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NATIONAL DAM INSPECTION PROGRAM. BEAR CREEK DAM (PA-00607), SCH--ETC(U)
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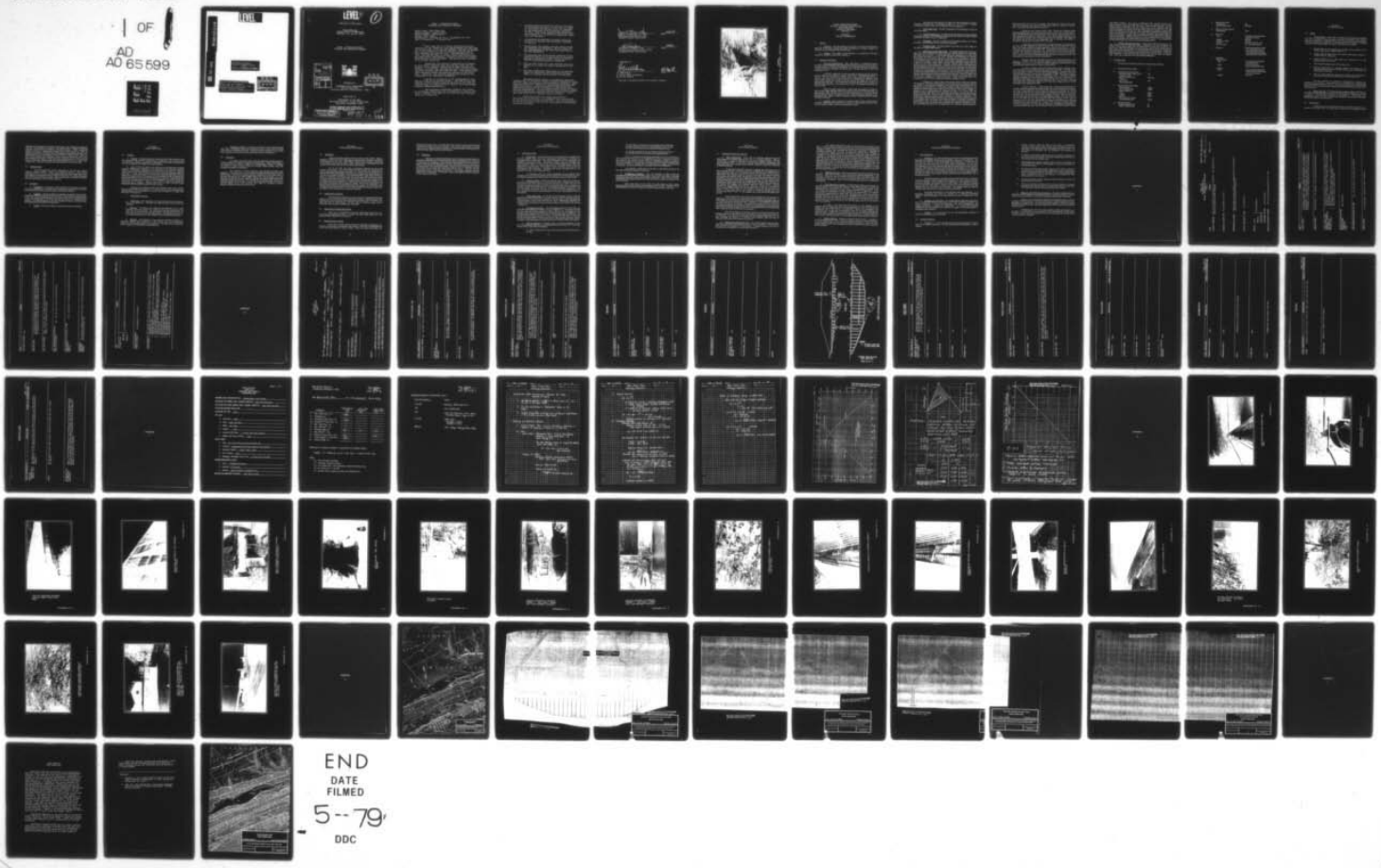

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Contract No. DACW31-78-C-0048

National Dam Inspection Program.
Bear Creek Dam (PA-00607),
Schuylkill River Basin, Bear Creek,
Carbon County, Pennsylvania.
Phase I Inspection Report.

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LEVEL II

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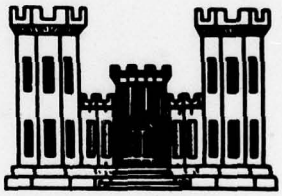
SCHUYLKILL RIVER BASIN

BEAR CREEK DAM
CARBON COUNTY, PENNSYLVANIA
NATIONAL I.D. NO. PA 00607

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



Prepared by:

WOODWARD-CLYDE CONSULTANTS
5120 Butler Pike
Plymouth Meeting, Pennsylvania 19462

Submitted to:

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

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

AUGUST 1978

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Bear Creek Dam
County Located: Carbon County
State Located: Pennsylvania
Stream: Bear Creek
Coordinates: Latitude 40° 51.6' Longitude 75° 54.0'
Date of Inspection: 2 August 1978

Bear Creek Dam is a hollow reinforced concrete structure of the "Ambursen" type approximately 450 feet long and 64 feet high at its central portion. The dam is founded on a full concrete mat with an upstream concrete cutoff wall extending into natural rock. The dam was built in 1915. The dam has been in service since construction and has experienced underseepage, concrete spalling and general deterioration of the structure. The dam has been assessed to be in poor condition.

Hydrologic and hydraulic computations presented in this report indicates that the dam will only pass 20 percent of the probable maximum flood (PMF) without overtopping. At this flow, overtopping would first occur along the right abutment and then over the dam. Overtopping could cause excessive damage and possible failure of the structure. Therefore, the spillway systems and structure are considered to be "Seriously Inadequate".

The dam is classified as an "Intermediate" size dam by virtue of its 64-foot height. The dam is also considered a "High" hazard structure because in the event of failure there is a possibility of loss of life and extreme property damage downstream.

The following recommended remedial work should be undertaken immediately and is presented in order of priority. However, this does not infer that the latter recommendations are unimportant.

1. Positive measures should be taken by the Owner to immediately maintain a water level at least 10 feet below the spillway crest as requested by the Department of Environmental Resources in 1972. This level should be maintained until the findings by a registered professional engineer are available.

2. A registered professional engineer should be retained to evaluate the structural integrity of the dam.

3. Underseepage and seepage through cracks should be evaluated and monitored, and the effect of the underseepage on the long term stability of the dam determined.

4. The spillway and flood storage capacity of the reservoir should be evaluated and the discharge systems be designed to meet current state-of-the-art hydrologic/hydraulic standards.

5. The low area along the right abutment should be graded to at least the design elevation of the dam.

6. The area immediately downstream of the spillway should be reassessed and appropriate measures taken to minimize deterioration of this area.

The Owner should develop an inspection checklist together with an operation and maintenance procedure to insure that all items are properly and periodically inspected, operated and maintained. Because of downstream population and industrial areas, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents and the industrial complex when high flows are to expected along the creek.

Considering that the access road parallels the stream up to the dam, it is expected that access would be cut off during periods of high flows. An alternate means of achieving access to the dam for the purpose of monitoring should be developed.

John H. Frederick, Jr., P.E.
Maryland Registration 7301
Woodward-Clyde Consultants

9/18/78
Date

William S. Gardner, P.E.
Pennsylvania Registration 4302E
Woodward-Clyde Consultants

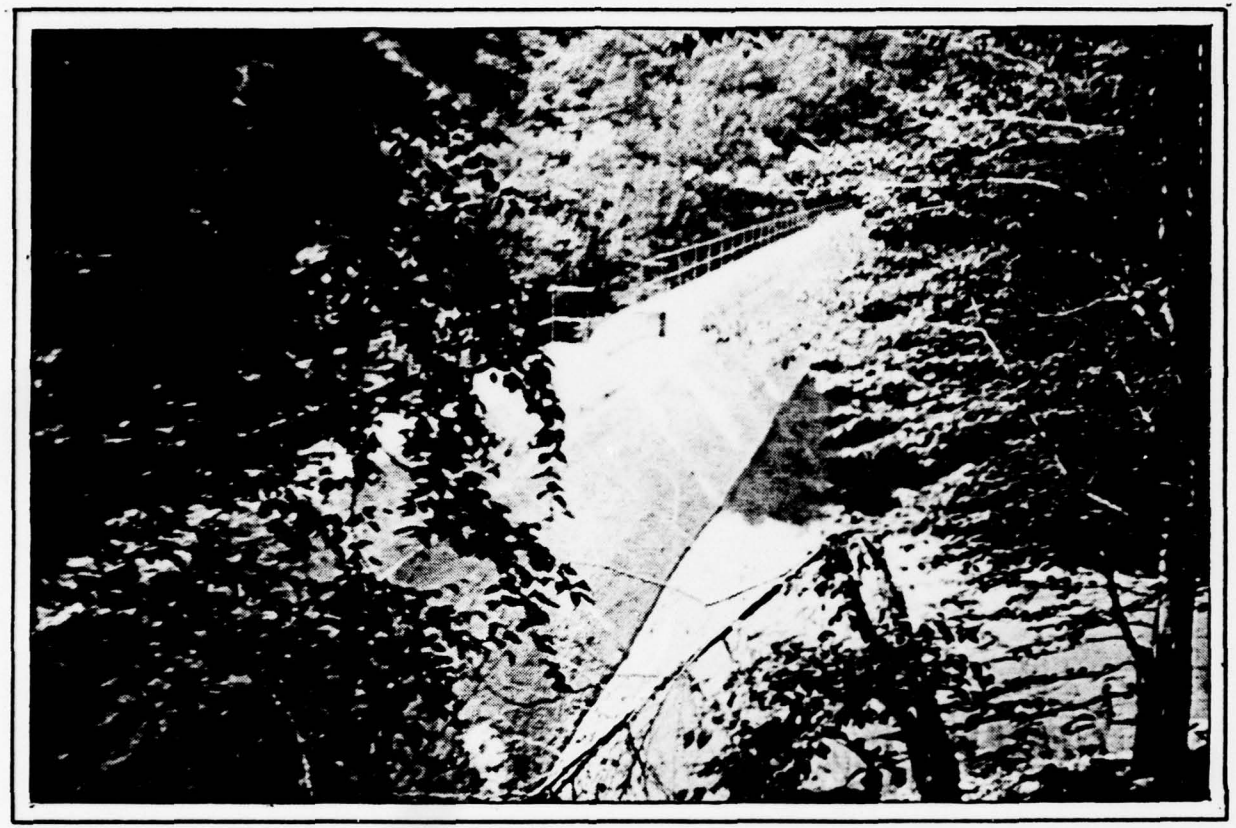
9/18/78
Date

APPROVED BY:

28 Sep 78
Date

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

This dam is considered unsafe in its present condition.



OVERVIEW
BEAR CREEK DAM, CARBON COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
BEAR CREEK DAM
NATIONAL ID #PA 00607
DER #13-2

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 inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Bear Creek Dam is a reinforced concrete structure of the "Ambursen" type, approximately 450 feet long, and 65 feet high at its central portion. The dam is founded on a full concrete slab with an upstream concrete cutoff wall extending into natural rock. The dam was built in 1914 and completed in 1915.

As shown in Appendix E, Plate 2, the dam is a hollow concrete structure with an upstream slab inclined at a batter of 10 H:12V. The downstream batter is 2H:12V. The dam contains 29 buttress walls forming 28 bays supported on a concrete slab. Each bay is 15 feet on center for a total length of 420 feet. Wing walls extend beyond the buttress walls and extend the length of the dam to approximately 480 feet. The twenty-third and twenty-fourth bays contain the spillway portion which has a crest elevation of 1295.0. The parapet walls extend to elevation 1298.

Water for public consumption is taken from the reservoir by means of three 14-inch pipes extending through the upstream slab with intake elevations at approximately 1286, 1269 and 1247. All three intakes feed into a common 18-inch pipe and blow-off valve at the downstream toe. All of the pipes are open and at full hydrostatic head. Water is taken by demand for public consumption after it passes through a chlorinator.

b. Location. Bear Creek Dam is located on Bear Creek in Mauch Chunk Township, Carbon County, Pennsylvania. The dam is located approximately 0.8 mile from the junction of Bear Creek with Nesquehoning Creek.

The dam site and reservoir are shown on USGS Quandrangle entitled, "Tamaqua, Pennsylvania", at coordinates N 40° 51.6' W 75° 54.0'. A regional location plan of Bear Creek Dam is enclosed as Plate 1, Appendix E.

c. Size Classification. The dam is classified as "Intermediate" by virtue of its 64-foot height.

d. Hazard Classification. A "High" hazard classification has been assigned to this dam because of the residential dwelling and the industrial complex located downstream as shown on Plate 1, Appendix E.

e. Ownership. The dam is owned by the Lansford-Coaldale Joint Water Authority, One East Ridge Street, Lansford, Pennsylvania.

f. Purpose of Dam. The sole purpose of this dam is for water supply for the towns of Lansford and Coaldale.

g. Design and Construction History. The original application to construct Bear Creek Dam, submitted on 5 May 1914, was rejected because the information submitted was incomplete. A second application was submitted on 23 June 1914, and construction began in July of 1914. Williams and Richardson of Scranton, Pennsylvania, were the design engineers and contractors for this project. The dam is an Ambursen type dam but was not constructed or designed by the Ambursen Construction Company. On 26 October 1914, the State inspected the dam and issued a letter to the Panther Valley Water Company (original owner) stating that the construction work was unsatisfactory. Thereafter, several letters of correspondence were exchanged between the State and the owner and it is assumed from the records that the difficulties and poor construction practices were corrected. Poor practices included over-size aggregate in concrete (up to 1 foot in diameter), poor placement of concrete, improper placement of reinforcing steel, freezing of concrete before it had set, honeycombing of concrete, bulging forms resulting in a wavy upstream slab, and there was a difference of opinion between the contractor and State Inspector as to the water tightness of construction joints. Major construction work was completed in late 1915, but the dam was officially completed in 1916.

