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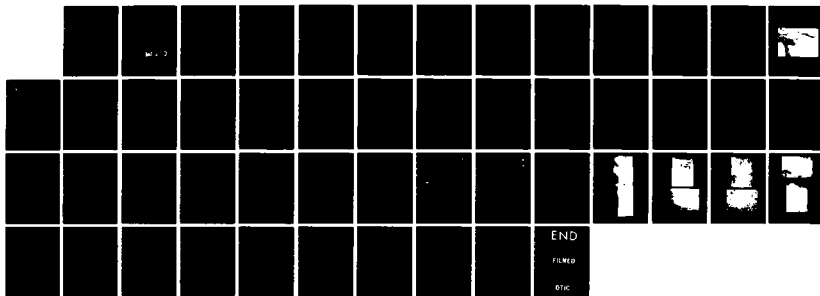
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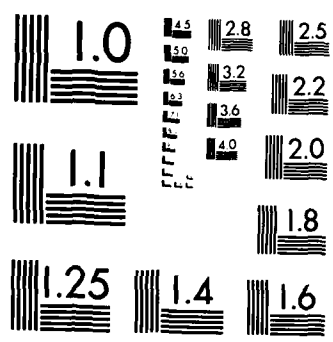
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ANNISQUAM RIVER BASIN
GLOUCESTER, MASSACHUSETTS

STRANGMAN POND DAM
MA 01097

**PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM**



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

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Annisquam River Basin Gloucester, Massachusetts Annisquam River Basin		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is a 100 ft. long, 16 ft. high earthfill dam. There are deficiencies which must be corrected to assure the continued performance of the dam. The dam is small in size with a hazard potential of high. It is recommended that the owner immediately institute a plan for surveillance of the dam during periods of heavy rainfall and a plan for notifying downstream residents in the event of an emergency.		



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

REPLY TO
ATTENTION OF:

NEDED

SEP 11 1961

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

Dear Governor King:

Inclosed is a copy of the Strangeman Pond Dam (MA-01097) Phase I Inspection Report, prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis.

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

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

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

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NEDED

Honorable Edward J. King

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

Copies of this report have been forwarded to the Department of Environmental Quality Engineering and to the owner, The Cape Ann Sportsman's Club, Gloucester. Copies will be available to the public in thirty days.

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

Sincerely,



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

STRANGMAN POND DAM

MA 01097

ANNISQUAM RIVER BASIN
GLOUCESTER, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

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NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA01097

Name of Dam: Strangman Pond Dam

Town: Gloucester

County and State: Essex County, Massachusetts

Stream: Annisquam River Basin

Date of Inspection: June 9, 1981

Strangman Pond Dam is a 100-foot long, 16-foot high earth-fill dam built prior to 1884. The dam is presently used for recreation and has a maximum storage capacity of 32 acre-feet. The top of the dam is at Elevation (El) 91.4 National Geodetic Vertical Datum (NGVD). A 10-inch corrugated metal pipe is the only spillway facility at the site. There is no low-level outlet.

There are deficiencies which must be corrected to assure the continued performance of this dam. This conclusion is based on the visual inspection of the site and a review of the available data. Generally the dam is in poor condition.

The following deficiencies were observed at the site: a heavy growth of brush and trees on the downstream slope, lack of an adequate spillway, seepage at the downstream toe, lack of a low-level outlet, erosion of the downstream slope at the right abutment, and mortar missing from the joints of the upstream masonry wall.

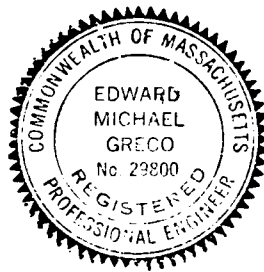
Based on Corps of Engineers' guidelines, the dam has been classified in the small size and high hazard categories. A test flood equal to one-half the probable maximum flood (PMF) was used to evaluate the capacity of the spillway. The test flood outflow is 62 cubic feet per second (cfs), resulting in a pond level at El 92.1. The test flood would overtop the dam by 0.7 feet. Hydraulic analyses indicate that the spillway can discharge about 1 cfs, or 1 percent of the test flood outflow before the dam is overtopped.

It is recommended that the Owner immediately institute a plan for surveillance of the dam during periods of heavy rainfall

STRANGMAN POND DAM

and a plan for notifying downstream residents in the event of an emergency. The Owner should employ a qualified registered professional engineer to conduct a more detailed hydrologic/hydraulic analysis and design adequate discharge capacity and a low-level outlet for the dam. The engineer should also establish a procedure for clearing trees and brush from the dam and conduct stability and seepage analyses of the embankment. The Owner should correct the other deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of annual technical inspections.

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



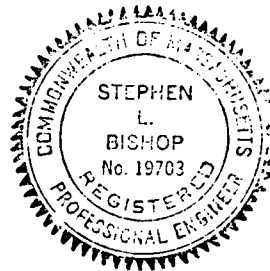
Edward M. Greco, P.E.
Project Manager
Metcalf & Eddy, Inc.

Massachusetts Registration
No. 29800

Approved by:

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

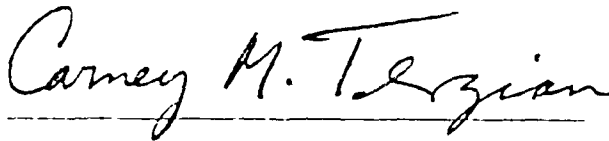
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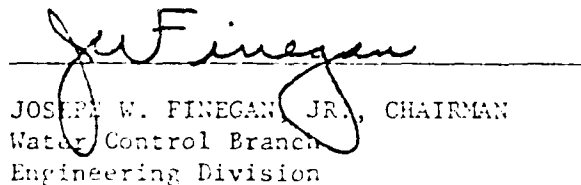
This Phase I Inspection Report on Strangman Pond Dam (MA-01097) has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgement and practice, and is hereby submitted for approval.



ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

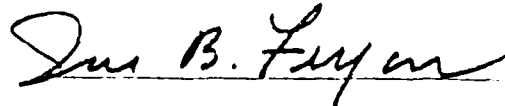


CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division



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

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for a Phase I Investigation. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general conditions and the downstream damage potential.

