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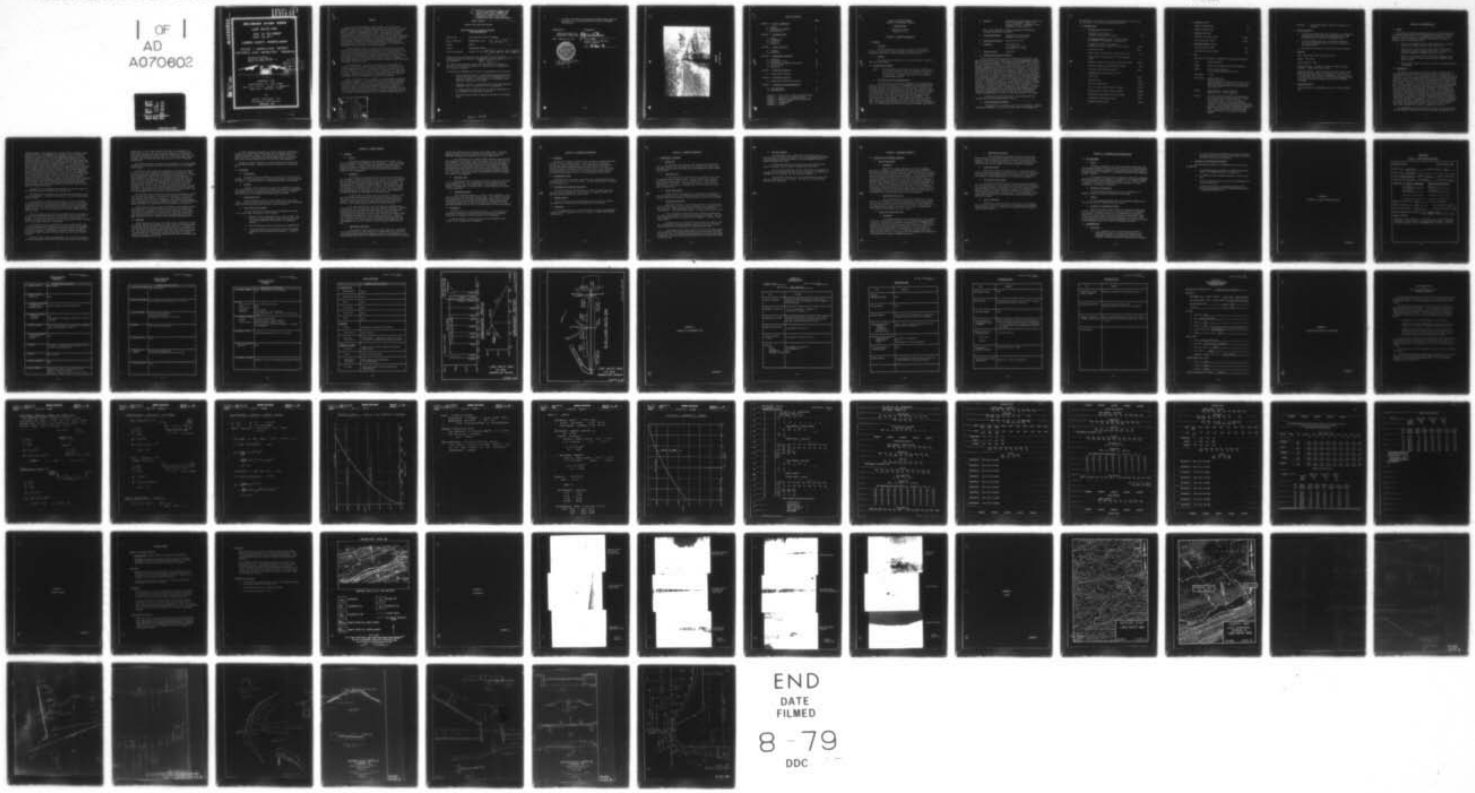

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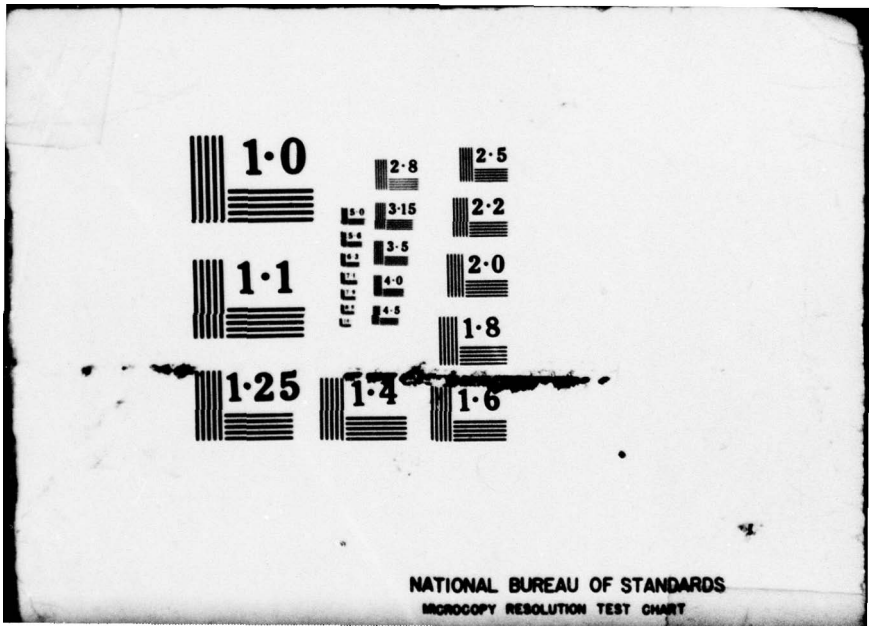
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LEVEL II

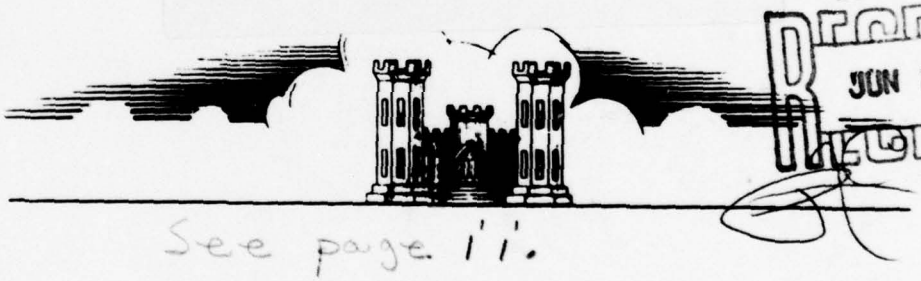
DELAWARE RIVER BASIN

LAKE HAUTO DAM

NDS No. PA-00606
DER No. 13-1

CARBON COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



See page ii.

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

BY

Berger Associates, Inc.
Harrisburg, Pennsylvania

FEBRUARY 1979

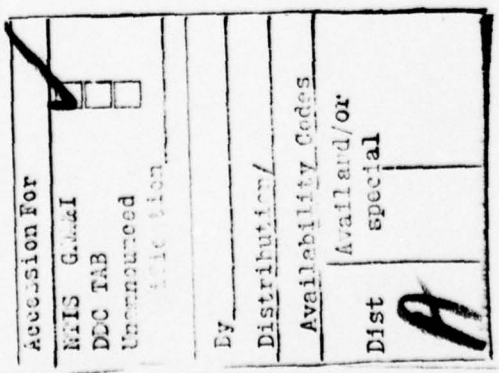
PREFACE

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. Lake Hauto Dam (NDS Number PA-00606, DER Number 13-1), Delaware River Basin, Nesquehoning Creek, Carbon County, Pennsylvania. Phase I Inspection Report.

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS
AND RECOMMENDATIONS

Name of Dam:	LAKE HAUTO DAM, NDS NO. PA-00606
State & State No.	PENNSYLVANIA, 13-1
County:	CARBON
Stream:	NESQUEHONING CREEK
Date of Inspection:	October 25, 1978

(11) Feb 79

(15) DACW31-79-C-0012

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

(12) 79 p.

The spillway and available storage have the capacity for passing 75 percent of the PMF and consequently is considered to be inadequate but not seriously inadequate.

The following recommendations are made for implementation by the owner:

1. A study should be made by a qualified professional engineer to evaluate the adequacy of protection of the embankment at the emergency spillway. If improvements are recommended, these should be constructed by the owner.

2. A positive closure of the upstream ends of the pipes under the embankment shall be provided for use in emergencies.

3. A program should be developed for the regular maintenance of the embankment and appurtenant facilities.

4. Protective riprap should be placed at the end of the spillway slab.

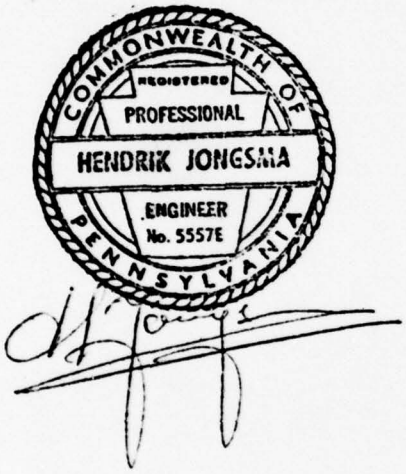
411 003

5. A formal surveillance and downstream warning system should be developed to be used during periods of high or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: February 20, 1979



APPROVED BY:

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

DATE 18 Mar 79

OVERVIEW

LAKE HAUTO DAM

TABLE OF CONTENTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE HAUTO DAM

NDS-ID NO. PA-00606
DER-ID NO. 13-1

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.

1.2 DESCRIPTION OF PROJECT

Note: All elevations in this report are based on a Mean Sea Level Datum elevation of 1034 for spillway crest obtained from the U.S.G.S. map, which is seven (7) feet above project datum. Therefore, add seven feet to elevations on engineering drawings.

A. Description of Dam and Appurtenances

Lake Hauto Dam is an earthfill embankment with a maximum fill height of 33 feet. The length of the embankment is approximately 1,600 feet and the spillway is located in the left abutment. The ogee type spillway crest is 6 feet below the top of the dam and is 100 feet long. A railroad crosses the right abutment of the dam. An emergency spillway is created here at an elevation of 3.25 feet below the top of the dam and is 33.2 feet wide. The main spillway is concrete paved and has concrete walls. A 20-inch pipe crosses under the embankment. This pipe was used for water supply. In the same trench, with the 20-inch pipe, there is a 24-inch blowoff pipe with a valve at the downstream end. The original dam construction started in 1912 and was completed in 1914. In 1923 the dam was raised two feet and the spillway was improved.

B. Location: Nesquehoning Township, Carbon County, PA
U.S.G.S. Quadrangle, Tamaqua, PA
Latitude 40°-50.8', Longitude 75°-54.0'
(Appendix F, Plates I and II)

Note: Lake Hauto Dam is located immediately downstream of Greenwood Dam (NDS No. PA-00701).

C. Size Classification: Intermediate (33 feet high, Storage = 6250 acre-feet)

D. Hazard Classification: High (Section 3.1.E)

E. Ownership: Lake Hauto Club
P. O. Box 67, R. D. #1
Nesquehoning, PA 18240

F. Purpose of Dam: Recreation

G. Design and Construction History

The present Lake Hauto Dam was constructed from 1912 to 1914 and replaced a smaller dam located 350 feet upstream ~~(Appendix F, Plate III)~~. The dam was designed by the Engineering Department of the American Pipe and Construction Company. Its Chief Engineer, J. W. Ledoux, made periodic inspection trips during construction, besides having a resident engineer engaged during the entire time of construction. The Contractor was McNichol Paving and Construction Company, Philadelphia. The dam was constructed for the Lehigh Coal and Navigation Company. The reservoir water was used as cooling water for a steam electric plant located south of the dam and for commercial water supply for collieries and washeries. The consulting firm Gannett, Seelye & Fleming, Inc., Harrisburg, designed a two-foot high addition to the dam and an enlargement of the spillway capacity by widening the spillway. The spillway crest was also raised two feet. A suspension bridge was located across the spillway. PennDER objected to the low under-clearance of this bridge and requested a replacement to prevent possible clogging up of the spillway. A drawing, dated 1920, indicates details of the present bridge supported on bent mine rails and presumably this bridge was extended in 1923 when the spillway was enlarged from 70 feet to 100 feet. The files did not contain an application or a permit for the construction of the bridge.

In 1963 major repairs were made to the concrete weir and upstream part of the spillway slab and walls.

H. Normal Operating Procedures

The reservoir is, at present, used only for recreation, fishing, boating and swimming. All inflow is either stored or discharged over

the spillway. The reservoir was lowered approximately 4 feet in 1975 for maintenance of docks and upstream slope repairs.

1.3 PERTINENT DATA

A. Drainage Area (square miles)

Computed for this report (Original design used 9.7 sq.mi.)	9.0

B. Discharge at Dam Site (cubic feet per second)
See Appendix C for hydraulic calculations.

Maximum known flood, 1955 (Hazel) estimated on basis of known pool Elev. 1037.50	2,490
Warm water outlet	None
Outlet works low-pool outlet at pool Elev. 1017	37
Outlet works at pool level Elev. 1034 (spillway crest)	72
Spillway capacity at pool Elev. 1040 (top of dam)	5,590
Emergency spillway at railroad and roadway	830
Total spillway discharge capacity	6,420

C. Elevation (feet above mean sea level)

Top of dam	1,040
Spillway crest	1,034
Top of railroad bed cut	1,036.9
Top of low area south of dam at roadway	1,039.0
Upstream portal invert of outlet tunnel	1,008.7
Downstream portal invert of outlet tunnel	1,008.3
Streambed at centerline of dam	1,007
Maximum tailwater about	1,010.2

D. Reservoir (miles)

Length of maximum pool	2.3
Length of normal pool	2.3

E. Storage (acre-feet)

Spillway crest (Elev. 1034)	4,250
Top of dam (Elev. 1040)	6,250

F. Reservoir Surface (acres)

Top of dam (Elev. 1040)	380
Spillway crest (Elev. 1034)	290

G. Dam

See Plates III through VI, Appendix F, for plan and sections.

Type: Rolled earthfill.

Length: 1600 feet embankment and 100 feet spillway.

Height: 33 feet above streambed.
45 feet above bottom cutoff trench.

Top Width: 15 feet.

Side Slopes: Upstream 2H to 1V.
Downstream 2H to 1V.
Due to raising of the dam, the top 8 feet of the downstream slope is supposed to be 1.5H to 1V. Field survey indicated that the upstream slope was 1.5H to 1V.

Zoning: Upstream half: selected material.
Downstream half: rolled material.

Cutoff: Six foot wide trench excavated at upstream toe to satisfactorily impervious material. Trench depth varies from 3.5 feet to 13.5 feet. Trench filled with a 2 foot thick concrete cutoff wall, and puddle backfilled with impervious material. Due to presence of quicksand, foundation grouted with 2-inch pipes from Station 6+00 to 7+85. From Station 8+00 to 10+22 steel sheet piling was driven to 19 feet below original ground.

Grouting: From Station 6+00 to 7+85 over a depth of 8 to 11 feet.

H. Outlet Facilities

1. A 20-inch pipe previously used for domestic and commercial water supply, placed under the embankment with an open upstream end and a valve on the downstream side.

2. A 24-inch blowoff pipe with a non-operable hydraulic valve at the upstream end and a valve in a valve pit at the downstream end.

3. Both pipes are encased in concrete with cutoff collars.

I. Spillway

Type: Uncontrolled ogee type concrete weir.

Length: 100.0 feet.

Crest Elevation: 1034.

Upstream Channel: Excavated to Elevation 1030, with good approach. A short wall on left side.

Downstream Channel: Concrete paved chute with concrete walls narrowing down from 100 feet at spillway weir to 35 feet at end of spillway, about 600 feet downstream. Slope of chute is 4 percent over first 140 feet. At end of paved spillway there is a 2-foot drop and the channel then joins the original streambed.

J. Regulating Outlet

A 24-inch valve on the downstream end of the 24-inch blowoff pipe.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The available engineering information did not contain design data or a design analysis for the dam and appurtenant structures. Refer to Appendix B of this report for the Engineering Data Check List. This report is based on information obtained from drawings reproduced in Appendix F and the following reports:

a. Report on the Application to receive permission to construct the dam, Mr. Gannett, PennDER, dated May 6, 1912.

b. "Report on the "Construction of Hauto Dam" by the Panther Valley Water Company, submitted by Francis B. McDowell, Jr., Assistant Engineer of PennDER, dated May 4, 1914.

c. Report on the "Application for Changes and Additions to the Dam", by George S. Beal, Division Engineer, PennDER, dated March 7, 1923.

d. Miscellaneous inspection reports, construction progress reports and drawings.

