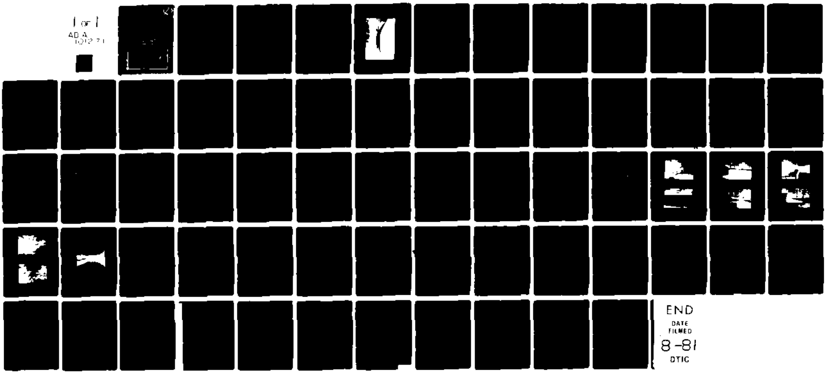
AD-A101 271 BERGER ASSOCIATES INC HARRISBURG PA F/G 13/13
NATIONAL DAM INSPECTION PROGRAM. BLACK CREEK INTAKE DAM (NDI NU--ETC(U)
JUN 81 H JONGSMA DACW31-81-C-0013

UNCLASSIFIED NL



LEVEL II

SUSQUEHANNA RIVER BASIN

BLACK CREEK INTAKE DAM

PINE GROVE WATER WORKS

(NDI NO. PA-00695
DER NO. 54-078)

SCHUYLKILL COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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

BY
Berger Associates
Harrisburg, Pennsylvania 17105
Contract DACW31-81-C-0018

JUNE 1981

PREFACE

This report has been 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

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

Name of Dam:	BLACK CREEK INTAKE DAM
State & State No.:	PENNSYLVANIA, 54-078
County:	SCHUYLKILL
Stream:	BLACK CREEK
Date of Inspection:	MARCH 26, 1981

Based on the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in good condition, with the exception of the growth of trees on the downstream slope.

In accordance with the Corps of Engineers' evaluation guidelines, the size classification of this dam is small and the hazard classification is significant. These classifications indicate that the Spillway Design Flood (SDF) should be in the range of the 100 year flood to one-half the Probable Maximum Flood (PMF). The recommended SDF for this flood control structure is the 100 year flood. The spillway capacity is sufficient for passing the SDF without overtopping the dam. The spillway, therefore, is considered to be adequate.

The following recommendations are presented for immediate action by the owner:

1. That the downstream slope and an area 10 feet beyond the toe be cleared of all trees and brush and be provided with a protective vegetative cover. The removal of trees should be under the direction of an engineer experienced in the design and construction of dams.

2. That the embankment be maintained on a regular basis to prevent growth of weeds, brush and trees.

3. That the valves in the valve pits and the downstream valve on the blowoff line be made operable and maintained on a regular basis.

11 Jun 81

12 64

BLACK CREEK INTAKE DAM NDI NO. PA-00695 DER NO. 54-078

PINE GROVE WATERWORKS SCHUYLKILL COUNTY

4. That a formal surveillance and downstream warning system be developed for use during periods of high or prolonged rainfall.

5. That an operation and maintenance manual be prepared for guidance in the operation of the dam during normal and emergency conditions, and that a schedule be developed for the annual inspection of the dam and its appurtenant structures.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: June 5, 1981

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
10 HENDRIK JONGSMA
ENGINEER
No. 5537E

APPROVED BY:

James W. Peck

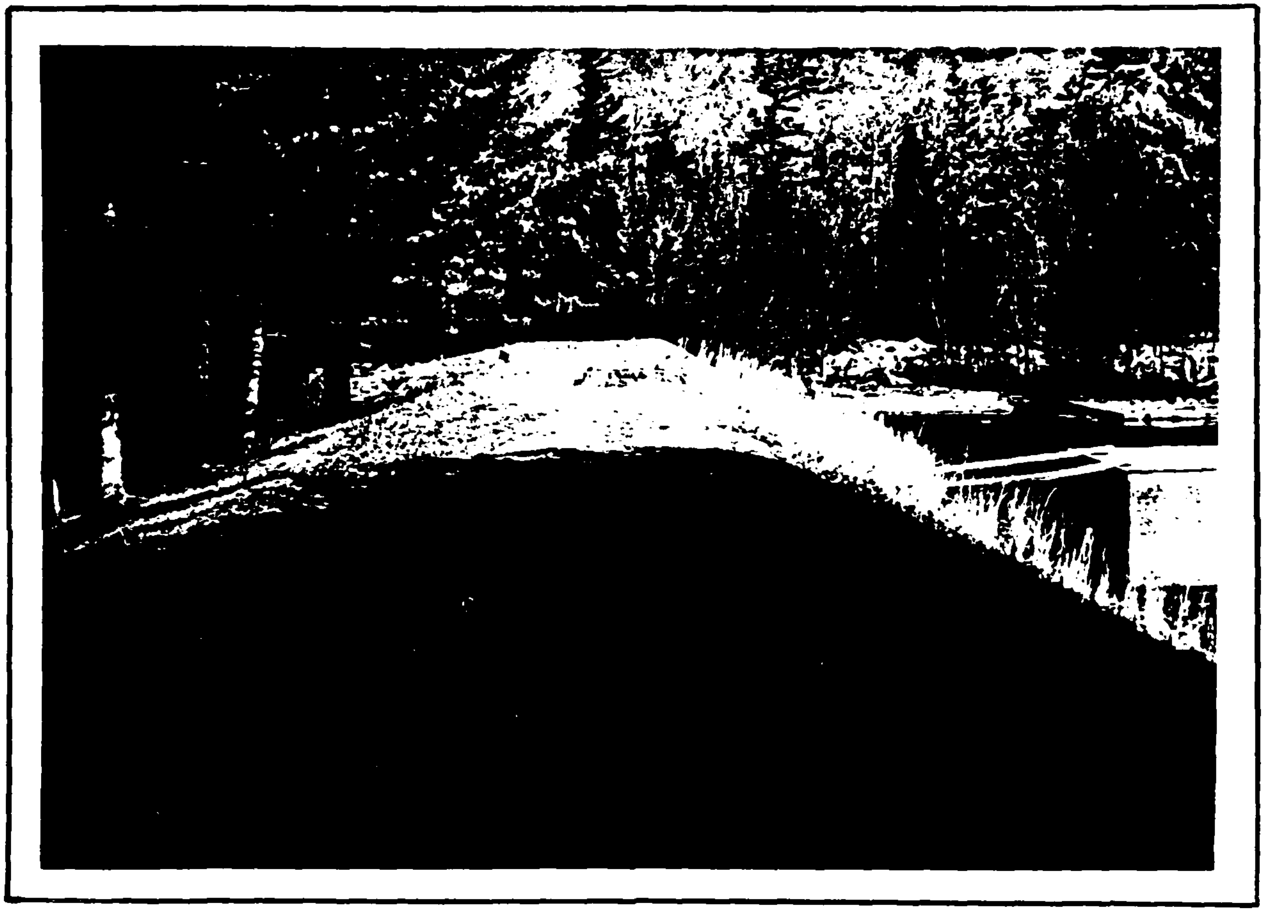
JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

DATE: 17 June 1981

6 National Dam Inspection Program. Black Creek Intake Dam (NDI Number PA-00695, DER Number 54-078), Susquehanna River Basin, Schuylkill County, Pennsylvania. Phase I Inspection Report,

15 DACW31-81-C-0013

411003



OVERVIEW

BLACK CREEK INTAKE DAM

Photograph No. 1

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BLACK CREEK INTAKE DAM

NDI NO. PA-00695
DER NO. 54-078

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 inspections of dams throughout the United States.

B. Purpose

The purpose of this inspection is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

Note: The normal pool elevation was estimated from the U.S.G.S. quadrangle sheet to be at elevation 770. This elevation is used in this report as the top of spillway elevation. Design drawings indicate elevation 98.0 as weir crest elevation (Plate V, Appendix E).

Black Creek Intake Dam is a 185 foot long earthfill embankment with a maximum height of 20 feet. The reservoir was partially excavated in the side of a mountain and has a large boulder field on its right side. Two valve pits are located on the upstream side of the crest of the dam. Valves in these pits control the flow through a blowoff line and a water supply line. These lines also have valve controls near the downstream toe.

The spillway is located on the right side of the reservoir. Normal low flows are discharged through a 33 foot wide side channel spillway. Larger flows can flow over a low area upstream of this spillway. This water is discharged through a boulder field.

B. Location

Tremont Township, Schuylkill County
U.S.G.S. Quadrangle - Pine Grove, Pa.
Latitude 40°-36.3', Longitude 76°-22.5'
Appendix E, Plates I & II

C. Size Classification: Small: Height - 20 feet
Storage - 90 acre-feet

D. Hazard Classification: Significant (Refer to Section 3.1.E.)

E. Ownership: Pine Grove Waterworks
Mr. M. Herring
Borough Works Manager
17 Mifflin Street
Pine Grove, PA 17963

F. Purpose: Water Supply

G. Design and Construction History

The first construction at this site took place in 1916. The Pennsylvania Department of Natural Resources (PennDER) issued a permit on July 6, 1916, for the construction of a concrete intake structure (Plate III, Appendix E). The designer was Mr. Edgar Weimer, Lebanon, Pennsylvania.

Construction, as a Work Project Administration (WPA) project, started in 1934 to enlarge the reservoir storage. Fill was placed for the dam and a dike on the left side of the reservoir. Mr. Weimer submitted plans in 1937 (Plate IV), and a permit was issued on September 23, 1937.

In 1939, an application was filed for a permit to make changes to the spillway discharge channel. The accompanying drawing, prepared by Mr. Fred Hatter, indicates that the surveyed condition varied from Plate IV. The revised surveyed condition is shown on Plate V, Appendix E. This drawing includes a 140 foot extension of the spillway channel at the downstream end, which was added in 1941.

H. Normal Operating Procedures

Operating procedures for this dam do not exist. The valves at the dam site are not used. All inflow above the normal pool level is discharged over the spillway.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

From files:	6.8
Computed for this report:	6.0
Use:	6.0

B. Discharge at Dam Site (cubic feet per second)
See Appendix D for hydraulic calculations.

Maximum known flood (estimated from records of U.S.G.S. gage on nearby West Branch Schuylkill River, September, 1975)	518
Outlet works at pool Elev. 770	9
Outlet works at low pool Elev. 761	4
Spillway capacity at pool Elev. 778 (low point of dam)	11,498

C. Elevation (feet above mean sea level)

Top of dam (low point as surveyed)	778
Top of dam (design crest)	776
Spillway crest	770
Upstream invert of 10" blowoff pipe	758
Downstream invert of 10" blowoff pipe	758
Streambed at downstream toe of dam (estimate)	758

D. Reservoir (miles)

Length of normal pool (Elev. 770)	.1
Length of maximum pool (Elev. 778)	.3

E. Storage (acre-feet)

Spillway crest (Elev. 770)	28.4
Top of dam (Elev. 778)	90

F. Reservoir Surface (acres)

Spillway crest (Elev. 770)	3.1
Top of dam (Elev. 778)	14.5

G. Dam

Refer to Plate V in Appendix E for plan and section.

Type: Earthfill.

Length: 185 feet.

Height: 20 feet.

Top Width: Design - 12 feet; Survey - 15 feet.

Side Slopes:

	Design	Surveyed
Upstream	2H to 1V	1.85H to 1V
Downstream	3.5H to 1V	3.7H to 1V

Zoning: Clay core wall.

Cutoff: Clay core wall.

Grouting: None.

H. Outlet Facilities

Type: 10" diameter blowoff pipe. Note: a 20" blowoff line shown on Plate IV was not located in the field.

Inlet Elevation: 758±

Closure: One valve in pit near centerline of dam and one valve near downstream toe.

Location: Near right end of dam.

I. Spillway

Principal:

Type: Concrete broad crested weir.

Length of Weir: 32.8 feet.

Crest Elevation: 770

Location: At right end and perpendicular to embankment.

Overflow Section:

Type: Earth and rock lined, broad crested weir.

Location: Extension of principal spillway on right side.

J. Regulating Outlets

See Section 1.3.H. above.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The available engineering data for Black Creek Intake Dam are limited to the information shown on two drawings (Plates IV & V, Appendix E). Plate V indicates the surveyed condition in 1941, which varies from the design shown on Plate IV. There are no calculations for embankment design or for hydrologic or hydraulic studies. Test boring data are not available.

2.2 CONSTRUCTION

Construction data for these facilities are limited. The actual construction took place as a W.P.A. project during the years between 1934 and 1940. Construction of the reservoir started in 1934. Several unrecorded changes did occur. In 1940, the available records indicate that the spillway discharge channel was extended to its present limits.

2.3 OPERATION

Records of operation are not maintained by the owner. Inspection reports by PennDER indicate that the flow of water at the toe has been in existence since 1941.

2.4 EVALUATION

A. Availability

The available engineering data are located in the files of PennDER, Harrisburg, Pennsylvania.

B. Adequacy

The available engineering data combined with the visual inspection are considered to be sufficiently adequate to make a reasonable assessment of the dam.

