CONNECTICUT RIVER BASIN
SPENCER, MASSACHUSETTS

SUGDEN RESERVOIR DAM
MA 00698

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

APRIL 1981

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**Sudgen Reservoir Dam**

**NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS**

**U.S. ARMY CORPS OF ENGINEERS**
NEW ENGLAND DIVISION

**DEPT. OF THE ARMY, CORPS OF ENGINEERS**
NEW ENGLAND DIVISION, NEEDED
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**COVER PROGRAM READS:** Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

**KEY WORDS**
DAMS, INSPECTION, DAM SAFETY,

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

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.
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
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.
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 L. 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.

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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.

4. 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 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.

5. 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 downstream 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.

SUGDEN RESERVOIR DAM
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, Superintendent 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.

SUGDEN RESERVOIR DAM
(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.
Total project discharge at top of dam: 7,042 cfs at El 846.7.

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).

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

Bottom of cutoff: N/A.

Maximum tailwater: unknown.

Normal pool: 840.8.

Full flood control pool: N/A

Spillway crest: 840.8.

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

Top of dam: 846.7.

Test flood surcharge: 845.6.

d. Reservoir (Length in feet)

Normal pool: 3,000

Flood control pool: N/A

Spillway crest pool: 3,000

Top of dam: 3,000

Test flood pool: 3,000

e. Storage (acre-feet)

Normal Pool: 900

Flood control pool: N/A

Spillway crest pool: 900

SUGDEN RESERVOIR DAM
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.

**SUGDEN RESERVOIR DAM**
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".

SUGDEN RESERVOIR DAM
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 with the watershed. Moose Hill Dam which was designed by the Soil Conser-
vation 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 spill-
way. 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 compu-
tations 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.

SUGDEN RESERVOIR DAM
14
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.

SUGDEN RESERVOIR DAM
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 sidewalks (Photo No. 8) and the leakage from the 36-inch outlet pipe.

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

SUGDEN RESERVOIR DAM
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 D.N.S._

PARTY:

1. L. Taverna (Metcalf & 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 INPECTED BY REMARKS

1. Dam Embankment Taverna/Nagel/Greco
2. Spillway Taverna/Greco/Branagan
3. Outlet Taverna/Greco/Branagan
4. 
5. 
6. 

page 1 of 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

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

*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

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

PROJECT: Sugden Reservoir Dam  DATE: December 3, 1980

PROJECT FEATURE: Gate House  NAME: L. Taverna

DISCIPLINE: Geotechnical  NAME: S. Nagel

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

Page 4 of 6
PERIODIC INSPECTION CHECK LIST

PROJECT        Sugden Reservoir Dam
Intake Channel and
PROJECT FEATURE Intake Structure
DISCIPLINE     Geotechnical

DATE          December 3, 1980
NAME          I. Taverna

NAME          S. Nagel

Note: u/s = upstream

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

...
PERIODIC INSPECTION CHECK LIST

PROJECT: Sugden Reservoir Dam  DATE: December 3, 1980
PROJECT FEATURE: Outlet Structure And  NAME: L. Taverna/E. Greco
DISCIPLINE: Geotechnical  NAME: L. Branagan

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

PLANS OF DAM AND PREVIOUS INSPECTION REPORTS

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
</tr>
<tr>
<td>B-2</td>
</tr>
<tr>
<td>B-3</td>
</tr>
<tr>
<td>B-4</td>
</tr>
<tr>
<td>B-5</td>
</tr>
<tr>
<td>B-13</td>
</tr>
</tbody>
</table>
Clay blanket behind Cap of Wet-down stream wall

Designed by Utility Eng. Bauth
H. M. Turner, Investigated

Leak along wing wall and apron - Bond
holes in apron - leak disappeared
COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

<table>
<thead>
<tr>
<th>Inspected by</th>
<th>Date</th>
<th>Dam No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. OM - WO</td>
<td>Oct. 26 1957</td>
<td>47-14</td>
</tr>
</tbody>
</table>

Town: SPENCER  
Location: Sugden Reservoir

Owner: Town of Spencer  
Use: Recreation

Material and Type: Earth and Concrete

Dam Designed by: MOPW Waterway  
Conducted by: Roger Mingolla  
Year: 1957

**SPILLWAY**

<table>
<thead>
<tr>
<th>El. top Abutment</th>
<th>El. Crest</th>
<th>El. Apron</th>
<th>El. Streambed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width top Abutment</td>
<td>Width top Crest</td>
<td>Width bottom Spillway</td>
<td></td>
</tr>
<tr>
<td>Width Flashboards carried</td>
<td>Kind Flashboards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>El. Flowline Cleanout Pipe</td>
<td>Size and Kind Cleanout Pipe</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Kind of Foundation under Spillway: Inspected, back in downstream spillway - water boil visible about 10” from abutment wall - pond full 2” of water over spillway

