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NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
CHINA DAM (NH 00023) (U) CORPS OF ENGINEERS WALTHAM
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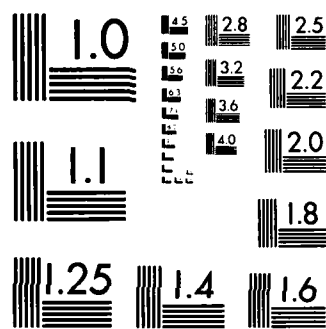
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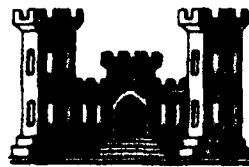
MERRIMACK RIVER BASIN
ALLENSTOWN - PEMBROKE, NEW HAMPSHIRE.

CHINA DAM

NH 00023

NHWRB 190.01

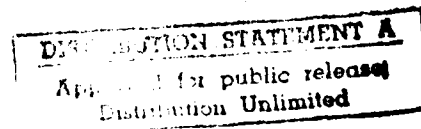
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



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

MARCH 1979

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is a concrete gravity dam with a total length of about 275 ft. and a height of 29 ft. It is small in size with a low hazard potential classification. The spillway is a run of the river structure having a total length of 147 ft. and a height of about 22 ft. The drainage area of the dam is 259 square miles moderately to steeply sloping forested terrain.		



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED-E

JUN 29 1979

Thomas Hodgson and Sons, Inc.
Canal Street
Suncook, New Hampshire 03275

Gentlemen:

Forwarded herewith for your information and use is a copy of the Phase I Inspection Report on the China Dam. This inspection was made under the authority of Public Law 92-367 by the firm of Goldberg, Zoino, Dunnicliff & Associates, Inc., Newton Upper Falls, Massachusetts under the direction and supervision of Corps of Engineers. Copies of the finished report have been forwarded to the Governor and the Water Resources Board, the cooperating agency for the State of New Hampshire.

Section 7 of the report contains an evaluation and recommendations. If you have any questions concerning this report, we suggest that you contact the Water Resources Board first. Then, if there are further questions contact the Project Management Branch, Engineering Division of this office. We thank you for your cooperation and assistance in carrying out this program.

Sincerely yours,

JOE B. FRYAR
Chief, Engineering Division

Incl
As Stated



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED-E

JUN 29 1979

Mr. George M. McGee, Sr.
Chairman, New Hampshire Water Resources Board
State of New Hampshire
Concord, New Hampshire 03301

Dear Mr. McGee:

Forwarded herewith for your information and use is a copy of the Phase I Inspection Report on China Dam. This inspection was performed in accordance with Public Law 92-367 under the direction of the Corps of Engineers. Copies of the finished report have been forwarded to the Governor and the owner. We thank you for your cooperation and assistance in carrying out this program and hope this report will help you to develop an effective dam safety program.

Sincerely yours,

JOE B. FRYAR
Chief, Engineering Division

Incl
As stated



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

JUN 29 1979

Honorable Hugh J. Gallen
Governor of the State of New Hampshire
State House
Concord, New Hampshire 03301

Dear Governor Gallen:

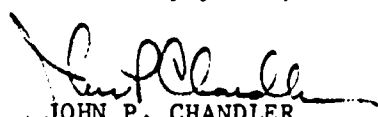
I am forwarding to you a copy of the China Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the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

A copy of this report has been forwarded to the Water Resources Board, the cooperating agency for the State of New Hampshire. In addition, a copy of the report has also been furnished the owner, Thomas Hodgson and Sons, Inc., Canal Street, Suncook, New Hampshire 03275.

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 Water Resources Board for your cooperation in carrying out this program.

Sincerely yours,


JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

CHINA DAM
NH 00023

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MERRIMACK RIVER BASIN
PEMBROKE-ALLENSTOWN, NEW HAMPSHIRE



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I REPORT

Identification No.: NH 00023
NHWRB No.: 190.01
Name of Dam: CHINA DAM
Town: Pembroke-Allenstown
County and State: Merrimack County, New Hampshire
River: Suncook River
Date of Inspection: November 7, 1978

BRIEF ASSESSMENT

China Dam is a concrete gravity dam with a total length of about 275 feet and a height of 29 feet. The spillway is a run-of-the-river structure having a total length of 147 feet and a height of about 22 feet. A gate house, which formerly controlled flow into a downstream canal leading to China Mill, is located at the left end of the dam. None of the gates at the gate house are presently operating. A sluice gate structure, located off the left spillway training wall, is also not operable.

According to the NHWRB the dam is owned by Thomas Hodgson and Sons, Inc. of Suncook, N.H. The dam was built in 1917 to provide power for China Mill downstream from the dam. The gate house was probably constructed at the same time as the spillway and remaining portions of the dam. The dam is no longer used to provide power.

The drainage area of the dam is 259 square miles of moderately to steeply sloping forested terrain. Only a small portion of the total drainage area is developed. The dam's maximum impoundment of 33 acre-feet and height of 29 feet place the dam in the SMALL size category. In the event of a dam failure the minimal damage that would occur downstream places the dam in the LOW hazard potential category.

Based on the size and hazard classification, and in accordance with the Corps' of Engineers guidelines, the Test Flood (TF) would be between the 50 and 100-year floods. Since the hazard potential is on the low side of LOW, the 50-year flood was used to determine the test inflow.

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

Joseph A. McElroy

JOSEPH A. MCELROY, MEMBER
Foundation & Materials Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph W. Finegan, Jr.

JOSEPH W. FINEGAN, JR., CHAIRMAN
Chief, Reservoir Control Center
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in 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 inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an 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.

TABLE OF CONTENTS

	<u>Page</u>
LETTER OF TRANSMITTAL	
BRIEF ASSESSMENT	
REVIEW BOARD SIGNATURE SHEET	
PREFACE	iv
TABLE OF CONTENTS	v
OVERVIEW PHOTOS	vii
LOCATION MAP	ix
 SECTION 1 - PROJECT INFORMATION	
1.1 General	1-1
1.2 Description of Project	1-2
1.3 Pertinent Data	1-5
 SECTION 2 - ENGINEERING DATA	
2.1 Design Records	2-1
2.2 Construction Records	2-1
2.3 Operational Records	2-1
2.4 Evaluation of Data	2-1
 SECTION 3 - VISUAL OBSERVATIONS	
3.1 Findings	3-1
3.2 Evaluation	3-7
 SECTION 4 - OPERATIONAL PROCEDURES	
4.1 Procedures	4-1
4.2 Maintenance of Dam	4-1
4.3 Maintenance of Operating Facilities	4-1
4.4 Description of Warning System	4-1
4.5 Evaluation	4-1

Table of Contents - Cont.

Page

SECTION 5 - HYDRAULICS/HYDROLOGY

5.1 Evaluation of Features	5-1
----------------------------	-----

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability	6-1
--	-----

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment	7-1
7.2 Recommendations	7-1
7.3 Remedial Measures	7-2
7.4 Alternatives	7-2

APPENDICES

APPENDIX A - VISUAL INSPECTION CHECKLIST	A-1
--	-----

APPENDIX B - FIGURES AND PERTINENT RECORDS	B-1
--	-----

APPENDIX C - SELECTED PHOTOGRAPHS	C-1
-----------------------------------	-----

APPENDIX D - HYDROLOGIC/HYDRAULIC COMPUTATIONS	D-1
--	-----

APPENDIX E - INFORMATION AS CONTAINED IN <u>THE NATIONAL INVENTORY OF DAMS</u>	E-1
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Sediment is located on the upstream side of the left third of the spillway to within 2 feet of the left spillway crest.

(3) Inverted "U" Wall (Refer to Fig. 3 on pg. B-4)

The right canal wall, the upstream retaining wall, and the portion of the wall upstream from the waste gate are in extremely poor condition. The vertical faces of these walls are spalled and eroded over approximately 80% of their surface area. The spalled areas at the normal water elevation averaged about 18 inches in depth with depths of 2 feet observed in some areas. In areas above the normal water level the average depth of spalling is about 4 inches. The erosion and spalling is attributed to ice damage, poor quality concrete, and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

The back side (earth side) of the left spillway training wall has a concrete face and a batter of about 3 horizontal to 12 vertical. In some places the original stone masonry is visible. The exposed back face of the wall has some minor cracking and associated efflorescence. Minor surface spalling on the top surface of the wall is attributed to poor quality concrete and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

The interface between the "U" wall and the spillway is severely eroded. The sloping downstream top of the structure is spalled to depths of up to 4 inches over its entire length. The base of the wall from the spillway to the downstream return wall is eroded to depths as great as 15 inches. The erosion is caused by cavitation and ice damage. Visual observations reveal a void in the concrete at bedrock level which is about three square feet in size and up to 8 inches deep. The void is about 2 feet above the channel. Two feet above this point there is additional erosion in the wall over an area of about 16 square feet and to depths as great as 8 inches. This erosion is attributed to poor quality concrete, cavitation, erosion, and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

this wall and the adjacent wall is open and spalled. Minor efflorescence is present on the face of the wall. The return of the wall is in fair condition.

The top of the cut-off wall extending into the right bank has rotated approximately 6 inches downstream. An open joint approximately 1 inch wide is located between this wall and the right upstream training wall.

(2) Spillway

This structure is severely eroded. The right third of the downstream ogee section (see photo #4 in Appendix C) is eroded from the crest down for a distance of about 10 feet. The depth of erosion is as great as 6 inches. The middle third of the back side of the spillway is eroded in a longitudinal pattern with widths as great as 20 inches, depths of 6 inches, and lengths varying from 10 to 30 feet. The remaining third of the spillway is eroded in a pattern similar to that of the middle third, but the erosion is not as severe. The erosion is attributed to ice damage and cavitation. Random open horizontal joints are prevalent on the downstream face of the spillway. These are construction joints which have been subjected to cavitation. Scattered effloresced spots were also observed.

The spillway crest was apparently faced with 3 to 4 inches of granolithic concrete which has minor erosion and horizontal cracking over the right and left thirds of the upstream side of the spillway crest. The erosion is attributed to ice damage and moisture intrusion which has been subjected to alternating freeze and thaw cycles. A vertical construction joint located approximately 20 feet from the left end of the spillway and extending from the spillway crest to its downstream face, has opened approximately 1-1/2 inches and is eroded to a depth of 3 inches. This open joint is attributed to cavitation and ice damage.

Flow of water over the spillway crest prevented observation of the outlet gate.

SECTION 3 - VISUAL OBSERVATIONS

3.1 Findings

(a) Condition

China Dam is in POOR condition at the present time. None of the gates are operable and significant concrete deterioration has occurred on many concrete structures. Much repair and maintenance of the dam is required.

(b) Dam

(1) Right Abutment Structure (See Fig. 3 on pg. B-4)

The upstream training wall has a back batter of about 3 horizontal to 12 vertical with a top width of 18 inches for the first 20 feet. The top width is 2 feet for the 32 foot upstream extension. This wall is eroded, has minor longitudinal cracks, and has a honeycombed surface. The erosion is from ice damage, and the longitudinal cracks are open construction joints. The top of the wall is spalled, effloresced, and has minor random cracking. The cemented stone masonry wall, including the portion extending into the right bank, is in fair condition. The exposed surface of the cut-off wall penetrating into the right bank is in fair condition with no evidence of spalls, cracks, or efflorescence.

The downstream extension of the structure is severely spalled with the sloping top surface spalled to depths as great as 2 feet. The vertical face of the wall is spalled over two-thirds of its area to depths up to 12 inches. The spalling starts at the spillway crest and continues to the base of the wall. The spalling is attributed to poor quality concrete, ice damage, and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

The low downstream wall, adjacent to the structure described above, has a diagonal crack at its base approximately 1-1/2 inches wide and 2 feet long. The wall is also undermined at this location. The diagonal crack is the result of stress relief, and the undermining is caused by erosion. The vertical construction joint between

SECTION 2 - ENGINEERING DATA

2.1 Design Records

The design of this dam is quite simple and incorporates no unusual features. The available design drawings are very limited.

2.2 Construction Records

No construction records are available for the dam.

2.3 Operational Records

No operational records are available for the dam.

2.4 Evaluation of Data

(a) Availability

The absence of design drawings and calculations is a significant shortcoming. An overall unsatisfactory assessment for availability is therefore warranted.

(b) Adequacy

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Validity

Since the observations of the inspection team generally confirm the information contained in the available drawings, a satisfactory evaluation for validity is indicated.

(e) Dam

- (1) Type: concrete gravity dam
- (2) Length: 275 feet ±
- (3) Height: 29 feet
- (4) Top width: approximately 2 feet at spillway
- (5) Side slopes: U/S of spillway - 1 horizontal
to 7 vertical

D/S of spillway - ogee section

(f) Spillway

- (1) Type: concrete gravity ogee section
- (2) Length of weir: 147 feet total less 4 feet
for the 2 concrete piers
yielding a net length of
143 feet
- (3) Crest elevation: 225.8
- (4) U/S channel: broad approach from pond
- (5) D/S channel: rather narrow and confined
between steep banks for approxi-
mately 500 feet. Below this
point the channel widens con-
siderably to its confluence with
the Merrimack River

(g) Regulating Outlet

See Section 1.3 (b) (1).

(b) Discharge at Damsite

(1) Outlet Works

The outlet works consist of 4 gates which are approximately 6.33 feet wide and 8 feet high leading to the downstream canal and an 18 foot high by 5 foot wide waste gate. The outlet opening for the waste gate is 10 feet wide by 4 feet high. None of the outlet gates is presently in operating condition.

(2) Maximum Flood at Damsite

12,100 cfs on March 19, 1936

(3) Spillway Capacity at Maximum Pool Elevation:

9800 cfs at El. 232.8

(c) Elevation (feet MSL)

- (1) Top of dam: 232.8
- (2) Maximum pool: 232.8
- (3) Normal pool: 225.8
- (4) Spillway crest: 225.8
- (5) Streambed: 204 ±
- (6) Maximum tailwater: Unknown

(d) Reservoir

- (1) Length of pool - normal: 300 feet +
maximum: 500 feet ±
- (2) Storage - normal pool: 22 acre-feet +
maximum pool: 33 acre-feet ±
- (3) Surface Area - normal pool: 1.5 acres +
maximum pool: 3 acres ±

40 foot limits for the SMALL size category as defined in the "Recommended Guidelines."

(d) Hazard Potential Classification

In the event of a dam failure the resultant flow would probably not cause significant damage to any downstream structures or threaten life. For these reasons a LOW hazard potential classification is warranted for the dam.

(e) Ownership

According to records obtained by the New Hampshire Water Resources Board (NHWRB), the dam is owned by Thomas Hodgson and Sons, Inc. The firm is located on Canal Street in Suncook Village, N.H. 03275.

(f) Operator

At present the dam is not operated.

(g) Purpose of Dam

The dam was originally used to supply power to a downstream mill. However, it is not presently used for that purpose.

(h) Design and Construction History

Available records indicate that the dam was originally constructed in 1917 and in all probability the gate house and canal were constructed at the same time. In 1950 or thereafter the concrete piers and the steel trusses for the steam line were constructed on the spillway.

(i) Normal Operational Procedures

The dam is not operated.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for the dam is 259 square miles of primarily forested terrain. Developed areas comprise only a small portion of the total drainage area.

of this structure is approximately 8 feet wide and twelve feet long. The structure houses a timber sluice gate. An outlet tunnel extends downstream and penetrates through the spillway.