C. Operating Records

Operating records, including maximum pool levels, have not been maintained by the owner.

D. Post Construction Changes

Assuming that final construction was completed in 1939, the only post construction change is the extension of the spillway discharge channel by a length of 140 feet in 1940.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of the Black Creek Intake Dam is good, except that a heavy growth of trees covers the downstream slope of the embankment (Photograph No. 2). The slopes appear to be stable. A considerable amount of water was flowing through rocks just beyond the downstream toe near the spillway. This water appears to originate from the spillway channel.

The spillway lies between a masonry abutment wall on the left side and a large boulder field on the right side. The length of the spillway is 32.8 feet. The low overflow section through the boulder field was considered to be part of the spillway in the hydraulic computations (Photograph No. 5). Visual observation indicates that overtopping of the dam is not feasible due to this low lying, large boulder field at the right abutment. Valves on the water supply line and blowoff line have not been operated for at least 15 years.

The visual inspection check list and sketches of the general plan and profile of the dam, as surveyed during the inspection, are presented in Appendix A of this report.

Photographs taken on the day of inspection are reproduced in Appendix C. Mr. Mark Herring, Borough Works Manager, represented the owners during the inspection.

B. Embankment

The dam is located in a long valley and is oriented in a north to south direction. The embankment is about 185 feet long. The left abutment ties into a relatively flat area. This area would be flooded if the embankment overtops. No erosion could occur due to the wide flat surface. The right abutment terminates at the spillway discharge channel and is protected with a stone masonry wall (Photograph No. 7). The upstream slope of the embankment is protected with handlaid riprap. A forty foot long section adjacent to the spillway has been grouted. Some grass and weeds are growing on the upstream slope. The crest of the dam has a cover of short grass and is in good condition.

The downstream slope is covered with large trees and some weeds. The trees vary up to 20 inches in diameter. The slope is relatively flat and irregular (Plate V, Appendix E). Heavy growth prevented the survey of an accurate cross section. Water was running through a rock bed beyond the downstream toe near the spillway discharge channel. Due to the rock lined surface, it was not feasible to estimate the quantity, but it appeared to be significant. Based on the location, it appears that the water comes from the spillway.

C. Appurtenant Structures

The spillway is located in the right bank of the reservoir. The primary overflow section is 32.8 feet long and starts at the toe of the dam. This section is a broad crested weir with a sloping surface (.9 foot drop in the 20 foot width). About 20 feet downstream of the weir the water flow makes a 90 degree turn and flows through a cemented stone, slightly dipped channel past the embankment. A masonry wall several hundred feet long directs the water away from the embankment and its immediate downstream area. At the end of the channel there is a rock lined plunge pool (Photograph No. 9). The right side of the spillway is formed by natural ground. The area is flat and consists of an extensive boulder field. Besides the 32.8 foot primary overflow section, the right bank of the reservoir consists of an additional 190 foot overflow section, slightly higher than normal pool elevation. The upstream section consists of a hand laid, sloped riprap wall. It appears that the overflow section consists of two stone walls. Water flowing through this section will flow partially over the main spillway and partially into the boulder field.

There are two valve pits on the embankment. Valve pit No. 1 is located on the crest. This pit is sealed off, except for one small opening. The borough manager stated that the valve in this pit is not operable. Drawings (Plate IV, Appendix E) indicate that a 20-inch blowoff line is located in the embankment. The downstream end of this pipe was not located. Valve pit No. 2 is located on the upstream slope and is accessible by wooden boards (Photograph No. 1). The cover of this pit consists of a wood plank deck. The borough manager stated that a 10-inch supply line begins in this wet well. The upstream side has screened openings. This supply line has an upstream and a downstream valve which are always left in the open position. A valve is located beyond the downstream toe. This 10-inch valve is buried as is the outlet for the pipe. This valve possibly could be used for drawdown after it is made operable.

An 8-inch pipe near the left abutment (Plate V) has been sealed off and was used in prior years for supply or blowoff.

D. Reservoir Area

The left bank of the reservoir has hand laid riprap protection over a length of 250 feet. The reservoir is surrounded with gentle slopes in the valley between two high and steep ridges. The drainage area is wooded. Two small dams are located upstream of the reservoir. The Black Creek Reservoir No. 2 dam is about 3 miles upstream. This dam has an earth embankment 430 feet long and a 60 foot long spillway weir. About three-quarters of a mile further upstream is the Silt Pond Dam. This dam has a 400 foot long earth embankment and a poorly defined spillway about 46 feet in length.

E. Downstream Channel

The downstream channel is a natural mountain stream through a wooded area. Black Creek joins the Swatara Creek about 6000 feet downstream of the dam. About 1000 feet before joining the Swatara Creek, the stream flows through a flat area with one house and a campground and crosses beneath a local road and State Route 125. A potential hazard to loss of a few lives exists downstream if the dam fails. The hazard category for Black Creek Intake Dam is considered to be "Significant."

3.2 EVALUATION

The overall visual evaluation of these facilities indicates that the dam is in good condition. The trees on the embankment should be removed. The observed steady seepage beyond the toe of the embankment adjacent to the spillway outlet channel has been a long standing condition (40± years) and is not considered to be a serious problem at this time. It is recommended that the valves in valve pit No. 2 and the blowoff valves on the 10-inch line be made operable.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The operational procedures for Black Creek Dam are very limited. The facilities are visited by the Borough Works Manager on a daily basis, mostly as a policing function of the area. The valves at the dam site are not operated.

4.2 MAINTENANCE OF DAM

The upstream slope has a hand laid riprap facing. The amount of weed growth is light but should be controlled. The crest of the dam is well maintained. The downstream slope is covered with trees of various sizes. Maintenance of this slope should have included the control of this growth.

4.3 MAINTENANCE OF OPERATING FACILITIES

The operating facilities consist of upstream and downstream valves on water supply and blowoff lines. These valves have not been operated in at least 15 years and are not in operating condition.

4.4 WARNING SYSTEM

Although the dam is visited on a daily basis, there is no formal surveillance and downstream warning system.

4.5 EVALUATION

The operational procedures for this dam should include the regular control of brush, weed and tree growth on the embankment and the regular maintenance and operation of the valves. A formal surveillance and downstream warning system should be developed for implementation during periods of high or prolonged rainfall.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analysis available from PennDER for Black Creek Intake Dam was not very extensive. No area-capacity curve, frequency curve, unit hydrograph, design storm design flood hydrograph, or flood routings were available.

B. Experience Data

There are no records of flood levels at Black Creek Intake Dam. Based on records of the U.S.G.S. stream gage on West Branch Schuylkill River at nearby Cressona, Pennsylvania, the maximum inflow to Black Creek Intake Dam is estimated to have occurred in September 1975 at 518 cfs.

C. Visual Observations

It was noted that a low area through a boulder field is located adjacent to the right side of the spillway. Flow through this area was included in the spillway discharge capacity calculations (Appendix D).

No other conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily until the dam is overtopped. Two small dams are located upstream of Black Creek Intake Dam.

D. Overtopping Potential

Black Creek Intake Dam has a total storage capacity of 90 acre-feet and an overall height of 20 feet above streambed. These dimensions indicate a size classification of "Small." The hazard classification is "Significant" (see Section 3.1.E.).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is in the range of the 100 year flood to one-half the Probable Maximum Flood (PMF). Because of the small size of this dam and the small population downstream, the recommended SDF is the 100 year flood. For this dam, the SDF peak inflow is 2288 cfs (see Appendix D for HEC-1 inflow computations).

Comparison of the estimated SDF peak inflow of 2288 cfs with the estimated spillway discharge capacity of 11498 cfs indicates that a potential for overtopping of the Black Creek Intake Dam does not exist.

E. Spillway Adequacy

Calculations show that the spillway discharge capacity, based on the present low point in the dam profile, can pass the SDF without overtopping (refer to Appendix D). The spillway, therefore, is considered to be adequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

The visual inspection of Black Creek Intake Dam did not detect any signs of embankment instability. The field survey indicates that the upstream slope is 1.85H to 1V. There were no signs of displacement of the hand laid riprap. The downstream slope appears to be stable and dry. No signs of sloughs were detected. The crest is level and adequately protected with grass. The trees on the downstream slope could cause a stability problem. The seepage below the downstream toe near the spillway outlet channel appears to originate from the channel and is not considered to be a threat to the stability of the embankment. Small cracks were observed in the spillway channel.

Portions of the left and right side of the reservoir are also constructed of fill with a hand laid riprap cover. All slopes appear to be stable.

2. Appurtenant Structures

The valve boxes were not inspected. They apparently are wet wells. Some deterioration of the concrete is occurring.

The spillway crest was in good stable condition and the discharge channel had only a few small cracks. The left abutment wall of the spillway is in good condition. There were no signs of settlement, cracks or movement.

B. Design and Construction Data

1. Embankment

The available design data are not adequate to evaluate the stability of the embankment. There are indications on the drawings and in one report that a clay layer exists under the rock covered valley at the dam site. Plate IV indicates that a clay core wall extends below the original ground and to a distance of 80 feet left and 15 feet right beyond the embankment abutments. The upstream slope is protected with 18 inches of hand laid riprap.

2. Appurtenant Structures

The spillway weir consists apparently of two masonry walls with clay fill between the walls. The downstream wall is supported by the natural ground. The main spillway discharge channel has a grouted hand laid riprap bottom. One report states that the left spillway abutment wall was to have a foundation width of 0.4 times the height.

C. Operating Records

Operating records for this dam have not been maintained. There are no indications that stability problems have occurred.

D. Post Construction Changes

There are no records of changes to the embankment or its appurtenant structures since the spillway channel was extended in 1940. This extension was to prevent washouts of the embankment.

E. Seismic Stability

This dam is located in Seismic Zone 1, and it is considered that the static stability is sufficient to withstand minor earthquake-induced dynamic forces. No studies or calculations have been made to confirm this assumption.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection of the Black Creek Intake Dam and the review of the available engineering and construction data indicate that the dam is in good condition. The field inspection did not detect any signs of instability. The water flow below the right toe of the dam embankment is apparently originating in the spillway channel. There were no signs of turbidity in the water flowing in this rock lined area. The presence of trees on the embankment could endanger the safety of the embankment. The recommended Spillway Design Flood (SDF) is the 100 year flood.

The hydrologic and hydraulic computations indicate that the combination of the storage capacity and the spillway discharge capacity is sufficient to pass the SDF without overtopping the dam. The spillway is considered to be adequate.

B. Adequacy of Information

The design information contained in the files together with the visual inspection are considered sufficiently adequate for making a reasonable assessment of this dam.

C. Urgency

The recommendations presented below should be implemented immediately.

D. Additional Studies

Additional studies are not required at this time.

7.2 RECOMMENDATIONS

In order to assure the continued satisfactory operation of this dam, the following recommendations are presented for immediate implementation by the owner:

1. That the downstream slope and an area 10 feet beyond the toe be cleared of all trees and brush and be provided with a protective vegetative cover. The removal of trees should be under the direction of an engineer experienced in the design and construction of dams.

2. That the embankment be maintained on a regular basis to prevent growth of weeds, brush and trees.

3. That the valves in valve pits and the downstream valve on the blowoff line be made operable and maintained on a regular basis.

4. That a formal surveillance and downstream warning system be developed for use during periods of high or prolonged rainfall.

5. That an operation and maintenance manual be prepared for guidance in the operation of the dam during normal and emergency conditions, and that a schedule be developed for the annual inspection of the dam and its appurtenant structures.

APPENDIX A

CHECK LIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 54-078 NDI NO. PA-00 695

NAME OF DAM Black Creek Intake Dam HAZARD CATEGORY Significant

TYPE OF DAM Earthfill

LOCATION Tremont TOWNSHIP Schuylkill COUNTY, PENNSYLVANIA

INSPECTION DATE 3/26/81 WEATHER Sunny-clear TEMPERATURE 40's

INSPECTORS:	OWNER'S REPRESENTATIVE(s):
R. Houseal (Recorder)	Mark Herring
H. Jongsma	
R. Shireman	
A. Bartlett	
Dennis Dickey (D.E.R.)	

NORMAL POOL ELEVATION: 770 (U.S.G.S.) AT TIME OF INSPECTION: 1" over spillway

BREAST ELEVATION: 778 (survey) POOL ELEVATION: 770.1

SPILLWAY ELEVATION: 770.0 TAILWATER ELEVATION: ______

MAXIMUM RECORDED POOL ELEVATION: Unknown

GENERAL COMMENTS:

The dam appears to be in good condition. The downstream embankment slope has tree growth which should be controlled. Valves were not operated at this time. Owners representative indicated that steps are being taken to make all valves operable.

NDI NO. PA-00 695

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None observed.
B. UNUSUAL MOVEMENT BEYOND TOE	None observed.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None observed.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Horizontal: Straight--no distress. Vertical: Refer to Profile on Plate A-II.
E. RIPRAP FAILURES	None observed.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Abutments appear sound on left with natural ground and on right with spillway outlet channel wall.
G. SEEPAGE	None observed on slope. Wet, small area beyond downstream toe. It appears that this water is coming from the spillway outlet channel.
H. DRAINS	None.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Crest: short grass. Upstream Slope: riprap overgrown with grass and some light weeds. Portion near spillway cemented. Downstream Slope: covered with evergreen trees and some weeds. Trees up to 20" in diameter.

