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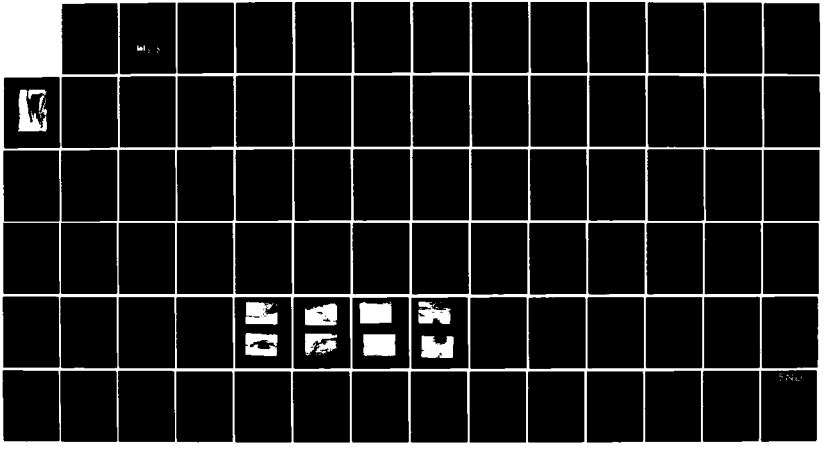

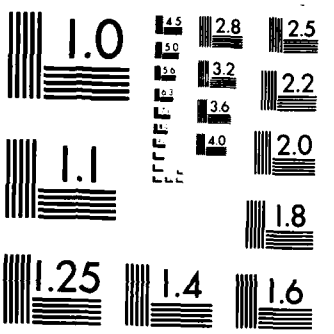

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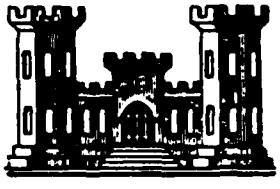
CONNECTICUT RIVER BASIN
MONTGOMERY, MASSACHUSETTS

WESTFIELD RESERVOIR DAM
MA 00734

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
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MARCH 1981

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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

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

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Montgomery, Massachusetts
Moose Meadow River

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

The dam is an earthen embankment structure about 350 ft. long and 40 ft. high. The dam is judged to be in fair condition. There was minor but widespread slumping on the downstream slope was noticed during inspection along with other deficiencies. It is intermediate in size with a high hazard potential.

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

REPLY TO
ATTENTION OF:

NEDED

JUL 16 1991

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

Dear Governor King:

Inclosed is a copy of the Westfield Reservoir Dam (MA-00734) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Westfield Reservoir Dam would likely be exceeded by floods greater than 21 percent of the Probable Maximum Flood (PMF). Our screening criteria specifies that a dam classified as high hazard with a spillway capacity insufficient to discharge fifty percent of the PMF be judged as having a seriously inadequate spillway. As a result this dam is assessed as unsafe, non-emergency until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as it would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

We recommend that within twelve months from the date of this report the owner of the dam engage the services of a qualified registered engineer to determine further the potential of overtopping the dam and the need for and the means to increase project discharge capacity. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed and round-the-clock surveillance should be provided during periods of heavy precipitation or high project discharge.

NEDED
Honorable Edward J. King

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

Copies of this report have been forwarded to the Department of Environmental Quality Engineering and to the owner, City of Westfield, Westfield, 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
Commander and Division Engineer

WESTFIELD RESERVOIR DAM
MA 00734

CONNECTICUT RIVER BASIN
MONTGOMERY, MA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

IDENTIFICATION NO:	MA 00734
NAME OF DAM:	Westfield Reservoir Dam
TOWN:	Montgomery
COUNTY AND STATE:	Hampden, Massachusetts
STREAM:	Moose Meadow Brook
DATE OF INSPECTION:	November 13, 1980

Westfield Reservoir Dam is an earthen embankment structure about 350 feet long and 40 feet high. It has an uncontrolled overflow spillway located on the left (east) abutment and a 24-inch diameter cast-iron pipe outlet conduit which passes beneath the dam and which is valve controlled at the outlet end. The dam was constructed in 1874 and has operated as part of the Westfield, Mass. municipal water supply system since that time.

Based on the visual inspection, the dam is judged to be in fair condition. The following deficiencies were observed at the dam: minor but widespread slumping on the downstream slope; an animal burrow on the downstream slope; large trees near both abutments; a soft, wet area along the right bank of the downstream channel; a small sinkhole on the right side of the spillway discharge channel; lack of vegetation on the crest of the dam; inoperable valves on the downstream end of the outlet conduit; and no valve or other means of regulating or shutting off flow at the intake end of the outlet conduit.

Based on the Recommended Guidelines for Safety Inspection of Dams, prepared by the Corps of Engineers, the dam is classified as "intermediate" in size, with a "high" hazard potential. A test flood equal to the Probable Maximum Flood (PMF) was used for the analyses performed for this report. With the stoplog in place, the spillway capacity of Westfield Reservoir Dam is 707 cfs, which is about 15 percent of the routed test flood outflow of 4670 cfs. With the stoplog removed, the spillway capacity is about 994 cfs, which is about 21 percent of the routed test flood outflow. The test flood would cause the dam to be overtopped by about 3.5 feet.

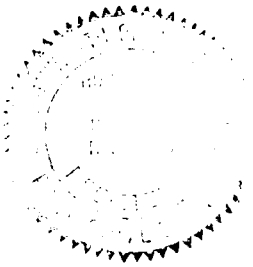
It is recommended that the Owner engage a professional engineer experienced in the design of dams to perform more detailed hydrologic and hydraulic analyses to determine spillway adequacy, investigate the cause of the slumping on the downstream slope, specify procedures for filling the animal burrow on the downstream slope, investigate the cause of the soft, wet area on the right bank of the downstream channel, investigate the cause of the sinkhole in the earth berm on the right side of the spillway channel, design erosion protection for the unprotected portion of the upstream slope, investigate the cause of inoperability of the valves at the downstream end of the outlet conduit, design a means of shutting off flow at the upstream end of the outlet conduit, and oversee removal of trees growing at the ends of the dam. In addition, the Owner should make necessary repairs for the deficiencies listed above and should also implement the remedial measures described in Paragraph 7.3.

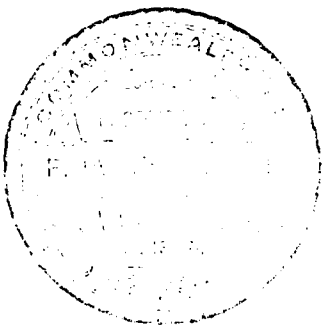
The measures outlined above, and discussed in detail in Section 7, should be implemented within one year after receipt of this Phase I Inspection Report.

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

Houghton R. Hallock, P.E.

F. James Knight, P.E.
Assistant Vice President
Project Manager





This Phase I Inspection Report on Westfield Reservoir 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 judgement and practice, and is hereby submitted for approval.

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

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

ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering Branch
Engineering Division

APPROVAL RECOMMENDED:

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 condition 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.

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category. In accordance with Corps of Engineers' guidelines, a spillway design flood equal to the Probable Maximum Flood (PMF) should be used to evaluate the spillway. In the following analysis, the PMF was used as the test flood. Conditions for the one-half PMF were also checked. The test flood (PMF) inflow of 5,560 cfs is based on a watershed area of 2.45 square miles in terrain varying in character from mountainous to rolling. The test flood was routed through Westfield Reservoir. The rating curves used for the dam were combined curves that accounted for the effects of the stoplog and the bridge at the spillway and for the effects of the varying top elevations of the embankment. The routed test flood outflow was determined in accordance with Corps of Engineer Guidance for Estimating Effect of Surcharge Storage on Maximum Probable Discharges. The routing was started with the pool level at the spillway crest level. With the stoplog in place, the routed test flood outflow was determined to be 4,670 cfs. The maximum capacity of the spillway, with the stoplog in place is about 707 cfs with the pool level at the top of the dam. The maximum spillway capacity is about 15 percent of the routed test flood outflow. The test flood would cause the dam to be overtopped by about 3.6 feet. The depth of overtopping was also checked for the one-half PMF; it was determined to be about 2.3 feet of overtopping. If the stoplog were removed, the routed test flood outflow would be 4,690 cfs. The maximum capacity of the spillway with the stoplog removed is about 994 cfs with the pool level at the top of the dam. That spillway capacity is about 21 percent of the routed test flood outflow. With the stoplog removed, the depth of overtopping during the test flood would be 3.5 feet. During the one-half PMF, the depth of overtopping would be 2.2 feet.

5.5 Dam Failure Analysis. The impact of failure of the dam was assessed using the "Rule of Thumb" Guidance for Estimating Downstream Dam Failure Hydrographs prepared by the Corps of Engineers. The breach discharge was estimated with the water surface at the top of the dam and a breach width equal to 40 percent of the mid-height length of the dam. The maximum breach discharge was determined to be 42,447 cfs.

The stream levels at downstream sections resulting from dam failure were determined by routing the breach discharge. Six stream sections were used in the analysis. At the location of the primary damage center, which is along Moose Meadow Brook about 3.6 miles downstream from the dam, the flood stage resulting from dam failure would be about 10.5 feet. The stage just prior to failure, with the spillway discharging its maximum capacity of 707 cfs, would be about 3.5 feet. Since the first floor level of one dwelling is about 5 feet above the streambed, and the first floor levels of three other dwelling are about 10 feet above the streambed, and since the results reflect only one possible failure mode,

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General. Westfield Reservoir Dam has a drainage area of 2.45 square miles. The watershed terrain varies in character from rolling to mountainous. It is mostly wooded and is relatively undeveloped. There are no other impoundments upstream from Westfield Reservoir Dam.

The dam is an earthen embankment 40 feet high and about 350 feet long. The lowest point on the top of the dam is at Elevation 923.1. A 60-foot long section of the embankment is at that level. The remaining 290 feet of the embankment varies in elevation somewhat, but has an average top elevation of 924.8. The combined rating curve developed for the spillway and embankment to assess overtopping accounted for the variations in top elevation on the embankment.

The spillway is located at the left abutment. It consists of a short, nearly horizontal rectangular channel followed by a long, steep, trapezoidal outlet channel. Both channel segments are lined. Spillway control is at a 1.3-foot high wooden stoplog that extends across the 19.8 foot wide rectangular section. The analysis considered the effects of removing the stoplog. A concrete bridge crosses the spillway channel. The bridge was constructed on a 10 percent slope, so the bottom of the lowest beam is 3 feet above the top of the stoplog on one end and 5 feet above the top of the stoplog on the other end. The top of the bridge deck varies similarly, with one end at Elevation 924.8 and the other end at Elevation 926.7. The bridge would have an affect on spillway discharge when pool levels approach the level of the top of the dam. The rating curve developed for the spillway takes the effects of the bridge into account. The hydrologic and hydraulic computations performed for this report are included in Appendix D.

The outlet works was not functional at the time of the inspection. The valves at the downstream end were open slightly, but damage to one of them prevents opening them further. Accordingly, no consideration of outlet works discharge was included in the analysis.

5.2 Design Data. There are no hydrologic or hydraulic design data available for the dam.

5.3 Experience Data. There are no records of the maximum discharge at the site.

5.4 Test Flood Analysis. Westfield Reservoir Dam is in the "intermediate" size category and in the "high" hazard

SECTION 4

OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures.

a. General. A damtender, in the employ of the Westfield Water Department, resides at the dam and makes daily observations of the facility. Because the reservoir is not in use by the City, it is not "operated". Aside from routine maintenance of the grounds, no special procedures are followed. There are no formally established procedures.

b. Description of any Warning System in Effect. No formal warning system is in effect.

4.2 Maintenance Procedures.

a. General. The embankment's downstream slope and the surrounding grounds are mowed in the summer months, and debris is removed from the reservoir as it accumulates. Fill material was added to the top of dam several years ago, apparently to correct settlement and vertical misalignment. Widespread minor slumping on the downstream slope, an animal burrow, a small sinkhole near the spillway and trees near both abutments have not been addressed in the maintenance program.

b. Operating Facilities. The only operating facility on the dam is the 24-inch outlet conduit. As discussed above, gate valves on the conduit are in poor condition. The downstream valve is broken and inoperable. Both valves appear to have been neglected for some time and are in need of attention.

4.3 Evaluation. Maintenance of the dam has been largely superficial and inadequate. Several items noted above need investigation and attention. There is no regular program of technical inspection and no written warning system. Considering the dam's size and hazard category, this is unsatisfactory. Such programs should be implemented by the Owner as recommended in Section 7.3.

A sinkhole in the earth berm on the right side of the spillway discharge channel might be an indication of subsurface erosion which could endanger the spillway channel. If the berm were to fail during a period of spillway flow, the release of water from the spillway channel could lead to erosion of the downstream toe of the dam.

The lack of vegetation on the crest of the dam makes the crest highly susceptible to erosion in the event that the dam were to be overtopped.

The inoperable condition of the valves on the downstream end of the outlet conduit makes release from the reservoir impossible. If an emergency situation were to develop, the pool level could not be drawn down. In addition, there is no valve or other means of shutting off flow at the intake end of the conduit. If the conduit were to develop a leak, there would be no means to stop it and piping failure of the dam could ensue.

d. Reservoir Area. The area immediately adjacent to Westfield Reservoir has moderate slopes and is heavily wooded. There are no impoundments located within the watershed upstream from Westfield Reservoir Dam. No evidence of significant sedimentation in the reservoir was observed.

e. Downstream Channel. The bottom of the downstream channel consists of sand, gravel, and boulders. The channel appears to be well-maintained, and trees and brush have been cleared from both banks of the channel for a distance of about 150 feet downstream from the gatehouse. The channel downstream from Westfield Reservoir is narrow, steep and wooded for the first 2.7 miles. Tekoa Dam, a 32-foot high stone masonry gravity dam, is located in this reach. Moose Meadow Brook goes through a large bridge opening beneath the Massachusetts Turnpike at a distance of 2.7 miles from the dam. The valley then becomes much wider and both channel slopes and valley slopes are flatter. The land changes from predominantly woodland to farmland. These conditions persist until Moose Meadow Brook joins the Westfield River at a point about 4.5 miles downstream from Westfield Reservoir Dam.

There are four low-lying dwellings and several farm buildings along Moose Meadow Brook about 3.6 miles downstream from the dam. At the same area, Moose Meadow Brook goes under Pochassic Road. Just upstream from the confluence with Westfield River, there is a railroad embankment with two sets of tracks. The downstream area is shown on Exhibit D-1 in Appendix D.

3.2 Evaluation. Minor but widespread slumping on the downstream slope of the embankment indicates that the stability of the slope may be marginal. Continued slumping might lead to serious seepage and piping problems, and a large slump could breach the crest of the dam.

A large animal burrow on the downstream slope of the embankment could become a focus for seepage and piping, which might in turn lead to breaching of the dam.

Large pine trees growing at both the right and left abutments could cause seepage and erosion problems during periods of high reservoir level if one or more of the trees should fall over and pull out their roots.

