

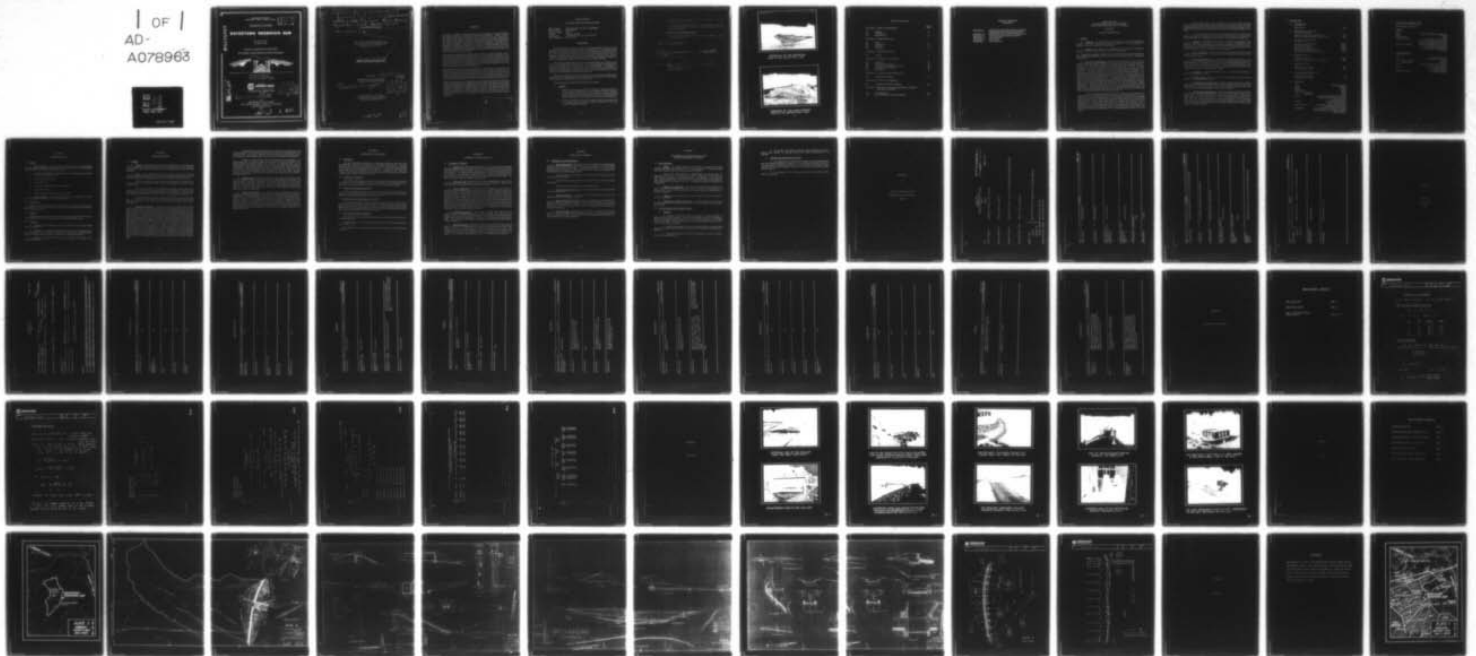
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NATIONAL DAM INSPECTION REPORT. BOYERTOWN RESERVOIR DAM (NDI-PA--ETC(U)
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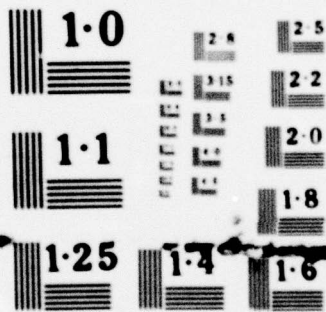
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LEVEL 4

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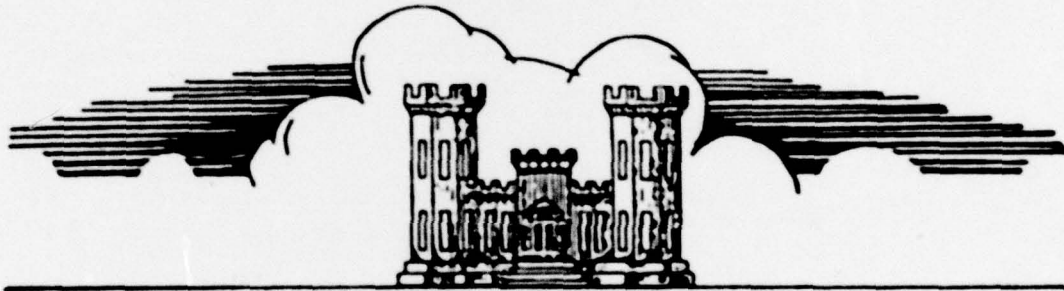
BOYERTOWN RESERVOIR DAM

NDI-PA 00707
PA DER 6-344

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PHASE I INSPECTION REPORT NATIONAL DAM INSPECTION PROGRAM



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Prepared By

O'BRIEN & GERE

Justin & Courtney Division

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FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND

21203

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AUGUST 1979

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⑥ National Dam Inspection Report,
Boyertown Reservoir Dam (NDI-PA 00707)
(PA/DER 6-344) Delaware River Basin,
Popodickon Creek, Berks County,
DELAWARE RIVER BASIN
Pennsylvania

Name of Dam: Boyertown Reservoir Dam
County & State: Berks County, Pennsylvania
Inventory Number: PA00707

⑩ John J. Williams

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by:

⑪ Aug 79

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O'BRIEN & GERE ENGINEERS, INC
JUSTIN & COURTNEY DIVISION

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

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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 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 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.

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PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Boyertown Reservoir Dam ID #PA00707
State Located: Pennsylvania
County Located: Berks
Stream: Popodickon Creek
Coordinates: Latitude 40° 20.4', Longitude 75° 41.0'
Date of Inspection: May 15, 1979

ASSESSMENT

Boyertown Reservoir Dam is an earth and rockfill embankment with a concrete corewall and a 20-foot wide, broad-crested, concrete spillway. The upstream portion of the dam is rolled earth embankment; the downstream section is earth and rockfill. The dam is approximately 620 feet long with a maximum height of 55 feet and impounds a reservoir with a normal pool storage capacity of 105 acre-feet. The dam is located on Popodickon Creek and serves as a source of water supply for Boyertown, which is situated approximately 2.5 miles downstream (east) of the dam.

The Spillway Design Flood (SDF) for this "Intermediate" size, "High" hazard dam is the Probable Maximum Flood (PMF). The spillway is capable of discharging 37 percent of the PMF without overtopping of the embankment. The spillway is classified as "Inadequate". The spillway is not classified as "Seriously Inadequate" because the depth and duration of overtopping are not considered sufficient to cause a failure of the embankment at 50 percent of the PMF.

Based on the visual observations and review of the information obtained from the Pennsylvania Department of Environmental Resources, Division of Dam Safety, Boyertown Dam is considered to be in good condition.

Recommendations and Remedial Measures are as follows:

a. Facilities.

1. The top of the dam should be restored to design elevation as determined by a detailed survey. As a result, the hydraulic capacity of the spillway would be increased by about 60 cfs so that about 45 percent of the PMF could be discharged. Surface monuments should be placed along the top of the dam to monitor any future settlement.
2. Detailed hydrologic and hydraulic analyses should be performed and the spillway capacity should be further increased to make the spillway hydraulically adequate.

3. A bare spot on the downstream slope should be reseeded to prevent erosion from surface runoff.

4. The cracks in the spillway discharge channel should be repaired to prevent scour beneath the discharge channel and further deterioration of the concrete.

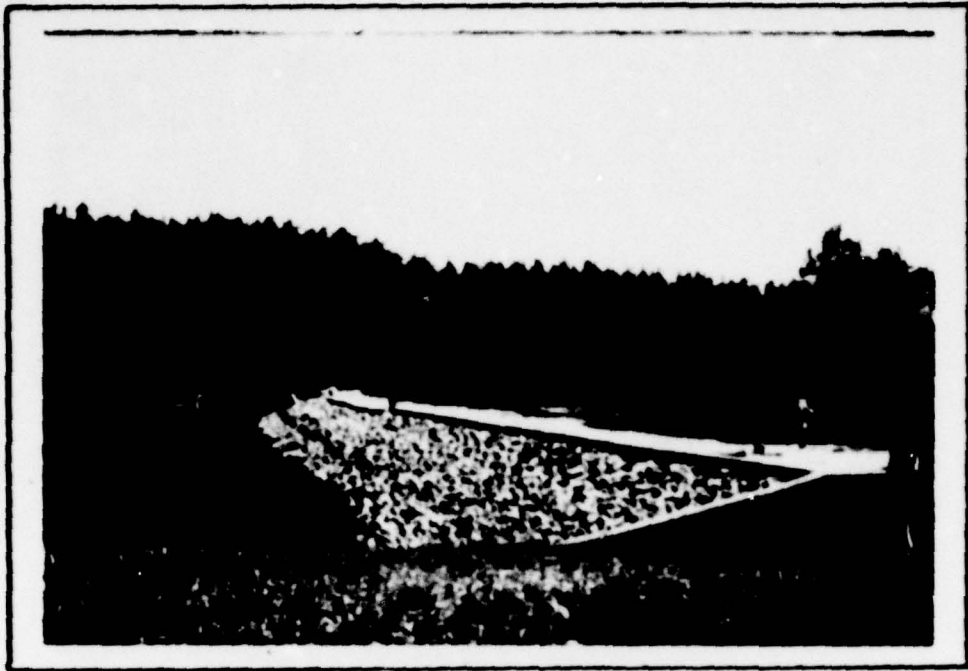
b. Operation and Maintenance Procedures.

1. The adequacy of the warning systems that are currently in effect should be evaluated.

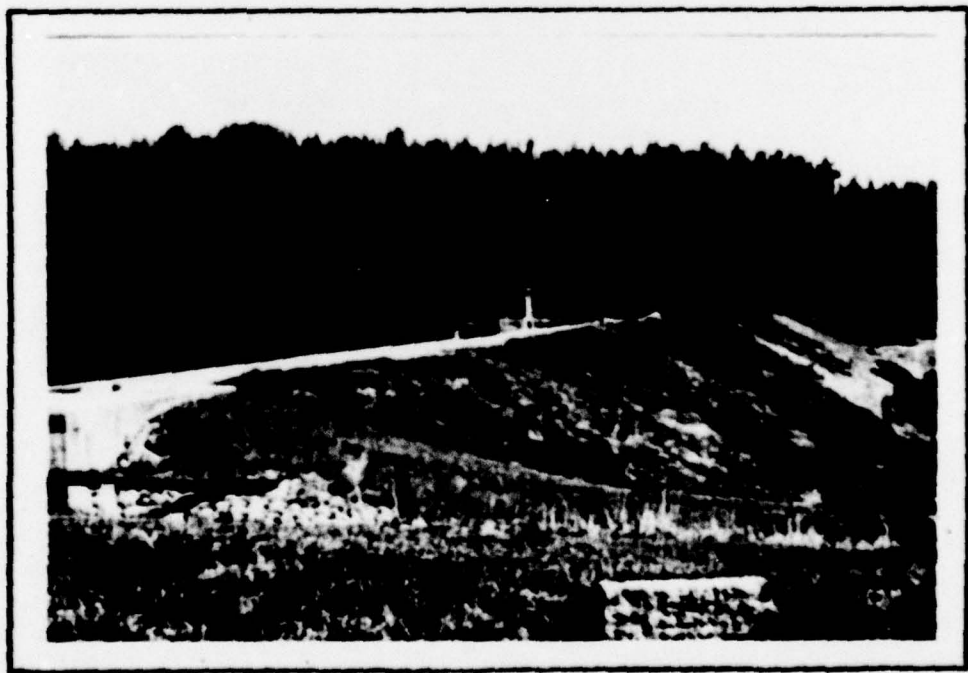
O'BRIEN & GERE ENGINEERS, INC.
JUSTIN & COURTNEY DIVISION

John J. Williams Date: 5 Sept. 1979
John J. Williams, P.E.
Vice President
Pennsylvania Registration PE006920E

Approved by: James W. Peck Date: 19 Sep 79
JAMES W. PECK
Colonel, Corps of Engineers
District Engineer



*OVERVIEW OF THE UPSTREAM
FACE OF THE BOYERTOWN DAM*



*OVERVIEW OF THE DOWNSTREAM
FACE OF THE BOYERTOWN DAM*

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APPENDIX F -	SITE GEOLOGY

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
BOYERTOWN RESERVOIR DAM ID #PA00707

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. The purpose of this inspection is to determine if Boyertown Reservoir Dam constitutes a hazard to human life or property.

