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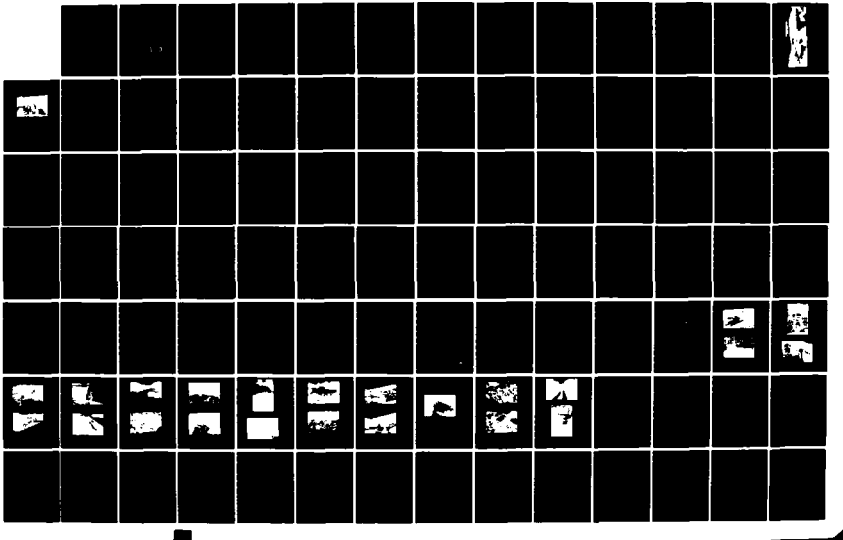
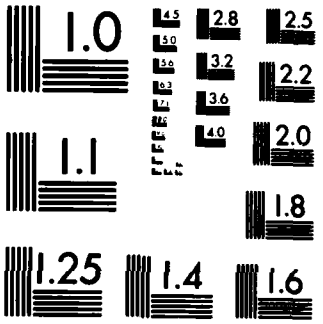
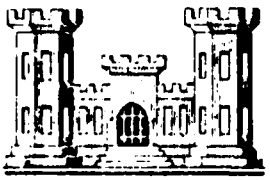




CONNECTICUT RIVER BASIN
RUSSELL, MASSACHUSETTS

WORONOCO MILLS (60 FEET) DAM MA 00738
WORONOCO MILLS (29 FEET) DAM MA 00737

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

FEBRUARY 1979

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

DAMS, INSPECTION, DAM SAFETY,

Connecticut River Basin
Russell, Massachusetts
Westfield River

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

Each of the dams is over 300 ft. in length and are about 60 ft. and 29 ft. high. The dams are in fair condition due to potential overtopping of the dams during the occurance of the test flood and the reported overtopping of the dams during prior floods. They have a significant hazard potential based on results of the dam failure analysis. Investigations are recommended to determine methods for providing additional spillway capacity.

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REPLY TO
ATTENTION OF:
NEDED

JUN 18 1979

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

Dear Governor King:

I am forwarding to you a copy of the two Woronoco Mills Dams Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Strathmore Paper Co., South Broad Street, Westfield, Massachusetts 01085.

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

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

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

WORONOCO MILLS (60 FEET) DAM
MA 00738

WORONOCO MILLS (29 FEET) DAM
MA 00737

CONNECTICUT RIVER BASIN
RUSSELL, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION PROGRAM

Identification No.: MA 00737 and MA 00738
Name of Dams: WORONOCO MILLS (29 feet and 60 feet)
Town: RUSSELL
County and State: HAMPDEN COUNTY, MA
Stream: WESTFIELD RIVER
Date of Inspection: 14 September 1978

BRIEF ASSESSMENT

The Woronoco (60 foot) Dam and the Woronoco (29 foot) Dam are in series (end to end) across the Westfield River. Each of the dams is over 300 feet in length and are approximately 60 feet and 29 feet high, respectively. They are separated by a ledge outcrop island in the center of the river. Each of the dams has a remote controlled sluice gate and outlet incorporated in the structures. A 680 foot long dike forms the closure from the 29 foot dam to the east side of the river valley while a small concrete dam, outlet works, screen house, and a wide earth embankment form the closure to the west side of the river valley. The west abutment area contains a large diameter penstock to the downstream hydro-electric station and two separate gated outlets.

The dams are in fair condition, due to the potential overtopping of the dams during the occurrence of the test flood and the reported overtopping of the dams during prior floods. There is some eroding of concrete joints in the dam, deteriorated concrete on appurtenant structures and observed seepage both from the joints in the concrete and from the embankments. The east dike is heavily overgrown with brush and young trees.

The dams are classified as having a "significant" hazard potential based on results of the dam failure analysis. There is essentially no development of the impacted area downstream of the dam. The City of Westfield is protected by state-constructed dikes and the flood wave would be dampened by flood plain storage between the dams and the City of Westfield. Only minor flood damage at the Westfield River - Little River confluence is expected.

Based on the size and hazard classifications, in accordance with Corps of Engineers Guidelines, the test flood selected for both dams is the 3/4 Probable Maximum Flood (3/4 PMF). This flood flow is slightly in excess of the estimated historical flood of record. The estimated peak discharge during the test flood is 110,000 cfs while the flood of record would have had a peak discharge of approximately 87,500 cfs under present day conditions. Hydraulic analysis indicates that the test flood stage would be at elevation 240.3 which is approximately 4.3 feet above the top of the right embankment. Approximately 95 percent of the test flood would pass over the 60 foot dam, 29 foot dam and the small dam spillways. The remaining flow would be over the right embankment between the screen house and the mill building.

Investigations are recommended to determine methods for providing additional spillway capacity, the adequacy of the earthfill at the west end of the facility, the source and effect of seepage at the east side of the downstream channel of the 29 foot dam and the structural repairs or modifications required on the 29 foot dam left abutment wingwall. Remedial measures recommended include the clearing of brush and trees from the dike, the repairs of eroded areas in the dams, the repair of minor eroded areas in the embankments and riprap, the removal and resurfacing of deteriorated concrete at the appurtenant structures and the performing of maintenance tasks, including the removal of minor vegetation from the concrete joints, cutting of grass and repainting of the screen house. The Owner should develop a formal maintenance procedures program, emergency preparedness plan and warning systems. The Owner should institute a program of annual technical inspections.

The Owner should institute the additional investigations and the remedial measures within 1 year of receipt of this report.

CAMP DRESSER & McKEE INC.

Roger H. Wood

Roger H. Wood
Vice President

This Phase I Inspection Report on Woronoco Mills Dams 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.

Joseph W. Finegan

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

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy

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

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, 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 Investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm runoff), or a fraction 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 aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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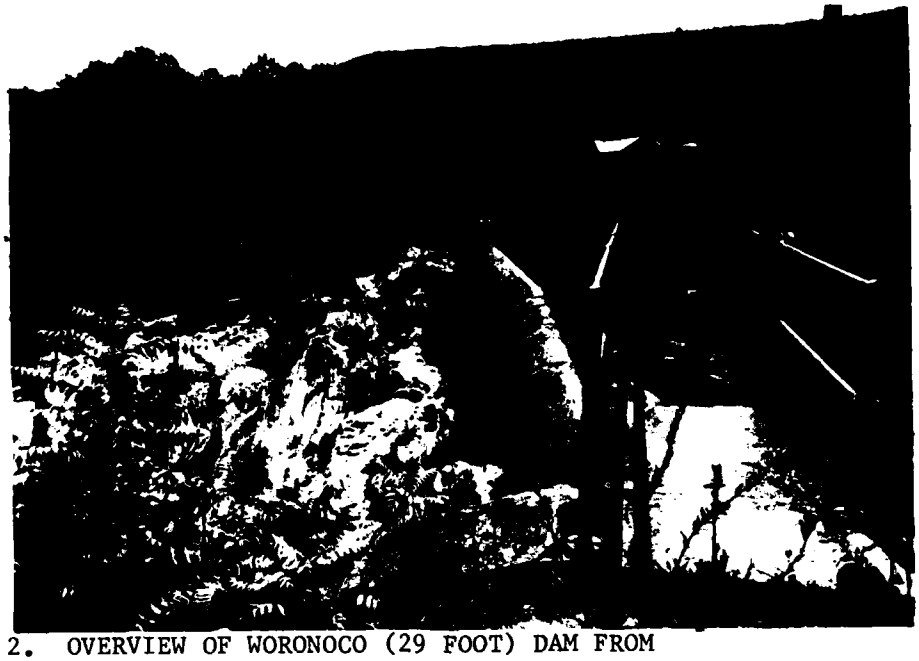
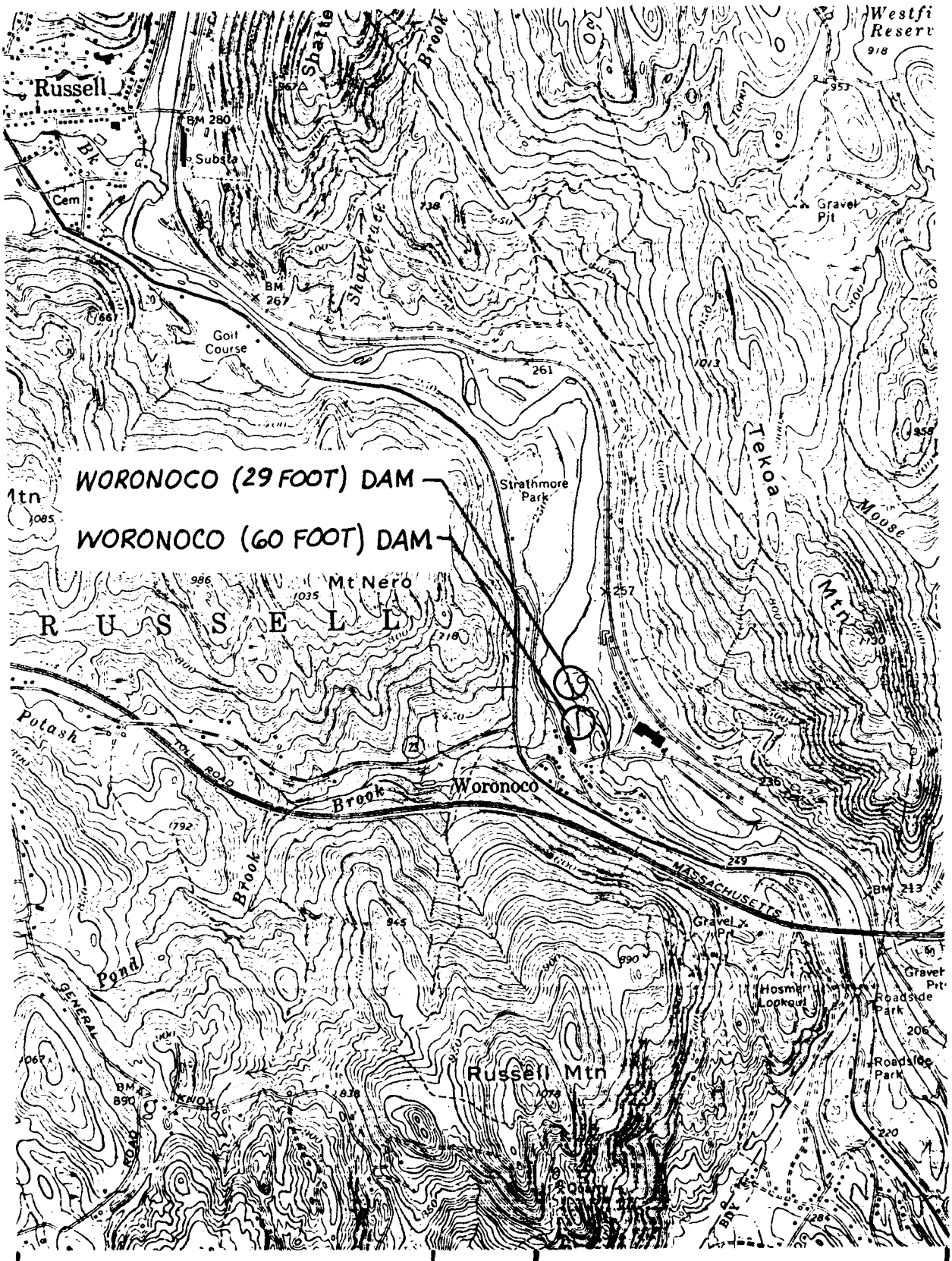
APPENDIXES

1. OVERVIEW OF WORONOCO (60 FOOT) DAM FROM DOWNSTREAM.



2. OVERVIEW OF WORONOCO (29 FOOT) DAM FROM LEFT ABUTMENT.



DAM: WORONOCO MILLS

IDENTIFICATION NO.: MA 00738

N

LOCATION MAP
USGS QUADRANGLE
WORONOCO MA
SCALE 1" = 2000'

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

WORONOCO MILLS (29 feet) DAM - MA 00737
WORONOCO MILLS (60 feet) DAM - MA 00738

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.

Camp Dresser & McKee Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Camp Dresser & McKee Inc. under letters of 12 July 1978 and 23 October 1978 from Colonel John P. Chandler, Corps of Engineers. Contract No. DACW 33-78-C-0354 has been assigned by the Corps of Engineers for this work. Haley and Aldrich, Inc. has been retained by Camp Dresser & McKee Inc. for soils and geological portions of the work.

b. Purpose - The primary purpose of the investigation is to:

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

(2) Encourage and assist the States to initiate quickly 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 Woronoco Dams are located on the Westfield River in the Town of Russell, Massachusetts, as shown on the report's location map. The dams are in the Woronoco portion of the Town of Russell which is approximately 2-1/2 miles downstream of the center of the Town of Russell. The Woronoco dams are approximately 4 miles upstream of the City of Westfield on the Westfield River and approximately 15 miles upstream of the confluence of the Westfield River and the Connecticut River. Access to the dams is by local roads off of U.S. Route 20.

b. Description of Dam and Appurtenances - The dams at Woronoco Mills consist of two concrete dams, each over 300 feet long, separated by a rocky knob in the river valley. The more southerly dam, on the west side of the valley, is referred to as the 1950 Dam or the 60-foot dam; this dam has a small dam at its right end and a screenhouse and abutment area with concrete walls and earth embankments adjacent to the mill building on the right side of the river valley. On the east side of the valley, the more northerly dam is referred to as the 1938 Dam or the 29-foot dam. The three dams (60 foot, 29 foot and the small dam) are concrete gravity dams constructed for full length overflow. An earth dike, approximately 680 feet long, extends from the left end of the 29-foot dam to the easterly valley slope.

All dams are mounded on steeply dipping foliated metamorphic rocks of the Goshen Formation; typically appearing as a gneissic schist. The presently exposed rock below the dams is generally sound and has very irregular surface contours, as would be expected where it has been exposed to highly erosive river flows.

The 60-foot dam has an outlet works control platform above the crest of the dam, approximately 1/3 of the distance in from the left abutment. The platform occurs at the highest point of the dam. A small concrete gravity dam is present at the right end of the 60-foot dam between the dam and the screenhouse. This small dam appears older than the 1950 dam. Two sluice gates are present at the right abutment of the small dam. A wooden screenhouse on a concrete foundation controls the intake of an 11-foot I.D. diameter penstock. The screenhouse is positioned between the small dam and the west side of the river valley. The training walls to the screenhouse are of concrete of an older vintage than the dam constructed in 1950. Upstream of the 1950 dam is the submerged remains of an old timber crib dam. This dam was purposely breached after the construction of the dam in 1950.

To the right of the 60-foot dam, between the screenhouse and the mill building, an irregular and relatively wide earth embankment is retained by concrete walls that extend about 7 feet above the adjacent dam crest. It is understood that at one time the mill owner had planned to construct an additional building in this area, using the walls for foundations. The portion of the embankment that is closest to the mill building is believed to be more recent fill in an old sluiceway. In general, the embankment and the upstream end of the sluiceway fill are approximately level with tops of the walls, but the sluiceway fill has a gradual downhill slope along the face of the mill building. The embankment area has a cover of grass, weeds and some brush.

The 29-foot dam extends from the island at the center of the river to the east shore. A dike starts at this location and

extends to the easterly valley wall. The concrete gravity dam contains an outlet works at the left abutment. The operating platform for the outlet works sluice gate is raised above the crest of the dam and is approximately at the elevation of the top of dike.

The long earth dike extends across the river flood plain from the left abutment of the 29-foot concrete dam to the left valley slope below a garage access road. Much of the length of the dike is approximately 10 feet high, but close to the dam abutments the height is about 40 feet with respect to river channel below the dam. The dike has a relatively narrow 10-foot wide crest and upstream and downstream slopes that appear to be roughly 2-1/2 to 3 horizontal to 1 vertical. There is upstream and downstream cobble and rock slope protection, and a gravel roadway on the dike crest; both are partly obscured by vegetation.

The river channel curves to the right below the 29-foot dam, and the left bank has been cut to approximately a 1-1/2 to 1 slope and protected with riprap to a considerable distance downstream from the dam. Immediately below the bedrock that is exposed at the toe of the dam and extending downstream along the toe of the riprap bank protection, the channel bottom has a cover of cobble and boulder size broken rock. Further downstream, the channel bottom has either exposed sand or a general cover of trees and brush.

c. Size Classification - The 60-foot high dam and the 29-foot dam impound 393 acre-feet at elevation 229. Based on guidelines established by the Corps of Engineers, the higher dam is classified in the intermediate category while the lower dam is classified in the small category.

d. Hazard Classification - The results of the dam failure analysis indicates that a flood wave resulting from a failure of either dam would be essentially dissipated prior to its arrival at any built-up areas, causing only economic loss due to minor flooding at the confluence of the Little River with the Westfield River. Consequently, it is recommended that both dams be classified as having a significant hazard potential.

e. Ownership - The dams are owned by Strathmore Paper Co., South Broad Street, Westfield, Massachusetts, a division of Hammermill Paper Co., A Penn Corp., East Lake Road, Erie, Pennsylvania. The Owner is represented by Mr. Jack Mudget at the South Broad Street Office in Westfield, Massachusetts, Telephone 413/568-9111, Ext. 333.

f. Operator - Mr. Daniel LaBombard, employed at the mill in Russell, Massachusetts, operates the dam. The operator can be contacted by phone at 413/568-9111.

g. Purpose of Dam - The dams were constructed to provide power for the adjacent mills.

h. Design and Construction History - The date of construction of the original dams at the site is unknown. The original dams may have been timber crib structures, as evidenced by the remains of one such structure which is submerged, upstream of the Woronoco (60 foot) dam. The present Woronoco (29 foot) dam was constructed shortly after the September 1938 flood. At the same time, a closure earthen dike was constructed from the left abutment of this dam to the easterly side of the Westfield River Valley. The present Woronoco (60 foot) dam was constructed in 1950, replacing the upstream timber crib dam. Both Woronoco dams (60 foot and 29 foot) were designed by Chas. T. Main, Inc. of Boston, Massachusetts.

The structures to the right of the Woronoco (60 foot) dam, including the screenhouse with its training walls and a small concrete dam, appear to be of earlier vintage than the other dams but no plans were located to indicate their age.

i. Normal Operational Procedures - There is no formally established operational procedure for the dams. The outlet gates of both dams in the screenhouse are maintained and checked at frequent intervals to assure that they remain operational. Debris is removed from the screens in front of the penstock entrance at frequent intervals. The reservoir pool is usually dewatered once a year during employee vacation at the Owner's mills.

1.3 Pertinent Data

Elevations given in this report are on National Geodetic Vertical Datum (NGVD) formerly referred to as Mean Sea Level (MSL).

a. Drainage Area - The drainage area above the dams is approximately 346 square miles. There are two major flood control dams within the basin--Knightville Dam which has a tributary drainage area of 162 square miles and Littleville Dam which has a tributary area of 52 square miles. The presence of the two flood control dams will reduce the flood flows on the Westfield River above the dam site by approximately 40 percent.

b. Discharge at Dam Site - Historic records of the Westfield River Basin indicate that 15 damaging floods occurred between March, 1776 and February, 1900. U.S. Geological Survey Water Resources Data Records show that floods might occur during any month of the year. Major floods in the Westfield River Basin occurred in November 1927, March 1936, September 1938, December 1948, August 1955, and October 1955. The August 1955 flood of record crested at the Woronoco Mills dams at elevation 238.8 or 9.8 feet above the spillway crest. This height corresponds to an estimated discharge of 87,500 cfs under present conditions.

(1) Outlet works size - 60-ft dam: 6-ft by 6-ft sluice gate at invert elev. 200.0; 29-ft dam: 6-ft by 6-ft sluice gate at invert elev. 217.0

(2) Maximum known flood at damsite - 87,500 cfs (estimated)

(3) Ungated spillway capacity at top of dam
50,100 cfs at elev. 236.0

(4) Ungated spillway capacity at test flood elevation
104,600 cfs at elev. 240.3

(5) Gated spillway capacity at normal pool elevation--------N/A

(6) Gated spillway capacity at test flood elevation---------N/A

(7) Total spillway capacity at test flood elevation
104,600 cfs at elev. 240.3

(8) Total project discharge at test flood elevation
110,000 cfs at elev. 240.3

c. Elevation (ft. above MSL)

(1) Streambed at centerline of dam: 60-ft dam - 175.0
29-ft dam - 205.0

(2) Test flood tailwater----------Below elevation 229.0

(3) Upstream portal invert diversion tunnel----------None

(4) Recreation pool----------229.0

(5) Full flood control pool----------N/A

(6) Spillway crest----------229.0

(7) Design surcharge (Original Design): 60-ft dam - 236.0
29-ft dam - unknown

(8) Top of dam----------236.0

(9) Test flood design surcharge----------240.3

d. Reservoir

(1) Length of test flood pool----------1 mile (Est.)

(2) Length of recreation pool----------1 mile (Est.)

(3) Length of flood control pool----------N/A

e. Storage (acre-feet)

(1) Recreation pool----------393 (Est.)

(2) Flood control pool----------N/A

(3) Spillway crest pool----------393 (Est.)

(4) Top of dam----------960 (Est.)

(5) Test flood pool----------1,350 (Est.)

f. Reservoir Surface (acres)

(1) Recreation pool----------59 (Est.)

(2) Flood-control pool----------N/A

(3) Spillway crest----------59 (Est.)

(4) Test flood pool----------120 (Est.)

(5) Top of dam----------93 (Est.)

g. Dike

(1) Type----------Earth embankment

(2) Length----------Approximately 680 ft

(3) Height----------Typically 10 to 15 ft

(4) Top width----------10 ft

(5) Side slopes----------Est. 2.5 to 3:1 U/S and D/S

(6) Zoning----------Unknown

(7) Impervious core----------Unknown

(8) Cutoff----------Unknown

(9) Grout curtain----------Unknown

h. Diversion and Regulating Tunnel ----------None

i. Spillway

(1) Type----------Concrete Parabolic Weir

(2) Length of weir----------small dam = 63'; 60' dam = 400'; 29' dam = 307'

(3) Crest elevation----------229.0

(4) Gates----------None

(5) U/S channel----------Westfield River

(6) D/S channel----------Two forks of the Westfield River which are separated by a natural rock island

j. Regulating Outlets

Both the 60-ft and the 29-ft dams have 6-ft by 6-ft box outlets with remote controlled sluice gates on their upstream sides. The invert elevations for the 60-ft and 29-ft box outlets are 200.0 and 217.0, respectively. The control tower for the 60-ft dam outlet is located approximately 85 ft from the left abutment whereas the 29-ft dam outlet is located at the left abutment. Overhead electric cables run from the control towers to the mill building on the right bank of the river from which the sluice gates are controlled.

The right abutment for the small dam located to the right of the 60-ft dam contains two manually-operated sluice gates controlling a 3-ft by 5-ft box outlet and a 3-ft by 3-ft box outlet. The intake for an 11-ft diameter penstock is within the screenhouse to the right of the small dam. The invert elevation of the penstock is Elev. 214.5. The penstock supplies water to a hydroelectric station downstream from the dams.

SECTION 2: ENGINEERING DATA

2.1 Design Data - Design records for this dam are available at the Office of Chas. T. Main, Boston, Massachusetts, and the Office of Strathmore Mills, South Broad Street, Westfield, Massachusetts. The design records are the contract plans for both the Woronoco (29 foot) dam and the Woronoco (60 foot) dam. Record drawings contain some of the subsurface exploration data obtained during design of the dams.

2.2 Construction Data - No construction records for either dam were located during the investigation.

2.3 Operational Data - No operational records other than inspection reports on the facilities and river level elevations were located during this investigation.

2.4 Evaluation

a. Availability - Documents described above are generally available at the office of the Design Engineer, Chas. T. Main, Prudential Center, Boston, Massachusetts, and the owner, Strathmore Paper Co., South Broad Street, Westfield, Massachusetts.

b. Validity - The record drawings viewed were in excellent agreement with the features observed in the field.

c. Adequacy - The available data, in combination with the visual evaluation described in the following section, is adequate for the purpose of the Phase I investigation.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General - The visual examination of the Woronoco Mills dams was conducted on 14 September 1978. In general, the concrete dams and outlet facilities were observed to be in excellent to good condition. The earth dike was observed to be in good to fair condition due to tree and brush growth and the presence of seepage at the downstream toe of the base embankment. The heavy vegetation growth on the dike may have concealed other problems.

