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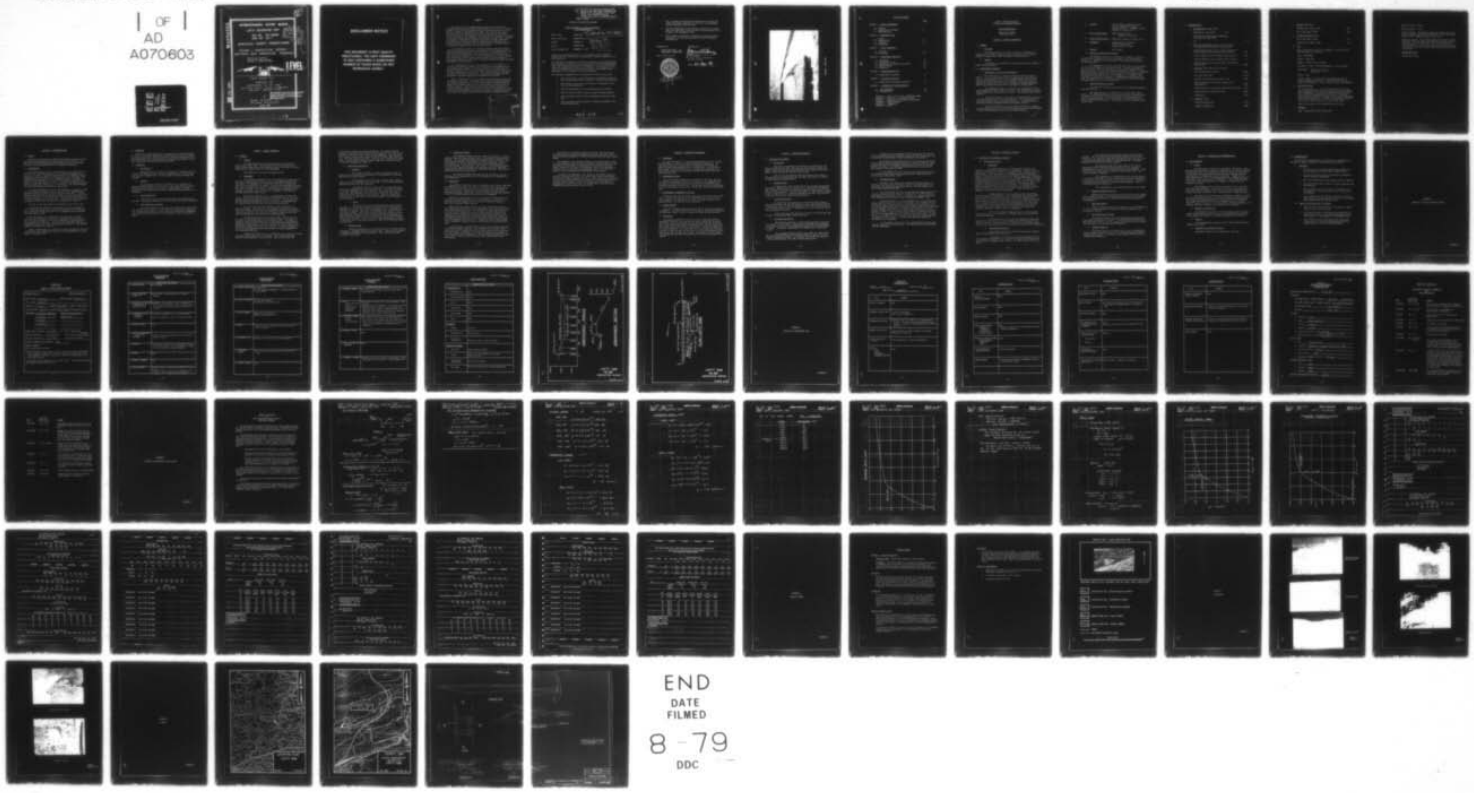

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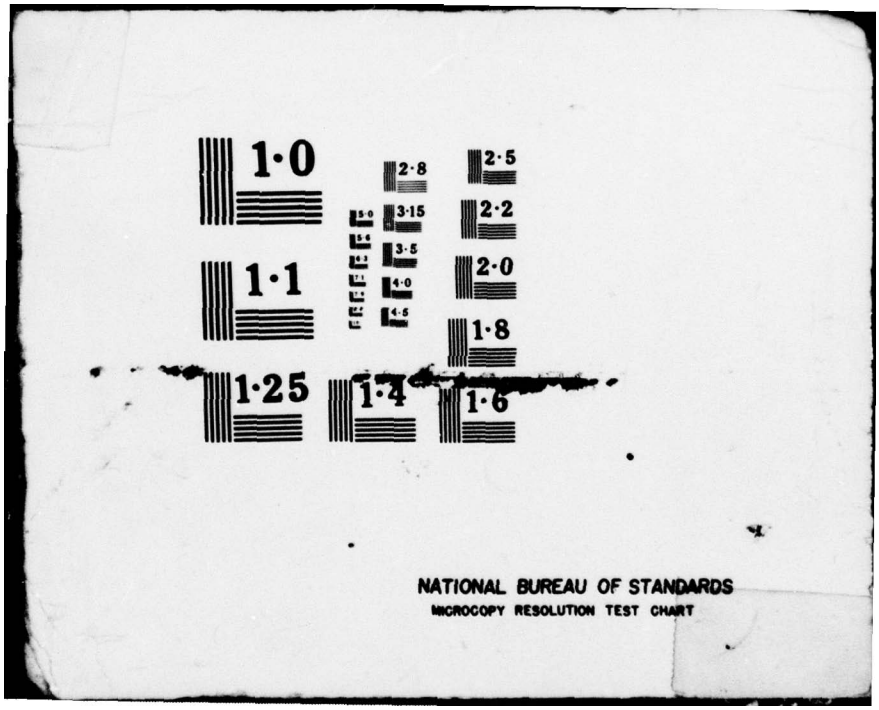
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MICROCOPY RESOLUTION TEST CHART

SUSQUEHANNA RIVER BASIN

LOFTY RESERVOIR DAM

NDI NO. PA-00681
DER NO. 54-1

SCHUYLKILL COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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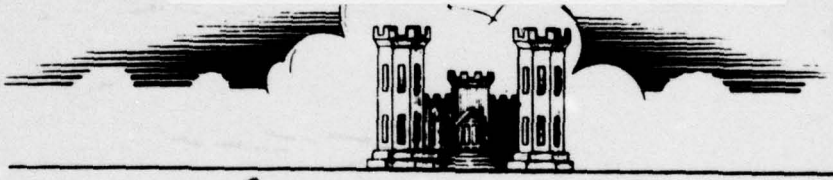

See page ii.

PREPARED FOR

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

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

APRIL 1979

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PREFACE

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evoluntionary 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.

(6) National Dam Inspection Program. Lofty Reservoir Dam (NDI Number PA-00681, DER Number 54-1), Susquehanna River Basin, Messers Run, Schuylkill County, Pennsylvania. Phase I Inspection Report.

~~PHASE I REPORT~~

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

(15) DACW 31-79-C-0012

Name of Dam:	LOFTY DAM
State & State No.:	PENNSYLVANIA, 54-1
County:	SCHUYLKILL
Stream:	MESSERS RUN
Date of Inspection:	NOVEMBER 1, 1978

(11) Apr 79

(12) 73 p.

Based on the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in fair condition.

The hydrologic and hydraulic calculations indicate that the spillway for this dam has the capacity for passing 33 percent of the Probable Maximum Flood (PMF) without overtopping the embankment. Although 1/2 PMF will cause some overtopping, the depth of flow due to the overtopping is less than that judged to cause failure and therefore, the spillway, while inadequate, is not considered seriously inadequate.

The following recommendations are presented for action by the owner:

1. That the low areas of the dam breast be immediately raised to the original design height to provide a uniform crest elevation.

2. That the end of the slab at the spillway be repaired to prevent further undermining.

3. That the deterioration on the spillway walls be repaired.

4. That the 20-inch blowoff valve be cleaned and made operable.

5. That the 20-inch blowoff valve be operated at least once each year.

6. That a positive upstream control or cutoff be provided on the 20-inch blowoff pipe.

7. That a program be developed and implemented to observe and record the seepage conditions at the toe of the embankment noting volume and clarity of flow.

8. That the maintenance of the slope be continued on an annual basis with particular attention given to the discovery of any seepage on the embankment slope.

9. That a formal surveillance and downstream warning system be developed to be used during periods of high or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: April 6, 1979

APPROVED BY:

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

DATE 22 Apr 79

OVERVIEW - LOFTY DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LOFTY RESERVOIR DAM

NDS-ID NO. PA-00681
DER-ID NO. 54-1

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

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

ABSTRACT

1.2 DESCRIPTION OF PROJECT

A. Description of Dam and Appurtenances

The Lofty Dam is an earthfill structure which was built in 1896-97. It was raised in elevation two times during its existence; once in 1912 and once in 1915. The 1915 modifications were not completed until 1922 because of a lack of funds. There were no major changes in the dam since 1922 and the embankment, spillway and outlet pipe of that design are reflected in the dam as it stands today.

The embankment length is 1,100 feet and the spillway at the left abutment has a crest length of 29 feet. The spillway is a concrete broad crested weir with concrete side walls. The spillway apron is also concrete.

The outlet feature of this dam is a 20-inch diameter pipe with a 20-inch control valve on the downstream end. The valve control is exposed, sitting at the existing ground surface. The upstream end of the 20-inch pipe is submerged and has no positive closure.

The dam functioned as a reserve water supply source feeding the Blue Head Dam 2.7 miles downstream through the natural stream channel to which the spillway and outlet of Lofty Dam discharge.

ABSTRACT

B. Location: Kline Township, Schuylkill County
U.S.G.S. Quadrangle - Delano
Latitude 40°-52.3', Longitude 76°-02.7'
Appendix F, Plates I & II

C. Size Classification: Small (Height 28 feet -
Storage 431 Acre-feet)

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

E. Ownership: Mahanoy Township Authority
46 North Main Street
Mahanoy City, PA 17948

F. Purpose: Water Supply

G. Design and Construction History

The original structure was constructed in 1896-97. There are no records in the file to identify the designer or the construction company. The embankment was constructed of clay and gravel taken from the reservoir area.

The embankment length was about 900 feet with a crest elevation of 105 and a spillway crest elevation of 100. A permit was issued on June 21, 1911 to raise the embankment and spillway to elevation 112 and 108 respectively. The work was completed in the fall of 1912. A subsequent permit was issued on October 20, 1913 to again raise the dam five feet. The design for this modification was prepared by A. B. Cochran & Son, Engineers of Pottsville, Pennsylvania. Although construction began in 1915, the project was not completed until 1922 due to the lack of funds. (Spillway datum 113 = U.S.G.S. datum 1391).

H. Normal Operating Procedures

The Lofty Dam facility has not been used or operated during the past twelve years.

The impounded water is available as a reserve water supply source. The normal operating procedure for the dam was to release water as needed to the natural stream, Messers Run, which transported the supply to Blue Head Dam, 2.7 miles downstream. Pumping facilities are part of the Blue Head Reservoir. This system is not in operation at the present time.

1.3 PERTINENT DATA

A.	Drainage Area (square miles)	
	Computed for this report - 1.48	
	From report to Water Supply Commission regarding dam application - 1.7	
	Use	1.5
B.	Discharge at Dam Site (cubic feet per second) (See Appendix C for hydraulic calculations)	
	Maximum known flood, June 22, 1972, estimated on basis of nearby gaging stations (peak inflow)	400
	20-inch blowoff at pool elevation 1,391 feet msl	48
	20-inch blowoff at pool elevation 1,370 feet msl	17
	Spillway capacity at pool elevation 1,396 feet msl (top of dam)	1,000
C.	Elevation (feet above mean sea level)	
	Top of dam (design elevation	1,396
	Low point top of dam	1,395.3
	Spillway crest (Design Datum Elev. 113)	1,391
	Blowoff and outlet pipe invert upstream end, approximately	1,368
	Blowoff and outlet pipe invert downstream end, about	1,366
	Stream bottom at centerline of dam	1,368
	Normal pool	1,391
D.	Reservoir (feet)	
	Length of maximum pool	2,200
	Length of normal pool	1,800

E. Storage (acre-feet)

Spillway crest (Elev. 1391)	276
Top of dam (Elev. 1396)	431

F. Reservoir Surface (acres)

Top of dam (Elev. 1396)	44
Spillway crest (Elev. 1391)	31

G. Dam

Refer to Plates A-I and A-II in Appendix A for section and plan and Plate III, Appendix F.

