SUSQUEHANNA RIVER BASIN
UNAMED TRIBUTARY OF JUNIATA RIVER, HUNTINGDON COUNTY,
PENNSYLVANIA.

National Dam Inspection Program.

HUNTINGDON SMITHFIELD DAM

NDI I.D. PA-00511
DER I.D. 31-81

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

(11) 1980
(15) DACW31-80-C-0022

(12) 63

(10) Lawrence D. Andersen

PREPARED FOR

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

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BY

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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 investigations 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.

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Huntingdon-Smithfield Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Huntingdon
STREAM: Lily Creek, a Tributary of the Juniata River
SIZE CLASSIFICATION: Intermediate
HAZARD CLASSIFICATION: High
OWNER: Smithfield Township Supervisors
DATE OF INSPECTION: April 29, 1980 and April 30, 1980

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

According to the recommended criteria, intermediate dams in the high hazard category are required to pass the full probable maximum flood (PMF) without overtopping the embankment. The flood discharge capacity was evaluated according to the recommended criteria and was found to pass full PMF without overtopping the embankment. Therefore, the spillway capacity is rated to be adequate.

The following recommendations should be implemented on a continuing basis.

1. 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.

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

Lawrence D. Andersen, P.E.
Vice President

July 30, 1980
Date

Approved by:

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date 27 Aug 1980

HUNTINGDON/SMITHFIELD DAM
NDI I.D. PA-511
DER I.D. 33-81
APRIL 29, 1980

Overview
(Upstream Face)

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
HUNTINGDON-SMITHFIELD DAM
NDI I.D. PA-511
DER I.D. 33-81

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. Huntingdon-Smithfield Dam is a part of the Huntingdon-Smithfield Flood Control Project. The dam consists of an earth embankment approximately 740 feet long with a maximum height of 37 feet from the downstream toe and a crest width of 15 feet. The dam is a flood control project and does not impound a reservoir under normal operating conditions. Both the upstream and downstream slopes of the dam are covered with grass and are 2H to 1V for the top 16 feet of the embankment and 3H to 1V below that elevation.

The flood discharge facilities of the dam consist of a low-level, uncontrolled outlet pipe which maintains normal flow in Lily Creek and an emergency spillway on the left abutment (looking downstream). The outlet works consist of a 24-inch reinforced concrete pipe equipped with intake and outlet structures. The inlet structure is a reinforced concrete trough which supports a trash rack. The outlet structure is a reinforced concrete impact basin energy dissipating structure. The outlet pipe is supported on a concrete cradle equipped with antiseepage collars spaced at 15-foot intervals along the upstream two-thirds of the pipe. The emergency spillway is a grass-lined trapezoidal channel with a base width of 60 feet. A 10-foot-wide, 4-foot-deep concrete slab extending across the emergency spillway channel constitutes the overflow section.

b. Location. Huntingdon-Smithfield Dam is located across Lily Creek approximately 3000 feet upstream from its confluence with the

Juniata River in Smithfield Township, Huntingdon County, Pennsylvania. Plate 1 illustrates the location of the dam.

c. Size Classification. Intermediate (based on 37-foot height and 1473 acre-feet maximum storage capacity).

d. Hazard Classification. The dam is classified to be in the high hazard category. Below the dam, Lily Creek flows under Route 22 approximately 1000 feet downstream from the dam and shortly thereafter discharges into a storm sewer system. Urban residential areas of Smithfield are located downstream of the Route 22 underpass. It is estimated that failure of the dam under maximum pool level would cause large loss of life and property damage in the downstream residential areas.

e. Ownership. Smithfield Township (address: Mr. Wayne W. Mateer, Secretary, Municipal Building, Mount Vernon Avenue and 13th Street, Huntingdon, Pennsylvania 16652).

f. Purpose of Dam. Flood control.

g. Design and Construction History. The dam was designed by the Commonwealth of Pennsylvania, Department of Forests and Waters, Division of Flood Control, in 1965 and was constructed by Gateway Equipment and Supply Company of Monroeville, Pennsylvania, with completion in 1967.

h. Normal Operating Procedure. Under normal flow conditions, the dam impounds no reservoir and normal flow of Lily Creek is maintained by discharge through the uncontrolled, low-level outlet works.

1.3 Pertinent Data. Elevations referred to in this and subsequent sections of the report were based on elevations shown on the design drawings.

a. Drainage Area	1.82 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	2269
Total spillway capacity at maximum pool	2329
c. Elevation (USGS Datum) (feet)	
Top of dam	666 (as designed); 665.8 (measured low spot)

Maximum pool	665.8
Normal pool	Not applicable
Upstream invert outlet works	630.5
Downstream invert outlet works	629.00
Maximum tailwater	Unknown
Toe of Dam	629±

d. Reservoir Length (feet)

Normal pool level	0
Maximum pool level	1300±

e. Storage (acre-feet)

Normal pool level	0
Maximum pool level	1473±

f. Reservoir Surface (acres)

Normal pool level	0
Maximum pool level	85±

g. Dam

Type	Earth
Length	740 feet
Height	37 feet
Top width	15 feet
Side slopes	2H:1V (top 16 feet of the dam); 3H:1V (the remaining portions of both upstream and downstream faces)
Zoning	No
Impervious core	No
Cutoff	No
Grout Curtain	No

h. Regulating Outlet

Type	24-inch reinforced concrete pipe
Length	170± feet
Closure	Not applicable (the pipe is unregulated)

Access	From upstream and downstream ends
Regulating facilities	None

i. Spillway (Emergency)

Type	Open channel
Length	60 feet (perpendicular to flow)
Crest elevation	660
Upstream channel	Trapezoidal earth approach channel
Downstream channel	Trapezoidal earth channel

SECTION 2
DESIGN DATA

2.1 Design

a. Data Available. The available data consist of files provided by the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), which contain design drawings, engineer's reports, construction progress reports, and correspondence.

(1) Hydrology and Hydraulics. The available information consists of design discharge capacity of the outlet pipe and the emergency spillway and the flood storage capacity of the dam.

(2) Embankment. The available information includes design drawings, engineer's report of the subsurface investigation, materials testing, and stability analysis.

(3) Appurtenant Structures. The available information consists of design drawings and design capacity of the outlet pipe.

b. Design Features

(1) Embankment. Plate 2 illustrates the plan of the embankment and the appurtenant structures. As shown in Plate 3, the dam consists of a homogeneous earth embankment with a drainage blanket located beneath the downstream slope. The details of the drainage blanket are shown in Plate 3. It consists of a 3-foot-thick blanket extending to the top of rock through a trench located at the upstream end of the blanket. Another feature of the embankment is a drainage ditch along the downstream toe of the dam protected by riprap placed on a 6-inch filter blanket. The available information indicates that because the dam was not intended to impound a pool under normal operating conditions, construction of a cutoff trench beneath the impervious section of the dam was not considered to be necessary. The embankment material was noted to be compacted clay and shale.

(2) Appurtenant Structures. The appurtenant structures consist of an uncontrolled outlet pipe and an emergency spillway located on the left abutment. Plate 4 shows the details of the outlet pipe. The pipe is supported on a concrete cradle and is equipped with antiseepage collars over the upstream two-thirds of the pipe. The outlet pipe is equipped with intake and outlet structures. The intake structure is a concrete structure supporting a trash rack and the outlet structure is an impact basin energy dissipating structure. Plate 5 shows the plan and the details of the emergency spillway. The emergency spillway is a trapezoidal earth channel 60 feet wide at its base with 2H to 1V side slopes.

A reinforced concrete slab type structure constitutes the overflow section of the spillway. The crest of the spillway is located at Elevation 660, providing 6 feet of freeboard to the top of the dam. The embankment side of the spillway discharge channel is provided with a reinforced concrete retaining structure for erosion protection.

c. Design Data

(1) Hydrology and Hydraulics. The dam was designed to impound 10.9 inches of runoff (100-year flood runoff is noted to be 5.5 inches) without activating the emergency spillway and to pass a flood from a maximum probable precipitation of 26 inches in 6 hours.

(2) Embankment. The dam was designed by the Commonwealth of Pennsylvania, Department of Forests and Water, Division of Flood Control, based on the evaluation of a subsurface investigation, laboratory testing, and engineering analysis. The stability of the embankment was analyzed for steady-state seepage at maximum pool and rapid drawdown conditions following saturation of the embankment for a period of 10 days at maximum pool level. The minimum factor of safety is reported to be 1.3 for the upstream slope under rapid drawdown conditions. The factor of safety for steady-state seepage was reported to be 1.6.

(3) Appurtenant Structures. The available information indicates that the outlet pipe was designed for a discharge of 55 cfs under maximum pool conditions.

2.2 Construction. Available records indicate that the dam was constructed in accordance with Commonwealth specifications. No reference was found to indicate that any unusual construction problems were encountered.

2.3 Operation. There are no formal operating records maintained for the dam. According to the dam tender, maximum pool level in the past was no more than 10 feet above the upstream invert of the outlet pipe.

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 hydrologic and hydraulic design of the flood discharge facilities of the dam was found to be in conformance with current spillway design criteria.

(2) Embankment. The design and construction of the embankment are considered to be in conformance with currently accepted engineering practices.

(3) Appurtenant Structures. The structural and hydraulic design of the appurtenant structures is considered to be in conformance with currently accepted engineering practices.

SECTION 3
VISUAL INSPECTION

3.1 Findings

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

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

2. Visual examination of the outlet pipe and spillway structures.

3. Evaluation of downstream area hazard potential.

The specific observations are illustrated in Plate 6.

b. Embankment. The general inspection of the embankment consisted of searching for indications of structural distress, such as cracks and subsidence, 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 crest of the dam was surveyed relative to the emergency spillway crest elevation and it was found to be generally at the design crest elevation. The dam crest profile is illustrated in Plate 7. The downstream and upstream slopes were surveyed and found to be reasonably within the design slopes of 2H to 1V on the upper half of the embankment and 3H to 1V on the lower half of the embankment.

c. Appurtenant Structures. The spillway structures were examined for deterioration and other signs of distress and obstructions that would limit flow. The structures were found to be in good condition and adequately maintained.

d. Reservoir Area. A map review and visual observations indicate that the watershed is predominantly covered by pasturelands. No signs of landslide activity in the vicinity of the dam were found. A review of the regional geology is included in Appendix F.

e. Downstream Channel. A description of the downstream channel is included in Section 1.2d.

3.2 Evaluation. The dam was found to be in good condition and adequately maintained.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedure. There are no formal operating procedures for the dam. The dam is maintained by Smithfield Township personnel, with maintenance operations including periodic mowing of the grass and clearing debris from the outlet pipe intake structure. Under normal operating conditions, the dam impounds no reservoir and the base flow of Lily Creek is maintained by discharge through the outlet pipe.

4.2 Maintenance of the Dam. The upstream and downstream slopes of the dam are covered with grass and appear to be periodically mowed. The maintenance of the dam is considered to be good.

4.3 Maintenance of Operating Facilities. The dam has no operable facilities.

4.4 Warning System. No formal warning system exists for the dam. Telephone communication facilities are available via commercial establishments and residences in the vicinity of the dam.

4.5 Evaluation. The maintenance condition of the dam is considered to be good.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features

a. Design Data. Huntingdon-Smithifield Dam is a flood control project with a watershed of 1.8 square miles and impounds no reservoir under normal operating conditions. As previously noted, the flood discharge facilities for the dam were designed to pass a flood from probable maximum precipitation of 26 inches in 6 hours without overtopping the embankment. The design discharge capacity of the emergency spillway was noted to be 2410 cubic feet per second (cfs). Based on the available freeboard relative to the low spot on the embankment, the current spillway discharge capacity was calculated to be 2269 cfs, as indicated in the computer output in Appendix D.

b. Experience Data. Huntingdon-Smithfield Dam is classified as an intermediate dam in the high hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass full PMF. Although the emergency spillway capacity was considered to be adequate based on the review of the design information, a further analysis was conducted to confirm this finding.

