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BERGER ASSOCIATES INC HARRISBURG PA  
NATIONAL DAM INSPECTION PROGRAM. LITTLE BUFFALO CREEK DAM, SUSQ--ETC(U)  
SEP 78

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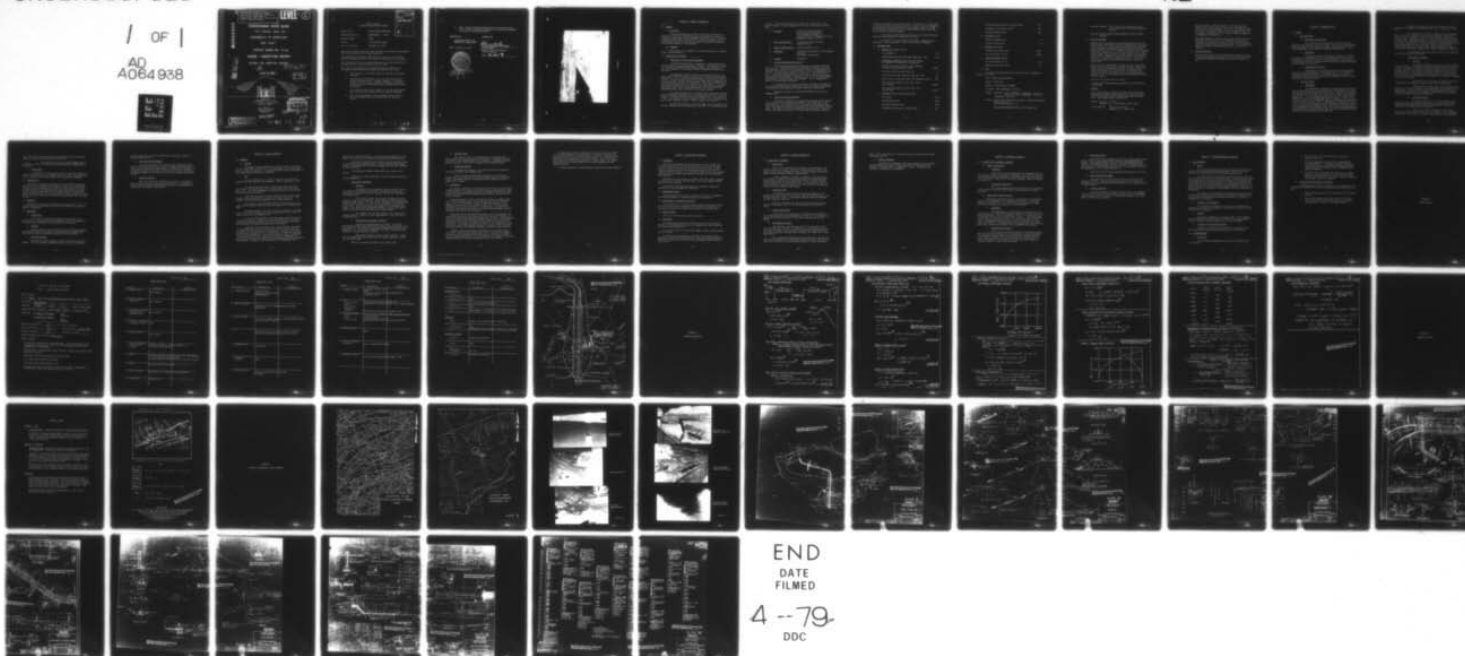
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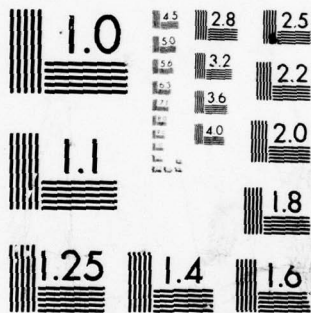
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National Dam Inspection Program,  
Little Buffalo Creek Dam, Susquehanna  
River Basin, Commonwealth of  
Pennsylvania, Perry County (NDS-PA-582),  
Phase I Inspection Report.

LEVEL II ①

## SUSQUEHANNA RIVER BASIN

LITTLE BUFFALO CREEK DAM

COMMONWEALTH OF PENNSYLVANIA

PERRY COUNTY

INVENTORY NUMBER NDS PA-582

## PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

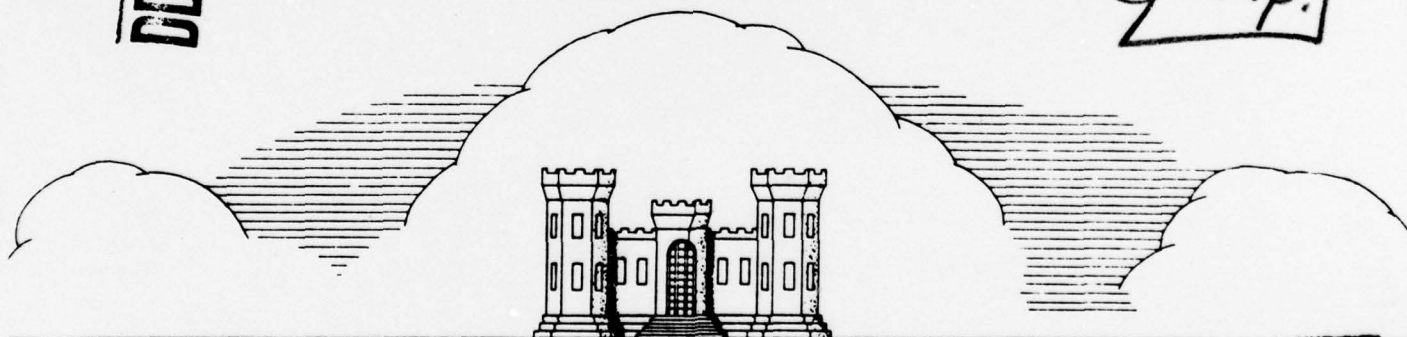
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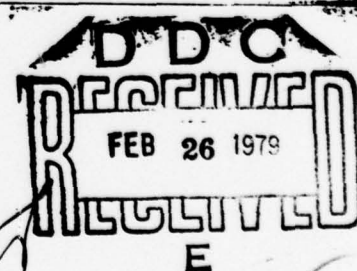
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Prepared For  
DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, Maryland

by  
BERGER ASSOCIATES, INC  
CONSULTING ENGINEERS  
HARRISBURG, PA



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PHASE I REPORT  
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: LITTLE BUFFALO CREEK DAM  
State and State No. PENNSYLVANIA - 50-60  
County Located: PERRY  
Stream: LITTLE BUFFALO CREEK  
Date of Inspection: September 11, 1978

ACCESSION for	
NTIS	White Section <input checked="" type="checkbox"/>
DDC	Buff Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
per Form 50	
BY	
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Dist.	AVAIL. CODE/DATE
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Based upon a visual inspection, past performance and available engineering data, the dam appears to be in good condition.

The spillway and available storage have the capacity to pass the PMF without overtopping the dam. The spillway is considered to be adequate.

There is concern for the wet spots detected on the downstream slope and the apparent high volume discharge in the toe drain.

As a result of the information obtained during this inspection the following recommendations are presented for action by the owner.

1. That the weir in the outlet channel be restored to operating condition.
2. That the volume and clarity of the toe drain discharge be monitored and reported on a regular schedule. If changes in volume or clarity occur, a detailed investigation should be carried out and if conditions warrant, remedial action taken as necessary.
3. That a study be made of the seepage on the downstream embankment slope and that remedial action be taken as required.
4. That a close inspection of the embankment slope surface be made on an annual basis and during periods of high pool levels.

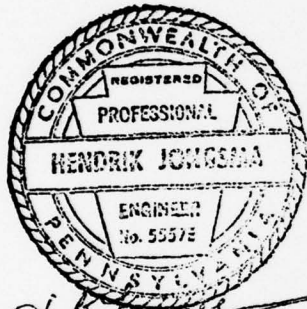


5. That a formal downstream warning system be developed along with a formal surveillance procedure to be used during periods of intense or prolonged rainfall.

SUBMITTED BY:

BERGER ASSOCIATES, INC.  
HARRISBURG, PENNSYLVANIA

DATE: October 26, 1978



APPROVED BY:

*G. R. Withers*

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

DATE: 26 Nov 78



OVERVIEW

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States. The Phase I Inspection and Report are limited to a review of available data, a visual inspection of the dam site and basic calculations to determine the hydraulic adequacy of the spillway.

B. Purpose

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

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

Little Buffalo Creek Dam is apparently a zoned rolled earth-fill structure with a maximum height of 52 feet. The embankment section is 1,750 feet in length from the right abutment to the juncture with the right abutment of the spillway. Refer to Appendix D, Plate V, for plan view.

The embankment section consists of an impervious core at its center with random fill abutting the core on both the upstream and downstream sides. A core trench is provided along a portion of the axis of the dam. A 3-foot sloping filter is located between the downstream side of the impervious core and the random fill. This filter extends vertically from elevation 490 to the bottom of the core trench. A horizontal continuation of this filter is located at the existing ground contact near Station 3+00 and is carried downstream to the rock toe of the downstream slope. Refer to Plate VI for typical sections.

The spillway consists of an uncontrolled concrete ogee section with a supplemental emergency weir extending beyond each end of the main spillway. The ogee section is 50 feet in length with a crest elevation of 495. The emergency weir has a length of 219.35 feet (2 sections) and has a crest elevation of 509.4. Refer to Appendix D, Plate VII.

The intake structure is an 8-foot square concrete tower located 130 feet upstream from the centerline of the dam. It is accessible only

by boat. A three-foot diameter pipe carries the intake flow to the outlet structure. Refer to Appendix D, Plate IX, for section of outlet pipe.

- B. Location: Centre and Juniata Townships  
Perry County, Pennsylvania  
USGS Quadrangle, Newport, Pa.  
Latitude 40°-27.3', Longitude 77°-10.4'  
Appendix D, Plates I and II
- C. Size Classification: Intermediate (4020 acre-feet,  
height 52 feet)
- D. Hazard Classification: High (See Section 3.1.E)
- E. Ownership: Pennsylvania Department of Environmental  
Resources  
Harrisburg, Pennsylvania
- F. Purpose: Recreation
- G. Design and Construction History

The dam and appurtenant structures were designed by Albright and Friel, Inc., Consulting Engineers, Philadelphia, Pennsylvania. The design engineer used the S.C.S. procedure to develop the hydrograph for the PMF. A 6-hour design storm of 25 inches with a corresponding runoff of 21.3 inches was used to establish the top of the dam elevation of 515.5. The spillway capacity was noted as 9440 cfs before the emergency spillway goes into operation. Foundation grouting was specified beneath the spillway structure and the south abutment. Refer to Appendix D, Plate VII, for grouting information.

The permit for construction was issued on August 26, 1968, and the project was completed on October 29, 1970. The dam was constructed by the Middle Creek Construction Company, Winfield, Pennsylvania.

Records or reports of construction progress are not in the PennDER files.

#### H. Normal Operating Procedures

This dam is operated as a recreational facility by the Pennsylvania Department of Environmental Resources. The regulation of the water surface in the reservoir can be controlled by the manually operated 3-foot diameter sluice gate located in the 8-foot by 8-foot concrete tower. The tower is 130 feet upstream from the centerline of the dam and is accessible only by boat. The water enters the tower through a 3-



foot square opening which is normally open, but which may be closed with a cover if necessary to dewater the tower. There is also an arrangement of 6-inch pipes which may be used to release smaller amounts of water. During periods of flooding the 3-foot gate remains closed. This gate can be used for emergency drawdown.

An Operation and Maintenance Manual is at the park office and describes the procedures for operation of the dam.

The lake is used for boating and fishing. Swimming is not permitted. There is, however, a pool in this park for swimming.

### 1.3 PERTINENT DATA

#### A. Drainage Area (square miles)

File indicated	13.4
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Computations made for this report gave 13.5. Use:	13.4
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#### B. Discharge at Dam Site (cubic feet per second)

See Appendix B for hydraulic calculations

Maximum known flood, June 23, 1972, estimated on basis of known pool Elev. 499.9	1,900
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Warm water outlet at pool Elev. 495	3
-------------------------------------	---

Outlet works low-pool outlet at pool Elev. 466	60
--	----

Outlet works at pool level Elev. 495 (spillway crest)	190
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Main spillway capacity at pool Elev. 509.4 (top of wall)	10,900
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Total spillway capacity at pool Elev. 515.5 (top of dam)	31,200
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#### C. Elevation (feet above mean sea level)

Top of dam	515.5
------------	-------

Main spillway crest	495.0
---------------------	-------

Emergency spillway crest	509.4
--------------------------	-------

Upstream portal invert of outlet tunnel	461
---	-----



Downstream portal invert of outlet tunnel	459
Streambed at centerline of dam	463
Maximum tailwater about	475
D. <u>Reservoir</u> (miles)	
Length of maximum pool	1.9
Length of normal pool	1.2
E. <u>Storage</u> (acre-feet)	
Spillway crest (Elev. 495)	1,020
Top of dam (Elev. 515.5)	4,020
F. <u>Reservoir Surface</u> (acres)	
Top of dam (Elev. 515.5)	213
Spillway crest (Elev. 495)	87
G. <u>Dam</u>	

For general plan and sections of the dam, refer to Appendix D, Plates V, VI and VII.