**EMBANKMENT**

<table>
<thead>
<tr>
<th>El. Top</th>
<th>El. Natural Ground</th>
<th>Width Top</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of Bottom</td>
<td>Upstream Slope</td>
<td>Downstream Slope</td>
</tr>
<tr>
<td>Kind of Corewall</td>
<td>Riprap</td>
<td></td>
</tr>
<tr>
<td>Material in Embankment</td>
<td>Foundation</td>
<td></td>
</tr>
</tbody>
</table>

Condition: OK

**GATES**

<table>
<thead>
<tr>
<th>Size</th>
<th>Kind</th>
<th>El. Flowline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition</td>
<td>Wide open</td>
<td></td>
</tr>
</tbody>
</table>

**WHEEL**

<table>
<thead>
<tr>
<th>Kind</th>
<th>Size</th>
<th>Rated H. P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Ave. Head</td>
<td></td>
</tr>
<tr>
<td>Evidence of Leaks in Structure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recent Repairs and Date:

Topography of Country below Dam:

Nature of Buildings and Roads below Dam:

<table>
<thead>
<tr>
<th>Number Acres in Pond</th>
<th>Drainage Area in Square Miles</th>
</tr>
</thead>
</table>

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

B-7  
SUGDEN RESERVOIR DAM
WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY: Town of Spencer
LOCATED: Spence Stream

INSPECTED BY: Lom
DATE: 5/10/62

TYPE OF DAM: Plan approved by C. C. in contents

SPILLWAY
FLASHBOARDS IN PLACE
RECENT REPAIRS
CONDITION: To lengthen
REPAIRS NEEDED

EMBANKMENT
RECENT REPAIRS
CONDITION: To rebuild
REPAIRS NEEDED

DATES
RECENT REPAIRS
CONDITION: To rebuild
REPAIRS NEEDED

LEAKS
HOW SERIOUS
DATE: 5/6

COUNTY ENGINEER

B-6
SUGDEN RESERVOIR DAM
<table>
<thead>
<tr>
<th>DAM NO.</th>
<th>DAM INSPECTION REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>47-14</td>
<td></td>
</tr>
</tbody>
</table>

**LOCATION**

Fly of Pauten Rd. Stream Sugden Reservoir Wire Village Sugden Reservoir

**WOCESTER COUNTY ENGINEERING DEPARTMENT**

WORCESTER, MASSACHUSETTS

**DAM INSPECTION REPORT**

**TOWN OF SPENCER**

Place Water Dept. Use Sand

**SUGDEN DAM**

Date Sept. 1955

**WORCESTER, MA**

1955-11-11

**USE**

by Town of Spencer Place Water Dept. Use Sand

**SUGDEN DAM**

Date Sept. 1955

**WORCESTER, MA**

1955-11-11

**ILLWAY**

ashboards in Place Recent Repairs

**Condition** Poor

**BANKMENT**

Recent Repairs

**Condition** 20% of earth embankment washed out by flood

**PAIRS NEEDED**

Dam was probably too low

**EFS**

Recent Repairs

**Condition** Probably ok - still in place

**PAIRS NEEDED**


**KCS**

Serious

**COUNTY ENGINEER**

SUGDEN RESERVOIR DAM
TOWN OR CITY: Spencer
LOCATION: Wire Village - Dam Maintained
DEGREE NO.

DESCRIPTION OF DAM

Earth Embankment
Height
Top
Bottom
Stem Slope

4th of Spillway

47

Depth = 4.0 Elcrest

21 Steel Pipe

None

Mill

Inspected: April 29, 1936 L.O. Marden, Vando, Nelson, Buck

[Measured: 12-19-36]

Vol. 27 - P. 487 - June 1892 - March Meeting 1893

Inspectors: Dec. 1926 - L.O. Marden

March 6, 1928

Dec. 31, 1931

Oct. 2, 1935 E. Wickwire - Spencer Ott

Oct. 21, 1936 - O.M. Conner, Lincoln

Selectmen Trail, Dunning (Caver)

47-14
POSED REPAIRS TO
JGDEN DAM
SPENCER
PUBLIC WORKS OF MASSACHUSETTS
ISION OF WATERWAYS
FEBRUARY 1957
SCALE: AS SHOWN

CHIEF WATERWAYS ENGINEER

CONTRACT NO. 1683

FIGURE B-3 ACC.03613-D
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.