1.2 Description of Project (Based upon information obtained from the Pennsylvania Department of Environmental Resources (DER), Division of Dam Safety, Harrisburg, Pennsylvania)

a. Dam and Appurtenances. Boyertown Reservoir Dam is an earth and rockfill embankment, approximately 620 feet long with a maximum height of about 55 feet and a crest width of 14 feet at Elevation 630.0. The upstream slope is 3 horizontal to 1 vertical (3H:1V) and the downstream slope is 2H:1V. The dam impounds a reservoir with a surface area of 9 acres and normal pool storage of 105 acre-feet. The dam consists of a central concrete corewall supported by a downstream earth and rock fill and an upstream rolled earth embankment. The corewall is step-tapered in section and has a base width of 5 feet which reduces to 2 feet at the top. The corewall extends from Elev. 628.0 to an average depth of about 4 feet below the original ground line. The upstream slope is protected by stone paving from the top of the dam to Elev. 611.0 where it terminates with a stone toe wall. A 6-foot square vertical shaft backfilled with stone and puddled clay is situated beneath the concrete corewall about 330 feet from the left abutment (looking downstream). The shaft, which was installed to collect discharge from a pervious substratum, is connected at Elev. 561.6 to a 6-foot square timbered gallery. The gallery extends about 200 feet downstream at a 0.5% slope where it directs discharge into a catch basin connected to the water supply system.

A broad-crested, concrete spillway with an Ogee nappe is located at the right abutment. The spillway is 20 feet wide and has a 3-foot drop from the weir crest (Elev. 625.0) to the discharge apron. A concrete training wall and a riprapped abutment slope form a 17-foot long approach channel which has a 1-foot thick concrete invert. The concrete outlet channel (invert Elev. 622.0) extends 15.5 feet downstream, is 20 feet wide, and includes an 18-inch long transition from a rectangular to a trapezoidal channel section. This stone paved section reduces to a 10-foot wide invert and continues for about 220 feet downstream at a 12% slope. The remaining 130 feet of the outlet channel is a trapezoidal earth section on a 15.4% slope.

The reservoir drain system consists of a concrete intake structure provided with three inlets at Elev. 591.0, 603.0 and 614.0. The inlets are controlled by sluice gates operated from the gatehouse, which is located approximately 50 feet upstream of the top of the dam and about 230 feet from the left abutment of the dam.

Two 12-inch cast iron concrete encased outlet pipes, one for water supply and one for reservoir drawdown, are located in the intake structure at invert Elev. 589.0. Both pipes are controlled by hand-operated 12-inch valves in the gatehouse.

b. Location. Boyertown Reservoir Dam is located on Popodickon Creek about 2.5 miles west of Boyertown, Pennsylvania. The dam is situated within Earl Township in Berks County and is shown on the USGS Quadrangle entitled, "Boyertown, Pennsylvania" at coordinates N 40° 20.4', W 75° 41.0'. A regional location plan of Boyertown Reservoir Dam is enclosed as Plate I, Appendix E.

c. Size Classification. The maximum height of 55 feet and maximum pool storage capacity of 156 acre-feet place Boyertown Reservoir Dam in the "Intermediate" size category.

d. Hazard Classification. An existing water treatment plant and a new treatment plant, which is under construction are located near the downstream toe of the embankment. In addition, several homes are located along Popodickon Creek less than one-half mile downstream of the dam. Failure of Boyertown Reservoir Dam would cause extensive property damage and probable loss of life in these areas. Therefore, the dam is classified as "High" hazard.

e. Ownership. Boyertown Reservoir Dam is owned by the Borough of Boyertown, Pennsylvania 19512.

f. Purpose of Dam. The dam was constructed to impound a water supply reservoir for the Borough of Boyertown.

g. Design and Construction History. Boyertown Reservoir Dam was designed and constructed by William H. Dechant and Sons, Engineers-Architects, Reading, Pennsylvania. Construction began in April of 1926 and was completed in May 1929. There is no record of any subsequent modifications to the dam.

h. Normal Operating Procedures. Hand operated gate hoists are provided for the control of the three inlet sluice gates and the two outlet gates located in the intake tower. Two inlet pipes and one outlet pipe are provided for water supply. These pipes are controlled by sluice gates which are operated from the gatehouse. A third inlet pipe and second outlet pipe allow for drawdown of the reservoir. According to Mr. Roland Reed, Boyertown Borough Manager, the drawdown sluice gates are operated periodically, but only during high reservoir stages to insure that a minimum of water is wasted.

1.3 Pertinent Data

a. Drainage Area.

Square Miles 0.5

b. Discharge at Dam Site. (cfs)

Maximum Flood of Record (estimated) 175
 Spillway discharge, reservoir at crest of dam 700

c. Elevation. (feet above MSL)

Spillway Crest (normal pool) 625.0
 Top of Dam (Design) 630.0
 Top of Dam (Low Point) 629.5
 Reservoir Drain Invert (inlet) 590.0
 Streambed at downstream toe of dam 575+

d. Reservoir. (miles)

Length of Normal Pool 0.19
 Length of Maximum Non-overtopping Pool 0.20

e. Storage. (acre-feet)

Normal Pool, Elev. 625.0 105
 Top of Dam, Elev. 630.0 156

f. Reservoir Surface Area. (acres)

Normal Pool, Elev. 625.0 9
 Top of Dam, Elev. 630.0 13

g. Dam Data.

Type	Earth and Rock Fill
Length	620 feet
Height	55 feet
Crest Width	14 feet
Side Slopes (upstream)	3H:1V
(downstream)	2H:1V
Zoning	Concrete corewall with a rolled earth upstream shell and earth and rockfill downstream shell.
Cutoff	Concrete corewall extends 4 feet into overburden.
Grout Curtain	Grout tubes installed at 8-foot centers in concrete core wall; not used.
Underdrain	A 6-foot square well backfilled with stone and connected to a 6-foot square timbered drainage gallery.

h. Diversion and Regulating Tunnel.

Does not apply to this site.

i. Spillway.

Type	Broad-crested weir with Ogee cap.
Width	20 feet
Crest Elevation	625.0
Upstream Channel	17-foot long concrete apron at Elevation 624.7 with concrete training wall and riprapped abutment slope.
Downstream Channel	Rectangular concrete section (invert Elev. 622.0) with transition to stone paved trapezoidal channel at 12% slope.

j. Regulating Outlets.

Type	Two 12-inch cast iron pipes encased in concrete.
Length (Reservoir Drain) (water supply)	165 feet
Closure	Unknown
Access	12-inch gate valves on both conduits at intake structure.
Regulating Facilities	Upstream gate house over intake structure. Hand operated wheels.

SECTION 2
ENGINEERING DATA

2.1 Design

a. Data Available. The information available for review of Boyertown Reservoir Dam includes the following (all information contained in the Pennsylvania DER main office files in Harrisburg, Pennsylvania):

1. "Permit", "Application", and "Report upon the Application" to construct Boyertown Reservoir Dam, 1926.
2. Construction specifications.
3. Design drawings.
4. Construction progress reports and photographs.
5. Inspection reports.
6. Miscellaneous correspondence and memoranda.

b. Design Features. The principal design features are described in Section 1.2.a. (Description of Project, Dam and Appurtenances).

2.2 Construction

Based on the field investigation and the information available in the construction reports, the dam appears to have been constructed in general conformance with the final design drawings.

2.3 Operation

Operation procedures are limited to the sluice gates located in the intake tower which control the inflow to the water supply and reservoir drawdown pipes.

2.4 Evaluation

a. Availability. The engineering information utilized in this report was made available by DER.

b. Adequacy. The available data (listed in Section 2.1.a), visual observations and conversations with the Owner's representative, Mr. Roland Reed, Boyertown borough Manager, provided adequate information for a Phase I investigation.

c. Validity. There appears to be no reason to question the validity of the data provided by DER.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The field inspection of Boyertown Reservoir Dam took place on May 15, 1979. At the time of the inspection, the water surface was approximately one foot below the spillway crest elevation. No underwater areas of the dam were inspected.

b. Dam. A survey revealed that the top of dam has settled several inches below design elevation along most of its length. A maximum depression of about six inches was observed from approximately 80 to 140 feet to the left of the spillway.

The riprap cover on the upstream face of the embankment appears to be in good condition. The riprap is fairly well graded, consisting of 6-inch to 2-foot rounded stone.

The downstream slope of the embankment supports a good cover consisting mainly of crown vetch. A bare spot about 50 feet by 100 feet was observed near the downstream toe approximately 200 feet from the left abutment. This bare spot was apparently related to the construction work on the new water treatment plant.

Gravel bordered by concrete curbing on either side covers the top of the dam. The curbing is about 5 inches thick and extends approximately 6 inches above the top of the dam. The curbing is out of alignment near the center of the embankment.

c. Appurtenant Structures. The spillway section and approach apron appear to be in good condition. A 12-inch diameter cast iron pipe is suspended from the left spillway training wall by metal brackets with the pipe invert about 6 inches above the spillway crest. According to Mr. Roland Reed, Boyertown Borough Manager, the pipe was installed around 1949 to provide additional water supply to the reservoir from Ironstone Creek. The spillway discharge channel is a composite section which differs from the channel section shown in the design drawings. Instead of a riprap lined channel which changes to a trapezoidal earth cut, the channel is brick-lined with a 5-foot wide concrete chute in the center for the entire 350-foot length. The channel side slopes are riprap lined. Numerous cracks in the concrete portion of the discharge channel were observed during the inspection. A trickle of water (0.1 gpm) was flowing from a 12-inch diameter cast iron pipe which serves as the backwash line for the treatment plant and directs flow into the spillway discharge channel about 200 feet downstream of the spillway. During the inspection, this water was seeping into the concrete cracks and emerging downstream from beneath the channel section. The discharge channel passes beneath the access road to the old treatment plant by means of two 24-inch diameter concrete pipes and two 18-inch diameter concrete pipes.

The gatehouse and sluice gate controls appear to be well maintained and in good condition. A concrete foot bridge provides access to the gatehouse from the top of the dam. The reservoir drawdown outlet pipe terminates at the same point as the spillway discharge channel, at the natural streambed about 300 feet downstream.

There is no evidence that the timber gallery is still in existence. In a letter dated 1926, Mr. William Dechant (the designer) stated that the timber in the gallery would be structurally sound for 15 or 20 years. He suggested that if the use of the gallery is still required after this period of time, the timber should be replaced with masonry. There is no record of any such modification and Mr. Reed stated that, to the best of his knowledge, the timber has never been removed. Neither Mr. Reed nor Mr. Lynn Griffith, Assistant Chief Engineer for Glace and Glace Engineers (Engineers responsible for the new water treatment plant design) knew if the gallery was still functioning.

d. Reservoir Area. The reservoir slopes are fairly steep and heavily wooded. A 12-inch diameter cast iron pipe extends from the right reservoir slope about 100 feet upstream of the dam. The invert of the pipe was about one foot above the reservoir surface during the inspection. According to Mr. Reed, this pipe allows water to be pumped from Trout Run Reservoir (2 miles away) into Boyertown Reservoir. Water may also be pumped directly into the Boyertown water supply system from Trout Run Reservoir.

e. Downstream Channel. The spillway discharge channel and reservoir drawdown outlet pipe both terminate at a small stilling basin approximately 300 feet downstream of the embankment. Beyond this basin, the natural stream (Popodickon Creek) resumes its course and flows beneath an access bridge for the new treatment plant by means of a 42-inch diameter corrugated metal pipe. Popodickon Creek continues downstream for about 1.5 miles on an approximate grade of 3 percent where it merges with Ironstone Creek in the town of Gabelsville. Approximately 10 people at the water treatment plant and about 20 people in 5 homes located along the stream between the dam and Gabelsville would be subject to danger in the event of a failure of the dam.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedures

The only operational procedures for Boyertown Reservoir Dam are those concerning the control of the water supply to the Borough of Boyertown. Two inlet pipes and one outlet pipe are provided for water supply. These pipes are controlled by sluice gates which are operated from the gatehouse. A third inlet pipe and second outlet pipe allow for drawdown of the reservoir. According to Mr. Reed, the drawdown sluice gates are operated periodically, but only during high reservoir stages to insure that a minimum of water is wasted.

4.2 Maintenance of the Dam

According to the Owner's representative, maintenance is performed as needed by a labor crew from the Boyertown Streets Department. The dam and appurtenant structures are inspected regularly by workers from the water treatment plant.

4.3 Maintenance of Operating Facilities

The only operating facilities are the sluice gates which control the inflow and outflow for water supply and reservoir drawdown. The gate hoists and control wheels appear to be well maintained and are in good condition.

4.4 Description of any Warning Systems in Effect

According to Mr. Reed, Boyertown Reservoir Dam is tied in with the Berks County Civil Defense System. The Borough of Boyertown also has a Wells Fargo warning system in effect. The Borough's Emergency Center is located in the Borough Hall. In this system, water levels are monitored and during dangerously high stages an alarm would be sounded at the Emergency Center.

4.5 Evaluation of Operational Adequacy

The maintenance and operational procedures for Boyertown Reservoir Dam are considered adequate.

It appears that the dam is accessible under all weather conditions for inspection and emergency action.

The adequacy of the warning systems that are currently in effect should be evaluated.