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

STRANGMAN POND DAM

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**OVERVIEW
STRANGMAN POND DAM
GLOUCESTER, MASSACHUSETTS**



SECTION 6

STRUCTURAL STABILITY

- 6.1 Visual Observations. The evaluation of the structural stability of Strangman Pond Dam is based on the visual inspection conducted on June 9, 1981.

As discussed in Section 3, Visual Inspection, the dam is in poor condition. Seepage was observed at the downstream toe of the embankment. A thick growth of trees and brush covers the downstream slope and toe of the dam.

- 6.2 Design and Construction Data. Strangman Pond Dam was constructed prior to 1884. Computations for design of the dam and spillway are not available. Drawings and specifications for the construction of the dam are also not available.

- 6.3 Post-Construction Changes. Since the original construction of the dam, the only known change was the addition of the spillway pipe about 1963.

- 6.4 Seismic Stability. The dam is located in Seismic Zone No. 3. Phase I guidelines recommend, as a minimum, that suitable analysis by conventional equivalent static load methods should be on record for dams in Zone No. 3. As far as can be determined, no such analysis has been made.

Hydraulic analyses indicate that the spillway can discharge about 1 cfs with the pond at El 91.4, which is the low point on the top of the dam.

During the test flood, the low point on the dam would be overtopped by 0.7 feet. About 2 cfs would discharge through the spillway, and about 60 cfs would discharge over the dam. Where critical flow occurs, the water would be 0.41 feet deep at a velocity of 3.6 feet per second (fps).

- 5.5 Dam Failure Analysis. The peak discharge rate due to failure of the dam was calculated to be 1,650 cfs with the pond at El 91.4. This calculation is based on a maximum head of 8.4 feet and an assumed 40-foot wide breach occurring in a narrow portion of the embankment near the spillway. Failure of the dam would produce a downstream flood wave 6 feet deep as compared to channel flow less than 1/2 foot deep prior to failure.

There are two houses located along the stream 600 feet downstream of the dam. The foundations of these structures are approximately 2 feet above the floor of the stream. Due to the configuration of the channel, little attenuation of the flood flow is expected. An assumed failure of the dam could result in a flood wave that would rise above the foundation level of these houses resulting in the possible loss of more than a few lives and an excessive amount of property damage. Accordingly, the dam has been placed in the "high" hazard category.

SECTION 5

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

- 5.1 General. Strangman Pond Dam has a drainage area of 30 acres (.042 square mile) in which there are no ponds or swamps (see Drainage Area shown on Location Map). The land is hilly, and undeveloped.

There are no dams upstream of Strangman Pond that would provide additional storage within the watershed.

Strangman Pond has a surface area of approximately 4 acres, and a maximum storage capacity of approximately 32 acre-feet at El 91.4.

There is no low-level outlet for the dam.

- 5.2 Design Data. There are no hydraulic or hydrologic computations available for the design of the pipes that serves as the spillway at Strangman Pond Dam.
- 5.3 Experience Data. There are no records of past flood levels at the dam, which was constructed prior to 1884. Representatives from the Cape Ann Sportman's Club do not recall that the dam was overtopped since their purchase of the facility in 1963.
- 5.4 Test Flood Analysis. Strangman Pond Dam has been classified in the "small" size and "high" hazard categories. According to the Corps of Engineers guidelines, a test flood ranging from one-half to the full PMF (Probable Maximum Flood) should be used to evaluate the capacity of the spillway. The one-half PMF was used for this analysis because the height and storage capacity of the pond is at the low end of the range for small sized dams.

The PMF rate for the Strangman Pond watershed was calculated to be 3,000 cfs per square mile of drainage area. This calculation is based on the average slope of 4.5 percent in the drainage area, the pond-plus-swamp area to drainage area ratio of 0 percent, and the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977).

Applying the one-half PMF rate to the .042 square mile drainage area results in a peak test flood inflow of 63 cfs. By adjusting the test flood inflow for surcharge storage, the peak test flood outflow was calculated to be 62 cfs (9,476 cfs per square mile). The pond level would rise to El 92.1.

STRANGMAN POND DAM

SECTION 4

OPERATING AND MAINTENANCE PROCEDURES

4.1 Operating Procedures

- a. General. There are no operating facilities and no regular operating procedures for this dam. Personnel from the Cape Ann Sportsman's Club reportedly visit the dam weekly for recreational activities.
- b. Warning System. There is no warning system in effect at this dam.

4.2 Maintenance Procedures

- a. General. The dam is not maintained. The Cape Ann Sportsman's Club is responsible for maintenance of the facility. There is no record of technical inspections having been conducted in the past.
- b. Operating Facilities. There are no operating facilities at the dam.

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

About 600 feet below the dam, flow in the stream is diverted through a 12-inch corrugated metal pipe into the storm drain under Cherry Street.

3.2 Evaluation. The visual inspection indicates that the dam is in poor condition. The stated deficiencies which must be corrected to assure the continued performance of this dam and measures to improve these conditions are outlined in Section 7. The following conditions could affect the long-term performance of the dam:

- a. Continued uncontrolled seepage through the dam could lead to internal erosion of the dam.
- b. The root system of the trees and brush on the downstream slope of the dam could provide pathways for seepage and internal erosion.
- c. The discharge from the pipe that serves as a spillway could lead to erosion on the downstream slope of the dam.
- d. A low-level outlet is needed to provide facilities for lowering the pond level during an emergency.
- e. Mortar missing from the upstream masonry wall could result in leakage through the dam or further deterioration of the wall.
- f. Erosion of the downstream slope at the right abutment could result in instability of the embankment.

SECTION 3
VISUAL INSPECTION

3.1 Findings

- a. General. The Phase I Inspection of the dam at Strangman Pond was performed on June 9, 1981. A copy of the inspection checklist is included in Appendix A. There are no records of any previous inspections. Selected photographs taken during our Visual Inspection are included in Appendix C.
- b. Dam. The dam is an earthfill structure with a pipe that serves as a spillway. Evidence of seepage was noted at one location at the downstream toe of the dam below the spillway pipe. The seepage is indicated by a stream of clear water flowing at approximately 1 gpm (see Photo No. 7).

The stone masonry on the upstream face is in fair condition. The mortar is missing in a few places.

