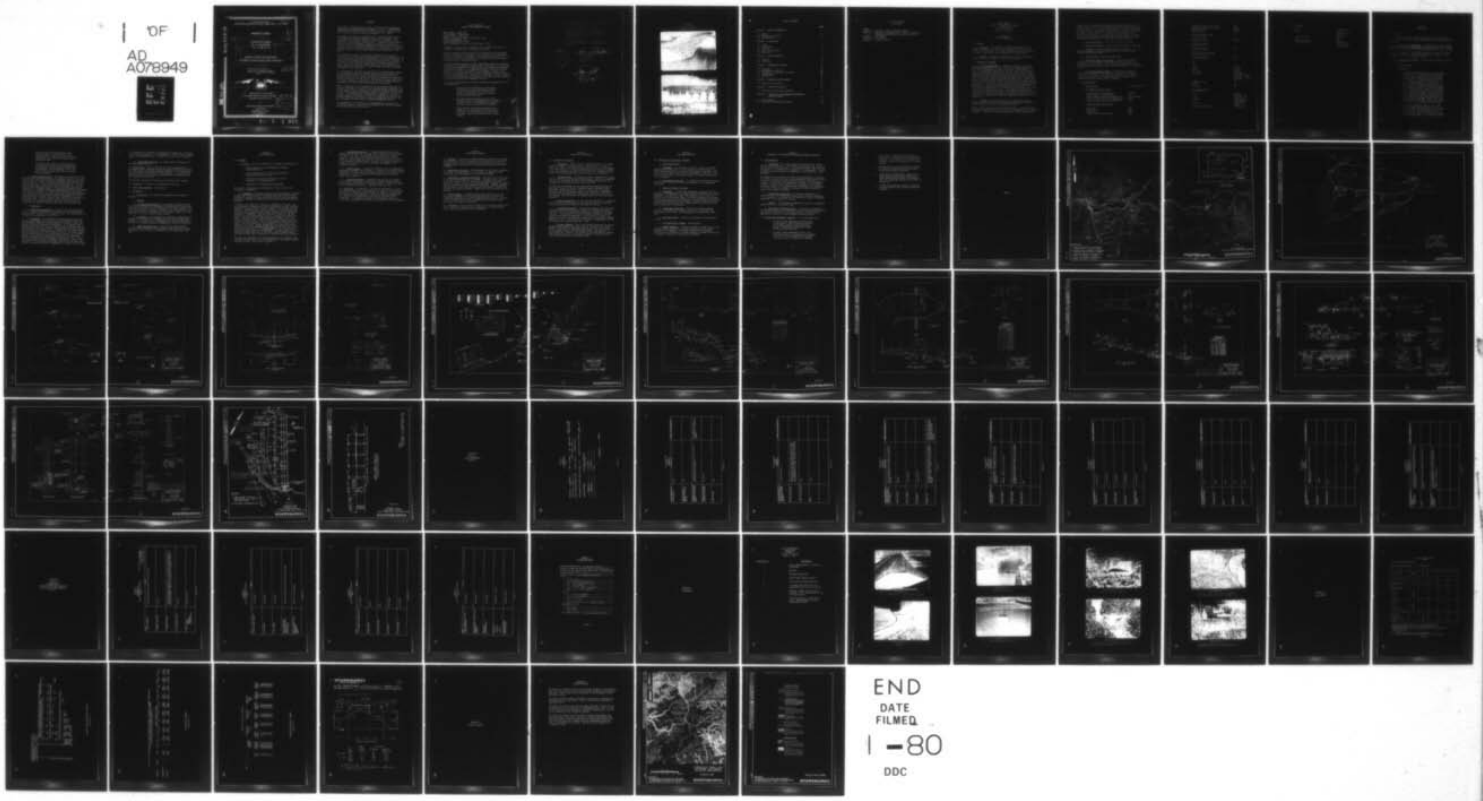
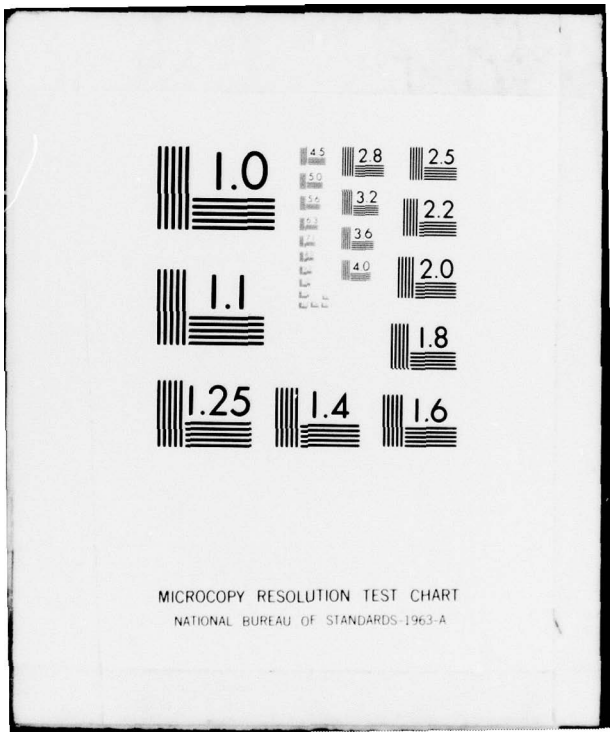
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OHIO RIVER BASIN
WHETSTONE BRANCH OF LITTLE TOBY CREEK, ELK COUNTY

PENNSYLVANIA

LEVEL II

(6) National Dam Inspection Program. STORAGE DAM
(NDI I.D. NO. PA-388 → Number
Number ← DER I.D. NO. 24-47), Ohio River Basin,
Whetstone Branch of Little Toby
Creek, Elk County, Pennsylvania.

PHASE I INSPECTION REPORT,
NATIONAL DAM INSPECTION PROGRAM

(10) Lawrence D. Anderson

(12) 76

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Contract No. (15) DACW31-79-C-0014

PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS
10 DUFF ROAD
PITTSBURGH, PA. 15235

(11) JUNE 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Department of the Army, 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 visual observations and review of available data. Detailed investigation and analyses involving topographic mapping, subsurface investigations, material testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the inspection is intended to identify any need for such studies which should be performed by the owner.

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 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 the dam depends on numerous and constantly changing internal and external factors which are 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.

The assessment of the conditions and recommendations was made by the consulting engineer in accordance with generally and currently accepted engineering principles and practices.

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Storage Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Elk County
STREAM: Whetstone Branch of Little Toby Creek
SIZE CLASSIFICATION: Small
HAZARD CLASSIFICATION: High
DATE OF INSPECTION: April 6, 1979 and May 25, 1979

ASSESSMENT: Based on the evaluation of the existing conditions, the condition of Storage Dam is considered to be good.

Numerous seeps were observed along the left abutment, but these seeps are not considered to be a threat to the integrity of the embankment. However, a slump and an associated wet area were observed along the toe of the dam near the left abutment. This condition should be investigated and necessary repairs performed.

The flood discharge capacity of the Storage Dam spillway was evaluated according to the recommended procedure and it was found to be 40 percent of the probable maximum flood (PMF) without overtopping the embankment. Therefore, according to the recommended criteria, the flood discharge capacity of the dam is classified to be inadequate. However, the spillway is not considered to be seriously inadequate because overtopping of the embankment for a duration of 2 hours with a maximum depth of 0.3 foot during the passage of 50 percent of the PMF would not represent a significant potential for embankment erosion.

The following recommendations should be implemented immediately or on a continuing basis:

1. The owner should immediately initiate additional studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity.

2. The owner should immediately retain a professional engineer to investigate the slumping along the toe of the embankment and prepare and execute plans to correct this condition.

3. Seeps from the left abutment should be collected into a channel and the flow quantities monitored. The turbidity of the seeps should be noted to assess the possibility of internal erosion.

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4. The access road to the dam should be improved to facilitate inspection of the facilities during severe weather conditions.

5. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

6. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.



Lawrence D. Andersen

Lawrence D. Andersen, P.E.
Vice President

9 AUG 1979
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

11 Sep 79
Date

STORAGE DAM
(BROCKWAY)
NDI I.D. NO. PA-388
APRIL 6, 1979



Upstream Face



Downstream Face

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
STORAGE DAM
NDI I.D. NO. PA-388
DER I.D. NO. 24-47

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct 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 or property.

1.2 Description of Project

a. Dam and Appurtenances. Storage Dam consists of an earth embankment approximately 500 feet long with a maximum height of 36 feet from the downstream toe and a crest width of approximately 15 feet. The appurtenant structures of the dam consist of a combined primary and emergency spillway located on the left abutment (looking downstream) and outlet works near the right abutment. The spillway structures include a 30-foot-wide concrete ogee overflow section at a level 6 feet below the dam crest which discharges into a 15-foot-wide concrete discharge channel terminating at a plunge pool approximately 100 feet below the toe of the dam. The outlet works include a concrete gate tower, a 24-inch cast-iron outlet pipe through the embankment, equipped with a concrete discharge basin at the downstream end. A 12-inch cast-iron pipe parallel to the outlet pipe is capped on both ends to be used as a future supply line. Both pipes are equipped with reinforced concrete cutoff collars. Flow through the outlet pipe is controlled by a manually operated sluice gate at the gate tower. This outlet system constitutes the emergency drawdown facilities for the reservoir.

b. Location. The dam is located on the Whetstone Branch of Little Toby Creek, approximately four miles southeast of Brockway in Horton Township, Elk County, Pennsylvania (Plate 1).

Below the dam, the Whetstone Branch flows through a narrow and steep valley for approximately one mile where it discharges into the Brockway Reservoir. There are no inhabited structures in this reach of the

stream. Below the Brockway Reservoir, the stream continues to flow west and joins Little Toby Creek approximately three miles downstream from Storage Dam. In the last one-mile reach of the Whetstone Branch, at least one house was found to be within 5 feet of the streambed and at least 10 houses within 10 to 20 feet of the streambed. It is estimated that failure of Storage Dam would in turn cause the failure of the downstream Brockway Reservoir dam, and the combined discharge would cause large loss of life and property damage downstream.

c. Size Classification. Small (based on 36-foot height).

d. Hazard Classification. High (based on downstream conditions).

e. Ownership. Brockway Municipal Authority (address: Mr. A. B. Bassetti, Manager, Brockway Municipal Authority, 501 Main Street, Brockway, Pennsylvania 15824).

f. Purpose of Dam. Emergency water supply.

g. Design and Construction History. The dam was designed by Bourquard, Geil, and Mathews, Consulting Hydraulic Engineers of Harrisburg, Pennsylvania, in 1957. The dam was constructed by River Valley Construction Company of Shawville, Pennsylvania, with completion in 1962.

h. Normal Operating Procedure. The reservoir is normally maintained at Elevation 1866, the level of uncontrolled spillway crest. When the lake is at or above the spillway level, inflow is discharged through the uncontrolled spillway. The supply water is released through the outlet works, as required.

1.3 Pertinent Data

a. Drainage Area — 1.6 square miles

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site	Unknown
Outlet conduit at maximum pool	60
Gated spillway capacity at maximum pool	Not applicable
Ungated spillway capacity at maximum pool	1720
Total spillway capacity at maximum pool	1720

c. Elevation (USGS Datum) (feet)

Top of dam	1872
Maximum pool	1872
Normal pool	1866
Upstream invert outlet works	1842

Downstream invert outlet works	1836
Streambed at center line of dam	1830±
Maximum tailwater	Unknown
Downstream toe	1836±

d. Reservoir Length (feet)

Normal pool level	1300
Maximum pool level	1400±

e. Storage (acre-feet)

Normal pool level	107
Maximum pool level	175

f. Reservoir Surface (acres)

Normal pool level	9.3
Maximum pool level	12.3

g. Dam

Type	Earth
Length	525 feet
Height	36 feet
Top width	15 feet
Side slopes	Downstream: 2H:1V and 2.5H:1V; Upstream: 2.5H:1V and 3H:1V
Zoning	No
Impervious core	No
Cutoff	Yes
Grouting	No

h. Regulating Outlet

Type	24-inch cast-iron pipe
Length	170± feet
Closure	Sluice gate on upstream end
Access	Gate control tower
Regulating facilities	Sluice gate

i. Spillway

Type	Concrete ogee
Length	30 feet (perpendicular to flow)
Crest elevation	1866 feet
Gates	None
Upstream channel	Lake
Downstream channel	Rectangular concrete discharge channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available information was provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER).

(1) Hydrology and Hydraulics. A state report entitled, Report Upon the Application of the Borough of Brockway, dated August 9, 1957, summarizes the available hydrology and hydraulic analysis for the dam.

(2) Embankment. The available information consists of design drawings, a subsurface investigation report and boring logs, and embankment seepage and stability analyses.

(3) Appurtenant Structures. The available information consists of design drawings.

b. Design Features

(1) Embankment

a. As designed, the dam (Plate 2) is a homogeneous embankment with a cutoff trench located on the upstream side of the dam axis and an internal drainage system located along the downstream toe (Plate 3). The cutoff trench, with a 10-foot base width and 1H:1V side slopes, is shown to extend through the overburden to the top of rock. The internal drainage system for the embankment consists of a drainage blanket one foot thick and 8 to 18 feet wide combined with a 10-foot-deep trench drain on the downstream side of the blanket. The trench drain is equipped with a 6-inch perforated vitrified clay pipe which collects and discharges the seepage from the drainage system into a ditch below the toe of the dam. Plate 4 illustrates the details of the internal drainage system.

b. The dam was designed to have a 2H:1V slope from the crest (Elevation 1872) to a berm on the downstream face at Elevation 1854. Below the berm level, the downstream slope was designed to be 2.5H:1V. The upstream slope of the dam was designed to be 2.5H:1V from crest

level to Elevation 1854 and 3H:1V below Elevation 1854 to the upstream toe. The upstream slope of the dam is protected with riprap from crest level to two feet below the normal pool level.

c. A design drawing (Plate 5) indicates that at least six borings were drilled for subsurface investigation. The boring logs indicate that the subsurface profile consists of 10 to 20 feet of stiff to very stiff silty clay underlain by sandstone.

(2) Appurtenant Structures. The appurtenant structures of the dam consist of a combined primary and emergency spillway on the left abutment and outlet works through the embankment near the right abutment. Plates 6, 7, and 8 illustrate the profile and details of the spillway structures. The spillway structures consist of a 30-foot-wide concrete ogee overflow section which discharges into a rectangular concrete discharge channel. The concrete discharge channel terminates at a riprapped plunge pool approximately 100 feet downstream from the toe of the dam. The outlet works structures consist of a gate tower and a 24-inch cast-iron outlet pipe through the embankment which terminates at a reinforced concrete discharge basin at the downstream toe of the dam. Plates 9 and 10 illustrate the details of the outlet works. Flow through the outlet pipe is controlled by a sluice gate on the upstream end of the pipe. The sluice gate is controlled by a manually operated hoist located at the gate tower.

c. Design Data

(1) Hydrology and Hydraulics. The 1957 state report indicates that the spillway was designed in accordance with the Pennsylvania design criteria in effect at the time (C curve). The full capacity of the spillway is reported to be 1710 cfs.

(2) Embankment. The available information indicates that the dam design was based on the evaluation of the subsurface conditions and on limited laboratory testing conducted by Borings, Soils, and Testing Company of Harrisburg, Pennsylvania. It is reported that in addition to classification tests, compaction and unconfined compression strength tests were performed. The optimum water content of the borrow material was reported to be 12 percent with a maximum Standard Proctor dry density of 120 pounds per cubic foot. The soils consultant recommended that the fill be placed at 95 percent of the maximum density. The unconfined compressive strength of the undisturbed samples and compacted borrow materials was reported to be 1.9 and 2.5 to 3.5 kilograms per square centimeter, respectively. Based on the evaluation of the unconfined compression test results and past experience, the consulting engineer recommended an internal friction angle

of 20 degrees and a cohesion of 500 pounds per square foot to be used in the stability analysis for the embankment. Based on these strength values, the downstream slope is reported to have a factor of safety of 1.5.

(3) Appurtenant Structures. No design data are available for the appurtenant structures.

2.2 Construction. The construction of the dam was apparently in accordance with the drawings and specifications prepared by Bourquard, Geil, and Mathews, Consulting Hydraulic Engineers. The construction was supervised by the designer's field personnel. No reference was found to indicate that any unusual problems were encountered during the construction of the dam.

The available information indicates no post-construction changes.

2.3 Operation. No records of operation have been kept.

2.4 Other Investigations. None reported.

2.5 Evaluation

a. Availability. The available information was provided by PennDER.

b. Adequacy

(1) Hydrology and Hydraulics. The available information indicates that the spillway was designed in conformance with the Pennsylvania spillway design criteria applicable at the time of design. Only the design capacity is reported. Therefore, this information is not adequate to assess the conformance of the spillway capacity in accordance with the current spillway design criteria.