SECTION 5

HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Boyertown Reservoir Dam has a drainage area of 0.5 square miles and impounds a reservoir with a normal pool storage capacity of 105 acre-feet. Ground elevations range from 1080 in the upper reaches of the drainage basin to 625 at normal pool. The slopes of the watershed adjacent to the reservoir range from 5 to 25 percent. The watershed is nearly 100 percent wooded. The spillway is a 20-foot wide broad-crested concrete weir with an Ogee-shaped downstream nappe. The spillway discharge capacity is approximately 700 cfs.

b. Experience Data. According to the Owner's representative, high and low flows are monitored at the treatment plant immediately downstream. There are no known rainfall or reservoir level records kept for this dam.

c. Visual Observations. On the day of the inspection, there were no indications that the spillway could be obstructed. The spillway discharge channel is a composite section which differs from the channel section shown in the design drawings. Instead of a riprap lined channel which changes to a trapezoidal earth cut, the channel invert is brick-lined with a 5-foot wide concrete chute in the center for the entire 350-foot length. The channel side slopes are riprap lined. Numerous cracks in the concrete portion of the discharge channel were observed during the inspection. A trickle of water (0.1 gpm) was flowing from a 12-inch diameter cast iron pipe which serves as the backwash line for the treatment plant and directs flow into the spillway discharge channel about 200 feet downstream of the spillway. During the inspection, this water was seeping into the concrete cracks and emerging downstream from beneath the channel section.

d. Overtopping Potential. The Spillway Design Flood (SDF) for this "Intermediate" size, "High" hazard structure is the full PMF. The peak inflow and outflow rates for the PMF were determined to be 1985 cfs and 1934 cfs, respectively. Based on the hydrologic analyses, the spillway is capable of discharging approximately 37 percent of the PMF without overtopping of the embankment (see Appendix C for computations).

e. Spillway Adequacy. Although the spillway is not capable of discharging 50 percent of the PMF, the dam would only be overtopped by a maximum of 0.34 feet (about 4 inches) for a duration of 1.5 hours at 50 percent of the PMF. This overtopping is not considered sufficient to cause a failure of the embankment and, therefore, the spillway is not classified as "Seriously Inadequate". However, the spillway is not capable of discharging the SDF, so it is classified as "Inadequate".

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The top of dam survey revealed that settlement has occurred in the embankment so that the top of dam is several inches below design elevation along most of its length. The settlement could be a result of poor compaction during construction. The lowered top of dam reduces the capability of the embankment to withstand major floods.

The bare spot on the downstream slope exposes the embankment to rapid erosion from surface runoff.

The embankment slopes appear to be in good condition and show no signs of instability.

The spillway section appears to be structurally stable.

b. Design and Construction Data. The design and construction data available is listed in Section 2.1.a.

c. Operating Records. According to Mr. Roland Reed, records for the operation of the sluice gates are maintained.

d. Post-Construction Changes. Construction photographs indicate that the spillway discharge channel was originally riprap lined as designed. Sometime subsequent to the completion of construction the channel was repaved with brick and concrete as described in Section 3.1.c. There is no evidence of any other post construction changes.

e. Seismic Stability. Boyertown Reservoir Dam is located in Seismic Risk Zone 1 of the Seismic Zone Map of Contiguous States. A dam located in Seismic Zone 1 is generally considered to be safe under any expected earthquake loading, if it is stable under static loading conditions.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety. The visual observations and review of available information indicate that Boyertown Reservoir Dam is in good condition. However, several deficiencies noted in Section 6.1.a require further attention.

The SDF for this structure was determined to be the full PMF, as discussed in Section 5.1.c. The spillway is capable of discharging 37 percent of the PMF without overtopping of the embankment. The spillway is not considered "Seriously Inadequate" due to the short duration and limited depth of overtopping of the embankment at 50 percent of the PMF. Therefore, the spillway is classified as "Inadequate".

b. Adequacy of Information. No design calculations were obtained from DER. However, the available data (listed in Section 2.1.a), visual observations, and conversations with the Owner's representative, provided adequate information for a Phase I investigation.

c. Urgency. The remedial measures recommended in Section 7.2 should be effected immediately.

d. Necessity for Further Investigation. Detailed hydrologic and hydraulic studies should be made to determine the extent to which the spillway capacity should be increased.

7.2 Recommendations and Remedial Measures

a. Facilities

1. The top of the dam should be restored to design elevation as determined by a detailed survey. As a result, the hydraulic capacity of the spillway would be increased by approximately 60 cfs so that about 45 percent of the PMF could be discharged. Surface monuments should be placed along the top of the dam to monitor any future settlement.

2. Detailed hydrologic and hydraulic analyses should be performed and the spillway capacity should be further increased so that the spillway is hydraulically adequate.

3. The bare spot on the downstream face should be reseeded to prevent erosion from surface runoff.

4. The cracks in the spillway discharge channel should be repaired to prevent scour beneath the discharge channel and further deterioration of the concrete.

b. Operation and Maintenance Procedures.

1. The operation and maintenance procedures for Boyertown Reservoir Dam are considered adequate. In addition to those procedures described in Section 4, Mr. Reed stated that Boyertown Borough is in the process of developing a formal inspection and maintenance program with the Glace and Glace Engineering Company from Harrisburg.

2. The adequacy of the warning systems that are currently in effect should be evaluated.

APPENDIX

A

Check List Engineering Data
Design, Construction, Operation
Phase I

NAME OF DAM Doyertown Dam
ID # PA_00707

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

Sheet 1 of 4

ITEM	REMARKS	
AS-BUILT DRAWINGS	No As-Built drawings were available.	
REGIONAL VICINITY MAP	Refer to Plate 1, Appendix E	
CONSTRUCTION HISTORY	Construction progress reports and photographs were obtained from DER.	
TYPICAL SECTIONS OF DAM	Refer to Plate 2, Appendix E	
OUTLETS - PLAIN DETAILS CONSTRAINTS	Refer to the Plates in Appendix E for available drawings.	
DISCHARGE RATINGS		None obtained from DER.
RAINFALL/RESERVOIR RECORDS		None obtained from DER.

REMARKS

ITEM

DESIGN REPORTS

None available.

GEOLOGY REPORTS

None available.

DESIGN COMPUTATIONS
HYDROLOGY & HYDRAULICS
DAM STABILITY
SEEPAGE STUDIES

None available.

MATERIALS INVESTIGATIONS
BORING RECORDS
LABORATORY }
FIELD }

None available.

POST-CONSTRUCTION SURVEYS OF DAM

None

BORROW SOURCES

Unknown

ITEM	REMARKS
MONITORING SYSTEMS	Monitoring systems exist but no records were obtained.
MODIFICATIONS	No records of modifications were obtained.
HIGH POOL RECORDS	Recorded at water treatment plant.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None
MAINTENANCE OPERATION RECORDS	Operating records are kept at the water treatment plant.

ITEM

REMARKS

SPILLWAY PLAN

SECTIONS

DETAILS

Refer to the Plates in Appendix E for available drawings.

OPERATING EQUIPMENT
PLANS & DETAILS

None available

MISCELLANEOUS

Refer to Section 2.1.a.

APPENDIX

B

Check List

Visual Inspection

Phase I

CONCRETE/MASONRY DAMS

Sheet 2 of 11

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

ANY NOTICEABLE SEEPAGE

N/A

STRUCTURE TO
ABUTMENT/EMBANKMENT
JUNCTIONS

N/A

DRAINS

N/A

WATER PASSAGES

N/A

FOUNDATION

N/A

CONCRETE/MASONRY DAMS

Sheet 3 of 11

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	N/A	
STRUCTURAL CRACKING	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT	N/A	
MOHOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	

EMBANKMENT

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

DRAINS

The reservoir drain runs beneath the embankment.

JUNCTION OF EMBANKMENT
AND ABUTMENT, SPILLWAY
AND DAM

No problems noted.

ANY NOTICEABLE SEEPAGE

None observed.

STAFF GAGE AND RECORDER

None

OUTLET WORKS

Sheet 6 of 11

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

CRACKING AND SPALLING OF
CONCRETE SURFACES IN
OUTLET CONDUIT

None observed.

INTAKE STRUCTURE

The intake structure was submerged.
The gate house above the intake
structure appeared to be in good
condition.

OUTLET STRUCTURE

None

OUTLET CHANNEL

The drawdown pipe terminates at a
stilling basin in the natural stream
channel.

EMERGENCY GATE

The sluice gates which control the
drawdown and water supply pipes are
located in the gate house.

UNGATED SPILLWAY

Sheet 7 of 11

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONS

CONCRETE WEIR

The weir appeared to be in good condition.

APPROACH CHANNEL

A 17-foot long approach apron slopes gently up to a point just below the spillway crest.

DISCHARGE CHANNEL

The discharge channel base is lined with brick and concrete which differs from the riprap lined section in the design drawings. The concrete portion of the channel was cracked in numerous places.

The cracks in the channel should be repaired so that no further deterioration or erosion takes place.

BRIDGE AND PIERS

None

GATED SPILLWAY

<u>VISUAL EXAMINATION OF</u>	<u>OBSERVATIONS</u>	<u>REMARKS OR RECOMMENDATIONS</u>
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION

MONUMENTATION/SURVEYS

None

OBSERVATION WELLS

None

WEIRS

None

PIEZOMETERS

None

OTHER

None

RESERVOIR

Sheet 10 of 11

VISUAL EXAMINATION OF

OBSERVATIONS

REMARKS OR RECOMMENDATIONS

SLOPES

Reservoir slopes are steep and heavily wooded but show no signs of instability.

SEDIMENTATION

Sedimentation level is unknown.

DOWNSTREAM CHANNEL

Sheet 11 of 11

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

CONDITION
(OBSTRUCTIONS,
DEBRIS, ETC.)

Immediately downstream of the stilling basin (at which point the natural stream channel resumes) the channel passes beneath an access road by means of a 42-inch diameter CMP. This pipe is the only apparent constriction to flow.

SLOPES

The channel progresses downstream on a fairly steep gradient - approximately 3 percent.

APPROXIMATE NO.
OF HOMES AND
POPULATION

Approximately 10 persons would be subject to danger in the water treatment plants immediately downstream. About 5 homes and approximately 20 additional persons would be endangered along the stream within a mile of the dam in the event of a failure.

APPENDIX

C

Hydrologic & Hydraulic Data

TABLE OF CONTENTS - APPENDIX C

PMP CALCULATIONS	SHEET 1
SNYDER COEFFICIENTS	SHEET 1
HEC - 1 DAM SAFETY VERSION COMPUTER OUTPUT	SHEETS 2-6



SUBJECT	BOYERTOWN DAM	SHEET	1	BY	RRB	DATE	3/22/79	JOB NO.	
---------	---------------	-------	---	----	-----	------	---------	---------	--

HYDROLOGY CALCULATIONS

DRAINAGE AREA (PLANIMETERED ON USGS QUAD SHEET): 0.50 mi.²

PMP CALCULATIONS (HMS REPORT 33)

AREA IS IN ZONE 6

24 HR., 200 SQ. MI. RAINFALL = 23"

<u>HR.</u>	<u>%</u>	<u>RAINFALL</u>	<u>Δ RF</u>
6	113	26.0"	26.0"
12	123	28.3"	2.3"
24	132	30.4"	2.1"
48	142	32.7"	2.3"

SNYDER COEFFICIENTS

FROM INFO. PROVIDED BY COE FOR THE DELAWARE RIVER BASIN, ZONE 7 (SCHUYLKILL RIVER SUB-BASIN):

$C_p = 0.65$

AND $C_e = 1.35$

$t_p = C_e (L \cdot L_{ca})^{0.3}$

$L = 0.9$ miles

$L_{ca} = 0.3$ miles

$t_p = 1.35 (0.9 \cdot 0.3)^{0.3} = 0.9$ HRS.

SUBJECT BOYERTOWN DAM	SHEET 1A	BY	DATE	JOB NO.
--------------------------	-------------	----	------	---------

STAGE-AREA INFORMATION

NORMAL POOL (EL. 625) SURFACE AREA = 9 ACRES (FROM INFO. PROVIDED BY PDER).

SURFACE AREA AT ELEVATION 640 = 22 ACRES (PLANIMETERED FROM USGS QUAD SHEET)

SURFACE AREA AT APPROXIMATE TOE OF DAM (EL. 595) IS DETERMINED FROM THE CONIC VOLUME EQUATION, USING THE KNOWN NORMAL POOL STORAGE OF 105 ACRE-Feet AND AN ASSUMED STORAGE OF 0 ACRE-Feet AT THE TOE ELEVATION.

$$\Delta V = \frac{\Delta h}{3} (\sqrt{A_1 A_2} + A_1 + A_2)$$

$$105 \text{ A-Feet} = \frac{30 \text{ ft}}{3} (\sqrt{9 A_2} + 9 + A_2)$$

TRY $A_2 = 0.2$ ACRES,

$$105 = 10 (\sqrt{9(.2)} + 9 + .2)$$

$$105 = 105.4$$

THEREFORE, THE SURFACE AREA AT ELEV. 595 = 0.2 ACRES

THE TOP OF DAM ELEVATION CHOSEN FOR USE IN THE PROGRAM IS 629.7 WHICH IS AN AVERAGE VALUE SO THAT AN AVERAGE DISCHARGE OVER THE TOP OF THE DAM WILL BE UTILIZED.

.....
 FLOOD HYDROGRAPH PACKAGE (MFC-11)
 7A SAFETY VERSION JULY 1978
 LAST MODIFICATION 27 SEP 78

RUN DATE 05/17/79.
 TIME 13.49.00.