The PMF inflow hydrograph for the reservoir was determined utilizing 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 50 percent and full PMF hydrographs were found to have peak flows of 2090 and 4180 cfs, respectively. Computer input and summary of computer output for the PMF analysis are included in Appendix D.

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

d. Overtopping Potential. The results of the computer analysis indicate that the dam can pass the PMF without overtopping the embankment.

e. Spillway Adequacy. Since the spillway can pass the recommended spillway design flood of 100 percent of the PMF without overtopping the embankment, the spillway capacity is rated to be adequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

(1) Embankment. As discussed in Section 3, the field observations did not reveal any signs of distress at this time that would significantly affect the stability of the dam.

(2) Appurtenant Structures. The structural performance of the appurtenant structures is considered to be satisfactory.

b. Design and Construction Data

(1) Embankment. The review of the available information indicates that the design of the dam was based on the evaluation of the subsurface conditions, laboratory testing, and engineering analysis. The stability of the dam under steady-state seepage and rapid drawdown conditions following saturation of the embankment for a period of 10 days at maximum pool level was considered. All calculated factors of safety were reported to exceed 1.3. Based on the review of the available design information and on field observations, the static stability of the dam is considered to be adequate.

(2) Appurtenant Structures. Review of the design information indicates that the appurtenant structures were designed in conformance with currently accepted engineering practices.

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 as a result of earthquakes.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Assessment. The visual observations indicate that Huntingdon-Smithfield Dam is in good condition. At this time, no conditions were observed that would significantly affect the overall performance of the structure.

The spillway capacity of full PMF was found to be in conformance with the recommended criteria, and therefore the spillway capacity is classified as adequate.

b. Adequacy of Information. Available information, in conjunction with visual observations, is considered to be sufficient to make a reasonable assessment of the condition of the dam.

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

d. Necessity for Additional Data. No additional data are required.

7.2 Recommendations/Remedial Measures. It is recommended that the following recommendations be implemented on a continuing basis:

1. 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.

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

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

APPENDIX A

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Huntingdon-Smithfield Dam COUNTY Huntingdon STATE Pennsylvania ID# NDI I.D. PA-511 DER I.D. 33-81

TYPE OF DAM Earth HAZARD CATEGORY High

DATE(S) INSPECTION April 29, 1980 WEATHER Sunny TEMPERATURE 60s

POOL ELEVATION AT TIME OF INSPECTION Not Applicable(1) M.S.L. TAILWATER AT TIME OF INSPECTION 630± M.S.L.

INSPECTION PERSONNEL:

B. Erel

W. T. Chan

REVIEW INSPECTION PERSONNEL:
(April 30, 1980)

E. D'Appolonia

L. D. Andersen

J. H. Poellot

B. Erel

OWNER'S REPRESENTATIVE:

Mr. Leo Morningstar
(Township Foreman)

B. Erel RECORDER

(1) The dam impounds no reservoir under normal operating conditions.

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	None	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	See Plate 7 for the longitudinal dam crest profile.	
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	None	
STAFF GAGE AND RECORDER	A staff gauge is located on the upstream side along the right abutment-embankment interface.	
DRAINS	None	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Because of flow in the outlet pipe, the outlet pipe could not be inspected.	
INTAKE STRUCTURE	In good condition.	
OUTLET STRUCTURE	In good condition.	
OUTLET CHANNEL	Earth channel. In good condition. A minor blockage by debris exists approximately 200 feet downstream from the dam.	
EMERGENCY GATE	The dam has no emergency gate.	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	In good condition.	
APPROACH CHANNEL	Trapezoidal earth channel. In good condition.	
DISCHARGE CHANNEL	Trapezoidal earth channel. In good condition.	
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	Gentle to moderately steep.	
SEDIMENTATION		
UPSTREAM RESERVOIRS	None	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	There are no obstructions that would affect the discharge capacity of the outlet pi	
SLOPES	No features pertinent to the safety of the dam.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Residential areas of Smithfield are located downstream from the dam. Population: 50 to 100.	

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 Huntingdon-Smithfield

ID# NDI I.D. PA-511
DER I.D. 33-81

ITEM	REMARKS
AS-BUILT DRAWINGS	Available in Commonwealth files.
REGIONAL VICINITY MAP	See Plate 1.
CONSTRUCTION HISTORY	The dam was designed by the Commonwealth of Pennsylvania, Department of Forests and Waters, Flood Control Division, in 1965 with completion in 1967.
TYPICAL SECTIONS OF DAM	See Plate 3.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS	See Plate 4.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	Not maintained
DESIGN REPORTS	Available in Commonwealth files.
GEOLOGY REPORTS	Available in Commonwealth files.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Available in Commonwealth files.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Available in Commonwealth files.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	None reported
BORROW SOURCES	Lake area
MONITORING SYSTEMS	None
MODIFICATIONS	Not reported
HIGH POOL RECORDS	According to the dam tender, the maximum pool in the past was within 10 feet of the upstream invert elevation of the outlet pipe.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	None reported
MAINTENANCE OPERATION RECORDS	Not maintained
SPILLWAY PLAN SECTIONS DETAILS	See Plate 5.
OPERATING EQUIPMENT PLANS AND DETAILS	The dam has no operable equipment.

CHECKLIST
ENGINEERING DATA
HYDROLOGIC AND HYDRAULIC

DRAINAGE AREA CHARACTERISTICS: 1.82 square miles (wood and pasturelands)

ELEVATION, TOP OF NORMAL POOL AND STORAGE CAPACITY: Not applicable(1)

ELEVATION, TOP OF FLOOD CONTROL POOL AND STORAGE CAPACITY: 666 (1473 acre-feet)

ELEVATION, MAXIMUM DESIGN POOL: 666

ELEVATION, TOP OF DAM: 665.8 (measured low spot); 666 (as designed)

SPILLWAY: (EMERGENCY)

a. Elevation 660

b. Type Earth open channel

c. Width 60 feet (perpendicular to flow)

d. Length Not applicable

e. Location Spillover Low spot on dam crest

f. Number and Type of Gates None

OUTLET WORKS:

a. Type 24-inch reinforced concrete pipe

b. Location Center of embankment

c. Entrance Inverts 630

d. Exit Inverts 629

e. Emergency Drawdown Facilities 24-inch outlet pipe

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

MAXIMUM NONDAMAGING DISCHARGE: Probable maximum flood

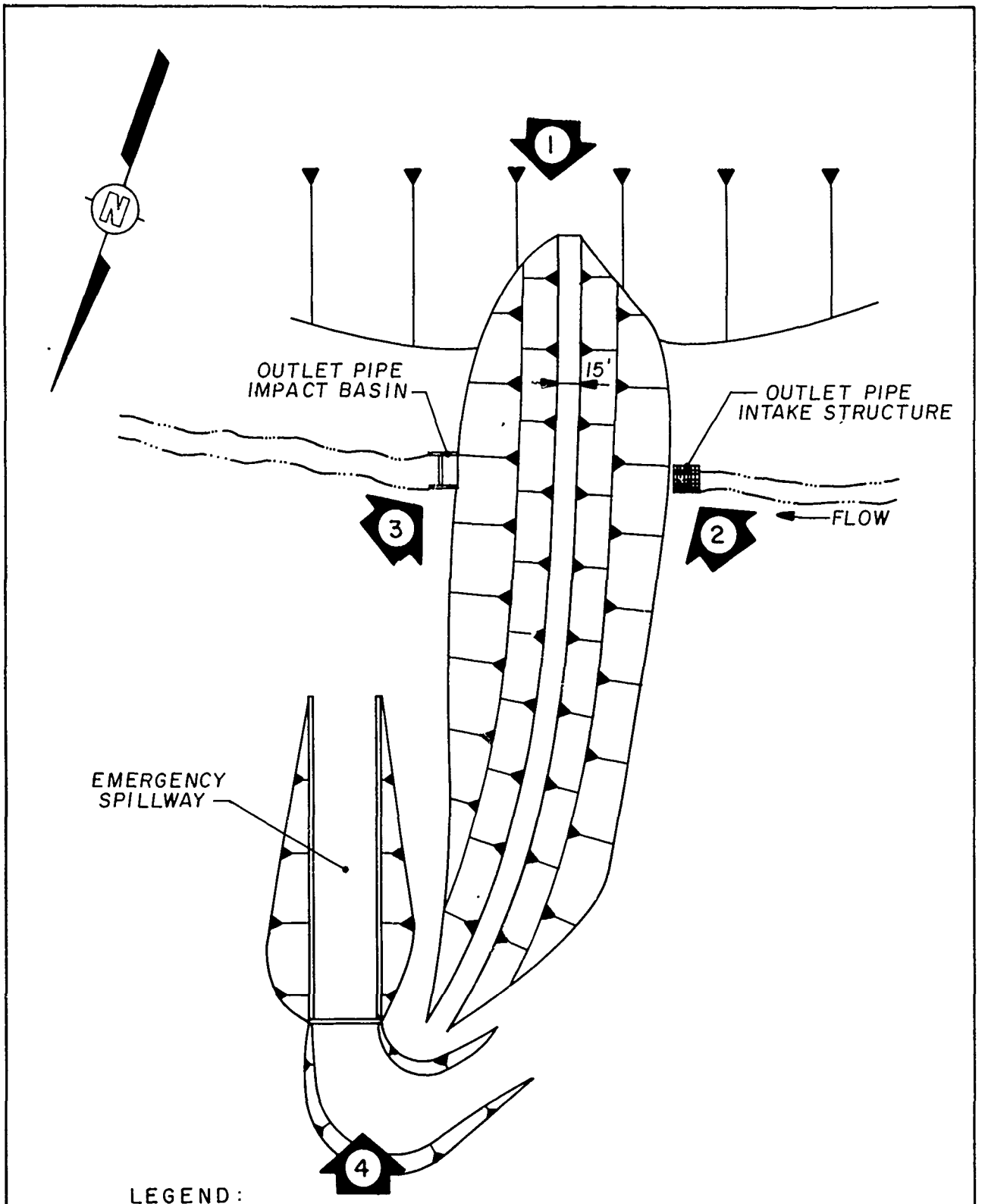
(1) The dam impounds no reservoir under normal operating conditions.

APPENDIX C

PHOTOGRAPHS

LIST OF PHOTOGRAPHS
HUNTINGDON/SMITHFIELD DAM
NDI I.D. PA-511
DER I.D. 33-81
APRIL 29, 1980

PHOTOGRAPH NO.	DESCRIPTION
1	Crest (looking north). Note: righthand side downstream.
2	Outlet pipe intake structure (upstream end of outlet pipe).
3	Outlet pipe discharge structure.
4	Emergency spillway control section and discharge channel (embankment in background).