Type: Rolled zoned earthfill.

Length: 1,750 feet.

Height: 52 feet above streambed.

Top Width: Main Embankment - 20 feet.

Slopes: Upstream - Top of embankment to Elev.495 - 2H to 1V.  
Elev.495 to toe of embankment - 2.5H to 1V.  
Downstream - 2H to 1V.

Zoning: Central core including core trench - impervious material.  
Slopes 0.4H to 1V.  
Core trench slopes 1H to 1V.

Upstream and downstream from core - random fill.

Internal Drainage: 3-foot thick filter downstream face of impervious core and core trench leading to rock toe.

Grouting: Beneath spillway and foundation of south (right) abutment.

#### H. Outlet Facilities

Releases from the reservoir are controlled from an 8-foot by 8-foot intake tower which is 130 feet upstream from the center-line of the dam. A 3-foot diameter prestressed concrete pipe passes through the embankment from the intake tower to the downstream toe of the dam. A manually operated, 3-foot diameter sluice gate regulates the flow of water from the tower to the concrete pipe. Water enters the tower through a 3-foot square opening which is normally open but which may be fitted with a cover if it is necessary to dewater the tower. The invert of the concrete pipe is at elevation 461 where it leaves the intake tower.

There is also an arrangement of 6-inch cast iron pipes which may be used to release smaller amounts of water. These pipes admit water from the reservoir through two openings with invert elevations of 484.5 and 465.67. The water is controlled by manually operated 6-inch cast iron valves and is released to the 3-foot diameter pipe on the downstream side of the sluice gate.

Access to the intake tower is by boat.

A plunge pool provides energy dissipation at the end of the release pipe.

#### I. Spillway

Type: Uncontrolled, standard type crest, ogee weir with a supplemental emergency weir consisting of vertical 18-inch-thick concrete walls extending out at each end of the main weir. (see sketch, Sheet 1, Appendix B).

Length: Main weir - 50 feet.  
Emergency weir - an additional 219.35 feet.

Crest Elevation: Main weir - 495 feet.  
Emergency weir - 509.4 feet.

Upstream channel: Approach channel is 270 feet long and ranges from a width of about 80 feet at the upstream end, to about 55 feet at the entrance to the weir. The depth is about five feet at normal pool stage. It is excavated in rock and is unlined. The banks are low so there is ample conveyance to the emergency spillway weir.

Downstream channel: The chute starts with a paved section 75 feet long and 50 feet wide. The remainder of the chute is excavated in rock and is unlined. The total length is about 1,500 feet and the slope is relatively flat. The rough surface helps to dissipate the energy and there is no sign of any distress.

J. Regulating Outlets

Water can be released from the reservoir by means of two six-inch valves with invert elevations of 484.5 and 465.67, and by a three-foot diameter sluice gate with invert elevation of 461.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

#### A. Data Available

##### 1. Hydrology and Hydraulics

Very little design information was available on the hydrologic and hydraulic design of the dam. There were no area-capacity curves, frequency curves, unit hydrographs, design storm data, design flood hydrographs, flood routings or spillway rating curves.

##### 2. Embankment

There were no design calculations regarding the embankment design in the PennDER files. The information relative to this structure are contained in the construction drawings. Test boring data are available as well as a geologic report which was prepared during the planning stage of the project.

##### 3. Appurtenant Structures

Calculations or criteria for design of the appurtenant structures are not available in the PennDER files. The construction drawings provide the information for evaluating these structures. Appurtenant structures include spillway and emergency spillway, intake structure and outlet structure.

#### B. Design Features

##### 1. Embankment

The embankment is apparently a zoned earthfill structure with an impervious zone in the central portion and random fill on both the upstream and downstream sides of this core. Impervious material is carried into the core trench which extends to the top of the underlying rock surface. The core trench does not extend the full length of the embankment. It is discontinued beyond Station 3+00. A 3-foot thick filter is located at the downstream slope of impervious core and extends to the bottom of the core trench. A horizontal continuation of this filter at Station 3+00 allows internal drainage to discharge at the rock toe of the downstream embankment slope. The filter is located in the main embankment section between Stations 0+75 at the right abutment and Station 6+85 at and below elevation 490. The rock toe extends from the left of the outlet structure to Station 6+75.



Foundation grouting was carried out beneath the south abutment of the embankment to Station 2+00, refer to Appendix D, Plate VII.

The embankment is 52 feet in height above the streambed and is 1750 feet in length. The horizontal alignment contains two curves. Refer to Appendix D, Plate V. The top width of the structure is twenty feet. Embankment slopes are 2H to 1V on the downstream side and 2H to 1V on the upstream side to normal pool elevation 495 and 2.5H to 1V below elevation 495. Slope cover consists of grassed slope on the entire downstream side and to elevation 500 on the upstream side. Eighteen inch riprap on a 9-inch filter blanket provides the cover on the upstream slope below elevation 500. Refer to Appendix D, Plate VI.

The embankment abuts the natural ground on the right and the concrete spillway on the left.

## 2. Appurtenant Structures

### A. Spillway

The primary spillway is located at the left abutment of the embankment. It consists of a concrete ogee section and is uncontrolled. An emergency spillway section is designed as a part of the primary spillway by extending the concrete structure right and left of the ogee section. The crest of the primary spillway is at elevation 495; the crest of the emergency spillway section is at elevation 509.4 and the top of the dam embankment is at elevation 515.5 (Refer to Appendix D, Plates IV and VII).

The ogee section is 50 feet in length and the combined primary and emergency sections total 270 feet in length.

Concrete walls form the sides of the spillway outlet channel to a distance of about 75 feet downstream from the end of the ogee section. A concrete slab covers the channel bottom in this area. Downstream from this point, the channel and an 80-foot long stilling basin are excavated into the existing rock.

### B. Intake and Outlet

The intake structure is an 8-foot by 8-foot tower located 130 feet upstream from the dam axis. A 3-foot diameter prestressed concrete pipe passes through the embankment to the outlet structure at the downstream toe of the dam.

Inflow to the tower is through a 3-foot square opening and the flow from the tower is controlled by a 3-foot diameter sluice gate. The invert at the outlet from the tower is at elevation



461. Two 6-inch diameter pipes permit additional control for smaller amounts of water from elevation 484.5 and 465.67.

The outlet structure is a concrete endwall with no wingwalls. The 36-inch diameter pipe discharges into a plunge pool at this point.

C. Design Data

As indicated in Section 2.1.A, there is no design criteria or calculations available in the PennDER files for review. The engineering data is limited to the details shown on the construction drawings.

2.2 CONSTRUCTION

There are no records of construction in the PennDER files except that the project was completed in October of 1970. Post construction inspection reports indicate some concern for seepage areas to the left of the outlet structure indicating also that this condition was under study by PennDER. Conclusions of the seepage studies and inspections led to the installation of a stone filter on the slope surface above the outlet structure in 1974 and the cleaning and repairing of the toe drain in 1976.

2.3 OPERATION

An Operation and Maintenance Manual dated February 1971 is on file and describes the procedures to be used in the operation of the dam under all conditions.

2.4 EVALUATION

A. Availability

A full set of construction drawings are available in the PennDER files. Calculations for the embankment design or the design of the spillway and the outlet facilities are not in the files.

B. Adequacy

Although there were not detailed design calculations available for examination, the details shown on the construction drawings were sufficient for making a reasonable evaluation of this facility.

C. Operating Records

There are no formal operating records available for review or comment. The only operation procedures involves the use of the outlet

pipe from the control tower for regulation of lake water surface or minimum downstream flow.

D. Post Construction Changes

The post construction activities at this facility involved repairs to the outlet channel as a result of damage incurred during the 1972 tropical storm Agnes. Additionally, a stone and rock drainage system was installed in the area to the left of the outlet structure to accommodate seepage in 1974 and the toe drain was cleaned and repaired in 1976.

E. Seismic Stability

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

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

#### A. General

The general outward appearance of the dam is good. The dam is part of a State Park facility and is well maintained. The visual checklist is presented in Appendix A. Photographs taken during the September 11, 1978 inspection are included in Appendix D.

#### B. Dam

The dam embankment is 1,750 feet in length and contains two horizontal curves along its axis alignment. Refer to Appendix D, Plate V.

The downstream slope cover is heavy grass, weeds and some small trees. The upstream slope also contains high grass cover above the riprap. The top of embankment is 20 feet wide with an 18-foot wide select 3/4-inch stone surface.

There were no signs of distress visible on any of the slopes. Sloughs, cracks, settlement or serious erosion were not evident. The riprap on the upstream slope appeared to be in good condition.

The junction at the abutments with the natural ground on the right and the concrete spillway on the left appear to be in sound condition.

Regarding seepage, there were no signs of leakage to the right side of the outlet structure. The stone paved ditch at the toe of the slope in this area was completely dry.

A wet spot was detected on the slope above and to the left of the outlet structure. A second wet spot was detected about 50 feet up the slope in this same general area. There was actually no flow from these locations but there was free water on the surface.

Adjacent to the left side of the outlet structure, the sound of underground flow of water was detected. By the sound of the flow, the volume of water appears to be considerable. The area at the outlet structure was examined closely to find the point at which this apparent heavy flow was discharging. There was no evidence visible in this area. It is surmised that the flow spreads laterally as it approaches the channel and thus loses its velocity and any turbulence that would identify the location. Information from discussions with PennDER personnel

during this inspection indicated a long term seepage condition in this general area and that the situation was studied by PennDER personnel.

Additional information from PennDER indicates remedial action to control the slope seepage in 1974. Later in 1976 further investigations revealed that the toe drain was clogged and that this condition was also rectified.

This discharge condition along with the wet spots are of concern.

There were no other conditions of note or concern relative to the dam embankment.

C. Appurtenant Structures

1. Spillway

The approach to the spillway from the reservoir area is an excavated section and is rock lined. The channel is clear and a trash boom is stretched across this channel about 50 feet upstream of the spillway crest.

The concrete forming the spillway, emergency spillway, and wall is all in good condition. Water was barely spilling over the primary spillway crest at the time of this inspection. The maximum flow reported for this dam was 4.9 feet over the spillway during the 1972 storm, Agnes. This flow did cause some damage to the spillway outlet channel. This damage was subsequently repaired in March, 1974 when a permit was issued to draw the lake down for this purpose.

The spillway and its outlet appear to be in good operational condition. There is a staff gage mounted on the left wall of the spillway weir.

2. Intake Tower and Outlet Structure

Access to the intake tower is by boat. The visual observations indicate that this structure and its gate and valves are in good condition. The 36-inch sluice gate was opened and closed for this inspection. It is noted that the deck of the tower is below the crest elevation of the dam (515.5 vs. 500.0).

The outlet structure is also in good condition. Except for the discharge when the 36-inch gate was opened, there was no flow from the outlet pipe.

There is a staff gage mounted on the control tower.



#### D. Reservoir Area

The reservoir area is surrounded by some woodlands, some grassed areas, boat launching areas and roadways. A sedimentation pond is located at the upstream limit of the reservoir to minimize the siltation of the lake. This pond is cleaned on an as-required basis.

#### E. Downstream Channel

The downstream channel is the natural stream with wooded and cultivated fields as the overbank areas.

There are about ten low-lying homes within the first mile downstream from the dam, and many more in Newport about 3.3 miles downstream. The hazard category on the basis of this population in the danger zone is "High".

### 3.2 EVALUATION

The overall condition of this facility, on the basis of this visual inspection appears to be good. The major concern is the apparent volume of the leakage at the downstream toe of the embankment and the wet spots noted on the slope above the outlet structure; both to the left of the outlet structure.

Inspection reports in 1973, 1974 and 1975 mention a seepage condition on the downstream slope. The records of 1976 indicate the need to repair a weir that was used to measure leakage from the dam. This apparently refers to the weir observed at the end of the plunge pool downstream from the outlet structure. Although these records are not complete, they indicate that there has been an ongoing seepage condition near and to the left of this structure.

Examination of the construction drawings, the test boring data and the geologic setting of this dam indicates that the rock formations are subject to leakage along the bedding planes and fractures. Since grouting was carried out in the foundation formations beneath the south abutment and beneath the spillway, the condition was noted and accounted for in these areas. The reason for partial treatment of the foundations is not described in any of the available records. It suggests that the leakage may be coming from the foundation formation which has not been grouted.

