OHIO RIVER BASIN

BEAVERDAM CREEK, SOMERSET COUNTY

PENNSYLVANIA

# STOUGHTON LAKE DAM

(BEAVER DAM)

**NDI No. PA 00468**

**PennDER No. 56-78**



# PHASE I INSPECTION REPORT

## NATIONAL DAM INSPECTION PROGRAM

*prepared for*

**DEPARTMENT OF THE ARMY**

**Baltimore District, Corps of Engineers**

Baltimore, Maryland 21203

*prepared by*

**MICHAEL BAKER, JR., INC.**

Consulting Engineers

4301 Dutch Ridge Road

Beaver, Pennsylvania 15009



**February 1980**

OHIO RIVER BASIN

(1)

(2) STOUGHTON LAKE DAM (BEAVER DAM)
(4) SOMERSET COUNTY, COMMONWEALTH OF PENNSYLVANIA
(5) NDI No. PA 00468
PennDER No. 56-78



(6) PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Stoughton Lake Dam (Beaver Dam), Ohio River Basin.
(NPA-00465, PennDER-56-78). Somerset County,
Commonwealth of Pennsylvania.
Phase I Inspection report.

Prepared for: DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

NDI Number

(10) PU

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(15) DACW31-80-C-0025

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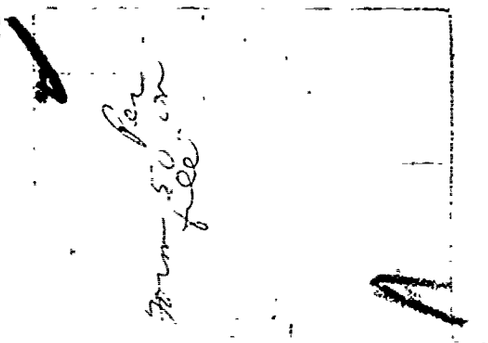
# PREFACE

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

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

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design 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 condition and the downstream damage potential.



PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Stoughton Lake Dam (Beaver Dam), Somerset County, Pennsylvania
NDI No. PA 00468, PennDER No. 56-78
Beaverdam Creek
Inspected 12 December 1979

## ASSESSMENT OF GENERAL CONDITIONS

Stoughton Lake Dam is a "Significant" hazard - "Small" size dam owned and operated by Mr. Robert A. Stoughton for commercialized recreation.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the spillway will pass the spillway design flood (SDF) without overtopping the dam. An SDF in the range of the 100-year flood to the 1/2 Probable Maximum Flood (1/2 PMF) is required for Stoughton Lake Dam. The 1/2 PMF was chosen because the dam is on the high side of the "Significant" hazard and "Small" size categories. The analysis indicated that the spillway will pass 53 percent of the Probable Maximum Flood (PMF) before overtopping will occur. Therefore, the spillway is assessed as being "adequate."

The dam was found to be in fair overall condition with the exception of the spillway training walls and the spillway discharge apron. The inspection revealed certain items of remedial work necessary for the dam which should be completed without delay by the owner. Items 1 and 2 below should be designed by a qualified professional engineer experienced in the design of earth dams and appurtenant structures.

1) Reconstruct spillway training walls.

2) Repair or reconstruct the spillway discharge apron. It would be advantageous for the continued stability of the ogee section to have the engineer examine for undermining of the ogee section after the reservoir has been drawn down.

3) The eroded areas around the outlet head wall should be repaired and the area reseeded.

4) Clear the trees and brush from the dam and continue in the future to maintain this item.

5) Repair the spalled concrete on the outside of the intake riser at the water level.

6) Reshaping the discharge channel for the outlet works will eliminate the backwater on this structure. By eliminating the backwater, the surges may be decreased or possibly eliminated.

7) As a part of the annual inspection the saturated condition of the embankment near the outlet head wall should be examined and recorded.

8) Stop logs in the intake riser should be replaced in the future as their condition demands.

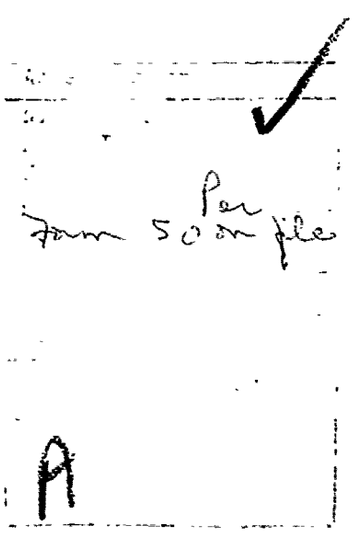
In addition, the following operational measures are recommended to be undertaken by the owner:

1) Develop a detailed emergency operation and warning system.

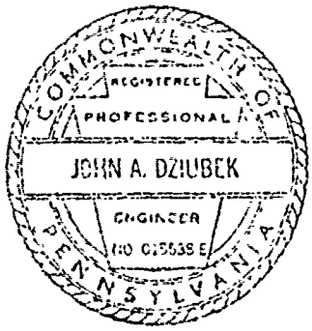
2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, and operation procedures and records be developed and implemented.



STOUGHTON LAKE DAM




Submitted by:

MICHAEL BAKER, JR., INC.

John A. Dziubek, P.E.
Engineering Manager-Geotechnical

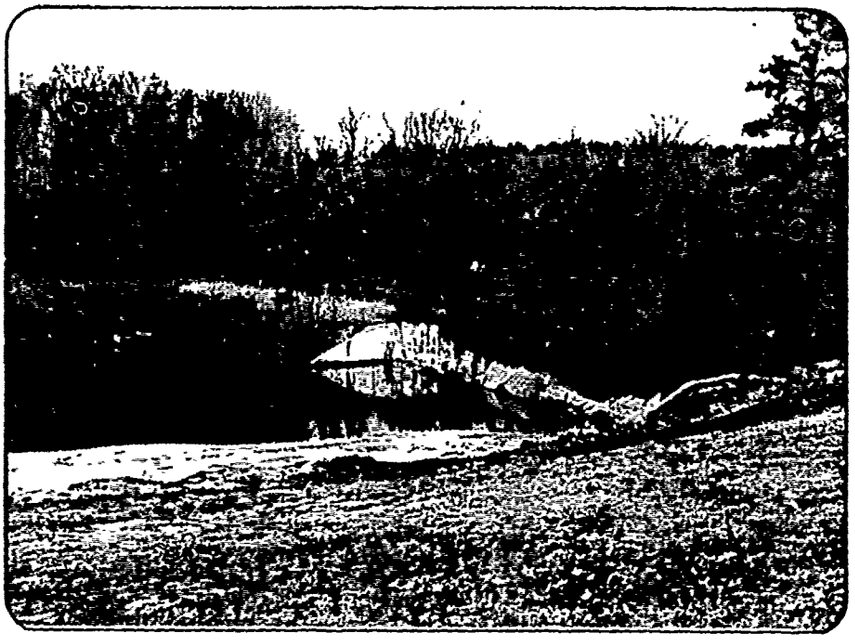
Date: 22 February 1980

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 19 MARCH 1980



Overall View of Dam from Right Abutment

Overall View of Dam from Left Abutment

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NATIONAL DAM INSPECTION PROGRAM
ST ɔGHTON LAKE DAM (BEAVER DAM)
NDI ɴo. PA 00468, PennDER No. 56-78

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority - The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - Stoughton Lake Dam is an earthfill dam with a maximum height of 23 feet and a crest length of 335 feet. The dam has also been referred to as Beaver Dam because it is situated on Beaverdam Creek. The reservoir is used for commercial recreation and real estate development. The upstream slope is 2H:1V (Horizontal to Vertical), the downstream slope is 3H:1V, and the crest width is 24 feet. The embankment consists of a central impervious clay core with select sand and clay upstream and random fill for the downstream slope. A 3 foot deep cut-off trench was extended below the clay core into the foundation.

The 90 feet crest length ogee spillway is located at the right abutment of the dam. The crest elevation of the spillway is Elevation 1814.3 feet and the top of dam is Elevation 1821.3 feet. An eight foot long low flow notch (Elevation 1813.8 feet) is located at the center of the spillway. The approach channel is the earth-lined reservoir bottom gently sloping up to within 3 feet of the spillway level. The ogee spillway discharges onto a grouted rock rubble apron approximately 25 feet long (in the direction of flow).

The outlet works consist of an intake, a riser, a 36 inch corrugated metal pipe outlet conduit, and an outlet head wall. The riser is divided into

two chambers by stop logs which can be removed to drawdown the reservoir. The outlet conduit is encased in one foot of concrete and has 5 anti-seep collars along its 100 foot length. The outlet pipe was designed to rest on "blue and yellow clay shale;" however, it is not known if it was constructed in this manner.

b. Location - Stoughton Lake Dam is located in Jenner Township, Somerset County, Pennsylvania. The dam is located on Beaverdam Creek approximately 0.5 mile northeast of Jenners Crossroads, Pennsylvania. U.S. Route 219 is located immediately upstream (northwest) of the reservoir and U.S. Route 30 runs parallel to the reservoir approximately 0.5 mile south of the dam. The coordinates of the dam are N 40° 9.5' and W 79° 2.7'. The dam and reservoir are shown on USGS 7.5 minute topographic quadrangle, Boswell, Pennsylvania.

c. Size Classification - The maximum height of the dam is 23 feet. The reservoir volume to the top of dam at Elevation 1821.3 feet is 643.5 acre-feet. Therefore, the dam is in the "Small" size category.

d. Hazard Classification - Economic damage to several homes and the township road located downstream from the dam could result in the event of a failure of the dam. Therefore, this dam is considered in the "Significa hazard category.

e. Ownership - The dam and reservoir are owned by Mr. Robert Stoughton, P.O. Box 54, Jennerstown, Pennsylvania 15547.

f. Purpose of the Dam - The reservoir is used for recreational purposes. Also, a few homes have been constructed along the shoreline.

g. Design and Construction History - The dam was designed by Mr. Walker Mong of Somerset, Pennsylvania. The construction of the dam was performed by Laubb, Collins, and Troal Construction Company of Somerset, Pennsylvania. Construction of the dam started in August 1951 and was essentially completed by 1 December 1951.

h. Normal Operating Procedures - The lake is maintained at approximately the same level all year. Mr. Stoughton visits the dam frequently during the summer and approximately once every two weeks during the

winter. In addition, during heavy rainfalls, Mr. Stoughton frequently checks the water level at the spillway.

## 1.3 PERTINENT DATA

| | |
|---|---|
| a. Drainage Area (square miles) - | 9.57 |
| b. Discharge at Dam Site (c.f.s.) - | |
| Maximum Flood - | 230 |
| Ungated Spillway Capacity (El. 1821.3 ft.) - | 6272.0 |
| c. Elevation (feet above Mean Level [M.S.L.]) - | |
| Design Top of Dam - | 1821.3 |
| Minimum Top of Dam - | 1821.2 |
| Maximum Pool (Design) - | Unknown |
| Normal Pool - | 1814.3 |
| Outlet Pipe - | |
| Invert at Entrance* - | 1798.0 |
| Invert at Outlet - | 1796.6 |
| Streambed at Centerline of Dam - | 1798 |
| Maximum Tailwater - | Unknown |
| d. Reservoir (feet) - | |
| Length of Maximum Pool - | 8200 |
| Length of Normal (Recreation) Pool - | 5500 |
| e. Storage (acre-feet) - | |
| At Top of Dam (El. 1821.3 ft.) - | 543.5 |
| At Spillway Crest (El. 1814.3 ft.) - | 200.5 |
| f. Reservoir Surface (acres) - | |
| Top of Dam (El. 1821.3 ft.) - | 84.5 |
| Spillway Crest (El. 1814.3 ft.) - | 44.1 |
| g. Dam - | |
| Type - | Earthfill |
| Length (feet) - | 335 |
| Height (feet) - | 23 |
| Top Width (feet) - | 24 |
| Side Slopes - Upstream - | 2H:1V |
| Downstream - | 3H:1V |

*From original design plans.

Zoning - The design plans show that the embankment is zoned with an impervious clay core. The upstream section of embankment is "selected fill - clay and sand." The downstream embankment is "graded semi-pervious fill."

Impervious Core - Clay

Cut-off - The design plans indicate a 3 feet deep and 8 feet wide cut-off trench extending below the clay core material. The backfill in the cut-off trench was to consist of the same clay core material.

Grout Curtain - None

Drains - None

h. Diversion and Regulating Tunnel - None

i. Spillway -

Type - Concrete ogee

Length of Crest Perpendicular to Flow (feet) - 90

Crest Elevation (feet M.S.L.) - 1814.3

Low Flow Notch Crest Elevation (feet M.S.L.) - 1813.7

Gates - None

Upstream Channel - The upstream channel consists of the earth-lined reservoir bottom gently rising to 3 feet below the crest level.

Downstream Channel - Grouted rock rubble apron discharging into channel cut into hillside.

j. Regulating Outlets - The outlet works consist of an intake riser, a 36 inch corrugated metal pipe outlet conduit, and an outlet head wall. The intake extends 19 feet upstream from the riser. The riser unit is divided into two chambers by stop logs. The 36 inch corrugated metal pipe is encased by one foot of concrete and has 5 cut-off collars along its length. The outlet head wall was earth formed and has a variable wall thickness.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

Information reviewed for the preparation of this report included the Pennsylvania Department of Environmental Resources' (PennDER) file for the dam and information obtained by interviewing the owner. This included:

1) Dam Permit Application Report prepared 1 August 1951. (Available in the PennDER file.)

2) Monthly construction progress reports.

3) Various correspondence.

4) Two design drawings incorporated into this report as Plates 3 and 4.

5) A post-construction inspection report by PennDER performed on 1 May 1963.

The dam was designed by Mr. Walker Mong of Somerset, Pennsylvania. Mr. Mong is deceased and his design files are not available.

### 2.2 CONSTRUCTION

Construction of the dam was started in August 1951 and was completed by 1 December 1951 except for riprapping the spillway channel. The contractor was Laubb, Collins, and Troal Construction Company of Somerset, Pennsylvania. During the construction period the owner frequently visited the site to observe the construction, otherwise, the quality and construction control was provided by the contractor's foreman.

### 2.3 OPERATION

No formal records are available for operation of the dam and reservoir. The spillway is uncontrolled and the reservoir does not fluctuate very much from the spillway crest level. The owner can control the reservoir level by adding or removing stoplogs in the outlet works. An A-frame with block and tackle which can be placed over the outlet works riser has been used to facilitate removal of the stoplogs.

During the summertime the dam is frequently (approximately daily) visited by the owner. During the wintertime the visits are less frequent (once every two weeks), except

during times of heavy rainfall or run-off. At these times the spillway level is observed; the reported maximum flow through the spillway was 9 inches above the crest, corresponding to a flow of 230 c.f.s.

## 2.4 EVALUATION

a. Availability - Other than the information contained in PennDER's File No. 56-78, very little design or construction data are available.

b. Adequacy - The information available with the visual inspection measurements and observations are adequate for a Phase I Inspection of this dam.

c. Validity - Comparison of the design drawings with the visual inspection observations and measurements shows several discrepancies. Notable co .truction revisions include:

1) The top width is approximately 24 feet and not 12 feet.

2) The downstream slope is approximately 3H:1V and not 2H:1V as indicated on the design plans. This resulted in an extension of the outlet conduit.

3) The intake riser unit was not constructed to Elevation 1821.3 feet but was constructed to Elevation 1816.1 feet.

4) The outlet pipe conduit is 36 inches and not 48 inches as shown on the plans.

5) No access bridge to the intake riser was constructed.

6) The spillway training wall footings are smaller than shown on the design plans.

7) The actual amount of steel reinforcement in the spillway walls as compared to the design plans is questionable.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

a. General - The embankment was found to be in fair overall condition. The spillway was in poor overall condition and the outlet works (the portions that could be examined) were found to be in good overall condition. On the evening and early morning prior to the visual inspection (12 December 1979) light rain showers occurred. Also, during the inspection some light intermittent rain occurred. Noteworthy deficiencies observed during the inspection are described briefly below. The complete visual inspection check list, field sketches, top of dam profile, and typical cross-section are given in Appendix A.

b. Dam - The dam has a cover of grass protecting the crest and downstream slope. No signs of distress or instability were observed. No seepage was observed; however, the toe of the embankment near the outlet contained a high percentage of moisture. Due to the recent rainfall, it was difficult to assess whether this is temporary or from steady state seepage conditions. According to the owner, no signs of seepage has occurred on the embankment. A minor amount of erosion has occurred on the embankment around the outlet head wall. This erosion extends for 6 to 10 feet around the head wall. Small trees and brush are present on both the upstream and downstream slopes of the embankment. The left downstream area (approximately 50 feet downstream extending to 100 feet and from the left hillside to the outlet conduit discharge channel) is saturated; however, it is estimated that this may be the result of backwater from the channel rather than underseepage. This area is not much higher than the water surface in the discharge channel.

c. Appurtenant Structures - At the time of inspection the right spillway training wall was being reconstructed. The embankment/abutment behind the wall had been excavated and the downstream half of the wall removed. The wall footing was left in place to serve as the foundation for the replacement wall consisting of masonry stone construction. The remaining upstream portion of the training wall was tilted and disjointed from the cut-off section (transition buttress). It should be noted

that these repairs were being performed under normal pool conditions which is an undesirable construction practice. In addition, some of the backfill material may be susceptible to piping if proper transition filters and proper drainage systems are not installed. Evidence of this could be seen along the downstream end of the completed wall where minor amounts of seepage/drainage from the backfill was carrying fine particles and also around the outlet head wall where erosion has occurred.

The left spillway training wall has two major cracks. One is at the junction of the cut-off wall (transition buttress) and the spillway training wall (see Photo 6). This crack is severe enough that the continued stability of this wall is in jeopardy. The other crack is approximately 5 feet from the downstream end of the wall.