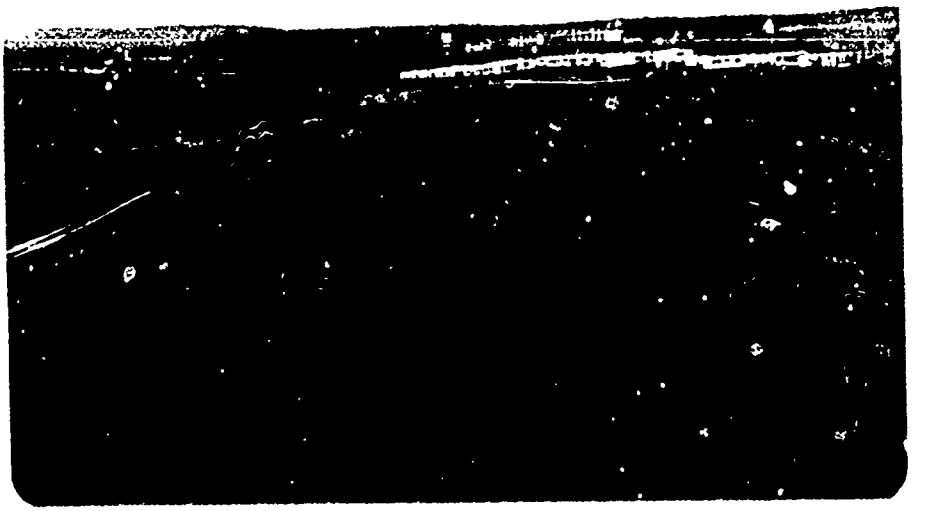


LEGEND:

2 INDICATES DIRECTION IN WHICH PHOTOGRAPH WAS TAKEN

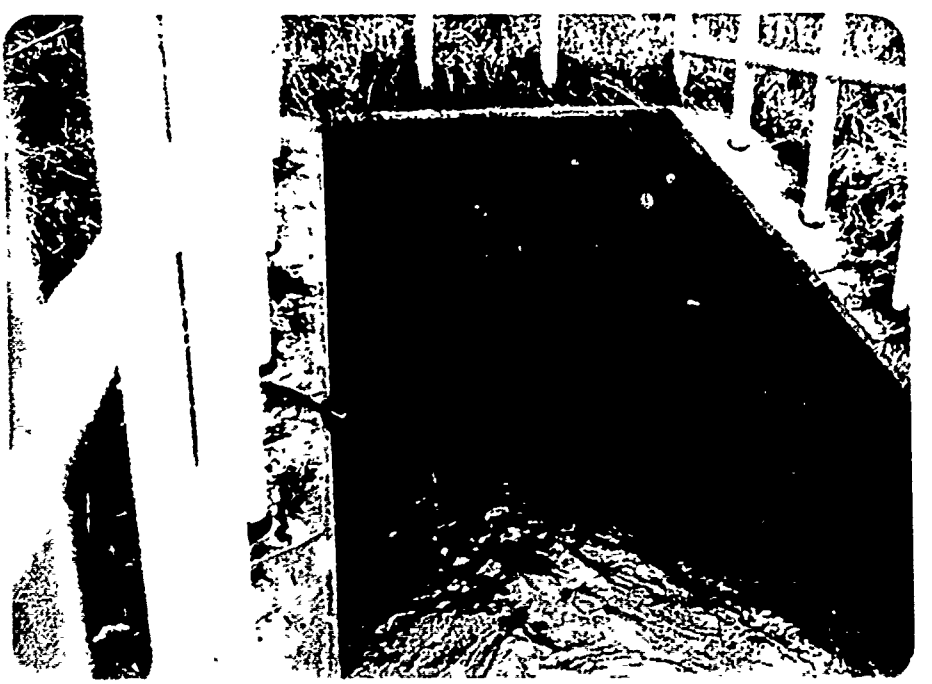
HUNTINGDON SMITHFIELD DAM
KEY PLAN OF PHOTOGRAPHS
FIELD INSPECTION DATE: APR. 29, 1980

D'APPOLONIA



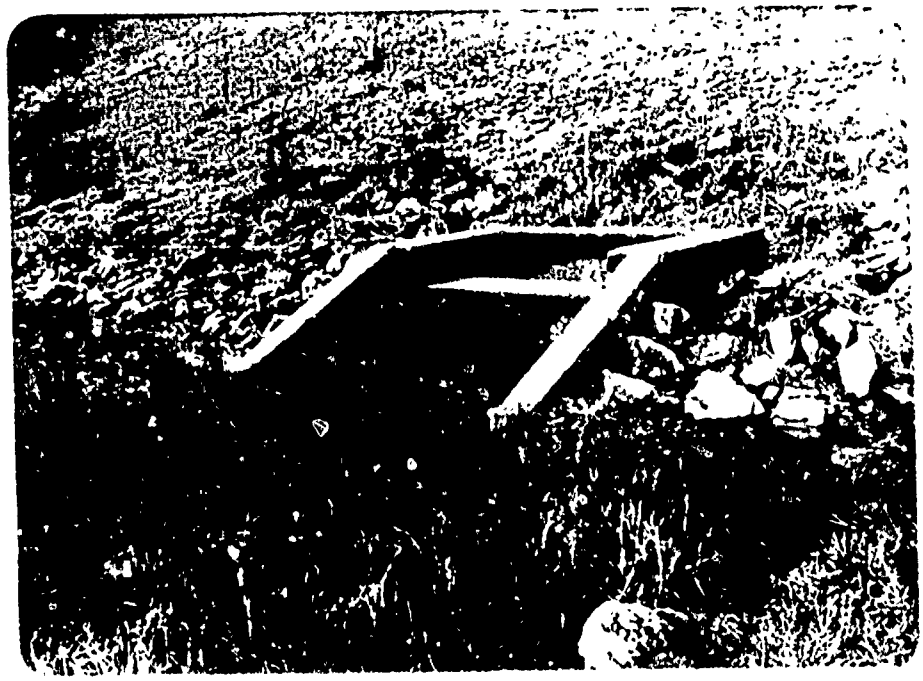
Photograph No. 1

Crest (looking north). Note: righthand side downstream.



Photograph No. 2

Outlet pipe intake structure (upstream end of outlet pipe).



Photograph No. 3

Outlet pipe discharge structure.

Photograph No. 4

Emergency spillway constrol section and discharge channel (embankment in background).

APPENDIX D

HYDROLOGY AND HYDRAULICS ANALYSES

HYDROLOGY AND HYDRAULIC ANALYSIS
DATA BASE

NAME OF DAM: Huntingdon-Smithfield Dam (NDI I.D. PA-511)

PROBABLE MAXIMUM PRECIPITATION (PMP) = 23.5 INCHES/24 HOURS[1]

STATION	1	2	3	4	5
Station Description	Lake	Dam			
Drainage Area (square miles)	1.8	-			
Cumulative Drainage Area (square miles)	1.8	1.8			
Adjustment of PMF for Drainage Area (%)[2]	(ZONE 7)				
6 Hours	102	-			
12 Hours	120	-			
24 Hours	130	-			
48 Hours	140	-			
72 Hours	-	-			
Snyder Hydrograph Parameters					
Zone[3]	21	-			
C_p/C_t[4]	0.55/1.50	-			
L (miles)[5]	2.2	-			
L_{ca} (miles)[5]	1.1	-			
$t_p = C_t(L \cdot L_{ca})^{0.3}$ (hours)	1.9	-			
Spillway Data		Primary / Emergency			
Crest Length (ft)	-	2'ϕ / 60			
Freeboard (ft)	-	35.3 / 5.8			
Discharge Coefficient	-	0.6 / 2.6			
Exponent	-	0.5 / 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.

STORAGE VS. ELEVATION

ELEVATION	ΔH, FEET	AREA (ACRES)[1]	ΔVOLUME (ACRE-FEET)[2]	STORAGE (ACRE-FEET)
630.5	9.5	-0.01	44.9	0
640.0		13.8		44.9
660.0	20.0	84.5	883.0	927.9
680.0	20.0	160.0	2405.2	3333.1

(1) Planimetered from USGS maps.
(2) $\Delta Volume = \Delta H/3 \ (A_1 + A_2 + \sqrt{A_1 A_2})$.

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                A1       SNYDER UNIT HYDROGRAPH,FLOOD ROUTING AND DAM OVERTOPPING ANALYSES
    2                A2       HUNTINGTON SMITHFIELD DAM,HUNTINGTON COUNTY,NDI-PA.511,PROJ.NO.79-543-22
    3                A3       FOR 20%,30%,40%,50%,60%,70%,80%,90%, AND 100% PMF
    4                B     300        0       15        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 HUTINGTON SMITHFIELD DAM
   10                M       1        1     1.82                1.82                                1
   11                P              23.5      102      120      130      140
   12                T                                                      1.0      .05         0.000009
   13                W    1.93     0.55
   14                X    -1.0    -0.05      2.0
   15                K       1        2                                          1
   16                K1       ROUTING FLOW THROUGH HUTINGTON SMITHFIELD DAM (NDI-I.D.PA.511)
   17                Y                                         1        1
   18                Y1      1                                                -630.5
   19                SA   0.01     13.8     84.5    160.0
   20                SE  630.5    640.0    660.0    680.0
   21                SS  660.0     60.0      2.6      1.5    630.5      0.6     3.14      0.5
   22                SD  665.8     3.08      1.5    900.0
   23                SL  250.0    450.0    650.0    700.0    800.0    900.0
   24                SV  665.8    666.1    666.2    666.3    666.4    666.5
   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	1.82 (4.71)	1	836. (23.67)	1254. (35.51)	1672. (47.35)	2090. (59.19)	2508. (71.02)	2926. (82.86)	3344. (94.70)	3762. (106.53)	4180. (118.37)
ROUTED TO	2	1.82 (4.71)	1	68. (1.94)	75. (2.12)	79. (2.25)	152. (4.31)	473. (13.40)	848. (24.02)	1246. (35.29)	1653. (46.82)	2063. (58.42)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	630.50	660.00	665.80
STORAGE	0.	928.	1473.
OUTFLOW	0.	82.	2269.

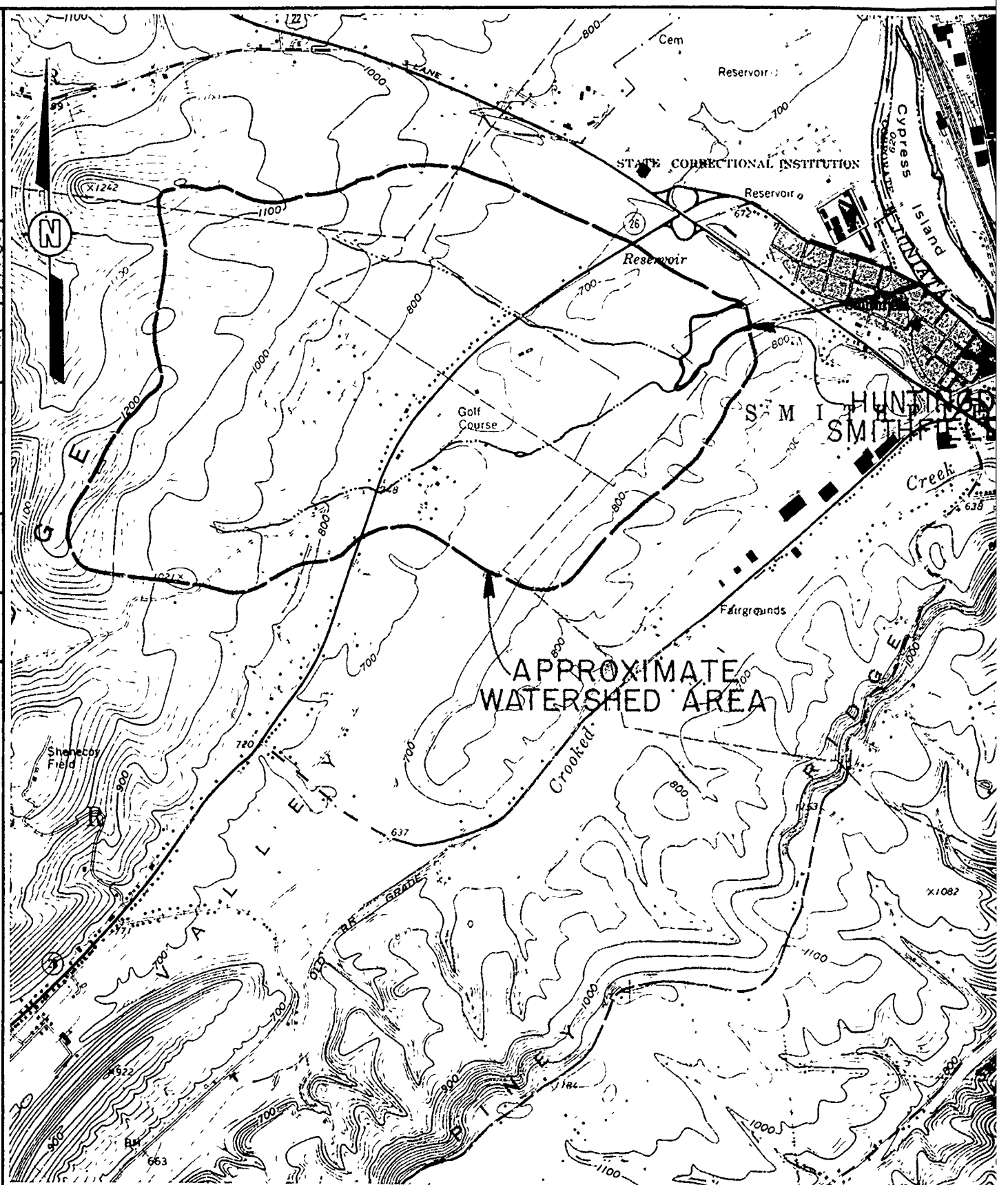
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.20	651.01	0.00	354.	68.	0.00	49.25	0.00
.30	654.97	0.00	563.	75.	0.00	50.00	0.00
.40	658.11	0.00	777.	79.	0.00	50.75	0.00
.50	660.58	0.00	978.	152.	0.00	49.75	0.00
.60	661.84	0.00	1089.	473.	0.00	46.75	0.00
.70	662.58	0.00	1185.	868.	0.00	45.75	0.00
.80	663.81	0.00	1273.	1246.	0.00	45.00	0.00
.90	664.65	0.00	1356.	1653.	0.00	44.75	0.00
1.00	665.43	0.00	1435.	2063.	0.00	44.25	0.00