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Concrete block structure with timber deck. Deck must be removed to gain access to the intake control valve on 10" water supply line.
B. OUTLET STRUCTURE	10" water supply line has downstream control located in a small valve house and at the chlorination plant at the village of Ravine.
C. OUTLET CHANNEL	Outlet is 10" water supply line--no channel. Emergency blowoff outlet is into wooded area downstream from embankment. It would eventually flow to the spillway channel outlet.
D. GATES	10" gate valve in intake structure. 10" gate valve in valve house.
E. EMERGENCY GATE	10" blowoff valve controlled from crest of dam and 10" valve beyond downstream toe. This lower valve is covered by debris and must be uncovered to be made accessible.
F. OPERATION & CONTROL	The 10" intake valve is always open. 10" downstream is open. Control of water supply is at chlorination plant at the village of Ravine. There are no indications that the blowoff has been used recently.
G. BRIDGE (ACCESS)	Access to the intake structure is by means of two wooden planks from upstream embankment slope.

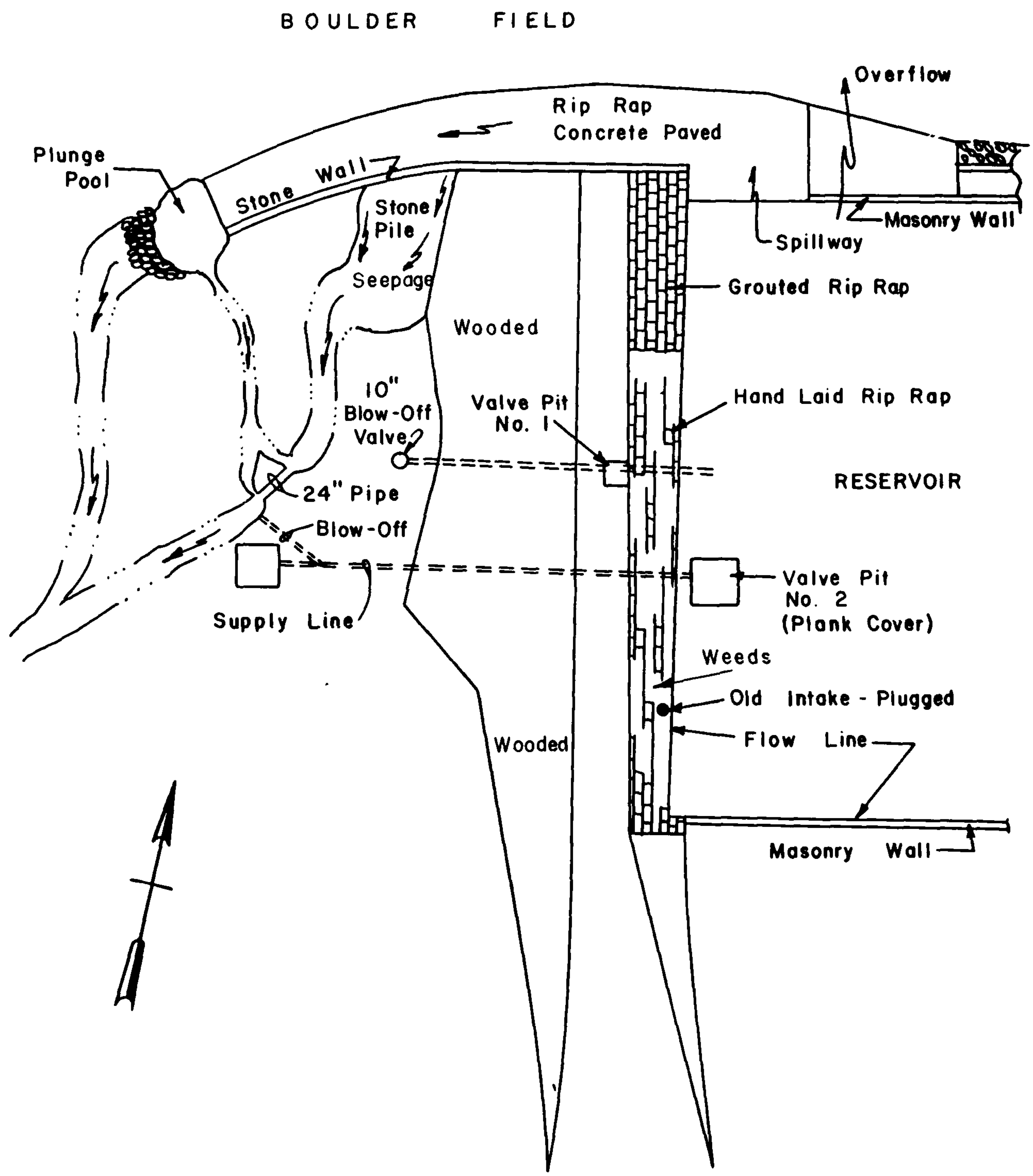
VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	The approach to the spillway is directly from the reservoir and perpendicular to the center-line of the dam at the right side.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	The spillway is a broad crested weir at the left abutment of the embankment. There is a very gently sloping concrete slab extending from the crest into a cemented rock channel. Condition of this feature is good. No major cracks or displacement.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	The discharge channel is a cemented rock channel. It turns 90° to downstream about 25 feet from the crest of the weir. The flow is controlled on the left side by a masonry wall extending to a natural rock filled plunge pool at the end of the channel. The right side is not controlled and high discharges will spill over the side slope of the channel into the flat area beyond the channel. This area is a
D. BRIDGE & PIERS	wide boulder field. The flow below the plunge pool is the natural mountain stream. There is no major distress or deterioration of this channel. None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	None.

NDI NO. PA-00 695

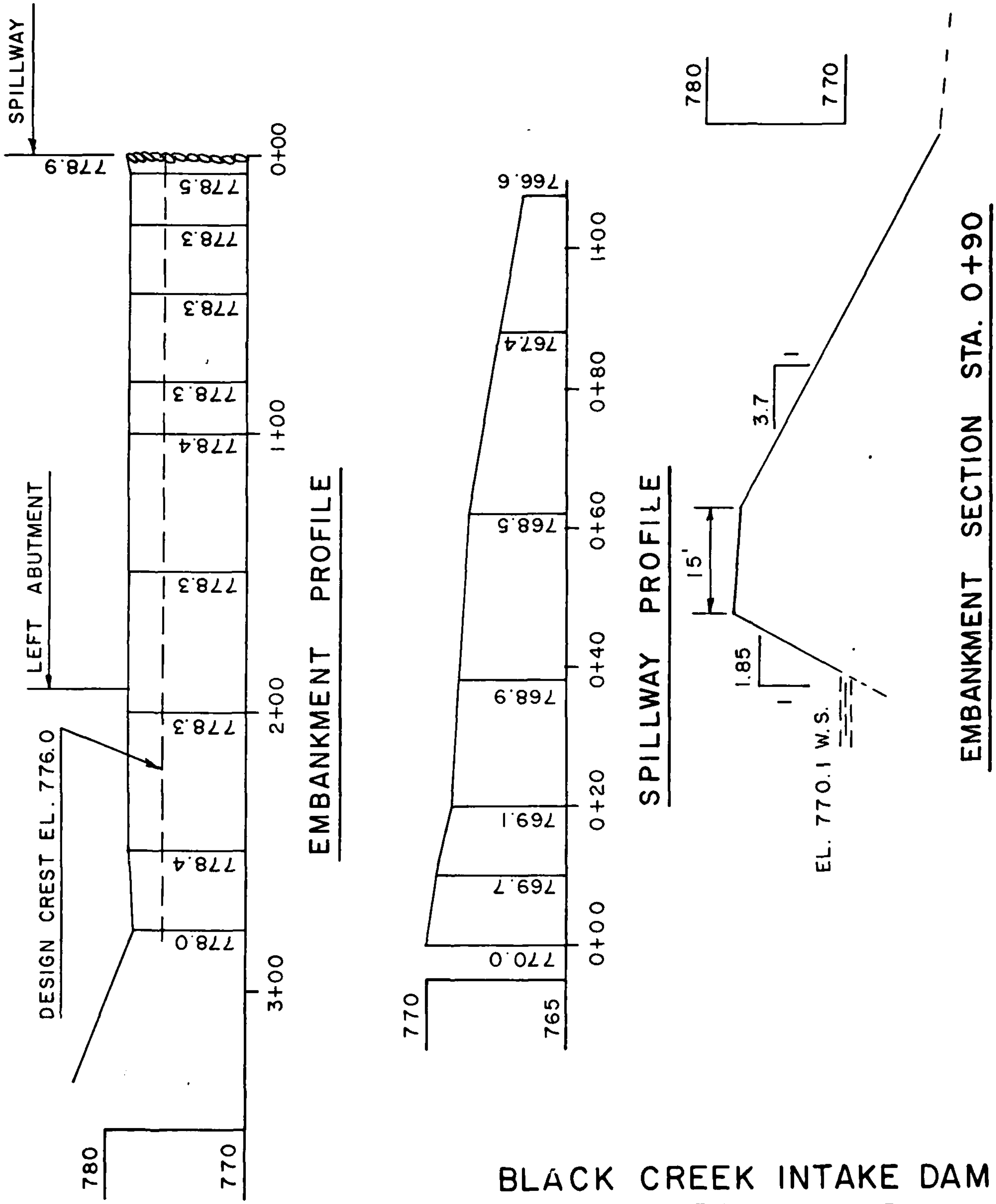
VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR	
Slopes	Gentle slopes surround the reservoir which lies in the valley between higher ridges. The slopes are entirely wooded.
Sedimentation	None reported.
Watershed Description	Forest and woodlands.
DOWNSTREAM CHANNEL	
Condition	Mountain stream to Swatara Creek.
Slopes	Gentle along stream floodplain--steep in some areas.
Approximate Population	Est. 3 permanent. Campground (variable).
No. Homes	1 home adjacent to stream. Campground and swimming pool in floodplain.



BLACK CREEK INTAKE DAM
PA-00695
INSPECTION SURVEY
PLATE A-I

SURVEYED 3-26-81



BLACK CREEK INTAKE DAM
PA-00695

INSPECTION SURVEY

PLATE A-II

SURVEYED 3-26-81

APPENDIX B

CHECK LIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 54-078 NDI NO. PA-00695

NAME OF DAM Black Creek Intake Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	Not available.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle - Pine Grove, Pa. See Plate II, Appendix E
CONSTRUCTION HISTORY	Intake structure built in 1917. Present dam constructed from 1937 to 1941. No records of construction available. Original designer Mr. Weimer, Lebanon, Pa. Final plans in 1939 prepared by Fred Hatter.
GENERAL PLAN OF DAM	Plate V, Appendix E.
TYPICAL SECTIONS OF DAM	Plate V, Appendix E.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	 Plate IV & V, Appendix D. Not available. Not available.

NDI NO. PA-00 695

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	No records.
DESIGN REPORTS	No reports.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	Plate V, Appendix E, dated June 1941, indicating survey of 1939.
BORROW SOURCES	From reservoir area.

NDI NO. PA-00 695

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Spillway chute extended in 1940.
HIGH POOL RECORDS	No records.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	No reports.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None reported.
MAINTENANCE & OPERATION RECORDS	No records.
SPILLWAY PLAN, SECTIONS AND DETAILS	Plate V, Appendix E.

NDI NO. PA-00 695

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	Valves on pipe lines. See Plate IV.
CONSTRUCTION RECORDS	No records.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Inspection reports by PennDER dated 1942, 1944, 1945 and 1962. These reports indicate leakage near the spillway channel since 1942. Tree growth reported in 1962.
MISCELLANEOUS	

NDI NO. PA-00695

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Forest

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 770 Acre-Feet 28.4

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 778 Acre-Feet 90

MAXIMUM DESIGN POOL: Elev. 776

TOP DAM: Elev. 778

SPILLWAY:

a. Elevation 770

b. Type Concrete broad crested weir.

c. Width 32.8 feet

d. Length --

e. Location Spillover At right end of embankment.