NATIONAL DAM INSPECTION PROGRAM
 BOZEMAN DAM
 PAF HYDROGRAPH

NO	NUM	MIN	1DAY	1M	1MIN	WTRC	1P1	1P1T	NATN
1	0	30	0	0	0	0	0	0	0
			JUMP	NWT	LHOPT	TRACE			
			0	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
 PLAN 1 OPTION 1

STAGE	ICOMP	IECON	ITAPE	JPLT	JPT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

SUB-AREA RUNOFF COMPUTATION
 WATERS TO BOZEMAN RESERVOIR

INFLW	1045	TAREA	SWAP	THSDA	THSPC	RATIO	ISNOW	ISLWE	LOCAL
1	1	1.50	0.00	.50	0.00	0.000	0	1	0

PRECIP DATA

DATE	PWS	RA	R12	R24	RA8	R72	R96
0.00	23.00	113.00	123.00	137.00	147.00	0.00	0.00

TABLE COMPUTED BY THE PROGRAM IS .000

LOSS DATA

LEOPT	STAGE	DLTDR	RTIOL	FRIN	STRES	RTIOW	STRTL	CWSTL	ALSW	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

STAGE	RECESSION DATA
1	STAGE -1.59 GRCSVA -.05 RTIORS 2.00

UNIT HYDROGRAPH & END-OF-PERIOD ORDINATES, LAGS .89 HOURS, CPU .44 VOL% 1.00
 79. 213. 200. 97. 37. 15. 0. 2.

MO,DA #H,MN PERIOD RAIN EXCS LOSS COMP 0 MO,DA #H,MN PERIOD RAIN EXCS LOSS COMP 0

SUM 76.13 23.73 7.40 18278.
 (665.11 603.11 61.11 665.06)

.....

HYDROGRAPH ROUTING

ROUTING THROUGH ROTEMTOON RESERVOIR

ISTAV	ICOMP	IECON	ITAPE	JPLT	JRBT	INAME	ISTAGE	IAUTO
OUTFLOW	1	0	0	0	0	1	0	0
GLDSS	GLDSS	AVG	ROUTING DATA	ISAMP	ISAMP	ISAMP	LSTM	
0.0	0.00	0.00	1	1	0	0	0	
NSIPS	ASTDL	L4G	EMSK	Z	TSS	STOMA	ISPRAT	
1	0	0	0.000	0.000	0.000	-625.	0	

SURFACE AREA 0. 9. 22.
 CAPACITY 0. 185. 311.
 ELEVATION 545. 645.

COEL NSPID COOP EXP LLFVL COOL CASEA FIPL
 625.0 20.0 3.1 1.5 0.0 0.0 0.0 0.0

TOPEL COOL FIPO DAMWID
 625.7 3.1 1.5 600.

PEAK OUTFLOW IS 315. AT TIME 01.50 HOURS

PEAK OUTFLOW IS 480. AT TIME 01.50 HOURS

PEAK OUTFLOW IS 602. AT TIME 01.00 HOURS

PEAK OUTFLOW IS 1076. AT TIME 01.00 HOURS

PEAK OUTFLOW IS 1198. AT TIME 01.00 HOURS

PEAK OUTFLOW IS 1303. AT TIME 00.50 HOURS

PEAK OUTFLOW IS 1561. AT TIME 01.00 HOURS

PEAK OUTFLOW IS 1700. AT TIME 01.00 HOURS

PEAK OUTFLOW IS 1936. AT TIME 01.00 HOURS

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 MILLS (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				.79	.30	.40	.50	.40	.70	.00	.00	1.00
HYDROGRAPH AT INFLOW	1	.50	387.	596.	704.	993.	1191.	1300.	1500.	1707.	1905.	
	1.20	11.26	16.87	22.09	28.11	33.73	39.35	44.97	50.60	56.22		
ROUTED TO OUTFLOW	1	.50	315.	449.	642.	1076.	1195.	1303.	1501.	1706.	1930.	
	1.20	9.92	13.50	18.75	30.97	33.03	39.10	44.20	49.40	54.76		

2

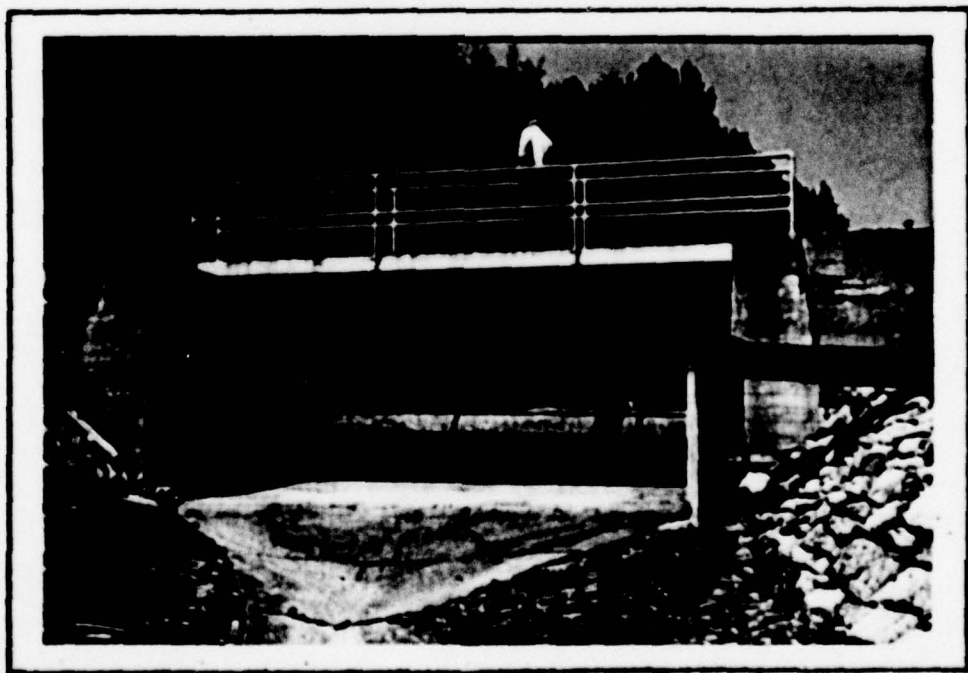
APPENDIX

D

Photographs



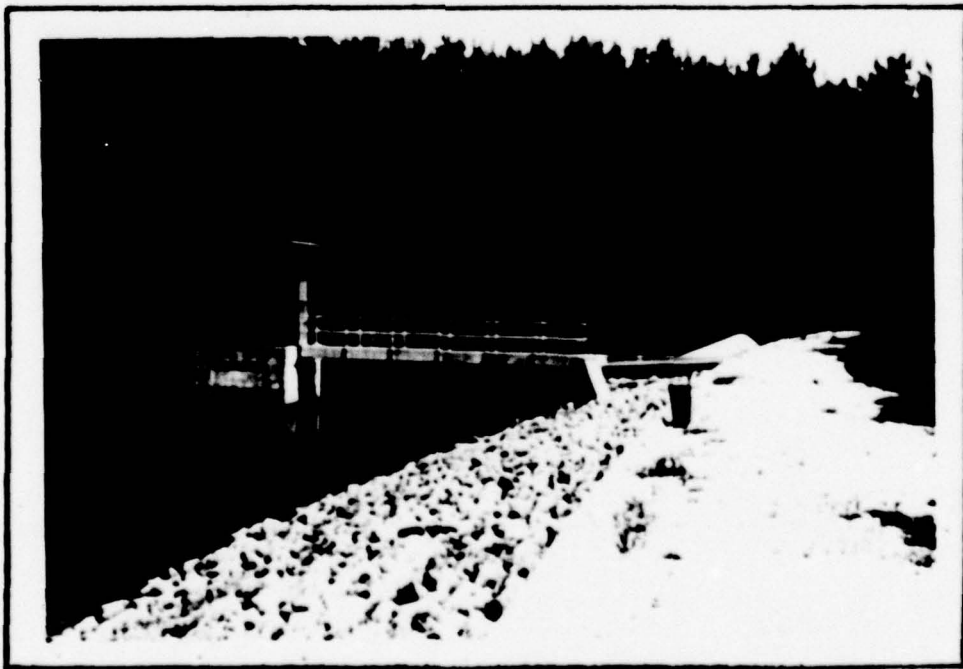
*UPSTREAM VIEW OF THE SPILLWAY
NEAR THE RIGHT ABUTMENT*



DOWNSTREAM VIEW OF THE SPILLWAY



*VIEW OF THE OUTLET END OF 12 INCH DIAMETER
PIPE WHICH CARRIES WATER FROM TROUT RUN
RESERVOIR 2 MILES TO THE WEST*



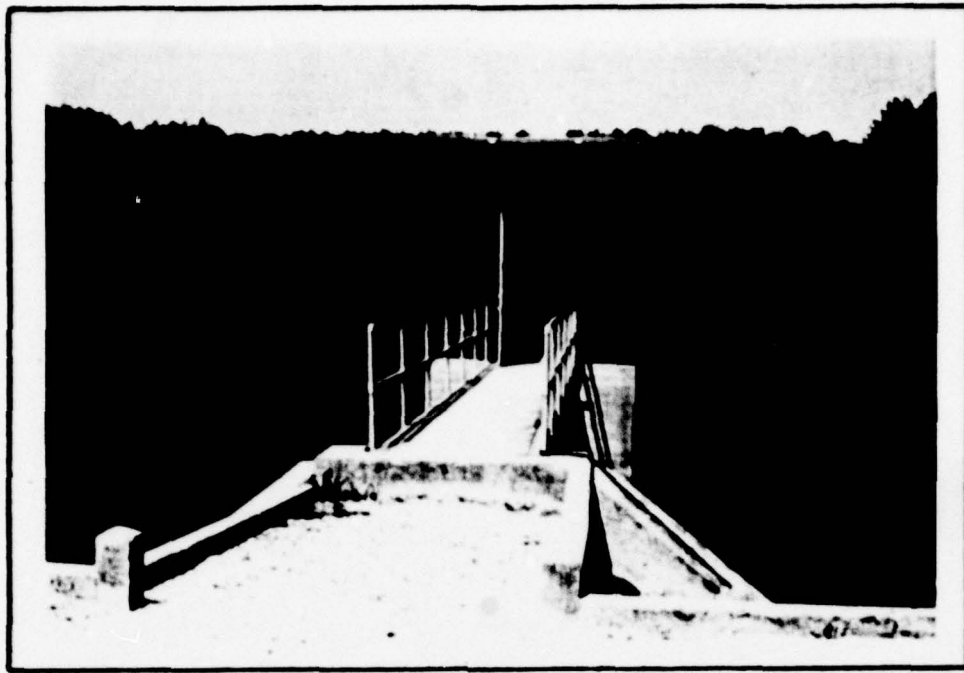
*UPSTREAM FACE AND CREST OF THE DAM
SHOWING THE GATEHOUSE, CATWALK AND
CURBING ALONG THE TOP OF THE DAM*