OVERTOPPING ANALYSIS SUMMARY

APPENDIX E

PLATES

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER 79-543-B79
	11-15-79	APPROVED BY		7.1400



REFERENCES:

1. U.S.G.S. 7.5' HUNTINGDON, PA. QUADRANGLE PHOTOREVISED 1972, SCALE 1:24000
2. U.S.G.S. 7.5' MOUNT UNION, PA. QUADRANGLE PHOTOREVISED 1971, SCALE 1:24000

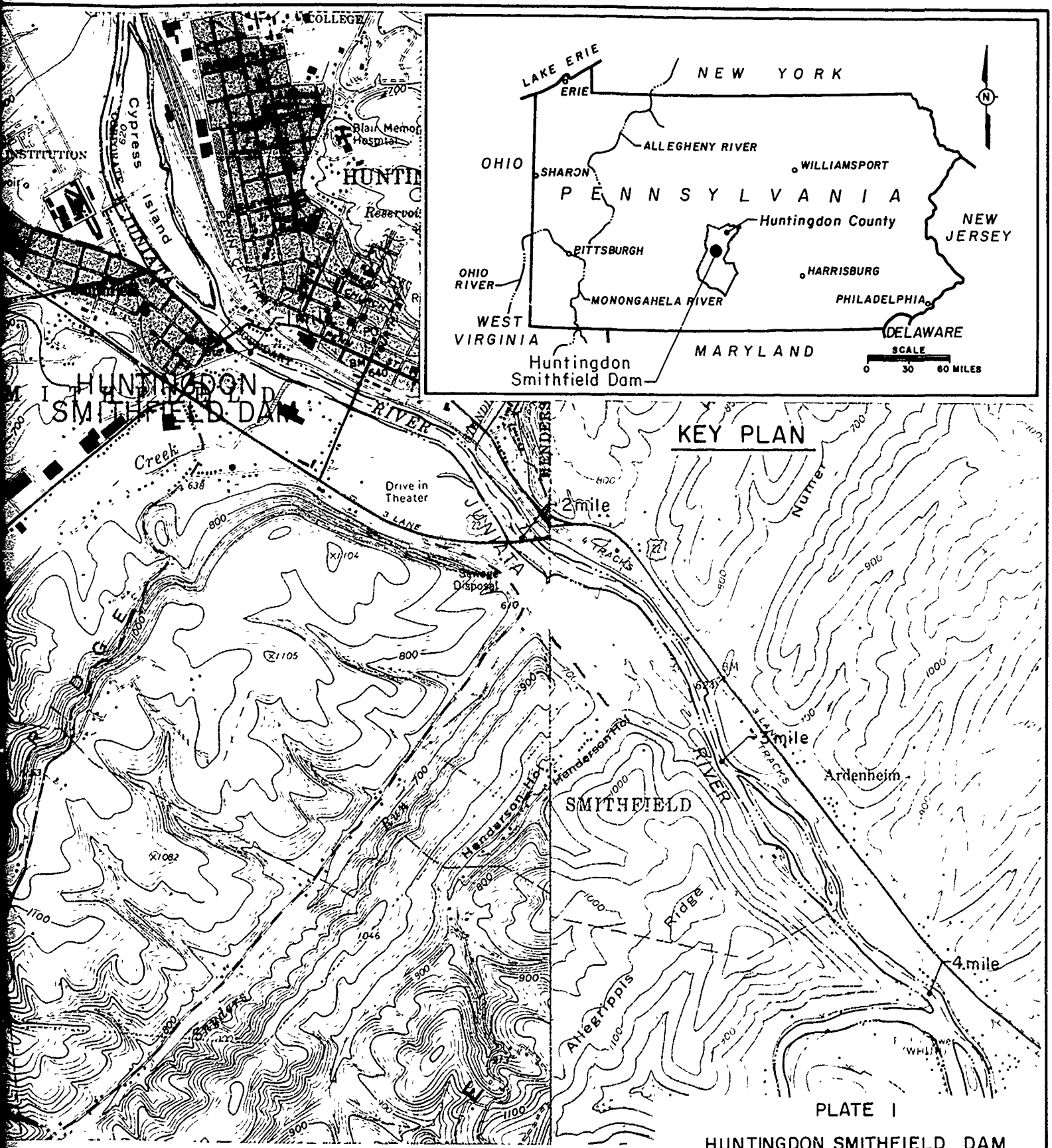
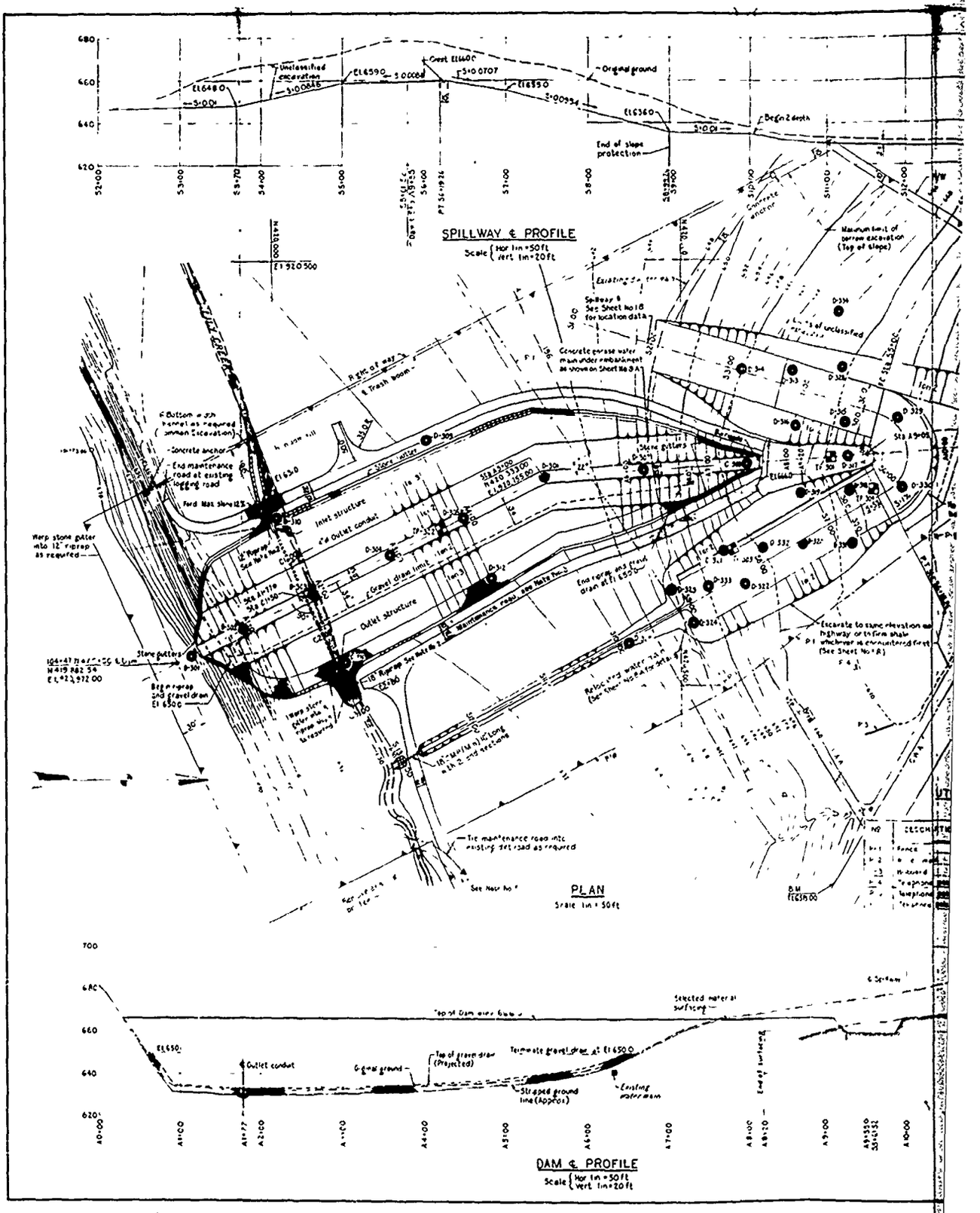