(5) Headworks Structure (See Fig. 3 on pg. B-4)

This structure, which spans the canal, is 41 feet long and 16 feet wide. This building is a wood frame structure with an "A" frame roof. The floor elevation is approximately 10 feet above the spillway crest elevation.

This structure houses four timber sluice gates which are about 6.33 feet wide and 8 feet high. The gates discharge into an outlet canal. The forebay entrance to the sluice gates consists of four 6 foot 6 inch openings divided by 3 intermediate piers approximately 2 feet wide. A concrete service platform is supported by the canal walls and the intermediate piers. Intermediate piers extend beyond the structure on the downstream side. All pier nosings are faced with steel plates. The downstream canal walls adjacent to the building are concrete-faced stone masonry. The remainder of the canal walls are dry stone masonry. The canal bed is earth.

(6) Left End Wall (See Fig. 3 on pg. B-4)

The concrete left end wall forms the left entrance to the canal. This wall is approximately 48 feet long. A concrete return wall at 45 degrees to the end wall extends into the left bank. This wall is approximately 15 feet long. The top widths of these walls are 3 feet.

(7) Cut-Off Walls (See Fig. 3 on pg. B-4)

These concrete structures are located on the left side of the headworks structure and extend into the left bank. The upstream wall splays away from the gate house at an approximately 60 degree angle and is 20 feet long. The top widths of these walls are 12 inches.

(c) Size Classification

The dam's maximum impoundment of 33 acre-feet and height of 29 feet are below the 1000 acre-foot and

training wall is approximately 58 feet long, and the dry stone masonry wall is about 20 feet long. A concrete return wall is located downstream of the ogee spillway section. The wall is at a right angle to the spillway end wall and is approximately 10 feet long. The concrete cut-off wall is located approximately 25 feet upstream of the spillway face. The wall is about 25 feet long and splays at a 45 degree angle upstream. The walls described above have top widths of 18 to 24 inches except for the cut-off wall which is 1 foot wide.

(2) Spillway (See pg. B-7)

The ogee spillway, which is approximately 147 feet long and 22 feet high, is a cyclopean concrete structure. The spillway supports two concrete piers located at the third points of the spillway. A steel truss, which spans over these piers, was the support for a now removed steam line. The lower chords of the truss are approximately 10 feet above the spillway crest. Flash-board sockets are embedded approximately 3 feet apart along the entire length of the spillway.

A waste gate outlet opening approximately 10 feet wide and 4 feet high penetrates through the left side of the spillway. The outlet elevation is approximately 18 inches above the downstream channel bed.

(3) Inverted "U" Wall (See Fig. 3 on pg. B-4)

The inverted "U" wall forms the right side of the forebay canal entrance to the headworks structure, an upstream retaining wall, a training wall for the left end of the lower spillway, a downstream return wall, and a downstream training wall. This structure, with the exception of a portion of the lower training wall, is concrete-faced stone masonry.

(4) Waste Gate Structure (See Fig. 3 on pg. B-4)

This concrete structure is located adjacent to and approximately 10 feet downstream from the upper end of the spillway training wall. The top

1.2 Description of Project

(a) Location

China Dam lies on the Suncook River approximately 2000 feet upstream from the confluence of the Suncook and Merrimack Rivers. China is the last in a series of three dams in Suncook Village, N.H. which used to supply power to mills in the area. The dam is accessible from a road fronting the south side of the river. This road intersects Main Street near the Main Street Bridge. The portion of USGS Suncook, N.H. quadrangle presented previously shows this locus. Figure 1 of Appendix B presents a detail of the site developed from the inspection visit and the quadrangle map.

(b) Description of Dam and Appurtenances

The dam consists of the following components:

- 1) a concrete ogee spillway supporting a utility truss,
- 2) an entrance canal and headworks structure,
- 3) an inverted "U" shaped concrete retaining structure separating the gate house and the spillway,
- 4) a left end wall,
- 5) a right abutment structure,
- 6) training walls, and
- 7) cut-off walls

The overall length of the dam is approximately 275 feet. The top of the dam is 7 feet above the spillway crest elevation. The spillway and its end walls are founded on bedrock.

(1) Right Abutment Structure (See Fig. 2 on pg. B-3)

The right abutment structure consists of an upstream concrete training wall with a dry stone masonry extension, a downstream concrete return wall, and a concrete cut-off wall. The concrete

PHASE I INSPECTION REPORT

CHINA DAM

SECTION 1

PROJECT INFORMATION

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD) has been retained by the New England Division to inspect and report on selected dams in the State of New Hampshire. Authorization and notice to proceed was issued to GZD under a letter of November 28, 1978 from Colonel Max B. Scheider, Corps of Engineers. Contract No. DACW 33-79-C-0013 has been assigned by the Corps of Engineers for this work.

(b) Purpose

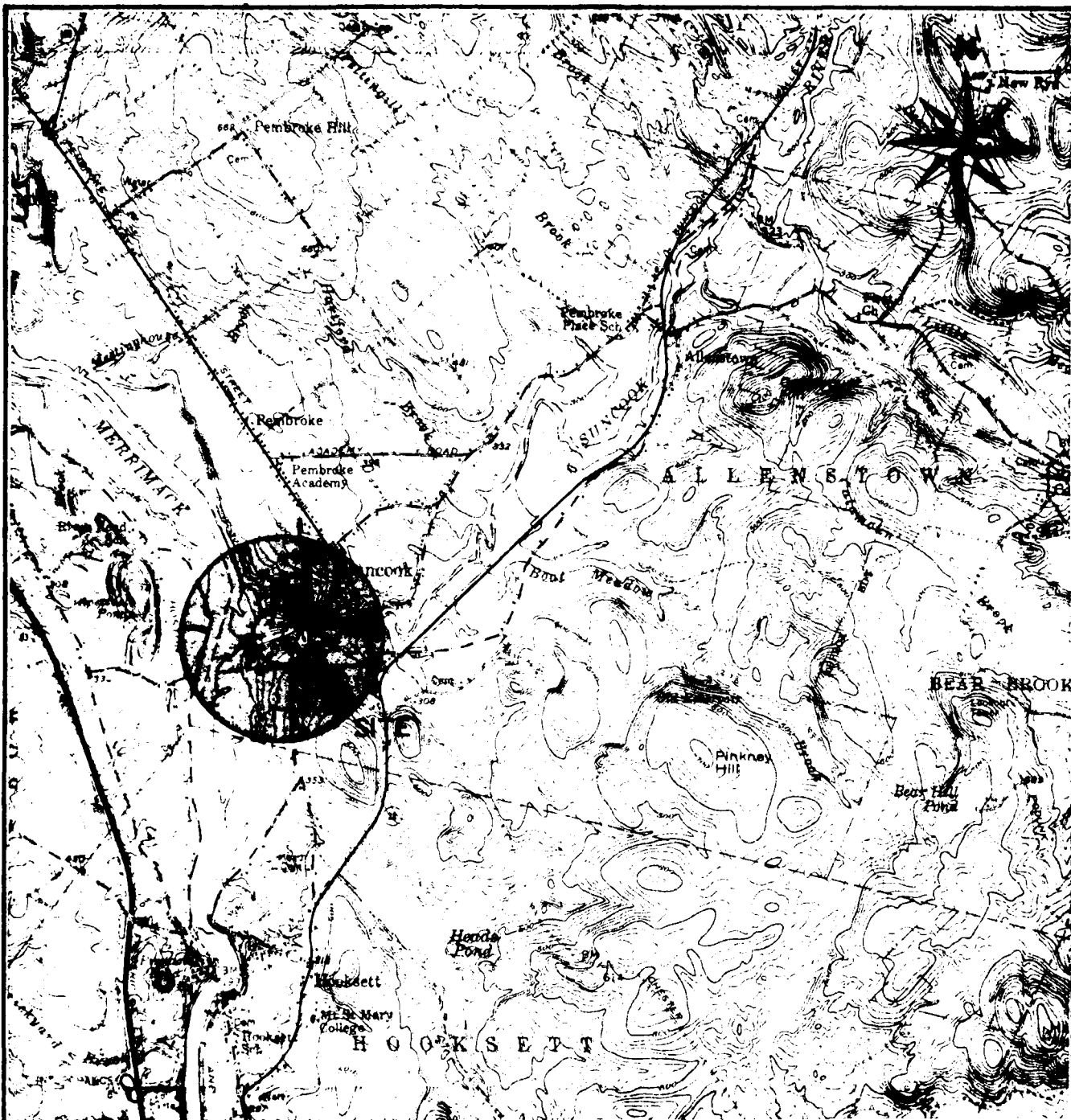
(1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

(2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

(3) Update, verify, and complete the National Inventory of Dams.

(c) Scope

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dam.



— SCALE —
 0 1/2 1 2 MILES
 FROM: USGS SUNCOOK, N.H.
 QUADRANGLE MAP

GOLDBERG, ZOINO, DUNNICLIFF & ASSOC., INC.
 GEOTECHNICAL CONSULTANTS
 NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV. NEW ENGLAND
 CORPS OF ENGINEERS
 WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCUS PLAN

FILE No. 2201

CHINA DAM

NEW HAMPSHIRE

			SCALE AS NOTED
			DATE NOVEMBER 1978



Overview from left side of downstream
channel



Overview from left abutment



Overview from right side of downstream
channel

The 90 degree return of the retaining wall is eroded to heights of four to five feet above the channel bed and to depths of 8 inches. The erosion and spalling is attributed to poor quality concrete, cavitation, and moisture intrusion which has been subjected to alternating freeze and thaw cycles. A crack extending the full height of the wall is located approximately 4 feet from the downstream end of the spillway training wall. The crack is about 1/2 inch wide. The expansive forces are so great that the original stone masonry is also cracked. The downstream end of the training wall and this portion of the return wall are leaning outwards. A 12 inch tree is growing behind this wall and, in all probability is the cause of the wall tilting. Seepage at the rate of approximately 15 to 30 gpm flows through the base of the interface of this wall and the downstream retaining wall.

The downstream retaining wall consists of 2 separate sections. The section closest to the dam is a stone masonry wall with a concrete facing; the second section is a dry stone masonry wall. The concrete-faced portion of the wall is eroded over its entire length to depths as great as 6 inches. This erosion is attributed to poor quality concrete, cavitation, ice damage, and moisture intrusion which has been subjected to alternating freeze and thaw cycles. Seepage at the rate of 1 to 2 gpm is flowing through the base of the concrete-faced and the stone masonry sections of the wall. Seepage flows out from the base of this wall at two other locations, but at a much lower rate. The stone masonry section is in fair condition with no evidence of displaced stones, bulging, or other signs of distress. No seepage was observed in this section of the wall.

(4) Waste Gate Structure (See Fig. 3 on pg. B-4)

The structure, located on the left upstream spillway training wall (part of the previously described "U" shaped structure), is a concrete structure housing a timber sluice gate. The gate was submerged at the time of inspection. The gate is operated with 2 hand wheels. The gate stems penetrate two 11 by 4 inch openings. The top of the stems are connected with a timber yoke. The bearing housing of the hand wheel shaft has been disconnected and displaced. The tie down bolts have been

removed. The gate stems are in good condition, however, the timber yoke is badly rotted.

Surface spalling was observed on the downstream face of the cantilevered section. This spalling is attributed to moisture intrusion which has been subjected to alternating freeze and thaw cycles. A vertical crack was observed on the right side of the upstream wall. This crack penetrates through the platform surface and terminates at the 11 inch by 4 inch stem openings. This observation indicates that this crack probably extends to the sluice gate. Vegetation is growing in this crack on the top surface of the slab.

(5) Headworks Structure and Appurtenances

The building portion of the structure is in fair condition. The timber sluice gates are in extremely poor condition.

The concrete foundation is supported by three intermediate piers and the canal walls. The concrete foundation walls and the deck slab are in good condition with the exception of isolated minor efflorescence on the exterior walls.

The three upstream piers separating the four sluice bay openings are severely eroded at the normal water level. The central pier is eroded to only about 25% of its initial cross-sectional area. The erosion of the other piers has reduced their cross-sectional area to about 75% of the original area. The erosion is attributed to poor quality concrete, ice damage, and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

The service deck spanning the upstream pier nosings is spalled over about 25% of its underside. The spalled area is up to 3 inches deep. The spalling is attributed to poor quality concrete, ice damage, and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

The three downstream sluice piers are severely eroded to a height of about 18 inches above the normal water line. Similar amounts of erosion have occurred below the water level. The depth of erosion is as great as 12 inches. The causes of the erosion are the same as described previously.

The left downstream canal wall, immediately adjacent to the headworks, is eroded for a height of 3 feet, a length of 6 feet, and a depth of 12 inches. The dry stone masonry wall, which was faced with concrete, is now completely exposed. The right canal wall was similarly eroded. The erosion on both walls is attributed to poor quality concrete, ice damage, and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

Each sluice gate is enclosed with a concrete gate pit equipped with an upstream access ladder. These gates were formerly operated with electric power, however, power has been disconnected to the structure. The manual operation of the gates is with two hand wheels. The hand wheels were bypassed when the gates were electrically operated.

For identification purposes Gate No. 1 is located at the left end (looking downstream) of the headworks structure, and the remaining gates are numbered consecutively to the right. Observations of these gates revealed the following:

Gate No. 1 - The base of the two vertical stems supporting the gate are rotted and the top of the gate is rotted. This gate is in a partially open position. The rack gears on the vertical stems are well lubricated. The timber gate, though deteriorating, appears operable. There is no visible seepage around the gate.

Gate No. 2 - This gate is completely submerged with no rack gears on the gate stems and has no lifting or operating mechanisms. The lower portion of the stems are rotted. Rubble fill has been placed on the upstream side of this gate.

Gate No. 3 - This gate appears to be in similar condition as that of Gate No. 1 except that its right bearing has been dislodged. At the time of inspection it was observed that this gate was about one inch above its seat. Discharge was observed through the gate opening. It could not be determined if seepage was flowing around this gate.

Gate No. 4 - The gate is in place, but all the operating mechanisms have been removed.

(6) Left End Wall (See Fig. 3 on pg. B-4)

This concrete gravity structure is severely spalled over 80% of its surface area. The average depth of spalling is 4 inches; the depth of spalling at normal water level is about 12 inches. The upstream return wall is similarly deteriorated. The spalling is attributed to poor quality concrete, ice damage, and moisture intrusion which has been subjected to alternating freeze and thaw cycles.

(7) Cut-Off Walls (See Fig. 3 on pg. B-4)

These concrete structures have diagonal and vertical cracks on their exposed faces. These cracks are the result of differential settlement of the walls.

3.2 Evaluation

The dam is in POOR condition, and the condition is a direct result of the lack of maintenance of the dam. Severe concrete erosion of all major structures was observed.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 Procedures

No operational procedures are performed at the dam.

4.2 Maintenance of Dam

No maintenance on the dam is presently performed.

4.3 Maintenance of Operating Facilities

Although there are several gates that appeared as though they might be in operating condition, or nearly operating condition, no periodic maintenance of the dam is performed.

4.4 Description of Any Warning System in Effect

There is no written formal warning system in effect for the dam.