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 10" diameter blowoff pipe.

b. Location Near right end of dam.

c. Entrance inverts 758

d. Exit inverts 758

e. Emergency drawdown facilities 10" valve on blowoff line.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location

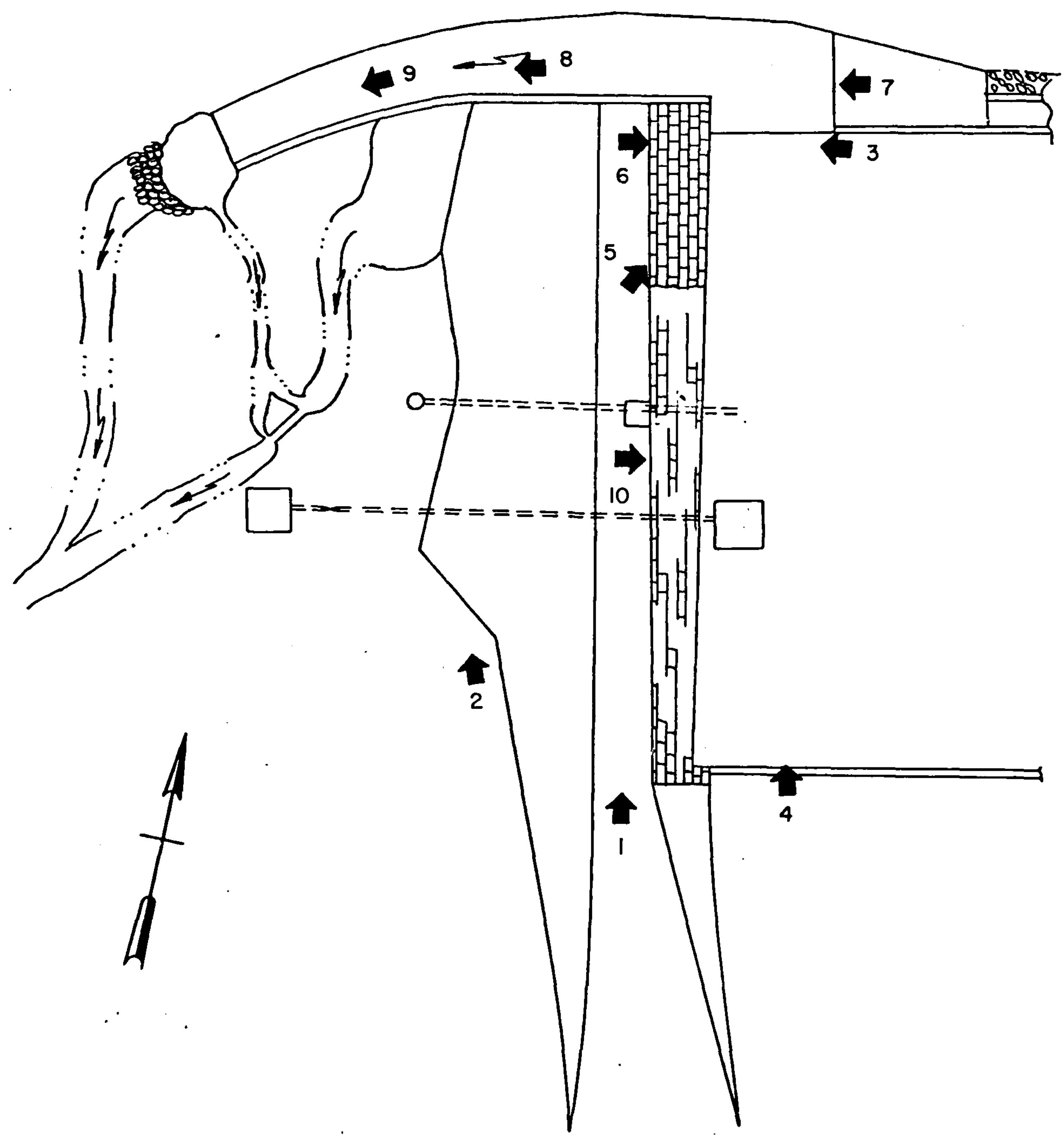
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 11498 cfs

APPENDIX C

PHOTOGRAPHS

C

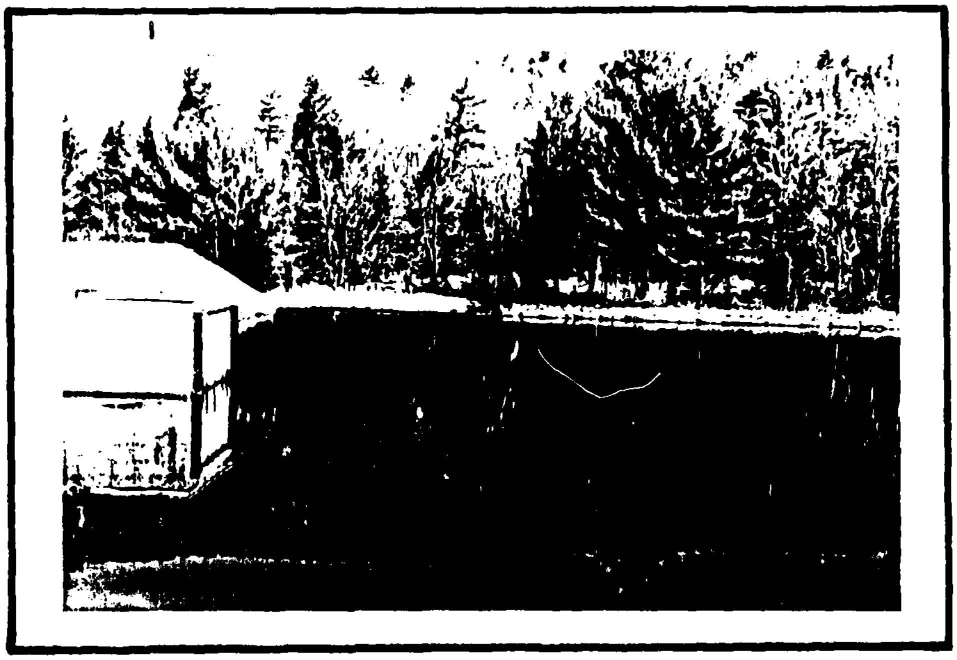


BLACK CREEK INTAKE DAM
PA-00695
KEY MAP OF PHOTOGRAPHS
PLATE C-I

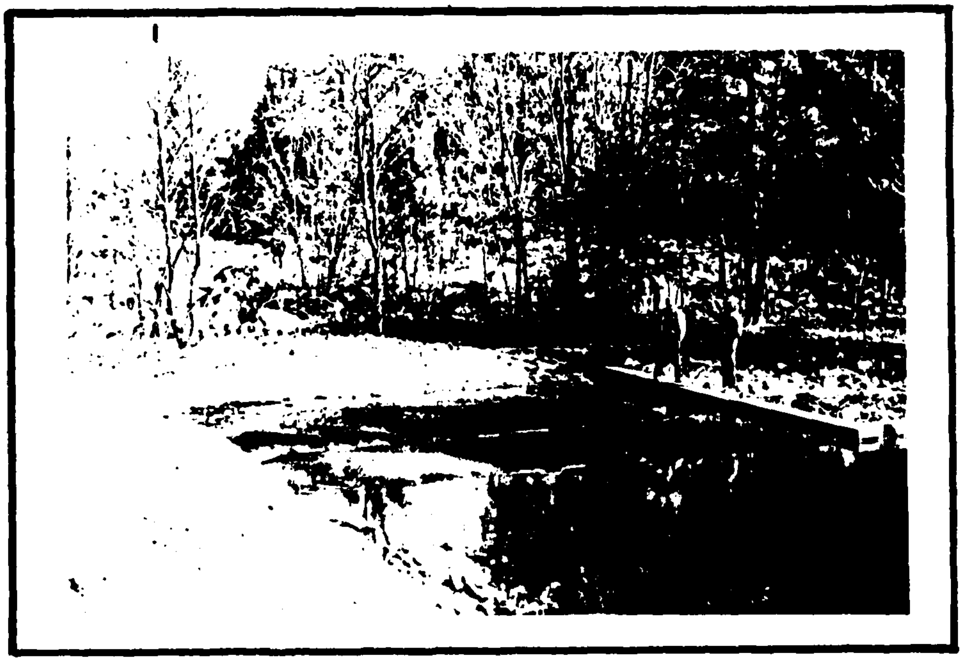
DOWNSTREAM SLOPE - NO. 2
NOTE: TREES ON SLOPE

UPSTREAM SLOPE ADJACENT TO SPILLWAY - NO. 3

PA-00695
Plate C-II



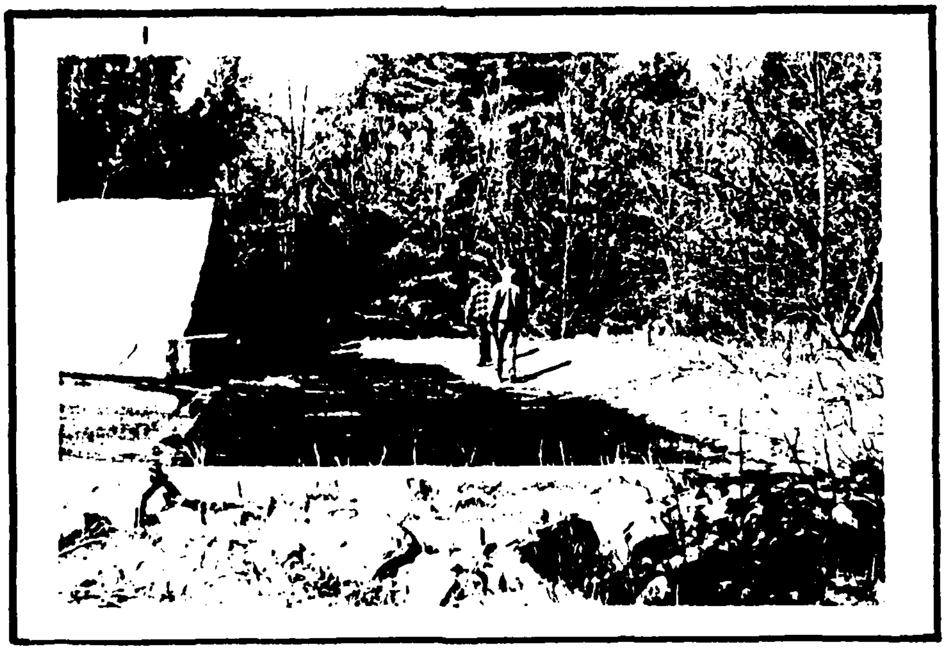
OVERVIEW OF SPILLWAY AND OVERFLOW SECTION - NO. 4



SPILLWAY FOREBAY - NO. 5
NOTE: BOULDER FIELD IN BACKGROUND

PA-00695
Plate C-III

OVERFLOW SECTION - SPILLWAY IN FOREGROUND - NO. 6



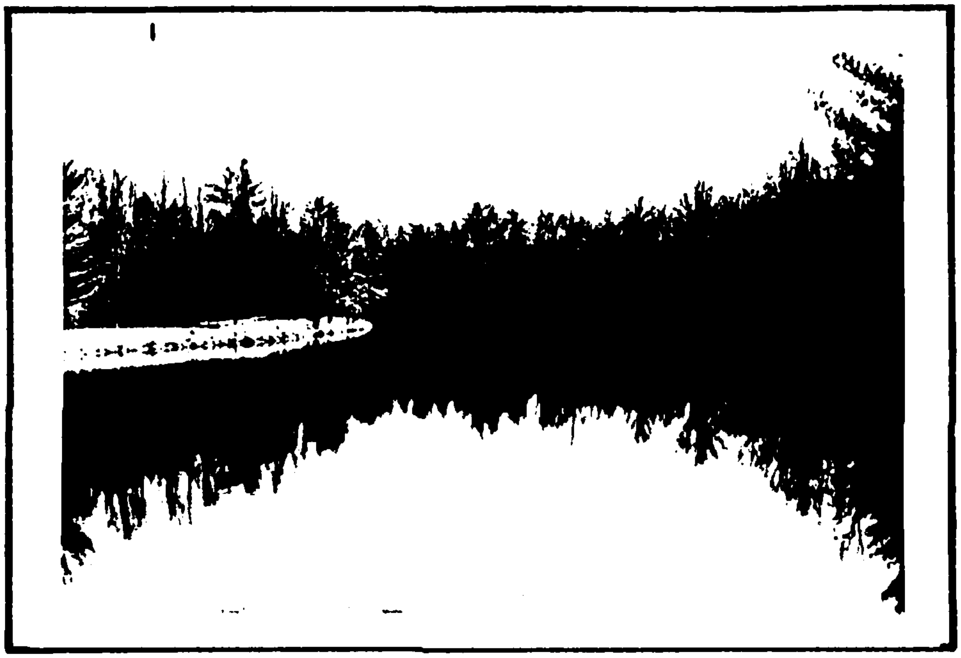
SPILLWAY DISCHARGE AT END OF DAM - NO. 7

PA-00695
Plate C-IV

SPILLWAY ABUTMENT WALL - NO. 8

SPILLWAY CHANNEL AND PLUNGE POOL - NO. 9

PA-00695
Plate C-V



RESERVOIR AREA - NO. 10

PA-00695
Plate C-VI

APPENDIX D

HYDROLOGY AND HYDRAULIC CALCULATIONS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.

- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.

- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

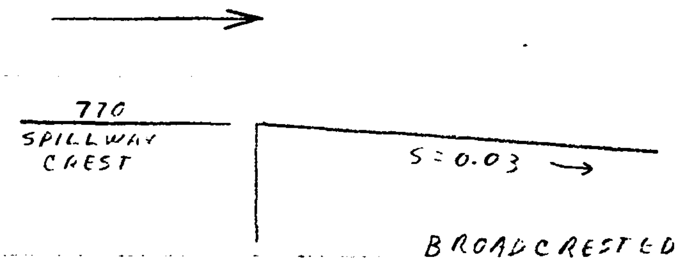
The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

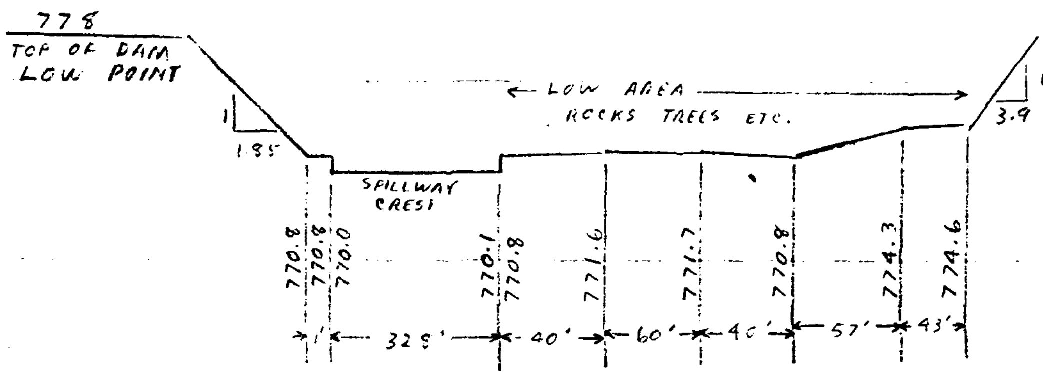
For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

SUBJECT BLACK CREEK INTAKE DAM

SPILLWAY RATING



BROADCRESTED WEIR
C = 2.7 (KINGS HDBK)



$$Q = C\left(L_1H_1^{3/2} + L_2H_2^{3/2} + L_3H_3^{3/2} + L_4H_4^{3/2} + L_5H_5^{3/2} + L_6H_6^{3/2} + L_7H_7^{3/2} + L_8H_8^{3/2} + L_9H_9^{3/2}\right)$$

AT ELEV 778

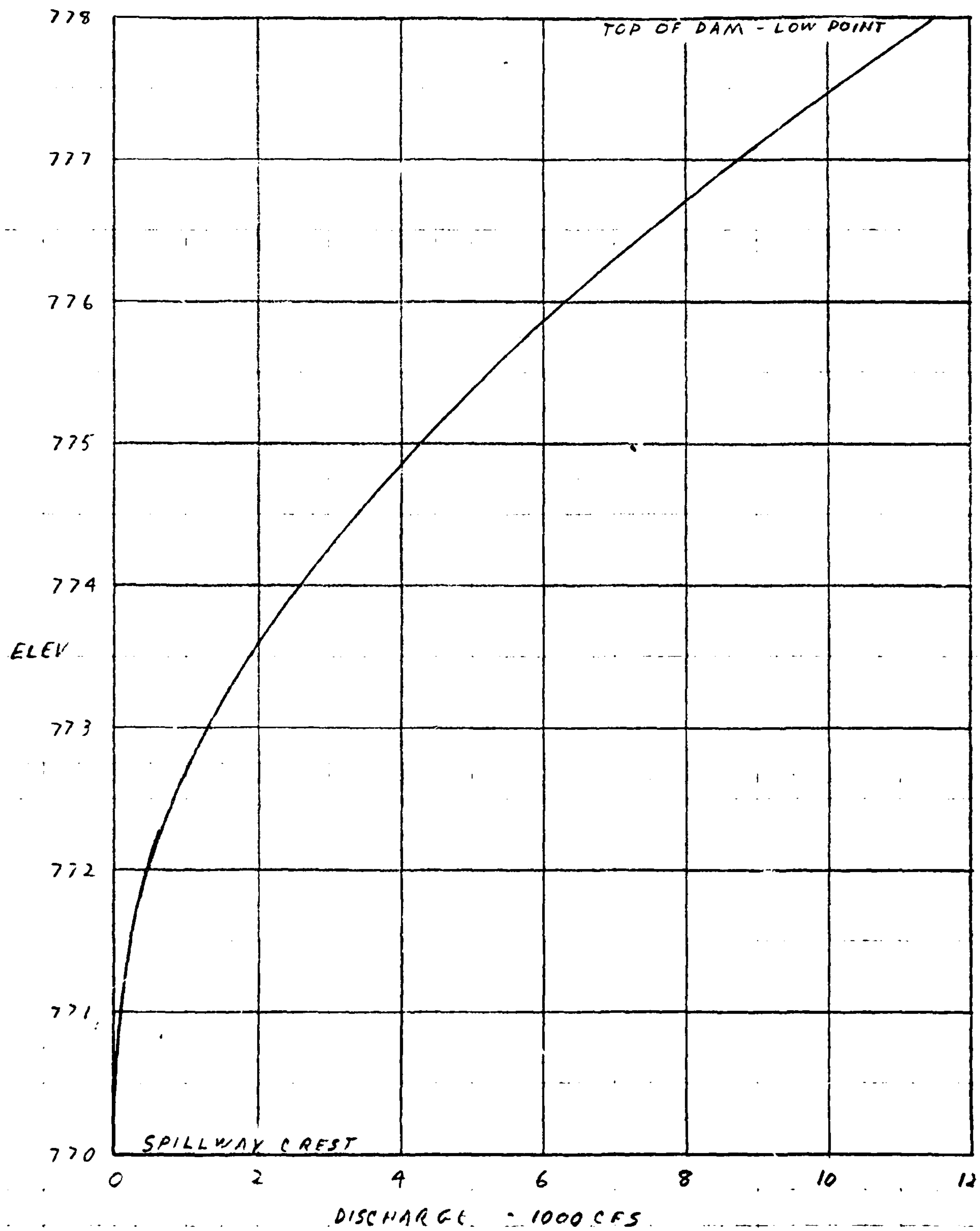
$L_1 = (778 - 770.8) \times 1.85 = 13.3$	$H_1 = (778-770.8)/2 = 3.6'$
$L_2 = 1'$	$H_2 = 778-770.8 = 7.2'$
$L_3 = 32.8'$	$H_3 = 778 - ((770+770.1)/2) = 7.95'$
$L_4 = 40'$	$H_4 = 778 - ((770.8+771.6)/2) = 6.8'$
$L_5 = 60'$	$H_5 = 778 - ((771.6+771.7)/2) = 6.35'$
$L_6 = 40'$	$H_6 = 778 - ((771.7+770.8)/2) = 6.75'$
$L_7 = 57'$	$H_7 = 778 - ((770.8+774.3)/2) = 5.45'$
$L_8 = 43'$	$H_8 = 778 - ((774.3+774.6)/2) = 3.55$
$L_9 = (778-774.6) \times 3.9 = 13.3$	$H_9 = (778-774.6)/2 = 1.7'$

$$Q = 2.7\times\left((13.3\times3.6^{1.5}) + (1\times7.2^{1.5}) + (32.8\times7.95^{1.5}) + (40\times6.8^{1.5}) + (60\times6.35^{1.5}) + (40\times6.75^{1.5}) + (57\times5.45^{1.5}) + (43\times3.55^{1.5}) + (13.3\times1.7^{1.5})\right)$$

$= 11498$ CFS

BY RLS DATE 4/1/81 **BERGER ASSOCIATES** SHEET NO. 2 OF 7
CHKD. BY ______ DATE ______ PROJECT D0590
SUBJECT BLACK CREEK INTAKE DAM

SPILLWAY RATING CURVE



DISCHARGE THROUGH OUTLET WORKS

10" DIA. BLOW-OFF PIPE C = 0.6 (KINGS HDBK.)

APPROX. INVERT ELEV: 758

$Q = CA\sqrt{2gH}$

AT NORMAL POOL LEVEL 770

$H: 770 - 758.4 = 11.6'$

$Q = 0.6 \times \pi \times (10/12)^2/4 \times (2 \times 32.2 \times 11.6)^{0.5}$

$= 8.9$ CFS SAY 9 CFS

AT LOW POOL LEVEL 761

$H: 761 - 758.4 = 2.6'$

$Q = 0.6 \times \pi \times (10/12)^2/4 \times (2 \times 32.2 \times 2.6)^{0.5}$

$= 4.2$ CFS SAY 4 CFS

EMBANKMENT RATING

$Q = CLH^{3/2}$ $C = 2.7$ (KINGS HDBK)

AT ELEV. 778.5

$2.7 \times 5 \times (.25)^{1.5} = 2$
$2.7 \times 28 \times (.3)^{1.5} = 12$
$2.7 \times 50 \times (.15)^{1.5} = 8$
$2.7 \times 50 \times (.2)^{1.5} = 12$
$2.7 \times 68 \times (.15)^{1.5} = 11$
$2.7 \times 57 \times (.2)^{1.5} = 14$
$2.7 \times 17 \times (.1)^{1.5} = 1$ $\Sigma = 60$ CFS

AT ELEV. 779

$2.7 \times 10 \times (.5)^{1.5} = 10$
$2.7 \times 28 \times (.8)^{1.5} = 54$
$2.7 \times 50 \times (.65)^{1.5} = 71$
$2.7 \times 50 \times (.7)^{1.5} = 79$
$2.7 \times 68 \times (.65)^{1.5} = 96$
$2.7 \times 57 \times (.7)^{1.5} = 90$
$2.7 \times 17 \times (.6)^{1.5} = 21$
$2.7 \times 8 \times (.3)^{1.5} = 4$ $\Sigma = 425$ CFS

AT ELEV 780

$2.7 \times 20 \times (1)^{1.5} = 54$
$2.7 \times 28 \times (1.8)^{1.5} = 183$
$2.7 \times 50 \times (1.65)^{1.5} = 286$
$2.7 \times 50 \times (1.7)^{1.5} = 299$
$2.7 \times 68 \times (1.65)^{1.5} = 389$
$2.7 \times 57 \times (1.7)^{1.5} = 341$
$2.7 \times 17 \times (1.6)^{1.5} = 93$
$2.7 \times 8 \times (1.3)^{1.5} = 32$ $\Sigma = 1677$ CFS

MAXIMUM KNOWN FLOOD AT DAMSITE

THERE ARE NO RECORDS OF POOL LEVELS FOR THIS DAM. BASED ON THE RECORDS OF THE GAGING STATION FOR WEST BRANCH SCHUYLKILL RIVER AT NEARBY CRESSONA, PA. (D.A. = 52.5 SQ.MI.) THE MAXIMUM DISCHARGE AT THE GAGE OCCURRED IN SEPTEMBER, 1975, WHEN A DISCHARGE OF 2940 CFS WAS OBSERVED. THE MAXIMUM INFLOW TO BLACK CREEK INTAKE DAM IS ESTIMATED TO BE:

$$Q = \left(\frac{6.0}{52.5}\right)^{0.8} \times 2940$$

$$= 518 \text{ CFS}$$

DESIGN FLOOD

SIZE CLASSIFICATION
- MAXIMUM STORAGE = 90 ACRE-FEET
- MAXIMUM HEIGHT = 20 FEET
- SIZE CLASSIFICATION IS "SMALL"

HAZARD CLASSIFICATION
- ONE HOME LOCATED NEAR THE DOWNSTREAM CHANNEL.
- USE "SIGNIFICANT"

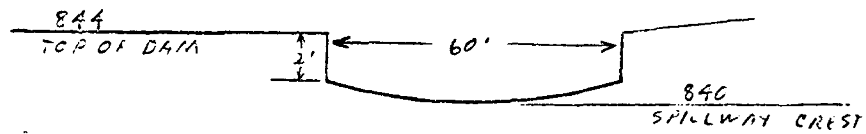
RECOMMENDED SPILLWAY DESIGN FLOOD
- THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO THE 100 YEAR FLOOD TO ONE-HALF THE PROBABLE MAXIMUM FLOOD.

UPSTREAM RESERVOIRS

BLACK CREEK RESERVOIR #2

DATA FROM: FIELD VISIT AND
PENN DER FILES

EARTH DAM
10' HIGH
430' EMBANKMENT LENGTH
EMBANKMENT C = 2.7



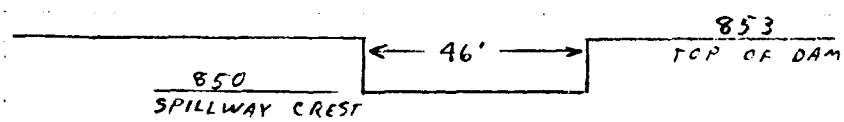
$Q = CLH^{3/2}$ H = 3.5' MEAN
C = 2.7 BROAD CRESTED WEIR

$Q = 2.7 \times 60 \times 3.5^{1.5} = 1061$ CFS

BLACK CREEK SILT POND

DATA FROM: FIELD VISIT AND
PENNDER FILES

EARTH DAM
6' HIGH
400' EMBANKMENT LENGTH
EMBANKMENT C = 2.7



SPILLWAY HIGHLY DETERIORATED
BROAD CRESTED WEIR
C = 2.7

$Q = CLH^{3/2}$
$= 2.7 \times 46 \times 3^{1.5} = 645$ CFS

BY RLS DATE 4/2/81 **BERGER ASSOCIATES** SHEET NO. 7 OF 8
CHKD. BY DATE PROJECT D0590
SUBJECT BLACK CREEK INTAKE DAM

100 YEAR FLOOD

REF: "HYDROLOGIC STUDY, TROPICAL STORM AGNES"
NORTH ATLANTIC DIVISION, U.S. ARMY, CORPS OF ENGINEERS.

DRAINAGE AREA = 6.0 SQ. MI.