CHIEF WATERWAYS ENGINEER

CONTRACT NO

FIGURE B-3 ACC.0
Both side walls to be dowelled to spillway section with 9° 34' 45" in both ways.

SECTION "B"
CHANNEL PROFILE ALONG C

SCALE 1:8.0' NO.

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 036/5-8
FIGURE B-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 ENGINEERING INC.
BOSTON, MASS.
CONTRACTOR
F16
NOTES:

1. Elevations shown based on an assumed benchmark of EL 843.8 at 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.
NOTES:
1. Elevations shown based on an assumed bench at Spillway Crest, as shown on record draw February, 1957.
2. Information shown based on field inspection.
3. Indicates location and direction of view.

SUGDEN RESERVOIR
W.S. EL. 840.94
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 of Weir & Mout  Date: Mar. 1, 1960
Type of Dam:  Condition: 

Spillway
Flashboards in Place:  Recent Repairs: 
Condition:  Repairs Needed: Planned being gotten out by Div. of Wm. 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

B-9  Sugden Reservoir Dam
WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by _______ Town of Spencer, Place _______ Selectmen Use _______ Storage pond

Inspected by _______ Date _______ Nov. 8, 1963

Type of Dam ___________ Condition _______ Fair to poor

SPILLWAY

Flashboards in Place _______ Recent Repairs _______

Condition _______ The new spillway section is good. The old section is 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 flume repair this dam has water in it, so cannot be done. Notice is for display)

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 _______ SUGDEN RESERVOIR DAM
DAM INSPECTION REPORT

Owned by ___________________________ Place ___________________________ Use ___________________________

Inspected by ___________________________ Date ___________________________

Type of Dam ___________________________ Condition ___________________________

SPILLWAY

Flashboards in Place ___________________________ Recent Repairs ___________________________

Condition ___________________________ The work on the proposed new spillway structure has ___________________________

Repairs Needed ___________________________ 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 ___________________________

SPOOLS

How Serious ___________________________

small leaks are visible in the distal spillway face ___________________________

DATE: ___________________________ B-1’ ___________________________

County Engineer ___________________________
LOCATION Worcester, Rt 170
STREET Show Brook

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by Town of Spencer

Place Selectman

Use: spring pool

INSPECTED BY ___________________ Date _______________

Type of Dam Earth and concrete

Condition

SPILLWAY

Flashboards in Place No boards

Recent Repairs

Condition The center section of aged concrete spillway has been

Repairs Needed recently reconstructed

The water level is 6" below the crest

EMBANKMENT

Recent Repairs

Condition

Repairs Needed

GATES

Recent Repairs

Condition

Repairs Needed

LEAKS

How Serious No leaks - all the leaks have now stopped

DATE: __________________________

County Engineer

SUGDEN RESERVOIR DAM
DESCRIPTION OF DAM

DISTRICT III

Submitted by P. Smith Date 4/2/72 Dam No. 3-14-280-11
City/Town Spencer Name of Dam SUGDEN RES. DAM

1. Locations 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 X
   Irrigation _____ Other ______

4. Drainage Area: 5.8 sq. mi. 3912 acres

5. Normal Ponding Areas: 90.5 acres; Ave. depth _______
   Impoundments: _______ gals; _______ acre ft.

6. No. and type of dwellings located adjacent to pond or reservoir
   30-50 i.e. summer homes, etc. 4 YEAR ROUND

7. Dimensions of Dams: Length 300-350' Max. Height 30'
   Slopes: Upstream Face 1.5:1 STONE RIP RAP
   Downstream Face 1.5:1
   Width across top 18' BOTTOM 60'

8. Classification of Dam by Materials:
   Earth X Conc. Masonry _______ Stone Masonry _______
   Timber _____ Rockfill _______ Other _______

9. A. Description of present land usage downstream of dams
   100 % rural; _______ % urban.
   B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? yes X no _______
10. Risk to life and property in event of complete failure.