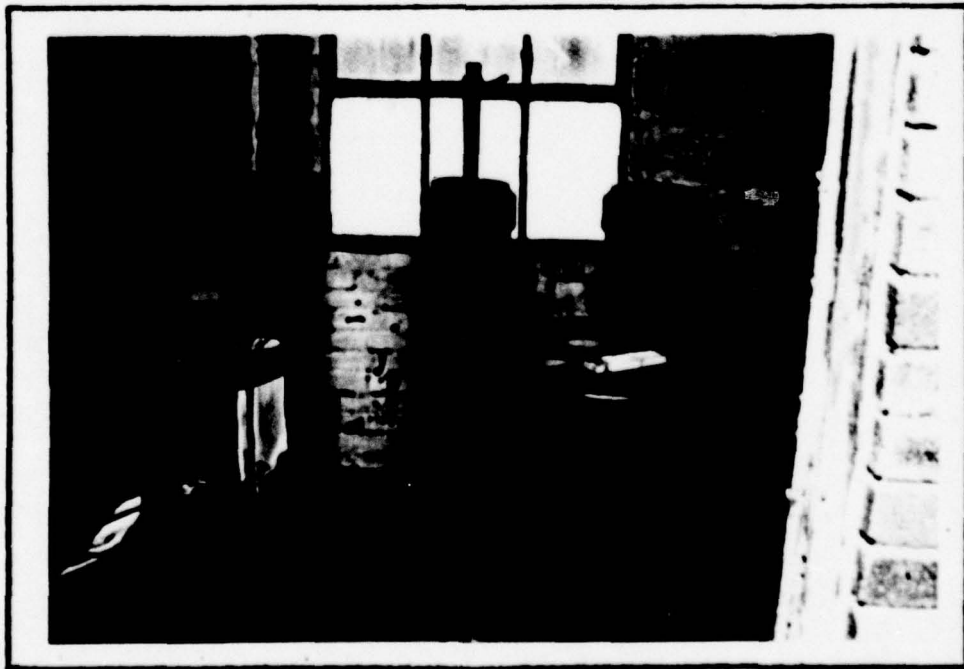
*THE SPILLWAY DISCHARGE CHANNEL AS
VIEWED FROM THE CREST OF THE DAM*



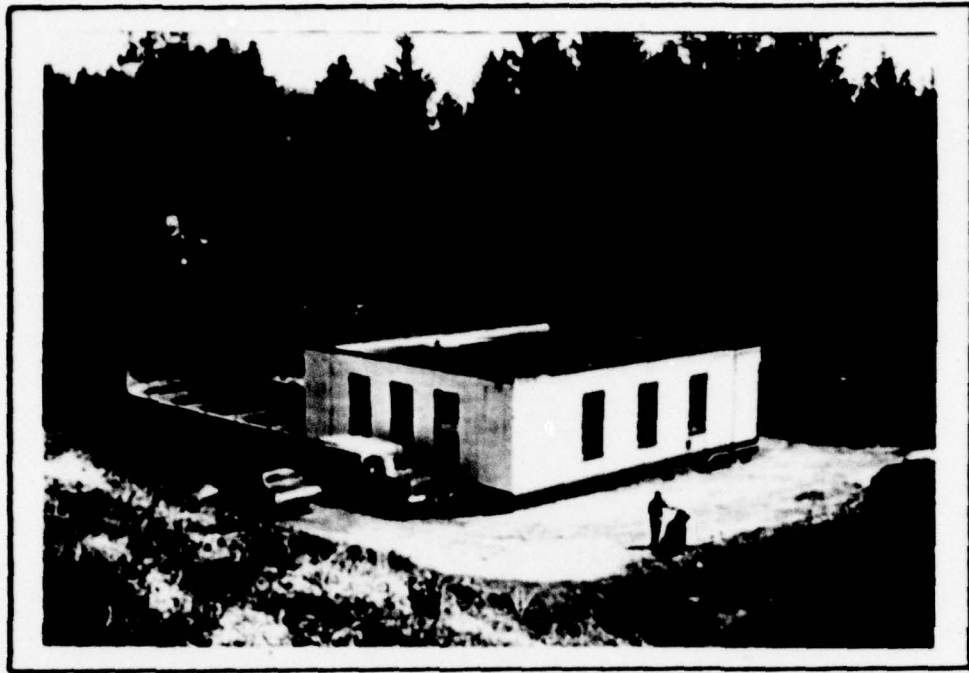
*THE SPILLWAY DISCHARGE CHANNEL
CULVERTS BENEATH THE ACCESS ROAD*



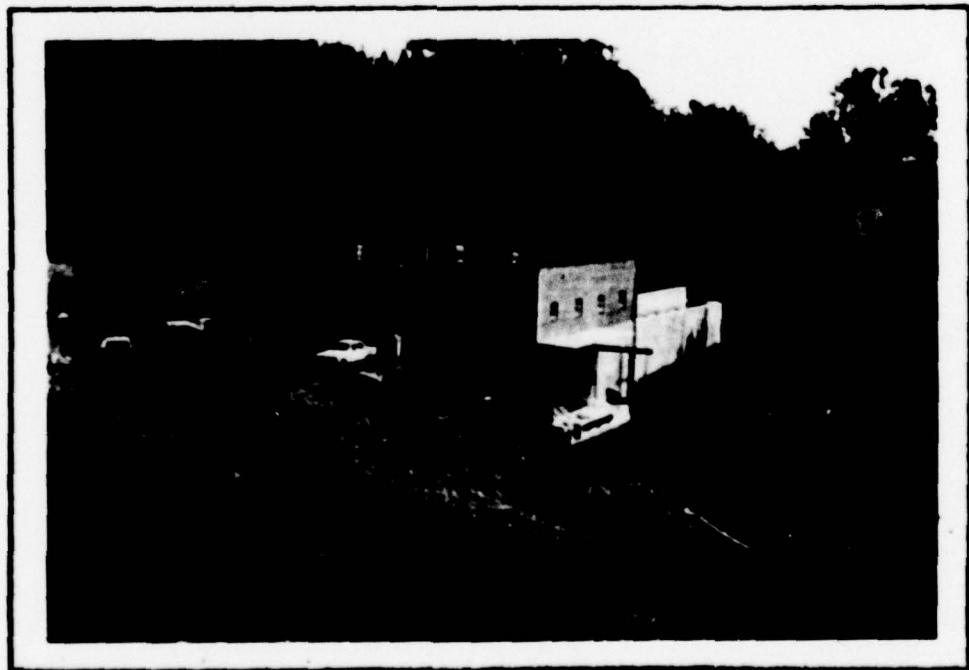
*VIEW OF THE GATEHOUSE LOOKING
TOWARDS THE RESERVOIR*



*INTERIOR VIEW OF THE GATEHOUSE
SHOWING THE GATE HOISTS*



*THE TREATMENT PLANT BUILT IN 1926 LOCATED
AT THE DOWNSTREAM TOE OF THE DAM*



*THE NEW TREATMENT PLANT LOCATED DOWNSTREAM
OF THE LEFT ABUTMENT OF THE DAM*

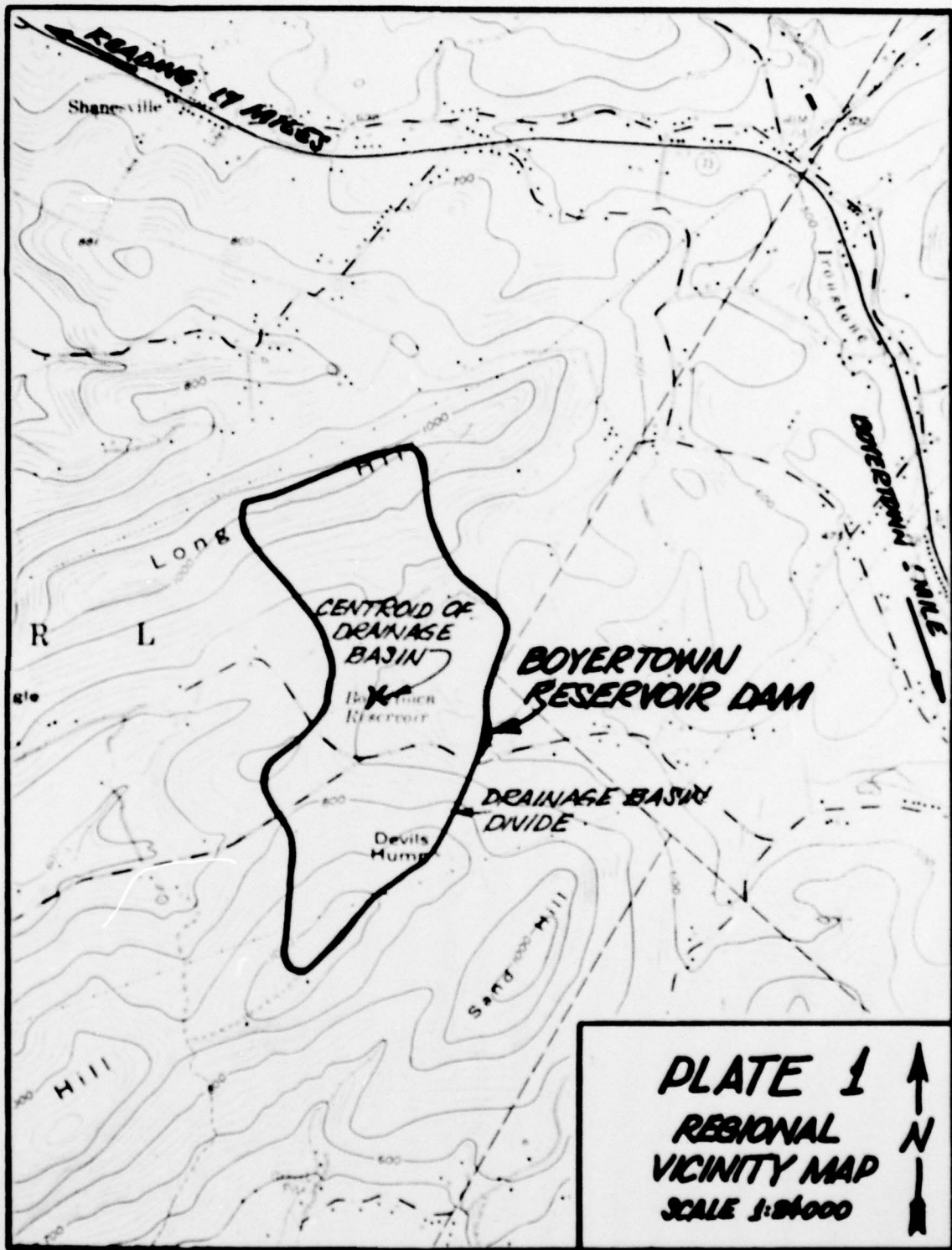
APPENDIX

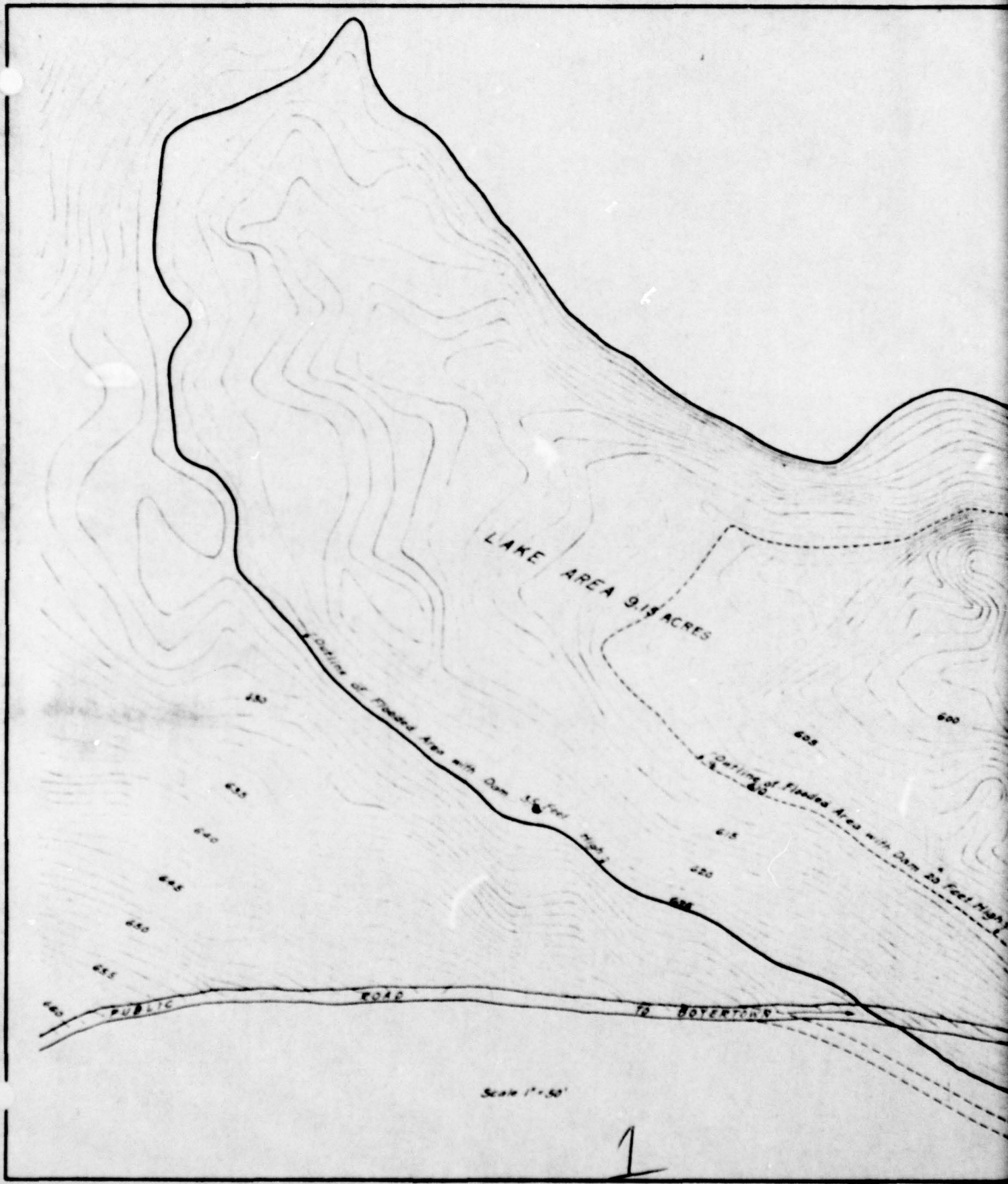
E

Drawings

TABLE OF CONTENTS - APPENDIX E

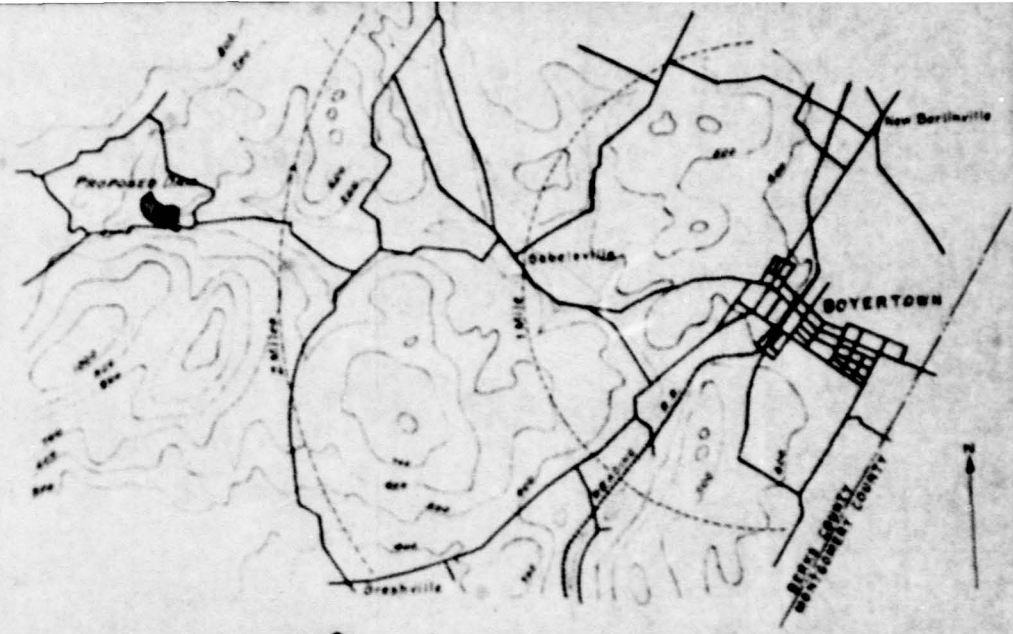
REGIONAL VICINITY MAP	PLATE 1
LOCATION PLAN DAM AND IMPOUNDMENT (1925)	PLATE 2
SECTIONS AND GENERAL DETAILS OF DAM (1924)	PLATE 3
SUPPLEMENTARY DETAILS OF DAM (1926)	PLATE 4
PLAN AND DETAILS OF SPILLWAY	PLATE 5
PLAN VIEW OF DAM SHOWING PROBLEM AREAS	PLATE 6
TOP OF DAM PROFILE LOOKING DOWNSTREAM	PLATE 7