A slightly soft, wet area on the right bank of the downstream channel may be due to seepage from the reservoir through the foundation and abutment of the dam, or it may be the result of a natural groundwater discharge from the side of the valley. If it is the result of seepage from the reservoir, it could develop into a more extensive seepage and lead to a piping failure of the dam.

c. Appurtenant Structures. Excess inflow is discharged through the rectangular spillway channel (Photo No. 7). The control section is concrete and is 19.8 feet wide. A 1.3-foot high wooden stoplog is in place atop the spillway crest. The stoplog is held in place by concrete piers located in the center and on either side of the spillway. Concrete gravity walls form the spillway sidewalls and also serve as supporting abutments for a concrete access bridge, which spans the spillway and provides for vehicular access to the left abutment area. The spillway approach channel is exposed soil, and is open and unobstructed. The discharge channel is concrete and stone masonry lined (Photo No. 8). It traverses the downstream left abutment at an average grade of about 10% and enters the stream about 200 feet downstream from the toe of the dam. Other than some minor spalling of concrete in the stoplog piers, the spillway appears to be in good condition. There is a small sinkhole in the earth berm which borders the right side of the channel. The sinkhole may be the result of downward erosion of soil fill at the surface of the berm into a coarse, dumped rockfill underlying the area. The spillway channel itself shows no sign of distress.

A high-level outlet pipe passes through the embankment near the left abutment. This outlet consists of a 6-inch diameter pipe that has an uncontrolled intake with a bar-screen and that outlets on the left abutment through a small, stone masonry headwall. The pipe's intake is about 5 feet lower than the spillway crest, so it flows whenever the pool level exceeds approximate Elevation 912. The specific purpose of this high-level outlet is unknown. Its purpose might have been to maintain the pool level at an elevation lower than spillway crest level. However, the size of the pipe is such that it would serve that purpose only during periods of low streamflow conditions. Throughout much of the year, it is unlikely that the pipe significantly affects pool levels.

The principal outlet is a 24-inch cast-iron pipe conduit which passes beneath the dam. Its intake end was submerged and could not be inspected. The conduit's outlet is at a concrete and brick masonry gatehouse structure at the downstream toe of the dam (Photo No. 5). The gatehouse is in good condition. Two gate valves, in-line at the outlet end of the conduit, control release. Both valves appear to be in poor condition resulting from lack of adequate maintenance. The upstream valve was open at the time of inspection and is reportedly operable. The downstream valve was partially open ("8 turns from closed" according to Water Department personnel) and was reported to be broken and locked in that position. Both valves were heavily encrusted with rust and scale. There is no valve or other means of shutting off flow at the intake end of the 24-inch conduit.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The Phase I inspection of the dam was performed on November 13, 1980. A copy of the inspection checklist is included in Appendix A. Photographs taken during the inspection are included in Appendix C. A summary of the results of this visual inspection is shown on Exhibit B-2 in Appendix B.

b. Dam. The crest of the dam is 14 feet wide and consists of sand and gravel. Little or no vegetation is growing on the crest (Photo No. 2). Most of the top of the dam is at approximately Elevation 924.8, but there is a reach about 60 feet long near the right abutment which is at approximately Elevation 923.1.

The upstream slope of the dam is covered with riprap (18-inch maximum size) from an elevation about 3 feet below the crest of the dam to an unknown elevation below the reservoir level (Photo No. 1). The riprap is in good condition. Between the top of the riprap and the crest of the dam, the upstream slope is covered with grass and coarse weeds.

The downstream slope of the dam consists of soil and is covered with grass which has been mowed. The downstream slope is quite irregular and appears to have experienced minor but widespread slumping (Photo Nos. 3 and 4). One large animal burrow was observed on the downstream slope. There is an area of minor erosion on the left side of the valley close to its contact with the downstream slope (Photo No. 6). There is a rock toe at the bottom of the downstream slope (Photo No. 5).

Both the right and left abutments appear to be soil and are in good condition. Two large pine trees are growing on the downstream side of the crest near the right abutment and several large pine trees are growing close to the end of the embankment on the left abutment.

There is a slightly soft, wet area on the right bank of the downstream channel close to the embankment. The wet area was about 15 feet square. No standing or flowing water was observed. It was not possible to determine whether this area is the result of seepage from the reservoir or the result of a natural discharge of groundwater from the side of the valley.

SECTION 2

ENGINEERING DATA

2.1 Design Data. No engineering data, design drawings or records are known to exist for Westfield Reservoir Dam.

2.2 Construction Data. No construction records are known to exist.

2.3 Operation Data. No operating records are available.

2.4 Evaluation of Data.

a. Availability. There are no engineering data available for this dam.

b. Adequacy. Not applicable.

c. Validity. Not applicable.

g. Dam.

(1) Type - earthfill
(2) Length - 350 feet
(3) Height - 40 feet.
(4) Top width - 14 feet
(5) Side slopes - 1V on 2H
(6) Zoning - unknown.
(7) Impervious core - unknown.
(8) Cutoff - unknown.
(9) Grout curtain - unknown.

h. Diversion and Regulating Tunnel. Not applicable.

i. Spillway.

(1) Type - concrete-lined channel.
(2) Length of control section - 19.8 feet.
(3) Spillway crest elevation - 916.7
(4) Stoplog crest elevation - 918.0
(5) Gates - none.
(6) Upstream channel - reservoir.
(7) Downstream channel - steep concrete - lined channel.

j. Regulating Outlets.

(1) Invert - Elev. 883.6
(2) Size - 24-inch diameter
(3) Description - cast-iron pipe
(4) Control mechanism - two in-line gate valves at downstream toe of dam in masonry gatehouse. No controls at intake end.
(5) Other - 6-inch diameter pipe through embankment at left abutment at Elevation 912. No control mechanisms.

b. Discharge at the Dam. There are outlet facilities at the dam, but they are not functional in their present condition. Normal discharge flows over the ungated, 19.8-foot long spillway (Photo No. 7). A 1.3-foot high stoplog is normally in place atop the spillway crest. Flows have not been recorded at this site and, therefore, the maximum flood discharge is unknown. Calculations performed for this report indicate that with the pool at the top of the dam, the spillway can discharge 707 cfs with the stoplog in place and 994 cfs with the stoplog removed. During the test flood (PMF) with the stoplog in place, the peak discharge would be 4,670 cfs with the pool level 3.6 feet above the top the dam. If the stoplog were removed, the peak discharge would be 4,690 cfs with the pool level 3.5 feet above the top of the dam.

c. Elevation (feet above NGVD).

(1) Streambed at toe of dam - 883.6
(2) Bottom of cutoff - unknown.
(3) Maximum tailwater - 886.0
(4) Normal pool - 918.0
(5) Full flood control pool - not applicable.
(6) Spillway crest - 916.7
(7) Top of stoplog in spillway - 918.0
(8) Design surcharge (original design) - unknown.
(9) Top of dam (low point) - 923.1
(10) Top of dam (average) - 924.8
(11) Test flood surcharge - 926.7

d. Reservoir (length in feet).

(1) Normal pool - 1900
(2) Flood control pool - not applicable.
(3) Spillway crest pool - 1900
(4) Top of dam - 2000
(5) Test flood pool - 2000

e. Storage (acre-feet).

(1) Normal pool - 390
(2) Flood control pool - not applicable.
(3) Spillway crest pool - 346
(4) Top of dam (low point) - 591
(5) Test flood pool - 753

f. Reservoir Surface (acres).

(1) Normal pool - 34
(2) Flood control pool - not applicable.
(3) Spillway crest - 33
(4) Test flood pool - 45
(5) Top of dam - 45

between 5 and 10 feet above the streambed. It is estimated that dam failure could produce stream depths in excess of 10.5 feet at the potential damage center. Failure of Westfield Reservoir Dam would probably cause failure of Tekoa Dam, washing out of Pochassic Road, damage to farm buildings and at least 4 dwellings, and possible loss of more than a few lives. Accordingly, the dam has been placed in the "high" hazard category.

e. Ownership. The dam is owned by the City of Westfield, Massachusetts. Permission to enter the property was granted by the Director of the Westfield Water Department (413-357-8811), and a Department representative accompanied the inspection team.

f. Operator. The dam is operated by personnel employed by the Westfield Water Department. A damtender resides on the property.

g. Purpose of Dam. The dam was constructed to supply water to the City of Westfield. It served the purpose for many years but is no longer being used. Problems with the quality of water produced by this facility reportedly led the city to develop alternative sources. The dam now serves only as a reserve supply.

h. Design and Construction History. The Westfield Reservoir Dam was constructed in 1874. No historical data for the dam were available. Personnel from the Westfield Water Department reported that the dam was raised approximately 3 feet about 7 or 8 years ago. Earthfill material was placed on top of the embankment. The fill apparently served to correct alignment problems which had developed along the crest of the dam. No riprap slope protection was placed on the upstream slope of this fill material. There are no known construction data available for the dam.

i. Normal Operational Procedures. There are no formal operating procedures. Pool level is controlled by flow over the stoplog, release through the partially open outlet conduit, and release through the uncontrolled high-level outlet.

1.3 Pertinent Data.

a. Drainage Area. The drainage area for Westfield Reservoir Dam is 2.45 square miles. The terrain varies from rolling to mountainous and is mostly wooded. There is a minor amount of residential development within the watershed. There are no other impoundments upstream from Westfield Reservoir Dam.

The embankment has upstream and downstream slopes of approximately 1 vertical to 2 horizontal (Photo Nos. 1-4). The downstream slope is grass covered and the upstream slope is riprapped from an unknown elevation below the normal pool level to about 3 feet below the top of the dam. The top 3 feet of the upstream slope is grass covered.

The spillway is located at the left abutment (Photo No. 2). It is a concrete-lined channel about 20 feet wide. A short reach of nearly horizontal, rectangular approach channel (Photo No. 1) is followed by a steep, trapezoidal outlet channel (Photo No. 8). The width at the control section is 19.8 feet and the crest is at Elevation 916.7. A 1.3-foot high stoplog is normally in place atop the spillway crest. A concrete access bridge crosses the spillway approach channel. The outlet channel has sidewalls that slope at approximately 1 vertical on 1.5 horizontal in the upper portion, and become vertical near the downstream end.

An outlet conduit, consisting of a 24-inch diameter cast-iron pipe, passes beneath the embankment at approximately its maximum section (Photo No. 5). Discharge is controlled by two gate valves located in a concrete and brick masonry gatehouse at the conduit's downstream end. In addition, there is a 6-inch diameter pipe at a high level passing through the dam near the left abutment about 100 feet from the spillway. There are no valves or controls for the 6-inch pipe. The invert of the pipe is about 5 feet lower than the spillway crest level.

c. Size Classification. Size classification is determined in accordance with Corps of Engineers guidelines and is based on either height or storage capacity, whichever gives the larger size category. Westfield Reservoir Dam has a maximum height of 40 feet and a maximum storage capacity of 591 acre-feet. By virtue of its height, Westfield Reservoir Dam meets the minimum size requirement for an "intermediate" size dam.

d. Hazard Classification. The valley downstream from the dam is generally steep and wooded. The first structure downstream from Westfield Reservoir Dam is Tekoa Dam, which is about 2.2 miles downstream. Tekoa Dam is a stone masonry, gravity dam having a maximum height of 32 feet and a maximum storage capacity of about 17 acre-feet. About 2.7 miles downstream from Westfield Reservoir Dam, Moose Meadow Brook goes through a large bridge opening beneath the Massachusetts Turnpike. At this point, the valley becomes much wider and both the side slopes and channel slopes are flatter. The primary potential damage center is located about 3.6 miles from the dam, where Moose Meadow Brook flows under Pochassic Road. At this location there is one dwelling situated about 5 feet above the streambed and three dwellings about 10 feet above the streambed. There are also farm buildings situated

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT
WESTFIELD RESERVOIR DAM

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. Public Law 92-367, dated August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility for supervising the inspection of dams within the New England Region. Gannett Fleming Corddry and Carpenter, Inc., has been retained by the New England Division to inspect and report on selected dams in the States of Vermont and Massachusetts. Contract No. DACW33-81-C-0013 dated November 5, 1980, has been assigned by the Corps of Engineers for this work.

b. Purpose. The purpose of the inspection and evaluation of non-Federal dams is to accomplish the following:

(1) 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 Moose Meadow Brook, which is a tributary to the Westfield River which, in turn, drains to the Connecticut River. The dam is located within the Town of Montgomery, Massachusetts. The dam is shown on USGS Quadrangle, Woronoco, MA, at latitude N 42° 11' 25" and longitude W 72° 48' 45". The location is shown on Figure 1 on page v.

b. Description of Dam and Appurtenances. Westfield Reservoir Dam is an earthen embankment structure approximately 350 feet long and 40 feet high. Details of the dam and appurtenances are shown on Exhibit B-1 in Appendix B, on the Overview Photograph on page iv and on the photographs in Appendix C. The dam has an uncontrolled overflow spillway located at the left (east) abutment, and a 24-inch diameter cast-iron pipe outlet conduit which passes beneath the dam and which is valve controlled at the outlet end.

Westfield Reservoir Dam

Overview

it is judged that the result of dam failure would be property damage and probable loss of more than a few lives. For this reason, the dam has been placed in the "high" hazard category. The probable flood impact area is shown on Exhibit D-1 in Appendix D.

SECTION 6

EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations. The following conditions observed during the visual inspection are indicative of problems that could result in long-term structural instability:

a. Minor but widespread slumping on the downstream slope of the embankment indicates that the stability of the slope may be marginal. Continued slumping might lead to serious seepage and piping problems, and a large slump could breach the crest of the dam.

b. A large animal burrow on the downstream slope of the embankment could become a focus for seepage and piping, which might in turn lead to breaching on the dam.

c. Large pine trees growing at both the right and left abutments could cause seepage and erosion problems during periods of high reservoir level if one or more of the trees falls over and pulls out their roots.

d. A slightly soft, wet area on the right bank of the downstream channel may be due to seepage from the reservoir through the foundation and abutment of the dam, or it may be the result of a natural groundwater discharge from the side of the valley. If it is the result of seepage from the reservoir, it could develop into a more extensive seepage and lead to a piping failure of the dam.

e. A sinkhole in the earth berm on the right side of the spillway discharge channel might be an indication of subsurface erosion which could endanger the spillway channel. If the berm were to fail during a period of spillway flow, the release of water from the spillway channel could lead to erosion of the downstream toe of the dam.

f. The lack of vegetation on the crest of the dam makes the crest highly susceptible to erosion in the event that the dam were to be overtopped.

g. There is no valve or other means of regulating or shutting off flow at the intake end of the 24-inch outlet conduit. As a result, the pipe is under pressure at all times. If the conduit were to develop a leak, there would be no means to stop it and piping failure of the dam could ensue.

6.2 Design and Construction Data. No design and construction data are available for this dam.

6.3 Post-Construction Changes. The crest elevation of the dam was raised 7 or 8 years ago, according to the caretaker. No riprap was placed on the upstream slope of the fill that was placed to raise the dam.