4.5 Evaluation

The dam's present POOR condition is a direct result of the lack of maintenance of the dam and its operating facilities.

SECTION 5 - HYDRAULICS/HYDROLOGY

5.1 Evaluation of Features

(a) General

China Dam is a run-of-the-river dam on the Suncook River at Suncook, New Hampshire. The dam is about 750 feet downstream of Pembroke Dam, 800 feet downstream of the Main Street Bridge over the Suncook River, and 2,200 feet upstream of the river's confluence with the Merrimack River. The dam is a concrete gravity structure with an ogee spillway 143 feet in length. The spillway has a waste gate 8 feet wide by 12 feet long which is no longer operational. There is also a canal and headworks structure with four 6.33 feet by 8 feet sluice gates to the left of the spillway. This was once used to supply water for power to a downstream mill but is no longer used for that purpose.

(b) Design Data

Data sources available for China Dam include prior inventory and inspection reports. Much of the basic data for the dam is contained in the New Hampshire Water Control Commission's "Data on Dams in New Hampshire" (April 26, 1939), "Data on Water Power Developments in New Hampshire" (April 13, 1939); the New Hampshire Water Resources Board's "Inventory of Dams and Water Power Developments" (August 3, 1934), "Water Power Developments in New Hampshire" (January 28, 1948), and "Water Powers of New Hampshire" (July 10, 1942); and the Public Service Commission of New Hampshire's "Dam Record" (undated). Reports of inspections on June 5, 1918; June 14, 1950; and November 29, 1977 are available, as are 1917 plans and a 1939 sketch of the dam and spillway capacity calculations. There are also several letters dating from the late 1970's in which the New Hampshire Water Resources Board attempts to identify the dam's owner and initiate repairs.

More recent data includes a 1977 Flood Insurance Study by Anderson-Nichols and Company, Inc. (ANCO) which covers this portion of the Suncook River. This work included 10, 50, 100, and 500-year peak inflows, cross-section data at various points on the Suncook River (including the dam and various downstream locations), and HEC-2 runs for the 10, 50, 100, and 500-year flows.

(c) Experience Data

No long-term records of stage or discharge are known to be available at China Dam. USGS Water Supply Paper 798, "The Floods of March 1936", gives a peak flood discharge of 12,100 cfs at China Dam on March 19, 1936. This is the flood of record for this location.

(d) Visual Observations

The channel downstream of China Dam is rather narrow and confined between steep banks for a distance of about 500 feet to a location where the river is crossed by a conduit bridge having a clear span of about 98 feet. In this general area, a number of homes are located at an elevation of about 216.9 feet, or about 15 feet above the stream bed. China Mill is at an elevation of 205 feet slightly downstream of the bridge. Below the conduit structure the floodplain of the river widens considerably before joining the Merrimack River another 1700 feet further on.

(e) Test Flood Analysis

The hydrologic conditions of interest in this Phase I investigation are those required to assess the dam's overtopping potential and its ability to safely allow an appropriately large flood to pass. This requires using the discharge and storage characteristics of the structure to evaluate the impact of an appropriately sized Test Flood. None of the original hydraulic and hydrologic design records are available for use in this study.

Guidelines for establishing a recommended Test Flood based on the size and hazard classification of a dam are specified in the "Recommended Guidelines" of the Corps of Engineers. The impoundment of less than 1000 acre-feet and the height of less than 40 feet classify this dam as a SMALL structure.

The appropriate hazard classification for this dam is LOW. Although the failure of China Dam would cause a 2.5 to 4.0 foot rise in downstream water surface, the surface would still be below a hazardous level. It is unlikely that failure of China Dam would cause loss of life or serious economic losses.

As shown in Table 3 of the Corps of Engineers' "Recommended Guidelines," the appropriate Test Flood for a dam classified SMALL in size with a LOW hazard potential would be between the 50-year flow and the 100-year flow. ANCO's Flood Insurance Study gives a 50-year flow of 12,190 cfs and a 100-year flow of 15,115 cfs. Since the hazard classification is on the low side of LOW, the 50-year flow of 12,190 cfs is appropriate for use as the Test Flood for this dam. The peak elevation created by the flow of 12,190 cfs would be 233.8 feet MSL, 8.0 feet above the spillway, and 1.0 foot above the dam crest.

China Dam would be overtopped by one foot by the Test Flood of 12,190 cfs. However, because of the large channel capacity of the Suncook River and limited development downstream of the dam, a dam failure would cause little or no damaging flooding.

(f) Dam Failure Analysis

The peak outflow that would result from the failure of China Dam is estimated using the procedure suggested in the Corps of Engineers New England Division's April 1978 "Rule of Thumb Guidelines for Estimating Downstream Dam Failure Hydrographs," as clarified in a December 7, 1978 meeting at the Corps' Waltham office. Failure is assumed to occur with the water surface elevation at the top of the abutments, 7.0 feet above the spillway crest at an elevation of 232.8 feet above Mean Sea Level (MSL).

To determine the normal discharge at the failure stage, refer to the Stage-Discharge curve in Appendix D. The discharge prior to failure with the water levels 7.0 feet above the spillway would be 9800 cfs as determined from the Stage-Discharge curve. The tailwater prior to failure would be 212.4 feet MSL, 13.4 feet below the spillway.

With a 55 foot gap opened in the spillway, dam failure would cause the flow to increase by 8520 cfs to 17,320 cfs. This would increase the tailwater elevation at the dam by 3 feet to 215.4 feet MSL.

There are 3 areas vulnerable to flooding downstream of China Dam. Between 50 feet and 100 feet downstream is a group of houses on the north bank at about elevation 216.0 feet MSL. The water surface elevation

at the houses would increase from 211.1 feet MSL to 213.6 feet MSL, which would not cause flooding. There is also a sewer trestle across the Suncook 500 feet downstream of China Dam, which would not be harmed by a dam failure flood wave. The last area of concern is China Mill, which is on the south bank from 500 to 1000 feet downstream of China Dam at about elevation 205.0 feet MSL. Dam failure would raise the water surface from 199.4 feet MSL to 203.3 feet MSL. The mill should not be damaged. Below the mill there is no development along the Suncook, which enters the Merrimack River about 2200 feet downstream of China Dam. The dam failure flood wave would quickly attenuate in the Merrimack.

SECTION 6 - STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

(a) Visual Observations

The field investigation revealed no significant displacement or distress that would warrant the preparation of structural stability calculations, based on assumed sectional properties and engineering factors.

The concrete in the right abutment structures and training walls, the left spillway end wall, the spillway, and the headworks structure are spalled and eroded. There is also some minor seepage. The gates in the headworks structure are rotted.

(b) Design and Construction Data

No plans or calculations of value to a stability assessment are available for this dam.

(c) Operating Records

No operating records are available for the dam.

(d) Post Construction Changes

The only post construction change that is noted for the dam is the addition of the concrete piers and steel trestle for the steam pipe that used to run across the dam. These additions did not affect the stability of the dam.

(e) Seismic Stability

The dam is located in Seismic Zone No. 2 and, in accordance with recommended Phase 1 guidelines, does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

(a) Condition

China Dam is in POOR condition at the present time. The outward tilting at the left downstream training wall must be corrected to prevent a possible failure. Furthermore, the deteriorated condition of the concrete in the appurtenant structures will require repair of the concrete faces in the near future.

(b) Adequacy of Information

The lack of in-depth engineering data does not permit a definitive review. Therefore, the adequacy of the dam cannot be assessed from the standpoint of reviewing design and construction data. This assessment is based primarily on the visual inspection, past performance, and sound engineering judgment.

(c) Urgency

The engineering studies, recommendations, and remedial measures should be implemented by the owner within one year of receipt of the Phase I report.

(d) Need for Further Investigation

Additional investigations should be performed by the owner as outlined in paragraph 7.2.

7.2 Recommendations

It is recommended that the services of a registered professional engineer be retained to:

- a) Perform an engineering study of the seepage flow and tilting of the left downstream training wall.
- b) Perform an engineering study of the condition of the waste gate, outlet tunnel, and other structures below the normal water level. This will probably require drainage of the impoundment pool.

- (c) Perform an engineering evaluation for rehabilitation or sealing of the sluice gates in the headworks structure.

The findings of these studies should be implemented.

7.3 Remedial Measures

The following remedial measures should be undertaken by the owner:

- a) Remove all trees and their roots on either side of the downstream canal with special emphasis on the trees at the left downstream canal training wall.
- b) Clear debris from downstream channel.
- c) Repair all deteriorated walls.
- d) Repair crest and ogee face of spillway.
- e) Institute a program of annual technical inspections.

7.4 Alternatives

Breaching the dam is a possible alternative to the above recommendations.

APPENDIX A
VISUAL INSPECTION CHECKLIST

INSPECTION TEAM ORGANIZATION

Date: November 7, 1978

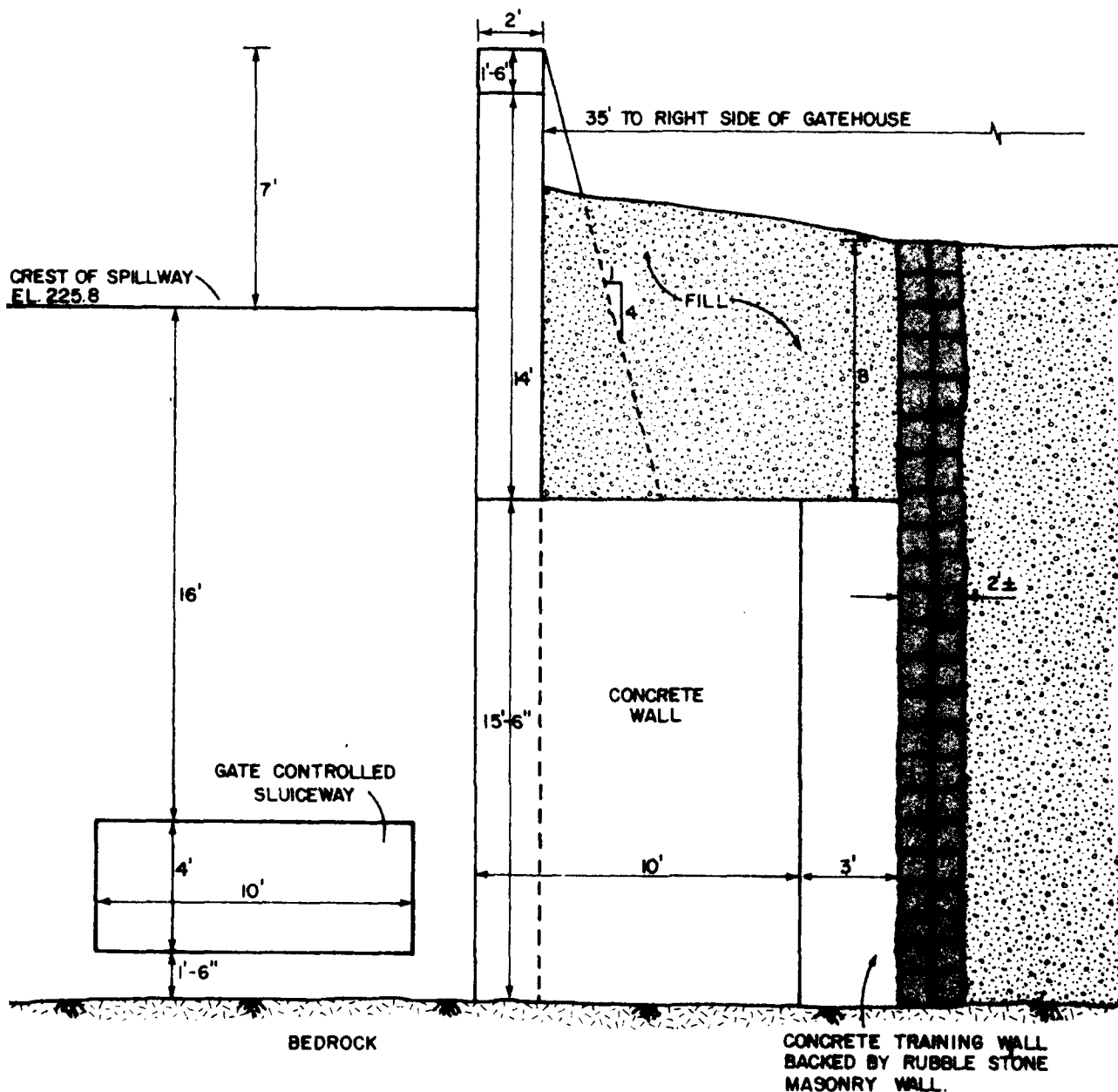
NH 00023
CHINA DAM
Allentown-Pembroke, New Hampshire
Suncook River
NHWRB 190.01

Weather: Overcast, 55° F ±

INSPECTION TEAM

Nicholas Campagna	Goldberg, Zoino, Dunnicliff & Associates, Inc. (GZD)	Team Captain
William Zoino	GZD	Foundations
Robert Minutoli	GZD	Soils
Andrew Christo	Andrew Christo Engineers (ACE)	Structural
Joe Mazgha	ACE	Concrete
Richard Laramie	Resource Analysis, Inc.	Hydrology

The inspection team was accompanied by Mr. Pattu Kesavan of the New Hampshire Water Resources Board.



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CORPS OF ENGINEERS
WALTHAM, MASS.