Subsequent to construction, leaks through joints, cracks, and beneath the foundation were observed and reported. Leaking and calcium carbonate leaching are evident in construction photographs. The reservoir was filling before the dam construction was completed. In June, 1920, Gannett, Seelye, and Fleming, Inc., of Harrisburg, Pennsylvania, were retained by the Panther Valley Water Company to prepare a set of specifications for repairing the dam. On 10 July 1920, the application report was submitted for the repair and a permit to repair the dam was issued on 23 July 1920. Due to the extensivenes of the repair work required, Morgan Engineering Company of Dayton, Ohio, performed a structural evaluation. This several page letter described in detail the structural evaluation analysis performed by the company which concluded that the dam was stable. This report was issued on 23 September 1920. On 28 April 1921, Gannet, Sealy and Fleming issued a letter which indicated that the repair work, performed by Ambursen Construction Company and consisting primarily of the construction of a cutoff wall and grouting, have

effectively sealed off much of the seepage. State inspection reports confirm that much of the seepage was arrested, but that weirs should be installed to monitor flow. These weirs were installed and monitored.

During the next several years, cyclic freezing and thawing caused severe spalling beneath the concrete slab on the dam. As a result, an application to install an asbestos facing on the downstream side of the dam was submitted 23 July 1927, and the permit issued 17 August 1927. The asbestos siding produced by the John Mansfield Company called "Transite" asbestos, was installed. The purpose of the facing was to seal off the downstream side to minimize the effect of temperature changes on the upstream face of the dam.

In May 1929, the State inspection revealed spalling in the underside of the deck slab and requested the Owner to inspect the dam with the aid of a strong light. The Owner's inspection revealed spalling of concrete in Bay Nos. 4, 7, 16 and 17, which was repaired by December 1929. Temperature within the bays had been monitored for the previous two winters by the use of maximum-minimum thermometers. The minimum temperature recorded was 32°F, and that occurred only once. Therefore, the Owner concluded that spalling had occurred prior to 1927, and the asbestos facing prevented further deterioratoin.

Between 1929 and 1946 there was very little work performed on the structure. In April of 1946, the inspection showed severe concrete deterioration of Buttresses 2, 3, 4, 5, 6, 7, 12, 14 and 19. Recent inspections confirmed that these same buttresses showed significant signs of deterioration.

In 1950, or possibly 1951, the Panther Valley Water Company transferred ownership to the Lansford-Coaldale Joint Water Authority. In October, 1951, weirs were again installed to monitor downstream seepage. Records in DER files and conversations with personnel from the Lansford-Coaldale Joint Water Authority indicated that seepage was monitored subsequent to 1951. Records of seepage indicate increasing rates in October and November 1951, and a constant rate of seepage through August 1952, the last month readings were sent to the State. In September, 1962, leakage was located at Bays 8, 9, 10, 11, 12, 13 and 14. A spring was noted 20 feet downstream of Bay No. 18. These same leakage zones were noted during the recent inspection of 1978.

In June, 1972, the J. J. Mair Gunite, Inc. contractor performed work on the dam and grouted spalled and cracked areas. Their work consisted of placing a 3 by 3 No. 10 wire mesh over the area and spraying the zone with gunite. Repairs were only surficial and no structural repairs or evaluations performed. On June 22 and June 23, tropical storm Agnes passed through this area producing run-off into the basin and a 14-inch overflow over the emergency spillway. This flow destroyed the two downstream catch basins and caused damage around the base of the dam. On 17 July 1972, the dam was inspected under the auspices of the Corps of Engineers, and it was recommended that the reservoir be drained and a thorough evaluation of the dam be made. On 7 August 1972, the State requested that the reservoir be lowered 10 feet and the dam evaluated. Subsequently, correspondence was exchanged between the Corps of Engineers, the State and the Lansford-Coaldale

Joint Water Authority. As a result, a 6 December 1972, Lansford-Coaldale Joint Water Authority letter stated that they had no money to repair the dam. In three letters dated 15 December 1972, 25 January 1973, and 22 February 1973, the Lansford-Coaldale Joint Water Authority issued letters which stated that they had difficulty keeping the reservoir level down during periods of rainfall. By April 1973, water was flowing over the spillway. Since that date, correspondence between the Corps of Engineers, the state and the Lansford-Coaldale Joint Water Authority could not be located. It appears that no further action was required by the State or Federal Government. During the summer of 1977, selected areas of the upstream face were regrouted by the Dual Valley Construction Company. It was reported by the Burough Manager that Seca 4 was used for the grout work.

h. Normal Operating Procedure. Under normal operating conditions, the upper intake valves are open and water is supplied to the town by gravity on demand. Excess water passes over the spillway into the downstream channel and to Bear Creek. Other than replacing the chlorine tanks, there is very little operational work required for this structure. It is assumed that the requirement to keep the reservoir at least 10 feet below full pool by the State is still in effect. During the field inspection, it was noted that the reservoir was 8.2 feet below the spillway crest. There are no minimum flow requirements downstream.

1.3 Pertinent Data.

Pertinent data for Bear Creek Dam is summarized as follows:

a.	Drainage Area (sq. miles)	1.3
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood at Site (June 23, 1972)	135
	Maximum Design Flow (Elev.)	Unknown
	Top of Dam (Max. Discharge)	560
c.	Elevation (Feet above MSL)	
	Top of Spillway	1295.0
	Top of Parapet Wall	1298.0
	Intake Elevations	
	Top	1286 ±
	Middle	1267 ±
	Bottom	1247 ±
	Normal Pool at 10 foot recommended level	1285.0
d.	Reservoir (miles)	
	Length at Normal Pool	0.2
	Fetch at Normal Pool	0.2

e.	Storage (acre-feet)	
	Normal Pool	273
	Top of Parapet Wall	320 (est)
f.	Reservoir Surface (acres)	
	Normal Pool	10.6±
g.	Dam Data	
	Type	"Ambursen" type reinforced concrete structure
	Length	480 feet
	Maximum Height	64 feet
	Cutoff	Concrete Wall into rock
	Grout Curtain	Yes. Details unknown.
h.	Diversion	During construction, stream was impounded in the old dam and a wooden flume carried spillway discharges around the new construction.
i.	Discharge	
	Water Supply	
	Type	Cast Iron Pipes embedded in upstream face
	Sizes	three 14-inch pipes one 18-inch blow-off pipe
	Spillway	
	Type	Concrete ogee shaped weir concrete chute discharging into a stilling basin.
	Length	28.3 feet

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. There were no original design calculations available for review. A summary of data available in the files is presented in the checklist, attached as Appendix A. Drawings were very limited, but those that were available have been reproduced in Appendix E of this report as Plates 2 through 5. Principal documents containing pertinent data used for this report are as follows:

1. Specifications of the proposed dam on Bear Creek prepared by the Panther Valley Water Company, dated 1914.

2. "Report Upon the Application of the Panther Valley Water Company", 2 October 1920, for repair work.

3. Progress reports for the 1920 repairs and summaries for the 1920 repairs prepared for the State.

4. State Inspection Reports from 1922 through 1972.

5. Contract specifications by Gannett, Seelye, and Fleming, Inc., of Harrisburg, Pennsylvania, dated 1920, describing the requirements for improvements of the dam.

6. 1914 and 1920 blueprints prepared by Williams and Richardson of Scranton, Pennsylvania, and Gannett, Seelye, and Fleming, Inc.

The data available was sufficiently comprehensive to perform an evaluation of the structure. Also included in this evaluation was a hand-written structural stability analysis of the dam. There was no date, but it is assumed that these are the structural calculations cited by Williams and Richardson in their letter of 22 June 1914.

b. Design Features. The principal design features of Bear Creek Dam are illustrated on the plans, profiles, and cross-sections enclosed in Appendix E as Plates 2 through 4, and described in Section 1.2, Paragraph a. These Plates were reproduced from the 1914 and 1920 drawings prepared by Williams and Richardson, and Gannett, Seelye, and Fleming, Inc.

2.2 Construction.

A description of the construction history is presented in Section 1.2. In summary, the original work was performed by Williams and Richardson, design

engineers and contractors of Scranton, Pennsylvania. They designed the Ambursen type dam and provided the blueprints and specifications. Morgan Engineering Company of Dayton, Ohio, performed a structural analysis in 1920 to assess the stability of the dam. Subsequently, Gannett, Seelye, and Fleming, Inc., were the general consultants for this dam and provided design specifications and repair work specifications for the improvement of this structure in 1920 and 1921. The J. J. Mair Gunite Company, Inc. performed a major refacing of the dam in June of 1972 after Tropical Storm Agnes. Further repair work was performed in 1978 by the Dual Valley Construction Company under the recommendations of the J. J. Mair Gunite Company, Inc. Their work included some refacing work on the upstream slab.

2.3 Operation Data.

The only operational records maintained for this dam are reservoir levels and rainfall records. There is no operational manual. Under normal conditions water is fed into the water supply system through 3 supply pipes which have intakes on the upstream face at different elevations. The 3 pipes are always open while the blow off pipe is closed. Water is fed by gravity through a chlorinator unit to the downstream town and used on demand.

2.4 Evaluation.

a. Availability. All engineering data reproduced in this report and studied for this investigation were provided by the Pennsylvania Department of Environmental Resources and the Lansford-Coaldale Joint Water Authority.

b. Adequacy. The data available was adequate to evaluate this structure. Construction data was adequate and documentation was provided by progress reports to the State, letters exchanged between the State and the Owner, and photographs. Letters and photographs in the files indicate that quality of construction was marginal. The visual inspection of the dam described in Section 3 confirms these 1914 assessments by the State of Pennsylvania.

c. Validity. There was no reason to question the validity of the data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix B and are summarized and evaluated as follows. In general, the appearance of the facility indicates that the dam is marginally maintained and in poor condition.

b. Dam. During the visual survey there were no indications or evidence observed of distortions in alignment or in movement of the crest that would be indicative of foundation settlement or imminent failure of the structure. Leaks and surface cracks were noted throughout most of the structure, especially along the right half. A close examination of the buttresses disclosed significant concrete deterioration, particularly of the portions of the buttresses outside the downstream facing and exposed to rain and extreme temperature variations. Also disclosed was the fact that coal was used as part of the course aggregate. The upstream slab also shows signs of deterioration. Many of the structural elements are spalled and reinforcing steel is exposed. However, there were no major structural cracks observed to indicate possible instability of the structure.

Seepage was emanating through the foundation along many buttress walls as shown on Sheet 5a, Appendix B. A spring, noted during a 1962 inspection, approximately 20 feet downstream of Buttress 18, was noted as a marshy zone during the 1978 inspection.

c. Appurtenant Structures.

1. Intake Pipes. The intake pipes are in good condition from the upstream face to the chlorinator. Thereafter the pipes are buried and could not be inspected.

2. Spillway. The spillway was inspected and observed to be in good condition. There was some minor spalling and concrete deterioration and areas that had been patched. The stilling basin was observed to be dry, in fair condition, with some concrete deterioration. The spillway channel to the first pond downstream was in fair condition with some deterioration noted.

d. Reservoir. Reconnaissance of the reservoir disclosed no evidence of significant siltation, slope instability, or other features that would significantly affect the flood storage capacity of the reservoir. All slopes are well vegetated with an assortment of hardwood and softwood trees.

e. Downstream Channel. Immediately downstream the spillway discharges into a pond. Thereafter, water flows downstream along a gravel bottom channel 0.85 miles into Nesquehoning Creek. Along this valley, construction is now under way to replace the current water supply pipes (see Section 5, paragraph f).

3.2 Evaluation.

In summary, the visual survey of the dam disclosed that the concrete is in poor condition with significant spalling and deterioration. Typical photographs of this deterioration are shown in Appendix D as Photographs 8 through 12. Seepage was noted at several locations along the structure, along buttress walls and, occasionally beneath the foundation.

The underside of several upstream slabs between buttresses were inspected. The concrete was in fair condition with several indications of concrete deterioration. Probing with a geologic hammer indicated that the surface layer of this concrete was soft for depths ranging from 1/8 to 1/4 of an inch. In a few locations, reinforcing steel was exposed. Seepage was noted through construction joints and through some cracks. The underside of all upstream slabs could not be inspected because the access doors to many bays could not be opened. In summary, the dam appears to be in poor condition and in need of a complete structural analysis to assess the stability of the structure.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Normal operating procedure does not require a dam tender. Water is supplied to residents by three intake pipes and fed by gravity through a chlorinator and downstream to the users. Under design conditions, the reservoir is maintained at the spillway level elevation (Elev. 1295). Excess water is discharged over the spillway into a stilling pool and into the downstream channel.

On 16 July 1972, the Corps of Engineers inspected the dam after Tropical Storm Agnes. They recommended that the reservoir be drained and the dam be thoroughly inspected and evaluated. On 7 August 1972, the Department of Environmental Resources (DER) recommended that the reservoir be lowered by 10 feet and the structure evaluated. The Lansford-Coaldale Joint Water Authority's letter of 6 December 1972 indicated that they did not have sufficient funds to repair the structural portions of the dam. Also, the owner's letters of 15 December 1972, 25 January 1973, and 22 February 1972 indicated that the discharge through the 18-inch blow-off pipe was insufficient to maintain the water level at an elevation of10 feet below the spillway during periods of rainfall. During this inspection it was observed that the water level was 8.2 feet below the spillway. Since the DER letter of August 1972, there have been no other letters issued authorizing the reservoir to be raised to either the present or normal pool elevation.

4.2 Maintenance of the Dam.

The last known maintenance of this structure was performed during the summer of 1977 by the Dual Valley Construction Company. Selected areas of the upstream face and the spillway were resurfaced with gunite grout. Since that time there have been no major repairs. The dam itself is in need of repair, and an evaluation of the structural components is warranted.

