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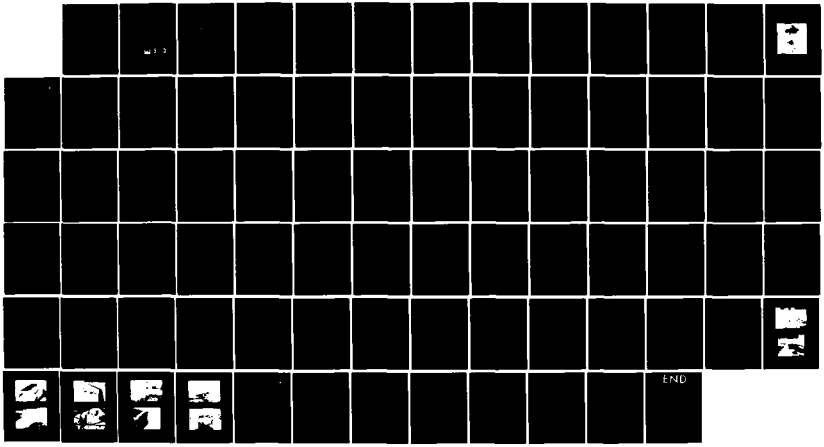

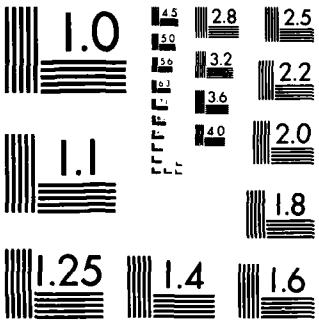

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CONNECTICUT RIVER BASIN
SPENCER, MASSACHUSETTS

SUGDEN RESERVOIR DAM
MA 00698

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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Connecticut River Basin
Spencer, Massachusetts
Shaw Brook, tributary of the Connecticut River

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

The dam is a 440 ft. long earthfill dam and is presently used for emergency water supply and recreation. There are deficiencies which must be corrected to assure the continued performance of this dam. Generally the dam is in good condition.The dam has been classified as intermediate in size with a hazard potential of high.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
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Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

Inclosed is a copy of the Sugden Reservoir Dam (MA-00698) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, Town of Spencer, Memorial Town Hall, Spencer, Massachusetts 01562.

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

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

Sincerely,

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Acting Division Engineer

Incl
As stated

SUGDEN RESERVOIR DAM

MA 00698

CONNECTICUT RIVER BASIN
SPENCER, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION
PROGRAM

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

BRIEF ASSESSMENT

Identification No.: MA00698

Name of Dam: Sugden Reservoir Dam

Town: Spencer

County and State: Worcester County, Massachusetts

Stream: Shaw Brook, tributary of the Connecticut River

Date of Inspection: December 3, 1980

Sugden Reservoir Dam is a 440-foot long earthfill dam and is presently used for emergency water supply and recreation. The original dam at this site, which was constructed in 1882, has undergone major repairs and reconstruction in 1937, 1957, and 1965. The dam has a maximum height of 33 feet and a maximum storage capacity of 1,435 acre-feet at Elevation (El) 846.7, the low point of the dam crest. The dam includes a spillway, a stilling basin, a gate house and an outlet structure. The top of the dam is at El 846.7 National Geodetic Vertical Datum (NGVD). The spillway is a concrete ogee weir, 127 feet long, with the crest at El 840.8. The outlet is a 36- inch diameter reinforced concrete pipe, and is controlled by a sluice gate. The intake invert of the outlet is at El 825.0. The outlet works are located in a gatehouse consisting of a reinforced concrete manhole and a galvanized corrugated metal shed.

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 good condition.

The following deficiencies were observed at the site: lateral displacement and cracking at the joints between the spillway sidewalls and the approach channel sidewalls; severe erosion approximately 2 to 3 feet in width along the north and south spillway sidewalls, moderate erosion at the south abutment of the dam, and at the outlet headwall; trees and vegetation on the downstream slope, trees and brush within the riprap on the upstream face; trees and vegetation overhanging and growing on the floor of both the spillway and outlet discharge channels; and slight leakage of the sluice gate.

SUGDEN RESERVOIR DAM

Based on Corps of Engineers' guidelines, the dam has been classified in the intermediate size and high hazard categories. A test flood equal to the full probable maximum flood (PMF) was used to evaluate the capacity of the spillway. Applying the full PMF rate to the 6.14 square mile drainage area results in a peak test flood inflow of 5,530 cfs. The test flood outflow is 5,150 cfs, resulting in a pond level at El 845.6. The test flood would not overtop the dam. Hydraulic analyses indicate that the spillway can discharge 7,042 cfs, or 137 percent of the test flood outflow with the pond at El 846.7 which is the low point on the top of the dam.

It is recommended that the Owner repair the deficiencies listed above, as described in Section 7.3. The Owner should also implement a program of biennial technical inspections, a plan for surveillance of the dam during and after periods of heavy rainfall, and a plan for notifying downstream residents in the event of an emergency at the dam.

The measures outlined above and in Section 7 should be implemented by the Owner within a period of 2 years 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.

Massachusetts Registration
No. 19703

This Phase I Inspection Report on Sugden Reservoir Dam (MA-00698) **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.**

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

ARAMAST MAHTESIAN, MEMBER
Foundation & Materials Branch
Engineering Division

CARNEY M. TERZIAN, CHAIRMAN
Design 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.

SUGDEN RESERVOIR DAM

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OVERVIEW
SUGDEN RESERVOIR DAM
SPENCER, MASSACHUSETTS

SECTION 4

OPERATING AND MAINTENANCE PROCEDURES

1 Operating Procedures

a. General. There are no regular operating procedures for this dam. Personnel from the Town of Spencer reportedly visit the dam periodically to check for vandalism, and to clear any debris from the spillway.

b. Warning System. There is no warning system in effect at this dam.

2 Maintenance Procedures

a. General. The dam is generally adequately maintained. The Town of Spencer is responsible for maintenance of the facility. Periodic inspections by the Worcester County Engineering Department have been conducted in the past. Typical maintenance procedures have included backfilling some eroded areas on the dam with asphalt, and clearing debris from the spillway.

b. Operating Facilities. The operating condition of the outlet works is checked periodically by the Owner. The outlet is generally opened in the spring and the water level is lowered approximately 2 feet to allow clearing of the beaches along the shoreline. The outlet was last operated in the spring of 1980.

.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.

Some erosion of the soil behind the headwall was noted. The concrete joints were tight. The discharge end of the outlet is clear of debris. A slight amount of flow (approximately 2 gpm) was discharging at the time of inspection.

d. Reservoir Area. The reservoir area is moderately developed. The Lambs Grove district of Spencer is located on the north side of the reservoir, and the Upper Wire Village district of Spencer is located on the west side of the reservoir. Residential development is located on all sides of the reservoir. Most of the land is wooded with hilly slopes. There is a slight potential that future development will occur in the reservoir area.

e. Downstream Channels. The spillway and the outlet discharge into separate downstream channels. The spillway discharge channel consists of riprapped earth slopes on both sides of the channel (Photo No. 3). The floor of the channel consists of exposed bedrock and boulders. The boulders and bedrock are grouted for 20 feet downstream of the stilling basin (Photo No. 5). There is no debris in the floor of the channel. Many trees (some trees up to 6 inches in diameter,)overhang the channel on both earth slopes (Photo No. 9).

The outlet discharge channel consists of earth slopes on both sides of the channel (Photo No. 10). The floor of the channel is unlined and consists of randomly scattered cobbles and boulders. There is no debris on the floor of the channel. There is a heavy growth of trees overhanging the channel on both earth slopes. Many saplings and trees up to 6 inches in diameter were observed. The outlet channel joins the spillway channel approximately 380 feet downstrem of the dam.

There is a bridge across the channel about 500 feet downstream of the dam. Water flows under the bridge in a 17 ft. by 30 ft. wide opening. There is also a 7.5 ft. high by 12 ft. wide culvert approximately 500 feet downstream of the dam through which the former streambed flowed. Water then flows approximately 8 miles downstream to Quaboag Pond.

3.2 Evaluation. The visual inspection indicates that the dam is in good 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.

located downstream of the spillway (Photo No. 5). At the time of the inspection, water was discharging over the spillway, so the weir, stilling basin, and downstream toe could not be examined. The concrete on the north and south sidewalls is in good condition. Lateral displacement of approximately 1 inch and cracking at the joints approximately 1 foot long and 0.5 inches wide were observed between the spillway sidewalls and the approach channel sidewalls (both the north and south sidewalls) (Photo No. 8). Minor staining was observed on the sidewalls at the water line of the stilling basin. Three weep holes exist in each sidewall. Although each drain hole was free of debris, none were flowing. One drain hole exhibited minor staining (Photo No. 3).

The concrete floor of the stilling basin was submerged and therefore not visible. Four 12" by 12" outlets through the concrete stilling basin wall allow the basin to drain the discharge channel (Photo No. 5). Minor cracking approximately 18" long and 0.25" wide was observed in the concrete above each outlet. The stilling basin was clear of debris.

The gate house consists of a reinforced concrete manhole with concrete cover, and a galvanized corrugated metal shed (Photo No. 1). Both the manhole and shed are in good condition although the door on the shed is kept open and not locked. The concrete joints are tight, and no leakage was observed.

The 36-inch sluice gate on the outlet is reportedly in good operating condition. The gate operator is located inside the metal shed. A removable handle operates the stem guard which opens the sluice gate. The handle is kept at the Town of Spencer Highway Department. Slight leakage was visible at the downstream end of the outlet (Photo No. 6).

According to the drawings, the inlet structure consists of a concrete inlet headwall with a trash rack across the 36-inch diameter pipe opening. At the time of inspection, the inlet structure was submerged and not visible.

The 36-inch diameter reinforced concrete outlet pipe discharges through a concrete outlet headwall and into a discharge channel (Photo No. 6). The concrete outlet headwall is in good condition. Minor staining of the concrete was observed below the discharge line. Minor efflorescence of the concrete was also observed.

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The Phase I Inspection of the dam at Sugden Reservoir was performed on December 3, 1980. A copy of the inspection checklist is included in Appendix A. Previous inspections were conducted by the Worcester County Engineering Department from 1924 to 1969 and by the Massachusetts Department of Public Works in 1972. Selected copies of those reports are given in Appendix B. Selected photographs taken during our Visual Inspection are included in Appendix C.

b. Dam. The dam is an earthfill structure and includes a spillway, stilling basin, outlet, and gate house.

There was no evidence of seepage on the downstream slope or at the toe of the embankment.

Severe erosion approximately 2 to 3 feet in width was noted along the north and south spillway sidewalls (see Figure B-1 in Appendix B). Moderate erosion was also observed at the south dam abutment. An asphalt patch for erosion protection was noted on the top of the dam near the south spillway wall (Photo No. 4 and 7).

The riprap on the upstream face of the embankment is intact. Grass and small trees were observed between the riprap above the water line (Photo No. 2).

Many saplings and 6 to 8 pine trees from 1 to 6 inches in diameter were observed on the downstream face of the dam (Photo No. 1, 4, and 7).

Three or four footpaths were observed along the downstream slope (Photo No. 4) and along the north and south sidewalls. Footpaths and tire tracks were also noted on the crest of the embankment (Photo No. 1 and 2).

c. Appurtenant Structures. The approach channel consists of concrete sidewalls (Photo No. 3 and 4). The floor of the approach channel was submerged and not visible.

The spillway is a concrete ogee weir with concrete sidewalls, and has no provisions for flashboards or stoplogs (Photo No. 3 and 4). A concrete stilling basin is

c. Validity. Comparison of the available drawings with the field survey conducted during the Phase I inspection indicates that the available information is valid.

SECTION 2

ENGINEERING DATA

2.1 General. The engineering data available for this Phase I inspection includes drawings dated June 1882 and September 1937 prepared by the Worcester County Engineering Department, and drawings dated February 1957 and September 1960 prepared by the Massachusetts Department of Public Works, Division of Waterways (see Figures B-2 and B-3). The drawings were obtained from the Worcester County engineering Department. There are no other drawings, specifications, or computations available from the Owner, State or County agencies. Selected copies of previous inspection reports dated 1924 to 1969, prepared by the Worcester County Engineering Department are included in Appendix B. The most recent inspection was conducted in 1972 by the Massachusetts Department of Public Works. A copy of that report is also given in Appendix B.

We acknowledge the assistance and cooperation of personnel from the Massachusetts Department of Environmental Quality Engineering, Division of Waterways; the Massachusetts Department of Public Works; and the Worcester County Engineers Office. In addition, we acknowledge the assistance of Mr. Lloyd Dyer, Superintendant of the Highway Department, of the Town of Spencer, Massachusetts, who provided information on the history and operation of the dam.

2.2 Construction Records. There are no construction records or as-built drawings available for the dam or appurtenances. Previous inspection reports by the Worcester County Engineering Department provided some construction information, and a summary of repairs and post-construction changes at the site.

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 is limited engineering data available for this dam.

b. Adequacy. The lack of detailed hydraulic, structural and construction data did not allow for a definitive review. Therefore, the evaluation of the adequacy of this dam is based on the visual inspection, past performance history, and engineering judgment.

(3) Crest elevation: 840.8

(4) Gates: N/A

(5) Upstream channel: concrete sidewalls

(6) Downstream channel: stilling basin

j. Regulating Outlets

(1) Invert El: 825.0 at upstream end.

(2) Size: 36-inch diameter

(3) Description: reinforced concrete pipe

(4) Control mechanism: sluice gate

(4) Top of dam: 1,435

(5) Test flood pool: 1,335

f. Reservoir Surface (acres)

(1) Normal pool: 90

(2) Flood-control pool: N/A

(3) Spillway crest: 90

*(4) Test flood pool: 90

*(5) Top of dam: 90

g. Dam

(1) Type: earthfill

(2) Length: 440 feet

(3) Height: 33 feet

(4) Top width: 20 feet

(5) Side slopes: 3:1 upstream and downstream

(6) Zoning: central impervious core, pervious fill

(7) Impervious core: central concrete wall 18" x 8' overlain by zone of impervious earth fill.

(8) Cutoff: N/A

(9) Grout curtain: N/A

(10) Other: N/A

h. Diversion and Regulating Tunnel: N/A

i. Spillway

(1) Type: concrete ogee weir

(2) Length of weir: 127 ft.

*Based on the assumption that the surface area will not significantly increase with changes in pool elevation from 839.0 to 846.7.

(8) Total project discharge at top of dam: 7,042 cfs at El 846.7.

(9) Total project discharge at test flood elevation: 5,150 cfs at El 845.6.

c. Elevation (feet above National Geodetic Vertical Datum of 1929 (NGVD)). A benchmark was established at El 840.8 on the crest of the spillway. This elevation was obtained from drawing No. 4 of 5 by the Massachusetts DPW (see Figure B-3).

(1) Streambed at toe of dam: 814.2 outlet channel
828.7 spillway channel.

(2) Bottom of cutoff: N/A.

(3) Maximum tailwater: unknown.

(4) Normal pool: 840.8.

(5) Full flood control pool: N/A

(6) Spillway crest: 840.8.

(7) Design surcharge (Original design): 844.4 (from Figure B-2).

(8) Top of dam: 846.7.