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FIGURE 4
ELEVATION OF LEFT END OF
SPILLWAY FROM DOWNSTREAM

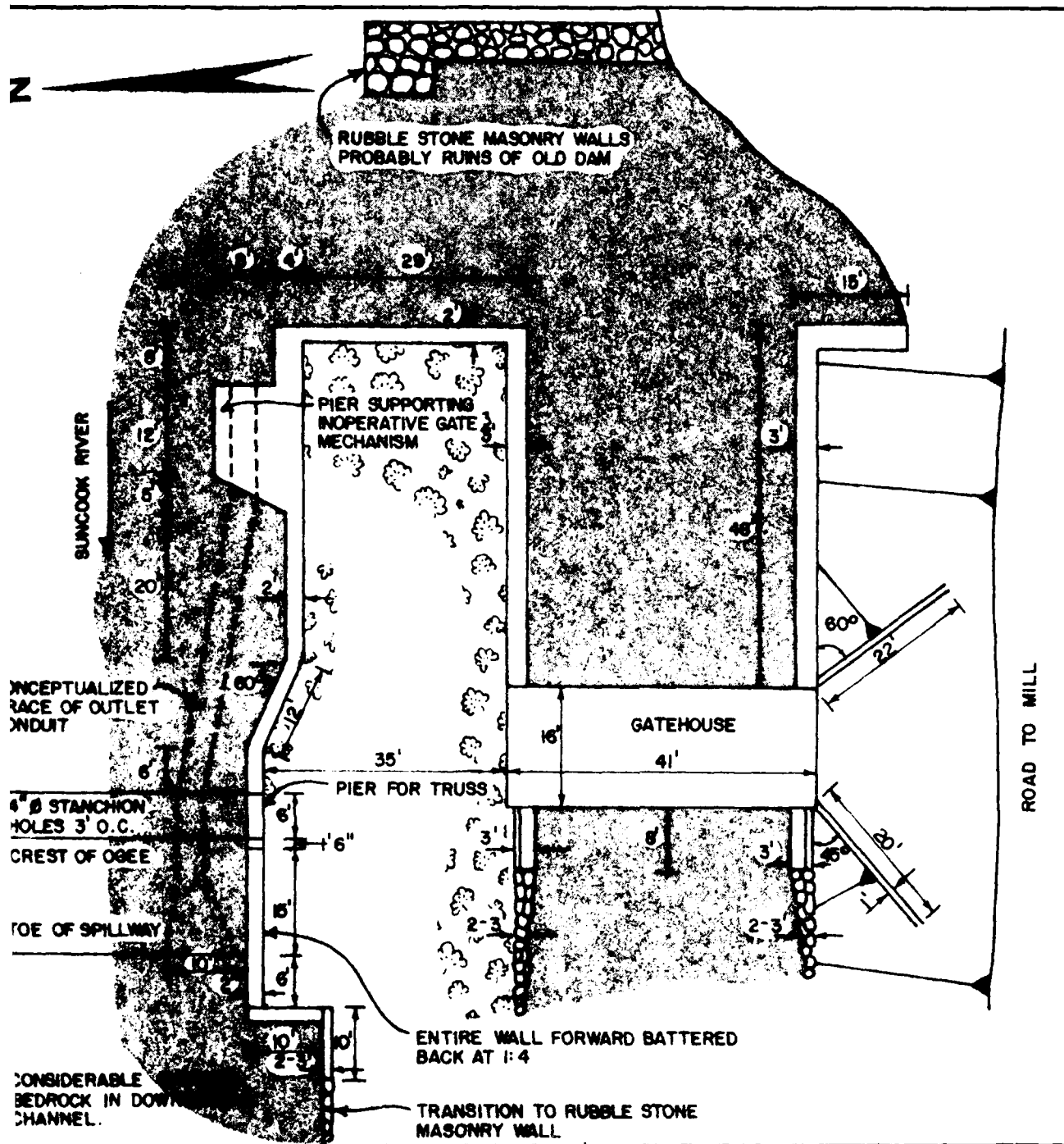
FILE No. 2201

CHINA DAM

NEW HAMPSHIRE

SCALE 1" = 5'

DATE NOVEMBER 1978



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U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

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FIGURE 3

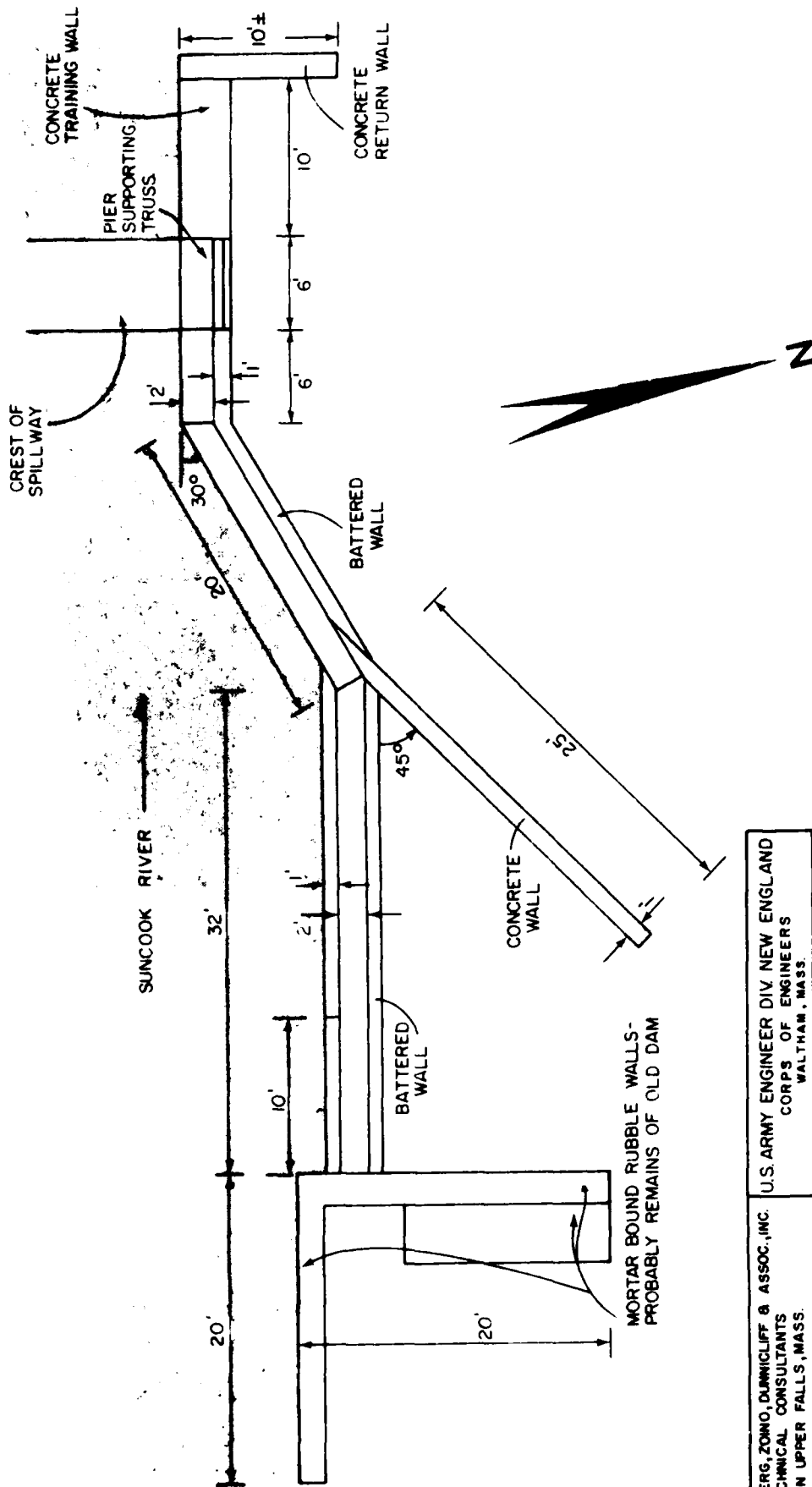
PLAN OF LEFT SIDE OF DAM

FILE No. 2201

CHINA DAM

SCALE 1" = 20'

DATE NOVEMBER 1978



FILE No. 2201

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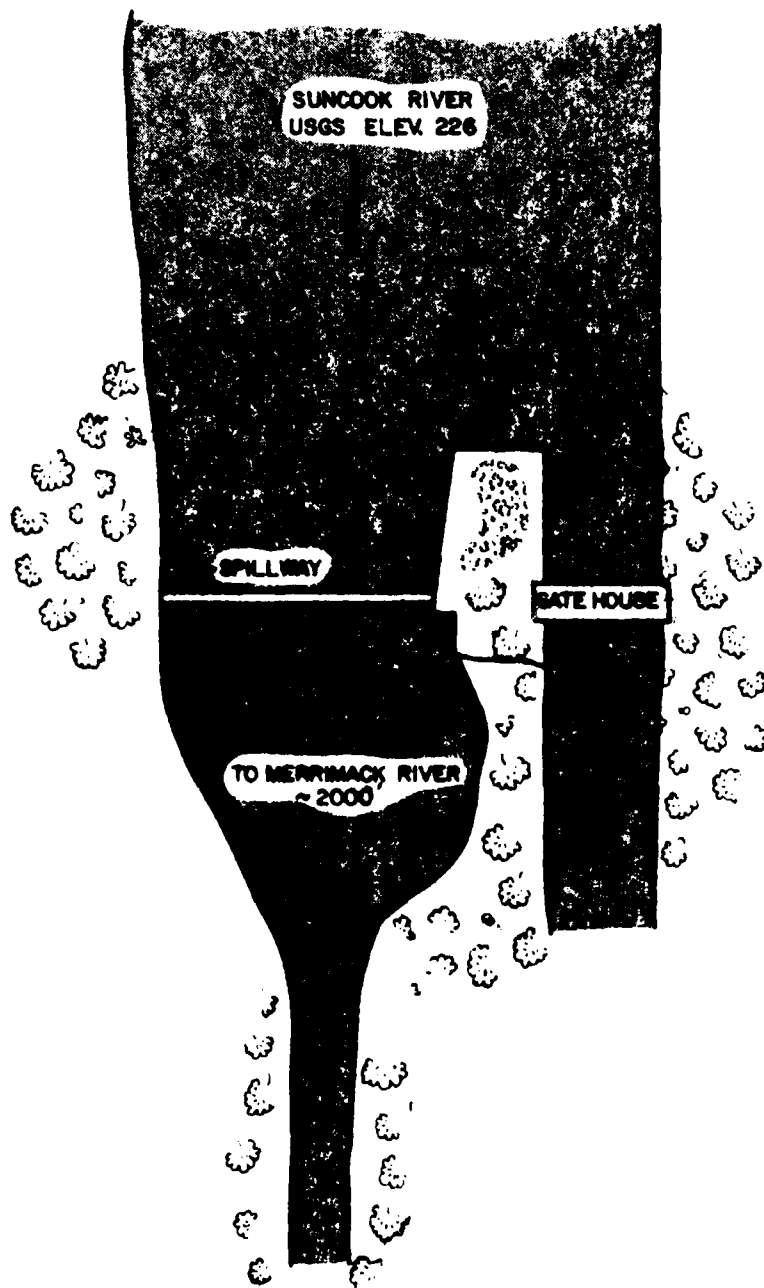
FIGURE 2

PLAN OF RIGHT ABUTMENT STRUCTURE

CHINA DAM

NEW HAMPSHIRE

SCALE	1" = 10'
DATE	NOVEMBER 1978



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SITE PLAN

FILE No. 2201

CHINA DAM

NEW HAMPSHIRE

SCALE 1" = 100'

DATE NOVEMBER 1978

APPENDIX B

		<u>Page</u>
FIGURE 1	Site Plan	B-2
FIGURE 2	Plan of Right Abutment Structure	B-3
FIGURE 3	Plan of Left Side of Dam	B-4
FIGURE 4	Elevation of Left End of Spillway From Downstream	B-5
FIGURE 5	Elevation of Gatehouse From Downstream	B-6
	Plan of Spillway	B-7
	List of Pertinent Data Not Included and its Location	B-8

CHINA DAM
Allenstown-Pembroke, NH

November 7, 1978
NH 00023

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
OPERATION AND MAINTENANCE FEATURES		
A. Reservoir regulation plan	NAC	None exists
B. Maintenance	NAC	No recent maintenance. A rigorous maintenance program is needed

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
C. Headworks Structure and Appurtenances (cont.) Sluice gates (cont.)	AC	Gate #4 completely dismantled with exception of gate. One stem resting in gate pit. All operating mechanisms removed
D. Outlet Canal Bottom conditions Trees overhanging canal	NAC	Silty earth bottom Many birches hanging over canal. Several birch trees growing out of left side rubble wall
RESERVOIR		
A. Shoreline		No evidence of slides or potential slides noted
B. Sedimentation		Sand and silt to within 2 ft. of spillway crest at left end of spillway
C. Upstream hazards in the event of backflooding		Old mill building on right shore about 700 ft. upstream of the dam
D. Changes in nature of watershed		None noted
DOWNSTREAM CHANNEL		
A. Bottom condition		Rocky
B. Trees overhanging channel		Several trees growing in channel, other overhang channel
C. Debris in channel	NAC	One uprooted tree in channel

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Erosion	AC	Upstream and downstream pier nosings severely eroded. Upstream center pier eroded through 75% of its cross section at water level. Right and left and all downstream piers eroded through 25% of their cross section. Immediate downstream concrete faced canal walls eroded up to 12" deep at normal water level
Cracking		Minor on pier faces
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Minor and isolated
Seepage		None noted
Sluice gates		Poor condition. Electric operating drive partially dismantled. No power distribution to building. Base of 2 vertical stems and top of gate #1 are rotted. Although deteriorating it appears operable. No visible seepage around gate
		Gate #2 completely submerged. No rack gears on stems or lifting and operating mechanisms. Rubble fill placed on upstream side of gate
	AC	Gate #3 appears to be operable however, right bearing is dislodged. Unseated by approximately 1". Discharge under gate

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
A. Spillway (cont.)	AC	
Cracking		Random horizontal joints prevalent over entire face of ogee sections. Horizontal cracks on granolithic capping over right and middle third of crest with intermittent vertical cracks. Vertical construction joint opened
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Minor at random locations
Seepage		None noted
B. Waste Gate Structure		
Condition of concrete		Fair. Downstream face of cantilevered section spalled
Gate operating mechanisms		Fair
Timber sluice gate		Submerged
Gate stems		Fair
Gate yoke		Rotted
Tunnel outlet	AC	Could not be observed
C. Headworks Structure and Appurtenances		
General condition of building		Fair, lacks maintenance
General condition of concrete		Poor

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
E. Cut-off Walls	AC	
Condition of concrete		Fair
Spalling		None noted
Erosion		None noted
Cracking		Horizontal and vertical cracks
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		None noted
Seepage		None noted
OUTLET WORKS		
A. Spillway	AC	
Condition of concrete		Poor
Spalling		See erosion
Erosion		Severe. Right third of ogee eroded from crest downward for 10', up to 6" in depth. Middle third has erosion patterns 18" to 20" wide tapering to 6", 10' to 30' long and up to 6" deep. Left third similar to middle third. Minor erosion on crest granolithic capping. Vertical construction joint 20' from left abutment eroded up to 3" deep

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
C. Left Spillway End Wall and "U" Wall (cont.)	PR	
Seepage		Seepage at the rate of 15 to 30 gpm is flowing out of the interface of the downstream concrete faced and dry stone masonry wall. Seepage is flowing at the rate of 1 to 2 gpm under the downstream concrete faced wall. Seepage at less than 0.5 gpm is flowing through the base of the connection between the return wall and the downstream wall
Dry stone training wall		No evidence of displaced stones, bulging or other signs of distress
D. Left End Wall		
Condition of concrete		Very poor
Spalling		Extensive over entire length and return into left bank. Spalled up to 80% of their vertical faces. Average depth 4", up to 12" at normal water line
Erosion		See spalling
Cracking		Random cracking over balance of wall
Rusting or staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence		Front face of wall above spalling
Seepage	PR	None noted