6.4 Seismic Stability. This dam is located in the boundary region between Seismic Zones 1 and 2, and, in accordance with the Phase I guidelines, does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. Based on the results of the visual inspection, Westfield Reservoir Dam is judged to be in fair condition. The following conditions are indicative of potential long-term problems:

(1) Hydraulic analyses indicate that the spillway can discharge 707 cfs with the stoplog in place and with the pool level at the top of the dam. The spillway capacity with the stoplog removed is 994 cfs. The test flood (PMF) outflow would cause the dam to be overtopped by about 3.5 feet. With the stoplog in place, the spillway can discharge about 15 percent of the routed tested flood outflow before the dam is overtopped. With the flashboard removed, the spillway can discharge about 21 percent of the routed test flood outflow before the dam is overtopped.

(2) Minor but widespread slumping on the downstream slope of the embankment indicates that the stability of the slope may be marginal. Continued slumping might lead to serious seepage and piping problems, and a large slump could breach the crest of the dam.

(3) A large animal burrow on the downstream slope of the embankment could become a focus for seepage and piping, which might in turn lead to breaching on the dam.

(4) Large pine trees growing at both the right and left abutments could cause seepage and erosion problems during periods of high reservoir level if one or more of the trees should fall over and pull out their roots.

(5) A slightly soft, wet area on the right bank of the downstream channel may be due to seepage from the reservoir through the foundation and abutment of the dam, or it may be the result of a natural groundwater discharge from the side of the valley. If it is the result of seepage from the reservoir, it could develop into a more extensive seepage and lead to a piping failure of the dam.

(6) A sinkhole in the earth berm on the right side of the spillway discharge channel may be an indicator of subsurface erosion which could endanger the spillway channel. If the berm were to fail during a period of spillway flow, the release of water from the spillway channel could lead to erosion of the downstream toe of the dam.

(7) The lack of vegetation on the crest of the dam makes the crest highly susceptible to erosion in the event that the dam were to be overtopped.

(8) The outlet valves on the downstream end of the 24-inch conduit are judged to be in poor condition. The downstream valve is reportedly inoperable. Emergency releases and reservoir drawdown cannot be accomplished under these conditions.

(9) There is no valve or other means of regulating or shutting off flow at the intake end of the outlet conduit. As a result, the pipe is under pressure at all times. If the conduit were to develop a leak, there would be no means to stop it and piping failure of the dam could ensue.

b. Adequacy of Information. The information available is such that the assessment of this dam must be based primarily on the results of the visual inspection, which is adequate for the purposes of this Phase I inspection.

c. Urgency. The owner should implement the recommendations in 7.2 and 7.3 within one year after receipt of this Phase I report.

7.2 Recommendations. The following investigations should be carried out and needed corrections performed under the direction of a registered engineer qualified in the design and construction of dams:

(1) Perform more detailed hydrologic and hydraulic analyses to determine spillway adequacy.

(2) Investigate the cause of the widespread slumping on the downstream slope of the embankment and design and oversee construction of any necessary remedial measures.

(3) Specify procedures for filling in the large animal burrow on the downstream slope of the dam and oversee the backfilling operation.

(4) Investigate the cause of the soft, wet area on the right bank of the downstream channel close to the toe of the embankment, and design and oversee construction of any necessary remedial measures.

(5) Investigate the cause of the sinkhole in the earth berm on the right side of the spillway discharge channel and design and oversee construction of any necessary remedial measures.

(6) Design and oversee construction of erosion protection for the unprotected portion of the upstream slope.

(7) Investigate the cause of inoperability of the valves at the downstream end of the outlet conduit, and design and oversee construction of repairs or replacements as deemed necessary.

(8) Design a means of shutting off flow at the upstream end of the outlet conduit.

(9) Oversee removal of trees and supervise backfilling on the abutments within 25 feet of the ends of the dam.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. The owner should:

(1) Visually inspect the dam once each month.

(2) Engage a professional engineer qualified in the design and construction of dams to make a comprehensive technical inspection of the dam once every year.

(3) Establish a surveillance program for use during and immediately after heavy rainfall and also a downstream warning program to follow in case of emergency.

(4) Implement seeding of the dam crest to develop good grass cover to deter erosion.

7.4 Alternatives. There are no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Westfield Reservoir Dam

DATE Nov. 13, 1980

TIME am

WEATHER cloudy, cold, windy

W.S. ELEV. 912 U.S. 880 DN.S.

PARTY:

1. F. James Knight (GFCC)
2. Ronald Hirschfeld (GEI)
3. Dennis Mehue (BAI)
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Hydrology/Physical	Knight	
2.	Geotechnical	Hirschfeld	
3.	Dimensional	Mehue	
4.			
5.			
6.			
7.			
8.			
9.			
10.			

PERIODIC INSPECTION CHECKLIST

PROJECT Westfield Reservoir Dam DATE Nov. 13, 1980

PROJECT FEATURE Dam Embankment NAME Knight

DISCIPLINE NAME Hirschfeld

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	Varies from 924.8 to 923.1.
Current Pool Elevation	Elev. ± 912.
Maximum Impoundment to Date	Unknown.
Surface Cracks	None observed.
Pavement Condition	Not paved.
Movement or Settlement of Crest	None observed.
Lateral Movement	None observed.
Vertical Alignment	Some low areas.
Horizontal Alignment	Good.
Condition at Abutment and at Concrete Structures	Good.
Indications of Movement of Structural Items on Slopes	Not applicable.
Trespassing on Slopes	None observed.
Sloughing or Erosion of Slopes or Abutments	Downstream slope has widespread minor slumping.
Rock Slope Protection - Riprap Failures	Riprap in good condition but missing along top 3' of slope.
Unusual Movement or Cracking at or Near Toe	None observed.
Unusual Embankment or Downstream Seepage	None observed.
Piping or Boils	None observed.
Foundation Drainage Features	None observed.
Toe Drains	None observed.
Instrumentation System	None.
Vegetation	Sparse cover of weeds and grass. Has been mowed.

PERIODIC INSPECTION CHECKLIST

PROJECT Westfield Reservoir Dam DATE Nov. 13, 1980

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITIONS
DIKE EMBANKMENT	
Crest Elevation	No dike.
Current Pool Elevation	
Maximum Impoundment to Date	
Surface Cracks	
Pavement Condition	
Movement or Settlement of Crest	
Lateral Movement	
Vertical Alignment	
Horizontal Alignment	
Condition at Abutment and at Concrete Structures	
Indications of Movement of Structural Items on Slopes	
Trespassing on Slopes	
Sloughing or Erosion of Slopes or Abutments	
Rock Slope Protection - Riprap Failures	
Unusual Movement or Cracking at or Near Toes	
Unusual Embankment or Downstream Seepage	
Piping or Boils	
Foundation Drainage Features	
Toe Drains	
Instrumentation System	
Vegetation	

PERIODIC INSPECTION CHECKLIST

PROJECT Westfield Reservoir Dam DATE Nov. 13, 1980

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	No control tower.
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	
Emergency Gates	
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECKLIST

PROJECT Westfield Reservoir Dam DATE Nov. 13, 1980

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Not visible beneath water surface.
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	
Stop Logs and Slots	

PERIODIC INSPECTION CHECKLIST

PROJECT Westfield Reservoir Dam DATE Nov. 13, 1980

PROJECT FEATURE _____ NAME _____

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITIONS
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Not visible beneath reservoir surface.
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

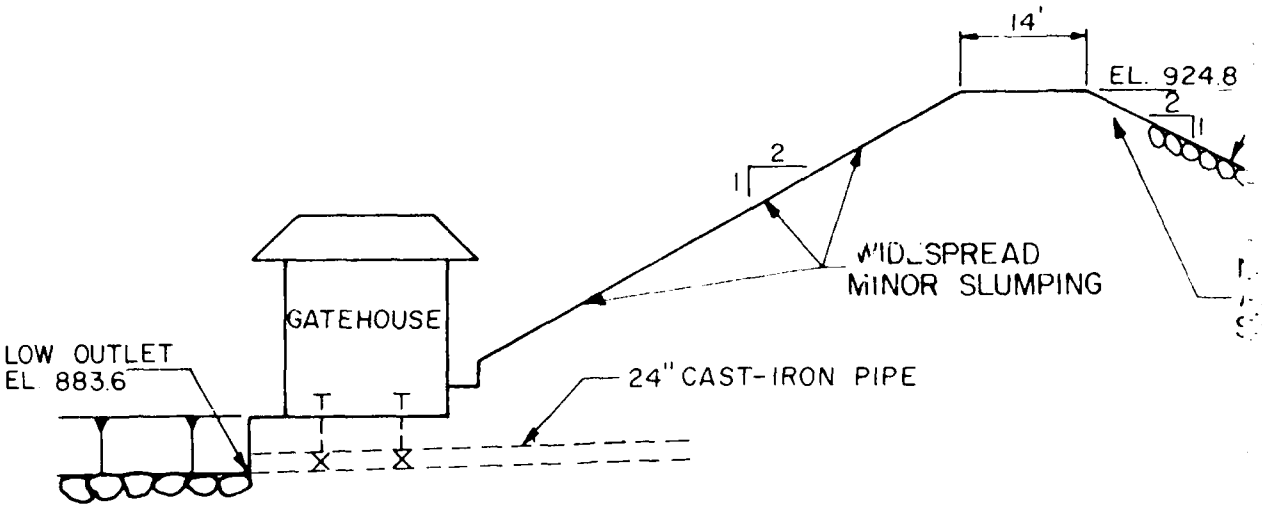
PERIODIC INSPECTION CHECKLIST

PROJECT Westfield Reservoir Dam DATE Nov. 13, 1980

PROJECT FEATURE Outlet Works Outlet Structure NAME Knight

DISCIPLINE _____ NAME Hirschfeld

AREA EVALUATED	CONDITIONS
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Fair.
Rust or Staining	Some minor staining.
Spalling	Some minor spalling.
Erosion or Cavitation	None observed.
Visible Reinforcing	None observed.
Any Seepage or Efflorescence	Minor efflorescence.
Condition at Joints	Good.
Drain Holes	None.
Channel	
Loose Rock or Trees Overhanging Channel	None observed.
Condition of Discharge Channel	Good.



SECTION A-A

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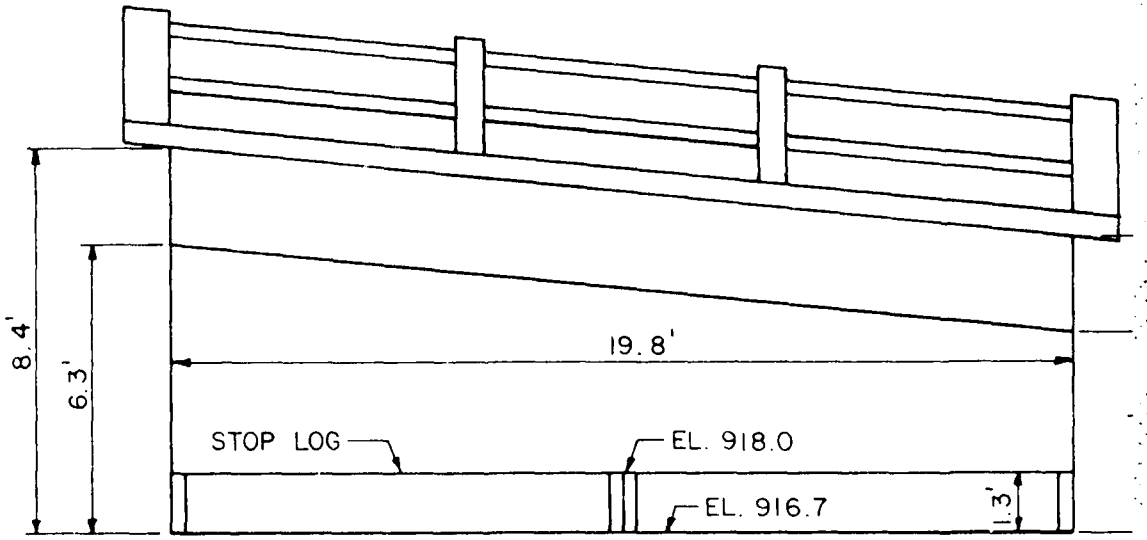

SECTION B-B

SCALE: 1 IN. = 4 FT.

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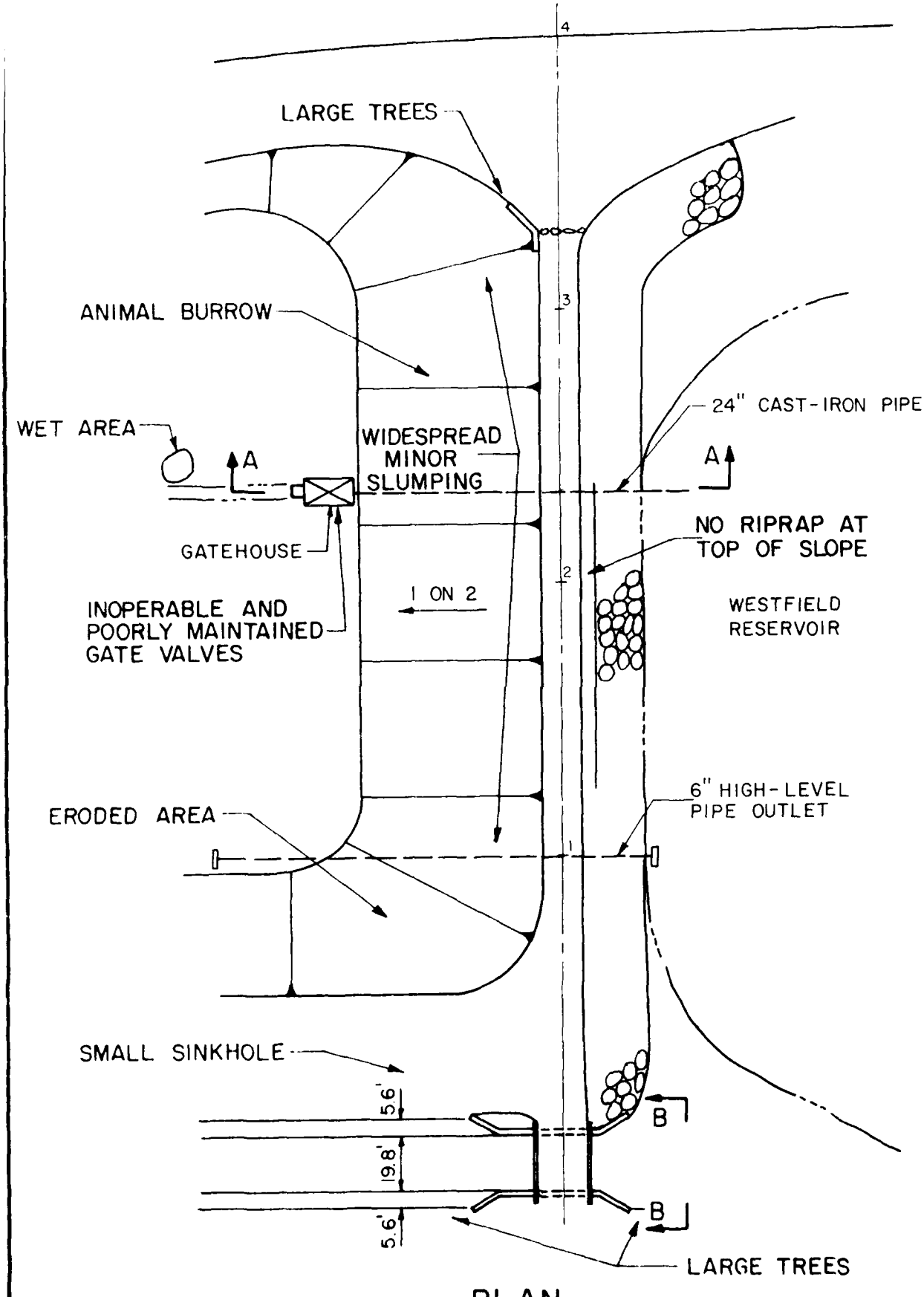
L. L. R	D. B. W	F. J. K