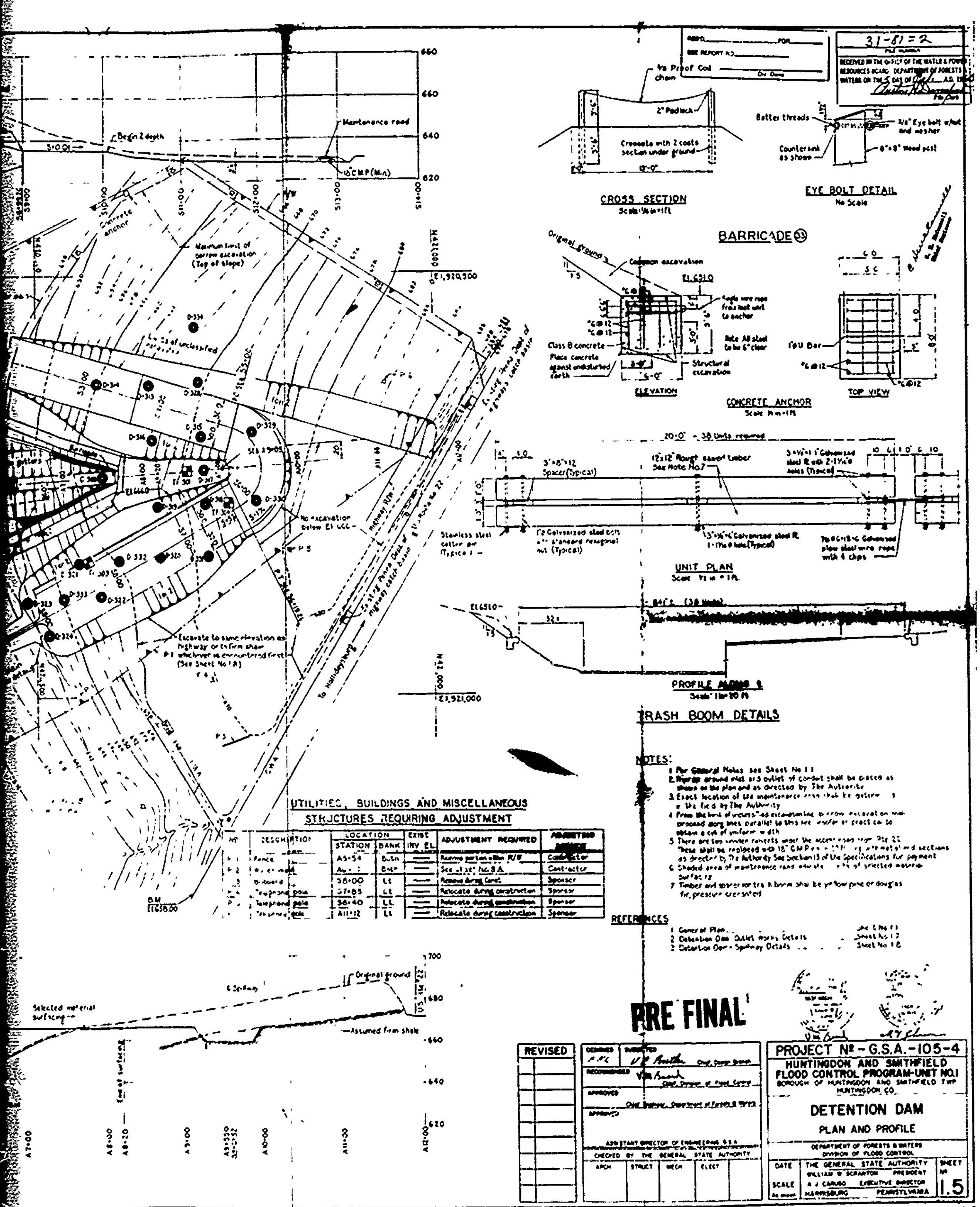
PLATE I

HUNTINGDON SMITHFIELD DAM
VICINITY, FLOOD PLAIN & WATERSHED MAP

D'APPOLONIA

DRAWN BY		CHECKED BY	BE	9-4-80	DRAWING NUMBER 79-543-B80
	6-11-80	APPROVED BY	JEH	7.14.80	





UTILITIES, BUILDINGS AND MISCELLANEOUS STRUCTURES REQUIRING ADJUSTMENT

Nº	DESCRIPTION	LOCATION STATION	LOCATION BANK	EXIST INV EL	ADJUSTMENT REQUIRED	ADJUSTING AGENCY
[illegible]	Fence	A5+54	Both	—	Remove portion within R/W	Contractor
[illegible]	Water main	[illegible]	Both	—	See sheet No. 9A	Contractor
3	Billboard	58+00	LL	—	Remove during const.	Sponsor
[illegible]	Telephone pole	57+65	LL	—	Relocate during construction	Sponsor
[illegible]	Telephone pole	56+40	LL	—	Relocate during construction	Sponsor
[illegible]	Telephone pole	A11+12	LL	—	Relocate during construction	Sponsor

NOTES:

1. For General Notes see Sheet No 1.1
2. Riprap around inlet and outlet of conduit shall be placed as shown on the plan and as directed by The Authority
3. Exact location of the maintenance road shall be determined in the field by The Authority
4. From the limit of unclassified excavation line borrow excavation shall proceed along lines parallel to this line insofar as practical to obtain a cut of uniform width
5. There are two wooden culverts under the access road from Rte 22. These shall be replaced with 18" C.M.P. [illegible] with metal end sections as directed by The Authority. See Section 13 of the Specifications for payment
6. Shaded area of maintenance road [illegible] of selected material surfacing
7. Timber and spacer for trash boom shall be yellow pine or douglas fir, pressure creosoted

REFERENCES

1. General Plan ... Sheet No 1.1
2. Detention Dam Outlet Works Details ... Sheet No 1.7
3. Detention Dam - Spillway Details ... Sheet No 1.8

PLATE 2

D'APPOLONIA

DRAWN BY ME / 6.11.80

CHECKED BY BE / 7-1?-80

APPROVED BY [illegible] / 7.14.80

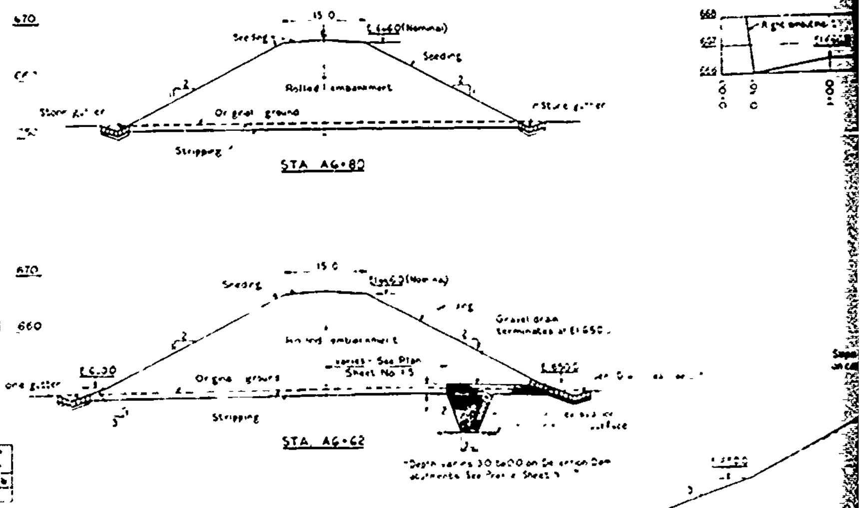
DRAWING NUMBER 79-543-B81

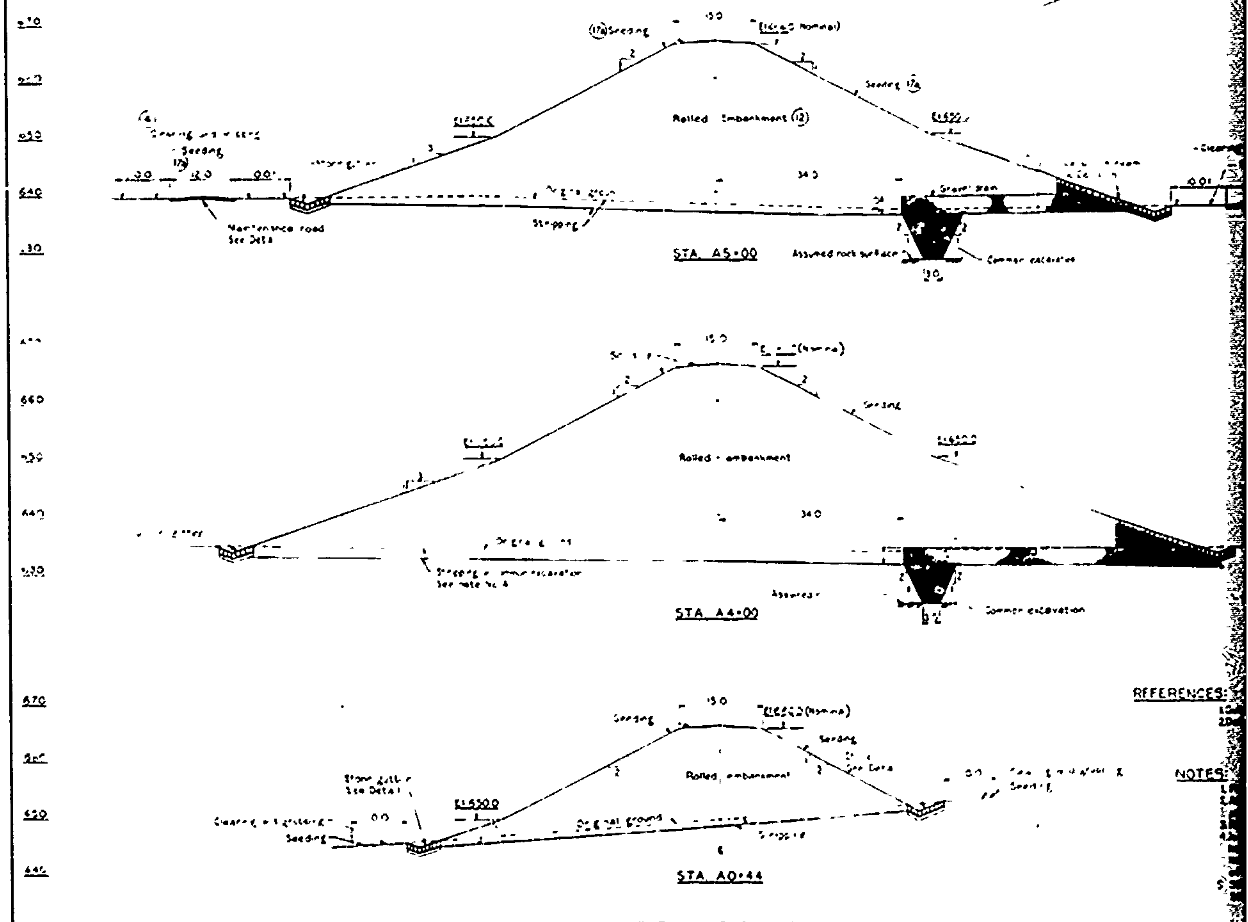
DRAIN AND FILTER GRADATIONS

Description	Specified Gradation				Contract Item No
	Manufactured		Natural		
	Gdn Type	%	Sieve Size	% Passing	
Filter Blanket Type A	A 2B 3A	50 25 25	2½" 2 1" #4 #20 #100	100 95-100 70-80 45-60 20-35 0 5	18a & 18c
Gravel Drain	A 2B	50 50	1½" 1 ½" #4 #30 #100	100 95 100 60-80 45 55 15 35 0 4	25
Filter Blanket Type B	No 4 2B	50 50	4 3½ 2½ 1" ½" #4 #8	100 95 100 65 85 45 55 10 30 0 5 0 3	18b

ROCK GRADATIONS

Description	20% of stone Average		25% of stone Maximum		Contract Item No
	in range	Weight	in range	Weight	
12" Riprap	0 27lbs	70 120lbs	140-250lbs	350lbs	18a & 18b
18" Riprap	0 32lbs	120-280lbs	360 600lbs	1000lbs	18c