CHECK LISTS FOR VISUAL INSPECTION

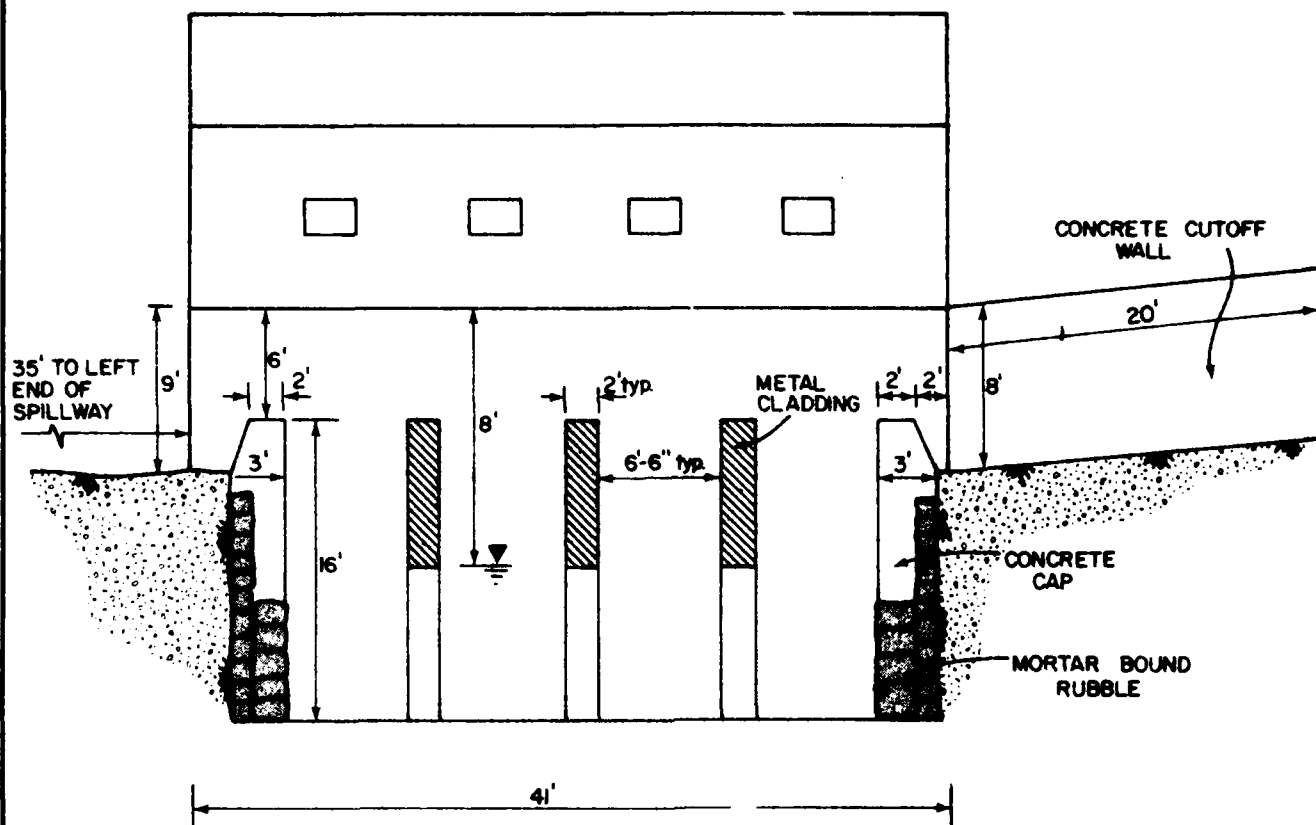
AREA EVALUATED	BY	CONDITION & REMARKS
C. Left Spillway End Wall and "U" Wall (cont.)		
Erosion	PR	See spalling. Interface between abutment and spillway eroded up to 15" deep over its entire length. Void in concrete at bedrock level 3 s.f. x 8" deep. Additional erosion 2' above approximately 16 s.f. up to depths of 8"
		90° return wall eroded from base up 4' with depths up to 18"
		Base of downstream training wall eroded over its entire length up to 24" deep
Cracking		Random cracking on front and back face of right canal wall, upstream end and left wall up to waste gate structure. Corner of return wall has crack 1/2" wide. Downstream end of abutment deflected outward. Stone masonry under this wall cracked due to outwards deflection
Rusting of staining of concrete		None noted
Visible reinforcing		None noted
Efflorescence	PR	Front and back face of right canal wall, upstream end and left wall up to waste gate structure effloresced over non-spalled areas

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
Visible reinforcing	AC	None noted
Efflorescence		Minor at top of upstream training wall. Minor on vertical face of downstream low wall
Seepage		Minor seep (less than .05 gpm) at the base of the downstream end of downstream training wall. Water is clear
Honeycombing		Minor on upstream training wall
Rotation		The cut-off wall has stated downstream 6" + with a 1" open joint adjacent to upstream training wall
Stone masonry training wall	AC	No deficiencies noted
C. Left Spillway End Wall and "U" Wall		
Condition of concrete		Very poor
Spalling		Extensive along entire length of right canal wall, upstream wall and left wall upstream of waste gate structure. These walls spalled over 80% of their vertical faces. Average depth of 4". Spalling at normal water line averages 18" deep up to 2' high. In some cases up to 2' deep. Minor surface spalling on top of wall
		Top of sloping downstream wall spalled up to 4" deep over its entire length

CHECK LISTS FOR VISUAL INSPECTION

AREA EVALUATED	BY	CONDITION & REMARKS
DAM SUPERSTRUCTURE		
A. General		
Vertical alignment and movement	AC	No deficiencies noted
Horizontal alignment and movement		Left downstream training wall deflected outward
B. Right Abutment Structure		
Condition of concrete		Poor
Spalling		The top of the upstream training wall has been subjected to minor surface spalling. Downstream extension severely spalled, up to 2' on top sloping surface and over 2/3 of its vertical face up to depths of 12". Vertical construction joint between end of sloping wall and continuation is spalled
Erosion		Face of upstream training wall subjected to surface erosion at normal water level. Downstream sloping wall is eroded over entire length of interface with bedrock
Cracking		Minor longitudinal cracks on upstream training wall. Minor random cracking on top surface. The downstream low wall has a diagonal crack 1-1/2" wide and 2' long. Vertical construction joint opened
Rusting or staining of concrete	AC	None noted



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NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS
FIGURE 5
ELEVATION OF GATEHOUSE
FROM DOWNSTREAM

FILE No. 2201

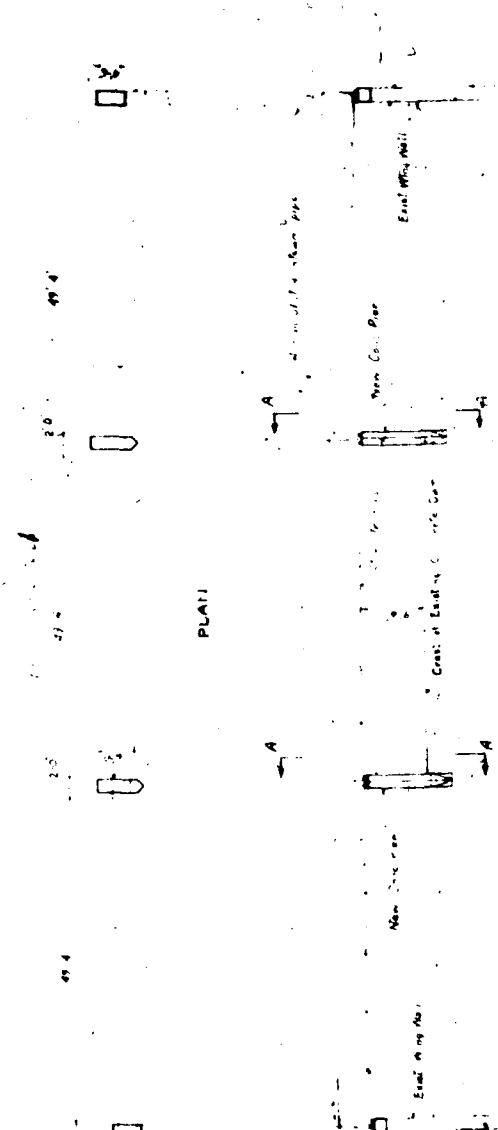
CHINA DAM

NEW HAMPSHIRE

SCALE 1" = 10'

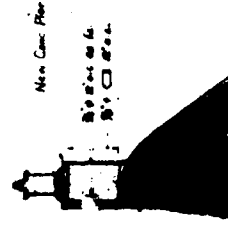
DATE NOVEMBER 1978

NOTE: DRAWING HAS BEEN REDUCED
 SCALES ARE NOT AS SHOWN



PLAN

ELEVATION
 Scale: 1" = 10'



SECTION A-A



Scale: 1" = 10'

PIERS on EXISTING DAM
 for support of
 STEAM PIPE LINE
 TEXTRON INC
 Searsville, N.H.

Notes:
 Piers to be constructed having an
 ultimate span of 24' or less
 than 2500' per sq ft
 For location of Dam & Pier see
 See Drawing



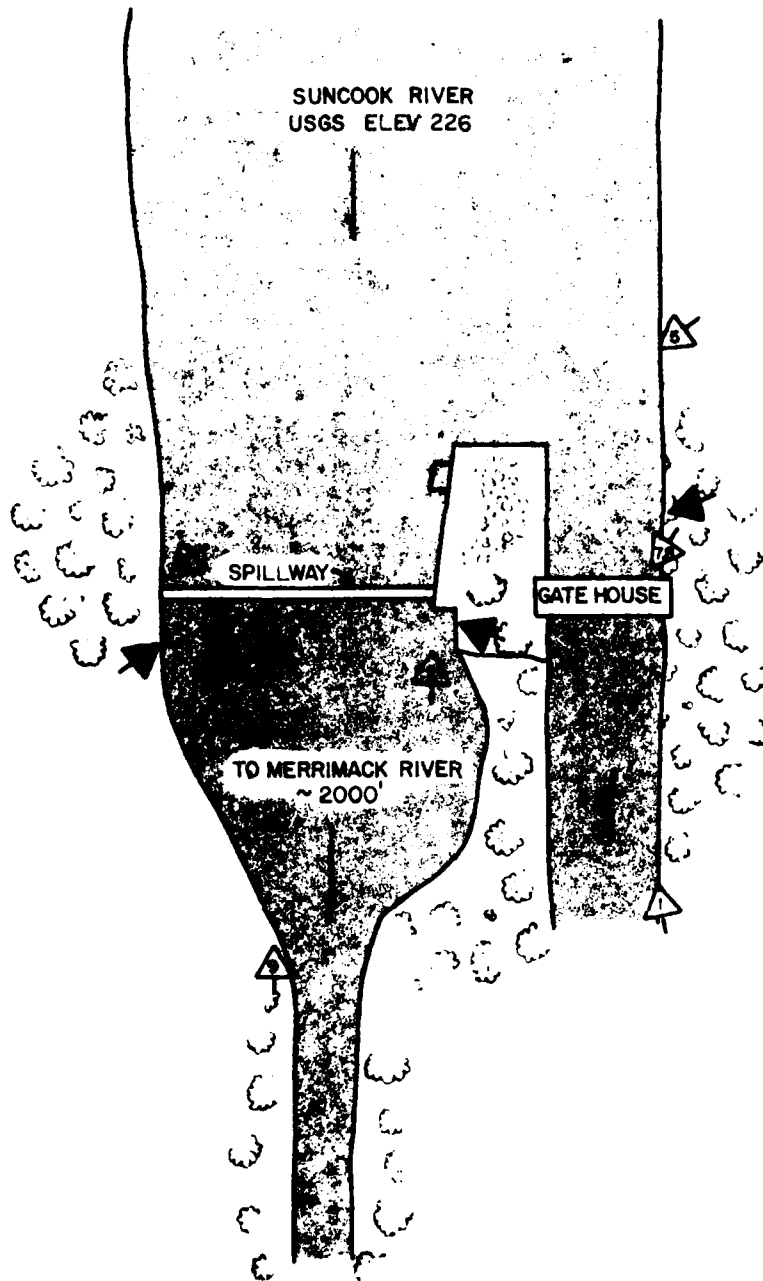
JOSEPH E. BODINE
 Professional Engineer
 License No. 1000
 State of New Hampshire

The New Hampshire Water Resources Board (NHWRB) located at 37 Pleasant Street, Concord, NH, 03301 maintains a comprehensive correspondence file for this dam. Some of the items included in the file are:

- (1) USGS "Report on China Dam" dated June 5, 1918.
- (2) NHWRB "Inventory of Dams and Water Power Developments" dated August 3, 1934.
- (3) The New Hampshire Water Control Commission's (NHWCC) "Water Power Developments in New Hampshire" dated April 26, 1939.
- (4) NHWCC "Data on Dams in New Hampshire" dated April 26, 1939.
- (5) NHWCC "Petition for Approval of the Construction or Repair of Dam" dated October 16, 1950 regarding the construction of the steam line structure.
- (6) NHWRB inspection reports dated June 1950 and November 1977.

APPENDIX C
SELECTED PHOTOGRAPHS

N



➡ OVERVIEW

▷ APPENDIX C

GOLDBERG, ZIMMO, DUNNCLIFF & ASSOC., INC.
GEOTECHNICAL CONSULTANTS
NEWTON UPPER FALLS, MASS.

U.S. ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

LOCATION AND ORIENTATION OF PHOTOS

FILE NO. 2201

CHINA DAM

NEW HAMPSHIRE

SCALE 1" = 100'

DATE NOVEMBER 1978



1. View of abandoned diversion channel from downstream looking towards old gatehouse



2. View of erosion and seepage under left spillway endwall from downstream channel



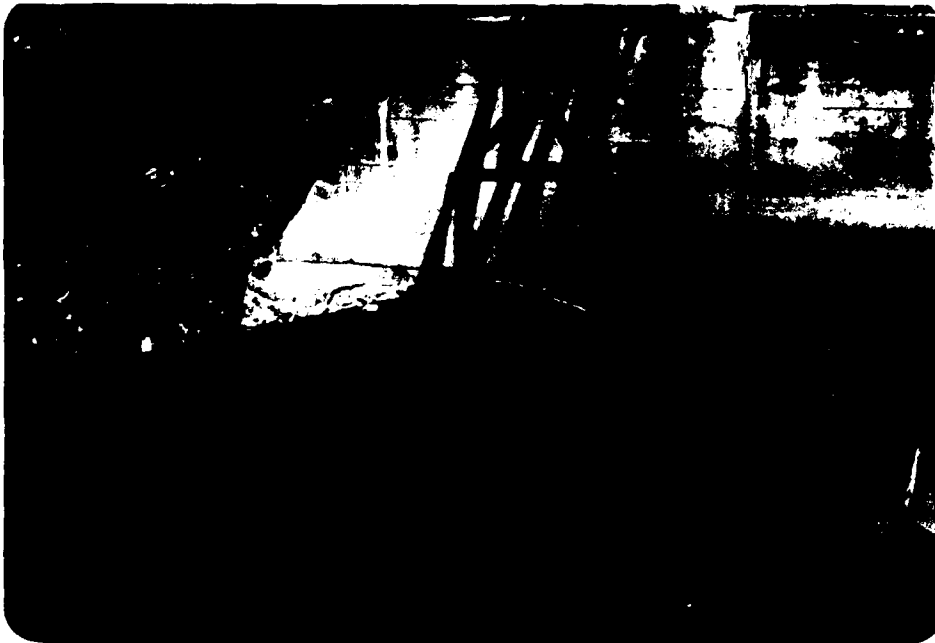
3. View of right abutment from left side of spillway showing bedrock foundation and deterioration of concrete