The spillway apron is very deteriorated and undermined. The apron consists of riprap which was slush grouted. The left side is extensively undermined and the footing for the left spillway training wall is exposed and undermined at the edge. The spillway apron has settled approximately 7 inches adjacent to the ogee weir section on the left side of the spillway. Some portions of the apron near the downstream edge have become completely disengaged from the rest of the apron.

The intake structure for the outlet works is submerged and could not be observed. The riser unit was in good overall condition except for some spalling of the concrete at the water line on the outside. The stop logs in the riser which divide the riser into two chambers were in good condition where they could be examined. However, it must be noted that displaced stop logs were observed in the downstream chamber indicating that these stop logs may need to be replaced.

The outlet structure was partially submerged and the observable portions were in good condition. Some erosion of the embankment has occurred around the outlet head wall. This erosion, according to the owner, is the result of surges from the outlet conduit washing onto the embankment. These surges are probably the result of air pockets trapped in the conduit which are later forced out.

d. Reservoir Area - Some sedimentation of the reservoir has occurred in the upper end of the reservoir and the swimming area immediately upstream from the dam. A cofferdam located approximately 1000 feet upstream from the dam (location of foot bridge across the reservoir) was left in place except for a 100 feet wide breach.

e. Downstream Channel - The downstream channel slope is mild and areas of accumulation of trees and brush are present. The outlet channel for the outlet works is almost level causing backwater on the outlet pipe. Reshaping this channel could easily eliminate the backwater. Located approximately 500 to 600 feet downstream is a township road which would probably be inundated and therefore suffer economic damage in the event of a dam failure. In addition, one house located on higher ground along the right side of the channel may incur economic damage. The confluence of Beaverdam Creek and Quemahoning Creek is approximately 1700 feet downstream from the dam. Some potential economic damage centers exist along Quemahoning Creek downstream from the confluence. Located 3 miles downstream from the dam is Quemahoning Reservoir (NDI No. PA 00740 and PennDER No. 56-4).

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

There are no formal procedures in the event of impending catastrophe for the dam. The owner visits the dam almost daily during the summertime and approximately every two weeks during the wintertime. In addition, during times of unusual rainfall or run-off, the owner visits the dam to determine the depth of flow in the spillway. Drawdown of the reservoir can be accomplished by removing the stop logs in the intake riser.

It is recommended that formal emergency procedures be prepared.

### 4.2 MAINTENANCE OF DAM

There are no formal records of maintenance or formal procedures for evaluating the necessity of maintenance for the structure. It is recommended that formal inspection procedures be developed.

### 4.3 MAINTENANCE OF OPERATING FACILITIES

There are no operating facilities installed at the dam. The stop logs of the intake riser are replaced on an as-needed basis.

### 4.4 DESCRIPTION OF ANY WARNING SYSTEM

There are no warning procedures in the event of a dam failure. An emergency warning procedure should be developed.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

a. Design Data - No hydrologic or hydraulic design calculations are available for Stoughton Lake Dam.

b. Experience Data - According to the owner of the dam, the maximum pool level occurred last fall (1978) and was 9 inches over the spillway crest. This corresponds to a spillway discharge of approximately 230 c.f.s.

c. Visual Observation - The crest of the dam slopes towards the spillway where it is at its lowest point (Elevation 1821.3 feet). This should not affect the performance of the dam since the spillway is large enough to pass the spillway design flood (SDF) required for this dam with approximately 0.3 foot of freeboard.

The owner of the dam mentioned that during high flows there are occasional surges from the outlet works. The outlet works were submerged at the time of inspection which made a thorough examination impossible. It is likely that these surges are caused by air pockets in the outlet pipe which collect during periods of low flow. Backwater on this pipe traps the air pockets until flow reaches a level high enough to force them through the pipe, causing surges as the air escapes.

It is difficult to estimate how this affects the functioning of the outlet works. Improvement of the exit channel would remove the backwater and should serve to reduce, if not eliminate, this problem.

d. Overtopping Potential - Stoughton Lake Dam is classified as a "Significant" hazard - "Small" size dam requiring evaluation for an SDF in the range of the 100-year flood to the 1/2 Probable Maximum Flood (1/2 PMF). Since the dam is on the higher end of the "Significant" hazard category, the 1/2 PMF was chosen for the SDF. The hydraulic capabilities of the dam, reservoir, and spillway were evaluated by routing the 1/2 PMF through the reservoir with the aid of the U.S. Army Corps of Engineers Flood Hydrograph Package, HEC-1. Unit hydrograph parameters used for developing the inflow hydrograph to the reservoir were based upon

a regionalized analysis conducted by the Baltimore District of the U.S. Army Corps of Engineers.

The results of this analysis indicates that the spillway would pass the 1/2 PMF with a maximum pool Elevation of 1821.0 feet or approximately 0.3 feet of freeboard in the spillway.

e. Spillway Adequacy - The dam, as outlined in the above analysis, is capable of passing approximately 53 percent of the Probable Maximum Flood (PMF) without overtopping. The spillway is therefore considered "adequate".

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - No evidence of embankment distress or instability was observed. The moisture and saturation observed at the toe and downstream, respectively, is considered minor but should be visually examined in future inspections.

The spillway structure should be investigated further and portions of it reconstructed. The owner has already started to reconstruct the right training wall of the spillway. It is recommended that the left training wall be repaired or replaced. The spillway apron should also be repaired or replaced. It is recommended that a professional engineer experienced in the design and construction of earth dams be retained to provide appropriate design recommendations and evaluations. It is further recommended that after the partial drawdown of the reservoir is completed that the engineer perform an inspection of the ogee weir to determine the extent, if any, of undermining to ensure the continued stability of this section.

b. Design and Construction Data - Calculations of embankment slope and foundation stability were not available for review. The departures from the design slope and crest width for the embankment during construction should give the structure a higher factor of safety. Considering that no evidence of embankment instability or seepage was observed during the inspection and the history of satisfactory performance of the slopes, it is estimated that further assessments of the embankment slope stability is not necessary. However, should future inspections observe signs of distress or seepage, further evaluations may become necessary.

Calculations of structural and foundation stability for the appurtenant structures were not available for review. Given the current condition of the spillway training walls, it is recommended that a qualified professional engineer perform the necessary calculations to ensure structural stability of these walls after reconstruction.

c. Operating Records - No operating records were available for Stoughton Lake Dam. Information obtained by interviewing the owner does not indicate

cause for concern relative to the structural stability of the embankment.

d. Post-Construction Changes - The only post-construction changes known are the clearing of some trees and brush on the dam, the prior replacement of the spillway apron, and the present required replacement of the spillway training wall. These modifications do not adversely affect the structural stability of the structure.

e. Seismic Stability - The dam is located in Seismic Zone 1 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is a zone of minor seismic activity. Therefore, further consideration of the seismic stability is not warranted.

## SECION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

a. Safety - The dam was found to be in fair overall condition at the time of inspection, except possibly for the spillway training walls and discharge apron. The dam is a "Small" size - "Significant" hazard dam requiring a spillway capacity in the range of the 100-year flood to the 1/2 PMF. The 1/2 PMF was chosen as the SDF. As presented in Section 5, the spillway is capable of passing approximately 53 percent of the PMF without overtopping the dam, therefore the spillway is considered "adequate."

No evidence of embankment distress or instability was observed. Moisture and saturated soil observed at the toe and downstream from the embankment is considered minor but should be visually examined in the future.

Portions of the spillway structure were in a state of disrepair and should be reconstructed. At the time of inspection, the right training wall was excavated and replacement of the downstream half with a masonry stone wall had started. For reasons of safety and good construction practice, it was recommended that the owner drawdown the reservoir pool approximately 5 feet until the repairs are complete. Further, the left spillway training wall has two major cracks and the continued stability of this wall may be in jeopardy. In order to protect the ogee weir section of the spillway, the deteriorated and undermined apron should be repaired or reconstructed.

b. Adequacy of Information - The information available and the observations made during the field inspection are considered adequate for this Phase I Inspection Report.

c. Urgency - The owner should immediately perform a partial drawdown of the reservoir until the construction is completed. In addition, the owner should initiate the action discussed in Paragraph 7.2 without delay.

d. Necessity for Additional Data/Evaluation - It is recommended that the owner engage the services of a qualified professional engineer experienced in

the design of earth dams and concrete structures to develop recommendations for the reconstruction of the spillway training walls and repair/reconstruction of the spillway discharge apron.

## 7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed certain items of remedial work necessary for the dam which should be completed without delay by the owner. Items 1 and 2 below should be designed by a qualified professional engineer experienced in the design of earth dams and appurtenant structures.

1) Reconstruct the spillway training walls.

2) Repair or reconstruct the spillway discharge apron. It would be advantageous for the continued stability of the ogee section to have the engineer examine for undermining of the ogee section after the reservoir has been drawn down.

3) The eroded areas around the outlet head wall should be repaired and the area reseeded.

4) Clear the trees and brush from the dam and continue in the future to maintain this item.

5) Repair the spalled concrete on the outside of the intake riser at the water line.

6) Reshaping the discharge channel for the outlet works will eliminate the backwater on this structure. By eliminating the backwater, the surges may be decreased or possibly eliminated.

7) As a part of the annual inspection the saturated condition of the embankment near the outlet head wall should be examined and recorded.

8) Stop logs in the intake riser should be replaced in the future as their condition demands.

In addition, the following operational measures are recommended to be undertaken by the owner.

1) Develop a detailed emergency operation and warning system.

2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.

3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

It is further recommended that formal inspection, maintenance, and operation procedures and records be developed and implemented.

# APPENDIX A

## VISUAL INSPECTION CHECK LIST, FIELD SKETCHES, TOP OF DAM PROFILE, AND TYPICAL CROSS-SECTION

# Check List
# Visual Inspection
# Phase 1

Name of Dam Stoughton Lake Dam (Beaver Dam) County Somerset State PA Coordinates Lat. N 40°9.5' Long. W 79°2.7'

NDI # PA 00468
DER # 56-78

Date of Inspection 12 December 1979 Weather Overcast, occasional light rain Temperature 50° F.

Pool Elevation at Time of Inspection 1814.5 ft. M.S.L. Tailwater at Time of Inspection 1800.6 ft. M.S.L.

Inspection Personnel:

Michael Baker, Jr., Inc.:

James G. Ulinski
Wayne D. Lasch
Jeff S. Maze

Owner:

Mr. Robert A. Stoughton

James G. Ulinski Recorder

## CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| LEAKAGE | | |
| STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS | | |
| DRAINS | | |
| WATER PASSAGES | | |
| FOUNDATION | | |

## CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)

NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS<br>CONCRETE SURFACES | | |
| STRUCTURAL CRACKING | | |
| VERTICAL AND HORIZONTAL<br>ALIGNMENT | | |
| MONOLITH JOINTS | | |
| CONSTRUCTION JOINTS | | |

## EMBANKMENT

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS | None observed | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | None observed | |
| SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES | Some erosion has occurred around the outlet head wall. This erosion is reportedly caused by surges from the outlet as a result of air pockets. Also, some small trees and brush are present on the upstream and downstream slopes. | The eroded areas around the outlet head wall should be repaired and reseeded. The trees and brush should be cleared from the dam. |
| VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST | The vertical and horizontal alignment of the dam is acceptable except for the excavated area behind the right spillway wall. | The excavated area should be properly backfilled after construction is completed. |
| RIPRAP FAILURES | The riprap on the upstream slope has become partially overgrown with grass, but no erosion is present. | |

## EMBANKMENT

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)

NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM | There were no problems observed at the junction of the embankment and the left abutment. At the junction of the spillway and the embankment, the spillway training wall has a major crack running through the joint of the training wall and cut-off wall (see Photo 6). | Necessary maintenance or repairs should be performed to avoid further structural distress and to insure continued stability of these walls. |
| ANY NOTICEABLE SEEPAGE | The eroded area around the outlet and the downstream left side were wet and saturated. Due to occasional showers the night before and during the day, it was difficult to determine if the moisture was steady state seepage or the result of rainfall. In either case the moisture at this time does not appear to present a problem. | The embankment toe and downstream should be periodically examined for moisture. |
| STAFF GAGE AND RECORDER | None | |
| DRAINS | None | |

## OUTLET WORKS

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT | The outlet at the downstream is a 36 in. diameter C.M.P. which was totally submerged at the time of inspection. The pipe is reported to be encased in a minimum of one ft. of concrete. The slope of the outlet conduit was reported to be installed almost level causing surges as a result of air pockets which develop in the conduit. | If possible the condition of the conduit should be examined after the spillway repairs are completed. |
| INTAKE STRUCTURE | The intake is submerged and could not be examined. The intake structure (riser) was in good overall condition except for some spalling of the concrete outside along the waterline (normal pool level). | The concrete surfaces that are spalled should be repaired. |
| OUTLET STRUCTURE | The outlet structure was partially submerged at the time of inspection. The observable portion was in good overall condition. The structure was apparently earth formed and has a variable wall thickness. | |
| OUTLET CHANNEL | The outlet channel slope is almost level and the valley narrows causing the outlet structure and outlet to remain partially submerged. However, no obstructions to the passage of the flow are present. | Reshaping the channel would eliminate the backwater. |

## OUTLET WORKS

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| EMERGENCY GATE | No emergency gate was designed for the dam. The intake (riser) structure is divided into two chambers by stop logs. These stop logs can be removed to draw the reservoir down. At the time of inspection the level of the top stop log was approximately the same as the low level notch on the spillway and flow was being discharged over the stop logs. The stop logs at the upper levels which could be observed were in good condition. However, some boards or stop logs were present in the outlet chamber indicating that possibly one or two of the stop logs are loose. | |

## UNGATED SPILLWAY

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)

NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONCRETE WEIR | The concrete weir was in good overall condition. Some minor spalling of the concrete has occurred but not to a significant amount. | |
| APPROACH CHANNEL | The approach channel is mildly sloping toward the reservoir. A fence has been placed immediately upstream from the crest to protect anyone swimming in the lake from passing over the spillway. | |
| DISCHARGE CHANNEL | The spillway apron is very deteriorated and undermined. The apron consists of riprap which was slush grouted. The left side is extensively undermined and the footing for the left spillway training wall is exposed and undermined at the end. The spillway apron has cracked and settled 7 in. from the downstream edge of the weir near the left side. | Necessary repairs to the spillway apron should be performed, including repairing the undermining of the slab. |
| BRIDGE AND PIERS | No bridge was constructed (although the design plans show a bridge to intake [riser] structure). | |

## UNGATED SPILLWAY

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SPILLWAY TRAINING WALLS | The right downstream half of the spillway training wall was currently being replaced with a stone and masonry wall. The original section reportedly was tilted and fell into the discharge channel. The remainining upstream half and cut-off wall are in a deteriorated condition and the cut-off wall is separated from the spillway section. The embankment (abutment) material has been removed from behind these walls. The left spillway training wall has two major cracks. One is at the junction of the cut-off wall and the upstream and downstream sections of the training wall (see Photo 6). The other is approximately 5 ft. from the downstream end of the wall. | It is recommended that the owner engage the services of a professional engineer experienced in the design and construction of spillways for earth dams to design and supervise the construction/ repairs necessary for the spillway. It is further recommended that the pool be drawn down 5 ft. while such repairs are being made. |

## GATED SPILLWAY - Not Applicable

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONCRETE SILL | | |
| APPROACH CHANNEL | | |
| DISCHARGE CHANNEL | | |
| BRIDGE AND PIERS | | |
| GATES AND OPERATION EQUIPMENT | | |

INSTRUMENTATION - None

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)

NDI # PA 00468

| VISUAL EXAMINATION | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS | | |
| OBSERVATION WELLS | | |
| WEIRS | | |
| PIEZOMETERS | | |
| OTHER | | |

## RESERVOIR

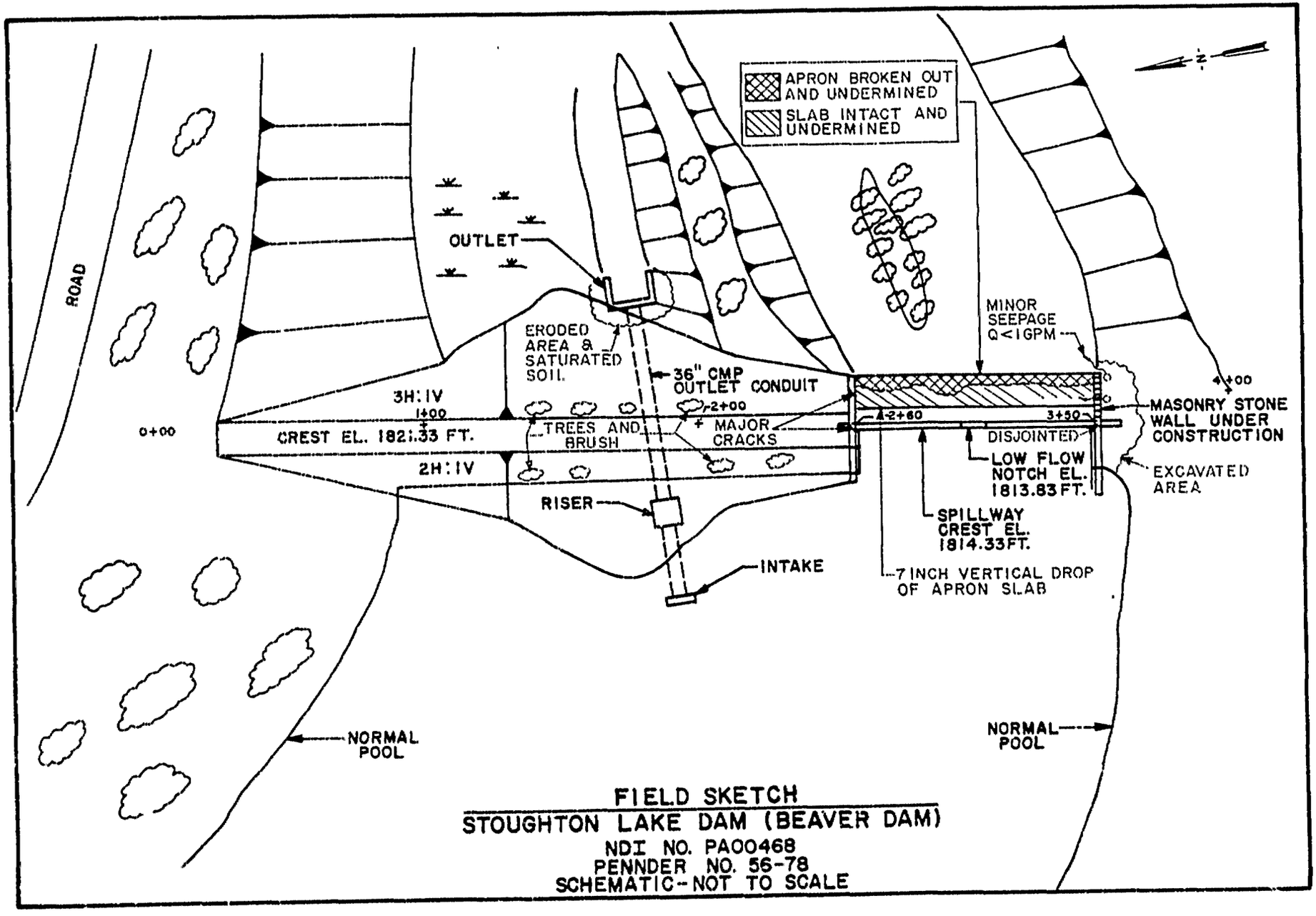
Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SLOPES | The reservoir slopes appear stable from a soil mechanics point of view. | |
| SEDIMENTATION | Some sedimentation has occurred at the upper end and in the swimming area (immediately upstream from the dam). This sedimentation is reportedly due to some bare areas in the watershed and due to some coal stripping operations. | |