2.2 CONSTRUCTION

Two lines of boring holes were drilled across the valley; one 170 feet upstream of the dam and the other line 780 feet below the dam (Appendix F, Plate IV). The borings indicate that the foundation material consisted of clay with varying percentages of sand. Although the typical section on Plate III indicates that the natural ground was stripped only under the upstream part of the dam, records indicate that the whole area was stripped. A cutoff wall was installed along the full length of the dam. It was intended to be 12.5 feet deep, but quicksand was encountered at 9.5 feet below the original ground between Station 6+00 and 6+60 (Station 0+00 is about the south end of the dam). The subsurface was pressure grouted between Station 6+00 and Station 7+85 to a depth of 8 to 11 feet. Grouting was continued until all the springs were cut off. Grouting was not effective in choking off springs from Station 8+00 to Station 10+22. Twenty foot long sheetpiling was driven in this area to reduce water passage under the trench. The whole trench was filled with concrete in this area. The puddle in the rest of the trench consisted of a select clay with a maximum stone size of 1-1/2 inches, spread in 4-inch layers and sprinkled and tamped. The actual trench varied in depth from a minimum of 3.5 feet to a maximum of 13.5 feet.

The embankment was built of material excavated for the power house, and from material borrowed from the north hillside, upstream from the

spillway approach. The material from the power house excavation, which forms about 80% of the embankment, is a dense red clay of excellent quality. "A cube cut from the rolled embankment showed the clay to weigh 148 pounds per cu.ft., and 134 pounds when perfectly dry. The material from the borrow pit was a mixture of red and yellow sandy clay, and while good, was inferior to that obtained from the power house site, but all of the material was of superior quality". The material was spread in 6-inch layers and rolled with 10-ton rollers over the first 12 feet of height. After that, the material was dumped from cars and spread by a spreader pulled by a 20-ton locomotive. The obtained compaction was not as good as that obtained by the 10-ton roller. The embankment slope on the upstream side was paved with concrete blocks 9-inches thick up to elevation 1028. Blocks varied in size from 2-feet by 2-feet to 46-feet long by 4-feet wide. The latter ones were poured in-place. Joints were filled with asphaltic cement. From elevation 1028 to elevation 1034, the slope was protected with sandstone masonry 18 inches thick, laid in mortar. The top of the slope and the downstream slope were protected with 12-inch thick hand placed riprap, rather than the broken stone fill shown on Plate III.

The approach to the spillway was excavated on a slope of 29H to 1V and a concrete wall was constructed on the left side.

The spillway has an 18-inch thick concrete slab and concrete walls with varying height. Top width of the walls is 2.5 feet and the bottom width is 3 feet.

At the outlet is an 18-inch concrete apron, 70 feet long and 68 feet wide, beneath which and entirely surrounding it, is a 4-foot thick grouted masonry wall, extending below the natural surface to a boulder foundation, from 4 to 8 feet below the natural surface, guarding well against erosion. The fall from the slab to the creek channel, 250 feet away, is 5 feet.

The valve chamber, which is 9 feet in diameter and 11 feet deep, is at the toe of the downstream slope, and 563 feet from the south end of the dam. The bottom is concrete, 12 inches thick, the side wall is masonry, 18 inches thick, and the top is an 8-inch concrete slab, provided with a steel frame trap door, 4 feet square.

In the valve pit are the gate valves on the 24-inch blowoff, and the force pump, with pipe connections, extending through the embankment in concrete to the 24-inch hydraulic valve at the end of the blowoff pipe in the reservoir. Provisions for a future connection is made off the 24-inch blowoff pipe by a 16-inch outlet tee, with a gate valve at the end.

The outlet pipes through the embankment, are in cut and encased in a concrete envelope, 10 feet wide and 6 feet deep, and have two concrete

cutoff walls, 2 feet thick, spaced 10 feet apart, surrounding it 18 inches from the face. The end of the 24-inch pipe, 24 feet from the valve house, is protected from erosion by a masonry pier, and there is an outlet channel dug to the old creek bed. The 20-inch supply pipe is provided with a 20-inch bevel gear gate valve at the toe of the downstream slope.

The water taken from the reservoir for industrial use was discharged through the 20-inch supply pipe into a wooden intake box, in the swamp below the dam .

On March 13, 1923, permission was granted to increase the storage capacity of the dam by raising the embankment and the spillway 2 feet. The alterations were designed by Gannett, Seelye & Fleming, Inc., Harrisburg, Pennsylvania, and are shown on drawings V and VI, Appendix F. The storage below the weir crest was increased from 3680 acre-feet to 4250 acre-feet. The embankment was raised by constructing a concrete wall on the upstream side and steepening the top 8 feet of the downstream slope to 1-1/2H on 1V. The length of the spillway weir was increased from 70 feet to 100 feet and a new slab and training wall was installed. The stepped weir elevation shown on Plate V was not constructed and the full length of weir was constructed at elevation 1034. The weir was presumably set in the concrete of the old slab.

The railroad passing through the south end of the embankment creates a 33-foot wide low section. The ends of the embankment are protected with concrete walls (Plate VI, Appendix F). This area is about 3.25 feet below the top of the wall. Possible overflow would be discharged along a riprapped ditch along the embankment abutment. Progress inspection reports indicate that construction was in accordance with the plans.

Deterioration of the weir crest and spillway walls required partial reconstruction of the upper 180-foot long section of the spillway in 1963 (Plate VII, Appendix F). The weir was recapped and a new 4-inch thick slab was placed over the existing slab. The slab was reinforced with mesh and anchored with dowels to the existing slab. Pours were made in 20-foot by 20-foot sections with pre-formed expansion joints.

2.3 OPERATION

Formal operation records for this dam were not available for review. The dam was constructed to augment the water supply of an existing lower dam located 300 feet upstream. The reservoir was used as a supply of cooling water for an electric generating plant near the south end of the dam. The intake was located close to the power plant and the used water was recirculated to the reservoir from the power plant to the upper reaches of the lake. The 20-inch supply line was used for washeries and collieries downstream of the dam.

In 1926, permission was granted to install temporary flashboards to increase the storage volume while another dam was constructed for the Panther Valley Water Company. This permit was extended on a yearly basis until 1931. The flashboards were designed to fail if pool level would reach 6 inches above the top of the 12-inch high flashboards.

Inspection reports indicate that slight seepage has occurred since the dam became operable, although no flow was discovered in the marshy toe.

2.4 EVALUATION

A. Availability

The engineering data available for review were in the files of PennDER. The data were limited to construction drawings, as-built drawings and reports. Actual design data or design analysis were not available.

B. Adequacy

Although actual engineering data were not available, the report listed under Section 2.1.b supplied a thorough description of construction. This report with the available drawings are adequate to make a reasonable evaluation of the embankment and appurtenant structures.

C. Operating Records

Formal operating records for these facilities are not maintained. Available inspection reports do not indicate any serious problems, other than the usual low priority given to good maintenance.

D. Post Construction Changes

The post construction changes have been discussed in Section 2.2 of this report and consist of the following.

1. Raising of dam and spillway weir by 2 feet in 1923. The spillway weir was lengthened at that time and a low area in the south embankment was designed as an emergency spillway.

2. Weir and upstream section of spillway were rehabilitated.

3. A 5-span footbridge was constructed across the spillway around 1921 and the bridge was lengthened to 7 spans in 1923.

SECTION 3 - VISUAL FINDINGS

3.1 FINDINGS

A. General

The general appearance of the Lake Hauto Dam is good. However, maintenance of the embankment can be improved. A point of concern is the low point in the dam at the right abutment which functions as an emergency spillway. Appendix A of this report contains the visual inspection check list. Reproductions of photographs taken during the inspection are in Appendix E.

B. Embankment

At the time of inspection the pool level was at the spillway weir elevation. The dam was raised using a concrete wall at the upstream side and although some deterioration of the concrete is occurring, the wall should function properly during periods of high pool levels. The upstream slope is covered with cemented riprap. Some dislocations have occurred due to ice and wave action, but this is not critical. Weeds were growing on the cemented slope. The top of the dam is grassed and the downstream slope is protected with loose stones. This slope has a considerable amount of weed growth and some small brush.

A small amount of seepage water was noticed at the toe of the dam and the flow was estimated to be about half a gallon per minute. Some pools of water were near the toe, formed by poor drainage of the surface. Several high spots and ridges were present in the original surface or were formed during construction by depositing spoil.

The right abutment has a low area where the railroad tracks pass through. This area could be used as an emergency spillway. Concrete abutment walls were constructed on both sides of the track and riprap was placed in the area where the water would flow down the slope. Visual observation indicates that most water would be concentrated along the embankment abutment and a serious washout could occur. South of the railroad cut is another low area, approximately one foot below the top of the dam. This low lying area is, however, far enough away from the embankment and of such a width to prevent possible erosion of the dam.

C. Appurtenant Structures

The intake of the 24-inch pipe is under water and is controlled by a 24-inch valve in a valve chamber at the downstream toe. The valve was partially opened during the inspection and is in good condition. The upstream hydraulic valve is not operable and there is no method of positively

closing the upstream end of the pipe at the present time. The outlet pipe was silted up, but will clean out after opening of the valve. Immediately downstream is Tippets pond, a small manmade pond.

The spillway weir is in good condition and has a good approach. Some spalling of the abutment walls has occurred, but they are still in good condition. The bridge supports and a fish screen do not appear to collect excessive debris, which could reduce the discharge efficiency. The upper part of the discharge channel is in good condition. Further downstream some deep erosion of the spillway slab joints has occurred. The cutoff wall at the end of the slab is undermined (Appendix E, Plate III). Failure at this point during a high discharge would not endanger the safety of the embankment.

D. Reservoir Area

The reservoir area is wooded, with homes around the north side of the impounded lake. No sedimentation has been reported and heavy precipitation does not cause turbid water. The watershed is mostly wooded. Greenwood Dam, a reservoir with a 32-foot high dam, is located 2.3 miles upstream.

E. Downstream Channel

The spillway discharges to a natural stream (Appendix E, Plate IV) which ends in the next pond (Tippets Pond). The stream is forested. Below Tippets Pond is a residential development (Hauto Estates) and the stream then runs through an industrial park and through Nesquehoning. The hazard category for the dam is considered to be "High" due to the expected additional loss of life if the dam would fail after overtopping.

3.2 EVALUATION

The main concern is the emergency spillway. If this opening is required an investigation should be made to determine if additional protection is required to prevent erosion of the embankment.

A better control of weed and brush growth and preventive maintenance on the spillway are recommended.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURE

The dam was originally constructed for an electric company producing electricity with a steam generator. Since 1967 ownership has been several real estate companies and in 1975 ownership was transferred to the Lake Hauto Club, an association of property owners. The lake is used for swimming, fishing and boating, and the pool level is maintained at spillway weir crest elevation. For boat dock maintenance the pool level was lowered several feet in 1975 by opening the 24-inch valve.

4.2 MAINTENANCE OF DAM

Representatives of the Club stated that the weeds and brush on the downstream slope is cut every two years. No other maintenance is provided at the present time.

4.3 MAINTENANCE OF OPERATING FACILITIES

The 24-inch valve on the drawdown pipe had been opened three years ago for a partial drawdown of the reservoir. No regular schedule for maintaining and operating this valve exists.

4.4 WARNING SYSTEM

There is no formal downstream warning system in effect at present. The owners of the facilities live year-round at the reservoir.

4.5 EVALUATION

It is recommended that a formal surveillance program and downstream warning system be implemented for use in periods of heavy and prolonged precipitation.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic data available from PennDER for Lake Hauto Dam were not very extensive. No stage-storage curve, stage discharge curve, design storm data, flood hydrographs or flood routings were available.

B. Experience Data

In the period that the dam has been in existence, since 1913, the maximum flood occurred in 1955. At that time the pool reached a level about 3.5 feet higher than the spillway crest. This flood was passed without difficulty. It appears that the pool level must have been about .75 feet above the railroad bed, but no records were available to confirm this.

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

Lake Hauto Dam has a total storage capacity of 6,250 acre-feet and an overall height of 33 feet above streambed, both referenced to the top of the dam. These dimensions indicate a size classification of "Intermediate". The hazard classification is "High" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is the Probable Maximum Flood (PMF). For this dam, the PMF peak inflow is 11,300 cfs (see Appendix C for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 11,300 cfs with the estimated total spillway discharge capacity of 6,420 cfs indicates that a potential for overtopping of the Lake Hauto 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 the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 75% of a PMF.

E. Spillway Adequacy

The intermediate size category and high hazard category, in accordance with the Corps of Engineer criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be the full Probable Maximum Flood (PMF).

Calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 75% of the PMF.

Since the dam cannot pass the full PMF without overtopping but can pass more than one-half the PMF without overtopping, the spillway is considered to be inadequate but not seriously 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

There were no visual indications of undue embankment stresses or sloughage. The embankment slopes appear to be stable and the amount of detected seepage is minimal. Some standing pools are near the toe but are caused by poor surface drainage. The top of the upstream slope is steep but is generally well cemented. The main concern during the visual inspection was the low area in the south abutment for a railroad crossing. The discharge in this area is along the embankment abutment and no indications of a protective concrete wall and riprap was noticed. Heavy growth in this area prevented a thorough inspection. It was the opinion of the inspection team that, due to the vulnerability of this area to erosion during periods of heavy flow, the area should be closed during high flow or the flow should be diverted farther away from the embankment. The area south of the railroad is also low but due to the width of this area serious erosion is not anticipated.

2. Appurtenant Structures

The 24-inch blowoff is operable and appears to be satisfactory. The spillway weir and discharge channel slab and walls appear to be in good condition, except that deterioration and undermining of the slab is occurring at the low end of the spillway. This condition is not endangering the safety of the dam at this point, but maintenance would prevent future damage and costly repairs.

B. Design and Construction Data

1. Embankment

The available design and construction data is not adequate to evaluate the structural stability of the embankment and appurtenant structures. Construction information indicates that the embankment was constructed with good material and under good supervision. The borings indicate that seepage through the foundation is likely, although a cutoff wall was constructed. Grouting probably occurred only over a short distance (Refer to Section 2.2) and sheetpiling was used over a length of about 200 feet. It appears that the embankment was constructed in accordance with accepted engineering practice.

2. Appurtenant Structures

The spillway weir constructed in 1923 is not shown as being anchored to the concrete and has only a 6-inch key in the old concrete. This condition was improved by repairs in 1963 (Plate VII, Appendix F) and the weir should be stable. The spillway walls are of sufficient size for the height, but no reinforcement is indicated.

C. Operating Records

There are no formal operating records. Inspection reports indicate that slight seepage has occurred at the toe and that brush and trees have been a maintenance problem. The presence of a downstream pond prevents a valid determination of how serious the seepage is.

D. Post Construction Changes

The raising of the dam and spillway weir and the widening of the spillway appear to be well engineered and constructed in accordance with acceptable methods. The design of the low area for the railroad in the south abutment included provisions to protect the embankment. Theoretically, the discharge through the opening (33.0 feet by 3.25 feet) would concentrate along the abutment. It is questionable if the riprap would be sufficient to prevent serious erosion and perhaps a washout of the dam.

E. Seismic Stability

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

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of available design data and the operational history indicates that Lake Hauto Dam is in good condition and has been designed in accordance with acceptable engineering practice. The main concern is the adequacy of embankment protection at the emergency spillway location.

In accordance with the Corps of Engineers' evaluation guidelines, the spillway capacity is inadequate for passing the PMF (Probable Maximum Flood) peak inflow without overtopping the dam. It is, however, capable of passing 75 percent of the PMF peak inflow; therefore, it is not considered to be seriously inadequate.

B. Adequacy of Information

The information available for review is considered to be adequate to make a reasonable assessment of the project.

C. Urgency

It is considered important that the recommended suggestions in this section should be implemented without delay.

D. Necessity for Additional Studies

Additional studies should be made by a qualified professional engineer after cleaning the area of the emergency spillway to evaluate the adequacy of existing protection of the embankment. An analysis, based on an accurate survey, should determine the concentration, depth of water and flow velocity of the water discharge in that area. This engineering analysis should include recommendations for preventing erosion of the embankment during flow through the emergency spillway.

7.2 RECOMMENDATIONS

A. Facilities

1. It is recommended that the owner engage a qualified professional engineer to evaluate the adequacy of the embankment protection at the emergency spillway and construct necessary improvements proposed by the engineer.

2. The owner should make provisions for temporary closing of the upstream ends of the 20 and 24-inch pipes for positive closure in the event of an emergency.