PennDER records have reported and described the seepage problems since 1973. Remedial measures have been taken to control the seepage to prevent erosion. Consideration had been given to grouting the foundation and the embankment soil, but the possibility of clogging the internal drainage system as a result of grouting ruled out this action.



The magnitude of flow, as indicated by the sound in the toe drain, is of concern and should be investigated to identify the source, the volume and the effect on the future safety of the dam. The entire flow appears to be discharging into the outlet channel. The weir in this area should be restored and monitored on a regular basis. The investigation should also closely examine the wet spots identified on the downstream slope.

A careful inspection of the downstream slope should be made annually.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

This dam was designed and constructed as a part of a State Park recreational facility. The water surface level in the lake is maintained, as near as possible, at the spillway crest elevation of 495. There is seldom need to use the 36-inch control gate in the tower to regulate the water surface. The two 6-inch intake valves on the control tower are used to release small quantities of water to the downstream when necessary.

Although not in the records, it appears that the volume of seepage is sufficient to maintain a steady flow in the outlet channel without using the valves or gates.

An Operation and Maintenance Manual is available to guide the operations of this dam under all conditions.

### 4.2 MAINTENANCE OF DAM

The maintenance of the dam is limited to the control of growth on the slopes and repairs to operating equipment as necessary.

### 4.3 MAINTENANCE OF OPERATING FACILITIES

The only facility at this dam requiring regular maintenance attention is the control tower and the gate and valves contained therein. The gates are operated as required for operation of the facility.

### 4.4 WARNING SYSTEM

There is no formal warning system in effect.

### 4.5 EVALUATION

The operational procedures of this facility deal with the maintenance of the embankment slopes and the regulation of water flow from the reservoir when necessary.

As this dam is part of a State Park complex, there is daily attendance at the dam.

The operational procedures are contained in the Operation and Maintenance Manual and are satisfactory. The slope surfaces should be inspected closely during the annual slope maintenance period when the cover is cut.

## SECTION 5 - HYDROLOGY/HYDRAULICS

### 5.1 EVALUATION OF FEATURES

#### A. Design Data

Very little information was available on the hydrologic and hydraulic design of the dam. There were no area-capacity curves, frequency curves, unit hydrographs, design storm data, design flood hydrographs, flood routings or spillway rating curves.

A report prepared by PennDER in response to the application for a permit to construct the dam indicated that the design hydrograph was developed using the SCS procedure and involved a 6-hour, 25-inch rainfall storm with 21.3 inches of runoff. It was noted that the "C" curve called for a spillway capacity of 9,770 cfs and that the spillway could pass well in excess of that amount.

#### B. Experience Data

In the period since 1971 when the dam was completed, the greatest flood was that of June 23, 1972, when the observed head on the main spillway was 4.9 feet. Calculations indicate that the discharge for that flood was 1,900 cfs.

There was no damage from that flood with the exception that some of the weathered slate in the unlined spillway chute was torn loose.

#### C. Visual Observations

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

#### D. Overtopping Potential

This dam has a size classification of "Intermediate" (52.5 feet high and 4,020 acre-feet of storage) and a hazard potential classification of "High". (There are about ten low-lying homes within the first mile downstream, and many more in Newport, Pa., which is 3.3 miles downstream).

The recommended Spillway Design Flood (SDF) for a dam with the above classifications is the Probable Maximum Flood (PMF). The PMF for this site is 29,200 cfs and the spillway capacity at top of dam level

(Elev. 515.5) is 31,200 cfs. Thus, the project can pass the PMF without overtopping the dam.

E. Spillway Adequacy

Calculations in Appendix B show that storage in Little Buffalo Creek Reservoir will reduce the PMF peak inflow of 29,200 cfs to an outflow of 24,600 cfs with a freeboard of 1.0 foot. Therefore, the spillway is considered to be adequate.



## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

#### A. Visual Observations

##### 1. Embankment

There were no visual observations of embankment distress with regard to cracks, settlement or sloughage. Wet spots were noted on the downstream slope and constant flow of subsurface water was detected in the toe drain to the left of the outlet structure. Refer to Section 3.1.B and 3.2.

##### 2. Appurtenant Structures

The visual inspection did not find any signs of distress on the spillway, spillway outlet channel, stilling basin or intake structure.

#### B. Design and Construction Data

There was no design criteria or calculations in the PennDER files for the embankment or the appurtenant structures. The design drawings and the results of the visual inspection provide the information for evaluating the stability of the structures.

##### 1. Embankment

The embankment is a zoned earthfill structure with side slopes of 2H to 1V on the downstream side and 2H to 1V and 2.5H to 1V on the upstream slope. Refer to Appendix D, Plate VI. Internal drainage is provided over the main portion of this structure. Even though there are wet spots on the slope and there is a continuous flow in the toe drain, the embankment does not show any signs of instability at this time. The sources of the seepage should be investigated, identified and monitored to assure the stability of the embankment in the future.

##### 2. Appurtenant Structures

On the basis of the details shown on the design drawings and the inspection observations, the appurtenant structures including the spillway, spillway channel and stilling basin, intake tower and outlet structure appear to be sufficient from a structural point of view. There were no visual signs of distress that would suggest an unstable condition of any of the structures.



C. Operating Records

This facility has withstood the tropical storms Agnes 1972 and Eloise 1975 with only minimal erosion damage to the spillway outlet channel. This damage has been repaired. The maximum observed water level over the spillway during a storm event was in 1972 when the elevation was 499.9. The emergency spillway crest is at elevation 509.4 and the embankment crest is at elevation 515.5.

There are no other records regarding the operation of the dam.

D. Post Construction Changes

There have been no major modifications to the dam since its completion in 1970. There are indications that stone fill and some drainage control was installed at the downstream toe for seepage control in 1974 and 1976.

E. Seismic Stability

This dam is located in Seismic Zone No.1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. However, no calculations, studies, etc., were made to confirm this conclusion.

## SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

#### A. Safety

The visual inspection, the review of the available plans and records, and discussions with PennDER personnel indicate that this facility is in good condition and performing satisfactorily.

The major concern is the volume of flow in the toe drain and the observed wet spots on the downstream slope. These conditions should be investigated to establish the source and quantity of discharges and observe the clarity of the drainage flow. Careful inspections of the slope should be made during the annual slope maintenance period and the weir at the end of the outlet structure channel should be restored. A regular program for monitoring of the discharge should be developed and implemented.

The results of the hydrologic and hydraulic evaluation indicate that the spillway and the available storage are sufficient to pass the PMF without overtopping the dam and the spillway is, therefore, considered to be adequate.

#### B. Adequacy of Information

The information available in the files is considered to be adequate for assessing the condition of this facility within the scope of the Phase I inspection.

#### C. Urgency

The overall appearance of the dam is good. The recommendations regarding the investigations to identify the seepage sources, flow and turbidity should be carried out as soon as possible.

#### D. Necessity for Additional Studies

Studies are limited to the recommended investigation and monitoring of the seepage condition presented in this section.

### 7.2 RECOMMENDATIONS

#### A. Facilities

The following recommendations are made for implementation by the owner:

1. That the weir in the outlet channel be restored to operating condition.
2. That the seepage from the toe drain be monitored on a regular schedule. If changes in volume or clarity of the discharge occur, a detailed investigation should be carried out and if conditions warrant, remedial action taken as necessary.
3. A study be made to determine the nature of the seepage problem on the downstream slope to determine the long time effect on the safety of the dam. Necessary remedial action shall be taken as required.

B. Operation and Maintenance Procedures

Although the facilities are maintained in good condition, the following is recommended to insure the satisfactory performance of the dam.

1. That an annual inspection of the downstream slope surface be made.
2. That a formal downstream warning system be developed along with a formal surveillance procedure to be used during periods of intense or prolonged rainfall.

APPENDIX A  
VISUAL CHECKLIST



CHECK LIST - DAM INSPECTION PROGRAM

PHASE I - VISUAL INSPECTION REPORT

NAD NO. 582

PA. ID # 50-60 NAME OF DAM Little Buffalo Creek HAZARD CATEGORY High

TYPE OF DAM: Earthfill dam  
Centerville &

LOCATION: Juniata TOWNSHIP Perry COUNTY, PENNSYLVANIA

INSPECTION DATE 9-11-78 WEATHER Warm - Cloudy TEMPERATURE 70's

INSPECTORS: H. Jongsma, R. Houseal Park  
John Baer

A. Bartlett, R. Steacy D.E.R.  
Dick Rahn

NORMAL POOL ELEVATION: 495 AT TIME OF INSPECTION:

BREAST ELEVATION: 515.5 POOL ELEVATION: Spillway (495)

SPILLWAY ELEVATION: 495 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: 499.9 (1972)

GENERAL COMMENTS:

This dam has a horizontally curved embankment. The right abutment joins the adjacent forested area. On the left the embankment passes through parking area to the spillway.

Upstream cover - high grass and weeds from top to riprap then riprap to and below water surface.

Downstream - heavy grass and weeds with some trees.

Top - grass and 3/4-inch stone topping.

Stone lined ditch right abutment - dry.

Although not visible, the sound of heavy flow of water is detectable at the left side of the outlet structure in the toe drain.

VISUAL INSPECTION

EMBANKMENT	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. SURFACE CRACKS	None evident.	
B. UNUSUAL MOVEMENT BEYOND TOE	None evident.	
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	None evident.	
D. VERTICAL & HORIZONTAL ALIGNMENT OF CREST	Good.	
E. RIPRAP FAILURES	None evident.	
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Embankment abutment - good at spillway Lt. Good at natural ground Rt.	
G. SEEPAGE	No surface seepage on or below the toe of the embankment to the right of outlet structure. Wet spot above and left of outlet on slope (see sketch).	
H. DRAINS	Toe drain and internal filter.	
J. GAGES & RECORDER	Staff gages on the intake tower and spillway.	
K. COVER(GROWTH)	See Sheet No.1	

VISUAL INSPECTION

OUTLET WORKS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. INTAKE STRUCTURE	Concrete tower. Platform below top of dam. Good condition.	
B. OUTLET STRUCTURE	Endwall with 3-foot diameter pipe (no wings). Plunge pool.	
C. OUTLET CHANNEL	Stone lined channel leading to natural stream, V-notch weir at end of channel.	
D. GATES	No gates at outlet structure, control at intake. One 3-foot gate opened at least twice a year.	
E. EMERGENCY GATE	3-foot gate.	
F. OPERATION & CONTROL	Good.	
G. BRIDGE (ACCESS)	Access to intake structure by boat. No bridge.	

VISUAL INSPECTION

SPILLWAY	OBSERVATIONS	REMARKS & RECOMMENDATIONS
A. APPROACH CHANNEL	Excavated and rock lined. Clear. Trash boom on cable 50± feet upstream from spillway crest.	
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Staff gage on the left spillway wall. Concrete walls and ogee section - all in good condition.  Water barely spilling over spillway crest.	
C. DISCHARGE CHANNEL Lining Cracks Stilling Basin	Concrete slabs and walls - slabs to end of walls at stilling basin. Channel excavated into rock. Stilling basin in rock with concrete end sill.	
D. BRIDGE & PIERS	None.	
E. GATES & OPERATION EQUIPMENT	None - uncontrolled spillway.	
F. CONTROL & HISTORY	4.9 feet over spillway during Agnes - 1972	



VISUAL INSPECTION

MISCELLANEOUS	OBSERVATIONS	REMARKS & RECOMMENDATIONS
<u>INSTRUMENTATION</u>		
Monumentation	--	
Observation Wells	None	
Weirs	One - below outlet structure	
Piezometers	None	
Other	Staff gages - 1 at spillway; 1 at intake structure.	
<u>RESERVOIR</u>		
Slopes	Wooded - some grassed areas - boat docks	
Sedimentation	None Sedimentation pond upstream, cleaned out as required.	
<u>DOWNSTREAM CHANNEL</u>		
Condition	Wooded & agricultural	
Slopes	Good	
Approximate Population	25 - 30	
No. Homes	10 homes in first mile.	

## SEEDING

RIP RAP BELOW  
ELE 500.