Slight erosion due to surface runoff was noted on the downstream slope of the dam near the right abutment.

A dense growth of brush and trees up to 6 inches in diameter covers the downstream slope and toe of the dam (see Photo No. 1). This growth hinders complete inspection of these areas.

- c. Appurtenant Structures. A 10-inch corrugated metal pipe serves as the spillway (see Photos No. 2 and No. 3). At the time of the inspection, there was no water discharging through the pipe. The upstream end of the pipe was bent inward at one place. No debris or other obstructions were observed inside the pipe. Discharge would flow onto the downstream slope of the dam and into a stream. Only minor erosion was observed on the downstream slope due to discharge from the pipe.

There is no low-level outlet at the dam.

- d. Reservoir Area. The reservoir area is wooded and undeveloped except for a few houses above the left abutment of the dam. There is a high potential that future development will occur in the reservoir area.
- e. Downstream Channel. The spillway would discharge into a densely wooded valley downstream of the dam. The earth slopes that form the sides of the valley are steep and also densely wooded.

STRANGMAN POND DAM

SECTION 2
ENGINEERING DATA

- 2.1 General. There are no plans, specifications or computations available from the City, County or State offices relative to the design or construction of this dam.

There are also no previous inspection reports available for Strangman Pond Dam.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Department of Environmental Quality Engineering, Division of Waterways; the Massachusetts Department of Public Works; and the Essex County Engineers Office. In addition, we acknowledge the assistance of Mr. Al Olson, President of the Cape Ann Sportman's Club, who provided information on the history and operation of the dam.

- 2.2 Construction Records. There are no construction records or as-built drawings available for the dam.

- 2.3 Operating Records. No operating records are available, and there is no daily record kept of the elevation of the pool or rainfall at the dam site.

2.4 Evaluation

- a. Availability. There are no engineering data available for this dam.
- b. Adequacy. The lack of detailed hydraulic, structural and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on the visual inspection.

j. Regulating Outlets: There is no regulating outlet at the dam.

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

g. Dam

- (1) Type: earthfill with masonry wall upstream
- (2) Length: 100 feet
- (3) Height: 16
- (4) Top width: Varies from 10 to 40 feet
- (5) Side slopes: upstream-vertical
downstream-2:1
- (6) Zoning: unknown
- (7) Impervious core: unknown
- (8) Cutoff: unknown
- (9) Grout curtain: unknown

h. Diversion and Regulating Tunnel: N/A

i. Spillway

- (1) Type: corrugated metal pipe
- (2) Length of weir: 10-inch diameter
- (3) Crest elevation (invert of pipe): 91.0
- (4) Gates: none
- (5) Upstream channel: none
- (6) Downstream channel: none - discharge flows onto downstream slope and into a stream

*Based on the assumption that the surface area will not significantly increase with changes in pool elevation from 91.4 to 92.1.

the upstream invert of the spillway pipe. This elevation was estimated from a United States Geological Survey (U.S.G.S.) topographic map.

- (1) Streambed at toe of dam: 75.6
- (2) Bottom of cutoff: unknown
- (3) Maximum tailwater: N/A
- (4) Normal pool: 91.0
- (5) Full flood control pool: N/A
- (6) Spillway crest: 91.0
- (7) Design surcharge (Original design): unknown
- (8) Top of dam: 91.4
- (9) Test flood surcharge: 92.1

d. Reservoir (Length in feet)

- (1) Normal pool: 900
- (2) Flood control pool: N/A
- (3) Spillway crest pool: 900
- (4) Top of dam: 900
- (5) Test flood pool: 900

e. Storage (acre-feet)

- (1) Normal pool: 30
- (2) Flood control pool: N/A
- (3) Spillway crest pool: 30
- (4) Top of dam: 32
- (5) Test flood pool: 35

f. Reservoir surface (acres)

- (1) Normal pool: 4

There are no drawings, specifications, or construction records available. About 1963, the pond was reportedly lowered and silt dredged out of the bottom. At that time, the 10-inch pipe that functions as a spillway was placed on the dam.

There are no records of previous inspections or other information on the condition of the dam.

- i. Normal Operating Procedures. There are no operating procedures at Strangman Pond Dam. Flow through the spillway is uncontrolled, and there is no low-level outlet.

1.3 Pertinent Data

- a. Drainage Area. The drainage area is approximately 30 acres (.042 square mile) and consists of hilly land (see Drainage Area shown on Location Map). The drainage area is woodland, and there is no residential development except at the left abutment of the dam (see Overview Photo).
- b. Discharge. Discharge from Strangman Pond flows uncontrolled through a 10-inch corrugated metal pipe that serves as the spillway. There is no low-level outlet.
 - (1) Outlet: None
 - (2) Maximum known flood at damsite: unknown
 - (3) Ungated spillway capacity at top of dam: about 1 cfs at El 91.4.
 - (4) Ungated spillway capacity at test flood elevation: 1.8 cfs at El 92.1.
 - (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: 1.8 cfs at El 92.1.
 - (8) Total project discharge at top of dam: about 1 cfs at El 92.1.
 - (9) Total project discharge at test flood elevation: 62 cfs at El 92.1.
- c. Elevation (feet above National Geodetic Vertical Datum of 1929 (NGVD)). A benchmark was established at El 91.0 at

of 16 feet (see Plan of Dam and Sections in Appendix B and photographs in Appendix C). The top of the dam varies from 10 to 40 feet wide and varies from El 91.4 to 92.0. The upstream face is a vertical masonry wall. The downstream face is a 2:1 slope covered with trees and brush.

A 10-inch corrugated metal pipe embedded in the top of the dam near the left abutment is the only spillway facility at the site. The invert of the pipe is at El 91.0. Discharge flows onto the downstream slope of the dam and into a stream. The valley containing the stream is about 80 feet wide with steep side slopes. The floor and sides of the valley are densely wooded.

There is no low-level outlet at the dam.