(9) Test flood surcharge: 845.6.

d. Reservoir (Length in feet)

(1) Normal pool: 3,000

(2) Flood control pool: N/A

(3) Spillway crest pool: 3,000

(4) Top of dam: 3,000

(5) Test flood pool: 3,000

e. Storage (acre-feet)

(1) Normal Pool: 900

(2) Flood control pool: N/A

(3) Spillway crest pool: 900

The low level outlet is opened generally in the Spring and the water level lowered approximately 2 feet to allow clearing of the beaches along the shoreline. The outlet was last operated in the spring of 1980.

1.3 Pertinent Data

a. Drainage Area. The drainage area is approximately 3,820 acres (6.14 square miles) and consists of hilly land (see Figure D-1 in Appendix). The drainage area includes drainage from Shaw Pond and Shaw Brook. Moose Hill Dam which was designed by the Soil Conservation Service is now under construction upstream of Sugden Reservoir Dam (see Location map and Figure D-1 in Appendix D). The drainage area for Moose Hill Dam is 4.73 square miles or 77 percent of the drainage into Sugden Reservoir. About 12.9 percent of the drainage area is ponds and swamps. In general, the undeveloped portions of the drainage area consist of 90 percent woodland, and 10 percent open fields. Moderate residential development occurs along the sides of the reservoir. The Lambs Grove district of Spencer is located on the north side of the reservoir, and the Upper Wire Village district of Spencer is located on the west side of the reservoir.

b. Discharge. Discharge from Sugden Reservoir Dam flows over the spillway, into a concrete stilling basin, and then into the discharge channel. Water also discharges from the outlet into a separate unlined discharge channel which joins the spillway discharge channel 380 ft. downstream of the dam.

(1) Outlet: Size - 36-in. dia. Invert El 825.0. Discharge Capacity - 137.2 cfs at El 840.8.

(2) Maximum known flood at damsite: unknown.

(3) Ungated spillway capacity at top of dam 7,042 cfs at El 846.7.

(4) Ungated spillway capacity at test flood elevation: 5,150 cfs at El 845.6.

(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: 5,150 cfs at El 845.6.

d. Hazard Classification. There are three houses located along the stream approximately 2,000 ft downstream of the dam. A playground also is located along the stream approximately 4,000 ft. downstream of the dam (see Flood Impact Area shown on the Location Map). The foundations of these structures and the playground elevation are approximately 10 feet above the streambed. An assumed failure of the dam would result in a flood wave 15 feet high 2,000 feet downstream of the dam as compared to a depth of flow of 7.5 feet before failure . 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 is owned by the Town of Spencer, Memorial Town Hall, Spencer, Massachusetts 01562. Mr. William D. Ekleberry, Chairman of the Board of Selectmen (telephone 617-885-2578) granted permission to enter the property and inspect the dam.

f. Operator. The dam is operated by personnel from the Town of Spencer Highway Department.

g. Purpose of the Dam. The water in Sugden Reservoir is currently used for emergency water supply and recreation by the Town of Spencer. The original purpose of the dam was water supply.

h. Design and Construction. The original Sugden Reservoir Dam was constructed in 1882. Major construction modifications and repairs have occurred since that time. A new spillway was constructed in 1937-1938. Subsequently the entire embankment was rebuilt in 1957, and the spillway was widened on either side of the old spillway. In 1965, the old spillway section was rebuilt. Drawings dated June 1882 and September 1937, prepared by the Worcester County Engineering Department, and drawings dated February 1957 and September 1960 prepared by the Massachusetts Department of Public Works, Division of Waterways are available.

Previous inspection reports indicate that since the 1965 repairs the dam has been in good condition.

i. Normal Operating Procedures. Personnel from the Town of Spencer reportedly visit the dam periodically. At that time, they check for vandalism and clear any debris from the spillway.

b. Description of Dam and Appurtenances. Sugden Reservoir Dam is a 440-foot long, earthfill dam with a maximum height of 33 feet (see Plan of Dam and Sections in Appendix B and photographs in Appendix C). The top of the dam is 20 feet wide and varies from El 846.7 to 847.1. A gate house is located on the top of the dam. The upstream face is a maximum 3:1 (horizontal:vertical) slope covered with riprap. The downstream face is a maximum 3:1 slope covered with grass. Available drawings indicate that the dam is a zoned embankment with a combination concrete and selected impervious earth fill central core wall (see Figure B-2). The drawings also show that the dam is founded on bedrock or "hardpan". The drawings do not show a cutoff trench below the base of the dam.

The spillway, located at the north abutment of the dam, is a 127-foot long, ogee-crested concrete weir. The approach channel consists of concrete sidewalls. There are no stoplogs or flashboards on the crest of the spillway. The crest of the spillway is at El 840.8 (see Figure B-3).

The stilling basin, located at the downstream end of the spillway, is 127 feet long and 20 feet wide. The concrete floor was submerged. Four 12-inch by 12-inch outlets through the concrete stilling basin wall allow the basin to drain to the discharge channel.

The discharge channel below the stilling basin is 100 feet wide. The earth sides are riprapped for a distance of 60 feet downstream. The floor of the channel is exposed bedrock and boulders and slopes at 7.5 percent.

The low-level outlet for the dam is a 36-inch diameter reinforced concrete pipe, located 170 feet from the south end of the spillway. The invert of the outlet is at El 825.0 at the upstream end. Flow into the outlet is controlled by a sluice gate located in the gate house. The outlet pipe discharges 137.2 cfs when the reservoir is at El 840.8. The water flows downstream in a separate unlined discharge channel which joins the spillway discharge channel 380 ft. downstream of the dam.

c. Size Classification. For a dam to be classified as intermediate, it must have a height between 40 and 100 feet or a maximum storage capacity between 1 000 acre-feet and 50,000 acre-feet. Sugden Reservoir has a storage capacity of 1,435 acre-feet, therefore the dam has been classified as "intermediate".

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

SUGDEN RESERVOIR 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

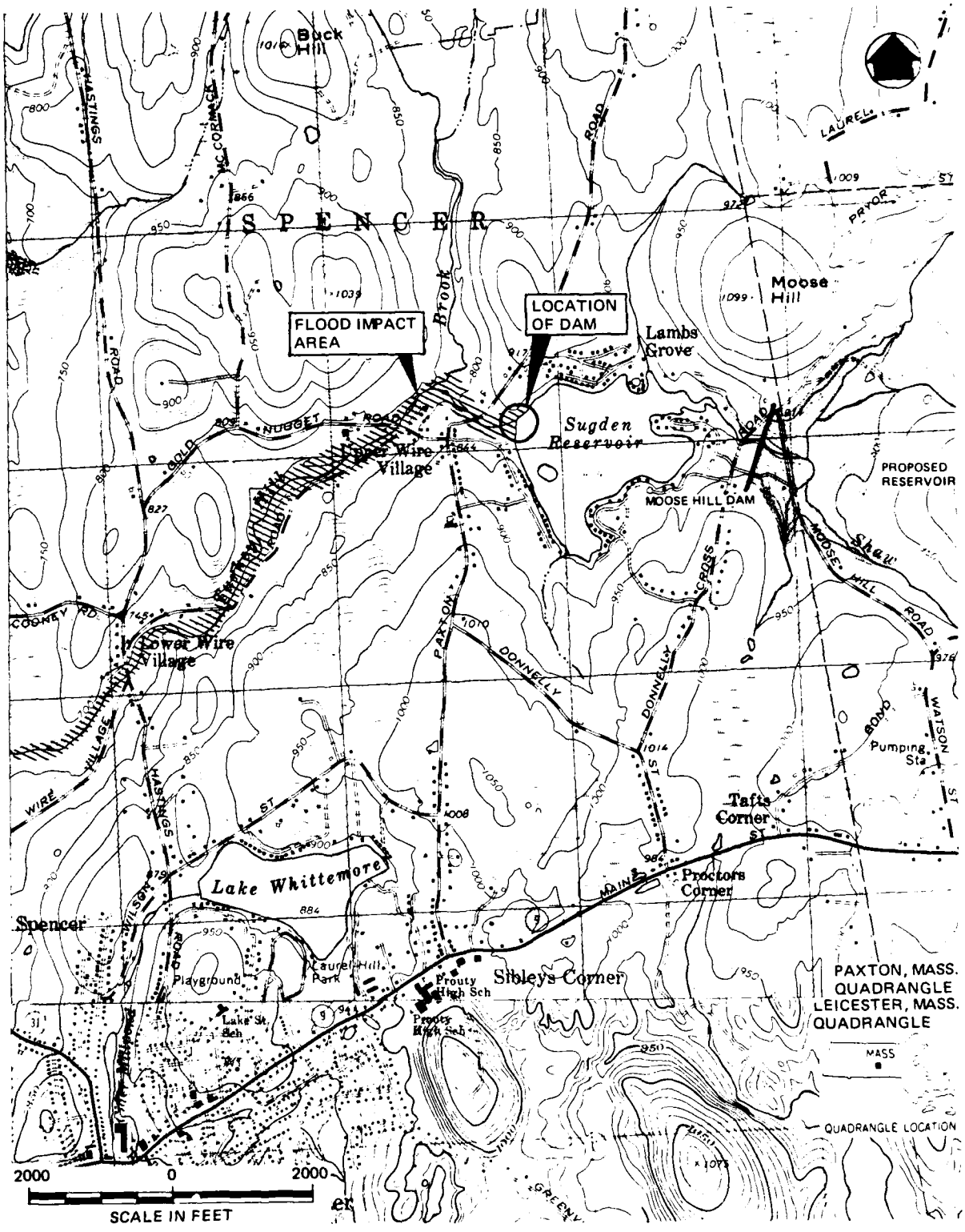
(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(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 Shaw Brook in the Town of Spencer, Worcester County, Massachusetts and in the Connecticut River Basin (see Location Map). The coordinates of this location are Latitude 42 deg. 16 min. north and Longitude 71 deg. 58 min. west. Shaw Brook joins Turkey Hill Brook approximately 0.25 miles downstream of the dam.



LOCATION MAP - SUGDEN RESERVOIR DAM

SECTION 5

EVALUATION OF HYDRAULIC/ HYDROLOGIC FEATURES

5.1 General. Sugden Reservoir Dam has a drainage area of 6.14 square miles of which 12.9 percent is ponds and swamps (see Figure D-1, Drainage Area Map). The land is hilly and moderately developed.

There is one existing dam (Shaw Pond) upstream of Sugden Reservoir that provides additional storage within the watershed. Moose Hill Dam which was designed by the Soil Conservation Service is presently under construction upstream of Sugden Reservoir. The dam is located between Sugden Reservoir and Shaw Pond and will provide additional storage within the watershed. The hydraulic and hydrologic computations of Moose Hill Dam have been obtained from the Soil Conservation Service and have been reviewed for the evaluation of the hydraulic and hydrologic features of Sugden Reservoir Dam.

Sugden Reservoir has a surface area of approximately 90 acres and a maximum storage capacity of 1,435 acre-feet at El 846.7, the low point of the crest of the dam.

The low-level outlet can discharge a flow of 137.2 cfs when the reservoir is at El 840.8 which is the crest of the spillway. At this reservoir elevation and with no additional inflow, the outlet can lower the reservoir by 1 foot in about 8 hours.

5.2 Design Data. There are no hydraulic or hydrologic computations available for the design of the spillway at Sugden Reservoir Dam.

5.3 Experience Data. According to the drawings and previous inspection reports, the dam was originally built around 1882. In March of 1936, the stone apron of the spillway was washed away by a flood. A new spillway and apron were constructed in 1937-1938. In August of 1955, approximately 200 feet of the earth embankment was washed out. Subsequently, the embankment and spillway were rebuilt in 1957. In 1965, the old center spillway section was rebuilt.

5.4 Test flood Analysis. Sugden Reservoir dam has been classified in the "intermediate" size and "high" hazard categories. According to the Corps of Engineers guidelines, a test flood equal to the full PMF (Probable Maximum flood) should be used to evaluate the capacity of the spillway.

The full PMF rate for the Sugden Reservoir Dam watershed was calculated to be 900 cfs per square mile of drainage area. This calculation is based on the average slope of 1.5 percent in the drainage area, the pond-plus-swamp area to drainage area ratio of 12.9 percent, and the U.S. Army Corps of Engineers' guide curves for Maximum Probable Flood Peak Flow Rates (dated December 1977). For this analysis, the peak flow rate was determined to be somewhat above the guide curve for flat and coastal topography.

Applying the full PMF rate to the 6.14 square mile drainage area results in a peak test flood inflow of 5,530 cfs. By adjusting the test flood inflow for surcharge storage, the peak test flood outflow was calculated to be 5,150 cfs (839 cfs per square mile). The pond level would rise to El 845.6.

Hydraulic analyses indicate that the spillway can discharge 7,042 cfs or 137 percent of the test flood outflow with the pond at El 846.7, which is the low point on the top of the dam.

The storage effects of Moose Hill Dam have not been included in the test flood inflow analyses since the spillway is adequate for the full PMF rate selected. IF the storage effects of Moose Hill Dam were considered, the test flood inflow would be reduced and the spillway could discharge a larger percentage of the test flood.

5.5 Dam Failure Analysis. The peak discharge rate due to failure of the dam was calculated to be 34,700 cfs with the pond at El 845.6. This calculation is based on a maximum head of 31.4 feet and an assumed 250-foot wide breach occurring in the south section of the embankment. Failure of the dam would produce a downstream flood wave 15.5 feet high approximately 2,000 feet downstream of the dam as compared to channel flow 7.5 feet high prior to failure.

There are three houses located along the stream approximately 2,000 feet downstream of the dam. A playground also is located along the stream approximately 4,000 feet downstream of the dam. The foundations of these structures and the playground elevation are approximately 10 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 and above the playground elevation, by approximately 5.5 feet, 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 6

STRUCTURAL STABILITY

6.1 Visual Observations. The evaluation of the structural stability of Sugden Reservoir Dam is based on a review of previous inspection reports, a review of available drawings, and the visual inspection conducted on December 3, 1980.

As discussed in Section 3, Visual Inspection, the dam is in good condition. Lateral displacement and cracking at the joints were observed between the spillway sidewalls and the approach channel sidewalls. Severe erosion approximately 2 to 3 feet in width was observed along the north and south spillway sidewalls; moderate erosion is occurring at the south abutment of the dam and at the outlet headwall (see Figure B-1 in Appendix B). Trees and vegetation were observed on the downstream embankment. Trees and brush were observed within the riprap on the upstream face. Slight leakage of the sluice gate was visible at the downstream end of the outlet. Trees and vegetation overhang and grow in the spillway and outlet discharge channels.

6.2 Design and Construction Data. The original construction of Sugden Reservoir Dam was completed around 1882. A new spillway was constructed in 1937-1938. The entire embankment was replaced after failure in 1957, and the spillway was widened on either side of the old spillway. In 1965, the old spillway section was rebuilt. Computations for design of the dam, spillway, and outlet are not available.

