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NATIONAL DAM SAFETY PROGRAM. GEORGE B. STEVENSON DAM (INVENTORY--ETC(U)
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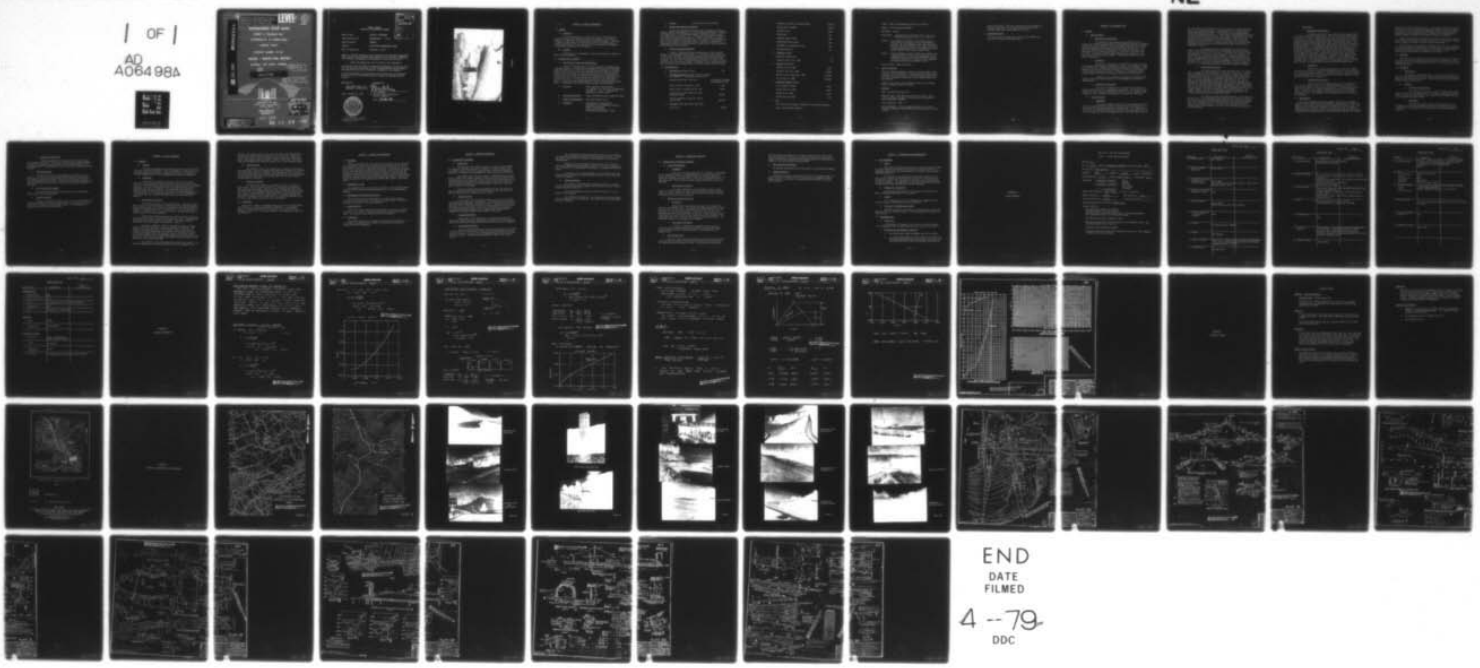

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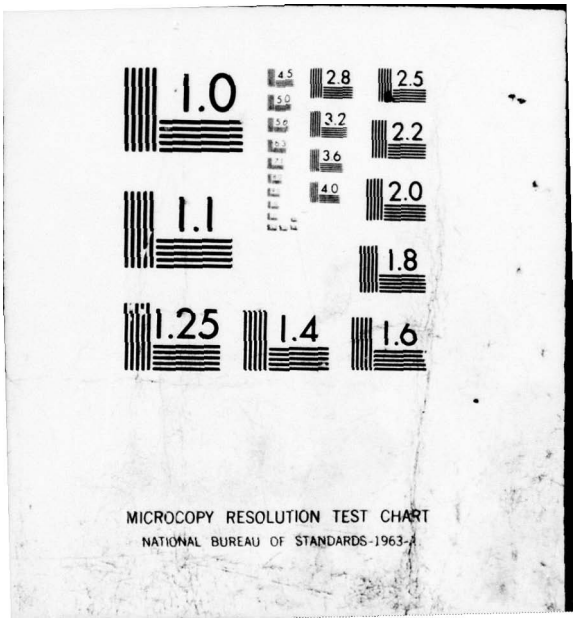
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(6) National Dam Safety Program. George B. Stevenson Dam (Inventory Number PA-914), Susquehanna River Basin, First Fork Sinnemahoning Creek, Cameron County, Pennsylvania. Phase I Inspection Report.

LEVEL II

(1) NW

SUSQUEHANNA RIVER BASIN

GEORGE B. STEVENSON DAM

COMMONWEALTH OF PENNSYLVANIA

CAMERON COUNTY

INVENTORY NUMBER PA-914

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

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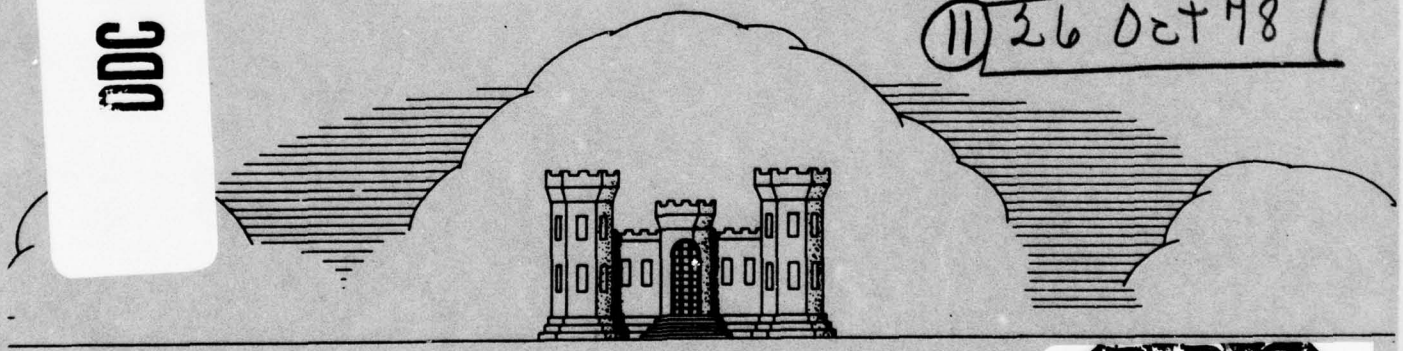

Prepared For
DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland
by
BERGER ASSOCIATES, INC.
CONSULTING ENGINEERS
HARRISBURG, PA.

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam:	GEORGE B. STEVENSON
State and State No.	PENNSYLVANIA - 12-11
County Located:	CAMERON
Stream:	FIRST FORK SINNEMAHONING CREEK
Date of Inspection:	September 7, 1978

Based on a visual inspection, past performance and available engineering data, the dam and its appurtenances appear to be in excellent condition. The following recommendation is presented for action by the owner:

1. Remove groundhogs and fill the holes in the embankment.

In accordance with the Corps of Engineers' guidelines, the spillway does have the capacity for passing the PMF (Probable Maximum Flood) without overtopping the dam and is, therefore, considered to be adequate.

A formal surveillance and downstream warning system shall be developed by the owner to be used during periods of high and prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

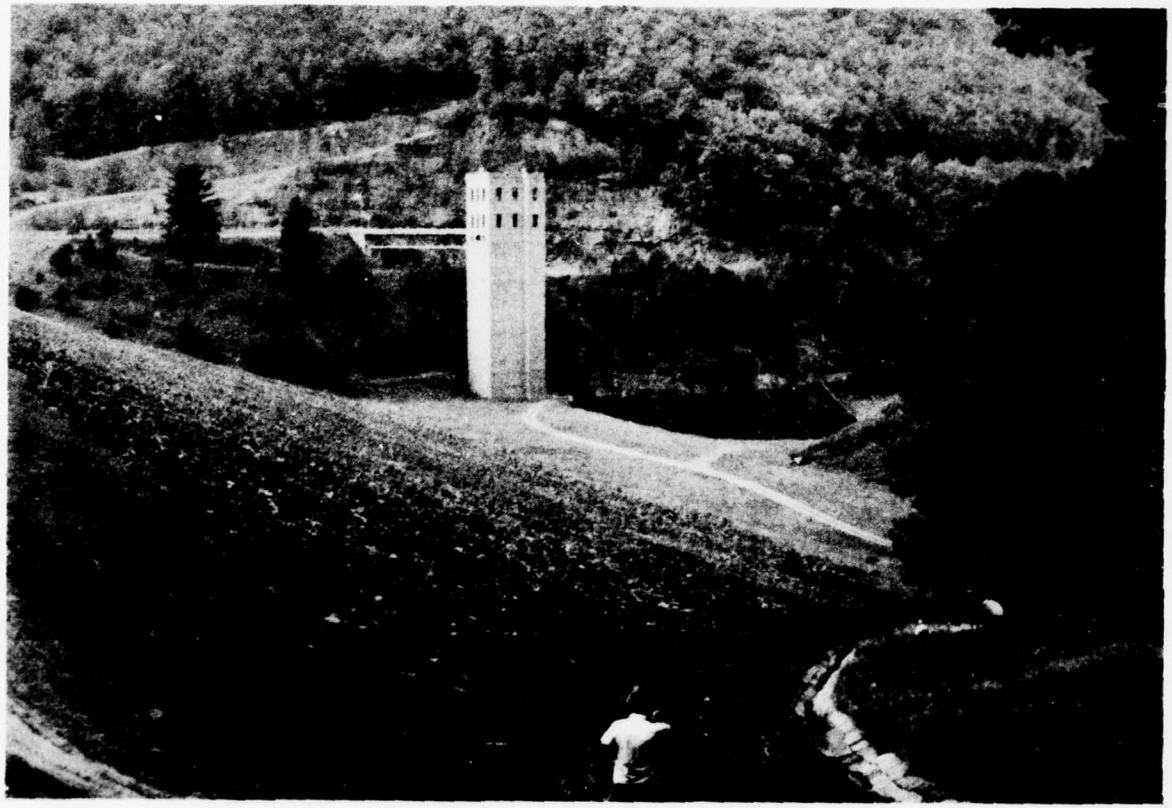
DATE: October 26, 1978

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
HENDRIK JONGSMA
ENGINEER
No. 5557E

APPROVED BY:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE: 26 Nov 78



OVERVIEW

ABSTRACT

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. The Phase I Inspection and Report are limited to a review of available data, a visual inspection of the dam site and basic calculations to determine the hydraulic adequacy of the spillway.

B. Purpose

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

1.2 DESCRIPTION OF PROJECT

ABSTRACT

A. Description of Dam and Appurtenances

George B. Stevenson dam is a rolled earthfill embankment with a maximum height of 166 feet above streambed elevation and an embankment length of 1,665 feet. A 260 foot long spillway is located in the right abutment and has a spillway crest elevation of 1026.0, which is 30 feet below the top of the dam. The dam was constructed as a flood control project and is also used for recreational purposes with a permanent pool elevation at 920. An intake structure is located at the upstream toe near the left side of the forebay area and has two 8-feet by 16-feet gates. A tunnel with an inside diameter of 16 feet was excavated through rock to a downstream outlet works which includes a stilling basin.

B.	Location:	Grove Township, Cameron County U.S. Quadrangle, First Fork, Pennsylvania Latitude 41° - 24.4', Longitude 78° - 1.1' Appendix D, Plates I and II
C.	Size Classification:	Large (127,000 acre-feet, height 166 feet)
D.	Hazard Classification:	High (See Section 3.1.E)
E.	Ownership:	Commonwealth of Pennsylvania Department of Environmental Resources Bureau of Operations Third & Reily Streets Harrisburg, Pennsylvania 17120

F. Purpose: Flood control and recreation

G. Design and Construction History

The dam and appurtenant structures were designed by Gannett, Fleming, Corddry and Carpenter, Inc., Harrisburg, Pennsylvania. Pennsylvania Department of Environmental Resources (PennDER) issued a permit for construction on June 24, 1953. The general contractor was Nello L. Teer Company, Durham, North Carolina. Construction started in August 1953, and was completed in October 1956. The design of the spillway and outlet structures were reviewed by Justin & Courtney, Philadelphia, consultants to GFC&C. Professor Hough of Cornell was a soils consultant during design and construction.

H. Normal Operating Procedures

George B. Stevenson Dam was constructed as a flood control project in the Susquehanna River Basin. A conservation pool elevation of 920 is maintained for recreational purposes with a lake surface area of 142 acres. The lake and park facilities are used for boating and swimming. The pool level is maintained by opening one or both of the 8-feet by 16-feet tractor type gates. Stormwater can be stored behind the dam from normal pool elevation (920) to spillway crest elevation (1026).

1.3 PERTINENT DATA

A. Drainage Area (square miles)	243
B. Discharge at Dam Site (cubic feet per second) See Appendix B for hydraulic calculations	
Maximum known flood, June 1972	No spillway discharge (see Section 5.1.B)
Outlet works at low pool El. 908	1,740
Outlet works at normal pool El. 920	4,620
Outlet works at pool level El. 1026 (spillway crest)	13,500
Spillway capacity at pool El. 1056.0 (top of dam)	144,200
C. Elevation (feet above mean sea level)	
Top of dam	1056.0

Underside of center of bridge arches	1054.68
Spring line of arches	1050.0
Spillway crest	1026
Normal pool	920
Upstream portal invert	890
Downstream portal invert	881
Streambed at centerline of dam	890
Maximum tailwater	925

D. Reservoir (miles)

Length of normal pool	1.6
Length of pool at El. 1056	9.2

E. Storage (acre-feet)

Normal pool (El. 920)	2,000
Spillway crest (El. 1026)	75,800
Spring line of arches (El. 1050)	115,000
Top of dam (El. 1056)	127,000

F. Reservoir Surface (acres)

Top of dam (El. 1056)	1,960
Spring line (El. 1050)	1,860
Spillway (El. 1026)	1,450
Normal pool (El. 920)	142

G. Dam

See Plates VIII through X, Appendix D for plan and sections.

Type: Rolled zoned earthfill.

Length: 1665 feet embankment and 260 feet spillway.

Height: 166 feet above streambed.

Top Width: 30 feet.

Side Slopes: Upstream varies from 2H to 1V to 3.5H to 1V.
Downstream varies from 2H to 1V to 3H to 1V.

Zoning: Four classes of material. See typical section. Starting from the upstream, select semi-pervious material, then the impervious soil zone, which also backfills the cutoff trench. The center of the dam is semi-pervious material and the downstream zone is random rockfill with a select rockfill toe.

Cutoff: Trench excavated to rock or impervious material and a bottom width of 15 feet on the centerline of the impervious zone and filled with embankment material. A concrete cutoff wall is placed in the centerline trench where trench is excavated to rock.

Grout Curtain: Under cutoff wall.

H. Outlet Facilities

Water is released through two 8-feet by 16-feet tractor gates located in the control tower. After passing through the gate openings, water is carried in a 16-feet diameter tunnel 1,170 feet long, including transitions, to the channel downstream from the dam.

Access to the control tower operating floor is by a bridge from the roadway on top of the dam.

I. Spillway

Type: Uncontrolled, ogee weir.

Length of weir: Four sections, each 62 feet long. Total effective length, 248 feet. The sections are separated by piers supporting a roadway.

Crest elevation: 1026.

Approach channel: 723 feet long excavated in rock 5-feet lower than spillway crest with 80 foot concrete apron in front of weir.

Downstream channel: 390 foot long concrete chute ending in a concrete bucket which is 18 feet high and 150 feet long. A 1300 foot long pilot trench leads to the creek.

J. Regulating Outlets

Two 8-feet wide by 16-feet high tractor gates regulate the flow into the 16-foot diameter tunnel.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Data Available

1. Hydrology and Hydraulics

The hydrologic and hydraulic data available from the files of the Pennsylvania Department of Environmental Resources (PennDER) for this dam was not complete. The construction drawings contain stage discharge and stage storage curves and a tailwater rating curve. The report by PennDER upon the application for a permit to construct this dam states that the design was based on a storm which took place July 17, 1942. The design storm had been assumed to be 22 inches in a 24-hour period, which was routed through. The maximum inflow was calculated as 147,000 cfs.

2. Embankment

The Bureau of Operations of PennDER had a full set of as-built construction drawings available for review. The embankment design as detailed on the construction drawings was based on the result of test borings, test pits and laboratory testing of the borrow area material. A soils report dated July 9, 1952, by Hough Soils Engineering Laboratories, Ithaca, New York, list typical test data of this material.

A report by S. L. Burdich, Dam Engineer, PennDER reviews seepage, piping and slope stability of the embankment and discusses these results.

3. Appurtenant Structures

The files of PennDER did not contain design criteria or design calculations for the appurtenant structures. The available data consisted of the as-built drawings and some notes by Mr. Burdich, dated October 21, 1952, reviewing the adequacy of the concrete structures.

B. Design Features

1. Embankment

The design drawings indicate that the embankment consists of four separate zones and a rockfill toe drain (Refer to Appendix D, Plate IX). The upstream slope has a variable slope. The lower part is 3.5H to 1V up to elevation 1000; at that point the slope changes to 2.5H to 1V over the next 30 feet of height and the top of the slope is 2H to

1V. The slope is protected with 3 feet of riprap of durable sandstone placed on a twelve inch filter. The upstream zone is constructed of select semi-pervious material. The next zone is a relatively thin section of impervious material. A trench with a bottom width of 15 feet is excavated underneath this zone. The trench is excavated to the rock surface across the valley and the right abutment. Due to the less pervious overburden material on the left hillside, this trench was shallower on the east side. A grout cap was poured in the trench and the underlying rock strata was grouted from Station 10+64 westward (Appendix D, Plate X).

The central zone of the embankment is constructed of select semi-pervious material and the downstream zone is from random rockfill with a select rock fill toe. A toe drain was installed under the downstream toe along the left abutment to the old streambed. A filter and rock drain was installed under the downstream random rockfill. The downstream slope is 2H to 1V above a 10 feet wide bench at elevation 1000. Below this bench the embankment is placed on a slope of 2.5H to 1V to a bench at elevation 950, where the slope changes to 3H to 1V. The downstream slope was covered with topsoil and seeded.