WORKING AREA  
RETURNED GENERAL  
ORIGINAL CONDITION

FILTER AND STRAINER

ROCK TOL EMP STA C+1

~~ROCK. JOE~~

INTAKE TOWER

- FILTER

Rushing Underground  
Flow in this area

CAMP

EXISTING SCOUT  
CAMP LITTLE PINE

EXISTING

FL

LITTLE

CONC. BLOCK SPRING HOUSE

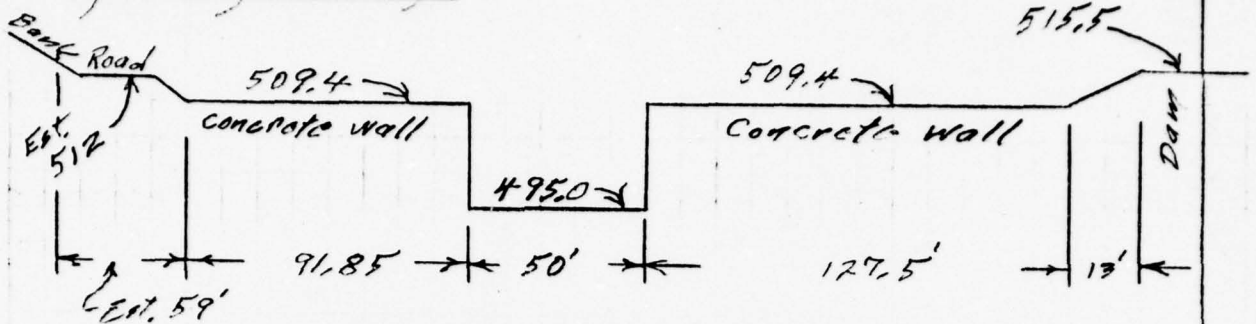
FILTER END ST. 0+75

MON. STA 0+0

SKETCH NO. 1

APPENDIX B  
HYDROLOGY/HYDRAULICS

Spillway Rating

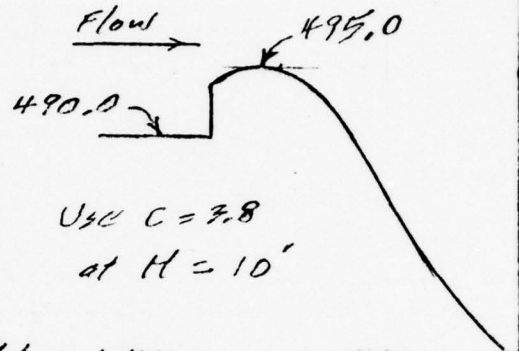


At H = 10 (Elev. 505)

$$Q = CLH^{3/2}$$

$$= 3.8 \times 50 \times (10)^{3/2}$$

$$= 6,010 \text{ cfs}$$



Use  $C = 3.8$   
 at  $H = 10'$

At H = 14.4 (Elev. 509.4)

$$Q = CL(H)^{3/2}$$

$$= 4.0 \times 50 \times (14.4)^{3/2}$$

$$= 10,930 \text{ cfs}$$

$$H/H_0 = 14.4/10 = 1.44$$

$$C = 1.07 \times 3.8 = 4.07$$

Use 4.0

At Max. Known Flood, June 23, 1972

Elev. = 499.9 from flood mark painted on wall, left side of weir

$$H = 4.9 \quad H/H_0 = 4.9/10 = 0.49$$

$$C = .92 \times 3.8 = 3.5$$

$$Q = CL(H)^{3/2}$$

$$= 3.5 \times 50 \times (4.9)^{3/2}$$

$$= 1,900 \text{ cfs}$$

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At Elev. 515.5 (Top of dam)

Road Section

$$H = 515.5 - 512 = 3.5, \quad L = 59', \quad C = 2.63$$

$$Q = CLH^{3/2} = 2.63 \times 59 \times (3.5)^{3/2} = \underline{\underline{1,020 \text{ cfs}}}$$



Spillway Rating (Cont.)

Left concrete wall (1.5 ft. thick)

$$H = 515.5 - 509.4 = 6.1 \text{ ft. (1" chamfer)}$$

$$L = 91.85 \text{ ft}$$

$$C = 3.32 \text{ (From Table 5-3 Beater + King)}$$

$$Q = CLH^{3/2}$$

$$= 3.32 \times 91.85 \times (6.1)^{3/2}$$

$$= 4,590 \text{ cfs}$$

$$\underline{\underline{4,590 \text{ cfs}}}$$

Main Spillway

$$H = 515.5 - 495.0 = 20.5 \text{ ft.}$$

$$L = 50 \text{ ft.}$$

$$C = 4.1$$

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$$Q = CL(H)^{3/2} = 4.1 \times 50 \times (20.5)^{3/2}$$

$$= 19,030 \text{ cfs}$$

$$\underline{\underline{19,030 \text{ cfs}}}$$

Right concrete wall

$$H = 6.1$$

$$L = 127.5$$

$$C = 3.32$$

$$Q = CLH^{3/2} = 3.32 \times 127.5 \times (6.1)^{3/2}$$

$$= 6,380 \text{ cfs}$$

$$\underline{\underline{6,380 \text{ cfs}}}$$

Right embankment

$$H = \frac{515.5 - 509.4}{2} = 3.0 \text{ ft}$$

$$L = 13 \text{ ft}$$

$$C = 2.0 \text{ (Flow is over riprap)}$$

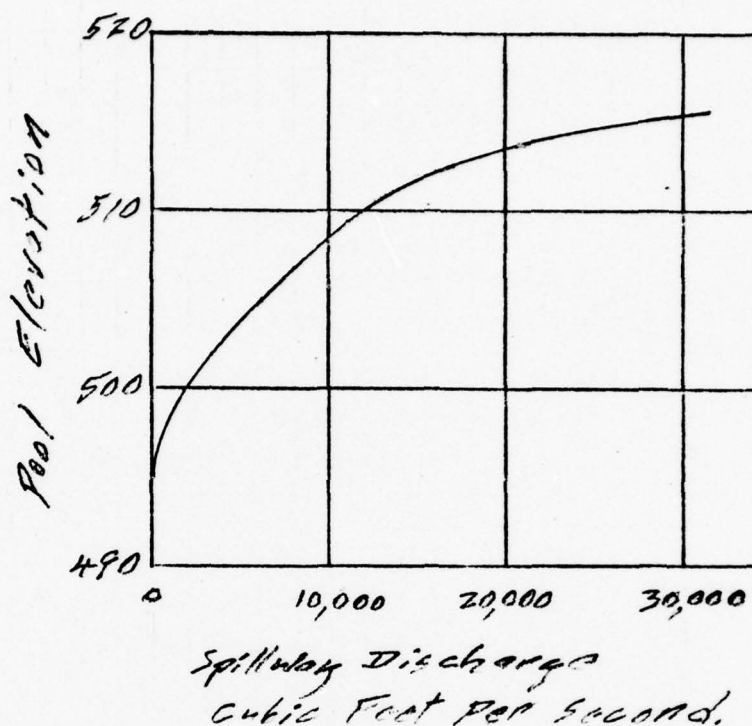
$$Q = CL(H)^{3/2} = 2.0 \times 13 \times (3.0)^{3/2}$$

$$= 140 \text{ cfs}$$

$$\underline{\underline{140 \text{ cfs}}}$$

$$\text{Total } 31,200 \text{ cfs}$$

Spillway Rating (contd)



Warm water outlet

There is a 6-inch inlet pipe in tower with invert at 484.5. Compute as an orifice with pool at spillway crest Elev.

$$Q = C a \sqrt{2gh}$$

$$C = 0.6, \quad a = \pi R^2 = \pi (0.25)^2 = 0.196 \text{ ft}^2$$

$$h = 495 - (484.5 + 0.25) = 10.25$$

$$Q = 0.6 \times 0.196 \times (64.3 \times 10.25)^{1/2}$$

$$= 3.02 \text{ cfs}$$

Use 3 cfs

Low pool outlet

There is a 3-foot diameter outlet pipe 260 feet long passing through embankment. Invert Elev. at tower = 461  
 Compute as orifice with pool at 466 feet.

Low Pool Outlet (Cont.)

$$Q = C a \sqrt{2gh}$$

$$C = 0.6, a = \pi R^2 = \pi (1.5)^2 = 7.07 \text{ ft}^2$$

$$h = 466 - (461 + 1.5) = 3.5 \text{ ft.}$$

$$Q = 0.6 \times 7.07 \times (64.3 \times 3.5)^{1/2}$$

$$= 63.6 \text{ cfs}$$

Use 60 cfs

Pool outlet at normal pool elev.

Compute as above but with pool Elev. 495

$$Q = C a \sqrt{2gh}$$

$$C = 0.6, a = 7.07 \text{ ft}^2$$

$$h = 495 - (461 + 1.5) = 32.5 \text{ ft.}$$

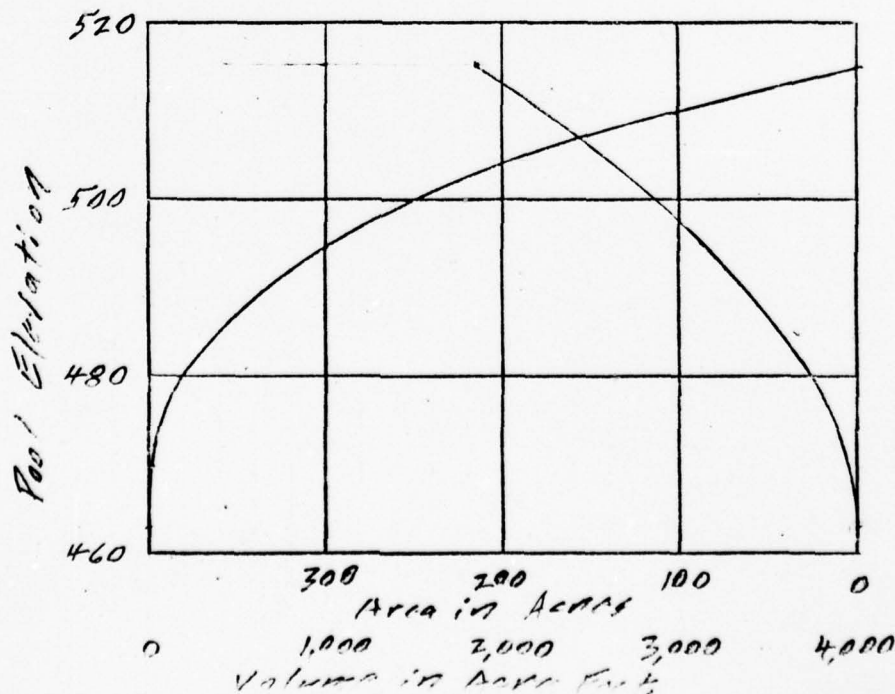
$$Q = 0.6 \times 7.07 \times (64.3 \times 32.5)^{1/2}$$

$$= 194 \text{ cfs}$$

Use 190 cfs

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Area-Capacity Curves



SUBJECT Little Buffalo Creek Dam, ID No. 582  
 COMPUTED BY REE DATE 9-12-78

CHECKED BY DJB 9/19/78

Area Capacity Curves (Cont.)

Elev	Area acres	Vol. ac. ft.	Total Vol. ac. ft.
463	0	0	0
		18	
470	5	160	18
		460	
480	27	380	178
		500	
490	65	1440	638
		1067	
495	87		1018
500	113		1518
510	175		2958
515.5	213		4025

Probable Maximum Flood (PMF)

Drainage Area 13.4 square miles

M. Kanowitz of the Baltimore District of the Corps of Eng. recommended use of their PMF curve for Region 1, Susquehanna River Basin.

That curve gives 2,180 cfs/sq. mi.  
= 29,200 cfs. = PMF

Spillway maximum capacity is 31,200 cfs  
so spillway can pass PMF.

Freeboard From C of E short cut routing method  

$$1 - \frac{\text{Spillway Discharge}}{\text{Peak Inflow}} = \frac{\text{Reservoir Storage}}{\text{Volume of Inflow}}$$
 Use 26" for vol of runoff  

$$1 - \frac{\text{Spillway Disch.}}{29,200} = \frac{\text{Resv. Storage}}{26 \times 59.33 \times 13.4}$$

$$\text{Spillway Discharge} = 29,200 \left( 1 - \frac{\text{Resv. Stor.}}{18,580} \right)$$

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SUBJECT Little Buffalo Creek Dam, LID No 582

COMPUTED BY RES DATE 9-15-78

CHECKED BY DJB 7/19/79

Freeboard (Cont)

Try Pool at 514.5 (1.0 ft freeboard)

$$\text{Spillway Discharge} = 29,200 \left( 1 - \frac{3940 - 1018}{18,580} \right) \\ = 24,600 \text{ cfs}$$

From rating on sheet 3,

$$24,600 \text{ cfs} = 514.5 \text{ pool stage}$$

Storage will reduce 29,200 cfs TWT  
inflow to an outflow of 24,600 cfs  
and there will be 1.0 foot  
of freeboard.

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APPENDIX C  
GEOLOGICAL REPORT

## GEOLOGIC REPORT

### Bedrock - Dam

Formation Name: Sherman Ridge Member of the Mahantango Formation.

Lithology: The Sherman Ridge Member consists of olive gray siltstones and shales with some interbeds of fine grained gray sandstone. The shales and sandstones weather to olive brown and yellowish brown color.