Visual inspection checklists for the dams are included in Appendix A and selected photographs are given in Appendix C.

b. Dams and Dike - The three dams; 60-foot dam, 29-foot dam, and the small dam are generally in good condition. There is some minor vegetation growth in the joints and cracks on the dams as shown in Photos 9 and 10. Construction joints and cracks in the structures, especially in the small dam and the 29-foot dam, have started to erode with seepage occurring at these locations, as shown on the 29-foot dam in Photo 20. Minor erosion of concrete has taken place at the crest of the dams as shown in Photos 2 and 14. Minor rusty seepage was observed at the concrete-ledgerock interface at all the dams as shown in Photos 16 and 23. The box screen at the 29-foot dam was discharging a small amount of rust stained water. Minor efflorescence was observed at the downstream face of all dams including the operating structure of the 60-foot dam. The top surface of the 29-foot dam's right concrete abutment has deteriorated. The left abutment structure of the 29-foot dam is in fair condition. There is noticeable efflorescence present on the face of the wing walls and a vertical crack in both upstream and downstream wing walls as shown in Photo 24. There is a transverse concrete wall below the outlet for the 29-foot dam which is in deteriorated condition as shown in the lower left corner of Photo 25. This wall may be the remains of an earlier structure or could be serving as an impact wall.

The short earth embankment at the right end of the 60-foot dam is generally in fair condition. There is no visible evidence of lateral movement, settlement or erosion, and no seepage that appears to come from the upstream pond. However, the somewhat irregular configuration of the embankment surface and the heavy weed growth, as shown in Photo 7, could obscure problems. In particular, the fill in the area that is believed to be an old sluiceway is generally lower than the rest of the embankment, has an irregular surface, and shows scattered debris at the surface. Seeping water is evident at several locations in the sluiceway, but each is close to an active mill building drain.

The earth dike embankment to the left of the 29-foot dam is generally in fair condition. There is no visible evidence of lateral movement, settlement, or erosion, but the heavy growth of brambles, brush and young trees obscures most of the embankment surface. There is no seepage apparent at the dike, with a pond level below the upstream toe; however, the seepage flow that is emerging from the riprap at the toe of the left bank at the channel bend, downstream from the dam, may be passing through the flood plain deposits that underlie the dike. The following specific items were noted:

(1) The dike has a heavy cover of brambles, brush, young trees and previously-cut brush that limits observation of its condition, as shown in Photos 28 and 27.

(2) One animal burrow was observed by chance in the upstream slope; there may be others that were not seen.

(3) There are wheel ruts in the crest, as shown in Photos 28 and 27, that offer some potential for concentration of runoff and slope erosion; however, the only location with potential for significant surface flow appears to be in the slope area from the road at the abutment.

c. Appurtenant Structures - The screenhouse is in good condition but it is starting to need some maintenance work such as painting the interior of the structure. The debris from the screens is being disposed of at the downstream side of the structure. While the present level of debris does not impede discharge at the two gates to the left of the screenhouse, a continued build-up of the material may reduce the capacity of these outlets. The right training walls, including the wall along the westerly pool of the reservoir, have general deterioration as shown in Photo 4.

d. Reservoir Area - There is no specific enlargement of the river channel to delineate the reservoir area of the Woronoco Mills dams. The river is bordered by forested moderate to steep banks that are essentially undeveloped. No development in the immediate upstream area was noted that would be affected by a river level at test flood elevation. The Penn Central Railroad follows the left bank of the river but is 15+ feet above the test flood pool elevation.

No significant potential was observed for landslides into the general pool area of the dams which could create waves that might overtop the dams. No conditions were noted that would result in a sudden increase in sediment load into the upstream pool.

e. Downstream Channel - Downstream of the 29-foot dam there is a considerable seepage flow entering the channel at the toe of the ripraped left slope below the dike, as shown in Photos 26 and 25.

Close to the dam, the seepage is flowing over exposed bedrock, and the seepage area extends over 250 feet downstream from the dam. Two locations, about 100 feet apart, have flow estimated at 10 gallons per minute or more. There is no evidence of current or recent soil movement with the flow, but there is extensive "rust staining" in flow areas, particularly those closest to the dam, as shown in Photos 26 and 25. Where there are pockets of water, a rust colored algae-like material is associated with the staining. About 250 feet downstream from the dam the seepage flow area has algae without the staining.

A sample of rust-colored, algae-like material was examined by microscope and subjected to laboratory analysis. By microscope it appears to be an iron-rich colloidial suspension, probably bacterial growth concentrating the iron. There are very fine fibres and a gelllike substance, without soil particles. The laboratory analysis, included in Appendix A, showed 1,000 milligrams per liter iron and 0.91 milligrams per litre manganese. The relatively high iron concentration can be derived from either metallic iron (rusting steel) or deterioration of the iron-rich minerals of the bedrock, but the low concentration of manganese indicates that it probably is not from a natural deposit.

In addition to the seepage that appears from the riprap, there is an unstable area of channel-bottom sand deposits about 200 feet downstream from the 29-foot dam. A 10 to 20 foot wide area of wet sand, shown in Photos 21 and 22, apparently has a slight upward seepage flow and will not readily support foot traffic. No actual soil movement with the flow was observed. Whether the seepage has its origin close upstream in the channel, or further away in the rock foundation of the concrete dam or the soils on either side of the channel is not known.

The Westfield River downstream of the dams to the confluence with the Little River in the City of Westfield is in a relatively deep valley. The overbanks of the river widen in the City of Westfield to provide significant flood plain storage. Essentially, the only developed area adjacent to the river is in the City of Westfield where the State has constructed flood dikes to protect the developed area.

3.2 Evaluation - While the concrete portions of the dams are generally in good condition, the erosion of the joints, seepage at the concrete-rock interface and the condition of Woronoco Mills (29 foot) dam left abutment along with the embankment portions of the dams limit the condition to fair. The screenhouse area needs maintenance and the right concrete training wall to the screenhouse is in deteriorated condition.

The limited embankment area to the right of the 60-foot Woronoco Mill Dam appears to be performing satisfactorily at the present time, although the uncertain quality and geometry of the fill in the old sluiceway could offer potential for dam failure in the event of unusually high water levels.

The long dike to the left of the 29-foot Woronoco Mills Dam is on the river flood plain, and will retain water only during high river levels. Thus, there would be no reason to expect evidence of unsatisfactory dike performance at the present time. However, the heavy vegetation on the dike can conceal defficiencies in the slopes or the erosion protection, and the seepage into the channel below the dam may result from flow under the dike embankment. Either of these conditions could lead to failure of the dike during a period of unusually high water levels.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures - In general, there is no formal established routine for the operation of the dams. Sluice gates are remotely operated on the dams and at the appurtenant structures to aid in the passage of flood flows.

4.2 Maintenance of the Dam - There is no established formal procedure for the maintenance of the dam. The dam and dikes receive maintenance upon demand. The storage pools are dewatered once a year during mill shutdown and the dams are inspected on a yearly basis. The present tree and brush growth on the east dike indicates little maintenance has been performed on this structure in the past.

4.3 Maintenance of Operating Facilities - There is no formal procedure for maintenance of operating facilities. Maintenance is performed frequently and on the basis of need. The screens in front of the penstock are cleaned at frequent intervals. The sluice gates at the facility are operated to aid in the passage of large flows.

4.4 Description of Any Warning System in Effect - There is no established warning system or emergency preparedness plan in effect for these dams.

4.5 Evaluation - Formal operational procedures, maintenance programs, warning system and an emergency preparedness plan should be established for the dams. Periodic observation (yearly) should be continued for these dams. The tree and brush growth at the dike should be brought under control. Maintenance of the structures should be performed at regular intervals.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. General - The Woronoco Mills dams are located on the Westfield River in the Town of Russell. The dams consist of concrete spillways cast and embedded into the ledgerock of the riverbed and separated by a natural rocky knob in the river valley. Additionally, there is an earth embankment to the left of the 29-foot dam with a top elevation of 245.0. The reservoir created by these dams has a water surface area of approximately 59 acres at spillway crest elevation 229.0 and an estimated total storage capacity of 393 acre-feet. Both dams are constructed of concrete and have a parabolic shape. The crest length of the 29-foot dam is 307 feet. At the left end of this dam is a 6-ft. by 6-ft. sluice gate at invert elevation 217.0. The 60-foot dam consists of a concrete spillway having a total length of 463 feet. Of this total, the concrete cast spillway at elevation 229 makes up a total of 400 feet. A 29-foot length of spillway with a raised crest at elevation 233 ties into a natural rock projecting to elevation 233 which is considered to be another 34 feet of spillway. Approximately 255 feet from the right end of the 60-foot dam is located a 6-ft. by 6-ft. sluice gate at invert elevation 200.0. At the right end of the 60-foot dam is an 11-foot diameter penstock which conveys water downstream to a powerhouse which is no longer used. Indications are, however, that this powerhouse will be placed back into service in the near future.

The drainage area above the dams is approximately 346 square miles. Within this drainage basin are located two major flood control dams and reservoirs: Knightville Dam which was constructed in 1949 on the Westfield River with a tributary drainage area of 162 square miles and Littleville Dam, constructed in 1958 on the Middle Branch of the Westfield River with a tributary drainage area of 52 square miles. In Design Memorandum No. 1, Westfield Local Protection Project, the Corps of Engineers presented hydrographs of past flood events showing how the Knightville and Littleville Dams would reduce peak flood discharges. The effect of these flood control dams is to reduce the natural flood flow by about 40 percent on the Westfield River in the vicinity of the Woronoco Dams.

b. Design Data - Pertinent design plans were obtained from Charles T. Main Inc., the design engineers for both of these dams. The plans are entitled "Strathmore Paper Company, West Springfield, Massachusetts, Woronoco Mills" (dated 1938), and "Strathmore Paper Company, Woronoco, Mass., New Concrete Dam," (dated 1949). The 1949 plans indicate that the 60-foot dam, constructed in

1950, was designed to discharge flow over its crest which would cause the water surface to reach elevation 236.0, or 7.0 feet above the spillway crest. The plans were utilized in this investigation to develop Area-Elevation-Storage Capacity data for the two dams together with field measurements made during the visual inspection and information shown on the U.S.G.S. quadrangle sheet. No specific hydraulic or hydrologic design information was found for either of the dams.

c. Experience Data - The flood of record on the Westfield River occurred on August 19, 1955 when Hurricane Diane produced a total rainfall of 19.75 inches in less than 36 hours in nearby Westfield. The river crested at the Woronoco Mills dams at elevation 238.8 or 9.8 ft. above the spillway crest. This is the maximum known level of the river since records were kept. This height corresponds to an estimated discharge of 87,500 cfs.

d. Visual Observations - The inspection of these dams was made on 14 September 1978. At that time, the water level was 3.75 inches below the spillway crest or elevation 228.65. All river flow at that time was passing through the 11-foot diameter penstock to the hydroelectric station some 600 feet downstream. The spillway crest for both dams was noted to be in good to excellent hydraulic condition. Downstream of the spillway the natural rock channel was observed to have a moderate to steep slope.

e. Test Flood Analysis - Based upon Corps of Engineers Guidelines, the recommended test flood for the 60-foot dam, which is in the intermediate size classification and significant hazard category, is within the range of 1/2 PMF to the PMF (Probable Maximum Flood). For the 29-foot dam, the hazard is again considered significant but the size is small, thereby resulting in a test flood of between the 100-year flood and 1/2 PMF. The PMF was determined using the Corps of Engineers Guideline curves for estimating Maximum Probable Discharges in the Phase I, Dam Safety Investigations. Using these guidelines, a value of 700 cfs per square mile was selected which results in a PMF inflow of 242,200 cfs. After taking one-half of this value and reducing it by 40 percent, to account for the flow reduction afforded by the Littleville and Knightville Flood Control Dams, an outflow of 73,000 cfs was determined for the 1/2 PMF. Since this value is less than the flood of record (87,500 cfs) and because of the importance of this river to the downstream community of Westfield, a test flood value equal to three-quarters of the PMF was adopted. This results in a test flood value of 110,000 cfs after accounting for storage reduction afforded by the upstream flood control reservoirs. Because the available storage above the dams is not substantial enough to require storage routing of the test flood flow, the value of 110,000 cfs would result in a water surface elevation of 240.3, or about 11.3 ft. above the

spillway crest. At elevation 236.0, both dams have a combined spillway capacity of 50,100 cfs (45.5 percent of the test flood flow). Between elevation 236.0 and elevation 245.0 (top of earth embankment on left bank) increasing amounts of flow are discharged over the overflow wall between the mill building, the 11-ft. diameter penstock and the Screening Building. At the test flood flow of 110,000 cfs, approximately 5,400 cfs is discharged over the overflow wall, leaving a total of 104,600 cfs to pass over the combined spillways.

f. Dam Failure Analysis - Dam Failure Analysis was performed based on Corps of Engineers Guidelines for Estimating Dam Failure hydrographs and assuming that only one of the two dams would fail at any given time. Analysis of the 29-foot dam assumed that the failure would take place with the water surface at elevation 236 and that the breach width would be 100 feet long. This produced a failure flow of 17,350 cfs which, when combined with the total flow over the spillways of 43,050, results in a total flow of 60,400 cfs. Analysis of the 60-foot dam, based on the same water surface elevation of 236 and a breach width of 80 feet, results in a failure flow of 18,900 cfs which, when combined with the total spillway flow of 44,500 cfs, results in a total flow of 63,400 cfs. This being the larger of the two flows, a value of 64,000 cfs was adopted for the dam failure flow. The 64,000 cfs was routed through no less than six sections in a 1.2 mile reach downstream of the dam and calculations show that significant overbank storage would vastly reduce the peak rate of flow. By the time the failure flow reaches the state-constructed dikes in the City of Westfield and the railroad tracks on the flood plain, the flow would be essentially assimilated resulting in very minor flooding damage to structures in the vicinity of the confluence of the Little River with the Westfield River. For this reason, it is recommended that the high hazard classification be significant for this dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations - There was no visible evidence of dam or dike embankment instability during the site examination on 14 September 1978. No movement or settlement was observed during the site examination of the concrete portions of the structures with the exception of the wing walls at the left abutment of the 29-foot dam. The wing walls exhibited two vertical cracks, one in each wall, indicating that movement has taken place. However, the probable cause of the cracks is that the dam provided resistance to deflection of the center portion of the abutment while the outer portion of the walls tried to deflect as normal cantilevered walls. The crack is, therefore, probably due to details of design rather than a result of basic structural instability.

The seepage at the toe of the channel riprap in the area below the dike has been previously reported, and it showed no evidence of currently active erosion or piping. Thus, it is not considered to pose an immediate hazard to the stability of the dike.

b. Design and Construction Data - Available Charles T. Main, Inc. drawings for the Woronoco Mills dams and dike, while providing information on the concrete portion of the dams, do not provide information on the embankment cross sections at the project or the materials used in the construction of the embankments. Thus, theoretical analysis of the structural stability of the dam and dike embankments is not possible. The concrete portions of the dams shown on the drawings indicate cross sections which would be expected to be adequately stable under normally expected static loading conditions.

The embankment area to the right of the 60-foot dam is relatively wide, and would be expected to have adequate stability under static loading conditions. The dike to the left of the 29-foot dam is relatively low, with a 10 foot top width and flatter than 2 horizontal to 1 vertical side slopes, and in the absence of seepage problems would also be expected to have adequate stability under static loading conditions. Whether the seepage that flows from the channel riprap is related to the dike foundation, and whether the dike itself has an effective impervious core cutoff is not known at this time. The rust stain in the seepage flow at the channel could be the result of flow through interlocks or breaks, or under the tips of a steel sheet piling cutoff wall at the dam abutment or under the dike. It could also indicate deterioration of such a cutoff.

c. Operating Records - There are no operating records for the dams other than river water levels and yearly inspection reports.

d. Post-Construction Changes - The facility at the site has been changed a number of times as evidenced by the observed differences in the type of construction present and by the presence of an older submerged dam upstream of the present structure. However, the observed conditions are in excellent agreement with design plans for the dams designed in 1938 and 1950 ,indicating that there has been no material changes since those dates. There is no information on post-construction changes to the dam and dike embankments, although there has evidently been past filling in of the old sluiceway area between the mill building and the screenhouse.

e. Seismic Stability - Woronoco Mills dams are located in seismic zone no. 1 and in accordance with recommended Phase I guidelines do not warrant seismic analysis.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition - The visual examination of the Woronoco Mills Dams and the review of available Charles T. Main information, did not reveal evidence of failure or conditions which would warrant urgent remedial treatment. The dam and dike embankments are generally in fair condition while the concrete portions of the dams are generally in good condition. However, due to the concrete joints, seepage and indicated overtopping of the dam during floods equal to the test flood and the past overtopping of the dam during recorded floods, the dam can only be considered in fair condition. Additional maintenance and investigations should be undertaken, particularly with respect to the seepage, as outlined hereinafter.

b. Adequacy of Information - Generally, the information obtained from visual examination and limited measurements at the site, supplemented by available drawings, was adequate for the Phase I investigation. However, there is insufficient information for a detailed evaluation of the seepage that is occurring around the left abutment of the 29 foot dam and/or under the dike.

c. Urgency - The recommended additional investigations outlined in Section 7.2 and the recommended remedial measures outlined in Section 7.3 should be undertaken by the Owner within 1 year of the receipt of this report.

d. Need for Additional Investigation - Additional investigations should be performed by the owner as outlined in the following section.

7.2 Recommendations

It is recommended that the following additional investigations be performed by the owner:

a. A detailed hydraulic/hydrologic investigation to determine methods of increasing the spillway capacity, providing an emergency spillway, and/or the protection of the earthen portions of the dam.

b. An investigation to attempt to determine the source and whether or not there are changes in the seepage that is occurring at the toe of the riprap downstream slope and out in the channel bottom below the 29-foot dam. This would include further research into available information and records, systematic observation of

conditions in the seepage areas during changes in pond levels, and, if necessary, the use of observation wells to monitor the phreatic surface and/or the introduction of tracer substances into the dike foundation area. This investigation would determine whether there should be corrective measures or continued regular monitoring of the seepage.

c. An investigation to confirm the adequacy of the fill in the old sluiceway area in the event of high water levels. This would include determining the character and condition of the fill, and the effective embankment cross section along the sluiceway.

d. An investigation to determine the necessary repairs to the cracks and/or modifications required to prevent further cracking in the Woronoco (29 foot) dam left abutment wing wall.

7.3 Remedial Measures

a. Operation and Maintenance Procedures - It is recommended that the following operation and maintenance procedures be adopted by the Owner to correct deficiencies noted during the visual examination.

(1) Clear brambles, brush and young trees, including stumps, and any trash and debris from the dam and dike embankments and backfill any resulting holes with compacted fill.

(2) Cut grass and weeds on the embankments at least once a year.

(3) Repair gaps in erosion protection and animal burrows that are revealed by the clearing operation.

(4) Clean and fill with epoxy mortar eroded joints, eroded cracks and eroded panels in the concrete which have eroded to a depth greater than 1-1/2 inches for cracks and 1 inch for panels. Larger size voids can be filled with peastone added to concrete bonded to the existing concrete with epoxy.

(5) Repair those concrete joints which are presently seeping water (especially on the 29-foot dam) and seal all suspicious locations on the upstream end of these joints, including the concrete-ledgerock interface joints, with epoxy or epoxy mortar during summer shutdown. Remove deteriorated concrete surface from the screenhouse right training wall, including the wall at the west side of the reservoir pool, the west abutment wall of the 29-foot dam and the transverse wall downstream of the 29-foot dam outlet (if the transverse wall is providing a definite function) and resurface the walls.

(7) Include in the maintenance work on the facilities the removal of minor vegetation from the concrete cracks and joints, the removal of screening debris that may be piled up downstream of the screenhouse, and the repainting of the screenhouse as necessary.

The Owner should also develop a formal maintenance procedures program for this facility, including the maintenance procedures listed above and a testing and maintenance program of all gates and outlets at a frequency not to exceed 90 days. A formal emergency procedures plan and warning system should be developed in cooperation with local officials in downstream communities. Finally, it is recommended that the Owner institute a program of technical inspections on a yearly basis.

7.4 Alternatives - Not applicable

APPENDIX A

INSPECTION TEAM ORGANIZATION AND CHECKLIST

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

DAM: WORONOCO MILLS

DATE: SEPTEMBER 14, 1978

TIME: 9:45 A.M.

WEATHER: CLEAR & CRISP, 45°- 50° F, LT. VAR. WINDS

WATER SURFACE ELEVATION UPSTREAM: 4-1/4" below spillway crest (229.00-0.35 = El. 228.65)

STREAM FLOW: All flow thru 11' dia. penstock to hydroelectric station 600' d.s.

INSPECTION PARTY:

1. Roger H. Wood - CDM
2. Joseph E. Downing - CDM
3. Charles E. Fuller - CDM
4. Peter LeCount - Haley & Aldrich
5.
6.

PRESENT DURING INSPECTION:

1. Danny Labombard - Woronoco Mills
2. Bill Warren - Woronoco Mills
3.
4.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Woronoco Mills DATE: 9/14/78

EMBANKMENT: Dike

CHECK LIST	CONDITION
1. Upstream Slope	1.
a. Vegetation	a. Heavy growth of brush & weeds, previous cuttings on slope.
b. Sloughing or Erosion	b. Not evident
c. Rock Slope Protection - Riprap Failures	c. Slope appears to have cover of cobbles for all or most of length (where could be observed).
d. Animal Burrows	d. One noted by chance at toe, approx. 6"dia.
2. Crest	2.
a. Vegetation	a. Slope growth encroaching on narrow roadway, grass & weeds except where exposed cobbles & gravel.
b. Sloughing or Erosion	b. None observed except wheel ruts.
c. Surface cracks	c. None observed
d. Movement or Settlement	d. None apparent
3. Downstream Slope	3.
a. Vegetation	a. Same as upstream
b. Sloughing or Erosion	b. Same as upstream
c. Surface cracks	c. None observed
d. Animal Burrows	d. None observed
e. Movement or Cracking near toe	e. None observed
f. Unusual Embankment or Downstream Seepage	f. No seepage at dike, but extensive seepage beyond dike from lower part of riprapped slope on left side of channel.
g. Piping or Boils	g. None at dike
h. Foundation Drainage Features	h. None known
i. Toe Drains	i. None known
4. General	4.
a. Lateral Movement	a., b., c. Alignment appears to be OK, with no indication of movement, but it is not possible to closely examine the dike.
b. Vertical Alignment	
c. Horizontal Alignment	
d. Condition at Abutments and at Structures	d. No indication of movement
e. Indications of Movement of Structural Items	e. N/A
f. Trespassing	f. Not extensive
g. Instrumentation Systems	g. None known

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Woronoco Mills (60 feet) DATE: 14 September 1978

SPILLWAY: Small Dam Rt. of Woronoco (60 feet)

CHECK LIST	CONDITION
1. Approach Channel	1.
a. General Condition	a. Good
b. Obstructions	b. None observed
c. Log Boom etc.	c. None observed
2. Weir	2.
a. Flashboards	a. None in place
b. Weir Elev. Control (Gate)	b. No weir elev. controls
c. Vegetation	c. Minor moss growth
d. Seepage or Efflorescence	d. Slight seepage at crack lines, efflorescence at apparently cold joints.
e. Rust or Stains	e. Rust in seepage
f. Cracks	f. Two vertical cracks, appear to be pour jts.
g. Condition of Joints	g. Fair, have been patched, deteriorated
h. Spalls, Voids or Erosion	h. Surface erosion, erosion at joints and horizontal lines.
i. Visible Reinforcement	i. None observed
j. General Struct. Condition	j. Good overall
3. Discharge Channel	3.
a. Apron	a. Natural ledge rock
b. Stilling Basin	b. None
c. Channel Floor	c. Ledge rock
d. Vegetation	d. Trees D/S of rock
e. Seepage	e. None observed
f. Obstructions	f. Logs & debris from screens
g. General Struct.Condition	g. Good
4. Walls	4. N/A
a. Wall Location_____	
(1) Vegetation	
(2) Seepage or Efflorescence	
(3) Rust or Stains	
(4) Cracks	
(5) Condition of Joints	
(6) Spalls, Voids or Erosion	
(7) Visible Reinforcement	
(8) General Struct.Condition	

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Woronoco Mills (60 feet) DATE: 14 September 1978

SPILLWAY: Woronoco (60 feet)