PLAN

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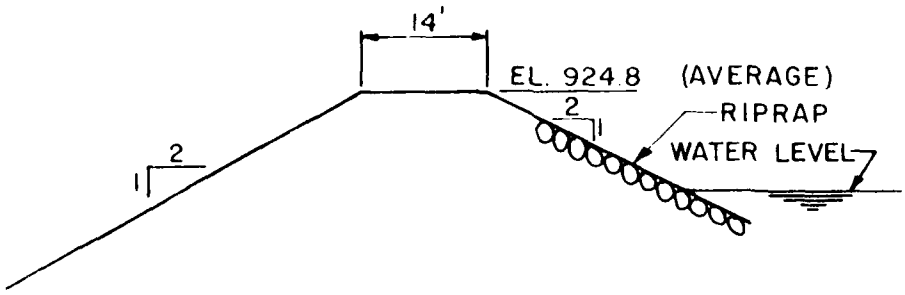

-24" CAST-IRON PIPE

ECTION A-A

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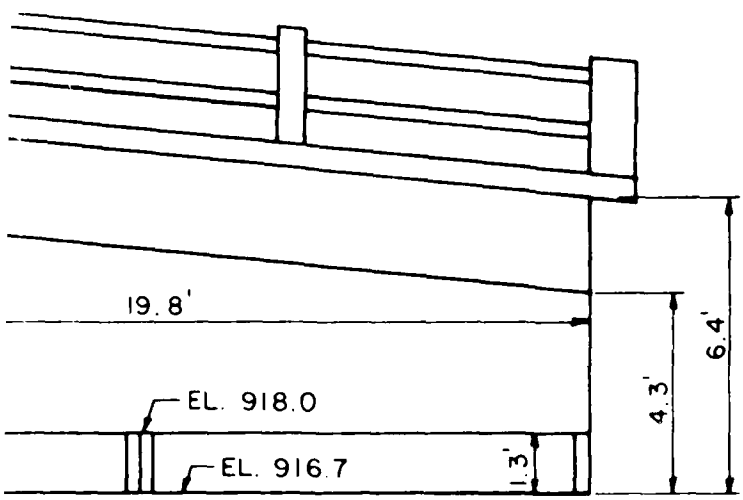


SECTION B-B

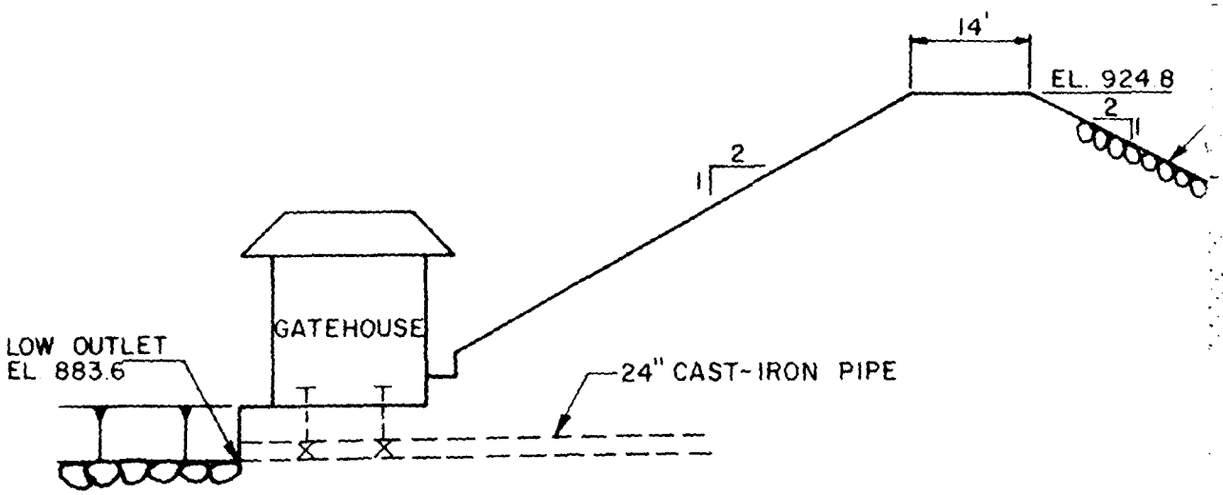
SCALE: 1 IN. = 4 FT.

GANNETT FLEMING CORDDRY AND CARPENTER, INC *CONSULTING ENGINEERS* BOSTON, MASS	U S ARMY ENGINEER DIVISION NEW ENGLAND *CORPS OF ENGINEERS* WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
WESTFIELD RESERVOIR DAM
EXHIBIT B-1

PLAN AND SECTIONS

DRAWN	CHECKED	APPROVED	SCALE AS SHOWN	
L.L.R.	D.B.W.	F.J.K.	DATE 2/81	PAGE B-1



SECTION A-A

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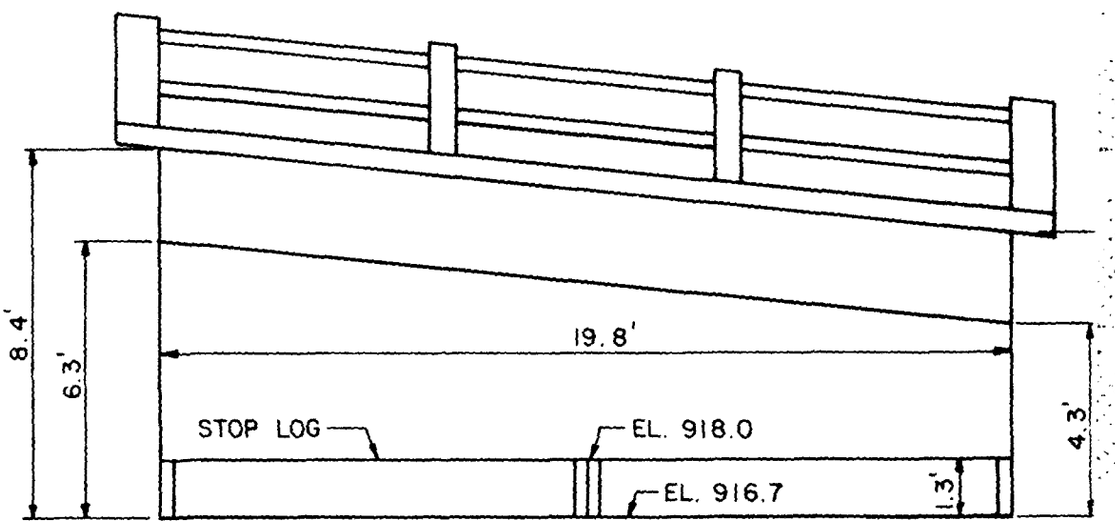

SECTION B-B

SCALE: 1 IN. = 4 FT.

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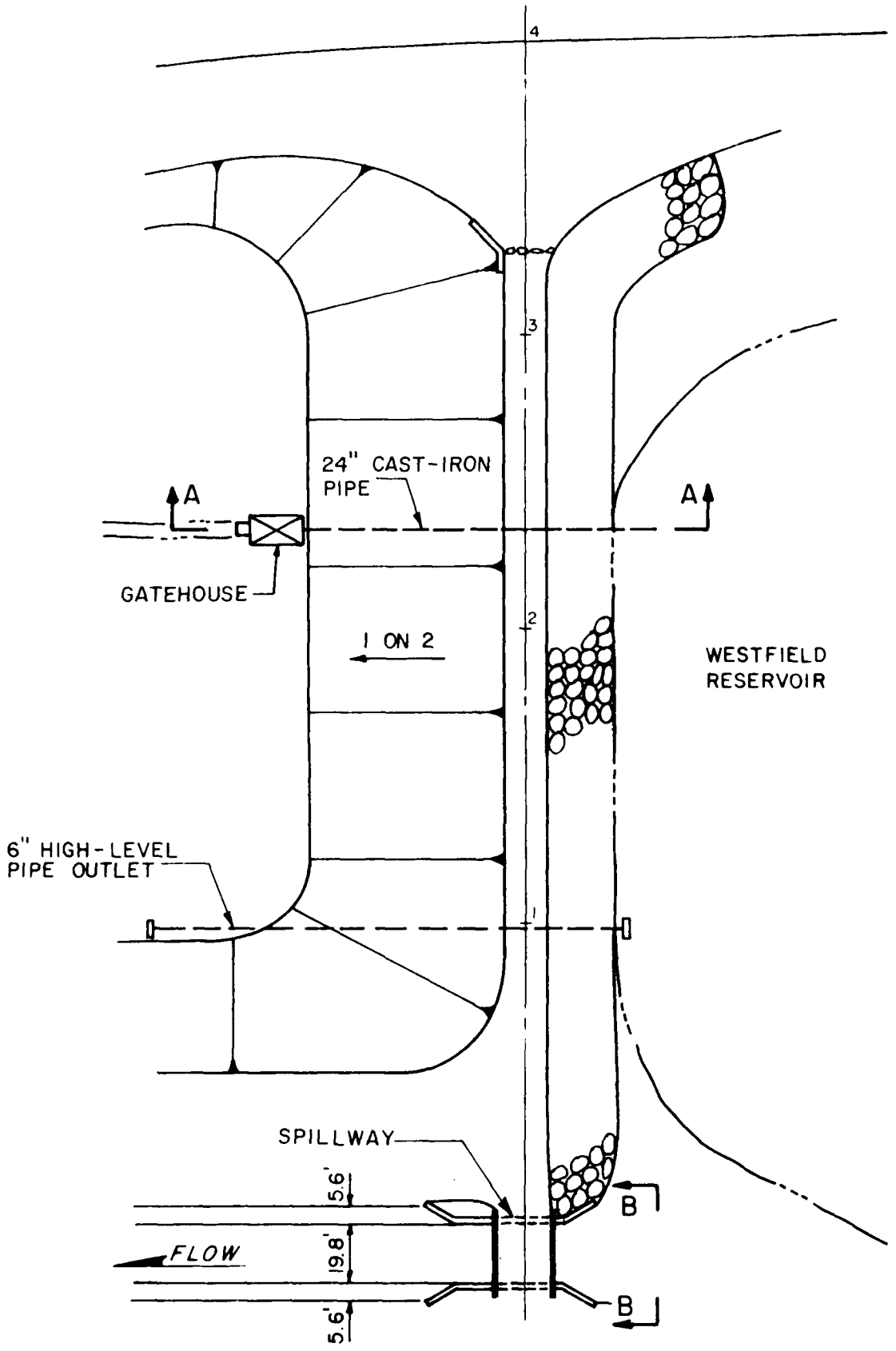

PLAN

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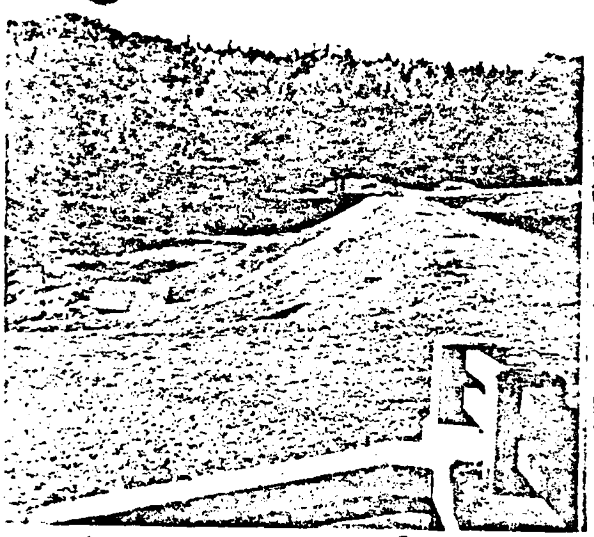
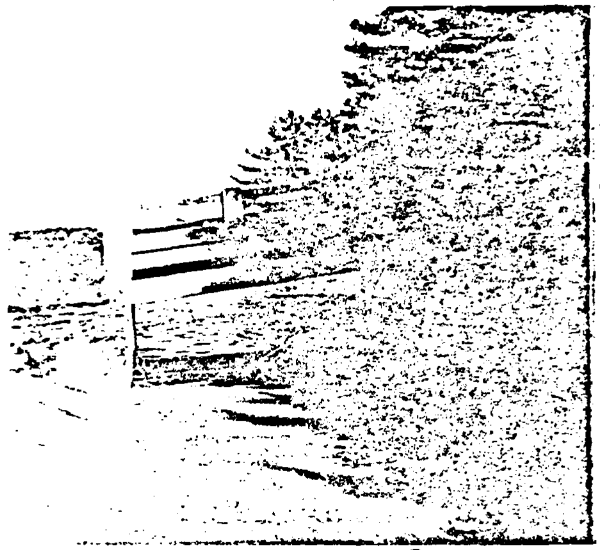


OCT 21 1974

WESTFIELD RES

1-7-1941



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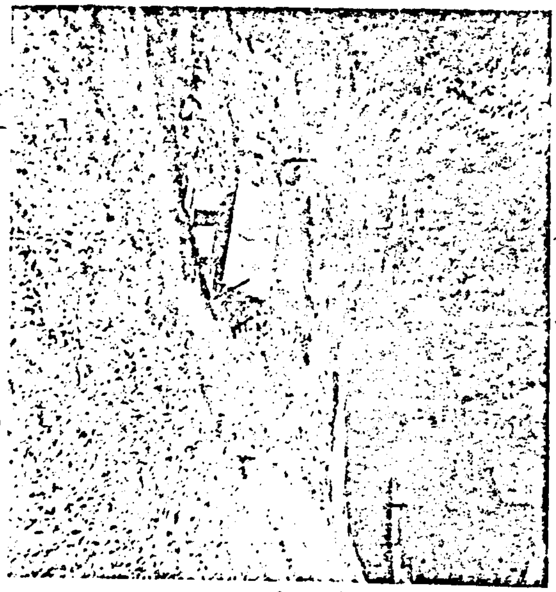