2. Appurtenant Structures

The intake structure at the upstream side of the embankment is founded on rock (Appendix D, Plates XII through XIV). The two large openings (8 feet by 16 feet) are closed by tractor type gates, lifted by a 100 ton hoist. An emergency gate with rubber gaskets can close off either opening for maintenance and repair to the tractor gates. The gate openings can also be closed with stop logs and the openings are protected with trash racks. The two gate openings transition into a 16-foot diameter concrete lined tunnel. The minimum thickness of the concrete liner is 16-inches and the concrete is reinforced and has vertical expansion joints with rubber waterstops spaced at 25 or 40 feet centers. The rock surrounding the tunnel was grouted. The conduit tunnel discharges in a concrete lined stilling basin, with energy dissipating concrete blocks (Plate XIV).

The spillway forebay area was excavated in rock (Appendix D, Plate XI). The reinforced concrete ogee weir is keyed into rock and the grout curtain was continued under the weir and a visitor's parking area. The spillway chute is a one foot thick slab with construction joints and a drainage system. The walls are a combination of rock anchored walls poured against the rock cut and a gravity section above the rock surface.

C. Design Data

1. Hydrology and Hydraulics

PennDER's report states that the designers maximum inflow of 147,000 cfs can be passed assuming that the pool level was at spillway crest at the time the storm began and that the gates on the intake structure were closed. Maximum discharge would be 100,000 cfs over the spillway and this design flood would leave a freeboard of 5 feet. The gates and tunnel were designed for a peak inflow of 80,000 cfs (equal to 8 inches runoff). If the gates were closed, the water level would rise to elevation 1034.5, discharging 13,000 cfs over the spillway. If the gates were open, pool level would reach elevation 1026, discharging 13,600 cfs through the tunnel. The report states that the capacity of the spillway is very ample. The hydraulic analysis and outlet works were reviewed by Justin and Courtney. Several of their comments were incorporated in the final construction drawings. Some concern was expressed that a full hydraulic model study of the gates and tunnel was not made, due to the unavailability of a large enough facility. Cavitation could be a problem under full head and partial opened gates.

2. Embankment

Notes by Mr. Burdich, Dam Engineer, reviews the seepage (30 cubic feet a day), vertical and horizontal piping. All was found to be well within acceptable limits or possibilities. Mr. Burdich reviewed also slope stability for a full reservoir and drawdown condition and the factors of safety were acceptable.

3. Appurtenant Structures

Design criteria and calculations were not available in the PennDER files for review. Mr. Burdich commented on October 21, 1952, on the design of the concrete structures. The spillway weir had a factor of safety of 9.3 against sliding using friction and allowable shear. Factor of safety against overturning was found to be within acceptable limits. The design of the spillway walls was also found to be acceptable.

2.2 CONSTRUCTION

The files at PennDER contained progress reports by the resident engineer and inspection reports by PennDER's representatives. Many test reports on soil compaction and concrete strength were in the files. The construction specifications required that the soil would be compacted under a method of moisture control to a density not less than 90 percent of densities at optimum moisture using the modified method of the American

Association of State Highway Officials. The rolling of the earth portion of the fill would be by either an approved sheepsfoot roller or rubber-tired roller. For rolling with a sheepsfoot roller the material would be spread in six inch layers and for a rubber-tired roller the soil would be spread in layers not more than 12 inches in thickness.

Reports indicate that the compaction tests did not meet the requirement of 90 percent density but had a range of 46 to 100 percent. These results appear to indicate incorrect testing procedures.

Field problems were reviewed by Professor Hough for the consultant and by Arthur and Leo Casagrande for the Contractor. A main problem was that field personnel were not familiar with testing procedures. No follow-up of this problem was available in the files.

2.3 OPERATION

Since the dam was completed in 1956 no major problems have occurred. The pool level has never reached the spillway crest elevation. Daily readings of the water surface elevations were in the files for the years 1956 through 1970.

2.4 EVALUATION

A. Availability

The available engineering data was obtained from PennDER. The Dams and Encroachments provided the letter files and only two drawings (general plan and typical section). The as-built drawings were obtained from the Bureau of Operations.

B. Adequacy

1. Hydrology and Hydraulics

The available data did not include a design flood hydrograph or routing of the design flood. Sufficient information was available to review the designers data and to assess the discharge capacity of the spillway and outlet works.

2. Embankment

Although the design criteria and design data for the embankment fill were not available for review the design slopes are considered to be adequate and in accordance with accepted engineering practice.

3. Appurtenant Structures

Design calculations of the appurtenant structures were not available for review. Sufficient details on the contract drawings are shown to evaluate these structures for structural adequacy. The spillway walls are a combination of rock anchored walls and gravity type sections.

C. Operating Records

Mr. Herb Fox, the dam tender reported no problems at this facility. The gates were kept closed during tropical storm Agnes and only partially opened to release a maximum of 8,000 cfs after flood levels downstream had diminished. The pool level reached elevation 1016 and was maintained at that level for about five days before releases were made.

D. Post Construction Changes

No reported modifications have been made to the facilities since construction was completed.

E. Seismic Stability

The dam is located in Seismic Zone 1 and it is considered that the static stability with normal safety factors is sufficient to withstand minor earthquake induced dynamic forces. No calculations or studies have been made to confirm this.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of the dam was excellent and the facilities are very well maintained. Refer to Appendix A of this report for the visual inspection checklist. Appendix D, Plates III through VII contains reproductions of the photographs made during the inspection.

B. Embankment

At the time of inspection the pool level was at elevation 920.5 and the full upstream side was exposed, except the toe which was used as a cofferdam during construction. The stone slope was in excellent condition. The top of the dam has a gravel roadway and had a good horizontal and vertical alignment. The downstream slope and toe is grassed, mowed closely and gives a very well maintained appearance. At a few locations the slope undulates slightly, but this was apparently constructed that way. Several groundhog holes and mole holes were noticed.

C. Appurtenant Structures

The intake structure was in good condition. The tractor type gates are pulled up once a year for maintenance after lowering an emergency close-off gate. The 8-feet by 16-feet gates are used regularly to maintain the conservation pool at elevation 920. They are used alternately on a monthly basis. The electrical hoist to open these gates is backed up with an L.P. gas generator.

During flood events the release of water through the gates is regulated by the Corps of Engineers, Baltimore District. The gates have never been opened fully during a flood event. The intake tower is accessible by a truss bridge (see Appendix D, Plate V).

The water through the gates is discharged through a 16-feet diameter concrete lined tunnel, excavated through the hillside. The tunnel was in good condition. Only one small leak in the roof was noticed. The tunnel discharges in a tapered stilling basin with some energy dissipating blocks. The concrete of the stilling basin walls was in good condition and the downstream channel rock lining appeared to be stable. Some rock on the slopes had eroded during the tropical storm Agnes, but this has been repaired.

The spillway in the right abutment has never been tested. All concrete appeared to be in good condition and no wall movements were

noticed. The forebay area, cut in rock, was clear of any obstructions. The spillway chute tapers down and ends in a flip bucket. Beyond the bucket the discharge channel consists of only a relatively small pilot ditch, which passes under a road with a small culvert pipe. The ditch joins the streambed just below this culvert at a nearly 90 degree angle.

D. Reservoir Area

The reservoir area of the normal pool is used as a park and is well maintained. Several buildings (restrooms and bathhouse) are located within the area which can be flooded. No sedimentation was reported by the park superintendent, but debris floats down during heavy precipitation. A long trash boom upstream of the intake tower over the full length of the dam protects the gates.

E. Downstream Channel

The downstream channel is a natural stream in a relatively wide valley. Most of the banks adjacent to the stream are wooded, but there are also open meadows. The First Fork Sinnemahoning Creek joins the West Branch of the Susquehanna River about 8 miles downstream of the dam. There are approximately 6 permanent homes and many hunting cabins and camping trailers located in this valley. The hazard category for this dam is considered to be "High" due to the expected additional loss of life if dam failure would occur after overtopping.

3.2 EVALUATION

Except for a number of groundhog holes the dam and its appurtenant structure were in excellent maintenance condition. A considerable amount of downstream erosion can be expected if the spillway would discharge a large flow. This would, however, not endanger the safety of the structure.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

George B. Stevenson Dam is a flood control project and is also used as a recreational facility by maintaining a conservation pool at elevation 920.0. This pool is maintained by opening or closing one or both 8-feet by 16-feet gates in the intake structure. These two gate openings are the only available discharge, until the pool level would reach the elevation of the spillway crest (Elevation 1026.0). Since the dam was completed in 1956, this has not happened. Maximum pool level was approximately at elevation 1016.0 during the tropical storm Agnes. During that storm the gates were not opened and all inflow was stored in the reservoir.

4.2 MAINTENANCE OF DAM

The downstream slope is mowed very regularly. Some groundhog holes were noticed and will be closed according to Mr. Fox, the Maintenance Foreman.

4.3 MAINTENANCE OF OPERATING FACILITIES

The two large gates are maintained on a yearly basis and used alternately on a monthly basis to regulate the pool level. The tower and other facilities are all well maintained.

4.4 WARNING SYSTEM

There is no formal downstream warning system in effect at present. However, Mr. Fox lives at the site and has radio communication available. All facilities are accessible during an emergency.

4.5 EVALUATION

The general operational procedures for this dam are excellent. It is, however, recommended that a formal surveillance and downstream warning system be implemented.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analysis available from PennDER for George B. Stevenson Dam was not complete. A stage storage curve, a tailwater rating curve and a stage discharge curve were contained in the files. No design flood hydrograph or flood routing were available.

The design storm, having 22 inches of rainfall falling in two 6-hour periods, was assumed to have the same rainfall pattern and infiltration losses as the July 1942 storm, which was the maximum known storm. The design storm was expected to produce a peak inflow of 147,000 cfs and the spillway-reservoir system was designed to pass that storm with about five feet of freeboard.

The files indicate that the hydrology of the 1942 storm had been reevaluated and the runoff may only have been about 60 percent or less of that which was estimated prior to design.

B. Experience Data

In the period that the dam has been in existence, since 1956, the spillway has never been in operation. The maximum flood occurred in June 1972, which produced a pool level of 1016 or 10 feet lower than the spillway crest. During this flood all water was impounded in the reservoir and no release was made. After the storm passed and flooding in the downstream channels subsided, the tractor gates were partially opened and a maximum release of about 8,000 cfs was made.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the appurtenant structures of the dam could not operate satisfactorily during a flood event until the dam is overtopped.

D. Overtopping Potential

George B. Stevenson Dam has a total storage capacity of 127,000 acre-feet and an overall height of 166 feet above streambed, both calculated to the top of the dam. These dimensions indicate a size classification of "Large". The hazard classification is "High" (See Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the PMF (Probable Maximum Flood). For this dam the PMF peak inflow is 144,000 cfs (see Appendix B for hydraulic calculations).

Comparison of the estimated PMF peak inflow of 144,000 cfs with the estimated spillway discharge capacity of 144,200 cfs indicates that a potential for overtopping of the George B. Stevenson Dam does not exist.

An estimate of the storage effect of the reservoir shows that this dam has the necessary storage available to pass the PMF with about 8 feet of freeboard.

E. Spillway Adequacy

For George B. Stevenson Dam, the PMF peak inflow is 144,000 cfs and the spillway discharge capacity with the water level at the top of dam is about 144,200 cfs.

Since the spillway can pass the PMF peak inflow, it 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

There are no visual indications of settlement or sloughing of the embankment slopes. The embankment is in excellent condition except the presence of some woodchuck holes on the downstream slope. It should be noted that the pool level at the time of inspection was 136 feet below top of dam and that critical seepage conditions could not be evaluated.

2. Appurtenant Structures

The visual inspection of the spillway, spillway chute, intake structure, conduit and outlet works did indicate that all structures are in good condiiton. There was no excessive cracking, spalling or deflection in any of the structures.

B. Design and Construction Data

1. Embankment

Design criteria and design data were not available for review in the PennDER files. The review by PennDER indicates that slope stability for full reservoir and drawdown were sufficient and that the possibility of piping did not exist. A review of the construction drawings indicate a well engineered section for a flood control project, where high pool levels would be only sustained for short periods. The downstream slope has a toe drain and a drain blanket with filters. The embankment section is considered to be adequate.

2. Appurtenant Structures

A review of construction drawings indicate that all structures were designed and detailed according to acceptable engineering standards and all structures appear to be adequate for the expected use.

C. Operating Records

While no formal operating records were reviewed, the files and interviews did not indicate that any major problem has occurred since the construction was completed in 1956. The spillway has never been

used and downstream erosion can be expected when the pool level would raise above the weir elevation. The outlet channel had a maximum discharge of 8,000 cfs, and although some erosion occurred on the banks, no damage to the stilling basin was experienced.

D. Post Constriction Changes

No reported modifications have been made to the original dam design.

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, the review of available design data and the operational history indicates that George B. Stevenson Dam is in excellent condition and has been designed in accordance with acceptable engineering practice.

The results of the hydrologic and hydraulic evaluation for this project indicate that the spillway capacity is sufficient to pass the PMF peak inflow, with the gates in the intake tower closed and is, therefore, adequate. The combination of storage and spillway discharge is sufficient to pass the PMF with an 8-foot freeboard.

B. Adequacy of Information

The available information is considered to be sufficient to make a reasonable assessment of this project.

C. Urgency

It is considered that the recommendations suggested in this section should be implemented as soon as practical.

D. Necessity for Additional Studies

Additional studies by the owner are not required at this time. However, attention should be given to the recommendations presented in this section.

7.2 RECOMMENDATIONS

A. Facilities

If the amount of leakage in the roof at one joint increases, it is recommended that the owner grout the rock strata in that area.

B. Operation and Maintenance Procedures

1. The owner should remove groundhogs and fill the holes.

2. It is considered important that a formal surveillance and downstream warning system be developed by the owner to be used during periods of high and prolonged precipitation.

APPENDIX A

VISUAL CHECKLIST

CHECK LIST - DAM INSPECTION PROGRAM

PHASE I - VISUAL INSPECTION REPORT

NAD NO. 914

PA. ID # 12-11 NAME OF DAM George B. Stevenson HAZARD CATEGORY High

TYPE OF DAM: Earth and Rock

LOCATION: Grove TOWNSHIP Cameron COUNTY, PENNSYLVANIA

INSPECTION DATE 9-7-78 WEATHER Clear - Warm TEMPERATURE 80's

INSPECTORS: H. Jongsma, R. Houseal D.E.R.
Herb Fox
R. Shireman, A. Bartlett Dick Rahn
Dick Conerby
Ed Bennett

NORMAL POOL ELEVATION: Conservation Pool 920.0 AT TIME OF INSPECTION:

BREAST ELEVATION: 1056.0 POOL ELEVATION: 920.5

SPILLWAY ELEVATION: 1026.0 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: 1016.0 (1972)

GENERAL COMMENTS:

Water has never flowed over spillway.
Upstream slope cover is rock riprap.
Downstream slope is grassed closely mowed - very good appearance.
Top - grassed at edges - 1/2 inch stone roadway

Horizontal and vertical alignment - good.

Numerous groundhog holes and mole holes on the downstream slope - some have been covered with a flat rock.

Downstream slope undulates slightly.

Primarily flood control dam with recreational pool at El. 920 Swimming in season, boating and fishing.

DAM NO. NAD 914

VISUAL INSPECTION

EMBANKMENT	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. SURFACE CRACKS	None evident.	
B. UNUSUAL MOVEMENT BEYOND TOE	None evident.	
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None evident Some slight surface channels on slope - not serious. Abutments appear sound.	
D. VERTICAL & HORIZONTAL ALIGNMENT OF CREST	Good	
E. RIPRAP FAILURES	None evident Entire slope was able to be observed.	
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good	
G. SEEPAGE	No seepage evident anywhere.	
H. DRAINS	See drawings.	
J. GAGES & RECORDER	Small weir - V-notch on left side below the embankment and in the drainage channel at end of 8-inch pipe. (underground pipe - origin?)	
K. COVER(GROWTH)	See Sheet No.1.	

VISUAL INSPECTION

OUTLET WORKS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. INTAKE STRUCTURE	Concrete tower near right abutment. Protected by trash boom.	
B. OUTLET STRUCTURE	16 feet diameter concrete culvert visible - refer to drawings. Concrete walls and bottom - flaring open from outlet and curved at the ends. Link fence around walls of outlet. One joint in roof leaks	
C. OUTLET CHANNEL	Stone lined slopes 100± feet beyond the downstream end of the concrete walls. Channel turns 90° to the right at 150± yards below outlet walls. Rocky bottom - below curve natural stream typical of mountain areas.	
D. GATES	Two tractor gates - 8 feet by 16 feet. with emergency gate closure and stop logs.	
E. EMERGENCY GATE	None	
F. OPERATION & CONTROL	100 ton hoist. Gates manually opened alternately on a monthly basis. Gates maintained once a year. Electrical joist backed up by LP gas generator. Federally regulated from Baltimore during flood events - via radio communications.	
G. BRIDGE (ACCESS)	Truss bridge.	

DAM NO. NAD 914

VISUAL INSPECTION

SPILLWAY	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. APPROACH CHANNEL	Wide flat excavation into rock. Approach is several hundred feet in length. Has never been used. The channel is clear of obstructions. Rockcut.	
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Concrete ogee section Good None None Not visible Concrete - good condition	
C. DISCHARGE CHANNEL Lining Cracks Stilling Basin	Concrete walls and slab to end of channel at bucket type energy dissipator. Below - dissipator channel is a pilot ditch.	
D. BRIDGE & PIERS	Concrete bridge spans spillway directly over its crest - 4 spans -	
E. GATES & OPERATION EQUIPMENT	None	
F. CONTROL & HISTORY	Never used.	