(2) Embankment. The embankment was apparently designed based on evaluation of the subsurface conditions and on limited engineering analyses. The stability of the embankment was evaluated based on the assumed soil strength parameters recommended by the soils consultant.

(3) Appurtenant Structures. Review of the design drawings indicates that as designed, no significant design deficiencies exist that should affect the overall performance of the appurtenant structures.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Storage Dam consisted of:

1. Visual inspection of the embankment, abutments, and embankment toe.

2. Visual examination of the spillway and exposed portions of the outlet works.

3. Observation of factors affecting the runoff potential of the drainage basin.

4. Evaluation of downstream hazard potential.

The specific observations are illustrated in Plate 11 and in the photographs in Appendix C.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks, subsidence, bulging, wet areas, seeps and boils and observing general maintenance conditions, vegetative cover, erosion, and other surficial features.

In general, the condition of the dam is considered to be good. The most significant condition noted was the presence of a small slump and associated wet area located at the toe level of the dam near the left abutment. Although at this time this condition is localized and does not appear to be threatening the overall stability of the embankment, repairs are recommended. Numerous seeps were observed on the left abutment at a level approximately 5 to 10 feet below the normal pool level. Combined flow from these seeps was estimated to be on the order of one to two cfs. Seeps were found to be clear with no indication of internal erosion. Due to their present limited extent, the seeps on the left abutment are not considered to be a threat to the integrity of the dam. Another seepage point was identified in line with the center of the embankment approximately 150 feet from the toe of the dam. The source of the seepage appears to be flow from the internal drainage system of the embankment. A small seepage of 2 to 4 gallons per minute was found in the outlet works discharge channel. The flow was clear and no indication of internal erosion was observed.

The top of the embankment was surveyed relative to the spillway crest elevation and was found to be in conformance with the design elevation. The crest profile is illustrated on Plate 12.

c. Appurtenant Structures. The appurtenant structures were examined for deterioration or other signs of distress or obstructions that would limit flow. The spillway structures and the visible portions of the outlet works structures were found to be in good condition. Some seepage was observed at several construction joints of the spillway discharge channel. However, the seepage condition is limited and should not affect the structural performance of the spillway structures.

d. Reservoir Area. A map review indicates that the watershed is predominantly covered with woodlands. A review of the regional geology (Appendix E) indicates that the reservoir slopes are not likely to be susceptible to massive landslides which would affect the storage volume of the reservoir.

e. Downstream Channel. Downstream from the dam, the stream flows through a narrow and steep valley. Inhabited areas below the dam are located approximately 2 miles downstream. Further description of the downstream conditions is included in Section 1.2b.

3.2 Evaluation. The condition of the dam is considered to be good. The present extent of the slump and wet area along the toe of the dam near the left abutment at this time does not appear to be affecting the stability of the embankment. However, further investigation of this condition and implementation of necessary remedial work is recommended. The seepage flows from the left abutment should be collected and monitored to determine if the amount of flow is changing.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no normal operating procedures for the dam. The reservoir is normally maintained at the crest level of the uncontrolled spillway. It is reported that the reservoir is used as an emergency water supply and water is released through the outlet works as needed.

4.2 Maintenance of the Dam. The maintenance of the dam is considered to be good. The downstream face of the dam is covered with well established grass and appears to be periodically mowed.

4.3 Maintenance of Operating Facilities. The outlet pipe sluice gate is the only operable facility of the dam. The gate hoist is located in the gate tower within the lake and is not readily accessible. Therefore, the gate could not be closely examined. However, it appears that the equipment is being adequately maintained. Borough personnel reported that at least annually the outlet sluice gate is opened and necessary maintenance performed. Operation of the sluice gate was not observed.

4.4 Warning System. No formal warning system exists for the dam. The nearest telephone communication facilities are available via residences approximately two miles downstream from the dam. The dam is not considered to be readily accessible during severe weather conditions for emergency inspections.

4.5 Evaluation. The maintenance condition of the dam was found to be good. The need for improving the accessibility of the dam during severe weather conditions should be considered.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Storage Dam has a watershed area of 1.6 square miles and impounds a reservoir with a surface area of 9.3 acres at normal pool level. The flood discharge facilities for the dam consist of a 30-foot-wide ogee overflow section which constitutes the combined primary and emergency spillways for the reservoir. Discharge capacity of the spillway was determined to be 1710 cfs with no freeboard.

b. Experience Data. As previously stated, Storage Dam is classified as a small dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass 1/2 to full PMF.

The PMF inflow hydrograph for the reservoir was determined using the Dam Safety Version of the HEC-1 computer program developed by the Hydrologic Engineering Center of the U.S. Army, Corps of Engineers. The data used for the computer analysis are presented in Appendix D. The PMF inflow hydrograph was found to have a peak flow of 4113 cfs. The computer input and summary of computer output are also included in Appendix D.

c. Visual Observations. On the dates of inspection, no conditions were observed that would indicate that the capacity of the spillway would be significantly reduced in the event of a flood.

d. Overtopping Potential. Various percentages of the PMF inflow hydrograph were routed through the reservoir, starting from normal pool level using the stage-volume relationship included in the design drawings. It was found that the dam can pass 40 percent of the PMF without overtopping the embankment. At 50 percent of the PMF, the embankment will be overtopped for a duration of 2 hours with a maximum depth of 0.3 foot. For 100 percent of the PMF, the embankment will be overtopped with a maximum depth of 1.3 feet.

e. Spillway Adequacy. Since the spillway cannot pass the recommended spillway design flood range of 50 to 100 percent of the PMF without overtopping the embankment required for dams in the 25-foot to 40-foot height range in the high hazard category, the spillway is rated inadequate. However, the spillway is not considered to be seriously inadequate because it can pass 50 percent of the PMF without significant potential for breaching the dam.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, there is a small slump observed along the toe of the dam near the left abutment. The field observations did not reveal any other signs of distress at this time that would significantly affect the stability of the dam. Correction of the slump is considered necessary to avoid future distress to the embankment.

(2) Appurtenant Structures. No conditions were noted that would significantly affect the structural performance of the appurtenant structures.

b. Design and Construction Data

(1) Embankment. The available information indicates that the stability of the embankment was analyzed based on assumed soil strength parameters. The factor of safety was reported to be 1.5 for the stability of the downstream slope. The stability analysis is preliminary in nature and is not considered to be in conformance with currently accepted engineering analysis techniques. However, based on the past performance of the dam and visual observations, the stability of the dam is considered to be adequate.

(2) Appurtenant Structures. Review of the design drawings indicates that there are no apparent structural deficiencies that would significantly affect the performance of the appurtenant structures.

c. Operating Records. There are no operating records kept for the dam.

d. Post-Construction Changes. None reported.

e. Seismic Stability. The dam is located in Seismic Zone 1, and based on visual observations, the static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for the evaluation of seismic stability of dams, the structure is presumed to present no hazard from earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Storage Dam is in good condition. A small slump was observed along the toe of the dam near the left abutment. In its present extent, the slump does not appear to be threatening the stability of the embankment. However, necessary repair work should be implemented to avoid distress to the embankment.

The capacity of the spillway was found to be approximately 40 percent of the PMF, which is less than the recommended spillway capacity based on the size and hazard classification of the dam. Therefore, the spillway is classified to be inadequate according to the recommended criteria. However, the spillway is not considered to be seriously inadequate because it is estimated that overtopping of the embankment by 0.3 foot during the passage of 50 percent of the PMF would not likely cause failure of the dam.

b. Adequacy of Information. The available information, in conjunction with the visual observations and the previous experience of the inspectors, is considered to be sufficient to make a reasonable assessment of the condition of the dam.

c. Urgency. The following recommendations should be implemented immediately or on a continuing basis.

d. Necessity for Additional Data. In view of the inadequacy of the spillway capacity, the owner should initiate additional studies to more accurately ascertain the spillway capacity and the extent of improvements required to provide adequate spillway capacity.

7.2 Recommendations/Remedial Measures. It is recommended that:

1. The owner should immediately initiate additional studies to more accurately ascertain the spillway capacity and the nature and extent of improvements required to provide adequate spillway capacity.

2. The owner should immediately retain a professional engineer to investigate the slumping along the toe of the embankment and prepare and execute plans to correct this condition.

3. Seeps from the left abutment should be collected into a channel and the flow quantities monitored. The turbidity of the seeps should be noted to assess the possibility of internal erosion.

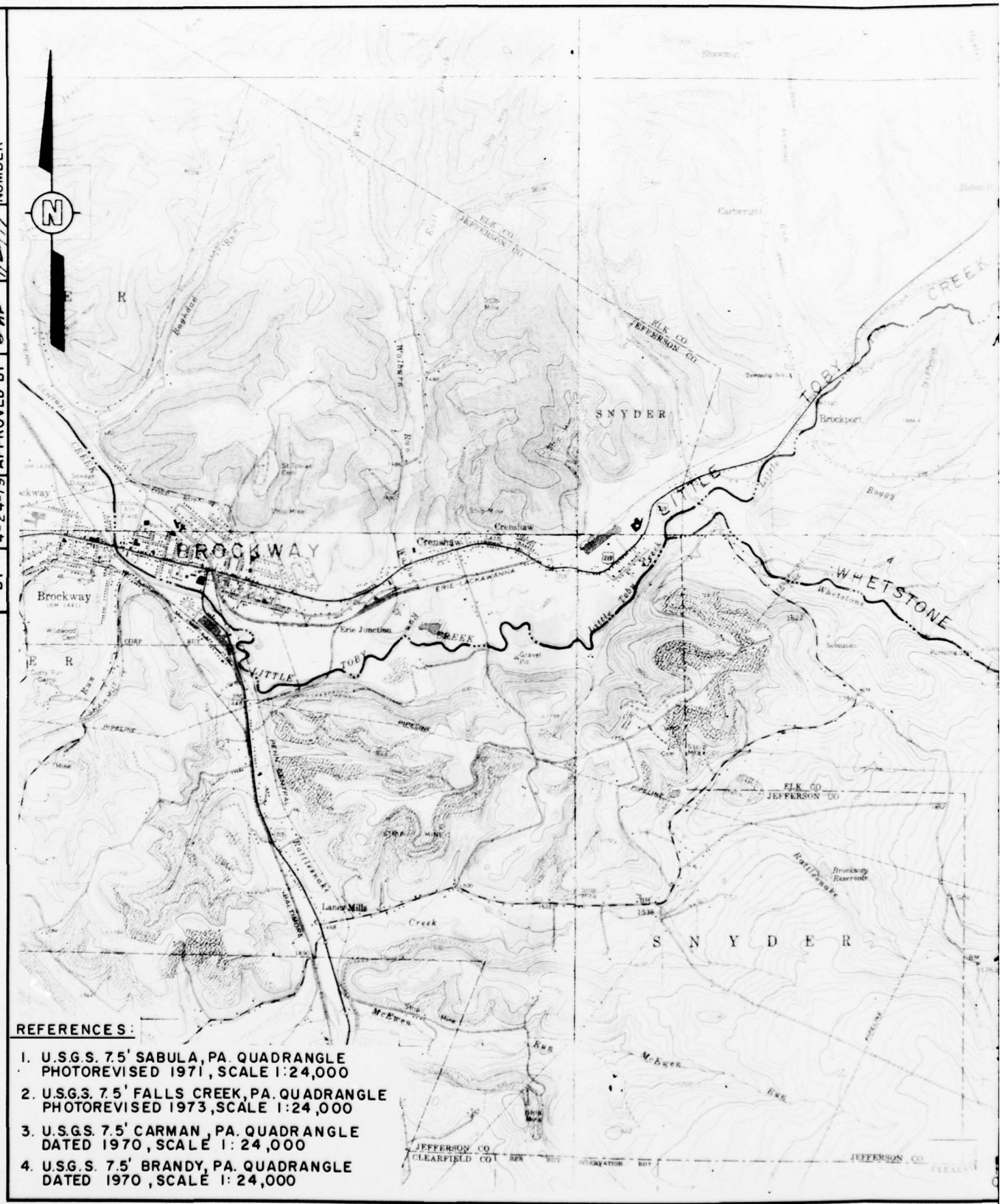
4. The access road to the dam should be improved to facilitate inspection of the facilities during severe weather conditions.

5. Around-the-clock surveillance should be provided during unusually heavy runoff and a formal warning system should be developed to alert the downstream residents in the event of emergencies.

6. The dam and appurtenant structures should be inspected regularly and necessary maintenance performed.

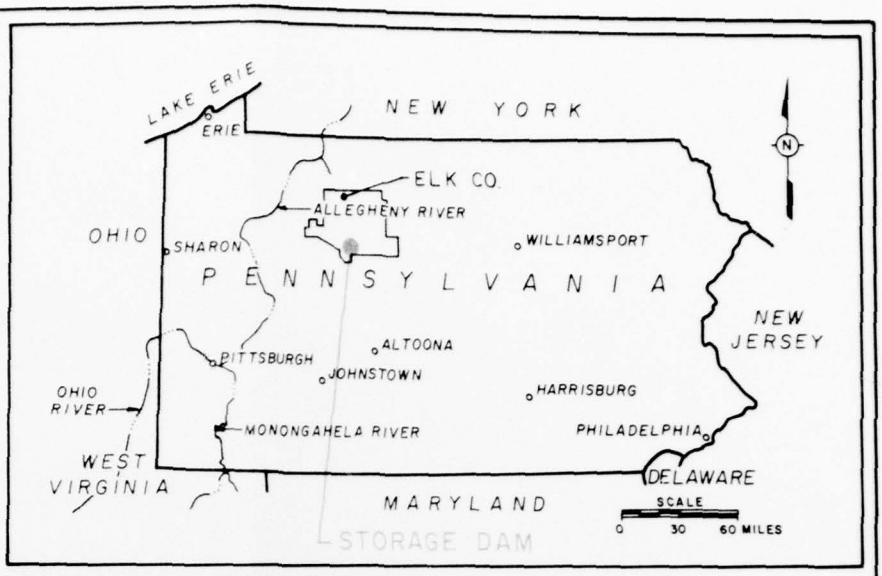
PLATES

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REFERENCES:

1. U.S.G.S. 7.5' SABULA, PA. QUADRANGLE PHOTOREVISED 1971, SCALE 1:24,000
2. U.S.G.S. 7.5' FALLS CREEK, PA. QUADRANGLE PHOTOREVISED 1973, SCALE 1:24,000
3. U.S.G.S. 7.5' CARMAN, PA. QUADRANGLE DATED 1970, SCALE 1:24,000
4. U.S.G.S. 7.5' BRANDY, PA. QUADRANGLE DATED 1970, SCALE 1:24,000



KEY PLAN

APPROXIMATE WATERSHED AREA

WHETSTONE BRANCH

STORAGE DAM

MOSHANNON STATE FOREST

SCALE
0 2000 4000 6000 8000 FEET

PLATE I

STORAGE DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

D'APPOLONIA

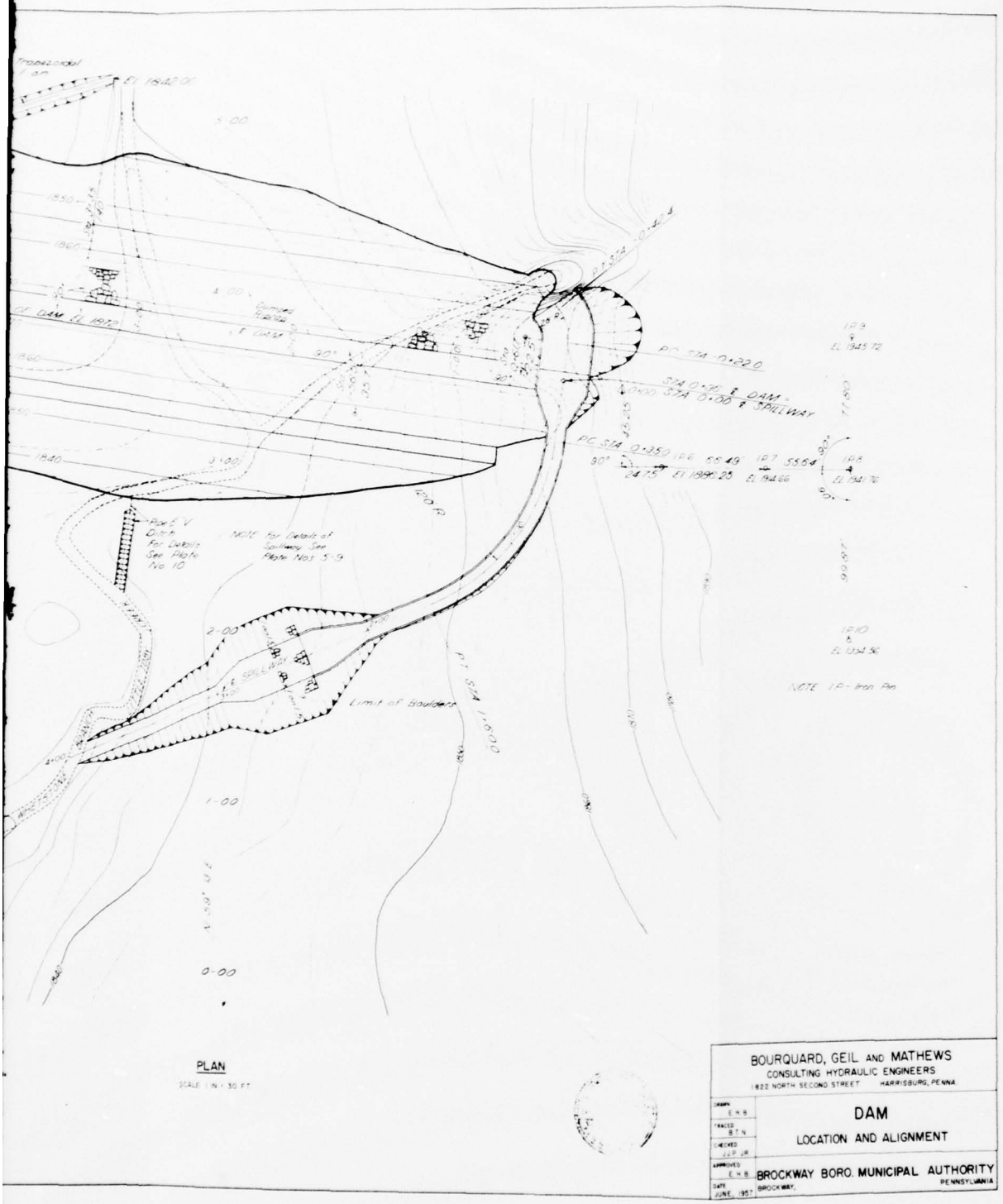
DRAWN BY	ACS	CHECKED BY		7-24-79	DRAWING NUMBER 78-367-B180
	6-13-79	APPROVED BY		7/24/79	



PLAN

SCALE 1 IN = 30 FT

1



PLAN

SCALE 1 IN = 30 FT

BOURQUARD, GEIL AND MATHEWS
CONSULTING HYDRAULIC ENGINEERS
1822 NORTH SECOND STREET HARRISBURG, PENNA.