### Bedrock - Reservoir

Formation Names: Sherman Ridge Member, the Harrell Formation, and the Trimmers Rock and Brallier Formations (undivided).

Lithology: The Harrell Formation, which overlies the Sherman Ridge Member, is only 75 to 90 feet thick, and consists of two members, the Tully Member and the Burkett Shale Member. The Tully consists of 17 feet of limy shale with a few interbeds of limestone. The Burkett is a grayish black fissile shale.

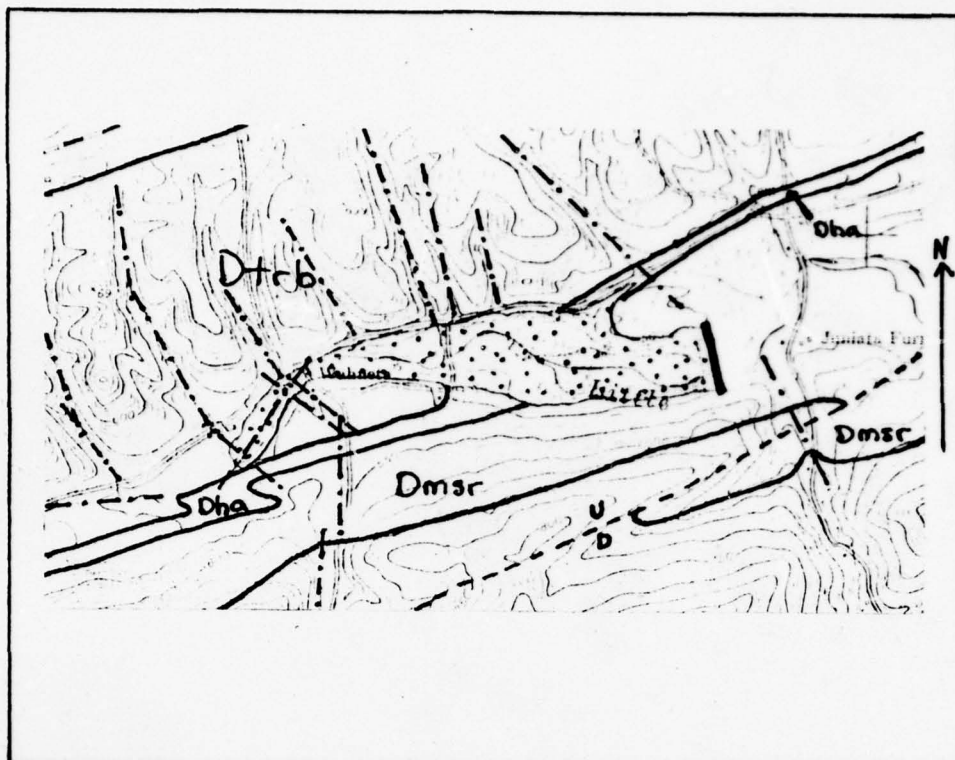
The lower part of the Trimmers Rock and Brallier Formations, which underlies part of the reservoir, consists of 250 feet of dark gray shale grading up into interbedded shale and thin bedded siltstone.

### Structure

The rocks of Little Buffalo Creek valley are folded into rather small amplitude folds. The axis of one of these folds, a syncline, passes through the dam foundation. The axis trends N70°E, approximately at right angles to the dam. Local minor faulting is commonly associated with folds of this kind where seen in outcrop. These faults are usually too small to be mapped.

Air photo fracture traces trend approximately: N35°W, N25°W, N10°W, N55°W, N-S, and N85°E.

# GEOLOGIC MAP - LITTLE BUFFALO CREEK DAM

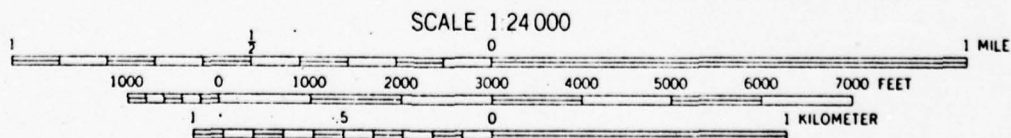


(geology from Pa. Geol. Surv. Atlas A 137ab)

KEY

- |                       |  |
|-----------------------|--|
| Dtrb                  | Trimers Rock and Brallier Fms. undivided |
| Dha                   | Harrell Fm.                              |
| Dmsr                  | Nahantango Fm.- Sherman Ridge Member     |
| --- $\frac{u}{d}$ --- | high angle fault                         |
| .....                 | air photo fracture trace                 |

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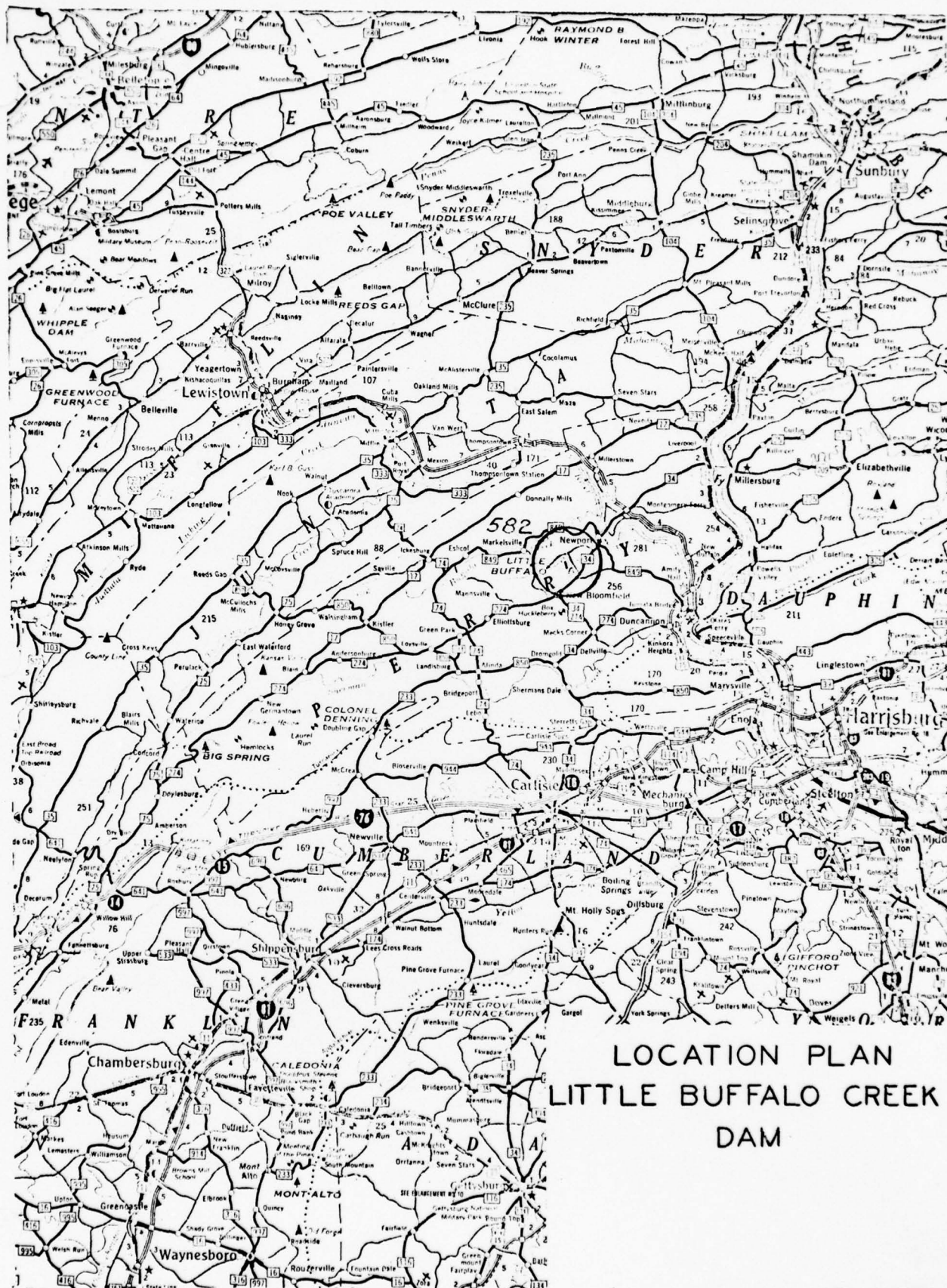


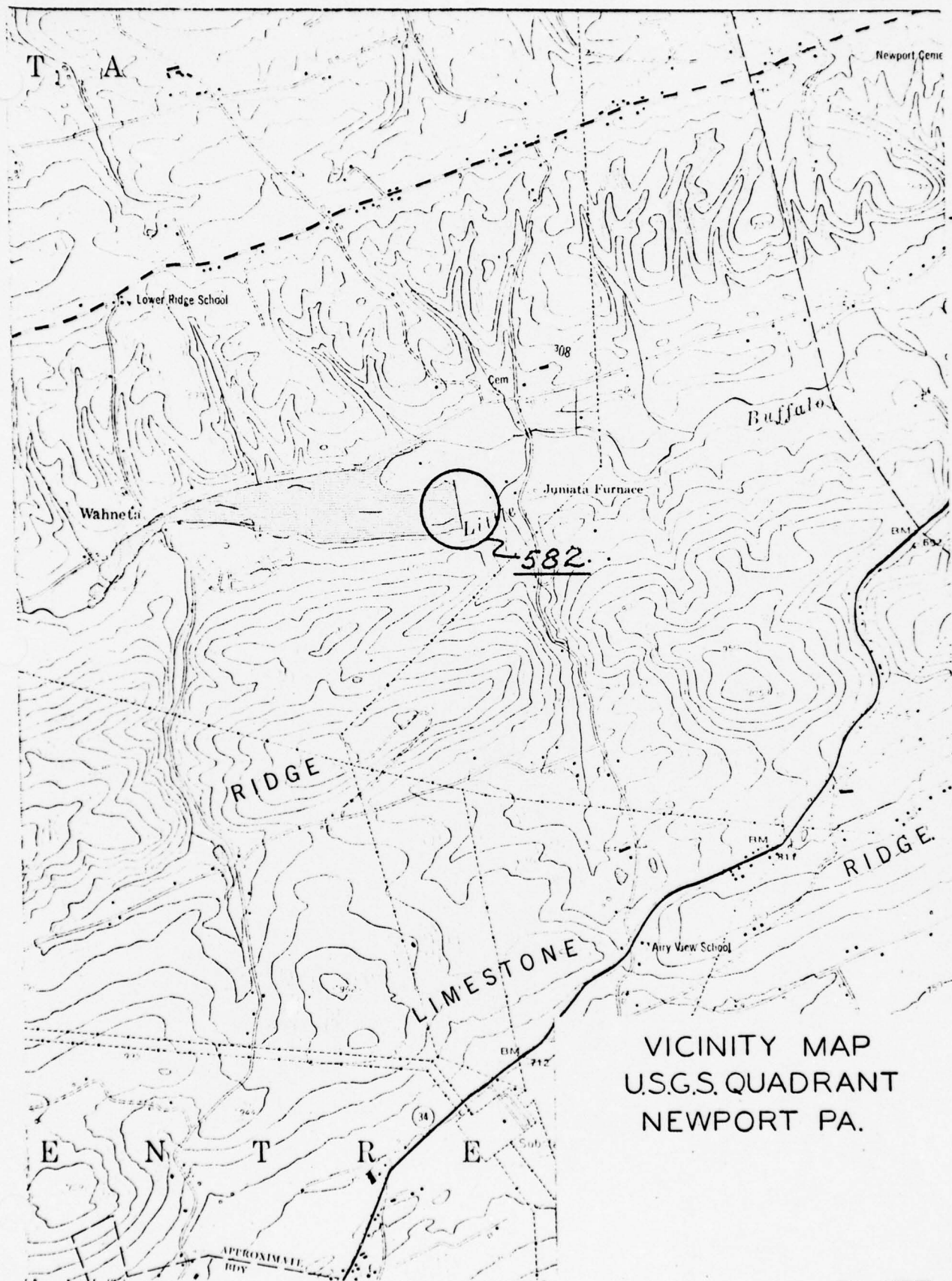
CONTOUR INTERVAL 20 FEET  
DOTTED LINES REPRESENT 10-FOOT CONTOURS  
DATUM IS MEAN SEA LEVEL



APPENDIX D

LOCATION, PHOTOGRAPHS & DESIGN DRAWINGS





VICINITY MAP  
U.S.G.S. QUADRANT  
NEWPORT PA.