B. Operation and Maintenance Procedures

The following procedures for implementation by the owner are recommended:

1. A yearly maintenance procedure for removal of brush and weeds on the embankment should be established.

2. The blowoff facility should be operated at least twice a year.

3. Protective riprap should be placed at the downstream end of the spillway slab.

4. A formal surveillance and downstream warning system should be established to be used during periods of high or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 13-1-A NDI NO. PA-00 606

NAME OF DAM Lake Hauto HAZARD CATEGORY High

TYPE OF DAM Earthfill

LOCATION Nesquehoning Boro. TOWNSHIP Carbon COUNTY, PENNSYLVANIA

INSPECTION DATE 10/25/78 WEATHER Sunny TEMPERATURE 60's

INSPECTORS:	OWNER'S REPRESENTATIVE(s):
H. Jongsma (Recorder)	
A. Bartlett	Ed Wise
R. Shireman	Louis Shinn

NORMAL POOL ELEVATION: 1034 AT TIME OF INSPECTION:

BREAST ELEVATION: 1040 POOL ELEVATION: 1034

SPILLWAY ELEVATION: 1034 TAILWATER ELEVATION: 1005

MAXIMUM RECORDED POOL ELEVATION: 1037.5 (Hazel - 1955)
1036.5 (Agnes - 1972) No valves open

GENERAL COMMENTS:

Railroad at right abutment is a low point in dam. Flow through this "emergency" spillway would run along embankment abutment. Although protected by riprap, failure of embankment at this point is likely.

NDI NO. PA-00 606

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	None evident.
B. UNUSUAL MOVEMENT BEYOND TOE	None.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	Upstream riprap with some undulations.
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Good. Good, except low emergency spillway at railroad crossing.
E. RIPRAP FAILURES	Minor on upstream due to wave action. Riprap is deep and no immediate concern.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Good.
G. SEEPAGE	See sketch - standing water along most of toe. Natural ground undulating.
H. DRAINS	None evident.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Downstream - Weeds - cut every two years Breast - Grass and footpath Upstream - Cemented riprap and concrete wall.

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Pipe under water.
B. OUTLET STRUCTURE	Valve chamber at downstream toe - 24" valve.
C. OUTLET CHANNEL	Wooded narrow streambed. Outlet pipe silted up. Recommended to blowoff twice a year.
D. GATES	One valve on blowoff pipe.
E. EMERGENCY GATE	None.
F. OPERATION & CONTROL	Opened during inspection. For partial drawdown opened 3 years ago.
G. BRIDGE (ACCESS)	None.

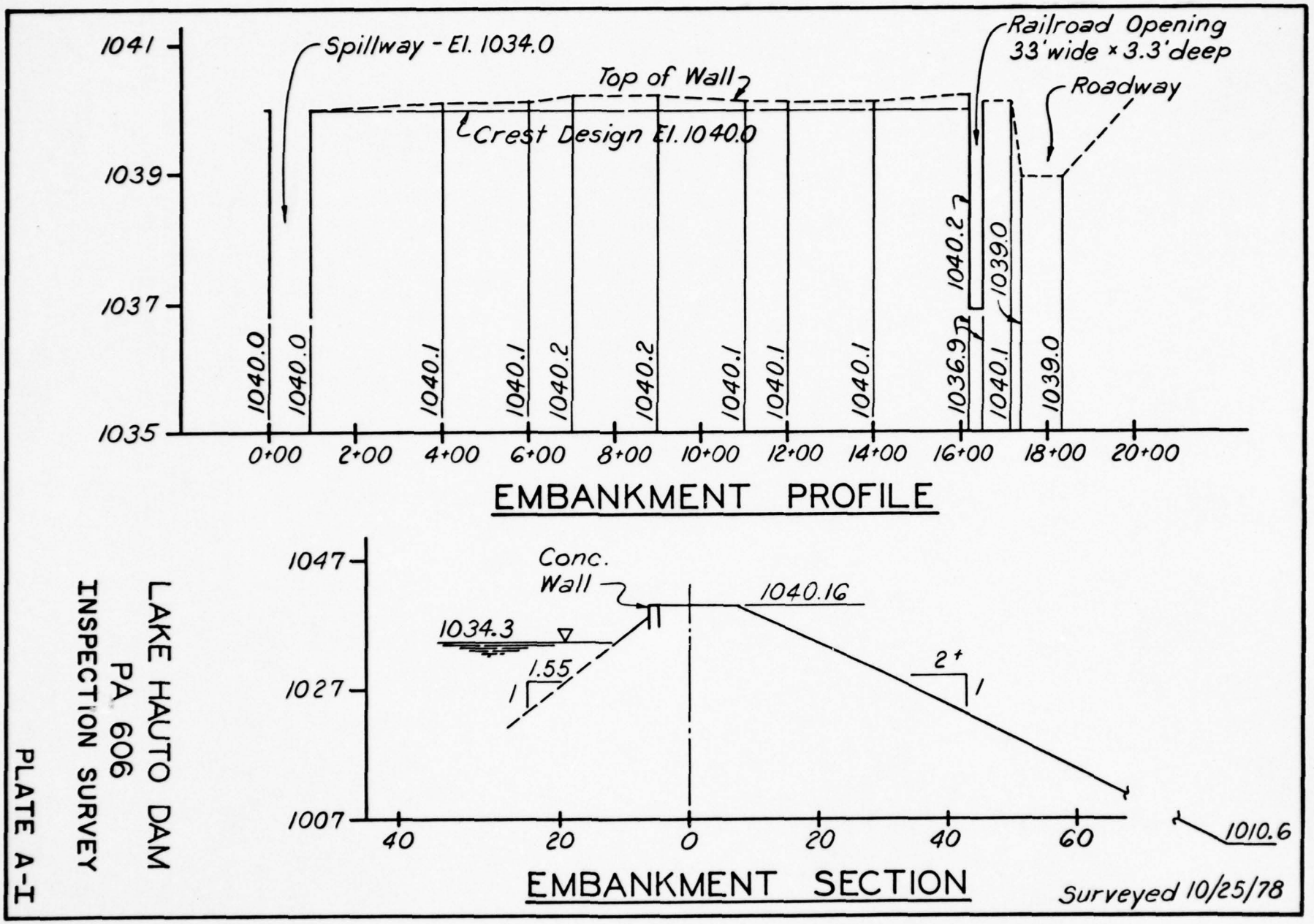
NDI NO. PA-00 606

VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Clear - small wall at left abutment.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	 Good - small ogee section. None. None. Not observed. Slight spalling - good condition. Fish screens on weir. Will lift up druing high water.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	 Concrete slab and walls. Upstream section in good condition Downstream badly eroded at joints. Last cutoff wall seriously undermined. No danger to embankment.
D. BRIDGE & PIERS	Footbridge supported on bent of railtrack.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	Maximum 3.5 feet over spillway during Hazel (1955).

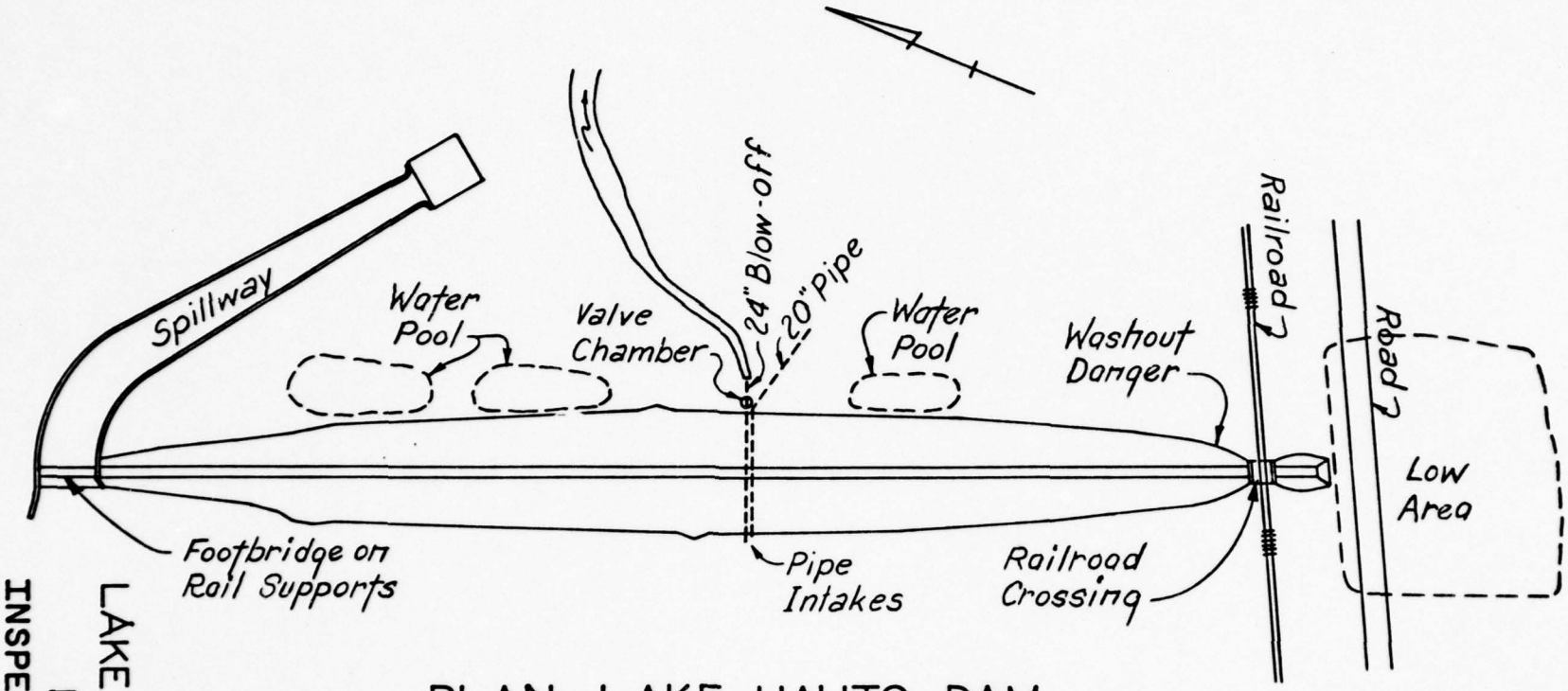
VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR Slopes	Wooded with residential development.
Sedimentation	None reported.
Watershed Description	Mostly wooded. Immediately upstream of this reservoir is Greenwood Dam (NDS NO. PA-00701)
DOWNSTREAM CHANNEL Condition	Wooded natural stream, ending in next pond. Tippets pond.
Slopes	Rocks, stone and trees.
Approximate Population	Hauto Estates and Nesquehoning 30 + Nesquehoning.
No. Homes	Couple dozen homes in Hauto Estates and Nesquehoning.



LAKE HAUTO DAM
PA 606
INSPECTION SURVEY

PLATE A-I



PLAN - LAKE HAUTO DAM

Surveyed 10/25/78

LAKE HAUTO DAM
PA. 606
INSPECTION SURVEY

PLATE A-II

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 13-1 NDI NO. PA-00 606

NAME OF DAM LAKE HAUTO DAM

ITEM	REMARKS
AS-BUILT DRAWINGS	Progress drawing with as-built details up to October 15, 1913 in PennDER file (poor condition not reproduced).
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle : Tamaqua, PA See Plate II, Appendix F
CONSTRUCTION HISTORY	Constructed from 1912 to January, 1914. Raised in 1923. Spillway weir and first 175 feet of spillway chute reconstructed in 1963.
GENERAL PLAN OF DAM	See Appendix F, Plate III.
TYPICAL SECTIONS OF DAM	See Appendix F, Plate III and V.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	 See Appendix F, Plate III In PennDER Files None None

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	None.
GEOLOGY REPORTS	Short description in Report on Construction of Hauto Dam, dated May, 1914 by PennDER.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None, except in reports on application for construction or additions.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	 See Palte IV, Appendix F. None. Description of visual inspection.
POST CONSTRUCTION SURVEYS OF DAM	None
BORROW SOURCES	From excavation of power plant at south end of dam (80%) and from north hillside.

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Raised dam and spillway crest in 1923. Widened spillway from 70 feet to 100 feet.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	Report by DER upon completion of construction. Reports by DER upon application for raising dam in 1923, installation of temporary flashboards and (1926-1930), and rehabilitation of spillway (1963).
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	No failures of dam.
MAINTENANCE & OPERATION RECORDS	Inspection reports by DER.
SPILLWAY PLAN, SECTIONS AND DETAILS	Plates III, V and VI, Appendix D.

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	Drawing in PennDER file detailing valve pit.
CONSTRUCTION RECORDS	As-built drawing, October, 1913. Progress reports on construction by PennDER.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Regular Inspection Reports by DER, since 1920. Most reports discuss seepage and marshy conditions at toe.
MISCELLANEOUS	

NDI NO. PA-00 606

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Mostly wooded - mountains

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 1034 4250 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: El.1040 6250 Acre-Feet

MAXIMUM DESIGN POOL: Elev. 1040

TOP DAM: Elev. 1040

SPILLWAY:

a. Elevation 1040

b. Type Uncontrolled Ogee

c. Width 100

d. Length 600

e. Location Spillover Left abutment plus emergency spillway in right abutment.

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 24-inch blowoff pipe.

b. Location 560 feet south of spillway

c. Entrance inverts 1008.7

d. Exit inverts 1008.3

e. Emergency drawdown facilities 24-inch blowoff

HYDROMETEOROLOGICAL GAGES:

a. Type None

b. Location None

c. Records None

MAXIMUM NON-DAMAGING DISCHARGE: 8,850 cfs

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.

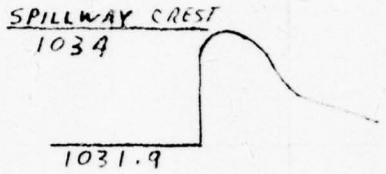
For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

BY RLS DATE 11/22/78 **BERGER ASSOCIATES** SHEET NO. 1 OF
CHKD. BY JC DATE 12/21/78 PROJECT D8490
SUBJECT HAUTO DAM

MAXIMUM KNOWN FLOOD AT DAMSITE

THE MAXIMUM KNOWN FLOOD AT HAUTO DAM OCCURRED IN 1955. AT THAT TIME THE WATER LEVEL IN THE POOL REACHED AN ELEVATION ABOUT 3.5' HIGHER THAN THE SPILLWAY CREST.