4.3 Maintenance of Operating Facilities.

There are no maintenance procedures delineating requirements for maintaining the operating facilities. Currently, the water supply pipes are in the process of being replaced by a new system.

4.4 Warning Systems in Effect.

There are no formal warning systems or procedures established to be followed during periods of exceedingly heavy rainfall. There are no representatives at the site during periods of heavy rainfall. Since the access road follows the

stream bed up to the dam, it is judged that access to the structure could be blocked because of flooding in the stream channel. The Owner's representative indicated that the dam is inspected daily to determine if unusual seepage is developing and to assess the water supply and chlorination systems.

4.5 Evaluation.

There are no operating procedures nor are there any warning systems or procedures established to be followed during periods of exceedingly heavy rainfall or in the event of an emergency. Commensurate with the possibility of loss of life and extreme property damage downstream and near Nesquehoning Creek in the event of failure or the passing of exceedingly high flows, a formal warning procedure should be implemented. An operating procedure, together with an inspection checklist should also be formulated and implemented by the Owner. Coupled with this operational manual, a maintenance manual and a maintenance inspection checklist should also be formulated. The listing of items to be inspected should include all critical items of the facility.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Data.

a. Design Data. The Department of Environmental Resources (DER) files and the Owner's files contain no calculations, statements or reference to hydrologic/hydraulic design data. Bear Creek Watershed is a small, mountainous and completely tree-covered area. According to USGS maps, the drainage area measures approximately 1.3 square miles, with elevations ranging from 1700 in the upper reaches to 1295 at the normal reservoir level. The Water Authority owns the watershed for approximately 1 mile above the dam and the rest is part of the Pennsylvania State Gamelands. Therefore, the runoff characteristics are not expected to change in the foreseeable future.

In accordance with the criteria established by the Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard potential classification, is the probable maximum flood (PMF).

b. Experience Data. Records of reservoir water levels and rainfalls are maintained at the Owner's office in Lansford, Pennsylvania. Records have not been kept since the dam was constructed but have been kept since 1965. The storm of record is Tropical Storm Agnes, June 1972. The depth of flow over the spillway was 14 inches on both June 22 and June 23. The estimated discharge for this flow is 135 cfs. The rainfall measured at the dam was 2.6 and 4.9 inches, respectively. The storm washed out two catch basins downstream of the dam and damaged the base of the spillway.

c. Visual Observations. On the date of the inspection, the only condition observed that would indicate that the outlet capacity could be reduced during the flood occurrence is that the ground adjacent to the wing wall on the right abutment is approximately 6 inches lower than the dam crest. Observations regarding the condition of the downstream channel, spillway conditions, and reservoir are located in Appendix B.

d. Overtopping Potential. The overtopping potential of this dam was estimated from approximate methods as shown in Appendix C. Calculations indicate that the maximum spillway discharge is 560 cfs (425 cfs with the reservoir at the elevation of the right abutment) while the estimated peak inflow was 2300 cfs. The available flood storage is only 33 acre-feet. It is estimated that the PMF storm will overtop the dam by approximately 1-1/2 feet and that 0.5 PMF storm will overtop the dam by approximately 1 foot (see Section 6). Under existing conditions, the dam is capable of discharging approximately 20 percent of the PMF without overtopping.

e. Spillway Adequacy. A spillway system is "Seriously Indequate" in that all of the following conditions exist (Engineering Technical Letter No. 1110-2-234, 10 May 1978, by the Corps of Engineers):

> "1. There is high hazard to loss of life from large flows downstream of the dam.

"2. Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

"3. The dam and spillway are not capable of passing one-half of the probable maximum flood without overtopping failure."

Item 1 is covered in the following sub-section. Item 3 is covered above, and it is shown that the structure is overtopped by 0.5 PMF. Evaluation of item 2, the results to the structure as the result of overtopping, requires an extensive structural evaluation of the structure. However, based on the visual inspection and review of the files, it is judged that the structure is not capable of withstanding overtopping. Therefore, the spillway is considered "Seriously Inadequate".

The tailwater is expected to be 60 feet or more below the top of the dam when the spillway capacity is maximum.

f. Downstream Conditions. Near the confluence of Bear Creek and Nesquehoning Creek, there is one house and a factory which are subject to damage and possible loss of life in the event of failure of the dam. There are 4 or 5 houses downstream along Nesquehoning Creek which would also be subject to damage in the event of failure.

Bear Creek does not pass under any public highways before joining Nesquehoning Creek about 0.85 miles downstream from the dam. The dam access road crosses Bear Creek and is subject to flooding during periods of high flows.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. There were no indications observed during the field inspection to indicate that the dam was in an unstable condition. Concrete deterioration is prevalent throughout the structure, especially along the load-bearing buttress walls. Cracks, joint leakage, deterioration, underseepage, and other phenomena were observed which should be evaluated in detail by a registered professional engineer.

As previously described in Section 3, seepage was noted along most of the downstream section. As shown on Sheet 5a of Appendix B, the seepage covers a fairly significant area and is emanating through many portions of the structure. Specifically, these seepage zones are located at the base and along the buttress walls through the upstream slab, through joints and cracks, and possibly under the foundation. This latter could not be assessed during this inspection in that it would require several days to trace each of the seepage channels. It was reported that an evaluation had been made stating that seepage comes from the hills. However, Mr. Joseph Ellam, Department of Environmental Resources (DER) Hydraulic Engineer, has reported that seepage rates decrease when the reservoir level is lowered, indicative of seepage through the dam or foundation. Since weir measurements taken in March 1929 and May 1929 are expressed in inches, and the record does not contain a rating curve, there is no means of comparing seepage rates with measurements taken in 1951. In 1951 seepage was on the order of 367,000 gallons per day.

Visual inspection of the buttress walls disclosed that the concrete was spalled and, in some cases, the reinforcing steel was exposed and deteriorated. A close inspection of the concrete showed that much of the coarse aggregate consisted of crushed coal and not high quality stone. Therefore, it is concluded that additional structural evaluations are required. Considering the condition of the structure and the materials used for the construction, there is a good possibility that overtopping could induce structural collapse of the dam. This possibility can only be determined after a detailed structural evaluation is completed.

With the exception of the short section of intake pipe between the upstream face of the dam and the chlorine building, the water supply pipes could not be inspected. It is noted that these pipes are being replaced downstream of the dam. Although the spillway is in relatively good condition, there are signs of concrete deterioration, but no signs of movement.

b. Design and Construction Data. All available design documentation, calculations and other data pertinent to the structural integrity of the structure were reviewed and assessed for completeness. A detailed listing of this data is included herein as Appendix A and discussed in Section 2.

The design documentation was, for the most part, relatively incomplete. The plans and specifications reviewed were limited and many drawings were missing. However, plans of the essential features of the structure, intake pipes, and emergency spillway were available and have been reproduced in Appendix E. Construction photographs were quite comprehensive covering almost all phases of the construction. Specifications for the original construction were available and reviewed. It is noted that during this period, several changes in design criteria were suggested by the designer, based on American Society of Civil Engineers proceedings. During this construction period, these changes of design, especially in the allowable stress, were incorporated in the dam components. These changes are documented by letters from the design engineer, Williams and Richardson, Inc. The designer performed one structural evaluation and described their findings in a letter dated 22 June 1914. A series of structural calculations were available in the files and were reviewed. It appears that their calculations are comprehensive and within the 1914 state-of-the-art.

c. Operating Records. There are no operating records maintained for this structure. There are no minimum flow requirements required downstream of the structure. Reservoir level and rainfall records have been maintained since 1965. The storm of June 22, 1972 is the storm of record and a flow of 14 inches was recorded over the spillway. There is no maintenance checklist nor are maintenance records kept.

d. Post-Construction Changes. In 1920, Gannett Seelye and Fleming, Inc., were retained by the former owner, Panther Valley Water Company, to assess the seepage beneath and through the structure. Their assessment resulted in the construction of an upstream core wall, as shown on Plate 5 of Appendix E. There are construction photographs available showing this construction. The designer issued a letter approximately one year after the construction, stating that much of the seepage had been cut off. Weirs were installed at that time to monitor that seepage. However, most records are not in the DER files. During the life of the structure, some concrete refacing work was performed in 1972 and as late as 1977. Most of this work was performed on the upstream slabs and not on the critical structural elements.

In 1926, it was noted that the concrete on the underside of the upstream slab was spalling and deteriorating, apparently as a result of temperature changes over the winter months. As described in Section 1.2, paragraph g, the downstream side of each bay was enclosed by the use of asbestos paneling and concrete blocks. Temperature monitoring over the next two winters indicated the enclosure was successful in reducing the extreme temperature variation within the bays. At that time the upstream face was chipped clean and resurfaced with gunite.

e. Seismic Stability. The dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. Since the static stability analysis could not be reviewed, the seismic stability of the dam could also not be evaluated.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Evaluation. The visual inspection, and review of the design and as-built documentation indicates that the dam across Bear Creek is in poor condition. The hydrologic and hydraulic computations presented in Appendix C indicate that the dam will only pass 20 percent of the PMF without overtopping. At this flow, overtopping will first occur along the right abutment and then over top of the dam. This overtopping could cause excessive damage and possible failure of the structure. Therefore, the spillway systems of the structure are considered to be "Seriously Inadequate". In the event of catastrophic failure of the structure, extreme property damage and possible loss of life could occur downstream. It is also assessed that in the event of failure, more property damage would be inflicted downstream than if the dam did not fail.

Although downstream seepage has been evaluated by many consultants, principally Gannett Fleming Corddry and Carpenter, Inc., of Harrisburg, Pennsylvania, this seepage is still considered to be undesirable. Since seepage rates have not been monitored continuously over the years, there is no means of correlating early records with later records. Therefore, there is no means of determining if the seepage rates have increased over the years. This seepage should be carefully monitored and evaluated by a registered professional engineer.

Structural deterioration of the buttress walls was observed. It is considered undesirable and should be evaluated by a registered professional engineer. Typical photographs of this deterioration are shown in Appendix D of this report.

b. Adequacy of Information. The available design information was sufficient to evaluate this structure in accordance with Phase I guidelines provided by the Corps of Engineers. Construction photographs were quite comprehensive and included practically all aspects of construction. It is noted that hydraulic calculations were not available and, therefore, this aspect of the documentation is considered quite inadequate.

c. Urgency. It is concluded that the recommendations presented in Section 7.2 be implemented immediately.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be undertaken by the Owner immediately. The recommendations are presented in order of priority.

1. Positive measures should be taken by the Owner to immediately maintain a water level at least 10 feet below the spillway crest, as requested by the Department of Environmental Resources in 1972. This level should be maintained until the findings by the engineer are available.

2. A registered professional engineer should be retained to evaluate the structural integrity of this dam. Particular emphasis should be given to the buttresses and the upstream slab.

3. Underseepage and seepage through cracks should be evaluated and monitored, and the effect of underseepage on the long term stability of the dam determined.

4. The spillway and the flood storage capacity of the reservoir should be evaluated and the discharge system redesigned to meet current state-of-the-art hydrologic/hydraulic standards. This can be accomplished by either increasing the size of the spillway, or increasing the flood storage capacity of the reservoir.

5. The low area along the right abutment should be filled to at least the design elevation of the dam.

6. The area immediately downstream of the spillway should be re-assessed and appropriate measures taken to minimize deterioration of this zone in the event that high flows are passed through the spillway.

b. Operation and Maintenance Procedures. The Owner should develop an inspection checklist together with an operation and maintenance procedure to insure that all items are properly and periodically inspected, operated and maintained.

Because of the downstream population and industrial areas, a formal procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents and the industrial complex that high flows are to be expected along the creek.

Considering that the access road currently parallels the stream up to the dam, it is expected that access could be cut off during periods of high flows. Alternate means of achieving access to the dam for the purpose of monitoring the structure should be developed.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Bear Creek Dam*

ID # *PA 00607*

ITEM	REMARKS
AS-BUILT DRAWINGS	*None, but construction drawings were available. See Appendix E for selected portions of these drawings.*
REGIONAL VICINITY MAP	*See Appendix E, Plate 1.*
CONSTRUCTION HISTORY	*DER records were quite complete in summarizing the construction (1914) history and repair through 1951.*
TYPICAL SECTIONS OF DAM	*See Appendix E.*
OUTLETS - PLAN	*See Appendix E.*
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	*None Available.*
RAINFALL/RESERVOIR RECORDS	*The only records available were in 1951.*

ITEM	REMARKS
DESIGN REPORTS	*A structural analyses report (without calculations) was prepared by Williams-Richardson, Design Engineers and Contractors of Scranton, Pennsylvania. A structural analyses was found in the files and it is assumed it is the analyses performed by Williams and Richardson.*
GEOLOGY REPORTS	*None available. See Appendix F for a general geologic description.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	1. *Stability and structure calculatins were included in the files. Letters in 1914 indicates that a thourough stability analyses was performed.* 2. *There was no information pertaining to hydrology or hydraulics of the drainage basin or spillway, respectively.* 3. *There were no seepage studies available.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*None available.*
POST-CONSTRUCTION SURVEYS OF DAM	*Yes. See the text of the report for details.*
BORROW SOURCES	*Not sepecified. Majority of dam is concrete.*

ITEM	REMARKS
MONITORING SYSTEMS	*None*
MODIFICATIONS	*No structural modifications but asbestos sheets were installed on the downstream face to minimize temperature changes on the underside of the upstream slab to prevent spalling and deterioration of the concrete.*
HIGH POOL RECORDS	*None. June 26, 1972, 14 inches of water passed over the spillway causing damage to two downstream catch basins.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*Yes. See the report text for further details.*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*Data pertaining to incidents are described in the text.*
MAINTENANCE OPERATION RECORDS	*No operation records but there were several letters describing maintenance work performed through 1951.*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E for selected portions of construction drawings.*
OPERATING EQUIPMENT PLANS & DETAILS	*See Appendix E. for details.*
MISCELLANEOUS	*1. Two contracts for improvement by Gannett, Seeyle & Fleming, Harrisburg, Pennsylvania, 1920* *2. Inspection reports on cracks from 1920 to as late as 1972 by the Owner, State and various consultants.* *3. A series of detailed Progress Reports by the Panther Valley Water Company.* *4. "Report Upon the Application of the Panther Valley Water Co.", Oct. 2, 1920 for repair work.* *5. Progress reports for the 1920 repairs.* *6. Semi-monthly progress summaries for the 1920 repairs.* *7. State inspection reports-1922 through 1972.* *8. Weir measurements for Nov. 1951 indicates seepage of 367,000 gallons per day through four weirs.* *9. "Specifications of the Proposed Dam on Bear Creek".*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Bear Creek Dam* County *Carbon* State *Pennsylvania* National ID # *PA 00607*

Type of Dam *Hollow Concrete Dam (Ambursen)* Hazard Category *I (High)*

Date(s) Inspection *2 Aug. 1978* Weather *Cloudy, Humid* Temperature *80's*

Pool Elevation at Time of Inspection *1286.8* M.S.L. Tailwater at Time of Inspection *N/A* M.S.L.