CHECK LIST	CONDITION
1. Approach Channel	1.
a. General Condition	a. Good
b. Obstructions	b. Remains at old breached dam beneath water surface upstream.
c. Log Boom etc.	c. None observed
2. Weir	2.
a. Flashboards	a. None in place
b. Weir Elev. Control (Gate)	b. No weir elev. controls
c. Vegetation	c. Minor isolated growth in joints
d. Seepage or Efflorescence	d. Slight seepage at concrete - ledge rock interface & isolated spots above. Efflorescence below operator pier.
e. Rust or Stains	e. Rust in seepage
f. Cracks	f. Minor vertical cracking
g. Condition of Joints	g. Erosion starting-minor-deep near band (see h).
h. Spalls, Voids or Erosion	h. General light surface erosion-one band on D/S face toward rt. abut.
i. Visible Reinforcement	i. None observed
j. General Struct. Condition	j. Good
3. Discharge Channel	3.
a. Apron	a. Natural ledge rock
b. Stilling Basin	b. None
c. Channel Floor	c. Ledge rock
d. Vegetation	d. None observed
e. Seepage	e.&f. None observed
f. Obstructions	g. Good to excellent
g. General Struct.Condition	
4. Walls	4. N/A
a. Wall Location_____	
(1) Vegetation	
(2) Seepage or Efflorescence	
(3) Rust or Stains	
(4) Cracks	
(5) Condition of Joints	
(6) Spalls, Voids or Erosion	
(7) Visible Reinforcement	
(8) General Struct.Condition	

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Woronoco Mills (29 feet) DATE: 14 September 1978

SPILLWAY: Woronoco Mills (29 feet)

CHECK LIST	CONDITION
1. Approach Channel a. General Condition b. Obstructions c. Log Boom etc.	1. a. Good b. None observed c. None observed
2. Weir a. Flashboards b. Weir Elev. Control (Gate) c. Vegetation d. Seepage or Efflorescence e. Rust or Stains f. Cracks g. Condition of Joints h. Spalls, Voids or Erosion i. Visible Reinforcement j. General Struct. Condition	2. a. None in place b. No weir elev. controls c. None observed d. Water seeping from some joints & dam-rock interface. Efflorescence on operator structure & local spots on dam. e. Rust in seepage, rust in drain discharge. f. No major cracks observed g. Joints definitely eroded and seepage from few horiz. joints. h. General erosion especially at joints top surface of rt. abut. deteriorated i. None observed j. Good
3. Discharge Channel a. Apron b. Stilling Basin c. Channel Floor d. Vegetation e. Seepage f. Obstructions g. General Struct.Condition	3. a. Natural ledge rock b. None c. Ledge adjacent to dam - broken rock & sand downstream. d. Minor adjacent to dam, brush & young trees downstream. e. Sand D/S saturated and may have some upward movement of water. Water coming out of channel lt. bank. f. None adjacent to dam. Brush etc. D/S g. Good
4. Walls a. Wall Location_____ (1) Vegetation (2) Seepage or Efflorescence (3) Rust or Stains (4) Cracks (5) Condition of Joints (6) Spalls, Voids or Erosion (7) Visible Reinforcement (8) General Struct.Condition	4. a.(1) None noted (2) Efflorescence on walls & control tower. (3) None noted (4) Deteriorated vertical cracks U/S wing wall. Vertical crack in D/S wing wall. (5) Good (6) Deteriorated concrete impact walls D/S of sluice gate outlet. (7) None observed (8) Good to fair (due to cracks & impact walls)

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Woronoco Mills Dam DATE: 14 September 1978
OUTLET WORKS:

CHECK LIST	CONDITION
1. Screen House	1. The outlet works of the screen house supplies water to an 11 foot internal diameter concrete lined steel penstock which feeds the downstream hydroelectric station. There are screens at the entrance of the penstock. The right concrete training wall has considerable surface deterioration. The intake channel is clear and no obstructions were observed in either the channel or up the intake. The wooden screen house is on a concrete foundation. The wooden building is indeed of paint. The exterior of the penstock appeared to be in good condition. The penstock outlet was not observed.
2. Outlets at Right Abutment of Small Dam	2. The intakes are on the screen house intake channel. No obstructions were observed at the inlet. The concrete structure appears to be in good condition. There are 2 manually operated gates, each controlling separate box outlets. The gate operators appear to be in good condition and maintained. Debris from the screens in the screen house is piled up below the outlets but it appears that the debris would not impede the discharge from the outlets.
3. Woronoco (60 foot) Dam Drain	3. Electric operated sluice gate in operating condition. The gate is remotely operated from the mill. The concrete surface platform is in good condition - (see also spillway checklist). The gate is at the upstream face of the
4. Woronoco (29 foot) Dam Outlet	

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Wonoroco Mills Dam DATE: 14 September 1978

OUTLET WORKS:

CHECK LIST	CONDITION
	spillway. No obstructions were observed in the inlet or outlet. The gate is not accessible and water is being discharged over the spillway.
	4. Electrically operated sluice gates in operative condition. The gate is remotely operated from the mill. The concrete surface platform is in fair condition - (see also spillway checklist). The gate is at the upstream face of the spillway. No obstructions were observed at the inlet or outlet. A concrete wall, possibly an old baffle wall, immediately downstream from the wall is severely eroded and deteriorated. The operator for the gate can be reached from the earthen dike during periods of high water.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: WORONOCO MILLS 60 FEET DAM DATE: September 14, 1978

HYDROLOGIC-HYDRAULIC CONSIDERATIONS:

CHECK LIST	CONDITION
1. Upstream Watershed a. Type of Terrain b. Hydrologic Controls	1a. Very steep to mountainous; very heavily wooded. 1b. Two flood control reservoirs by Corps of Engineers: (1) Knightville Reservoir (1941) on the Westfield River with 49,000 acre-ft. of storage. (2) Littleville Reservoir (1965) on the Middle Branch of the Westfield River with 32,400 acre-ft. of storage.
2. Reservoir a. Type of Terrain b. Development	2a. Mountainous with reservoir on gorge with 30-40% ground slopes adjacent. 2b. Very sparse development; Strathmore Park 0.8 mi. upstream. Strathmore Paper Co. mill buildings downstream of No. 1 Mill on reservoir. Some houses downstream of reservoir but not on flood plain.
3. Spillway a. Adjacent Low Points b. Spillway Approach (Slope) c. Spillway Discharge (Slope) d. Spillway Type	3a. Spillway founded on bedrock with extremities tied into adjacent rising bedrock. No low points adjacent. Bedrock as deep as 50-ft below dam crest. 3b. Spillway approach consists of 10-20-ft deep pool on bedrock which shallows to 5-10 ft. at spillway. 3c. Spillway discharge is over a curved concrete crest dropping an average of 10-30 ft to bedrock below and more than 50-ft to tailwater. 3d. Spillway is a concrete parabolic shaped crest and anchored into bedrock below.
4. Downstream Watershed a. Reach No. 1 (1) Control (Bridge, dam, culvert, etc.) (2) Channel Characteristics (3) Development (4) Visible Utilities (5) Special Problems (Hospital, etc.)	4a. REACH NO. 1 1. Control is Strathmore Paper Co. Bridge 1500 ft. downstream. 2. Channel is bedrock with boulders and cobbles and bottom slope of 3-5%. 3. No development within river flood plain-few residences on left bank above crest of dam. 4&5. No utilities or special problems.
4. Downstream Watershed b. Reach No. 2 (1) Control Bridge, dam, culvert, etc. (2) Channel Characteristics	4b. REACH NO. 2 1. Control is channel constriction 3000-ft downstream. 2. Channel is bedrock with boulders and cobbles in very steep gorge. Channel bottom slope is 3%

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: WORONOCO MILLS 60 FEET DAM DATE: September 14, 1978

HYDROLOGIC-HYDRAULIC CONSIDERATIONS:

CHECK LIST	CONDITION
4. Downstream Watershed (cont.) b. Reach No. 2 (3) Development (4) Visible Utilities (5) Special Problems (Hospital, etc.)	3. No development along river bank within expected limits of flow. 4&5. No utilities or special problems.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: WORONOCO MILLS 29 FEET DAM DATE: September 14, 1978

HYDROLOGIC-HYDRAULIC CONSIDERATIONS:

CHECK LIST	CONDITION
1. Upstream Watershed a. Type of Terrain b. Hydrologic Controls	1a. Very steep to mountainous; very heavily wooded. 1b. Two flood control reservoirs by Corps of Engineers: (1) Knightville Reservoir (1941) on the Westfield River with 49,000 acre-ft. of storage. (2) Littleville Reservoir (1965) on the Middle Branch of the Westfield River with 32,400 acre-ft. of storage.
2. Reservoir a. Type of Terrain b. Development	2a. Mountainous with reservoir on gorge with 30-40% ground slopes adjacent. 2b. Very sparse development; Strathmore Park 0.8 mi. upstream. Strathmore Paper Co. mill buildings downstream of No. 1 Mill on reservoir. Some houses downstream of reservoir but not on flood plain.
3. Spillway a. Adjacent Low Points b. Spillway Approach (Slope) c. Spillway Discharge (Slope) d. Spillway Type	3a. Spillway founded on bedrock; no low points adjacent as structures at abutments tie into rising ground. 3b. Spillway approach consists of 15-20 ft. deep pool on bedrock which shallows to 5-15 ft. at spillway. 3c. Spillway discharge is over a curved concrete crest dropping an average of 10-20 ft. to the bedrock below. 3d. Spillway is a concrete parabolic shaped crest cast and anchored into bedrock below.
4. Downstream Watershed a. Reach No. 1 (1) Control (Bridge, dam, culvert, etc.) (2) Channel Characteristics (3) Development (4) Visible Utilities (5) Special Problems (Hospital, etc.)	4a. REACH NO. 1 1. Control is Strathmore Paper Co. Bridge 1500 ft. downstream 2. Channel is bedrock with boulders and cobbles and bottom slope of 3-5%. 3. No development within river flood plain-few residences on left bank above crest of dam. 4&5. No utilities or special problems.
4. Downstream Watershed b. Reach No. 2 (1) Control Bridge, dam, culvert, etc.) (2) Channel Characteristics (3) Development (4) Visible Utilities (5) Special Problems (Hospital, etc.)	4b. REACH NO. 2 1. Control is channel constriction 3000 ft. downstream 2. Channel is bedrock with boulders and cobbles in very steep gorge. Channel bottom slope is 3%. 3. No development along river bank within expected limits of flow. 4&5. No utilities or special problems.

CAMP DRESSER & McKEE INC.

January 8, 1979

CERTIFICATE OF LABORATORY ANALYSIS

Sample: Rust Deposit, CDM Lab. No. 3945

Submitted By: Haley and Aldrich, Inc.
U.S. Corps of Engineers
Dam Inspections
Woronoco No. 20
(File No. H&A 4208; CDM 380-5-RT-20)

Date Received: 28 November 1978

Analysis:	CDM Lab. No. 3945
Total Iron, mg/l	1000.
Total Manganese, mg/l	0.91

The sample was analyzed for total metals according to procedures outlined in Standard Methods, 14th Edition.

Diane M. Chaplick

Donald G. Muldoon, Manager

File No. 7021-0

APPENDIX B

LIST OF AVAILABLE DOCUMENTS AND PRIOR INSPECTION REPORTS

LIST OF DOCUMENTS

DOCUMENTS	LOCATION
WORONOCO (29 FOOT) DAM	
1. Drawings by C. T. MAIN Inc. entitled "Strathmore Paper Co.	
Sheet Nos. 1393-1 Plans and Sections dated Oct. 1938	A
1393-1A Plans and Sections of Spillway & Dike dated Oct. 28, 1938	A & B
1393-2 Topographical Map showing Location of Dam, Dike, & Riprap dated Nov. 9, 1938	A & B
1393-3 Miscellaneous Details dated Nov.14,1938	A & B
2. Drawings by F. T. Ley Co. dated 1938	
Topographic Map	A
Elev. & Section of Spillway and Abut. File No 1527	A
3. Drawing by A. D. Donald Co. Reinforcement of Stand # 1425	A
WORONOCO (60 FOOT) DAM	
4. Drawing by Ley Const. Co. dated 1948 entitled Proposed Dam Site.	A
5. Drawings by C. T. Main Inc. entitled "Strathmore Paper Co. Woronoco, Mass. New Concrete Dam" dated Oct, 3, 1949	
Sheet Nos. 1393-4-1 Location Plan	A & B
1393-4-2 General Plan	A & B
1393-4-3 Sections	A & B
1393-4-4 *Stability Analysis*	A & B
1393-4-5 Diversion Sluice	A & B
1393-4-6 Small Scale Sections	A & B

Location A is Strathmore Paper Co., South Broad Street, Westfield, Massachusetts.
Location B is Charles T. Main, Inc. Prudential Center, Boston, Mass.

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

TIGHE & BOND CONSULTING ENGINEERS

CIVIL, SANITARY AND ELECTRICAL ENGINEERING
INVESTIGATIONS, REPORTS, PLANS AND SPECIFICATIONS
SUPERVISION OF CONSTRUCTION AND OPERATION

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

CD Russell
September 22, 1969

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

Gentlemen:

Inspections carried on recently within the Town of Russell have now resulted in all dams in that community having been inspected at least once during the present year. The following is a report on the general condition of the various dams situated within Russell.

(TIGHE & BOND'S COMMENTS ON OTHER DAMS IN THE AREA INCLUDED ON PAGE 2 AND A PORTION OF PAGE 1 ARE OMITTED FROM THIS REPRODUCTION)

D. Strathmore Paper Co. Dam - 1938 Structure

At the time of the inspection the water level in storage was just above the crest of the overflow dam and water was passing over the dam. No flashboards were on the crest. An inspection of the toe was made by closely examining this area thru and under the overflowing water. There is some minor concrete surface erosion on the downstream face of the overflow dam but the toe itself shows little evidence of erosion. The vertical construction joints show some opening and wear, but this is of a very minor nature. The crest is well shaped and shows no excessive wear.

The gate structure and the left concrete abutment were noted to be in very good condition. The right abutment consisting mainly of natural ledge and a small concrete wall was in good condition.

In the opinion of the undersigned, this dam is safe.

E. Strathmore Paper Co. Dam - 1950 Structure

The concrete masonry forming this dam is in very good condition. Joints were o.k. The crest concrete is good and no flashboards are on the crest. Water level in storage was passing over the crest. The toe area was noted to be satisfactory. The gate structure out on the dam was o.k. Concrete abutment walls on each side and the natural abutment ledge were o.k.

In the opinion of the undersigned, this is a very good dam and it is safe.

F. Strathmore Paper Co. Dike

The shape of the dike is satisfactory. However, it has not been maintained properly in that brush growth is becoming quite high and thick. All brush growth on the slopes should be kept cut down. The toe area appears to be good. Examination of the toe area was difficult because of the thick brush growth. Seepage at the toe, just to the left of the 1938 dam, seems to be about normal. No soil moves with the seepage water.

The owner should be advised to remove all brush growth and to keep the dike clear of this growth.

(TIGHE & BOND'S COMMENTS ON OTHER DAMS IN THE AREA INCLUDED ON PORTIONS OF PAGE 3 AND 4 ARE OMITTED FROM THIS REPRODUCTION)

Respectfully submitted,

George H. McDonnell
County Hydraulic Engineer

TIGHE & BOND CONSULTING ENGINEERS

The last routine inspections of all dams situated within the Town of Russell were conducted in the late summer of 1969. A letter-report on the conditions noted at each of the dams was sent to the Board of County Commissioners on September 22, 1969.

Of all the dams listed, only two required maintenance. Russell Pond Dam and the dike located to the left of the 1938 dam.

A copy of my report to the Commissioners of Hampden County is attached hereto for your information and file. Letters outlining the recommended maintenance and repair work at the Russell Pond Dam and at the Dike were sent to the Strathmore Paper Co. by the Commissioners of Hampden County.

George H. McDonnell
County Hydraulic Engineer
Hampden County

1-7-256-5

INSPECTION OF DAMS Hampden #4-5

City or Town Russell Date June 29, 1971

Name of Dam Strathmore 1950 Inspector R. Northrup P. Fezzie

Owner Strathmore Paper Co. Address Russell

Caretaker Strathmore Address Russell

Location on Westfield River - Woronoco - Behind #1 Mill

Type of Dimensions concrete - 350' long - 15' high - built on ledge

Spillway, type and size 270' long - 4' freeboard south - ~~4' freeboard - 75' long~~ north - concrete - 80' long - 4' freeboard - Center

Outlets, type and size 6' x 6' and slide gate at center of dam-at gate house southend - 3' x ~~5'-3' x 3'-10'~~ dia. pipe all with slide gates

Flashboards, type and height none

Date Built 1950 Condition good - except as noted

When last repaired _____ By whose orders _____

Nature of Repairs _____

Purpose of Dam mill

Approximate storage of water ½ mile of river

Approximate area of water shed _____

Possible damage due to failure of dam disasterous

Remarks no water ponded - gate open - large cracks in south end of dam - concrete spalling and deteriorating

Recommendations repair masonry

Corrective Action

1-7-30-6

INSPECTION OF DAMS Hampden #4-6

City or Town of Russell Date June 30, 1971

Name of Dam Strathmore Dike Inspector R.Northrup P.Fezzie

Owner Strathmore Paper Co. Address Russell

Caretaker Strathmore Paper Co. Address Russell

Location extension of 1938 dam - northerly along westfield river

Type of Dimensions earth embankment - 10' high - 10' wide at top - 400' long

Spillway, type and size none

Outlets, type and size none

Flashboards, type and height none

Date Built _____ Condition good

When last repaired _____ By whose orders _____

Nature of Repairs _____

Purpose of Dam to divert water to dams below during flood conditions

Approximate storage of water none

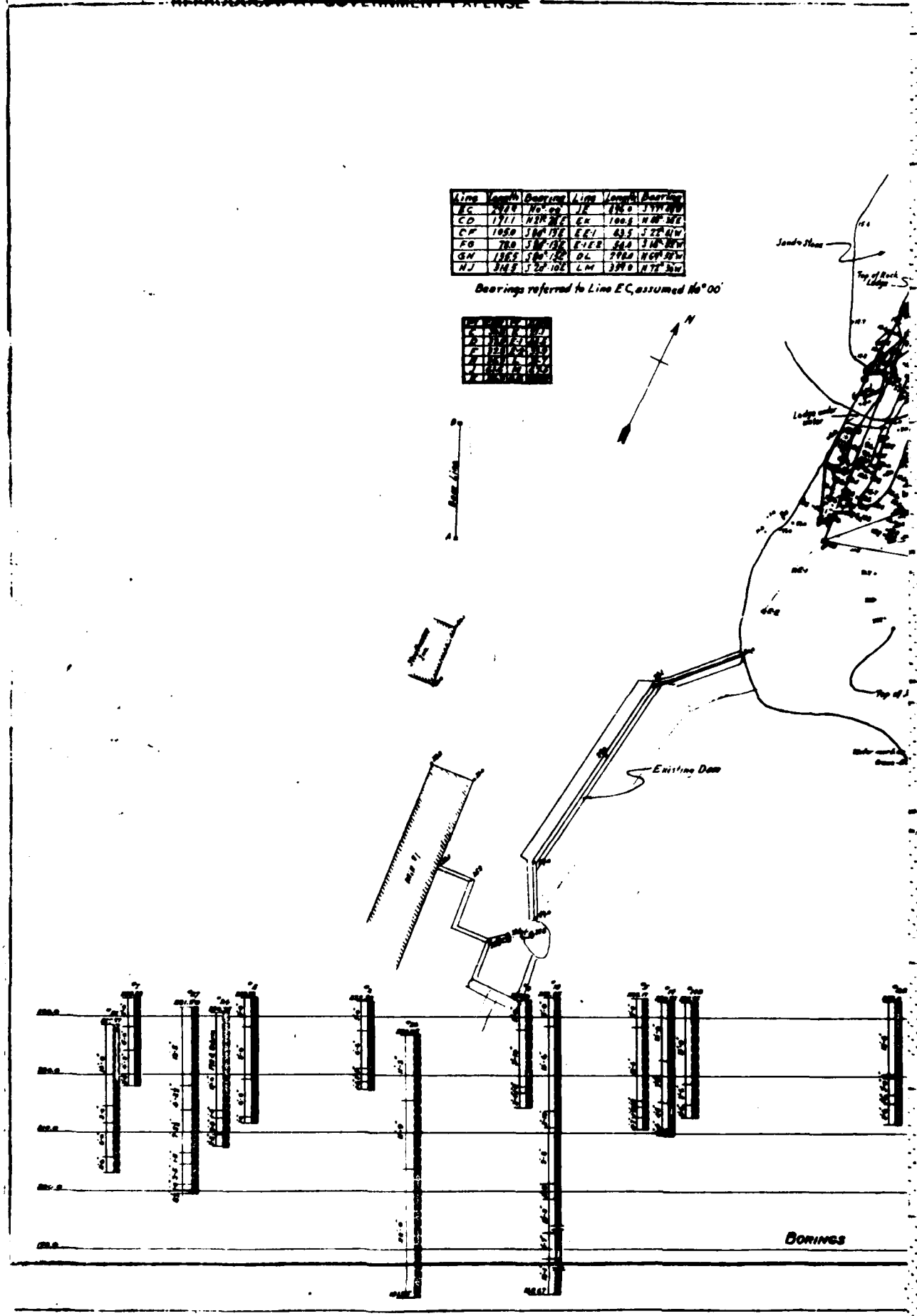
Approximate area of water shed _____

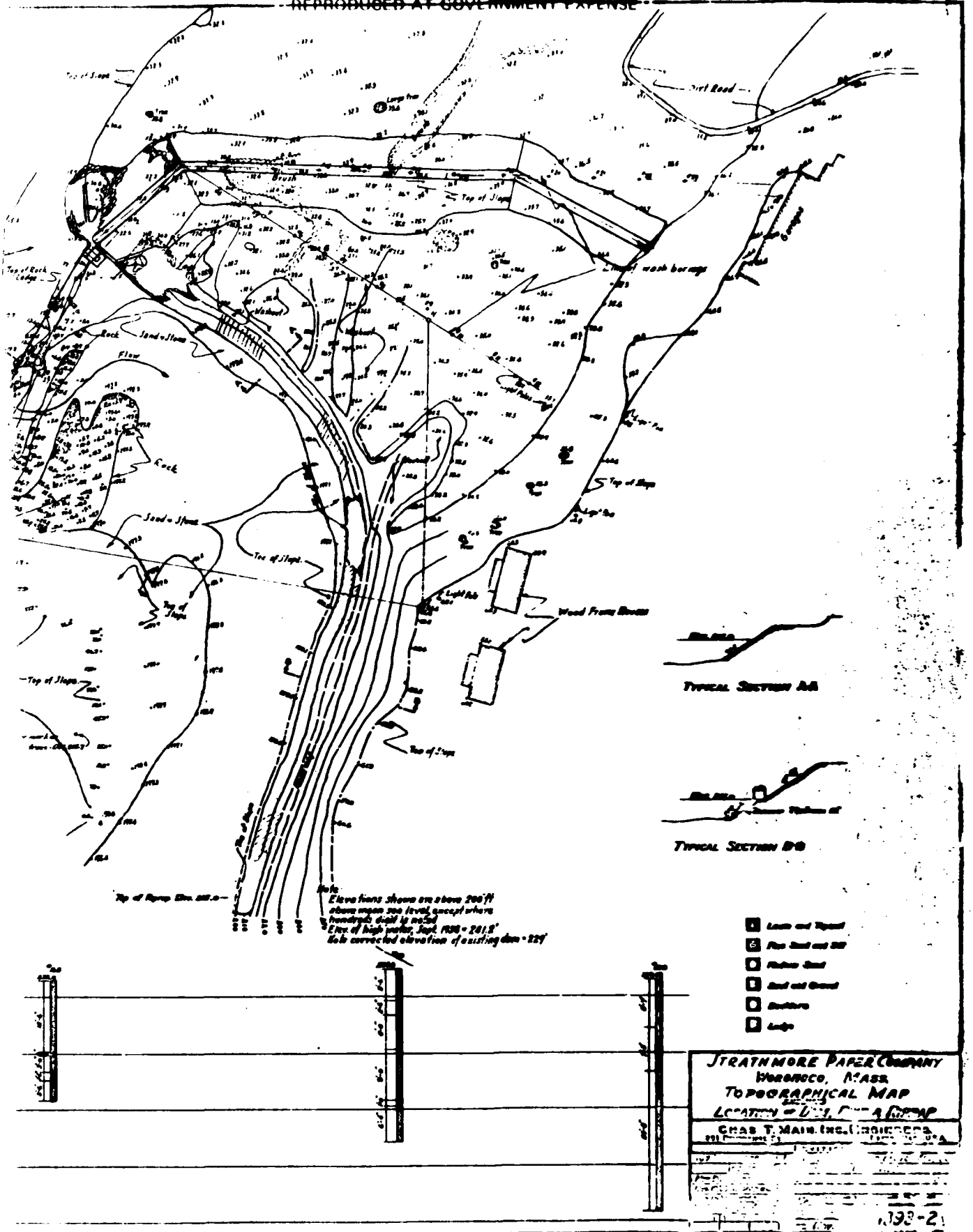
Possible damage due to failure of dam to mill and property below in flooded condition