(FIG. 21) $C_M = 1.95$

$LOG(Q_m) = C_m + .75\ LOG(DA)$

$= 1.95 + .75\ LOG(6) = 2.534$

(FIG. 22) $C_S = .40$

$S = C_S - 0.05\ LOG(DA)$

$= .40 - 0.05\ LOG(6) = .361$

(FIG. 23) SKEW $(g) = .42$

STANDARD DEVIATE $= K(P,g) = 2.6295$

$LOG(Q(P)) = LOG(Q_m) + K(P,g)\,S$

$LOG(Q_1) = 2.534 + (2.6295 \times .361)$

$= 3.483$

$Q_1 = 3043$ CFS

100 YR FLOOD

REF: WATER RESOURCES BULLETIN NO. 13, "FLOODS IN PENNSYLVANIA", PENNA. DEPT. OF ENVIRONMENTAL RESOURCES AND U.S GEOLOGICAL SURVEY

DRAINAGE AREA = 6.0 SQ. MI.

(PLATE 1) MODEL = 5

PRECIPITATION INDEX
(PLATE 2) RAINFALL = 47"
(PLATE 2) EVAPOTRANSPIRATION = 26.5"

$P_i = 47 - 26.5 = 20.5''$

$Q_T = C A^x P_i^P$

$C = 42.2$
$x = .751$
$P = .744$

$Q_{100} = 42.2 \times (6)^{.751} \times (20.5)^{.744}$

$Q_{100} = 1533$ CFS

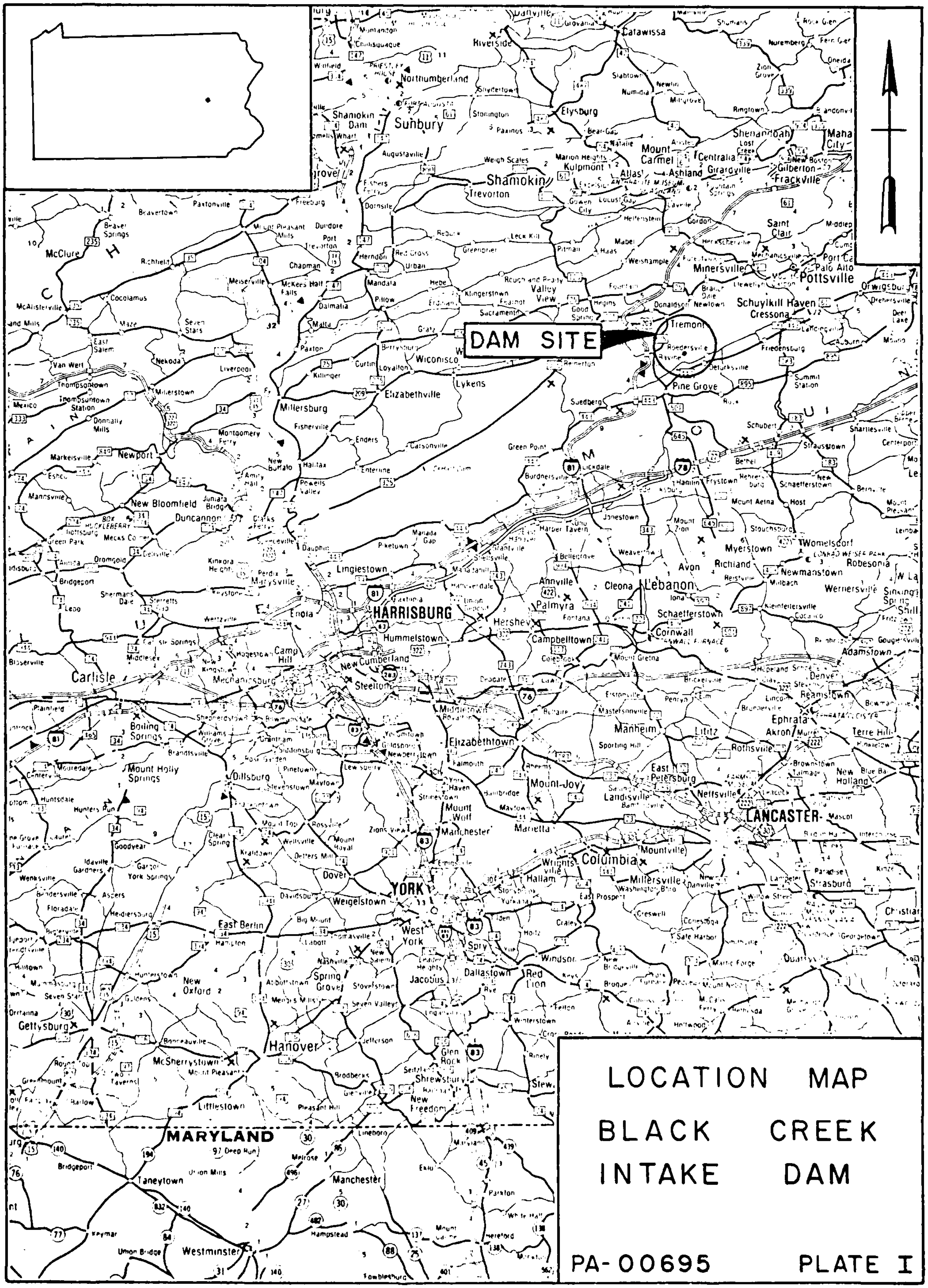
APPROXIMATE 100 YR DISCHARGE

$(1533 + 3043)/2 = 2288$ CFS

APPENDIX E

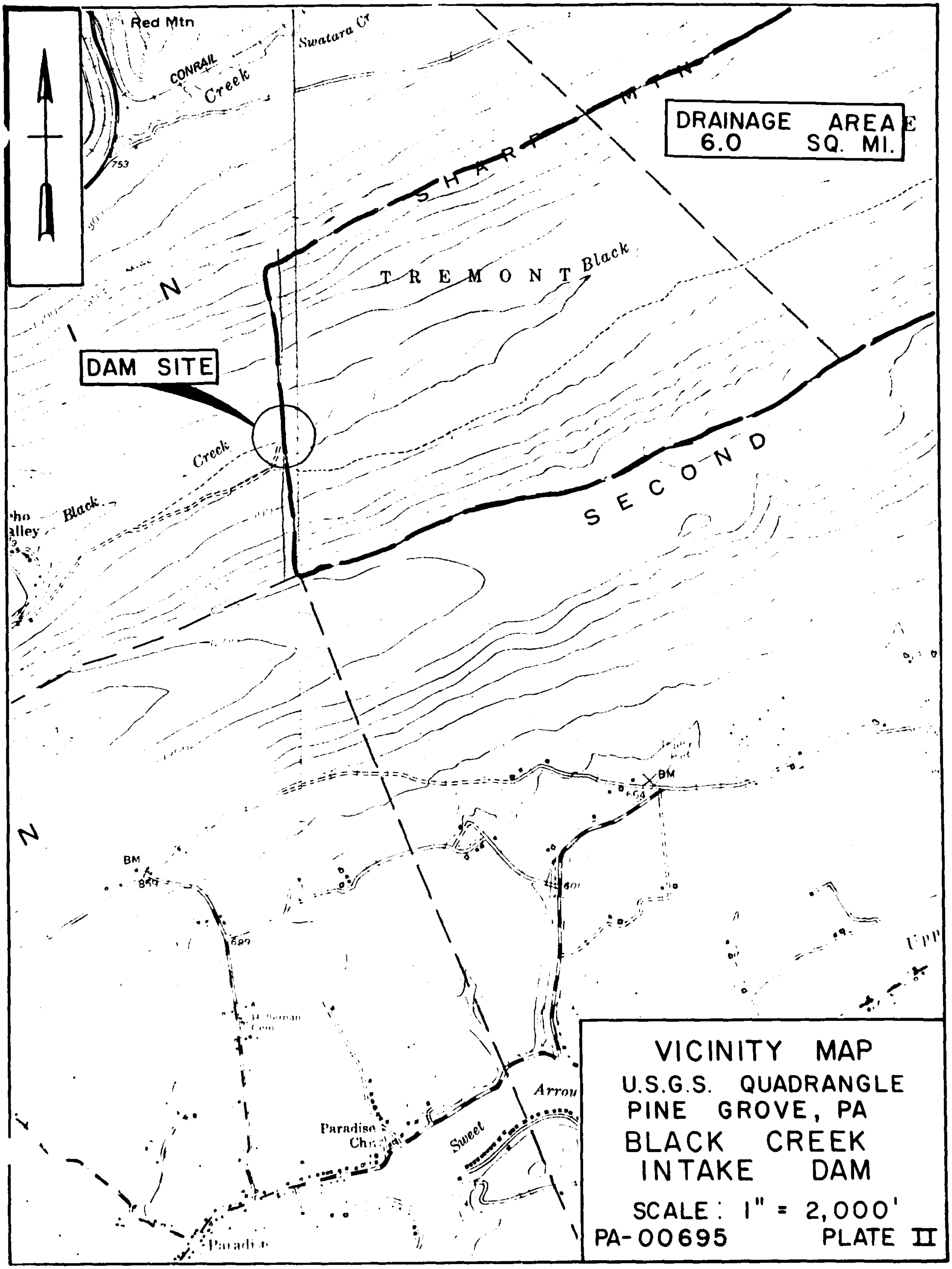
PLATES

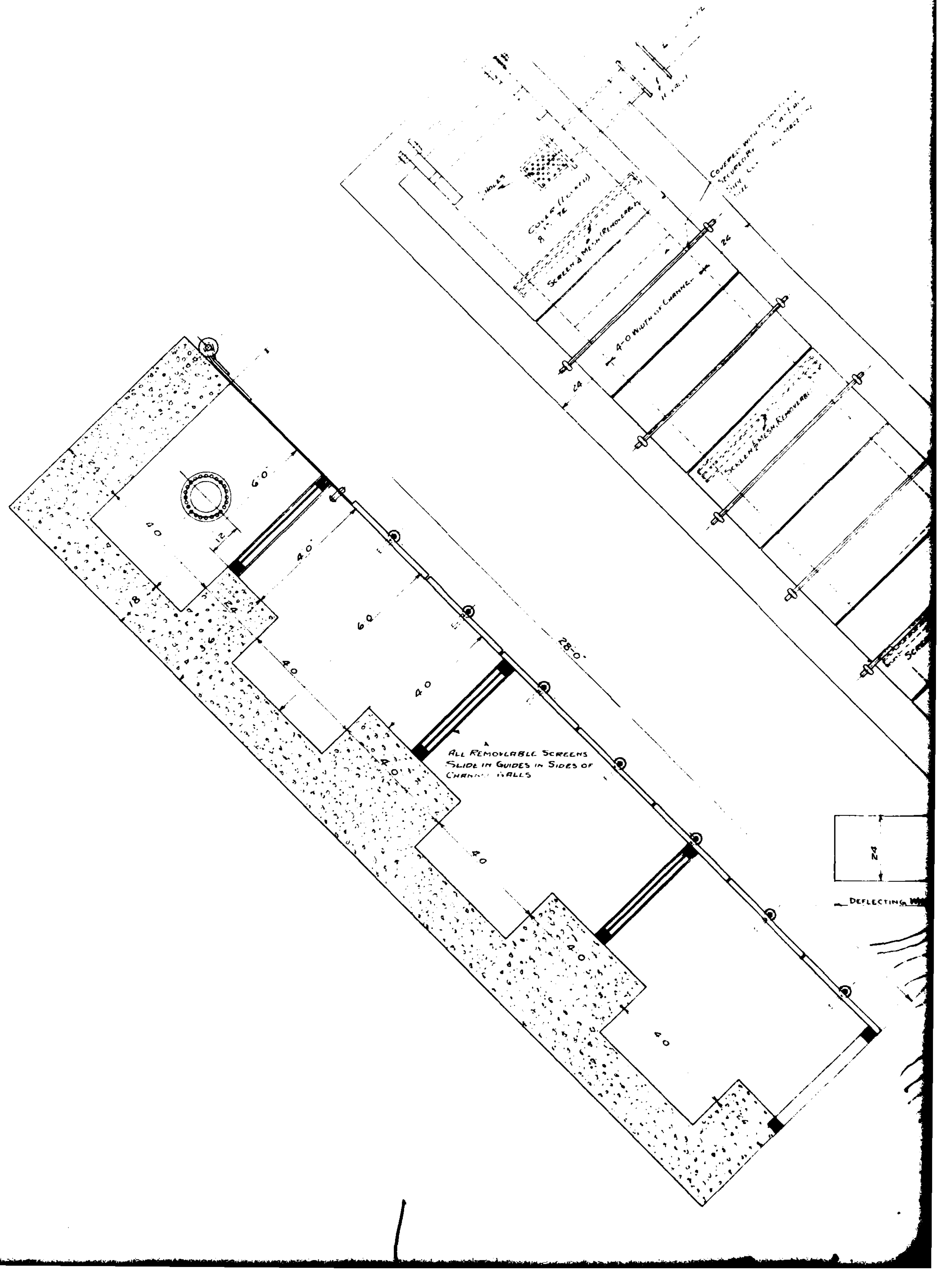
C

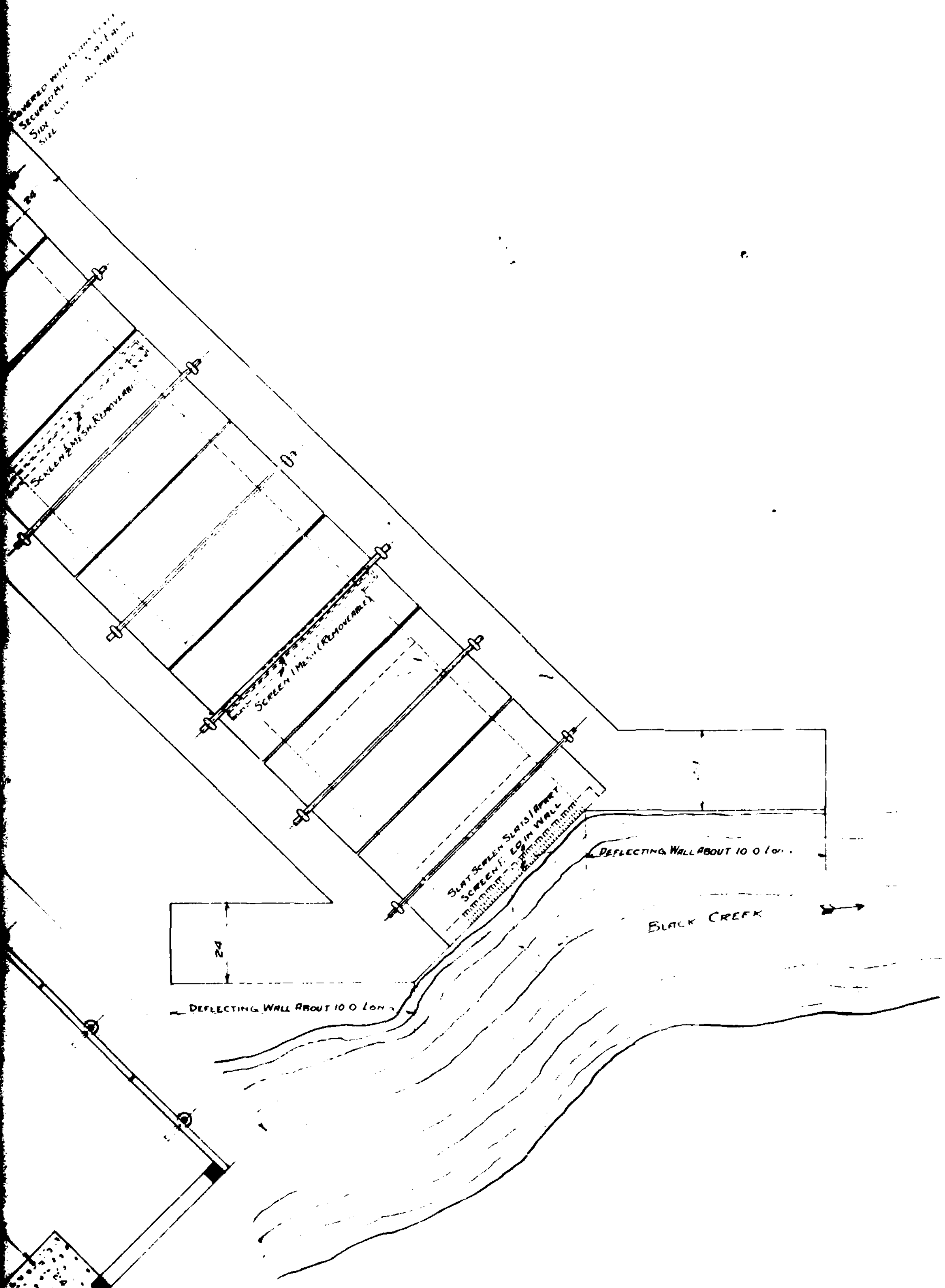


LOCATION MAP
BLACK CREEK INTAKE DAM

PA-00695 PLATE I