Drawings dated June 1882 and September 1937, prepared by the Worcester County Engineering Department, and drawings dated February 1957 and September 1960 prepared by the Massachusetts Department of Public Works, Division of Waterways show the proposed construction of the dam (see Figures B-1 through B-3). The drawings show that the dam is a zoned earthfill embankment with a combination core wall. The bottom section consists of an 18 inch wide by 8 foot high concrete wall which is overlain by a top section consisting of selected impervious earth fill. The drawings also show that the spillway and the core wall are founded on bedrock or firm "hardpan". Seams in the bedrock were grouted. The remaining earthfill consists of pervious placed fill on either side of the central core. The upstream slope has 18 inches of riprap on 6 inches of gravel from El 847.0 to El 839.0. The downstream slope has 6 inches of loam and is grass covered. The drawings do not show a cutoff trench below the base of the dam. The side slopes of the embankment vary, but are 3:1 maximum upstream and downstream. A 3-foot wide berm exists on the upstream slope at El 839.0.

Specifications for construction of the dam are not available.

There is no information on the shear strength or permeability of the soil and/or rock materials of the embankment.

6.3 Post-Construction Changes. Since the original construction of the dam, several changes have been made. According to the drawings and previous inspection reports, the dam was originally built around 1882. In March of 1936, the stone apron of the spillway was washed away by the flood. A new spillway and apron were constructed in 1937-1938. In August of 1955, approximately 200 feet of the earth embankment was washed out. The embankment was rebuilt in 1957, and the spillway was widened by adding new spillway sections to either side of the old spillway, and leaving the old spillway intact. In 1959, the old section of the spillway started leaking. This old section of spillway was rebuilt to match the new spillway sections in 1965.

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

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. As a result of the visual inspection, the review of available data, and limited information on operation and maintenance, the dam is considered to be in good condition. The following deficiencies must be corrected to assure the continued performance of this dam: lateral displacement and cracking at the joints between the spillway sidewalls and the approach channel sidewalls; severe erosion approximately 2 to 3 feet width along the north and south spillway sidewalls; moderate erosion at the south abutment of the dam, and at the outlet headwall; trees and vegetation on the downstream embankment; trees and brush within the riprap on the upstream face; trees and vegetation overhanging and growing on the floor of both the spillway and outlet discharge channels; and slight leakage of the sluice gate.

The sluice gate on the low level outlet is reportedly operable, and the outlet apparently is not blocked.

The peak test flood (full PMF) outflow is estimated to be 5,150 cfs with the pond at El 845.6. The test flood would not overtop the low point on the dam. Hydraulic analyses indicate that the spillway can discharge 7,042 cfs or 137 percent of the test flood outflow with the pond at El 846.7, which is the low point on the top of the dam.

b. Adequacy. The lack of detailed design and construction data did not allow for a definitive review. Therefore, the evaluation of this dam is based on a review of the available data, the visual inspection, past performance and engineering judgment.

c. Urgency. The recommendations and remedial measures outlined below should be implemented by the Owner within 2 years after receipt of this Phase I Inspection Report.

7.2 Recommendations. As a result of the visual inspection and a review of available data, further investigations to assess the adequacy of the dam are not considered necessary at this time. Future changes within the watershed, the downstream area or to the dam may necessitate future investigations.

The recommendations on repairs and maintenance procedures are outlined below under Section 7.3, Remedial Measures.

7.3 Remedial Measures

a. Operating and Maintenance Procedures. It is recommended that the Owner accomplish the following:

(1) Clear trees, brush and roots from the dam embankment, and to a distance of 25 feet from the toe of the dam. All stumps and roots removed should be backfilled with select material.

(2) To prevent continued erosion, fill in all eroded areas and all footpaths on the upstream and downstream face of the earth embankment portions of the dam and behind the outlet headwall and place loam and seed or crushed stone.

(3) Repair all displaced and cracked concrete between the spillway sidewalls and the approach channel sidewalls.

(4) Remove all brush, trees, debris and loose stone in the floor of the spillway and outlet discharge channels.

(5) Institute a definite plan for surveillance of the dam and spillway during and after periods of heavy rainfall and a plan to warn people in downstream areas in the event of an emergency at the dam.

(6) Implement a systematic program of maintenance inspections. As a minimum, the inspection program should consist of a monthly inspection of the dam and appurtenances and be supplemented by additional inspections during and after severe storms. All repairs and maintenance should be undertaken in compliance with all applicable State regulations. The maintenance program should include removal of any debris caught on the spillway weir to prevent clogging of the spillway.

(7) Institute a program of technical inspections of this dam on a biennial basis. Particular attention should be given to the lateral displacement and cracking of the sidewalls (Photo No. 8) and the leakage from the 36-inch outlet pipe.

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

APPENDIX A

PERIODIC INSPECTION CHECKLIST

SUGDEN RESERVOIR DAM

PERIODIC INSPECTION

PARTY ORGANIZATION

PROJECT Sugden Reservoir Dam

DATE Dec. 3, 1980

TIME 08:00 to 16:00

WEATHER 30°F Overcast

W.S. ELEV. 840.8 U.S 830.1 DN.S.

PARTY:

1. L. Taverna (Metalf & Eddy - Geotechnical)
2. S. Nagel (Metcalf & Eddy - Geotechnical)
3. F. Gordon (Metcalf & Eddy - Geotechnical)
4. W. Diesl (Metcalf & Eddy - Geotechnical)
5. L. Branagan (Metcalf & Eddy - Hydraulics)
6. E. Greco (Metcalf & Eddy - Geotechnical)
7.
8.
9.
10.

	PROJECT FEATURE	INSPECTED BY	REMARKS
1.	Dam Embankment	Taverna/Nagel/Greco	
2.	Spillway	Taverna/Greco/Branagan	
3.	Outlet	Taverna/Greco/Branagan	
4.			
5.			
6.			

PERIODIC INSPECTION CHECK LIST

PROJECT Sugden Reservoir Dam DATE December 3, 1980

PROJECT FEATURE Dam Embankment NAME L. Taverna

DISCIPLINE Geotechnical NAME S. Nagel/E. Greco

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	846.7
Current Pool Elevation	840.8
Maximum Impoundment to Date	Unknown.
Surface Cracks	None visible.
Pavement Condition	No pavement. Crest of dam is grass covered.
Movement or Settlement of Crest	None visible.
Lateral Movement	None visible.
Vertical Alignment	Level.
Horizontal Alignment	Straight.
Condition at Abutment and at Concrete Structures	South abutment ties into hillside-some erosion, north abutment ties into south sidewall of spillway-severe erosion, north sidewall of spillway ties into hillside-severe erosion.
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes *	3 or 4 footpaths on downstream slope, footpaths along north and south sidewalls, tire tracks and footpaths along crest.
Sloughing or Erosion of Slopes or Abutments	Erosion along north and south sidewalls. Erosion along south abutment, asphalt patch placed on embankment crest where crest meets South sidewall
Rock Slope Protection - Riprap Failures	Riprap intact, grass and some small trees between riprap above water line.
Unusual Movement or Cracking at or near Toes	None visible.
Unusual Embankment or Downstream Seepage	None visible.
Piping or Boils	None visible.
Foundation Drainage Features	None visible.
Toe Drains	None visible.
Instrumentation System	None.

*6 to 8 pine trees to 6" dia. and many saplings on downstream slope.

PERIODIC INSPECTION CHECK LIST

PROJECT Sugden Reservoir Dam DATE December 3, 1980

PROJECT FEATURE Spillway NAME L. Taverna/E. Greco

DISCIPLINE Geotechnical/Hydraulics NAME L. Branagan

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Concrete sidewalls. Floor not visible.
General Condition	Open joints (1" wide) and cracking at joints (1'long and 0.5"wide) where north and south sidewalls meet spillway sidewalls.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	None.
Floor of Approach Channel	Not visible, submerged.
b. Weir and Training Walls	Ogee weir, concrete spillway and sidewalls, no flashboards.
General Condition of Concrete	Open joints (1" wide) and cracking at joints (1' long and 0.5" wide) where north and south sidewalls meet approach channel sidewalls.
Rust or Staining	Minor staining at stilling basin water line.
Spalling	None visible.
Any Visible Reinforcing	None visible.
Any Seepage or Efflorescence	None visible.
Drain Holes	3 drain holes on each sidewall, none flowing, 1 has staining.
c. Discharge Channel	Riprapped natural slopes both sides Floor is exposed bedrock, boulders.
General Condition	Floor has grout between bedrock & boulders for 20 ft. downstream of stilling basin.
Loose Rock Overhanging Channel	None.
Trees Overhanging Channel	Many trees overhang channel on North and South slopes.
Floor of Channel	Bedrock, boulders, grout. Many trees between boulders.
Other Obstructions	Bridge with one opening. Also one culvert for old streambed. Approx. 500' downstream of dam.
d. Stilling Basin	Concrete floor not visible, submerged. Minor cracking (18" long & 0.25" side) in concrete above each outlet in stilling basin wall.

PERIODIC INSPECTION CHECK LIST

PROJECT Sugden Reservoir Dam DATE December 3, 1980

PROJECT FEATURE Gate House NAME L. Taverna

DISCIPLINE Geotechnical NAME S. Nagel

AREA EVALUATED	CONDITION
OUTLET WORKS - GATE HOUSE ~~XXXXXXXXXXXXXX~~	Reinforced concrete manhole, galvanized corrugated metal shed, 36" slide gate.
a. Concrete and Structural	
General Condition	Manhole in good condition, shed in good condition.
Condition of Joints	Joints tight, slab covers tight.
Spalling	None visible.
Visible Reinforcing	None visible.
Rusting or Staining of Concrete	None visible.
Any Seepage or Efflorescence	None visible.
Joint Alignment	Joints tight, slab covers tight.
Unusual Seepage or Leaks in Gate	Leak in slide gate, approx. 2 gpm flow. Visible at d/s end of outlet.
Cracks	None visible.
Rusting or Corrosion of Steel	Minor rusting of ironworks.
b. Mechanical and Electrical	
Air Vents	None.
Float Wells	None.
Crane Hoist	None.
Elevator	None.
Hydraulic System	None.
Service Gates	Reportedly operable.
Emergency Gates	None.
Lightning Protection System	None.
Emergency Power System	None.
Wiring and Lighting System in Gate Chamber	None.

PERIODIC INSPECTION CHECK LIST

PROJECT Sugdon Reservoir Dam DATE December 3, 1980

PROJECT FEATURE Intake Channel and Intake Structure NAME L. Taverna

DISCIPLINE Geotechnical NAME S. Nagel

Note: u/s = upstream

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE a. Approach Channel	36" dia. RCP, concrete inlet headwall, trash bars, not visible submerged.
Slope Conditions	Riprapped u/s slope of dam.
Bottom Conditions	Submerged.
Rock Slides or Falls	None.
Log Boom	None.
Debris	None.
Condition of Concrete Lining	Not visible.
Drains or Weep Holes	None.
b. Intake Structure	
Condition of Concrete	Not visible.
Stop Logs and Slots	Not visible.

PERIODIC INSPECTION CHECK LIST

PROJECT Sugden Reservoir Dam — DATE December 3, 1980

PROJECT FEATURE Outlet Structure And Outlet Channel — NAME L. Taverna/E. Greco

DISCIPLINE Geotechnical — NAME L. Branagan

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	36" dia. RCP, concrete outlet headwall, discharge channel. Concrete in good condition.
General Condition of Concrete	
Rust or Staining	Minor staining of concrete below discharge line.
Spalling	None.
Erosion or Cavitation	Some erosion of soil behind headwall
Visible Reinforcing	None.
Any Seepage or Efflorescence	Minor efflorescence, leakage from pipe, approx. 2 gpm flow.
Condition at Joints	Joints tight.
Drain Holes	None.
Channel	Outlet channel meets spillway ~~channel approx. 380' downstream~~ of dam.
Loose Rock or Trees Overhanging Channel	Heavy growth of trees overhanging channel, pine trees to 6" dia., ~~many saplings.~~
Condition of Discharge Channel	Unlined, many scattered cobbles and boulders.

APPENDIX B

PLANS OF DAM AND PREVIOUS
INSPECTION REPORTS

	Page
;ure B-1, Plan of Dam	B-1
;ure B-2, Section through Dam Embankment	B-2
;ure B-3, Section through Spillway	B-3
le card for Sugden Reservoir Dam ;om Worcester County Engineer's Office	B-4
evious Inspection Reports Dated 955 through 1965 by Worcester ounty Engineer's Office	B-5
ated 1972 by Massachusetts epartment of Public Works	B-13

Sugden Reservoir Dam

Dec. 9. 1959 Spencer

Clay Blanket behind Cor. of Abt-down stream wall

Designed by Utilities Eng. Bath
H. M. Turner Investigated
Leak along wing wall and apron - Bored
holes in apron - Leak disappeared

COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.O.M. - W.O.L. Date Oct 26 1959 Dam No. 47-14

Town Spencer Location Sugden Reservoir

Owner Town of Spencer Use Recreation

Material and Type Earth and Concrete

Dam Designed by MDPW - Waterways Div Constructed by Bayer-Mingello Year 1958

SPILLWAY

El. top Abutment ..... El. Crest ..... El. Apron ..... El. Streambed .....

Width top Abutment ..... Width top Crest ..... Width bottom Spillway .....

Width Flashboards carried ..... Kind Flashboards .....

El. Flowline Cleanout Pipe ..... Size and Kind Cleanout Pipe .....

Kind of Foundation under Spillway .....

Condition Inspected leak in downstream spillway - water boil visible about 10' from S'ly abutment wall - pond full - 2" of water over spillway

EMBANKMENT

El. Top ..... El. Natural Ground ..... Width Top .....

Width of Bottom ..... Upstream Slope ..... Downstream Slope .....

Kind of Corewall ..... Riprap .....

Material in Embankment ..... Foundation .....

Condition OK

GATES ..... Location .....

Size ..... Kind ..... El. Flowline .....

Condition Wide open

WHEEL ..... Kind ..... Size ..... Rated H. P. .....

Location ..... Ave. Head .....

Evidence of Leaks in Structure .....

Recent Repairs and Date .....

Topography of Country below Dam .....

Nature of Buildings and Roads below Dam .....

Number Acres in Pond ..... Drainage Area in Square Miles .....

Discharge in Second Feet per Square Mile .....

Estimated Storage Million Cubic Feet .....

OWN Spencer DAM NO. 474

OCATION Sugden STREAM

WORCESTER COUNTY ENGINEERING DEPARTMENT

WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

WNED BY Town of Spencer PLACE Spencer USE

NSPECTED BY LOM DATE 57 Oct 8,

YPE OF DAM CONDITION

Plans approved by C. C. for reconstruction

SPILLWAY

FLASHBOARDS IN PLACE RECENT REPAIRS

CONDITION To lengthen

REPAIRS NEEDED

EMBANKMENT

RECENT REPAIRS

CONDITION To rebuild

REPAIRS NEEDED

GATES

RECENT REPAIRS

CONDITION To rebuild

REPAIRS NEEDED

LEAKS

HOW SERIOUS

DATE 56

LOM
COUNTY ENGINEER

/N Spencer DAM NO. 47-14

:ATION Ely of Paxton Rd STREAM Sugden Res. Shaw Brook

"Wire Village" "Sugden Reservoir"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

ned by Town of Spencer Place Water Dept. Use Pond

spected by WOC Date Sept. 1955

pe of Dam Earth-Stone-Concrete Condition Poor.

ILLWAY

ashboards in Place _____ Recent Repairs _____

ndition Too small - should be enlarged.

pairs Needed _____

BANKMENT

:ent Repairs _____

ndition 20'± of earth embankment washed out by flood

pairs Needed Dam was probably too low.

:FS

:ent Repairs _____

ndition Probably ok. - Still in place.