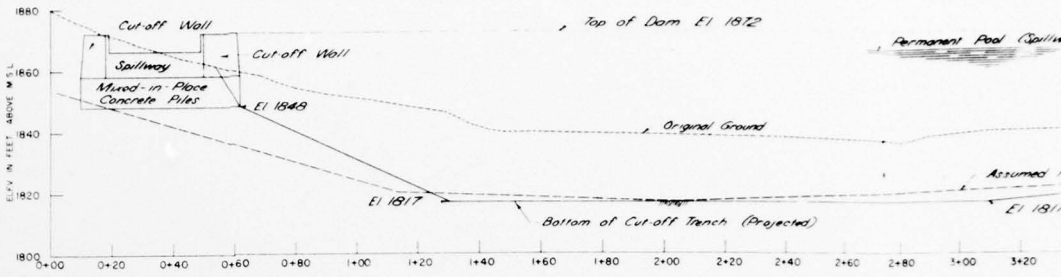
DRAWN E.H.S.	DAM
TRACED B.T.N.	LOCATION AND ALIGNMENT
CHECKED J.J.P. JR	
APPROVED E.H.S.	BROCKWAY BORO. MUNICIPAL AUTHORITY
DATE JUNE, 1957	BROCKWAY, PENNSYLVANIA

PLATE 2

2

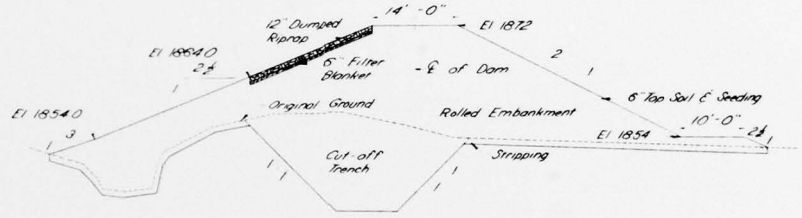
D'APPOLONIA

DRAWN BY	ACS	CHECKED BY		2-24-25	DRAWING NUMBER 76 367-B181
	6-13-79	APPROVED BY		3/24/79	

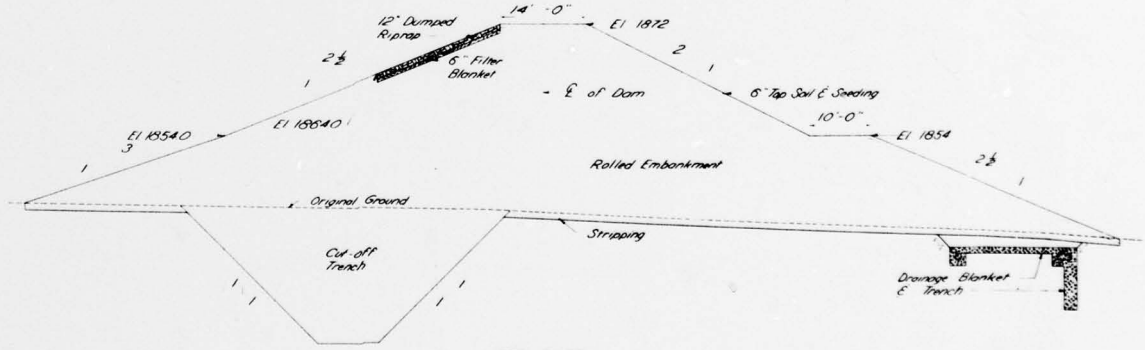


PROFILE ALONG ℄ OF DAM

SCALE 1 IN = 20 FT



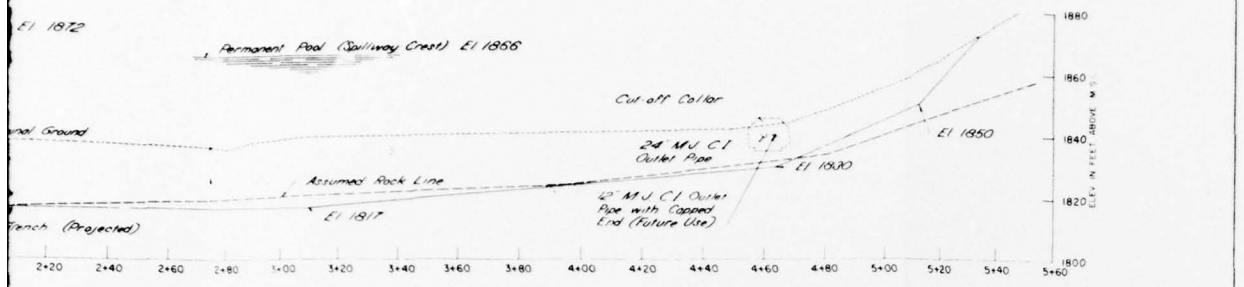
STA. 0+75



STA. 3+50

SECTIONS

SCALE 1 IN = 10 FT

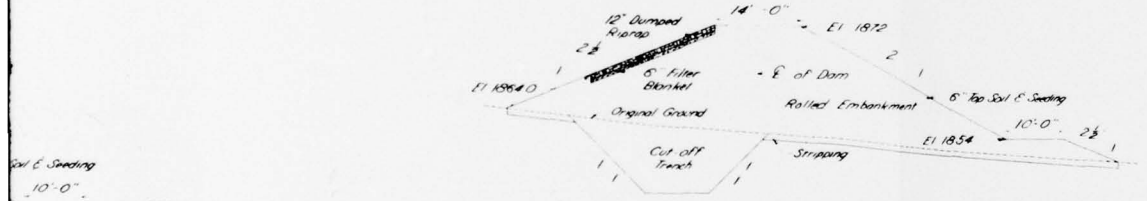


PROFILE ALONG ℄ OF DAM

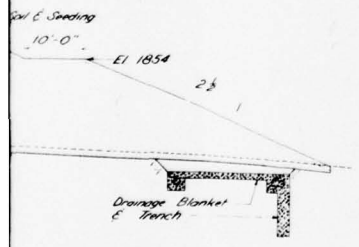
SCALE 1 IN = 20 FT



STA 2+00



STA 5+00



SECTIONS

SCALE 1 IN = 10 FT

NOTE: Excavation for Cut off Trench and for Installation of Drainage Blanket and Trench shall be Classified as Common Excavation

NO.	REVISION	DATE	BY

BOURQUARD, GEIL AND MATHEWS
CONSULTING HYDRAULIC ENGINEERS
1822 NORTH SECOND STREET HARRISBURG, PENNA

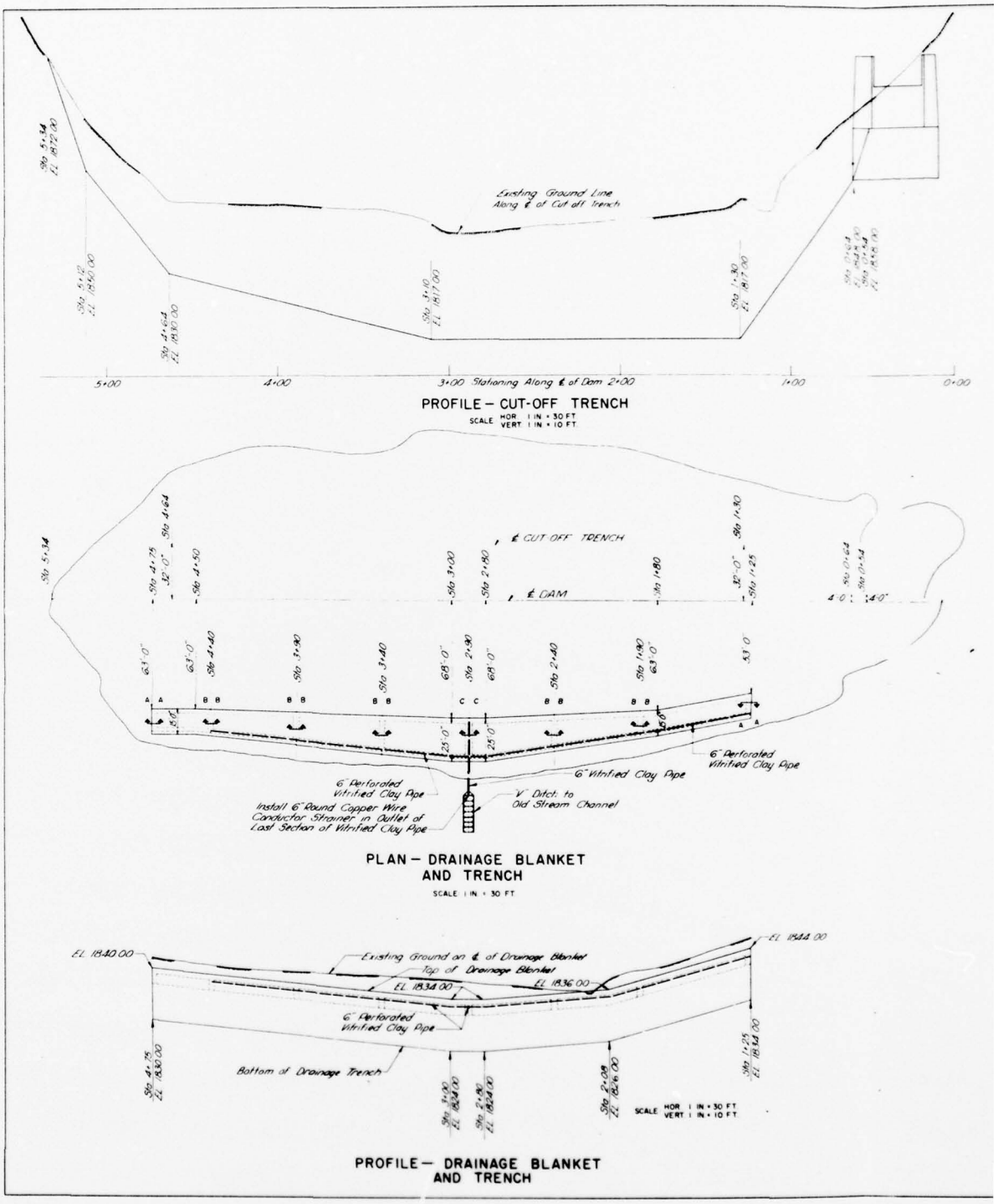
DRAWN N.A.D.	EMBANKMENT
TRACED B.T.N.	SECTIONS & PROFILE
CHECKED J.J.P. JR	
APPROVED E.H.B.	BROCKWAY BORO MUNICIPAL AUTHORITY
DATE JUNE 1957	BROCKWAY, PENNSYLVANIA

PLATE 3

2

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	2-24-33	DRAWING NUMBER 78-367-B182
	6-13-79	APPROVED BY	JHD	2/24/33	



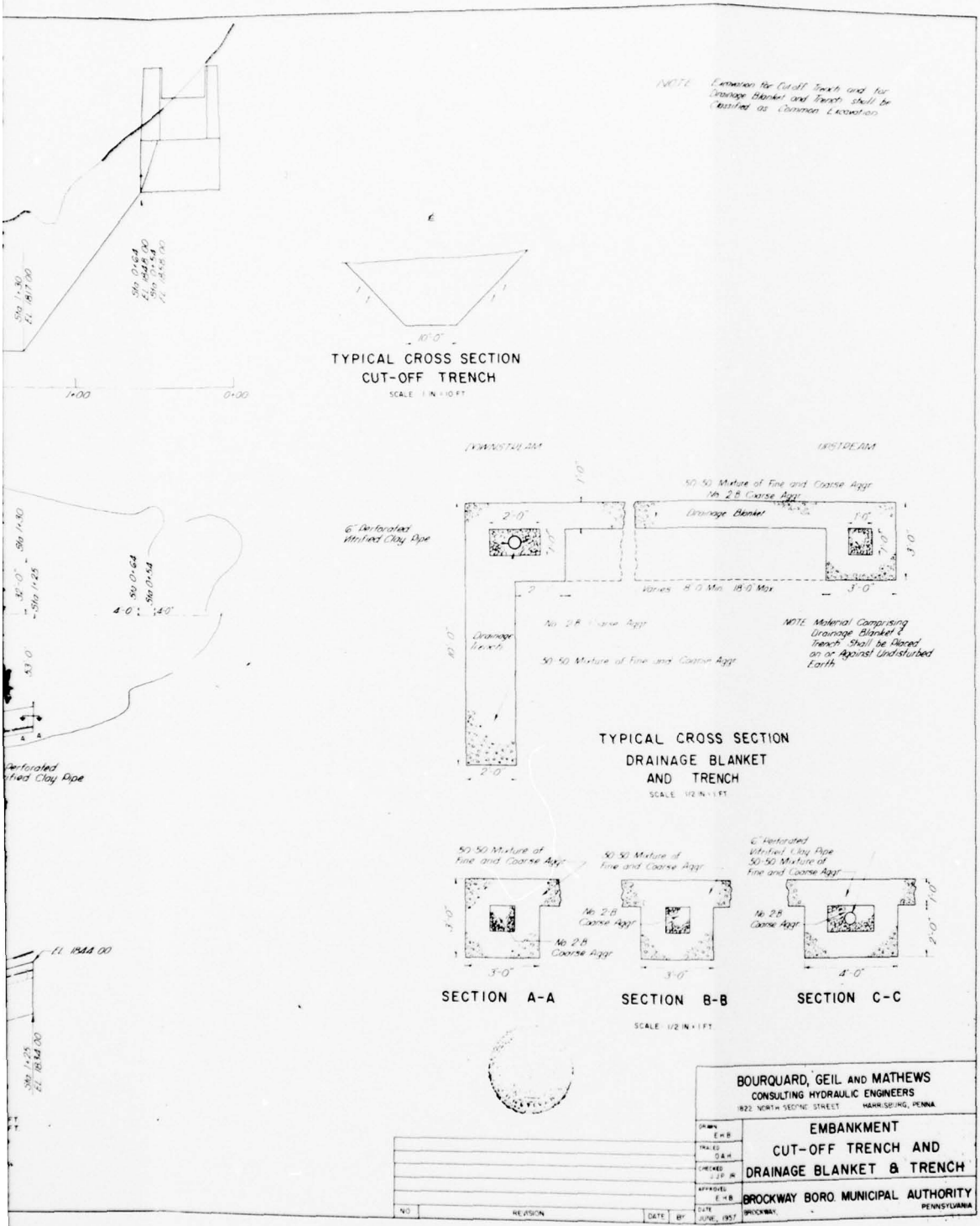
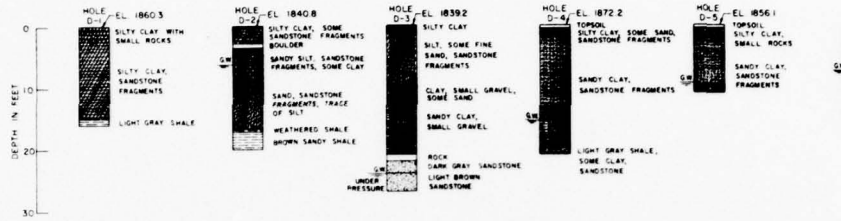