Reservoir and  
Intake Tower

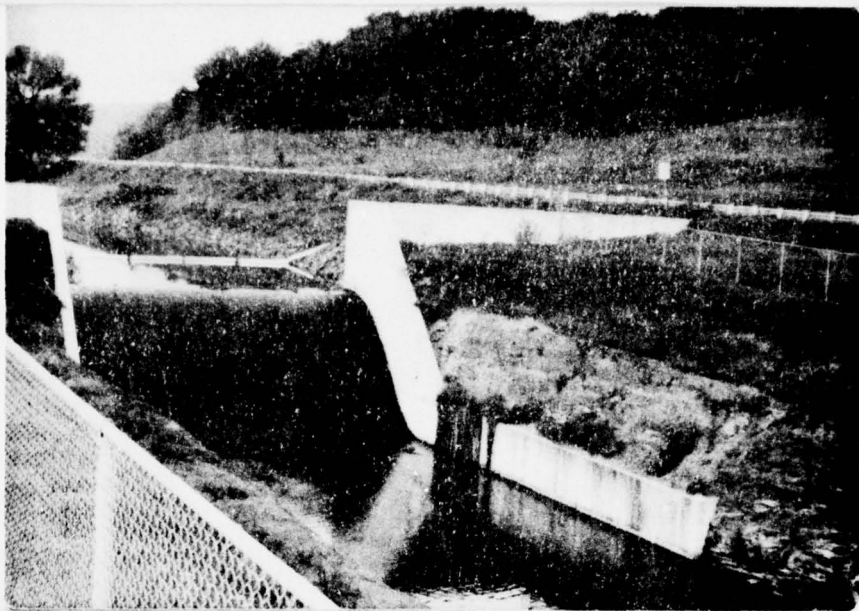


Downstream Slope

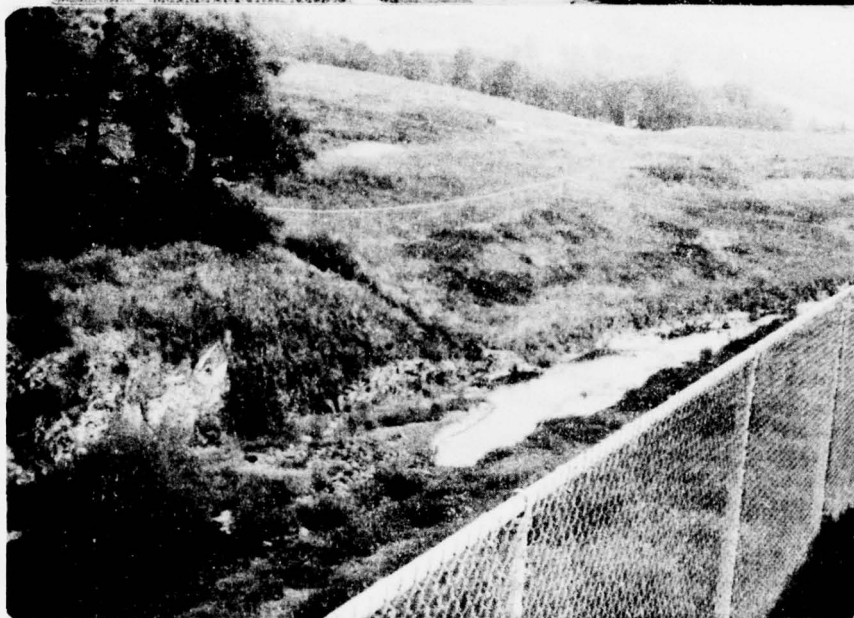


Toe Near  
Conduit Outlet

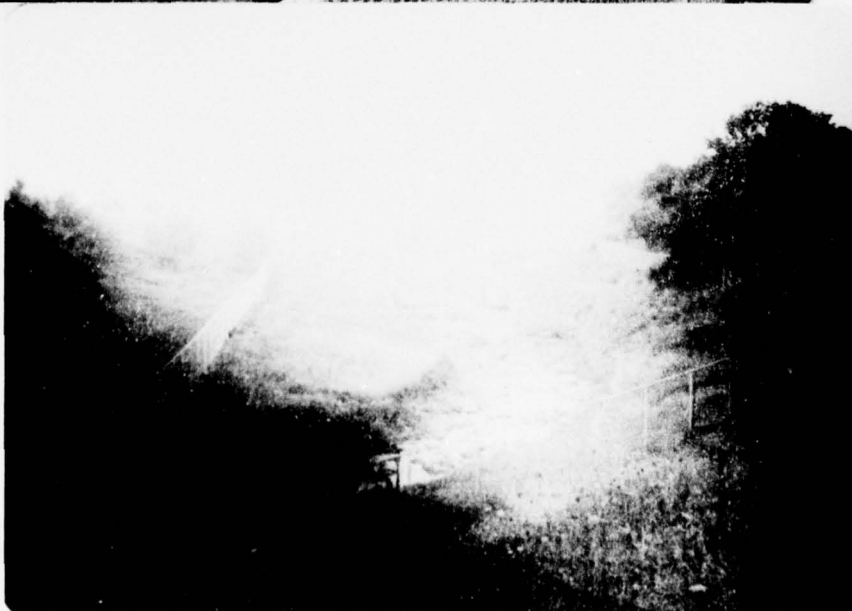




Spillway and  
Emergency Spillway



Spillway Channel  
Looking Downstream



Spillway Channel  
Looking Upstream



582

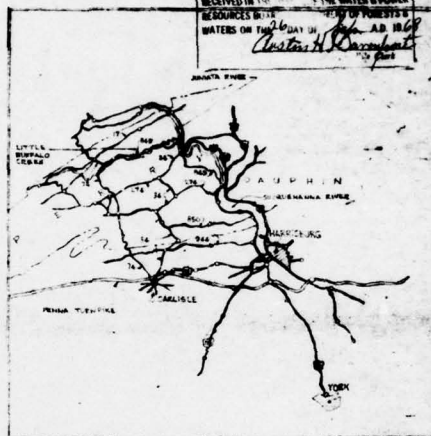


NOTE:-  
SUITABLE STRIPPED MATERIAL SHALL BE REPLACED FOR TOP SOILING OVER ENTIRE BORROW AREA.

SCALE - 1" = 1 MILE

$$50 - 60 = 1$$

RECEIVED IN THE OFFICE OF THE WATER & POWER  
RESOURCES DIVISION  
WATERS ON THE 26 DAY IN  
*Arthur H. [Signature]*



HIGHWAY MAP 7 LITTLE BUFFALO  
CREAK TO HARRISBURG

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# PLATE V

ALBRIGHT & FREL, INC.  
CONSULTING ENGINEERS  
PHILADELPHIA, PA.

SCALE 1"=100'-0"

• COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF FORESTS AND WATERS  
DIVISION OF FLOOD CONTROL

### GENERAL LOCATION PLAN

**LITTLE BUFFALO CREEK DAM.**

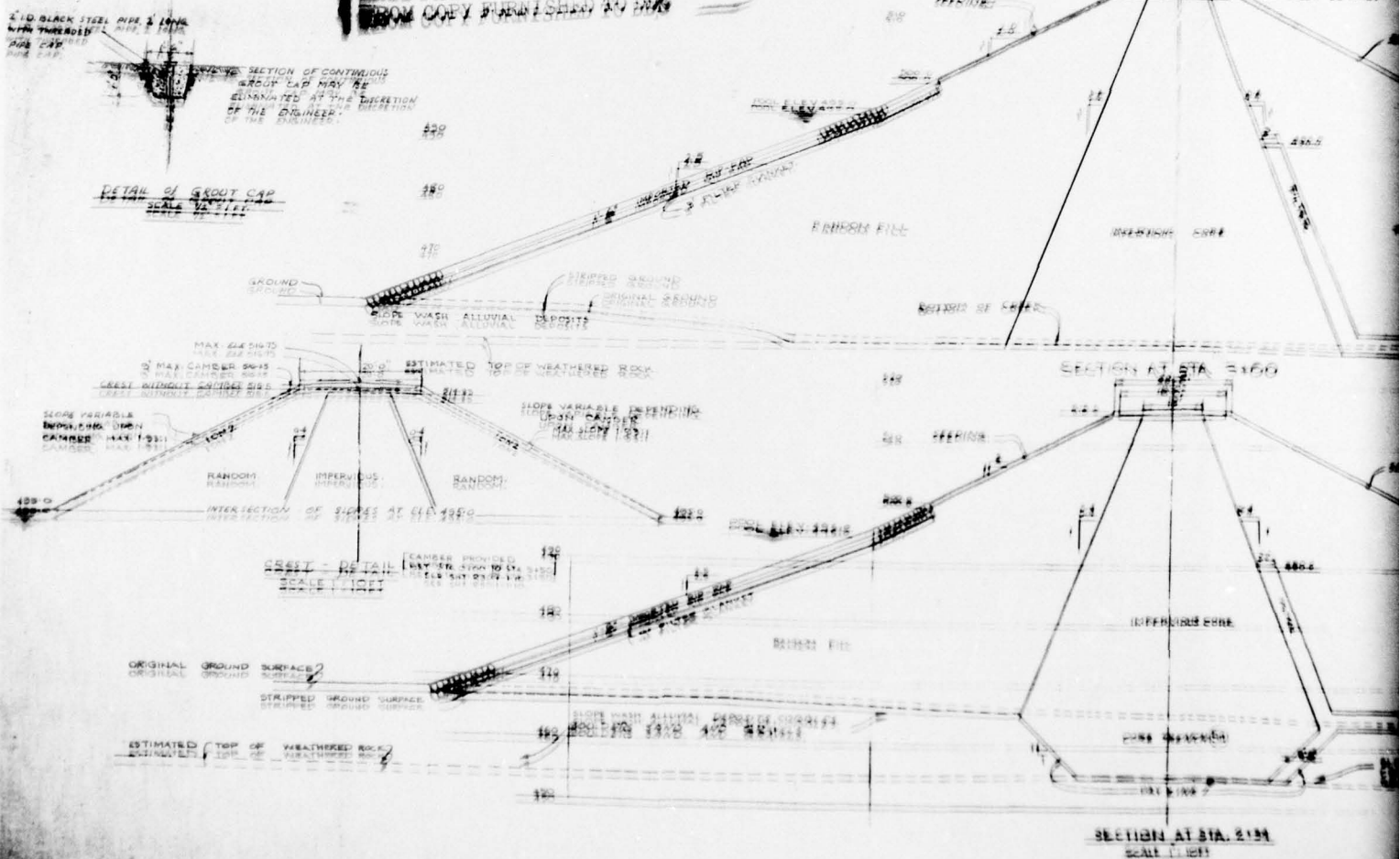
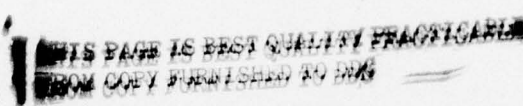
**PERRY COUNTY**

**PENNSYLVANIA**

CONTRACT NO. R50-1-101-1

				DESIGNED _____	SUBM _____	CHECK PLANS CONTINUED BY _____
				DRAWN _____	RECON _____	DEPT. _____
				TRACED _____	APPR. _____	REMARKS _____
NO.	DATE	REVISIONS	REV.	CHK.	DATE	



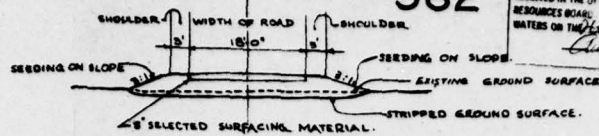




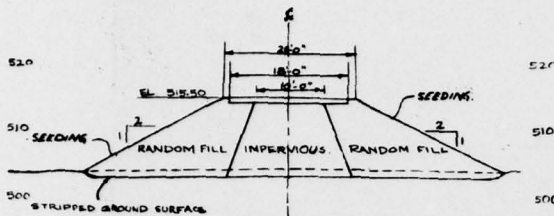
582

50-60-11

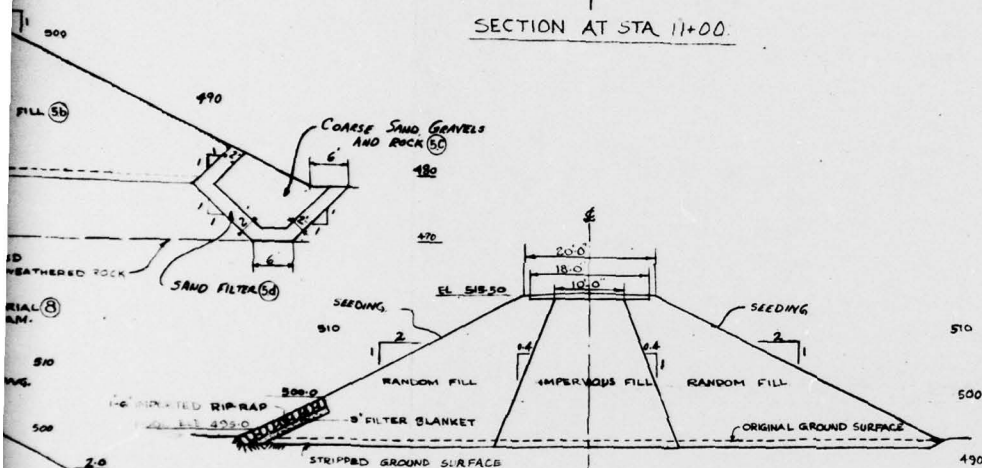
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RESOURCES BOARD, DEPARTMENT OF FORE  
WATERS ON THE DAY OF *APR 10 1961*  
*Charles H. H.*



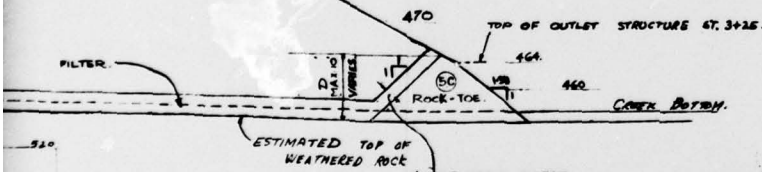
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SECTION AT STA 11+00.