:airs Needed _____

.KS

' Serious _____

E: _____ County Engineer

TOWN OR CITY Spencer DECREE NO. PLAN NO. [redacted] DAM NO. 47-14

LOCATION Wire Village - Dam Maintained by Town of Spencer Water Dept. C.C. DOCKET NO.

DESCRIPTION OF DAM

Earth Embankment El 100'
gth 300'-350'
ght 30'±
kness top abt 10' emb = 10'
" bottom 60'
mstream Slope 1½:1
tream " " , Riprap
gth of Spillway 47' Depth = 4.0 El. crest = 96.
of Gates 21" Steel Pipe El. 70±
ation of Gates Mill
ihboards used None
ith Flashboards or Gates —
n designed by
g constructed Spillway 1937
r constructed 1957 Owned by Town of Spencer
GENERAL REMARKS
ner: Wickwire Spencer Steel Corp.
ndation: Rocky Soil
cent repairs: None
ikage: None
ndition: Good
oog.: Wooded
spected 12-22-1924 - L.O. Marden
: 1 slope upstream
" " downstream

DESCRIPTION OF RESERVOIR & WATERSHED

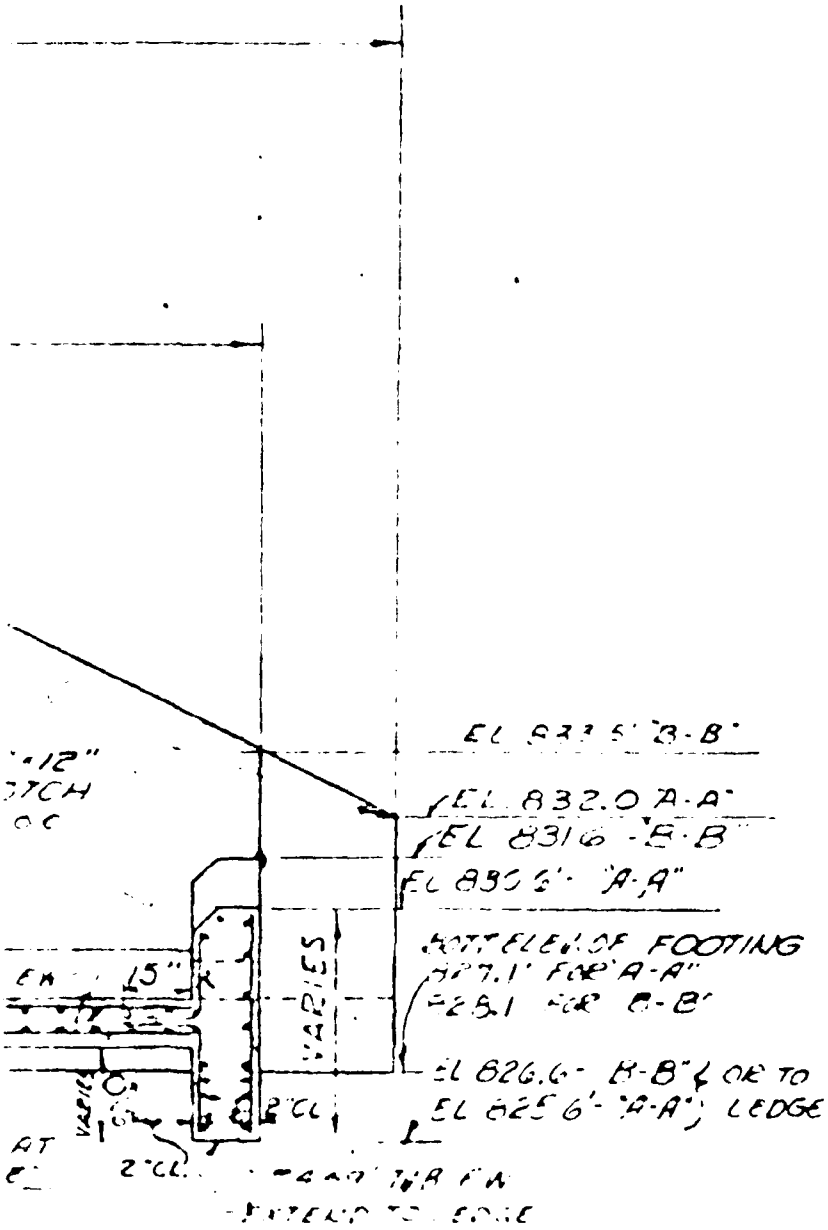
Name of Main Stream Sugden Reservoir
" " any other Streams Div. of W.W. Spec's Special
Length of Watershed Provisions No. 290
Width " "
Is Watershed Cultivated
Percent In Forests
Steepness of Slope
Kind of Soil Rocky
No. of Acres in Watershed 5.8 Sq. Miles = 3712.1
" " " " Reservoir 90.5
Length of Reservoir
Width " "
Max Flow Cu. Ft. per Sec.
Head or Flashboards-Low Water
" " " -High "
GENERAL REMARKS
Vol. 27 - P. 489 - June 1882 - March Meeting 188
Inspected: Dec. 1926 L.O. Marden.
" : March 5, 1928 " "
" : Dec. 31, 1931 " "
" : " 21, 1934 " "
" : Oct. 2, 1935 " " and Wickwire-Spencer Ott
" : Oct. 21, 1936 L.O.M., Connor, Lincoln Selectmen Trail, Dunton Cover,
2-Library Bureau 1-92260

Inspected: April 29, 1936 L.O. Marden, Vandal, Nelson & Buck [Measured: 12-19-36 - Herholz - Vosselin - Doyle - Bk 157 - P. 14
" : Nov. 8, 1937 " " Haggerty + Sugrue
" : Oct. 4, 1938 K. M. Finlayson
" : May 20, 1938 L.O. Marden.
" : June 3, 1938 " "
Patrol : March 16, 1939 " "
Inspected : Dec. 9, 1940 - W.O. Lindquist
" Dec. 11, 1946 - K. M. Finlayson
" May 6, 1947 - L.O. Marden

" Feb. 10, 1960 - LOM.

47-14

REPRODUCED AT GOVERNMENT EXPENSE



POSED REPAIRS TO
JGDEN DAM
SPENCER
PUBLIC WORKS OF MASSACHUSETTS
ISION OF WATERWAYS
FEBRUARY 1957
SCALE: AS SHOWN

John E. Bradford
CHIEF WATERWAYS ENGINEER

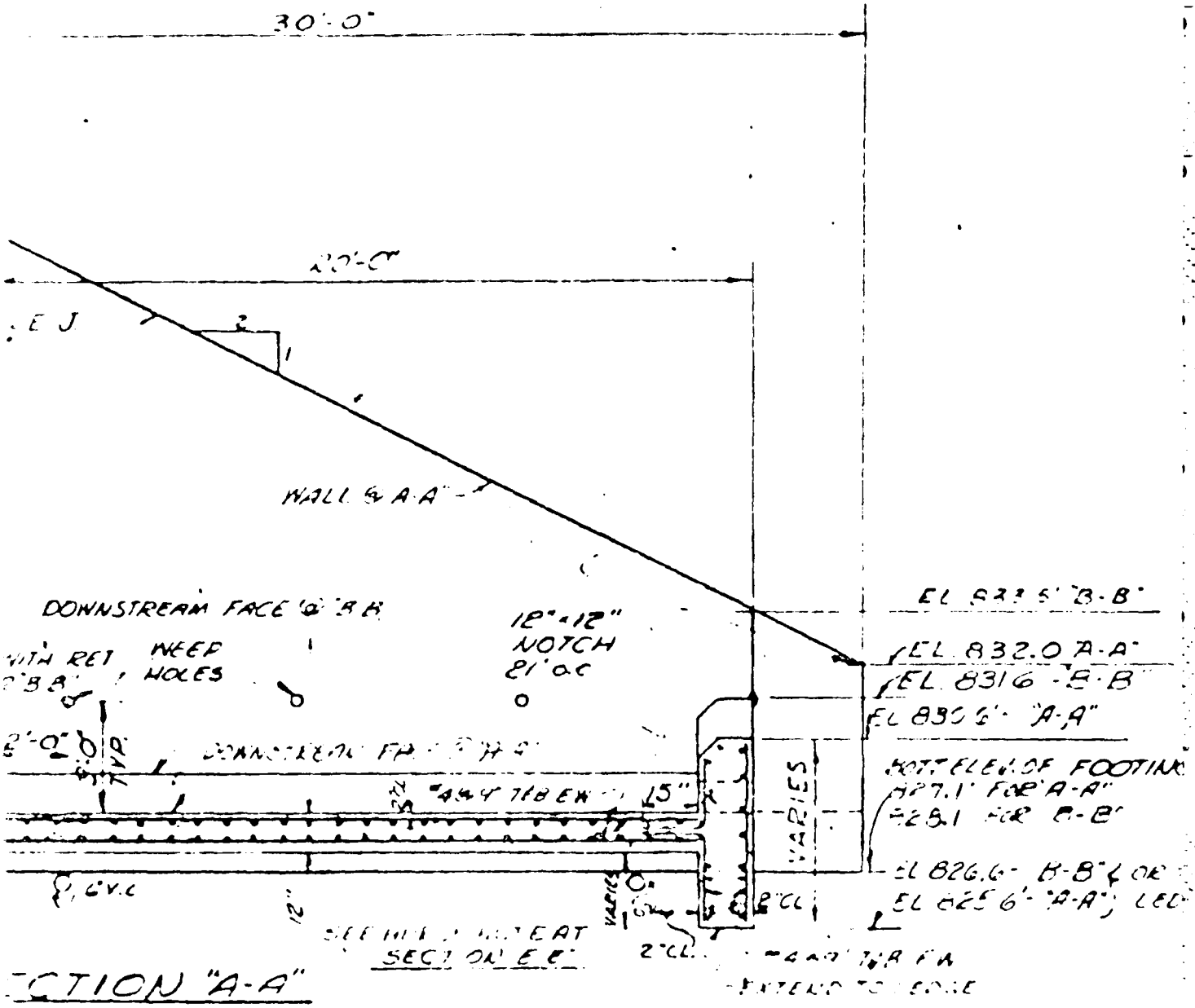
IC.

CONTRACT NO. 1683

FIGURE B-3 ACC.03613-D

REPRODUCED AT GOVERNMENT EXPENSE

DAM NO.



PROPOSED REPAIRS TO SUGDEN DAM

SPENCER

DEPARTMENT OF PUBLIC WORKS OF MASSACH
DIVISION OF WATERWAYS
FEBRUARY 1957
SCALE : AS SHOWN

CHIEF WATERWAYS ENGINEER

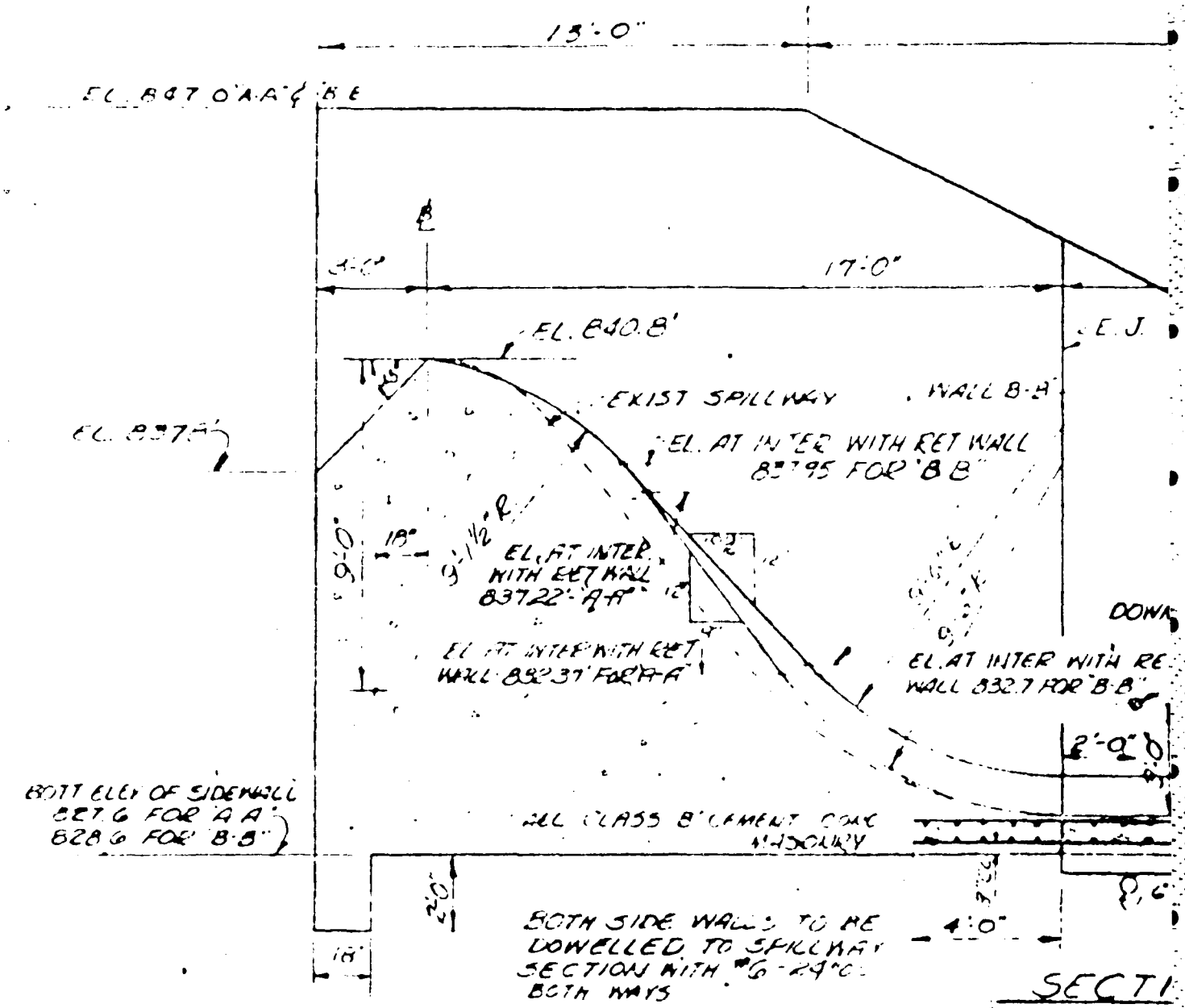
PREPARED BY
UTILITY ENGINEERS INC.
BOSTON MASS.