Type: Earthfilled.

Length: 1,100 feet.

Height: 28 feet above streambed.

Top Width: 18 feet (Field Measurement); 14 feet (Design).

Side Slopes: Upstream - 2H to 1V
Downstream - 2H to 1V

Zoning: None.

Cutoff: Trench - 16 feet deep with puddled clay core up to the original ground surface. This information is not shown on the drawing but was so reported in the correspondence.

H. Outlet Facilities

The outlet facility is a single 20-inch diameter cast iron pipe approximately 130 feet long extending through the embankment. Regulation is provided by a 20-inch gate valve about ten feet from the downstream end of the pipe. The valve bonnet and gear mechanism is exposed to the weather and appears to be in poor condition. The owner's representative said the valve had not been operated in at least twelve years.

There is no closure on the upstream end of the pipe.

I. Spillway

Type: Uncontrolled broad crested weir.

Length of weir: 29 feet.

Crest Elevation: 1,391.

Upstream channel: Rectangular channel with gravel invert and vertical concrete side wall 5.0 feet high. Invert has upward slope of 0.05. Channel is about 40 feet long.

Downstream channel: Rectangular channel with concrete bottom and sides, is 75 feet long. The first 40 feet from crest has a downward slope of about 0.025. The final 35 feet has a slope of about 0.3. At the end of the concrete chute, water is delivered to an earth channel lined with riprap which seems to be stable.

J. Regulating Outlets

See Section H above.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

This dam was constructed in 1896-97 and modified twice by raising the spillway and embankment crest elevations in 1911 and 1915. The design data available includes limited drawings and no calculations. The check list of engineering data is included as Appendix B.

2.2 CONSTRUCTION

The initial construction, as indicated above, was carried out in 1896-97, with a spillway elevation of 1,378 and an embankment crest elevation of 1,383. A report of September 25, 1912, indicates that the original dam was about 900 feet in length and 15 feet in height. The embankment was constructed of clay and gravel having a top width of eight feet and side slopes of 2H to 1V. The upstream slope was rip-rapped. It was reported that a clay core trench 16 feet deep was filled with clay puddle as a cutoff wall. A 20-inch pipe was carried through the trench and through the downstream valve house.

The 1912 improvements raised the dam embankment to elevation 1,390 and the spillway to elevation 1,386. The top of the embankment was widened to 16 feet and the length increased to 1,030 feet. A 20-foot berm was constructed on the downstream slope at a vertical distance of 5 feet below the crest of the embankment. The downstream slope was 2H to 1V with no change to the upstream slope. The spillway crest length was increased to 29 feet and its capacity was indicated as 1400 cfs.

The work on this improvement was completed in the fall of 1912.

Application for additional improvements was made on September 5, 1913. This improvement again provided for increasing the capacity of the reservoir by raising the crest of the embankment and the spillway. This work began in 1915.

The plan called for an embankment crest elevation of 1,396, a spillway crest elevation of 1,391 and an embankment top width of 14 feet. The design height of the dam was now 28 feet and the length of the structure was 1,100 feet. The berm on the downstream slope was eliminated and the slope ratio was indicated as 2H to 1V. The spillway capacity was reported as 1,000 cfs.

Lack of funds delayed the completion of this modification until the early 1920's. This modification reflects the dam dimensions as it now stands in November, 1978.

2.3 OPERATION

There are no formal records of the operation of this dam available for review. The owner reported that the dam serves as a reserve supply of water, wherein water releases are made to the Blue Head Dam some 2.7 miles downstream on an as needed basis. The Lofty Dam; however, has not been operated for the past 12 years (since 1966).

2.4 EVALUATION

A. Availability

Engineering data of value for evaluating the condition of this facility are limited to a few drawings, correspondence, and inspection reports in the PennDER files. No calculations or design criteria were available.

B. Adequacy

The engineering information available is not adequate for making detailed analyses of the structure. The condition of the dam is based upon visual observations, historic correspondence, available drawings and new calculations based upon field measurements, maps, and hydrology.

C. Operating Records

There were no operating records available for examination for this dam. Information obtained was from the owners during this inspection.

D. Post Construction Changes

Two major changes were made after the completion of the initial dam construction at this site. Both involved increasing the capacity of the reservoir and included, in both cases, the raising of the embankment crest elevation and the spillway crest elevation. Refer to Section 2.2 above.

VISUAL 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The Lofty Dam has not been used or operated over the past twelve years (since 1966). In its time of use, it was operated as a reserve water supply source when releases of water were made to the Blue Head Reservoir located about 2.7 miles downstream.

The condition of the dam is described as fair.

B. Embankment

The existing embankment reflects the modification completed in 1920 and is constructed of earthfill with a clay puddled core wall at its center. The embankment is approximately 1100 feet in length and about 28 feet in height at its center. The top width was measured at 18 feet with an average crest elevation (referenced to the spillway elevation of 1,391) of 1,395.5±. The design crest elevation is indicated on the drawings as 1,396.0. Refer to Plate A-I in Appendix A for sketch of surveyed profile and cross section.

The exposed upstream slope of the embankment is relatively steep, 1.25H to 1V, to the waters edge at elevation 1,391.0. The slope appears to flatten somewhat below the water surface. The drawings for the 1915 modification indicate a 2H to 1V slope on the upstream side. The exposed slope cover is soil with some short weed growth.

The top of the dam shows evidence of some recent fill at various locations. This indicates some attempts to maintain a reasonably level surface over the crest and probably accounts for the variation shown on the profile. The crest cover is mostly sandy soil with some short weed growth near the upstream and downstream edges.

The downstream slope has an average slope ratio of 2H to 1V. The cover is weeds and stumps of small brush or trees. The slope is reasonably clear of heavy growth and is rather uneven. The unevenness appears to be the result of long term erosion where shallow gullies are dispersed at random along the entire length of the slope. There was no evidence of seepage on the slope above its toe. Tree growth begins at the toe of the downstream slope and continues as typical woodlands in the downstream direction.

Seepage was evident below the downstream toe at several locations along the entire length of the embankment. This condition has been reported by inspections as early as 1920. Prior to that time, the

records do not mention any seepage condition. The seepage observed during this inspection was wet marshy areas beyond the toe from the left abutment to the right of the center of the embankment. Near the right end, a steady flow creating a small stream was observed just beyond the toe. All water observed was clear. The flow rate is estimated at about 5 gpm. A tabulation of seepage comments taken from inspection reports is included in Appendix B, Table I.

C. Appurtenant Structures

1. Spillway

The present spillway is a broad crested weir having a length of 29 feet from the left abutment of the embankment to the abutment with the natural ground.

The spillway abutment walls are concrete walls showing signs of serious weathering on the right side. The left side shows less deterioration and is in fair condition.

The spillway slab also shows signs of erosive deterioration and is undermined at its downstream limit. Some debris is laying on the slab including logs, rock and brush. Heavy flow will wash the slab clear. The approach to the spillway is reasonably clear and is directly from the left side of the reservoir. Some tree stumps and large rock are in this area but should not interfere with the capacity of the spillway.

2. Outlet

The outlet from the Lofty Dam Reservoir, aside from the spillway, is a 20-inch pipe extending from the reservoir beneath the embankment to a point just beyond the downstream toe. The condition of this pipe is unknown. The outlet end discharges into a ditch at its downstream terminus. The exposed portion of the pipe appears to be in good condition. Regulation of flow through the pipe is controlled by means of an exposed valve control about 10 feet upstream from the downstream end of the pipe. This valve has not been operated for at least 12 years and is in a very rusty condition. There is no upstream control for this pipe.

D. Reservoir Area

The area surrounding the Lofty Dam Reservoir is typical mountain topography. Woodlands surround the entire lake. There are no residences or commercial properties in the watershed. Only rough access roads encroach on this land.

E. Downstream Channel

The downstream channel directly below the spillway is a narrow channel lined with brush and small trees. The bottom is rock and gravel material. The stream flows through the mountain terrain leading to the Blue Head Dam Reservoir located about 2.7 miles downstream. There is one residence at the Blue Head Dam along with an abandoned pumping station building. This facility is not in use. The downstream channel below the Blue Head Dam continues as a mountain stream and eventually joins Catawissa Creek some 3,000 feet below Blue Head Dam. There are no additional residences in this area.

The hazard category, based upon the one residence, the Blue Head Dam and the pumping station at the Blue Head Dam is considered to be "Significant".

3.2 EVALUATION

The condition of the Lofty Dam, on the basis of the visual inspection is considered to be fair. The age of the dam, 84 years, and the fact that it has not been used for at least the past 12 years contribute to this fair condition. Maintenance has been minimal and from present observations appears to have been limited to slope clearing and placement of fill at random locations on the crest of the embankment.

The outlet control valve is in the closed position and appears to be in poor operating condition, if it can actually be operated. It is doubtful that this control could be used in an emergency condition. This control should be made operable.

While there was a small pool of water just outside of the outlet pipe, downstream from the toe of the embankment, there was no detectable flow from or around this pipe. The observed wet conditions below the toe and the free running water near the right abutment below the toe together with the records of seepage over many years recorded in the inspection reports point out an ongoing seepage condition. Because of the length of time this condition has persisted and the absence of any signs of embankment distress such as sloughs, or slides, the condition is not considered a serious threat to the stability of the dam at this time.

A letter report to PennDER from the owner July 29, 1929, dealt with the reported seepage condition. The conclusion of the owner in this report was that the seepage was due to natural springs in this area and not from the dam. The report stated that the springs were abundant in this area before the dam was built. The files did not contain any data such as flow records or regular observations to substantiate these conclusions.

The spillway is in need of repairs to both the slab and the abutment walls and the channel just downstream from the end of the slab could be dressed and graded. The end of the slab also needs some support repair.

The embankment crest should be brought to a uniform elevation over its entire length in order to insure the proper storage capacity of the reservoir and to minimize the possibility of concentrated flow and channel erosion in the event of overtopping. Except for continuing to maintain control of growth on the downstream slope, there does not appear to be any reason to make improvements to this slope.

In summary, the embankment crest should be improved by filling to maintain a uniform level crest; the outlet valve should be made operational and a positive upstream control or cutoff should be provided; the spillway and spillway abutment walls should be repaired along with the spillway outlet channel; a regular program should be developed and implemented to observe and record the seepage flow at the toe of the embankment noting volume and clarity of flow.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The Lofty Dam serves as a reserve water supply source for the Blue Head Dam which is located 2.7 miles downstream on Messers Run. The operational plan is to release water to the Messers Run channel to supply the Blue Head Reservoir on an as needed basis. The release is made through the 20inch blowoff pipe. As previously mentioned, this water supply system is not in service and the Lofty Dam has not been operated since 1966.

4.2 MAINTENANCE OF DAM

There is no regular maintenance procedure for this dam. However, the presence of recently placed fill on the top of the embankment and the stumps of small trees and brush observed on the downstream slope indicates some effort in this area. The spillway and outlet channel are in need of attention as well as the control valve on the 20-inch blowoff pipe.

4.3 MAINTENANCE OF OPERATING FACILITIES

The outlet pipe for this dam has not been used over the past twelve years. The pipe, as observed at the downstream end appears to be in fair condition. The control valve, which is exposed, sitting on the ground surface, is rusty and in poor condition.

4.4 WARNING SYSTEM

There is no formal warning system for this facility in the event of an emergency. The owner indicated that the dam is visited by an employee at least once a week. There is no plan or records of this activity.

4.5 EVALUATION

The observed condition of this dam is fair indicating minimal maintenance activity. The spillway and outlet channel are in need of some repair to the deteriorated areas of the walls and the downstream end of the spillway apron where undermining of the slab has taken place. The control valve on the 20-inch blowoff pipe is rusted and appears to be in poor condition. It is not known if it is operable as no attempt was made to open the valve at this time or, as far as determined by this inspection, over the past twelve years. The condition of the blowoff pipe through the dam and in the reservoir could not be observed and is unknown.

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 nor spillway rating curves.

Notes in the file indicate that this dam was first built in 1896 and that it was modified in 1911 and 1922, well before the advent of sophisticated design procedures.

B. Experience Data

As noted above, this dam has been in the present configuration since 1922. Comparison with a nearby U.S.G.S. gaging station indicates that the flood of June 22, 1972 probably produced a peak inflow of about 400 cfs at this reservoir. The flood of August 18, 1955 may have produced a peak of about 600 cfs. Available information indicates that this dam passed both of the above floods without distress.