DAM NO. NAD 914

VISUAL INSPECTION

MISCELLANEOUS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
INSTRUMENTATION		
Monumentation	None	
Observation Wells	None	
Weirs	On drainage ditch - left side of abutment	
Piezometers	None	
Other	Staff gauge on intake tower	
RESERVOIR		
Slopes	Wooded	
Sedimentation	None reported	
DOWNSTREAM CHANNEL		
Condition	Clear - stone bottom Typical mountain stream	
Slopes	No erosion	
Approximate Population	25-30	
No. Homes	6 permanent and hunting cabins and trailers.	

APPENDIX B

HYDROLOGY/HYDRAULICS

BY RLS DATE 9/19/78 **BERGER ASSOCIATES** SHEET NO. 1 OF
CHKD. BY DATE PROJECT D 7530
SUBJECT G.B. STEVENSON DAM

MAXIMUM KNOWN FLOOD AT DAMSITE

THE DAM SUPERINTENDENT INDICATED THAT THE MAXIMUM FLOOD AT STEVENSON DAM, SINCE ITS CONSTRUCTION IN 1956, OCCURRED IN JUNE 1972. AT THAT TIME THE WATER LEVEL IN THE POOL REACHED ELEVATION 1016, WHICH IS 10 FEET LOWER THAN THE SPILLWAY CREST. DURING THIS FLOOD, NO WATER WAS RELEASED FROM THE RESERVOIR. AFTER THE STORM HAD PASSED, THE TRACTOR GATES WERE PARTIALLY OPENED AND A MAXIMUM RELEASE OF ABOUT 8000 CFS WAS MADE.

DISCHARGE THROUGH OUTLET WORKS

ASSUME TAILWATER = 906

AT NORMAL POOL ELEV. 920

$H = 920 - 906 = 14$ $\quad C = 0.6$

$$Q = CA\sqrt{2gH}$$

$$= .6 \times 16 \times 8 \times (2 \times 32.2 \times 14)^{0.5}$$

$= 2310$ CFS PER GATE

$\times 2 = 4620$ CFS TOTAL

AT LOW POOL ELEV. 908

$H = 908 - 906 = 2'$

$$Q = CA\sqrt{2gH}$$

$$= .6 \times 16 \times 8 \times (2 \times 32.2 \times 2)^{0.5}$$

$= 870$ CFS PER GATE

$\times 2 = 1740$ CFS TOTAL

BY RLS DATE ____ **BERGER ASSOCIATES** SHEET NO. 2 OF ____
CHKD. BY ____ DATE ____ PROJECT D 7530
SUBJECT G. B. STEVENSON DAM

DISCHARGE AT HIGH POOL ELEV. 1026

$H = 1026 - 906 \quad 120$

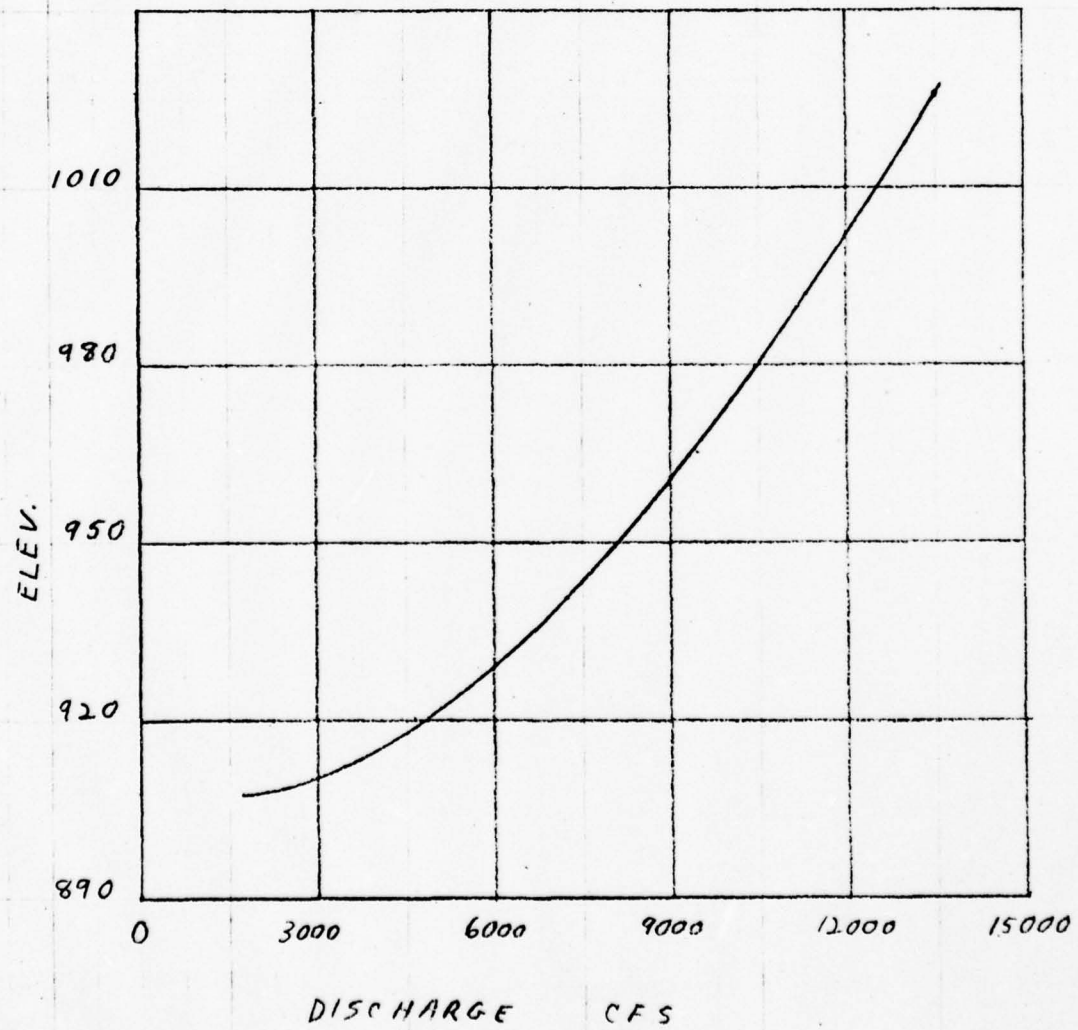
$Q = CA\sqrt{2gH}$

$= .6 \times 16 \times 8 \times (2 \times 32.2 \times 120)^{0.5}$

$= 6750$ CFS PER GATE

$\times 2 = 13500$ CFS TOTAL

OUTLET WORKS RATING



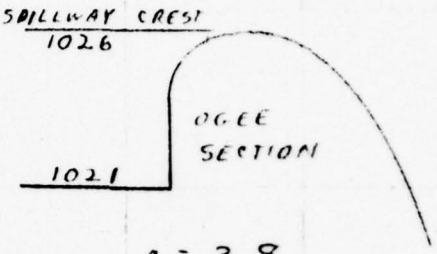
BY RLS DATE 9/13/78 **BERGER ASSOCIATES** SHEET NO. 3 OF
CHKD. BY DATE PROJECT 07530
SUBJECT G. B. STEVENSON DAM

SPILLWAY DISCHARGE CAPACITY

POOL ELEV. AT 1050

L = 260 WITH 3 PIERS
HAVING MAXIMUM
WIDTH OF 4'

EFFECTIVE L = 248'



USE C = 3.8

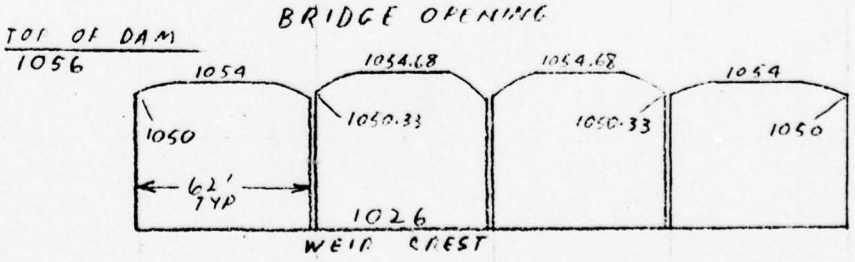
SPRING LINE ELEV = 1050
H = 1050 - 1026
= 24'

C = 3.8

$Q = CLH^{3/2}$
$= 3.8 \times 248 \times (24)^{3/2}$
$= 110800$ CFS

POOL ELEV AT 1056

DISCHARGE THROUGH ORIFICE C = 0.65



LOWER OPENINGS

INCREMENT	H	A	H×A
1026 TO 1050	19	1488	26784
1050 TO 1054	4	216	864
		1704	27648

H TO CENTROID = $\frac{27648}{1704} = 16.23'$

BY RLS DATE 9/20/78 **BERGER ASSOCIATES** SHEET NO. 4 OF
CHKD. BY DATE PROJECT 07530
SUBJECT G. B. STEVENSON DAM

DISCHARGE PER OPENING

$$Q = CA\sqrt{2gH}$$
$$= .65 \times 1704 \times (2 \times 32.2 \times 16.23)^{0.5}$$
$$= 35808 \text{ CFS}$$

HIGHER OPENINGS

INCREMENT	H	A	H x A
1026 TO 1050	18	1488	26784
1050 TO 1050.33	5.84	20.5	119.4
1050.33 TO 1050.68	5.5	216.2	1188
		1724.7	28091.9

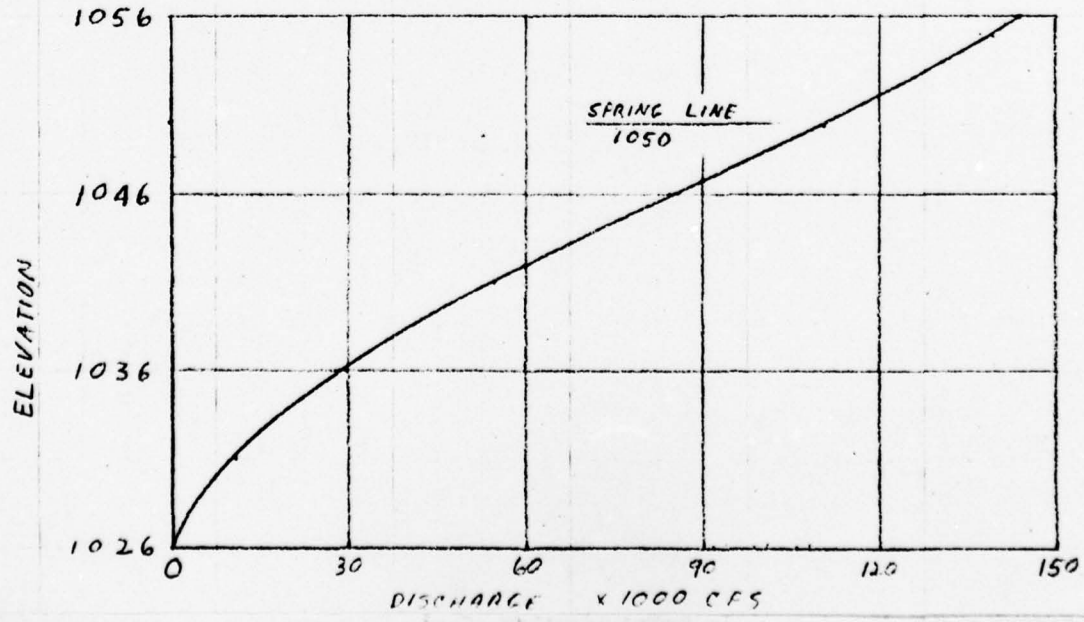
H TO CENTROID = $\frac{28091.4}{1724.7} = 16.29'$

DISCHARGE PER OPENING

$$Q = CA\sqrt{2gH}$$
$$= .65 \times 1724.7 \times (2 \times 32.2 \times 16.29)^{0.5}$$
$$= 36310$$

TOTAL DISCHARGE =
$(2 \times 36310) + (2 \times 35808) = 144236$ SAY 144200 CFS

SPILLWAY RATING



BY RLS DATE 9/20/78 **BERGER ASSOCIATES** SHEET NO. 5 OF
CHKD. BY DATE PROJECT D7530
SUBJECT G. R. STEVENSON DAM

SIZE CLASSIFICATION

MAXIMUM STORAGE = 127000 ACRE-FEET
MAXIMUM HEIGHT = 171 FEET
SIZE CLASSIFICATION IS "LARGE"

HAZARD CLASSIFICATION

SEVERAL HOUSES BUILT ALONG STREAM DOWNSTREAM OF DAM. USE "HIGH".

RECOMMENDED SPILLWAY DESIGN FLOOD

THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO THE PROBABLE MAXIMUM FLOOD.

PMF

DRAINAGE AREA = 243 SQ. MI.

PMF = 144,000 CFS (FROM CORPS OF ENGRS., BALT. DIST.)

USE 26 INCHES RUNOFF
= 336960 ACRE-FEET

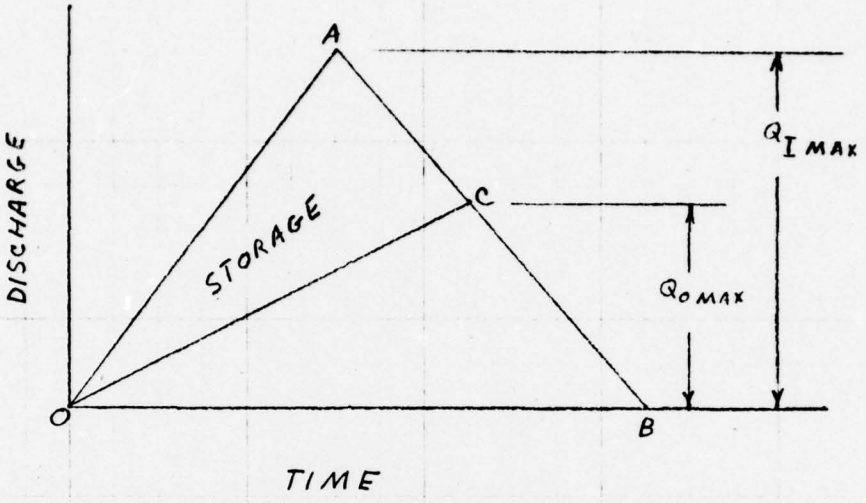
$$\frac{\text{MAX. SPILLWAY DISCHARGE}}{\text{PEAK INFLOW}} = \frac{144200}{144000} \simeq 100\ \%$$

∴ THE SPILLWAY SHOULD PASS A FLOW EQUAL TO THE PMF PEAK INFLOW WITHOUT ANY FREEBOARD.

BY RLS DATE 9/20/78 **BERGER ASSOCIATES** SHEET NO. 6 OF
CHKD. BY DATE PROJECT D7530
SUBJECT G. B. STEVENSON DAM

ROUTING OF PMF BY C. OF E. SHORT CUT METHOD

VOLUME OF PMF = 26"
= 336960 AC-FT



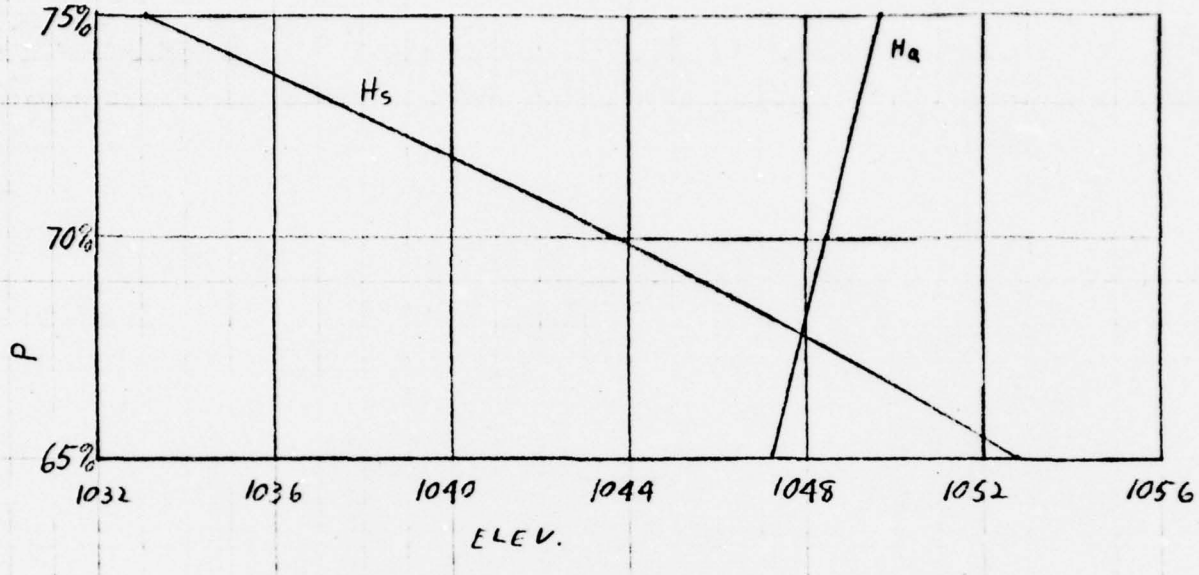
$$\frac{\Delta AOC}{\Delta AOB} = \frac{\Delta AOB - \Delta COB}{\Delta AOB} = 1 - \frac{\Delta COB}{\Delta AOB}$$

$$\frac{\Delta AOC}{\Delta AOB} = 1 - \frac{T\,P\,Q_{I\,MAX}/2}{T\,Q_{I\,MAX}/2} = 1 - P$$