4. Detail of above photo showing deterioration of spillway surface



5. View of deterioration of concrete facing on upstream end of natural ground between main channel and diversion



6. View of deterioration of upstream face of spillway crest from upstream



7. View of upstream side of abandoned gatehouse showing deterioration of concrete training walls



8. Detail of above photo showing deterioration of concrete

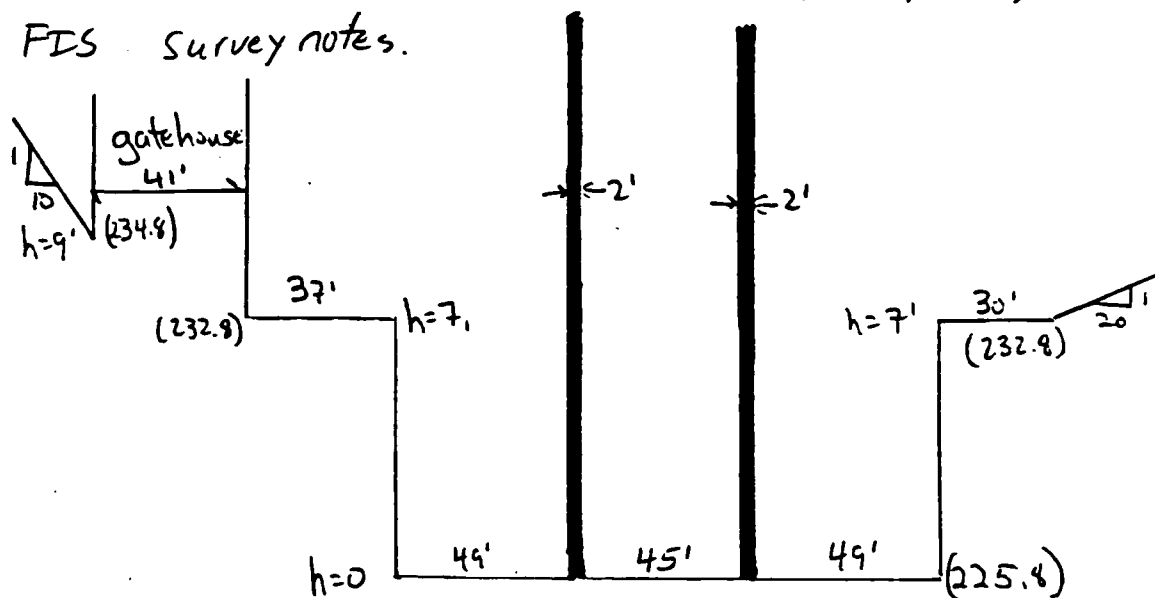


9. View of downstream channel looking
upstream at spillway

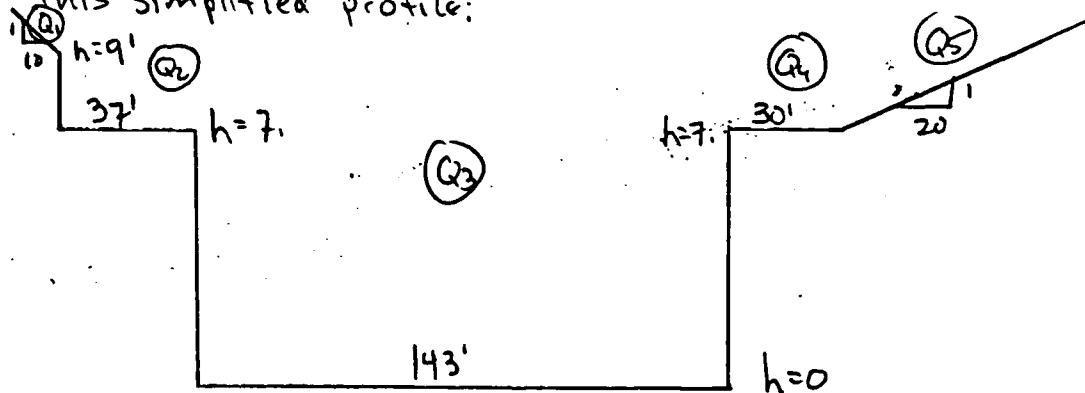
APPENDIX D
HYDROLOGIC/HYDRAULIC COMPUTATIONS

Stage- Discharge Curve.

The information used to establish the cross-section at China Dam was determined from field notes, old plans, and ANCO FDS survey notes.



The discharge over the profile shown above is equivalent to that over this simplified profile:



$h=0$ at spillway crest

No operable gates

for $h=0$ to 7

$$Q_3 = 3.7 (143) (h)^{3/2}$$

$$Q_1 = Q_2 = Q_4 = Q_5 = 0 \quad D-2$$

Ogee weir
 $C=3.7$

for $h = 7$ to 9

$$Q_2 = 2.5(37)(h-7)^{3/2}$$

$$Q_4 = 3.3(30)(h-7)^{3/2}$$

$$Q_5 = 2.8(20)(h-7)(.5(h-7))^{3/2}$$

all others unchanged

for $h > 9$

$$Q_1 = 2.8(10)(h-9)(.5(h-9))^{3/2}$$

all others unchanged.

for broad-crested
earth weir, overgrown
 $\rightarrow C = 2.5$

for sharp-crested
weir
 $\rightarrow C = 3.3$

for broad-crested
earth weir
 $\rightarrow C = 2.8$

A BASIC program to calculate a stage-discharge curve is shown on pp. 3-5

There is a gate at the dam which could be made operable. This 5' x 18' gate leads to a 4' x 10' conduit through the spillway. If we assume that the 4' x 10' conduit controls flow as a slot (with invert 20' below the spillway crest), this equation applies:

$$Q = A \sqrt{2g} C_d \sqrt{H}$$

$A = \text{area} = 40 \text{ sq. ft.}$

$H = \text{average head} = h + 18$

$C_d = \text{coefficient} = f \frac{b}{2H} = f \left(\frac{4}{36} \right) \text{ at spillway level} \rightarrow .614$

With the water surface at the spillway:

$Q = 40 \sqrt{2g} (.614) \sqrt{18} = 836 \text{ cfs.}$ Thus the gate could carry 836 cfs with the water at spillway level if it were open.

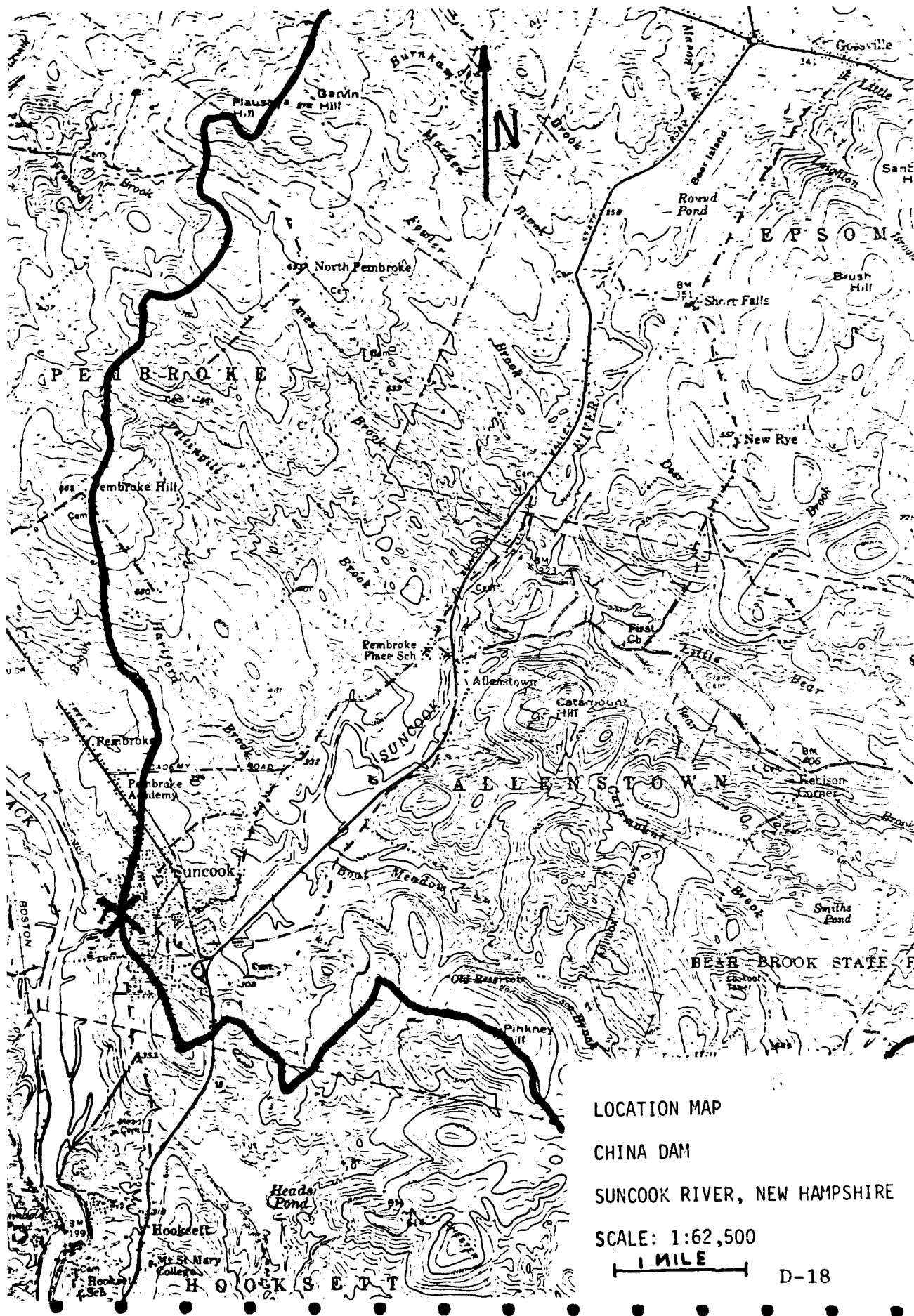
* Rouse, Engineering Hydraulics, p. 48-3 + Figure 36, Rouse, p. 50