SECTION AT STA 7+50



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## PLATE VI

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CONSULTING ENGINEERS  
PHILADELPHIA PA

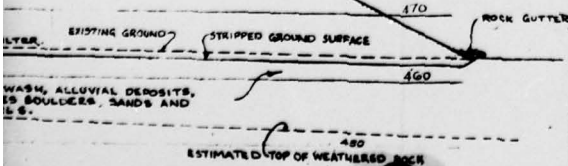
COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF FORESTS AND WATERS  
DIVISION OF FLOOD CONTROL

## DAM SECTIONS

LITTLE BUFFALO CREEK DAM  
PERRY COUNTY PENNSYLVANIA  
CONTRACT NO. R80-1-101.1

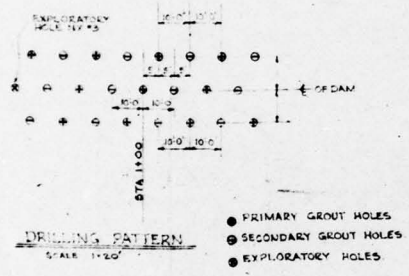
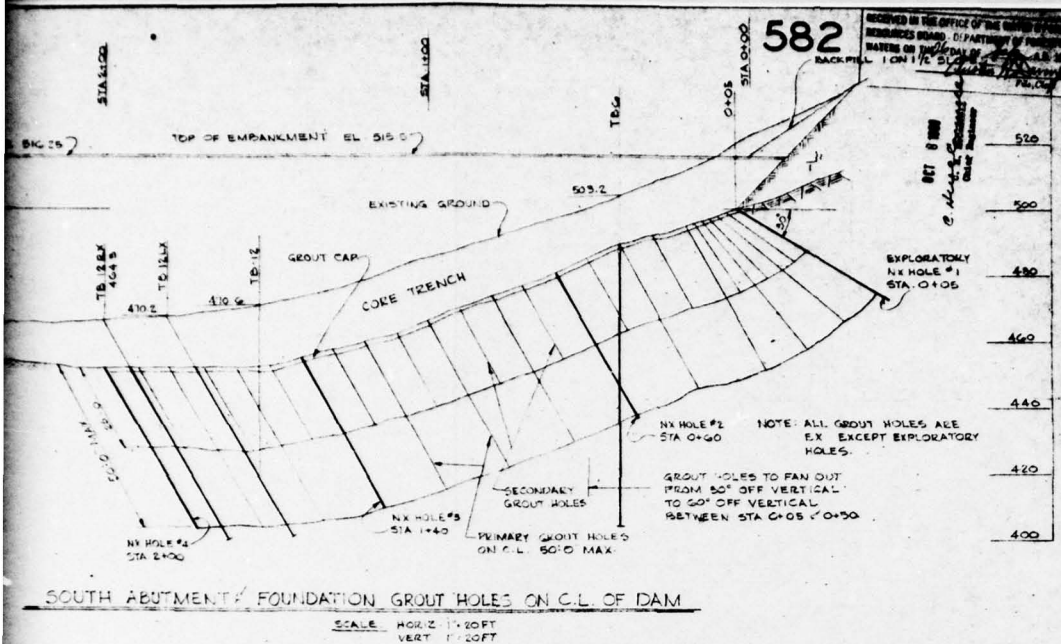
DESIGNED	SUBM	CHIEF FLOOD CONTROL DIV
DRAWN	RECOM	CHIEF ENGR
TRACED		
CHECKED		

2



NO DATE	REVISIONS	REV	CHK	DATE

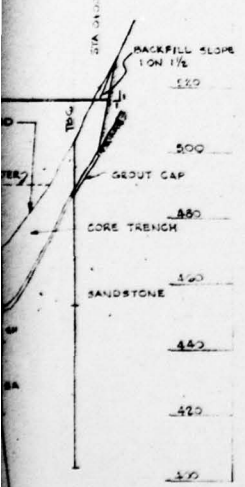




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OF GROUTING (SEE SPECIFICATIONS)  
ABOVE



# **PLATE VII**

ALBRIGHT & FRIEL INC  
CONSULTING ENGINEERS  
PHILADELPHIA PA

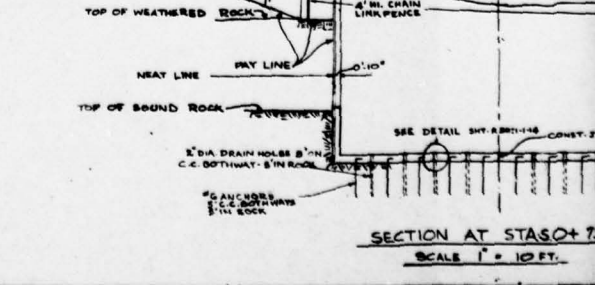
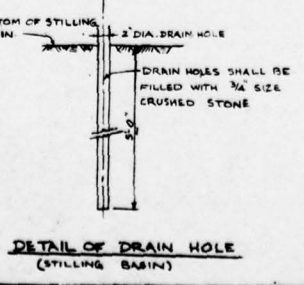
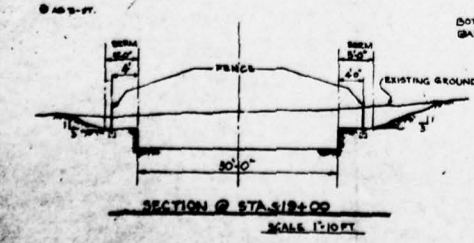
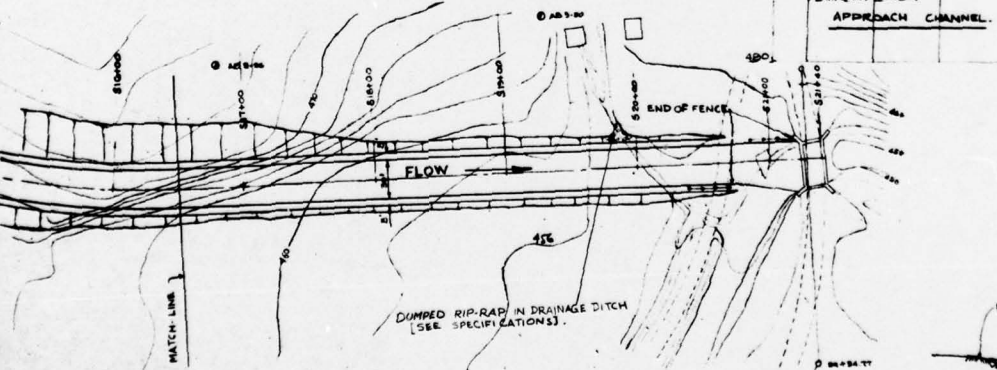
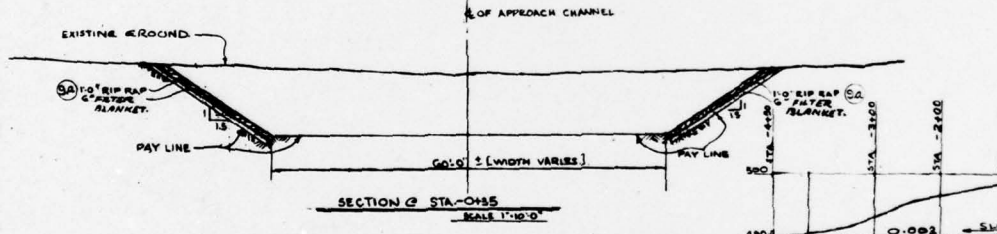
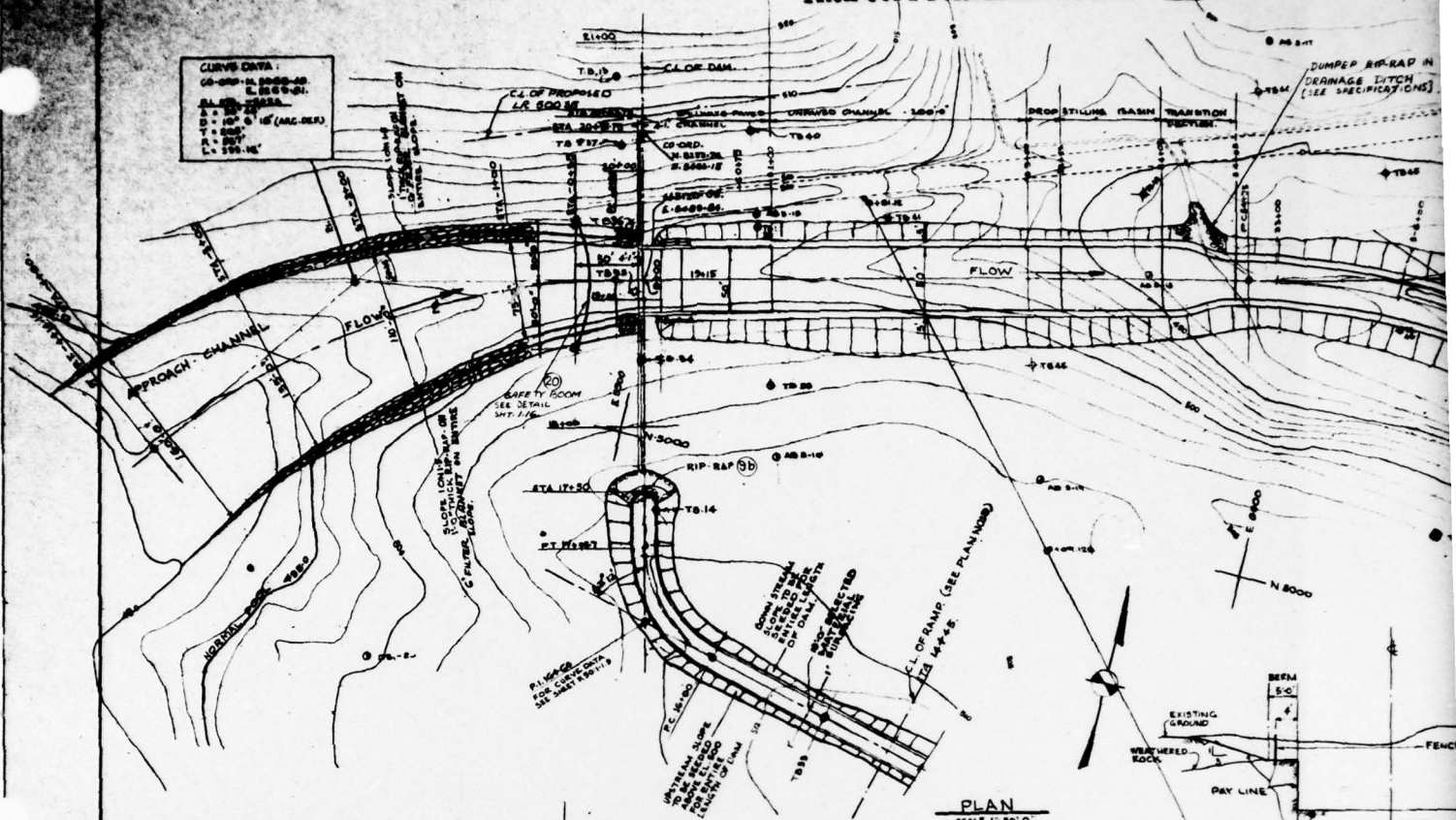
COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF FORESTS AND WATERS DIVISION OF FLOOD CONTROL		
LONGITUDINAL SECTION OF DAM FOUNDATION GROUTING		
LITTLE BUFFALO CREEK DAM		
PERRY COUNTY	PENNSYLVANIA	
CONTRACT NO. R50-1-101.1		
DESIGNED _____	SURE _____	CHEF FLOOD CONTROL DIV.
DRAWN _____	RECON _____	CHEF ENR.
TRACED _____	APPR. _____	SECRETARY
CHECKED _____		

NO.	DATE	REVISIONS	REV.	CHK.	APPR.