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WESTFIELD RES

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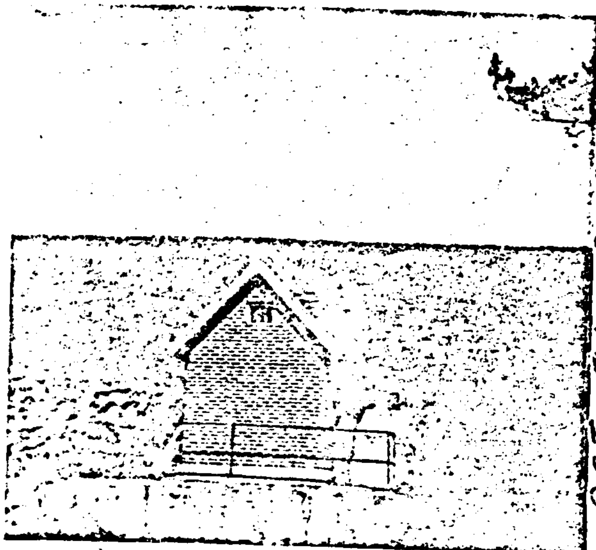

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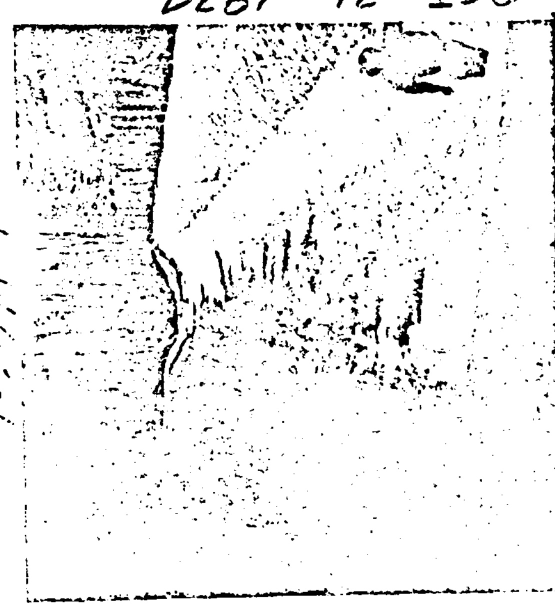
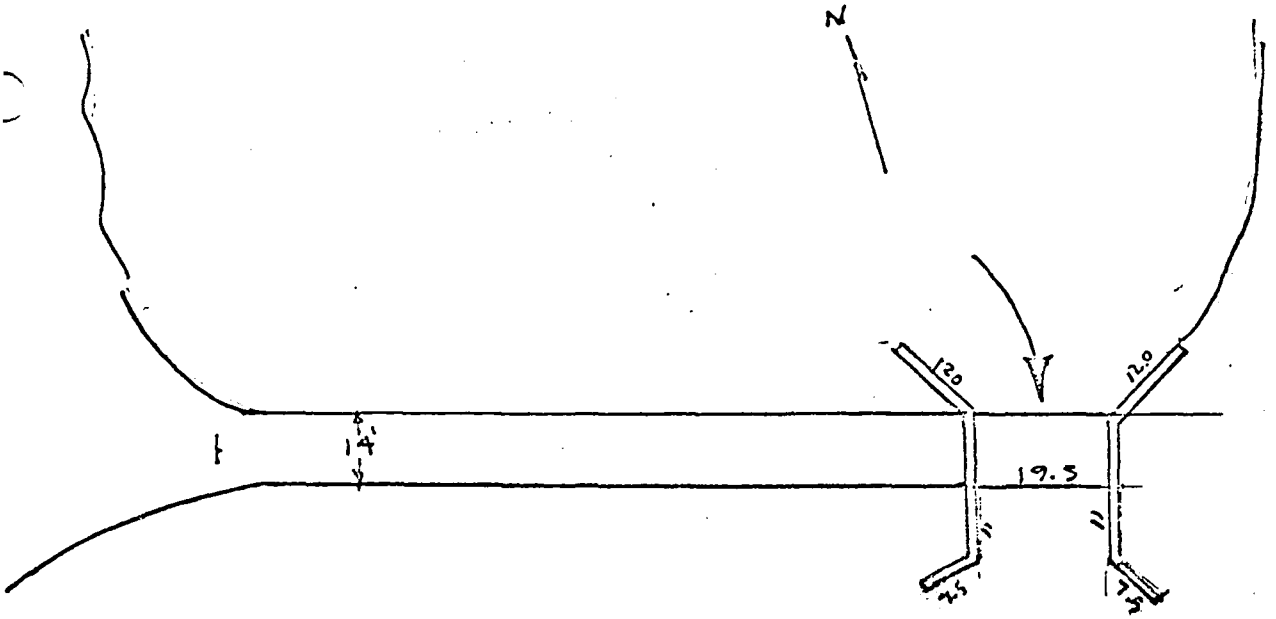
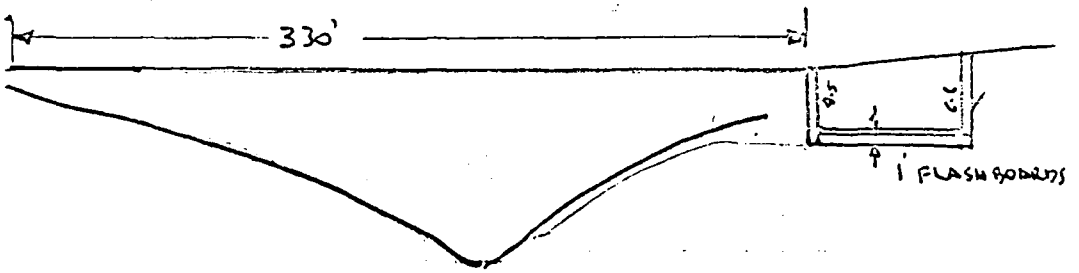
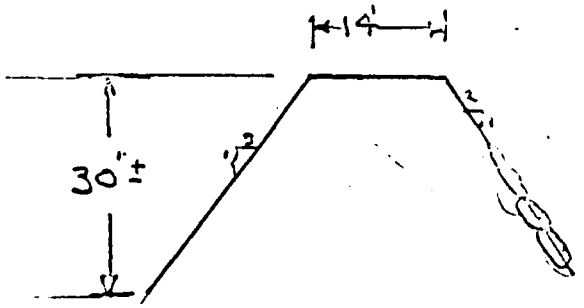


WESTFIELD RES

1-7-194-1
WESTFIELD RES.







L-169 A

DAM NO. 1-7-194-1

10.

Risk to life and property in event of complete failure.

No. of people_____.

No. of homes_____.

No. of Businesses_____.

No. of Industries_____.

No. of Utilities_____.

Railroads_____.

Other dams_____.

Other_____.

The remote location of this structure would cause little damage if failure should occur.

Type_____.

Type_____.

11.

Attach Sketch of dam to this form showing section and plan on 8-1/2" x 11" sheet.

L-168

DESCRIPTION OF DAM

DISTRICT ONE.

Submitted by R. D. Jordan

Dam No. 1-7-194-1

Date 10/21/74.

City/Town Montgomery

Name of Dam Westfield Reservoir

---

1. Location: Topo Sheet No. 9 - B.

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 X. Recreational

Irrigation . Other

---

4. Drainage Area: 1 sq. mi. acres.

---

5. Normal Ponding Area: 37 Acres; Ave. Depth.

Impoundment: gals; acre ft.

---

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

i.e. summer homes etc. None

---

7. Dimensions of Dam: Length 350'. Max. Height.

Slopes: Upstream Face earth - riprap.

Downstream Face earth.

Width across top 14'.

---

8. Classification of Dam by Material:

Earth X. Conc. Masonry. Stone Masonry.

Timber. Rockfill. Other.

A. Description of present land usage downstream of dam: 100 % rural; % 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 X.

12. Remarks & Recommendations: [Fully Explain]

This is the initial District inspection of the dam.

The earth embankment appears to be in good condition. It has a good turf cover and there are no signs of sloughing or settlement. The concrete spillway is in good shape. The channel outlet has been newly grouted and is in excellent condition.

Approximately 25' east and 20' south of the draw down structure there is a wet area. No movement of water was detected. According to Mr. M. Rusin, caretaker, the condition has existed for many years and has never increased in size. The surrounding ground is stable and dry.

This dam is well maintained and appears to be safe.

13.

Overall Condition:

1. Safe X .
2. Minor repairs needed_____
3. Conditionally safe - major repairs needed_____.
4. Unsafe_____.
5. Reservoir impoundment no longer exists [explain]

   Recommend removal from inspection list_____.

8.

Downstream Face of Dam: Condition: 1. Good X. 2. Minor Repairs___.

3. Major Repairs___. 4. Urgent Repairs___.

Comments:_____

_____.

9.

Emergency Spillway: Condition: 1. Good X. 2. Minor Repairs_____.

3. Major Repairs_____. 4. Urgent Repairs_____.

Comments:_____

_____

_____

10.

Water level @ time of inspection: _____. ft. above_____. below_____.

top of dam_____.

principal spillway_____.

other 9 flash boards.

11.

Summary of Deficiencies Noted:

Growth [Trees and Brush] on Embankment NONE.

Animal Burrows and Washouts "

Damage to slopes or top of dam "

Cracked or Damaged Masonry "

Evidence of Seepage "

Evidence of Piping "

Erosion "

Leaks "

Trash and/or debris impeding flow "

Clogged or blocked spillway "

Other "

L-108

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: City/Town MONTGOMERY. Dam No. 1-7-194-1.

Name of Dam Westfield Reservoirs. Inspected by: RJordan-FVancari.

Date of Inspection 10/21/74.

2. Prev. Inspection X.

Owner/s: per: Assessors_____.

Reg. of Deeds_____. Pers. Contact_____.

1. Westfield Water Works Montgomery, 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.

Mike Rusin Montgomery, MA

Name St. & No. City/Town State Tel. No.

4. No. of Pictures taken 6.

5. Degree of Hazard: [if dam should fail completely]*

1. Minor X. 2. Moderate_____.

3. Severe_____. 4. Disastrous_____.

*This rating may change as land use changes [future development]

6. Outlet Control: Automatic_____. Manual X.

Operative X yes: _____no.

Comments:_____

_____

_____

Upstream face of Dam: Condition:

1. Good X. 2. Minor Repairs_____.

3. Major Repairs_____. 4. Urgent Repairs_____.

Comments:_____

_____

_____

APPENDIX B

ENGINEERING DATA

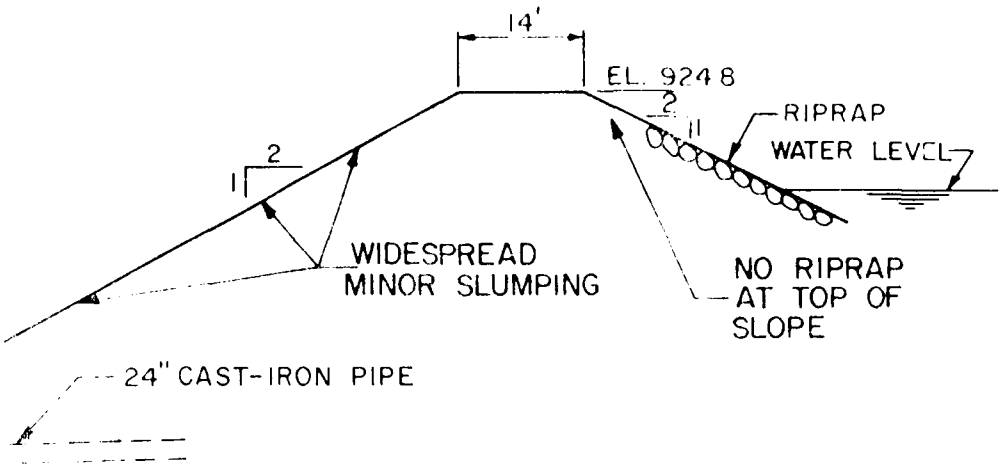
PERIODIC INSPECTION CHECKLIST

PROJECT Westfield Reservoir Dam DATE Nov. 13, 1980

PROJECT FEATURE Spillway NAME Knight

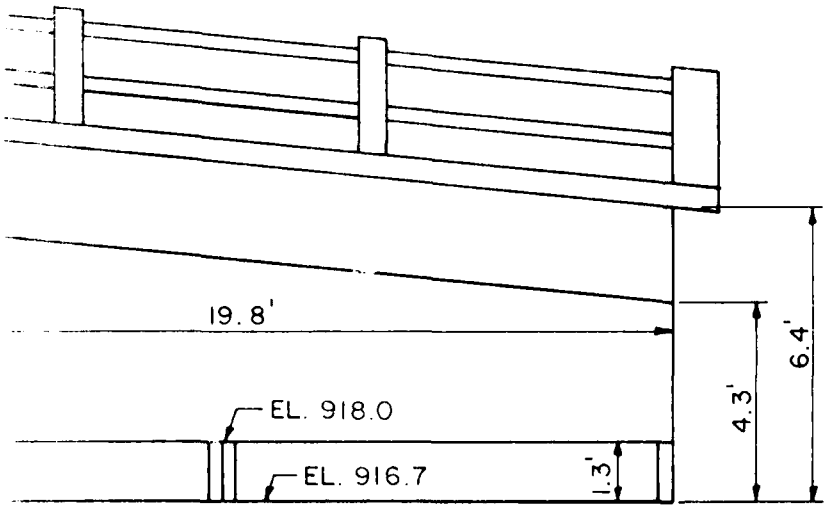
DISCIPLINE NAME Hirschfeld

AREA EVALUATED	CONDITIONS
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Approach Channel	Sand and gravel.
b. Weir and Training Walls	
General Condition of Concrete	Fair.
Rust or Staining	Some minor staining.
Spalling	Spalling of stoplog supports.
Any Visible Reinforcing	None observed.
Any Seepage or Efflorescence	Minor efflorescence.
Drain Holes	None.
c. Discharge Channel	
General Condition	Good.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Some overhanging trees.
Floor of Channel	Good, slush grouted rock.
Other Obstructions	None.
Other Comments	



SECTION A-A

SCALE: 1 IN. = 20 FT.



SECTION B-B

SCALE: 1 IN. = 4 FT.