→ OGEE SECTION



$L = 100'$
$H = 3.5'$
$C = 3.8$

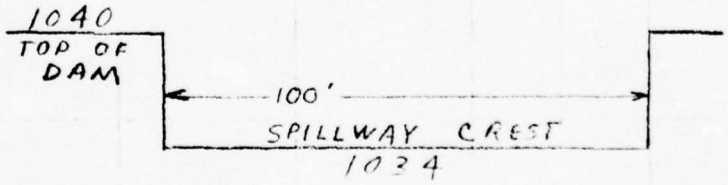
$Q = C L H^{3/2}$

$C = 3.8$
(FIG. 249 DESIGN OF SMALL DAMS)

$Q = 3.8 \times 100 \times (3.5)^{3/2}$

$= 2488$ CFS SAY 2490 CFS OVER SPILLWAY

SPILLWAY CAPACITY



$L = 100'$
$H = 6'$
$C = 3.8$

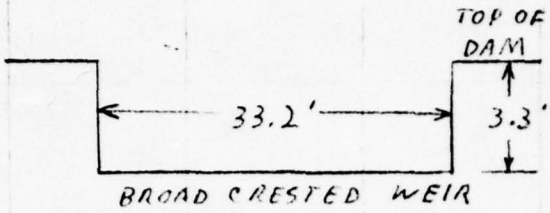
$Q = C L H^{3/2}$

$Q = 3.8 \times 100 \times (6)^{3/2}$

$= 5585$ CFS SAY 5590 CFS

EMERGENCY SPILLWAY DISCHARGE

THRU RAILROAD CUT:



BROAD CRESTED WEIR

C = 2.63 (KING'S HDBK)

$L = 33.2'$
$H = 3.3'$
$C = 2.63$

$Q = C L H^{3/2}$

$Q = 2.63 \times 33.2 \times 3.3^{3/2}$

$= 523$ CFS

THRU ROADWAY CUT:
APPROX. DISCHARGE

BROAD CRESTED WEIR

C = 2.63 (KING'S HDBK)

$L = 100'$
$H = 1.1'$
$C = 2.63$

$Q = C L H^{3/2}$

$Q = 2.63 \times 100 \times (1.1)^{3/2}$

$= 303$ CFS

TOTAL DISCHARGE CAPACITY

$303 + 523 + 5590 = 6416$ CFS

SAY 6420 CFS

BY RLS DATE 11/27/78 **BERGER ASSOCIATES** SHEET NO. 3 OF
CHKD. BY DJR DATE 12/21/78 PROJECT D8490
SUBJECT HAVTO DAM

DISCHARGE THROUGH OUTLET WORKS

$D = 24''$ $R = .5$ $A = \pi$
$L = 173'$ $N = .015$ (KING'S HDBK.)
NORMAL TAILWATER = 6" ABOVE OUTLET PIPE CROWN
= 1010.8

DISCHARGE AT POOL ELEV = 1034 (NORMAL POOL)

$S = (1034 - 1010.8)/173 = .1341$

$$Q = \frac{1.486}{N} A R^{2/3} S^{\frac{1}{2}}$$

$$= \frac{1.486}{.015} \times \pi \times (.5)^{2/3} \times (.1341)^{1/2}$$

$= 72$ CFS

DISCHARGE AT LOW POOL ELEV = 1017

$S = (1017 - 1010.8)/173 = .03584$

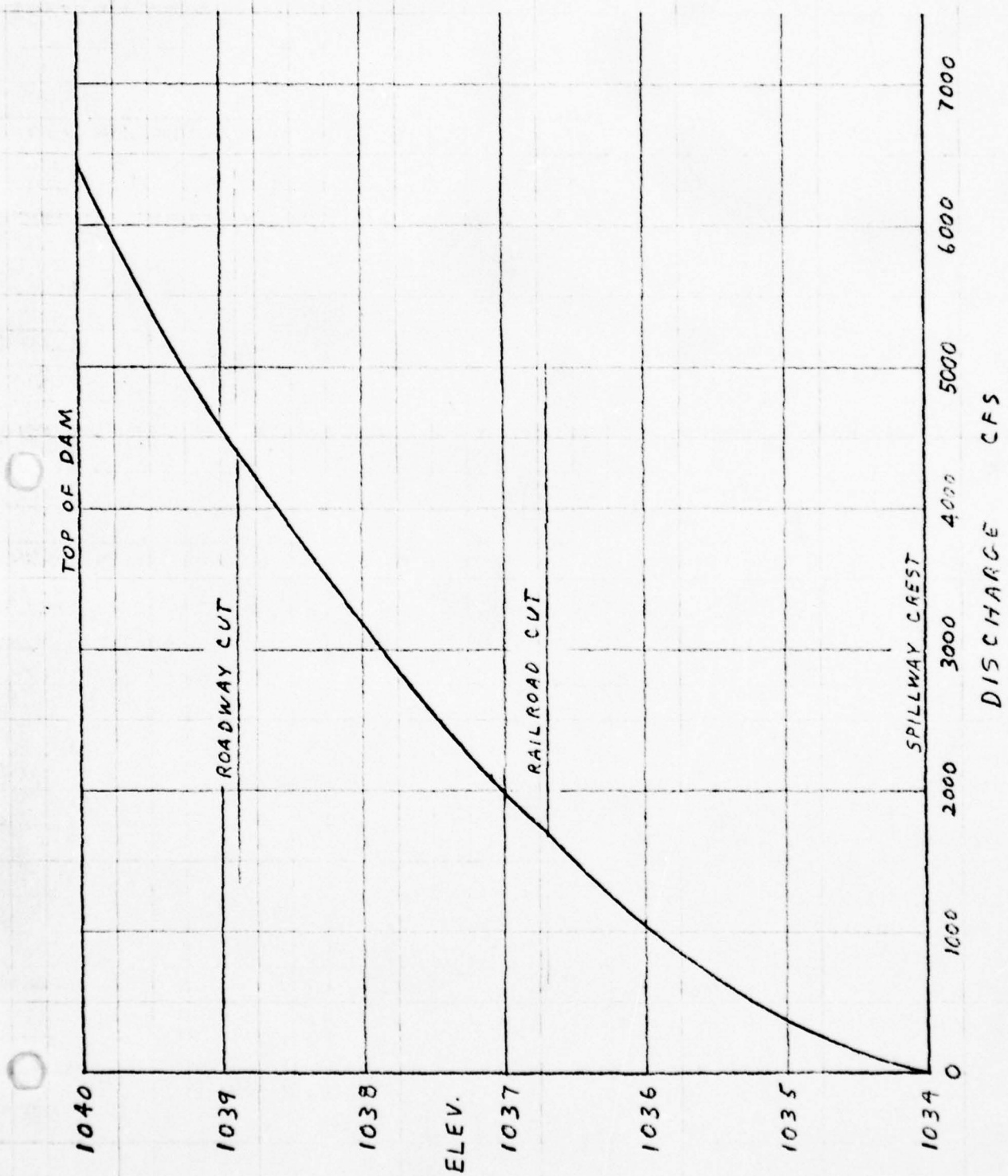
$$Q = \frac{1.486}{N} A R^{2/3} S^{1/2}$$

$$= \frac{1.486}{.015} \times \pi \times (.5)^{2/3} \times (.03584)^{1/2}$$

$= 37$ CFS

BY RLS DATE 11/27/79 **BERGER ASSOCIATES** SHEET NO. 4 OF
CHKD. BY DJK DATE 12/11/79 PROJECT D 8490
SUBJECT HAUTO DAM

RATING CURVE, SPILLWAY AND EMERGENCY SPILLWAYS



BY RLS DATE 12/19/78 BERGER ASSOCIATES SHEET NO. 5 OF
CHKD. BY DJA DATE 12/21/78 PROJECT D8490
SUBJECT HAUTO DAM

SIZE CLASSIFICATION

MAXIMUM STORAGE = 6250 ACRE-FEET
MAXIMUM HEIGHT = 33 FEET
SIZE CLASSIFICATION IS INTERMEDIATE.

HAZARD CLASSIFICATION

THE BOROUGH OF NESQUEHONING LIES ALONG THE DOWNSTREAM CHANNEL.
USE "HIGH".

RECOMMENDED SPILLWAY DESIGN FLOOD

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

BY RLS DATE 1/11/79 **BERGER ASSOCIATES** SHEET NO. 6 OF
CHKD. BY DATE PROJECT D8490
SUBJECT HAUTO DAM

HEC-1 DATA

DRAINAGE AREA = 9.02 SQ.MI.
HAUTO SUB AREA = 3.44 SQ. MI.
GREENWOOD SUBAREA = 5.58 SQ. MI.

DELAWARE BASIN REGION 2
CP = 0.45

HAUTO SUBAREA
LONGEST WATER COURSE = 13100' = 2.48 MI
L TO CENTROID = 7100' = 1.34 MI.

$T_P = 2.1 (L \times L_{CA})^{.3}$
$T_P = 3.01$

GREENWOOD SUBAREA
LONGEST WATER COURSE = 20000' = 3.79 MI.
L TO CENTROID = 10500' = 1.99 MI

$T_P = 2.1 (L \times L_{CA})^{.3}$
$T_P = 3.85$

RAINFALL (HMR-33)
INDEX = 22.6"

ZONE 6

INCREMENTAL RAINFALL
6 HR = 113%
12 HR = 123%
24 HR = 132%
48 HR = 142%

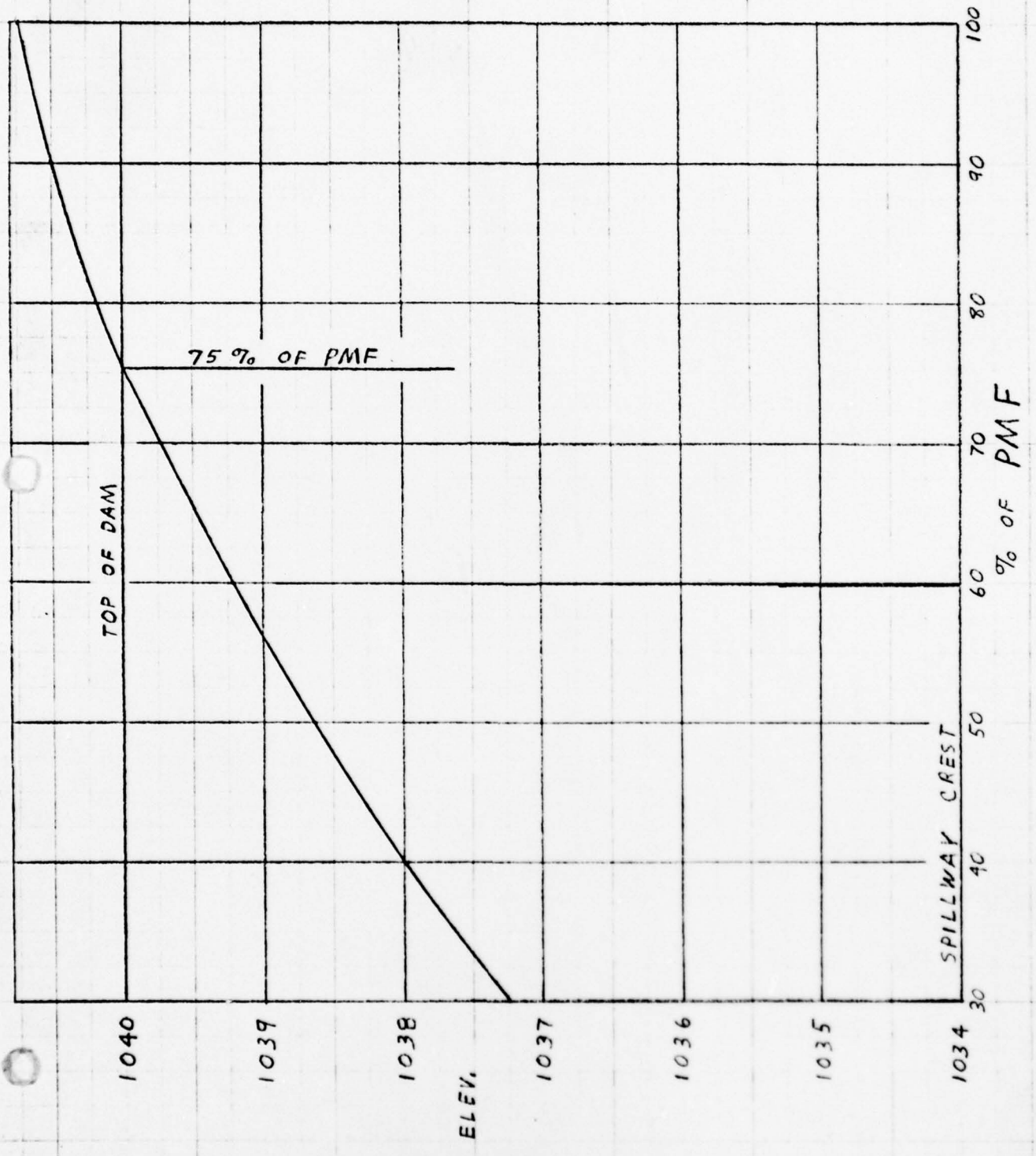
PLANIMETERED AREAS (FROM QUAD SHEETS)
ELEV: 1034 = 287.7 ACRES
1040 = 380.5 ACRES
1060 = 464.6 ACRES

BY RLS DATE 1/15/79 **BERGER ASSOCIATES** SHEET NO. OF

CHKD. BY DATE PROJECT D8490

SUBJECT HAVTO DAM

SPILLWAY CAPACITY CURVE



DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 21 AUG 78

OVERTOPPING ANALYSIS
1/7

```
**********
    1          A1     LAKE HAUTO DAM    ****    NESQUEHONING CREEK
    2          A2     MAUCH CHUNK TWP., CARBON COUNTY, PA.
    3          A3     NDI # PA-00606     PA DER # 13-1-A
    4          B   300      0     15      0      0      0      0      0     -4      0
    5          B1    5
    6          J     1      9      1
    7          J1    1     .9     .8     .7     .6     .5     .4     .3    .15
    8          K            1                                          1
    9          K1                INFLOW HYDROGRAPH    GREENWOOD DAM SUBAREA
   10          M     1      1    5.58           9.02
   11          P           22.6    113    123    132    142
   12          T                                                     1    .05
   13          W  3.85    .45
   14          X  -1.5   -.05      2
   15          K     1      2                                          1
   16          K1               RESERVOIR ROUTING - GREENWOOD DAM
   17          Y                                 1      0
   18          Y1    1                                                    1135    -1
   19          YA 1059   1060   1061   1062   1063   1064   1065  1066.1 1066.4 1066.8
   20          Y4 1067 1067.4   1068
   21          Y5    0    355    960   1642   2282   2922   3594   4378   4674   5443
   22          Y5 5948   7080   9980
   23          $A    0  111.1  130.4  275.5
   24          $E1028.4   1059   1060   1080
   25          $$ 1059
   26          $D1066.1
   27          K            3                                          1
   28          K1               INFLOW HYDROGRAPH    HAUTO SUBAREA
   29          M     1      1   3.44           9.02
   30          P           22.6    113    123    132    142
   31          T                                                     1    .05
   32          W  3.01    .45
   33          X  -1.5   -.05      2
   34          K     2      4                                          1
   35          K1               COMBINED HYDROGRAPHS
   36          K     1      5                                          1
   37          K1               RESERVOIR ROUTING - LAKE HAUTO
   38          Y                                 1      0
   39          Y1    1                                                    4250    -1
   40          Y4 1034 1034.5   1035   1036 1036.7 1037.1 1037.9 1038.9 1039.1 1039.5
   41          Y4 1040
   42          Y5    0    134    380   1075   1686   2096   3042   4407   4726   5432
   43          Y5 6411
   44          $A    0  287.7  380.5  464.6
   45          $E 989.7   1034   1040   1060
   46          $$ 1034
   47          $D 1040    2.7    1.5   1600
   48          K    99
1                        PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                         RUNOFF HYDROGRAPH AT          1
                         ROUTE HYDROGRAPH TO           2
                         RUNOFF HYDROGRAPH AT          3
                         COMBINE  2 HYDROGRAPHS AT     4
                         ROUTE HYDROGRAPH TO           5
                         END OF NETWORK

**********
```

LAKE HAUTO DAM **** NESQUEHONING CREEK
MAUCH CHUNK TWP., CARBON COUNTY, PA.
NDI # PA-00606 PA DER # 13-1-A

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 .90 .80 .70 .60 .50 .40 .30 .15

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH GREENWOOD DAM SUBAREA

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	5.58	0.00	9.02	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.60	113.00	123.00	132.00	142.00	0.00	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= 3.85 CP= .45 NTA= 0

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

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 3.88 HOURS, CP= .45 VOL= .98

6.	24.	49.	80.	115.	152.	193.	235.	278.	317.
351.	380.	403.	420.	430.	431.	421.	404.	386.	373.
358.	344.	330.	317.	304.	292.	280.	269.	258.	248.
238.	228.	219.	210.	202.	194.	186.	179.	172.	165.
158.	152.	146.	140.	134.	129.	124.	119.	114.	110.
105.	101.	97.	93.	89.	86.	82.	79.	76.	73.
70.	67.	64.	62.	59.	57.	55.	53.	50.	48.
46.	45.	43.	41.	39.	38.	36.	35.	34.	32.
31.	30.	28.	27.	26.	25.	24.	23.	22.	21.
21.	20.	19.	18.	17.	17.	16.	15.	15.	14.

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 25.47 23.08 2.40 3[illegible]

HYDROGRAPH ROUTING

RESERVOIR ROUTING - GREENWOOD DAM

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	1135.	-1

STAGE	1059.0	1060.0	1061.0	1062.0	1063.0	1064.0	1065.0	1066.1	1066.4	1066.8
	1067.0	1067.4	1068.0							
FLOW	0.	355.	960.	1642.	2282.	2922.	3594.	4378.	4674.	5443.
	5948.	7080.	9980.							
SURFACE AREA=	0.	111.	130.	276.						
CAPACITY=	0.	1133.	1254.	5223.						
ELEVATION=	1028.	1059.	1060.	1080.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1059.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1066.1	0.0	0.0	0.