Inspection Personnel:

Mary Beck (Hydrologist) *John Boschuk, Jr. (Geotechnical/Civil)*

Vince McKeever (Hydrologist) *John H. Frederick Jr. (Geotechnical)*

John Boschuk, Jr. Recorder

Remarks:

Reservoir level about 8.2 feet below spillway crest at time of inspection.

Mr. Henry Vadyak-Manager of Water Company; Mr. Edward Gaydos-Water Company Engineer.

Mr. Stephen Labosky-Leadman for Water Company; were on site during the inspection.

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*Yes. See Sheet 5a for details and locations of seepage.*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*The junctions were in very good condition.*	
DRAINS	*None observed. Seepage was flowing beneath the downstream facing wall. There were no connecting drains observed between buttress walls.*	
WATER PASSAGES	*N/A*	
FOUNDATION	*The foundation could not be inspected but there was evidence of seepage flowing beneath the foundation. Confirmation would require a detailed field investigation.*	

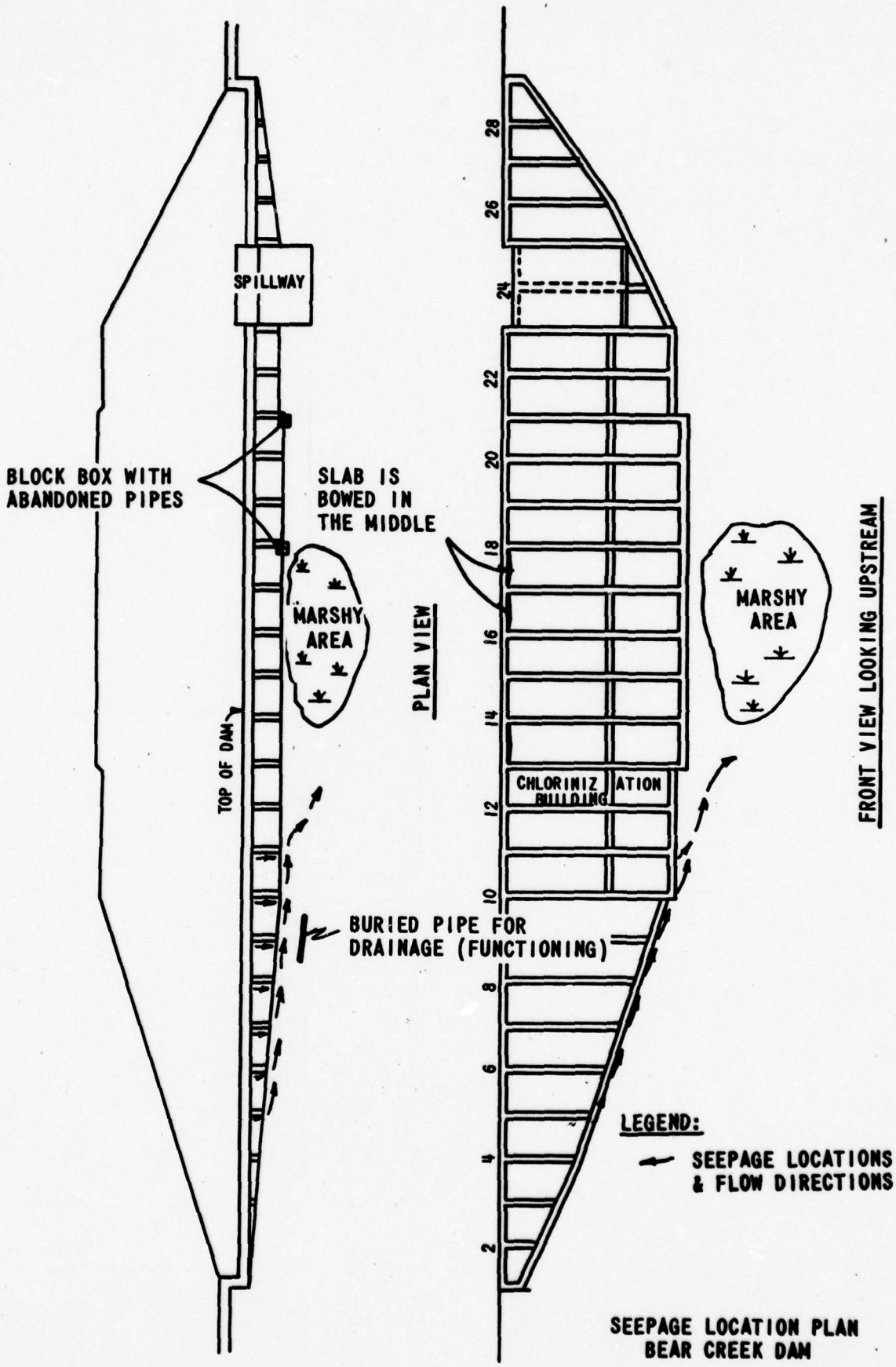
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*Many of the concrete sufaces were spalled and in varying degrees of deterioration. Several cracks were noted and slabs between buttresses were curved. Construction photographs dated 6/2/15 show that the forms were bulging at the time of construction.*	
STRUCTURAL CRACKING	*The buttresses are in generally poor condition especially on the right half of the dam. The concrete is deteriorating, spalled and it was noted that some of the concrete aggregate is composed of coal which is most undesireable. A structural evaluation should be made. The left side of the dam is in somewhat better condition with less noticeable spalling.*	
VERTICAL AND HORIZONTAL ALIGNMENT	*Vertical and horizontal alignment along the crest is very good.*	
MONOLITH JOINTS	*Several of the joints seep or leak. A evaluation of the structure should be made.*	
CONSTRUCTION JOINTS	*Many joints were seeping and several were leaking.*	
BUTTRESS SLABS	*Slabs between buttress walls are deflected and appear to be in poor condition. The concrete is deteriorating and the surface is soft. These slabs should be evaluated. Construction photos confirm that the slab bulged while the concrete was being poured.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*N/A*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*N/A*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*N/A*	
RIPRAP FAILURES	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*N/A*	
ANY NOTICEABLE SEEPAGE	*N/A*	
STAFF GAGE AND RECORDER	*N/A*	
DRAINS	*N/A*	



SEEPAGE LOCATION PLAN
BEAR CREEK DAM

SHEET 5a OF 11

OUTLET WORKS
(WATER SUPPLY)

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*Intake pipes lead from the dam to a chlorinization plant inside the dam and then downstream to the users. Good condition from upstream face to chlorinator. Beyond this point, pipes are buried and could not be inspected. The old pipes are being replaced.*	
INTAKE STRUCTURE	*N/A*	
OUTLET STRUCTURE	*N/A*	
OUTLET CHANNEL	*N/A*	
EMERGENCY GATE	*N/A*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*Appears to be in good condition with only minor concrete spalling.*	
APPROACH CHANNEL	*None*	
DISCHARGE CHANNEL	*Concrete chute discharges into the stilling basin and then into rock/concrete channel into a catch basin. The concrete chute is spalling, especially the right wall, and the channel below the stilling basin is eroding (damaged during Tropical Storm Agnes, June 1972).*	
BRIDGE AND PIERS	*None*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*None*	
APPROACH CHANNEL	*None*	
DISCHARGE CHANNEL	*None*	
BRIDGE AND PIERS	*None*	
GATES AND OPERATION EQUIPMENT	*None*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*Destroyed over the years and never replaced.*	
PIEZOMETERS	*None*	
OTHER	*Standard rain gage located at the dam.*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*Reservoir slopes are steep, rocky with timber growth above the water line.*	
SEDIMENTATION	*Minimal, no effect on flood storage.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*New conduits from the dam are being laid in the flood plain, so brush and timber have been cut. It is understood that this will be removed after construction is complete.*	
SLOPES	*Valley gradient about eight percent, channel side slopes vary from vertical to 2H:1V.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*About 0.85 miles downstream near the confluence of Bear Creek and Nesquehoning Creek is one house and a factory subject to damage in case of failure. There are four or five houses downstream on Nesquehoning which would be subject to damages in the event of a failure.*	

APPENDIX

C

BEAR CREEK DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Mountainous, tree covered*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *1295 (273 Acre-Feet)*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *1298 (304 Acre-Feet)*

ELEVATION MAXIMUM DESIGN POOL: *----*

ELEVATION TOP DAM: *1298*

SPILLWAY

a. Elevation *1295*

b. Type *Ogee type weir*

c. Width *28.3 feet*

d. Length *N/A*

e. Location Spillover *75 feet from left abutment.*

f. Number and Type of Gates *None*

OUTLET WORKS:

a. Type *3-14 inch cast iron pipes through dam.*

b. Location *Approximately 160 feet right of the spillway*

c. Entrance inverts *1286±, 1267±, 1247±*

d. Exit inverts *N/A*

e. Emergency draindown facilities *18 inch cast iron pipe.*

HYDROMETEOROLOGICAL GAGES:

a. Type *Standard rain gage.*

b. Location *At the dam.*

c. Records *Owner's office in Lansford, Pa.*

MAXIMUM NON-DAMAGING DISCHARGE: *Less than 100 cfs.*

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC DATA

Date: 8/15/78
By: MFB
Sheet: 2 of 9

DAM Bear Creek Dam Nat. ID No. PA 00607 DER No. 13-2

	ITEM/UNITS	Permit/Design Files (A)	Calc. from Files/Other (B)	Calc. from Observations (C)
1.	Min. Crest Elev., ft.	1298		
2.	Freeboard, ft.	–		
3.	Spillway(1) Crest Elev, ft.	1295		
3a.	Secondary(2) Crest Elev, ft.	–		
4.	Max. Pool Elev., ft.	–		
5.	Max. Outflow(3), cfs	–		
6.	Drainage Area, mi^2	1.4	1.1	1.3
7.	Max. Inflow(4), cfs	–		
8.	Reservoir Surf. Area, Acre	10.7		10.7
9.	Flood Storage(5), Acre-Feet	33.0		
10.	Inflow Volume, ft^3	–		

Reference all figures by number or calculation on attached sheets:

Example: 3A - Drawing No. xxx by J. Doe, Engr., in State File No. yyyy.

NOTES:

(1) Main emergency spillway.

(2) Secondary ungated spillway.

(3) At maximum pool, with freeboard, ungated spillways only.

(4) For columns B, C, use PMF.

(5) Between lowest ungated spillway and maximum pool.

Date: 8/15/78
By: MFB
Sheet: 3 of 9

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

Item (from Sheet 2)	Source
1A, 3A	Drawing dated May 27, 19
6A	1914 Application
6B	Water and Resources Power Board Inspection Report, Aug. 21, 1951
6C, 8C	USGS Maps Tamaqua (1976) Hazleton (1969)
8A, 9A	1915 Stage - Storage / Area Table

Classification (Ref. Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is "High" as there would be loss of life if the dam failed.

2. The size classification is "Intermediate" based on its height.

3. Spillway design flood, based on size and hazard classification, is the probable maximum flood (PMF).

Hydrology and Hydraulic Analysis

1. Original Data. There were no calculations, statements or references to hydrology or hydraulics in DER files

2. PMF

Peak inflow - Information from C of E, Balt. District estimates a peak PMF inflow of 1700 cfs/sq. mile.

As the drainage area is 1.3 sq. miles (USGS), peak PMF inflow, Q,

$Q = 1.3 \cdot 1700 = 2210$ cfs

USE 2300 cfs

Volume of inflow

Maximum probable precipitation (PMP)

PMP = 25.0 inches - 10 sq. mile 6 hr. storm from TP-40

Assume 90% runoff

Volume of runoff, V_R =

$$\frac{0.9 \cdot 25.0}{12} \cdot 1.3 \cdot 640 = 1560 \text{ Ac-Ft.}$$

3. Spillway Capacity

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

H = head, the maximum head (w/o overtopping) is 3 ft.
L = length, design length = 28.5 ft.; field checked as 28.3 ft.
C = coefficient of discharge, spillway shape similar to ogee, assume C = 3.8

$Q = 3.8 \cdot 28.3 \cdot 3^{3/2} = 559$ cfs
SAY 560 cfs

[existing conditions: $Q = 3.8 \cdot 28.3 \cdot 2.5^{3/2} = 425$ cfs]

4. Overtopping Potential

Available flood water storage, V_S
Reservoir surface area at 1295 = 10.7 Ac.
(from original elevation-volume-area chart)

V_S = 33 Ac-Ft. (see sheet 7)

By inspection, the spillway will not pass the PMF

$0.5 Q_I = 1150$ cfs
$0.5 V_I = 780$ Ac-Ft.