- c. Size Classification. For a dam to be classified as small, it must have a height between 25 feet and 40 feet and a maximum storage capacity between 50 acre-feet and 1,000 acre-feet. Strangman Pond Dam has a height of 16 feet and a maximum storage capacity of 32 acre-feet. For the purposes of this report, it has therefore been classified in the "small" size category.
- d. Hazard Classification. There are two houses located along the stream 600 feet downstream of the dam (see Flood Impact Area shown on the Location Map). The foundations of these structures are approximately 2 feet above the stream channel. An assumed failure of the dam would result in a flood wave 6 feet high 600 feet downstream of the dam. More than a few lives could be lost and an excessive amount of property damage could occur. Accordingly, the dam has been placed in the "high" hazard category.
- e. Ownership. The dam has been owned since 1963 by The Cape Ann Sportsman's Club, Cherry Street, Gloucester, Massachusetts 01930. Mr. Al Olson (telephone 617-283-0304) granted permission to enter the property and inspect the dam.
- f. Operator. There are no operators of the dam.
- g. Purpose of the Dam. The water in Strangman Pond is currently used for recreational purposes by the Cape Ann Sportman's Club. The original purpose of the dam is unknown, but may have been for commercial ice production.
- h. Design and Construction History. Historical data indicates that the dam was built sometime prior to 1884.

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

STRANGMAN POND DAM

SECTION 1

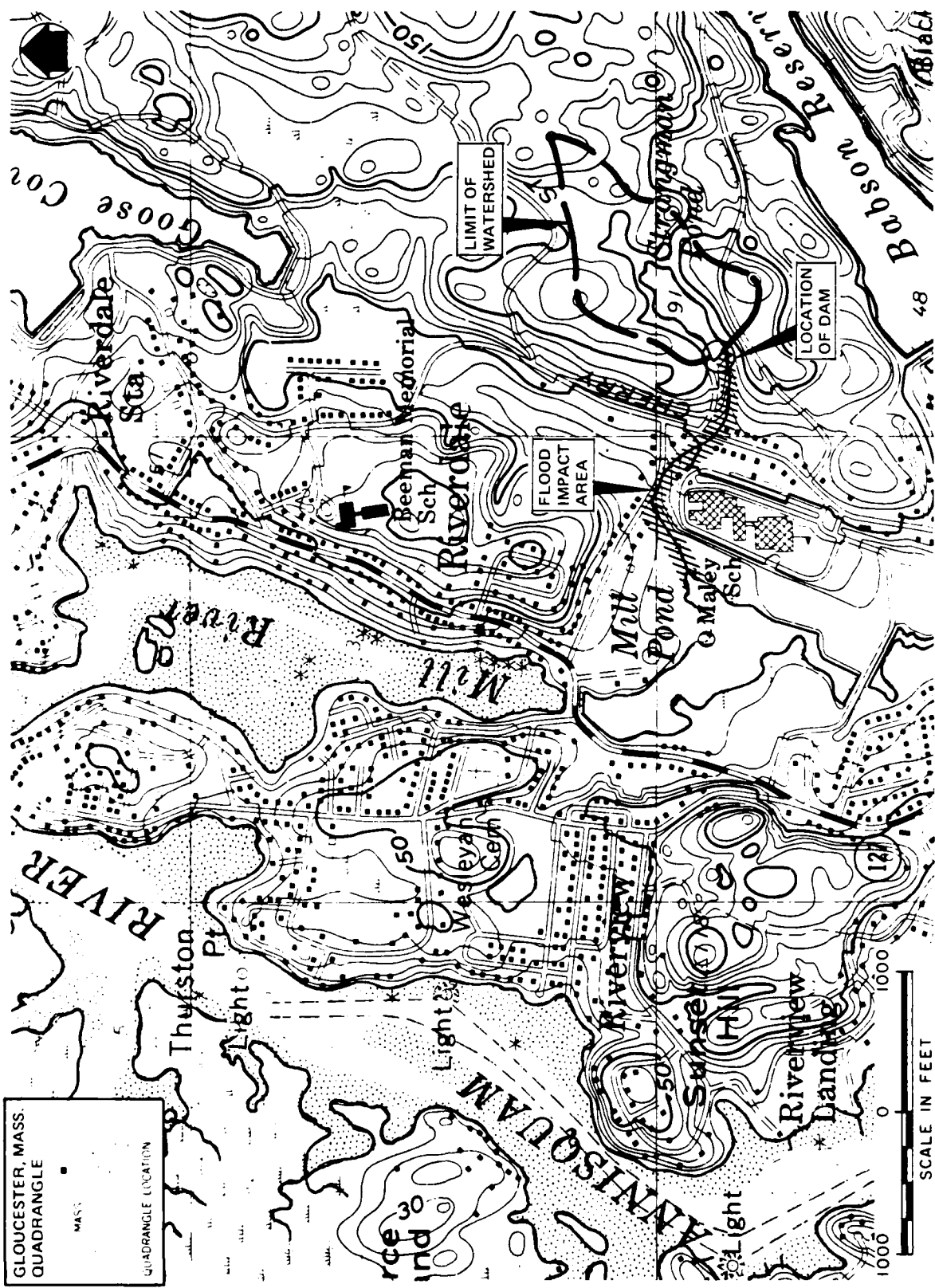
PROJECT INFORMATION

1.1 General

- a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Metcalf & Eddy, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Contract No. DACW 33-80-C-0054, dated April 18, 1980, has been assigned by the Corps of Engineers for this work.
- b. Purpose
- (1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
 - (2) Encourage and assist the States to quickly initiate effective dam safety programs for non-Federal dams.
 - (3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

- a. Location. The dam is located on a tributary of the Mill River in the City of Gloucester, Essex County, Massachusetts and in the Annisquam River Basin (see Location Map). The coordinates of this location are Latitude 42 deg. 37.8 min. north and Longitude 70 deg. 40.1 min. west.
- b. Description of Dam and Appurtenances. Strangman Pond Dam is a 100-foot long, earthfill dam with a maximum height



LOCATION MAP - STRANGMAN POND DAM

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

- a. Condition. As a result of the visual inspection, the review of available data, and limited information on operation and maintenance, the dam is considered to be in poor condition. The following deficiencies must be corrected to assure the continued performance of this dam: seepage at the downstream toe of the embankment; a dense growth of trees and brush on the downstream slope and toe; lack of an adequate spillway, and the lack of a low-level outlet.