TYPICAL SECTIONS
Scale 1in=10ft

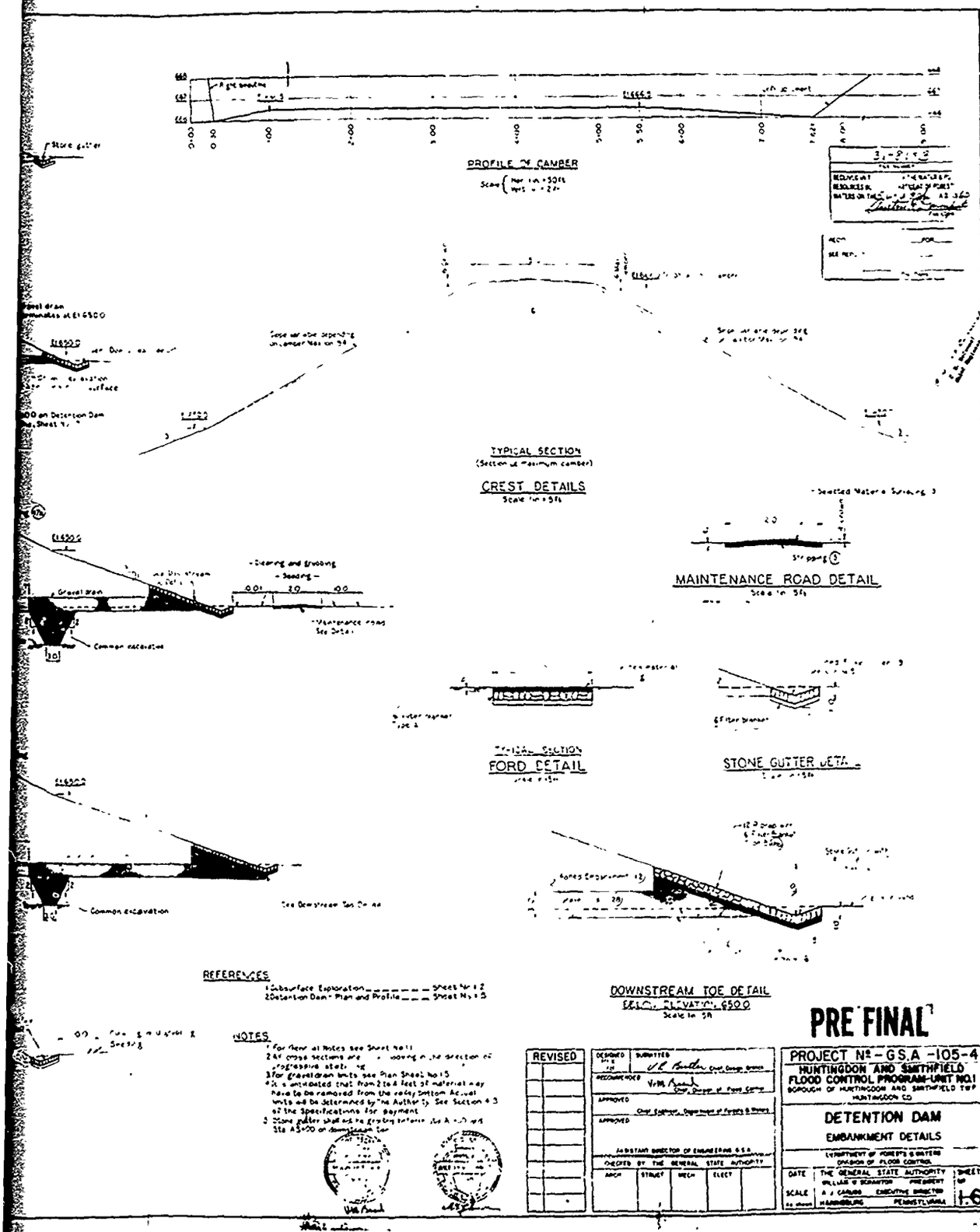
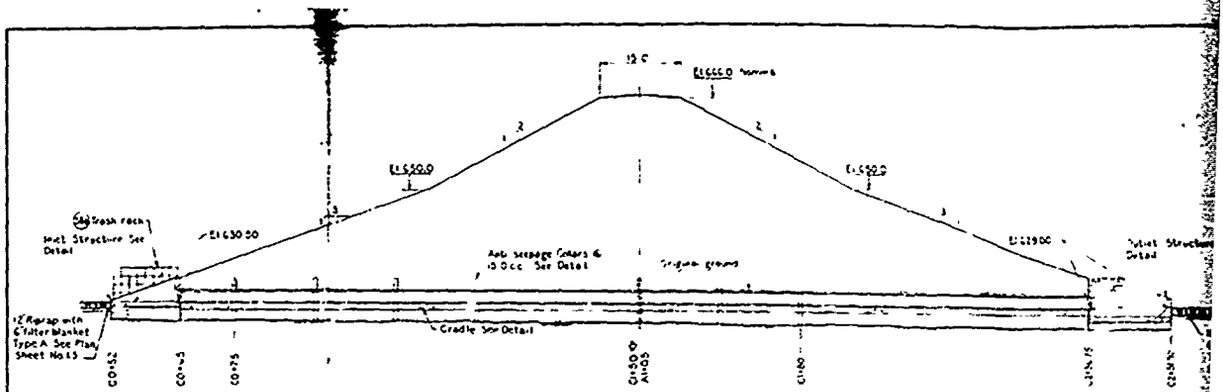


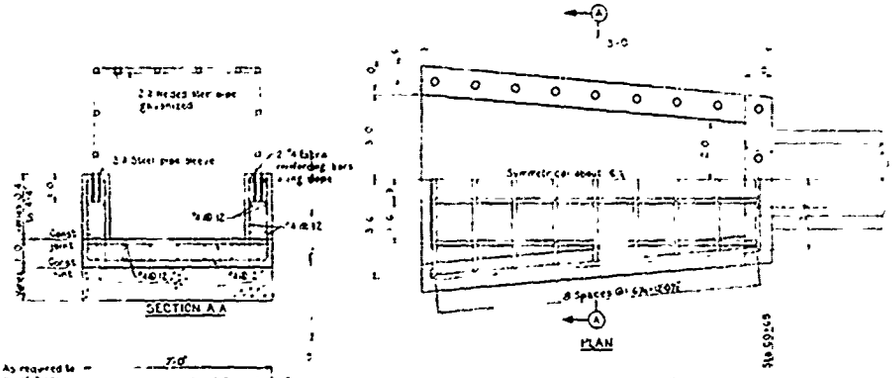
PLATE 3

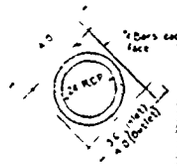
D'APPOLONIA

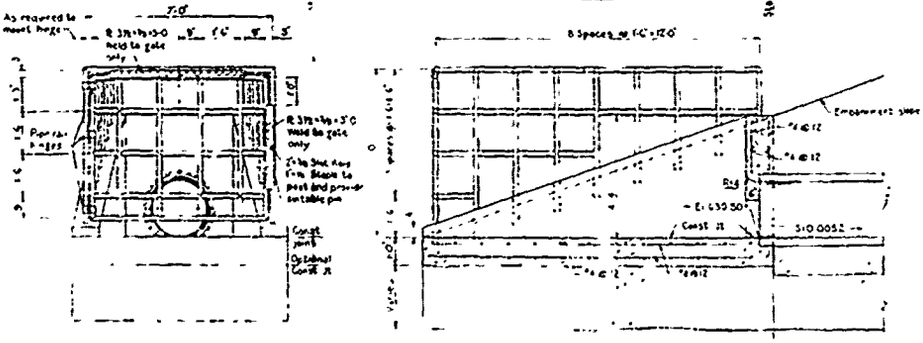
DRAWN BY	mel	CHECKED BY	BC	2-17-80	DRAWING NUMBER 79-543-882
	6-11-80	APPROVED BY	JRH	7.14.80	



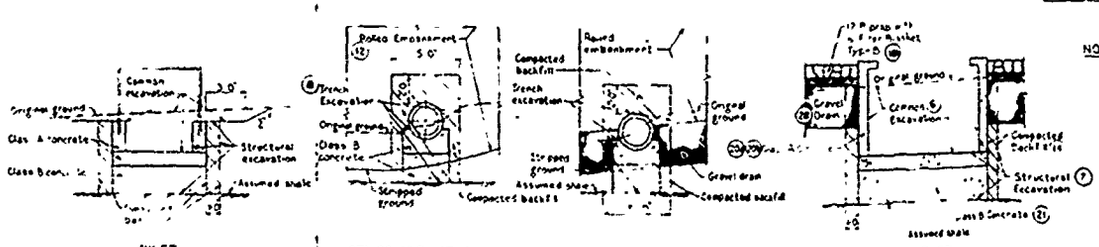
CENTER LINE PROFILE





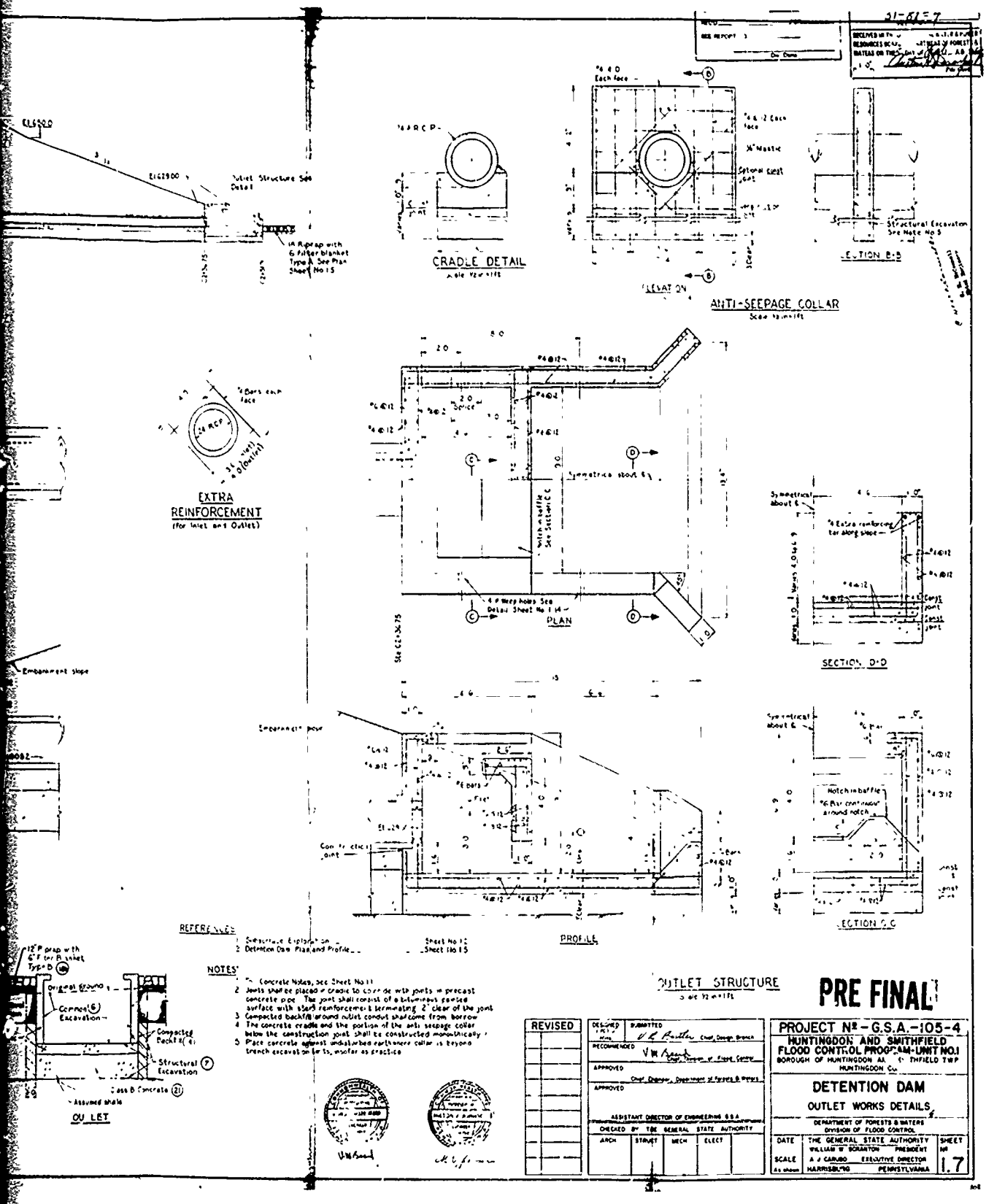


INLET STRUCTURE



INLET STA CO+65 TO STA C1+84 STA 1+84 TO STA C2+36.75 OUTLET

TYPICAL SECTIONS



REFERENCES

1 Subsurface Exploration — Sheet No 12
2 Detention Dam Plan and Profile — Sheet No 15

NOTES:

1 For Concrete Notes, see Sheet No 11
2 Joints shall be placed in cradle to coincide with joints in precast concrete pipe. The joint shall consist of a bituminous exposed surface with steel reinforcement terminating 2" clear of the joint
3 Compacted backfill around outlet conduit shall come from borrow
4 The concrete cradle and the portion of the anti seepage collar below the construction joint shall be constructed monolithically
5 Place concrete against undisturbed earth where collar is beyond trench excavation limits, insofar as practical

OUTLET STRUCTURE

PRE FINAL

REVISED

DESIGNED — SUBMITTED: V. E. Hartley, Chief, Design Branch
RECOMMENDED: V. W. Arnold, Chief, Division of Flood Control
APPROVED: Chief, Division, Department of Forests & Waters
APPROVED: ASSISTANT DIRECTOR OF ENGINEERING G.S.A.
CHECKED BY THE GENERAL STATE AUTHORITY

ARCH	STRUCT	MECH	ELECT

PROJECT Nº - G.S.A.-105-4
HUNTINGDON AND SMITHFIELD FLOOD CONTROL PROGRAM-UNIT NO.1
BOROUGH OF HUNTINGDON AS. & TWP. SMITHFIELD TWP
HUNTINGDON Co.