Required storage, V_R (sheets 8 & 9)

$V_R = (1 - \frac{560}{1150}) 780 = 400$ Ac-Ft $> V_S$

Therefore, the spillway will not pass 0.5 PMF and is "Seriously Inadequate" based on capacity

Estimate of PMF percentage that will pass
(use of triangular inflow hydrograph means that the peak inflow rate and inflow volume are directly proportional, ie if $Q_I = 0.4 Q_{PMF}$, then $V_I = 0.4 V_{I_{PMF}}$)

$33 = (1 - \frac{560}{X \cdot 2300}) X \cdot 1560$

$X = 26\%$

[existing conditions, $X = 20\%$]

BY MEB DATE 8/15/78 SUBJECT Bear Creek Dam SHEET 6 OF 9

CHKD. BY DATE Hydrology / Hydraulics JOB No.

Depth of overtopping during 0.5 PMF, PMF

Flow over top of dam (neglect spillway)

$Q = CLH^{3/2}$

$C = 3.1$

$L = 420$ ft. (not including wing walls)

(1) if $H = 1.43$ ft 1.0 PMF

$Q_0 = 2226$ cfs

$V_3 = 45$ Ac-Ft

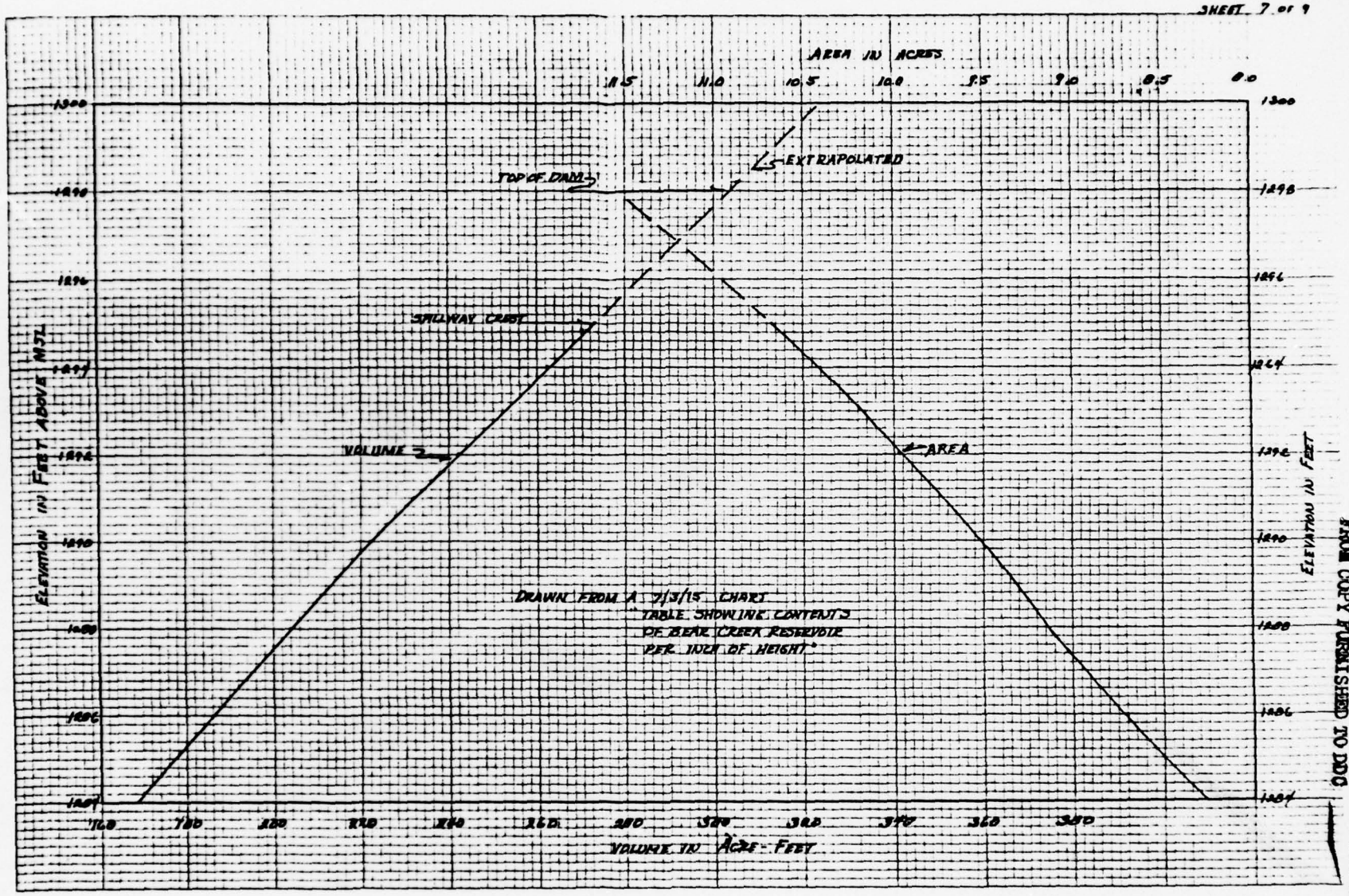
$V_2 = (1 - \frac{2226}{2300})1560 = 50$ Ac-Ft ~ 45 Ac-Ft.

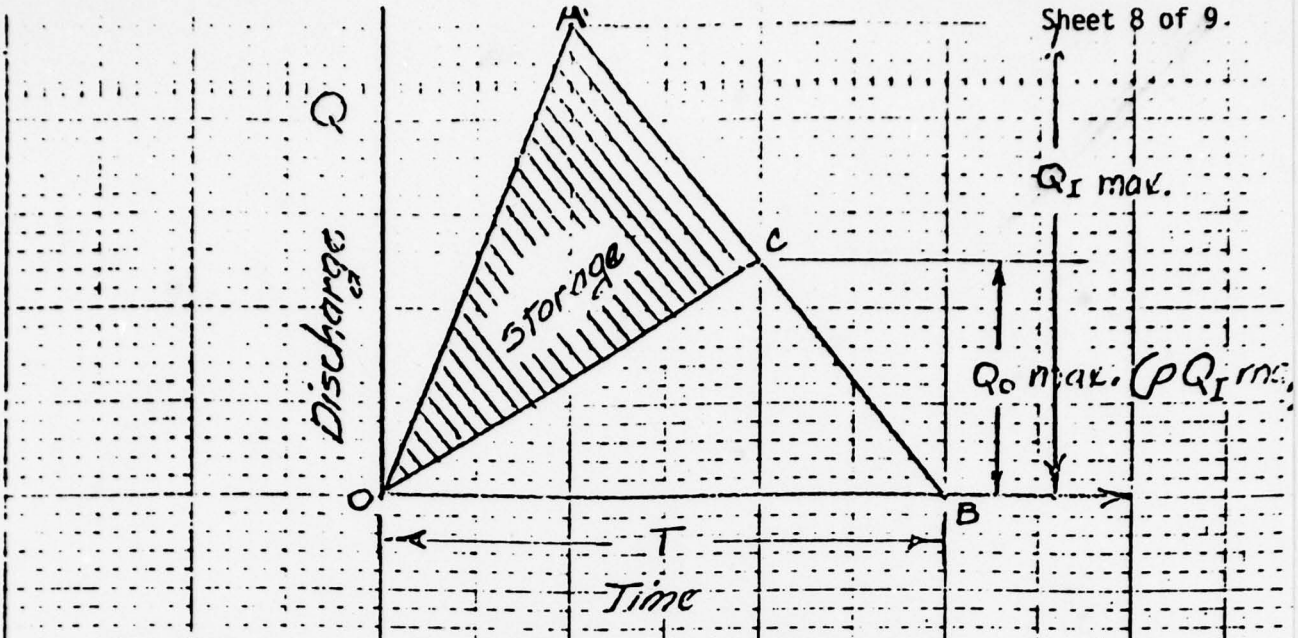
(2) if $H = 0.9$ 0.5 PMF

$Q_0 = 1112$ cfs

$V_3 = 39$ Ac-Ft

$V_2 = (1 - \frac{1112}{1150})760 = 26$ Ac-Ft < 39 Ac-Ft





PURPOSE: Establish relationship between maximum spillway discharge and storage required to pass flood hydrograph without exceeding maximum pool level.

$$\frac{\Delta AOC}{\Delta AOB} = \frac{\Delta AOB - \Delta COB}{\Delta AOB} = 1 - \frac{\Delta COB}{\Delta AOB}$$

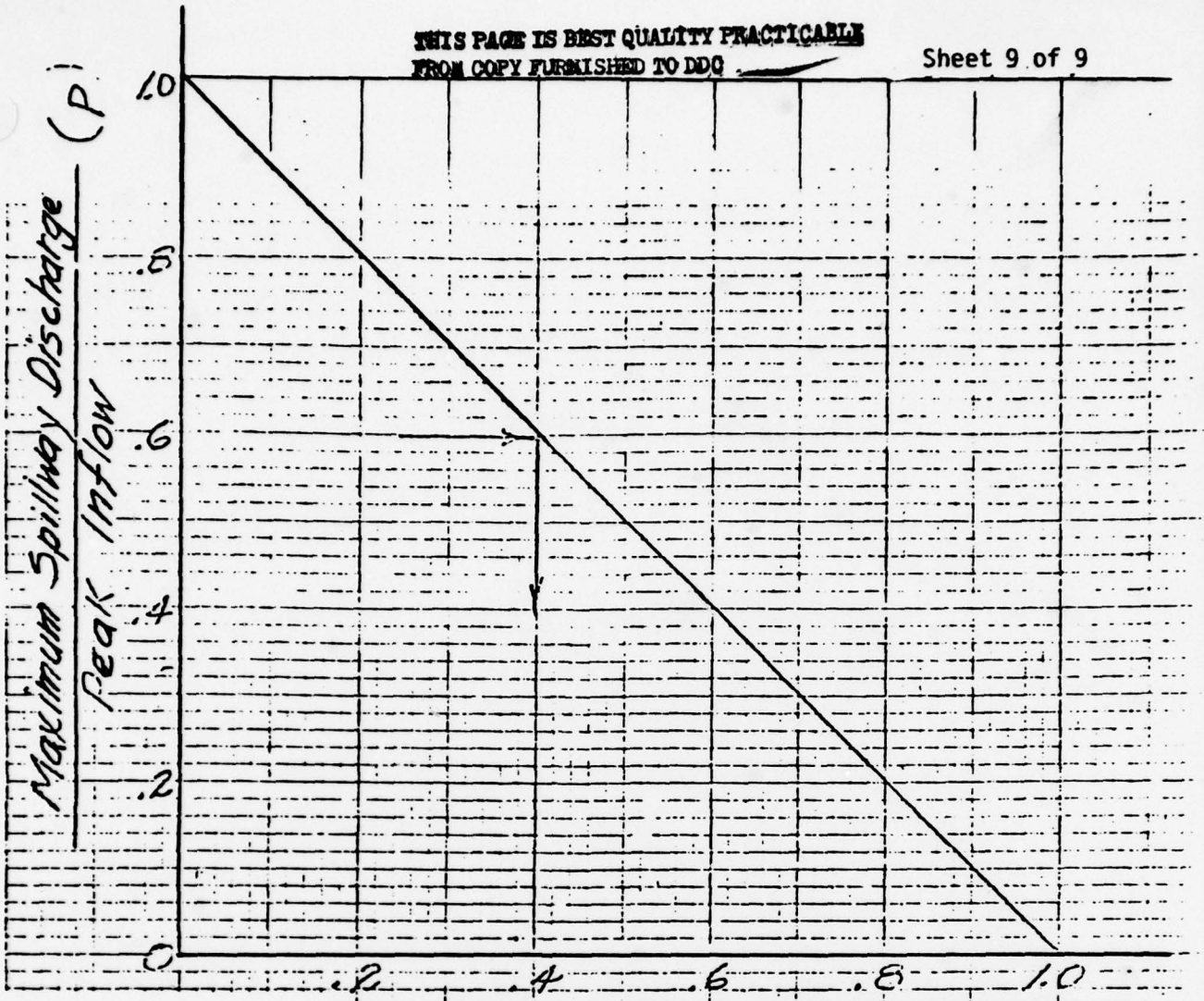
$$\frac{\Delta AOC}{\Delta AOB} = 1 - \frac{T \rho Q_{I\,max}/2}{T\, Q_{I\,max}/2} = 1 - \rho$$

$$\Delta AOC = (1-\rho)\,\Delta AOB \quad \text{where } 0 \le \rho \le 1.0$$

ρ	ΔAOC
1.00	0
0.75	0.25 ΔAOB
0.50	0.50 ΔAOB
0.25	0.75 ΔAOB
0	1.00 ΔAOB

REFERENCE

PRELIMINARY ENGINEER TECHNICAL LETTER NO. 1110-2- 25 January 1978



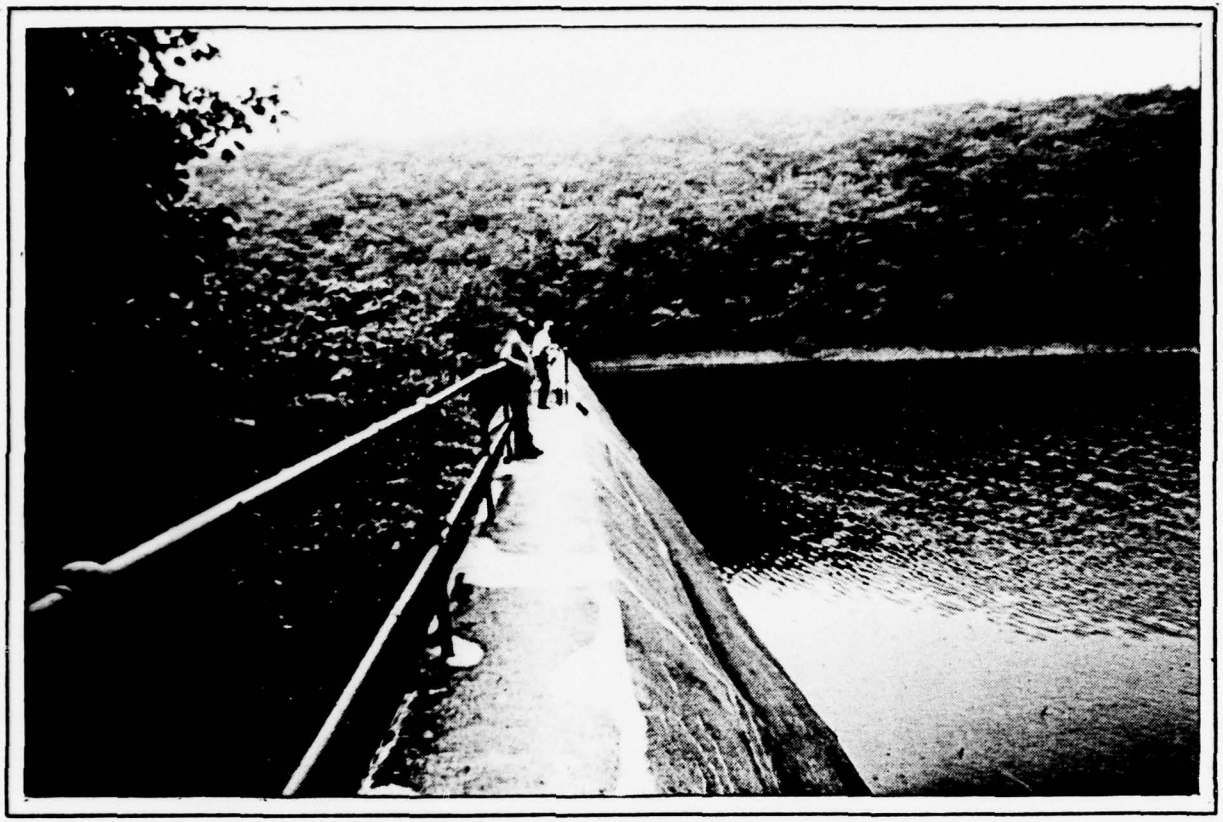
Steps to obtain required reservoir to pass inflow hydrograph without overtopping dam.