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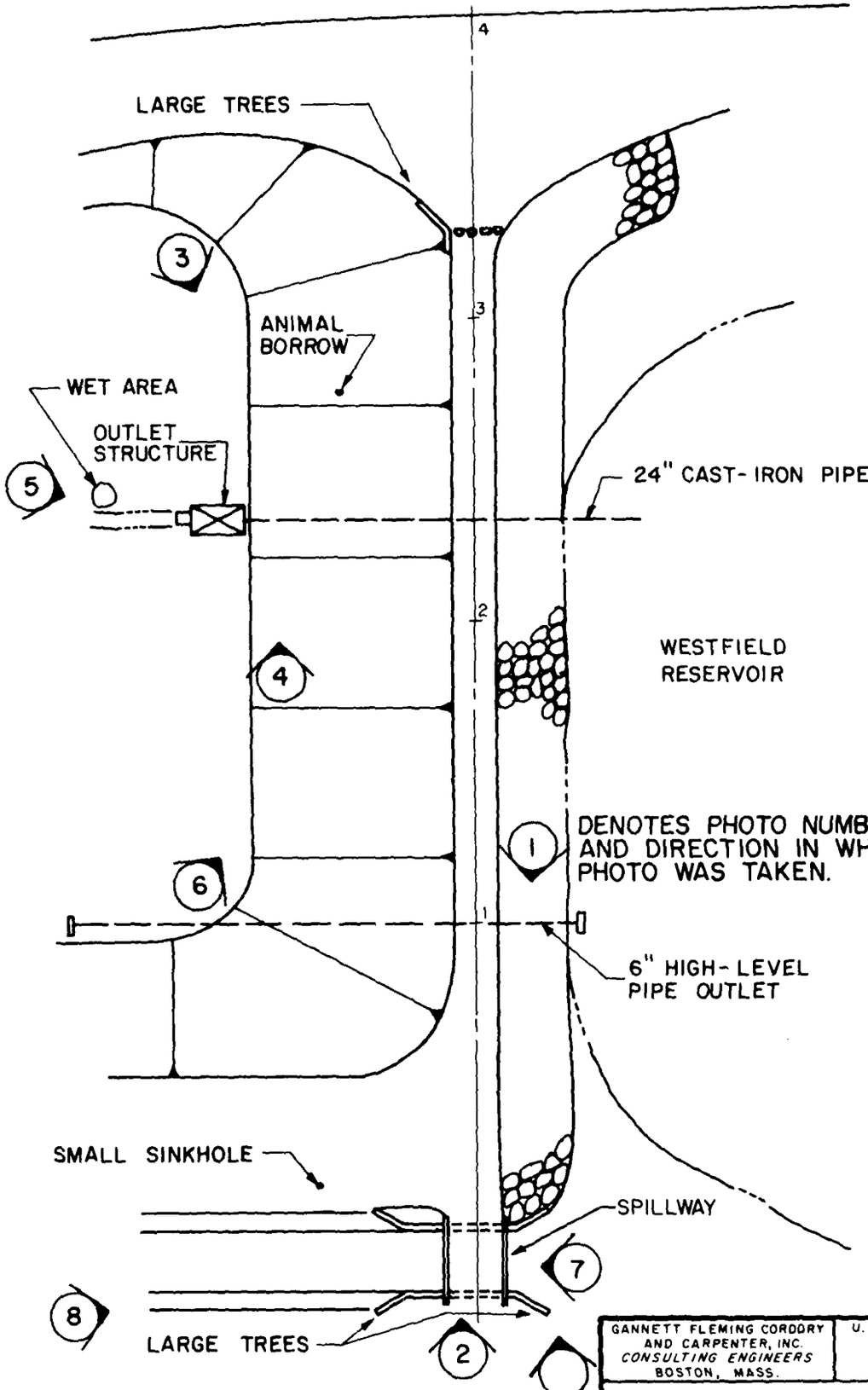
NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
WESTFIELD RESERVOIR DAM
EXHIBIT B-2

RESULTS OF VISUAL INSPECTION

DRAWN	CHECKED	APPROVED	SCALE AS SHOWN	
L.L.R	D.B.W	F.J.K	DATE 2/81	PAGE B-2

APPENDIX C

PHOTOGRAPHS



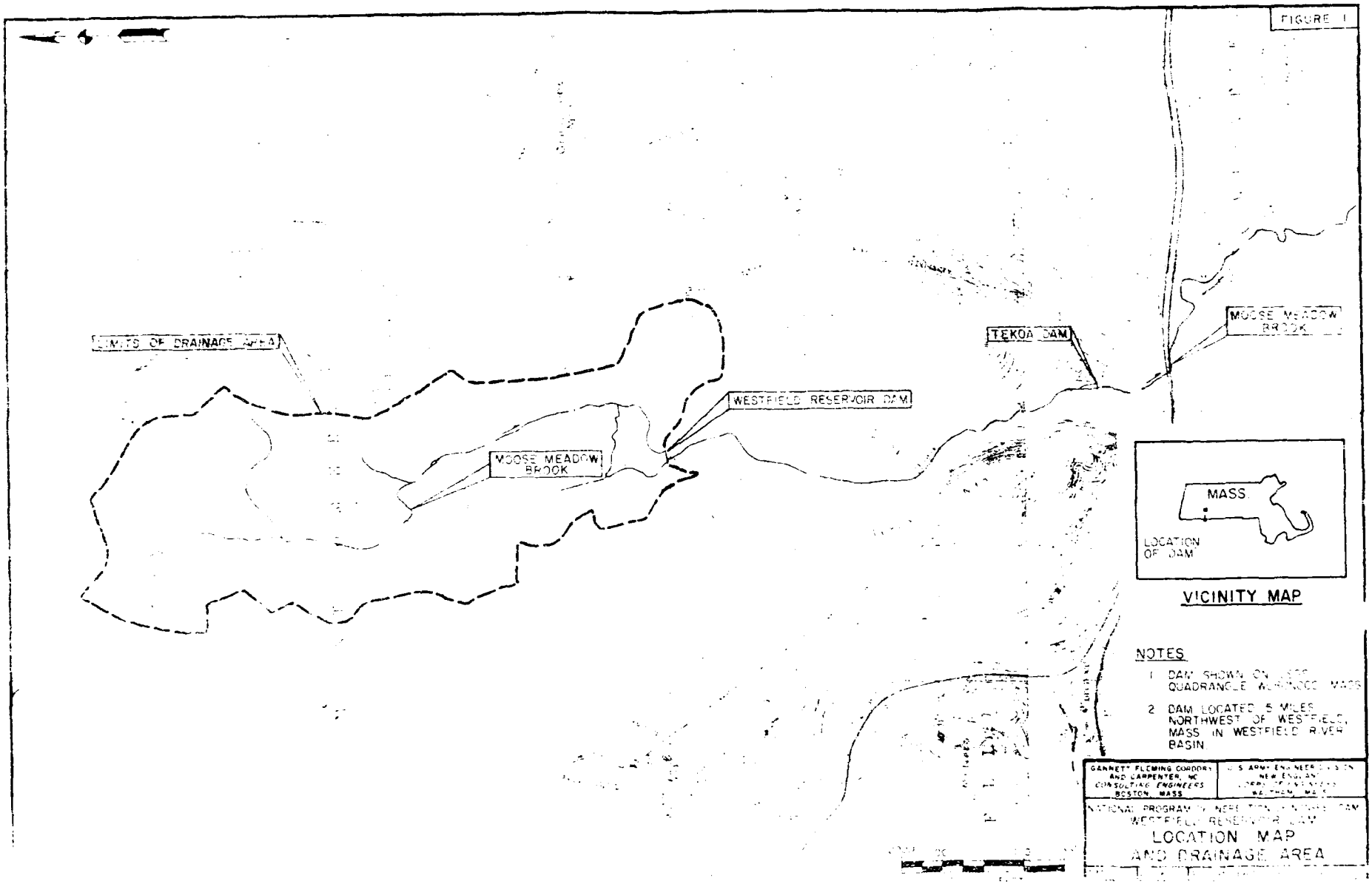
GANNETT FLEMING CORDDRY AND CARPENTER, INC. CONSULTING ENGINEERS BOSTON, MASS.	U. S. ARMY ENGINEER DIVISION NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS
WESTFIELD RESERVOIR DAM
EXHIBIT C-1

GUIDE TO PHOTOGRAPHS

DRAWN	CHECKED	APPROVED	SCALE: AS SHOWN	
L.L.R.	D.B.W.	F.J.K.	DATE 2/81	PAGE C-1

FIGURE 1



VICINITY MAP

NOTES

1. DAM SHOWN ON USGS QUADRANGLE WORTHINGTON MASS
2. DAM LOCATED 5 MILES NORTHWEST OF WESTFIELD, MASS IN WESTFIELD RIVER BASIN

GANNETT FLEMING CORDRY AND CARPENTER, INC CONSULTING ENGINEERS BOSTON, MASS	U S ARMY ENGINEER DIVISION NEW ENGLAND WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS
WESTFIELD RESERVOIR DAM

LOCATION MAP AND DRAINAGE AREA

Photo No. 1

View of upstream slope from right abutment. Note the absence of riprap at top of slope.

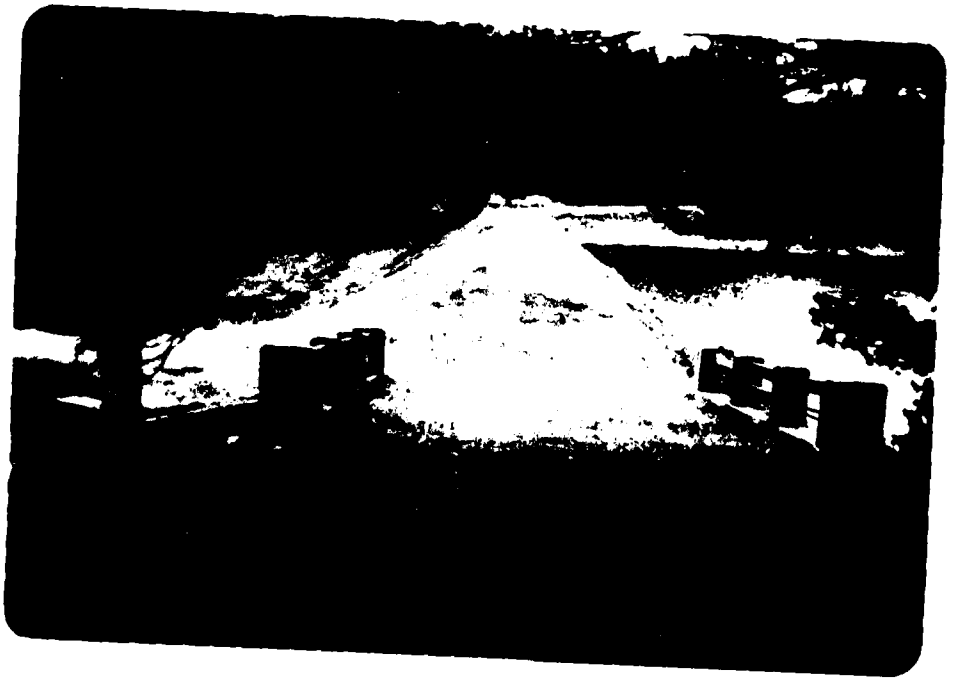


Photo No. 2

View of dam from left abutment. Spillway bridge in center foreground.

Photo No. 3

View of downstream slope. Note widespread minor slumping, erosion on far abutment and animal burrow in left center.

Photo No. 4

View of downstream slope. Note widespread minor slumping.

Photo No. 5

View of downstream slope, outlet structure and discharge channel.

Photo No. 6

View of downstream slope from left abutment.
Note slumping and erosion in lower left.

Photo No. 7

View of spillway, bridge, stoplogs and channel looking downstream.

View of spillway discharge channel looking upstream.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

Westfield Reservoir Dam
Basic Data

Drainage Area = 2.45 mi^2 (determined from USGS)
Watershed Classification : Rolling to mountainous
Size : Intermediate (40 ft. high ; max. storage = 591 acre-feet)
Hazard Classification : High hazard
Reservoir Surface Area :

At spillway crest :	33 acres
At top of stop log :	34 acres
At top of dam :	45 acres

*Elevations :

Streambed at toe	El. 883.6
Invert outlet works	El. 883.6
Spillway crest	El. 916.7
Top of stop log	El. 918.0
Top of dam (low point)	El. 923.1
Top of dam (average)	El. 924.8

Storage Capacity :

At spillway crest	346 acre-ft.
At top stop log	390 acre-ft.
At top of dam (low point)	591 acre-ft
Spillway Length	19.8 feet
Length of Dam	350 feet ±

* Note : Elevations used for report are based on pool elevation of 918 as shown on USGS map. It is assumed that this elevation is at the top of the stop log in the spillway.

Test Flood Inflow

For the size (intermediate) and hazard classification (high hazard) of Westfield Reservoir Dam, the recommended test flood is the PMF. Conditions will also be checked for the 1/2 PMF.

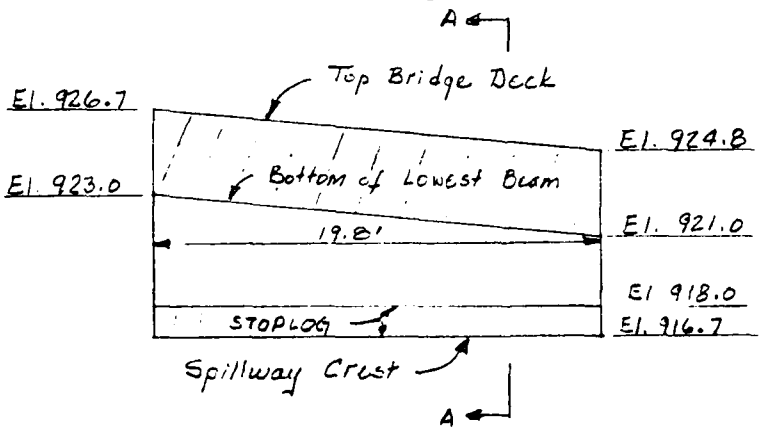
Using the NED curves, and interpolating between the curve for mountainous terrain and the curve for rolling terrain, the test flood inflow (PMF) is 2,270 cfs / mi^2 for a 2.45 mi^2 drainage area:

Test Flood Inflow = $Q_{P_1} = (2.45\ mi^2)(2{,}270\ cfs/mi^2)$

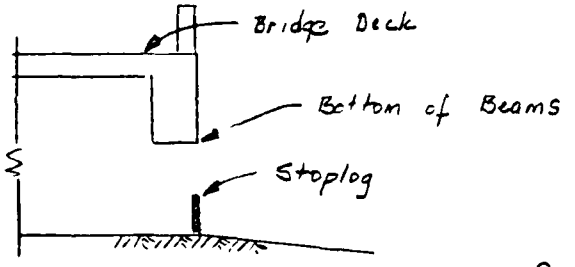
$Q_{P_1} = 5{,}560$ cfs (PMF)

1/2 PMF Inflow = $5{,}560/2 = 2{,}780$ cfs

Spillway Rating Curve



SPILLWAY ELEVATION
LOOKING DOWNSTREAM



SPILLWAY - SECTION A-A

Spillway Rating Curve (Cont'd)

Low point on top of dam is at El. 923.1. A simplified rating curve for the spillway will be used. It is assumed that the weir equation $Q = CLH^{3/2}$ applies until the pool level reaches 923.1, with no significant bridge effects. Above El. 923.1, it is assumed that the orifice equation ($Q = CA\sqrt{2gH}$) applies. Use C = 3.1 in weir equation and C = 0.7 in orifice equation.