$\Delta AOC = (1-P)\,\Delta AOB$ $\qquad \Delta AOB = 336960$

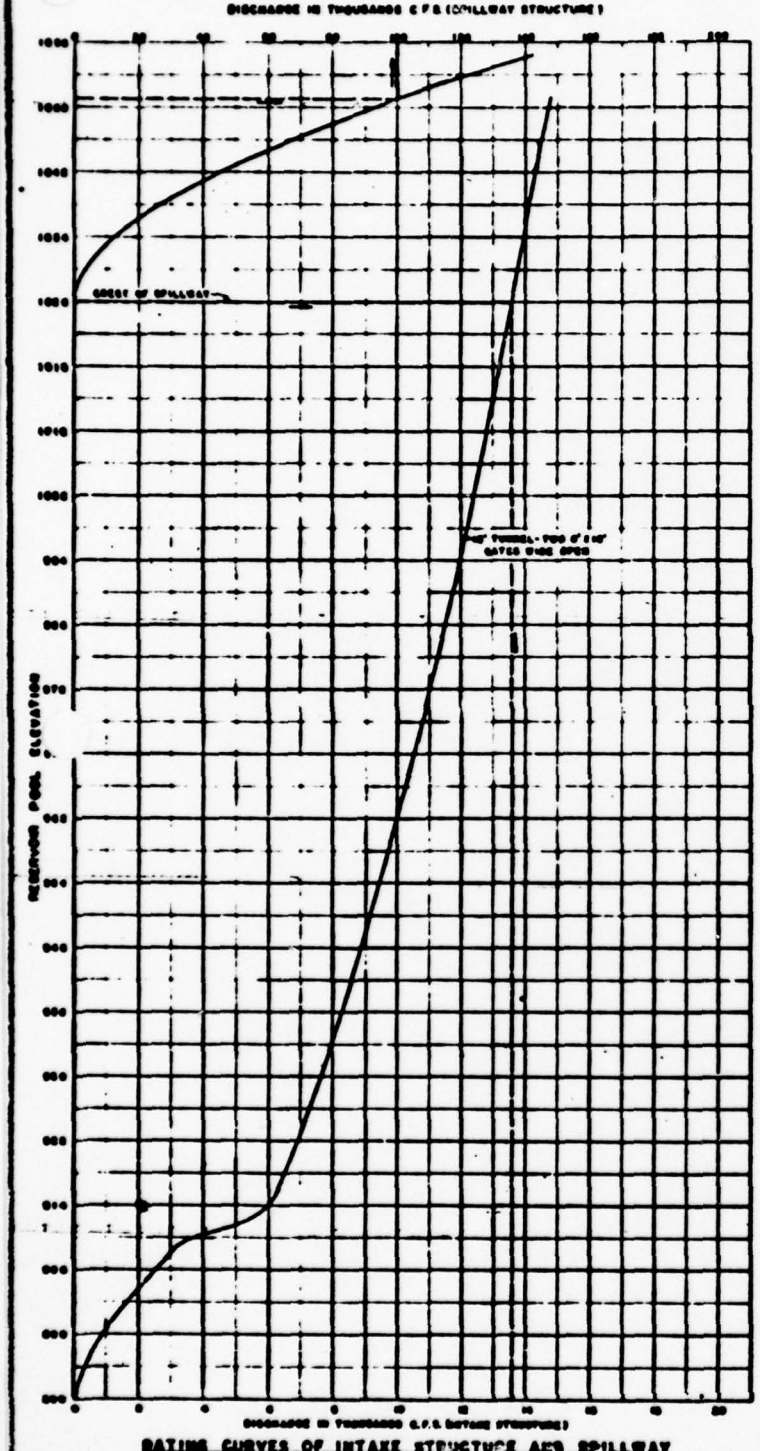
P =	ΔAOC (A-F)	H_S =	Q_O = (CFS)	H_Q
70%	101088	1043.5	100800	1048.5
65%	117936	1052.7	93600	1047.2
75%	84240	1033.1	108000	1049.7

BY PLS DATE 9/20/78 **BERGER ASSOCIATES** SHEET NO. 7 OF
CHKD. BY DATE PROJECT D7530
SUBJECT G. B. STEVENSON DAM

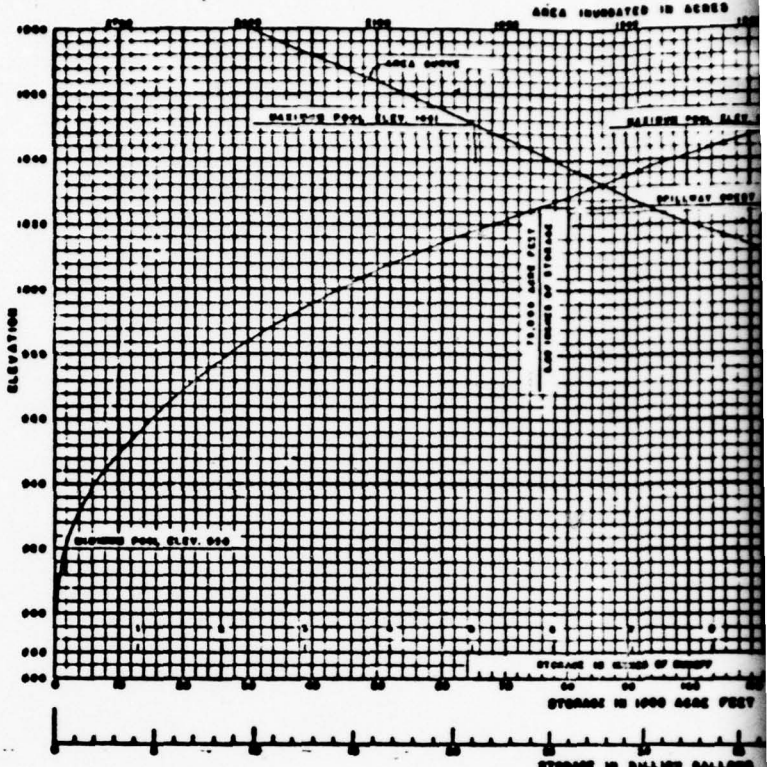


MAX. POOL LEVEL = 1047.9 SAY 1048

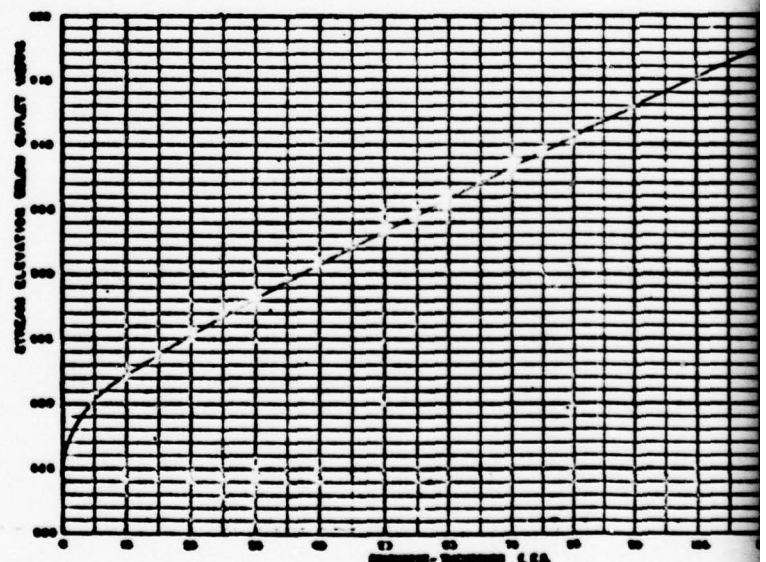
MAX. DISCHARGE OVER SPILLWAY = 97500 CFS



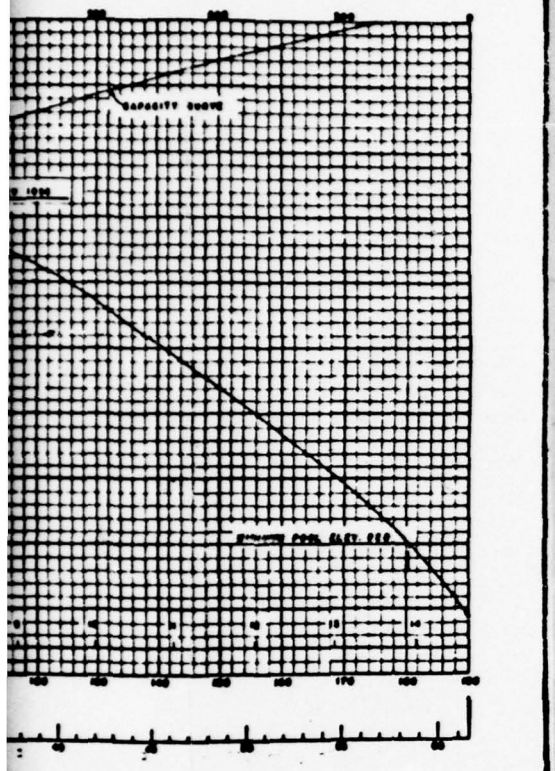
RATING CURVES OF INTAKE STRUCTURE AND SPILLWAY

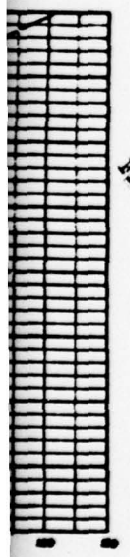


RESERVOIR AREA-CAPACITY



RATING CURVE





...RAL STATE AUTHORITY	PROJECT NO. - GSA - 104 - 1
	FLOOD CONTROL DAM AND RESERVOIR FIRST FORK SINNEMAHONING CREEK CAMERON AND POTTER COUNTIES PENNSYLVANIA
	RATING AND CAPACITY CURVES
	...FLEMING GREEN & CARPENTER INC. ENGINEERS 320 N. 2nd ST. HARRISBURG, PENNA.
1951	THE GENERAL STATE AUTHORITY
	SHEET NO. AS 2

APPENDIX C

GEOLOGICAL REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Catskill Formation.

Lithology: The Catskill Formation here consists of interbedded gray sandstone, red sandstone, red siltstone and red shale with greenish gray streaks.

Structure

The dam is located on the south limb of the Kettle Creek syncline, a broad gentle fold. The strike here is N60°E and the dip is about 3° NW.

Air photo fracture traces have the following trends, N55°W, N70°W, N90°E, N30°E and N10°W.

Overburden

On the valley sides the overburden is slope wash and talus consisting of red sandy silt, gravel and boulders with some clay. Core borings show this to be 20 to 58 feet thick. The valley floor is underlain by glacial outwash, consisting of sand, gravel, and boulders. Core borings and wash borings indicate this gravel is 5 to 51 feet thick. The bedrock is generally fresh, but in some places was weathered and broken for 10 to 15 feet below the overburden.

Aquifer Characteristics

The sandstones, siltstones and shales of the Catskill Formation generally have little, or no primary permeability, but in general, ground water movement is along bedding planes and along joints. Most movement is along these paths in the sandstone units, as the fractures and bedding planes in the shales tend to be clogged with clay.

Discussion

The valley of First Fork of Sinnemahoning Creek is probably controlled here by the N10°W fracture system. Some leakage below the grout curtain along fractures and along bedding planes is a possibility. However, the bedrock is sound and has very little, if any, carbonate cement. Continued movement of ground water is, therefore, unlikely to cause any deterioration of the bedrock.

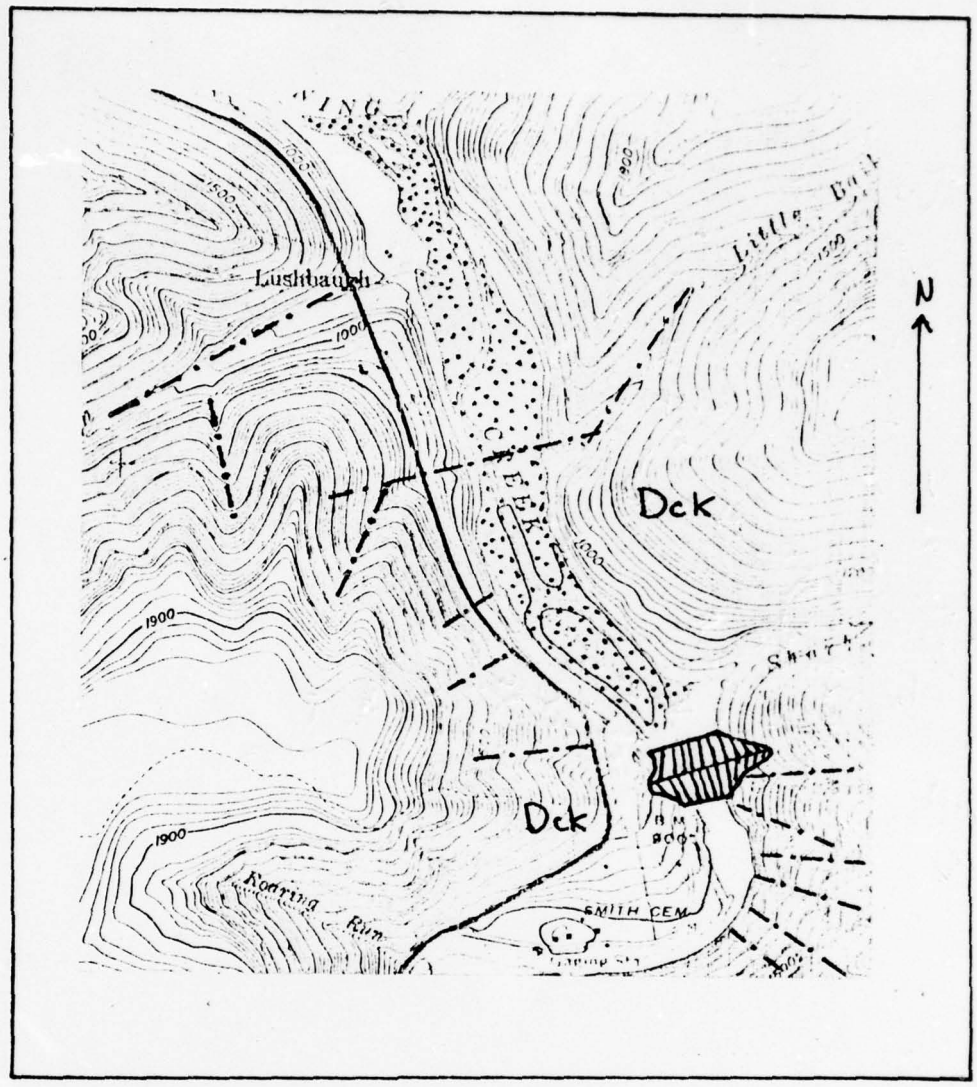
Sources of Information

1. Bolger, R. C. and Gouse, H.V. (1953) "Surface and Subsurface Geology of the Driftwood Quadrangle". Pa. Geological Survey, 4th Series, Bulletin M.36.

2. Air photographs, scale 1:24,000, dated 1971.

3. Core borings in file.

GEOLOGIC MAP - STEVENSON DAM



(geology from geologic map of Pa.)

KEY

Dck — Catskill Fm.

—·—·—· air photo fracture trace

SCALE 1:24000

1 0 1 MILE

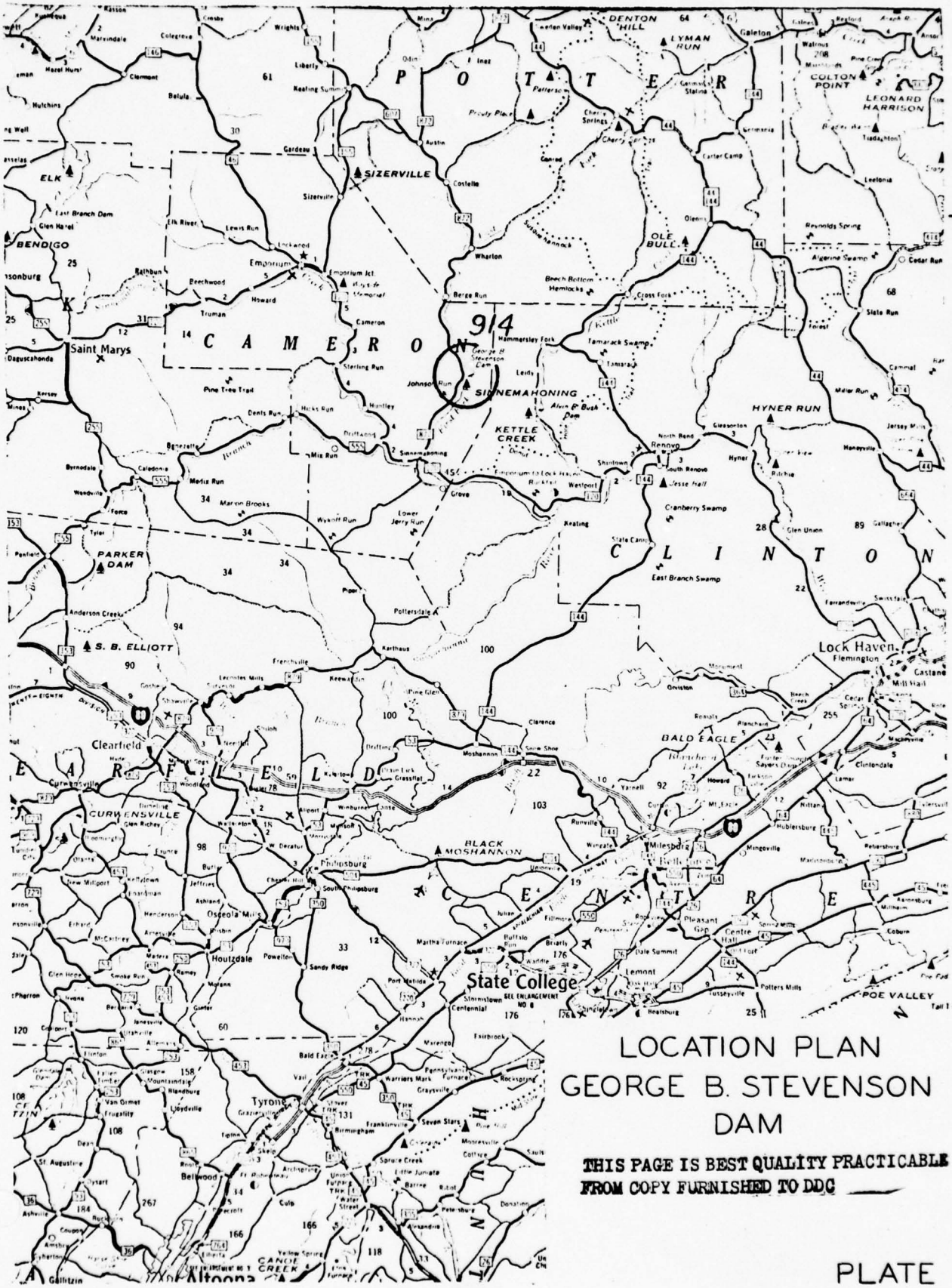
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