C. Visual Observations

On the date of the inspection, no conditions were observed that would indicate that the dam could not operate satisfactorily during a flood event, until the dam is overtopped. The outlet control valve is in the closed position and it is doubtful that it can be operated without some maintenance or repairs.

In the event that this dam fails, failure of the Blue Head Dam, located 2.7 miles downstream, would also occur.

D. Overtopping Potential

Lofty Reservoir Dam has a total storage capacity of 431 acre-feet and an overall height of 28 feet above streambed, both referenced to the top of the dam. These dimensions indicate a size classification of "Small". The hazard classification is "Significant" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the 100-year frequency flood to 1/2 the Probable Maximum Flood (PMF). For this dam 1/2 the PMF peak inflow is 1,558 cfs (See Appendix C for HEC-1 inflow computations).

Comparison of the estimated 1/2 PMF peak inflow of 1,558 cfs with the estimated spillway discharge capacity of 800 cfs indicates that a potential for overtopping of the Lofty Reservoir Dam exists.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam does not have the necessary storage available to pass 1/2 the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 33 percent of a PMF.

If the embankment would be improved by filling the low area to the intended design level, the spillway-reservoir system would still only be able to pass 40% of a PMF.

E. Spillway Adequacy

The small size category and significant hazard category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be 1/2 the Probable Maximum Flood (PMF).

The calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 33% of the (PMF) without overtopping the dam (refer to Sheet 9, Appendix C). These calculations have considered the existing low point along the embankment crest.

Because this dam is an earth embankment, it is susceptible to erosion and deterioration caused by overtopping. Small amounts of water flowing over the top of the dam for a short period of time would cause very little damage, while greater amounts of water would have the potential for more damage. Therefore, it is judged that a depth of 0.5 foot or greater, flowing over the top of the dam, would be sufficient to cause a breach to develop. These analyses indicate that the depth of flow over the top of the embankment due to 1/2 PMF is less than 0.5 foot. On this basis, it is judged that 1/2 of the PMF will cause some overtopping but not enough to cause a breach. Therefore, the spillway capacity is considered to be inadequate.

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

SECTION 6 STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations

1. Embankment

The visual inspection of this dam did not detect any evidence of structural instability of the embankment. Erosion of the slopes over the years has created an undulating type condition along the slope surface. The slope angle on the downstream side is reasonably uniform. The slope, measured by survey instrument during this inspection, showed an average angle of 26° (2H to 1V). The upstream slope is somewhat steeper, measured at 1.25H to 1V to the waters edge. This steeper slope is apparently the result of filling along the crest over the years in an attempt to maintain a uniform crest elevation. The upstream slope appears to become flatter below the water level. A surveyed profile shows a variation of crest surface elevations across the dam to a maximum of 0.7 foot below the design crest level. Refer to Plate A-I, Appendix A for plot of survey information.

Seepage along the toe of the dam has been a persistent condition since its construction. Post construction inspection reports have continuously reported the seepage. The records indicate that a major source of the water observed along the toe is natural springs that were in this area prior to the initial construction of the dam. There are no records or observed information to substantiate this conclusion. The inspection record of December 12, 1930 reported that the streams mentioned in previous reports were still flowing, even though the reservoir was empty. Refer to Table I, Appendix B.

All of the reported seepage has been in the area along or beyond the toe of the embankment. Seepage from or on the slope has never been reported.

The seepage along the toe of the embankment, having been reported over the life of the dam, evidently has not affected the stability of the dam. This conclusion is based upon the long time seepage condition and the appearance of the structure at the time of this inspection.

2. Appurtenant Structures

Appurtenant structures at this dam include the spillway and the blowoff pipe and control valve.

The spillway is a broad crested weir measured at 29 feet from abutment to abutment. The weir slab is concrete and slopes downward toward the spillway outlet channel. The outlet slab is 34 feet in length.

The abutment walls show signs of weathering and deterioration. The left wall has been patched and appears to be in good condition. The right wall shows more deterioration with the top of the wall severely spalled and broken at the downstream end. Bituminous material has been used in previous repairs.

The spillway outlet slab shows signs of the erosive deterioration due to the water overflow and is in fair condition. Undermining of the slab at its downstream edge was also observed. Some of the slab has broken away as a result of this support loss. This condition should be improved.

The condition of the blowoff pipe could only be observed at its outlet below the toe of the downstream slope of the embankment. It appears to be in fair condition. Its control, however, is rusty and in poor condition and should be scheduled for maintenance. There is no upstream control of this pipe.

The serviceability of the blowoff facility is not known.

B. Design and Construction Data

Design or construction data were not available in the PennDER files or from the owner. The information gathered for this inspection was obtained from previous post construction inspection reports and correspondence.

C. Operating Records

There are no operating records identified in the PennDER files or from the owner to judge the behavior of the dam relative to the stability of the dam.

D. Post Construction Changes

As described earlier, this dam was modified two times since the initial construction in 1896-97. The modifications increased the dam height both times in order to improve the capacity of the reservoir. Refer to Section 2.2 for additional information.

E. Seismic Stability

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

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The Lofty Dam, on the basis of the visual inspections, available drawings and historic records, is considered to be in fair condition. Although the surface of the downstream slope is uneven, this condition is attributed to erosion gullies caused by surface drainage over the slope and does not indicate any slope instability. Seepage at and downstream from the toe of the embankment has been recorded and reported since 1920. Refer to Table No.1 in Appendix A. Since there has never been any distress associated with the seepage, it appears that the condition is stable.

The embankment crest elevation is from 0.5 feet to 0.7 feet below the design elevation. This affects the safety of the dam only to the extent that the capacity of the dam to pass flood stage storms is reduced from what it would be with a uniform crest at design elevation.

The results of the hydrologic and hydraulic studies, in accordance with the Corps of Engineers' evaluation guidelines indicates that the spillway discharge and reservoir storage do not have the capacity for passing the one-half PMF without overtopping the dam. The data shows the capacity to be 33 percent PMF without causing overtopping. The spillway capacity, therefore, is considered to be inadequate.

B. Adequacy of Information

The information available for review together with the observations made during the visual inspection are considered to be sufficiently adequate for making a reasonable assessment of this facility.

C. Urgency

The recommendations presented in this report should be given immediate attention.

D. Necessity for Additional Studies

Additional studies are not indicated at this time.

7.2 RECOMMENDATIONS

The following recommendations are presented for consideration by the owner in order to improve the condition of this facility.

A. Facilities

1. That the crest of the dam be immediately brought to an uniform elevation of 1396.0 (Ref. spillway 1391.0).

2. That the end of the slab at the spillway be repaired to prevent continued undermining.

3. That the deterioration on the spillway walls be repaired.

4. That the 20-inch blowoff valve be cleaned, lubricated and made operable.

5. That a positive control or cutoff be provided on the upstream end of the 20-inch pipe for use in the case of an emergency.

6. That a program be developed and implemented to observe and record the seepage condition at the toe of the embankment noting volume and clarity of flow.

B. Operation and Maintenance Procedures

1. That the 20-inch blowoff valve be operated on a regular basis, at least once each year.

2. That the maintenance of the slopes be continued on an annual basis and that particular attention be given to the discovery of any seepage on the embankment slope.

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

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 54-1 NDI NO. PA-00 681

NAME OF DAM Lofty Dam HAZARD CATEGORY Significant

TYPE OF DAM Earthfill

LOCATION Kline TOWNSHIP Schuylkill COUNTY, PENNSYLVANIA

INSPECTION DATE 11/1/78 WEATHER Sunny - Breezy TEMPERATURE 52°F

INSPECTORS: R. Houseal (Recorder) OWNER'S REPRESENTATIVE(s):

R. Steacy George Palmer

D. Remmel

A. Bartlett

NORMAL POOL ELEVATION: 113 (1391) AT TIME OF INSPECTION:

BREAST ELEVATION: 118 (1396) POOL ELEVATION: 113 (1391) (Spillway)

SPILLWAY ELEVATION: 113 (1391) TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: None

GENERAL COMMENTS:

Water flowing over spillway.

Some maintenance has been made recently to level the top of the embankment. Seepage conditions still persist below the downstream toe of the embankment. No intake structure. Outlet not operational, valve gear heavily rusted.

The general outward appearance of the dam is fair. This dam has not been used during the past twelve years.

NDI NO. PA-00681

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None evident.
B. UNUSUAL MOVEMENT BEYOND TOE	None evident. Area beyond toe is heavily wooded.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	Embankment slopes uneven in the longitudinal direction. No apparent slides. Uneven condition appears to be the result of long term erosion.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Horizontal alignment good - no displacement. Vertical alignment - refer to surveyed profile.
E. RIPRAP FAILURES	None.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Abutments sound at spillway and at the natural ground junction.
G. SEEPAGE	Considerable number of wet areas located beyond the downstream toe of the embankment. Steady flow in vicinity of right abutment.
H. DRAINS	None.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Upstream Slope - soil and some weeds to waters edge. Downstream Slope - rock, soil, some small tree stumps. Top - sand and gravel surface.

NDI NO. PA-00 681

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	No structure - 20" pipe through embankment - entrance submerged - not visible.
B. OUTLET STRUCTURE	20" CIP with endwall. Rusty valve, not used recently.
C. OUTLET CHANNEL	Grown over with brush. Reduced to drainage ditch.
D. GATES	No gate - outlet control is 20" valve (in very poor condition)
E. EMERGENCY GATE	No Gate - 20" valve if it can be operated.
F. OPERATION & CONTROL	This facility has not been used for the past 12 years.
G. BRIDGE (ACCESS)	None.