P.3

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LIST REM: STAGE DISCHARGE PROGRAM FOR PEMBROKE CHINA DAM, JOB 165
100 REM: ON TAPE 10, FILE 60
120 PAGE "DISCHARGE FROM CHINA DAM AS A FUNCTION OF HEAD ABOVE SPILLWAY"
130 PRI "DISCHARGE FROM CHINA DAM AS A FUNCTION OF HEAD ABOVE SPILLWAY"
140 PRINT USING 150:
150 IMAGE // 2T*HEAD"30T"DISCHARGE"
160 PRINT USING 170:
170 IMAGE 1T"(FEET)"32T"(CFS)"
180 PRINT USING 190:
190 IMAGE 15T"TOTAL"8X"LEFT BANK"8X"RIGHT BANK"8X "SPILLWAY"
200 FOR H=0 TO 13 STEP 0.5
210 Q1=0
220 Q2=0
230 Q4=0
240 Q5=0
250 Q3=3.7*143*H^1.5
260 IF H<=7 THEN 320
270 Q2=2.5*37*(H-7)^1.5
280 Q4=3.3*30*(H-7)^1.5
290 Q5=2.8*20*(H-7)*(0.5*(H-7))^1.5
300 IF H<=9 THEN 320
310 Q1=2.8*10*(H-9)*(0.5*(H-9))^1.5
320 T1=Q1+Q2
330 T2=Q5+Q4
340 T3=T1+T2+Q3
350 PRINT USING 360:H,T3,T1,T2,Q3
360 IMAGE 2T,2D.1D,14D,15D,18D,17D
370 NEXT H
380 END

```



LOCATION MAP

CHINA DAM

SUNCOOK RIVER, NEW HAMPSHIRE

SCALE: 1:62,500

1 MILE

D-18

TEST FLOOD ANALYSIS:

Size Classification: SMALL

HAZARD CLASSIFICATION: LOW

The hazard classification is LOW because the failure of China Dam would create little or no significant downstream flooding. The failure would cause a 2.5'-4' rise in downstream water levels, but the flow would remain below the levels likely to cause damage.

Test Flood: 50 year to 100 year

Arco gives a fifty year discharge of 12,190 cfs and a 100 year discharge of 15,115 cfs. Because the hazard is on the low side of low, we will use 12,190 cfs. ($\frac{12,190 \text{ cfs}}{259 \text{ sq. mi}} \rightarrow 47.1 \text{ csm}$)

Due to the large drainage area (see map, p. 17) and small storage available (Storage - Elevation curve, p. 7), this flow would not be significantly attenuated by the pond behind China Dam.

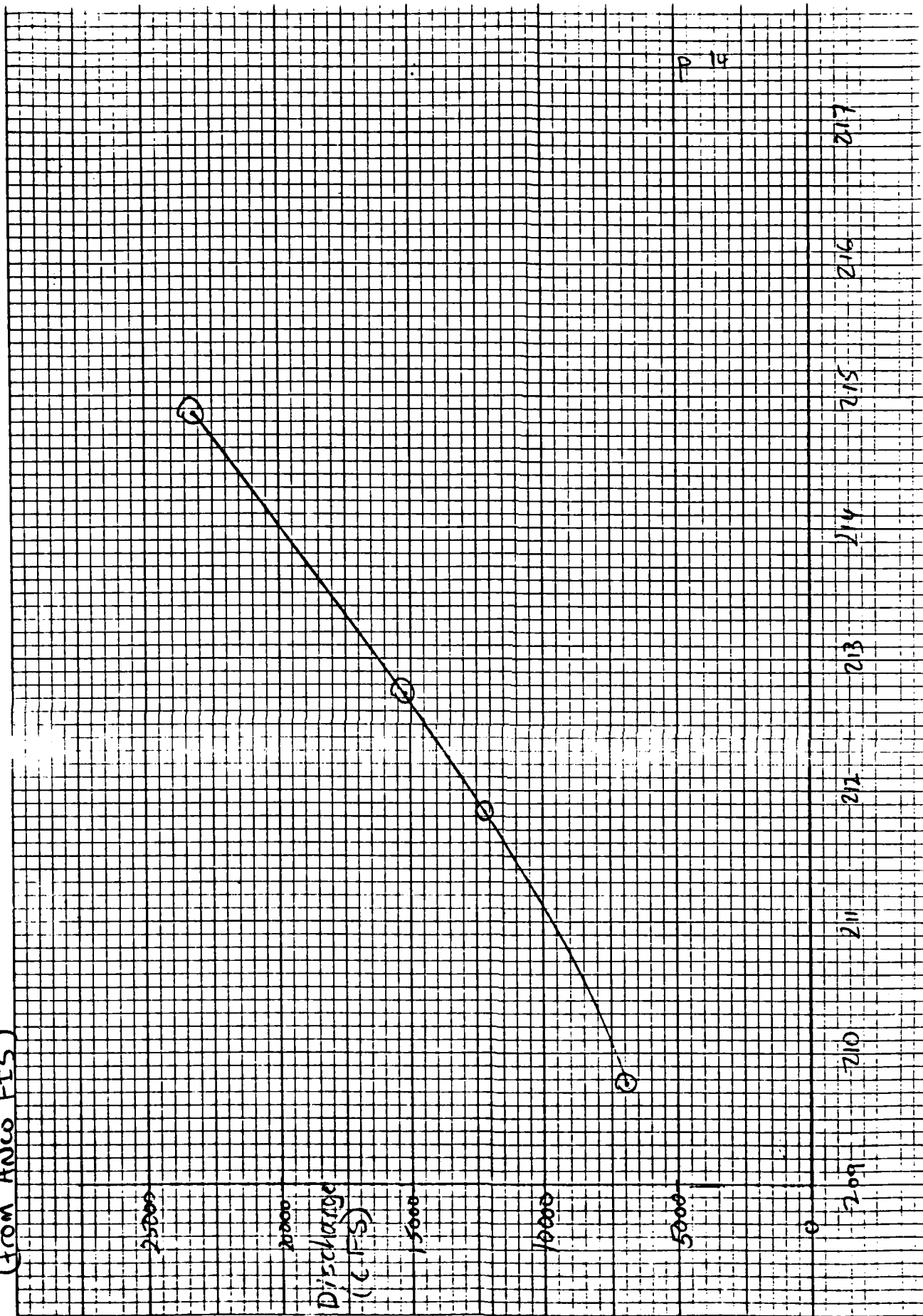
The flow of 12,190 cfs would produce a stage of about 8.0' above the spillway (1.0' above the dam crest, elevation 233.4')

Elevation at Upstream End of China Mill vs. Discharge,
(from ANCO FIS)

P-15



Elevation at houses 50' downstream of China Dam vs. Discharge
(from ANCO FIS)



165 Dam Safety

China Dam, # 14 TCG, 2/17/79, p. 3

About 50'-100' downstream of the dam there are four houses ^{on the North bank} with the ground floors at 216.0' MSL. The Discharge-Elevation curve for the Suncook River at these houses is on p. 14

Before failure: $Q = 9800 \rightarrow 211.1' \text{ MSL}$

After failure: $Q = 18,320 \rightarrow 213.6' \text{ MSL}$. The houses are not affected by the flood wave.

The sewer trestle across the Suncook about 450' downstream of the dam is high enough that it would not be affected by the flood wave or constrict flow.

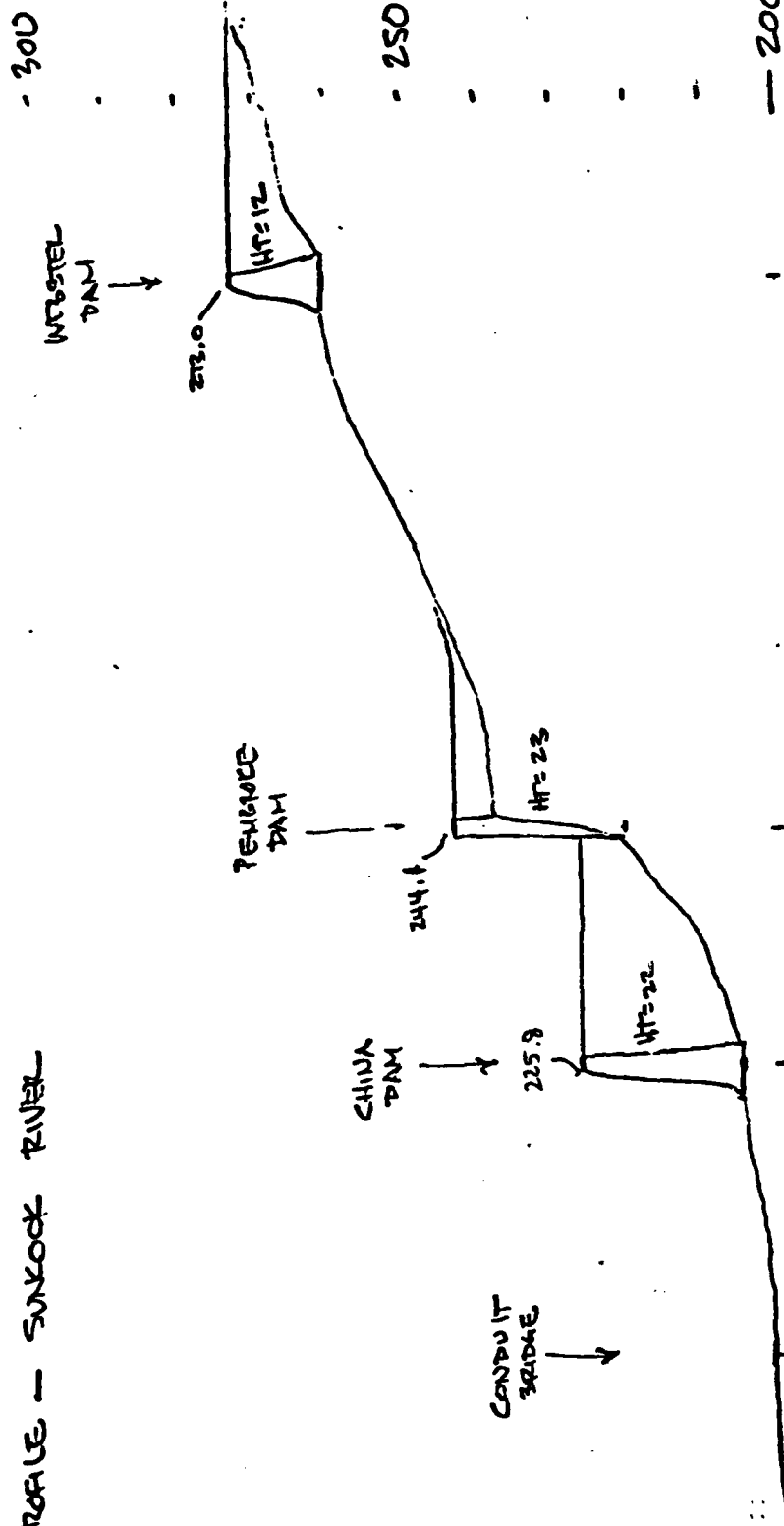
China Mill is on the south bank from 500' to 1000' downstream of China Dam. The Discharge elevation for the Suncook at the upstream end of the factory is given on p. 15. The factory is at an elevation 205.0' MSL (ground floor).

Before failure: $Q = 9800 \text{ cfs} \rightarrow 199.4' \text{ MSL}$

After failure: $Q = 18,320 \text{ cfs} \rightarrow 203.3' \text{ MSL}$. The factory is also above the dam failure flood wave.

Between the factory and the confluence with the Merrimack there are no structures in the path of the flood wave.

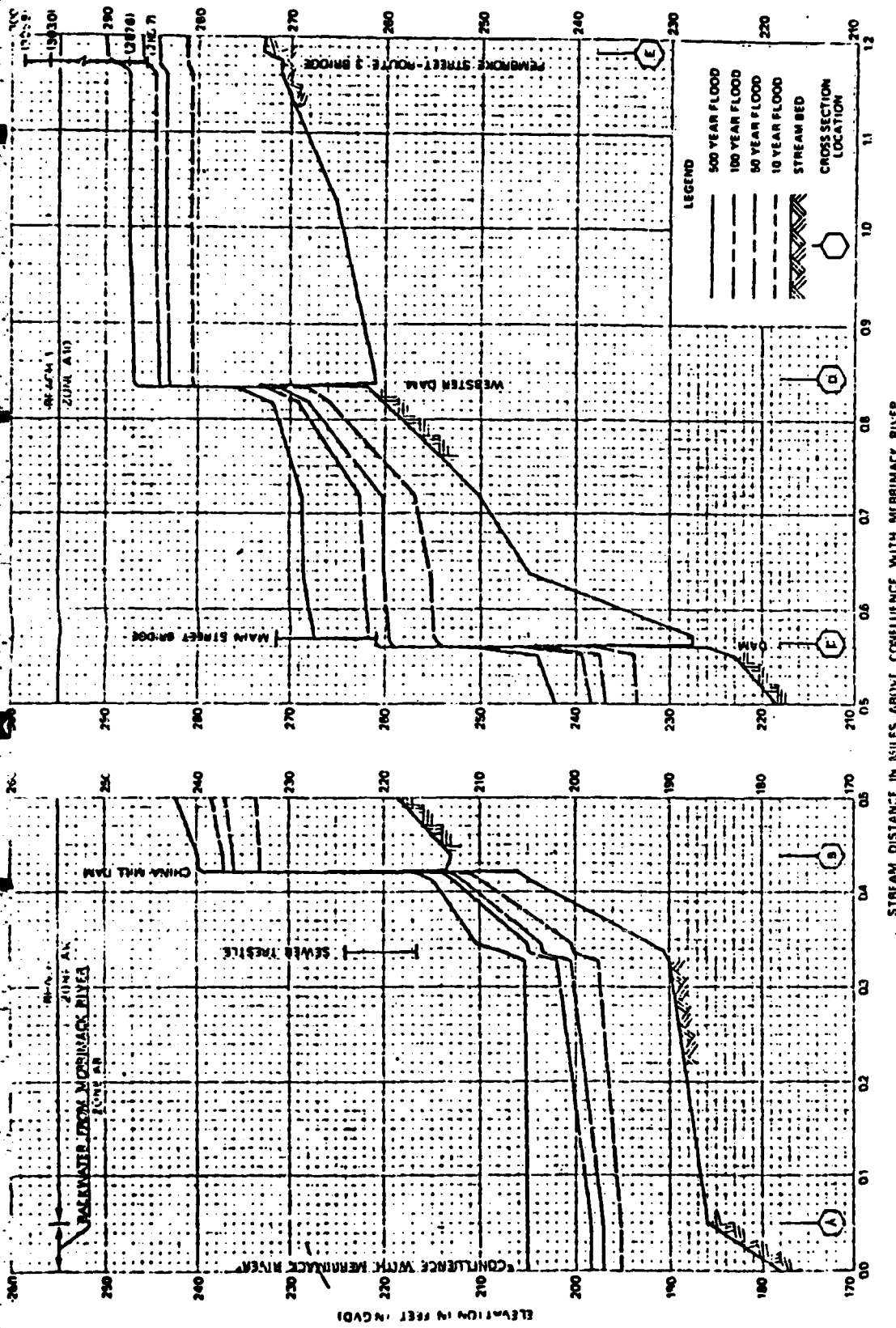
PROFILE - SINKOON RIVER



D. 12

FLOOD PROFILES

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Housing Administration



SUNCOOK RIVER DOWNSTREAM OF CHINA DAM

SCALE: 1" = 400'

1000'

Main St. Bridge

Old Mill

WEBSTER DAM

Houses about
650' d.s. of
Pembroke Dam

PEMBROKE DAM

Houses d.s.
of China Dam

CHINA DAM

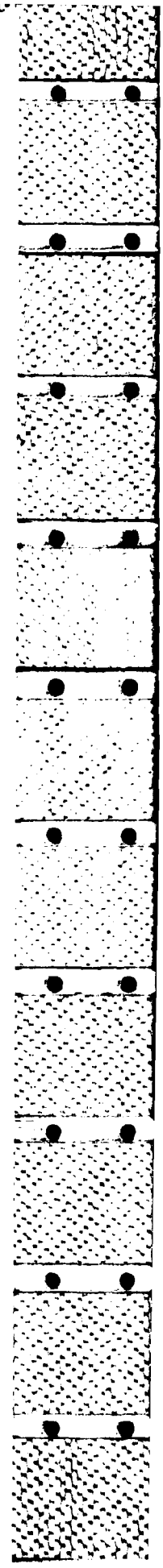
Conduit

China Mill

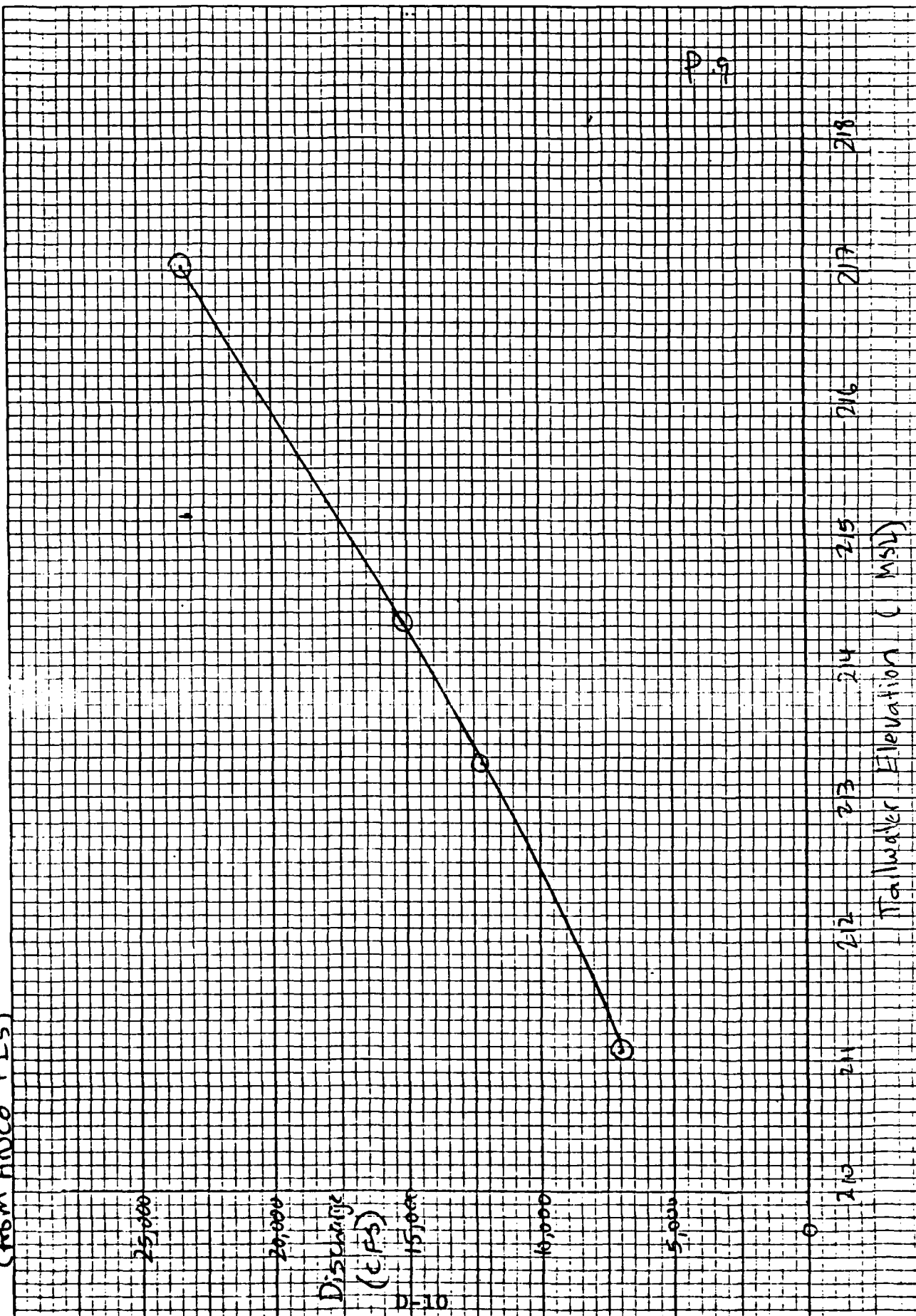
MERRIMACK R.

SUNCOOK R.

D-11



Tailwater Elevation at China Dam $V =$ Discharge