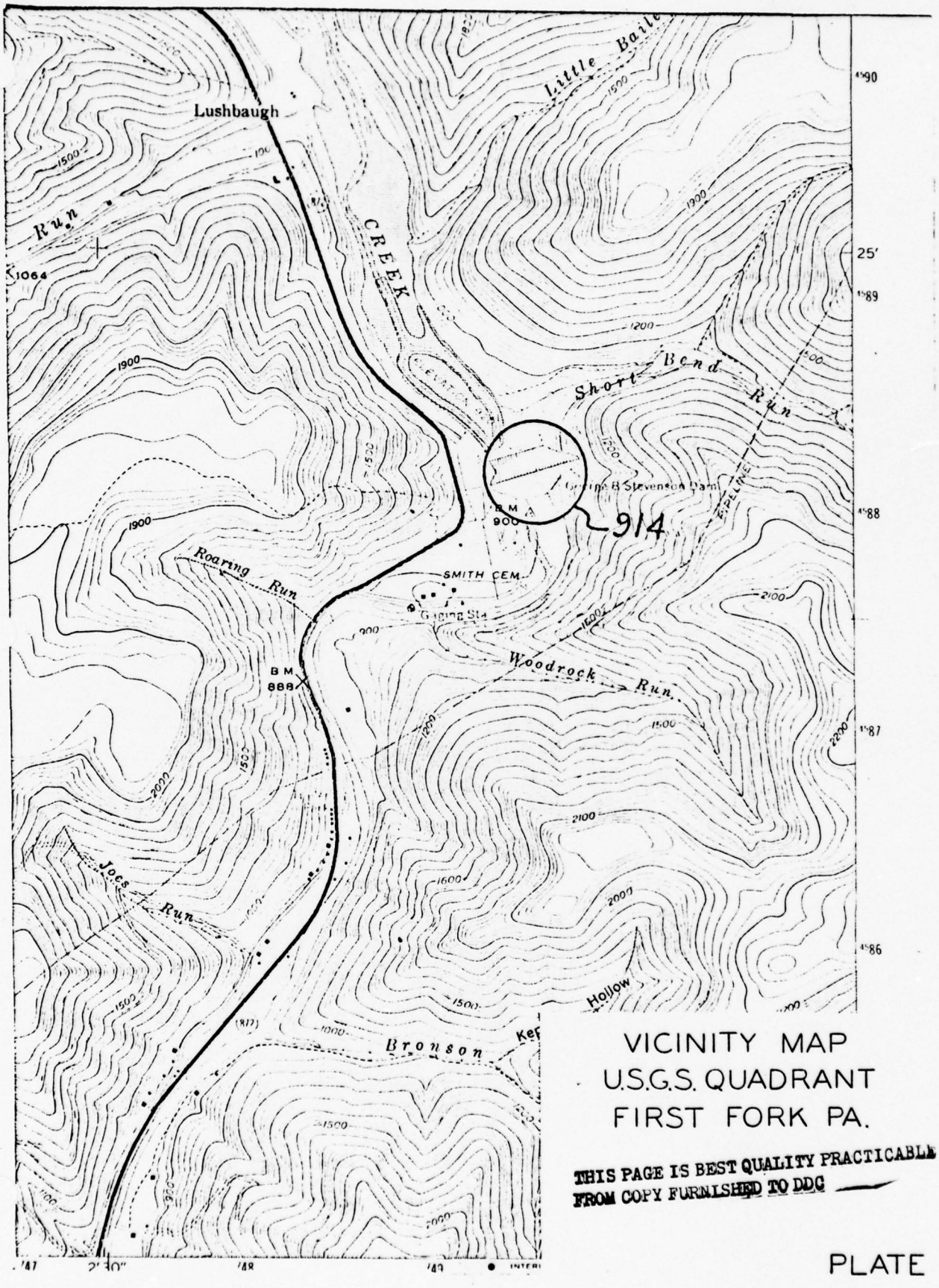
APPENDIX D

LOCATION, PHOTOGRAPHS & DESIGN DRAWINGS



LOCATION PLAN
GEORGE B. STEVENSON DAM

PLATE I

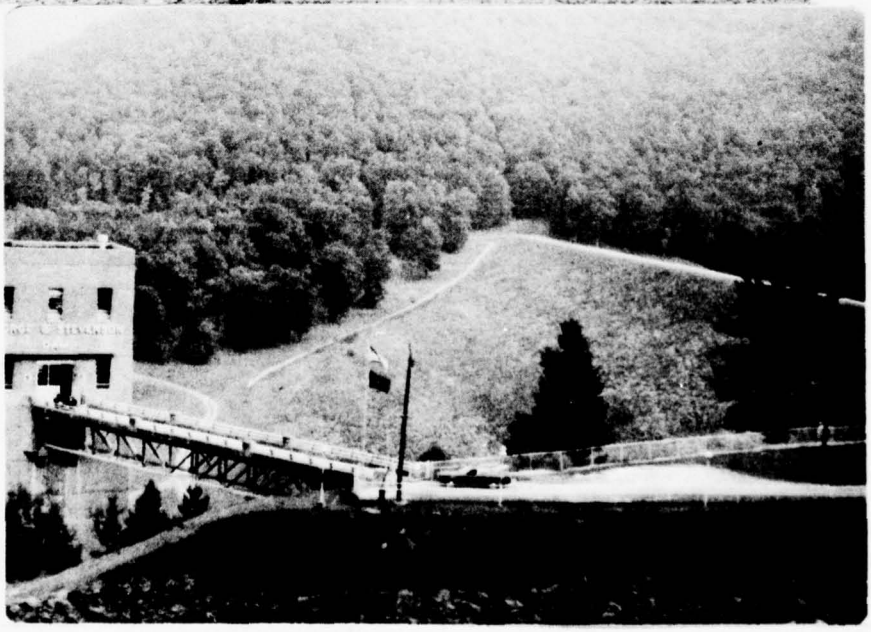


VICINITY MAP
U.S.G.S. QUADRANT
FIRST FORK PA.

