 1.02 \frac{23}{4(.625)} \right) \approx \frac{V^2}{2g} (1.7); V = 6.15\sqrt{H}; Q = 38.5\sqrt{H}$

Water Elev	427	426
Head	2.84	1.84
Q	65	52

Ave. Q over 12" range = 58.5

Time to lower water 12" = $\frac{43560(13)}{3600(58.5)} = 2.7 \text{ hours or min.}$

(IV) Failure of Dam

A- Failure of the dam during the test flood, or with the res. at the low point on the dam crest (el. ±435.5) would appear to be only a "signifi. hazard" due to the prior high tail water, which would have already flooded out the lower factory floor.

B- "Dry weather" failure with the res at the top of the flashboards might produce the following failure flow:

$$Q_F = 1.68 (30') (428.85 - 416.43)^{1.5} = 2235 \text{ cfs.}$$

This could result in a tailwater level of ±426.5, between the dam & the factory. The impact on the factory should be significant, and impact further down stream major.

C- As an alternative to the above, assume a "minor flood" condition failure. An outflow of 2100 cfs would cause the tailwater to be at ±el. 426 the 1st floor factory window sill elev. (The 1st floor struct. appears to be sound, reinf. conc.) The reservoir would be at el ±432.8 with flashboards in place.

Dam failure for any appreciable width would bring the pond level up against the factory. This produces a water depth of ±6.8 feet against the 1st floor windows, which should cause their failure.

Assuming critical depth at the window sills and 12 - 6' wide windows:

$$Q_{\text{factory}} = 12(6) 3.09 (6.8)^{1.5} = 3945 \text{ cfs into the 1st floor of the factory.}$$

The adjacent 1st floor area is ±5400 ft²

$$\text{The rate of water rise is } \frac{5400}{3945} = 1.37 \text{ ft/sec.}$$

If the concrete wall is ±5.5' high from floor to window sill, the area would fill in:

$$\frac{5.5}{1.37} = 4.0 \text{ seconds}$$

This could be a major hazard to workers in the area; a "high hazard" condition.

(XV) Failure of Dam - T.W. at Window Sill

Peak Failure Flow:

Pond Elevation - 432.8	T.W. Depth = 9.6', $\frac{H}{L} = 0.585$ $n = 0.854$ Ref.: Davis' <u>Hyd. Appl. Hydr.</u> pg. 1224
Toe Elevation - 416.4	
$Y_0 = 16.4$	

Dam Length Subject to Breaching = 76 ft

$W_0 = 40\% (76) = 30.4'$

$Q_P = 1.68 W_0 (Y_0)^{1.5} = 1.68 (30.4) (16.4)^{1.5} = 2680 \text{ cfs}$

Continuing Spill. Disch.: $0.6(2100) = 1260$

Peak Failure Flow: $\frac{2680}{3940}$

Storage Volume Released:

Storage Above Spillway $(0.427) \cdot 5.8(13) = 75.4 \text{ ac. ft.}$

Storage Below Spillway $10.6(Y_0) \cdot 13 = 45.9 \text{ " "}$

Total Storage $\frac{121.3 \text{ " "}}$

Channel Hydraulics:

See prior Tailwater evaluation.