- No. of people
- No. of homes
- No. of Businesses
- No. of industries
- No. of utilities
- Railroads
- Other dams

Other: Paxton Rd, Nugget Rd, Possibly 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.
INSPECTION REPORT - DAM AND RESERVOIRS

1. Location: City/Town **SPENCER** Dam No. 3-14-280-14
   Name of Dam **SUGDEN RESERVOIR** Inspected by **R. NICHOLSON**
   Date of Inspection **5/9/72**

2. Owner/s: pers Assessors _______ Prev. Inspection _______
   Reg. of Deeds _______ Pers. Contact _______

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

5. Degree of Hazard: (if dam should fail completely)*
   *This rating may change as land use changes (future development)

6. Outlet Controls: Automatic _______ Manual _______ Operative _______ Yes; _______ No. _______
   Comments: _______

7. Upstream Face of Dam Conditions:
   Comments: _______
8. Downstream Face of Dam:
   Comments:

9. Emergency Spillway:
   Comments:

10. Water Level at time of inspection: ft. above below
    top of dam principal spillway other

11. Summary of Deficiencies Noted:
    Growth (Trees and Brush) on Embankment
    Animal Burrows and Washouts
    Damage to slopes or top of dam
    Cracked or Damaged Masonry
    Evidence of Seepage
    Evidence of Piping
    Erosion
    Leaks
    Trash and/or debris impeding flow
    Clogged or blocked spillway
    Other
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

Figure D-1, Drainage Area Map
Figure D-2, Hydrologic and Hydraulic Computations

Page
D-1
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 mi²

2. Pond(s) Area: \( 0.11 + 0.14 \) = 0.25 mi²
Swamp(s) Area: \( 0.38 + 0.11 + 0.05 \) = 0.54 mi²
Total Area Pond(s) & Swamp(s) = 0.79 mi²

3. \( \frac{1185 - 839}{23200} = 0.0149 \) 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./mi²
Size Class: Interv; 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 8, 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 \( Q_{out} = Q_{in}[1 - \frac{S_{out}}{R}] \)

9. Storage Functions: (Test Flood \& \( \frac{1}{2} \) PMF - if needed)

\[
\begin{align*}
F_{out} &= 5530 - 291 \quad S = 5530 - 79.7 \ D \\
F_{\frac{1}{2}PMF} &= 2765 - 291 \quad S = 2765 - 79.7 \ D
\end{align*}
\]

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

1 - Spillway

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

Crest El. 840.8, \( Q_1 = 3.9(126') \), \( H_{1.5} = 49.14 \) H, 1.5

Res. Elev. 842 844 845 843 846 846.7
\( H_1 \) 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: \( \pm 76' @ 830.6 \), 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
\( EQ \) 750 2330 4420 3320

No tailwater effect on spillway

III Low Level Outlet

\[ H = \frac{V^2}{2} \left[ \frac{0.5 + 1.0 + 0.5 + 1.0 + 0.5}{3} \right] = 0.0658 V^2 \cdot 0.00132 Q^2 \]

\( Q = 27.6 \sqrt{H} \)

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' = \( \frac{90.5(33.52)}{137.2(3600)} = 8 \) hours.
IV Discharge, Storage Function, & Storage vs Res. Elev.
Failure of Dam

Peak Failure Flow:

Pond Elevation = 845.6 (Peak T.F. El.)
Toe Elevation = 614.2

\[ Y_0 = \frac{845.6 - 614.2}{31.4} \]

Dam Length Subject to Breaching = 250'

\[ W_0 = 40\% (250) = 100' \]

\[ Q_P = 1.68 \times W_0 \times (Y_0)^{1.5} = 1.68 \times (100) \times (31.4)^{1.5} = 29550 \]

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

Storage Volume Released:

Storage Above Spillway (Item 17): 435 ac. ft.
Storage Below Spillway: \( \frac{1}{3} (29.8) \times 90.5 = 900 \)
Total Storage (el. 845.6) = 1,335 ac. ft.

Channel Hydraulics:

\[ S = \frac{25}{150} = 0.167, \quad n = 0.06, \quad R \geq \frac{1}{2} \]

\[ V = \frac{1.49}{100} \times (\frac{1}{2}) \times (0.0286)^{0.6} = 2.644 \]

\[ A = \frac{1}{2} B y^2 = 9 y^2 \]

Maximum Storage Capacity (C.B. 840.7, L.P. Crest):

Storage Below Spillway = \( \frac{1}{3} (29.8) \times 90.5 = 900 \) ac. ft.
Storage Above Spillway = (840.7—800.8) 90.5 = 533 ac. ft.

Maximum Storage = 1,435 ac. ft.
APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

SUGDEN RESERVOIR DAM
NOT AVAILABLE AT THIS TIME
END

FILMED

7-85

DTIC