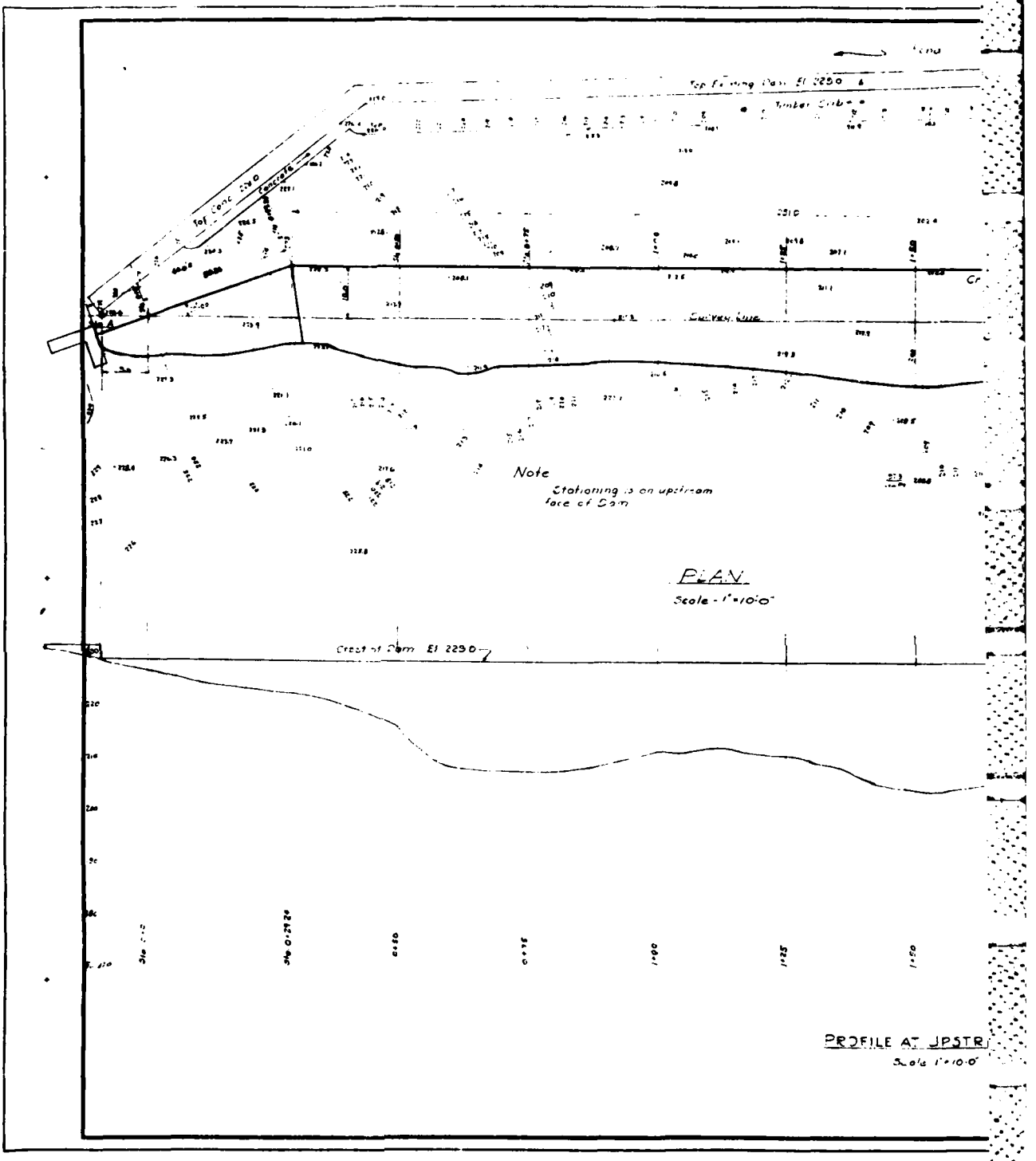
Remarks entire embankment covered with growth - no water within at least 150' of upstream toe - this area is overgrown with trees and brush

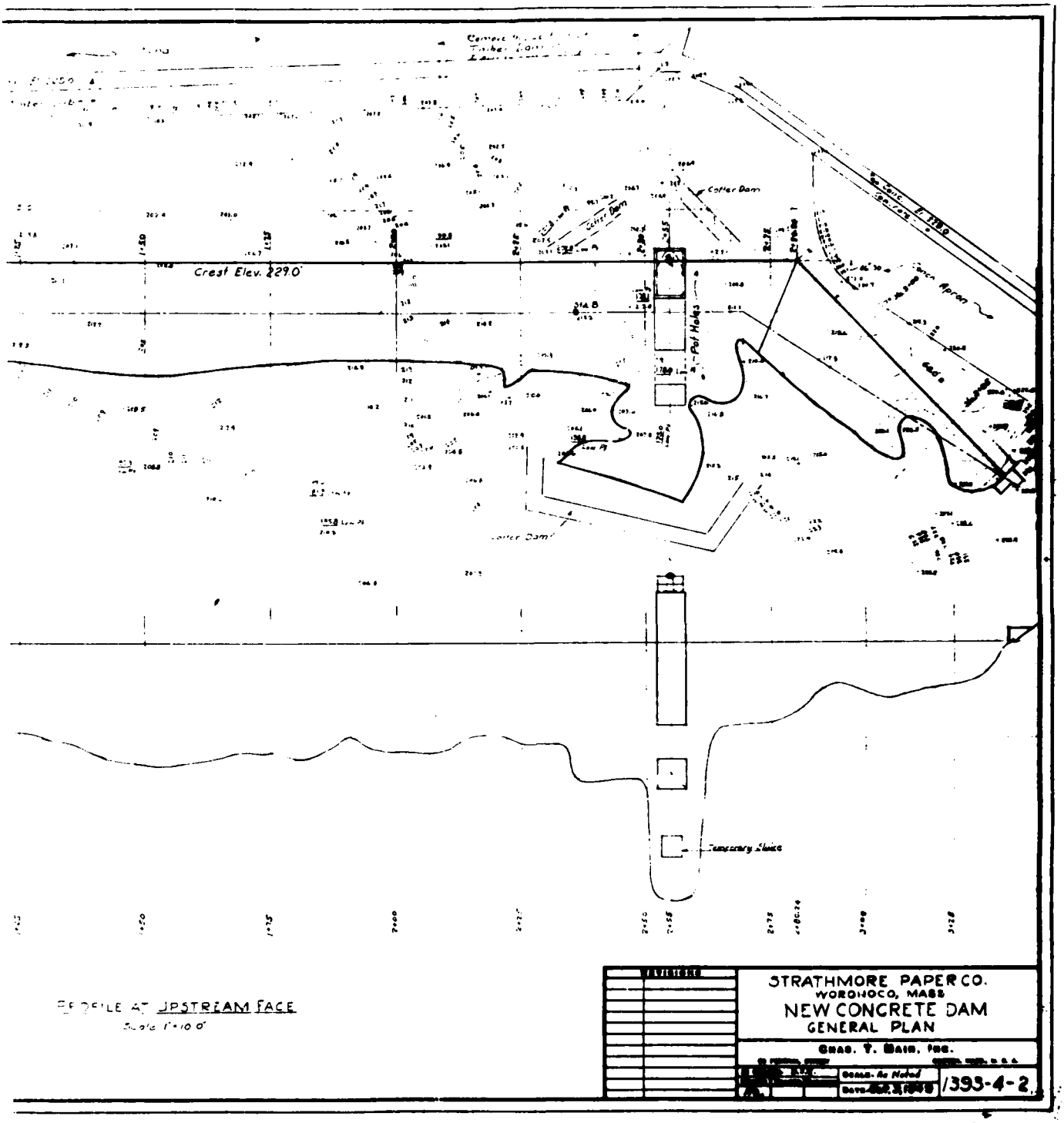
Recommendations clear embankment

Corrective Action

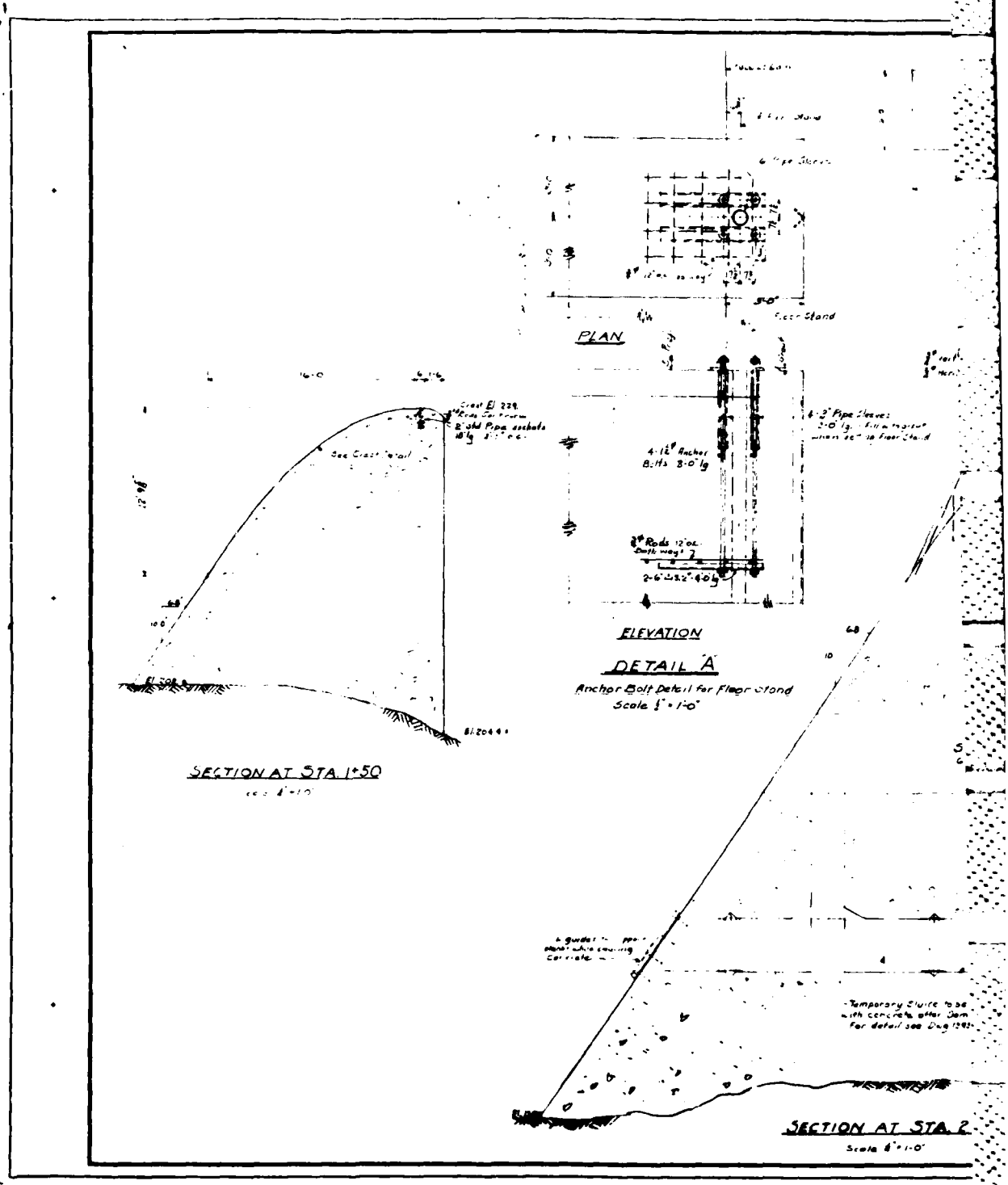


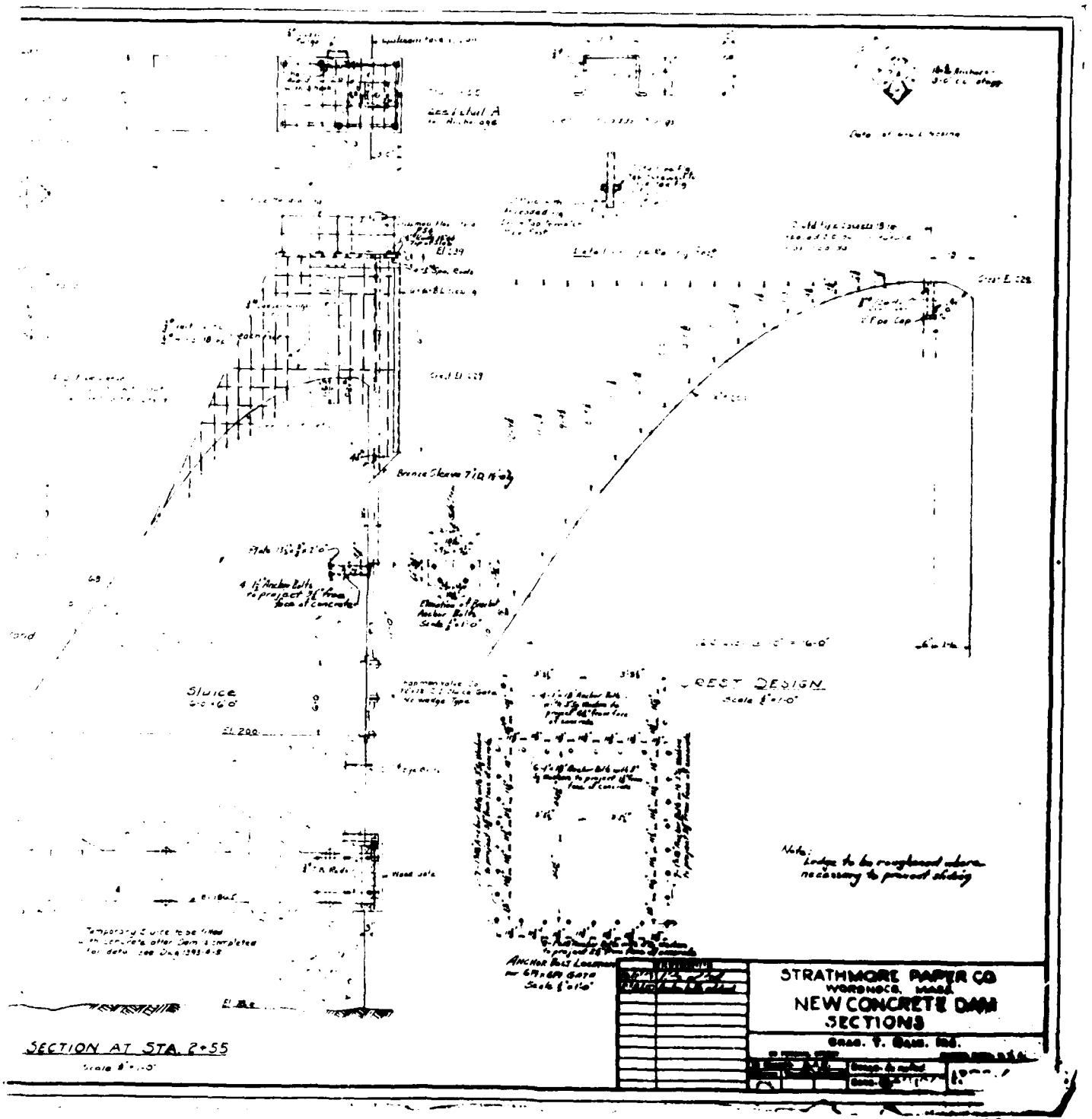




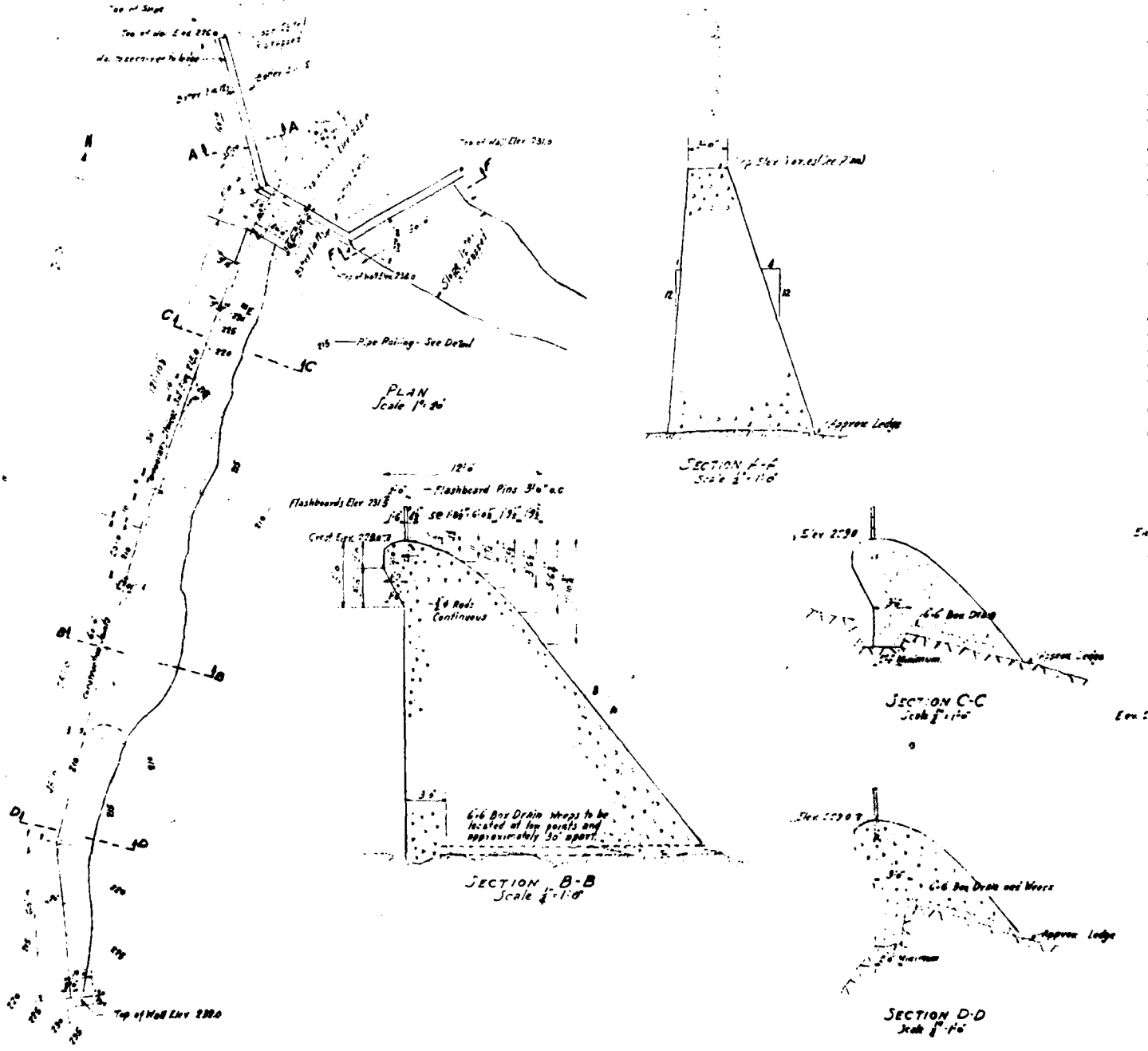


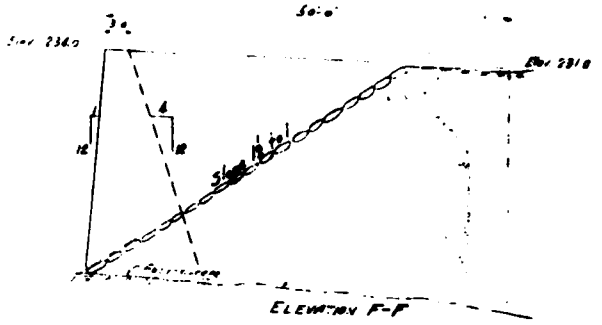
APPENDIX B-9

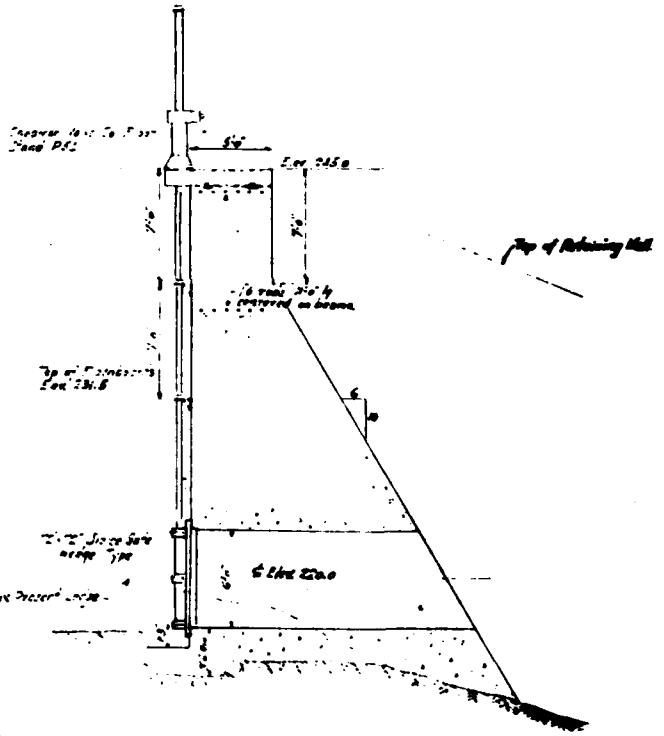


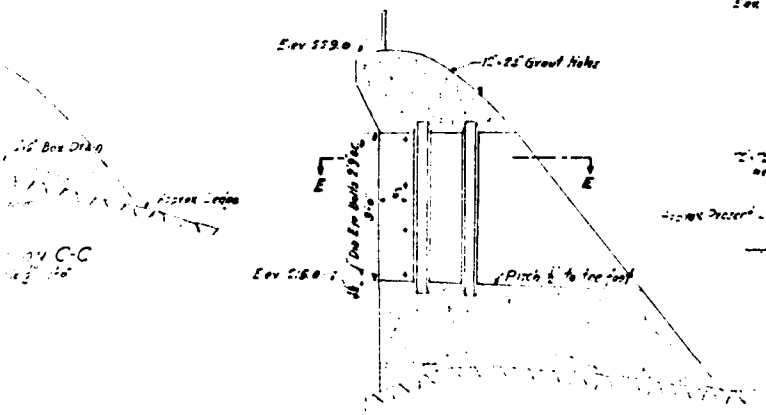


APPENDIX B-10









SECTION THROUGH TEMPORARY SLUICE
Scale 1"=10'

SECTION THROUGH SLUICE GATE
Scale 1"=10'

SECTION E-E
Scale 1"=10'

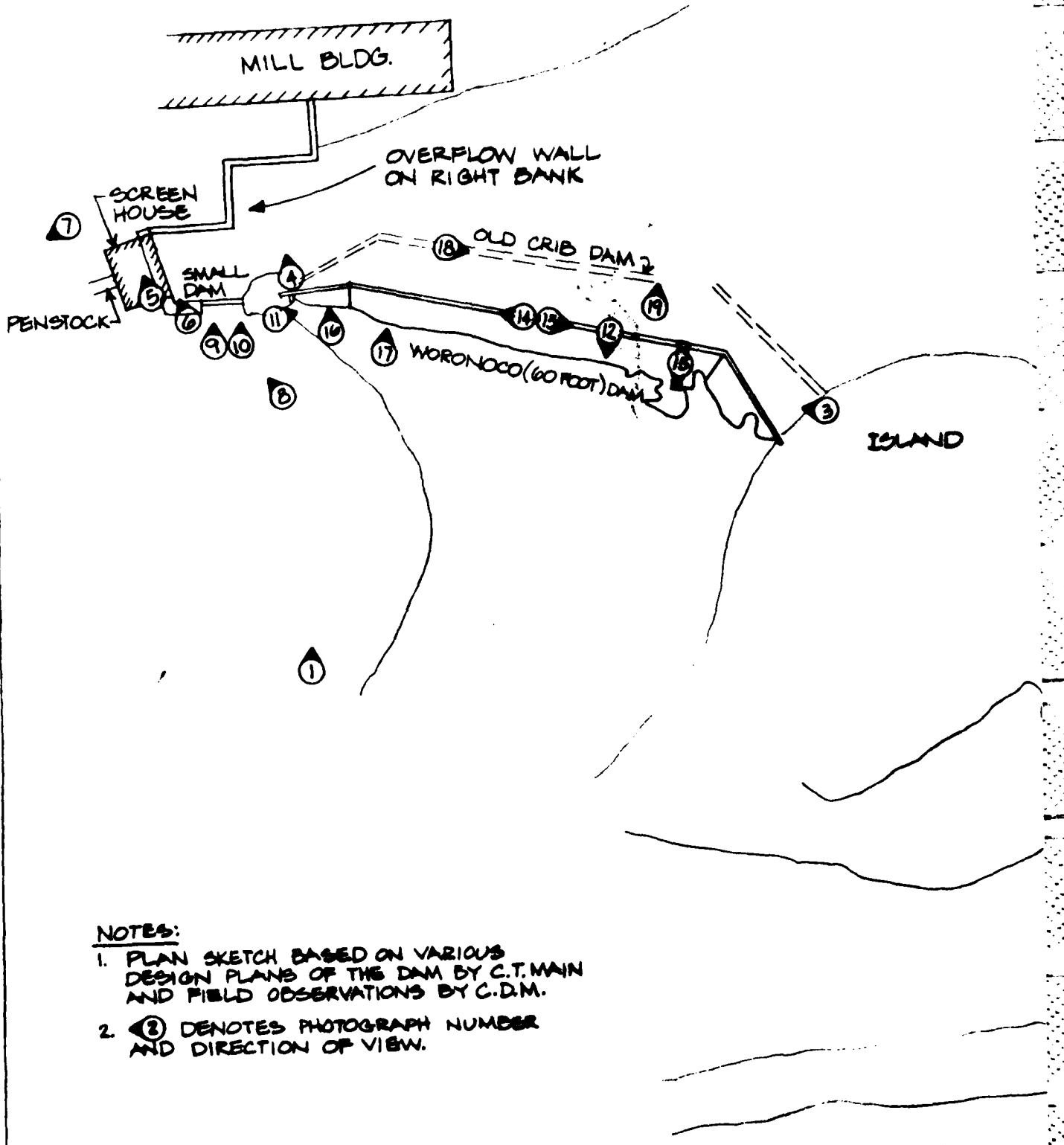
STRATHMORE PAPER COMPANY
WEST SPRINGFIELD MASS.
WORONOCO MILLS
PLAN & SECTIONS OF SPILLWAY & DAM
CHAS. T. MAIN, Inc. ENGINEERS
1953-1A

APPENDIX B-11

APPENDIX C

SELECTED PHOTOGRAPHS OF PROJECT

PHOTOGRAPHS (cont'd)



NOTES:

1. PLAN SKETCH BASED ON VARIOUS DESIGN PLANS OF THE DAM BY C.T. MAIN AND FIELD OBSERVATIONS BY C.D.M.
2. ◀(2) DENOTES PHOTOGRAPH NUMBER AND DIRECTION OF VIEW.