PEAK OUTFLOW IS 6820. AT TIME 45.00 HOURS

PEAK OUTFLOW IS 5899. AT TIME 45.25 HOURS

PEAK OUTFLOW IS 4934. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 4165. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 3568. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 2979. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 2396. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 1809. AT TIME 45.75 HOURS

PEAK OUTFLOW IS 879. AT TIME 46.00 HOURS

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

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

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH HAUTO SUBAREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	3.44	0.00	9.02	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.60	113.00	123.00	132.00	142.00	0.00	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= 3.01 CP= .45 NTA= 0

RECESSION DATA

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

UNIT HYDROGRAPH100 END-OF-PERIOD ORDINATES, LAG= 3.03 HOURS, CP= .45 VOL= .99

7.	27.	56.	90.	128.	170.	213.	252.	285.	311.
330.	339.	336.	322.	305.	290.	275.	261.	248.	235.
223.	212.	201.	191.	181.	172.	163.	155.	147.	140.
133.	126.	119.	113.	108.	102.	97.	92.	87.	83.
79.	75.	71.	67.	64.	61.	58.	55.	52.	49.
47.	44.	42.	40.	38.	36.	34.	32.	31.	29.
28.	26.	25.	24.	23.	21.	20.	19.	18.	17.
16.	16.	15.	14.	13.	13.	12.	11.	11.	10.
10.	9.	9.	8.	8.	8.	7.	7.	6.	6.
6.	6.	5.	5.	5.	4.	4.	4.	4.	4.

Q

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	25.67	23.28	2.40	205723.
										(652.)	(591.)	(61.)	(5825.43)

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

COMBINE HYDROGRAPHS

COMBINED HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	2	0	0	0	0	1	0	0

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

HYDROGRAPH ROUTING

HYDROGRAPH ROUTING

RESERVOIR ROUTING - LAKE HAUTO

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	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	4250.	-1

STAGE	1034.0	1034.5	1035.0	1036.0	1036.7	1037.1	1037.9	1038.9	1039.1	1039.5
	1040.0									
FLOW	0.	134.	380.	1075.	1686.	2096.	3042.	4407.	4726.	5432.
	6411.									
SURFACE AREA=	0.	288.	381.	465.						
CAPACITY=	0.	4248.	6246.	14684.						
ELEVATION=	990.	1034.	1040.	1060.						

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1034.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1040.0	2.7	1.5	1600.

PEAK OUTFLOW IS 10507. AT TIME 45.50 HOURS

PEAK OUTFLOW IS 8855. AT TIME 46.00 HOURS

PEAK OUTFLOW IS 7131. AT TIME 46.75 HOURS

PEAK OUTFLOW IS 5906. AT TIME 47.25 HOURS

PEAK OUTFLOW IS 4931. AT TIME 47.50 HOURS

PEAK OUTFLOW IS 4020. AT TIME 47.75 HOURS

PEAK OUTFLOW IS 3138. AT TIME 48.00 HOURS

PEAK OUTFLOW IS 2267. AT TIME 48.25 HOURS

PEAK OUTFLOW IS 1001. AT TIME 49.25 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)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO
				1.00	.90	.80	.70	.60	.50	.40	.30	.15
HYDROGRAPH AT	1	5.58	1	7581.	6823.	6065.	5307.	4549.	3791.	3033.	2274.	1137.
		(14.45)		(214.68)(	193.21)(	171.74)(	150.27)(	128.81)(	107.34)(	85.87)(	64.40)(	32.20)
ROUTED TO	2	5.58	1	6820.	5899.	4934.	4165.	3568.	2979.	2396.	1809.	879.
		(14.45)		(193.13)(	167.04)(	139.73)(	117.94)(	101.03)(	84.37)(	67.86)(	51.21)(	24.89)
HYDROGRAPH AT	3	3.44	1	5540.	4986.	4432.	3878.	3324.	2770.	2216.	1662.	831.
		(8.91)		(156.88)(	141.19)(	125.50)(	109.81)(	94.13)(	78.44)(	62.75)(	47.06)(	23.53)
COMBINED	4	9.02	1	11321.	9733.	8178.	7159.	6142.	5132.	4123.	3105.	1504.
		(23.36)		(320.57)(	275.60)(	231.59)(	202.71)(	173.92)(	145.32)(	116.74)(	87.92)(	42.60)
ROUTED TO	5	9.02	1	10507.	8855.	7131.	5906.	4931.	4020.	3138.	2267.	1001.
		(23.36)		(297.53)(	250.74)(	201.93)(	167.24)(	139.63)(	113.82)(	88.86)(	64.21)(	28.35)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1059.01	1059.00	1066.10
STORAGE	1135.	1133.	2164.
OUTFLOW	5.	0.	4378.

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	1067.31	1.21	2373.	6820.	6.25	45.00	0.00
.90	1066.98	.88	2316.	5899.	5.00	45.25	0.00
.80	1066.54	.44	2239.	4934.	3.25	45.75	0.00
.70	1065.80	0.00	2114.	4165.	0.00	46.00	0.00
.60	1064.96	0.00	1976.	3568.	0.00	46.00	0.00
.50	1064.09	0.00	1837.	2979.	0.00	46.00	0.00
.40	1063.18	0.00	1699.	2396.	0.00	46.00	0.00
.30	1062.26	0.00	1564.	1809.	0.00	45.75	0.00
.15	1060.87	0.00	1369.	879.	0.00	46.00	0.00

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1034.00	1034.00	1040.00
STORAGE	4250.	4246.	6246.
OUTFLOW	1.	0.	6411.

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	1040.73	.73	6527.	10507.	6.50	45.50	0.00
.90	1040.50	.50	6436.	8855.	5.25	46.00	0.00
.80	1040.19	.19	6319.	7131.	3.50	46.25	0.00
.70	1039.73	0.00	6144.	5906.	0.00	47.25	0.00
.60	1039.22	0.00	5953.	4931.	0.00	47.50	0.00
.50	1038.62	0.00	5736.	4020.	0.00	47.75	0.00
.40	1037.97	0.00	5508.	3133.	0.00	48.00	0.00
.30	1037.24	0.00	5260.	2267.	0.00	48.25	0.00
.15	1035.89	0.00	4819.	1001.	0.00	49.25	0.00

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

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Middle Member of the Mauch Chunk Formation.

Lithology: Grayish red and reddish brown sandstone interbedded with similarly colored siltstone, mudstone and shale. Some thin interbeds of green to grayish green mudstones are common.

Structure

The dam is located on the south limb of the Frackville anticline. Bedding plane thrust faults are mapped on both the nortn and south sides of the valley of Nesquehoning Creek. The beds in the vicinity of the dam strike N70°E and dip 40°S.

Fracture traces are scarce in the area, traces trending N10°W, N5°W, N60°W and N55°W were observed.

Overburden

The overburden in the area of the dam is very thick, and consists of both colluvium, a poorly sorted mixture of boulders, sand and clay derived from the adjacent ridges, and alluvium, consisting of sand, silt and clay in the valley of Nesquehoning Creek.

The available boring logs include only one that penetrated the colluvium to bedrock. The colluvium in that hole was 106 feet deep. Another was apparently in alluvium to 87.5 feet, and it may have been in alluvium or weathered bedrock to 113 feet. The remaining holes are from 13 to 80 feet deep and all bottomed in overburden material.

Aquifer Characteristics

While some of the sandstone units in the Mauch Chunk Formation may have some primary porosity and permeability, most or 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 enlargement of fracture openings by ground water movement.

Discussion

This dam was constructed with a concrete cutoff wall and puddle trench, that was specified to be to "impervious material". There is no indication that this trench reached bedrock anywhere. Sheet piling was driven near the center of the dam, and some grouting was done.

The colluvium on which this dam was founded is described to be sand, clay and silt. Generally speaking this is probably rather impermeable material, but permeable streaks do exist in some places. Leakage apparently occurs through the colluvium below the cutoff wall. If any of this leakage is turbid at any time, there is the possibility that the leakage could increase through removal of clay and silt particles.

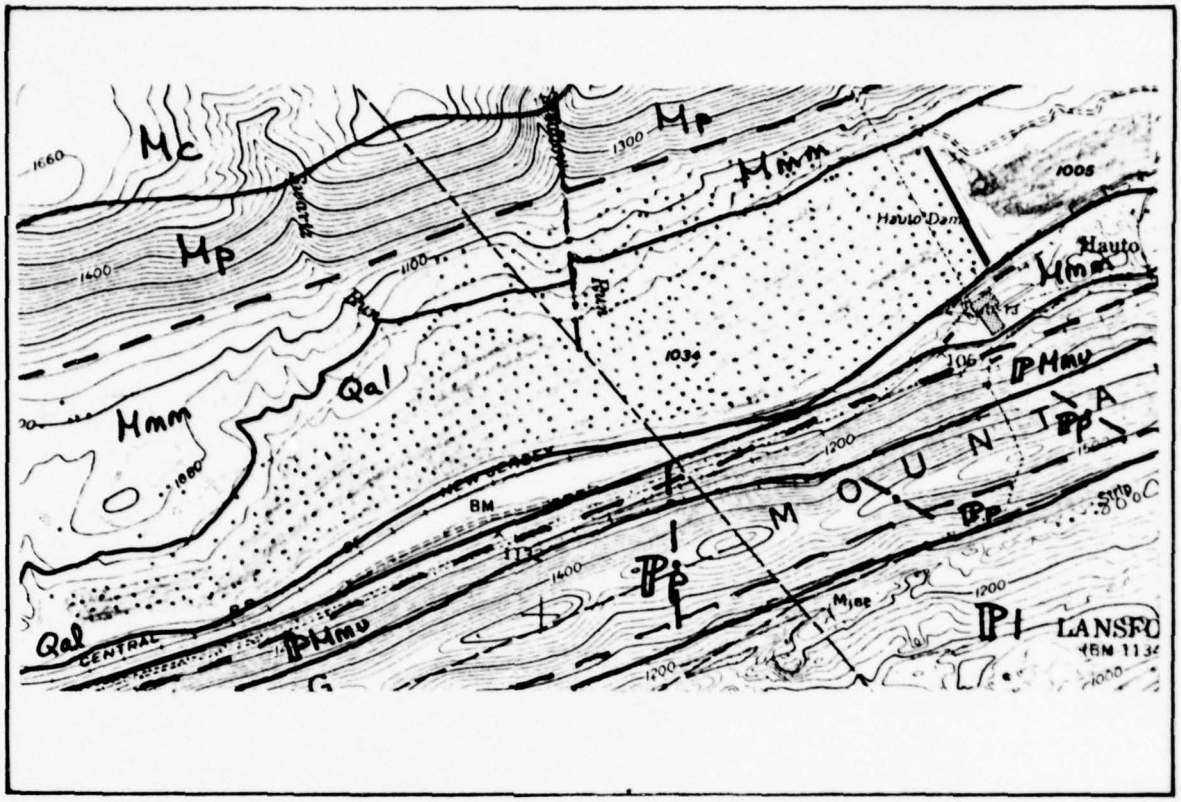
Sources of Information

1. Wood, Gordon H. (1974) "Geologic Map of the Tamaqua Quadrangle, Carbon and Schuylkill Counties, Pa.".

2. Air Photographs, scale 1:24,000, dated 1969.

3. Core Boring information in file.

GEOLOGIC MAP - Hauto Dam



(geology from U.S.G.S. Map GQ-1133)

Qal — Alluvium	Mp — Pocono Fm.
Pl — Llewellyn Fm.	Mc — Catskill Fm.
Pp — Pottsville Fm.	——— thrust fault
PHmu — Mauch Chunk Fm; upper member	—·—·— air photo fracture trace
Pmm — Mauch Chunk Fm; middle member	

N

SCALE 1:24000

1 0 1 MILE

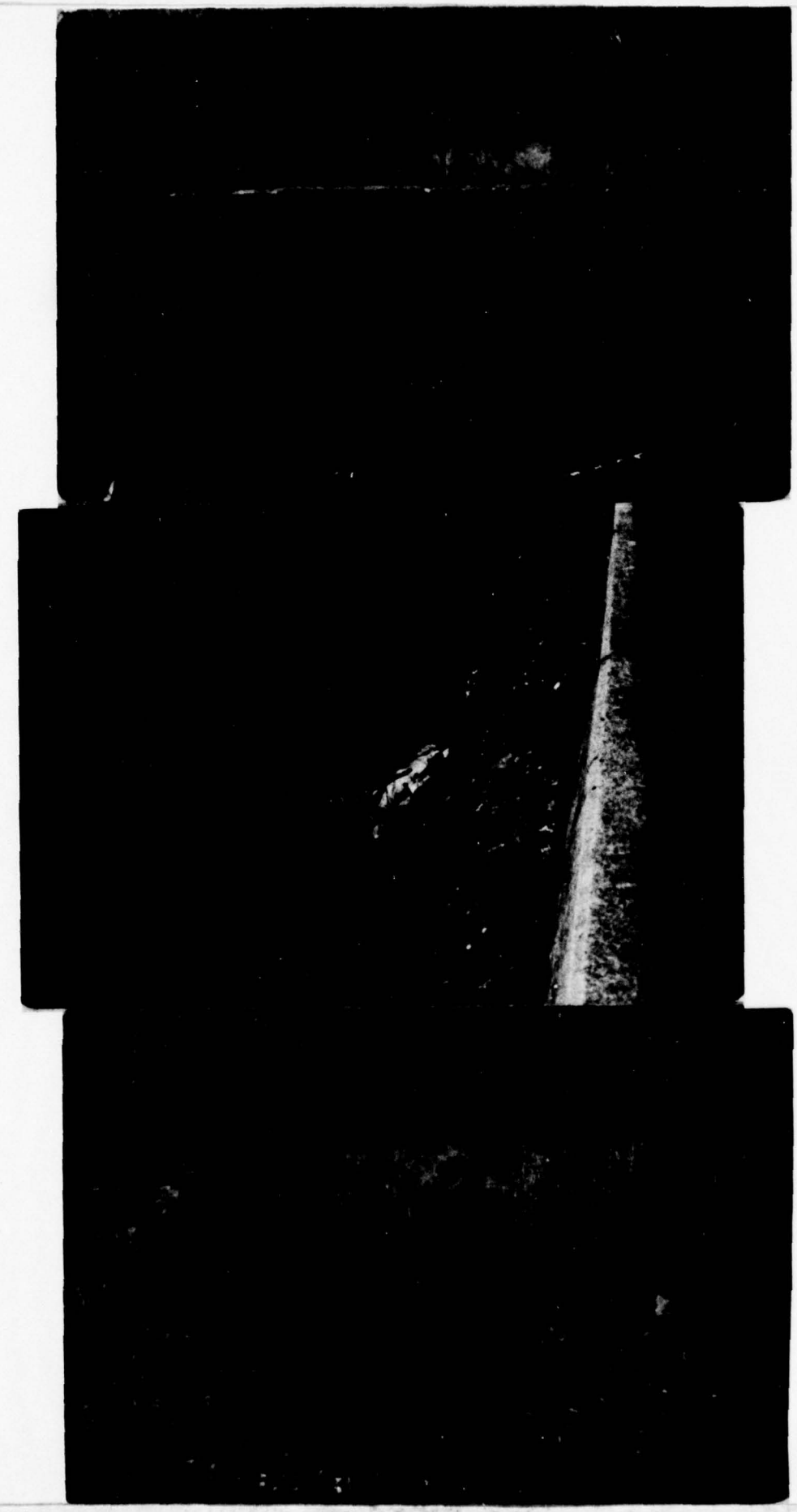
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET
DOTTED LINES ARE 10-FOOT CONTOURS