PLATE 4

2

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	7-24-79	DRAWING NUMBER 76-87-B183
	6-13-79	APPROVED BY	JMD	7/24/79	



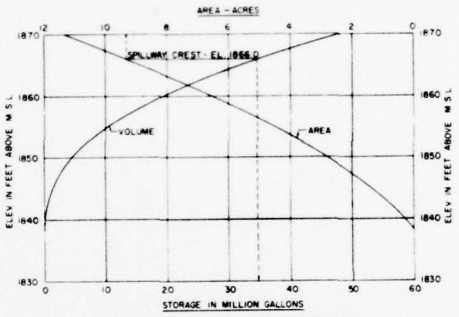
LEGEND

CLAY · SAND · SILT · SHALE · SANDSTONE · GRAVEL & ROCK

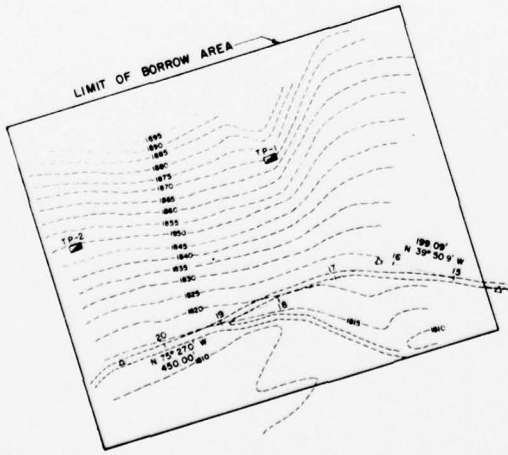
● D-5 CORE BORING

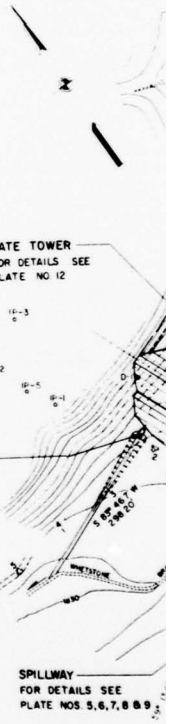
◢ TP-2 TEST PIT

RECORD OF SUBSURFACE EXPLORATIONS

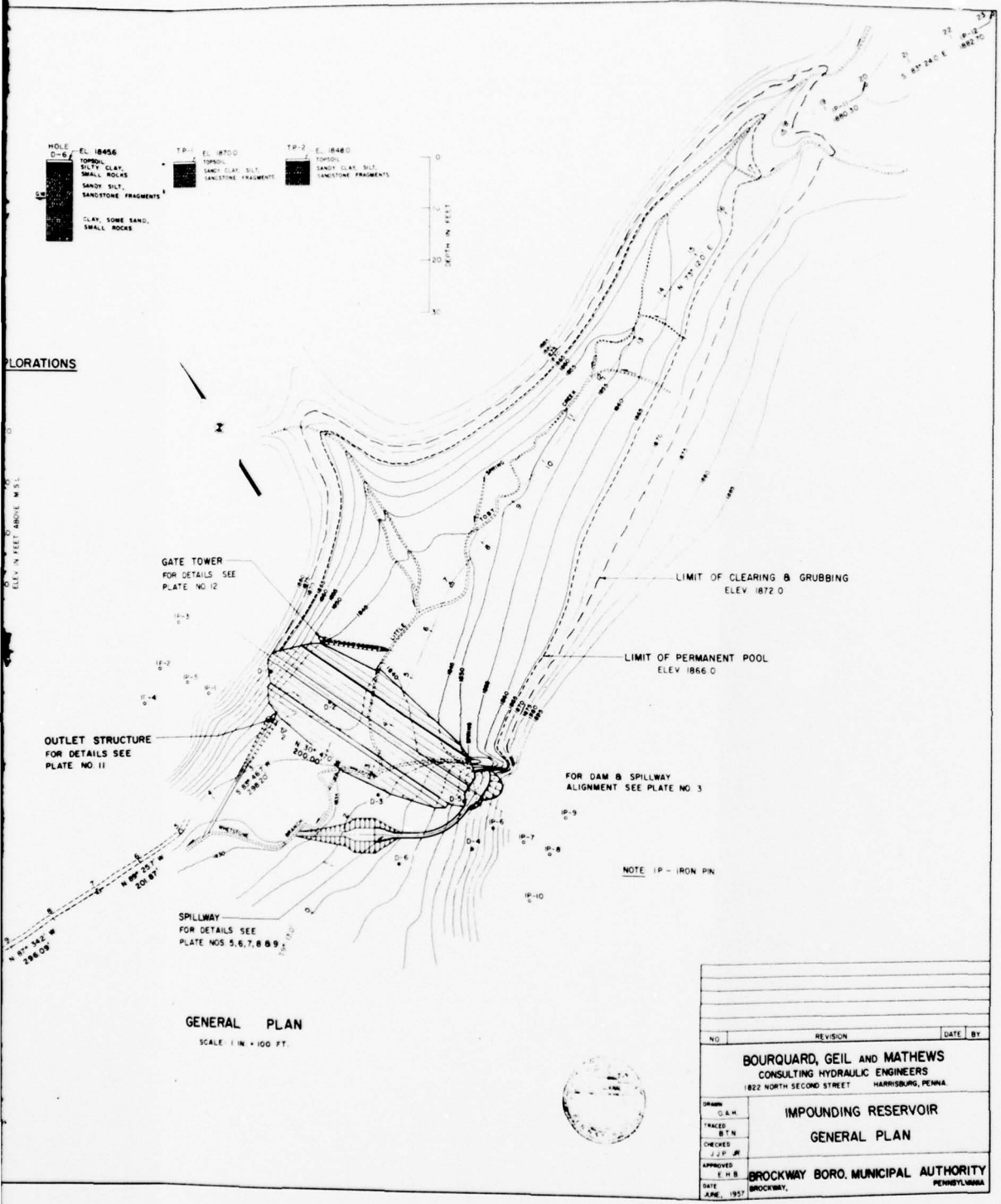


AREA - CAPACITY RELATIONSHIP





1



GENERAL PLAN

SCALE 1 IN. = 100 FT.

NO.	REVISION	DATE	BY

BOURQUARD, GEIL AND MATHEWS
CONSULTING HYDRAULIC ENGINEERS
1822 NORTH SECOND STREET HARRISBURG, PENNA.

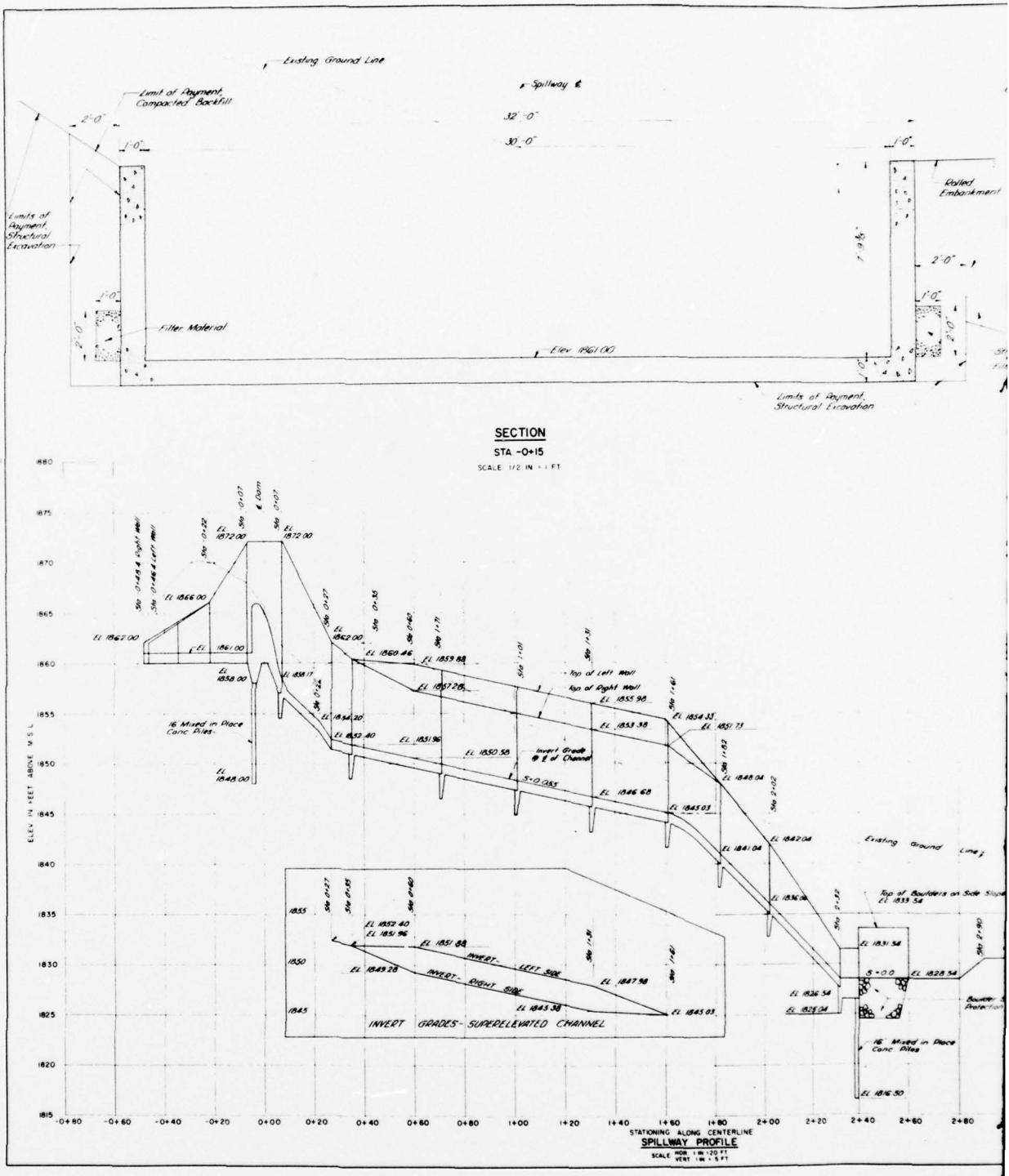
DRAWN O.A.H.	IMPOUNDING RESERVOIR
TRACED B.T.N.	GENERAL PLAN
CHECKED J.J.P. JR.	
APPROVED E.H.B.	BROCKWAY BORO. MUNICIPAL AUTHORITY BROCKWAY, PENNSYLVANIA
DATE JUNE, 1957	

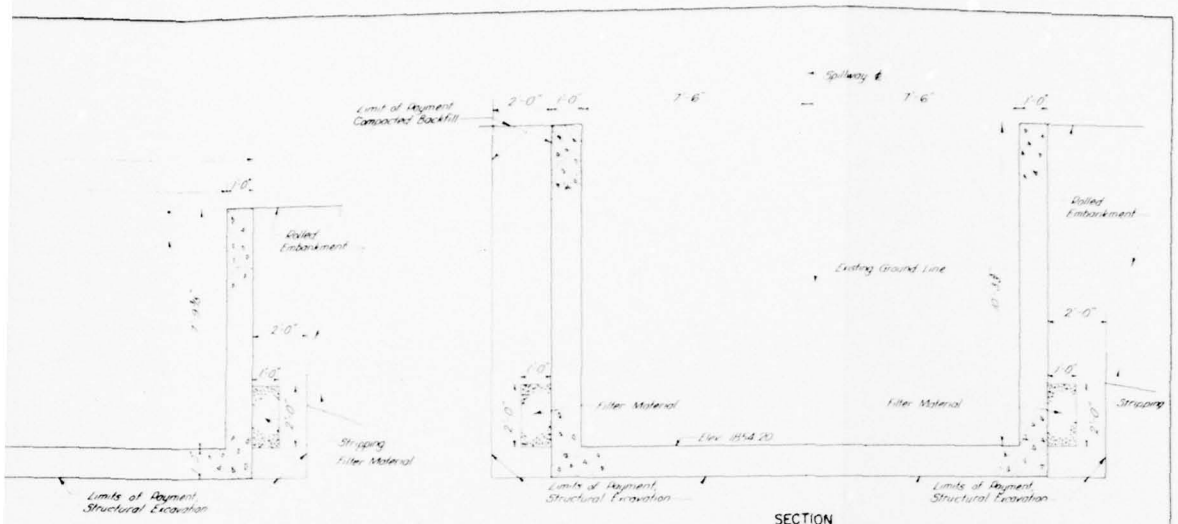
PLATE 5

2

D'APPOLONIA

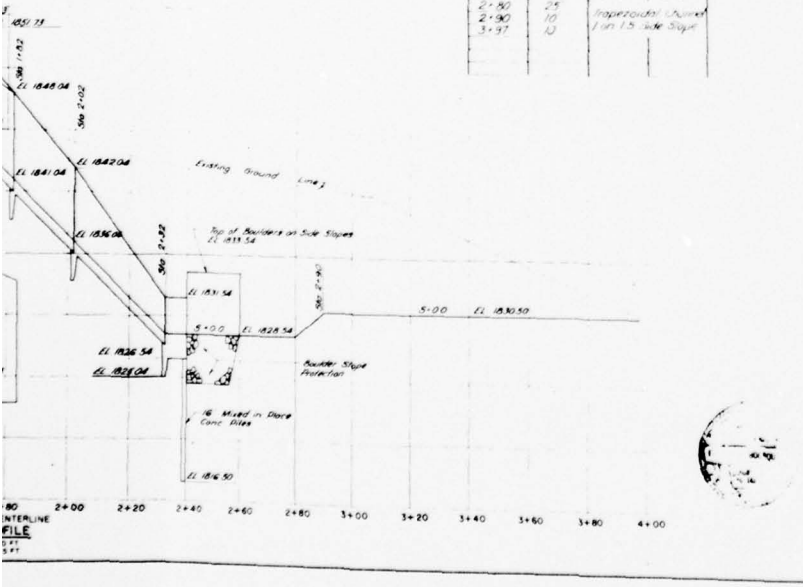
DRAWN BY	ACS	CHECKED BY	BE	7-24-79	DRAWING NUMBER	76-07-B184
	6-13-79	APPROVED BY	JBD	7/24/79		





SECTION
STA 0+22

CHANNEL DIMENSION TABLE			
SPILLWAY STATION	CHANNEL WIDTH	HEIGHT OF WALL	
		LEFT	RIGHT
0+48.4	30'		1'-0"
0+46.4	30	1'-0"	
0+22	30'	5'-0"	5'-0"
0+07	30'	11'-0"	11'-0"
0+07	30'	13'-10"	13'-10"
0+22	15'	10'-3½"	10'-3½"
0+27	10'	9'-7½"	9'-7½"
0+35	10'	8'-6"	8'-6"
0+60	10'	8'-0"	8'-0"
1+31	10'	8'-0"	8'-0"
1+61	10'	9'-3½"	7'-8½"
1+82	10'	7'-0"	7'-0"
2+02	10'	6'-0"	6'-0"
2+32	25'	3'-0"	3'-0"
2+83	25'	3'-0"	3'-0"
2+90	25'	Trapezoidal Channel	
3+97	10'	1 on 1.5 Side Slope	



NO.	REVISION	DATE	BY

BOURQUARD, GEIL AND MATHEWS
CONSULTING HYDRAULIC ENGINEERS
822 NORTH SECOND STREET HARRISBURG, PENNA.