CONTRACT NO

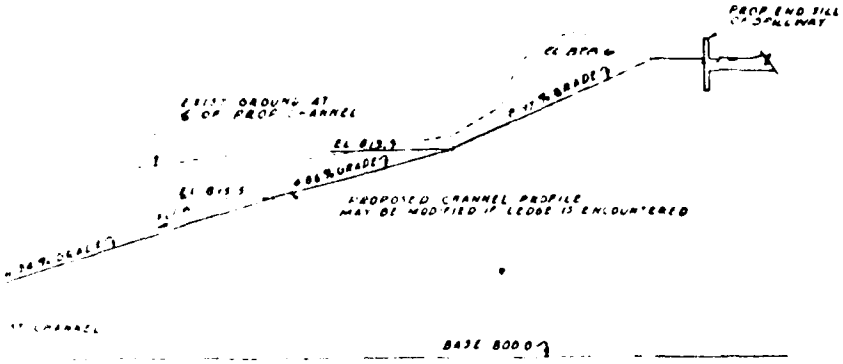
FIGURE B-3

ACC.0

REPRODUCED AT GOVERNMENT EXPENSE

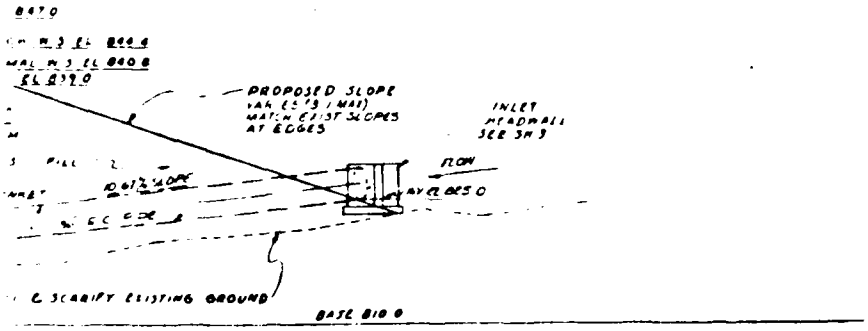


REPRODUCED AT GOVERNMENT EXPENSE



CHANNEL PROFILE ALONG ℄

SCALE 1" = 40'-0" HOR.
1" = 8'-0" VERT.



SCALE IN INCHES

0 1 2 3

NOTE: PLAN REDUCED FOR THIS REPORT.

PROPOSED REPAIRS TO

SUGDEN DAM

SPENCER

DEPARTMENT OF PUBLIC WORKS OF MASSACHUSETTS
DIVISION OF WATERWAYS
FEBRUARY 1957
SCALE AS SHOWN

PREPARED BY
UTILITY ENGINEERS INC
BOSTON MASS

CONTRACT NO 1683

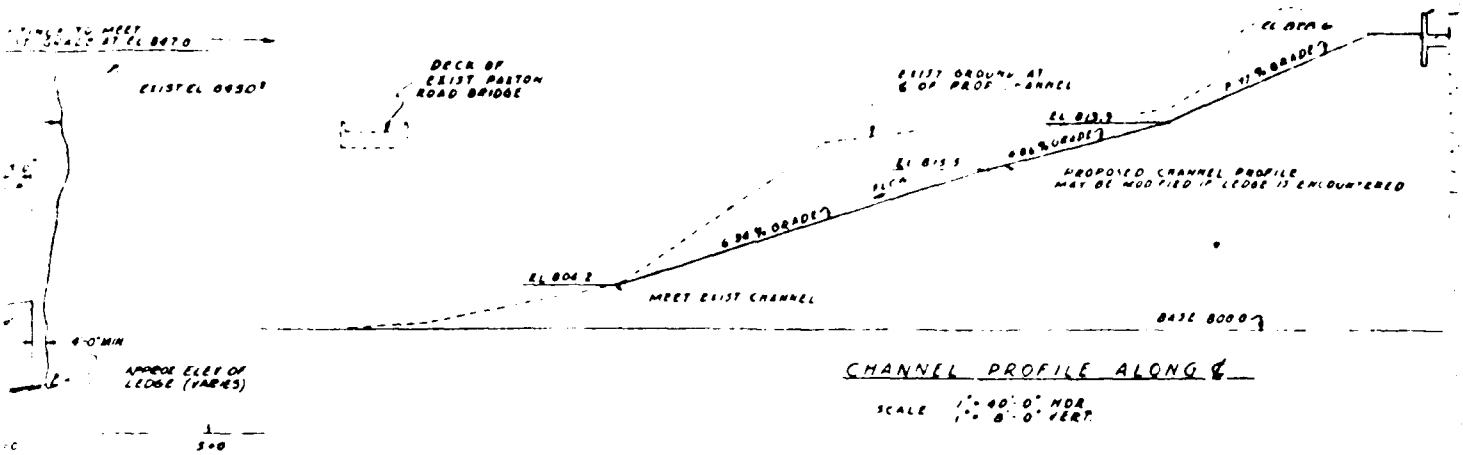
ACC 03613-B

FIGURE B-2

REPRODUCED AT GOVERNMENT EXPENSE

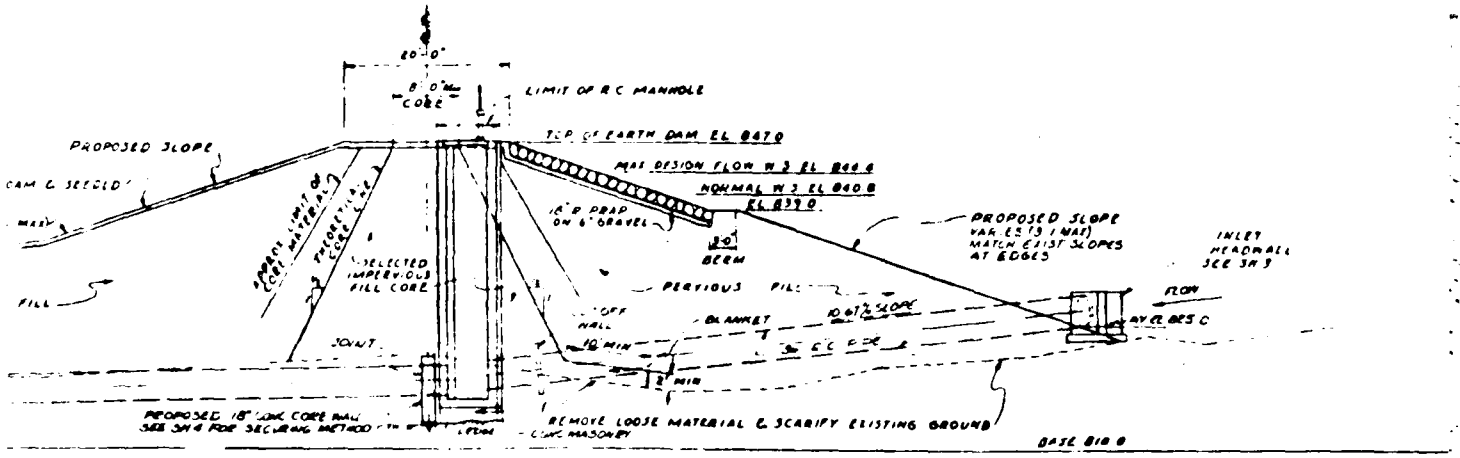
SHEET 1

DAM



CHANNEL PROFILE ALONG ℄

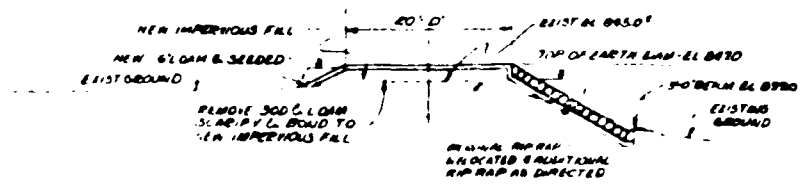
SCALE 1" = 40'-0" HOR. 1" = 8'-0" VERT.



SECTION C-C THRU BREACH AT ℄ STATION 3+30 (TYPICAL)

SCALE 1" = 5'-0" HORIZ 1" = 10'-0" VERT

36" R.C. PIPE FORESHORTENED



SECTION C-C

TYPICAL PIPE HEIGHT OF EXISTING EARTH DAM IS TO BE INCREASED

SCALE 1" = 10'-0" HORIZ 1" = 10'-0" VERT

SCALE IN INCHES

0 1 2

NOTE: PLAN REDUCED FOR THIS

PROPOSED REPAIRS TO
SUGDEN DAM
SPENCER

DEPARTMENT OF PUBLIC WORKS OF MASS.
DIVISION OF WATERWAYS
FEBRUARY 1957
SCALE AS SHOWN

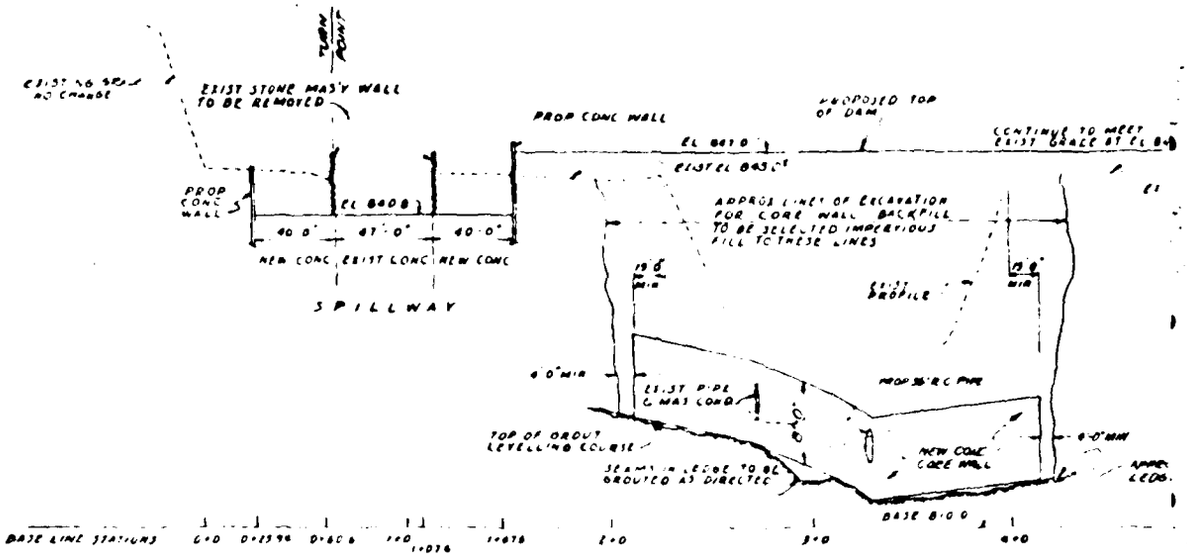
PREPARED BY
UTILITY ENGINEERS INC
BOSTON MASS

CONTRAC

AC

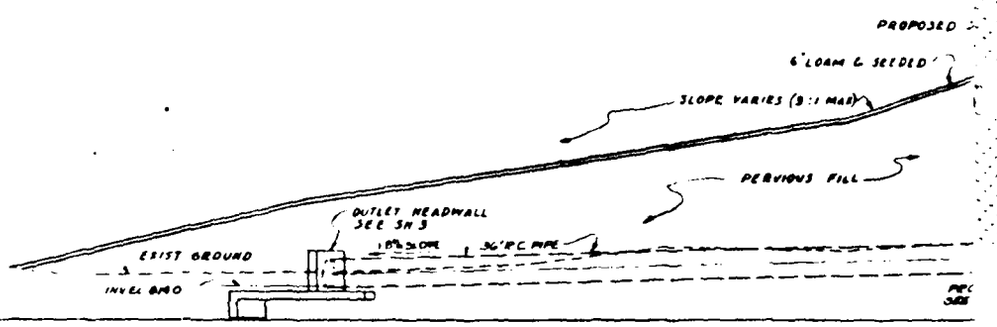
FIG

REPRODUCED AT GOVERNMENT EXPENSE

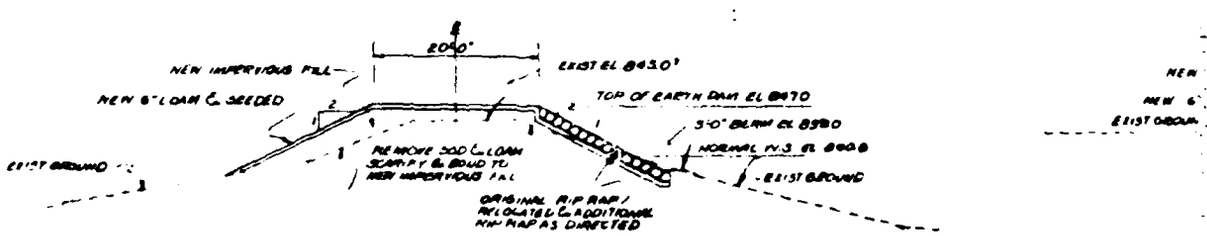


PROFILE OF CREST OF PROPOSED SPILLWAY AND EARTH DAM

SCALE 1" = 40'0" HOR 1" = 10'0" VERT



SECTION



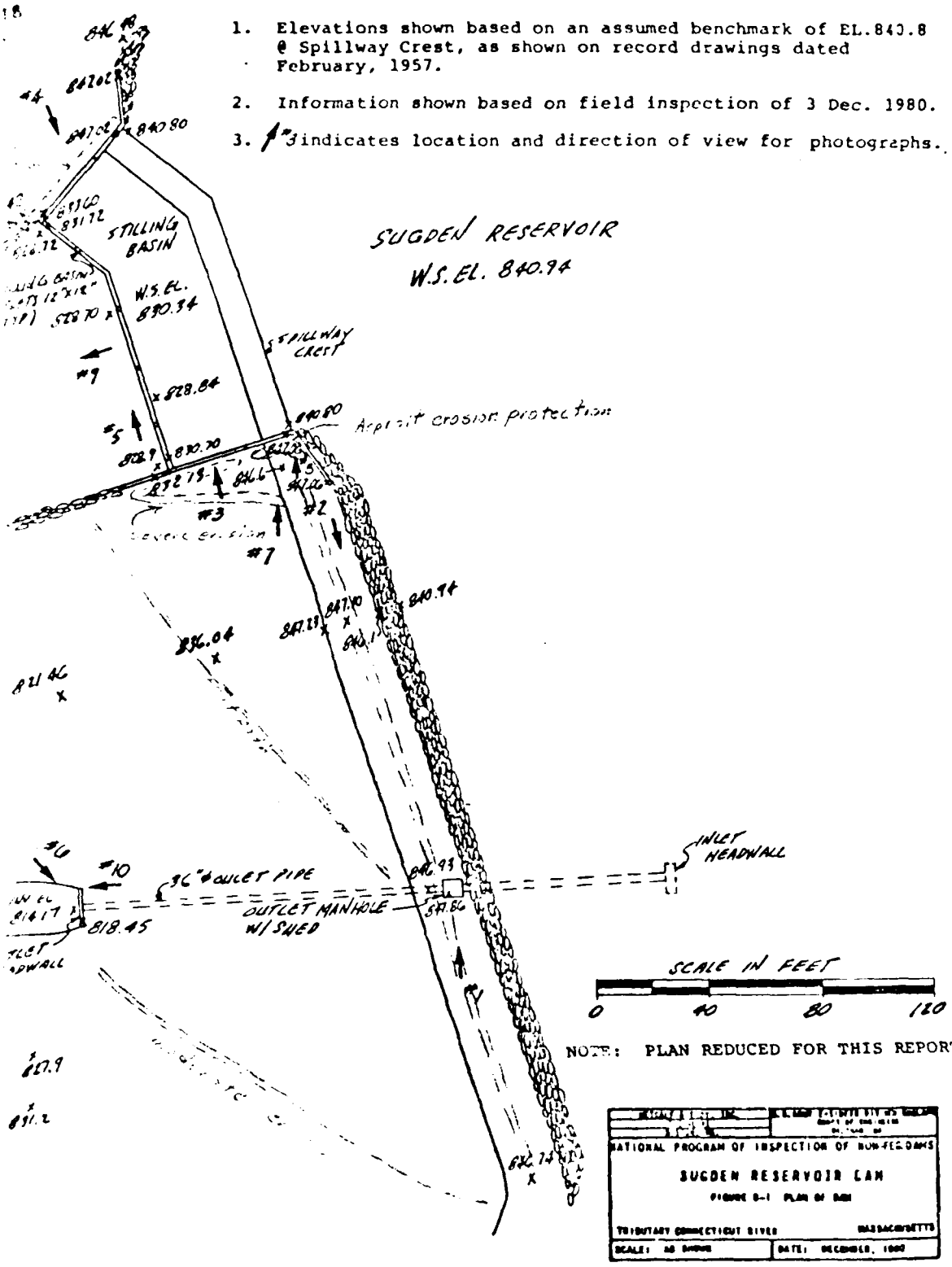
SECTION M-M

SCALE 1" = 10'0" HORIZ 1" = 10'0" VERT

REPRODUCED AT GOVERNMENT EXPENSE

NOTES:

1. Elevations shown based on an assumed benchmark of EL.840.8 @ Spillway Crest, as shown on record drawings dated February, 1957.
2. Information shown based on field inspection of 3 Dec. 1980.
3. ↑ indicates location and direction of view for photographs.