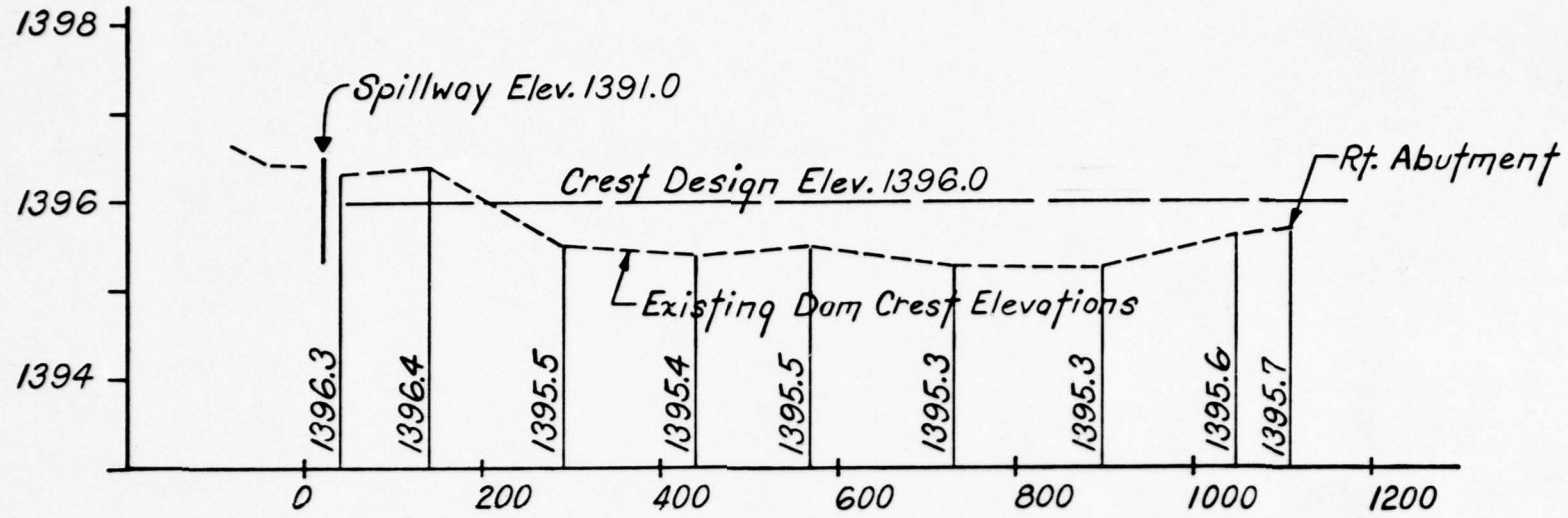
NDI NO. PA-00 681

VISUAL INSPECTION
SPILLWAY

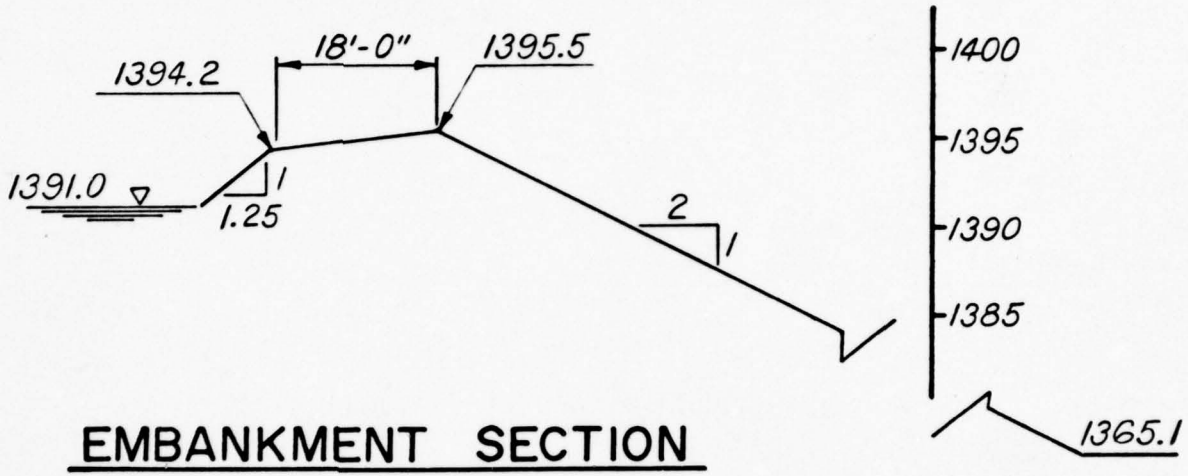
	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Some debris, tree stumps, several large rocks, coarse gravel.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	Some debris on crest, tree trunks, weathers, some cracks. Left abutment good condition - two cracks, had been patched, appears stable; right abutment more deterioration, concrete crumbling near the top, had been covered with thin layer of bituminous material which is also deteriorating.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	Rocks ranging from 6" to 3' and red clay bottom. 1 to 2 feet of clay washed out from under toe of spillway apron, some chunks of concrete have broken off toe, spillway weathered, 1 horizontal crack across spillway at downstream end of abutments.
D. BRIDGE & PIERS	None.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	The dam was used as a reserve water supply. Blue Head Dam is located about 2.7 miles downstream.

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION	
Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR	
Slopes	Forested.
Sedimentation	None reported.
Watershed Description	Mountain terrain - heavily wooded.
DOWNSTREAM CHANNEL	
Condition	Banks somewhat eroded.
Slopes	Soil, rock and cobbles to tree line. Channel narrows.
Approximate Population	Few at one residence.
No. Homes	One at Blue Head Dam 2.7 miles downstream.



EMBANKMENT PROFILE

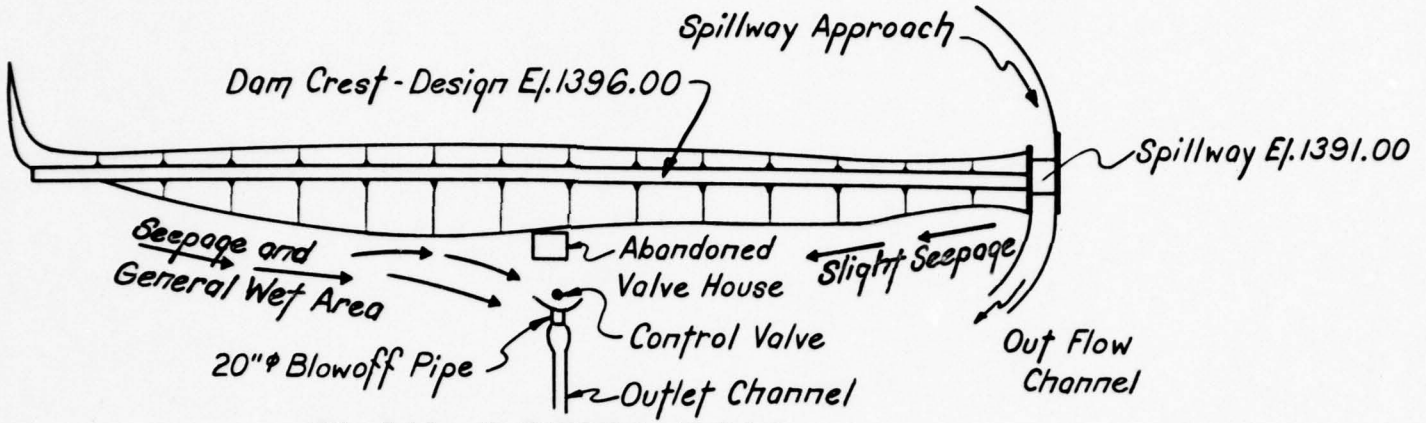


EMBANKMENT SECTION

Surveyed 11/1/78

LOFTY DAM
PA. 681
INSPECTION SURVEY

PLATE A-I



PLAN – LOFTY DAM

LOFTY DAM
PA. 681
INSPECTION SURVEY

PLATE A-II

Surveyed 11/1/78

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 54-1 NDI NO. PA-00 681

NAME OF DAM Lofty Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle See Plate II, Appendix F
CONSTRUCTION HISTORY	Originally built in 1896-97. No construction records. Historic information found in applications for permits, correspondence and inspection reports.
GENERAL PLAN OF DAM	1913-14 plans with some sections of spillway. Appendix F, Plate III.
TYPICAL SECTIONS OF DAM	1913 modification - limited information.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	None.

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None. Inspection reports from 1915 forward describe seepage conditions.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	Inspection Reports
BORROW SOURCES	Correspondence indicates embankment material from reservoir area.

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Files indicate raising of dam in 1912 and 1915 with repairs and improvements to spillway in 1922.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None. Inspection reports describe conditions of dam.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	Unknown.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	1913-14 plans - limited - no details.

NDI NO. PA-00 681

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	None.
CONSTRUCTION RECORDS	Limited to narrative information in the annual inspection reports.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Inspection reports dating from 1915 describe seepage and general conditions of the dam.
MISCELLANEOUS	None.

NDI NO. PA-00 681

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Forest Land.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 1391 276 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev. 1396 431 Acre-Feet

MAXIMUM DESIGN POOL: Elev. Unknown

TOP DAM: Elev. 1396

SPILLWAY:

a. Elevation 1391

b. Type Broad Crest Weir

c. Width 29 Feet

d. Length 47 Feet

e. Location Spillover Left Abutment.

f. Number and Type of Gates None - Exposed valve on 20" outlet pipe.

OUTLET WORKS:

a. Type 20" outlet pipe.

b. Location Beneath the embankment near center of dam.

c. Entrance inverts Unknown.

d. Exit inverts 1366±

e. Emergency drawdown facilities 20" pipe.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location None.

c. Records None.

MAXIMUM NON-DAMAGING DISCHARGE: Unknown.

LOFTY DAM - TABLE NO. 1

TABULATION OF SEEPAGE INFORMATION
FROM
INSPECTION REPORTS

Date	Reservoir Water Level	Comment
7/10/1915	Sp. + 1-1/2"	The toe of the embankment was examined but no evidence of seepage was discovered.
5/26/1920	Sp. + 1-1/2"	Small leakage at downstream toe (location not identified).
4/9/1921	Sp. + 1"	Slight seepage at toe (location not identified).
6/20/1922	Sp. + 2"	Seepage was noted (location not identified).
8/4/1924	Sp. + 1"	No reference to seepage.
9/26/1927	Sp. + 1/2"	A fairly strong flow appearing toward the right end of the dam and just to the right of the blowoff pipe.
8/7/1928	Sp. + 1"	No reference to seepage.
12/7/1928 z	Sp. - (Minus) 9.5 feet	Three leaks appeared along the toe of the embankment to the right of the spillway. Also a large flow emerges at a point adjacent to the pipeline and the source of this should be investigated.
5/17/1929	Sp. + 1"	A stream continues to flow from a point adjacent to the outlet pipe and it has not been determined whether there is a leak in the blowoff line or whether this is the flow from the pool immediately below the outlet pipe. There is a strong stream flowing from the toe near the right end of the dam, while another stream emerges at a point about 100 feet to the right of the outlet pipe.
12/12/1930	Res. Empty	Two streams mentioned in previous report still flowing, with reservoir empty, as evidence of spring origin.

Date	Reservoir Water Level	Comment
7/14/1932	Sp. + 1/4"	Two streams emerge from the toe of the embankment toward the right end of the dam.
10/10/1934	Sp. + 1/2"	Spring at toe near left end; another 100 feet right of blowoff, producing a swampy area; another 50 feet further to the right; two more near the right end. All these are said to continue with the reservoir drained.
9/13/1938	At. Sp. level	Spring at toe near left end; small swampy area about 100 feet to right of blowoff and about 200 feet from right end and below toe; two springs below toe near right end.
4/22/1941	Sp. + 1"	Small amount of leakage about 100 feet to right of blowoff. The flow of water near the left end and also at the right end was said to be coming from springs.
4/30/1945	Sp. + 1"	Small amount of leakage about 100 feet to right of blowoff. Also at right and left end.
6/7/1962	Sp. + 1/2"	Slight leakage along toe at left abutment.
4/12/1971	No Record	Seepage from 50 to 150 feet from the right abutment at lower toe.

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

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

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

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

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

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

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

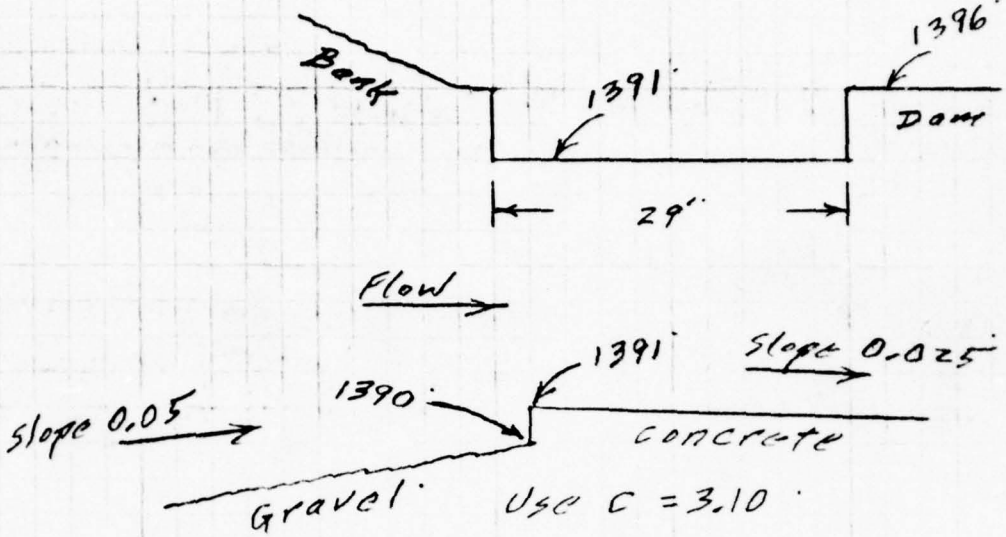
For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

PROJECT Dam Investigation SHEET NO. 1 A

SUBJECT Lofty Reservoir Dam - ID NO. 681

COMPUTED BY RES DATE 11-7-78 CHECKED BY JJP 11-21-78

Spillway Rating



Brater + King
Page 5-24

Pool at 1396

H = 5.0', L = 29' C = 3.10

$Q = CLH^{3/2} = 3.10 \times 29 \times (5)^{3/2} = 1{,}000$ cfs

---

Maximum known flood

Ringtown USGS gage 1.77 sq. mile
487 cfs on 6-22-72

Lofty Resv. 1.48 sq. mile.

$\left(\frac{1.48}{1.77}\right)^{0.8} \times 487 = 400$ cfs.

20" Outlet and Flowoff

20" CI pipe, L = 130'

Est Upstr invert 1368
" Dnstr invert 1366
K = 0.5

Pool at 1370

H = 1370 - 1367 = 3 ft

$H = 3 = 2.87(n)^2 \times \frac{L V^2}{d^{4/3}} + K\frac{V^2}{2g}$

$= 2.87(0.015)^2 \times \frac{130 V^2}{(1.67)^{1.33}} + 0.5\frac{V^2}{64.3}$

$= 0.000646 \times 65.7 \times V^2 + 0.00778 V^2$

PROJECT Dam Evaluation SHEET NO. 4 OF 10

SUBJECT Lofty Reservoir Dam - ID No. 681

COMPUTED BY RES DATE 11-7-78 CHECKED BY JJP 11-21-78

20" Outlet and Blowoff (cont)

$3 = V^2(0.0424 + 0.00778) = V^2 \times 0.0502$

$V^2 = 59.8$

$V = 7.73$ ft/sec.