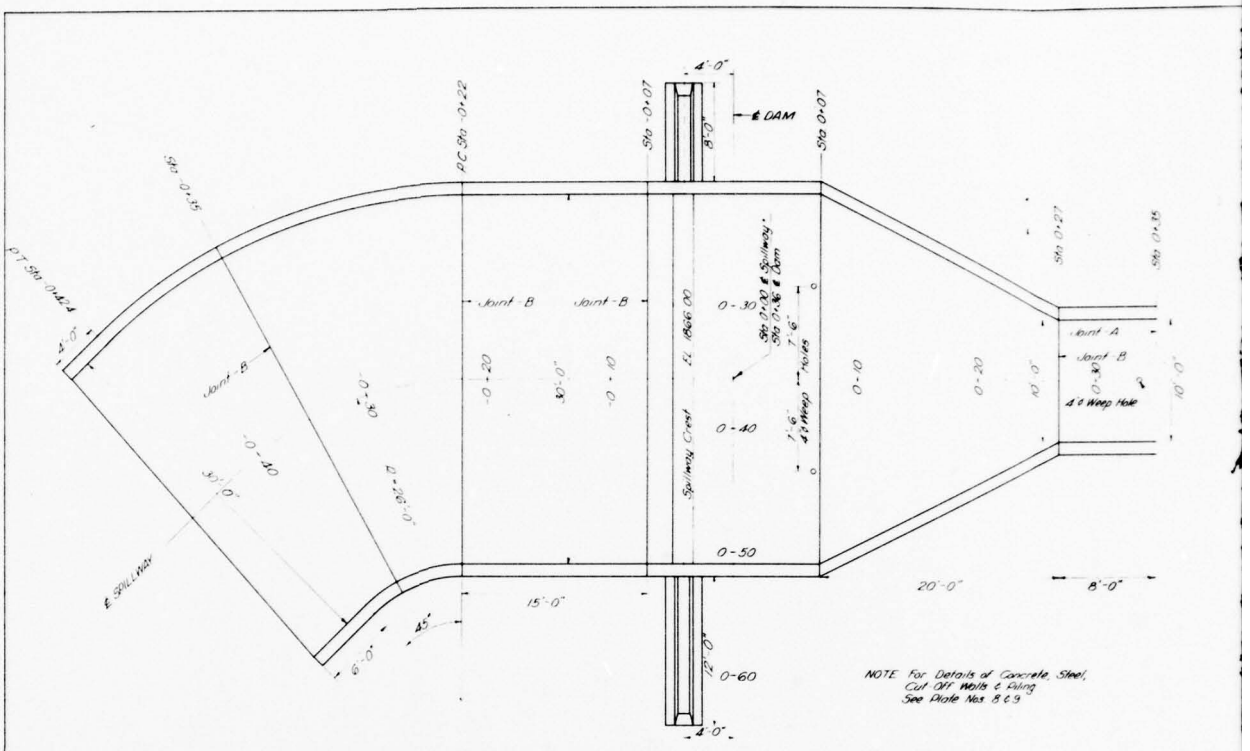
DRAWN E.H.B.	SPILLWAY
TRACED D.A.H.	TYPICAL SECTIONS
CHECKED J.J.P. JR.	PROFILE & CHANNEL DIMENSIONS
APPROVED E.H.B.	BROCKWAY BORO MUNICIPAL AUTHORITY
DATE JUNE, 1957	BROCKWAY, PENNSYLVANIA

PLATE 6

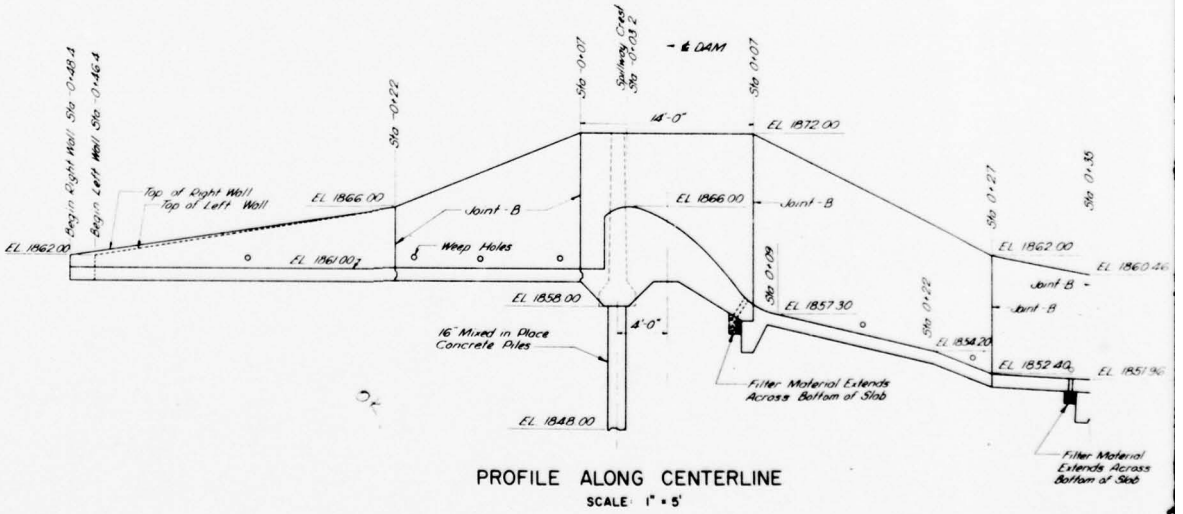
2

D'APPOLONIA

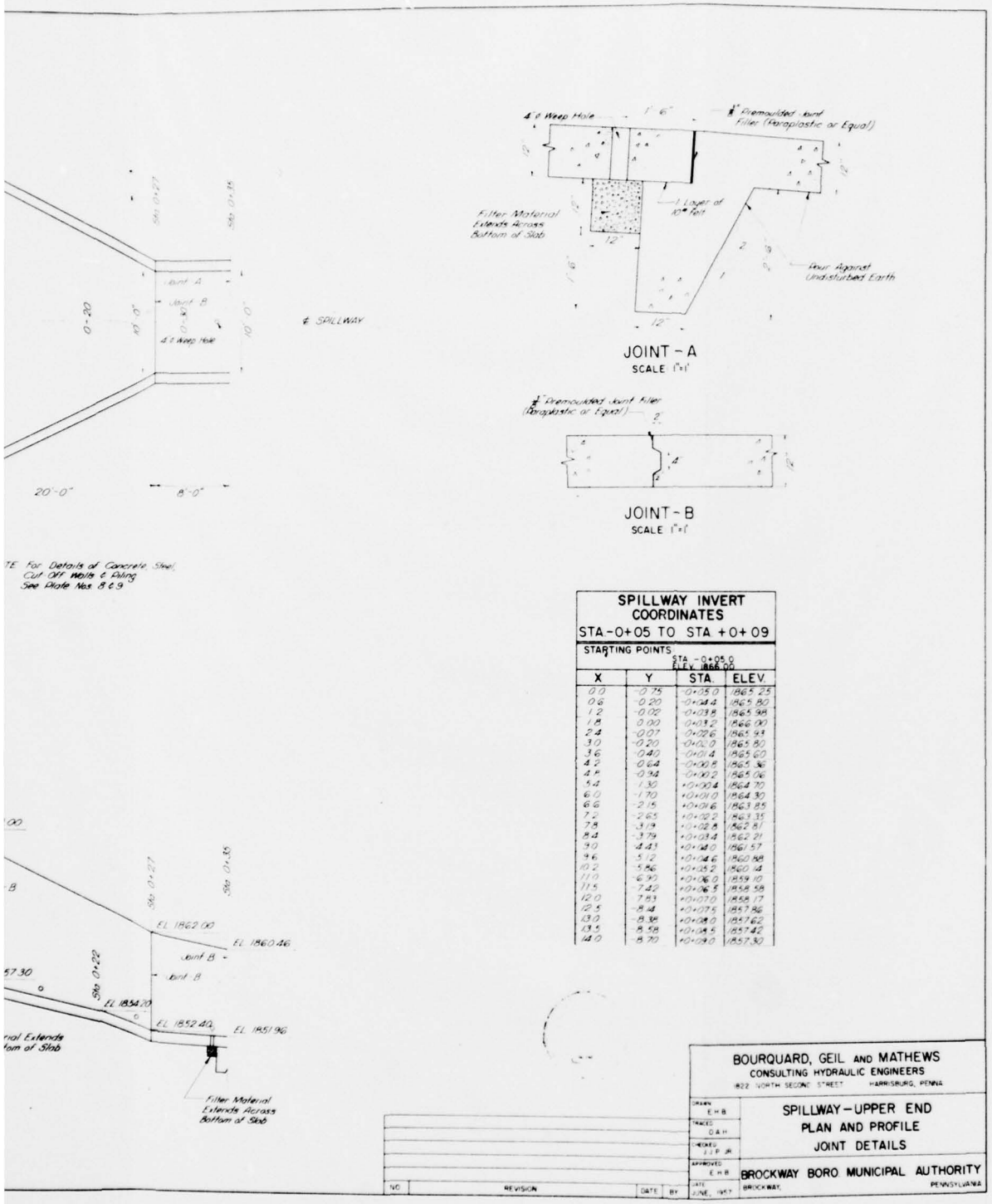
DRAWN BY	ACS	CHECKED BY	RE	2-24-79	DRAWING NUMBER 76-067-B185
	6-13-79	APPROVED BY	JHD	9/24/79	



PLAN
SCALE: 1" = 5'



PROFILE ALONG CENTERLINE
SCALE: 1" = 5'



TE For Details of Concrete Steel, Cut Off Walls & Piling See Plate Nos. 8 & 9

JOINT - A
SCALE 1"=1'

JOINT - B
SCALE 1"=1'

SPILLWAY INVERT COORDINATES
STA -0+05 TO STA +0+09

STARTING POINTS STA -0+05.0 ELEV. 1866.00

X	Y	STA.	ELEV.
0.0	-0.75	-0+05.0	1865.25
0.6	-0.20	-0+04.4	1865.80
1.2	-0.02	-0+03.8	1865.98
1.8	0.00	-0+03.2	1866.00
2.4	-0.07	-0+02.6	1865.93
3.0	-0.20	-0+02.0	1865.80
3.6	-0.40	-0+01.4	1865.60
4.2	-0.64	-0+00.8	1865.36
4.8	-0.94	-0+00.2	1865.06
5.4	-1.30	+0+00.4	1864.70
6.0	-1.70	+0+01.0	1864.30
6.6	-2.15	+0+01.6	1863.85
7.2	-2.65	+0+02.2	1863.35
7.8	-3.19	+0+02.8	1862.81
8.4	-3.79	+0+03.4	1862.21
9.0	-4.43	+0+04.0	1861.57
9.6	-5.12	+0+04.6	1860.88
10.2	-5.86	+0+05.2	1860.14
11.0	-6.90	+0+06.0	1859.10
11.5	-7.42	+0+06.5	1858.58
12.0	-7.83	+0+07.0	1858.17
12.5	-8.14	+0+07.5	1857.86
13.0	-8.38	+0+08.0	1857.62
13.5	-8.58	+0+08.5	1857.42
14.0	-8.70	+0+09.0	1857.30

BOURQUARD, GEIL AND MATHEWS
CONSULTING HYDRAULIC ENGINEERS
1822 NORTH SECOND STREET HARRISBURG, PENNA.

DRAWN E.H.B	SPILLWAY - UPPER END PLAN AND PROFILE JOINT DETAILS
TRACED D.A.H	
CHECKED J.J.P. JR.	
APPROVED E.H.B	BROCKWAY BORO MUNICIPAL AUTHORITY
DATE JUNE, 1957	BROCKWAY, PENNSYLVANIA

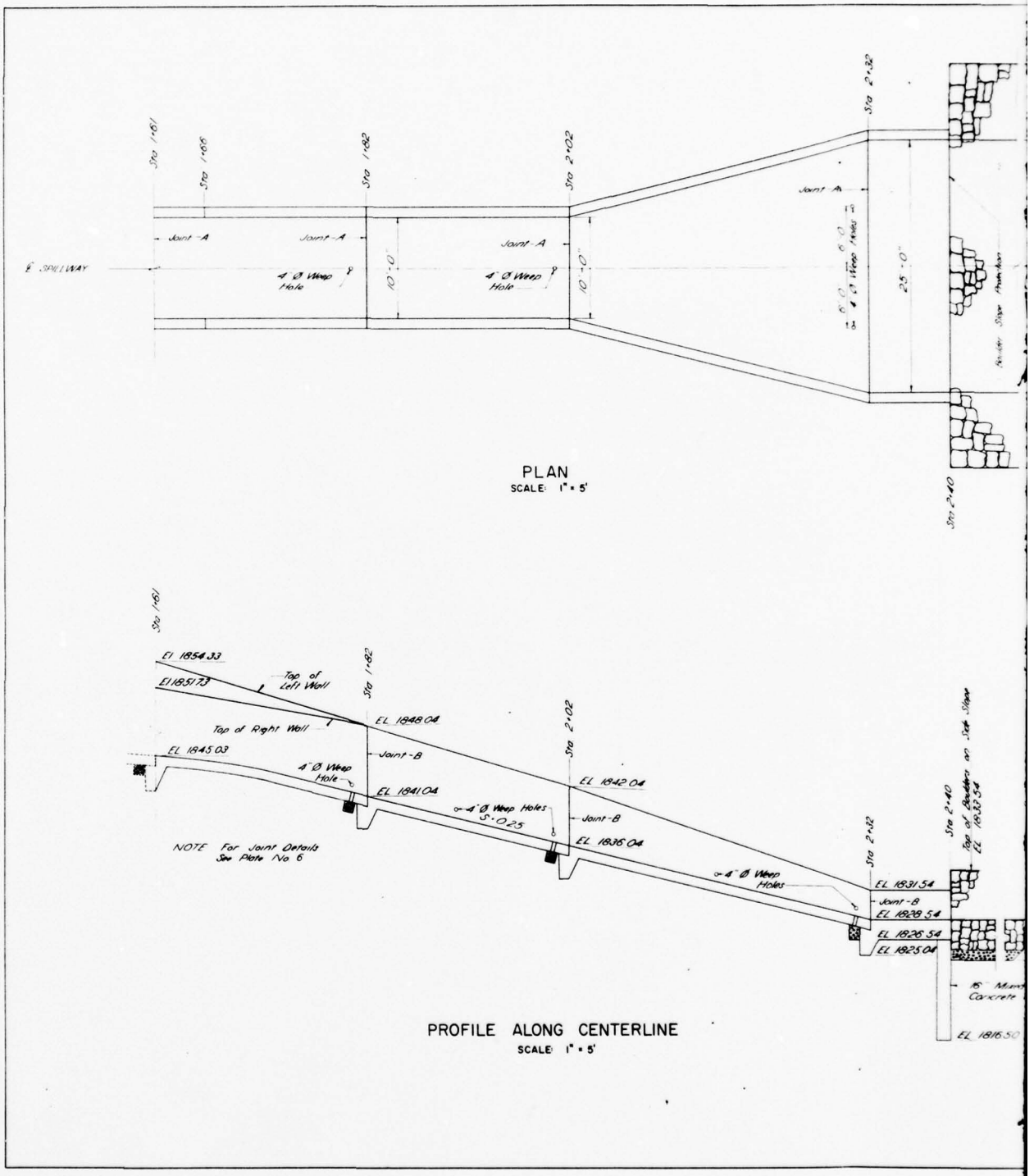
NO.	REVISION	DATE	BY

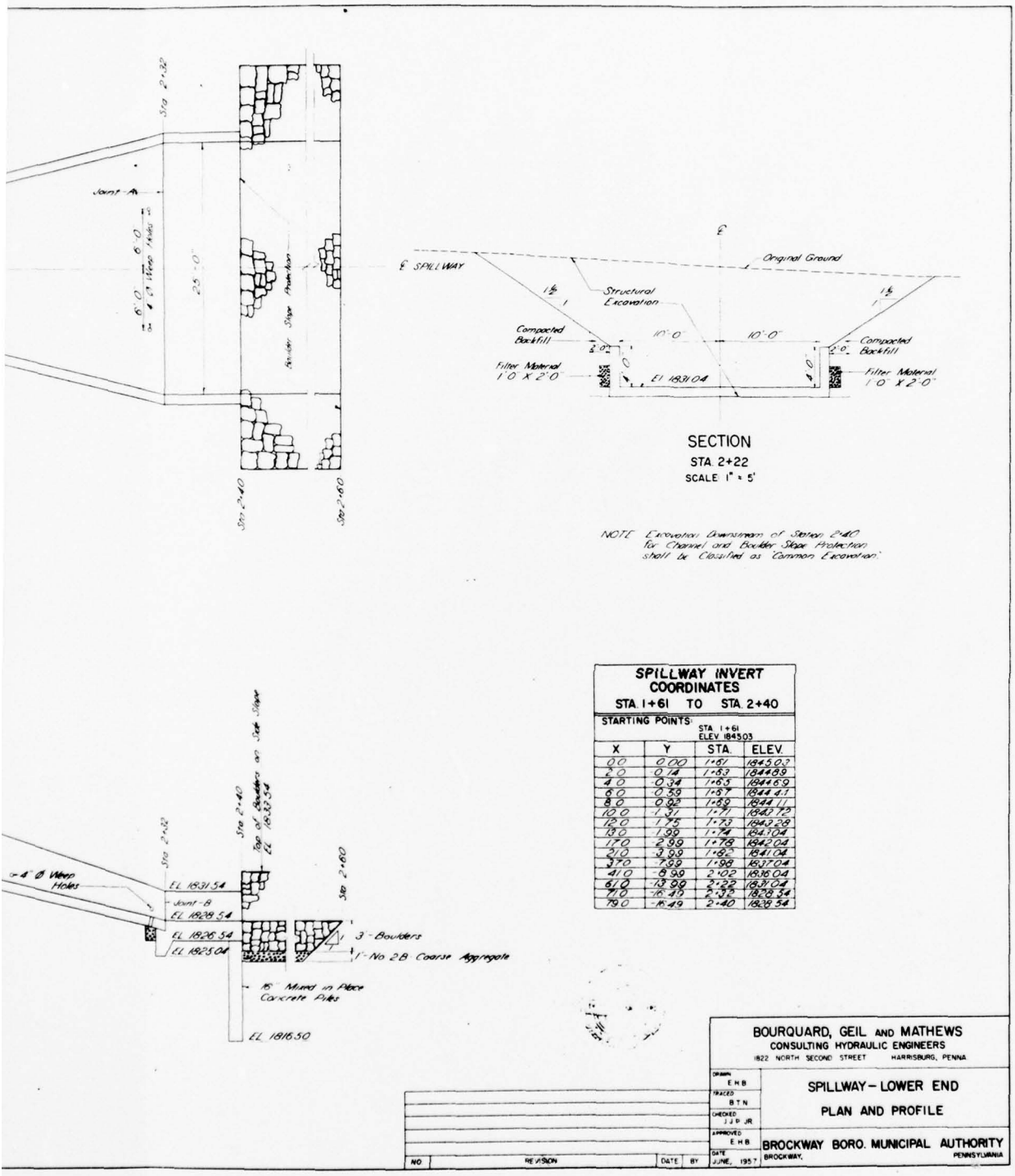
PLATE 7

2

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	7-24-79	DRAWING NUMBER
	6-13-79	APPROVED BY	JHD	7/30/79	78-367-B186





SPILLWAY INVERT COORDINATES
STA. 1+61 TO STA. 2+40

STARTING POINTS: STA. 1+61 ELEV. 1845.03

X	Y	STA.	ELEV.
0.0	0.00	1+61	1845.03
2.0	0.14	1+63	1844.89
4.0	0.34	1+65	1844.69
6.0	0.59	1+67	1844.41
8.0	0.93	1+69	1844.11
10.0	1.31	1+71	1843.73
12.0	1.75	1+73	1843.29
13.0	1.99	1+74	1843.04
17.0	2.99	1+78	1842.04
21.0	3.99	1+82	1841.04
37.0	7.99	1+98	1837.04
41.0	8.99	2+02	1836.04
61.0	13.98	2+22	1831.04
71.0	16.49	2+32	1828.54
79.0	18.49	2+40	1826.54

BOURQUARD, GEIL AND MATHEWS
CONSULTING HYDRAULIC ENGINEERS
1822 NORTH SECOND STREET HARRISBURG, PENNA.