NOTE: PLAN REDUCED FOR THIS REPORT.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SUGDEN RESERVOIR DAM

FIGURE 8-1 PLAN OF DAM

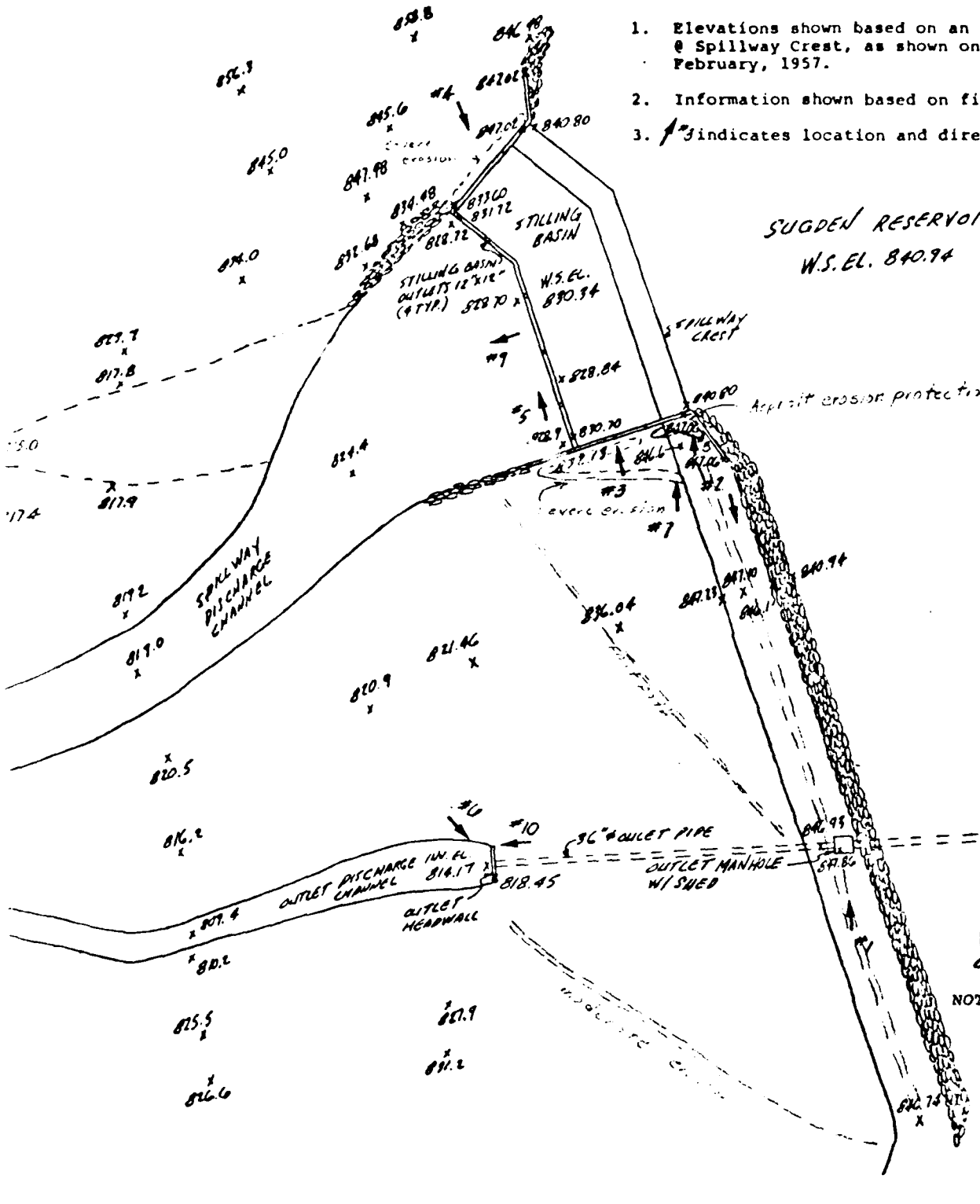
TRIBUTARY CONNECTICUT RIVER — MASSACHUSETTS

SCALE: AS SHOWN — DATE: DECEMBER, 1980

REPRODUCED AT GOVERNMENT EXPENSE

NOTES:

1. Elevations shown based on an assumed benc
   @ Spillway Crest, as shown on record draw
   February, 1957.
2. Information shown based on field inspecti
3. ↗ #3 indicates location and direction of vie



NOTE: PLAN RED

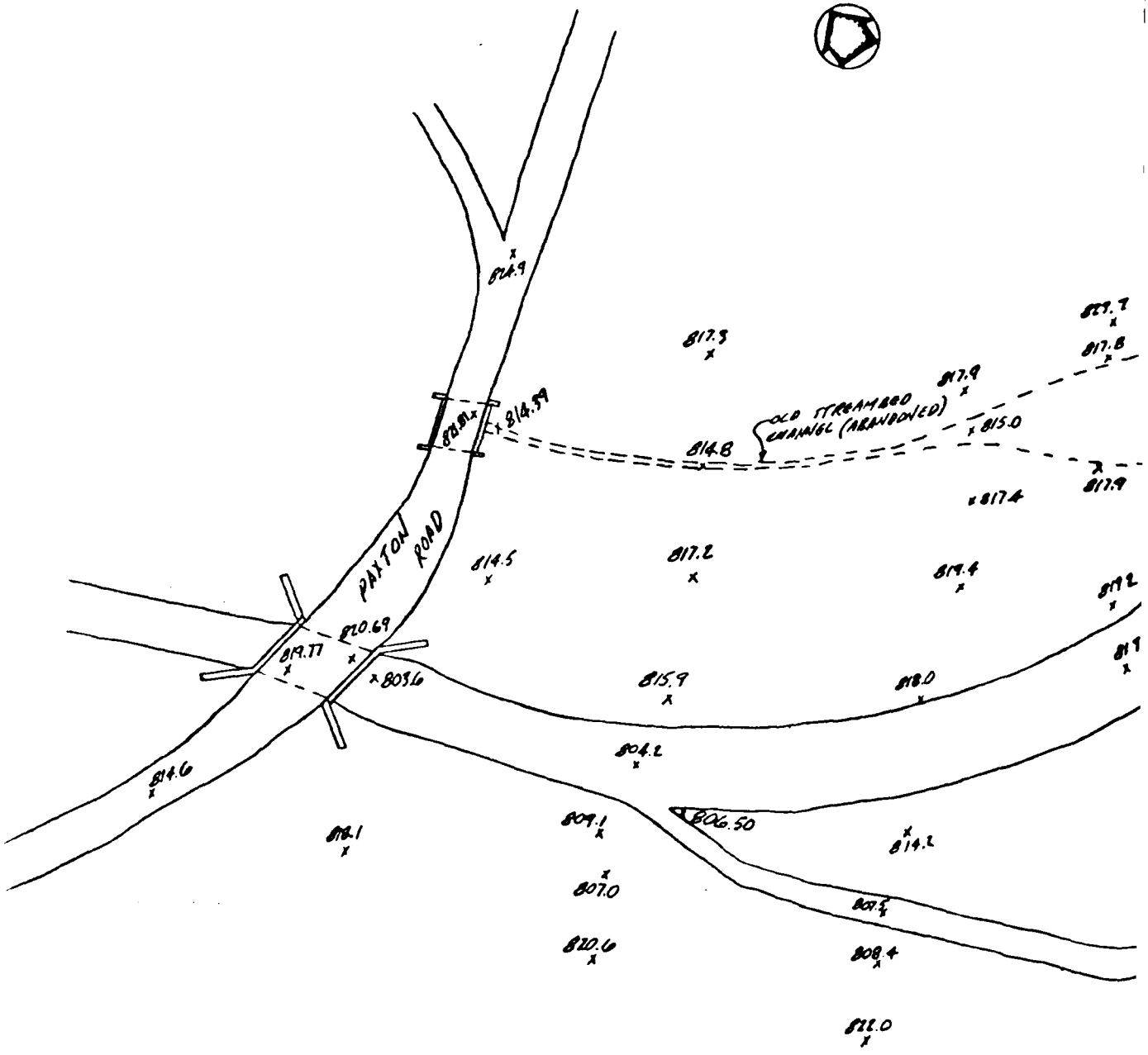
NATIONAL PROGRAM

SUGDEN

TRIBUTARY CONNECTION

SCALE: AS SHOWN

REPRODUCED AT GOVERNMENT EXPENSE



TOWN Spencer DAM NO. 47-14

LOCATION Sugden Reservoir STREAM Sugden Reservoir Brook

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Town of Spencer Place _____ Use _____

Inspected by office Loan - Talks to M Crot Date Mar. 4, 1960

Type of Dam _____ Condition _____

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition _____

Repairs Needed Plans being gotten out by Div. of W.W. M.D.P.W. for elimination of leaks.

EMBANKMENT

Recent Repairs _____

Condition _____

Repairs Needed _____

GATES

Recent Repairs _____

Condition _____

Repairs Needed _____

LEAKS

How Serious _____

DATE: _____ County Engineer

TOWN Spencer DAM NO. 47-14

LOCATION 1½ east of U-Paxton Rd STREAM Sugden Res ~~Shaw~~ Brook ?

"Sugden Reservoir"

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Town of Spencer Place Selectmen Use Recreation and storage pond

Inspected by WOL Date Nov. 8 1963

Type of Dam Earth and concrete Condition Fair to poor

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition The new spillway section is good. The old section is

Repairs Needed poor - the water is bubbling up through the drilled holes in the downstream floor slab.

EMBANKMENT

Recent Repairs The present water level is 2' below the spillway

Condition crest

Repairs Needed (The Bill to repair this dam has passed the Legislature but has not been signed into law by Gov. Peabody

GATES

Recent Repairs _____

Condition Good condition - this gate is now closed

Repairs Needed _____

LEAKS

How Serious There is a small leak at the gate outlet

DATE: _____ B-10 County Engineer

TOWN Spencer DAM NO. 47-14

LOCATION 47 assarly - Paxton Rd STREAM Sugden Res. Shaw Brook

"Upper Wire Village"

WORCESTER COUNTY ENGINEERING DEPARTMENT "Sugden Reservoir"
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Town of Spencer Place Selectmen Use Recreation and storage pond

Inspected by WOL Date Dec. 15 1964

Type of Dam Earth and concrete Condition Repairs required

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition The work on the proposed new spillway structure has

Repairs Needed not started to-date. The water still bubbles up through the cut holes in the downstream floor slab.

EMBANKMENT

Recent Repairs _____

Condition _____

Repairs Needed _____

GATES

Recent Repairs _____

Condition _____

Repairs Needed _____

LEAKS

How Serious 2 small leaks are visible in the d/str. spillway face.

DATE: _____ B-1' County Engineer

TOWN Spencer DAM NO. 47-14

LOCATION ~~100 easterly of Paxton Rd~~ STREAM Sugden Res ~~Shaw~~ Brook

WORCESTER COUNTY ENGINEERING DEPARTMENT "Sugden Reservoir"
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Town of Spencer Place Selectman Use old Storage Pond

Inspected by WOL Date June 29, 1965

Type of Dam Earth and concrete Condition Good

SPILLWAY

Flashboards in Place No boards Recent Repairs

Condition The center section of ogee concrete spillway has been

Repairs Needed recently reconstructed

The water level is 6" below the crest

EMBANKMENT

Recent Repairs

Condition Good

Repairs Needed

GATES

Reeent Repairs

Condition Good

Repairs Needed

LEAKS

How Serious No leaks - all of the leaks have now stopped

DATE:

County Engineer

SUGDEN RESERVOIR DAM

C.E. ... Town CHECK

DESCRIPTION OF DAM

DISTRICT III

Submitted by R. Sjedolson

Dam No. 3-14-280-14

Date 4/12/72

City/Town SPENCER

Name of Dam SUGDEN RES. DAM

1. Location: Topo Sheet No. 20C

   Provide 8½" x 11" in clear copy of topo map with location of Dam clearly indicated.

2. Year built: ? Year/s of subsequent repairs 1937-1957

3. Purpose of Dam: Water Supply _____ Recreational ✓

   Irrigation _____ Other _____

4. Drainage Area: 5.8 sq. mi. 3712 acres

5. Normal Ponding Area: 90.5 acres; Ave. depth _____

   Impoundment: _____ gals; _____ acre ft.

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

   30-50 i.e. summer homes, ~~etc.~~ & YEAR ROUND

7. Dimensions of Dam: Length 300-350'± Max. Height 30'±

   Slopes: Upstream Face 1.5:1 STONE RIP RAP

   Downstream Face 1.5:1

   Width across top ~~4~~' 18' BOTTOM 60'±

8. Classification of Dam by Material:

   Earth ✓ Conc. Masonry SPILLWAY Stone Masonry _____

   Timber _____ Rockfill _____ Other _____

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

   100 % rural; _____ % urban.

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

DAM NO. 3-14-280-14

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

No. of people 0.

No. of homes 0.

No. of Businesses 0.