PLAN - WORC

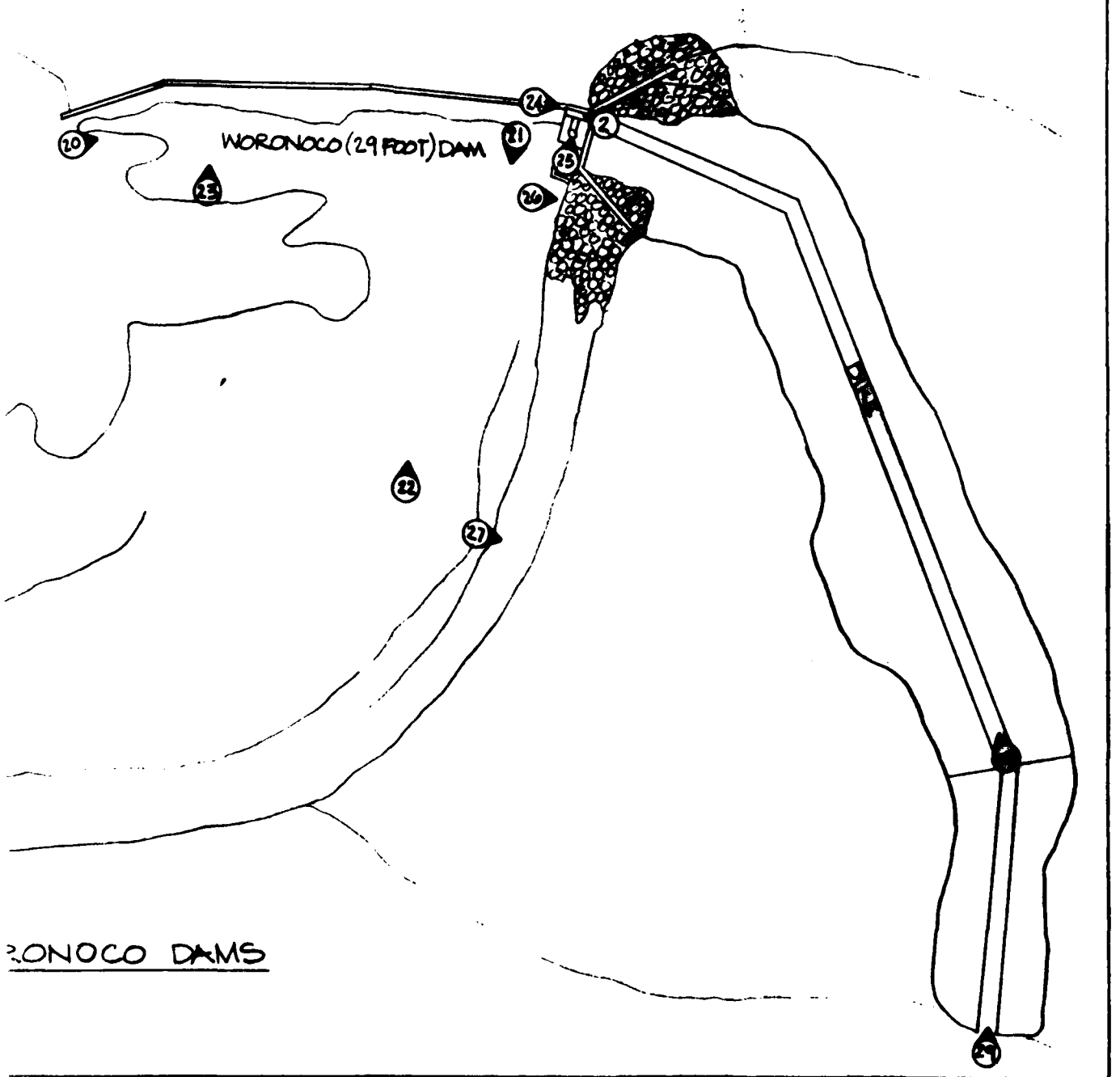
CAMP DRESSER & MCKEE INC BOSTON, MASSACHUSETTS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MA.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

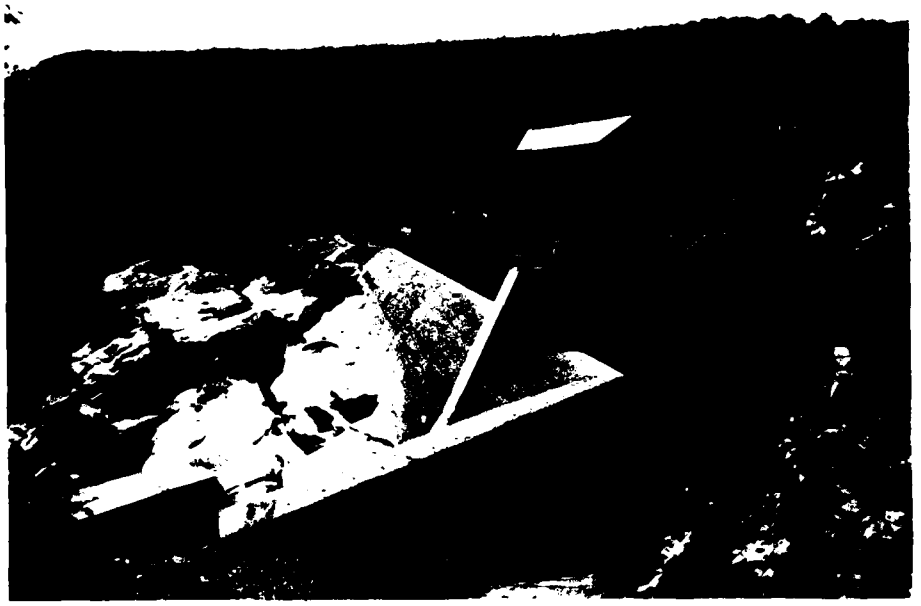
WORONOCO (60 AND 29 FOOT) DAMS
SITE PLAN SKETCH

RUSSEL — MASSACHUSETTS

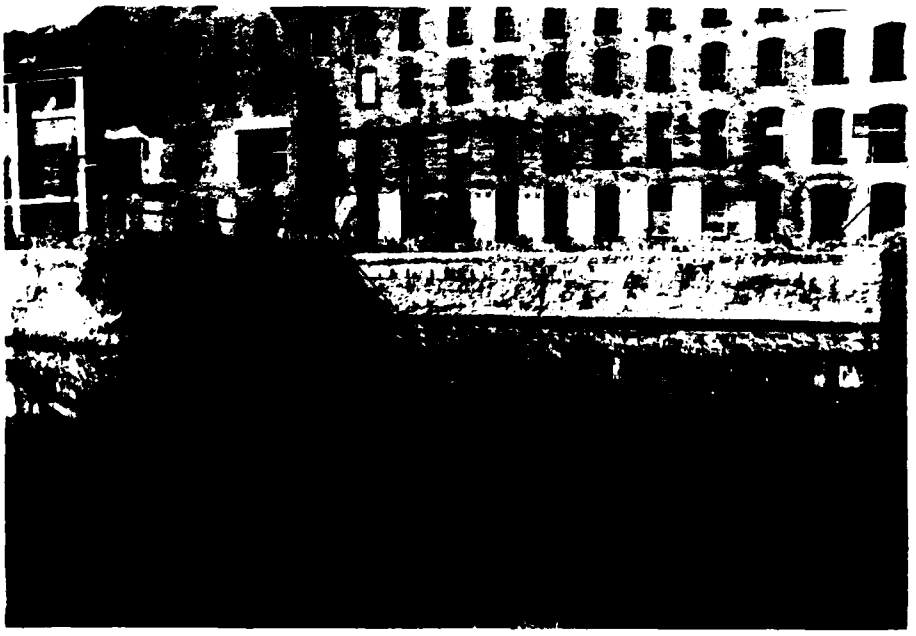
SCALE: NONE
DATE: FEB. 1979



WORONOCO DAMS

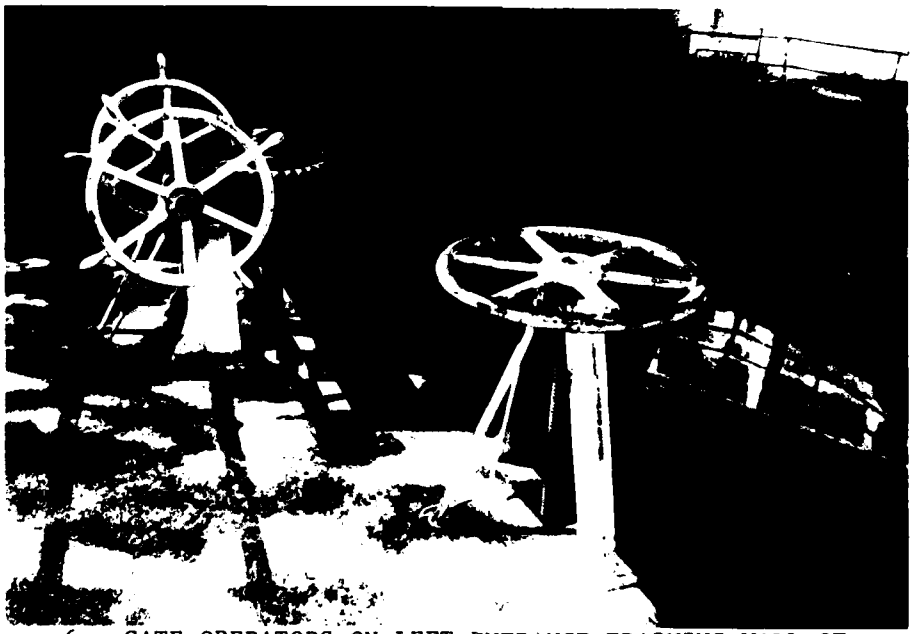


3. OVERVIEW OF WORONOCO (60 FOOT) DAM FROM LEFT ABUTMENT.

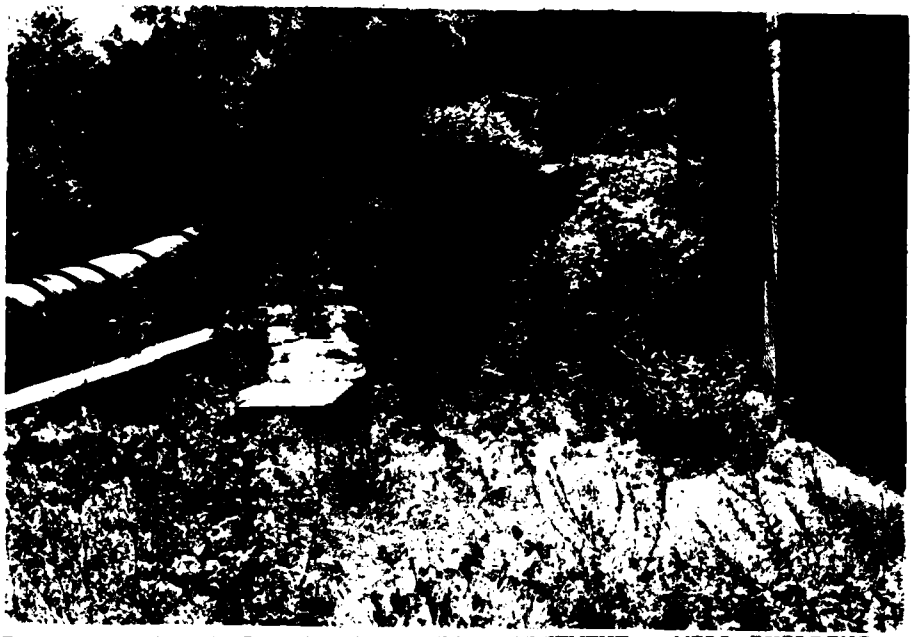


4. RIGHT ENTRANCE TRAINING WALL OF SCREEN HOUSE.

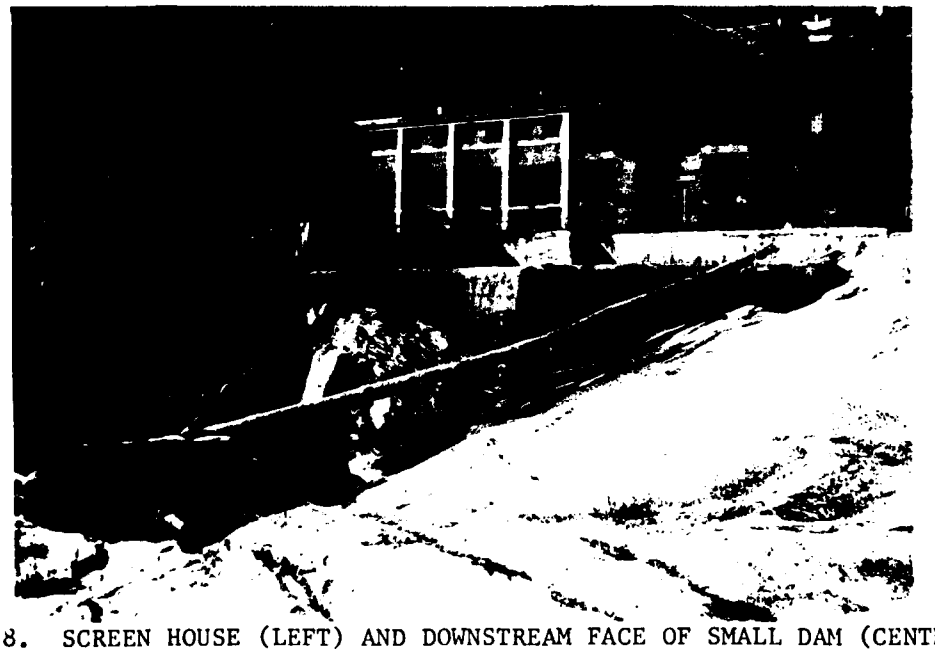
5. GATE & SCREEN OPERATORS WITHIN SCREEN HOUSE.



6. GATE OPERATORS ON LEFT ENTRANCE TRAINING WALL OF SCREEN HOUSE.



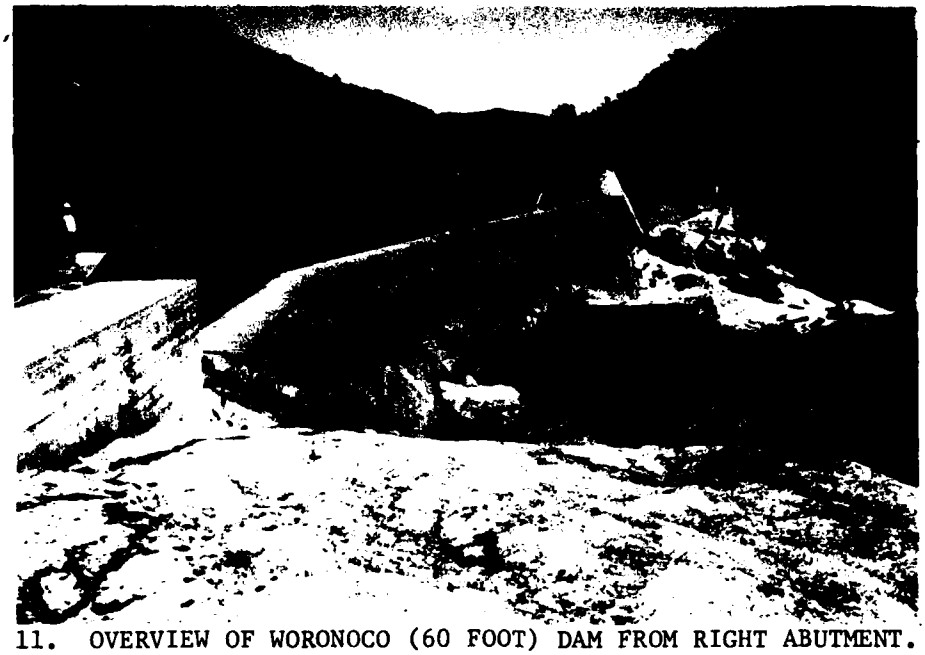
7. LOOKING DOWNSTREAM FROM RIGHT ABUTMENT. MILL BUILDING SHOWN ON RIGHT AND PENSTOCK ON LEFT.



8. SCREEN HOUSE (LEFT) AND DOWNSTREAM FACE OF SMALL DAM (CENTER). MILL IS IN BACKGROUND.

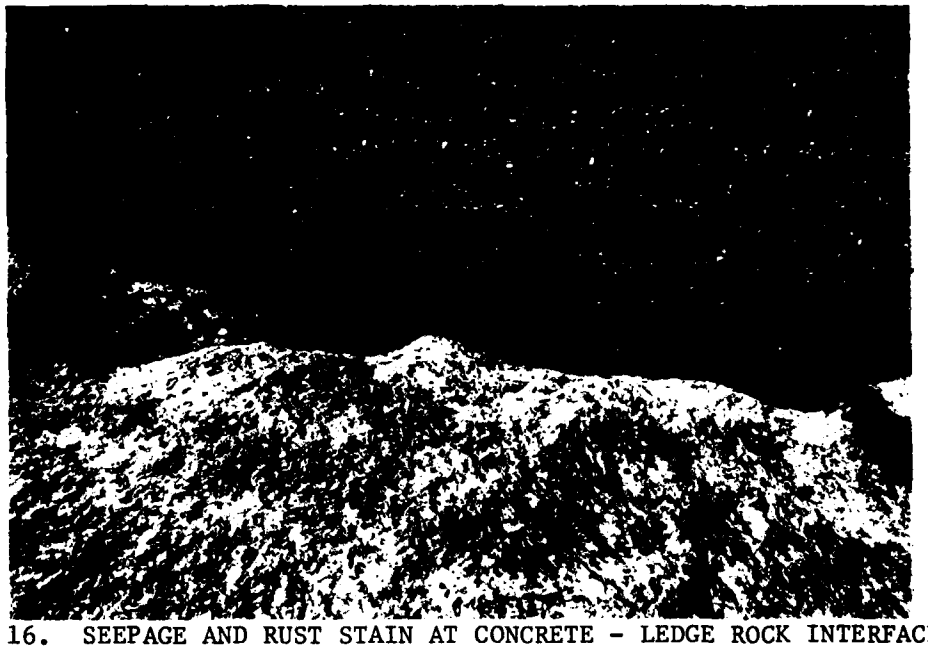
9. JOINT DETERIORATION AND SURFACE EROSION ON SMALL DAM.

10. DOWNSTREAM FACE OF SMALL DAM LEFT ABUTMENT SHOWING SLIGHT SEEPAGE, DETERIORATED COLD JOINT AND SLIGHT EFFLORESCENCE.



11. OVERVIEW OF WORONOCO (60 FOOT) DAM FROM RIGHT ABUTMENT.

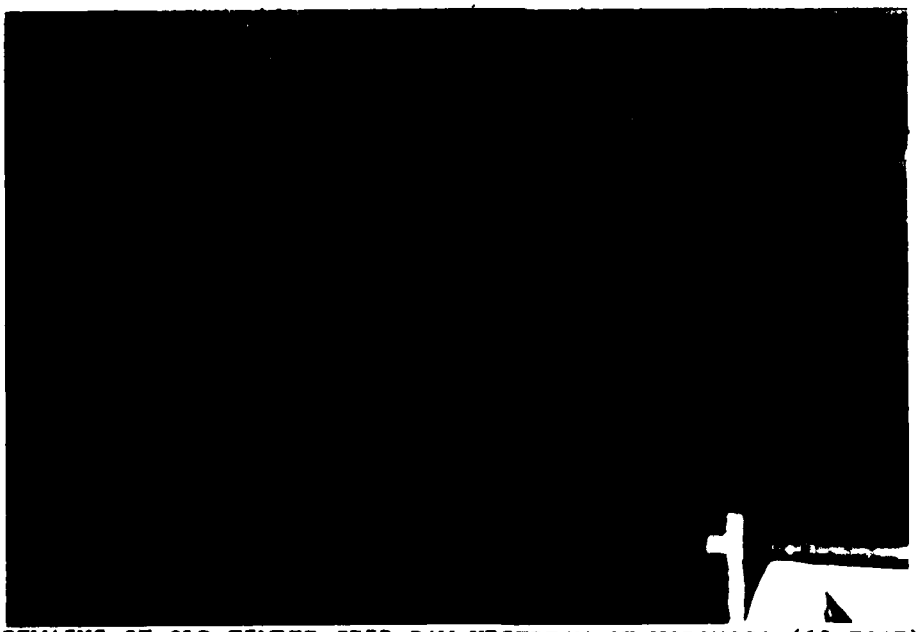
12. VIEW OF DOWNSTREAM CHANNEL BELOW WORONOCO (60 FOOT) DAM.



16. SEEPAGE AND RUST STAIN AT CONCRETE - LEDGE ROCK INTERFACE AT DOWNSTREAM FACE OF WORONOCO (60 FOOT) DAM NEAR RIGHT ABUTMENT.

17. ERODED DOWNSTREAM FACE OF WORONORO (60 FOOT) DAM. NOTE DETERIORATION AT JOINTS AND CRACKS.

18. CREST OF OLD TIMBER CRIB DAM UPSTREAM OF WORONOCO (60 FOOT) DAM.



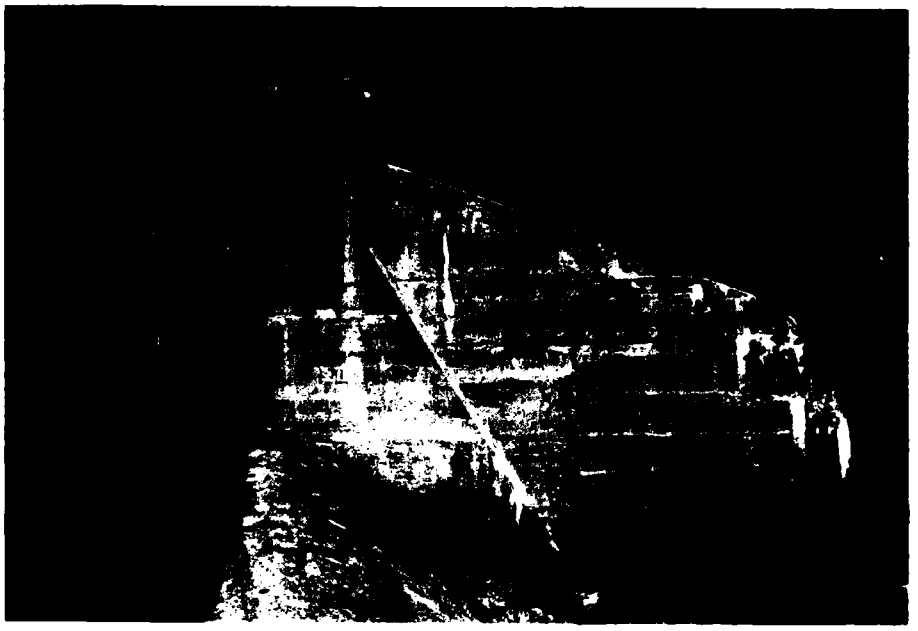
19. REMAINS OF OLD TIMBER CRIB DAM UPSTREAM OF WORONOCO (60 FOOT) DAM. BREACH MADE IN OLD DAM AFTER THE CONSTRUCTION OF WORONOCO (60 FOOT) DAM IS EVIDENT AT RIGHT.

20. OVERVIEW OF WORONOCO (29 FOOT) DAM FROM RIGHT ABUTMENT (ISLAND). NOTE SURFACE EROSION OF RIGHT CONCRETE ABUTMENT IN FOREGROUND.