The peak test flood (one-half PMF) outflow is estimated to be 62 cfs with the pond at El 92.1. The test flood would overtop the low point on the dam by 0.7 feet. Hydraulic analyses indicate that the spillway can discharge about 1 cfs or 1 percent of the test flood outflow before the dam is overtopped.

- b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of this dam is based on the visual inspection and engineering judgment.
- c. Urgency. In view of the inadequate discharge capacity of the dam, the Owner should immediately institute surveillance and warning programs as described in Section 7.3. The other recommendations and remedial measures outlined below should be implemented by the Owner within 1 year after receipt of this Phase I Inspection Report.

7.2 Recommendations. The Owner should employ a qualified registered engineer to:

- a. Perform a detailed hydrologic/hydraulic analysis to design adequate discharge capacity and a low-level outlet for the dam.
- b. Develop procedures for clearing the trees and brush from the downstream slope of the dam and to a distance of 25 feet below the downstream toe. All stumps and roots removed should be backfilled with select material.
- c. Evaluate the static and seismic stability of the dam embankment. This should include an investigation of the seepage noted at the downstream toe. The investigation should be conducted after the embankment is cleared of trees and brush.

STRANGMAN POND DAM

The Owner should implement the recommendations of the Engineer.

7.3 Remedial Measures

- a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:
- (1) Immediately institute a definite plan for surveillance of the dam during and after periods of heavy rainfall and a plan to warn people in downstream areas in the event of an emergency at the dam.
 - (2) Replace missing mortar in the joints of the upstream masonry wall.
 - (3) Repair the erosion of the downstream slope at the right abutment.
 - (4) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations. The maintenance program should include removal of any debris inside the corrugated metal pipe to prevent clogging of the spillway.
 - (5) Institute a program of technical inspections of this dam on an annual basis.

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

APPENDIX A
PERIODIC INSPECTION CHECKLIST

STRANGMAN POND DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT STRANGMAN POND DAM

DATE JUNE 9, 1981

TIME 08:30

WEATHER Cloudy-showers-80F

W.S. ELEV. 90.3 U.S. 83.0 DN.S.

PARTY:

- 1. LYLE BRANAGAN- METCALF & EDDY- HYRDAULIC
- 2. BILL CHECCHI- METCALF & EDDY- GEOTECHNICAL
- 3. ED GRECO- METCALF & EDDY- GEOTECHNICAL
- 4. JIM PETER- METCALF & EDDY- GEOTECHNICAL
- 5. CAROL SWEET- METCALF & EDDY- GEOTECHNICAL
- 6. _____
- 7. _____
- 8. _____
- 9. _____
- 10. _____

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	<u>DAM</u>	<u>GRECO/SWEET/CHECCHI</u>	
2.	<u>SPILLWAY</u>	<u>BRANAGAN</u>	
3.	_____	_____	_____
4.	_____	_____	_____
5.	_____	_____	_____
6.	_____	_____	_____

PERIODIC INSPECTION CHECK LIST

PROJECT STRANGMAN POND DAM DATE JUNE 9, 1981
 PROJECT FEATURE DAM EMBANKMENT NAME GRECO / SWEET
 DISCIPLINE GEOTECHNICAL NAME SWEET

AREA EVALUATED	CONDITIONS
<u>DAM EMBANKMENT</u>	VARIES FROM 91.4 to 91.8
Crest Elevation	
Current Pool Elevation	90.3
Maximum Impoundment to Date	unknown
Surface Cracks	none
Pavement Condition	none
Movement or Settlement of Crest	slight settlement of crest near spillway-possible erosion
Lateral Movement	none visible
Vertical Alignment	good
Horizontal Alignment	good
Condition at Abutment and at Concrete Structures	slight erosion due to storm runoff
Indications of Movement of Structural Items on Slopes	none
Trespassing on Slopes	large trees and brush on slopes-trespassing along crest
Sloughing or Erosion of Slopes or Abutments	slight erosion due to storm runoff
Rock Slope Protection - Riprap Failures	none-stone masonry wall in good condition
Unusual Movement or Cracking at or near Toes	none
Unusual Embankment or Downstream Seepage	immediately below spillway, at toe of embankment-clear, at 1 GPM
Piping or Boils	none visible
Foundation Drainage Features	none
Toe Drains	none
Instrumentation System	none

PERIODIC INSPECTION CHECK LIST

PROJECT STRANGMAN POND DAM DATE JUNE 9, 1981
 PROJECT FEATURE SPILLWAY NAME CHECCHI/BRANAGAN
 DISCIPLINE GEOTECHNICAL NAME _____

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	10-inch Corrugated Metal Pipe spillway set on vertical stone masonry wall Invert elevation 91.0 (estimated)
a. Approach Channel	
General Condition	unobstructed
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	none
Floor of Approach Channel	stone masonry
b. Weir and Training Walls	
General Condition of Concrete	none
Rust or Staining	slight rusting of C.M.P.
Spalling	none
Any Visible Reinforcing	N/A
Any Seepage or Efflorescence	N/A
Drain Holes	N/A
c. Discharge Channel	downstream slope to natural streambed
General Condition	slight erosion
Loose Rock Overhanging Channel	none
Trees Overhanging Channel	many trees in and around channel
Floor of Channel	heavy brush-fallen trees
Other Obstructions	none