DETENTION DAM
OUTLET WORKS DETAILS

DEPARTMENT OF FORESTS & WATERS
DIVISION OF FLOOD CONTROL

DATE — THE GENERAL STATE AUTHORITY
WILLIAM W. SCRANTON PRESIDENT
A. J. CARUSO EXECUTIVE DIRECTOR
HARRISBURG PENNSYLVANIA

SCALE: As shown

SHEET No. 1.7

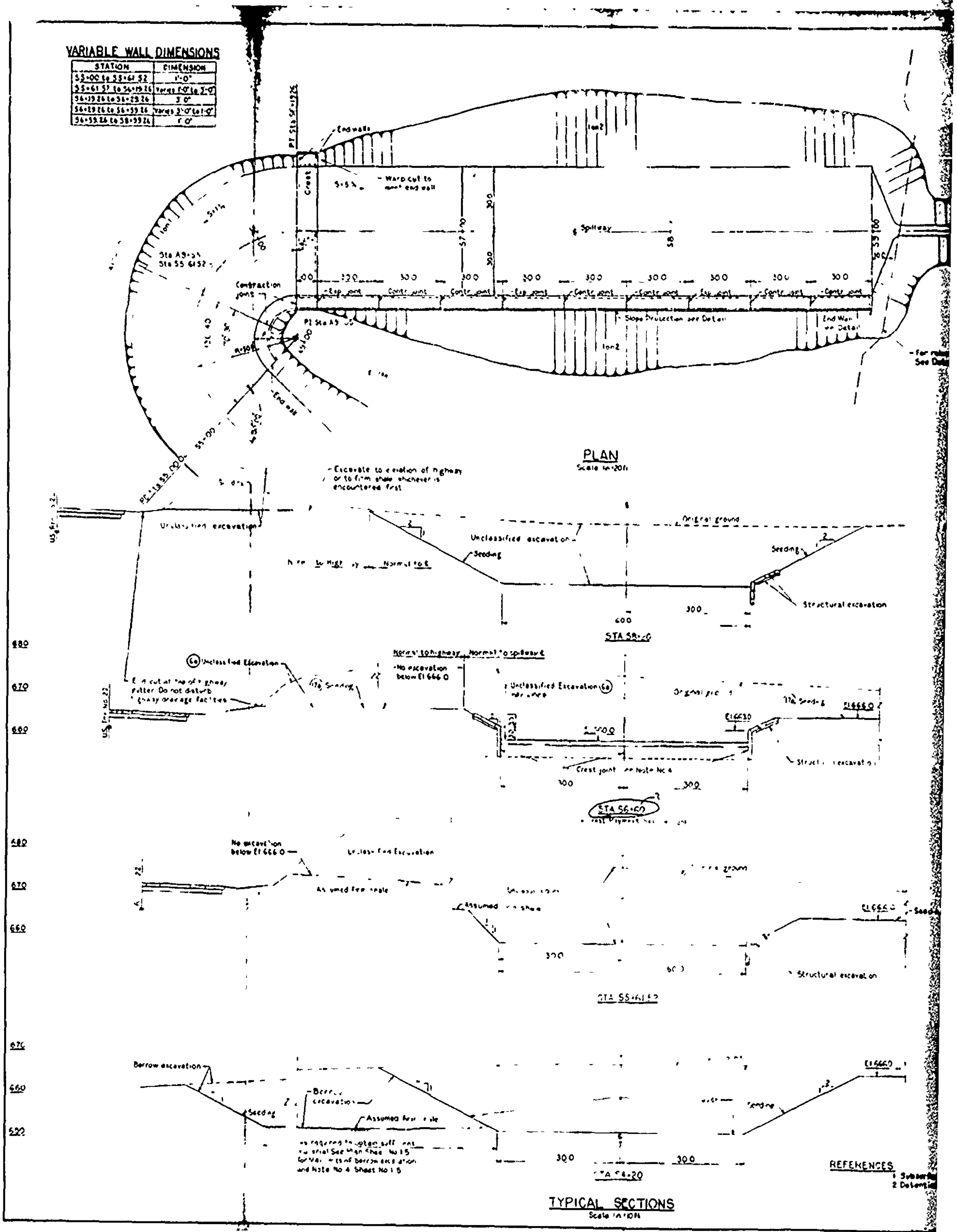
PLATE 4

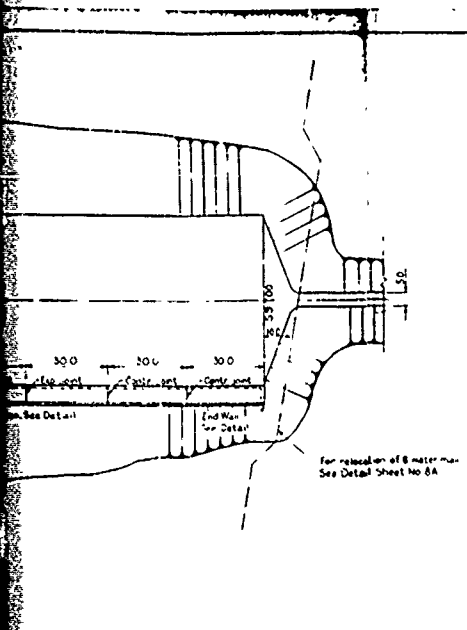
D'APPOLONIA

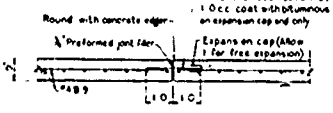
DRAWN BY	CHECKED BY	APPROVED BY	DRAWING NUMBER
6.11.80	7-14-80	7.14.80	79-543-B83

VARIABLE WALL DIMENSIONS

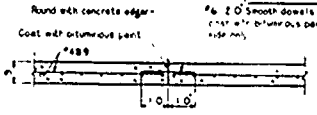
STATION	DIMENSION
55+00 to 55+61 52	1'-0"
55+61 57 to 56+19 26	Varies 1'-0" to 3'-0"
56+19 26 to 56+29 26	3' 0"
56+29 26 to 56+59 26	Varies 3'-0" to 1'-0"
56+59 26 to 58+59 26	1' 0"



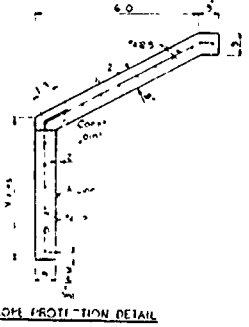




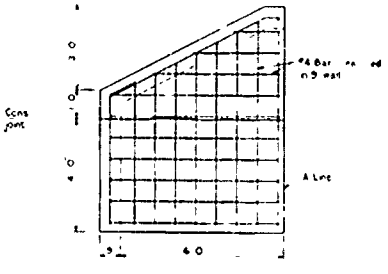
EXPANSION JOINT



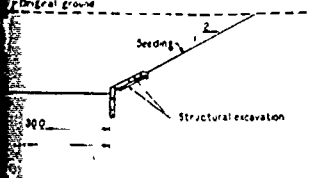
CONTRACTION JOINT

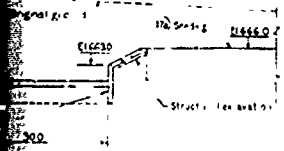


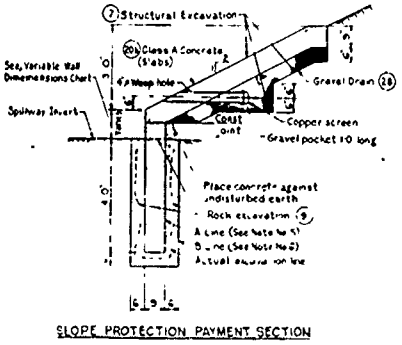
SLOPE PROTECTION DETAIL



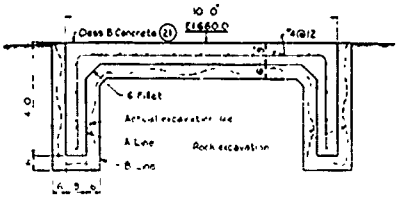
END WALL DETAIL



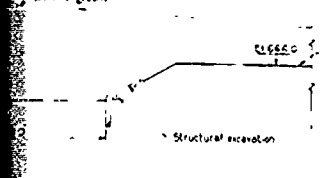


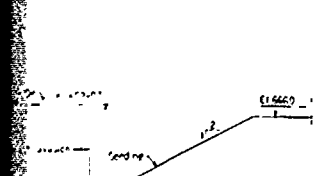


SLOPE PROTECTION PAYMENT SECTION



CREST PAYMENT SECTION





CONCRETE DETAILS

Scale 3/4"=1'0

NOTES

1 For General Notes, see Sheet No 11.
2 For Concrete Notes, see Sheet No 11
3 All sections are
4 Crest joints shall
5 T
6 Payment for
7 B line also
8 The Authority reserves the right to waive any of the requirements of these specifications when in the opinion of the Authority such action is deemed necessary to protect the interest of the Authority or when unusual conditions arise during the construction period which in the opinion of the Authority justify such action. Any such waiver shall be made only after approval by the Authority and shall be confirmed in writing to the Contractor. No waiver of any requirement of these specifications shall be binding upon the Authority unless it was executed

REFERENCES

1 Subsurface Exploration ..... Sheet Nos 13&14
2 Detention Dam - Plan and Profile ..... Sheet No 15

PRE FINAL

REVISED

DESIGNED — SUBMITTED
RECOMMENDED
APPROVED — Chief Engineer, Department of Forests & Waters
APPROVED — ASSISTANT DIRECTOR OF ENGINEERING GSA

CHECKED BY THE GENERAL STATE AUTHORITY

ARCH	STRUCT	MECH	ELECT	

PROJECT Nº - G.S.A - 105 - 4
HUNTINGDON AND SMITHFIELD FLOOD CONTROL PROGRAM-UNIT NO.1
BOROUGH OF HUNTINGDON AND SMITHFIELD TWP
HUNTINGDON CO