PLATE II

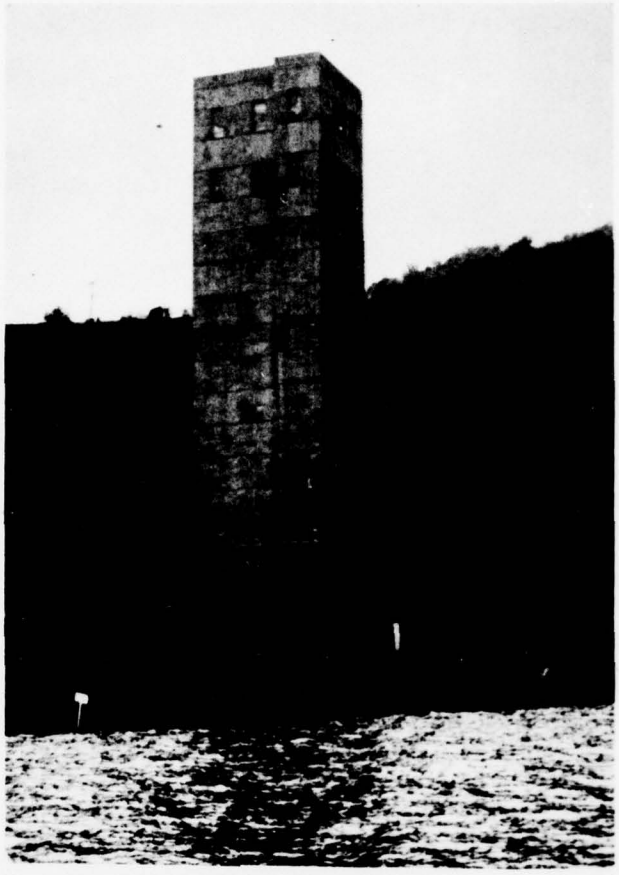
Reservoir and
Trash Boom

Upstream Slope



Upstream Slope
and
Intake Tower

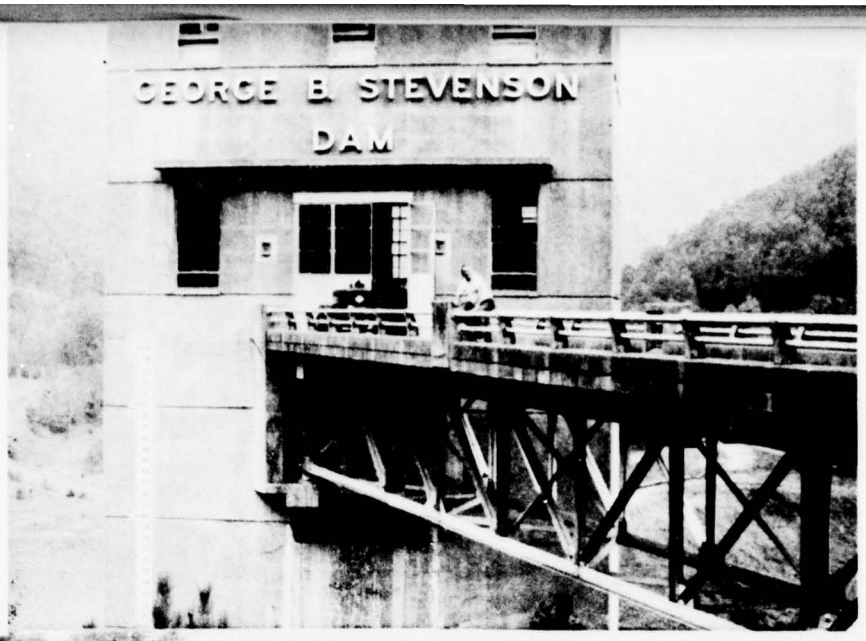
Plate III



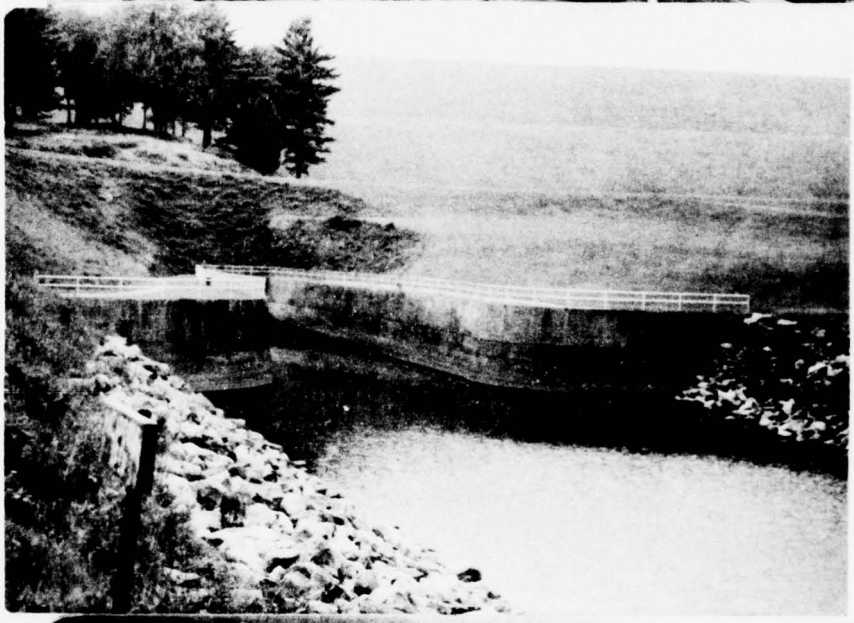
Intake Tower and Trash Boom

Reservoir and Tower

Plate IV



Access Bridge
to Tower



Conduit Outlet

Outlet Channel

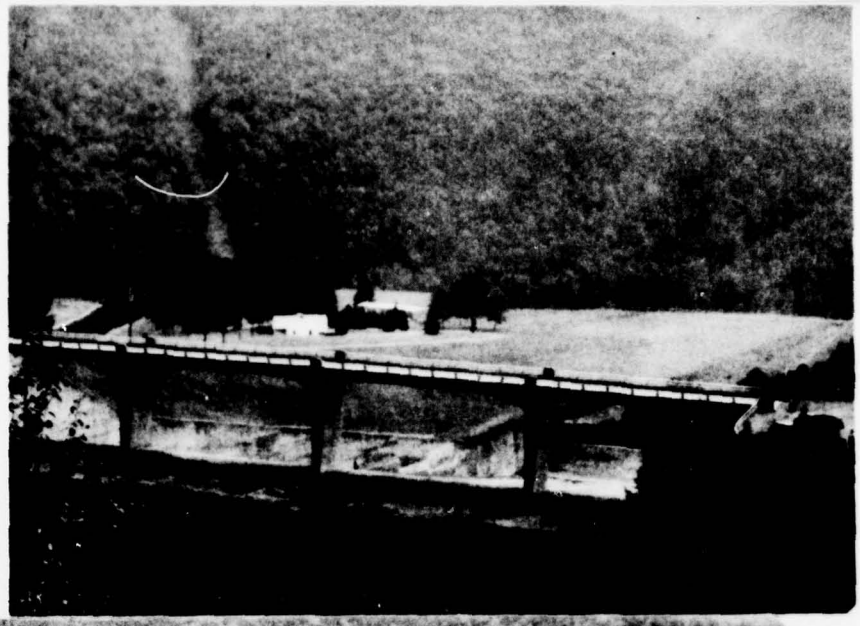
Plate V

Downstrean Slope
Looking West

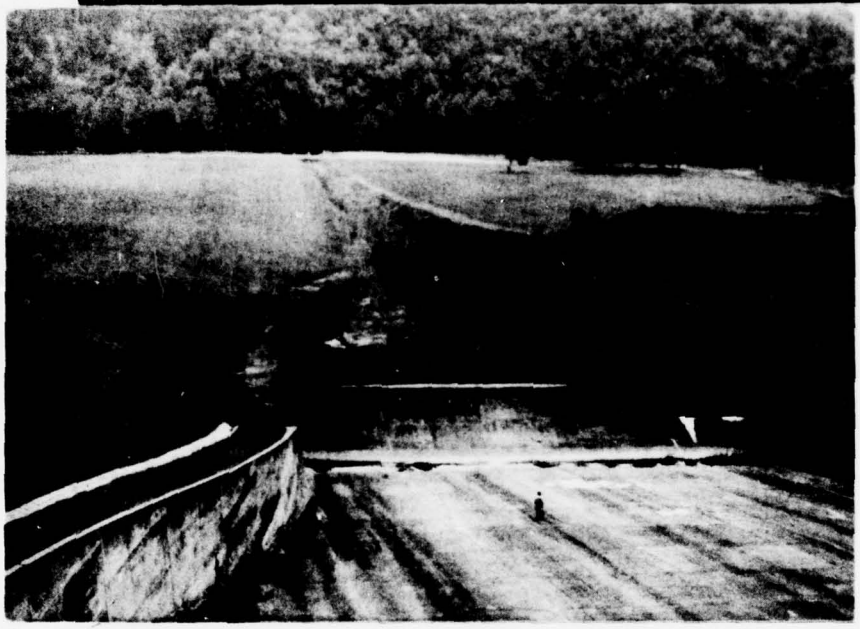
Downstream Slope
Looking East

Forebay and
Spillway Bridge

Plate VI



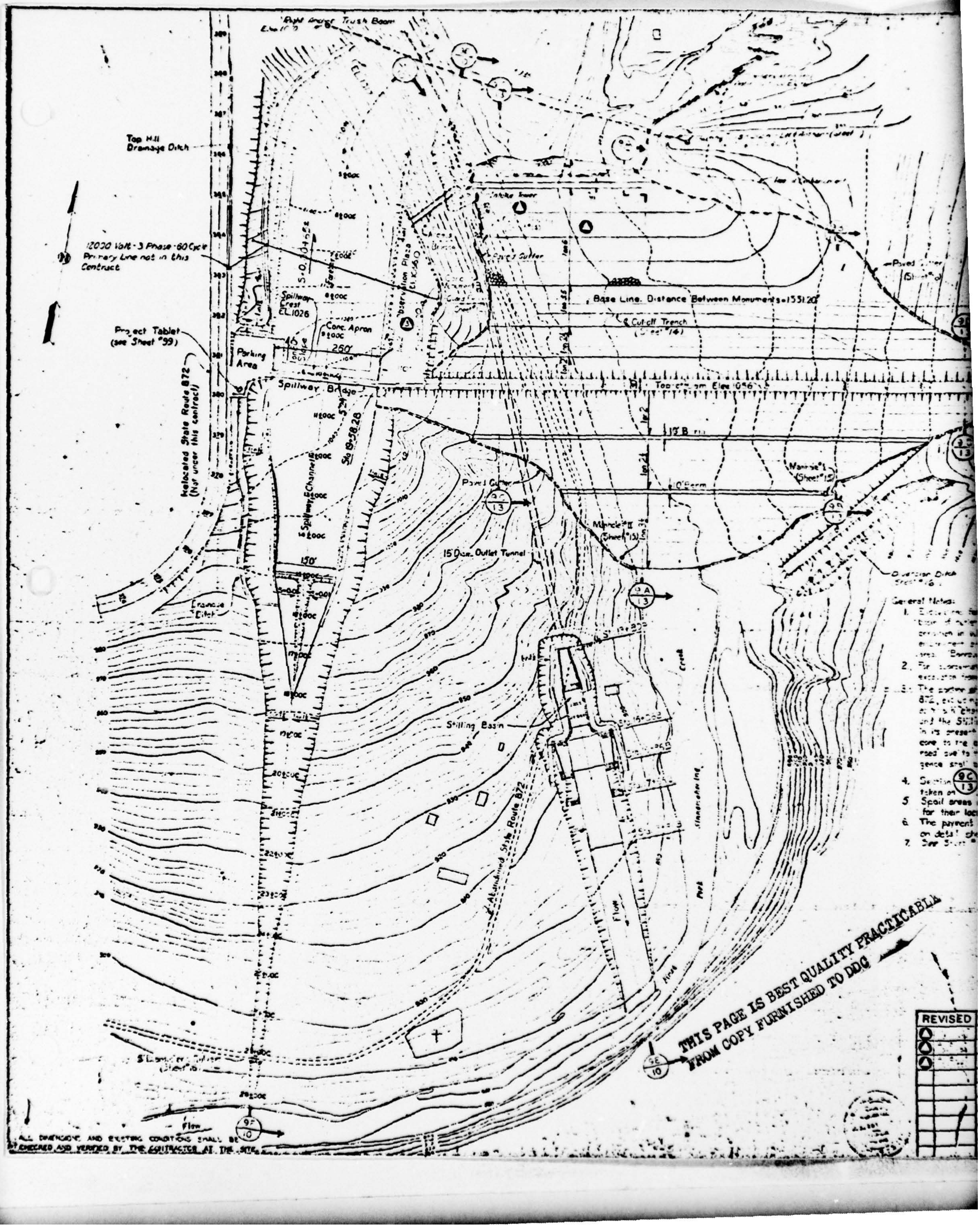
Spillway



Spillway Flipbucket

Downstream
Spillway Channel

Plate VII



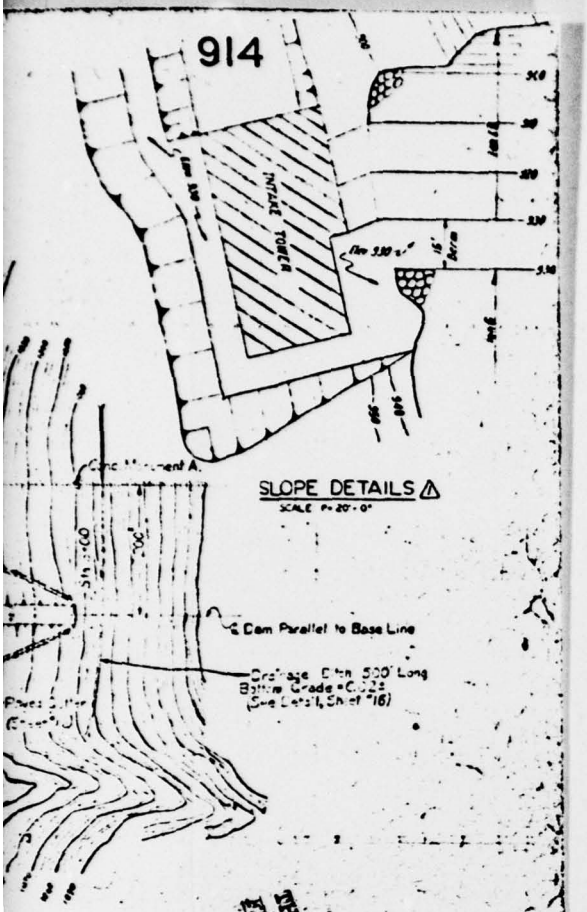


PLATE VIII

GENERAL STATE AUTHORITY

PROJECT NO. - GSA - 1 - 1

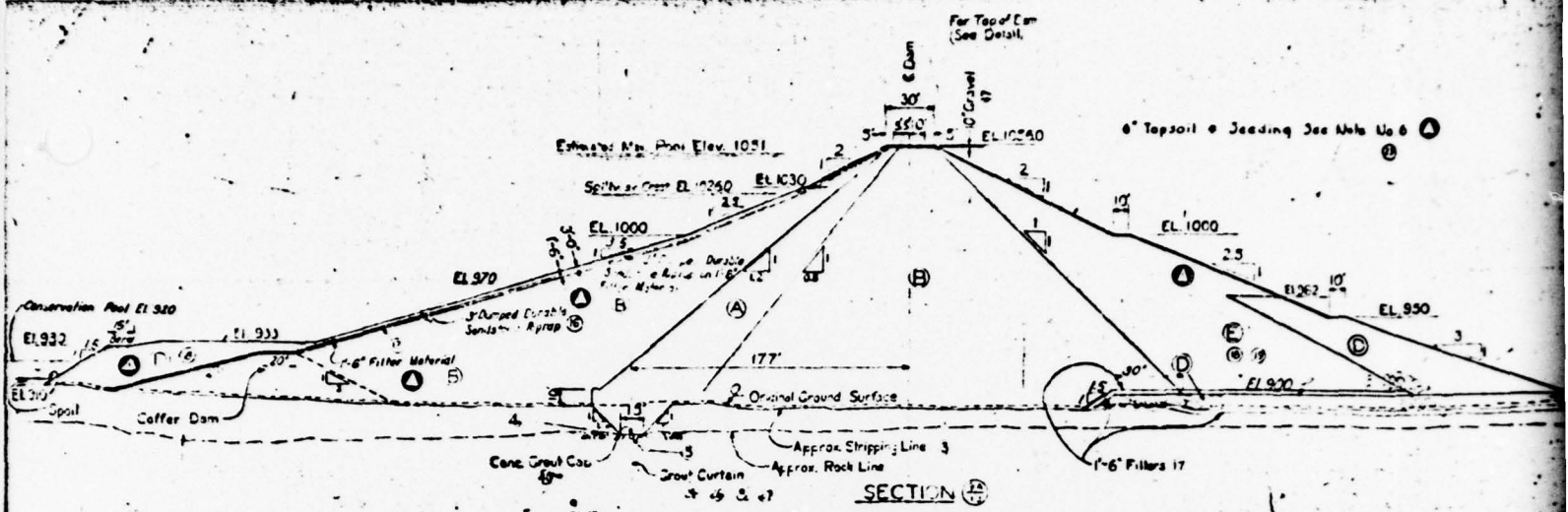
FLOOD CONTROL DAM AND RESERVOIR
FIRST FORK SINNEMAHONING R. IN
CAMERON AND POTTER COUNTIES PENNSYLVANIA

GENERAL PLAN

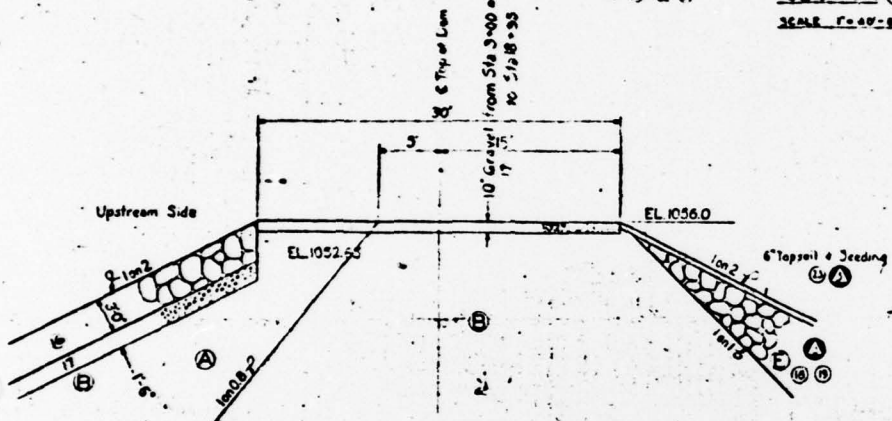
GANNETT FLEMING CORDRY & CARPENTER INC.
HARRISBURG PENNA.

APRIL 1958

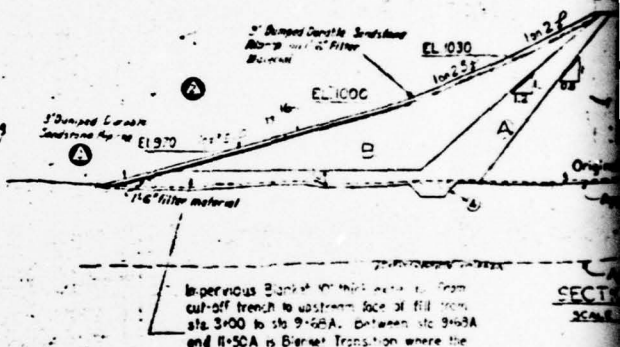
9



SECTION



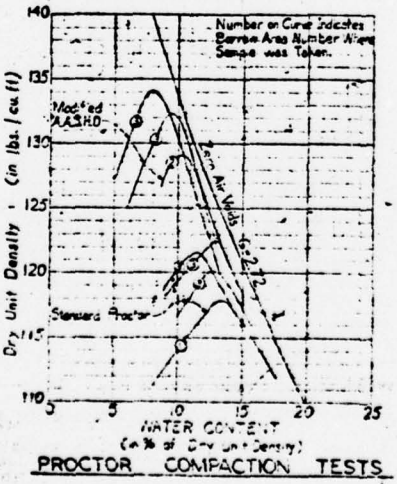
TYPICAL SECTION SHOWING TOP OF DAM



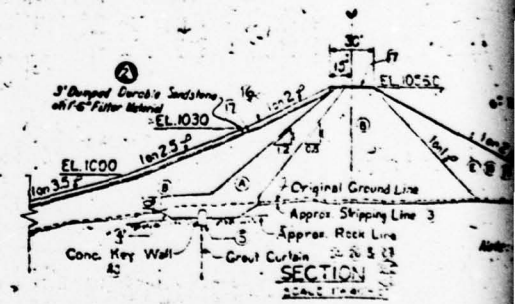
Impervious Blanket on this section is from cut-off trench to upstream face of fill from sta 3+00 to sta 9+68A, between sta 9+68A and 11+50A is Blanket Transition where the Blanket Extension from Cut-off Trench varies from full width to zero width.

Notes:

1. The Lines & Grades to Indicate Zoning of Materials in the Embankment on This Sheet are Approximate. They May be Modified by Engineer in the Field According to the Availability of Suitable Materials.
2. Modification of Sizes, Thicknesses, & Locations of Downstream Filters or Engineer in the Field May be Necessary to Meet Actual Soil Conditions.
3. Section (13) indicates that Section "C" is taken on Sheet "9" and is shown on Sheet "13".
4. The curves of compaction test results on samples from various borrow areas are included here solely for the purpose to indicate the possible ranges of compacted densities. Modified AASHO compaction tests on embankment soils are made by the Resident Engineer during placement and the result of which was considered as control for determining the degree of compaction.
5. Figure in circles indicates item number under which payment will be made.
6. Contractor Prepared the Downstream face of E Zone to Receive Topsoil as Directed by the Engineer. This Preparation Consists of Scoring the Downstream Slope or Flashing the Downstream Slope with Suitable Material so that Top Soil will not Filtrate into E Zone. No Extra Payment will be Made for This Preparation.
7. Interpretation of Upon which this Section is Based.



PROCTOR COMPACTION TESTS



SECTION

REVISED

ALL DIMENSIONS AND EXISTING CONDITIONS WERE CHECKED AND VERIFIED BY THE CONTRACTOR AT THE SITE.

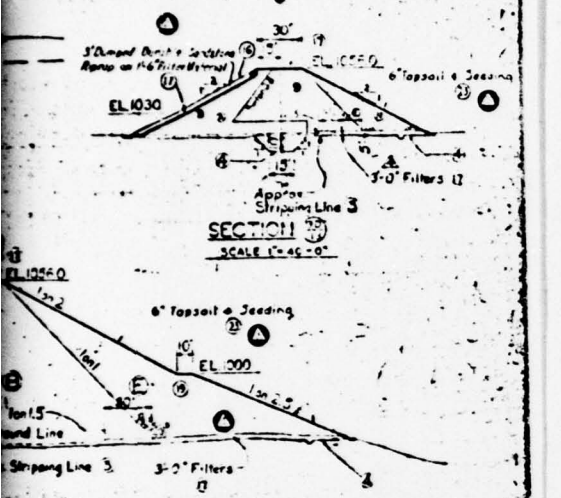
Embankment Explanation 914

(A) Impervious Material of Coarser Clay, Silt & Gravel Mixture Increasing in Permeability Towards Outer Slopes, & Containing [illegible] or 15

(B) Selected Semi-pervious Material of Well-graded Sandy Gravel Mixtures with Traces of Fines, Increasing in Permeability Towards Outer Slopes, Containing [illegible] or 5

(D) Selected Rock Fill Consisting of Durable Sandstone from Excavations Dumped in 3-foot Layers Increasing in Coarseness Towards Outer Slopes

(E) Random Rock Fill Consisting of Sandstone or Shale from Excavations Increasing in Coarseness and Hardness Towards Outer Slopes Dumped in 3-foot Layers



Rock Line

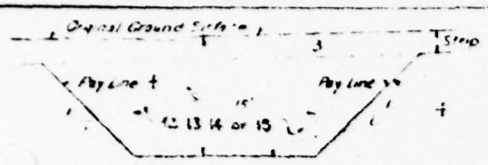
Topsoil & Seeding

EL 1000

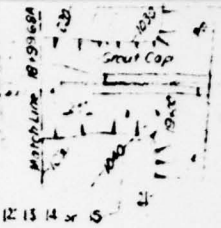
3'-0" Filter Material to Elevation 975
See Sheet #16 for Details

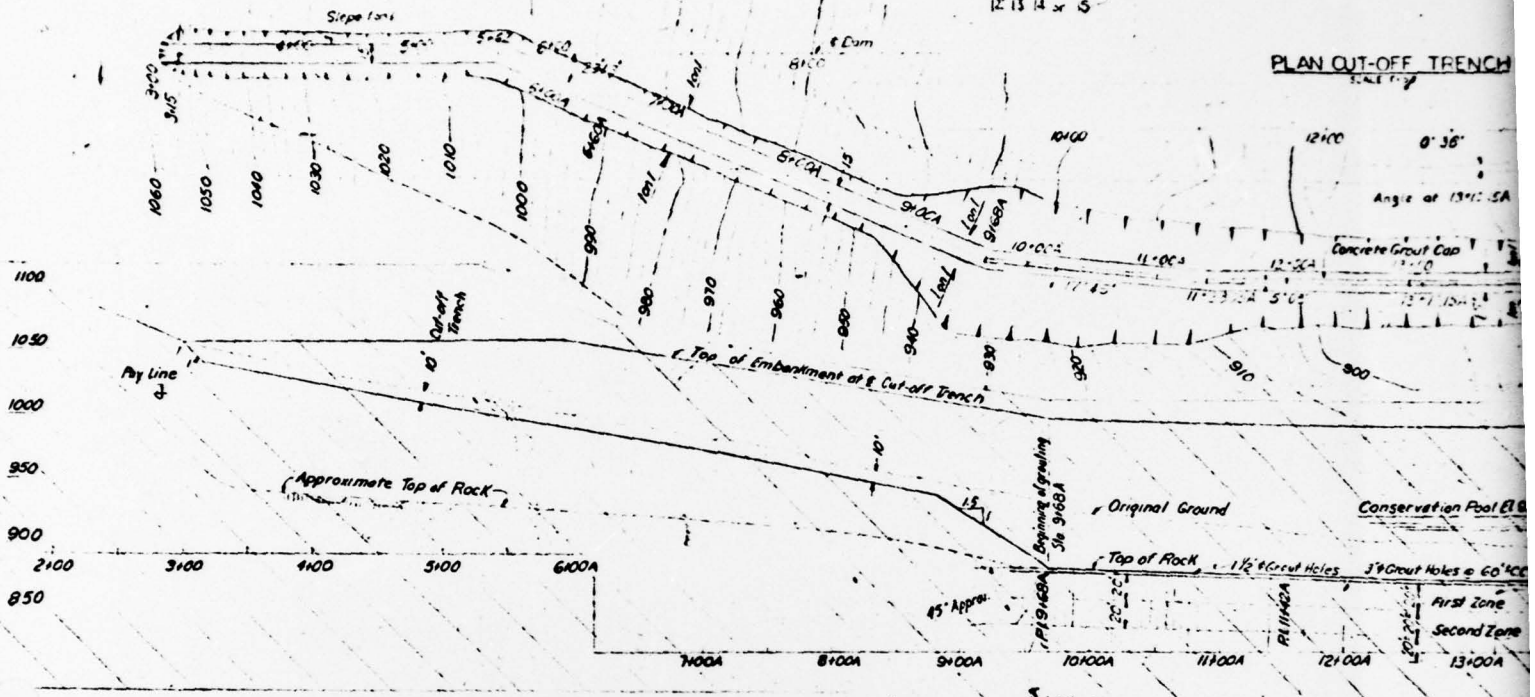
PLATE IX

GENERAL STATE AUTHORITY	PROJECT NO. - GSA - 104 - 1
	FLOOD CONTROL DAM NO. 5 RESERVOIR FIRST FORK SINNEMAHONING CREEK CAMERON AND POTTER COUNTIES, PENNSYLVANIA
	EMBANKMENT SECTIONS
	GARRETT, FLEMING, GORDON & CARPENTER, INC. ENGINEERS 601 N. 2ND ST.
	1951 — THE GENERAL STATE AUTHORITY — ALAN J. [illegible] — WARREN W. HOLMES — SHEET 13 BUILT
	DATE — BY — CHECKED — APPROVED