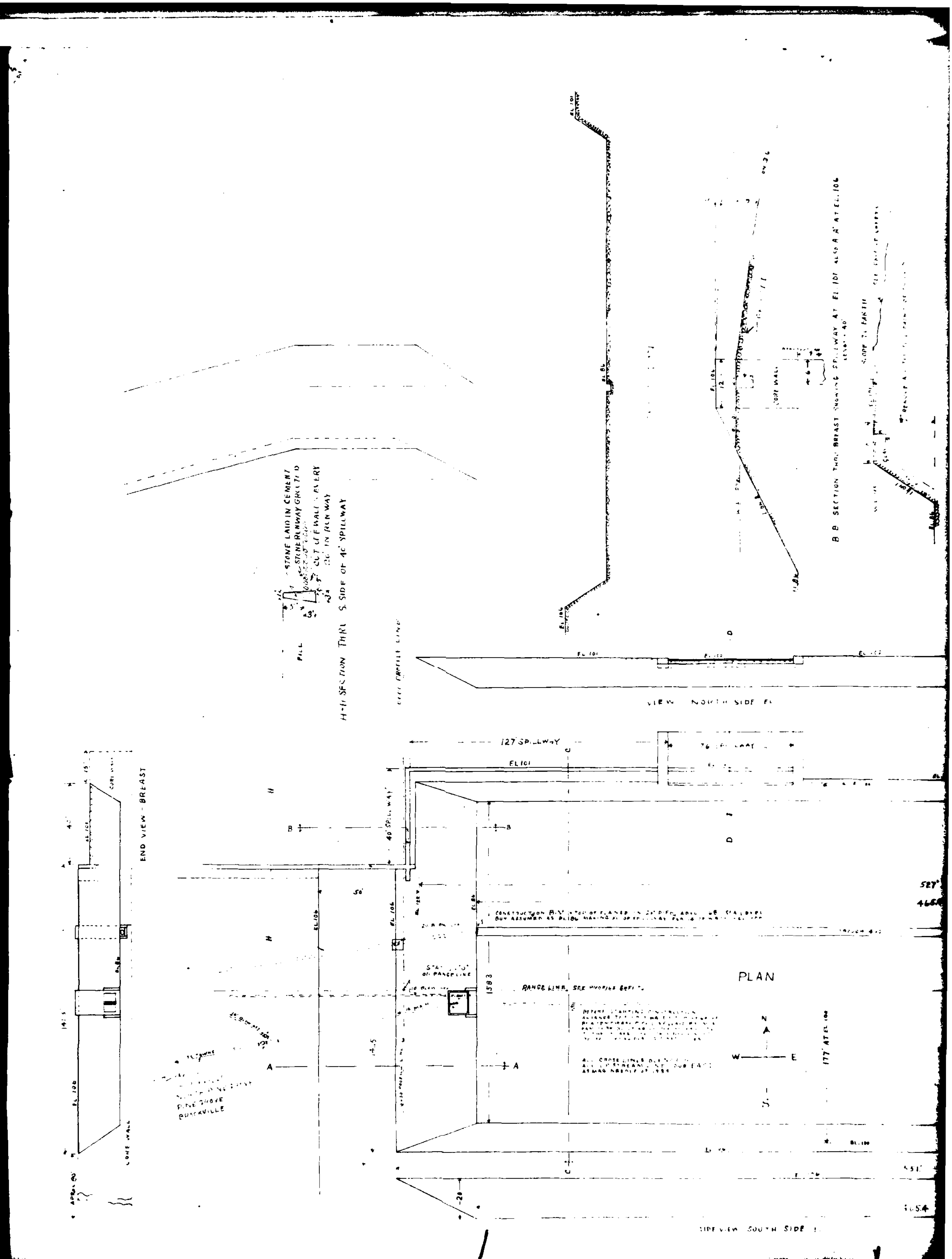

Red Mtn
Swatara Cr
CONRAIL
Creek
753
SHARP MTN
DRAINAGE AREA
6.0 SQ. MI.
TREMONT Black
N
DAM SITE
Creek
Black
SECOND
N
BM
BM
849
Paradise Church
Sweet
Arrow
VICINITY MAP
U.S.G.S. QUADRANGLE
PINE GROVE, PA
BLACK CREEK
INTAKE DAM
SCALE: 1" = 2,000'
PA-00695
PLATE II


ALL REMOVABLE SCREENS
SLIDE IN GUIDES IN SIDES OF
28-0
4-0 WIDTH OF CHANNEL
SCREEN 4 MESH (REMOVABLE)
DEFLECTING



INTAKE BLACK CREE[illegible]
PINEGROVE WATER SUPPLY
[illegible] A WEIMER CONSULTING ENG
LEBANON PA
SCALE $\frac{1}{2}$ 1 0 FEB 24 1916

PLATE III
PA-00695



H-H SECTION THRU S. SIDE OF 40' SPILLWAY
STONE LAID IN CEMENT
FILL
B-B SECTION THRU BREAST SHOWING SPILLWAY AT EL. 101 ALSO A-A' AT EL. 106
CORE WALL
VIEW - NORTH SIDE
127' SPILLWAY
40' SPILLWAY
EL. 101
EL. 106
END VIEW - BREAST
CORE WALL
PLAN
RANGE LINE, SEE PROFILE SHEETS
ALL CROSS LINES ... AS MAG. NEEDLE ... 1934
N
W
E
S
177' AT EL. 106
1583
527'
551'
654
SIDE VIEW - SOUTH SIDE
PINE GROVE
BUCKVILLE

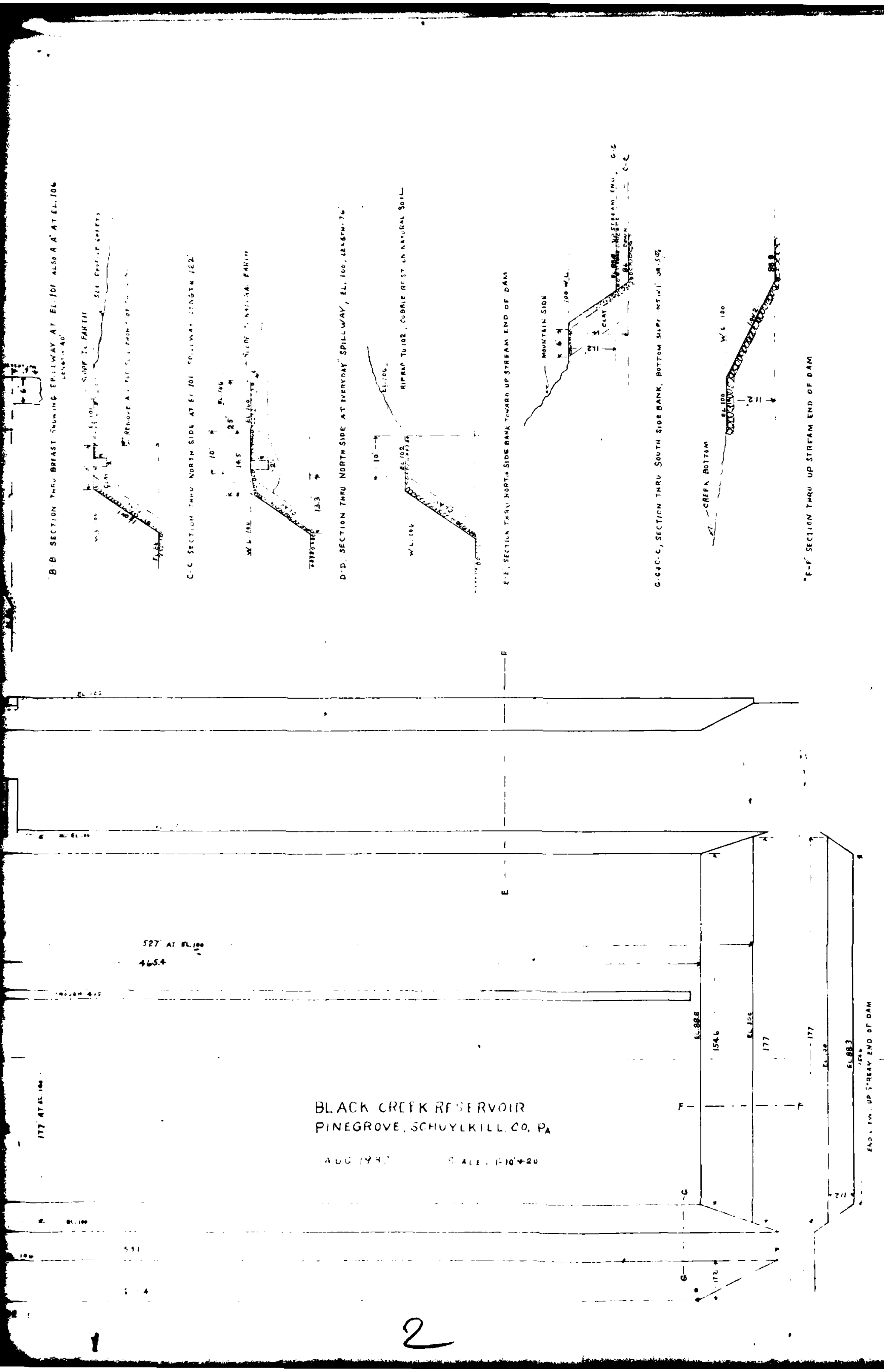
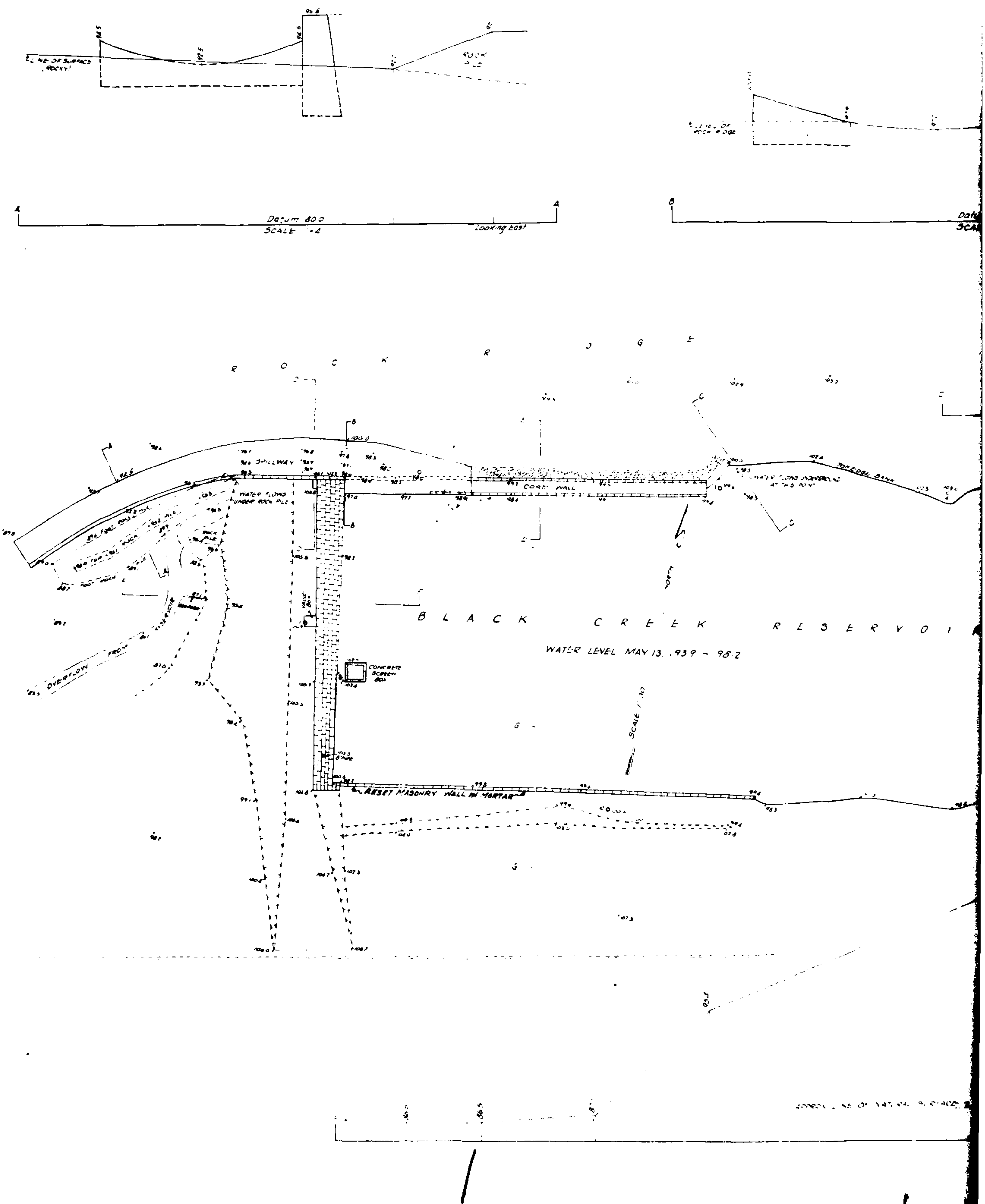