21. CHANNEL DOWNSTREAM OF WORONOCO (29 FOOT) DAM.

22. DOWNSTREAM FACE OF WORONOCO (29 FOOT) DAM. SAND IN FOREGROUND IS SATURATED AND VERY LOOSE.

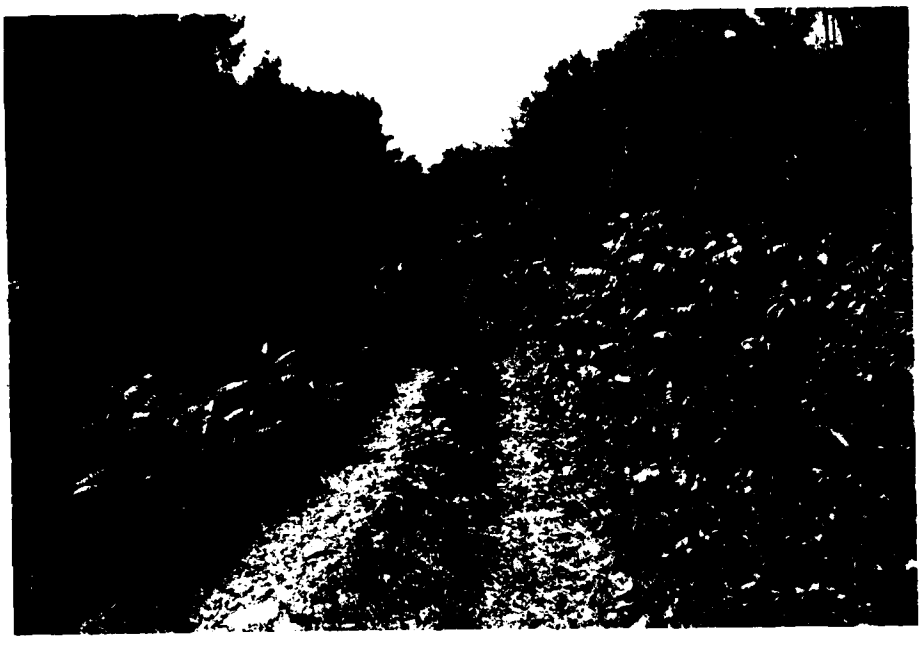
23. SURFACE AND JOINT EROSION IN DOWNSTREAM FACE OF WORONOCO (29 FOOT) DAM.



24. SLUICE GATE OPERATOR AND LEFT ABUTMENT OF WORONOCO (29 FOOT) DAM.

25. SEEPAGE AND RUST STAIN FROM DOWNSTREAM CHANNEL LEFT BANK JUST BELOW LEFT ABUTMENT OF WORONOCO (29 FOOT) DAM.

26. SEEPAGE AND RUST STAIN FROM LEFT CHANNEL BANK APPROXIMATELY 300 FEET DOWNSTREAM OF WORONOCO (29 FOOT) DAM LEFT ABUTMENT.



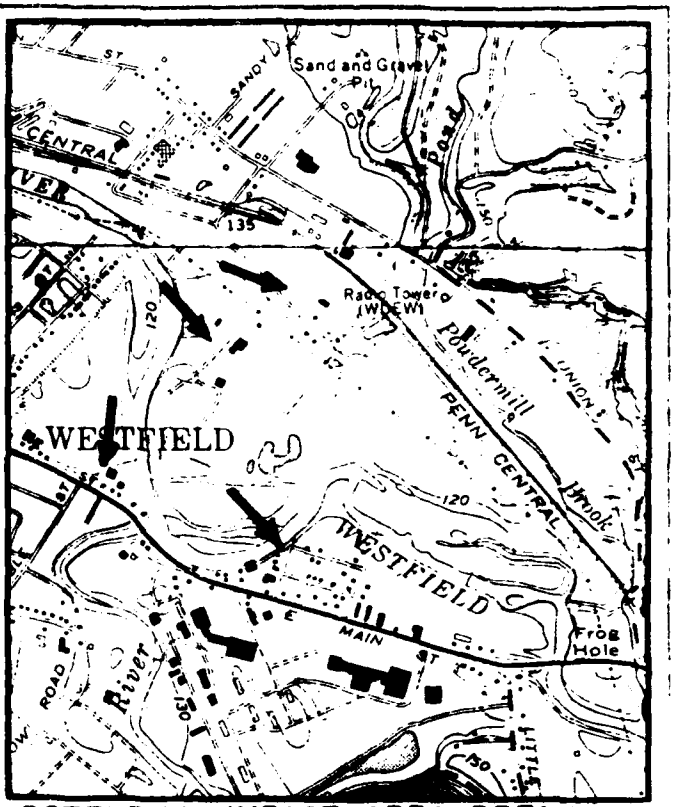
27. CREST OF DIKE ON EAST BANK OF WESTFIELD RIVER. VIEW IS APPROXIMATELY AT MIDPOINT OF DIKE LOOKING SOUTH.

28. LEFT END OF DIKE AS VIEWED FROM ROADWAY LOOKING WEST.

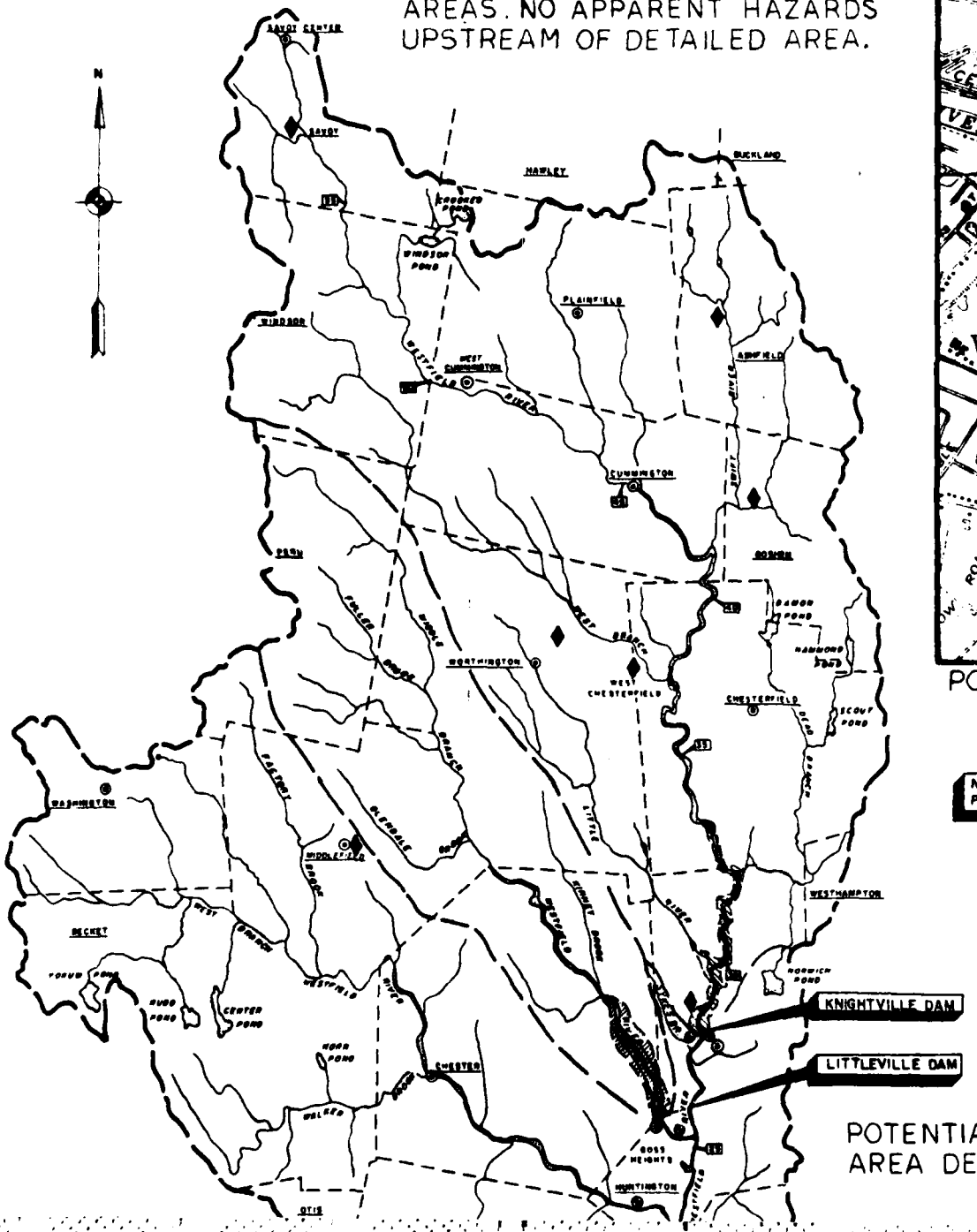
APPENDIX D

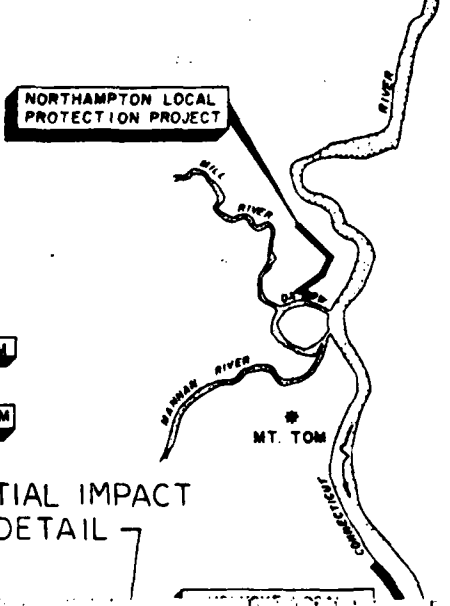
OUTLINE OF DRAINAGE AREA AND HYDRAULIC COMPUTATIONS

NOTE: ➡ DENOTES POTENTIAL IMPACT AREAS. NO APPARENT HAZARDS UPSTREAM OF DETAILED AREA.



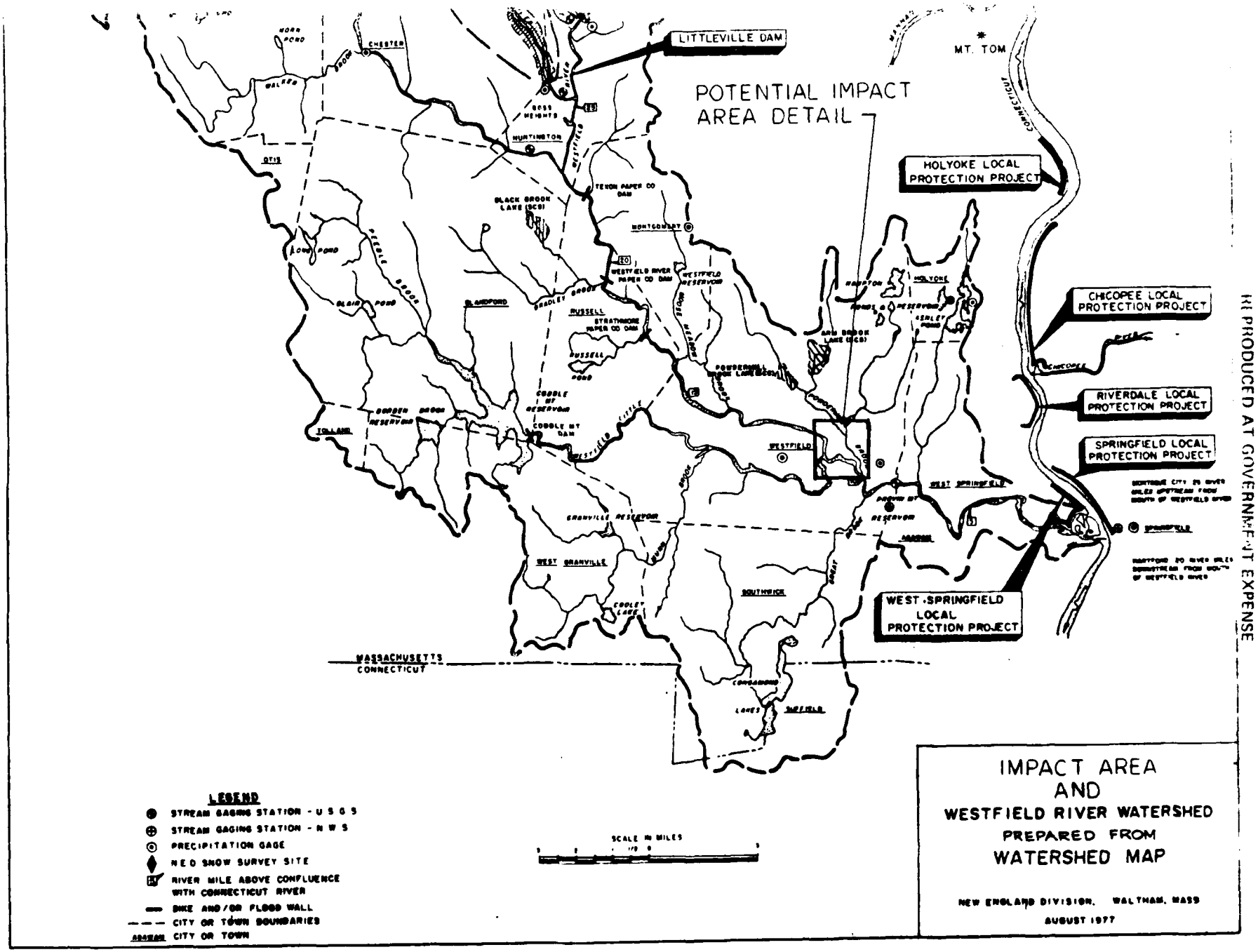
POTENTIAL IMPACT AREA DETAIL





POTENTIAL IMPACT AREA DETAIL

REPRODUCED AT GOVERNMENT EXPENSE



APPENDIX D-1

REPRODUCED AT GOVERNMENT EXPENSE

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass

CLIENT COE
PROJECT WOONSOCKET
DETAIL

JOB NO 380-5-8720
DATE CHECKED 1-10-79
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SIZE CLASSIFICATION

1949 DAM

Crest el 229
low point el 175

greatest height 54 → Intermediate category by height

At crest el 229 storage = 393 ac-ft

→ small category by storage

Height controls size classification

∴ Dam is INTERMEDIATE SIZE DAM

1938 DAM

Crest el 229
low point el 205 (approx)
24'

→ Small category by height

At crest el 229 storage = 393 Ac-ft

→ small category by storage

∴ Dam is SMALL SIZE DAM

HAZARD POTENTIAL CLASSIFICATION

Several structures would be damaged as well as the potential for loss of a few lives. Large storage area just upstream of built up area of town helps to reduce flow.

∴ Low to Significant Hazard Potential for both dams

TEST FLOOD

	Significant Hazard	Low Hazard
1949 Dam: low to significant hazard; intermediate size →	½PMF to PMF	100yr to ½PMF
1938 Dam: low to significant hazard; small size →	100yr to ½PMF	50 to 100yr

USE ½ PMF FOR TEST FLOOD because: 1. 1949 dam is at lower limit of its classification;

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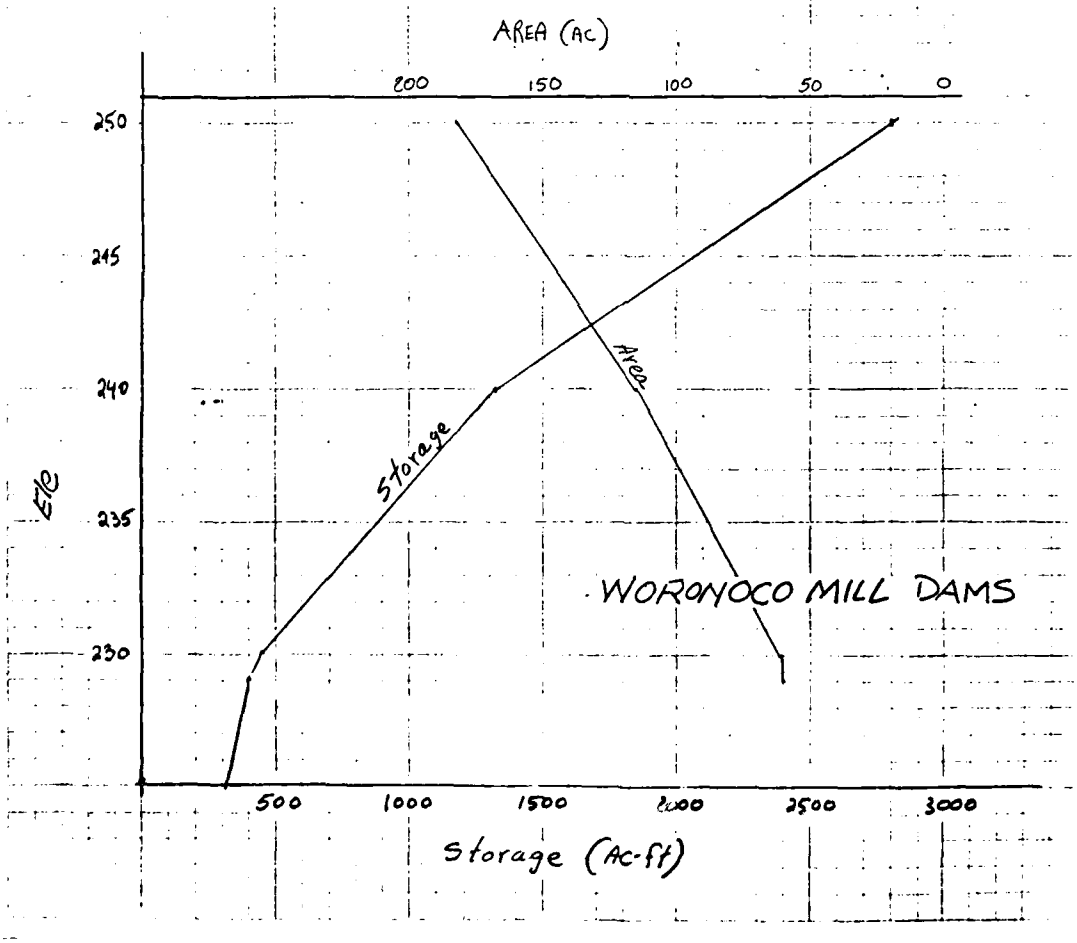
Elevations

Crest el 229 acres = 59
el 230 acres = 59.7
el 240 acres = 114.8
el 250 acres = 182.7

Storage Volumes

Crest el 229 20' high Vol = 393 ac-ft $\frac{1}{3}(59ac)(20)$
el 230 Vol = 452 ac-ft
el 240 Vol = 1324 ac-ft
el 250 Vol = 2811 ac-ft



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TEST FLOOD

Flood control dams are located in Westfield River watershed. They are Knightville and Littleville. The dams were designed by the Corps to store and safely pass the PMF through their spillway. Compare hydrographs of various flood events to see if there is a uniform percentage in flow reduction because of these dams. If some percentage of flow reduction can be found, Then this same percentage reduction will be used to reduce PMF discharge at Woronoco Dams.

EVENT	LOCATION	Q_{pk} Natural	Q_{pk} Mod. by Knvl + Ltlvl	% of Q_{pk} Natural
1. Sept 1938	Westfield River @ Elm St	81,000 cfs	47,000	58%
2. Sept 1938	Westfield River USGS Gage Inflow to Westfield flood plain	87,000	54,000	62%
3. Aug 1955	Westfield River @ Elm St	82,000	56,000	68%
4. Aug 1955	Westfield River USGS Gage outflow from Westfield flood plain	77,000	62,500	81%
5 Sept 1938	Westfield River USGS Gage outflow from Westfield flood plain	55,500	36000	65%

FROM DISCHARGE - FREQUENCY CURVE

EVENT	LOCATION	Q_{pk} Natural	Q_{pk} Modified by Knvl + Ltvl	% of Q_{pk} Natural
1. 50 yr	Westfield River @ Elm St	84,000	40,000	48%
2. 100 yr	" "	120,000	60,000	50%
3. 500 yr	" "	270,000	147,000	54%
4 50 yr	Westfield River @ USGS Gage	65,000	42,000	65%
5 100 yr	" " "	90,000	57,000	63%
6 500 yr	" " "	180,000	112,000	62%
		Σ 1191500	713500	60%

$$\% \text{ Reduction} = 1 - \frac{Q_{pk}}{Q_{nat}}$$

Avg ≈ 40% reduction

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D.A. tributary to Knightville Dam 162 mi²
D.A. tributary to Littleville Dam 52 mi²
214 mi²

D.A. Tributary to Woronoco Dam 346 mi²

From PMF curves, using mountainous terrain

PMF₁ @ Woronoco Dam:

$= (346\ mi^2)(725\ CSM)(.60) = 150,500\ cfs$

60% outflow @ dam because of flood control dams

PMF₂ @ Woronoco Dam:

Assume Knightville + Littleville hold back all flows in their tributary D.A.

$(346 - 214\ mi^2) = 132\ mi^2$

$(132\ mi^2)(1075\ CSM) = 141,900$

$\frac{1}{2}$ PMF $= \left(\frac{150,500 + 141,900}{2}\right)(.5)$

$= (146,200)(.5) = 73,100\ cfs$ @ el 237.8

APPENDIX D-5

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CLIENT Corps of Engineers, New England JOB NO. 380-5-08
PROJECT Wareham Tidal Dam DATE CHECKED 20 Feb 79
DETAIL Spillway Rating Curve CHECKED BY JW

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DATE June 10, 1979
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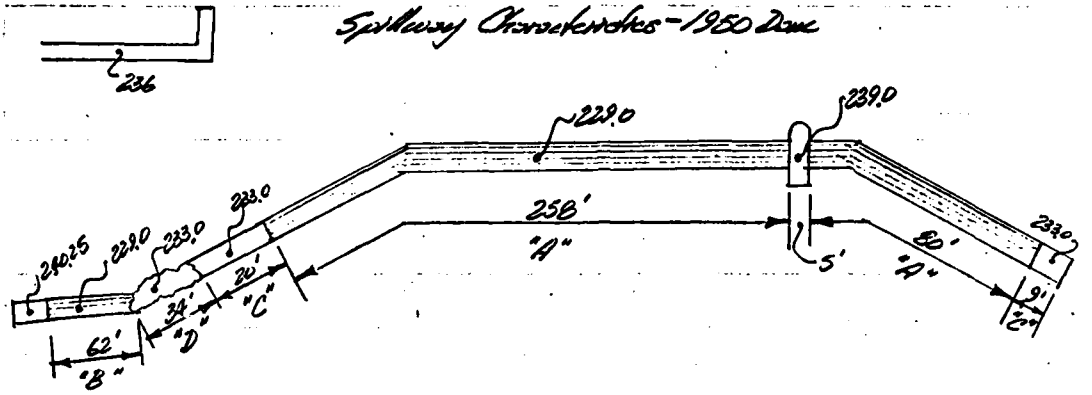
Spillway Characteristics - 1950 Dam



Water Surf. Elev.	Spillway "A" L = 238' "C" Head	Q_A	Spillway "B" L = 62' "C" Head	Q_B	Spillway "C" L = 204.29' "C" Head	Q_C	Spillway "D" L = 34' "C" Head	Q_D	Total Discharge (A+B+C+D)
229.0	3.8 0	0	— 0	0					0
229.5	0.5	454	2.62 0.5	57					511
230.0	1.0	1284	2.66 1.0	165					1,449
230.5	1.5	2360	2.66 1.5	303					2,663
231.0	2.0	3633	2.70 2.0	473					4,106
231.5	2.5	5077	2.76 2.5	676					5,753
232.0	3.0	6674	2.88 3.0	912					7,586
232.5	3.5	8410	2.86 3.5	1161					9,571
233.0	4.0	10,275	2.13 4.0	1453	— 0		0		11,728
234.0	5.0	14,360	3.10 5.0	2,189	2.67 1.0	77	2.5 1.0	85	16,691
235.0	6.0	18,877	3.20 6.0	2,916	2.68 2.0	220	2.6 2.0	250	22,263
236.0	7.0	23,787	3.32 7.0	3,812	2.73 3.0	411	2.7 3.0	477	28,487
237.0	8.0	29,063	8.0	4,658	2.79 4.0	647	2.73 4.0	718	35,116
238.0	9.0	34,679	9.0	5,558	3.07 5.0	995	3.0 5.0	1,140	42,372
239.0	3.8 10.0	40,616	3.32 10.0	6,509	3.32 6.0	1,415	3.3 6.0	1,649	50,189
240.0	3.8 11.0	46,859	3.32 11.0	7,510	3.32 7.0	1,783	3.3 7.0	2078	58,230

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CLIENT: Corps of Engineers [illegible]
PROJECT: [illegible] Mills Dam
DETAIL: Spillway Rating Curve

JOB NO. 390-5-20
DATE CHECKED: 20 Feb 79
CHECKED BY: JW

PAGE: 2 of
DATE: Jan 10 1979
COMPUTED BY: [illegible]