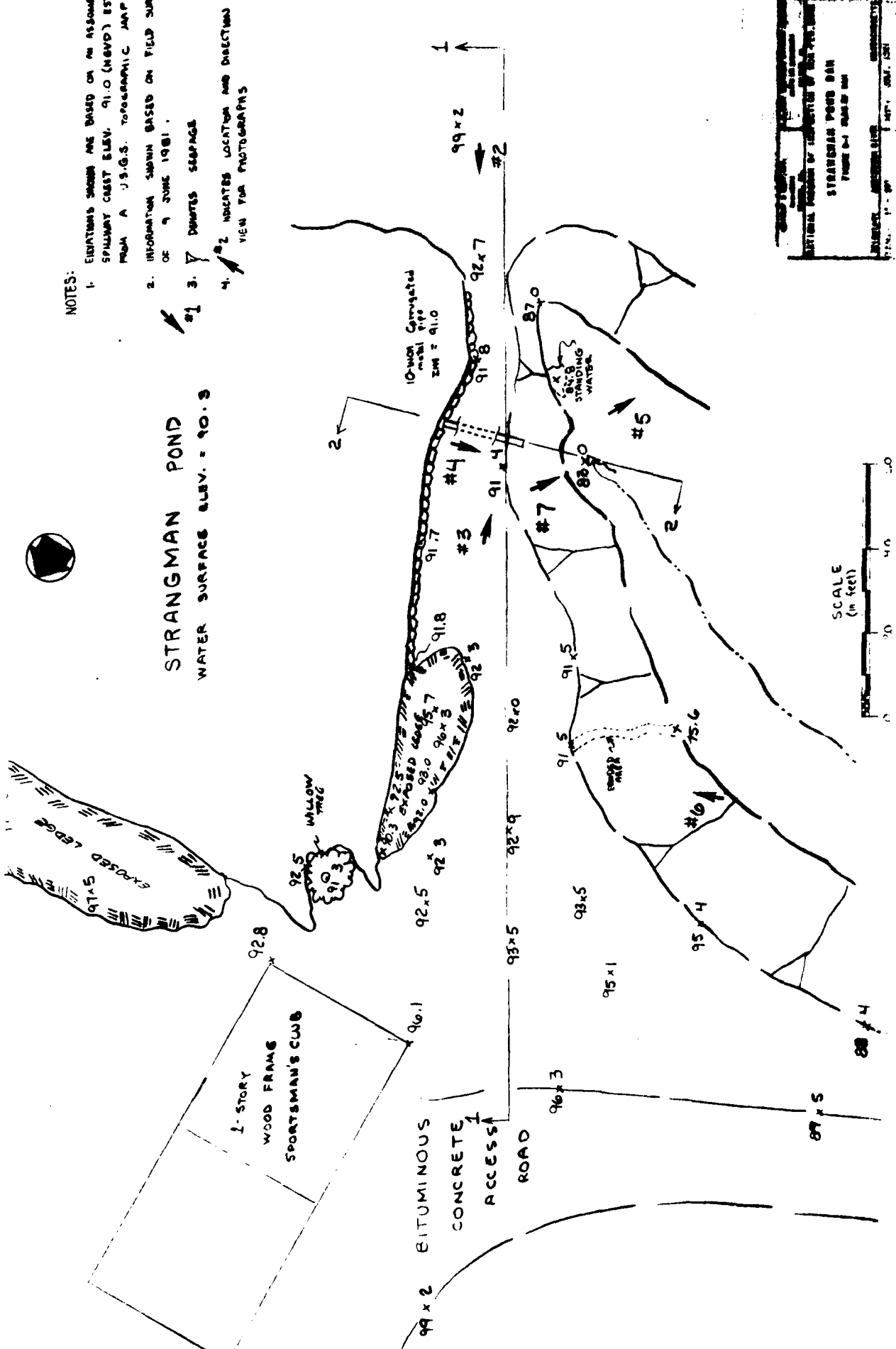
APPENDIX B
PLANS OF DAM

	<u>Page</u>
Figure B-1, Plan of Dam	B-1
Figure B-2, Profile and Section of Dam	B-2

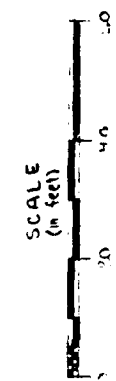
NOTES:

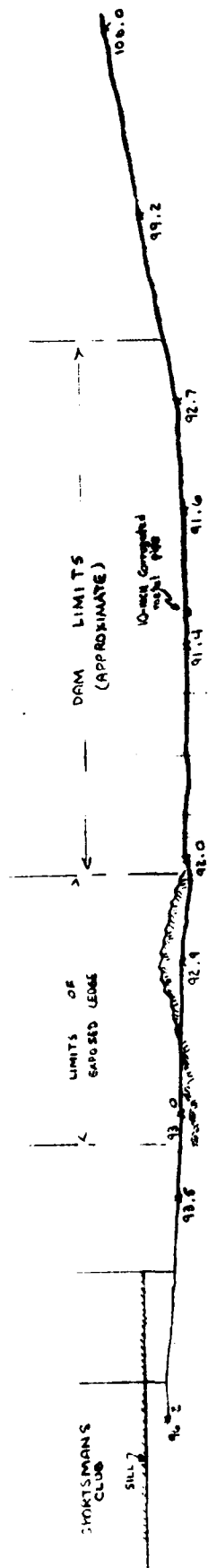
1. ELEVATIONS SHOWN ARE BASED ON AN ASSUMED SPILLWAY CREST ELEV. 91.0 (MVD) ESTIMATED FROM A U.S.G.S. TOPOGRAPHIC MAP.
2. INFORMATION SHOWN BASED ON FIELD SURVEY OF 9 JUNE 1981.
3. ∇ POINTS SEAPAGE
4. #2 INDICATES LOCATION AND DIRECTION OF VIEW FOR PHOTOGRAPHS

STRANGMAN POND
 WATER SURFACE ELEV. = 90.3

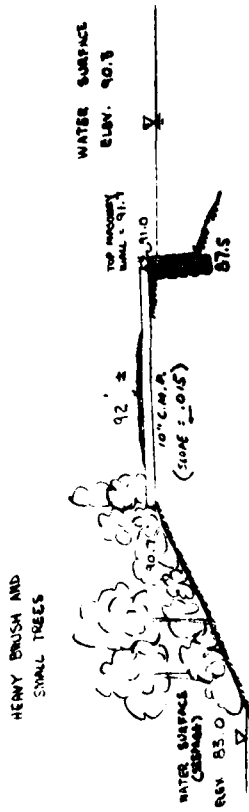


STRANGMAN POND DAM
 PROJECT # 1 - 1981
 NATIONAL SYSTEM OF RECORDS OF THE FEDERAL GOVERNMENT
 NATIONAL ARCHIVES



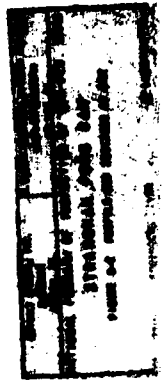


1-1
 PROFILE
 DAM AND ABUTMENTS
 HORIZONTAL SCALE: 1"=20'
 VERTICAL SCALE: 1"=2'