PLATE IV
PA-00695

2


LINE OF SURFACE (ROCKY)
ROCK PILE
Datum 800
SCALE 1:4
Looking East
LEVEL OF ROCK RIDGE
R O C K R I D G E
SPILLWAY
CORE WALL
WATER FLOWS UNDER ROCK PILE
WATER FLOWS UNDERGROUND AT THIS POINT
TOP EDGE BANK
NORTH
VALVE BOX
B L A C K C R E E K R E S E R V O I R
WATER LEVEL MAY 13, 1939 - 98.2
CONCRETE SCREEN BOX
SCALE 1:30
RESET MASONRY WALL IN MORTAR
OVERFLOW FROM RESERVOIR
ROCK PILE

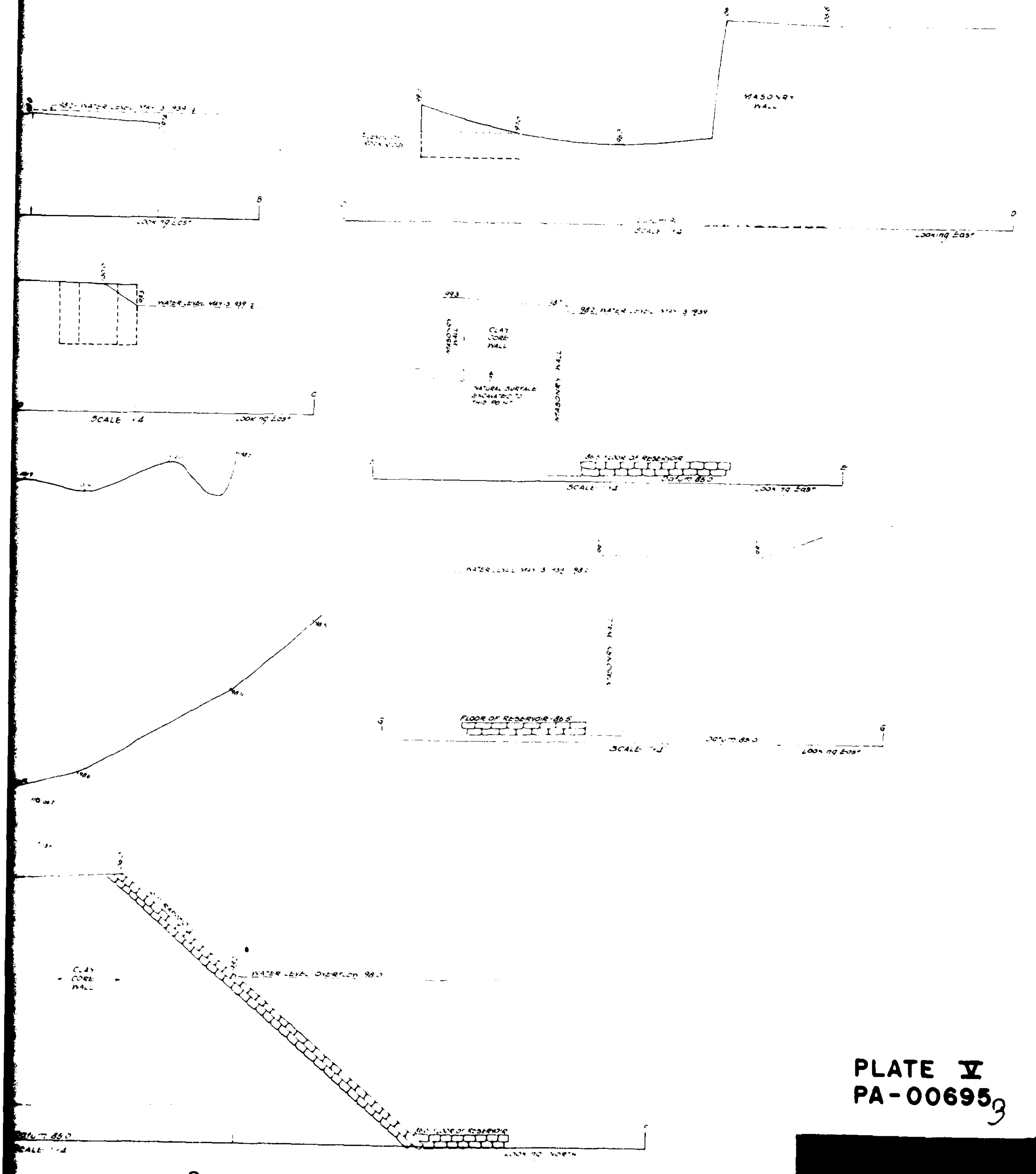


PLATE V
PA-00695 3

2

1

APPENDIX F

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

The dam and reservoir are located within a small, narrow valley bordered by Sharp Mountain to the north and Second Mountain to the south. The surfical geology of the valley is comprised mainly of Quaternary talus deposits. Talus is a collection of dislodged material found at the base of a slope. In this case it consists of small to large rectilinear blocks of sandstone and conglomerate, mixed with smaller fragments of siltstones, shales and anthracite beds. The depth of this talus is only a few tenths of feet thick. This material most probably originated from the rim rocks of the surrounding ridges.

Sharp Mountain, located to the north of the dam, is made up of conglomerates, sandstones, siltstones and shales of the Upper Member of the Mauch Chunk Formation. This formation is known as a valley former because of its low resistance to weathering relative to other formations in the area. The other formation which is a probable contributer to the talus is found to the south on Second Mountain. This mountain is made up of the ridge forming, resistant, Mount Carbon Member of the Pocono Formation. The Mount Carbon Member consists of sandstone shale and siltstone.

Structure

From the available information, there are no major structural features which would directly influence the site area. However, this portion of the state is highly folded and faulted and this could produce localized faulting and fracturing not evident on a large scale map.

Overburden

The overburden material in this area probably consists of residual material resulting from the weathering of the talus material and the parent bedrock.

Aquifer Characteristics

Due to the generally unconsolidated nature of talus material and the good to excellent aquifer characteristics of the Mauch Chunk and Pocono Formations, subsurface seepage is a distinct possibility. However, the extent of this seepage is dependent on the localized lithology and structure.

Discussion

There is little available information on the structural integrity of talus material. However, both the Mauch Chunk and Pocono

Formations provide a good foundation base when excavated to sound material. According to available construction plans, the dam core foundation was placed on a solid foundation. This should minimize the possibility of subsurface seepage, but not totally eliminate it.

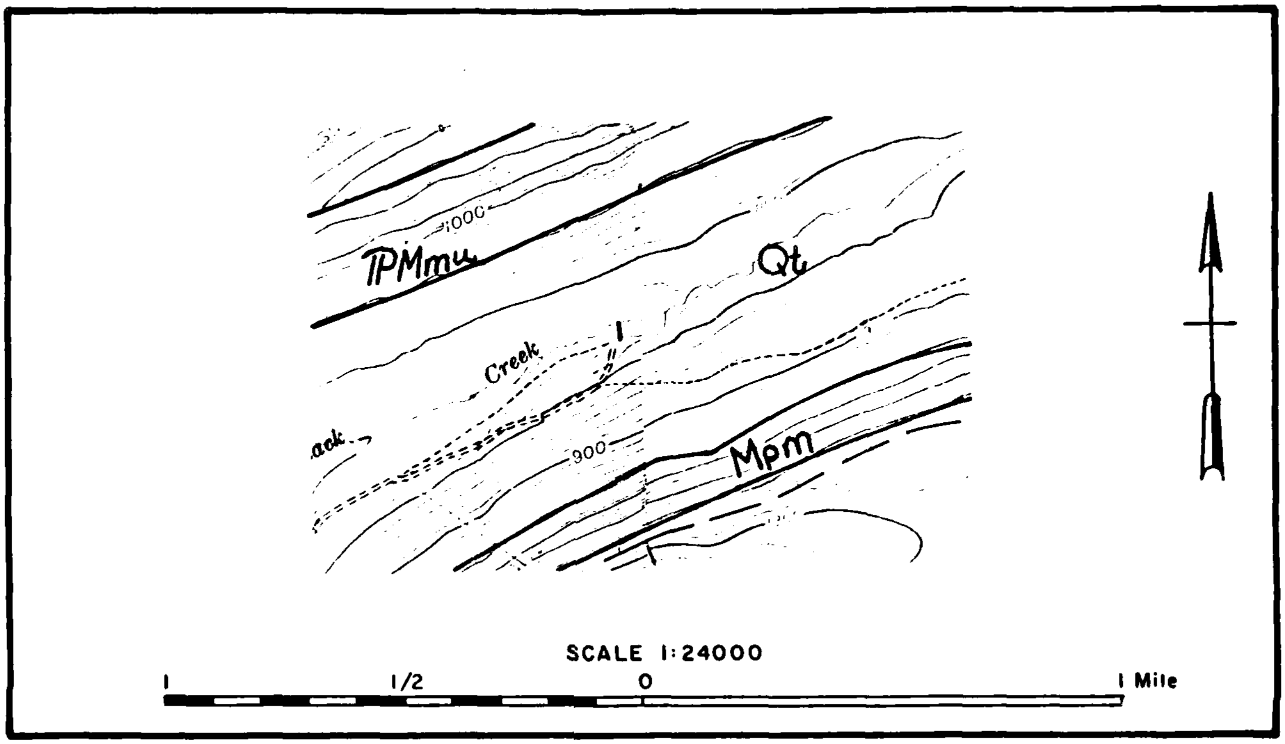
Sources of Information

1. McGlade, W.G., et al., 1972. Pennsylvania Characteristics of the Rocks of Pennsylvania, Pennsylvania Geological Survey EG-1.

2. Wood, G.H., Jr., et al., 1968. Geologic Map of the Swatara Hill Quadrangle. U.S. Geological Survey GQ 698.

3. Wood, G.H., Jr., et al., 1968. Geologic Map of the Pine Grove Quadrangle. U.S. Geological Survey GQ 691.

GEOLOGICAL MAP - BLACK CREEK INTAKE DAM



LEGEND

Qt	Quarternary Talus
ℙMmu	Mauch Chunk - Upper Member
Mpm	Mount Carbon Member