Spillway Characteristics – 1938 Dam

Water Surf. Elev.	Spillway L=307' C	Spillway Head	Spillway Q	Overflow wall L=180' Top @ Elev. 236 C	Overflow wall Head	Overflow wall Q	Gate Tower LS C	Gate Tower Head	Gate Tower Q	Spillway Capacity 1950 Dam (A+B+C+D)	Total Spillway Capacity 1938 and 1950 Dams
229.0	3.8	0	0							0	0
229.5		0.5	412							511	923 cfs
230.0		1.0	1167							1449	2616
230.5		1.5	2143							2,663	4,806
231.0		2.0	3300							4,106	7,406
231.5		2.5	4611							5,753	10,364
232.0		3.0	6062							7,586	13,648
232.5		3.5	7639							9,571	17,210
233.0		4.0	9333							11,728	21,061
234.0		5.0	13043							16,671	29,714
235.0		6.0	17145							22,263	39,408
236.0		7.0	21606	—	0	0				28,487	50,093
237.0		8.0	26,397	2.95	1.0	495				35,116	62,008
238.0		9.0	31,498	3.0	2.0	1527				42,372	75,397
239.0	3.8	10.0	36,891	3.3	3.0	3086	2.63	0	0	50,189	90,166
240.0		11.0	42,561	3.3	4.0	4752		1.0	13	58,230	105,556
241.0		12.0	48,495		5.0	6641		2.0	37	66,667	121,840
242.0	3.8	13.0	54,601	3.3	6.0	8720	2.63	3.0	68	75,480	138,959
243.0											156,940
244.0											175,800

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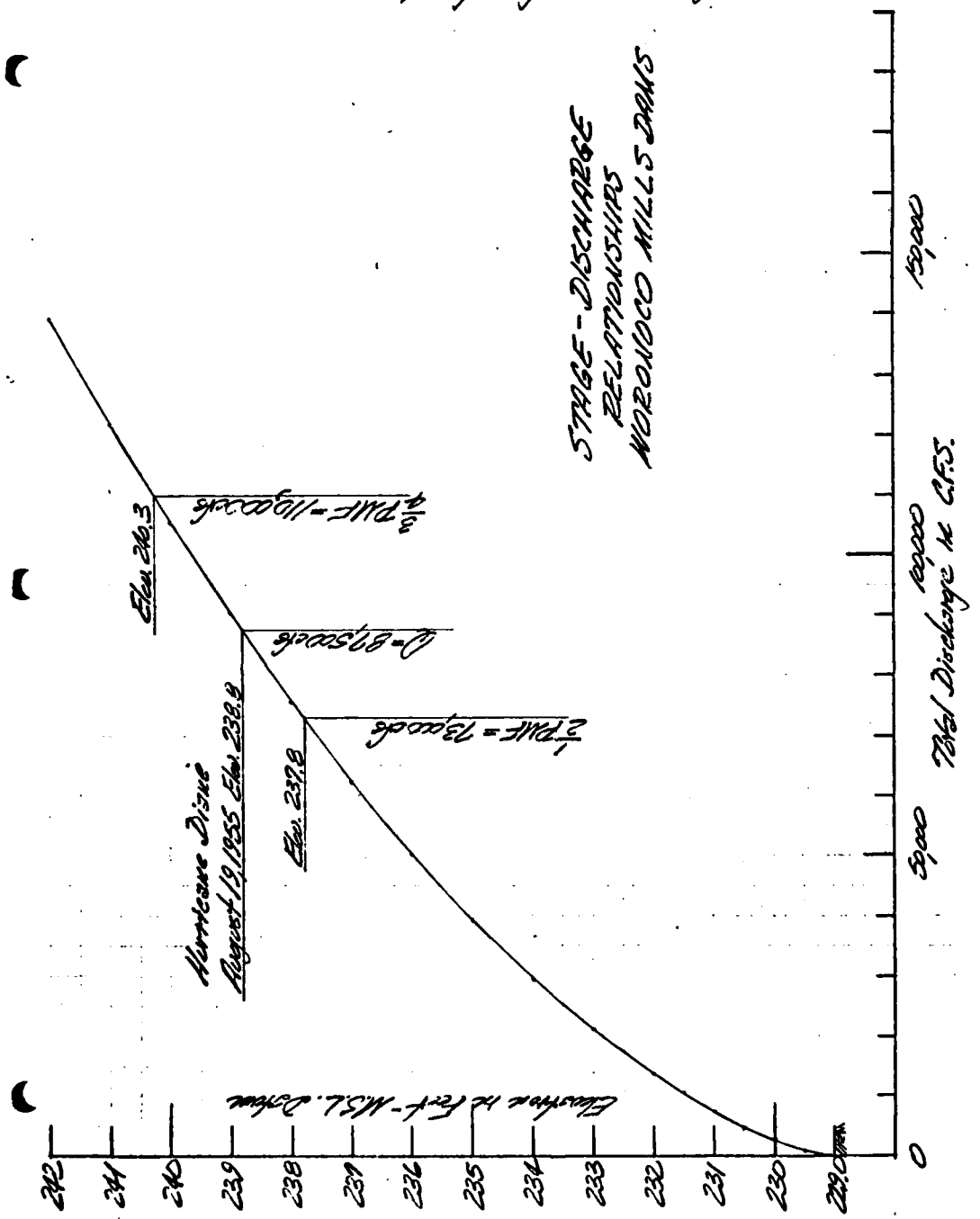
CLIENT Corps of Engineers Newbridge JOB NO. 3905-B&D PAGE 3 of
PROJECT Ohio River Mills Dams DATE CHECKED 20 Feb 79 DATE Dec 11, 1979
DETAIL Combined Spillway & Lock Discharge CHECKED BY JW COMPUTED BY CBaker



APPENDIX D-8

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CLIENT Corps of Engineers - Dam Safety JOB NO 380-5-00 E20 PAGE 4 of
PROJECT Worcester Lights Dams DATE CHECKED 2-6-79 DATE Nov. 11, 1978
DETAIL Peak Flood CHECKED BY JD COMPUTED BY Baker

Consider PMF to be average of 2 approaches by Joel Williams:

$PMF = \frac{150{,}500 + 141{,}900}{2} = 146{,}200$ cfs - say 146,000 cfs

then $\frac{1}{2}$ PMF = 73,000 cfs

and $\frac{3}{4}$ PMF = 109,500 cfs - say 110,000 cfs

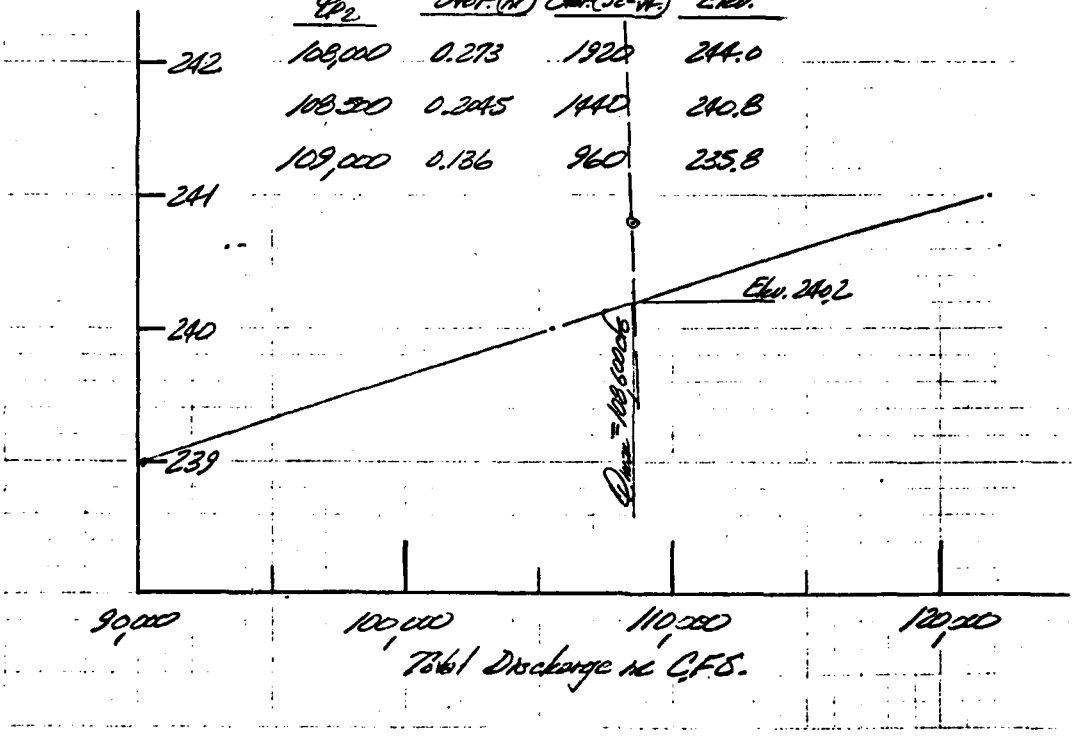
Consider effect of surcharge-storage on reduction of peak flow

surcharge to Q = 110,000 cfs = Elev. 240.3

storage @ Elev. 240.3 = 1369 ac-ft. $\frac{1369}{(53.33)(132 \text{ sq. mi.})} = 0.194$" R.O.

$Q_{P_2} = 110{,}000 \text{ cfs}\left(1 - \frac{0.194"}{15"}\right) = 108{,}574$ cfs

Q_{P_2}	Stor. (in.)	Stor. (ac-ft.)	Elev.
108,000	0.273	1920	244.0
108,500	0.2045	1440	240.8
109,000	0.136	960	235.8



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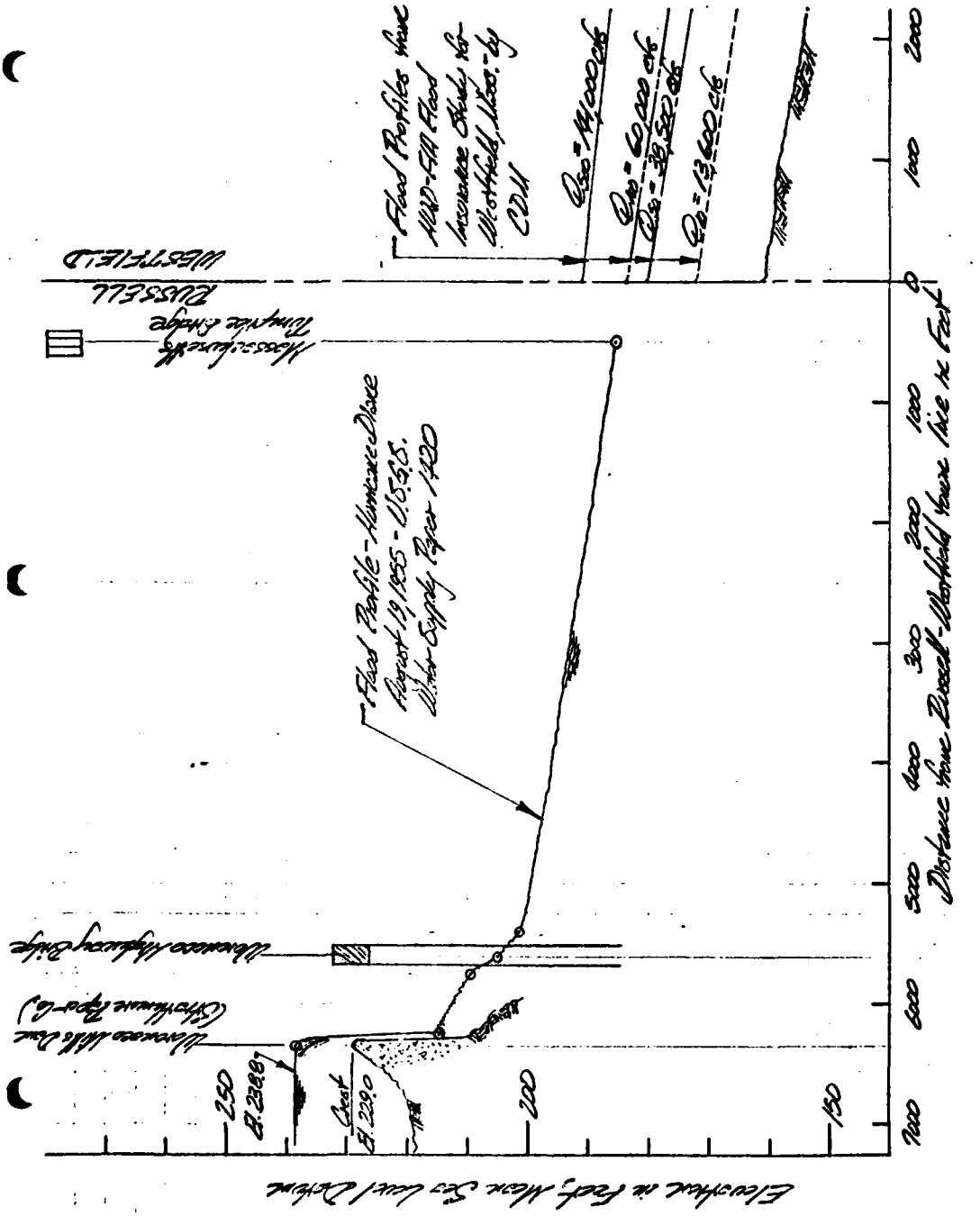
CLIENT Corps of Engineers Waltham Mass. JOB NO. 220-5-8820 PAGE 5 of
PROJECT Hodges Village Dam DATE CHECKED 2-6-79 DATE Dec. 11, 1978
DETAIL Downstream Flood Profile CHECKED BY JD COMPUTED BY Keller



APPENDIX D-10

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CLIENT Corps of Engineers - Dams Inspect. JOB NO. 320-5-08820 PAGE 6 of
PROJECT Worcester Hills Dams DATE CHECKED 2-6-79 DATE Sept. 11 1978
DETAIL Dam Failure Analysis CHECKED BY JPD COMPUTED BY Baker

DAM FAILURE ANALYSIS

1950 Dam

Sta. 0+50 to 2+50 has soc. bedrock @ Elev. 209

Assume dam fails with water surface @ Elev. 236, then $W_B = (0.4)(200') = 80'$

$H = 236 - 209 = 27'$

$Q_{pf} = \left(\frac{8}{27}\right)(80')(\sqrt{32.2})(27')^{1.5} = 18871$ cfs

$Q_{spillways} = \left(\frac{338-80}{338}\right)(23787) + 3812 + 411 + 477 + 21{,}606 = 44{,}963$ cfs (1950 dam; 1938 dam)

$Q_{total} = 63{,}334$ cfs

say 64,000 cfs

1938 Dam

Assume dam fails with water surface @ Elev. 236 and $W_B = (0.4)(250') = 100'$

$Q_p = \left(\frac{8}{27}\right)(100')(\sqrt{32.2})(22')^{1.5} = 17{,}350$ cfs

$H = 236 - 214 = 22'$

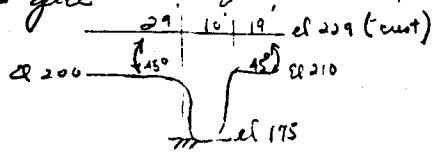
$Q_{spillways} = \left(\frac{307-100}{307}\right)(21606) + 28{,}487 = 43{,}055$ cfs (1938 dam; 1950 dam)

$Q_{total} = 60{,}405$ cfs $< 63{,}334$ cfs

so use 64,000 cfs from above

Because both dams are more or less similar in length and height and because they are at the same location, the use of 21,000 cfs for dam failure flood was used as an average flow. The assumption made is that only one dam would fail at one time. Failure was assumed to have occured in the middle of the structure.

Note the configuration of the 1950 dam in the vicinity of the sluice gate



If dam were to fail by sluice gate:

$Q = \frac{8}{27}(.4)(58)\sqrt{32.5}(55)^{1.5}$

$Q = 15{,}910$ cfs which is less than 64000 cfs which is planned to be used.

NOTE: Upstream of the 1948 dam is an old timber crib which has been breached. If the 1948 dam failed instead of the 1938 dam, the failure discharge of 21,000 cfs would be reduced. By using the 21,000 cfs discharge more conservative results are obtained.

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DETAIL

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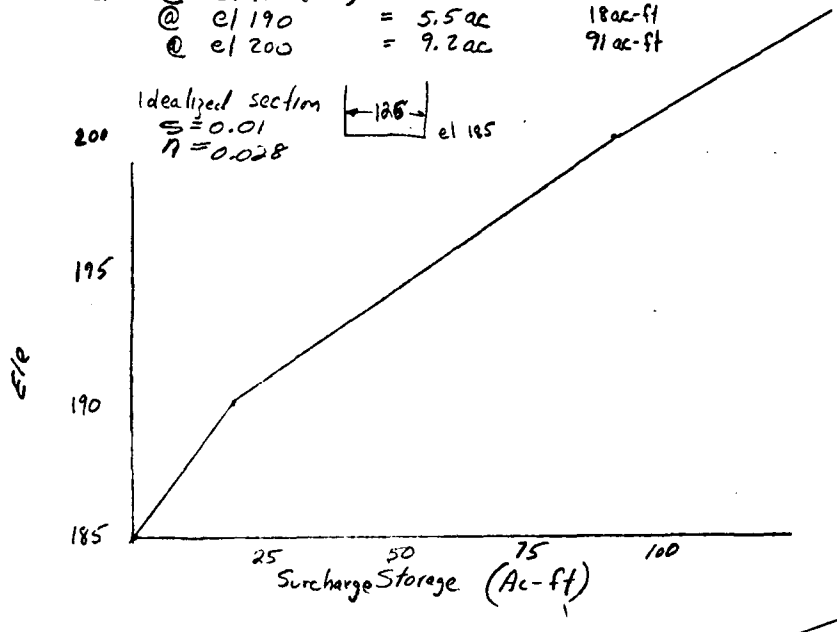
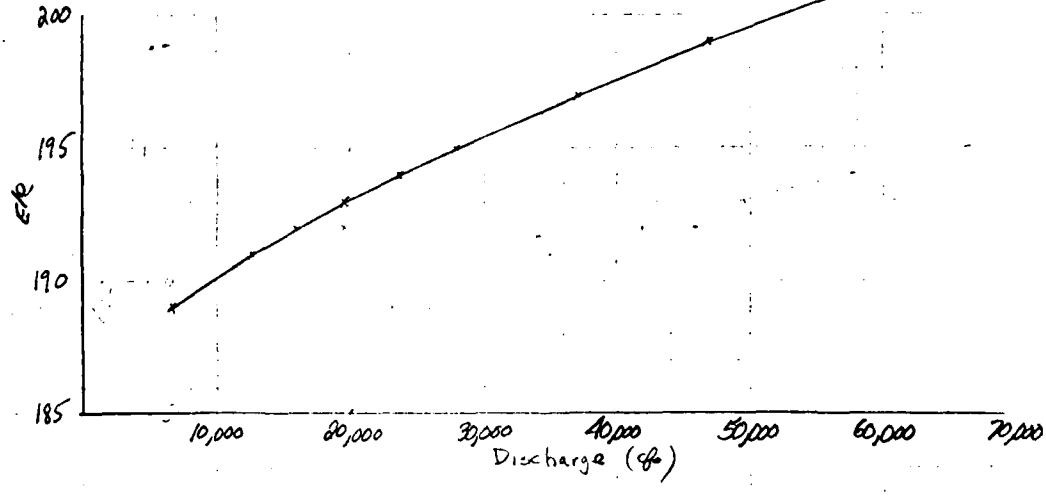
Reach #1 dam to 1st bridge

		Area	Surcharge Vol
area @	el 185 (W.S.) =	1.8 ac	0
@	el 190 =	5.5 ac	18 ac-ft
@	el 200 =	9.2 ac	91 ac-ft

Idealized section ← 125 → el 185
$S = 0.01$
$n = 0.028$





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Surcharge stage - discharge for reach #1

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$

$n = 0.028 \quad S = 0.01$

$A = 125y \quad R = \frac{125y}{2y+125}$

$= \frac{1.49}{0.028} (.01)^{1/2} (125) y \left(\frac{125y}{2y+125}\right)^{2/3}$

$= 665.18\, y \left(\frac{125y}{2y+125}\right)^{2/3}$

$y = 4$	$Q = 0494$	el = 189	$y = 14$	$Q = 47,275$	el = 199
$= 8$	$Q = 19772$	= 193	$= 16$	$= 58,051$	= 201
$= 9$	$Q = 23843$	= 194	$= 18$	$= 69,468$	= 203
$= 7$	$Q = 15972$	= 192			
$= 6$	$Q = 12467$	= 191			
$= 10$	$Q = 27,986$	= 195			
$= 12$	$Q = 37,245$	= 197			

Route Dam Failure Flow through Reach #1

at $Q = 64000$ cfs el = 237 $S = 1073$ ac-ft

Q_{P_2} (trial) $= Q_{P_1}\left(1 - \frac{V_1}{S}\right)$ for $Q_{P_1} = 64000$ cfs el = 202 $V_1 = 108.5$ ac-ft

$= 64000\left(1 - \frac{108.5}{1073}\right) = 57528$

@ 57528 cfs el = 200.9 $V_2 = 98.5$

$V_{avg} = \left(\frac{108.5 + 98.5}{2}\right) = 1035$

$Q_{P_2} = Q_{P_1}\left(1 - \frac{V_{avg}}{S}\right) = 64,000\left(1 - \frac{103.5}{1073}\right) = 57,827$ @ el 200.96

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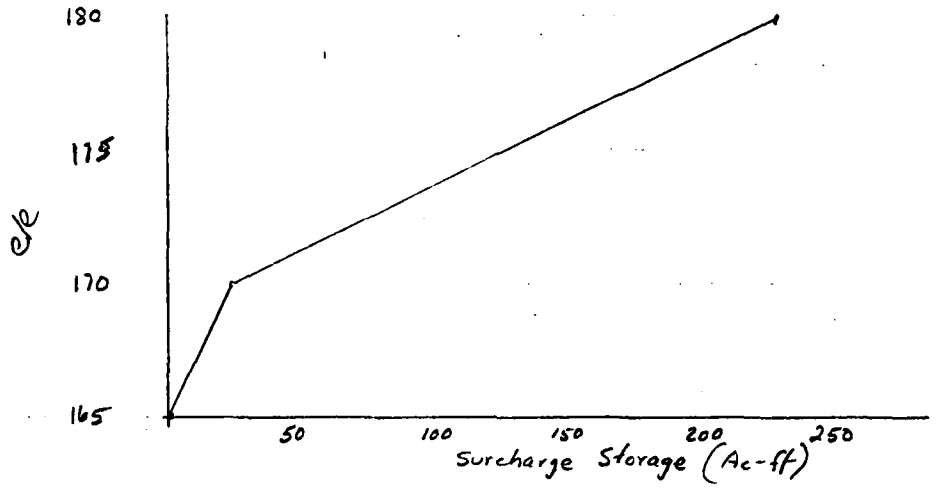
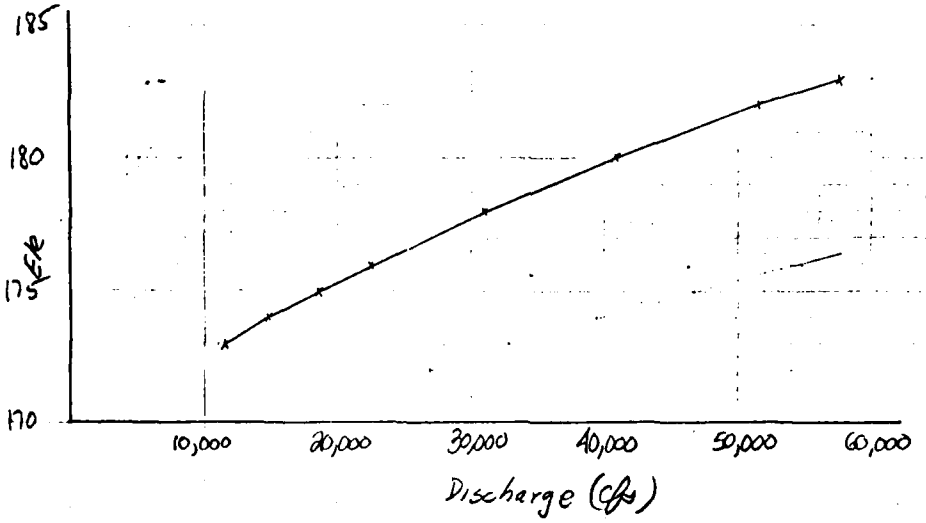
Reach # 2 1st bridge to Mass Pike

		Surcharge Vol
el 167 (w.s.)	area = 6.9 acres	0
170	= 7.8	22 ac-ft
180	= 33.5	228 ac-ft

Idealized outlet control section: 200' wide, 1:1 slope





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Surcharge Stage-Disch. for reach #2

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $\quad n = 0.028 \quad S = 0.003$

$= \frac{1.49}{.028} (.003)^{1/2} \; y(200+.7y) \left[\frac{y(200+.7y)}{200+2.44y}\right]^{2/3}$

$= 2.9 \; y(200+.7y) \left[\frac{y(200+.7y)}{200+2.44y}\right]^{2/3}$

y = 5	Q = 8420 cfs	el = 167+5 = 172	y = 13	Q = 40,839	el-180
= 6	Q = 11414	el = 173	= 15	= 51,696	= 182
= 7	Q = 14696	el = 174	= 16	= 57,491	= 183
= 8	Q = 18387	el = 175			
= 9	Q = 22264	el = 176			
= 11	Q = 31,000	el = 178			