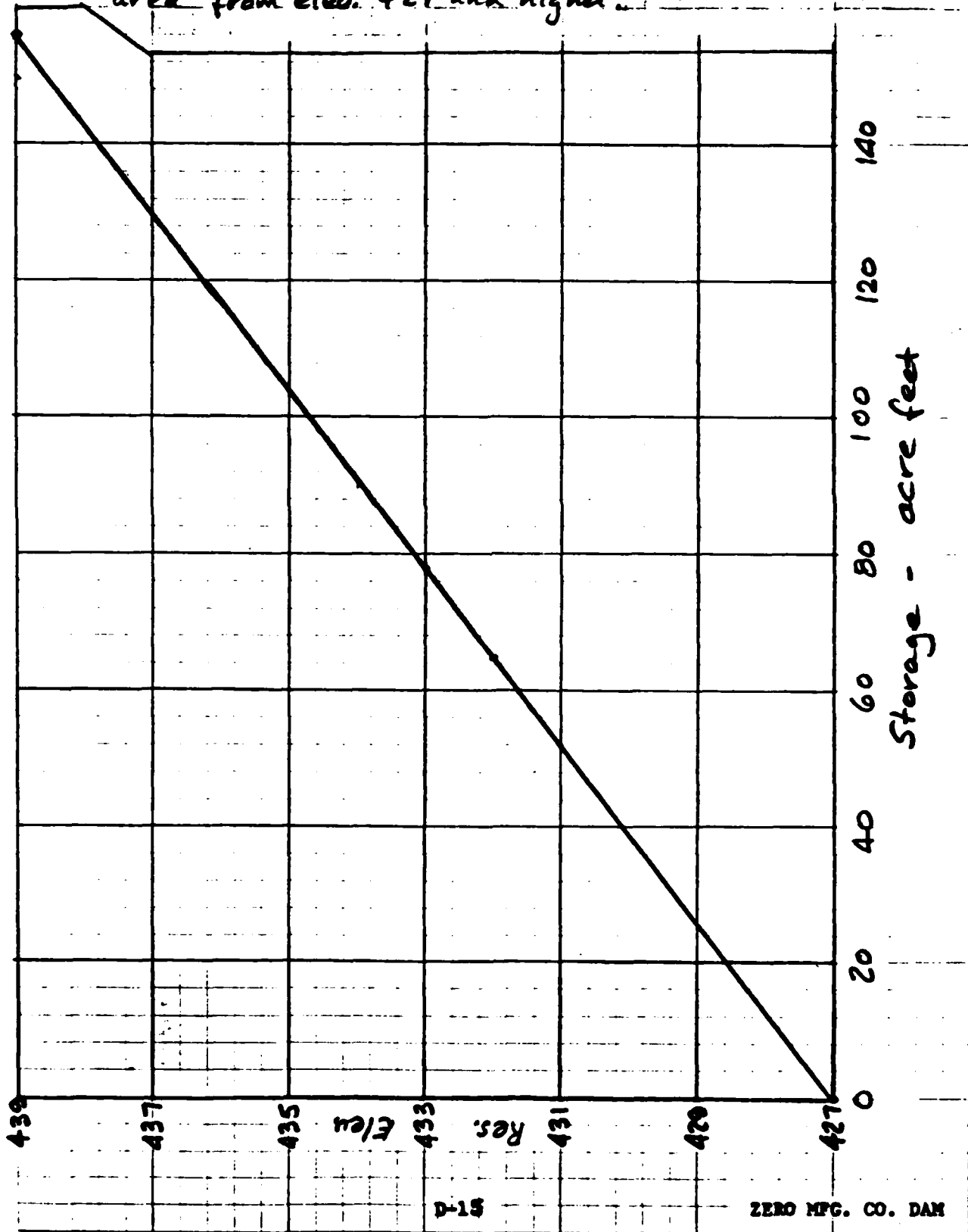
Failure causes sudden rise in water level in 1st floor of factory, just below dam, from 0' (dry) to 5.5' or more in 4.0 seconds.

NONREPRODUCIBLE GRID FORM 145

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(XVI) Storage vs Reservoir Elev.

Res. area is 13 acres at el. ±430. Assume const. area from elev. 427 and higher.



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(XV) Failure of Dam

A- Failure of the dam during the test flood, or with the res. at the low point on the dam crest (el. ±435.5) would appear to be only a "signif. hazard" due to the prior high tailwater, which would have already flooded out the lower factory floor.

B- "Dry weather" failure with the res at the top of the flashboards might produce the following failure flow:

$$Q_F = 1.68 (30') (429.85 - 416.43)^{1.5} = 2235 \text{ cfs.}$$

This could result in a tailwater level of ±426.5, between the dam & the factory. The impact on the factory should be significant, and impact further down stream major

C- As an alternative to the above, assume a "minor flood" condition failure. An outflow of 2100 cfs would cause the tailwater to be at ±el. 426 the 1st floor factory window sill elev. (The 1st floor struct. appears to be sound, reinf. conc.) The reservoir would be at el ±432.8 with flashboards in place.

Dam failure for any appreciable width would bring the pond level up against the factory. This produces a water depth of ±6.8 feet against the 1st floor windows, which should cause their failure.

Assuming critical depth at the window sills and 12 - 6' wide windows:

$$Q_{\text{factory}} = 12(6) 3.09 (6.8)^{1.5} = 3945 \text{ cfs into the 1st floor of the factory.}$$

The adjacent 1st floor area is ±5400 ft²

$$\text{The rate of water rise is } \frac{5400}{3945} = 1.37 \text{ ft/sec.}$$

If the concrete wall is ±5.5' high from floor to window sill, the area would fill in:

$$\frac{5.5}{1.37} = 4.0 \text{ seconds}$$

This could be a major hazard to workers in the area; a "high hazard" condition.

(XV) Failure of Dam - T.W. at Window Sill

Peak Failure Flow:

<u>Pond Elevation - 432.8</u>	T.W. Depth = 9.6', $\frac{d}{H} = 0.585$ $n = 0.854$ Ref: Davis' <u>Hubb Appl. Hydro</u> pg 1224
<u>Toe Elevation - 416.4</u>	
<u>$Y_0 = 16.4$</u>	

Dam Length Subject to Breaching = 76 ft

$W_0 = 40\% (76) = 30.4'$

$Q_{P_1} = 1.68 W_0 (Y_0)^{1.5} = 1.68 (30.4) (16.4)^{1.5} = 2680 \text{ cfs}$

Continuing Spill. Disch. : $0.6(2100) = 1260$

Peak Failure Flow:
 $\frac{2680}{3940}$

Storage Volume Released:

Storage Above Spillway $(0.427) \cdot 5.8(13) = 75.4 \text{ ac. ft.}$

Storage Below Spillway $10.6(Y_0)^{1.3} = 45.9 \text{ "}$

Total Storage $\frac{75.4}{45.9} = 121.3 \text{ "}$

Channel Hydraulics:

See prior Tailwater evaluation.