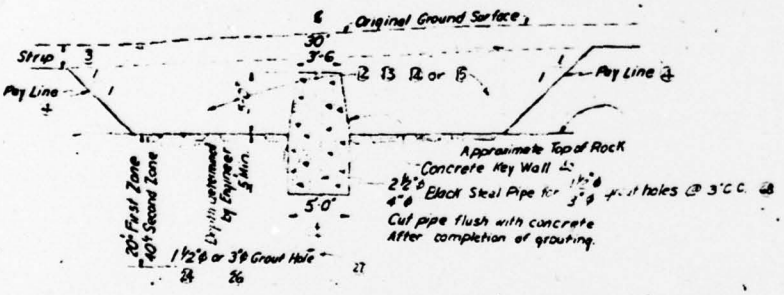


TYPICAL SECTION-TRENCH NOT IN ROCK

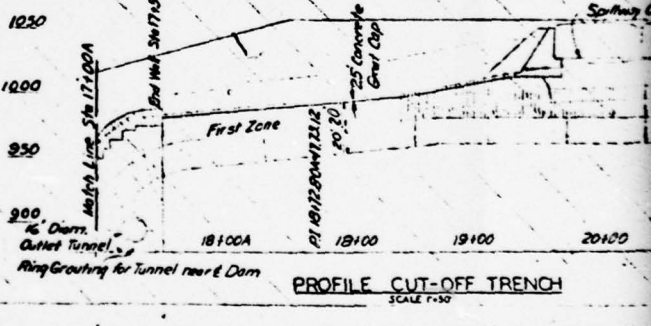




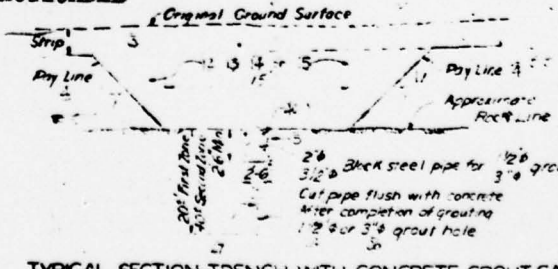
PLAN CUT-OFF TRENCH



TYPICAL SECTION-TRENCH WITH CONCRETE KEY WALL

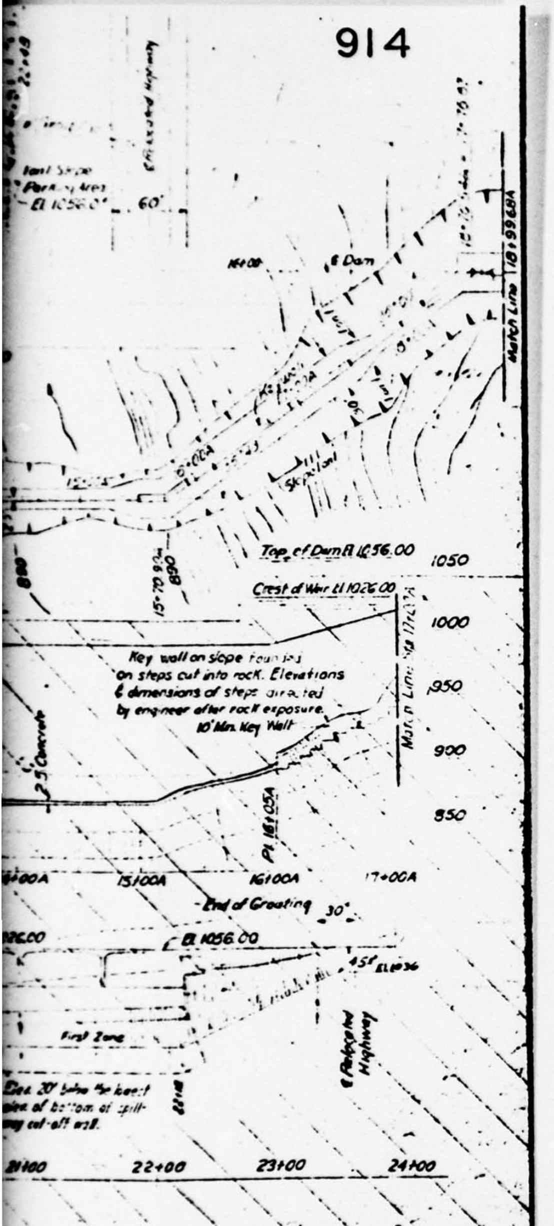


PROFILE CUT-OFF TRENCH



TYPICAL SECTION-TRENCH WITH CONCRETE GROUT CAP

REVISED



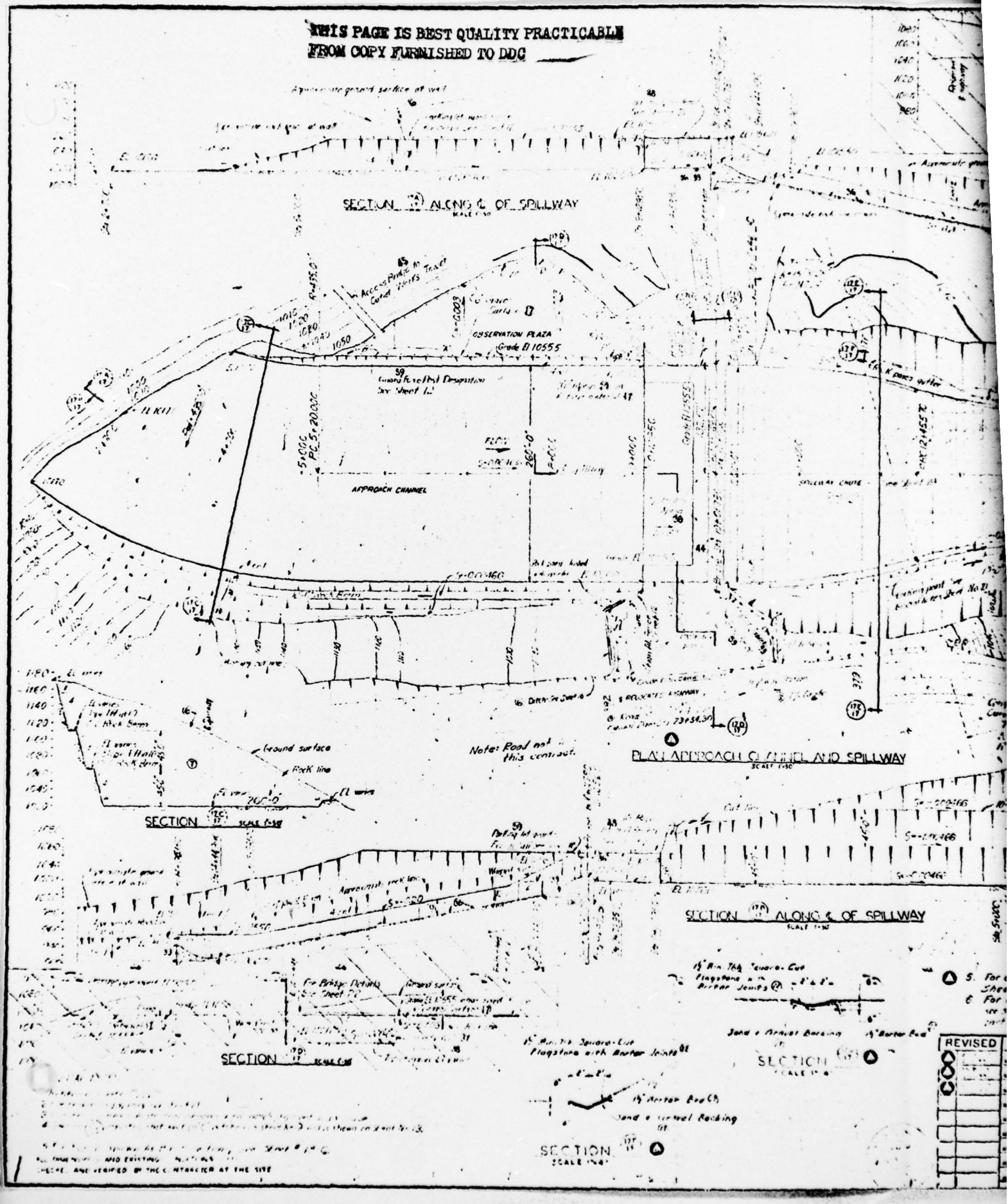
GENERAL NOTES

hole drilling, its final direction and depth determined ...er.
...g Method was used for all curtain grouting for cut-off.
... were 1½ inch diameter except at every 80 ft. spacings where ...r grout holes are required.
...of any two adjacent 3 inch diameter holes was completed ...½ inch diameter intermediate grout hole was ... .
...ts in key wall are determined in the field. Rubber waterstop ...d in all vertical joints.
...rcles indicates item number under which payment was
... 14A and 4B for as built profile of cut-off trench.

...ITY PRACTICABLE
...DDC

PLATE X

...NERAL STATE AUTHORITY	PROJECT NO. - GSA - 104 - 1
	FLOOD CONTROL DAM AND RESERVOIR FIRST FORK SINNEMAHONING CREEK CAMERON AND POTTER COUNTIES PENNSYLVANIA
	EMBANKMENT CUT-OFF TRENCH AND GROUTING HARRISBURG, PENNA.
	1951 — THE GENERAL STATE AUTHORITY — JOHN S. FINE, PRESIDENT — WARREN W. HOLMES, EXECUTIVE DIRECTOR — SHEET NO. AS 14 BUILT



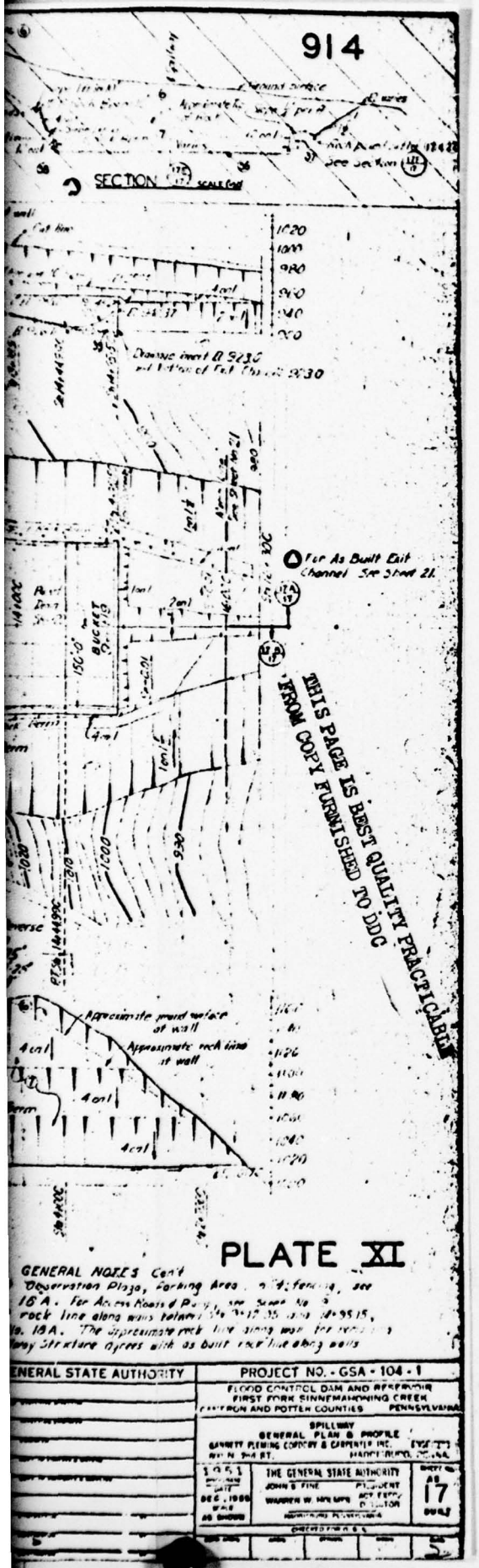
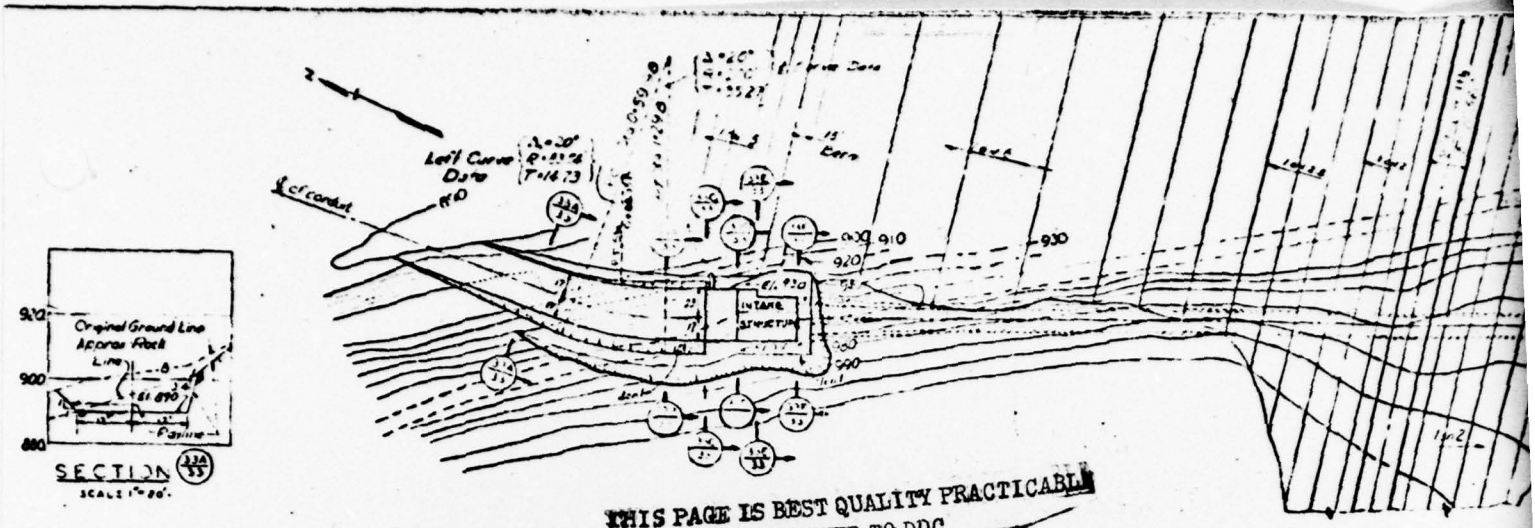


PLATE XI

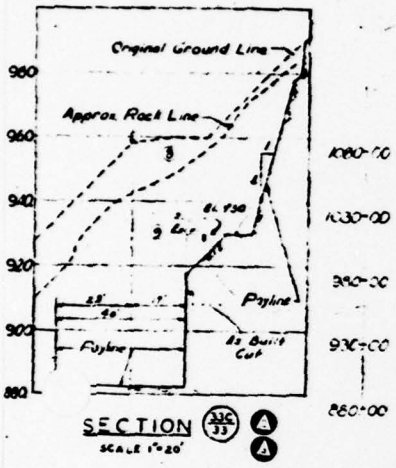
GENERAL NOTES Cont'd

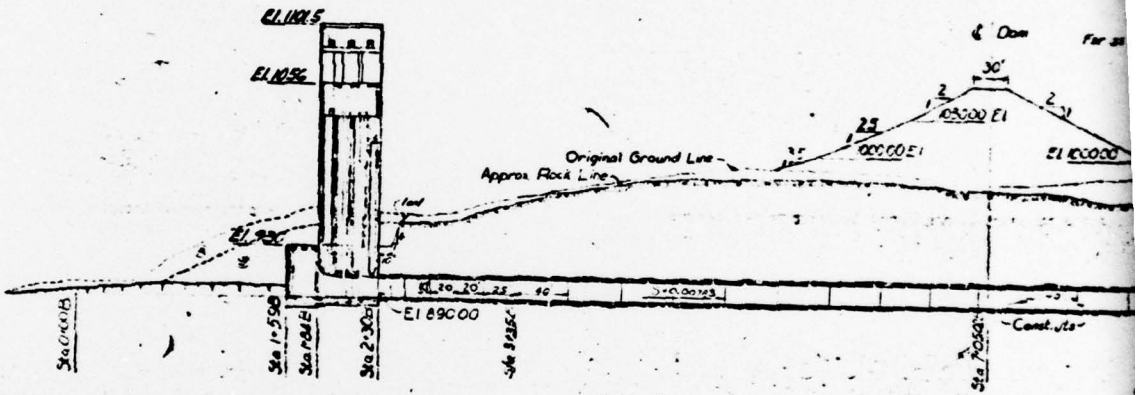
"Observation Plaza, Parking Area ... " Reference, see 16A. For Access Roads & Parking ... see Sheet No. 3 ... rock line along walls between ... 10+17.35 and 10+95.15, ... 16A. The approximate rock line along wall for ... Spillway Structure agrees with as built rock line along walls

GENERAL STATE AUTHORITY	PROJECT NO. - GSA - 104 - 1
	FLOOD CONTROL DAM AND RESERVOIR FIRST FORK SINNEMAHONING CREEK CAMERON AND POTTER COUNTIES PENNSYLVANIA
	SPILLWAY GENERAL PLAN & PROFILE GANNETT FLEMING CORDRY & CARPENTER INC.
1955 DEC. 1956 AS SHOWN	THE GENERAL STATE AUTHORITY JOHN S. FINE PRESIDENT WARREN W. HOYLMAN KEY ENGR. DIVISION
	SHEET NO. 17



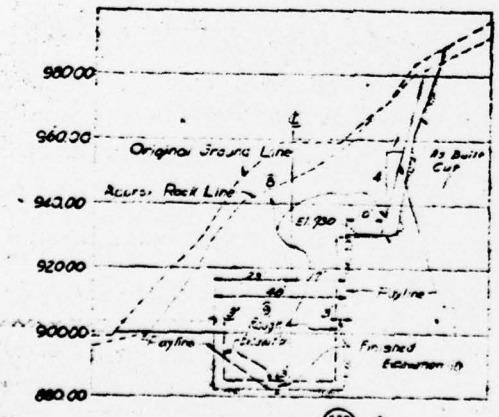
PLAN

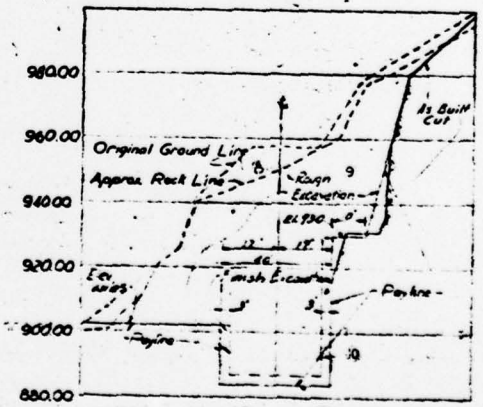


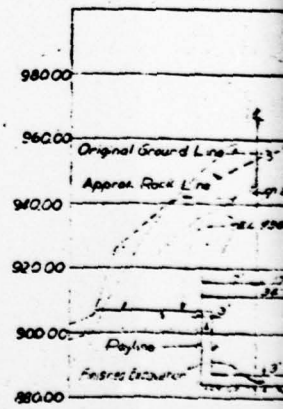


PROFILE ON CENTER LINE OF OUTLET WORKS

SCALE 1"=50'