## DOWNSTREAM CHANNEL

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONDITION (OBSTRUCTIONS, DEBRIS, ETC.) | The channel is mildly sloping with areas of accumulation of small trees and brush. Approximately 500 to 600 ft. below the dam, a township road passes over Beaverdam Creek. According to information contained in PennDER's file, this culvert backed up to within one ft. of the top of the arch on 5 July 1951 (prior to construction of the dam). | |
| SLOPES | The downstream channel slope is mild. The slopes of the channel are moderate and stable. A slight amount of erosion on the spillway channel side is occurring on the dividing hill between the spillway and outlet channels. | |
| APPROXIMATE NO. OF HOMES AND POPULATION | The township road located approximately 500 ft. downstream would probably be flooded in the event of a dam break. In addition, a house located on the right side of the channel on high ground would probably incur economic damage. The confluence of Beaverdam Creek and Quemahoning Creek is approximately 1700 ft. downstream from the dam. Some potential economic damage areas exist along Quemahoning Creek downstream from the confluence. Located 3 miles downstream from the dam is Quemahoning Reservoir (NDI # PA 00740 and PennDER # 56-4). | |




FIELD SKETCH

STOUGHTON LAKE DAM (BEAVER DAM)

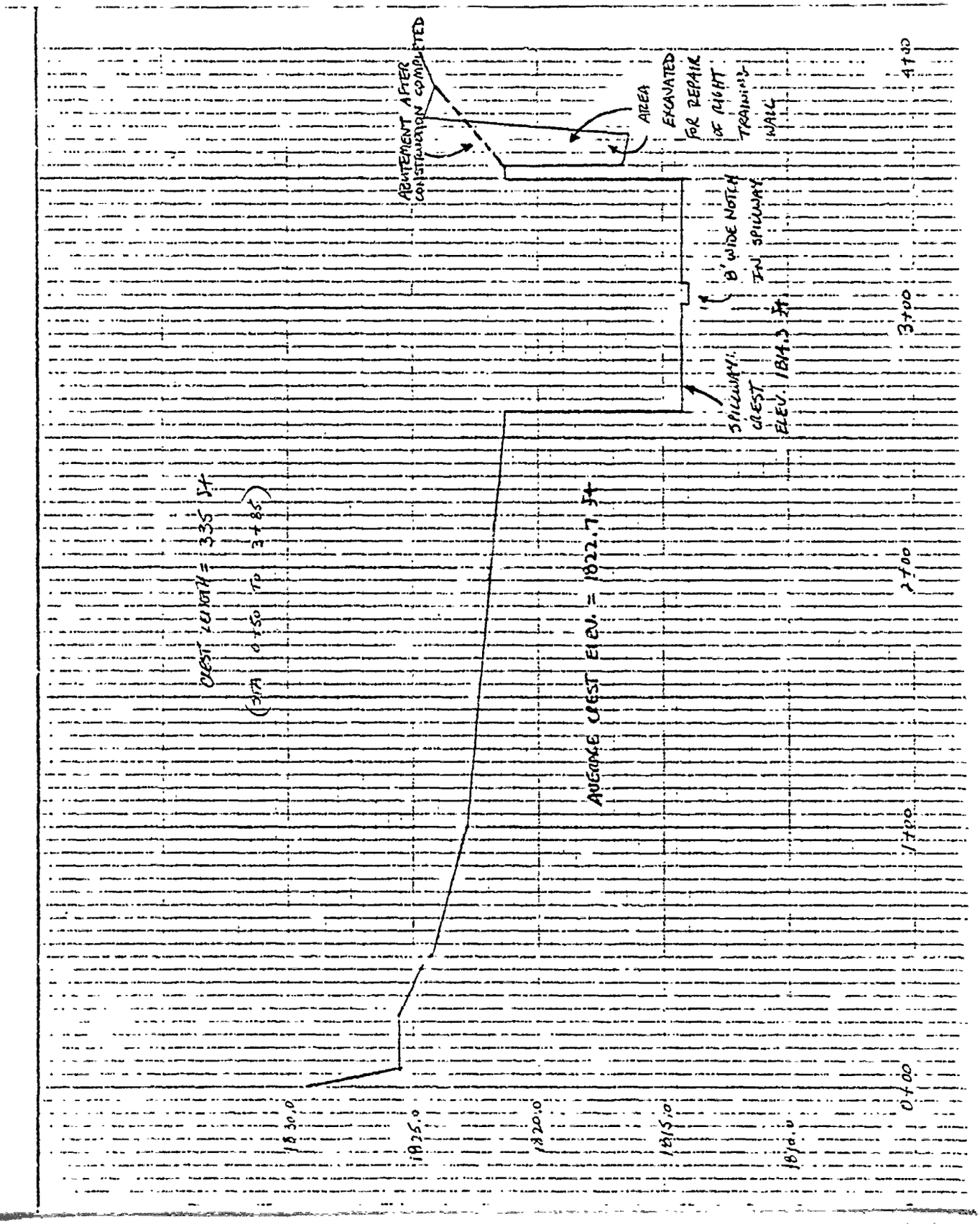
NDI NO. PA00468

PENNDER NO. 56-78

SCHEMATIC--NOT TO SCALE

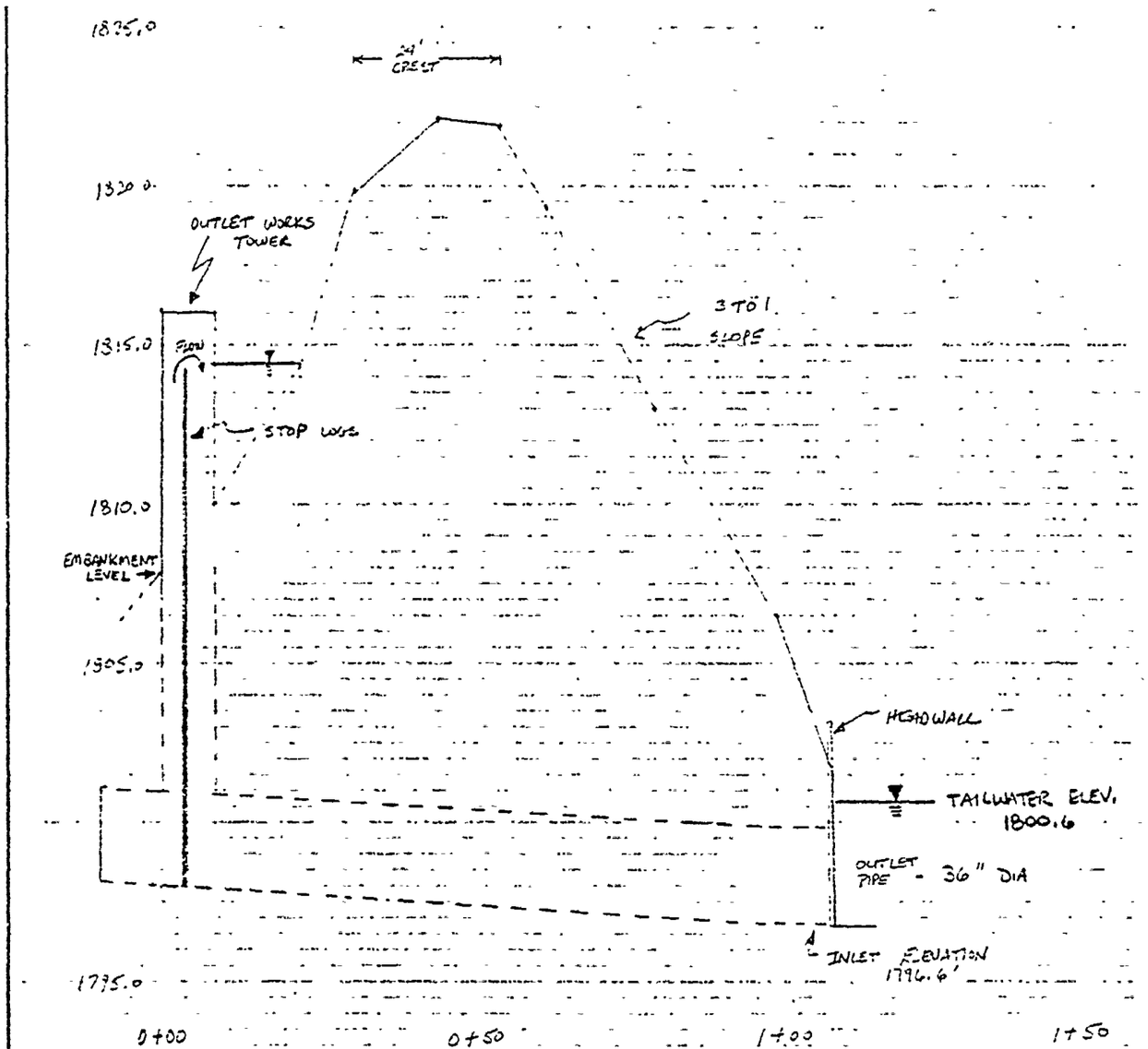
# STOUGHTON LAKE DAM

## TOP OF DAM PROFILE



# STOUGHTON LAKE DAM

## TYPICAL CROSS-SECTION



# APPENDIX B

## ENGINEERING DATA CHECK LIST

# CHECK LIST
## ENGINEERING DATA
## DESIGN, CONSTRUCTION, OPERATION

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| ITEM | REMARKS |
|---|---|
| PLAN OF DAM | See Plate 3. |
| REGIONAL VICINITY MAP | A USGS 7.5 minute topographic quadrangle, Boswell, Pennsylvania, was used to prepare the vicinity map which is enclosed in this report as the Location Plan (Plate 1). |
| CONSTRUCTION HISTORY | The dam was designed by Walker Mong of Somerset, Pennsylvania. The dam was constructed by Laubb, Collins, Troal Construction Company of Somerset, Pennsylvania in 1951. |
| TYPICAL SECTIONS OF DAM | See Plates 3 and 4; however, some changes were made during construction which are not shown on these design drawings. Notably, 1) the crest width of the embankment is 24 ft., not 12 ft.; 2) the upstream slope is locally (above the water level) steeper than 2H:1V; 3) the outlet pipe conduit is 36 in. and not 48 in. and was constructed at a very flat gradient; 4) the intake tower is not as high in elevation as shown on the design plans, rather it was stopped at El. 1816.1 ft.; 5) it is doubtful that an access bridge to the intake tower as shown on the plans was ever constructed; 6) the footing for the spillway walls was constructed smaller than shown on the design plans; 7) the amount of steel reinforcement in the spillway walls as compared to the design plans is questionable. |
| HYDROLOGIC/HYDRAULIC DATA | No information available. |

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)
NDI # PA 00468

| ITEM | REMARKS |
|---|---|
| OUTLETS - PLAN,<br>DETAILS,<br>CONSTRAINTS,<br>and<br>DISCHARGE RATINGS | See Plates 3 and 4. However as reported under "Typical Sections" these design plans do not represent the "as built" construction. Mr. Stoughton reported that occasionally a surge will occur. This is reportedly due to the release of a built up air pocket. No other information is available. |
| RAINFALL/RESERVOIR RECORDS | No rainfall or reservoir level records are kept. However, during periods of unusual rainfall, Mr. Stoughton checks the level of flow over the spillway. |
| DESIGN REPORTS | None available |
| GEOLOGY REPORTS | No geology reports are available for the dam. See Appendix F for the regional geology. |
| DESIGN COMPUTATIONS<br>HYDROLOGY & HYDRAULICS<br>DAM STABILITY<br>SEEPAGE STUDIES | No design computations are available. |
| MATERIALS INVESTIGATIONS<br>BORING RECORDS<br>LABORATORY<br>FIELD | Three soil borings are shown on the design plans (Plate 3). No other information is available. |

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)

NDI # PA 00468

| ITEM | REMARKS |
|---|---|
| POST-CONSTRUCTION SURVEYS OF DAM | None performed. |
| BORROW SOURCES | According to Mr. Stoughton, the borrow for the dam came from the right hillside of the dam. The clay core material was from the same area but consisted of a more "select" material. |
| MONITORING SYSTEMS | None |
| MODIFICATIONS | According to Mr. Stoughton, the riprapped spillway apron did not last a year and was replaced by grouted riprap. At the time of the inspection the right spillway training wall was being replaced by a masonry stone wall. |
| HIGH POOL RECORDS | According to Mr. Stoughton the highest pool was 9 in. over the spillway crest. This occurred this past fall (1979). |
| POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS | A post-construction inspection report dated 6 May 1963 (inspection 1 May 1963) is available in the PennDER file. |
| PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS | None |
| MAINTENANCE OPERATION RECORDS | No formal records are kept. The reservoir has been drawn down approximately 5 ft. on two different occasions to try and control the weeds in the reservoir. The stop logs in the intake structure have been replaced when necessary. |

Name of Dam: STOUGHTON LAKE DAM (Beaver Dam)

NDI # PA 00468

| ITEM | REMARKS |
|---|---|
| SPILLWAY PLAN, SECTIONS, and DETAILS, | See Plate 3. |
| OPERATING EQUIPMENT PLANS & DETAILS | There is no operating equipment. |

# CHECK LIST
## HYDROLOGIC AND HYDRAULIC DATA
## ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 9.57 sq.mi. (primarily farmland with some strip mining activity)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1814.3 ft. (200.5 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1821.3 ft. (643.5 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1821.3 ft.