$Q = VA = 7.73 \times \pi (0.833)^2 = 17$ cfs

Pool at 1391 $H = 1391 - 1367 = 24$ ft.

$24 = V^2 \times 0.0502$

$V^2 = 478$

$V = 21.9$ ft/sec

$Q = 21.9 \times \pi \times (0.833)^2 = 48$ cfs

BY ... DATE ... BERGER ASSOCIATES SHEET NO. 8 OF ...
CHKD. BY ... DATE ... PROJECT ...
SUBJECT LOFTY RESERVOIR DAM

SPILLWAY RATING: C = 3.10 Spillway ELEV = 1391 L = 29'

ELEV. 1392 $Q = 3.10 \times 29 \times (1)^{1.5} = 89.9$ cfs

ELEV. 1393 $Q = 3.1 \times 29 \times (2)^{1.5} = 254$ cfs

ELEV. 1394 $Q = 3.1 \times 29 \times (3)^{1.5} = 467$ cfs

ELEV. 1395 $Q = 3.1 \times 29 \times (4)^{1.5} = 719$ cfs

ELEV. 1396 $Q = 3.1 \times 29 \times (5)^{1.5} = 1005$ cfs

ELEV. 1396.4 $Q = 3.1 \times 29 \times (5.4)^{1.5} = 1128$ cfs

EMBANKMENT RATING C = 2.7

ELEV. 1395.5

$Q_1 = 2.7 \times (145 + 133) \times (.05)^{1.5} = 8.4$ cfs

$Q_2 = 2.7 \times (158 + 103) \times (.1)^{1.5} = 22.3$ CFS

$Q_3 = 2.7 \times 171 \times (.2)^{1.5} = 41.3$ CFS

$Q = 72$ CFS ←

ELEV. 1395.6

$Q_1 = 2.7 \times (145 + 133) \times (.15)^{1.5} = 43.6$ CFS

$Q_2 = 2.7 \times 158 \times (.2)^{1.5} = 38.2$ CFS

$Q_3 = 2.7 \times 171 \times (.3)^{1.5} = 75.9$ CFS

$Q_4 = 2.7 \times 155 \times (.15)^{1.5} = 24.3$ CFS

$Q = 182$ CFS ←

EMBANKMENT RATING (CONT.)

ELEV. 1395.7

$Q_1 = 2.7 \times (145+133) \times (.25)^{1.5} = 93.8$

$Q_2 = 2.7 \times 158 \times (.3)^{1.5} = 70.1$

$Q_3 = 2.7 \times 171 \times (.4)^{1.5} = 107.9$

$Q_4 = 2.7 \times 155 \times (.25)^{1.5} = 52.3$

$Q = 325$ cfs ←

ELEV. 1396.4

$Q_1 = 2.7 \times 150 \times (.45)^{1.5} = 122.3$

$Q_2 = 2.7 \times (145+133) \times (.95)^{1.5} = 695$

$Q_3 = 2.7 \times 158 \times (1)^{1.5} = 426.6$

$Q_4 = 2.7 \times 171 \times (1.1)^{1.5} = 517.6$

$Q_5 = 2.7 \times 155 \times (.95)^{1.5} = 387.5$

$Q_6 = 2.7 \times 53 \times (.4)^{1.5} = 36.2$

$Q = 2185$ cfs ←

BY DJR DATE 1/11/79 BERGER ASSOCIATES SHEET NO. 5 OF 10
CHKD. BY DATE PROJECT D8490
SUBJECT LOFTY RESERVOIR DAM

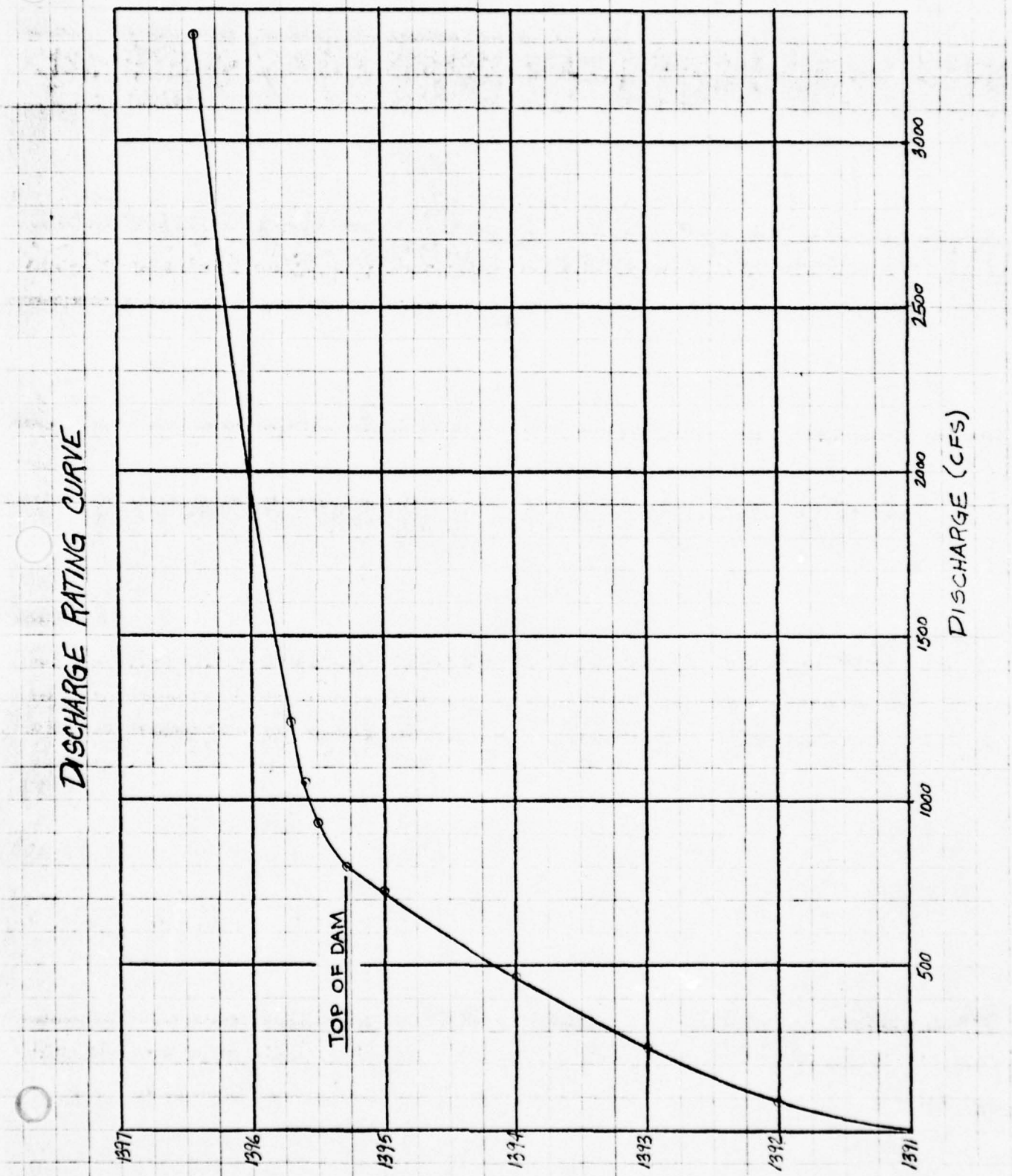
TOP OF DAM RATING CURVE: HEC1 COORDINATES

	STAGE	DISCHARGE (CFS)
	1391	0
	1392	90
	1393	254
	1394	467
	1395	719
overtopping begins →	1395.3	800
	1395.5	927
	1395.6	1065
	1395.7	1231
	1396.4	3313

BY DJR DATE 1/16/79 **BERGER ASSOCIATES** SHEET NO. 6 OF 10

CHKD. BY DATE PROJECT D8490

SUBJECT LOFTY RESERVOIR DAM RATING



BY DJR DATE 1/18/79 **BERGER ASSOCIATES** SHEET NO. 7 OF 10
CHKD. BY DATE PROJECT D8490
SUBJECT LOFTY RESERVOIR DAM

SIZE CLASSIFICATION:

Maximum Storage = 431 ACRE-FT
Maximum Height = 28 FEET
Size Classification is "SMALL"

HAZARD CLASSIFICATION:

One residence is located near the stream channel about 2.7 miles downstream of the Dam
Hazard Classification is "SIGNIFICANT"

RECOMMENDED SPILLWAY DESIGN FLOOD:

The above classifications indicate use of an SDF OF THE 100-yr frequency flood to 1/2 the Probable maximum flood.

HEC-1 DATA:

Drainage Area = 1.48 SQ. MI.

Susquehanna Basin Region 13

$C_p = .5$

$C_T = 1.85$

Longest water course $L = 1.97$ mi.

Length to centroid $L_{CA} = 1.08$ mi.

Time to peak:

$$T_p = C_T (L \times L_{CA})^{.3}$$

$T_p = 2.32$ HRS.

Rainfall (HMR-40)
index = 22.37"

incremental rainfall:
6 hr = 117.5 %
12 hr = 127 %
24 hr = 136.5 %
48 hr = 142.5 %
72 hr = 145 %