DRAWN E.H.B.	SPILLWAY – LOWER END
TRACED B.T.N.	PLAN AND PROFILE
CHECKED J.J.P. JR.	
APPROVED E.H.B.	BROCKWAY BORO. MUNICIPAL AUTHORITY
DATE JUNE, 1957	BROCKWAY, PENNSYLVANIA

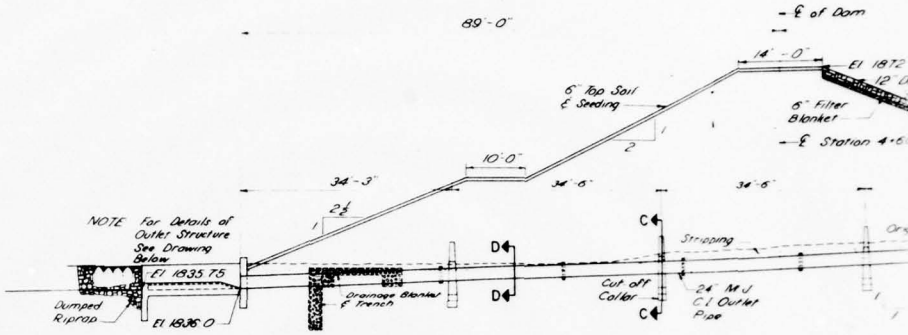
NO.	REVISION	DATE	BY

PLATE 8

2

D'APPOLONIA

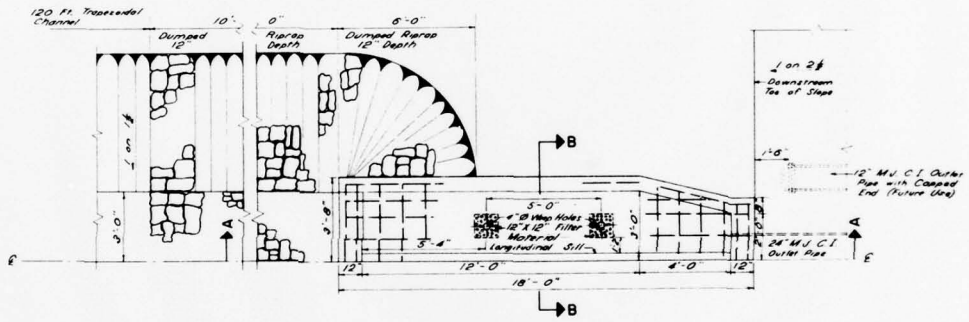
DRAWN BY	ACS	CHECKED BY	BE	2-24-79	DRAWING NUMBER	78-367-B187
	6-13-79	APPROVED BY	JHP	7/31/79		



PROFILE

OUTLET WORKS

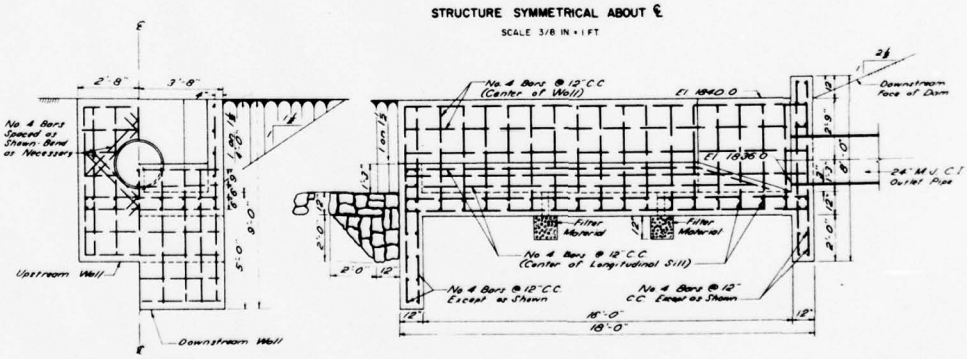
SCALE 1 IN = 10 FT



HALF PLAN

STRUCTURE SYMMETRICAL ABOUT ℄

SCALE 3/8 IN = 1 FT



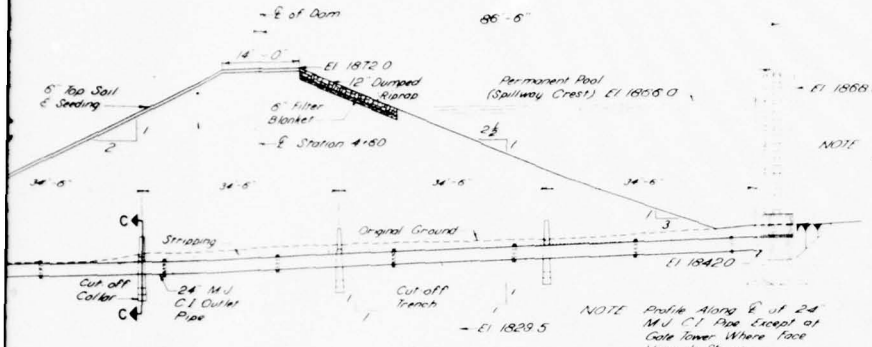
HALF ELEVATIONS

SECTION A-A

OUTLET STRUCTURE DETAILS

SCALE 3/8 IN = 1 FT

1



PROFILE

OUTLET WORKS

SCALE 1 IN = 10 FT

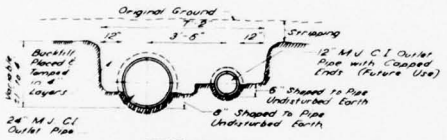


CONSTRUCTION JOINT

8 IN. WALL—NO WATERSTOP

SCALE 1 IN = 1 FT





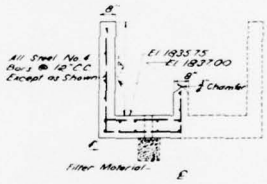
SECTION D-D

TYPICAL INSTALLATION DETAILS
CAST IRON PIPES

SCALE 3/8 IN = 1 FT

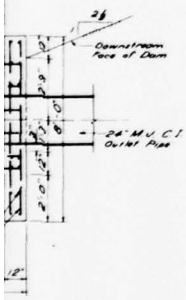
GENERAL NOTES

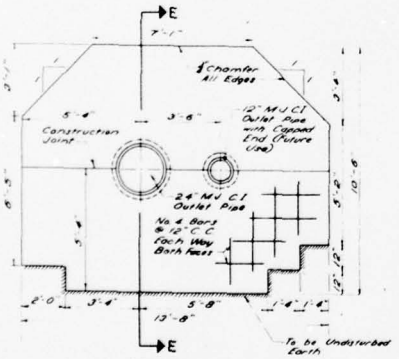
1. 24" ℄ 12" M.J. C.I. Pipes to be Class 300 Both to Conform to following Specifications
   Cast Iron - A.W.W.A. C 108-53
   Cement Lining - A.W.W.A. C 104-53
   Mechanical Joints - A.W.W.A. C 111-53
2. For General Concrete Notes Refer to Plate No. 9



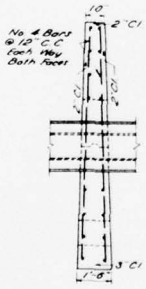
SECTION B-B

SCALE 3/8 IN = 1 FT





SECTION C-C



SECTION E-E

TYPICAL CUT-OFF COLLAR DETAILS

SCALE 3/8 IN = 1 FT

NO.	REVISION	DATE	BY

BOURQUARD, GEIL AND MATHEWS
CONSULTING HYDRAULIC ENGINEERS
1822 NORTH SECOND STREET HARRISBURG, PENNA.

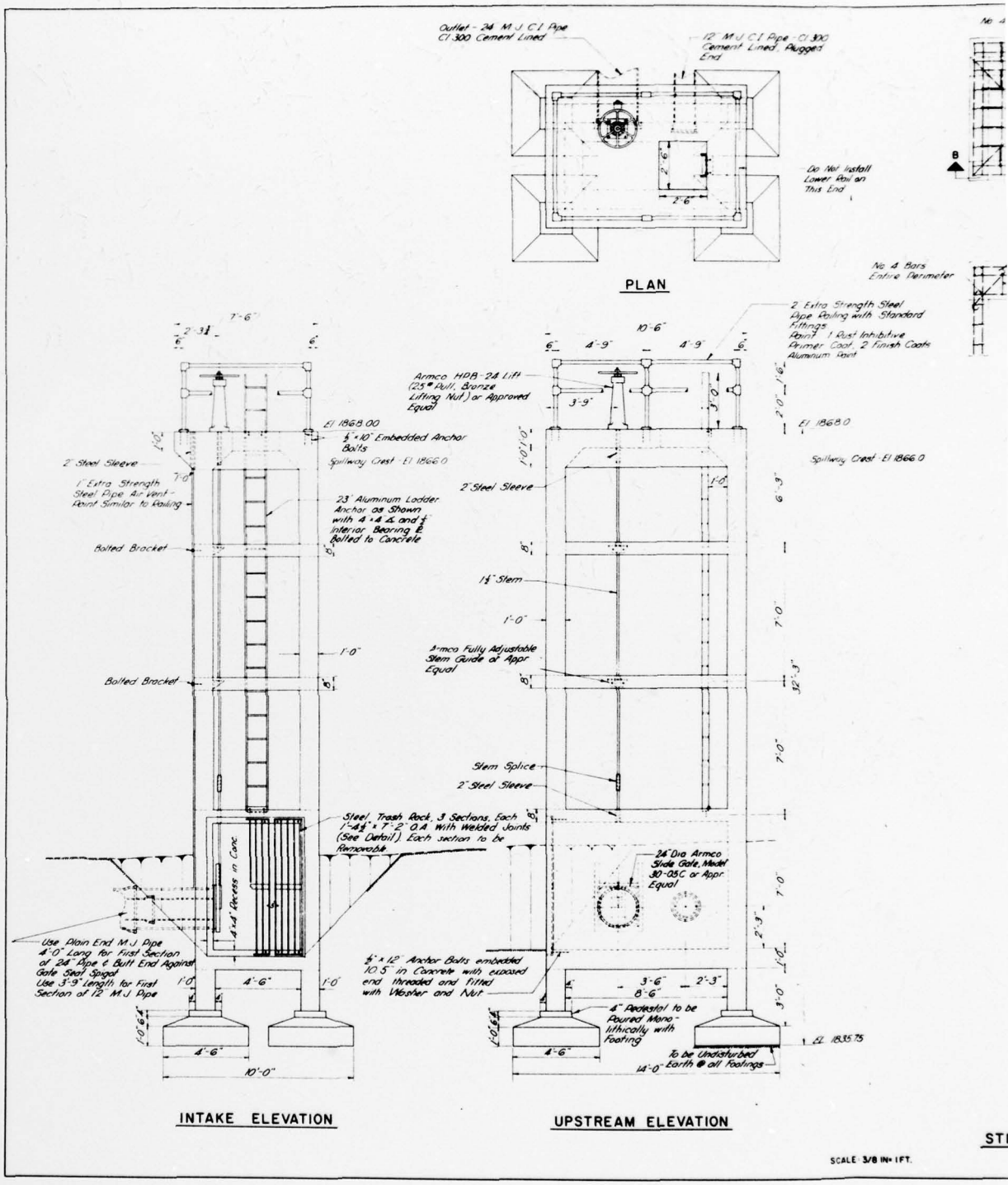
DRAWN J.J.P. JR.	OUTLET WORKS DETAILS
TRACED B.T.N.	
CHECKED O.A.H.	
APPROVED E.H.B.	BROCKWAY BORO. MUNICIPAL AUTHORITY
DATE JUNE, 1957	BROCKWAY, PENNSYLVANIA

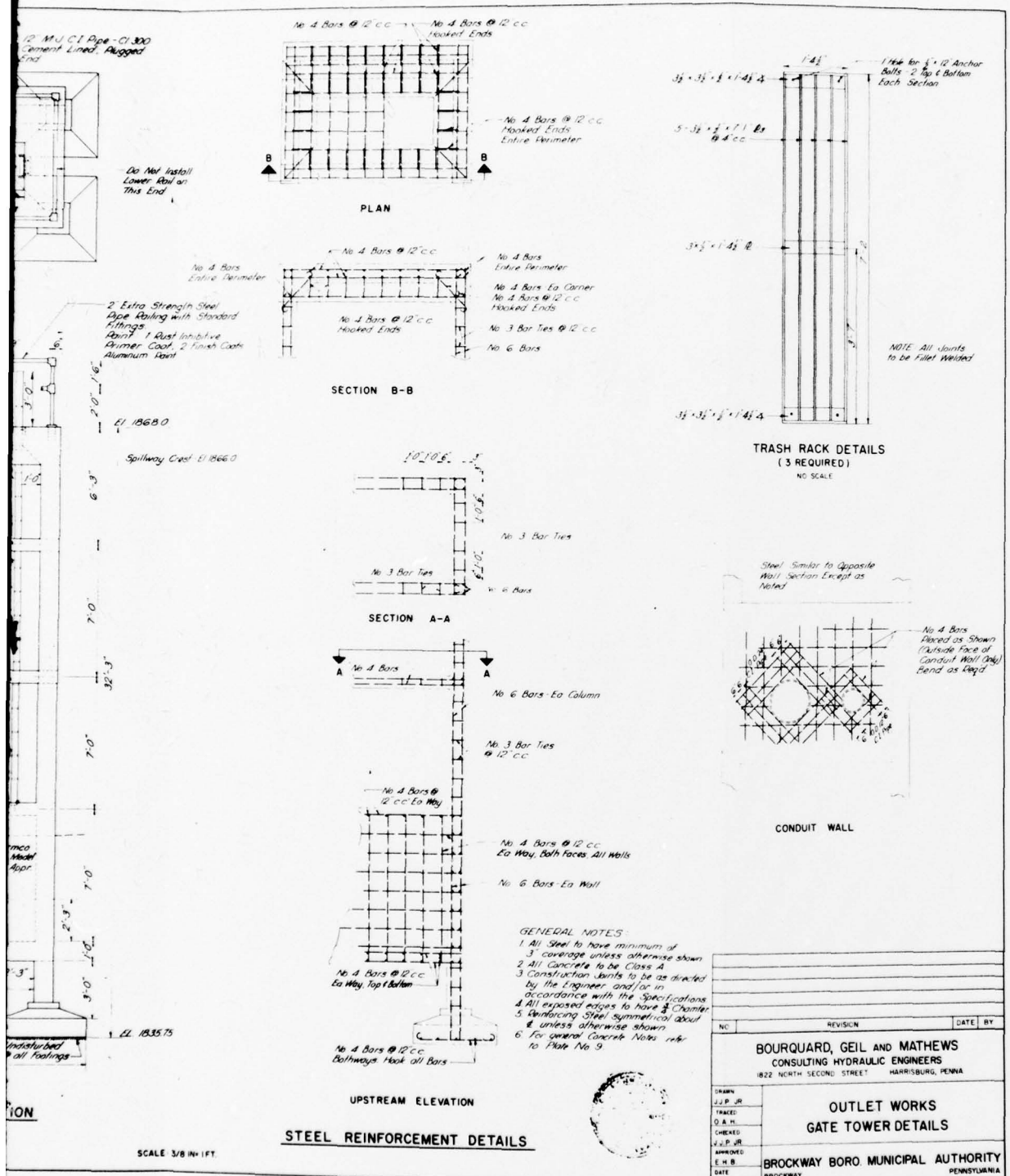
PLATE 9

2

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	7-24-79	DRAWING NUMBER	78-367-B188
	6-13-79	APPROVED BY	JHD	7/24/79		