CREST: Spillway

a. Elevation 1814.3 ft.
b. Type Concrete ogee weir
c. Width of Crest Parallel to Flow Approximately 40 ft.
d. Length of Crest Perpendicular to Flow 90 ft.
e. Location Spillover
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 36 in. diameter C.M.P.
b. Location Center of embankment
c. Entrance inverts El. 1798.0 ft. (elevation with all stop logs removed)
d. Exit inverts El. 1796.6 ft.
e. Emergency draindown facilities None

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE No records available

# APPENDIX C

## PHOTOGRAPH LOCATION PLAN AND PHOTOGRAPHS

# DETAILED PHOTOGRAPH DESCRIPTION

Overall View of Dam

Top Photo - Overall View of Dam from Right Abutment (OV-T)

Bottom Photo - Overall View of Dam from Left Abutment (OV-B)

Photo 1 - View of Spillway Entrance (Note excavation behind the right training walls)

Photo 2 - View Across Spillway

Photo 3 - View of Repairs to Right Downstream Spillway Training Wall

Photo 4 - View Looking Upstream at Left Side of Spillway Structure

Photo 5 - View of Exposed Footing for the Left Spillway Training Wall (Downstream End)

Photo 6 - Closeup View of Left Spillway Training Wall Junction with Cut-off Wall

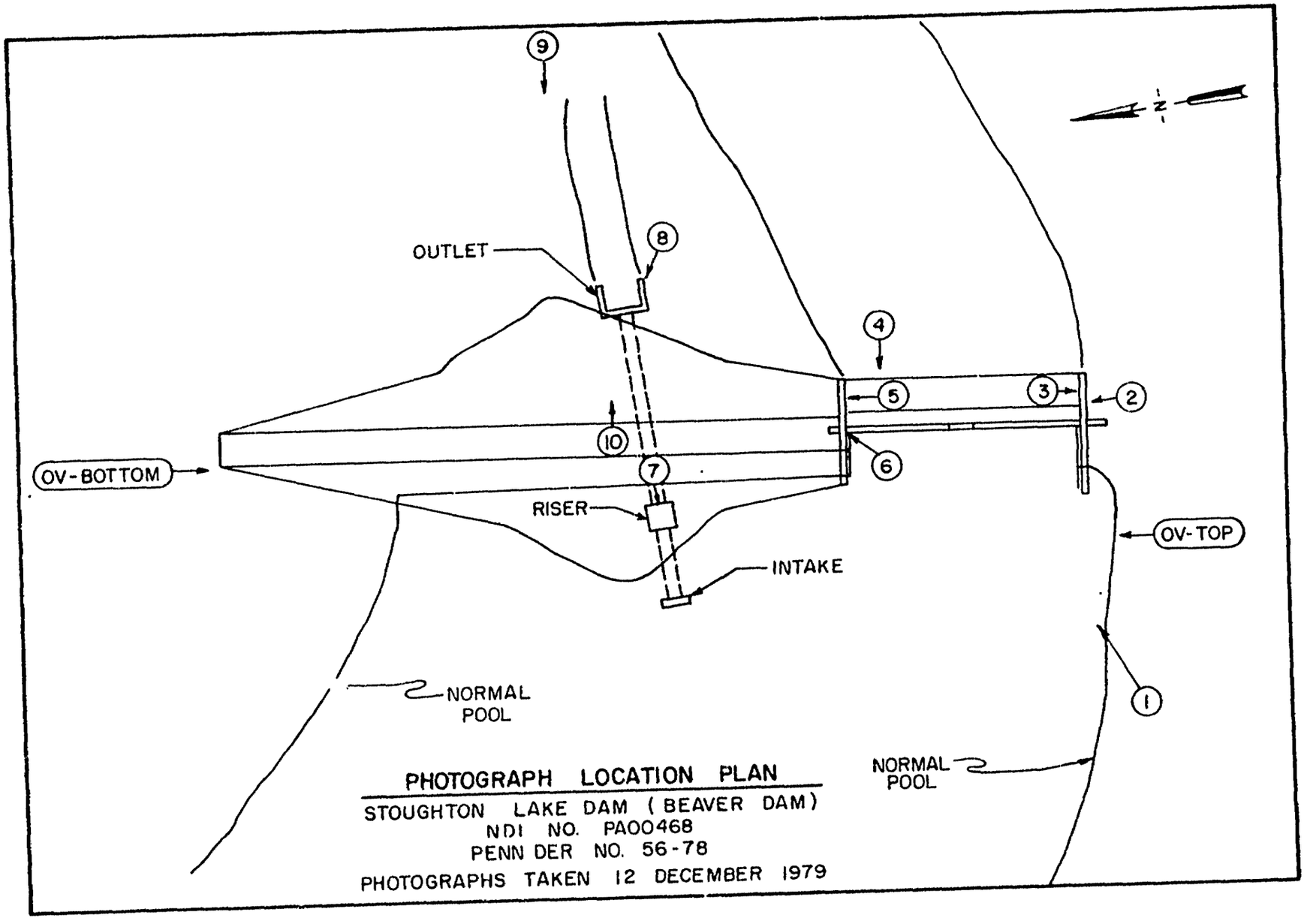
Photo 7 - View of Intake Structure

Photo 8 - View of Outlet Structure (Note erosion around structure)

Photo 9 - View from Downstream Looking Upstream at Outlet Structure and Embankment

Photo 10 - View Looking Downstream of Embankment along Outlet Channel

Note: Photographs were taken on 12 December 1979.




PHOTOGRAPH LOCATION PLAN

STOUGHTON LAKE DAM (BEAVER DAM)
NDI NO. PA00468
PENN DER NO. 56-78
PHOTOGRAPHS TAKEN 12 DECEMBER 1979

# STOUGHTON LAKE DAM

**PHOTO 1. View of Spillway Entrance**
**(Note excavation behind the right training wall)**

**PHOTO 2. View Across Spillway**

**PHOTO 3. View of Repairs to Right Spillway Training Wall**

**PHOTO 4. View Looking Upstream at Left Side of Spillway Structure**

**PHOTO 5. View of Exposed Footing for the Left Spillway Training Wall (Downstream end)**

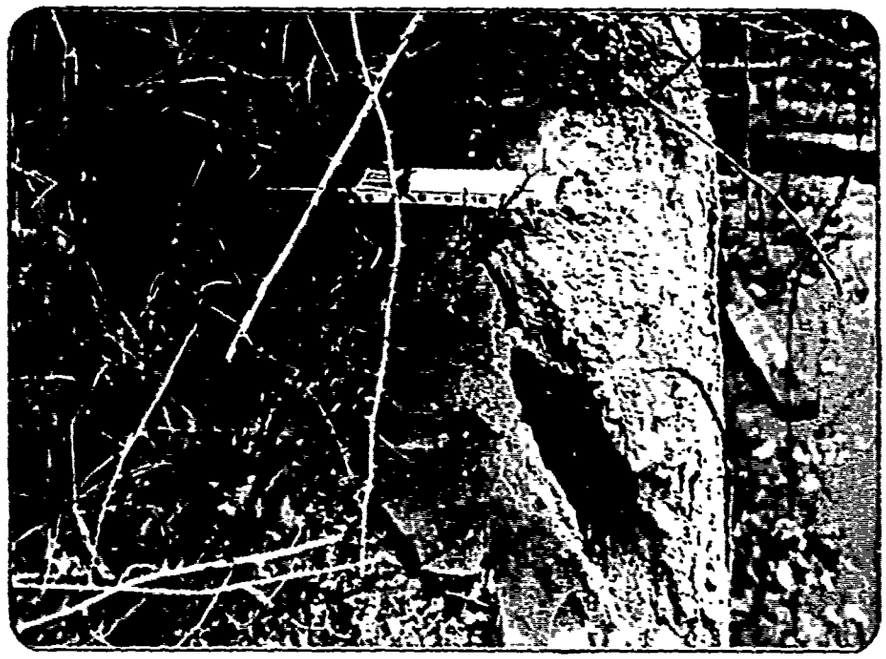


**PHOTO 6. Closeup View of Left Spillway Training Wall Junction with Cut-off Wall**

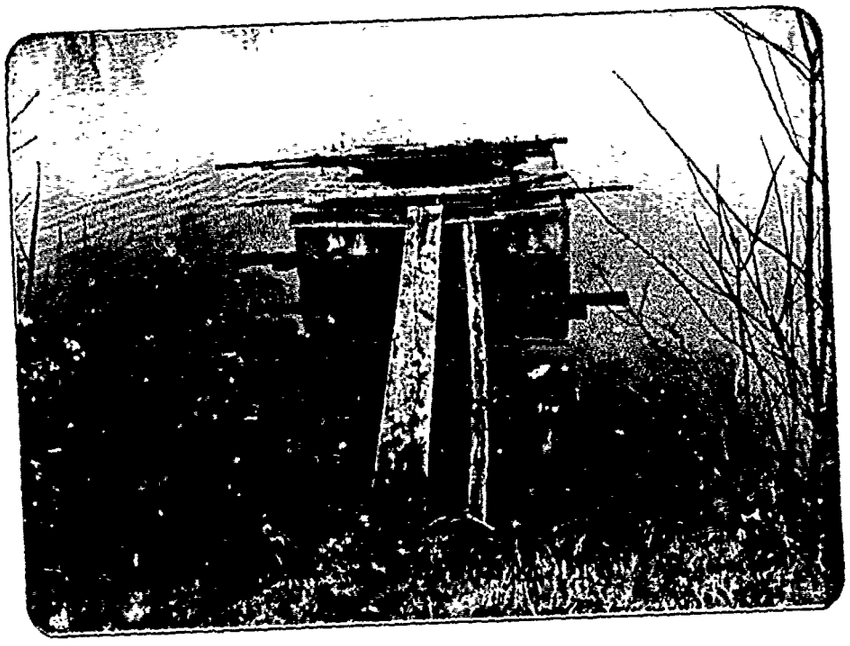


PHOTO 7. View of Intake Structure

PHOTO 8. View of Outlet Structure (Note erosion around structure)

PHOTO 9. View from Downstream Looking Upstream at Outlet Structure and Embankment

PHOTO 10. View Looking Downstream of Embankment along Outlet Channel

# APPENDIX D

# HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject STOUGHTON LAKE DAM S.O. No.
APPENDIX D - HYDROLOGIC Sheet No. of
AND HYDRAULIC ANALYSES Drawing No.
Computed by Checked by Date

# TABLE OF CONTENTS

# PREFACE

## HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variations of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: STOUGHTON LAKE DAM

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.9 INCHES/24 HOURS[1]

| STATION | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Station Description | STOUGHTON LAKE DAM | | | | |
| Drainage Area (square miles) | 9.57 | | | | |
| Cumulative Drainage Area (square miles) | 9.57 | | | | |
| Adjustment of PMF for Drainage Area (%)[2] | ZONE 7 | | | | |
| 6 Hours | 102 | | | | |
| 12 Hours | 120 | | | | |
| 24 Hours | 130 | | | | |
| 48 Hours | 140 | | | | |
| 72 Hours | - | | | | |
| Snyder Hydrograph Parameters | | | | | |
| Zone [3] | 24 | | | | |
| $C_p/C_t$ [4] | 0.45/1.6 | | | | |
| L (miles) [5] | 6.27 | | | | |
| $L_{ca}$ (miles)[5] | 3.17 | | | | |
| $t_p = C_t (L \cdot L_{ca})^{0.3}$ (hours) | 3.9 | | | | |
| Spillway Data | | | | | |
| Crest Length (ft) | 90.0 | | | | |
| Freeboard (ft) | 7.0 | | | | |
| Discharge Coefficient | 3.80 | | | | |
| Exponent | 1.5 | | | | |

[1] Hydrometeorological Report 33 (Figure 1), U.S. Army, Corps of Engineers, 1956.

[2] Hydrometeorological Report 33 (Figure 2), U.S. Army, Corps of Engineers, 1956.

[3] Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's Coefficients ($C_p$ and $C_t$).

[4] Snyder's Coefficients.

[5] L = Length of longest water course from outlet to basin divide.
$L_{ca}$ = Length of water course from outlet to point opposite the centroid of drainage area.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject BEAVER DAM (STOUGHTON LAKE DAM) S.O. No.

Sheet No. 2 of 16

Drawing No.

Computed by WLS Checked by WDL Date

HYDROLOGIC AND HYDRAULIC DATA:

DRAINAGE AREA ABOVE DAM = 9.57 MI.$^2$ (MEASURED ON BOSWELL AND LIGONIER, PA. QUADS)

$L_{ca}$ = 16,720 FT = 3.17 MI.

L = 33,100 FT = 6.27 MI.

STORAGE COMPUTATIONS:

ELEVATION VS. SURFACE AREA DATA (MEASURED ON QUADS)

| ELEVATION (FT) | AREA (ACRES) |
|---|---|
| 1819.3 | 44.077 |
| 1820.0 | 75.298 |
| 1840.0 | 426.079 |

NOTE: NORMAL POOL ASSUMED TO BE AT ELEV. 1819.3

STORAGE AT NORMAL POOL:

THE ORIGINAL (DESIGN) STORAGE AT NORMAL POOL WAS CALCULATED TO BE 233.5 AC-FT (FROM ORIGINAL PLANS). USING A NORMAL POOL SURFACE AREA OF 44.077 ACRES, THE INITIAL AVERAGE DEPTH OF THE IMPOUNDMENT WAS 5.3 FT. FROM DISCUSSIONS WITH THE OWNER AND MEASUREMENTS MADE DURING THE TIME OF THE INSPECTION, IT IS ESTIMATED THAT AN AVERAGE DEPTH OF 0.75 FT OF SEDIMENT HAS ACCUMULATED IN THE RESERVOIR. THIS REPRESENTS A 15% REDUCTION IN STORAGE OR A PRESENT STORAGE OF 200.5 AC-FT.

TOP OF DAM STORAGE:

TOD STORAGE = NORMAL POOL STORAGE + ADDITIONAL STORAGE BETWEEN ELEV. 1819.3 AND 1821.3

= 200.5 + 443.0 (443.0 AC-FT CALCULATED FROM ELEV. VS. AREA DATA)

TOD STORAGE = 643.5 AC-FT

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: BEAVER DAM — S.O. No.:
HYDROGRAPH AND RAINFALL DATA — Sheet No. 3 of 16
Drawing No.:
Computed by: JDL — Checked by: MED — Date: 12/21/09

HYDROGRAPH DATA: (FROM BALTIMORE DISTRICT, U.S. ARMY CORPS OF ENGINEERS)

DAM AND DRAINAGE AREA LOCATED IN ZONE 24

$C_p = 0.45$

$C_T =$ PLATE M

$t_p = 1.6 (L L_{ca})^{0.3}$ $\quad L = 6.27$ MI $\quad L_{ca} = 3.17$ MI

$t_p = 1.6[(6.27)(3.17)]^{0.3} = 3.9$ HRS

RAINFALL DATA: (FROM HMR-33)

DAM AND DRAINAGE AREA ARE LOCATED IN ZONE 7

PMP $(24\ HR)_{200\ MI^2} = 23.9$ IN.

DRAINAGE AREA $= 9.57\ MI^2$

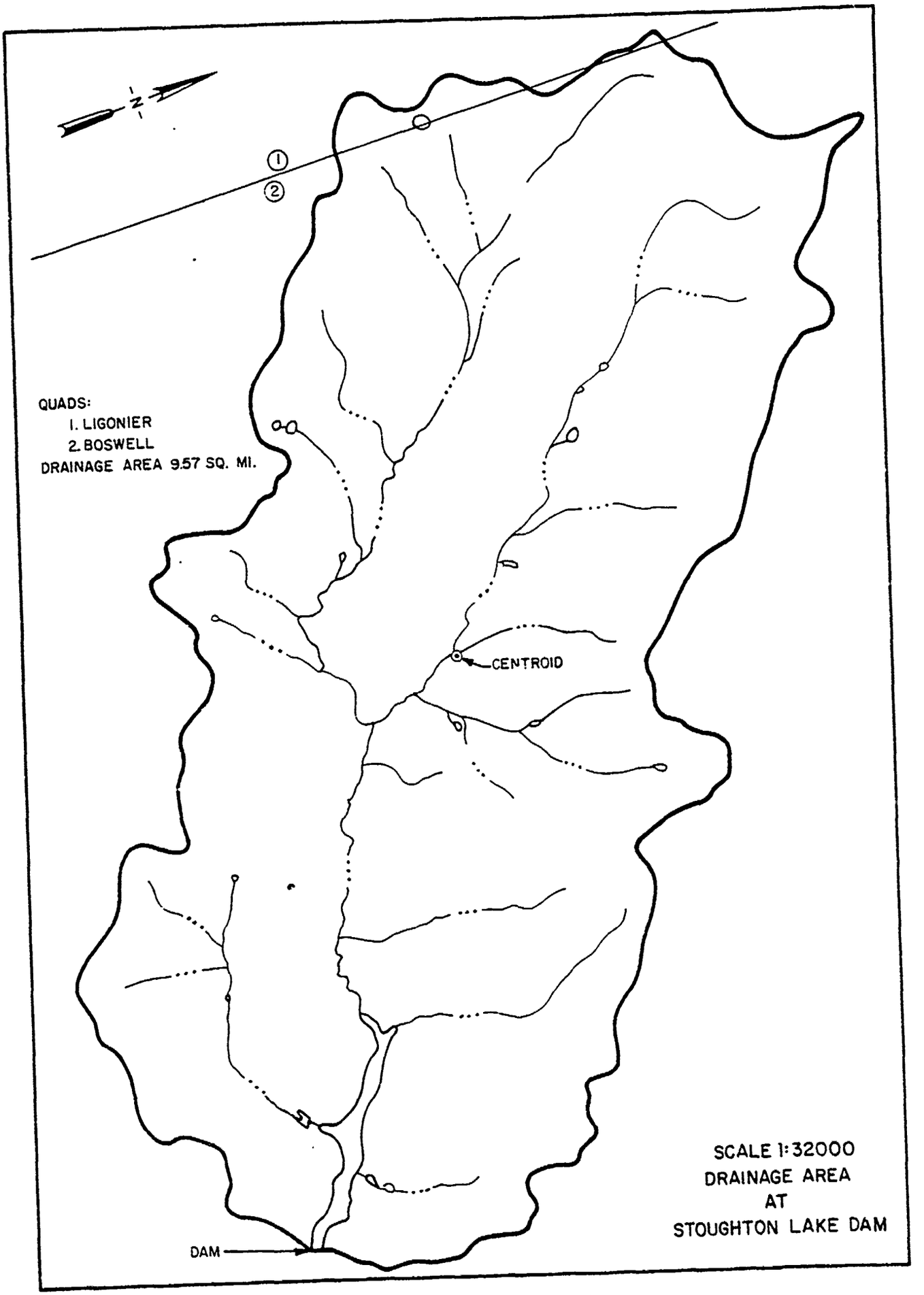
PMP (6 HR) = 102 % PMP $(24\ HR)_{200\ MI^2}$

PMP (12 HR) = 120 % PMP $(24\ HR)_{200\ MI^2}$

PMP (24 HR) = 130 % PMP $(24\ HR)_{200\ MI^2}$

PMP (48 HR) = 140 % PMP $(24\ HR)_{200\ MI^2}$

100 YR - 24 HR RAINFALL (FROM TP-40) = 5.7 IN


N
1
2
QUADS:
1. LIGONIER
2. BOSWELL
DRAINAGE AREA 9.57 SQ. MI.
CENTROID
DAM
SCALE 1:32000
DRAINAGE AREA
AT
STOUGHTON LAKE DAM