(from APDC FIS)



Dam Failure Analysis

Assume that the dam fails when the water surface reaches the abutments, at $h=7.0$ (232.8' MSL). The plot of Tailwater Elevation vs. discharge on p. 9 indicates that the flow of 9800 cfs (stage-discharge curve) would create a tailwater elevation of 212.4' MSL.

Peak Failure outflow = Normal outflow + Breach outflow

Normal outflow = 9800 cfs

$$\text{Breach outflow} = Q_{P1} = \frac{8}{27} W_b \sqrt{g} (y_0)^{3/2}$$

$$y_0 = \text{height of water surface above tailwater} = 232.8 - 212.4 = 20.4'$$

$$W_b = \text{width of breach} \leq .4 (\text{width of span}) = .4(147) \approx 55'$$

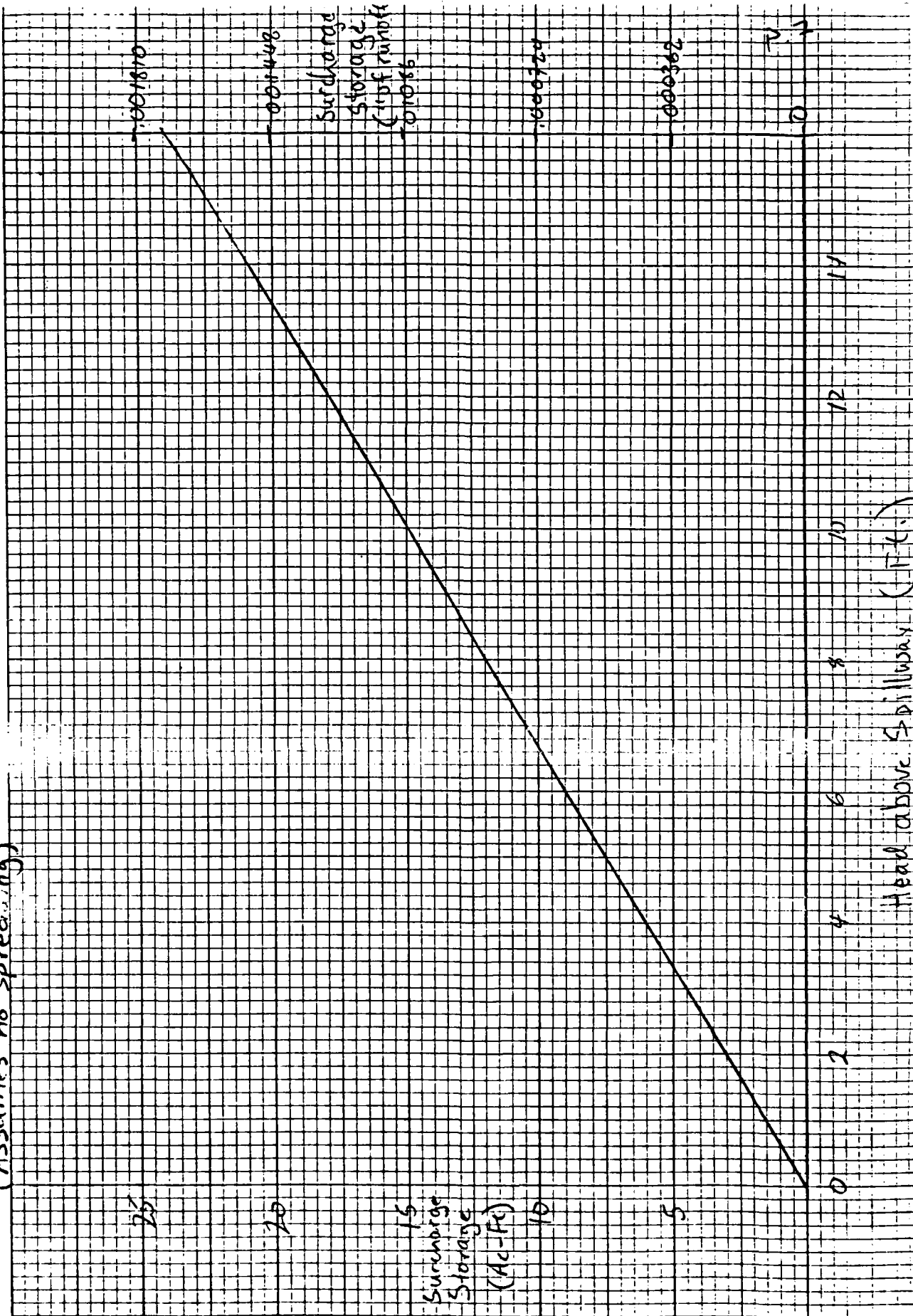
$$Q_{P1} = \frac{8}{27} (55) \sqrt{g} (20.4)^{3/2} = 8520 \text{ cfs}$$

$$\text{Failure flow} = 9800 + 8520 = 18,320 \text{ cfs}$$

This flow would raise the tailwater 3' to 215.4' MSL.

The Suncook River below China Dam runs 2250' through Suncook, New Hampshire before entering the Merrimack River. (See map, p. 10, profiles pp 11-12.) Due to the limited storage available between the dam and the areas of potential flooding, we will assume negligible attenuation of the peak outflow.

Storage-Elevation curve for China Dam (Assumes no Spreading)



Storage- Elevation

The storage-elevation curve for China Dam is given on p. 7. This curve is based on a surface area of 1.5 acres and the assumption that the pond does not spread as it rises.

1" of runoff over 259 sq. mi

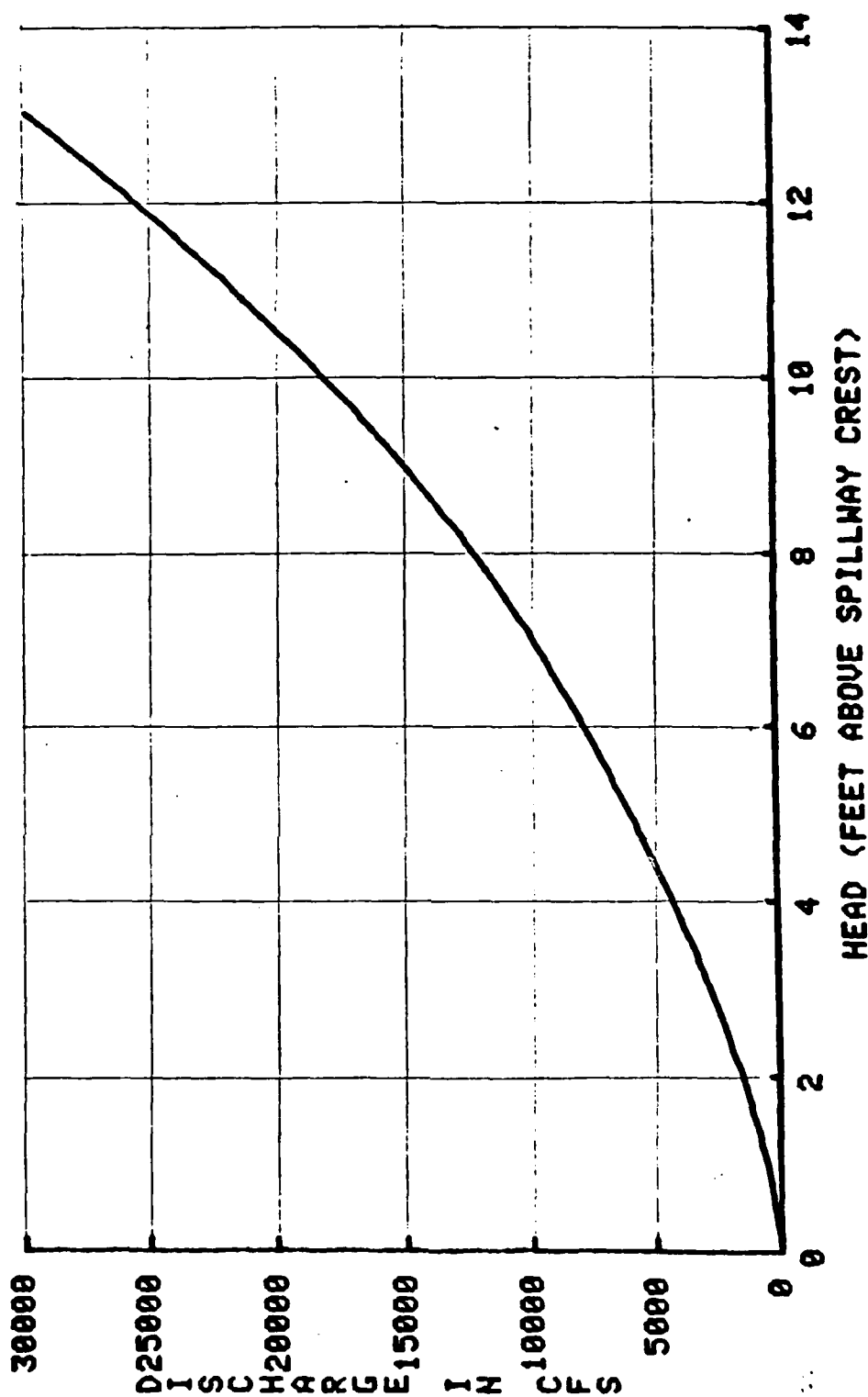
$$\rightarrow 1'' (259 \text{ sq. mi}) \left(\frac{640 \text{ acres}}{\text{sq. mi}} \right) \left(\frac{1 \text{ ft}}{12''} \right)$$

$$= 13,813 \text{ Ac-Ft.}$$

$$\text{So } 1 \text{ Ac-Ft of storage} = \frac{1}{13,813} = .000072'' \text{ of runoff}$$

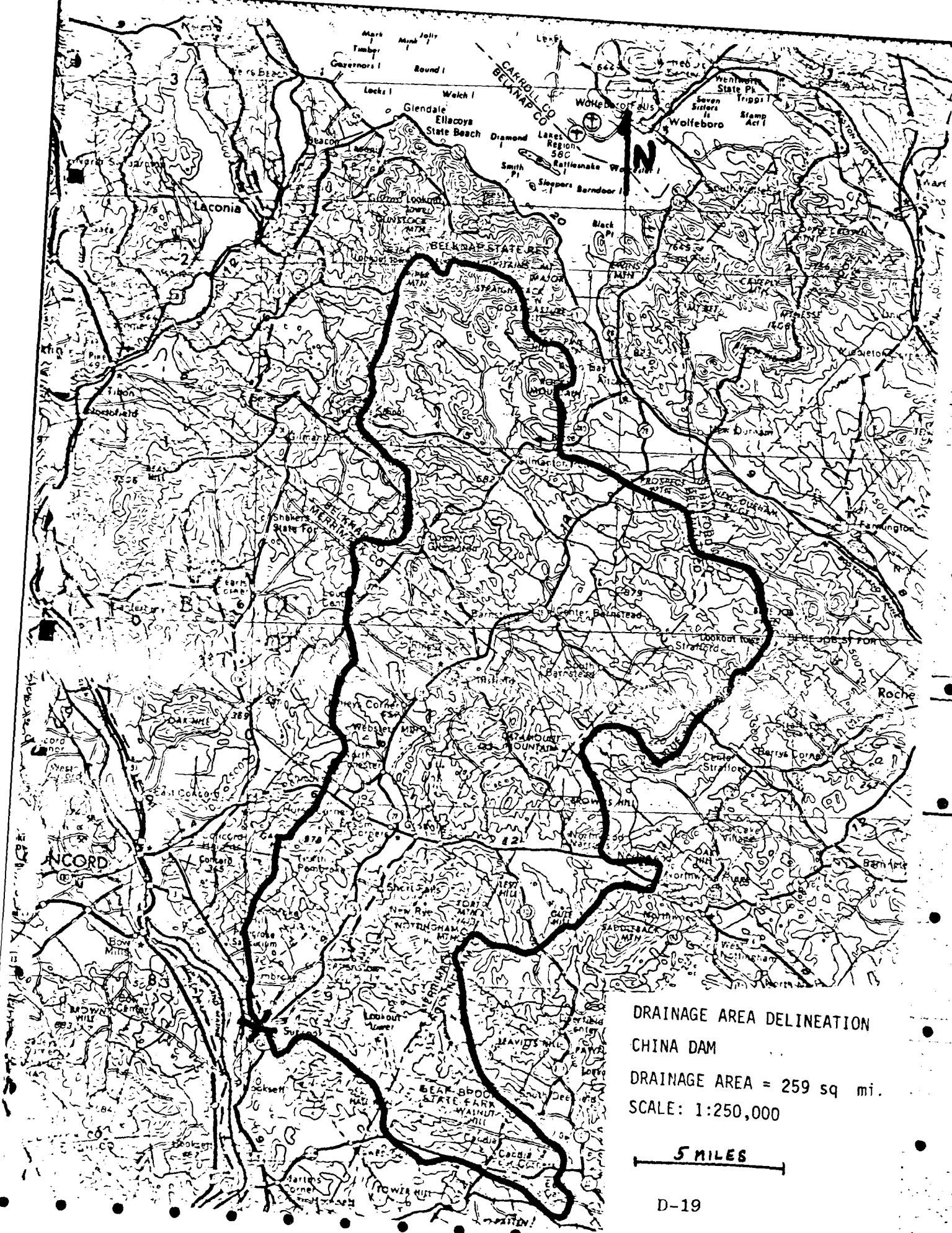
1' of rise will store .000108'' of runoff.

DISCHARGE FROM CHINA DAM AS A FUNCTION OF HEAD ABOVE SPILLWAY



DISCHARGE FROM CHINA DAM AS A FUNCTION OF HEAD ABOVE SPILLWAY

HEAD (FEET)	TOTAL	DISCHARGE (CFS) LEFT BANK	RIGHT BANK	SPILLWAY
0.0	0	0	0	0
0.5	187	0	0	187
1.0	529	0	0	529
1.5	972	0	0	972
2.0	1497	0	0	1497
2.5	2091	0	0	2091
3.0	2749	0	0	2749
3.5	3464	0	0	3464
4.0	4233	0	0	4233
4.5	5051	0	0	5051
5.0	5916	0	0	5916
5.5	6825	0	0	6825
6.0	7776	0	0	7776
6.5	8768	0	0	8768
7.0	9799	0	0	9799
7.5	10939	33	39	10868
8.0	12183	93	119	11972
8.5	13518	170	236	13112
9.0	14939	262	392	14286
9.5	16447	367	587	15493
10.0	18045	491	823	16732
10.5	19737	633	1102	18002
11.0	21525	796	1426	19383
11.5	23410	981	1796	20634
12.0	25396	1188	2214	21994
12.5	27485	1420	2682	23383
13.0	29677	1676	3201	24800



DRAINAGE AREA DELINEATION

CHINA DAM

DRAINAGE AREA = 259 sq. mi.

SCALE: 1:250,000

5 MILES

D-19

APPENDIX E
INFORMATION AS CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	UNION	CONGR. STATE COUNTY DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
NH	25	NED	NH 013 02	CHINA DAM	4307.8	7127.4	21MAR79

POPULAR NAME	NAME OF IMPOUNDMENT
--------------	---------------------

REGION BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01 05	SUNCOOK RIVER	PEMBROKE-ALLENSTOWN	0	

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRAINING HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES MAXIMUM NORMAL	DIST OWN FED R PRV/ED SCS A	VER/DATE
PGCT	1917	0	29	29	33	22 NED N N N	21MAR79

REMARKS

Q-POINT	SPILLWAY LENGTH (FT.)	MAXIMUM DISCHARGE (CY)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (KW)	PROPOSED (KW)	NAVIGATION LOCKS LENGTH WIDTH DEPTH
3	275	11	143	9800		

OWNER	ENGINEERING BY	CONSTRUCTION BY
THOMAS HODGSON AND SONS		

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NH WATER RES BD	NH WATER RES BD	NH WATER RES BD	NH WATER RES BD

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
GOLDBERG ZIND DUNNICLIFF ASSOC	07NOV78	PUBLIC LAW 92-367

REMARKS

END

FILMED

8-85

DTIC