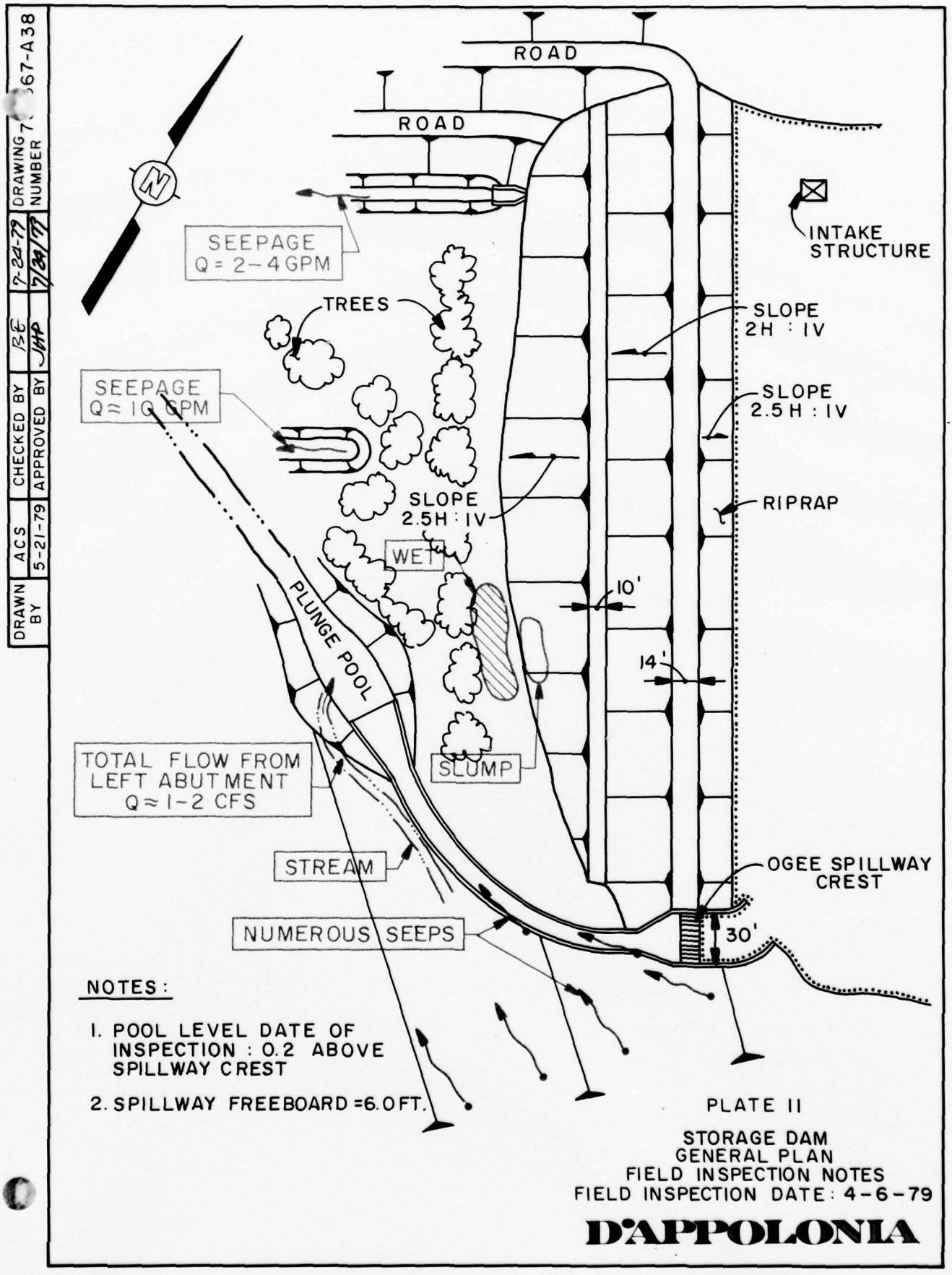


STEEL REINFORCEMENT DETAILS

PLATE 10

2

D'APPOLONIA



NOTES:

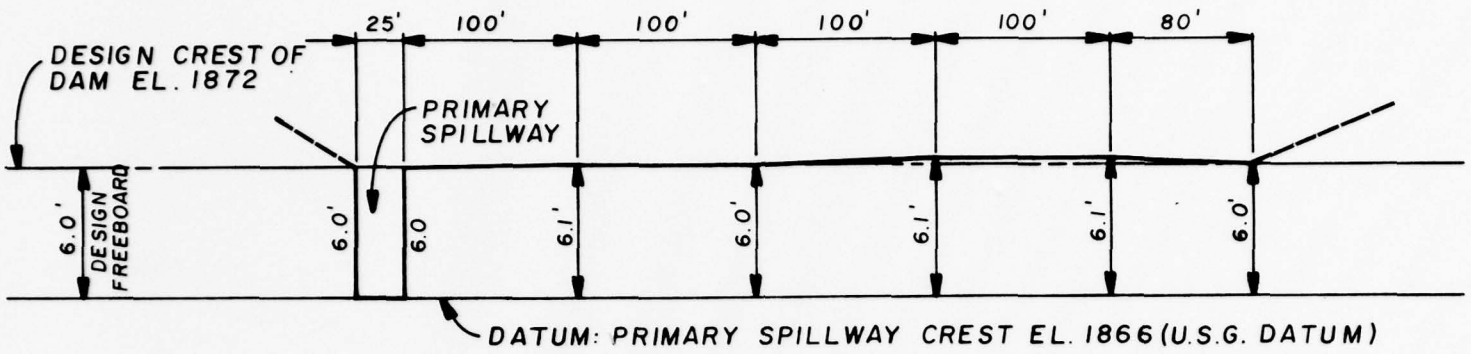
1. POOL LEVEL DATE OF INSPECTION : 0.2 ABOVE SPILLWAY CREST
2. SPILLWAY FREEBOARD = 6.0 FT.

PLATE II

STORAGE DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: 4-6-79

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	RE	7-24-79	DRAWING NUMBER 78-367-A47
	6-28-79	APPROVED BY	JHP	7/24/79	



DAM CREST PROFILE

(LOOKING UPSTREAM)

NOTE:

DAM CREST IS SURVEYED RELATIVE TO PRIMARY SPILLWAY CREST LEVEL

STORAGE DAM
DAM CREST SURVEY
FIELD INSPECTION DATE: APRIL 6, 1979

PLATE 12

D'APPOLONIA

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Storage Dam COUNTY Elk County STATE Pennsylvania ID# NDI I.D. PA-388 DER I.D. 24-47

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION April 6, 1979 WEATHER Sunny TEMPERATURE 40s

POOL ELEVATION AT TIME OF INSPECTION 1866.2 M.S.L. TAILWATER AT TIME OF INSPECTION 1830± M.S.L.

INSPECTION PERSONNEL:	REVIEW INSPECTION PERSONNEL: (May 25, 1979)
Bilgin Erel	L. D. Andersen
Wah-Tak Chan	J. H. Poellot
	B. Erel

Bilgin Erel RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	A small slump and associated wet area along the toe of the dam near the left abutment.	This condition should be investigated by a professional engineer.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	See Plate 12.	
RIPRAP FAILURES	None.	

VISUAL INSPECTION
PHASE I
EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	No signs of distress.	
ANY NOTICEABLE SEEPAGE	Numerous seeps on the left abutment. Estimated quantity, 1 to 2 cfs. Two other seeps, one located at the center of the embankment and the second near the right abutment, both below the toe of the dam. See Plate 11 for location.	
STAFF GAGE AND RECORDER	None.	
DRAINS	None.	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	The outlet conduit was not accessible for inspection. Only the downstream end was visible. No distress was observed.	
INTAKE STRUCTURE	Submerged.	
OUTLET STRUCTURE	In good condition.	
OUTLET CHANNEL	In good condition.	
EMERGENCY GATE	Water Authority personnel reported that the emergency gate, which is the only outlet facility for the reservoir, is annually operated. Operation of the gate was not observed.	Operational condition of the outlet pipe sluice gate should be evaluated and necessary maintenance performed if required.

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	In good condition. Some seepage was observed at the construction joints. The seepage is not structurally significant.	
APPROACH CHANNEL	Submerged. Appears to be free of debris.	
DISCHARGE CHANNEL	Rectangular concrete channel in good condition. Several 4-inch-diameter weepholes were found to be discharging half full.	
BRIDGE AND PIERS	None.	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	

VISUAL INSPECTION
PHASE I
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderately steep to steep. No signifcant shoreline erosion was noted.	
SEDIMENTATION	Unknown.	
UPSTREAM RESERVOIRS	None.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	No apparent obstructions immediately downstream from the dam that would affect the discharge capacity of the spillway or the outlet works.	
SLOPES	No apparent instability (immediately downstream from the dam).	
APPROXIMATE NUMBER OF HOMES AND POPULATION	There are approximately 10 homes within the potential flood plain approximately 1-1/2 miles downstream from the dam. Population: approximately 40.	

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
AND HYDROLOGIC AND HYDRAULIC
PHASE I

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Storage Dam
ID# NDI I.D. PA-388
DER I.D. 24-47

ITEM	REMARKS
AS-BUILT DRAWINGS	The design drawings are available in the state files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed by Bourquard, Geil, and Mathews, Consulting Engineers, of Harrisburg, Pennsylvania in 1957. The dam was constructed by River Valley Construction Company of Shawville, Pennsylvania, with completion in 1962.
TYPICAL SECTIONS OF DAM	See Plate 3.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plates 9 and 10.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not available.
DESIGN REPORTS	Not available.
GEOLOGY REPORTS	Not available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Hydraulics and dam stability calculations are available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	See Plate 5 for boring logs.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported.
BORROW SOURCES	Unknown.
MONITORING SYSTEMS	None.
MODIFICATIONS	None reported.
HIGH POOL RECORDS	Not recorded.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None reported.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported.
MAINTENANCE OPERATION RECORDS	Not recorded.
SPILLWAY PLAN SECTIONS DETAILS	See Plates 6, 7, and 8.
OPERATING EQUIPMENT PLANS AND DETAILS	See Plates 9 and 10.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 1.6 square miles (woodlands)

ELEVATION; TOP NORMAL POOL AND STORAGE CAPACITY: 1866 (35 acre-feet)

ELEVATION; TOP FLOOD CONTROL POOL AND STORAGE CAPACITY: 1872 (57 acre-feet)

ELEVATION; MAXIMUM DESIGN POOL: 1872

ELEVATION; TOP DAM: 1872 (as designed and as surveyed)

SPILLWAY:

a. Elevation 1866
b. Type Concrete ogee overflow section
c. Width 30 feet (perpendicular to flow)
d. Length Not applicable
e. Location Spillover Middle of embankment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 24-inch cast-iron pipe
b. Location Near right abutment
c. Entrance Inverts 1842
d. Exit Inverts 1836
e. Emergency Draindown Facilities 24-inch outlet pipe

HYDROMETEOROLOGICAL GAGES:

a. Type None
b. Location None
c. Records None

MAXIMUM NONDAMAGING DISCHARGE: 1720 cfs full capacity of spillway

APPENDIX C
PHOTOGRAPHS

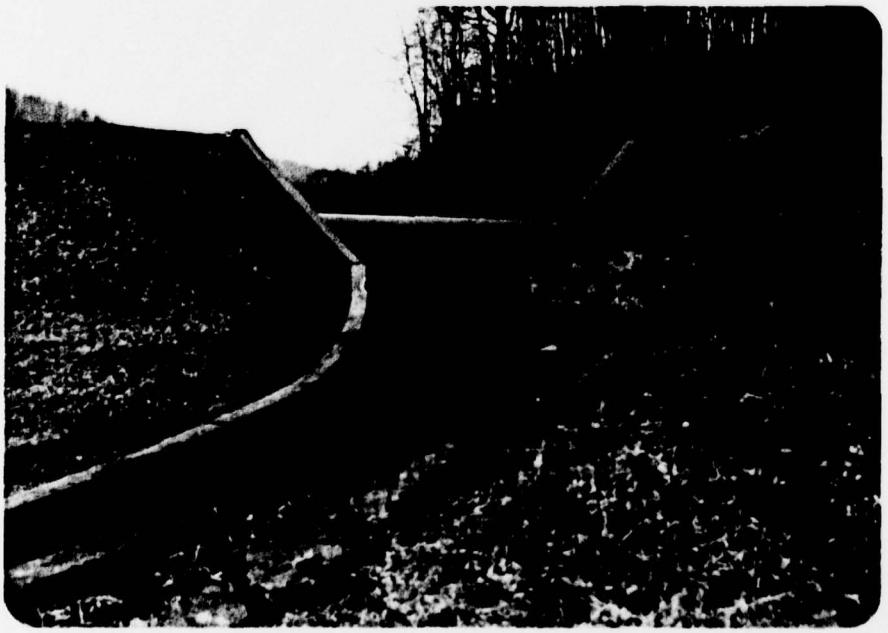
LIST OF PHOTOGRAPHS
STORAGE DAM
(BROCKWAY)
NDI I.D. NO. PA-388
APRIL 6, 1979

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking north). Spillway in foreground.
2	Spillway.
3	Spillway plunge pool.
4	Outlet works intake structure.
5	Outlet pipe discharge structure.
6	A seepage point about 200 feet downstream from the toe of the dam.
7	Numerous seepage points on left abutment. Note stream along the top of spillway wall.
8	Whetstone Branch of Little Toby's Creek. Approximately two miles downstream from dam.



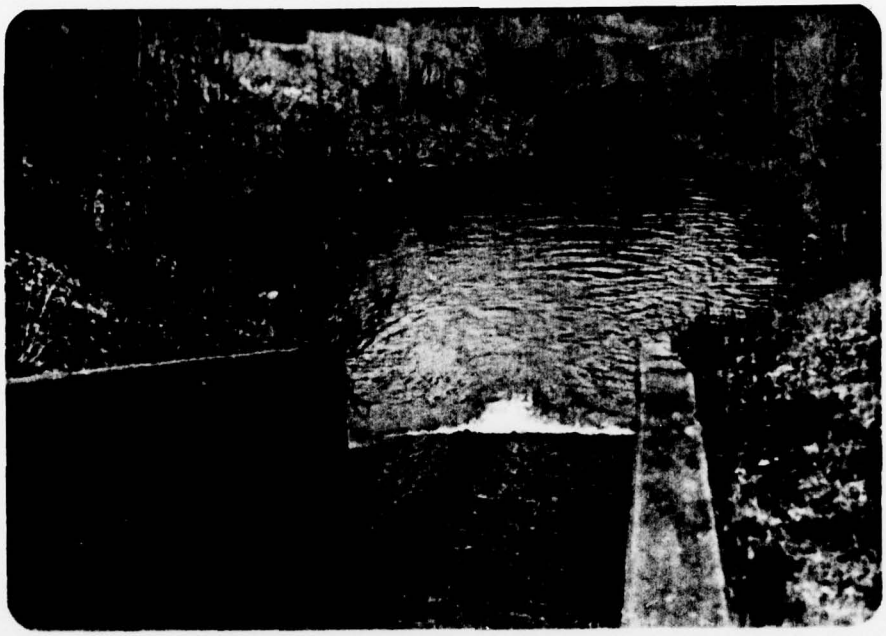
Photograph No. 1

Crest (looking north). Spillway in foreground.