For pool el. ≤ 923.1 ; $Q_S = (3.1)(19.8)(\text{Pool El} - 918)^{3/2}$ (stoplog in place)

$Q_S = (3.1)(19.8)(\text{Pool El.} - 916.7)^{3/2}$ (stoplog removed)

For pool el. > 923.1 ; $Q_S = (0.7)(79.2)(2 \times 32.2 \times (\text{Pool El.} - 920))^{1/2}$ (stoplog in)

$Q_S = (0.7)(79.2)(2 \times 32.2 \times (\text{Pool El.} - 919.4))^{1/2}$ (stoplog out)

Embankment Rating Curve

The low area on the top of dam (El. 923.1) is about 60 feet long. The remaining 290-foot length is at an average elevation of 924.8. The rating curve for the two sections is:

$$Q_E = (3.1)(60)(\text{Pool El.} - 923.1)^{3/2} + (3.1)(290)(\text{Pool El.} - 924.8)^{3/2}$$

Combined Rating Curves

Total Outflow = $Q_T = Q_S + Q_E$ (Q_S & Q_E as given above)

Combined Rating Curves

		Stoplog in place		Stoplog Removed	
Pool Elev.	Q_E (cfs)	Q_S (cfs)	Q_T (cfs)	Q_S (cfs)	Q_T (cfs)
918.0	0	0	0	91	91
920.0	0	174	174	368	368
923.1	0	707	707	994	994
924.0	159	890	1,049	954	1,113
924.8	412	975	1,387	1,034	1,446
925.0	568	995	1,563	1,053	1,621
926.0	2,100	1,090	3,190	1,143	3,243
927.0	4,366	1,177	5,543	1,227	5593

Routing Curve for Test Flood (PMF) and for ½ PMF:

For PMF:

$Q_{p2} = Q_{p1}\,(1 - Stor/19)$ $\quad Q_{p1} = 5{,}560$ cfs; Stor = Storage in inches

$$Stor = \frac{\text{Storage (acre-ft)} \times 12}{2.45 \times 640} = 0.007653 \times \text{Storage (acre-ft)}$$

For ½ PMF:

$Q_{p2} = Q_{p1}\,(1 - Stor/9.5)$ $\quad Q_{p1} = 2{,}780$ cfs; Stor is as defined above

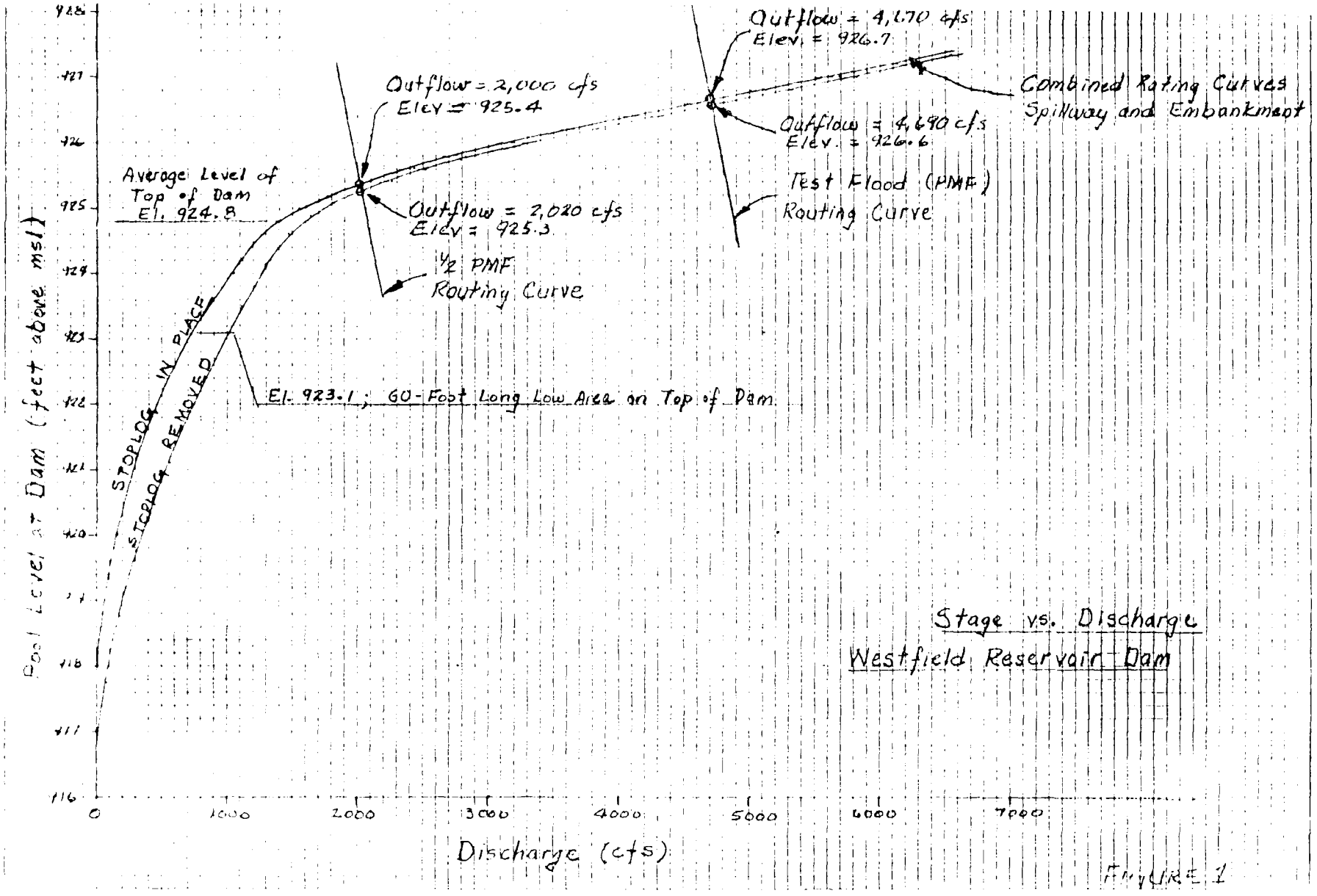
Start routing with pool level at spillway crest level. This will be used for both cases (stoplog in and stoplog out).

Pool Elevation	Storage (acre-feet)	Stor (inches)	PMF Q_{p2} (cfs)	½ PMF Q_{p2} (cfs)
916.7	0	0	5,560	2,780
918.0	44	0.34	5,461	2,681
923.1	245	1.88	5,010	2,230
925.0	331	2.53	4,820	2,040
930.0	556	4.26	4,313	1,533

From Results Shown on Figure 1 (next sheet):

For test flood (PMF):

Routed outflow = 4,670 cfs (stoplog in place)
Routed outflow = 4,690 cfs (stoplog removed)
Depth of overtopping = 3.6 feet (stoplog in place)
Depth of overtopping = 3.5 feet (stoplog removed)



Stage vs. Discharge
Westfield Reservoir Dam

FIGURE 1

Dam Failure Analysis

Assumed conditions at time of failure:

1. Pool level at top of dam (El. 923.1)
2. Stoplog in place (Top El. = 918.0)

Storage at time of failure = 591 acre-ft.
Outflow just prior to failure = 707 cfs.

Breach Outflow

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

$Y_o = 39.5'$

$W_b \leq 40\%$ of dam length at midheight

$W_b \leq (0.4)(260) \leq 104$ feet

Use $W_b = 100$ feet

$Q_B = (8/27)(100)(32.2)^{1/2}(39.5)^{3/2}$

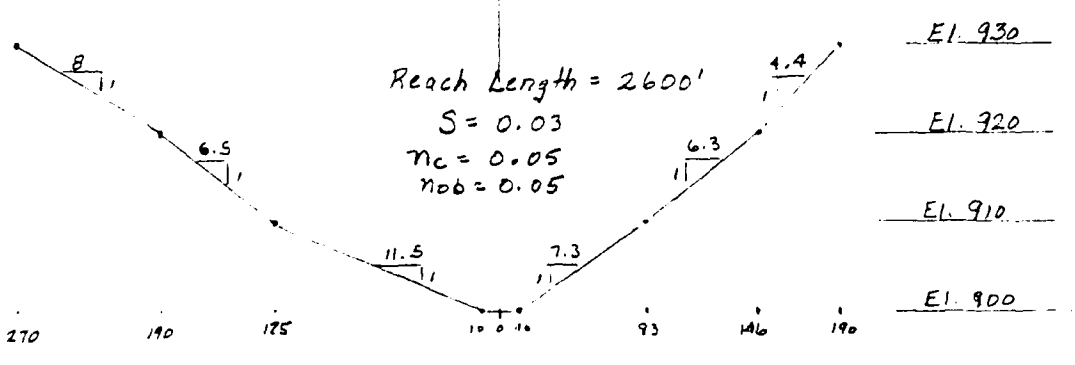
$Q_B = 41{,}740$ cfs.

Remaining spillway flow: since breach would not occur at the spillway, the remaining spillway flow, Q_{SR}, is equal to the spillway discharge just prior to failure. $Q_{SR} = 707$ cfs

Total Failure Outflow = $Q_{P1} = Q_B + Q_{SR}$

$Q_{P1} = 41{,}740 + 707 = 42{,}447$ cfs

Stream Section 1



1" = 20' VERT.
1" = [illegible]' HOR.

Rating Curve - Reach 1

d (ft)	Q (cfs)	A (ft²)
2	488	77.6
5	3,549	335.0
7	7,771	600.6
10	18,335	1140.2
15	55,641	2340.3

Pre-failure stage in Reach 1:

For $Q = 707$ cfs, stage = 2.4' and Area = 102.1 ft²

Reach Outflow : Reach 1

$Q_{p_1} = 42,447$ cfs Stage = 13.5' Area = 1946.7 ft²

Δ Area = 1946.7 - 102.1 = 1844.6 ft²

$$V_1 = \frac{(1844.6)(2600)}{43560} = 110.1 \text{ acre-ft}$$

Check for $V_1 \leq S/2$ where S = storage at top of dam

$S/2 = 591/2 = 295.5$ acre-ft ; Since 110.1 < 295.5, reach length OK

$$Q_{p_2} = Q_{p_1}(1 - V_1/S) = 42447\left(1 - {}^{110.1}/_{591}\right)$$

$Q_{p_2} = 34,539$ cfs

Stage for $Q_{p_2} = 12.5'$ Area = 1700.2

Δ Area = 1700.2 - 102.1 = 1598.1

$$V_2 = \frac{(1598.1)(2600)}{43560} = 95.4 \text{ acre-ft}$$

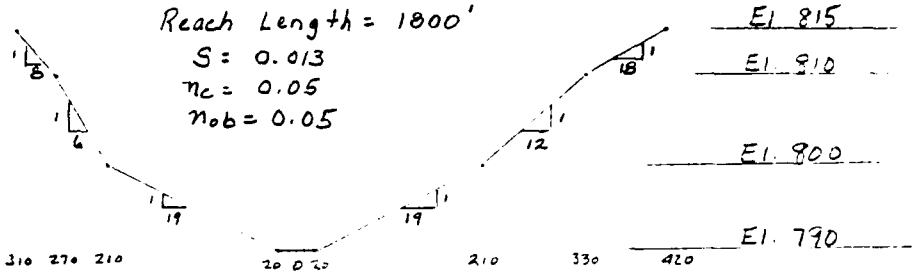
$$V_{avg.} = \frac{V_1 + V_2}{2} = \frac{110.1 + 95.4}{2} = 102.8 \text{ acre-ft.}$$

$$Q_{p_2} = Q_p(1 - V_{avg}/S) = 42447\left(1 - {}^{102.8}/_{591}\right)$$

$Q_{p_2} = 35,064$ cfs

Stage = 12.6'

Stream Section 2



1" = 20' VERT
1" = 200' HOR

Rating Curve - Section 2

d (ft)	Q (cfs)	A (ft²)
2	646	156.0
5	4,714	675.0
10	24,404	2300.0
12	41,163	3176.5

Reach Outflow: Reach 2

Pre-failure stage in reach 2:

For Q = 707 cfs ; stage = 2.1' and area = 167.8 ft²

Q_{p1} = 35,064 cfs stage = 11.3' Area = 2861.7 ft²

Δ Area = 2861.7 - 167.8 = 2693.9 ft²

$V_1 = \frac{(2693.9)(1800)}{43560}$ = 111.3 acre-ft < 59½ Reach length ok.

Q_{p2} = 35064 $(1 - {}^{111.3}/_{591})$ = 28,461 cfs

Stage for Q_{p2} = 10.5' Area = 2512.7 ft²

Δ Area = 2512.7 - 167.8 = 2344.9 ft²

$V_2 = \frac{(2344.9)(1800)}{43560}$ = 96.9 acre-ft

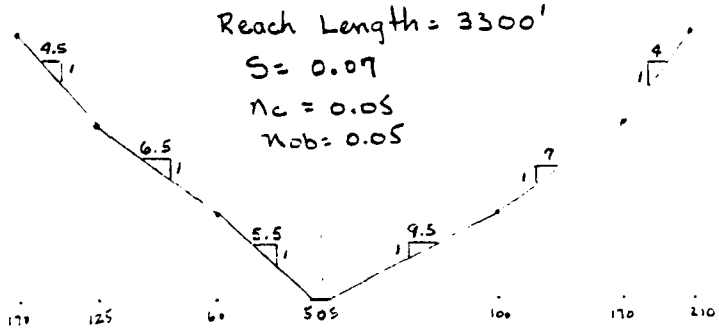
$V_{avg.} = \frac{111.3 + 96.9}{2}$ = 104.1 acre-ft

Q_{p2} = 35,064 $(1 - {}^{104.1}/_{591})$

Q_{p2} = 28,888 cfs
stage = 10.6'

Stream Section 3

Reach Length = 3300'
S = 0.07
n_c = 0.05
n_{ob} = 0.05



1" = 20' VERT.
1" = 100' HOR.

Rating Curve - Section 3

d (ft)	Q (cfs)	A (ft²)
2	456	50.0
5	3707	237.5
7	8395	437.5
10	20403	850.0
12	34997	1197.2

Reach Outflow: Reach 3

Pre-failure stage (Q = 707 cfs) = 2.4' ; Area = 67.2 ft²

Q_{p_1} = 28,888 cfs stage = 11.2' Area = 1051.9 ft²

Δ Area = 1051.9 - 67.2 = 984.7 ft²

$V_1 = \frac{(984.7)(3300)}{43560} = 74.6$ acre-ft < 591/2 Reach length O.K.

$Q_{p_2} = 28,888 \left(1 - \frac{74.6}{591}\right) = 25,242$ cfs

Stage for Q_{p_2} = 10.7' Area = 965.5 ft²

Δ Area = 965.5 - 67.2 = 898.3 ft²

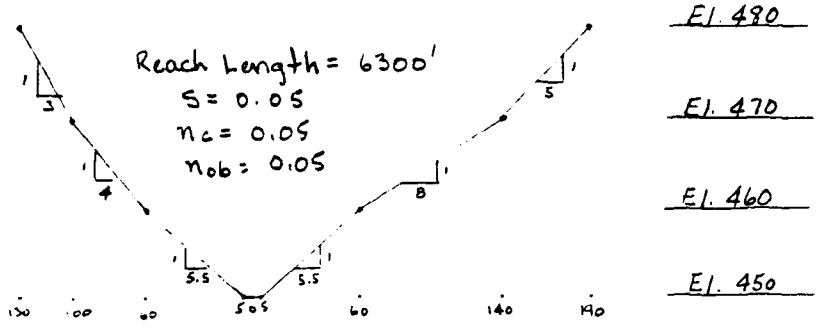
$V_2 = \frac{(898.3)(3300)}{43560} = 68.1$ acre-ft

$V_{avg} = \frac{74.6 + 68.1}{2} = 71.4$ acre-ft

$Q_{p_2} = 28,888 \left(1 - \frac{71.4}{591}\right)$

Q_{p_2} = 25,398 cfs

Stream Section 4



1" = 20' VERT.
1" = 100' HOR.