APPENDIX E

PHOTOGRAPHS

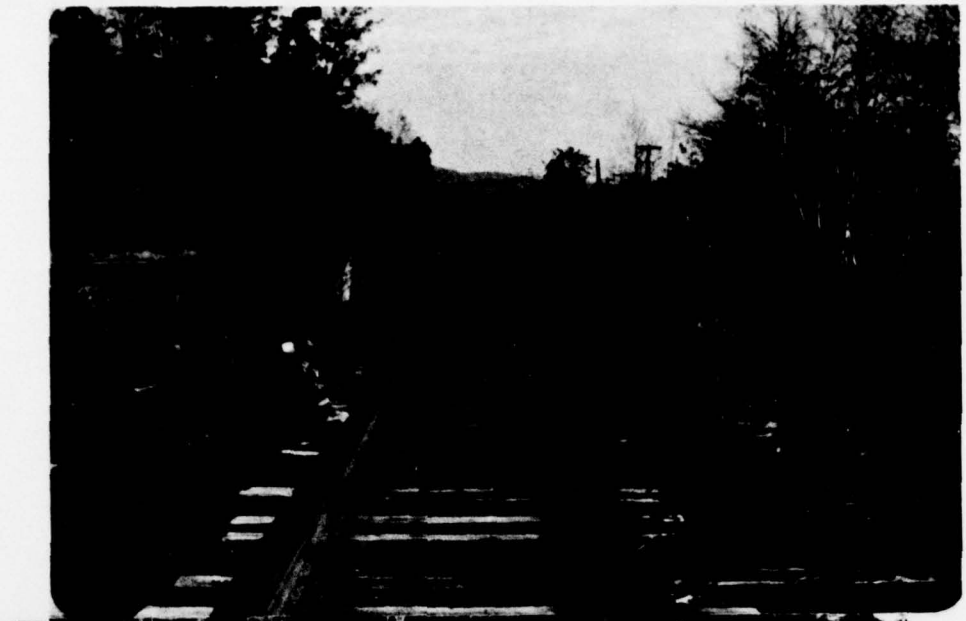


Upstream Slope
of Dam with
Concrete Wall

Slope Protection
Displacement

Downstream
Embankment Slope

PA-606
PLATE E-I

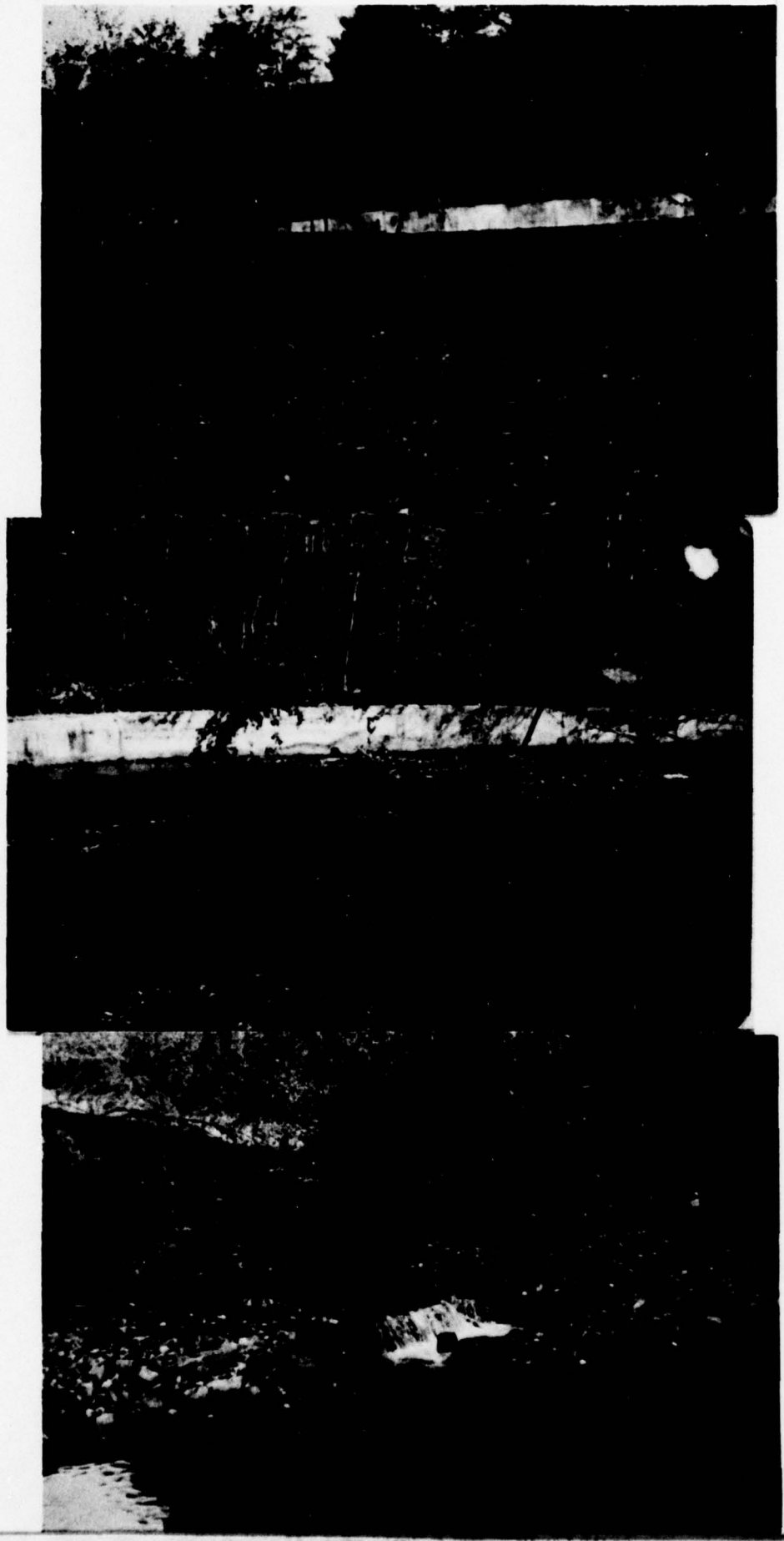


Emergency Spillway
With Railroad

Upstream Side of
Spillway and
Footbridge

Spillway With
Fish Screens

PA-606
PLATE E-II



Spillway Chute

Spillway Chute
Wall with Weepholes

End of Spillway
Pavement

PA-606
PLATE E-III

Downstream
Channel

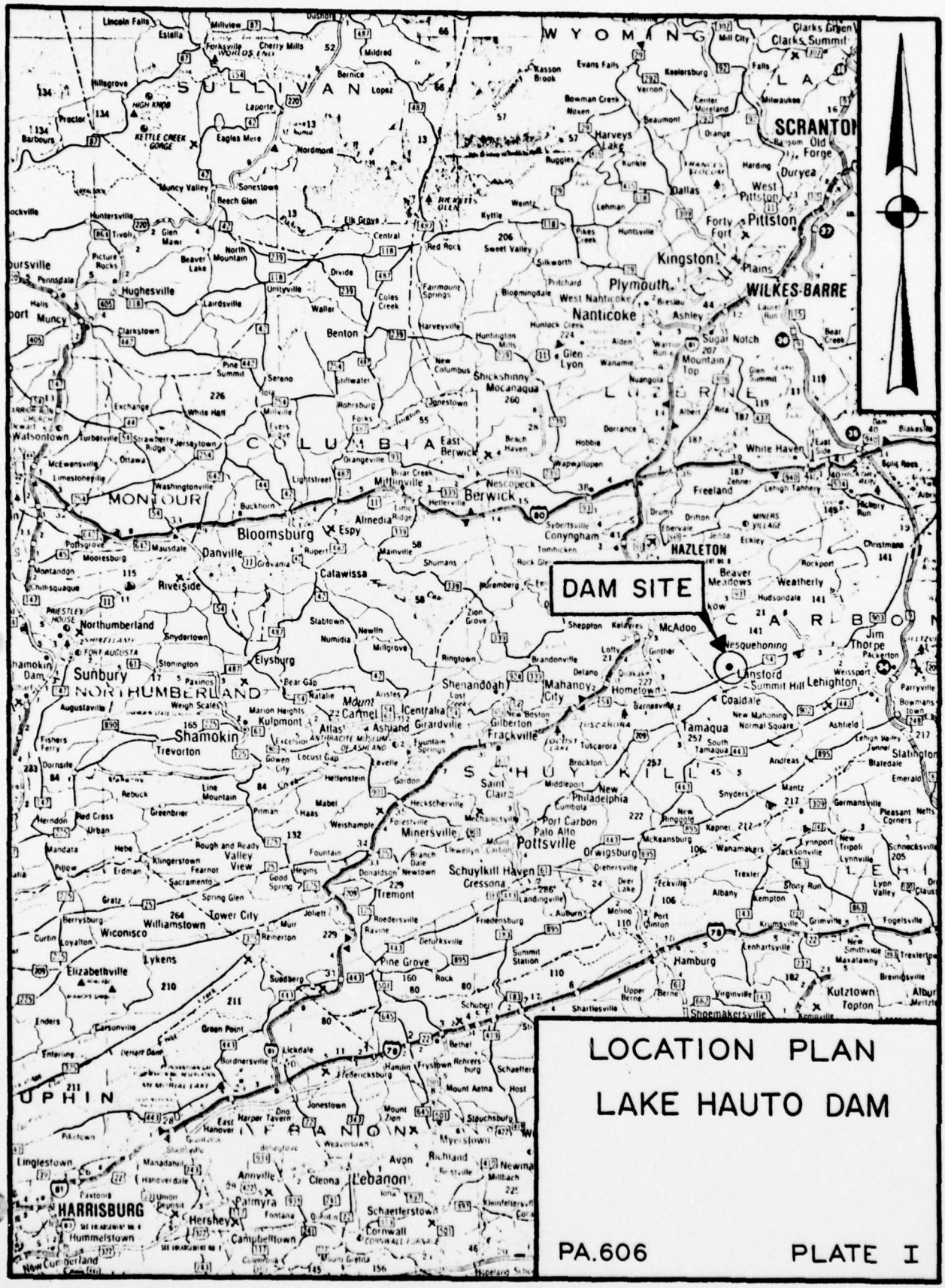
Valve Chamber

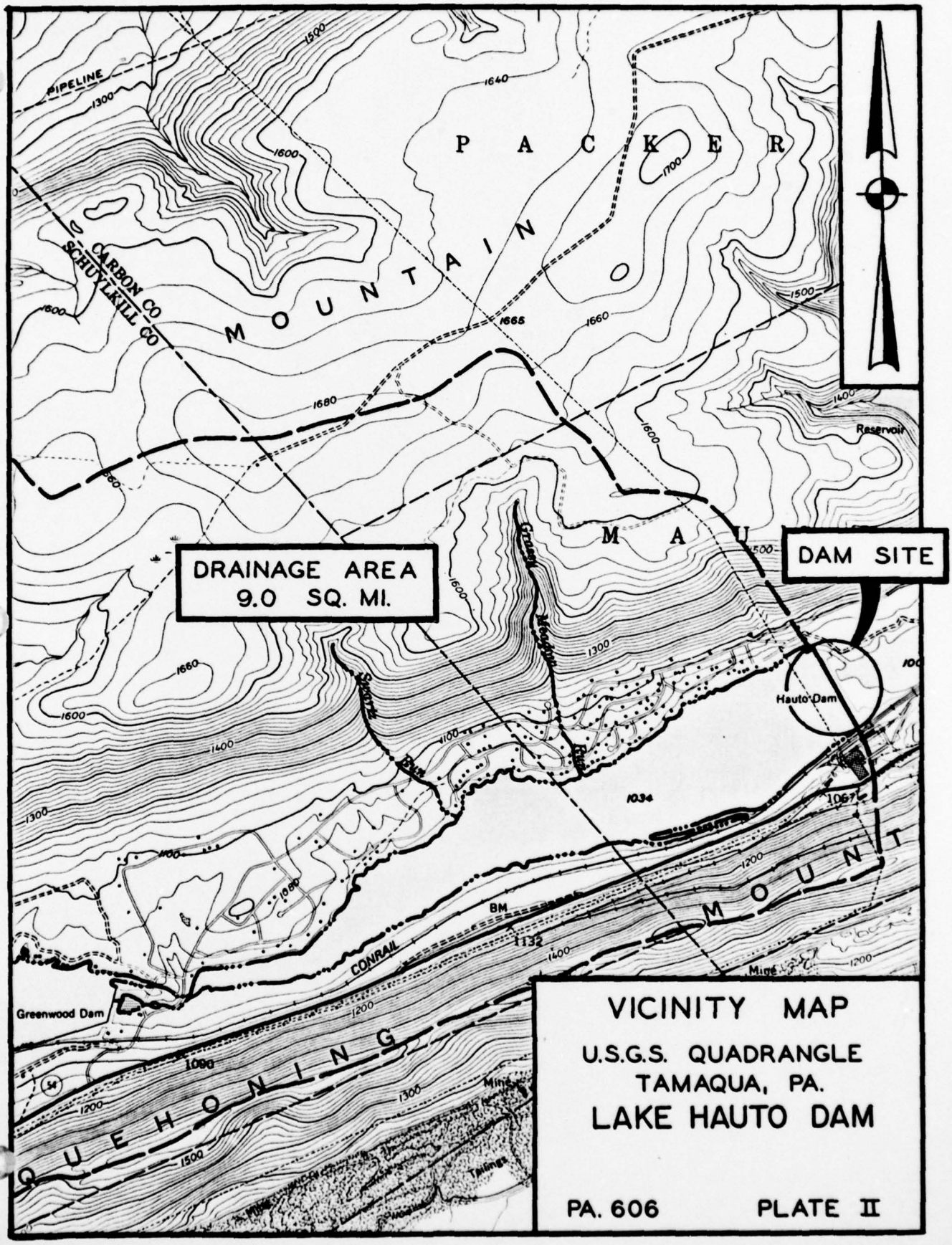
Downstream Pond

PA-606
PLATE E-IV

APPENDIX F

PLATES


DAM SITE
LOCATION PLAN
LAKE HAUTO DAM
PA.606
PLATE I

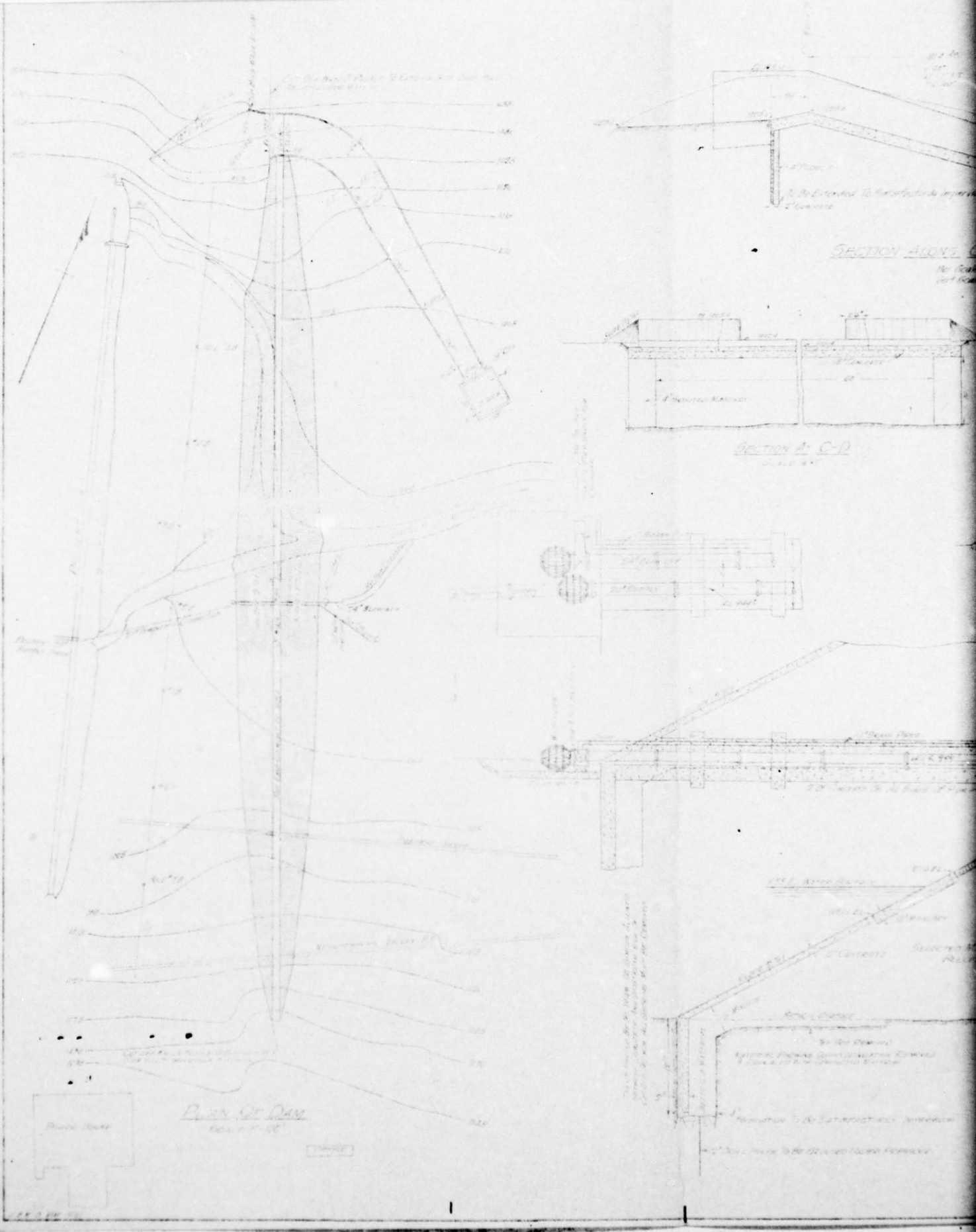


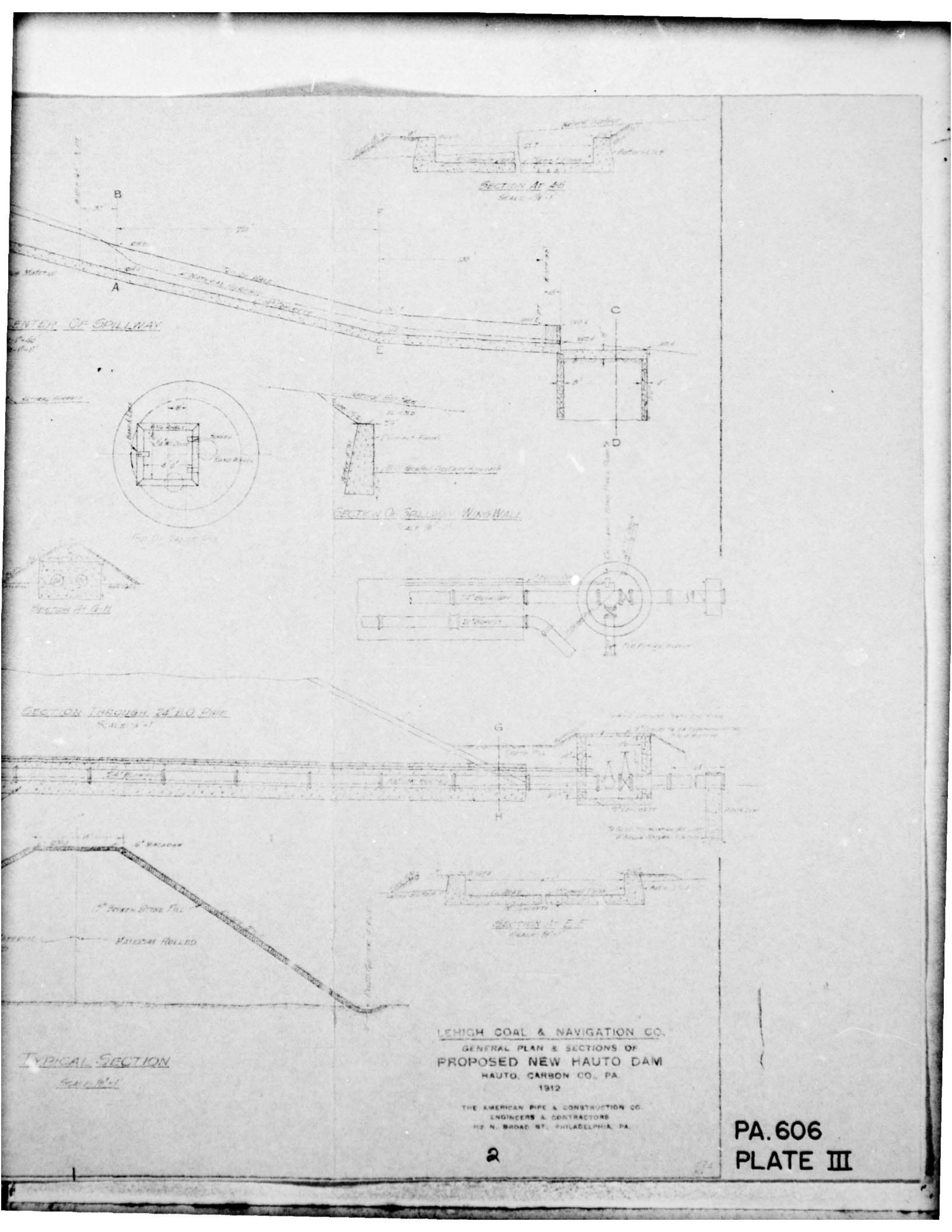
VICINITY MAP

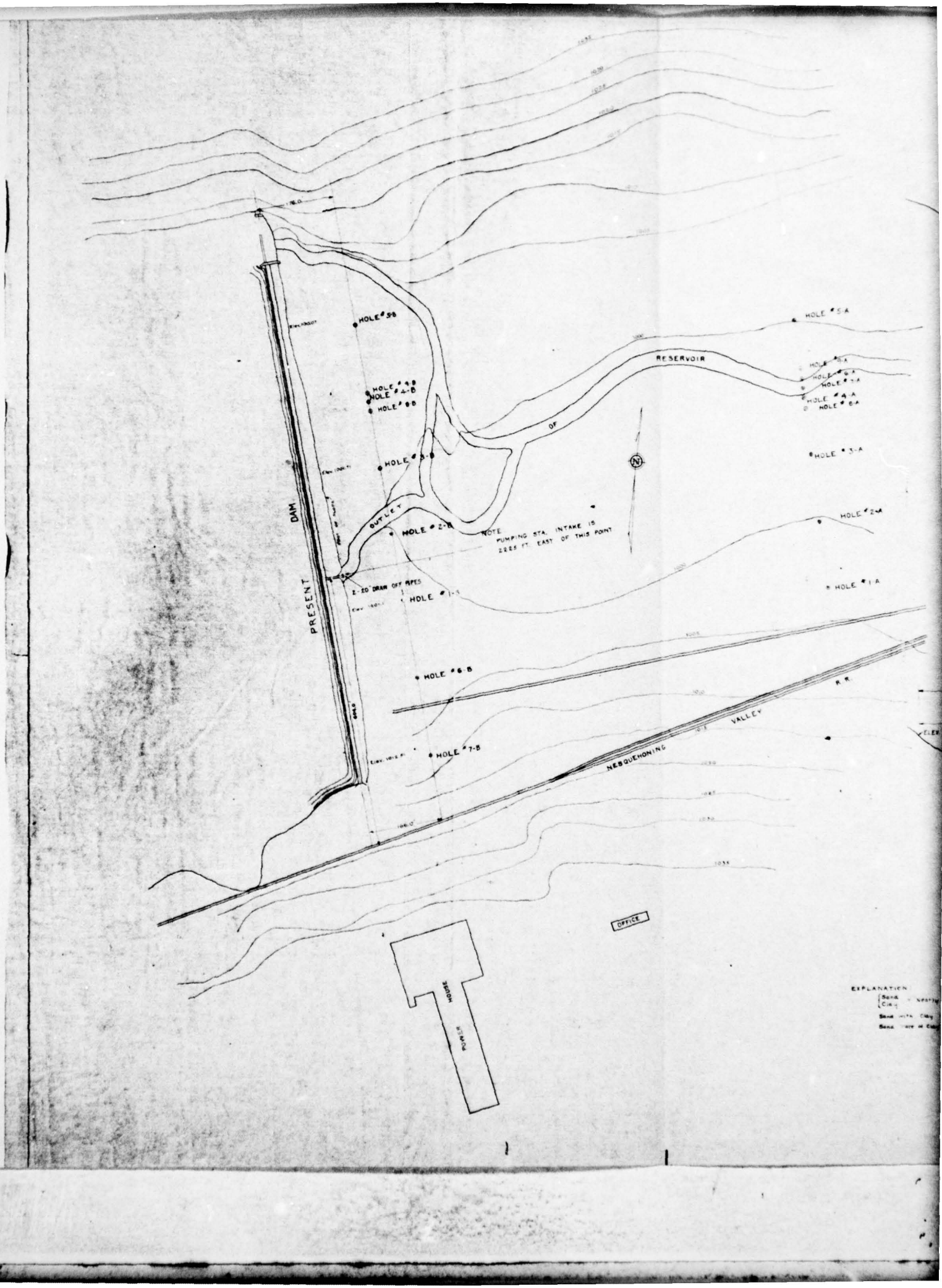
U.S.G.S. QUADRANGLE
TAMAQUA, PA.

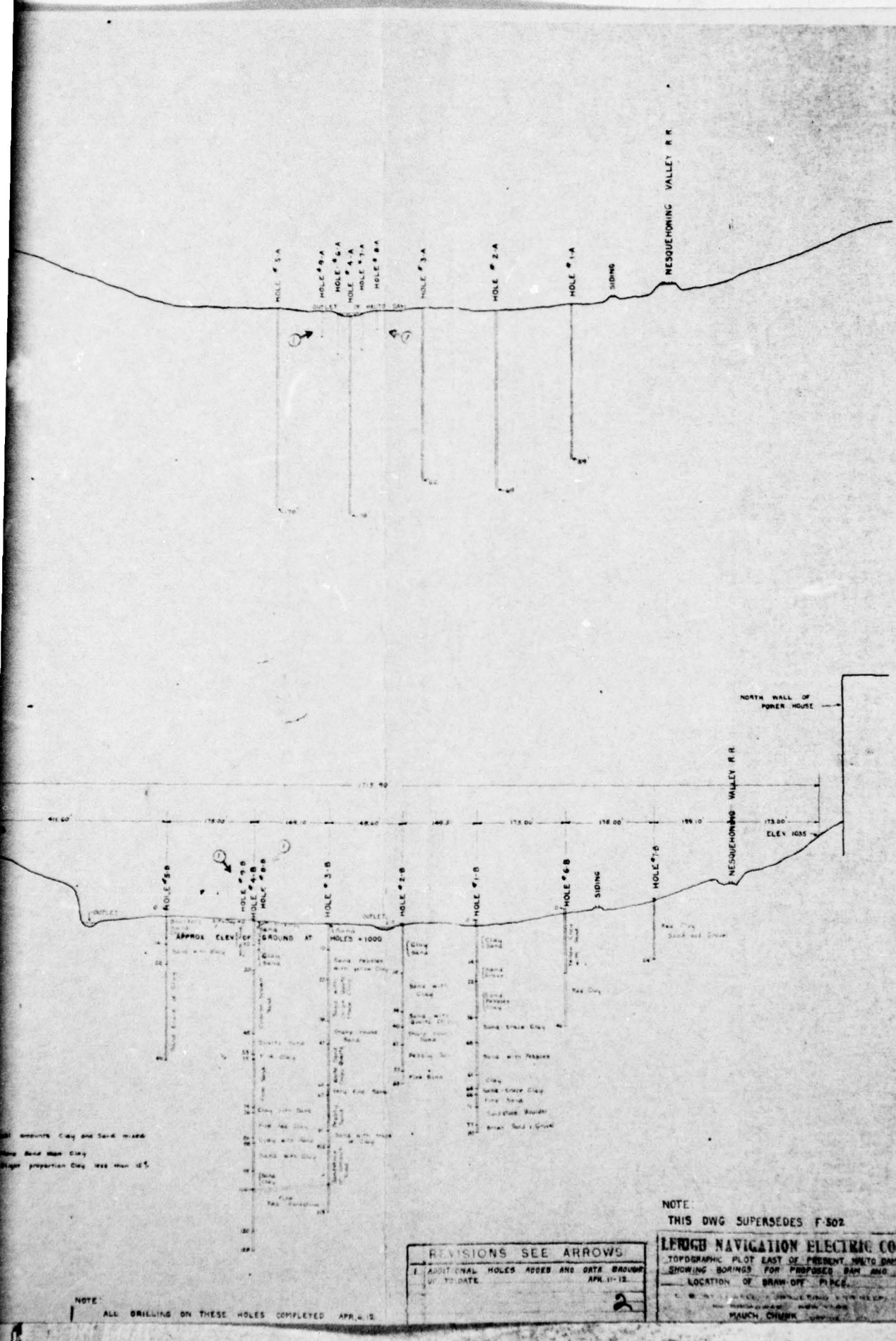
LAKE HAUTO DAM

PA. 606 PLATE II


PLAN OF DAM
SECTION ALONG
SECTION A-C-D


SECTION AT AB
CENTER OF SPILLWAY
SECTION OF SPILLWAY WING WALL
SECTION AT G-H
SECTION THROUGH 24" I.D. PIPE