1. Obtain maximum spillway discharge
2. Develop inflow hydrograph
3. Compute relationship of maximum spillway capacity to peak inflow
4. Read relationship of required reservoir storage to volume of inflow hydrograph from curve

page 2 of 2

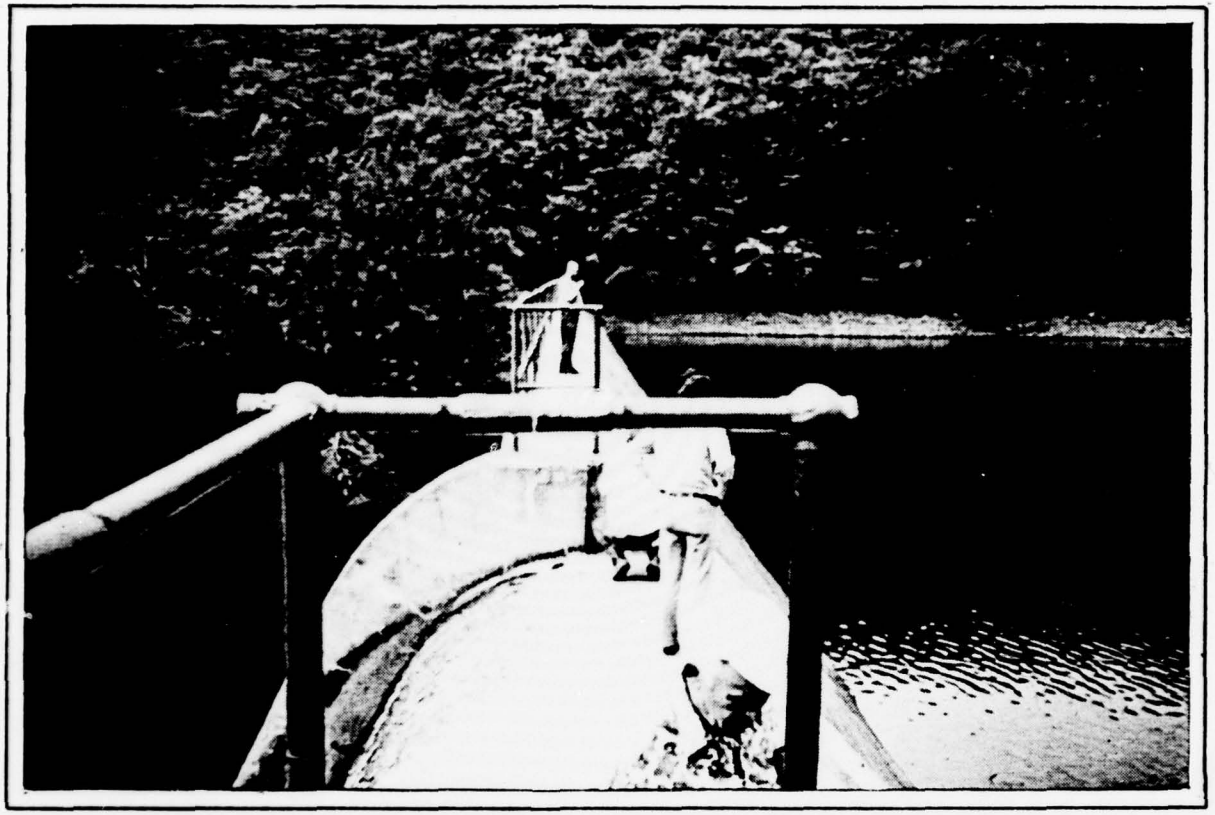
APPENDIX

D



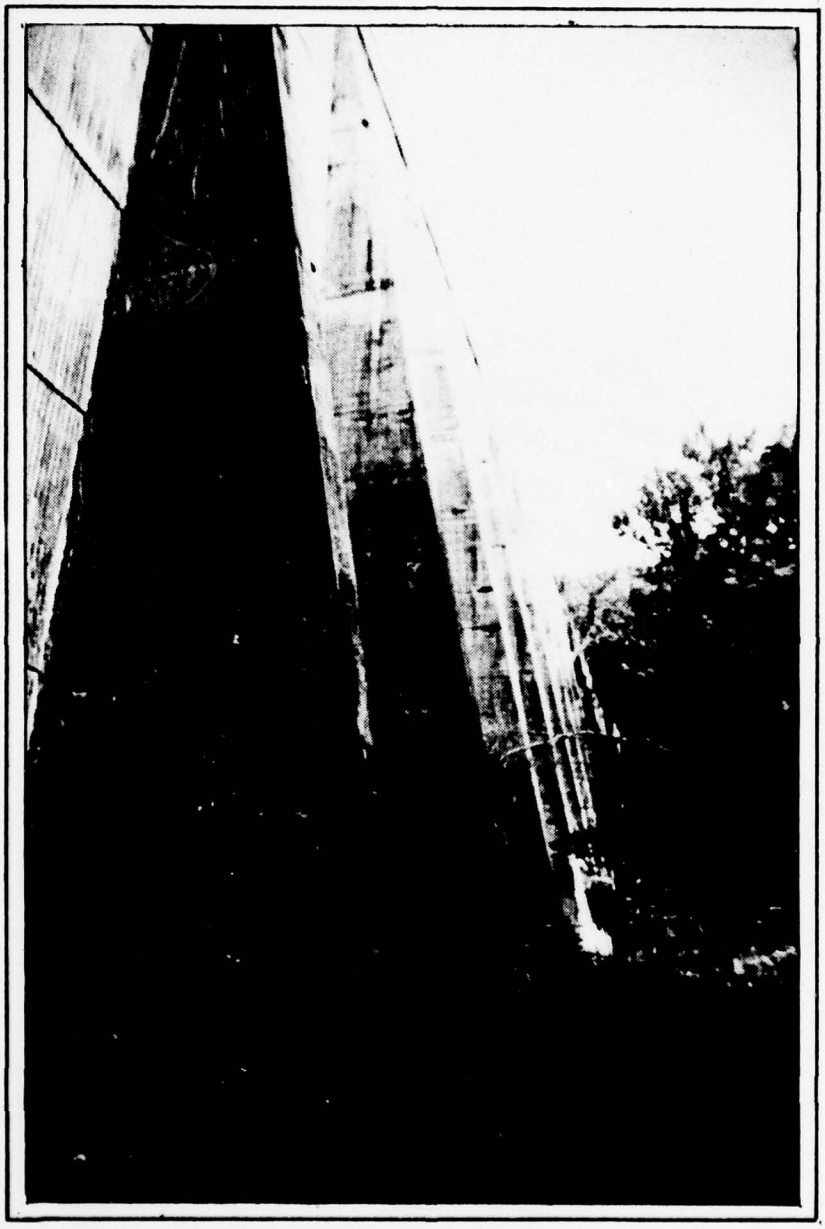
VIEW LOOKING FROM LEFT ABUTMENT ALONG CREST.

PHOTOGRAPH NO. 1



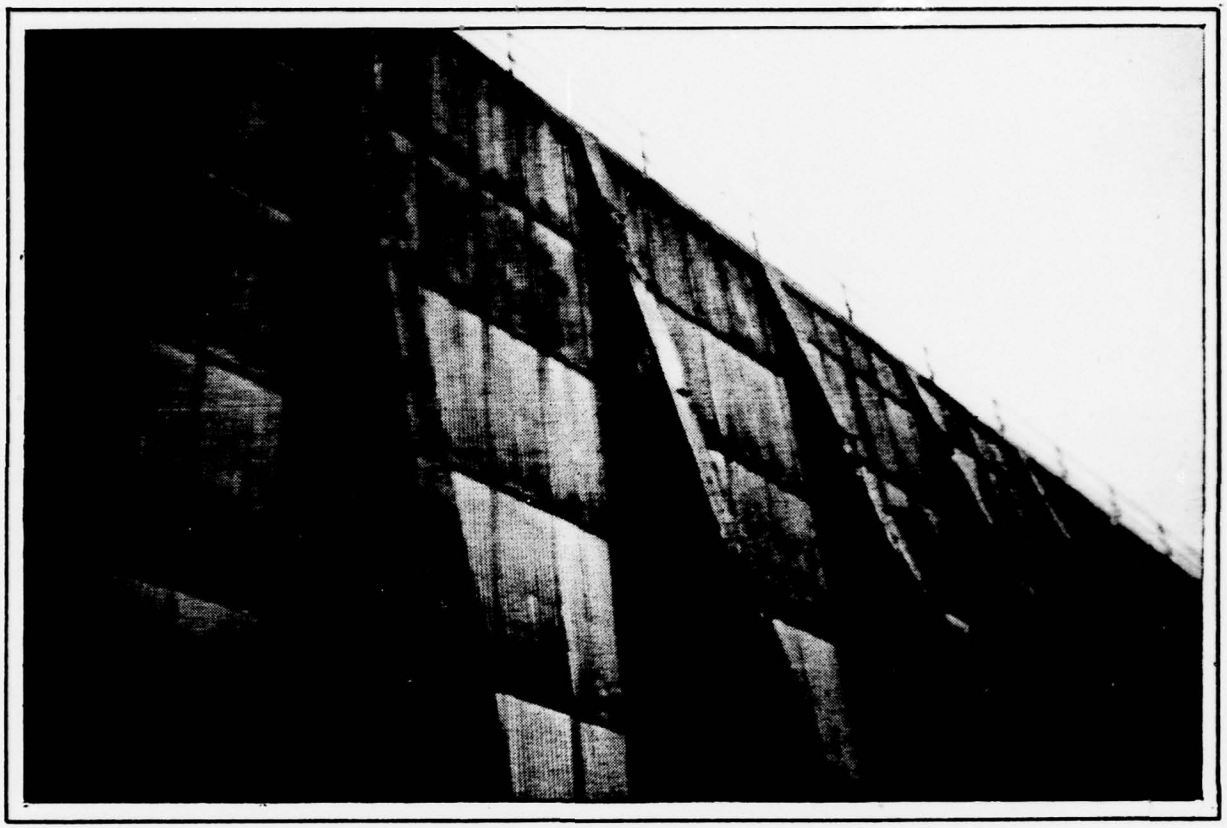
VIEW OF SPILLWAY. NOTE SPALLING AND
PATCH WORK ON SURFACE.

PHOTOGRAPH NO. 2



VIEW OF DOWNSTREAM BUTTRESS
LOOKING TOWARD RIGHT ABUT-
MENT.

PHOTOGRAPH NO. 3

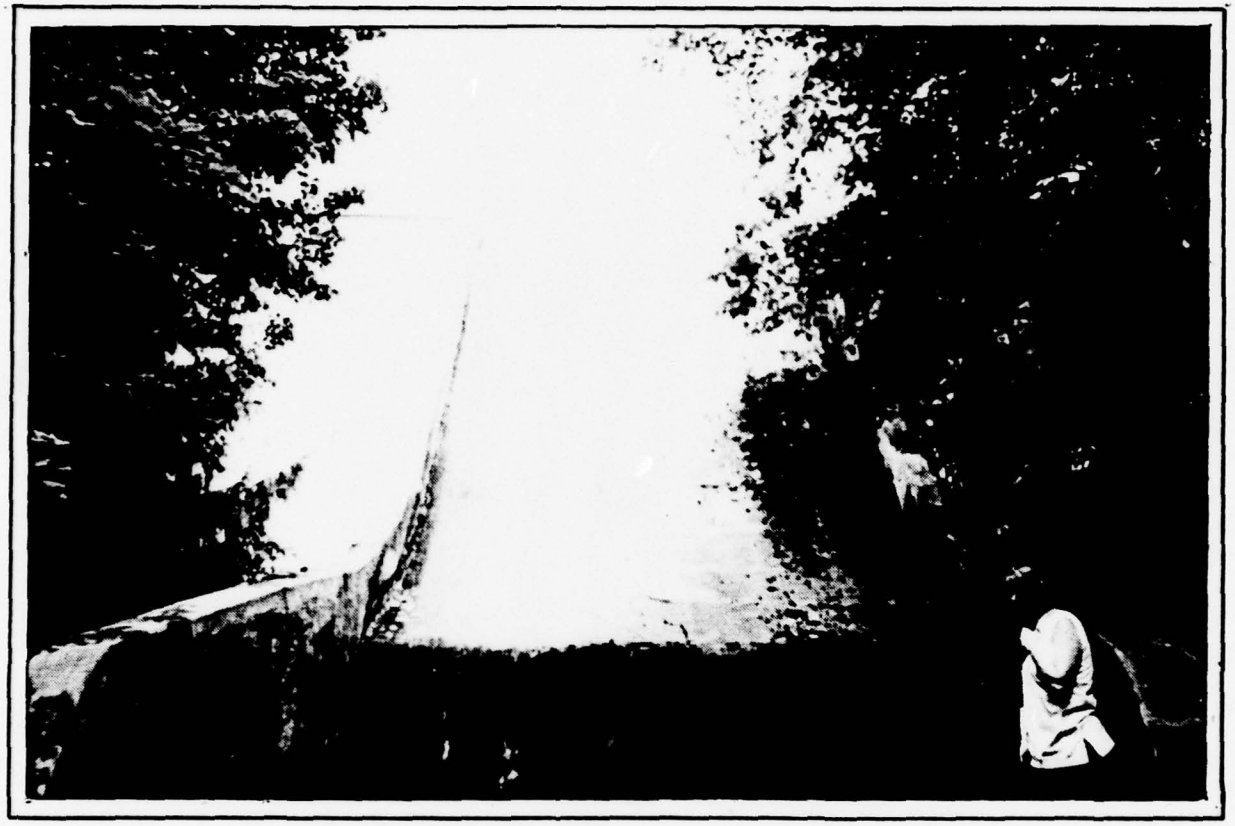


DOWNSTREAM BUTTRESSES WITH ASBESTOS
FACIAL PLATES.