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 260
Beaver, Pa. 15009

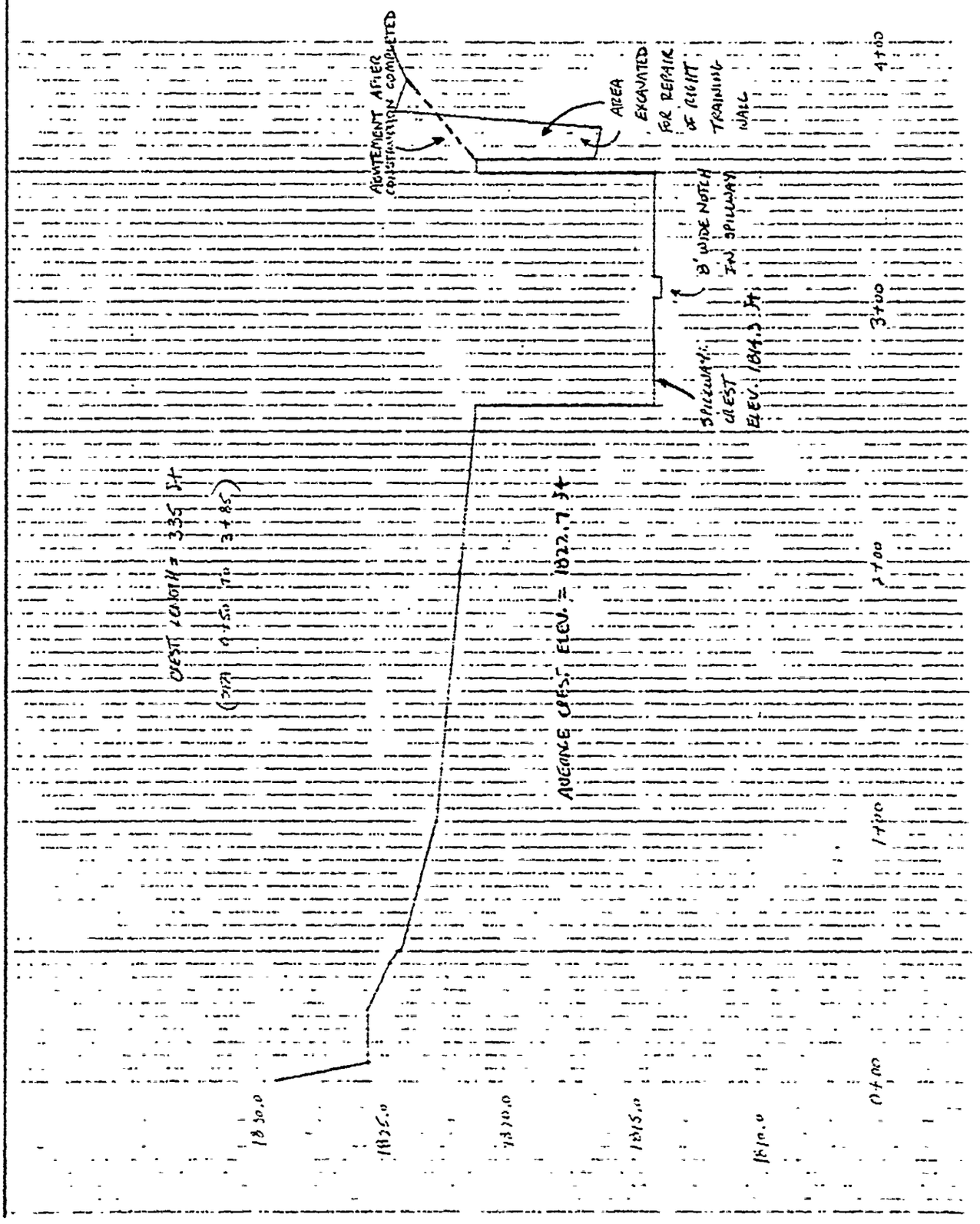
Subject STOUGHTON LAKE DAM (LOWER DAM)

S.O. No. _____

Sheet No. 5 of 16

Drawing No. _____

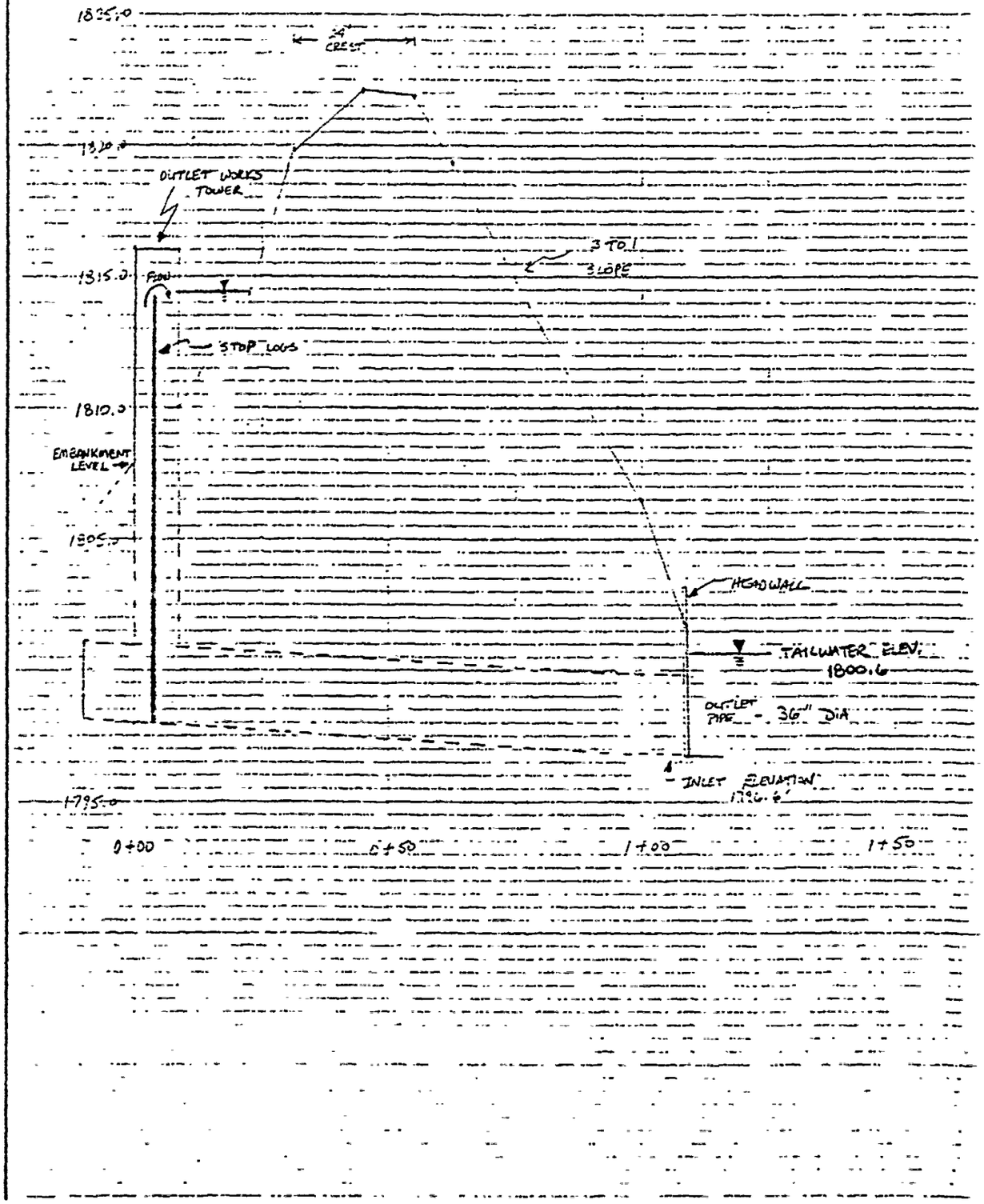
Computed by WLL Checked by RWD Date 1/27/80



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

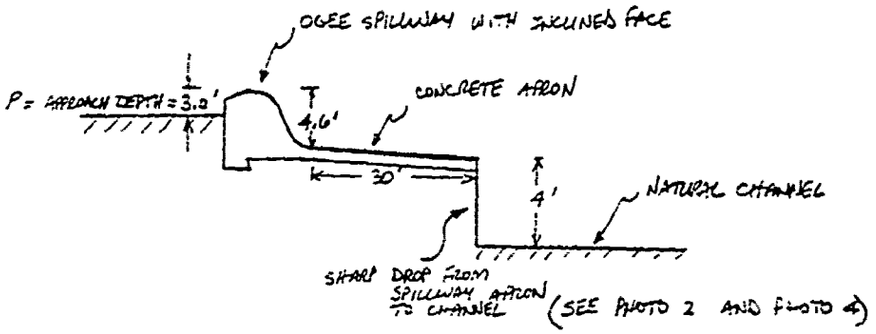
Subject STOUDEN LAKE DAM S.O. No.
(EMBER DAM) Sheet No. 6 of 16
CROSS - SECTION OF DAM Drawing No.
Computed by ACL Checked by MED Date



MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject STOUFFTON LAKE DAM S.O. No.
SPILLWAY DISCHARGE COEFFICIENT Sheet No. 7 of 16
DETERMINATION Drawing No.
Computed by WNL Checked by MED Date



(SEE PHOTO 2 AND PHOTO 4)

THE GENERALIZED DESIGN CURVES FOR SHAPING OGEE WEIRS IN DESIGN OF SMALL DAMS WERE USED TO DETERMINE THAT THE DESIGN HEAD FOR THIS WEIR IS APPROXIMATELY 3.0 ft ($H_0 = 3.0$ ft).

$\frac{P}{H_0}$ IS THEN $\frac{3.0}{3.0} = 1.0$ (FIGURES 249-253 IN DESIGN OF SMALL DAMS ARE USED FOR THE FOLLOWING CALCULATIONS)

FOR $\frac{P}{H_0} = 1$, $C_0$ FOR A VERTICAL-FACED WEIR IS 3.88

AND THE CORRECTION FACTOR FOR THE INCLINED FACE IS 0.998

$C_{INCLINED} = 0.998\, C_0 = 0.998\,(3.88) = 3.87$

THE WEIR SHOULD NOT BE SUBMERGED DURING HIGH FLOWS DUE TO THE SLOPE OF THE SPILLWAY APRON AND LARGE DROP TO THE OUTLET CHANNEL WHICH SHOULD PREVENT BACKWATER ON THE WEIR.

CORRECTING FOR APRON EFFECTS, $\frac{h_1 + d}{H_e} = \frac{11.58}{7} = 1.65$

AT MAXIMUM 7' HEAD

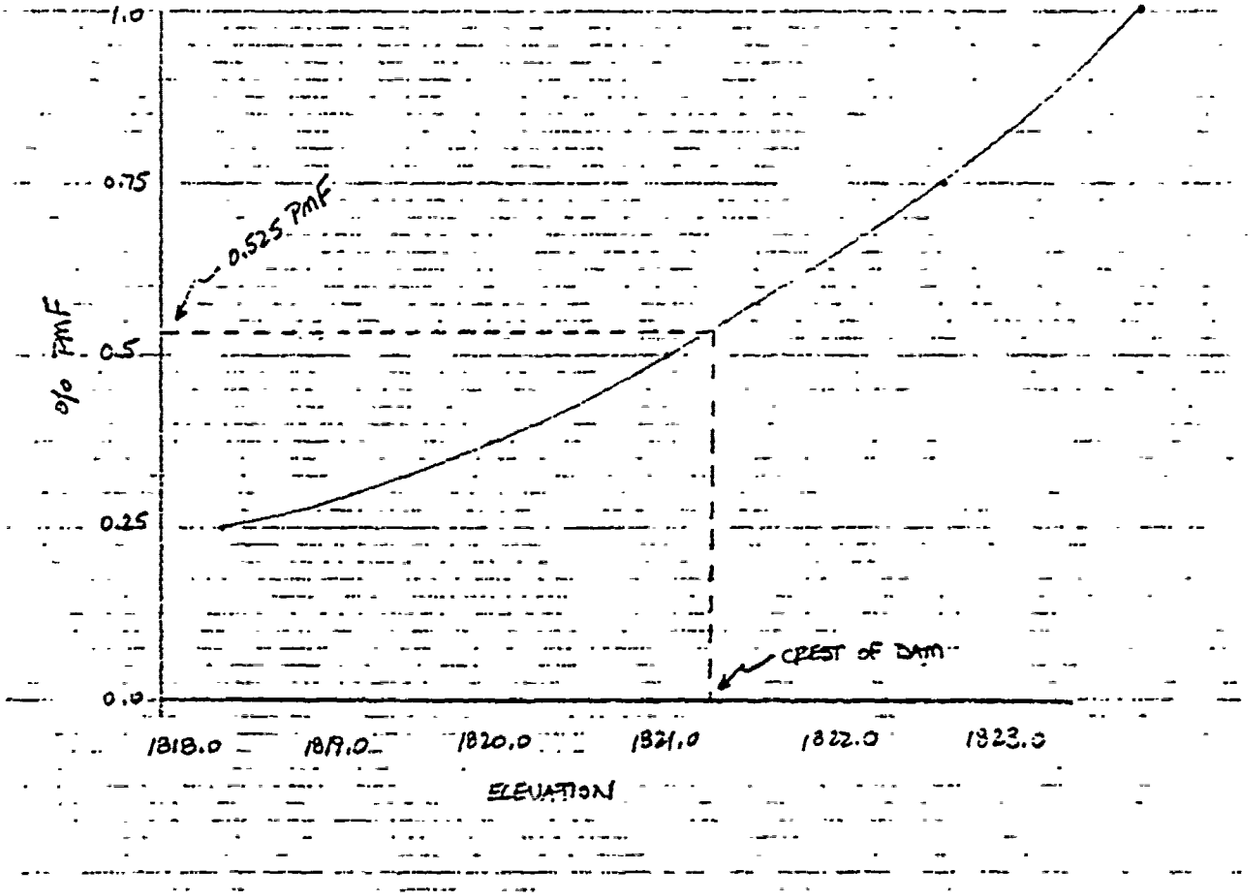
THE MODIFIED COEFFICIENT OF DISCHARGE IS THEN $0.997\,(3.87)$

$C = \underline{3.86}$ (FINAL COEFFICENT CORRECTED FOR SIGNIFICANT INFLUENCES)

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject BEAVER DAM S.O. No.
Sheet No. 8 of 16
Drawing No.
Computed by UHL Checked by [illegible] Date 1/4/80




NOTE: STORAGE VALUES CALCULATED IN THE HEC-1 ANALYSIS FOR NORMAL POOL AND TOP OF DAM STORAGE ARE LOWER THAN THOSE CALCULATED ON SHEET 2 OF THIS APPENDIX.

SINCE NORMAL POOL STORAGE DOES NOT INFLUENCE THE ROUTING COMPUTATIONS FOR THIS DAM, A ROUGH ESTIMATE OF THIS STORAGE WAS USED. THE STORAGE BETWEEN NORMAL POOL AND TOP OF DAM IS THE ONLY IMPORTANT STORAGE VALUE FOR DAM OVERTOPPING ANALYSIS; THIS VALUE IS 443.0 AC.-FT IN THE HEC-1 ANALYSIS AND THE ANALYSIS ON SHEET 2.

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
  ABJ UPDATE         05 JUN 79
**********************************
    1                 A1       NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
    2                 A2       HYDROLOGIC AND HYDRAULIC ANALYSES OF BEAVER DAM
    3                 A3       UNIT GRAPH BY SNYDERS METHOD
    4                 B    300        0       30        0        0        0        0        0        0        0
    5                 B1     5
    6                 J      1        4
    7                 J1   1.0     0.75     0.50     0.25
    8                 K      0        1                          1        1        1
    9                 K1       RUNOFF HYDROGRAPH TO DAM
   10                 M      1        1     9.97
   11                 P              25.9      102      120      130      140
   12                 T                                                    1.0     0.05
   13                 W    3.87     0.45
   14                 X    -1.5    -3.05      .0
   15                 K      1        2                                    1
   16                 K1       ROUTING FOR BEAVER DAM
   17                 Y                                  1        1
   18                 Y1     1                                        -1814.3
   19                 $A     0     44.1     75.3    426.1
   20                 $E1812.0   1814.3     1820     1840
   21                 $S1814.1       90     5.00      1.5
   22                 $D1821.3     5.00      1.5      265
   23                 $L     0      139      172      234      275      295      314      329
   24                 $V1821.2   1921.3   1822.0   1822.5   1824.0   1825.5   1824.0   1924.5
   25                 K     99
```

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
  MBJ UPDATE         04 JUN 79
**********************************

RUN  DATE 01/10/80
     TIME    18.46
```

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSES OF BEAVER DAM
UNIT GRAPH BY SNYDERS METHOD

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 300 | 0 | 30 | 0 | 0 | 0 | 0 | 0 | -4 | 0 |

| JOPER | NWT | LROPT | TRACE |
|---|---|---|---|
| 5 | 0 | 0 | 0 |

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 0

RTIOS= 1.00 0.75 0.50 0.25

**********  **********  **********  **********  **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH TO DAM

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 9.57 | 0.0 | 9.57 | 0.0 | 0.0 | 0 | 0 | 0 |

PRECIP DATA

| SPFE | PMS | R6 | R12 | R24 | R48 | R72 | R96 |
|---|---|---|---|---|---|---|---|
| 0.0 | 23.90 | 102.00 | 120.00 | 130.00 | 140.00 | 0.0 | 0.0 |

TRSPC COMPUTED BY THE PROGRAM IS 0.800

LOSS DATA

| LROPT | STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0.0 | 1.00 | 0.0 | 0.0 | 1.00 | 1.00 | 0.05 | 0.0 | 0.0 |

UNIT HYDROGRAPH DATA
TP= 3.87  CP=0.45  NTA= 0

RECESSION DATA
STRTQ= -1.50  QRCSN= -0.05  RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 8.06 AND R=12.45 INTERVALS

UNIT HYDROGRAPH 71 END-OF-PERIOD ORDINATES, LAG= 3.88 HOURS, CP= 0.45 VOL= 1.00

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 29. | 110. | 225. | 360. | 498. | 614. | 692. | 725. | 701. | 648. |
| 598. | 552. | 509. | 470. | 433. | 400. | 369. | 341. | 314. | 290. |