Route Dam Failure Flow Through Reach #2

at Q = 57,827 el 183 $V_1 = 290$

$Q_{P_2}(\text{trial}) = 57,827\left(1 - \frac{290}{1073}\right) = 42,198$ cfs

@ 42,198 el 180.25 $V_2 = 233$

$V_{avg} = \left(\frac{233+290}{2}\right) = 261.5$

$Q_{P_2} = 57,827\left(1 - \frac{261.5}{1073}\right) = 43,734$ cfs el 180.5

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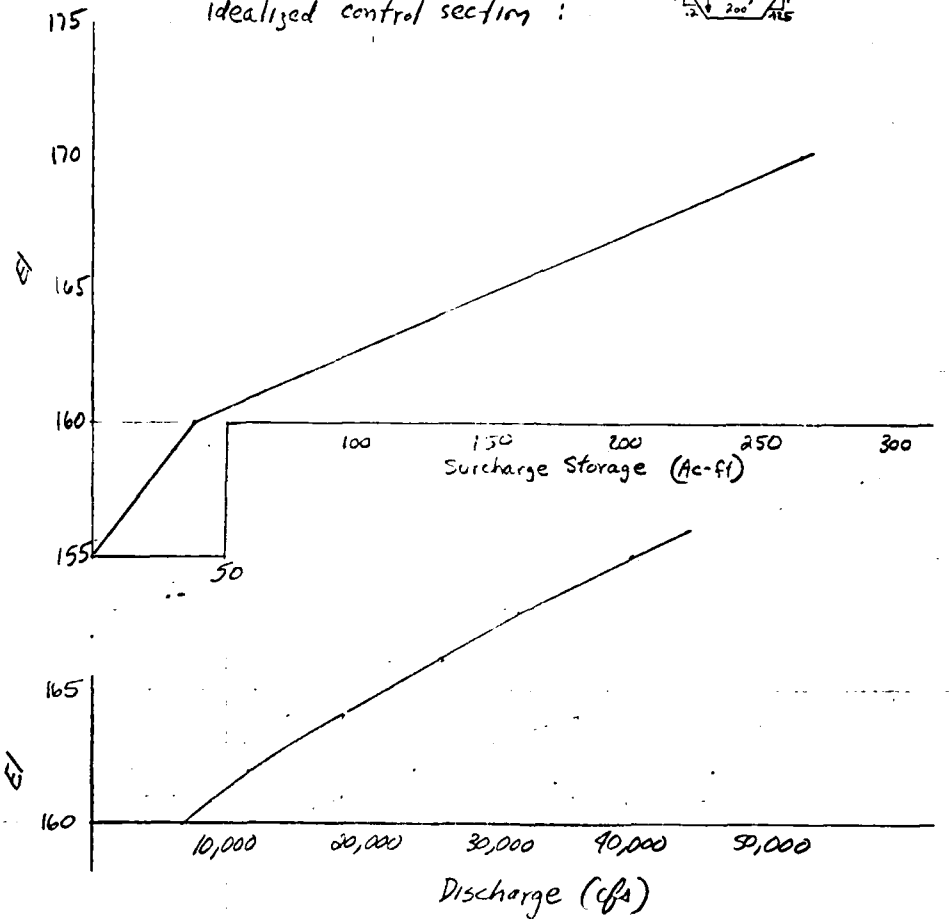
Reach #3 Mass Pike to First Dirt Rd across flood plain

		area	Surcharge Vol
el	155 (w.s.)	5.5 ac	0
	160	9.2 ac	37 ac-ft
	170	36.7 ac	266 ac-ft
	180	65.2 ac	775 ac-ft

Idealized control section :



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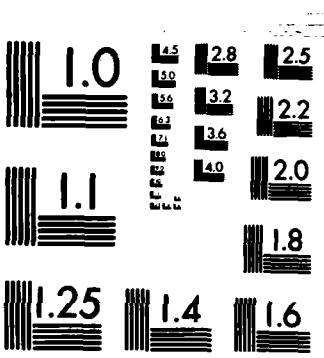
WORONOCO MILLS (60 FE. (U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV FEB 79

UNCLASSIFIED F/G 13/13 NL



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Surcharge Stage-Discharge for Reach #3

$Q = \frac{1.49}{n} AR^{2/3} S^{1/2}$ $\quad n = 0.028 \quad S = .002$

$= \frac{1.49}{.028}(.002)^{1/2}\, y(200+.16y)\left[\frac{y(200+.16y)}{200+2.83y}\right]^{2/3}$

$= 2.38\, y(200+.16y)\left[\frac{y(200+.16y)}{200+2.83y}\right]^{2/3}$

$y = 6$	$Q = 9138$	el = 161	$y = 11$	$Q = 26,411$	el = 166
$= 7$	$Q = 11756$	= 162	13	= 32,047	168
$= 8$	$Q = 14935$	163	15	= 40,305	170
$= 9$	$Q = 18835$	164	16	= 44,680	171

Route Flows Through Reach #3

at $Q = 43,734$ el 170.7 $V_1 = 305.9$

$Q_{P_2}(\text{Trial}) = 43,734\left(1 - \frac{305.9}{1073}\right) = 31,274$ cfs

@ 31,274 cfs el = 167.72 $V_2 = 213.8$ ac-ft

$V_{avg} = \frac{213.8 + 305.9}{2} = 257.9$

$Q_{P_2} = 43,734\left(1 - \frac{257.9}{1073}\right) = 33,147$ cfs @ el 168.27

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Surcharge Stage discharge for reach #4

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $n = 0.028$ $S = 0.002$ $A = 1600 + 85y^2 + 200y$

$R = \frac{1600 + 85y^2 + 200y}{216 + 170.02y}$

$Q = 2.38 (1600 + 85y^2 + 200y) \left[\frac{1600 + 85y^2 + 200y}{208 + 170.02y}\right]^{2/3}$

$= 2.38 (1600 + 85y^2 + 200y)^{1.67} \left(\frac{1}{216 + 170.02y}\right)^{2/3}$

$Q = \frac{1.49}{0.028} (.002)^{\frac{1}{2}} (200z)^{1.67} \left(\frac{1}{2z + 200}\right)^{.67}$

$= 2.38 (200z)^{1.67} \left(\frac{1}{2z + 200}\right)^{.67}$

$y = 0$	$Q = 14,567$	el = 160
$z = 5$	$Q = 6771$	el = 157
$z = 6$	$= 9123$	$= 158$
$z = 7$	$= 11728$	$= 159$
$z = 8$	$= 14567$	$= 160$
$y = 1$	$=$	
$= 2$	$= 14587$	$= 162$
$= 4$	$= 23,400$	$= 164$
$= 5$	$= 30,500$	$= 165$
$= 6$	$= 39,560$	$= 166$

Route Flow through Reach #4

@ $Q = 33,147$ cfs el 165.2 $V_1 = 335$ ac-ft

Q_{P_2} (Trial) $= 33147 \left(1 - \frac{335}{1073}\right) = 22798$ cfs @ el 162.9 $V_2 = 262$ ac-ft

$V_{avg} = \frac{262 + 335}{2} = 298.5$

$Q_{P_2} = 33147 \left(1 - \frac{298.5}{1073}\right) = 23,926$ cfs @ el 164

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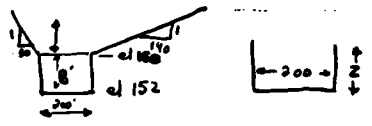
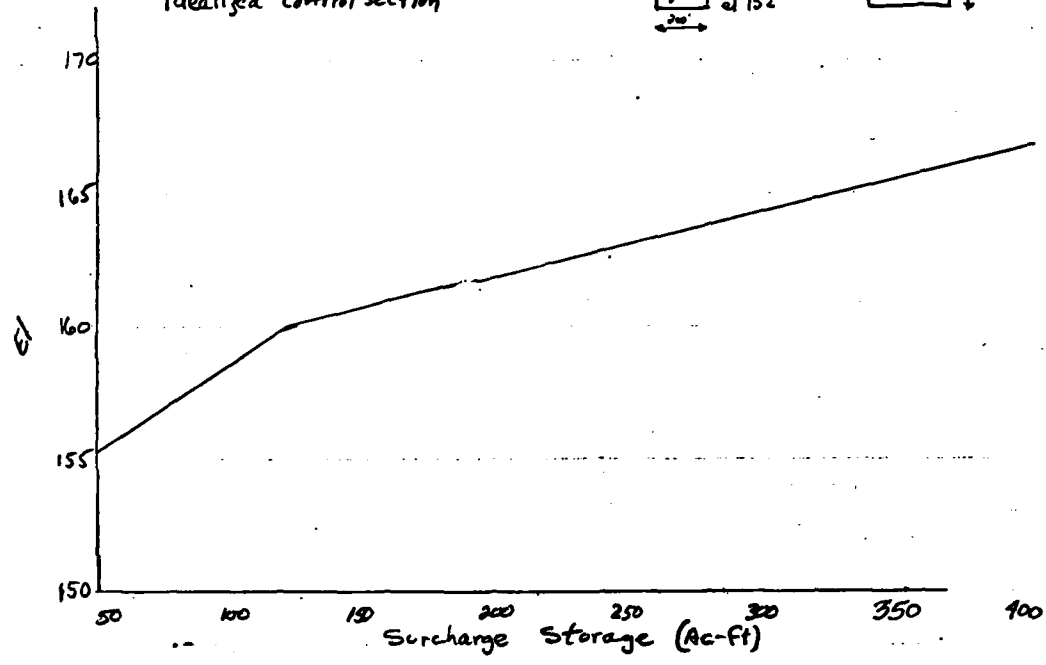
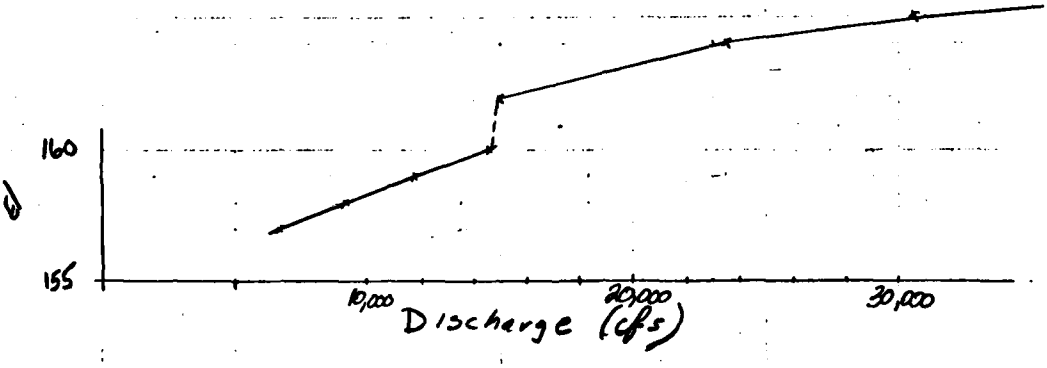
Reach #4 1± Dirt Road to Powerline

	Area	Surcharge Vol
el 152 (e.s.)	10 ac	0
160	20 ac	120 ac-ft
170	62 ac	530 ac-ft

Idealized control section







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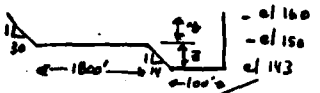
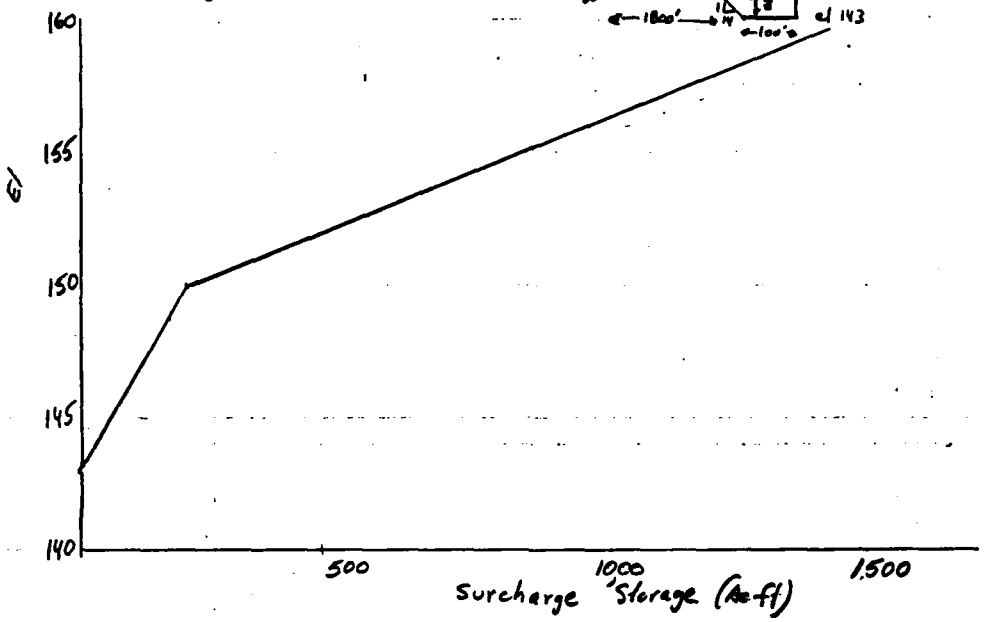
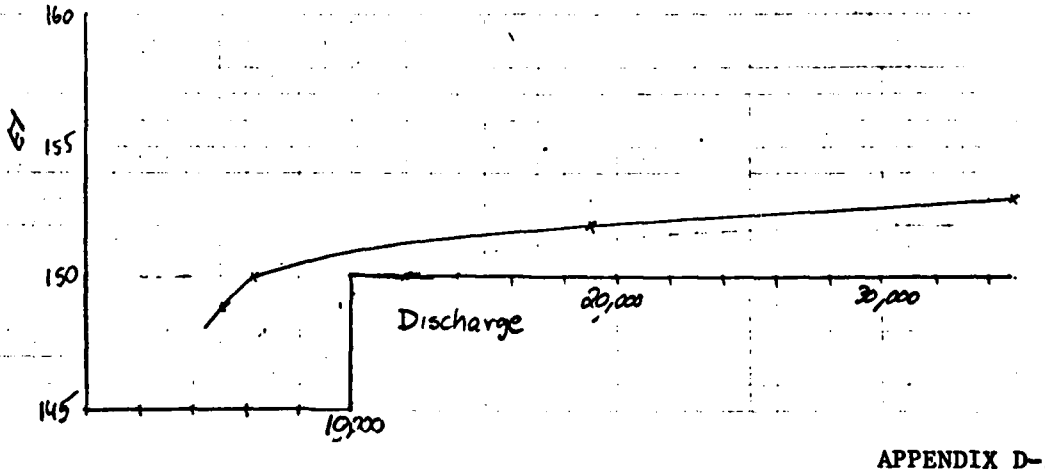
Reach #5 Powerline to Middle of Tekoa Country Club

	Area	Surcharge Storage
el 143 (W.S.)	18 ac	0
150	40 ac	203 ac-ft
160	210 ac	1453 ac-ft

Idealized control section







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Surcharge Stage-Discharge for Reach 95

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $n = 0.028$ $S = .0014$

$A = 1043 + 1998y + 15y^2$

$R = \frac{1043 + 1998y + 15y^2}{2005 + 31y}$

$Q = 1.99 \left(1043 + 1998y + 15y^2\right)^{1.67} \left(\frac{1}{2005 + 31y}\right)^{.67}$

$y = 0$ $Q = 6173$ el 150 $\left(R = \frac{1043 + 2000\,y}{2005 + 2y}\right.$ for el ≥ 150)

$y = 1$ $Q = 7784$ el 151 @ el ≤ 150 $Q = 1.99 \left(1002 + 72^2\right)^{1.67} \left(\frac{1}{1002 + 15^2}\right)^{.67}$

$y = 2$ $Q = 18560$ el 152

$z = 7$ $Q = 6173$ el 150 $z = 5$ $Q = 3318$ el 148

$z = 6$ $Q = 4632$ el 149

$y = 3$ $Q = 32520$ el 153

$y = 4$ $Q = 49475$ el 154

@ $Q = 23926$ el 152.4 $V_1 = 415$

Q_{P_2} (trial) $= 23926 \left(1 - \frac{415}{1073}\right) = 14{,}672$ cfs

@ 14,672 cfs el 151.4 $V_2 = 330$

$V_{avg} = \frac{330 + 415}{2} = 372.5$

$Q_{P_2} = 23926 \left(1 - \frac{372.5}{1073}\right) = 15620$ cfs @ el 151.5

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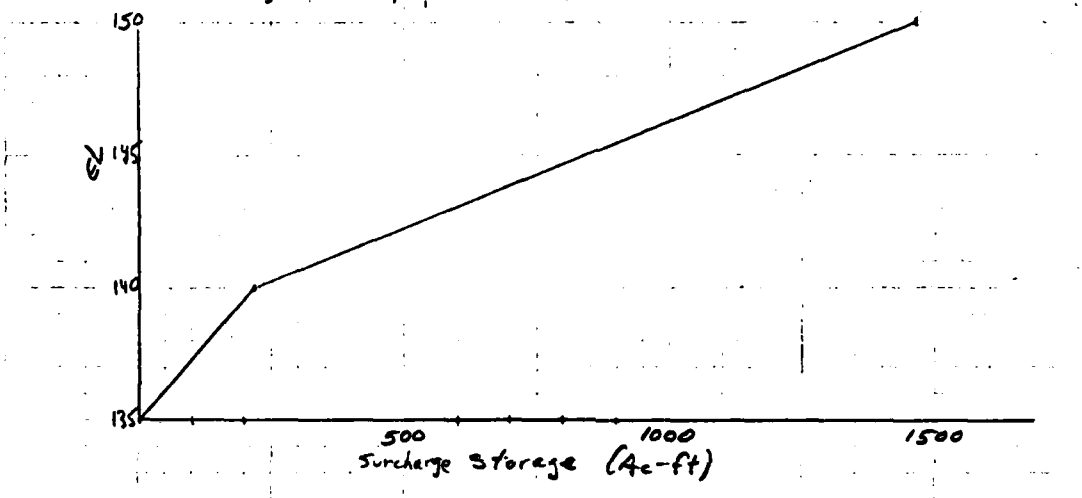
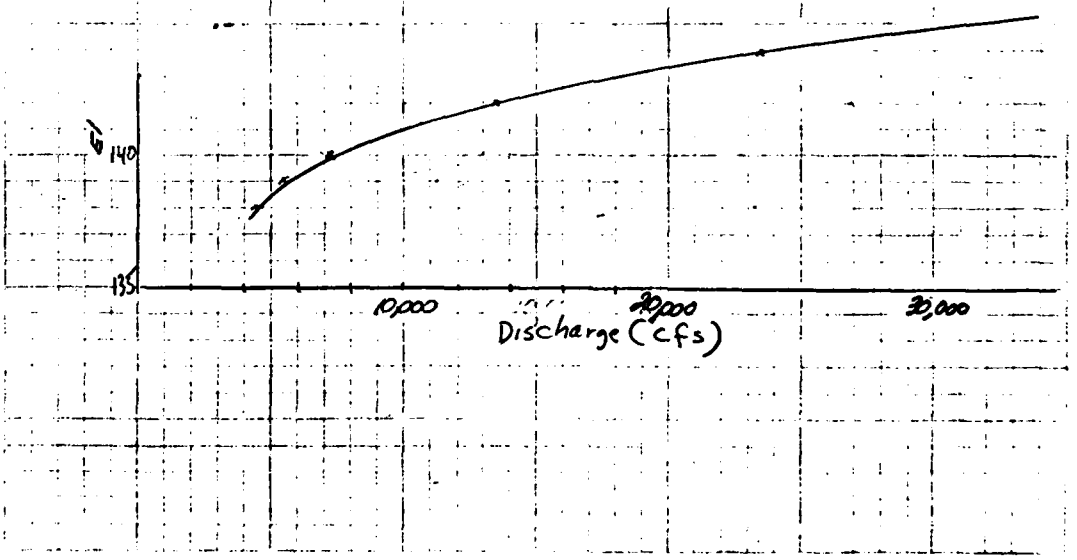
Reach #6 Middle of Tekoa C.C. to mt. sect. , BM151 to U.S. end of dike

	Area	Surcharge Storage
el 135 (W.S.)	25 ac	0
140	61 ac	215 ac-ft
150	198 ac	1460 ac-ft
160	355 ac	4175 ac-ft

Idealized section





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Surcharge Stage -discharge for Reach #6

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $n = 0.028$ $S = 0.0007$

$Q = 1.42 \left(200 y + 43.5 y^2\right)^{1.67} \left(\frac{1}{200 + 87.1 y}\right)^{.67}$

y	Q	el
5	6576	140
7	13452	142
4	5639	139
3	2350	138
9	23430	144

Route flow through reach #6

@ $Q = 15{,}620$ $el = 142.5$ $V_1 = 525$ Ac-ft.

Q_{P_2} (Trial) $= 15{,}620\left(1 - \frac{525}{1073}\right) = 7977$ cfs @ el 139.7 $V_2 = 200$ Ac-ft

$V_{avg} = \frac{200 + 525}{2} = 362.5$

$Q_{P_2} = 15620\left(1 - \frac{362.5}{1073}\right) = 10{,}342$ cfs @ el 141.2

At this point in the river, the failure flow is contained within the limits of the river bank and the state constructed dike. Downstream of this point there is additional storage available to further reduce the failure flow before passing through the railroad bridge and Elm St bridge. Once through Elm St bridge the flow is contained within the limits of the river by the state dike and the high ground by the railroad tracks. In the vicinity of the confluence with the Little River and in the floodplain on the left bank of the Westfield River at this confluence, there are existing structures which may be effected by the failure flow which reaches this point.

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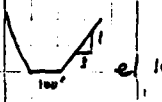
TAILWATER ANALYSIS

at Q = ½PMF = 72,600 cfs w.s. at crest = 238.5

at a section about 1000 ft d.s. from dams:

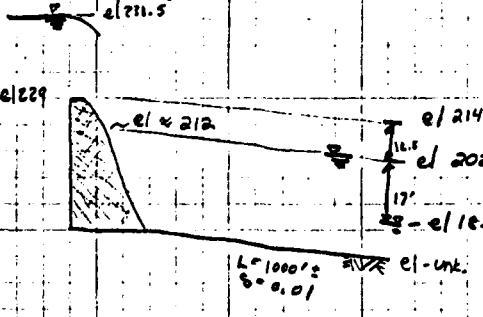


el 185 (w.s.) $n = 0.028$ $S = 0.01$

$A = 100y + 3y^2 = y(100+3y)$ $R = \frac{y(100+3y)}{100+6.32y}$

$Q = 5.32\left[y(100+3y)\right]^{1.67}\left(\frac{1}{100+6.32y}\right)^{.67}$

@ $y = 17$ $Q = 73,677$ cfs OK



at Q = ½PM = 72,600 cfs, Dam is not submerged

APPENDIX E
INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
MA	737	NED	MA	013	01				NORONOCO MILLS 29 FT DAM	4210.0	7249.6	00FEB79

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
193R DAM	WESTFIELD RIVER

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	08	WESTFIELD RIVER	WESTFIELD	1	33000

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(27) NORMAL (ACRE-FT.)
REPCTGR	1939	H	29	24	960	393

DIST	OWN	FED R	PRV/FED	BCS	A	VER/DATE
NED	N	N	N	N		

(28) REMARKS

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) PROPOSED (MW)	(37) NAVIGATION LOCKS NO	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
?	1560	C	307	21600												

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
STRATHMORE PAPER CO	CHARLES T MAIN CO INC	FRED T LEY CONST CO

(49) REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

(50) INSPECTION BY	(51) INSPECTION DATE DAY | MO | YR	(52) AUTHORITY FOR INSPECTION
CAMP DRESSER + MCKEE INC	14SEP78	PL 92-367

(53) REMARKS
30 ALSO INCLUDES 60 FT DAM 33 29 FT DAM ONLY

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CON DIS)	(10) NAME	(11) LATITUDE (NORTH)	(12) LONGITUDE (WEST)	(13) REPORT DATE DAY | MO | YR
MA	738	NED	MA	013	01				NORONOCO MILLS 60 FT DAM	4209.7	7249.6	00FEB79

(15) POPULAR NAME	(16) NAME OF IMPOUNDMENT
1950 DAM	WESTFIELD RIVER

(17) REGION	(18) BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	08	WESTFIELD RIVER	WESTFIELD	1	33000

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE–FT.)	(27) NORMAL (ACRE–FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
EGGRCT	1950	H	60	54	960	393	NED	N	N	N	N	

(28) REMARKS

(29) O/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) PROPOSED (MW)	(37) NAVIGATION LOCKS NO.	(38) LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
2	1560	C	400	28500												

(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
STRATHMORE PAPER CO	CHARLES T MAIN CO INC	

(49) REGULATORY AGENCY DESIGN	(50) CONSTRUCTION	(51) OPERATION	(52) MAINTENANCE
		NONE	NONE

(53) INSPECTION BY	(54) INSPECTION DATE DAY | MO | YR	(55) AUTHORITY FOR INSPECTION
CAMP DRESSER + MCKEE INC	14SEP78	PL 92-367

(56) REMARKS
32-400FT AT EL 229. 63FT AT EL 233 30-ALSO INCLUDS 29FT 33-29FT DAM ONLY

END

FILMED

7-85

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