GENERAL NOTES

Section 8C indicates that Section C is cut on Sheet 12 and is shown on Sheet 13

Concrete at intake structure

Class A concrete for rock above below El 930

Rough bench El 930 is for rock excavation only

Figure in circles indicates item numbers under which payment will be made

ALL DIMENSIONS AND EXISTING CONDITIONS MUST BE CHECKED AND VERIFIED BY THE CONTRACTOR AT THE SITE

REVISED

914

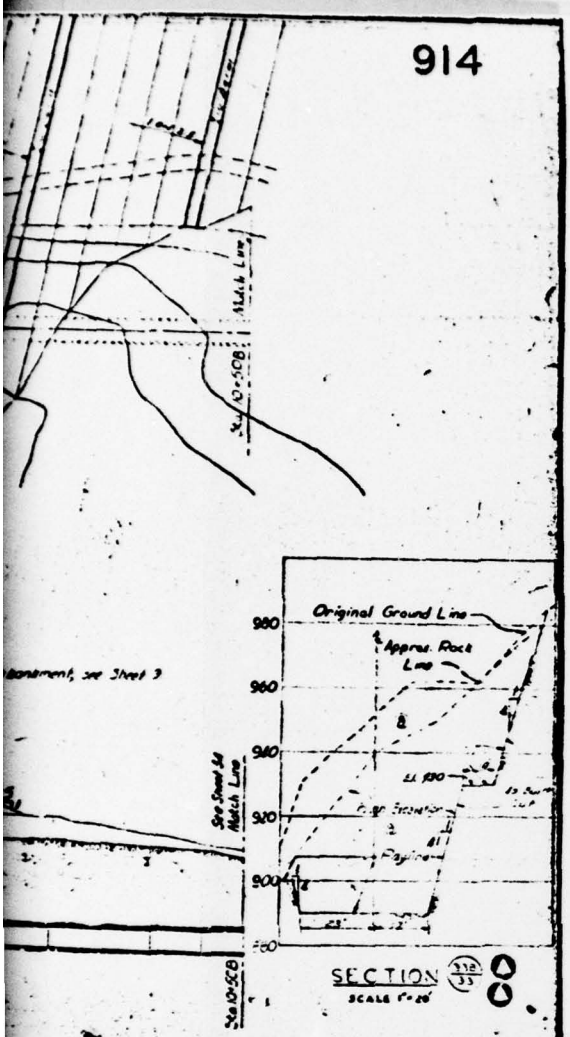
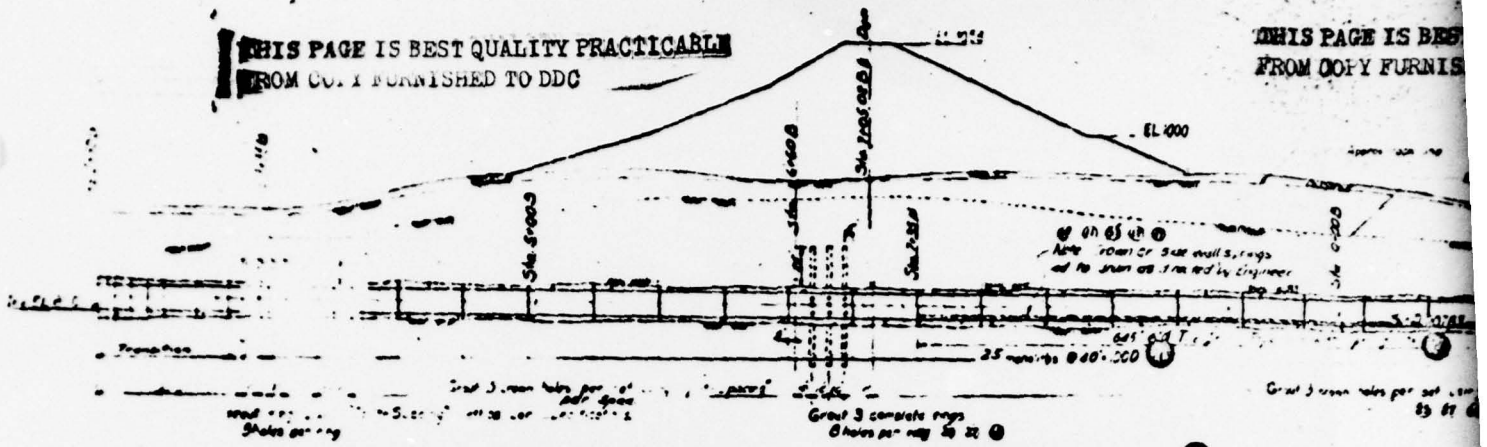
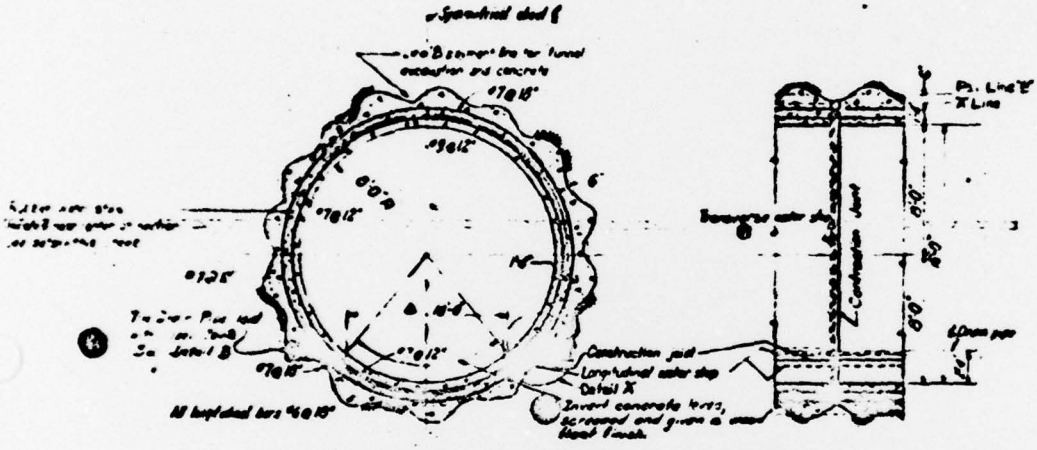


PLATE XII

GENERAL STATE AUTHORITY	PROJECT NO. - GSA - 104 - 1
	FLOOD CONTROL DAM AND RESERVOIR FIRST FORK SINNEMAHONING CREEK CAMERON AND POTTER COUNTIES PENNSYLVANIA
	OUTLET WORKS PLAN & PROFILES - I
	GARRETT, FLEMING, O'MARY & SAYLOR, INC. ENGINEERS 644 N. 3rd ST. HARRISBURG, PENNA.
1951 DEC. 1958 AS SHOWN	THE GENERAL STATE AUTHORITY JOHN D. KANE ASSISTANT WARREN W. HOLMES DIRECTOR SECRETARY OF PROPERTY AND SUPPLY
	SHEET NO. AS BUILT 33

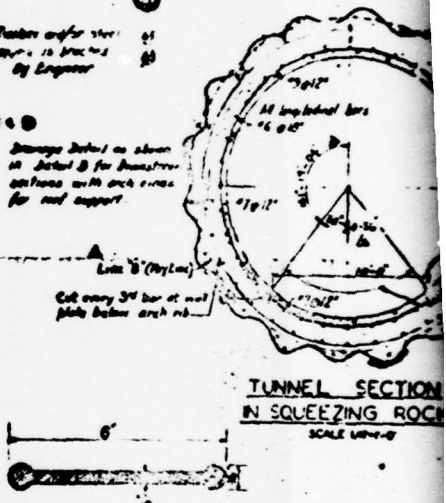


PROFILE ALONG ℄ OF TUNNEL



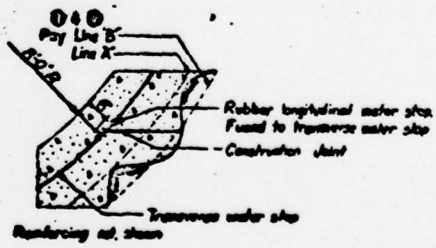
TYPICAL TUNNEL SECTION

LONGITUDINAL SECTION AT JOINT A



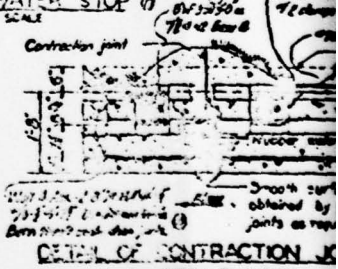
TUNNEL SECTION
IN SQUEEZING ROCK

DETAIL OF CONTRACTION JOINT

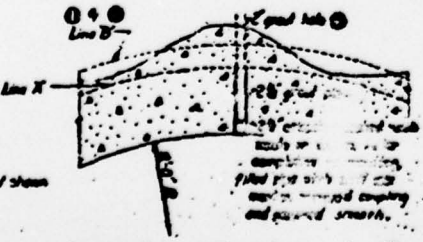


DETAIL A

RUBBER WATER STOP



DETAIL OF CONTRACTION JO
IN SQUEEZING ROCK



DETAIL OF JOINT

914

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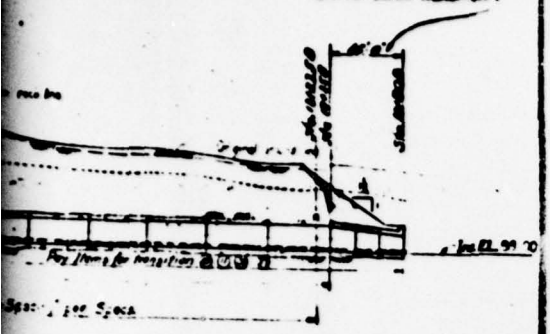
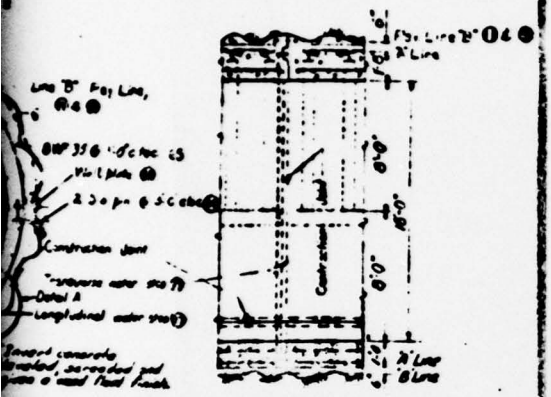
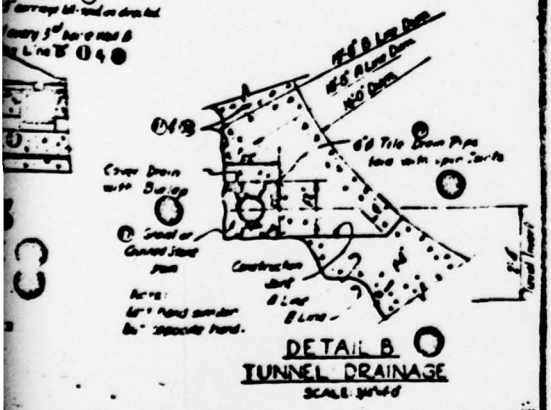




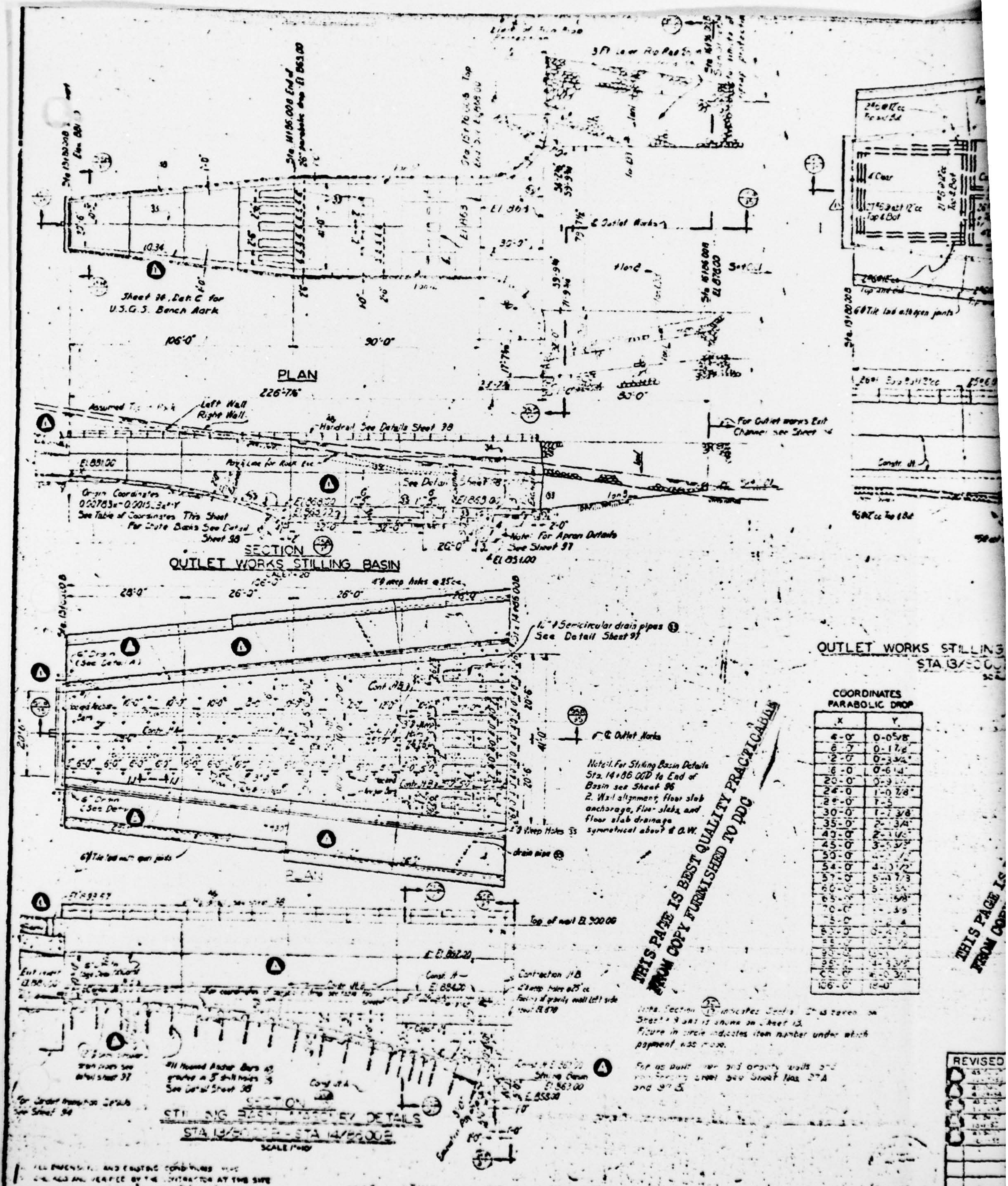
LONGITUDINAL SECTION AT JOINT
IN SQUEEZING ROCK



DETAIL B
TUNNEL DRAINAGE

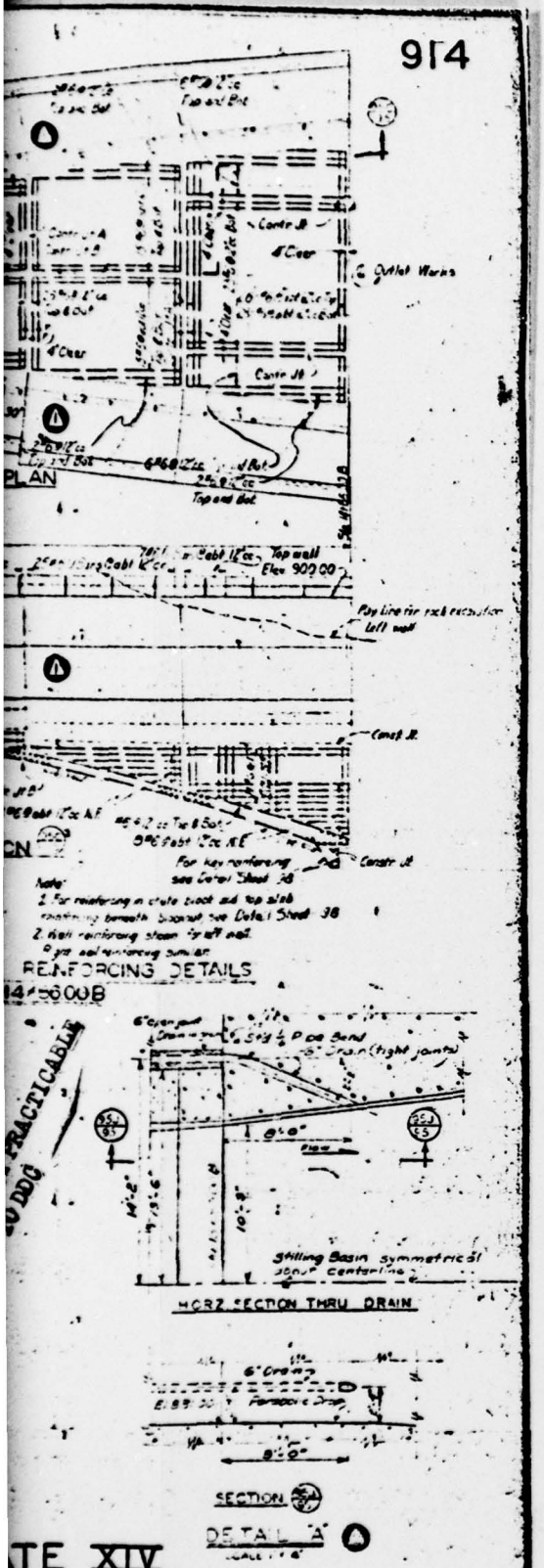
PLATE XIII

	PROJECT NO. - GSA - 104 - 1
	[illegible] DAM AND RESERVOIR
	[illegible] TOWNSHIP, MANORING CREEK
	[illegible] COUNTIES, PENNSYLVANIA
	TUNNEL
	[illegible] HARRISBURG, PENNA.
	THE GENERAL STATE AUTHORITY
	SHEET NO. 93



COORDINATES PARABOLIC DROP

X	Y
4-0"	0-0 5/8"
8-0"	0-1 7/8"
12-0"	0-3 3/4"
16-0	0-6 1/4"
20-0"	0-9 [illegible]
24-0	1-0 7/8"
28-0"	1-5
30-0"	1-7 3/8"
35-0"	2-[illegible] 3/4"
40-0"	2-[illegible]
45-0"	3-5 [illegible]
50-0"	[illegible]
54-0"	4-[illegible] 1/2"
57-0"	5-[illegible] 7/8
60-0"	5-[illegible]
65-0"	[illegible] 5/8"
70-0"	[illegible]
75-0"	[illegible]
80-0"	[illegible]
85-0"	[illegible]
90-0"	[illegible]
95-0"	[illegible]
100-0"	[illegible]
106-0"	18-0"



PLAN

CN

PRACTICABLE

TE XIV

ERAL STATE AUTHORITY