No. of industries 0. Type

No. of utilities 0. Type

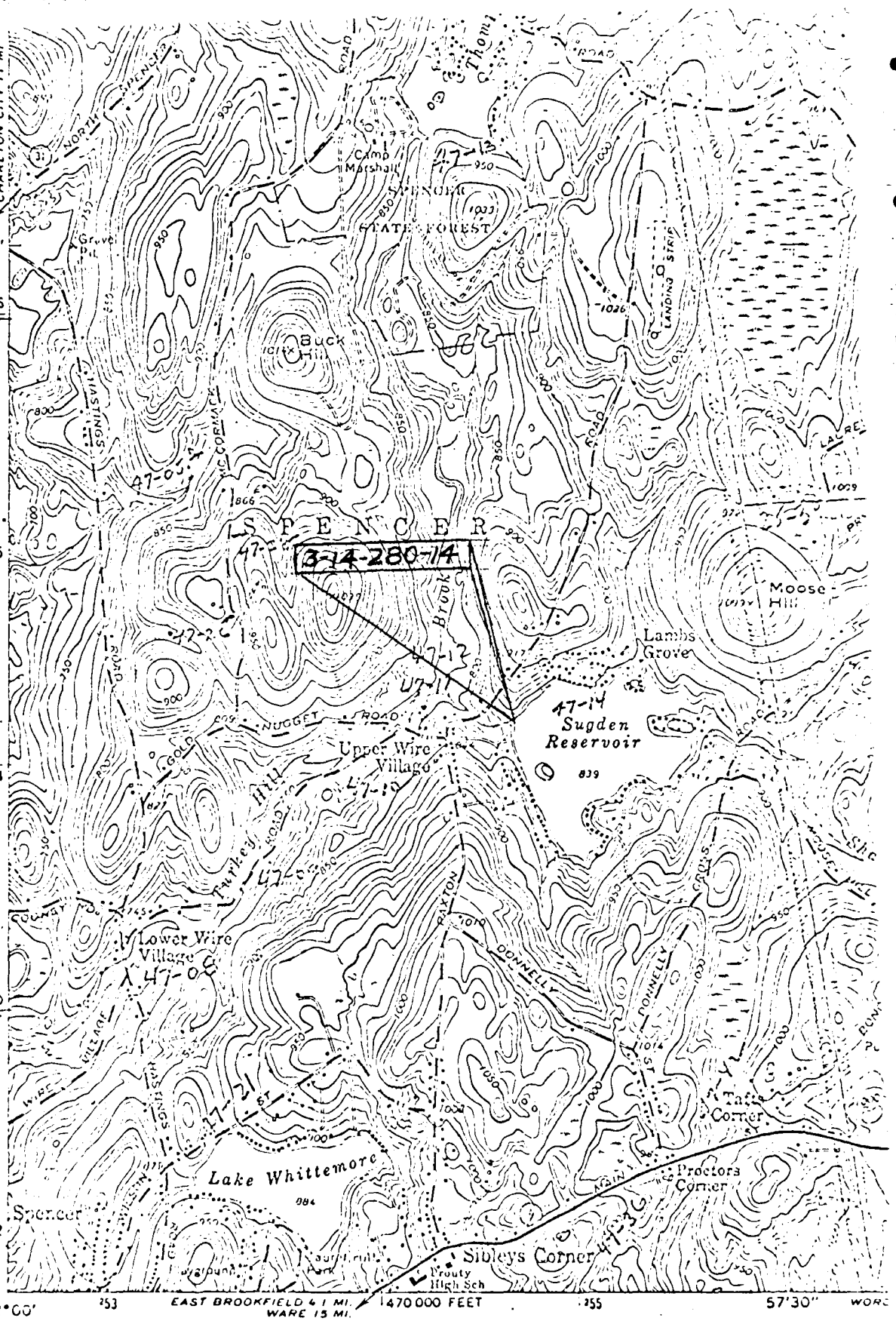
Railroads 0.

Other dams 0.

Other PAXTON RD + NUGGET RD, POSSIBLY - WIRE VILLAGE RD + HASTINGS RD.

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

12. HOW TO LOCATE.
.10 MILE N.E. ON PAXTON RD FROM JCT OF COONEY RD, NUGGET FARM RD, AND PAXTON RD.



Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, and Massachusetts Geodetic Survey

Topography by planetable surveys 1937. Revised 1965

Polyconic projection. 1927 North American datum

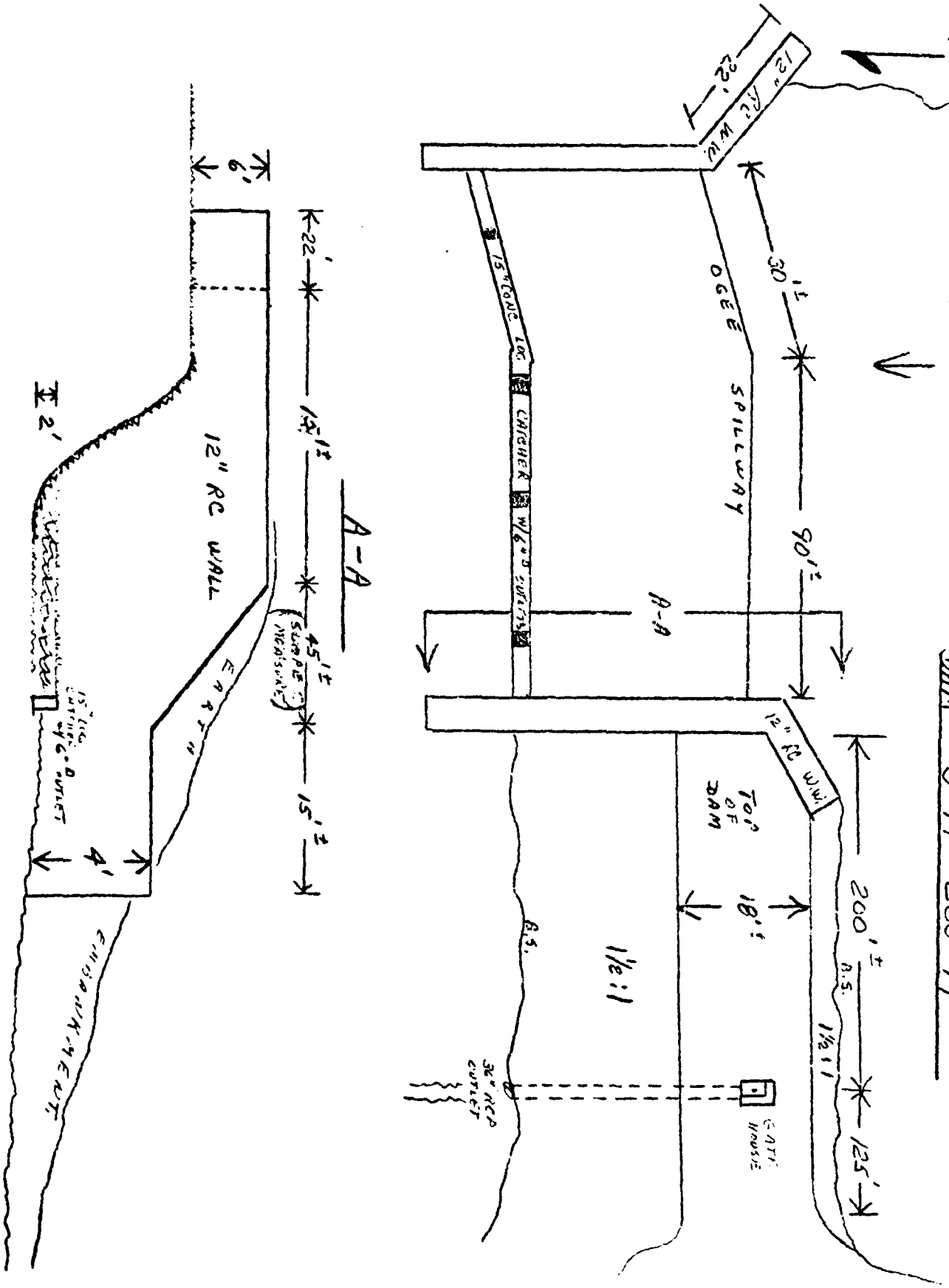
10,000-foot grid based on Massachusetts coordinate system, mainland zone

1000-meter Universal Transverse Mercator grid ticks, zone 19, shown in blue

MN GN 14½° 258 MILS 1°59' 35 MILS

20C

SUGDEN RESERVOIR DAM


N
FLOW
WALL 3-14-COUT-14
200'±
R.S.
1½:1
125'
12" RC W.W.
TOP OF DAM
18'±
1½:1
R.S.
GATE HOUSE
36" RCP OUTLET
30'±
90'±
OGEE SPILLWAY
B-A
12" RC W.W.
22'
15" CONC. LOC.
CHICHER W/6" D SUPPORT
22'
15'±
45'±
15'±
A-A
SUMPLE (NEGASWAY)
12" RC WALL
EARTH
6'
2'
4'
15" RCP OUTLET PIPE
CUTWATER

INSPECTION REPORT - DAMS AND RESERVOIRS

1. Location: City/Town SPENCER Dam No. 3-14-280-14

Name of Dam SUGDEN RESEVOIR Inspected by R. NICHOLSON

Date of Inspection 5/8/72

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

Reg. of Deeds _____ Pers. Contact _____

1. WICKWIRE SPENCER STEEL CORP. SPENCER MASS
Name St. & No. City/Town State Tel. No.

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

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

3. Caretaker (if any) e.g. superintendant, plant manager, appointed by absentee owner, appointed by multi owners.

NOTE: DAM MAINTAINED BY TOWN OF SPENCER WATER DEPT

Name: St. & No.

City/Town: State: Tel. No.

4. No. of Pictures taken 1 ✗

5. Degree of Hazard: (if dam should fail completely)*

1. Minor _____ 2. Moderate ✓

3. Severe _____ 4. Disastrous _____

*This rating may change as land use changes (future development)

6. Outlet Control: Automatic _____ Manual ✓

Operative ✓ Yes; _____ No.

Comments:

7. Upstream Face of Dam: Condition:

1. Good ✓ 2. Minor Repairs _____

3. Major Repairs ___ 4. Urgent Repairs _____

Comments:

DAM NO. 3-14-2[illegible]

8. Downstream Face of Dam:

Condition: 1. Good ✓ 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

9. Emergency Spillway:

Condition: 1. Good ✓ 2. Minor Repairs _____

3. Major Repairs _____ 4. Urgent Repairs _____

Comments:

10. Water Level at time of inspection: 6 ft. above ____ below ✓

top of dam ✓ principal spillway _____

other _____

11. Summary of Deficiencies Noted:

Growth (Trees and Brush) on Embankment None

Animal Burrows and Washouts "

Damage to slopes or top of dam "

Cracked or Damaged Masonry "

Evidence of Seepage "

Evidence of Piping "

Erosion "

Leaks "

Trash and/or debis impeding flow "

Clogged or blocked spillway "

Other

12. Remarks and Recommendations: (Fully Explain)

13. Overall Condition:

1. Safe ✓
2. Minor repairs needed _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)

   Recommend removal from inspection list _____

APPENDIX C

PHOTOGRAPHS

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

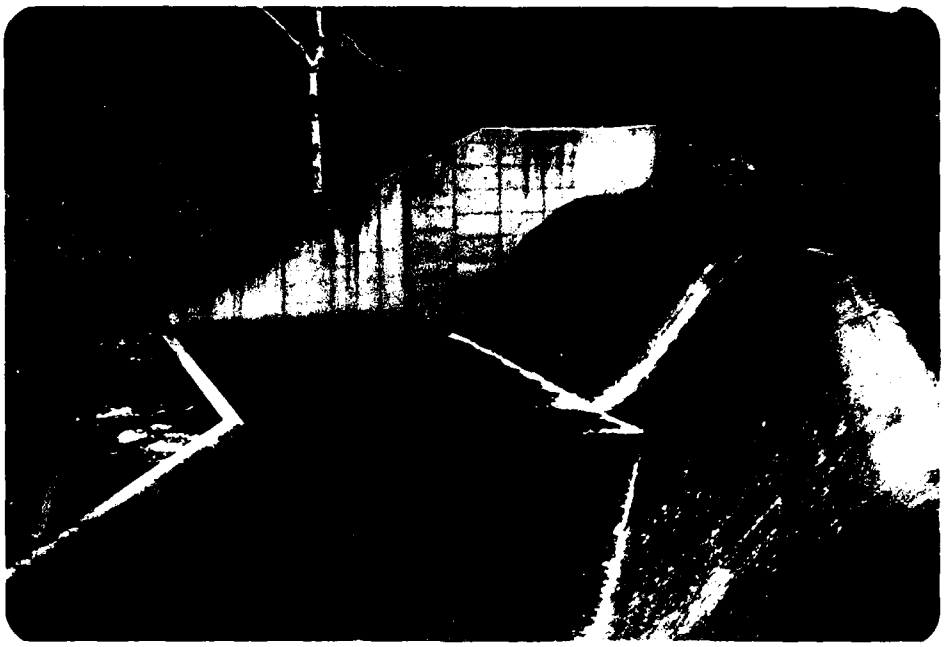
APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