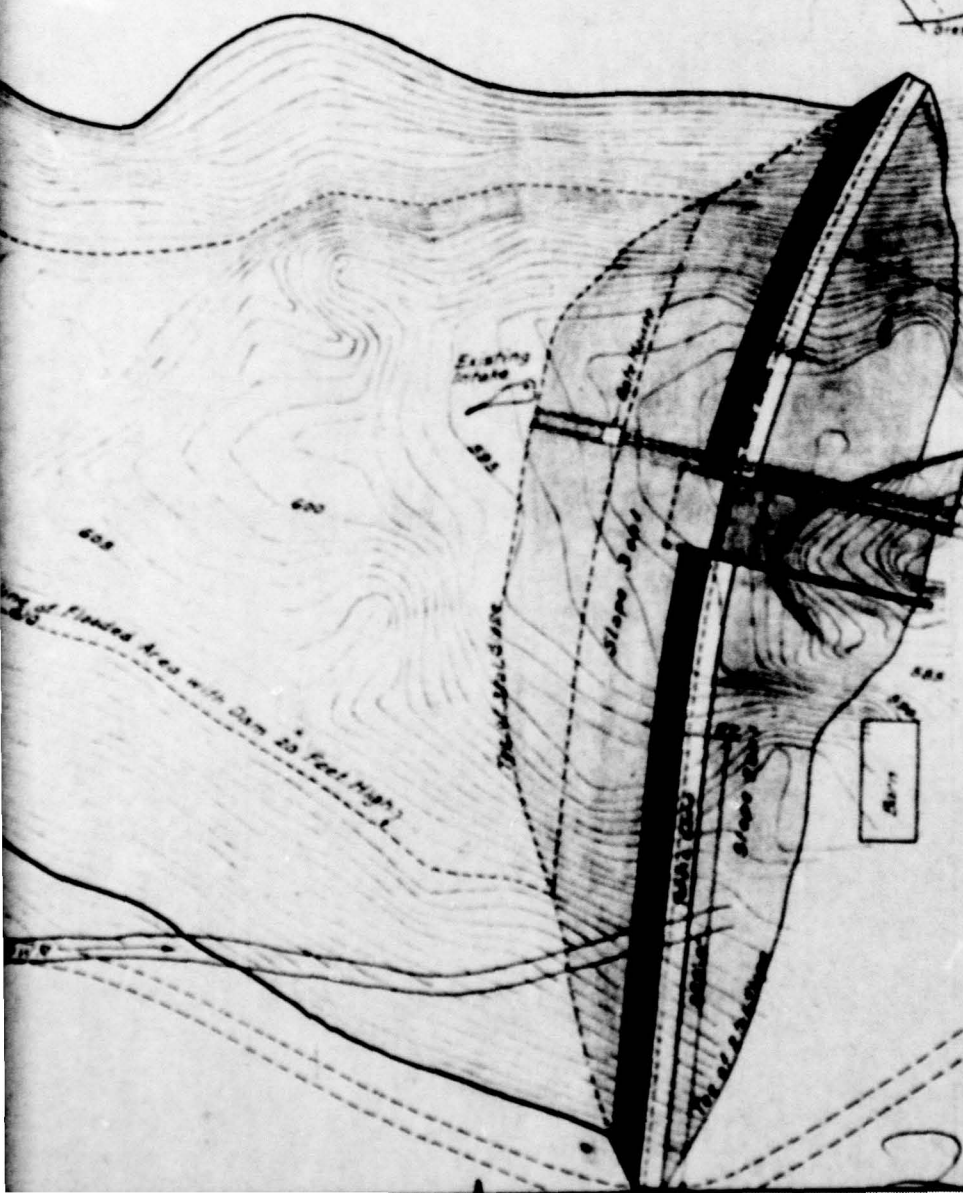


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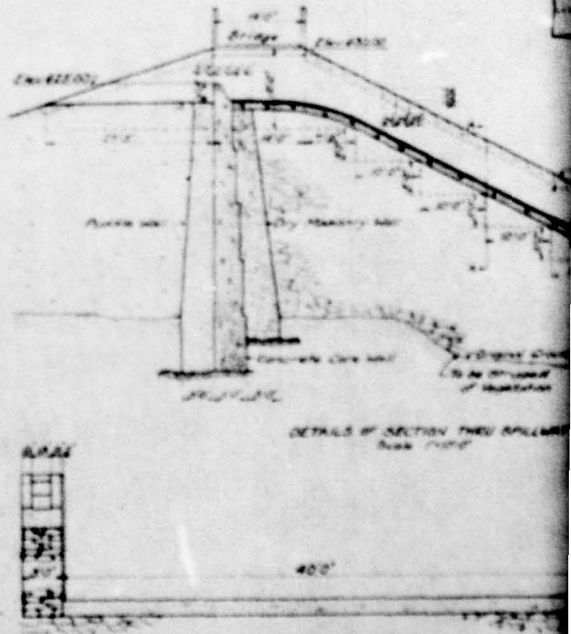
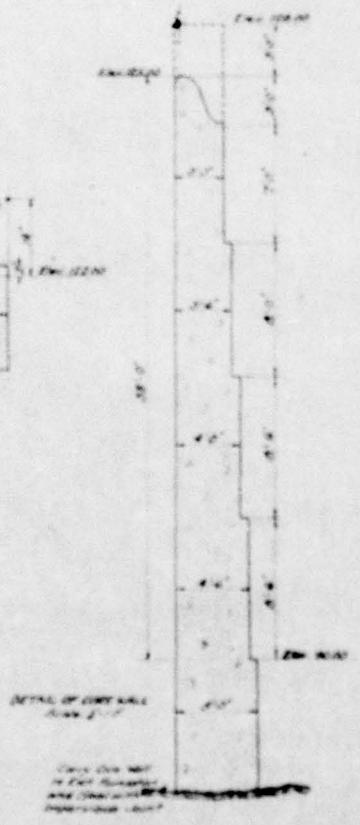
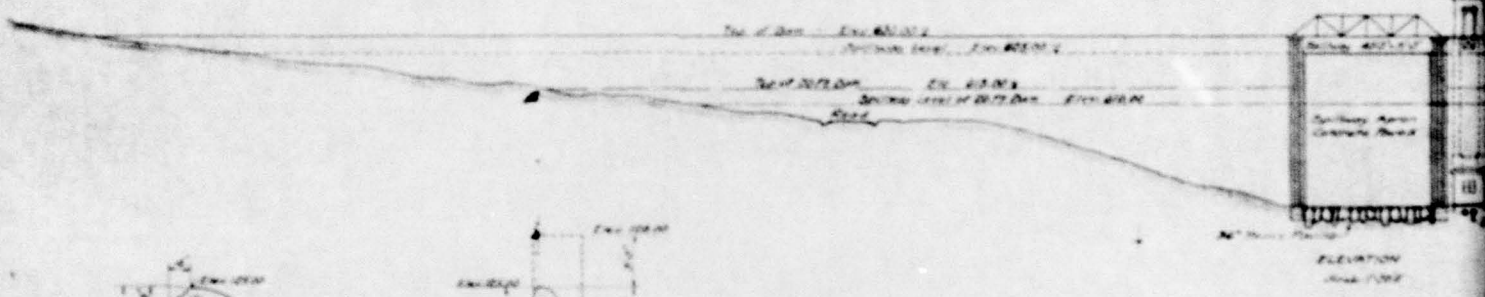
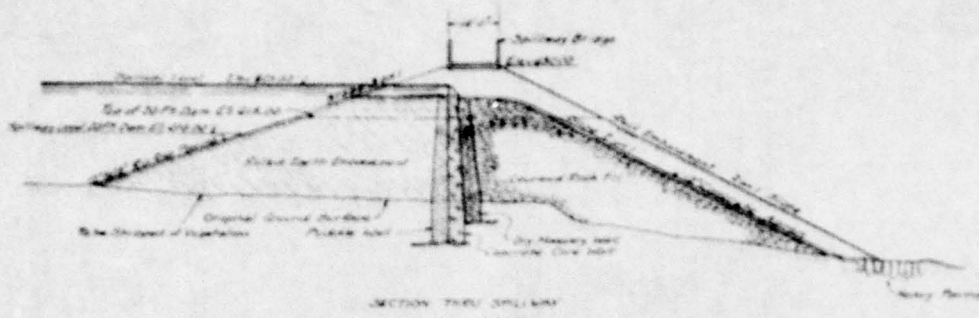
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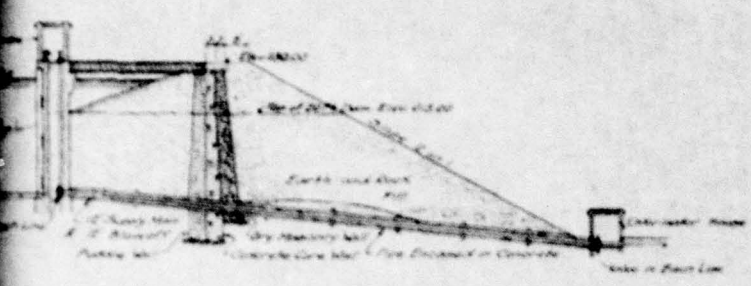
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 For Details of Construction
 See Sheet 107-12E

PLATE 2

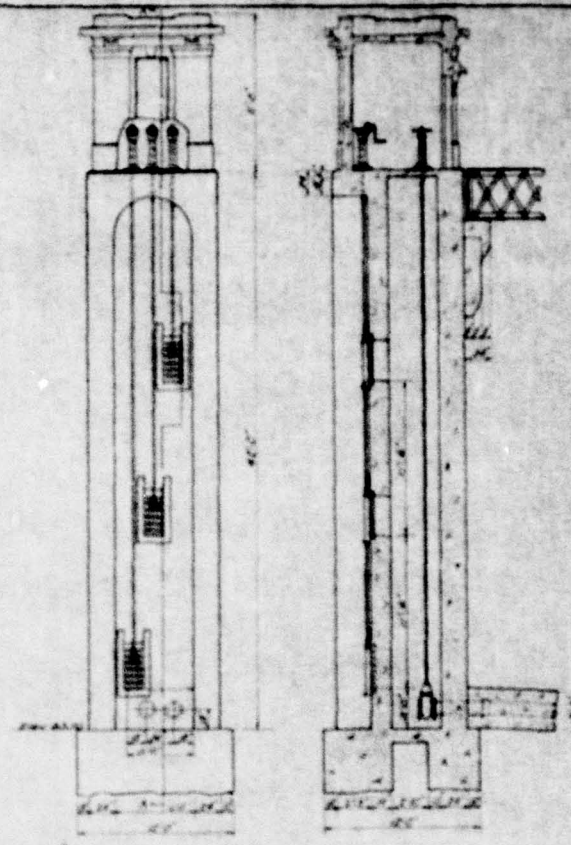
WM. H. DECHANT and SONS
 Reading, Pa.
 CLIENT - BOROUGH OF BOYERTOWN
 Berks Co., Pa.
 DESCRIPTION - Topographical Survey
 and Location Plan for Impounding
 Dam.
 January 13, 1925
 Order 8187-E
 Scale - Shown
 File 107-11E



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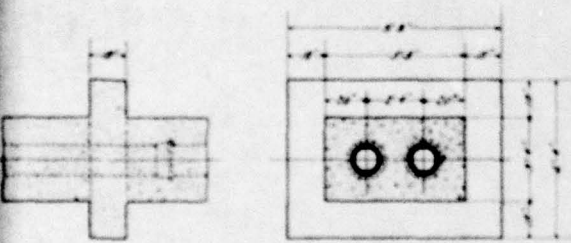
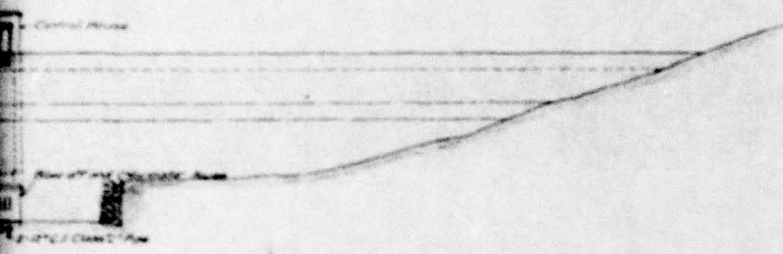
SECTION THROUGH GUYWIRE MASS
Scale 1/4\"/>