PHOTOGRAPH NO. 4

WATER TREATMENT (CHLORINE) BUILDING.
NOTE BUTTRESS DETERIORATION.

PHOTOGRAPH NO. 5



VIEW OF SPILLWAY. NOTE SPALLING CONCRETE.

PHOTOGRAPH NO. 6

DISCHARGE CHANNEL BELOW
SPILLWAY.

PHOTOGRAPH NO. 7

SPALLED CONCRETE OF BUTTRESS NUMBER 3. SEE PLATE 2 APPENDIX E FOR BUTTRESS LOCATION.

PHOTOGRAPH NO. 8

SPALLED CONCRETE OF BUTTRESS NUMBER 4. SEE PLATE 2 APPENDIX E FOR BUTTRESS LOCATION.

PHOTOGRAPH NO. 9

SEEPAGE BENEATH BUTTRESS NUMBER 8.
FLOW WAS CLEAR.

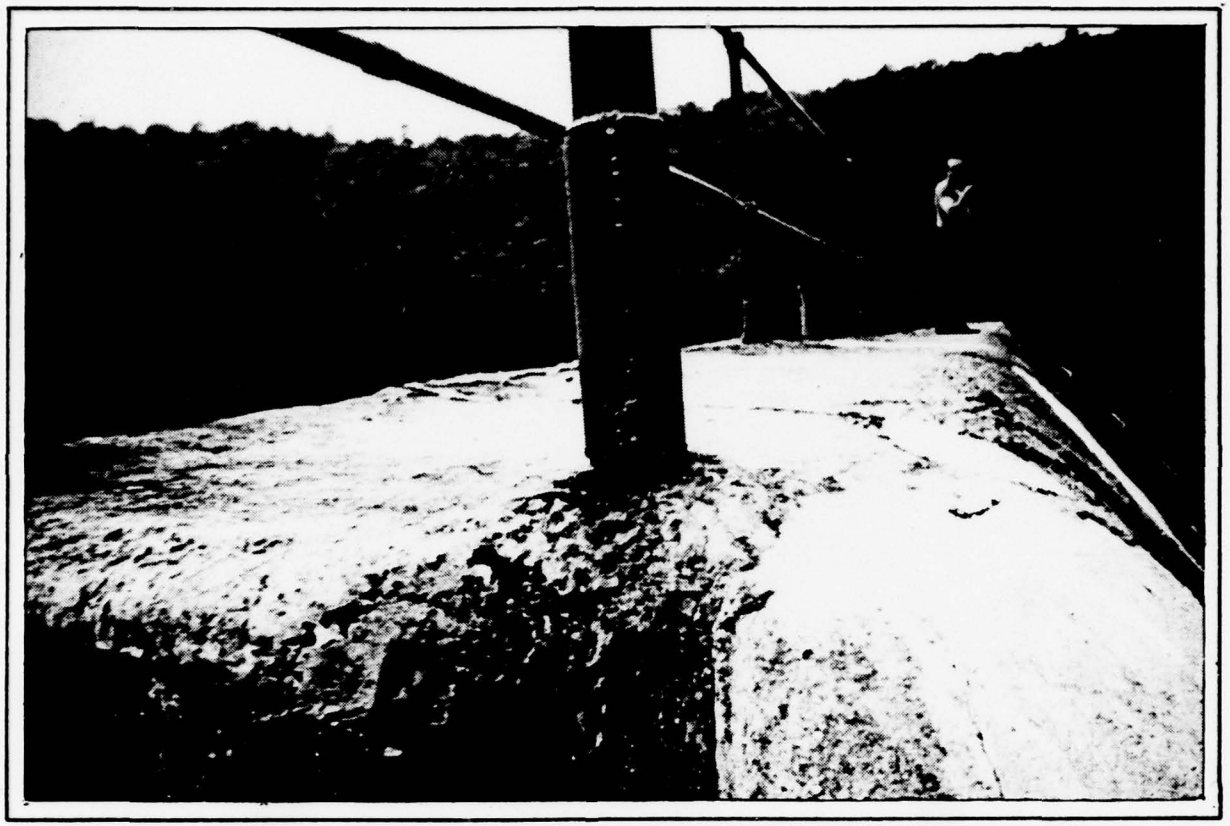
PHOTOGRAPH NO. 10

SPALLED CONCRETE OF BUTTRESS NUMBER 4.

PHOTOGRAPH NO. 11

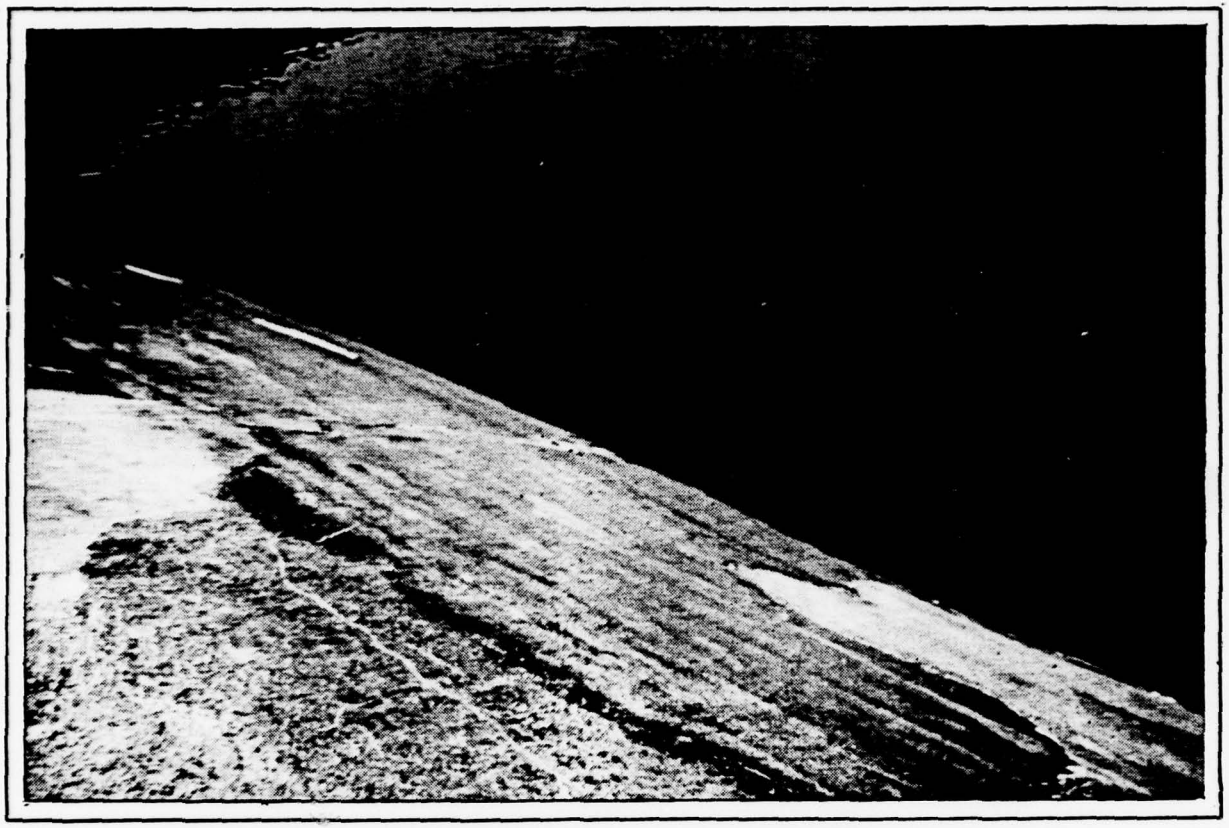
DETERIORATED CONCRETE OF BUTTRESS
NUMBER 8.

PHOTOGRAPH NO. 12



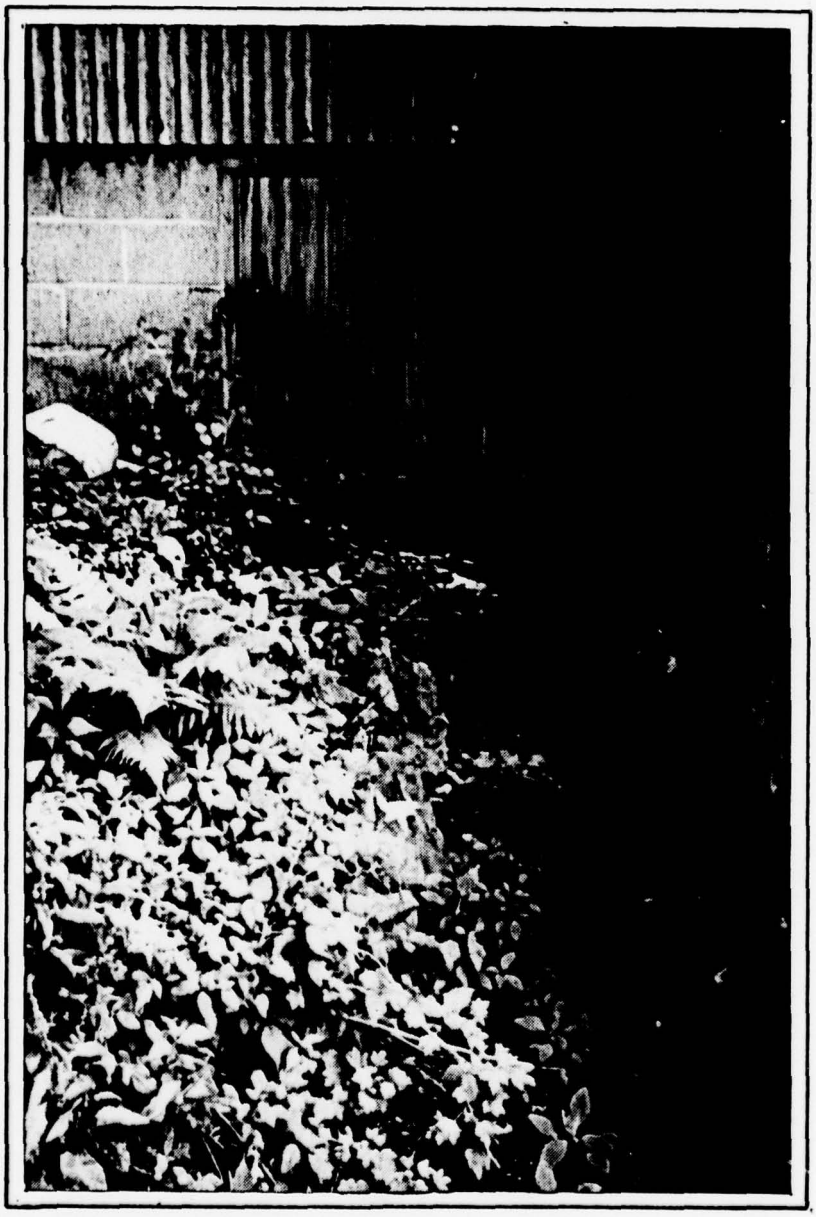
TYPICAL DETERIORATION AT BASE OF HANDRAILS.

PHOTOGRAPH NO. 13



PATCHING OF UPSTREAM FACE OF DAM.

PHOTOGRAPH NO. 14



TYPICAL SEEPAGE ADJACENT TO BUTTRESSES. ALL SEEPAGE WAS CLEAR.