	Page
igure D-1, Drainage Area Map	D-1
ydrologic and Hydraulic Computations	D-2

NO. 1 VIEW OF CREST AND GATEHOUSE – SOUTH SECTION

NO. 2 VIEW OF UPSTREAM FACE – SOUTH SECTION

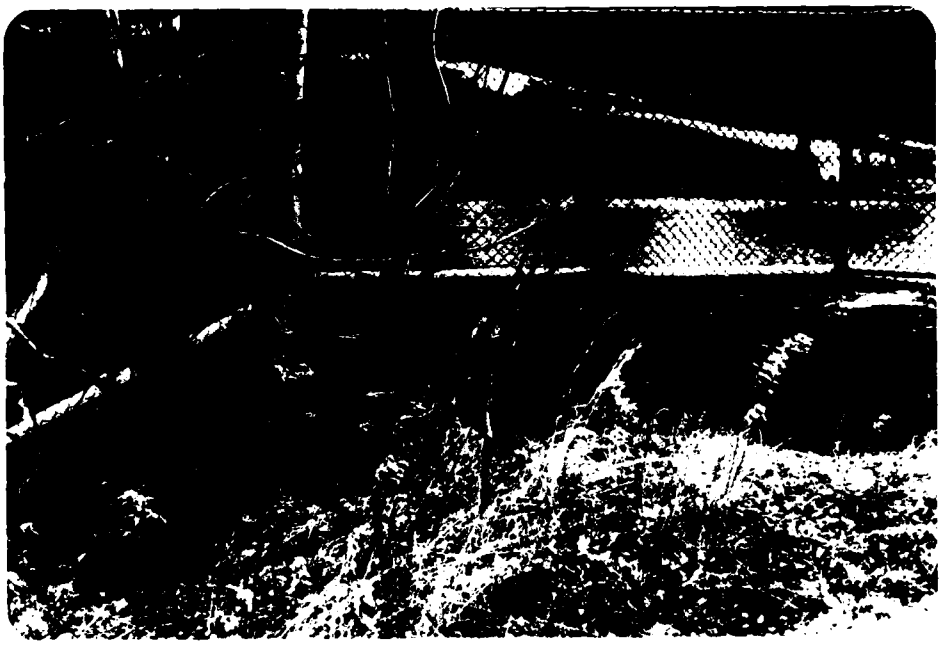


NO. 3 VIEW OF SPILLWAY AND NORTH SIDEWALL

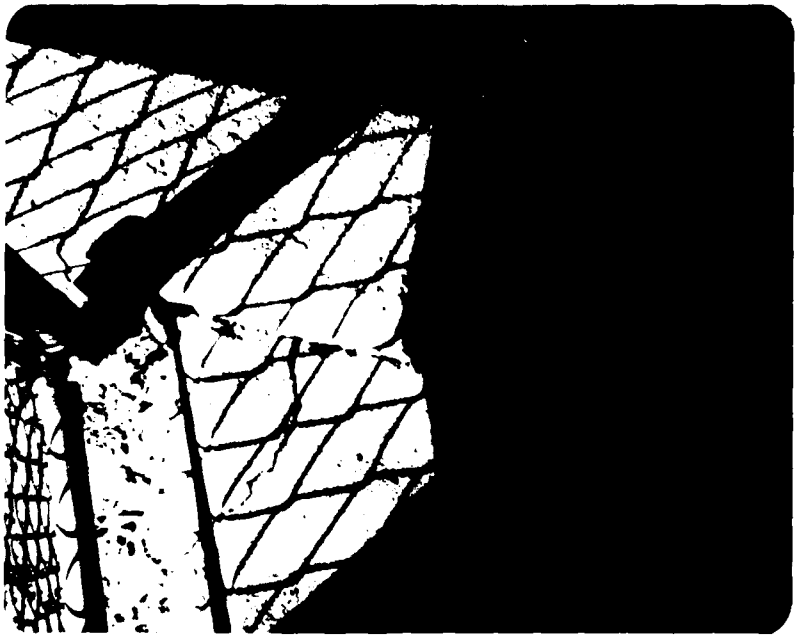
NO. 4 VIEW OF SPILLWAY AND SOUTH SIDEWALL

NO. 5 VIEW OF STILLING BASIN WALL

NO. 6 VIEW OF DOWNSTREAM OUTLET HEADWALL



NO. 7 VIEW OF ASPHALT EROSION PROTECTION



NO. 8 VIEW OF OPEN JOINT SOUTH SIDEWALL

NO. 9 VIEW OF SPILLWAY DOWNSTREAM CHANNEL

NO. 10 VIEW OF OUTLET DOWNSTREAM CHANNEL

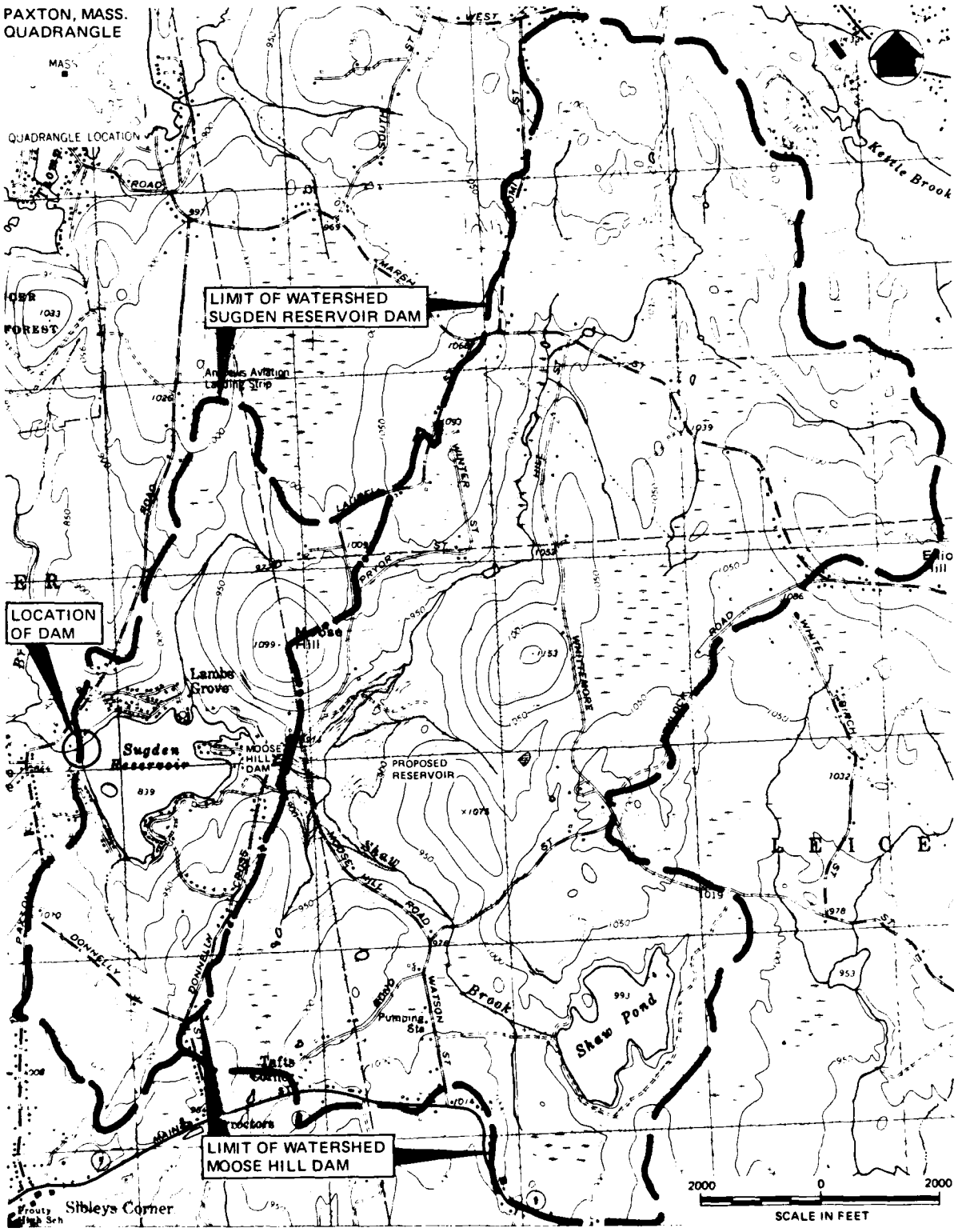


FIG. D-1 DRAINAGE AREA MAP

(I) Test Flood, Storage & Storage Function

1- Total Drainage Area - 6.14 mi^2

2- Pond(s) Area: 0.11 + 0.14* = 0.25 mi^2
Swamp(s) Area: 0.38 + 0.11 + 0.05 = 0.54 "
Total Area Pond(s) & Swamp(s): 0.79 mi^2

% Ponds & Swamps = $\frac{0.79}{6.14}$ = 12.9 %

3- $\frac{1185-839}{23200} = .0149$ } Say Ave Slope = 1.5 %

4- Using C. of E. Curves for Peak Flow Rates & above guide values the Peak Flow Rate was estimated to be somewhat above "Flat & Coastal" and taken at 900 c.f.s./mi^2
Size Class: Inter. ; Hazard Pot.: High ; Spill. Des. Flood: Full PMF
Use: Test Flood = Full PMF

5- Test Flood Inflow = (6.14) 900 = 5530 c.f.s.

6- Pond Storage
The pond area is 0.14 sq. mi. at elev. 839. (USGS)
Based on a const. area, storage increases at 90.5 ac. feet per foot of depth increase.

7- Spillway crest elev. is 840.8

8- Storage Functions are based on $Q_{out} = Q_{in}\left[1 - \frac{S_{out}}{R}\right]$
S_{out} = Storage Vol. in Reservoir related to final Q_{out} in terms of inches of rain over the drainage area.

S(in Inches) = $12\,D\left(\frac{0.14}{6.14}\right) = 0.274\,D$; R = 6hr rain of storm
D = Storage depth in feet above spillway crest in reservoir

9- Storage Functions: (Test Flood & ½ PMF - if needed)

$F_{TF} = 5530 - 291\,S = 5530 - 79.7\,D$	
$F_{½PMF} = 2765 - 291\,S = 2765 - 79.7\,D$	

* Area of Moose Hill Res. @ el. 909 - crest of emerg. spillway - now under constr.

NONREPRODUCIBLE GRID FORM 145
METCALF & EDDY, ENGINEERS

(II) Discharge Relations

1 - Spillway

Ogee crest - $C \simeq 3.9$, $L \simeq 127'$ - use $L = 126'$ for side contr.

Crest el. 840.8, $Q_1 = 3.9(126)H_1^{1.5} = 491.4\,H_1^{1.5}$

Res Elev.	842	844	845	843	846	L.P. Crest 846.7
H_1	1.2	3.2	4.2	2.2	5.2	5.9
Q_1	650	2810	4230	1600	5830	7042

Note: When res. is at el. 846.7, Q_{out} = 137% of T.F. Q_{out}

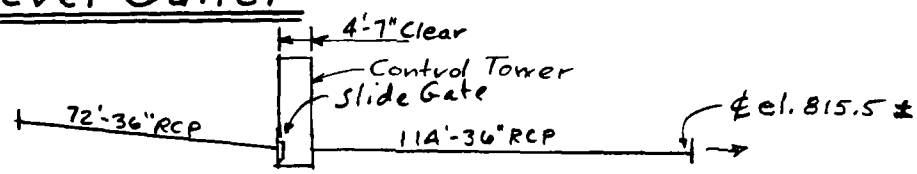
2 - Tailwater in Jump Basin

Basin lip: ± 76' @ 830.6, plus 28' @ 831.6, $Q = 3.09\,L\,H^{1.5}$

H_A	2	4	6	5
Q_A	660	1880	3450	2630
Q_B	90	450	970	690
ΣQ	750	2330	4420	3320

No tailwater effect on spillway

(III) Low Level Outlet



$$H = \frac{V^2}{2g}\left[\underbrace{0.5 + 1.0 + 0.5 + 1.0}_{\text{Exit \& Ent. Losses}} + .02\,\frac{186}{3}\right] = .0658\,V^2 = .00132\,Q^2$$

or $Q = 27.6\sqrt{H}$

Res. El.	840.8	839.8
H	25.3	24.3
Q	138.6	135.8

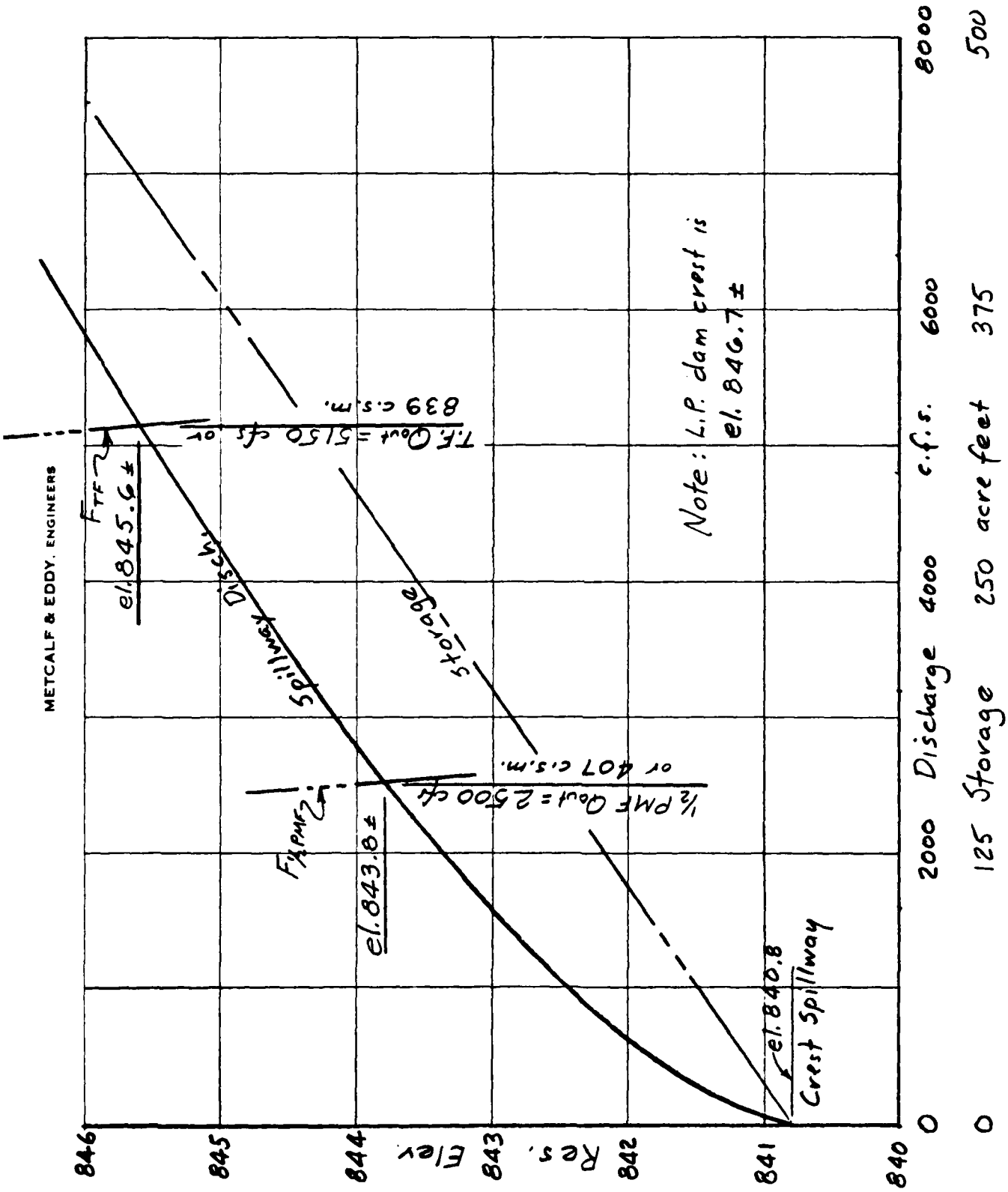
– Ave 137.2 cfs.

Time to draw res. down 1' = $\frac{90.5(43560)}{137.2(3600)}$ = 8 hours.

METCALF & EDDY, ENGINEERS

Project National Rev. of Non-Fed. Dams Acct No 7252 Page 3 of 4
Subject Worcester County, Mass. Comptd By LEB Date 1/9/80
Detail SUGDEN RES. Ck'd By [illegible] Date 1-14-81

(IV) Discharge, Storage Function & Storage vs Res. Elev.



(V) Failure of Dam

Peak Failure Flow:

Pond Elevation - 845.6 (Peak T.F. el.)
Toe Elevation — 814.2 ±
Y_o = 31.4

Dam Length Subject to Breaching = 250'
W_o = 40% (250) = 100'

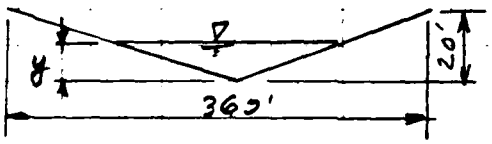
$$Q_{P_1} = 1.68\, W_o (Y_o)^{1.5} = 1.68(100)(31.4)^{1.5} = 29550$$

Continuing Spill. Disch.: 5,150
Peak Failure Flow: 29,550
34,700 Peak Flow

Storage Volume Released:
Storage Above Spillway (Item (IV)) : 435 ac. ft.
Storage Below Spillway : 1/3(29.8) 90.5 = 900
Total Storage @ EL. 845.6 : 1335 ac. ft.

Channel Hydraulics:

$S \cong \frac{20}{700} = .0286$; $n = .06$; $R \cong \frac{1}{2}y$; $V = \frac{1.49}{.06}\left(\frac{1}{2}y\right)^{2/3}(.0286)^{1/2} = 2.644\, y^{2/3}$



$A = \frac{1}{2} 18y^2 = 9y^2$

y	A	V	Q
5	225	7.73	1740
10	900	12.27	11050
15	2025	16.08	32570
7	441	9.68	4270
8	576	10.58	6090
12	1296	13.86	17960
13	1521	14.62	22230
16	2304	16.79	38680

Stream flow near Upper Wire Village changes from ± 7.5' deep to ± 15.5' deep due to the dam failure. This village is too close to dam for attenuation of failure flow

MAXIMUM STORAGE CAPACITY (@ EL. 846.7 I.P. CREST)

STORAGE BELOW SPILLWAY = 1/3 (29.8) 90.5 = 900 AC. FT.
STORAGE ABOVE SPILLWAY = (846.7 - 840.8) 90.5 = 535 AC. FT.
MAXIMUM STORAGE = 1435 AC. FT.

METCALF & EDDY, ENGINEERS

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

SUGDEN RESERVOIR DAM

NOT AVAILABLE AT THIS TIME

END

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