2-2
 SECTION
 DAM EMBANKMENT
 HORIZONTAL SCALE 1"=10'
 VERTICAL SCALE 1"=1'

SCALE (INCHES)



APPENDIX C

PHOTOGRAPHS

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

STRANGMAN POND DAM



NO. 1 UPSTREAM FACE OF DAM AND NORTH ABUTMENT

C-1

STRANGMAN POND DAM



NO. 2 TOP OF DAM



NO. 3 DOWNSTREAM END OF SPILLWAY PIPE



NO. 4 DOWNSTREAM SLOPE OF DAM



NO. 5 SEEPAGE AT DOWNSTREAM TOE OF DAM



NO. 6 CHANNEL DOWNSTREAM OF SPILLWAY



NO. 7 SOUTHERLY EMBANKMENT OF DOWNSTREAM CHANNEL

APPENDIX D
HYDROLOGIC AND HYDRAULIC
COMPUTATIONS

STRANGMAN POND DAM

I Test Flood, Storage & Storage Function

1- Total Drainage Area - 0.042 mi²

2- Pond(s) Area: 0.0

Swamp(s) Area: 0.0

Total Area Pond(s) & Swamp(s): 0.0

% Ponds & Swamps = — = 0%

3- $\frac{141-91}{1100} = 0.04545$ } Say Ave Slope = 4.6%

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be 3000 cfs/mi²

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

5- Test Flood Inflow = 1/2 (3000) 0.042 = 63 cfs.

6- Pond Storage

The pond area is .0057459 mi. at elev. 91.0.
 Based on a const. area, storage increases at 3.67 ac. feet per foot of depth increase.

7- Spillway crest elev. is 91.0

8- Storage Functions are based on $Q_{out} = Q_{in} [1 - \frac{S_{out}}{R}]$

S_{out} = Storage Vol. in Reservoir related to final Q_{out} in terms of inches of rain over the drainage area.

S (in Inches) = $12 D (\frac{.00574}{.042}) = .137 D$; $R = 6$ hr rain of storm

D = Storage depth in feet above spillway crest in reservoir

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

$F_{TF} = 63$	$- 6.63 S = 63$	$- .906 D$
$F_{1/2 PMF} = F_{TF}$	$-$	$S = - D$

NONREPRODUCIBLE GRID FORM 149

METCALF & EDDY, ENGINEERS

② Discharge Relations

1 - Spillway

10" ϕ C.M.P., Ent. Inv. 91.0, Exit Inv. 90.7, $n = 0.026$

a - Entrance Control

[Ref. V.T. Chow - "Open Chan. Hydr.", pg 498, Fig. 17-30]

H/d	0.5	0.7	1.0	1.25	1.50
Pond El.	91.5	91.7	92.0	92.25	92.50
Q _a	0.67	1.0	1.5	1.9	2.4

b - Pipe Control

Length 20', Ent. Loss 0.5 h_v, Exit Loss 1.0 h_v
 Assume full flow $n = 0.026$ under flood conditions

$$Q_b = H_b^{3/2} (2.024)$$

Pond El.	92.0	92.25	92.50
H _b	0.83	1.08	1.33
Q _b	1.84	2.10	2.33

Use Ent. Contr. Flow from Pond El. 92.25 and Below
 Use Pipe Contr. Flow from Pond El. 92.50 and Higher

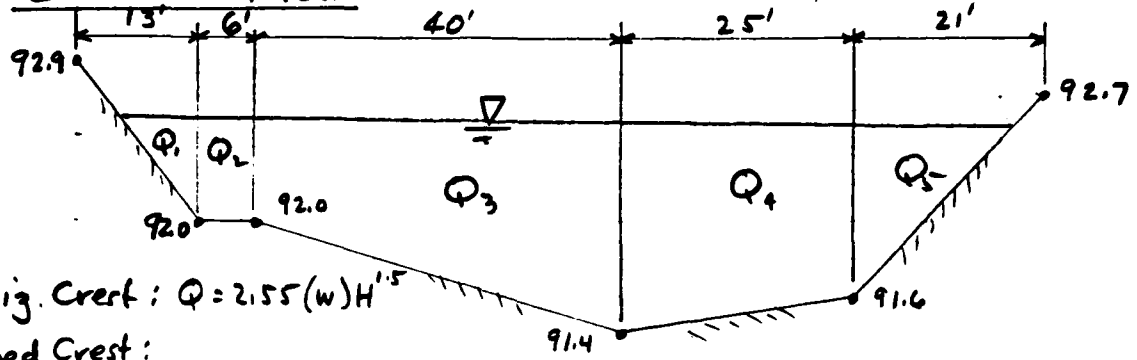
2 - Crest Flow - see next page

NONREPRODUCIBLE GRID FORM 143

METCALF & EDDY, ENGINEERS

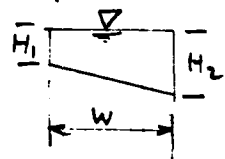
II Discharge Relations - Cont.

2-Crest Flow.



Horiz. Crest: $Q = 2.55(w)H^{1.5}$

Sloped Crest:



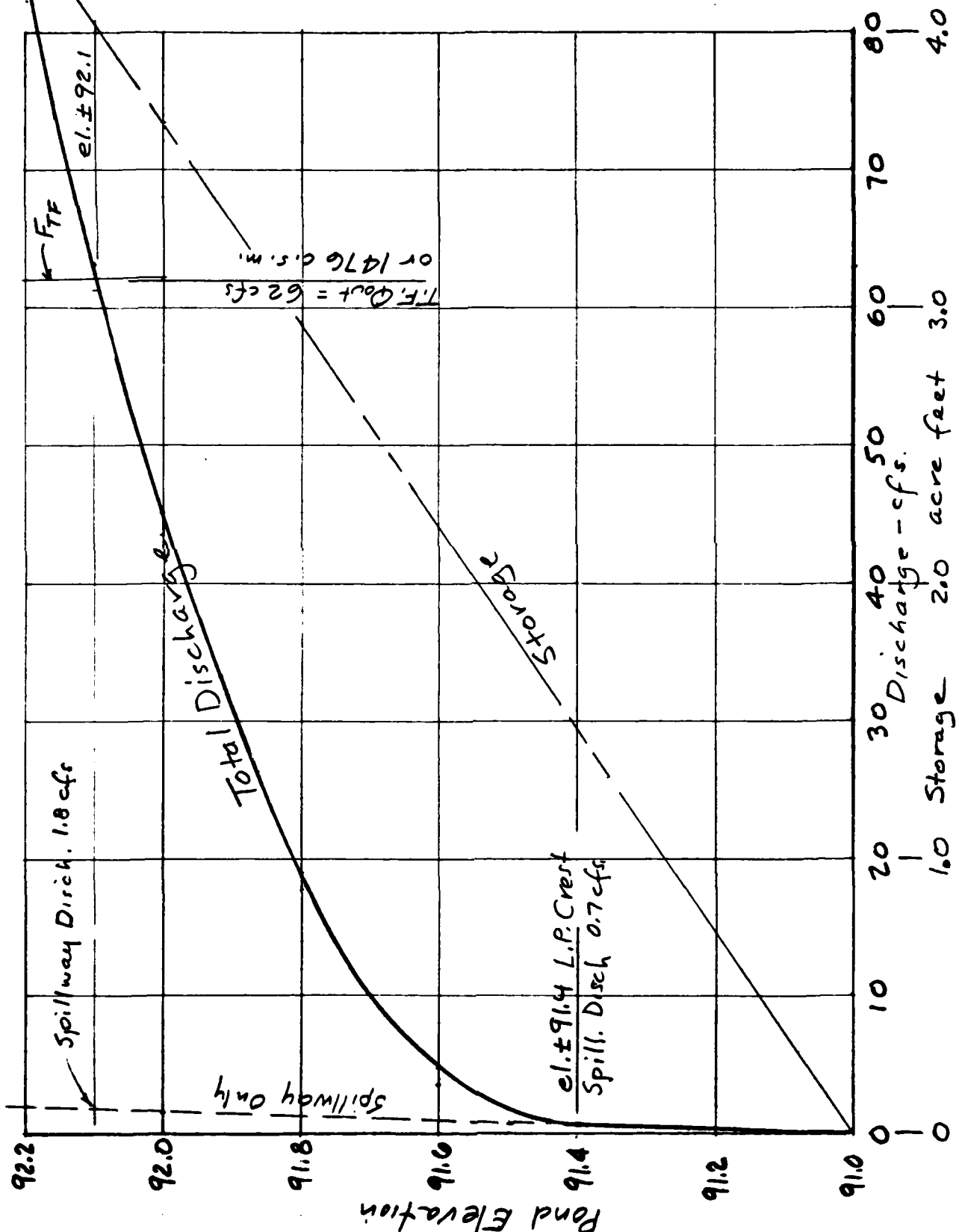
Assumed Effective Crest Profile
 $Q = 2.55\left(\frac{2}{5}\right)w \frac{H_2^{2.5} - H_1^{2.5}}{H_2 - H_1}$

Pond #1	91.6	92.0	92.1	92.2	91.8
Q_1	—	—	0.05	0.26	—
Q_2	—	—	0.48	1.37	—
Q_3	1.21	18.96	27.66	37.71	6.90
Q_4	2.28	22.65	29.73	37.43	10.62
Q_5	—	1.97	3.44	5.43	0.35
ΣQ	3.49	43.58	61.36	82.20	17.87

METCALF & EDDY, ENGINEERS

III Discharge, Storage & Storage Function vs Pond Elevation

METCALF & EDDY, ENGINEERS



Project Nat. Rev. of Non Fed. Dams Acct. No. 7252 Page 5 of 6
Subject Essex County, Mass. Comptd. By LEB Date 7/16/81
Detail STRANGMAN POND Ck'd. By WJC Date 7/28/81

④ Crest Flow Conditions

Max. Hd. on Crest - 92.10' Max el. under T.F.
91.40' L.P. dam crest
0.70' max head

$$\text{Max discharge/ft} = q = 2.55 (0.70)^{1.5} = \underline{1.49 \text{ cfs/ft}}$$

When flow is critical:

$$y_c = \left[\frac{q^2}{g} \right]^{1/3} = \underline{0.41 \text{ ft.}}$$

$$V_c = \underline{3.64 \text{ fps.}}$$

NO. REF. RODUCIBLE GRID FORM 143

METCALF & EDDY, ENGINEERS

Ⓟ Failure of Dam

Peak Failure Flow:

Pond Elevation - 91.4 (L.P. Crest.)

Toe Elevation - 83.0

$$Y_0 = 8.4$$

Dam Length Subject to Breaching = 100'

$$W_0 = 40\% (100) = 40'$$

$$Q_p = 1.68 W_0 (Y_0)^{1.5} = 1.68 (40) (8.4)^{1.5} \approx \underline{1650 \text{ cfs}}$$

Continuing Spill. Disch.: None

Peak Failure Flow: 1650 cfs

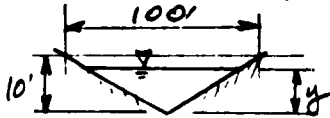
Storage Volume Released:

Storage Above Spillway = 1.5 ac. ft.

Storage Below Spillway $\frac{1}{3} (8.4) 3.67 = 10.3 \text{ " "}$

Total Storage = 11.8 ac. ft.

Channel Hydraulics:



$$S \approx \frac{30}{380} = .07895; R \approx \frac{1}{2} y; n \approx 0.1$$

$$V = \frac{1.49}{n} R^{2/3} S^{1/2} = 2.637 y^{2/3}; Q = V 5 y^2$$

y	5	10	7	6	6.1
V	7.71	12.24	9.65	8.71	8.80
Q	970	6100	2400	1567	1650

Failure flow below dam would be ± 6' deep at ± 9 fps

Failure flow would last for: $\frac{11.8 (43560)}{1650 (3600)} 2 = 0.17 \text{ hours or } 10.4 \text{ minutes}$

Failure flow would impact ± 2 houses on Cherry St., flow partly across and partly down Cherry St. to the next street to the north. Up to 9 houses will be impacted by failure flow after the it passes the 1st 2 houses on Cherry St.

APPENDIX E
INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

STRANGMAN POND DAM

NOT AVAILABLE AT THIS TIME

END

FILMED

8-85

DTIC