Sheet 10 of 16

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.03 | 13.30 | 123 | 0.0 | 0.0 | 0.0 | 898. | 1.06 | 16.30 | 273 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 14.00 | 124 | 0.0 | 0.0 | 0.0 | 829. | 1.06 | 17.00 | 274 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 14.30 | 125 | 0.0 | 0.0 | 0.0 | 765. | 1.06 | 17.30 | 275 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 15.00 | 126 | 0.0 | 0.0 | 0.0 | 706. | 1.06 | 18.00 | 276 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 15.30 | 127 | 0.0 | 0.0 | 0.0 | 651. | 1.06 | 18.30 | 277 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 16.00 | 128 | 0.0 | 0.0 | 0.0 | 606. | 1.06 | 19.00 | 278 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 16.30 | 129 | 0.0 | 0.0 | 0.0 | 565. | 1.06 | 19.30 | 279 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 17.00 | 130 | 0.0 | 0.0 | 0.0 | 528. | 1.06 | 20.00 | 280 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 17.30 | 131 | 0.0 | 0.0 | 0.0 | 492. | 1.06 | 20.30 | 281 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 18.00 | 132 | 0.0 | 0.0 | 0.0 | 459. | 1.06 | 21.00 | 282 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 18.30 | 133 | 0.0 | 0.0 | 0.0 | 429. | 1.06 | 21.30 | 283 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 19.00 | 134 | 0.0 | 0.0 | 0.0 | 400. | 1.06 | 22.00 | 284 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 19.30 | 135 | 0.0 | 0.0 | 0.0 | 373. | 1.06 | 22.30 | 285 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 20.00 | 136 | 0.0 | 0.0 | 0.0 | 348. | 1.06 | 23.00 | 286 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 20.30 | 137 | 0.0 | 0.0 | 0.0 | 325. | 1.06 | 23.30 | 287 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 21.00 | 138 | 0.0 | 0.0 | 0.0 | 303. | 1.07 | 0.0 | 288 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 21.30 | 139 | 0.0 | 0.0 | 0.0 | 283. | 1.07 | 0.30 | 289 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 22.00 | 140 | 0.0 | 0.0 | 0.0 | 264. | 1.07 | 1.00 | 290 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 22.30 | 141 | 0.0 | 0.0 | 0.0 | 246. | 1.07 | 1.30 | 291 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 23.00 | 142 | 0.0 | 0.0 | 0.0 | 230. | 1.07 | 2.00 | 292 | 0.0 | 0.0 | 0.0 | 0. |
| 1.03 | 23.30 | 143 | 0.0 | 0.0 | 0.0 | 214. | 1.07 | 2.30 | 293 | 0.0 | 0.0 | 0.0 | 0. |
| 1.04 | 0.0 | 144 | 0.0 | 0.0 | 0.0 | 200. | 1.07 | 3.00 | 294 | 0.0 | 0.0 | 0.0 | 0. |
| 1.04 | 0.30 | 145 | 0.0 | 0.0 | 0.0 | 187. | 1.07 | 3.30 | 295 | 0.0 | 0.0 | 0.0 | 0. |
| 1.04 | 1.00 | 146 | 0.0 | 0.0 | 0.0 | 174. | 1.07 | 4.00 | 296 | 0.0 | 0.0 | 0.0 | 0. |
| 1.04 | 1.30 | 147 | 0.0 | 0.0 | 0.0 | 162. | 1.07 | 4.30 | 297 | 0.0 | 0.0 | 0.0 | 0. |
| 1.04 | 2.00 | 148 | 0.0 | 0.0 | 0.0 | 152. | 1.07 | 5.00 | 298 | 0.0 | 0.0 | 0.0 | 0. |
| 1.04 | 2.30 | 149 | 0.0 | 0.0 | 0.0 | 141. | 1.07 | 5.30 | 299 | 0.0 | 0.0 | 0.0 | 0. |
| 1.04 | 3.00 | 150 | 0.0 | 0.0 | 0.0 | 132. | 1.07 | 6.00 | 300 | 0.0 | 0.0 | 0.0 | 0. |

SUM 26.77 24.35 2.42 302040.
( 680.1) ( 619.1) ( 61.) ( 8552.8)

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 12732. | 10951. | 5586. | 2094. | 302028. |
| CMS | 361. | 310. | 158. | 59. | 8552. |
| INCHES | | 10.64 | 21.72 | 24.43 | 24.40 |
| MM | | 270.37 | 551.70 | 620.40 | 621.41 |
| AC-FT | | 5430. | 11080. | 12460. | 12480. |
| THOUS CU M | | 6698. | 13667. | 15370. | 15394. |

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 13. | 12. | 12. | 11. | 10. | 9. | 8. | 8. | 7. | |
| 7. | 6. | 6. | 5. | 5. | 5. | 4. | 4. | 4. | 4. |
| 3. | 3. | 3. | 3. | 3. | 2. | 2. | 2. | 2. | 2. |
| 2. | 15. | 52. | 109. | 183. | 267. | 348. | 415. | 460. | 473. |
| 462. | 441. | 414. | 384. | 354. | 327. | 302. | 278. | 258. | 241. |
| 233. | 230. | 234. | 243. | 257. | 272. | 288. | 303. | 317. | 329. |
| 347. | 382. | 442. | 532. | 651. | 796. | 957. | 1126. | 1288. | 1438. |
| 1577. | 1704. | 1843. | 2027. | 2289. | 2651. | 3132. | 3736. | 4457. | 5397. |
| 6593. | 7928. | 9307. | 10618. | 11697. | 12423. | 12732. | 12578. | 12101. | 11483. |
| 10780. | 10047. | 9339. | 8686. | 8082. | 7526. | 7010. | 6528. | 6075. | 5646. |
| 5238. | 4851. | 4483. | 4139. | 3819. | 3524. | 3252. | 3001. | 2769. | 2555. |
| 2358. | 2176. | 2008. | 1853. | 1710. | 1578. | 1456. | 1344. | 1240. | 1144. |
| 1055. | 974. | 898. | 829. | 765. | 706. | 651. | 606. | 565. | 528. |
| 492. | 459. | 429. | 400. | 373. | 348. | 325. | 303. | 283. | 264. |
| 246. | 230. | 214. | 200. | 187. | 174. | 162. | 152. | 141. | 132. |
| 123. | 115. | 107. | 100. | 93. | 87. | 81. | 76. | 71. | 66. |
| 62. | 57. | 54. | 50. | 47. | 44. | 41. | 38. | 35. | 33. |
| 31. | 29. | 27. | 25. | 23. | 22. | 20. | 19. | 18. | 16. |
| 15. | 14. | 13. | 12. | 12. | 11. | 10. | 9. | 9. | 8. |
| 8. | 7. | 7. | 6. | 6. | 5. | 5. | 5. | 4. | 4. |
| 4. | 4. | 3. | 3. | 3. | 3. | 3. | 2. | 2. | 2. |
| 2. | 2. | 2. | 2. | 2. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |

Sheet 11 of 16

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

TOTAL RAIN 26.77, TOTAL RAINFALL EXCESS 24.39, TOTAL FLOW 302040.

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 12732. | 10951. | 5586. | 2094. | 302028. |
| CMS | 361. | 310. | 158. | 59. | 8552. |
| INCHES | | 10.64 | 21.72 | 24.43 | 24.46 |
| MM | | 270.37 | 551.70 | 620.40 | 621.41 |
| AC-FT | | 5430. | 11083. | 12460. | 12480. |
| THOUS CU M | | 6698. | 13667. | 15370. | 15394. |

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 13. | 12. | 12. | 11. | 10. | 9. | 9. | 8. | 8. | 7. |
| 7. | 6. | 6. | 5. | 5. | 5. | 4. | 4. | 4. | 4. |
| 3. | 3. | 3. | 3. | 3. | 2. | 2. | 2. | 2. | 2. |
| 2. | 4. | 12. | 27. | 49. | 78. | 109. | 138. | 161. | 174. |
| 177. | 173. | 164. | 153. | 141. | 130. | 120. | 111. | 103. | 96. |
| 99. | 97. | 102. | 110. | 121. | 133. | 144. | 155. | 164. | 173. |
| 187. | 213. | 258. | 325. | 414. | 522. | 643. | 769. | 891. | 1003. |
| 1107. | 1203. | 1306. | 1445. | 1641. | 1912. | 2273. | 2725. | 3266. | 3971. |
| 4868. | 5870. | 6803. | 7887. | 8696. | 9240. | 9472. | 9396. | 8999. | 8535. |
| 8098. | 7659. | 6928. | 6437. | 5985. | 5567. | 5181. | 4820. | 4481. | 4162. |
| 3859. | 3573. | 3302. | 3048. | 2813. | 2596. | 2395. | 2210. | 2039. | 1882. |
| 1737. | 1603. | 1479. | 1365. | 1259. | 1162. | 1072. | 990. | 913. | 843. |
| 777. | 717. | 662. | 611. | 563. | 520. | 480. | 447. | 417. | 389. |
| 363. | 339. | 316. | 295. | 275. | 257. | 240. | 223. | 209. | 195. |
| 182. | 169. | 158. | 147. | 138. | 128. | 120. | 112. | 104. | 97. |
| 91. | 85. | 79. | 74. | 69. | 64. | 60. | 56. | 52. | 49. |
| 45. | 42. | 40. | 37. | 34. | 32. | 30. | 28. | 26. | 24. |
| 23. | 21. | 20. | 18. | 17. | 16. | 15. | 14. | 13. | 12. |
| 11. | 11. | 10. | 9. | 9. | 8. | 7. | 7. | 7. | 6. |
| 6. | 5. | 5. | 5. | 4. | 4. | 4. | 3. | 3. | 3. |
| 3. | 3. | 2. | 2. | 2. | 2. | 2. | 2. | 2. | 2. |
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 1. | 1. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

TOTAL RAIN 29.39, TOTAL RAINFALL EXCESS 17.70, TOTAL FLOW 219661.

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 6472. | 6136. | 4127. | 1524. | 219653. |
| CMS | 264. | 230. | 117. | 43. | 6220. |
| INCHES | | 7.91 | 16.05 | 17.76 | 17.79 |
| MM | | 200.89 | 407.57 | 451.12 | 451.93 |
| AC-FT | | 4035. | 8186. | 9060. | 9077. |
| THOUS CU M | | 4977. | 10097. | 11176. | 11196. |

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 3

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 13. | 12. | 12. | 11. | 10. | 9. | 9. | 8. | 8. | 7. |
| 7. | 6. | 6. | 6. | 5. | 5. | 4. | 4. | 4. | 4. |
| 3. | 3. | 3. | 3. | 3. | 2. | 2. | 2. | 2. | 2. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 0. | 1. |
| 1. | 2. | 4. | 7. | 11. | 16. | 21. | 26. | 30. | 34. |
| 42. | 57. | 86. | 129. | 188. | 259. | 338. | 421. | 501. | 576. |
| 644. | 707. | 776. | 867. | 997. | 1178. | 1418. | 1717. | 2079. | 2549. |
| 3147. | 3814. | 4503. | 5158. | 5698. | 6060. | 6214. | 6137. | 5898. | 5584. |
| 5238. | 4871. | 4517. | 4190. | 3888. | 3610. | 3352. | 3113. | 2889. | 2679. |
| 2481. | 2295. | 2120. | 1958. | 1806. | 1667. | 1538. | 1417. | 1310. | 1209. |
| 1115. | 1029. | 950. | 877. | 809. | 746. | 689. | 636. | 587. | 541. |
| 499. | 461. | 425. | 392. | 362. | 334. | 309. | 285. | 269. | 251. |
| 234. | 218. | 204. | 190. | 177. | 165. | 154. | 144. | 134. | 125. |
| 117. | 109. | 102. | 95. | 89. | 83. | 77. | 72. | 67. | 63. |
| 58. | 55. | 51. | 48. | 44. | 41. | 39. | 36. | 34. | 31. |
| 29. | 27. | 25. | 24. | 22. | 21. | 19. | 18. | 17. | 16. |
| 15. | 14. | 13. | 12. | 11. | 10. | 10. | 9. | 8. | 8. |
| 7. | 7. | 6. | 6. | 6. | 5. | 5. | 5. | 5. | 4. |
| 4. | 3. | 3. | 3. | 3. | 3. | 2. | 2. | 2. | 2. |
| 2. | 2. | 2. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

TOTAL RAIN 13.38, TOTAL RAINFALL EXCESS 11.22, TOTAL FLOW 139303.

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 6214. | 5324. | 2669. | 966. | 139297. |
| CMS | 176. | 151. | 76. | 27. | 3944. |
| INCHES | | 5.17 | 10.38 | 11.27 | 11.28 |
| MM | | 131.44 | 263.61 | 286.13 | 286.60 |
| AC-FT | | 2640. | 5294. | 5747. | 5756. |
| THOUS CU M | | 3256. | 6530. | 7089. | 7100. |

HYDROGRAPH AT STA 1 FOR PLAN 1, RTIO 4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 13. | 12. | 12. | 11. | 10. | 9. | 9. | 8. | 8. | 7. |
| 7. | 6. | 6. | 5. | 5. | 5. | 4. | 4. | 4. | 4. |
| 3. | 3. | 3. | 3. | 3. | 2. | 2. | 2. | 2. | 2. |
| 2. | 2. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 1. | 4. | 11. | 24. | 43. | 68. |
| 98. | 131. | 170. | 221. | 290. | 385. | 508. | 663. | 846. | 1084. |
| 1386. | 1722. | 2069. | 2398. | 2670. | 2853. | 2933. | 2890. | 2779. | 2626. |
| 2452. | 2271. | 2096. | 1934. | 1785. | 1647. | 1520. | 1402. | 1294. | 1194. |
| 1102. | 1017. | 938. | 866. | 799. | 737. | 681. | 628. | 580. | 535. |
| 493. | 455. | 420. | 388. | 358. | 330. | 305. | 281. | 259. | 239. |
| 221. | 204. | 188. | 174. | 160. | 148. | 138. | 129. | 120. | 112. |
| 104. | 97. | 91. | 85. | 79. | 74. | 69. | 64. | 60. | 56. |
| 52. | 49. | 45. | 42. | 40. | 37. | 34. | 32. | 30. | 28. |
| 26. | 24. | 23. | 21. | 20. | 18. | 17. | 16. | 15. | 14. |
| 13. | 12. | 11. | 11. | 10. | 9. | 9. | 8. | 8. | 7. |
| 7. | 6. | 6. | 5. | 5. | 5. | 4. | 4. | 4. | 3. |
| 3. | 3. | 3. | 3. | 2. | 2. | 2. | 2. | 2. | 2. |
| 2. | 2. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. |
| 1. | 1. | 1. | 1. | 1. | 1. | 1. | 1. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |
| 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. | 0. |

TOTAL RAIN 6.69, TOTAL RAINFALL EXCESS 4.92, TOTAL FLOW 61229.

| | PEAK | 6-HOUR | 24-HOUR | 72-HOUR | TOTAL VOLUME |
|---|---|---|---|---|---|
| CFS | 2933. | 2489. | 1199. | 424. | 61229. |
| CMS | 83. | 70. | 34. | 12. | 1734. |
| INCHES | | 2.42 | 4.66 | 4.94 | 4.90 |
| MM | | 61.46 | 118.40 | 125.57 | 125.98 |
| AC-FT | | 1234. | 2378. | 2522. | 2530. |
| THOUS CU M | | 1523. | 2933. | 3111. | 3121. |

**********  **********  **********  **********  **********

HYDROGRAPH ROUTING

ROUTING FOR BEAVER DAM

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT | INAME | ISTAGE | IAUTO |
|---|---|---|---|---|---|---|---|---|
| 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME | IOPT | IPMP | | LSTR |
|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | 0.0 | 1 | 1 | 0 | 0 | | 0 |
| | NSTPS | NSTOL | LAG | AMSKK | X | TSK | STORA | ISPRAT |
| | 1 | 0 | 0 | 0.0 | 0.0 | 0.0 | -1814. | 0 |

| | | | | |
|---|---|---|---|---|
| SURFACE AREA= | 0. | 44. | 75. | 426. |
| CAPACITY= | 0. | 34. | 370. | 4907. |
| ELEVATION= | 1812. | 1814. | 1820. | 1840. |

| CREL | SPWID | COQW | EXPW | ELEVL | COQL | CAREA | EXPL |
|---|---|---|---|---|---|---|---|
| 1814.3 | 90.0 | 3.8 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 |

DAM DATA

| TOPEL | COQD | EXPD | DAMWID |
|---|---|---|---|
| 1821.3 | 3.1 | 1.5 | 245. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CREST LENGTH | 0. | 139. | 172. | 234. | 275. | 295. | 314. | 325. |
| AT OR BELOW ELEVATION | 1821.2 | 1821.3 | 1822.0 | 1822.5 | 1823.0 | 1823.5 | 1824.0 | 1824.5 |

PEAK OUTFLOW IS 12572. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 9290. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 5980. AT TIME 44.50 HOURS

PEAK OUTFLOW IS 2814. AT TIME 44.50 HOURS

**********  **********  **********  **********  **********

Sheet 14 of 16

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS.
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO PRECIPITATION | | | |
|---|---|---|---|---|---|---|---|
| | | | | RATIO 1 1.00 | RATIO 2 0.75 | RATIO 3 0.50 | RATIO 4 0.25 |
| HYDROGRAPH AT | 1 | 9.57 | 1 | 12732. | 9472. | 6214. | 2933. |
| | | ( 24.79) | | ( 360.52)( | 268.22)( | 175.97)( | 83.04)( |
| ROUTED TO | 2 | 9.57 | 1 | 12572. | 9290. | 5985. | 2814. |
| | | ( 24.79) | | ( 355.99)( | 263.06)( | 169.33)( | 79.67)( |

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1814.30 | 1814.30 | 1821.30 |
| STORAGE | 34. | 34. | 477. |
| OUTFLOW | 0. | 0. | 6339. |