PLANIMETERED AREAS (FROM QUAD SHEET)
ELEV.: 1391 = 31 ACRES
1400 = 54.5 ACRES

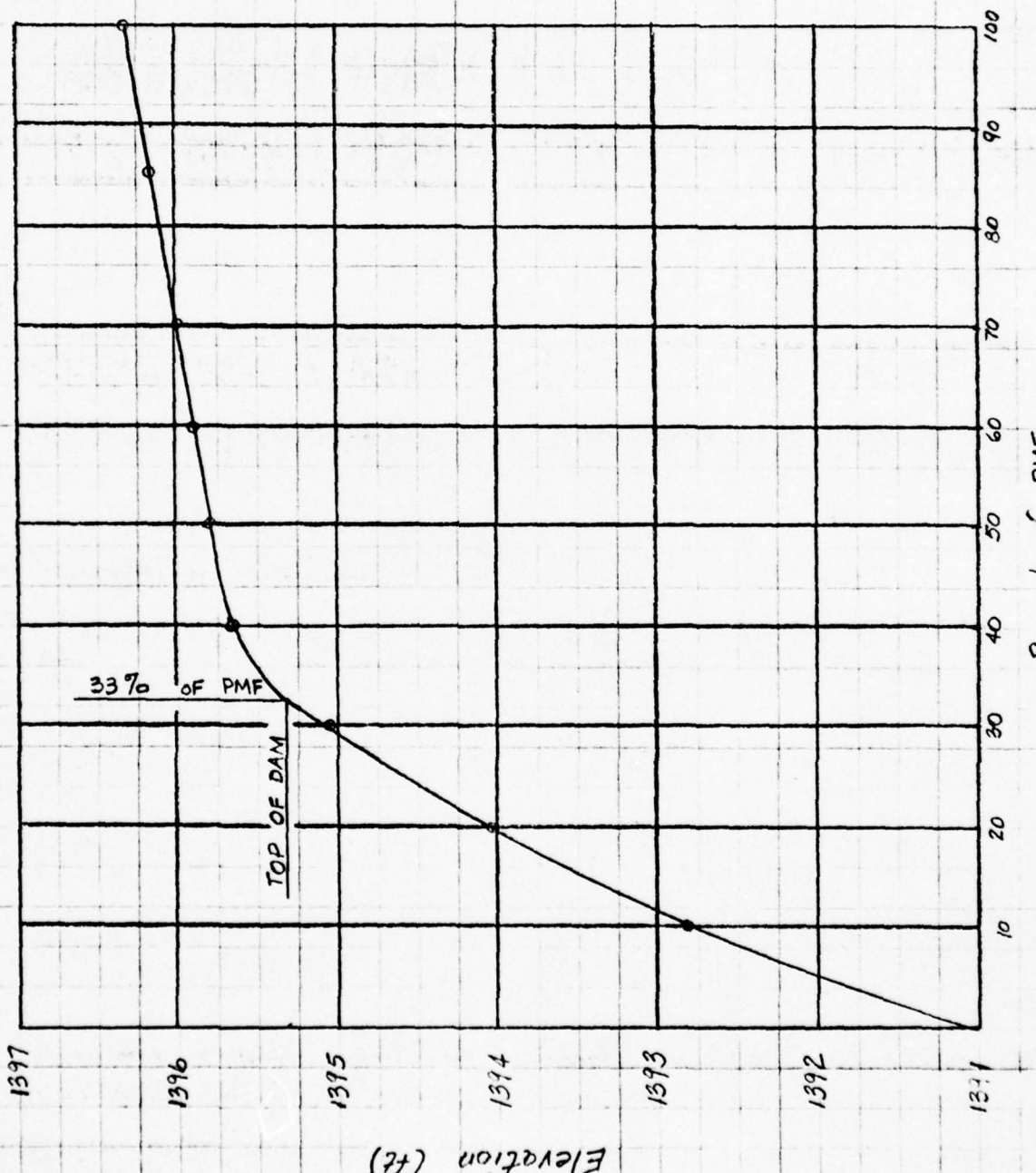
ZERO STORAGE ELEVATION
ELEV = 1391 − (STORAGE × 3/AREA)
= 1364.3

BY DJR DATE 1/17/79 **BERGER ASSOCIATES** SHEET NO. 9 OF 10

CHKD. BY DATE PROJECT D8490

SUBJECT LOETY RESERVOIR DAM RATING

SPILLWAY CAPACITY CURVE

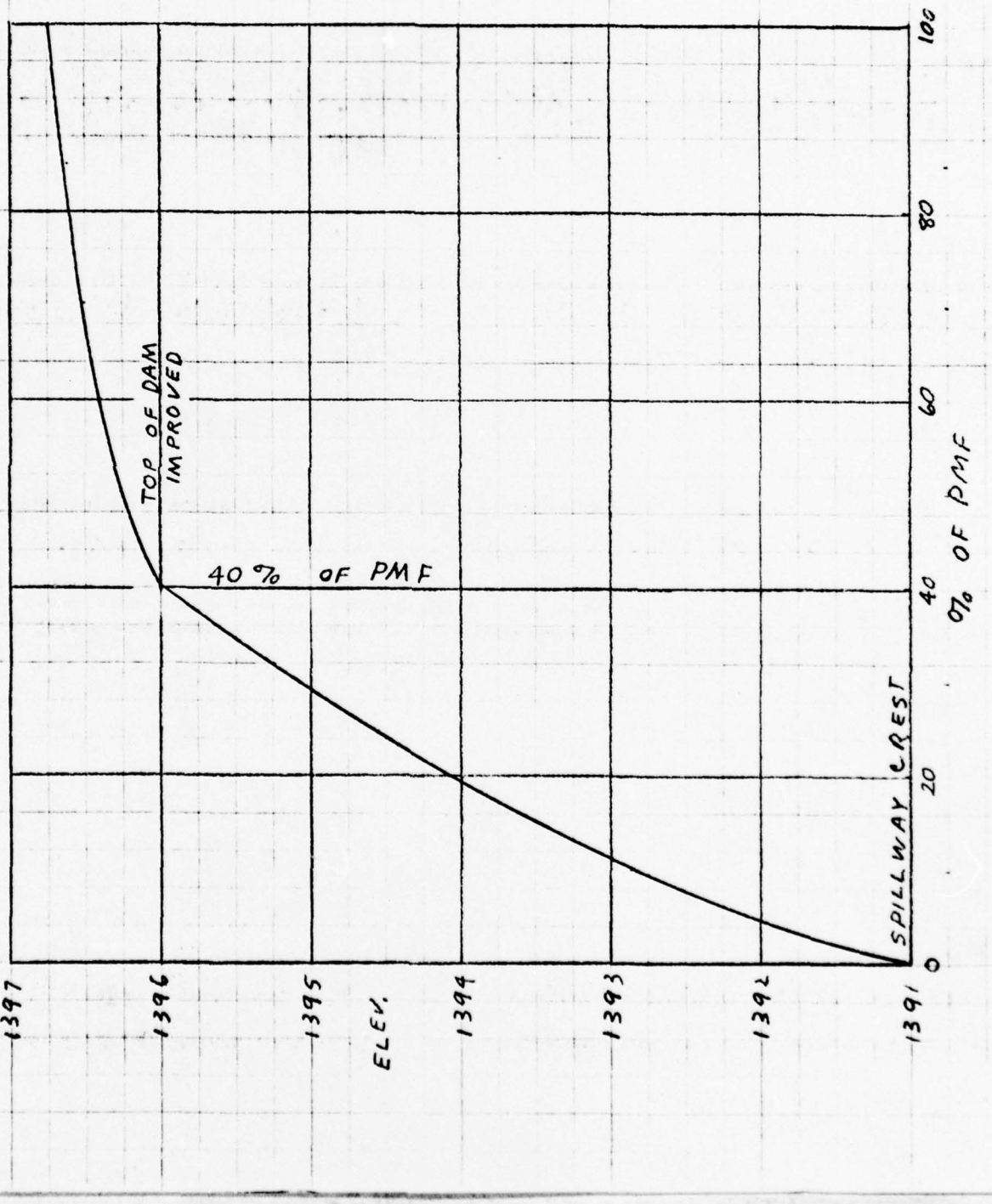


BY RLS DATE 2/22/79 **BERGER ASSOCIATES** SHEET NO. 10 OF 10

CHKD. BY DATE PROJECT D8490

SUBJECT LOFTY RESERVOIR

SPILLWAY CAPACITY CURVE
IMPROVED EMBANKMENT



OVERTOPPING ANALYSIS

1/4

```
1*****,**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  21 AUG 78
 **********************************
    1          A1     LOFTY RESERVOIR DAM   ****   MESSERS RUN
    2          A2     KLINE TWP.,  SCHUYLKILL COUNTY
    3          A3     NDI # PA-00681    PA DER # 54-1
    4          B   300      0      15       0       0       0       0       0      -4       0
    5          B1    5
    6          J     1      9       1
    7          J1    1    .85      .7      .6      .5      .4      .3      .2      .1
    8          K                 1                                 1
    9          K1                   INFLOW  HYDROGRAPH
   10          M     1      1    1.48
   11          P                22.37   117.5     127   136.5   142.5     145
   12          T                                                   1     .05
   13          W   2.32     .5
   14          X   -1.5    -.05      2
   15          K     1      2                                      1
   16          K1                    RESERVOIR ROUTING
   17          Y                                      1
   18          Y1    1                                                276      -1
   19          Y4 1391   1392    1393    1394    1395  1395.3  1395.5  1395.6  1395.7  1396.4
   20          Y5    0     90     254     467     719     800     927    1065    1231    3313
   21          $A    0     31    54.5
   22          $E1364.3   1391    1400
   23          $$ 1391
   24          $D1395.3
   25          K    99
1                        PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                 RUNOFF HYDROGRAPH AT          1
                                 ROUTE HYDROGRAPH TO           2
                                 END OF NETWORK

1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  21 AUG 78
 **********************************

 RUN  DATE# 79/02/22.
      TIME# 12.01.14.


                          LOFTY RESERVOIR DAM   ****   MESSERS RUN
                          KLINE TWP.,  SCHUYLKILL COUNTY
                          NDI # PA-00681    PA DER # 54-1

                                        JOB SPECIFICATION
                    NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
                   300       0      15       0       0       0       0       0      -4       0
                                       JOPER     NWT   LROPT   TRACE
                                           5       0       0       0


                                  MULTI-PLAN ANALYSES TO BE PERFORMED
                                  NPLAN = 1  NRTIO = 0  LRTIO =
```

LOFTY RESERVOIR DAM **** MESSERS RUN
KLINE TWP., SCHUYLKILL COUNTY
NDI # PA-00681 PA DER # 54-1

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.48	0.00	1.48	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.37	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.32 CP= .50 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 73 END-OF-PERIOD ORDINATES, LAG= 2.34 HOURS, CP= .50 VOL= 1.00

6.	24.	49.	79.	111.	144.	172.	192.	205.	209.
200.	185.	171.	158.	146.	135.	124.	115.	106.	98.
91.	84.	77.	71.	66.	61.	56.	52.	48.	44.
41.	38.	35.	32.	30.	28.	26.	24.	22.	20.
19.	17.	16.	15.	14.	13.	12.	11.	10.	9.
8.	8.	7.	7.	6.	6.	5.	5.	4.	4.
4.	4.	3.	3.	3.	3.	2.	2.	2.	2.
2.	2.	1.							

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.95	23.35	2.60	89341.
										(659.)	(593.)	(66.)	(2529.86)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	276.	-1

STAGE	1391.0	1392.0	1393.0	1394.0	1395.0	1395.3	1395.5	1395.6	1395.7	1396.
FLOW	0.	90.	254.	467.	719.	800.	927.	1065.	1231.	3313
SURFACE AREA=	0.	31.	55.							
CAPACITY=	0.	276.	656.							
ELEVATION=	1364.	1391.	1400.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1391.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1395.3	0.0	0.0	0.

PEAK OUTFLOW IS 3099. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 2632. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 2169. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1859. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1541. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1141. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 733. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 473. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 219. AT TIME 44.25 HOURS

********** ********** **********

1 ********** ********** ********** ********** **********

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)

				RATIOS APPLIED TO FLOWS								
OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .85	RATIO 3 .70	RATIO 4 .60	RATIO 5 .50	RATIO 6 .40	RATIO 7 .30	RATIO 8 .20	RATIO 9 .10
HYDROGRAPH AT	1	1.48	1	3115.	2648.	2181.	1869.	1558.	1246.	935.	623.	312.
		(3.83)		(88.22)(	74.98)(	61.75)(	52.93)(	44.11)(	35.29)(	26.46)(	17.64)(	8.82)
ROUTED TO	2	1.48	1	3099.	2632.	2169.	1859.	1541.	1141.	733.	473.	219.
		(3.83)		(87.75)(	74.54)(	61.43)(	52.65)(	43.64)(	32.30)(	20.77)(	13.39)(	6.20)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1391.00	1391.00	1395.30
STORAGE	276.	276.	431.
OUTFLOW	0.	0.	800.

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
1.00	1396.32	1.02	475.	3099.	8.50	42.25	0.00
.85	1396.14	.84	467.	2632.	7.50	42.25	0.00
.70	1395.99	.69	460.	2169.	6.50	42.25	0.00
.60	1395.88	.58	456.	1859.	5.50	42.25	0.00
.50	1395.77	.47	451.	1541.	4.50	42.25	0.00
.40	1395.65	.35	445.	1141.	3.00	43.00	0.00
.30	1395.05	0.00	421.	733.	0.00	43.75	0.00
.20	1394.02	0.00	380.	473.	0.00	44.00	0.00
.10	1392.79	0.00	335.	219.	0.00	44.25	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78
****
EOI ENCOUNTERED.
N>

OVERTOPPING A
IMPROVED EMBANKMENT

1/4

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  21 AUG 78
**********************************
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     1          A1     LOFTY RESERVOIR DAM   ****   MESSERS RUN
     2          A2     KLINE TWP.,  SCHUYLKILL COUNTY
     3          A3     NDI # PA-00681    PA DER # 54-1
     4          B   300      0     15      0      0      0      0      0     -4      0
     5          B1    5
     6          J     1      9      1
     7          J1    1    .85     .7     .6     .5     .4     .3     .2     .1
     8          K                 1                                    1
     9          K1                   INFLOW  HYDROGRAPH
    10          M     1      1   1.48
    11          P           22.37  117.5    127  136.5  142.5    145
    12          T                                                  1    .05
    13          W  2.32     .5
    14          X  -1.5    -.05      2
    15          K     1      2                                       1
    16          K1                   RESERVOIR ROUTING
    17          Y                                      1
    18          Y1    1                                          276
    19          $A    0     31    54.5
    20          $E1364.3   1391   1400
    21          $$ 1391     29    3.1    1.5
    22          $D 1396    2.7    1.5   1100
    23          K    99
```

```
1                    PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                RUNOFF HYDROGRAPH AT          1
                                ROUTE HYDROGRAPH TO           2
                                END OF NETWORK
```

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1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  21 AUG 78
 **********************************

 RUN  DATE# 79/02/26.
      TIME# 12.27.02.
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                LOFTY RESERVOIR DAM   ****   MESSERS RUN
                KLINE TWP.,  SCHUYLKILL COUNTY
                NDI # PA-00681    PA DER # 54-1

                                JOB SPECIFICATION
          NQ     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
         300       0      15       0       0       0       0       0      -4       0
                              JOPER     NWT   LROPT   TRACE
                                  5       0       0       0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                              NPLAN= 1 NRTIO= 9 LRTIO= 1
      RTIOS=   1.00    .85    .70    .60    .50    .40    .30    .20    .10
```

LOFTY RESERVOIR DAM **** MESSERS RUN
KLINE TWP., SCHUYLKILL COUNTY
NDI # PA-00681 PA DER # 54-1

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .85 .70 .60 .50 .40 .30 .20 .10

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	1.48	0.00	1.48	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.37	117.50	127.00	136.50	142.50	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.32 CP= .50 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 73 END-OF-PERIOD ORDINATES, LAG= 2.34 HOURS, CP= .50 VOL= 1.00

6.	24.	49.	79.	111.	144.	172.	192.	205.	209.
200.	185.	171.	158.	146.	135.	124.	115.	106.	98.
91.	84.	77.	71.	66.	61.	56.	52.	48.	44.
41.	38.	35.	32.	30.	28.	26.	24.	22.	20.
19.	17.	16.	15.	14.	13.	12.	11.	10.	9.
8.	8.	7.	7.	6.	6.	5.	5.	4.	4.
4.	4.	3.	3.	3.	3.	2.	2.	2.	2.
2.	2.	1.							