SECTION AT E-F
TYPICAL SECTION
MATERIAL ROLLED
LEHIGH COAL & NAVIGATION CO.
GENERAL PLAN & SECTIONS OF
PROPOSED NEW HAUTO DAM
HAUTO, CARBON CO., PA.
1912
THE AMERICAN PIPE & CONSTRUCTION CO.
ENGINEERS & CONTRACTORS
112 N. BROAD ST., PHILADELPHIA, PA.
2
PA. 606
PLATE III


HOLE #5-B
HOLE #5-A
RESERVOIR
HOLE #4-B
HOLE #3-B
HOLE #3-A
DAM
OUTLET
HOLE #2-B
NOTE
PUMPING STA. INTAKE IS
2225 FT. EAST OF THIS POINT
HOLE #2-A
2-20" DRAW OFF PIPES
HOLE #1-B
HOLE #1-A
PRESENT
HOLE #6-B
HOLE #7-B
NESQUEHONING
VALLEY
R.R.
OFFICE
HOUSE
EXPLANATION



NOTE:
THIS DWG SUPERSEDES F-502

REVISIONS SEE ARROWS

1. ADDITIONAL HOLES ADDED AND DATA BROUGHT UP TO DATE APR. 11-12.

2

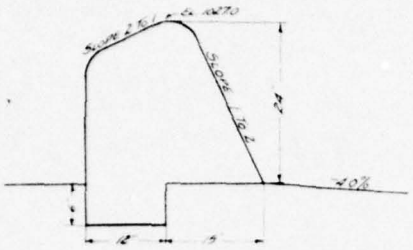
LEHIGH NAVIGATION ELECTRIC CO.

TOPOGRAPHIC PLOT EAST OF PRESENT MAUCH DAM SHOWING BORINGS FOR PROPOSED DAM AND LOCATION OF DRAW-OFF PIPES.

MAUCH CHUNK

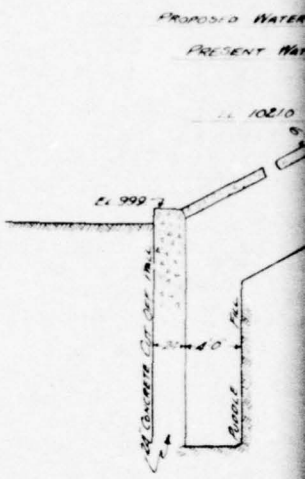
NOTE:
ALL DRILLING ON THESE HOLES COMPLETED APR. 4-12.

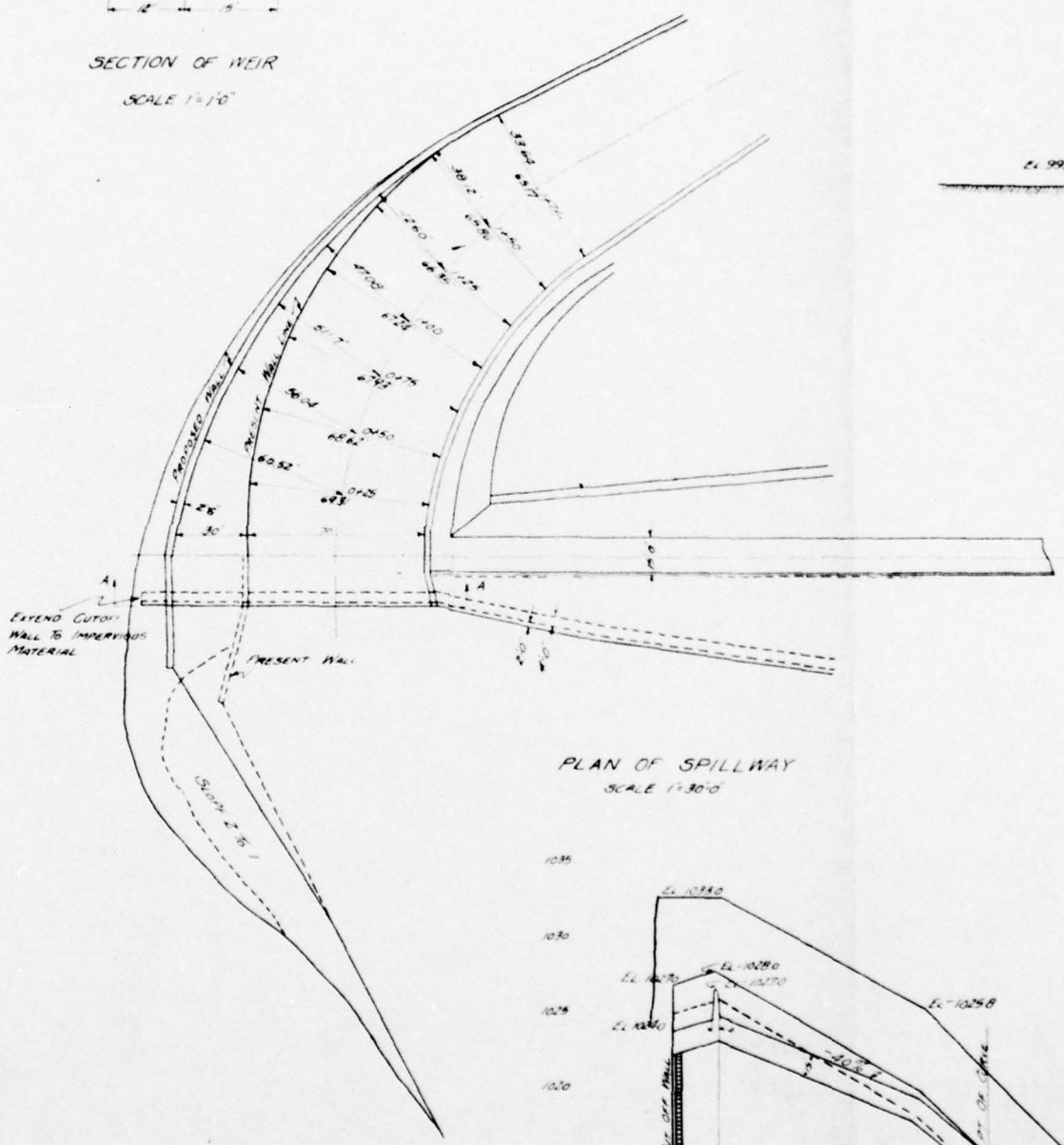
PA.606
PLATE IV



SECTION OF WEIR

SCALE 1"=1'0"