DETENTION DAM
SPILLWAY DETAILS

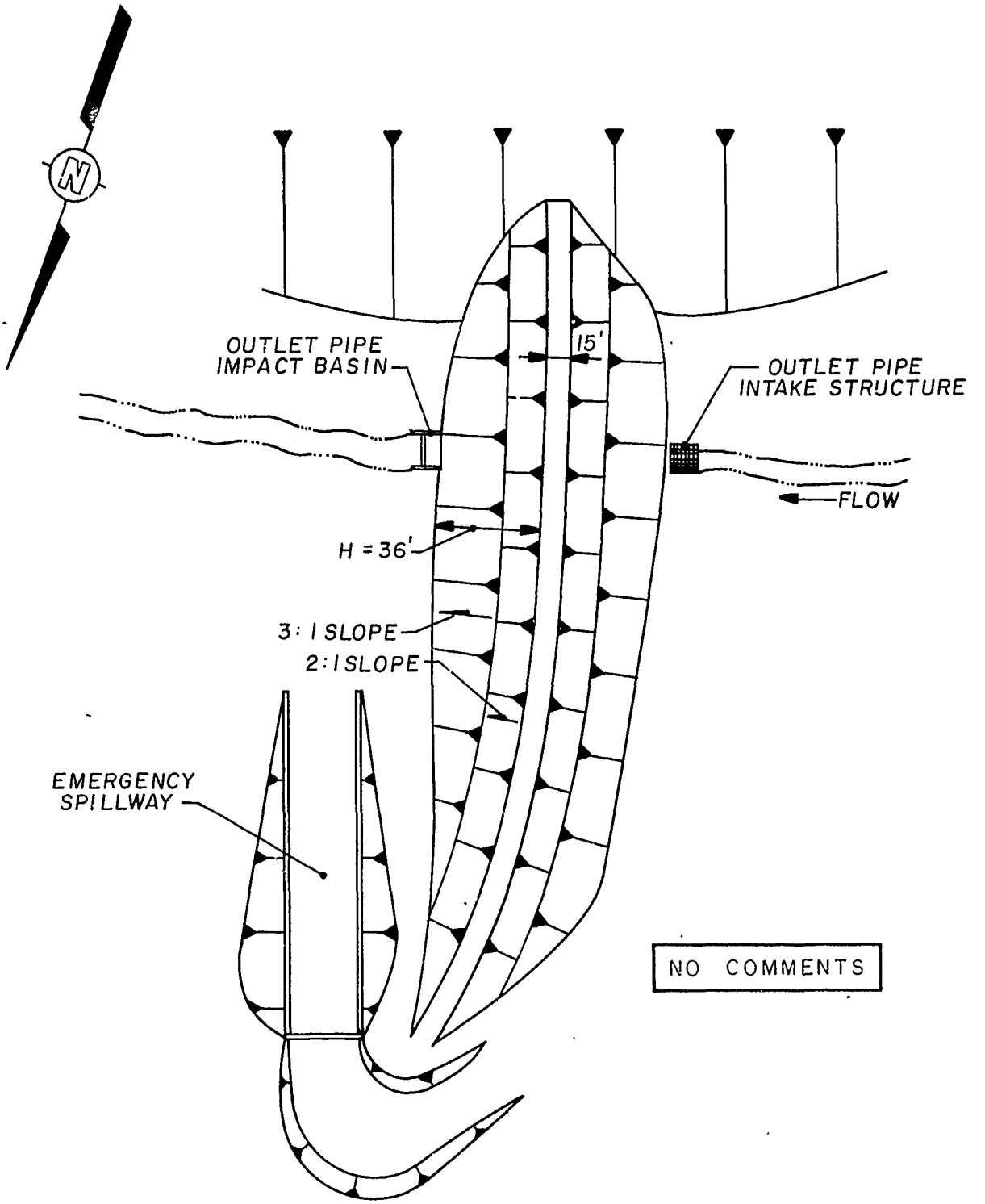
DEPARTMENT OF FORESTS & WATERS
DIVISION OF FLOOD CONTROL

DATE
THE GENERAL STATE AUTHORITY
WILLIAM W SCRANTON PRESIDENT
SCALE
As shown
A J CAPUTO EXECUTIVE DIRECTOR
HARRISBURG PENNSYLVANIA
SHEET NO 1.8

PLATE 5

D'APPOLONIA

DRAWN BY	ACS	CHECKED BY	BE	DRAWING NUMBER	79-13-A53
	7-10-80	APPROVED BY	[illegible]		7 14 80



NO COMMENTS

NOTES:

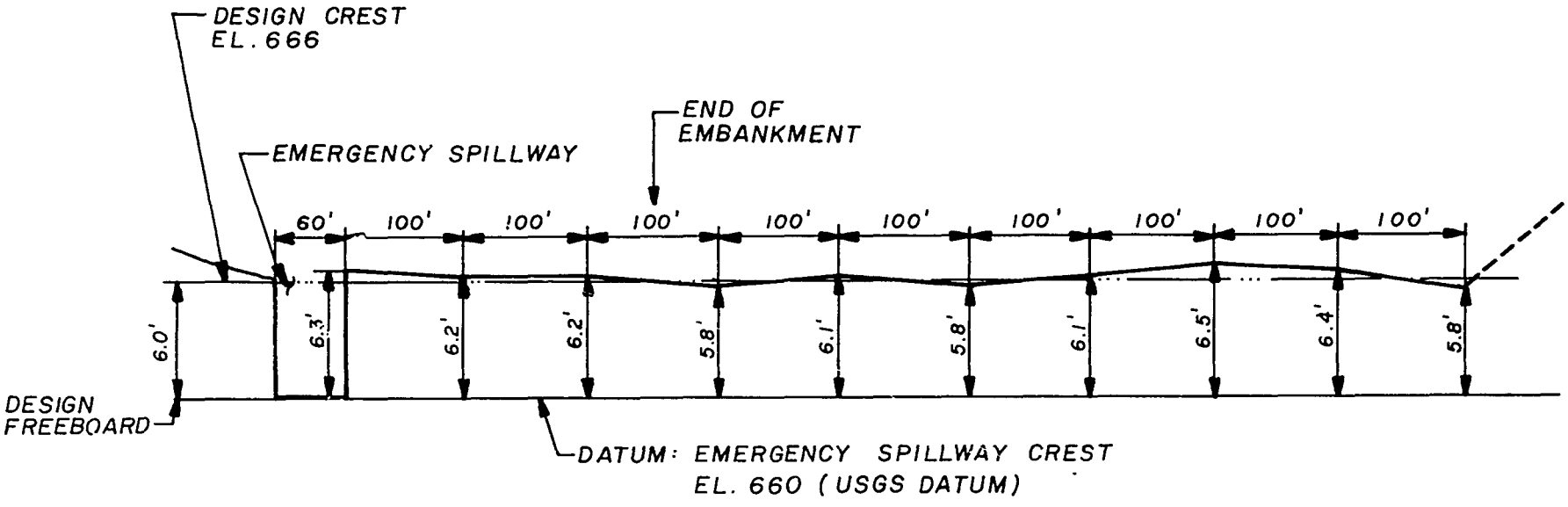
1. POOL LEVEL DATE OF INSPECTION: DAM DOES NOT IMPOUND A RESERVOIR UNDER NORMAL FLOW CONDITIONS

PLATE 6

HUNTINGDON SMITHFIELD DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE: APR. 29, 1980

D'APPOLONIA

DRAWN BY	SH	CHECKED BY	BE	7-14-80	DRAWING NUMBER 79-C 3-A54
	7-10-80	APPROVED BY	JDD	7.14.80	



DAM CREST PROFILE

(LOOKING DOWNSTREAM)

NOTES:

1. DAM CREST IS SURVEYED RELATIVE TO SPILLWAY CREST LEVEL
3. DATUM ELEVATION PER DESIGN DRAWINGS

PLATE 7

HUNTINGDON SMITHFIELD DAM
DAM CREST SURVEY
FIELD INSPECTION DATE: APR. 29, 1980

DAPPOLONIA

APPENDIX F

REGIONAL GEOLOGY

APPENDIX F

REGIONAL GEOLOGY
HUNTINGDON-SMITHFIELD DAM

Huntingdon-Smithfield Dam is located east of the Allegheny Front in the Valley and Ridge Province, an area of moderately to intensely folded strata. The dam lies along the west flank of the Broad Top Syncline which trends to the northeast. Strata dip to the southeast toward the axis of the syncline which lies along the Raystown Branch of the Juniata River.

Strata at the dam site consist of the Marcellus Shale and the Onondaga Formation of Devonian Age. The Marcellus Shale is a black fissile shale with closely spaced joints. The Onondaga Formation is predominantly a greenish-blue shale with interbeds of dark gray limestone. Warrior Ridge, a resistant ridge just northwest of the dam, is the surface exposure of the Oriskany Sandstone.

DRAWN BY	ACS	CHECKED BY		DRAWING NUMBER
	12-31-79	APPROVED BY		79-543-A14

SCALE

0 2 4 6 8 10miles

REFERENCE.

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

HUNTINGDON SMITHFIELD DAM

GEOLOGY MAP

D'APPOLONIA

DRAWING NUMBER	79-543-A18
CHECKED BY	1/14/80
APPROVED BY	1/14/80

DRAWN BY	ACS
	12-31-79

LEGEND

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

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

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

Sc — **Clinton Group**
Predominantly Rose Hill Formation - Reddish purple to greenish gray, thin to medium bedded, fossiliferous shale with interfingering "iron sandstones" and local gray, fossiliferous limestone above the Rose Hill is brown to whit- quartzitte sandstone (Keefer) interbedded upward with dark gray shale (Rochester)

Dm — **Marine beds**
Gray to olive brown shales, graywackes and sandstones contains "Chemung" beds and "Portage" beds including Burket Brallier, Harrell, and Trimmers Rock, Tully Limestone at base

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

Do — **Oriskany Formation**
White to brown fine to coarse grained partly calcareous, locally conglomeratic, fossiliferous sandstone (Ridgeley) at the top, dark gray, cherty limestone with some interbedded shales and sandstones below (Shriver)

Tuscarora Formation
White to gray medium to thick bedded, fine grained quartzitic sandstone, conglomeratic in part

Marcellus Formation
Black, fissile, carbonaceous shale with thick, brown sandstone (Turkey Ridge) in parts of central Pennsylvania

Onondaga Formation
Greenish blue, thin bedded shale and dark blue to black medium bedded limestone with shale predominant in most places includes Selinsgrove Limestone and Needmore Shale in central Pennsylvania and Buttermilk Falls Limestone and Esopus Shale in easternmost Pennsylvania, in Lehigh Gap area includes Palmerton Sandstone and Bowmanstown Chert

Dmo

Wills Creek Formation
Greenish gray, thin bedded, fissile shale with local limestone and sandstone zones, contains red shale and siltstone in the lower part

Bloomsburg Formation
Red, thin and thick bedded shale and siltstone with local units of sandstone and thin impure limestone, some green shale in places

McKenzie Formation
Greenish gray, thin bedded shale interbedded with gray, thin bedded, fossiliferous limestone, shale predominant at the base intraformational breccia in the lower part Absent in Harrisburg quadrangle and to the east

Keyser Formation
Dark gray, highly fossiliferous, thick bedded, crystalline to nodular limestone, passes into Manlius, Rondout, and Decker Formations in the east

Skt — **Tonoloway Formation**
Gray, highly laminated, thin bedded, argillaceous limestone, passes into Bossardville and Poxono Island beds in the east

Dck — **Catskill Formation**
Chiefly red to brownish shales and sandstones includes gray and greenish sandstone tongues named Elk Mountain, Honesdale, Shohola, and Delaware River in the east

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

GEOLOGY MAP LEGEND

D'APPOLONIA