Rating Curve - Section 4

d (ft)	Q (cfs)	A (ft^2)
2	333	42.0
5	2,517	187.5
10	13,304	650.0
13	28,240	1064.0

Reach Outflow: Reach 4

Pre-failure stage (Q = 707 cfs) = 2.8' Area = 71.1 ft^2

Q_{p1} = 25,398 cfs Stage = 12.5' Area = 987.7 ft^2

Δ Area = 987.7 - 71.1 = 916.6 ft^2

$V_1 = \frac{(916.6)(6300)}{43560}$ = 132.6 acre-ft < 591/2 Reach Length OK

$Q_{p2} = 25398\left(1 - \frac{132.6}{591}\right)$ = 19,700 cfs

Stage for Q_{p2} = 11.4' Area = 829.9 ft^2

Δ Area = 829.9 - 71.1 = 758.8 ft^2

$V_2 = \frac{(758.8)(6300)}{43560}$ = 109.7 acre-ft

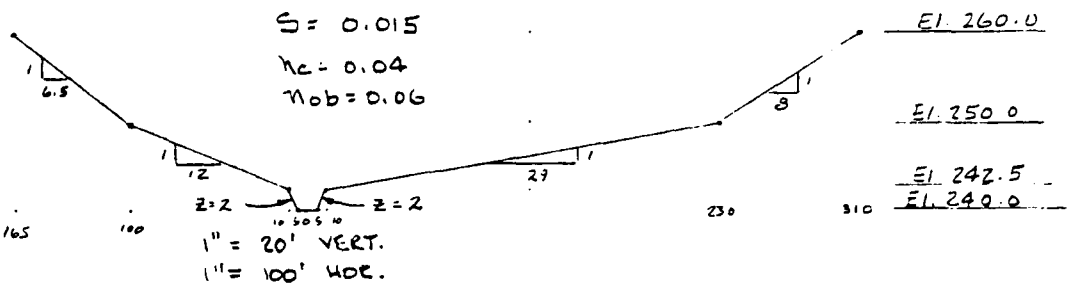
$V_{avg} = \frac{132.6 + 109.7}{2}$ = 121.2 acre-ft

$Q_{p2} = 25398\left(1 - \frac{121.2}{591}\right)$

Q_{p2} = 20,190 cfs

Note: Tekoa Dam is located within Reach 4 but was not included in the analysis. Since its total storage is only 16.7 acre-ft, it has no significant effects.

Stream Section 5:



Rating Curve - Section 5

d (ft)	Q (cfs)	A (ft²)
2.5	251	37.5
5.0	1,486	215.7
10.0	12,186	1341.0
12.0	21,868	2025.0

Reach Outflow - Reach 5

Pre-failure stage (Q = 707 cfs) = 3.8' Area = 98.2 ft²

Qp_1 = 20,190 cfs Stage = 11.7' Area = 1918.7 ft²

Δ Area = 1918.7 - 98.2 = 1820.5 ft²

$V_1 = \frac{(1820.5 \times 3700)}{43560} = 154.6$ acre-ft < 591/2 Reach Length OK

$Qp_2 = 20,190 \left(1 - \frac{154.6}{591}\right) = 14,908$ cfs

Stage for Qp_2 = 10.6' Area = 1540.0 ft²

Δ Area = 1540.0 - 98.2 = 1441.8 ft²

$V_2 = \frac{(1441.8 \times 3700)}{43560} = 122.5$ acre-ft

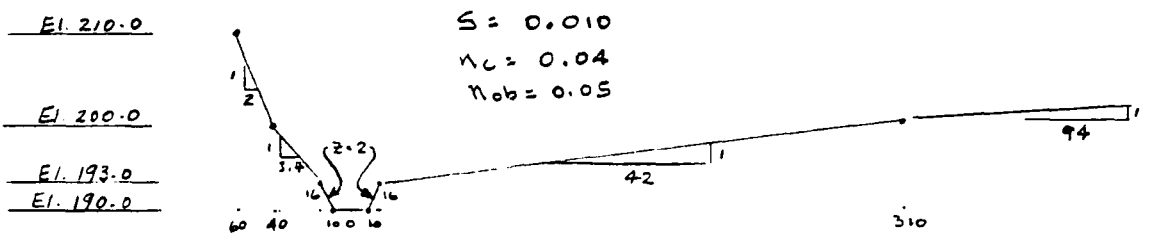
$V_{avg.} = \frac{154.6 + 122.5}{2} = 138.6$ acre-ft

$Qp_2 = 20,190 \left(1 - \frac{138.6}{591}\right)$

Qp_2 = 15,455 cfs

Stream Section 6

Reach Length = 1500'
S = 0.010
n_c = 0.04
n_{ob} = 0.05



1" = 20' VERT.
1" = 100' HOR.

Rating Curve - Section 6

d (ft)	Q (cfs)	A (ft²)
3.0	513	78.0
5.0	1,665	232.9
10.0	12,575	1414.6
12.0	20,907	2306.4

Reach Outflow: Reach 6

Pre-failure stage (Q = 707 cfs) = 3.5' Area = 99.7 ft²
Q_{p1} = 15,455 cfs Stage = 10.8' Area = 1725.3 ft²
Δ Area = 1725.3 − 99.7 = 1625.6 ft²

$$Y_1 = \frac{(1625.6)(1500)}{43560} = 56.0 \text{ acre-ft} < 591/2 \text{ Reach Length OK}$$

$$Q_{p2} = 15455\left(1 - \frac{56}{591}\right) = 13{,}990 \text{ cfs}$$

Stage for Q_{p2} = 10.4' Area = 1562.3 ft²
Δ Area = 1562.3 − 99.7 = 1462.6 ft²

$$V_2 = \frac{(1462.6)(1500)}{43560} = 50.4 \text{ acre-ft}$$

$$V_{avg} = \frac{56.0 + 50.4}{2} = 53.2 \text{ acre-ft}$$

$$Q_{p2} = 15{,}455\left(1 - \frac{53.2}{591}\right)$$

Q_{p2} = 14,064 cfs
Stage = 10.5'

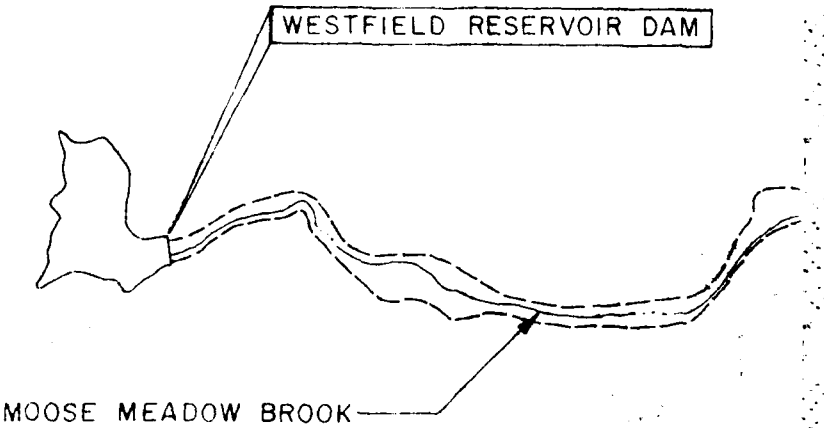
Note: Section 6 is representative at the primary damage center

BY DJW DATE 1/81 SUBJECT Westfield Reservoir Dam SHEET NO 12 OF 2
CHKD BY CLH DATE 2/81 Hydrology and Hydraulics JOB NO

Dam Failure Analysis
Summary of Results

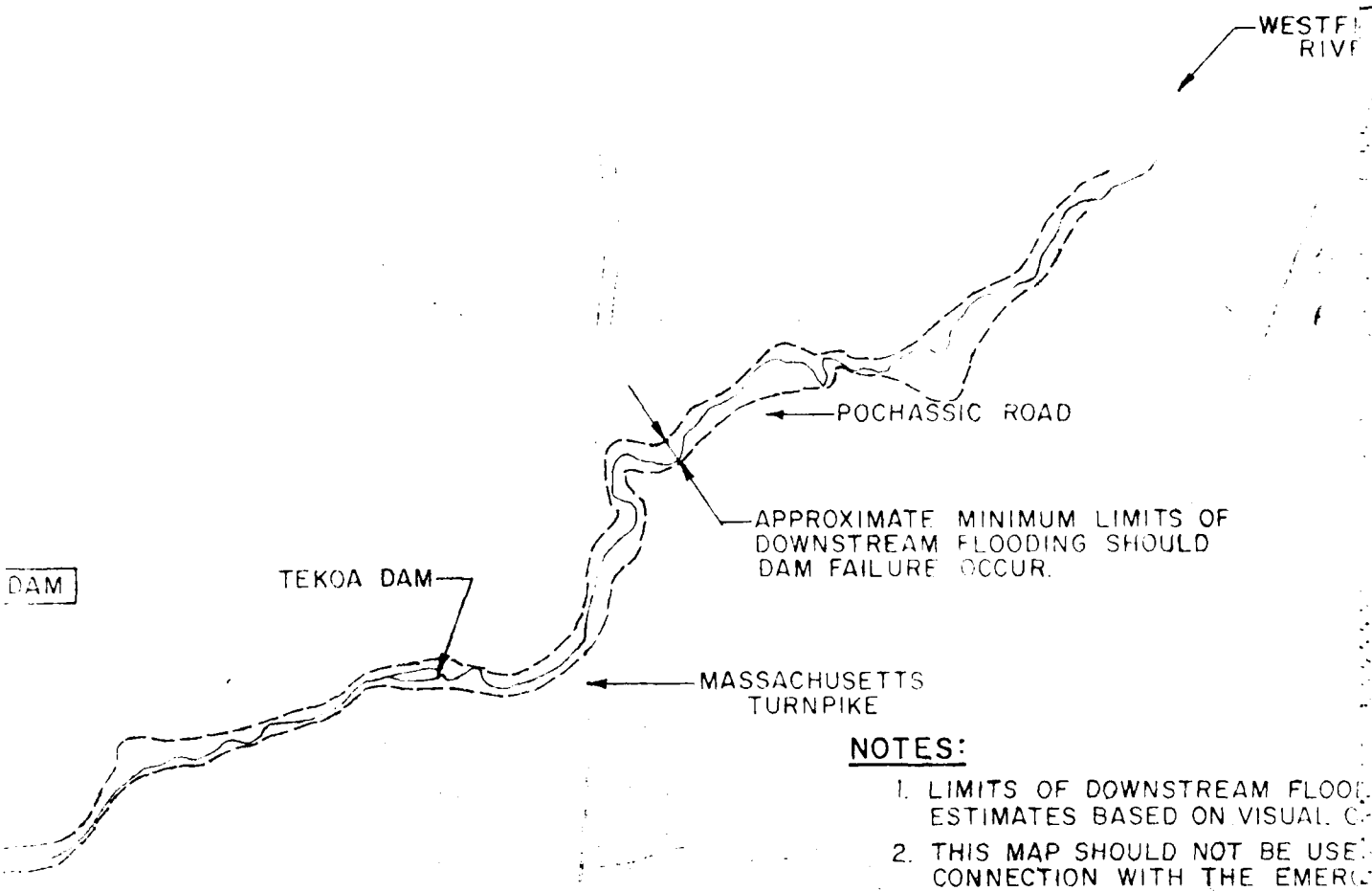
Condition	Discharge (cfs)	Stage (ft)
Pre-failure (spillway flowing full; pool at top of dam)	707	3.5
After failure (using previously described failure parameters)	14,064	10.5

Discussion: The results shown above apply at the primary damage center located about 3.6 miles downstream from the dam. The structures that would be affected include one dwelling and several farm buildings situated about 5 feet above the streambed and three dwellings situated about 10 feet above the streambed. Based on the results, which reflect only one mode of failure, it is judged that a high hazard classification is warranted because more than a few lives could be lost as a result of dam failure. In addition to property damage and possible loss of life at the damage center, there would be additional damage consisting of probable destruction of Tekoa Dam, washing out of Pochassic Road, and possibly damage to a railroad.



2000 1000 0

SCALE IN FE



NOTES:

1. LIMITS OF DOWNSTREAM FLOOD
   ESTIMATES BASED ON VISUAL C
2. THIS MAP SHOULD NOT BE USE
   CONNECTION WITH THE EMERG
   OPERATION AND WARNING PLA

1000 0 1000 2000

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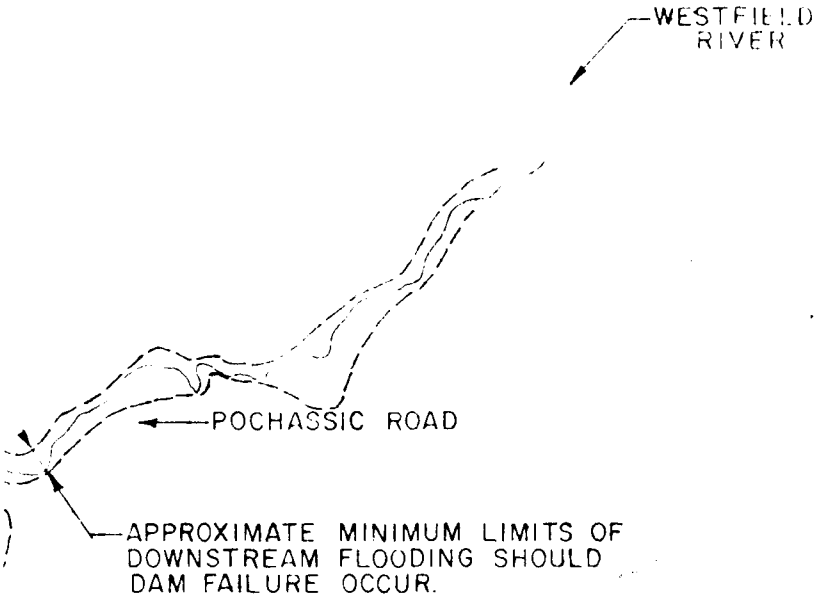
WESTFIELD RESERVOI
EXHIBIT D-1

FLOOD IMPACT A

DRAWN	CHECKED	APPROVED	SCALE A
L.L.R	D.B.W.	F.J.K.	DATE 2/



NOTES:

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.

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WESTFIELD RESERVOIR DAM
EXHIBIT D-1

FLOOD IMPACT AREA

DRAWN	CHECKED	APPROVED	SCALE AS SHOWN	
L.L.R	D.B.W.	F.J.K.	DATE 2/81	PAGE D-14

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

NOT AVAILABLE AT THIS TIME

END

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