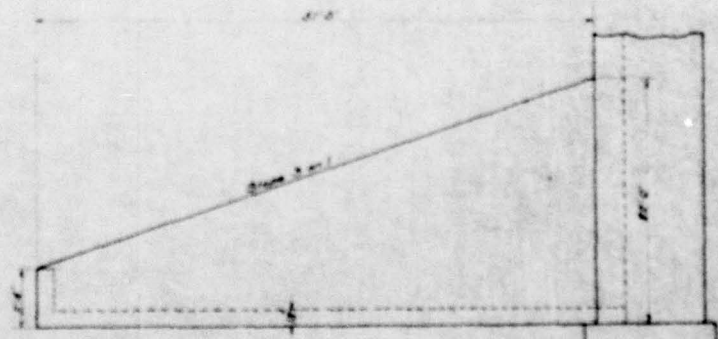
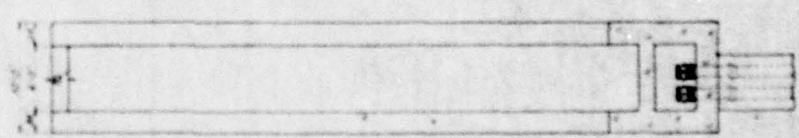
ELEVATION OF GUYWIRE MASS
SECTION A-A
Scale 1/4\"/>



ELEVATION OF BUCKET
Scale 1/4\"/>



SECTION THROUGH PIPE CROSS
Scale 1/4\"/>



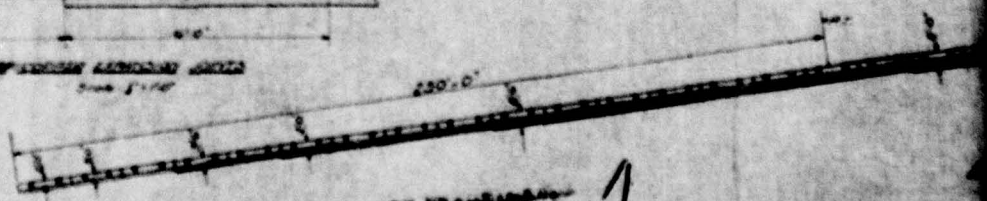
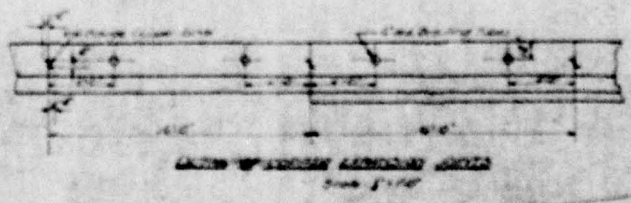
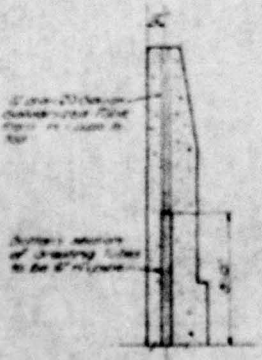
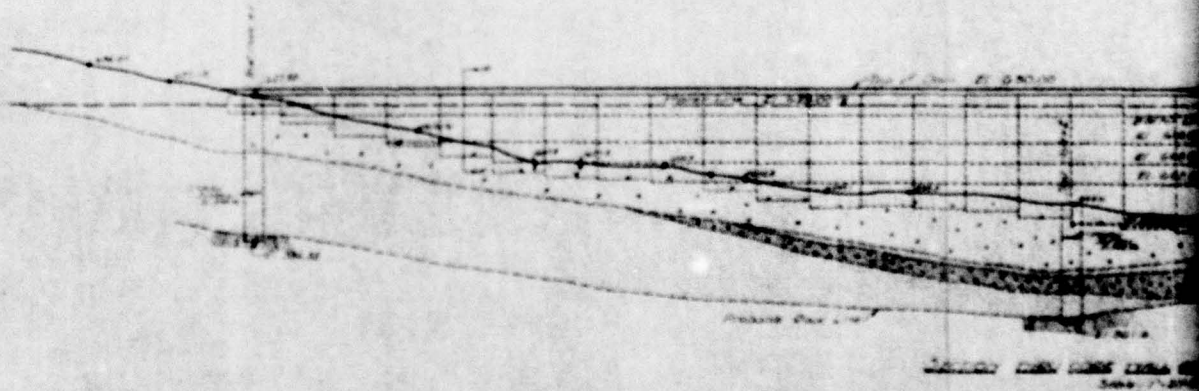
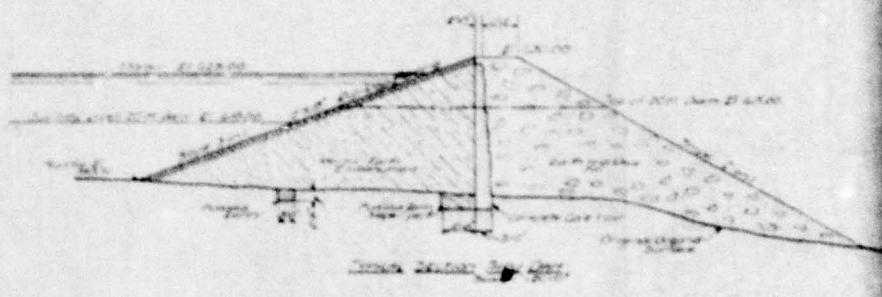
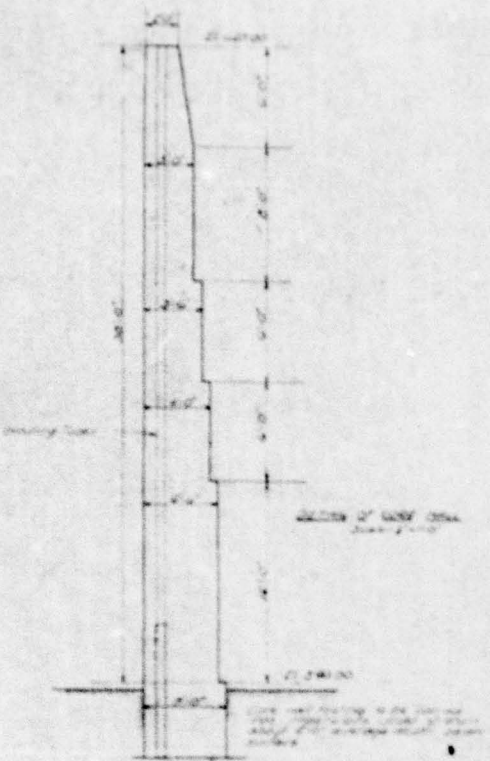
SECTION THROUGH PIPE CROSS
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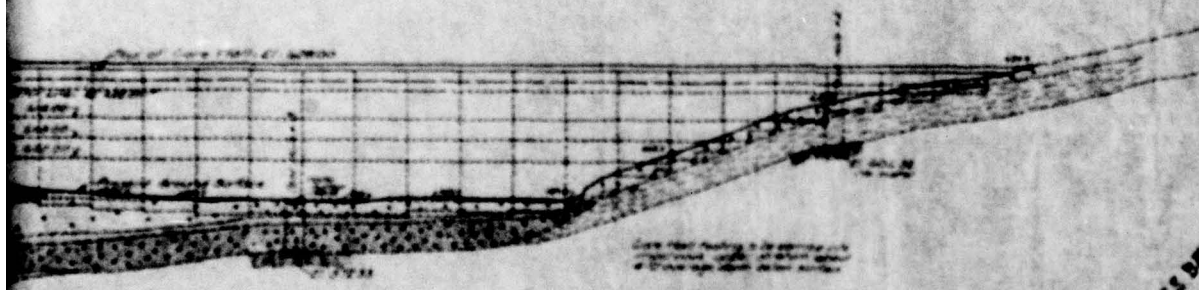
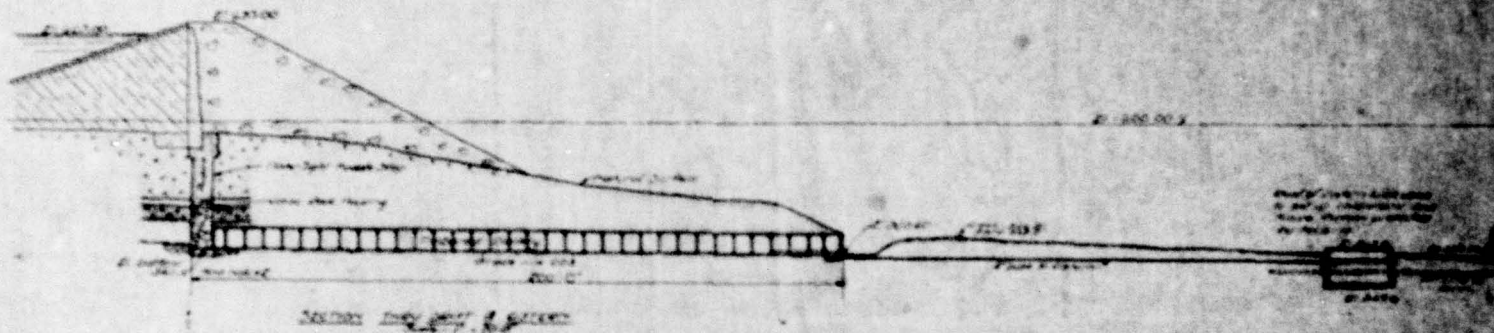
W. H. DECHANT and SONS
 Engineers
 1100 - BROADWAY
 New York
 Details for Engineering
 Dec 27 1904
 Order 887C
 File 107-87C

2



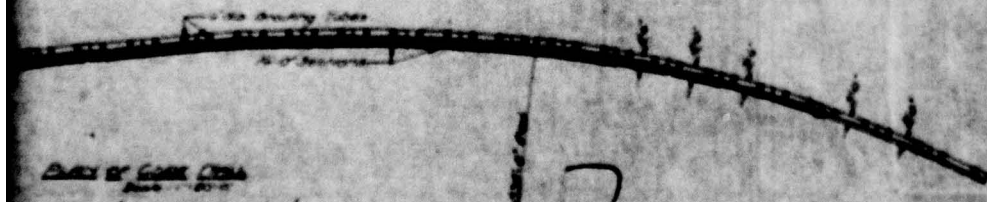
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	Concrete
	Gravel
	Earth
	Water
	Steel



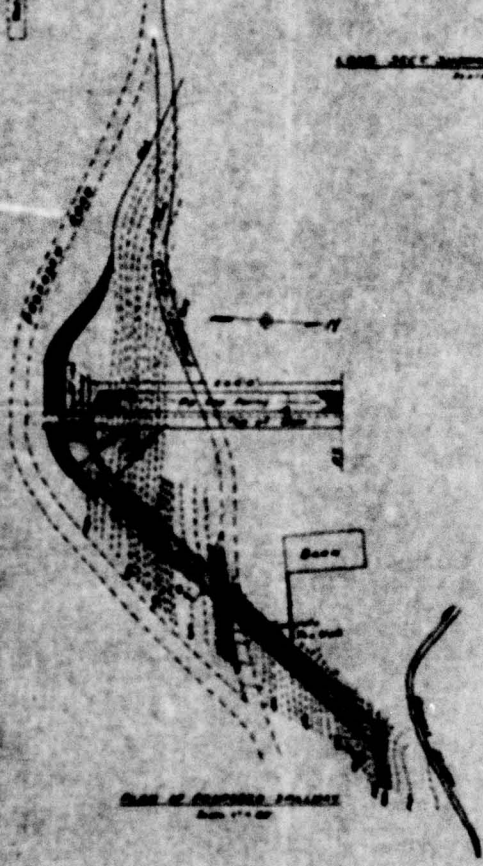
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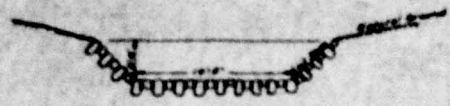
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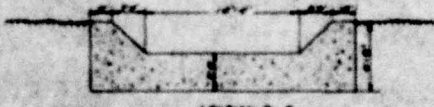
PLAN OF BRIDGE STRUCTURE



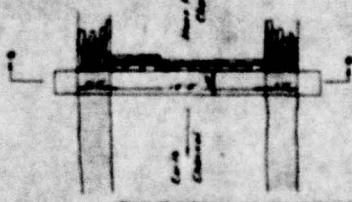
PLAN OF BRIDGE STRUCTURE



SECTION 5-5 (TYPICAL SECTION)



SECTION 6-6



PLAN OF BRIDGE AT END OF PIER



PLAN OF BRIDGE AT END OF PIER

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THE BEST METHOD OF CONCRETE SPALLS
 1914