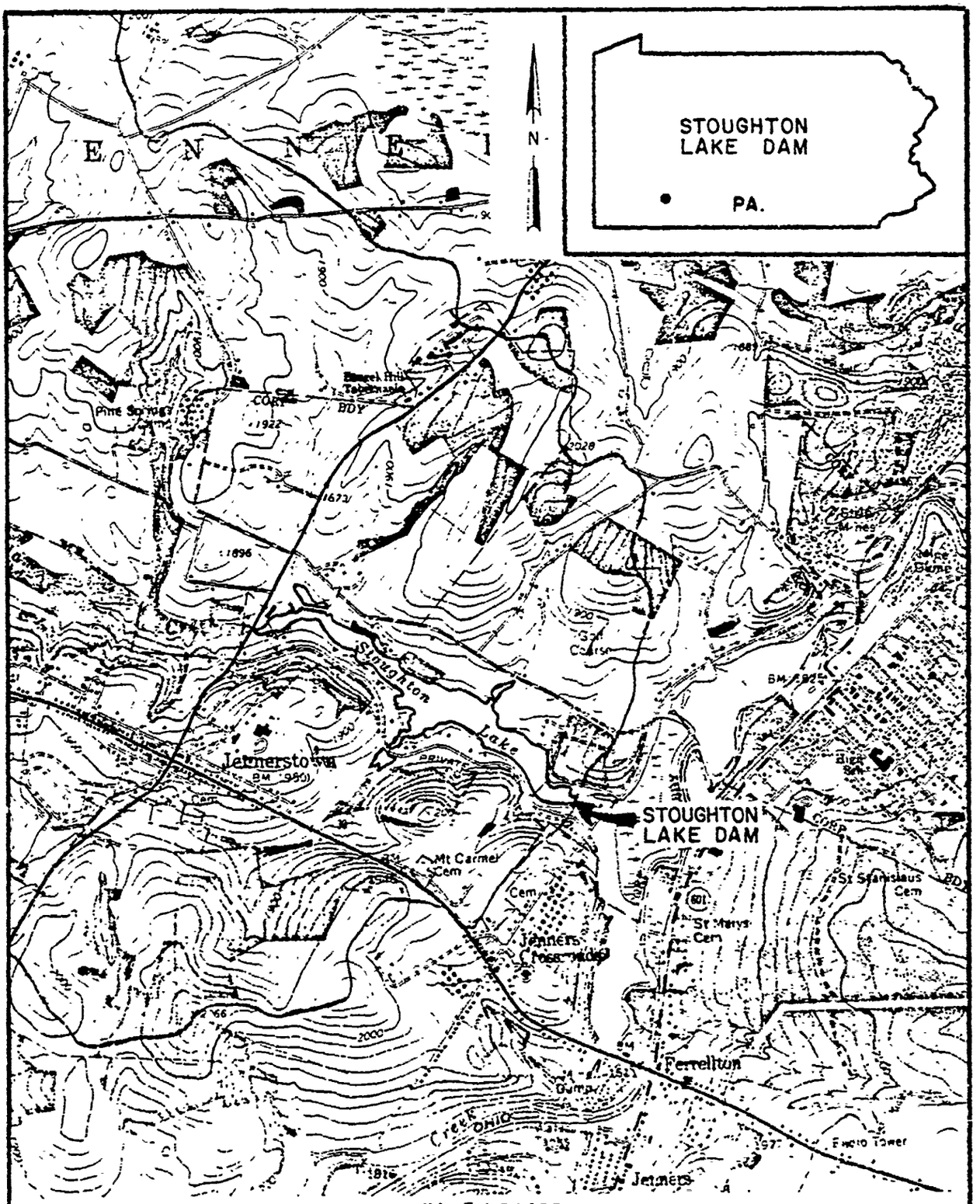
| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 1823.79 | 2.49 | 736. | 12572. | 8.50 | 44.00 | 0.0 |
| 0.75 | 1822.72 | 1.42 | 615. | 9290. | 6.00 | 44.00 | 0.0 |
| 0.50 | 1821.04 | 0.0 | 454. | 5983. | 0.0 | 44.50 | 0.0 |
| 0.25 | 1818.38 | 0.0 | 256. | 2814. | 0.0 | 44.50 | 0.0 |

Sheet 16 of 16

# APPENDIX E

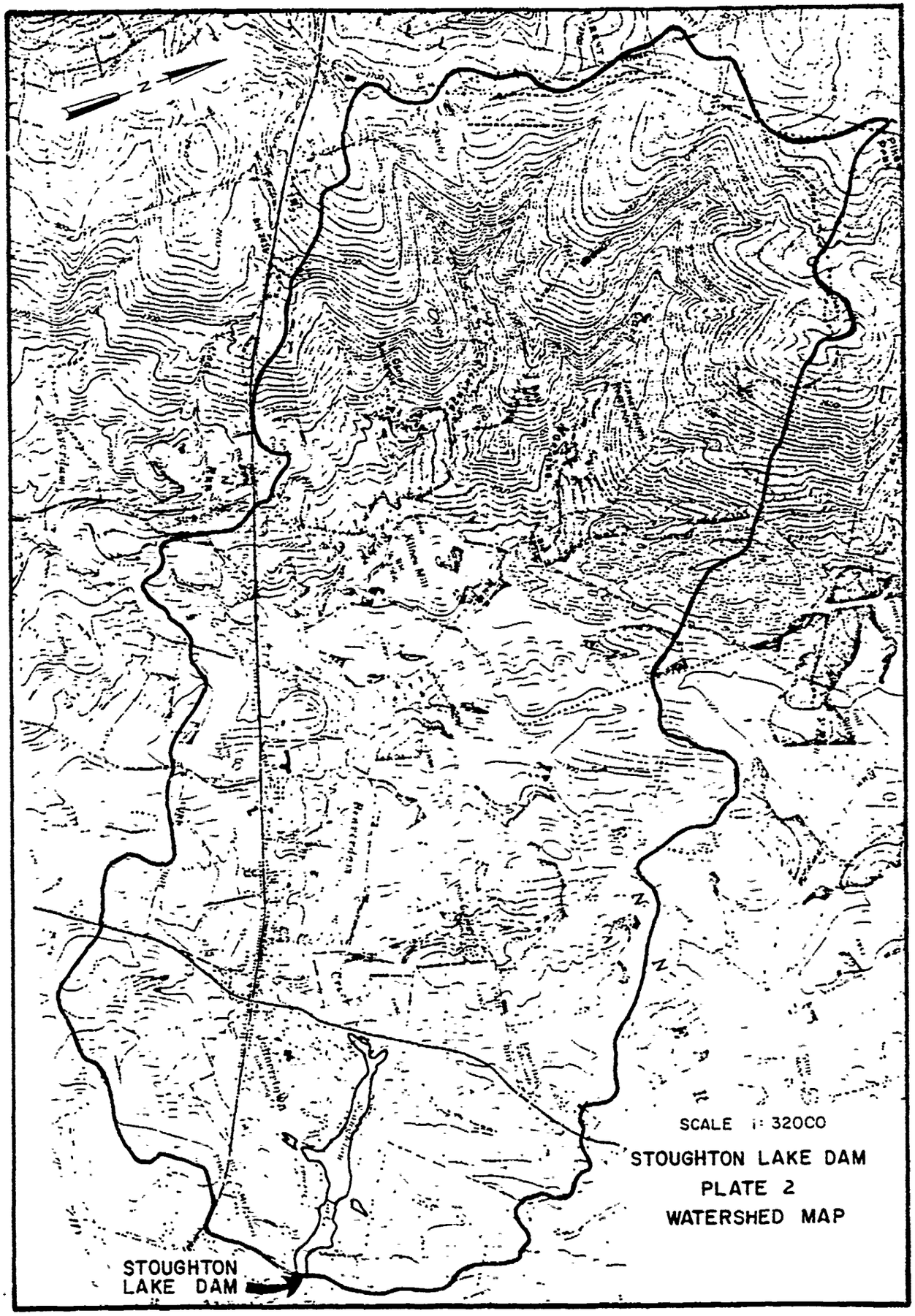
# PLATES

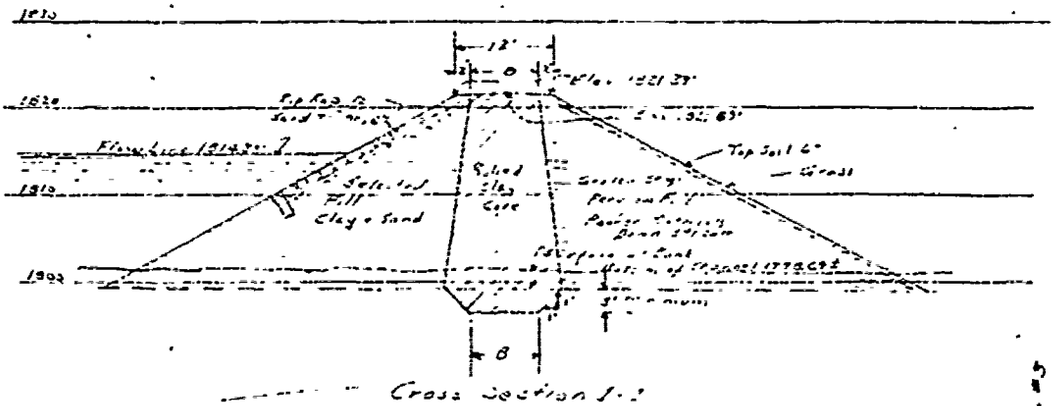
CONTENTS



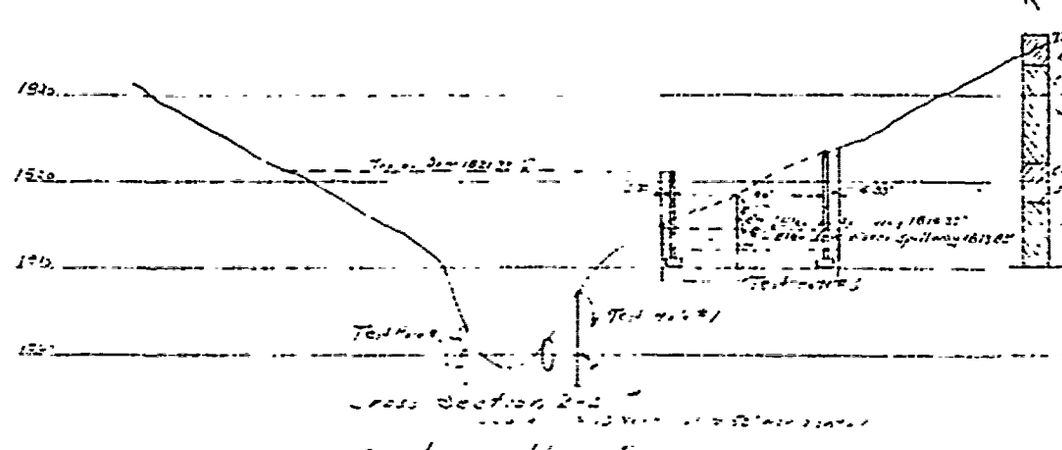

STOUGHTON LAKE DAM

PLATE I LOCATION MAP


N
SCALE 1: 32000
STOUGHTON LAKE DAM
PLATE 2
WATERSHED MAP
STOUGHTON
LAKE DAM



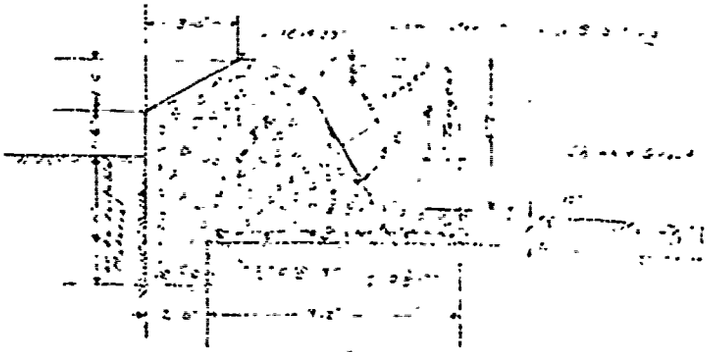

Cross Section 1-1
Scale 1" = 15' Vert. & Horizontal




Cross Section 2-2

Sections thru Dam

Test Hole Data.



Section thru Spillway
Scale as shown

PL-6

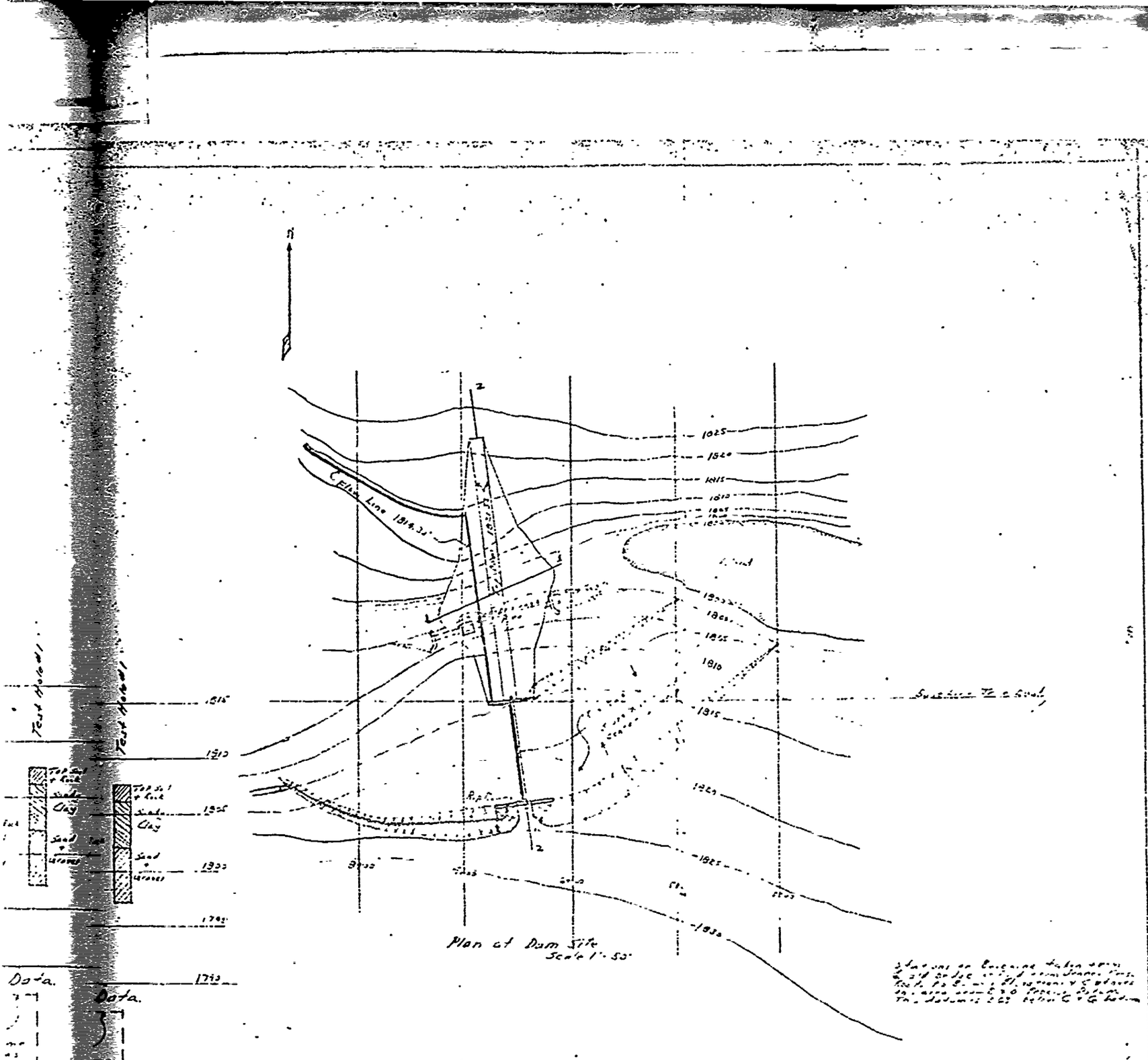
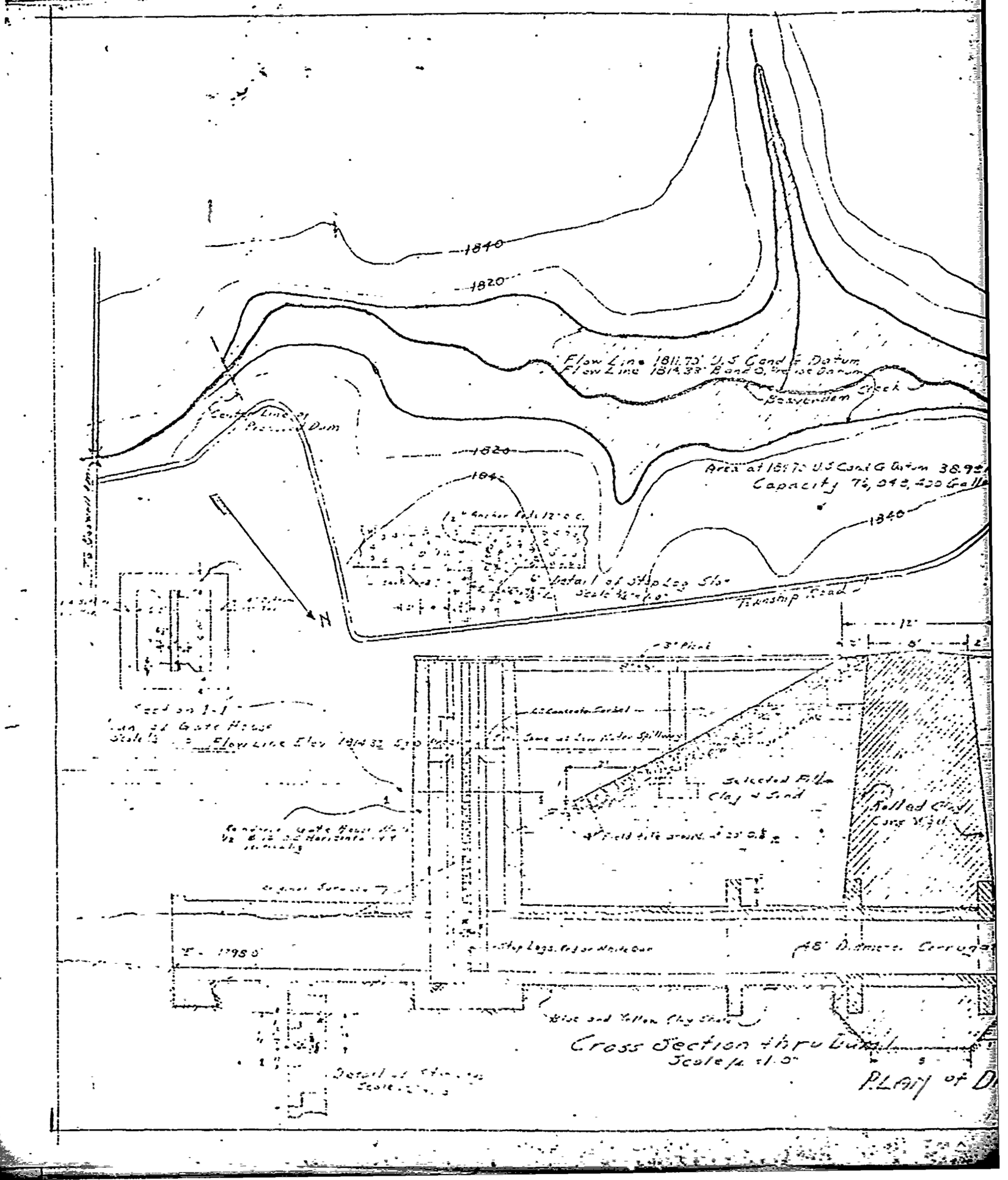
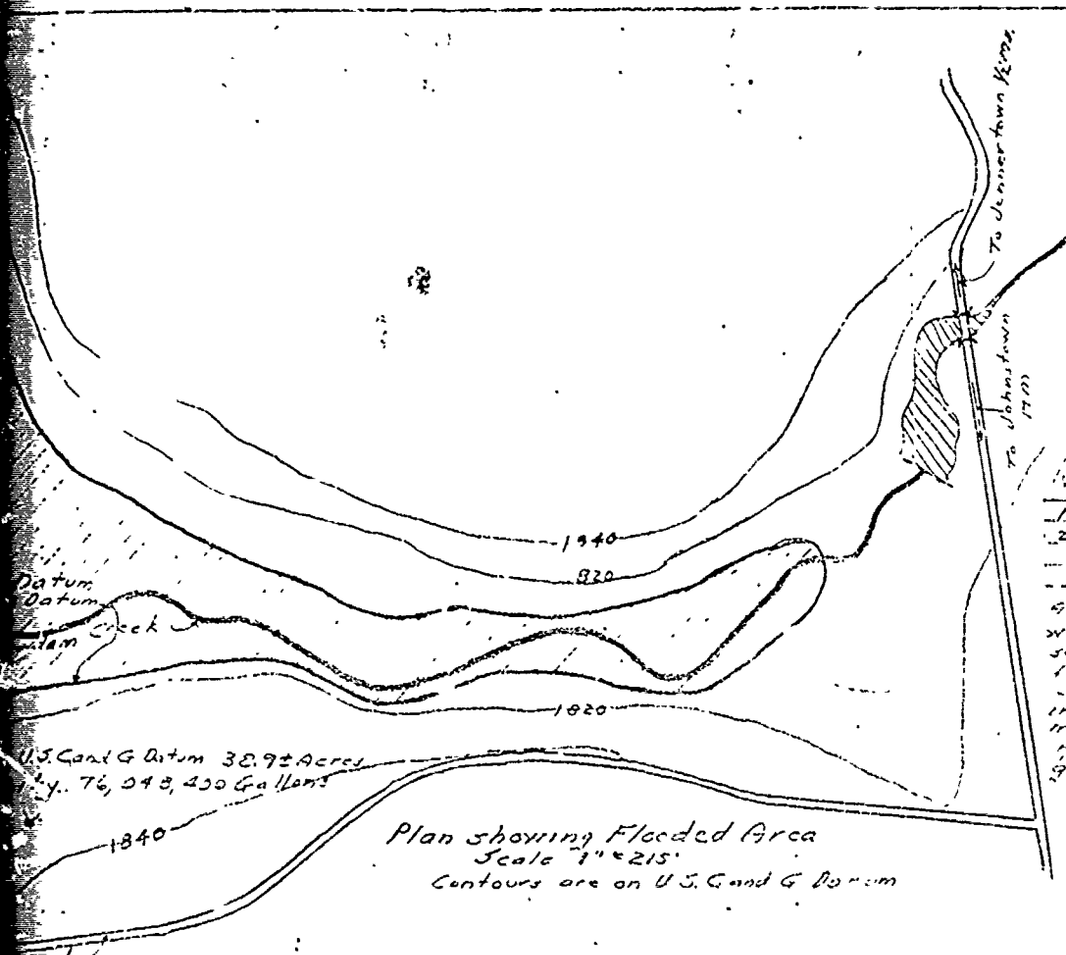