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.95	23.35	2.60	89341.
										(659.)	(593.)	(66.)	(2529.86)

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	276.	0

SURFACE AREA=	0.	31.	55.
CAPACITY=	0.	276.	656.
ELEVATION=	1364.	1391.	1400.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1391.0	29.0	3.1	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1396.0	2.7	1.5	1100.

PEAK OUTFLOW IS 3106. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 2639. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 2172. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1850. AT TIME 42.25 HOURS

PEAK OUTFLOW IS 1491. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 1000. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 738. AT TIME 43.75 HOURS

PEAK OUTFLOW IS 477. AT TIME 44.00 HOURS

PEAK OUTFLOW IS 223. AT TIME 44.25 HOURS

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

********** ********** ********** ********** **********

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)

				RATIOS APPLIED TO FLOWS								
OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				1.00	.85	.70	.60	.50	.40	.30	.20	.10
HYDROGRAPH AT	1	1.48	1	3115.	2648.	2181.	1869.	1558.	1246.	935.	623.	312.
		(3.83)	(	88.22)(	74.98)(	61.75)(	52.93)(	44.11)(	35.29)(	26.46)(	17.64)(	8.82)
ROUTED TO	2	1.48	1	3106.	2639.	2172.	1850.	1491.	1000.	738.	477.	223.
		(3.83)	(	87.96)(	74.74)(	61.49)(	52.40)(	42.21)(	28.32)(	20.90)(	13.52)(	6.31)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1391.00	1391.00	1396.00
STORAGE	276.	276.	461.
OUTFLOW	0.	0.	1005.

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
1.00	1396.74	.74	493.	3106.	7.00	42.25	0.00
.85	1396.62	.62	488.	2639.	6.00	42.25	0.00
.70	1396.49	.49	482.	2172.	5.00	42.25	0.00
.60	1396.39	.39	478.	1850.	4.25	42.25	0.00
.50	1396.26	.26	472.	1491.	2.75	42.75	0.00
.40	1395.98	0.00	460.	1000.	0.00	43.75	0.00
.30	1395.07	0.00	422.	738.	0.00	43.75	0.00
.20	1394.04	0.00	381.	477.	0.00	44.00	0.00
.10	1392.83	0.00	337.	223.	0.00	44.25	0.00

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78
****
EOI ENCOUNTERED.

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Mauch Chunk Formation, middle member.

Lithology: The middle member of the Mauch Chunk Formation consists of mappable units of grayish red to red brown sandstone, with lesser siltstone and shale, alternating with units consisting of grayish red to red brown siltstone and shale with lesser sandstones.

Structure

The dam is located on the south flank of the Centralia Anticline. The beds here strike about N75°S and dip 30° to 40°S. Air Photo fracture traces strike N35°E, N10°E, and N40°W. A major thrust fault, the Potchunk fault is mapped a short distance south of the dam. This fault is a thrust fault which has been folded since its formation, so that renewed movement on the fault is not possible.

Overburden

No core boring information is avialable for this dam. Overburden in the Mauch Chunk Formation can be several tens of feet thick. Reports in the file indicate this dam had a puddle trench 16 feet deep into a "stratum of clay". This could be either alluvium or weathered Mauch Chunk. When the dam was raised in 1914-15, a concrete cutoff trench was recommended, but details are not available.

Aquifer Characteristics

While some of the sandstone units of the Mauch Chunk Formation may have some primary porosity and permeability, most, if not all, ground water movement is along bedding planes and fractures. Since the grains and cement of the rock are essentially insoluble minerals, there is little chance of decomposition of the rock by ground water movement.

If the dam is founded on a layer of clay in alluvium, or on weathered bedrock there is a possibility of freer movement in this more permeable material.

Discussion

This dam has a history of some leakage. It is possible that some of this leakage is below the cutoff trench in weathered bedrock or alluvium. The dam is old and leakage has apparently stabilized, but it should be kept in mind that there is no evidence that this dam is founded on solid rock. None of the mapped faults are active faults.

Sources of Information

1. Wood, G.H. and Arndt, H.H. (1973), "Geologic Map of the Delano Quadrangle, Schuylkill County, Pa."

2. Air Photos, dated 1968, scale 1:24,000.

3. Inspection reports in file.

GEOLOGIC MAP - Lofty Reservoir Dam

(geology from U.S.G.S. GQ-1054, and Pa. Geol. Surv. open file)

Pps	Pottsville Fm.- Sharp Mountain Member
Ppc	Pottsville Fm.- Schuylkill Member
Ppt	Pottsville Fm.- Tumbling Run Member
PMmu	Mauch Chunk Fm.- upper member
Mmm	Mauch Chunk Fm.- middle member
----	fault
—.—.—	air photo fracture trace