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CURVE DATA:  
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L-5000-10  
R-5000-10  
T-5000-10  
P-5000-10  
L-5000-10

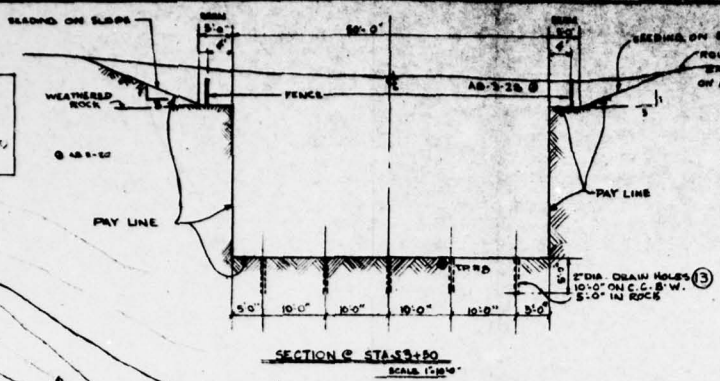




CURVE DATA  
 CO ORD - N 5146-25  
 E 6108-00  
 P1 STATION  
 A = 35' 10"  
 D = 11' 58" 18" (ARC DEF.)  
 T = 500'  
 R = 581.54'  
 L = 537.89'

582

REMOVED TO THE OFFICE OF THE  
 RECORDS AND MAPS DEPARTMENT  
 OF THE PENNSYLVANIA DEPARTMENT OF  
 FLOOD CONTROL

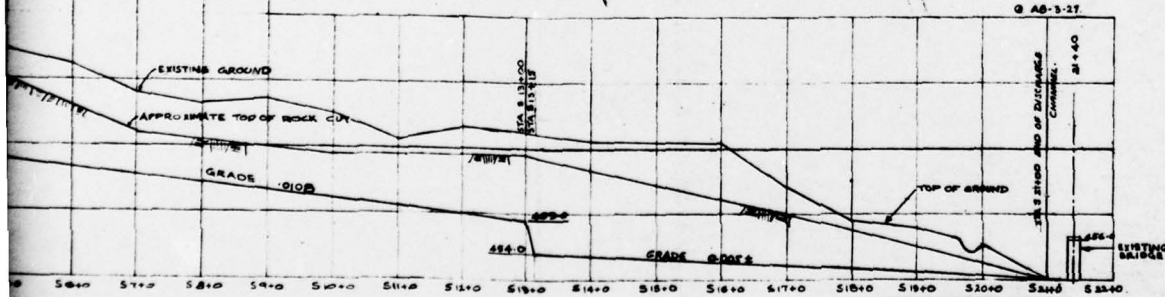


SECTION C STAS 13+00  
 SCALE 1"=100'

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THIS PAGE IS BEST QUALITY PRACTICABLE  
 FROM COPY FURNISHED TO DDC

CURVE DATA:  
 CO ORD - N 5146-25  
 E 6108-00  
 P1 STATION  
 A = 35' 10"  
 D = 11' 58" 18" (ARC DEF.)  
 T = 500'  
 R = 581.54'  
 L = 537.89'



ALBRIGHT & FUEL INC.  
 CONSULTING ENGINEERS  
 PHILADELPHIA PA.

PROFILE  
 SCALE: VERTICAL 1"=10 FT.  
 HORIZONTAL 1"=100 FT.

COMMONWEALTH OF PENNSYLVANIA  
 DEPARTMENT OF FORESTS AND WATERS  
 DIVISION OF FLOOD CONTROL

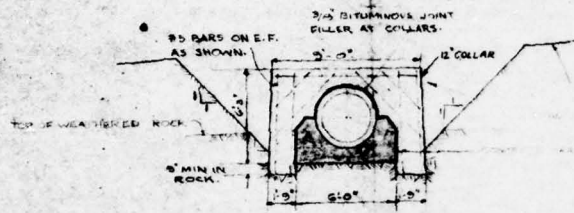
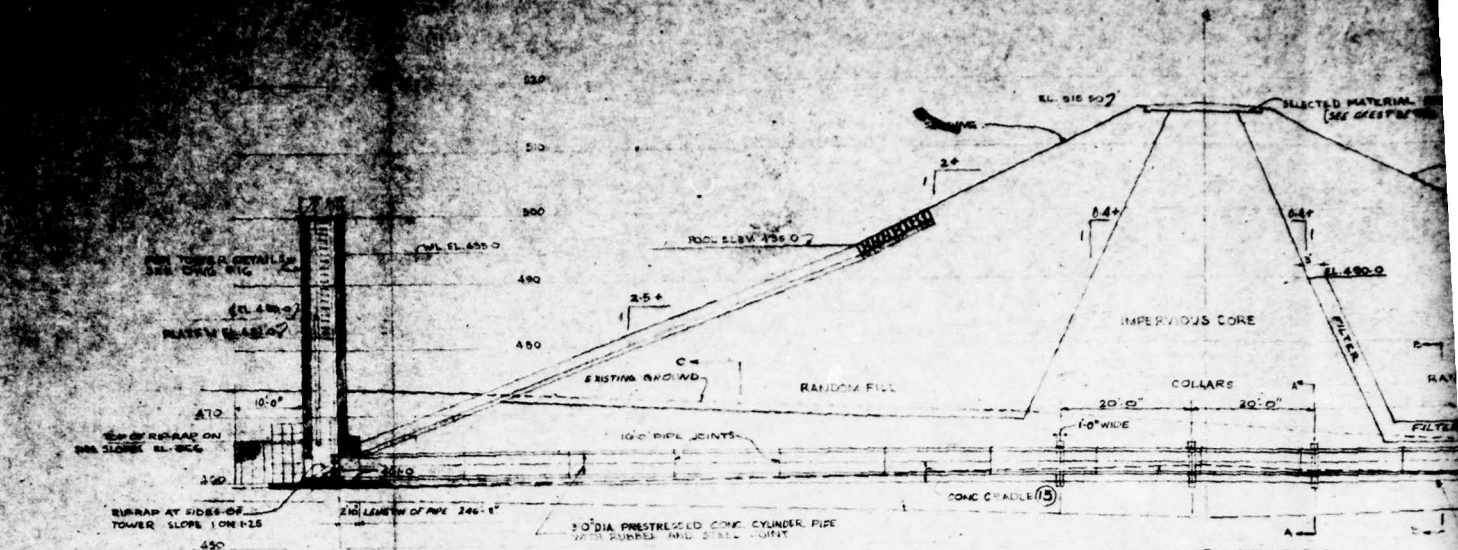
PLAN & PROFILE OF DISCHARGE CHANNEL

LITTLE BUFFALO CREEK DAM  
 PERRY COUNTY PENNSYLVANIA  
 CONTRACT NO. R50-1-101.1

PLATE VIII

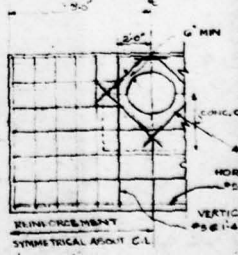
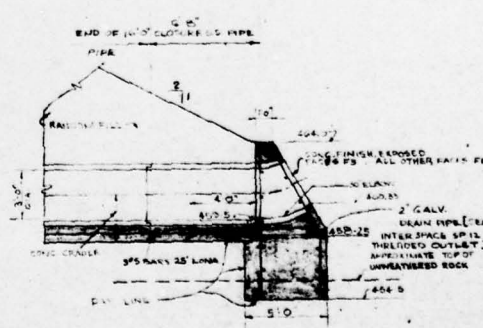
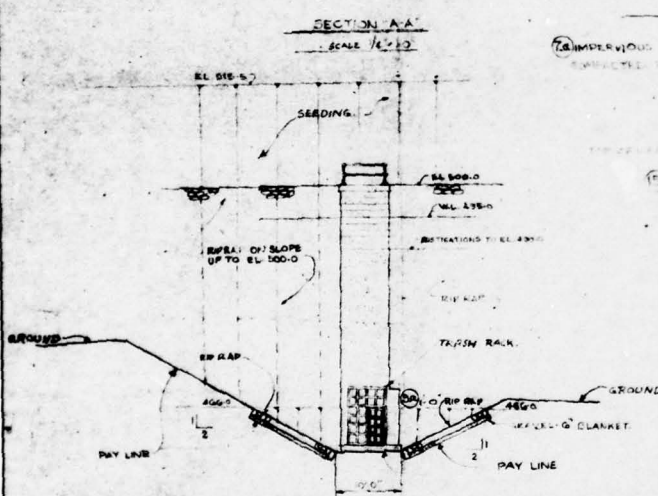
DESIGNED	DRAWN	CHECKED
REVISION	RECORD	APPROVED
TRACED		
CHECKED		

ONLY FLOOD  
 CONTROL ON  
 THIS DAM



SECTION THROUGH E OF 10' DIA. AFTER CONDUIT  
SCALE 1/4" = 1'-0"

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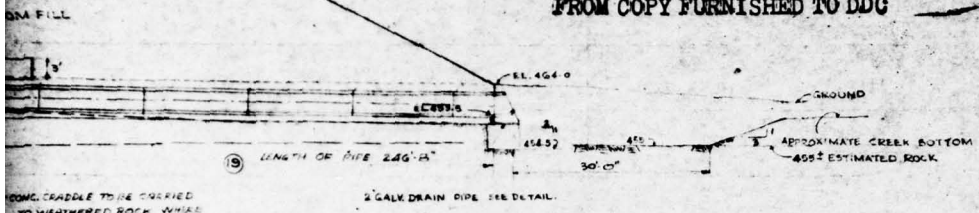
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CONCRETE CRADLE

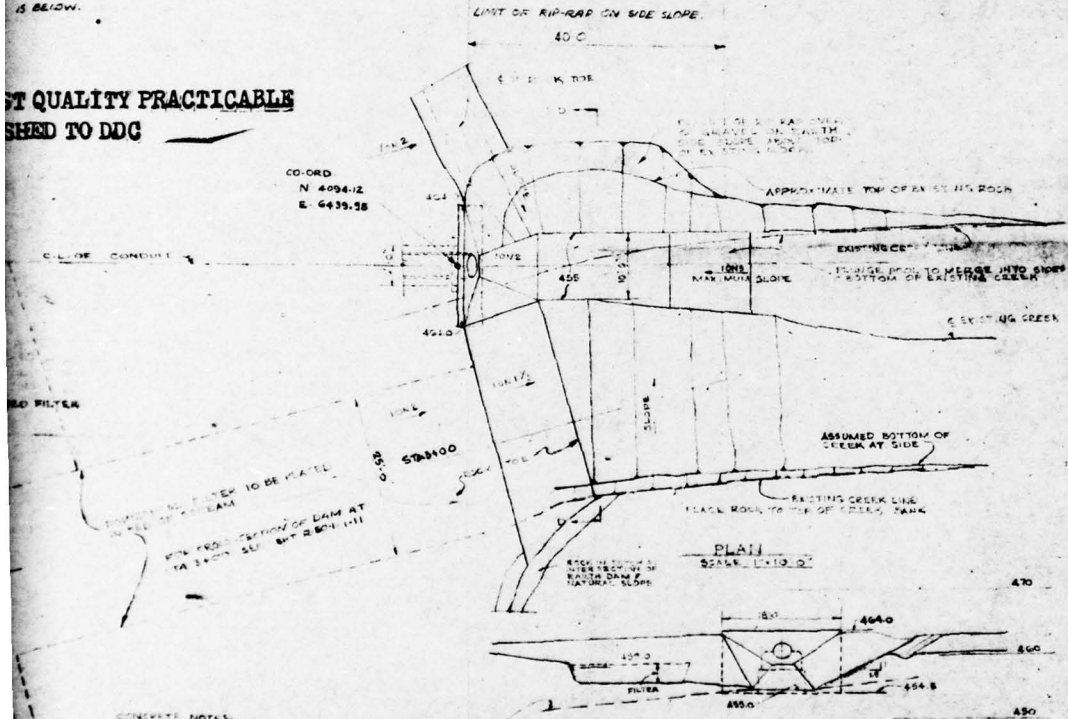


SECTION B-B  
SCALE 1/4"=1'-0"

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PLAN  
SCALE 1/4"=1'-0"

SECTION D-D  
SCALE 1/4"=1'-0"

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CONSULTING ENGINEERS  
PHILADELPHIA, PA.

COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF FORESTS AND WATERS  
DIVISION OF FLOOD CONTROL

OUTLET STRUCTURES

LITTLE BUFFALO CREEK DAM

PERRY COUNTY PENNSYLVANIA

CONTRACT NO. R50-1-101.1

PLATE IX

DESIGNED	DATE	BY
DRAWN	DATE	BY
CHECKED	DATE	BY
APPROVED	DATE	BY