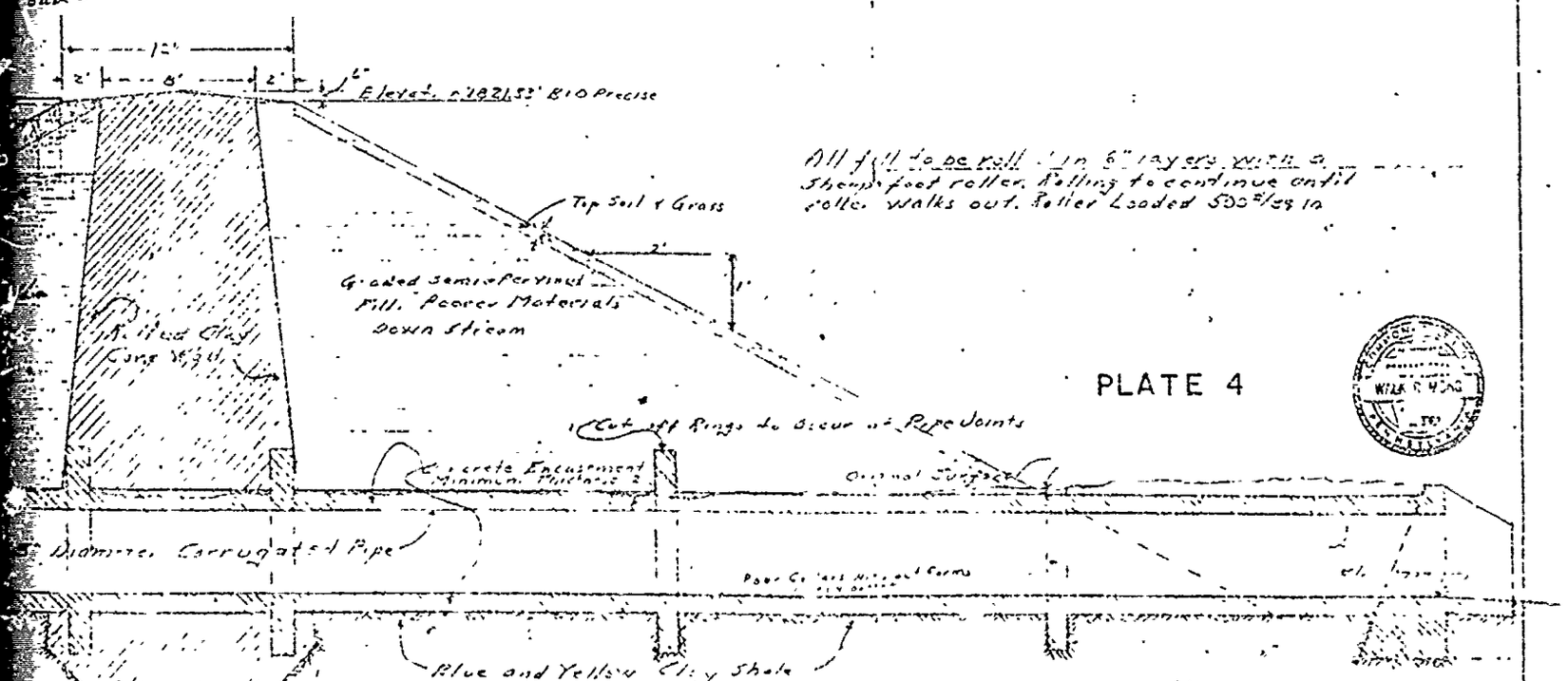

PLATE 3

Plan of Dam for M.R.A. Stoughton, Jr., Jenner Township Somerset Co Pa


1840
1820
Flow Line 1811.73' U.S. Coast & Datum
Flow Line 1814.33' Bond Datum
Beaverdam Creek
Center Line of Proposed Dam
Area at 1811.7' U.S. Coast & Datum 38.92
Capacity 76,042,400 Gallons
Detail of Stop Log Slot
Township Road
N
Plan of Gate House
Flow Line Elev 1814.33
Selected Fill Clay & Sand
Rolled Earth Core Wall
Stop Logs for Work Gate
48" Diameter Corrugated
Blue and Yellow Clay Shale
Cross Section thru Dam
Scale 1" = 10'
PLAN of D




Plan showing Flooded Area
Scale 1" = 215'
Contours are on U.S. Cand G Datum




All fill to be roll in 6" layers with a Sheep's foot roller. Rolling to continue until rolls walks out. Roller Loaded 500 #'s in

Note: If type of rock above indicated is not encountered throughout full length of drainage pipe, more pipe length until suitable material is obtained

PLATE 4

PLAN of DAM for J.R.R.A. STOUGHTON IN JENNER TOWNSHIP SOMERSET CO. PA.

Walker Maye P.E., Somerset, Pa

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# APPENDIX F

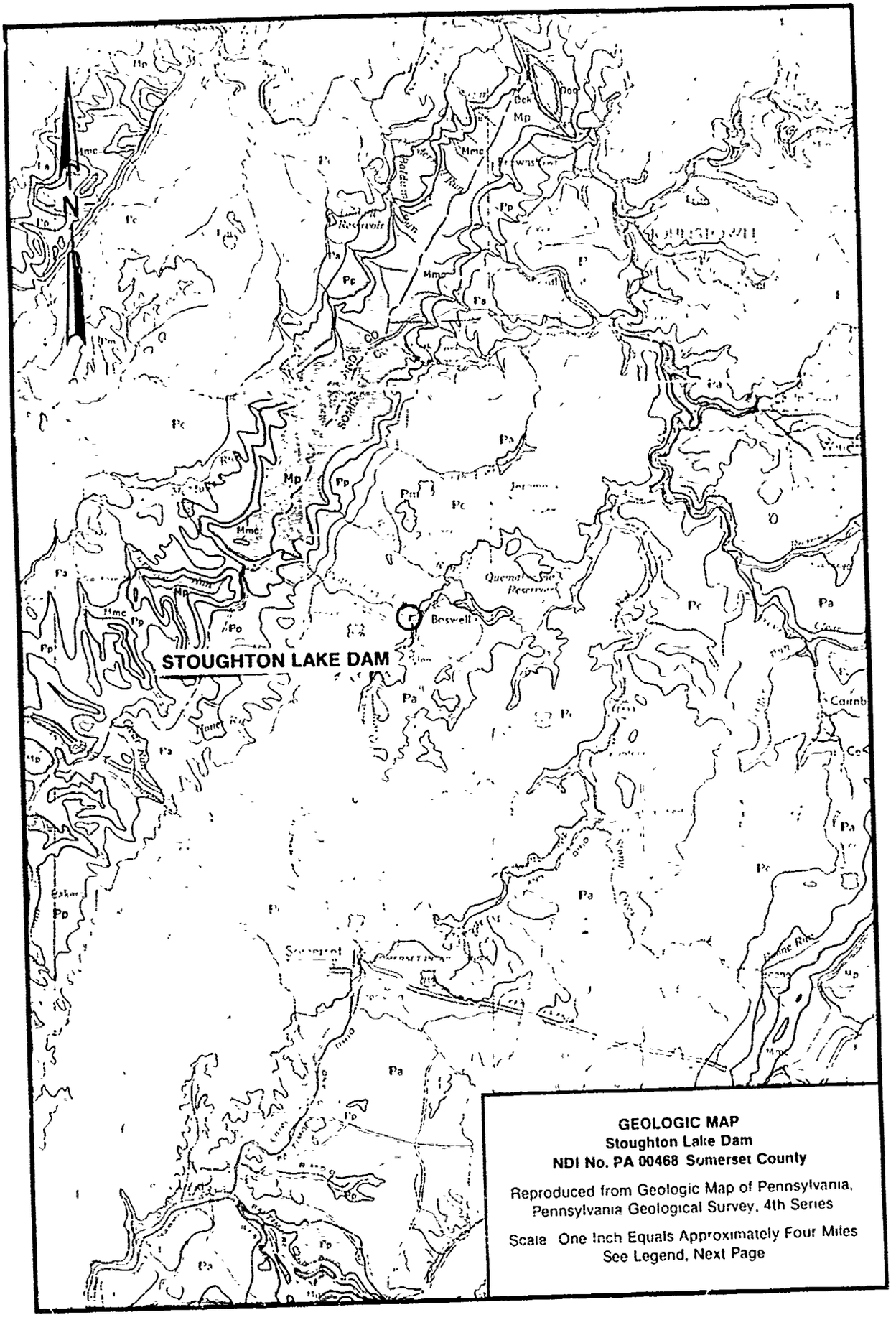
# REGIONAL GEOLOGY

STOUGHTON LAKE DAM
NDI No. PA 00468, PennDER No. 56-78

## REGIONAL GEOLOGY

Stoughton Lake Dam is in the Allegheny Mountain Section of the Appalachian Plateaus Physiographic Province. The area has not been glaciated and bedrock units below the dam are members of the Allegheny Group, Pennsylvanian System. The dam is near the contact between the Allegheny and Conemaugh Groups. The Allegheny/Conemaugh contact is marked by the Upper Freeport Coal. The Allegheny Group consists of cyclic sequences of shale, sandstone, limestone, and coal. The Conemaugh Group, Glenshaw Formation underlies the entire reservoir area and consists of cyclic sequences of sandstone, shale, red beds, and thin limestone and coal. Bedrock forming the foundation of the dam, as indicated by an original design boring, is shale.

Several coal seams are possibly located beneath the dam, including the Upper Freeport, Lower Freeport, Upper Kittanning, Middle Kittanning, Lower Kittanning, Clarion, Brookville, and Mercer coals. The thicknesses of the coals beneath the dam are not known; however, according to "Bituminous Coal Resources in Western Pennsylvania" by M.A. Sholes and V.W. Skema (1974), Pennsylvania Bureau of Topographic and Geologic Survey, Mineral Resource Report 68, only the Upper Freeport and Upper and Lower Kittanning Coals have been mined in the general area of the dam with Upper Kittanning being mined out directly below the dam by the Consolidation Coal Company.




**GEOLOGIC MAP**
**Stoughton Lake Dam**
**NDI No. PA 00468 Somerset County**

Reproduced from Geologic Map of Pennsylvania, Pennsylvania Geological Survey, 4th Series

Scale One Inch Equals Approximately Four Miles
See Legend, Next Page

# LEGEND

## PERMIAN

**Greene Formation**
*Cyclic sequences of sandstone, shale, red beds, limestone and coal; base at the top of the Upper Washington Limestone*

## PERMIAN AND PENNSYLVANIAN

**Washington Formation**
*Cyclic sequences of sandstone, shale, limestone and coal; some red shale; some minable coal; base at the top of the Waynesburg Coal*

## PENNSYLVANIAN

### APPALACHIAN PLATEAU

Pm

**Monongahela Formation**
*Cyclic sequences of sandstone, shale, limestone and coal, limestone prominent in northern outcrop areas, shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.*

Pc

**Conemaugh Formation**
*Cyclic sequences of red and gray shales and siltstones with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of sections; Brush Creek Limestone in lower part of section.*

Pa

**Allegheny Group**
*Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestones thicken westward; Vanport Limestone in lower part of section, contains Freeport, Kittanning, and Clarion Formations.*

Pp

**Pottsville Group**
*Predominantly sandstones and conglomerates with thin shales and coals; some coals minable locally.*

### ANTHRACITE REGION

Ppp

**Post-Pottsville Formations**
*Brown or gray sandstones and shales with some conglomerate and numerous minable coals.*

Pp

**Pottsville Group**
*Light gray to white, coarse grained sandstones and conglomerates with some minable coal; includes Sharp Mountain, Schuylkill, and Tumbling Run Formations.*

## MISSISSIPPIAN

Mmc

**Mauch Chunk Formation**
*Red shales with brown to greenish gray clayey sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties, Loyalhanna Limestone at the base in southwestern Pennsylvania.*

Mp

**Pocono Group**
*Predominantly gray, hard, massive, coarse bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations; includes part of "Chemung" of M. J. Fuller in Fulton and Tioga counties*

## DEVONIAN

### UPPER

### WESTERN PENNSYLVANIA

**Oswayo Formation**
*Greenish gray to gray shales, siltstones and sandstones becoming increasingly shaly westward; considered equivalent to type Oswayo, Riceville Formation Or in Erie and Crawford Counties; probably not distinguishable north of Corry.*

Dcr

**Cattaraugus Formation**
*Red, gray and brown shale and sandstone with the proportion of red decreasing westward; includes Venango sands of drillers and Kalamanca sandstone and conglomerate; some limestone in Crawford and Erie counties.*

Dc

**Conneaut Group**
*Alternating gray, brown, greenish and purplish shales and siltstones; includes "pink rock" of drillers and "Chemung" and "Girard" Formations of northwestern Pennsylvania.*

Dcn

**Canadaway Formation**
*Alternating brown shales and sandstones; includes "Portage" Formation of northwestern Pennsylvania.*