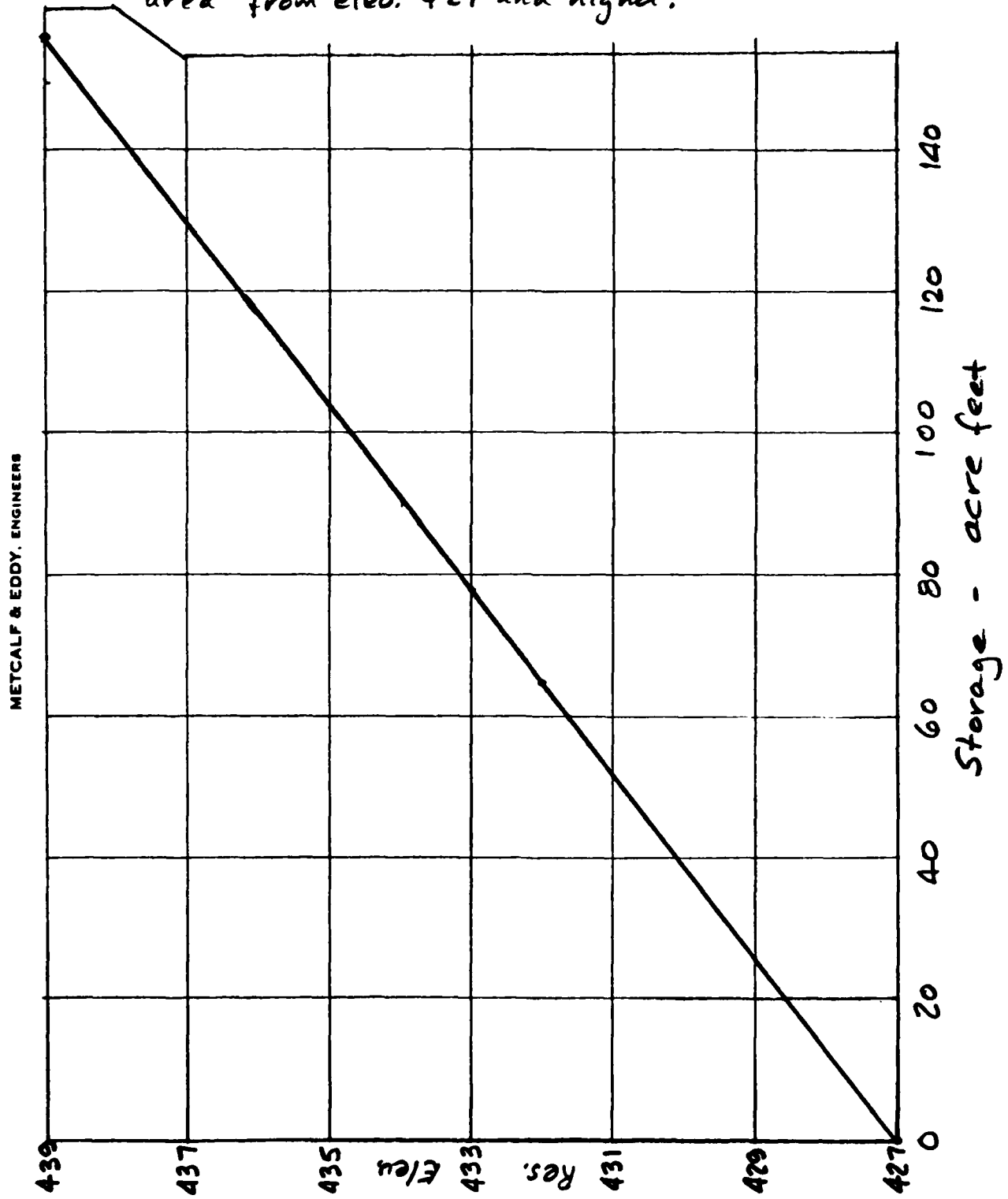
Failure causes sudden rise in water level in 1st floor of factory, just below dam, from 0' (dry) to 5.5' or more in ± 4.0 seconds.

NONREPRODUCIBLE GRID FORM 148

METCALF & EDDY, ENGINEERS

(XVI) Storage vs Reservoir Elev.

Res. area is 13 acres at el. ±430. Assume const. area from elev. 427 and higher.



NONREPRODUCIBLE GRID FORM 145

APPENDIX E

INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

ZERO MANUFACTURING COMPANY DAM

NOT AVAILABLE AT THIS TIME

END

FILMED

7-85

DTIC