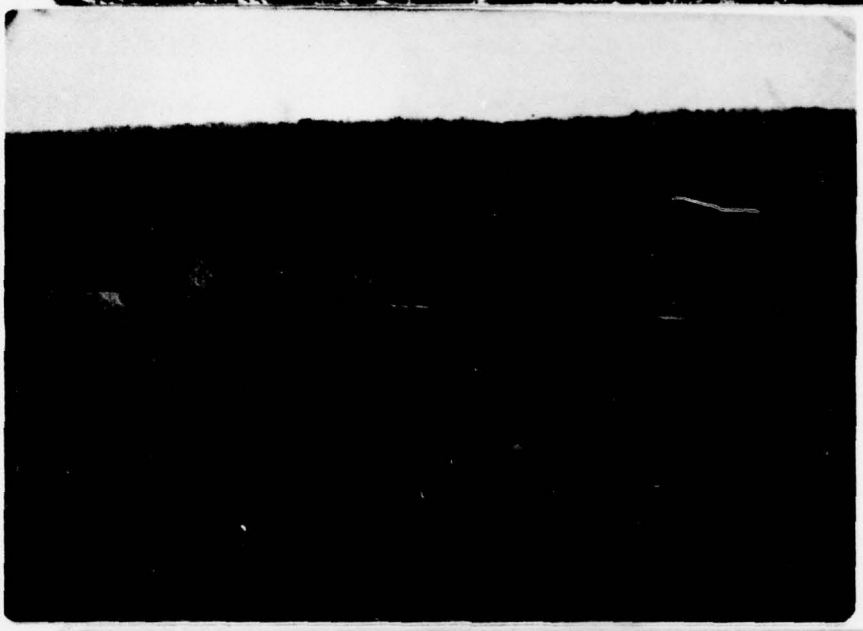
SCALE 1:24000

1 0 1 MILE

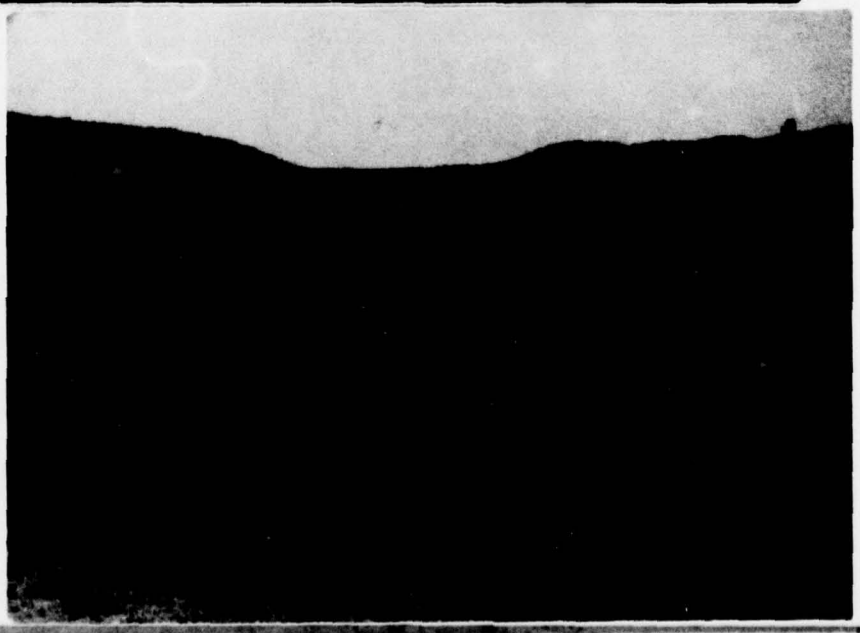
APPENDIX E

PHOTOGRAPHS

Downstream Slope
With Cut Brush



Upstream Slope



Reservoir Area

PA-681
PLATE E-I

Spillway Approach Channel

Spillway Chute

PA-681
PLATE E-II

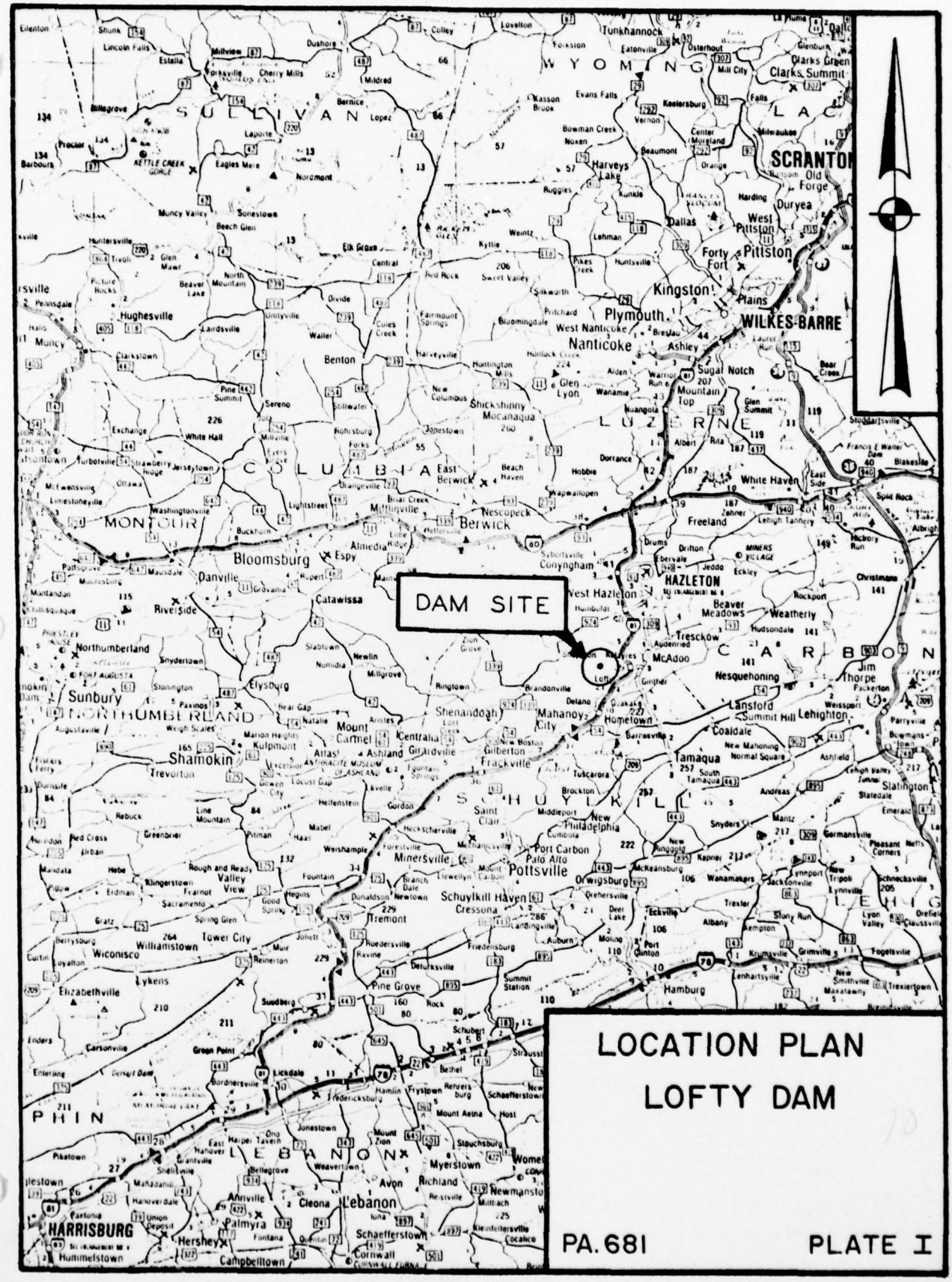
Spillway Outlet Channel

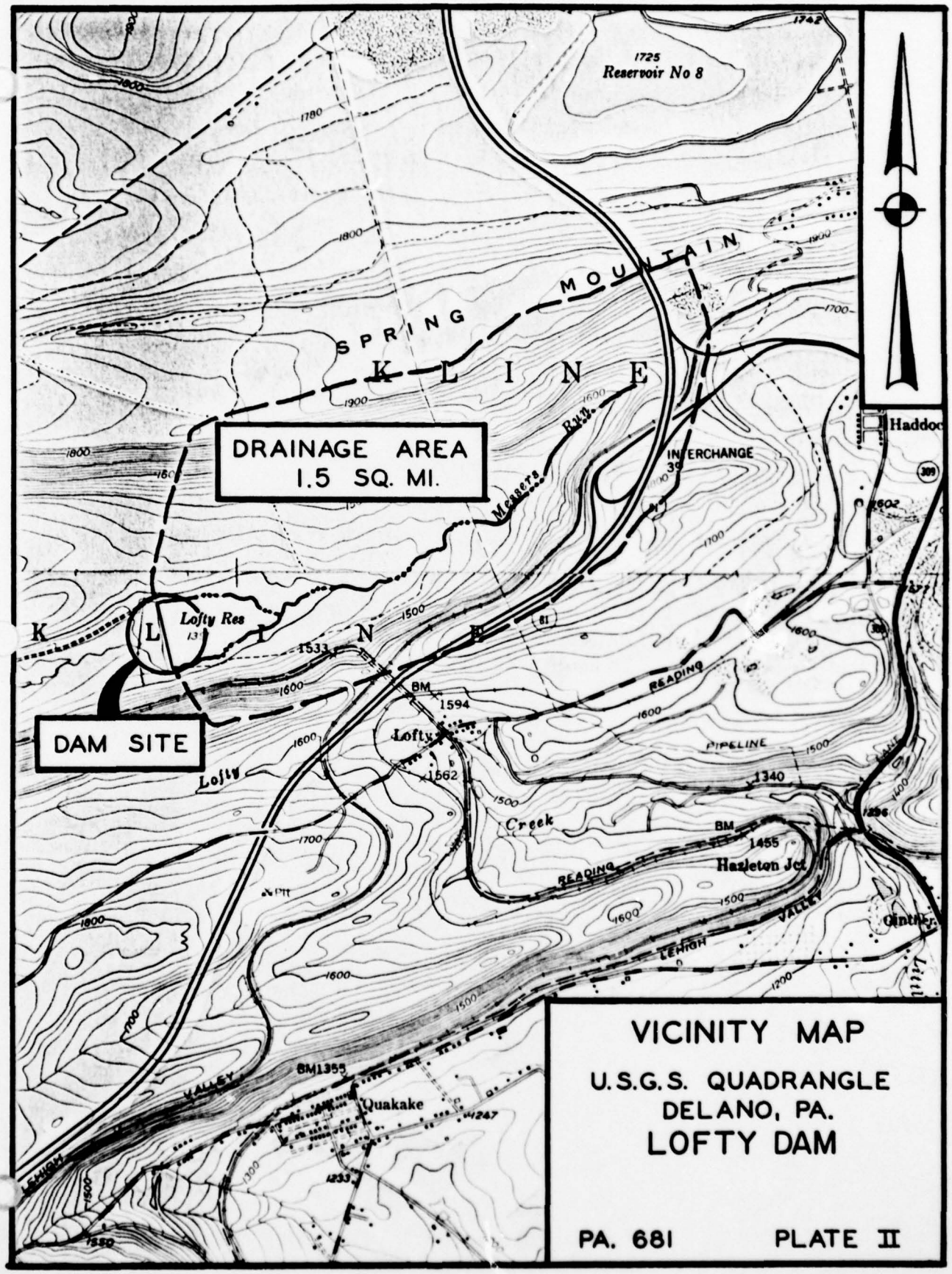
Blowoff - Outlet

PA-681
PLATE E-III

APPENDIX F

PLATES


DAM SITE
LOCATION PLAN
LOFTY DAM
PA. 681
PLATE I

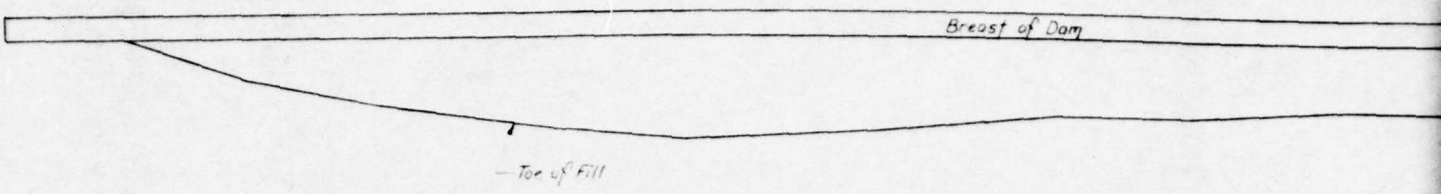


VICINITY MAP

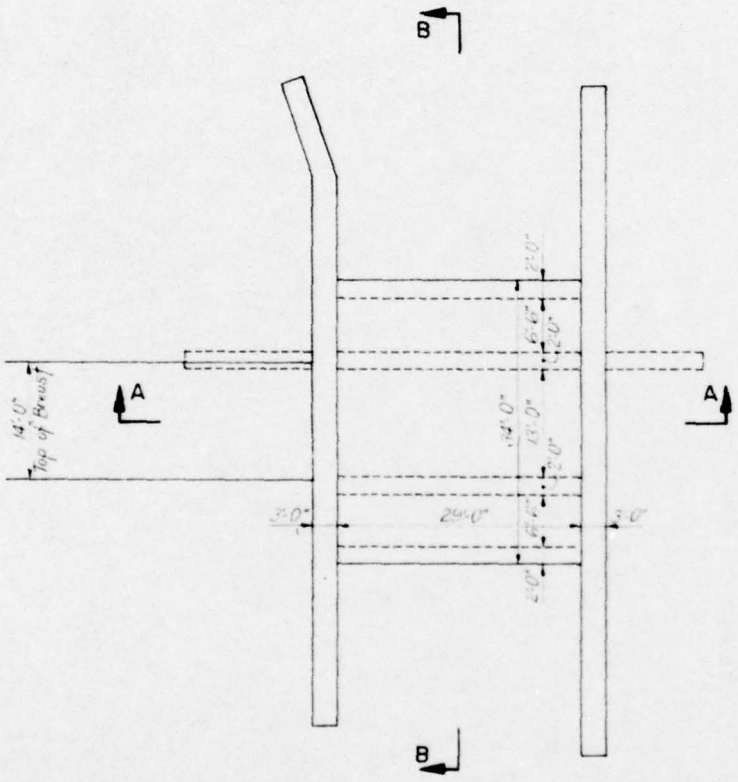
U.S.G.S. QUADRANGLE
DELANO, PA.

LOFTY DAM

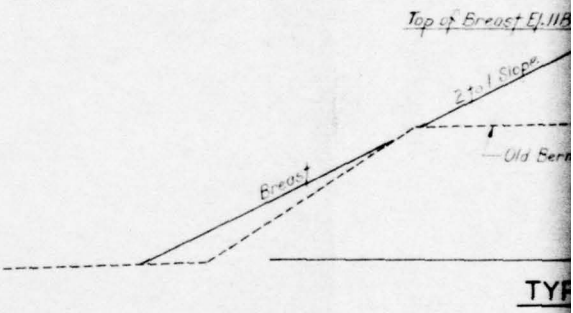
PA. 681 PLATE II



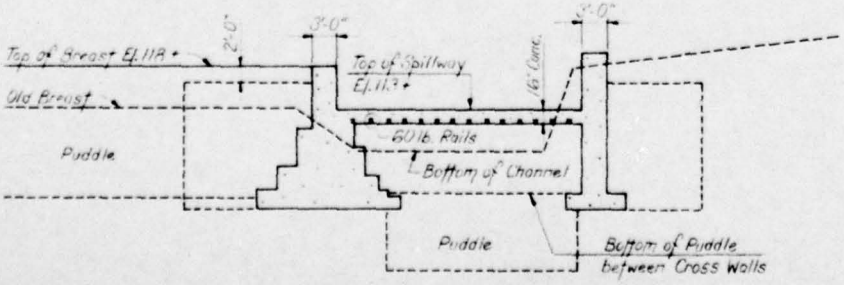
GENERAL PLAN
Scale: 1" = 50'-0"



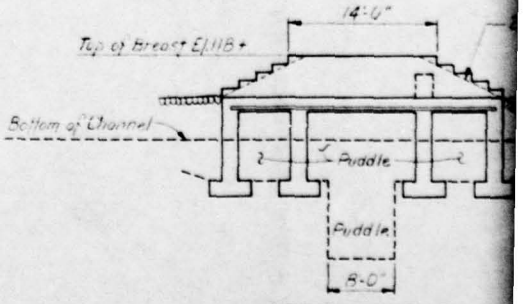
PLAN
Scale: 1" = 10'-0"



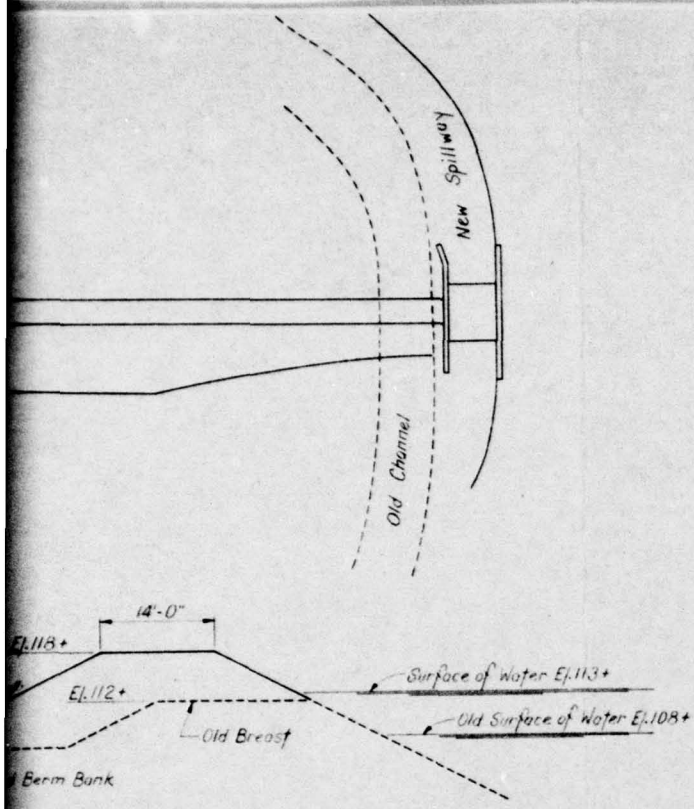
TYP



SECTION A-A
Scale: 1" = 10'-0"

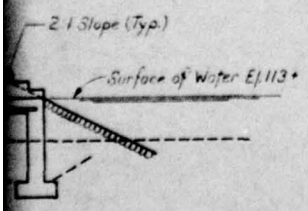


SECTION B-B
Scale: 1" = 10'-0"



TYPICAL SECTION
Scale: 1" = 10'-0"

NOTE: Project Elev. 118 is equal to U.S.G.S. Elev. 1396 ± .



LOFTY DAM
SCHUYLKILL COUNTY PENNSYLVANIA
PA. No. 54-1

PLANS & SECTIONS

PA.681 | PLATE III

REPRODUCED From DRAWINGS By A.B. COCHRAN & Son, Engineers 1914.