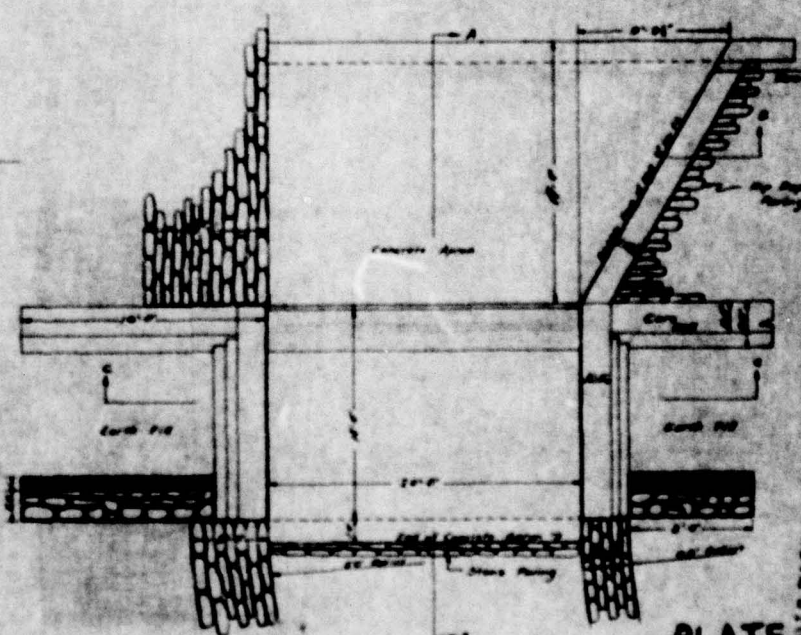
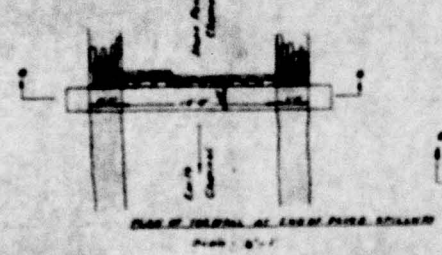
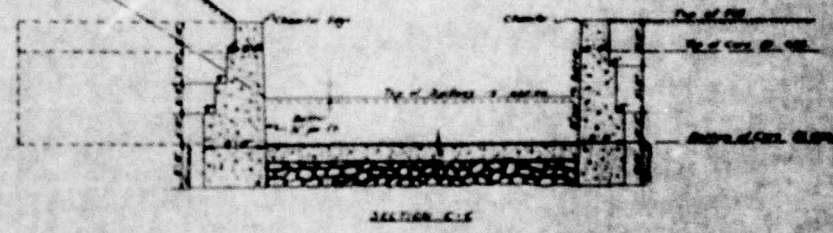
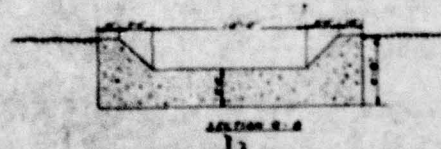
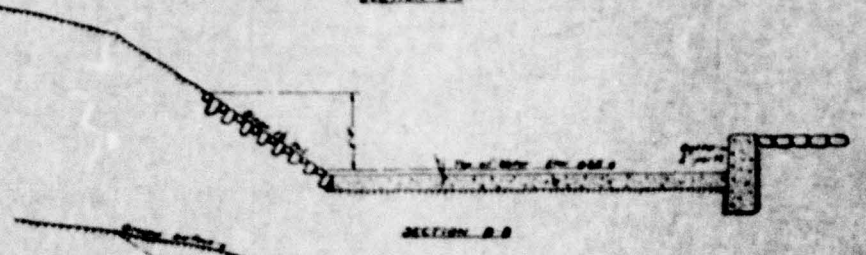
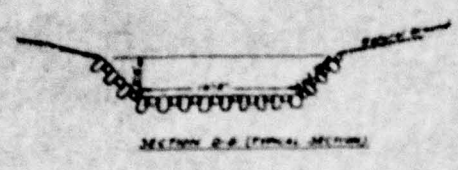
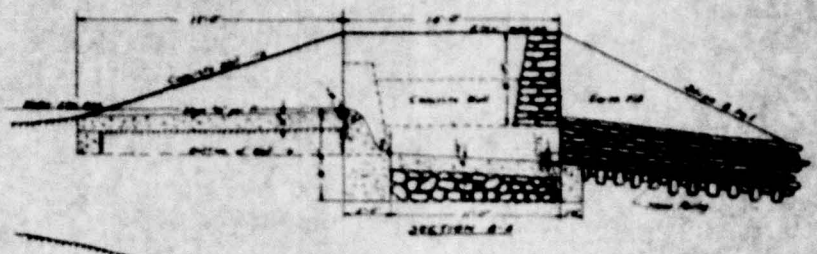


PLATE 8

DR. H. DECHERT & SONS	
Engineers	San Francisco, Cal.
Contract	Plan of Structures
Specification	Plan and Details of Spalling
Scale	1/4" = 1'-0"

THE BEST METHOD OF CONCRETE SPALLS
 1914

1

1 2

THE BEST METHOD OF CONCRETE SPALLS
 1914

SUBJECT BOYERTOWN DAM	SHEET	BY	DATE	JOB NO
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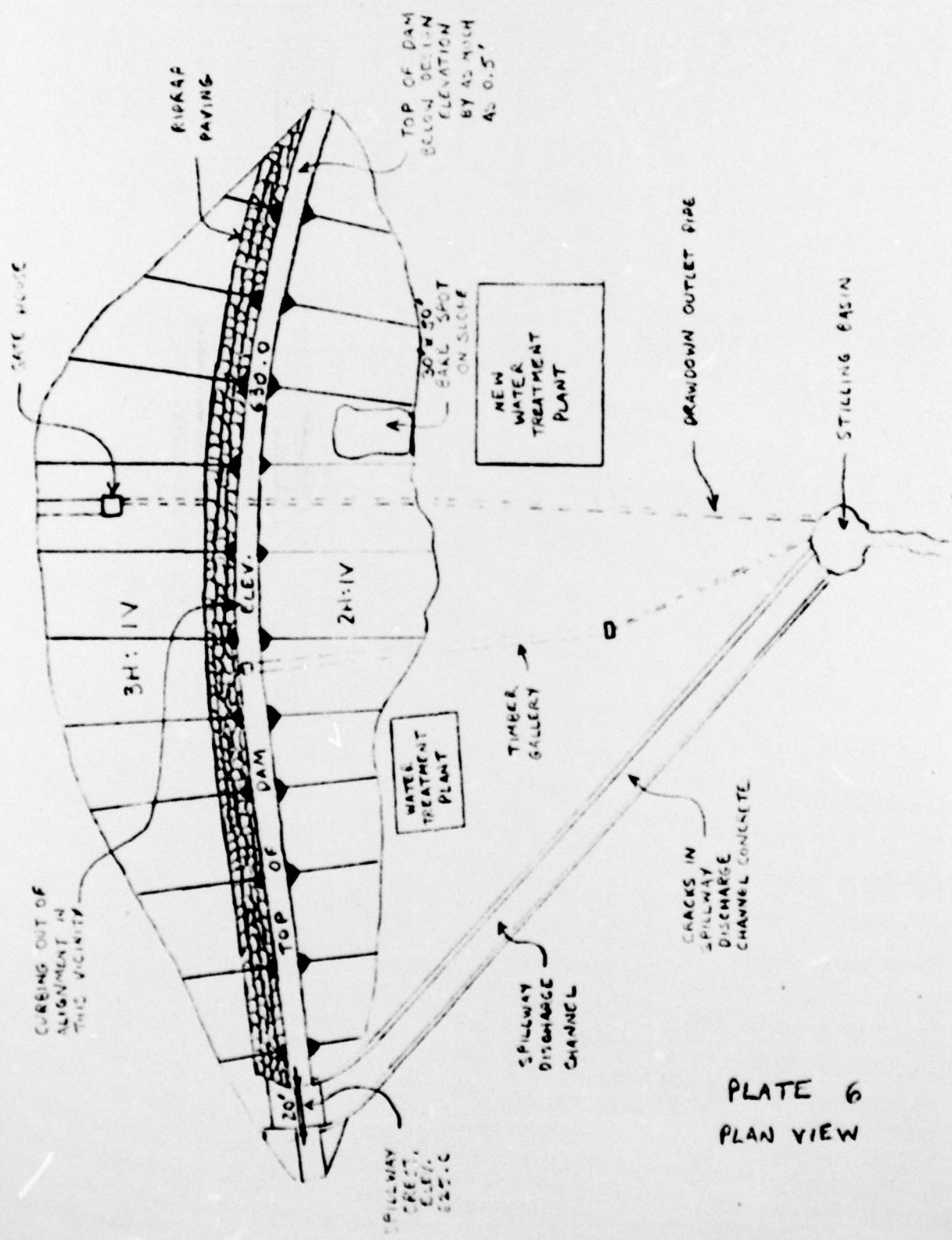
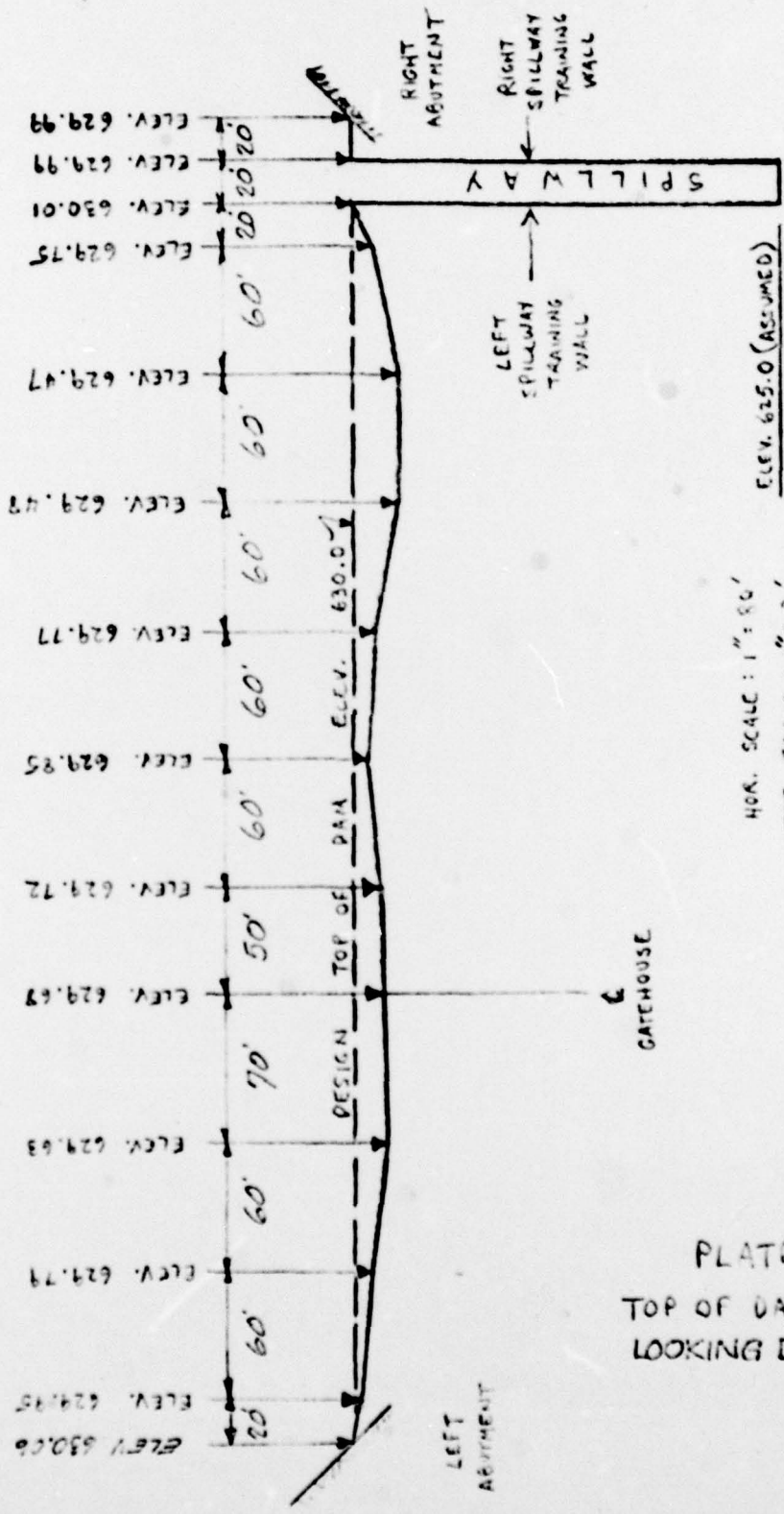


PLATE 6
PLAN VIEW

SUBJECT	BOYERTOWN DAM	SHEET	BY	DATE	JOB NO.
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ELEV. 635.0 (ASSUMED)

HOR. SCALE : 1" = 50'
VERT. SCALE : 1" = 2'

PLATE 7
TOP OF DAM PROFILE
LOOKING DOWNSTREAM

APPENDIX

F

Site Geology

SITE GEOLOGY

Boyertown Dam is located in the Reading Prong of the New England Uplands physiographic province. The crystalline rocks in this province are folded and highly faulted complex Precambrian metamorphics. Bedrock at the dam site is probably a granitic gneiss. However, inspection of the upper reaches of the reservoir indicated the presence of quartzite which comprises the Hardyston Formation.