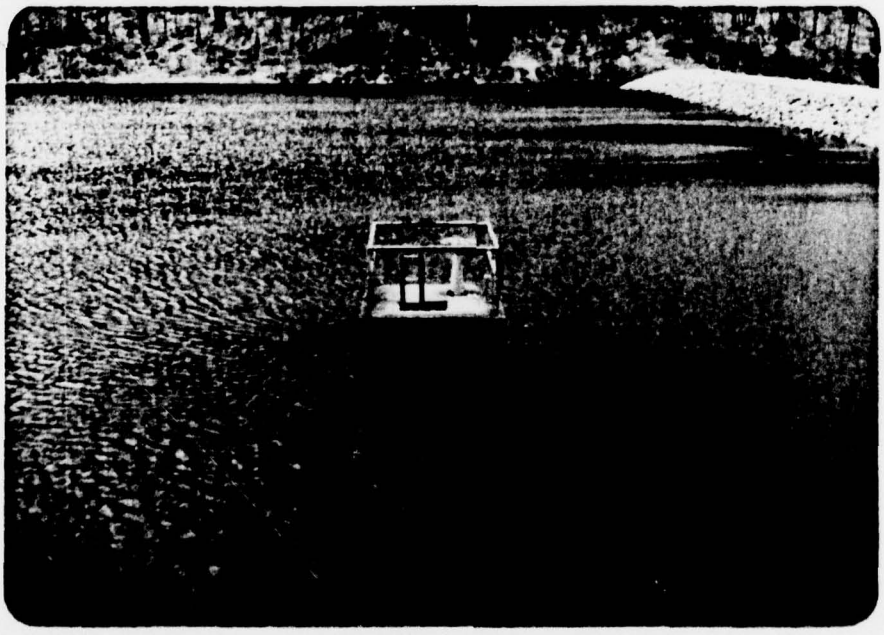
Photograph No. 2

Spillway.



Photograph No. 3

Spillway plunge pool.



Photograph No. 4

Outlet works intake structure.



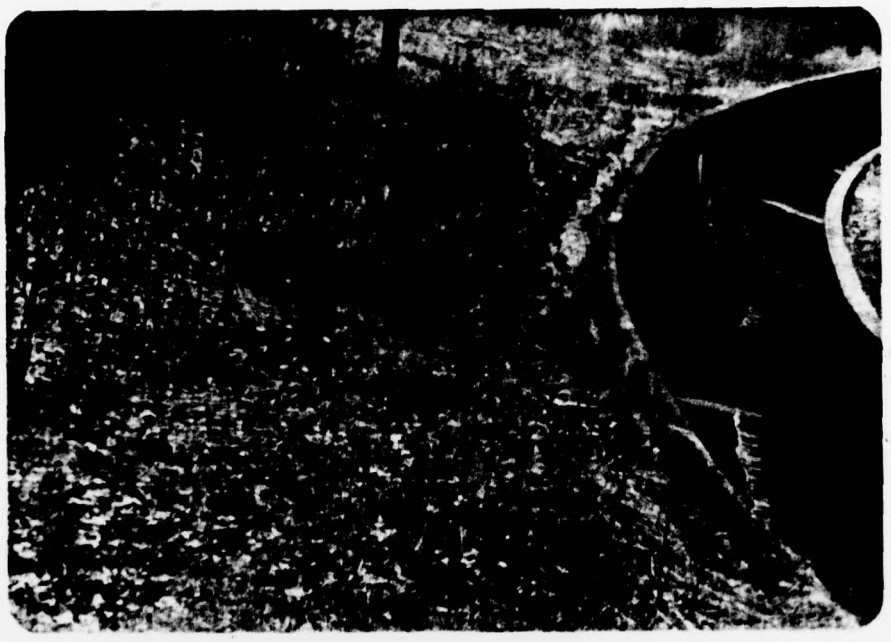
Photograph No. 5

Outlet pipe discharge structure.



Photograph No. 6

A seepage point about 200 feet downstream from the toe of the dam.



Photograph No. 7

Numerous seepage points on left abutment.
Note stream along the top of spillway wall.



Photograph No. 8

Whetstone Branch of Little Toby's Creek.
Approximately two miles downstream from dam.

APPENDIX D

CALCULATIONS

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Storage Dam (NDI I.D. PA-388)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.2 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Reservoir	Dam			
Drainage Area (square miles)	1.6	-			
Cumulative Drainage Area (square miles)	1.6	1.6			
Adjustment of PMF for Drainage Area (%)[2]					
6 Hours	117	-			
12 Hours	127	-			
24 Hours	141	-			
48 Hours	151	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone[3]	24	-			
C_p/C_t[4]	0.45/1.6	-			
L (miles)[5]	1.6	-			
L_{ca} (miles)[5]	0.7	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	1.7	-			
Spillway Data					
Crest Length (ft)	-	30			
Freeboard (ft)	-	6			
Discharge Coefficient	-	3.9			
Exponent	-	1.5			

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

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

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

[4] Snyder's Coefficients.

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

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1              A1      SNYDER UNIT HYDROGRAPH,FLOOD ROUTING AND DAM OVERTOPPING ANALYSES
    2              A2      BROCKWAY STORAGE DAM,ELK COUNTY,NDI-I.D.PA388        PROJECT NO.78-367-25
    3              A3      FOR 20%,30%,40%,50%,60%,70%,80%,90%,AND 100% PMF
    4              B    300       0      10       0       0       0       0       0      -4       0
    5              B1     5
    6              J      1       9       1
    7              J1  0.20    0.30    0.40    0.50    0.60    0.70    0.80    0.90    1.00
    8              K      0       1                                       1
    9              K1      CALCULATION OF SNYDER INFLOW HYDROGRAPH TO BROCKWAY STORAGE DAM
   10              M      1       1     1.7               1.7                             1
   11              P             23.2     117     127     141     151
   12              T                                                     1.0     .05             0.009
   13              W    1.7    0.45
   14              X   -1.0   -0.05     2.0
   15              K      1       2                                       1
   16              K1      ROUTING FLOW THROUGH BROCKWAY STORAGE DAM(NDI-I.D.PA388)
   17              Y                                       1       1
   18              Y1     1                                                107.4
   19              $S   0.0   107.4   147.3   174.9   285.5
   20              $E1838.0  1866.0  1870.0  1872.0  1880.0
   21              $$1866.0    30.0    3.90     1.5
   22              $D1872.0    3.08     1.5   450.0
   23              $L-175.0   275.0   450.0
   24              $V1872.0 1872.05 1872.10
   25              K     99
```

COMPUTER INPUT OVERTOPPING ANALYSIS

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

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1 .20	RATIO 2 .30	RATIO 3 .40	RATIO 4 .50	RATIO 5 .60	RATIO 6 .70	RATIO 7 .80	RATIO 8 .90	RATIO 9 1.00
HYDROGRAPH AT	1	1.70	1	823.	1234.	1645.	2057.	2468.	2879.	3291.	3702.	4113.
	(	4.40)	(	23.30)(	34.94)(	46.59)(	58.24)(	69.89)(	81.53)(	93.18)(	104.83)(	116.48)
ROUTED TO	2	1.70	1	797.	1187.	1587.	2046.	2461.	2871.	3282.	3692.	4102.
	(	4.40)	(	22.56)(	33.60)(	44.93)(	57.92)(	69.68)(	81.31)(	92.93)(	104.54)(	116.15)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1866.00	1866.00	1872.00
STORAGE	107.	107.	175.
OUTFLOW	0.	0.	1720.

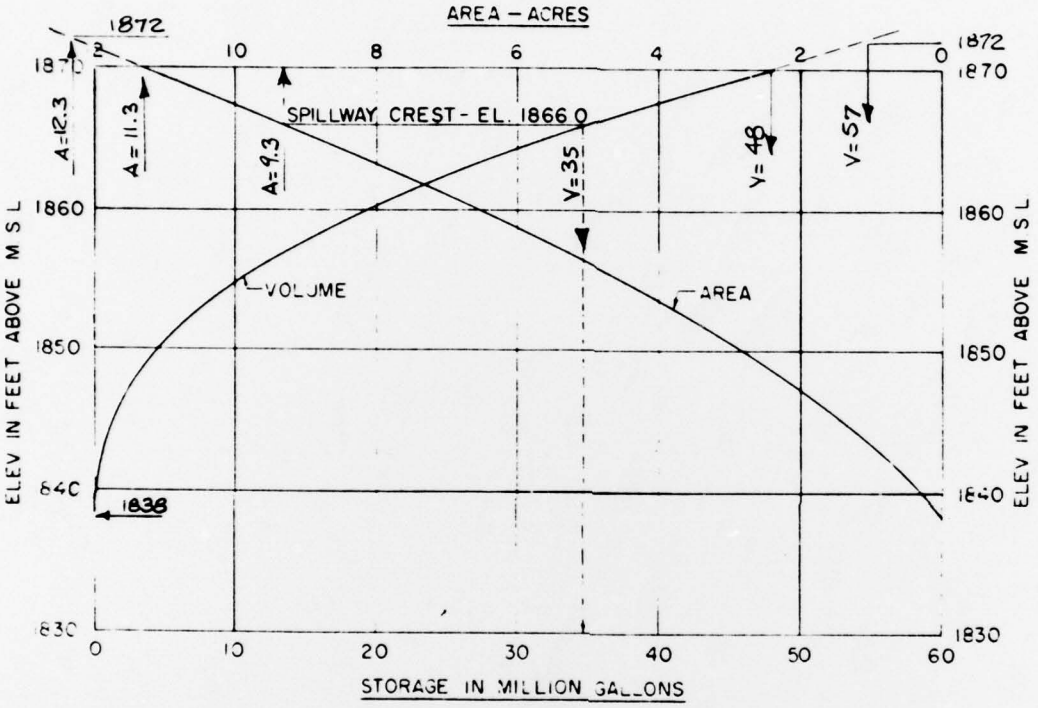
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	1869.59	0.00	143.	797.	0.00	41.83	0.00
.30	1870.69	0.00	157.	1187.	0.00	41.83	0.00
.40	1871.69	0.00	171.	1587.	0.00	41.83	0.00
.50	1872.39	.39	179.	2046.	2.00	41.50	0.00
.60	1872.54	.54	182.	2461.	3.17	41.50	0.00
.70	1872.74	.74	185.	2871.	4.00	41.50	0.00
.80	1872.92	.92	188.	3282.	4.50	41.50	0.00
.90	1873.08	1.08	190.	3692.	5.00	41.50	0.00
1.00	1873.23	1.23	192.	4102.	5.67	41.33	0.00

OVERTOPPING ANALYSIS SUMMARY

D'APPOLONIA
CONSULTING ENGINEERS, INC

By BE Date 8/7/79 Subject STORAGE DAM Sheet No. 1 of 1
Chkd. By SRP Date 8/7/79 STORAGE VS ELEVATION. Proj. No. 78-367-25

REF: DESIGN DRAWINGS (PLATE 2)



	ELEV.	AREA ACRES	VOLUME 10^6 GALLONS	VOLUME ACRE-FT
	1880	16.5 *	—	285.5 **
DAM CREST	1872	12.3	57	174.9
	1870	11.3	48	147.3
SPILLWAY	1866	9.3	35	107.4
	1838	0.0	0	0.0

* AREA FROM USGS

** $V = \frac{10}{3}\left(6.5 + 11.3 + \sqrt{11.3 \times 16.5}\right) + 147.3$ AC-FT = 285.5 AC-FT

(1 x 10^6 GAL = 3.07 ACRE-FT)

APPENDIX E

REGIONAL GEOLOGY

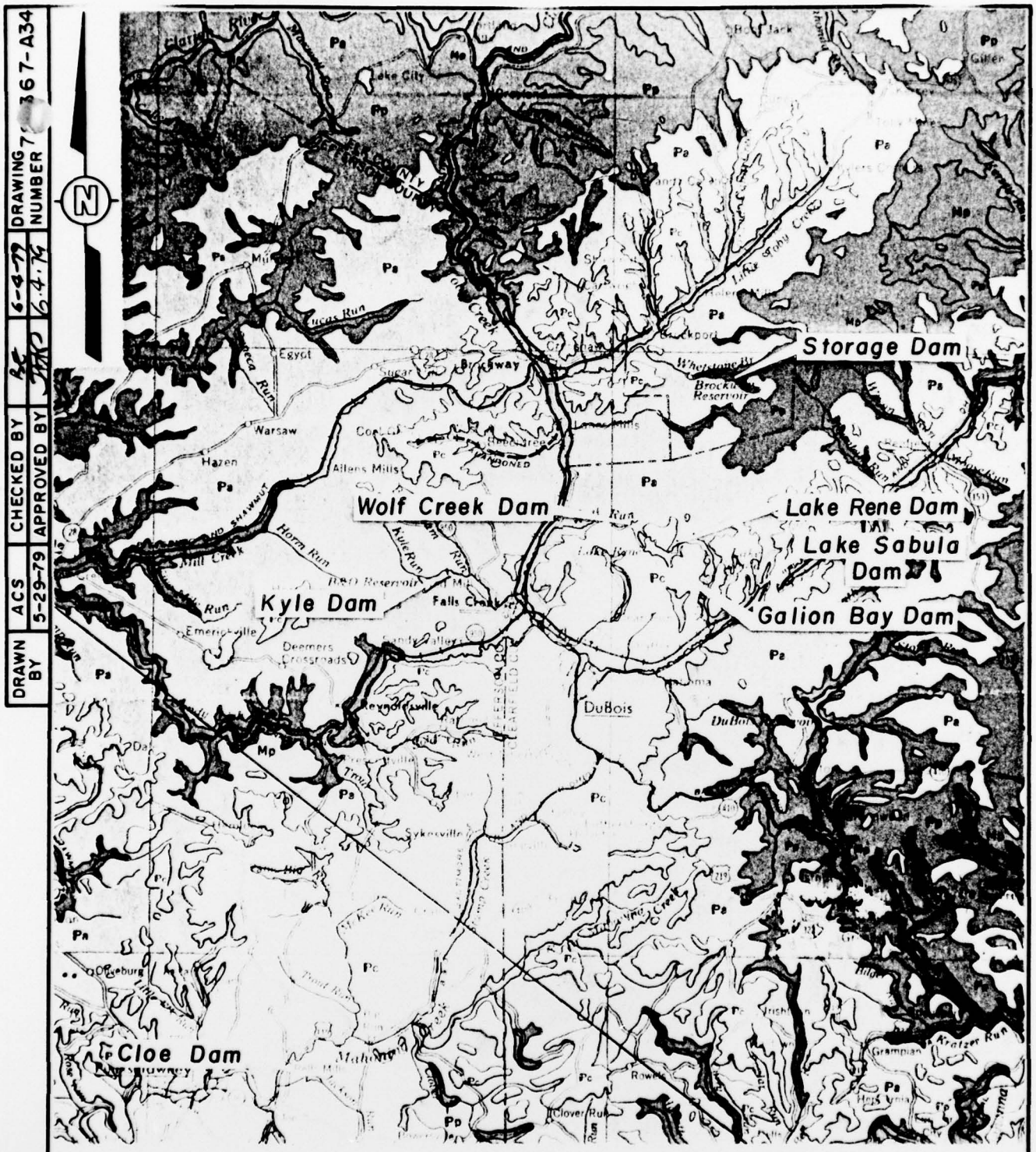
APPENDIX E
REGIONAL GEOLOGY

Storage Dam is located on strata of the Pocono Formation of Mississippian Age. The site lies just north of the northeast trending Boone Mountain Anticline. Strata near the site dip gently to the northwest at about 200 feet per mile.

The Pocono Formation consists primarily of gray massive conglomerates and sandstones with some shales. Some of the shales are suitable for industrial uses.

The major coal seams in the area, the Upper and Lower Freeport and the Kittanning coals, lie above the site stratigraphically. Also, no coals occur within the Pocono Formation. Therefore, undermining of the site is not considered to be a potential problem.

One major fault exists in the area and is located approximately two miles southeast of the site. The fault is known as the Mountain Run Fault and trends to the northeast along the southeastern flank of the Boone Mountain Anticline. Maximum vertical displacement along the fault is estimated to be 400 feet. The fault is not reported to be seismically active.



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	5-29-79	APPROVED BY		6.4.79	

SCALE

0 2 4 6 8 10 miles

STORAGE, WOLF CREEK, KYLE, LAKE RENE, LAKE SABULA, GALION BAY AND CLOE DAM

GEOLOGY MAP

REFERENCE:

GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA., DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

DAPPOLONIA

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER 78-67-A35
	6-1-79	APPROVED BY		

PENNSYLVANIAN

APPALACHIAN PLATEAU

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

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

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

Pp — **Pottsville Group**
Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.

ANTHRACITE REGION

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

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

MISSISSIPPIAN

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

Pocono Group
Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau Burgoon, Shenango, Cuyahoga, Cussewago, Corry, and Knapp Formations; includes part of "Oswayo" of M. L. Fuller in Potter and Tioga counties.

GEOLOGY MAP LEGEND

REFERENCE:
GEOLOGIC MAP OF PENNSYLVANIA PREPARED BY COMMONWEALTH OF PENNA. DEPT. OF INTERNAL AFFAIRS, DATED 1960, SCALE 1" = 4 MILES

D'APPOLONIA