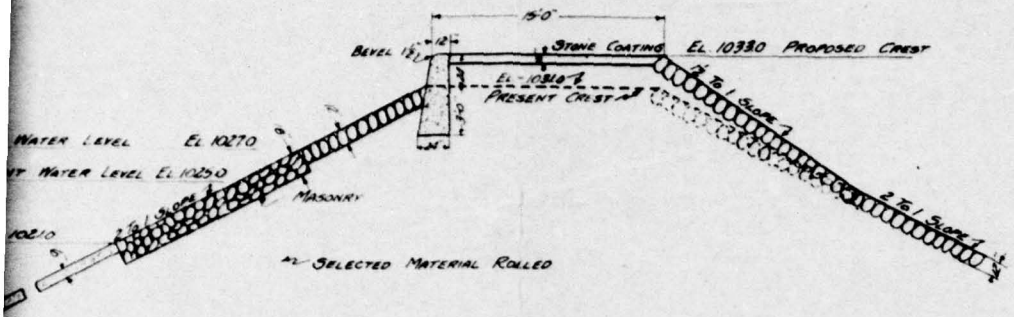


PLAN OF SPILLWAY

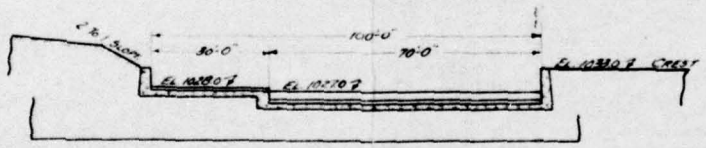
SCALE 1"=30'0"

PROFILE OF SPILLWAY

HOR SCALE 1"=30



TYPICAL SECTION
SCALE 1"=5'0"



SECTIONAL ELEVATION A-A
SCALE 1"=20'0"

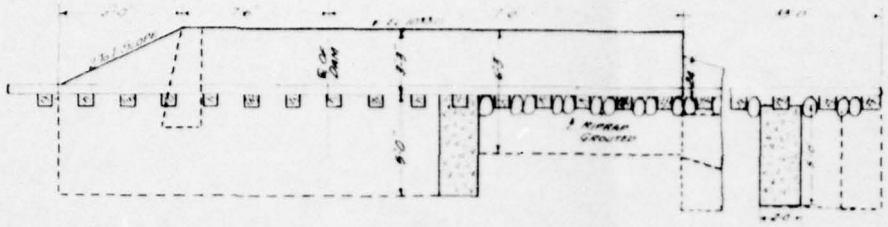
PANTHER VALLEY WATER CO.
LANSFORD, PA.

PROPOSED ENLARGEMENT AND CHANGES IN
NORTH SPILLWAY OF
HAUTO DAM

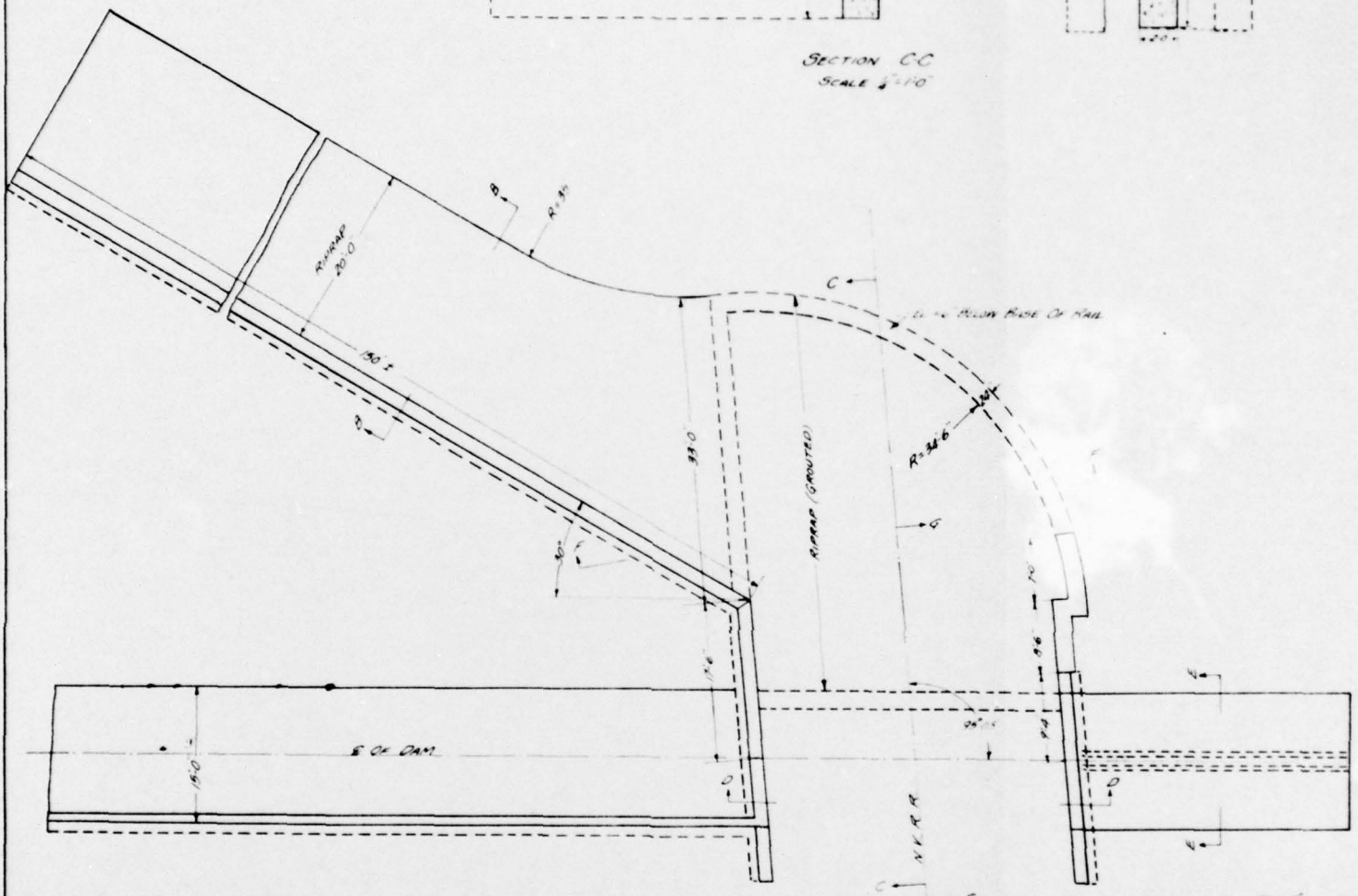
SCALES As Shown — APRIL 1939

Gannett, Seelye & Fleming, Incorp.
Engineers
Harrisburg, Penna.

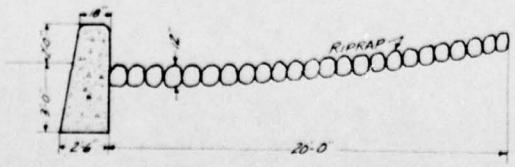
PA.606
PLATE V



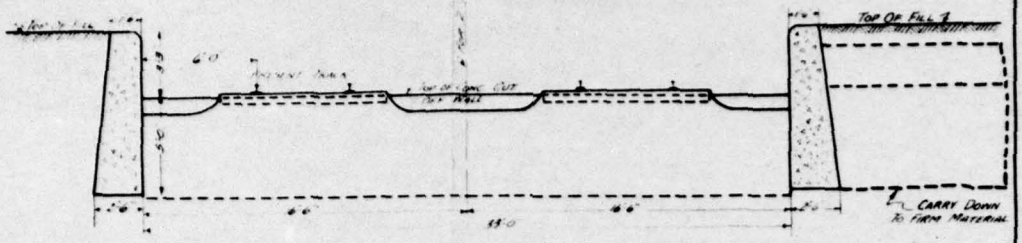
SECTION CC
SCALE 1/4"=1'-0"



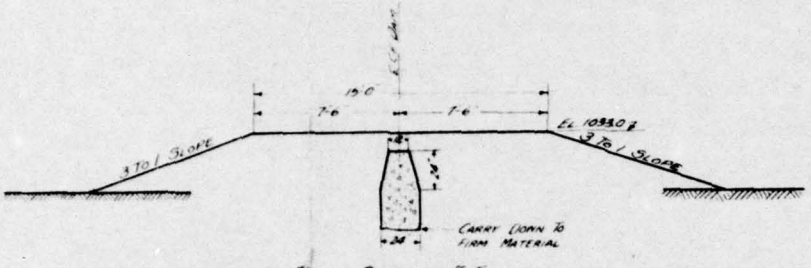
PLAN OF RAILROAD THRU DAM
SCALE 1/4"=1'-0"



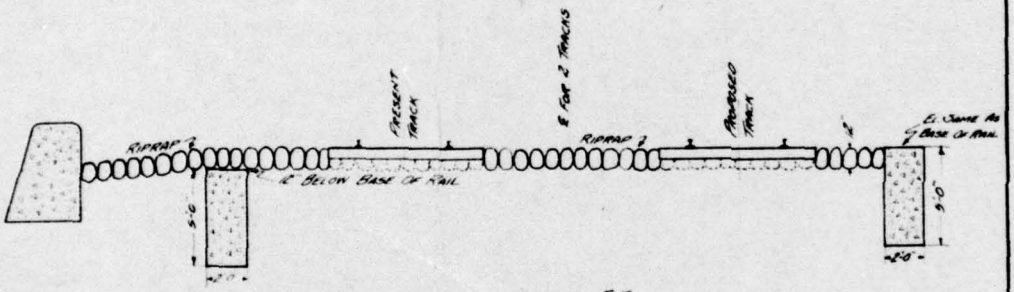
SECTION B-B
SCALE 1/4"=1'-0"



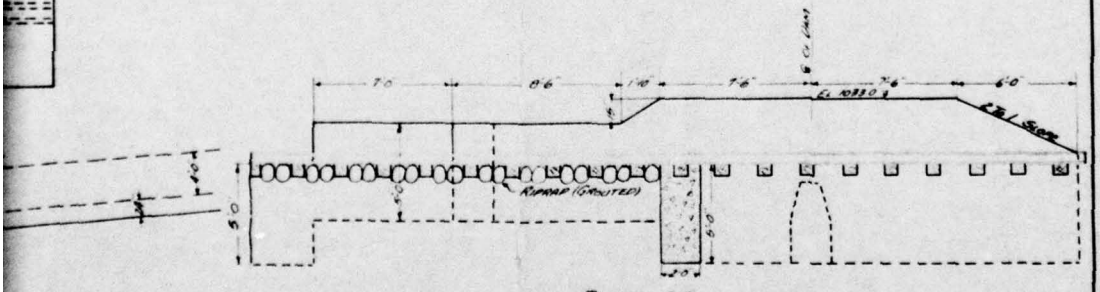
SECTION D-D
SCALE 1/4"=1'0"



DYKE SECTION E-E
SCALE 1/4"=1'0"



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



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

PANTHER VALLEY WATER CO.
LANSFORD, PA.
PROPOSED EMERGENCY SPILLWAY ON THE SOUTH END OF HAUTO DAM

SCALES AS SHOWN MARCH 1973

Gannett, Seelye & Fleming, Inc.
Engineers
Harrisburg, Pa.

PA.606
PLATE VI

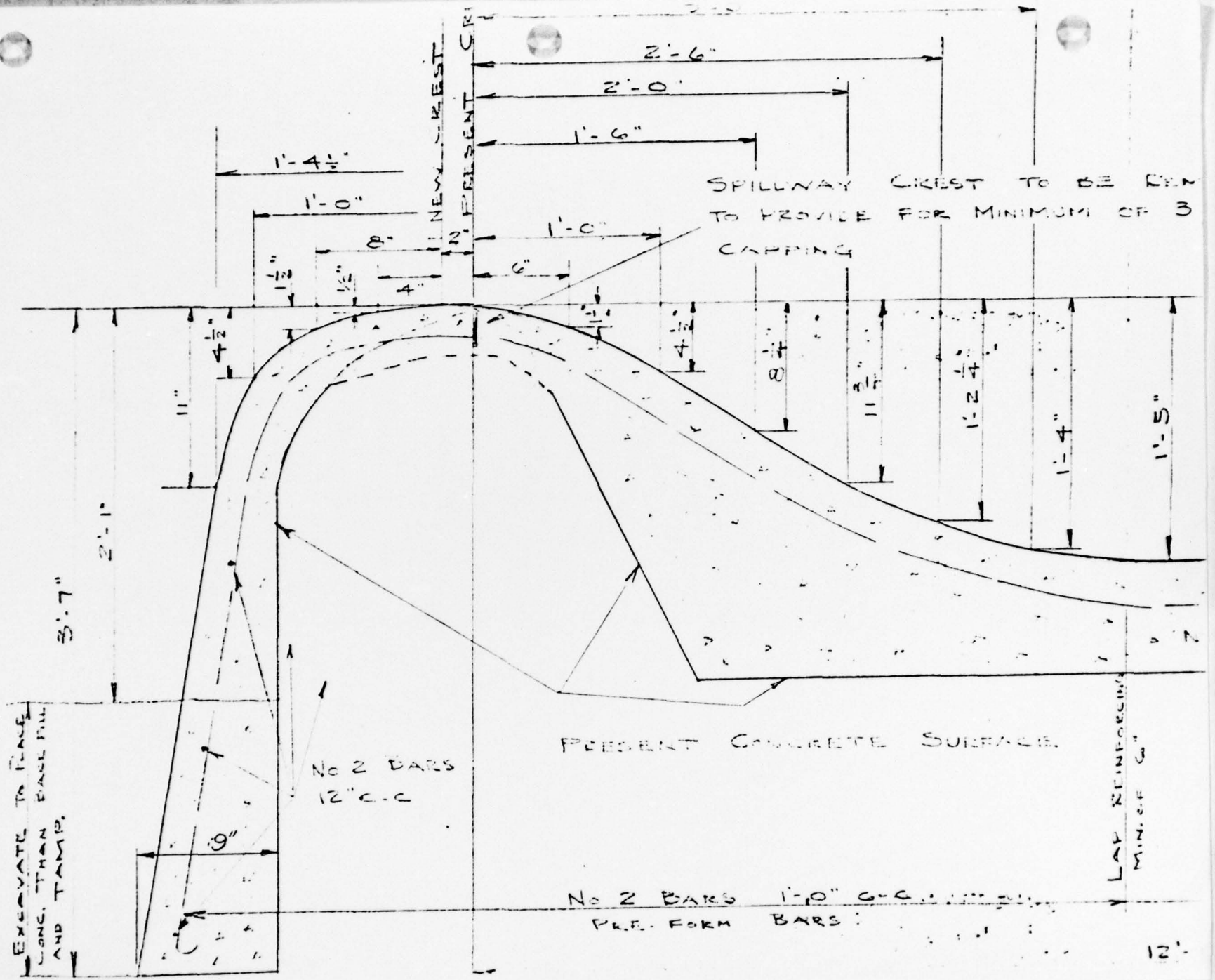

2'-6"
2'-0"
1'-6"
1'-4½"
1'-0"
8"
4"
NEW CREST
2" PRESENT CR
1'-0"
6"
SPILLWAY CREST TO BE RUN TO PROVIDE FOR MINIMUM OF 3 CAPPING
1"
2'-1"
3'-7"
1'-5"
EXCAVATE TO FIRM LONG. THAN BACK FILL AND TAMP.
No 2 BARS 12" C-C
9"
PRESENT CONCRETE SURFACE
No 2 BARS 1'-0" C-C
PREF. FORM BARS
LAP REINFORCING MIN. OF 3"
12'-

PLATE VII