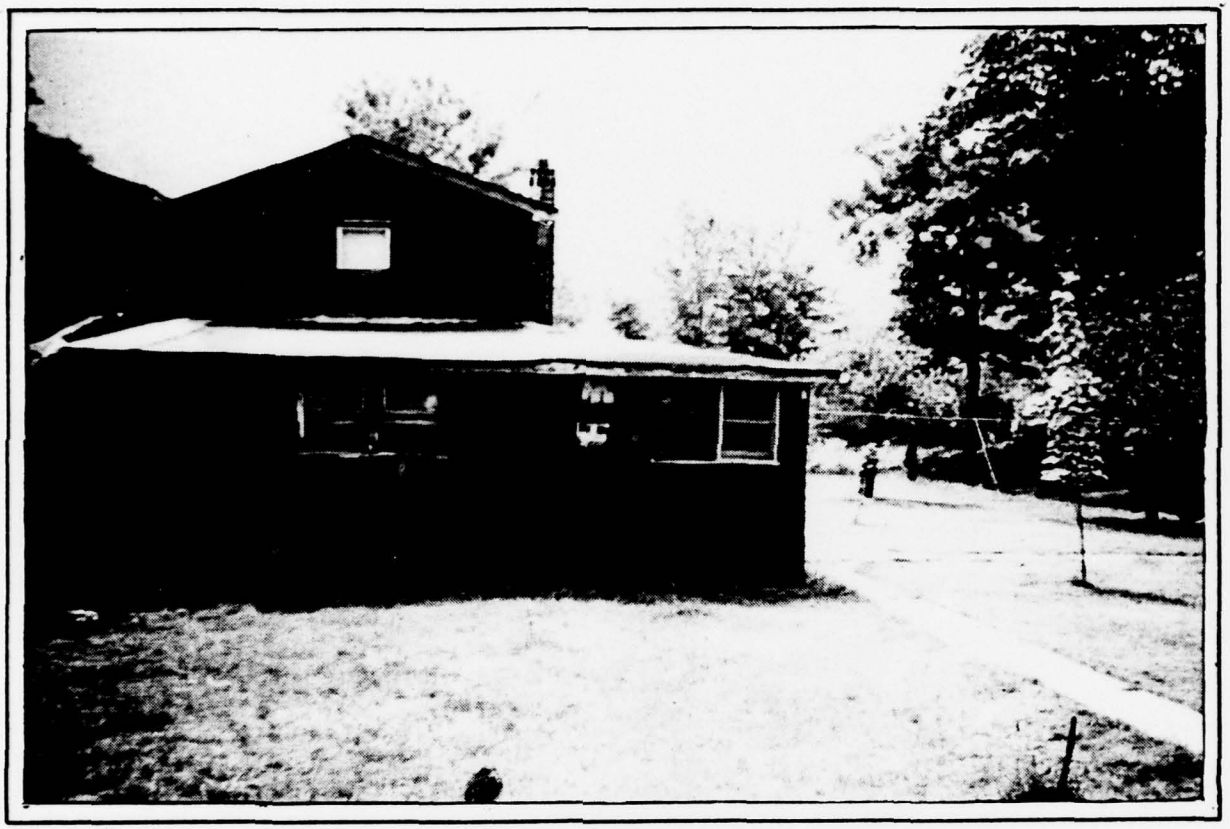
PHOTOGRAPH NO. 15

TYPICAL SEEPAGE CHANNELS BELOW
DAM.

PHOTOGRAPH NO. 16

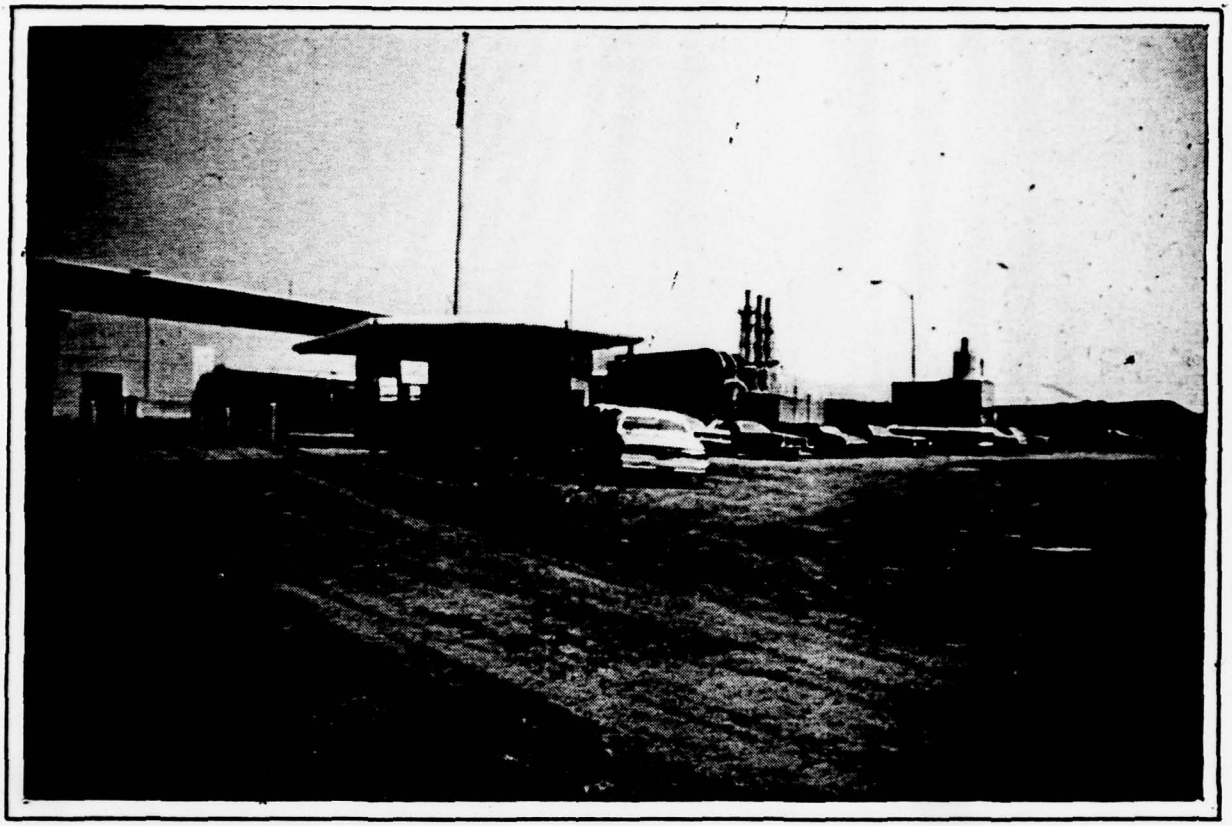
DETERIORATED DOWNSTREAM MATERIALS
WITH ANIMAL HOLES/SEEPAGE HOLES.

PHOTOGRAPH NO. 17



VIEW OF ONLY HOUSE DOWNSTREAM IN DIRECT PATH OF FLOOD WAVE IN EVENT OF FAILURE. DWELLING IS USED AS A SUMMER HOME.

PHOTOGRAPH NO. 18

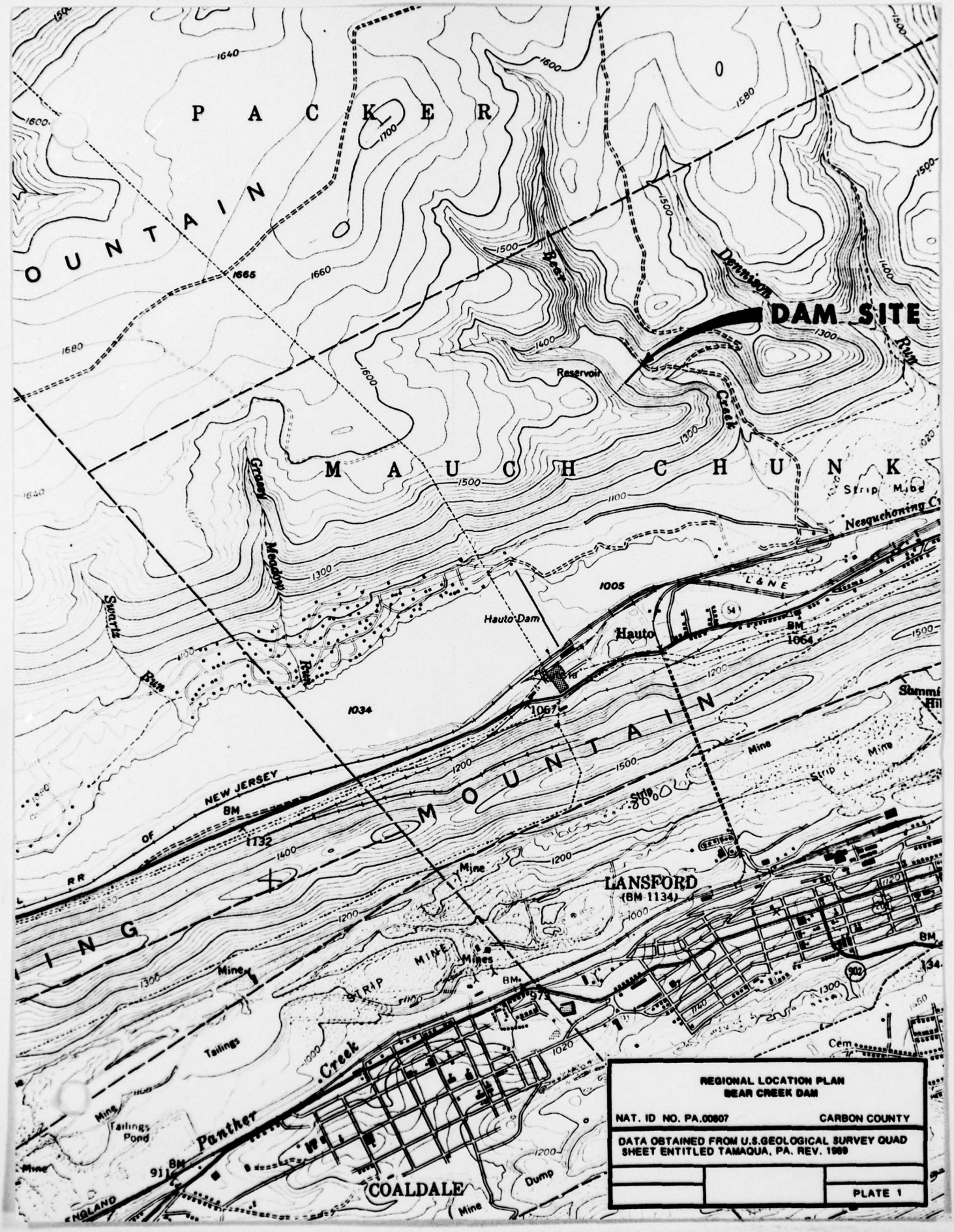


CASTING FACTORY DOWNSTREAM OF DAM
THAT WOULD BE AFFECTED IN EVENT OF
DAM FAILURE.

PHOTOGRAPH NO. 19

APPENDIX

E



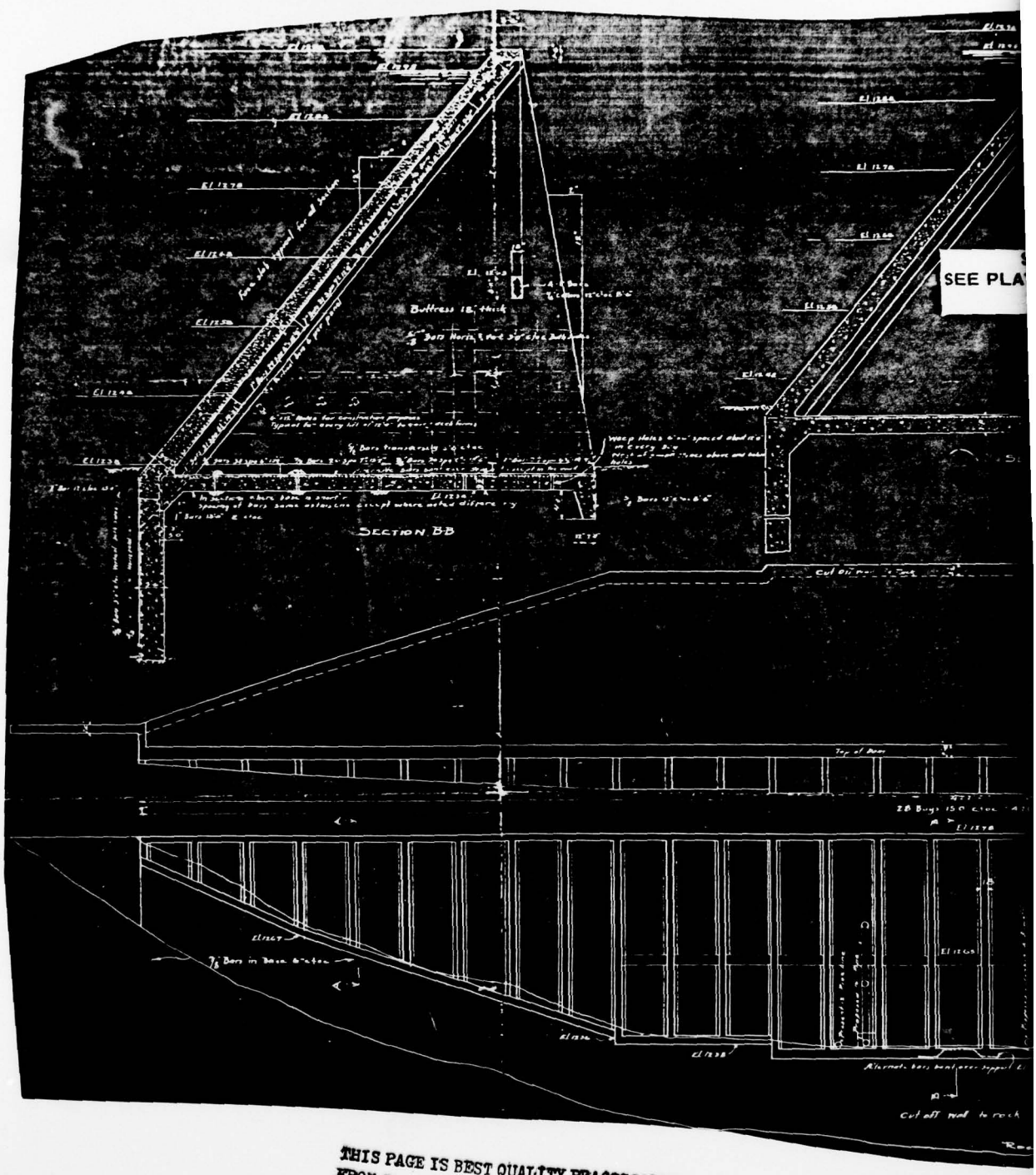
REGIONAL LOCATION PLAN
BEAR CREEK DAM

NAT. ID NO. PA.00807 CARBON COUNTY

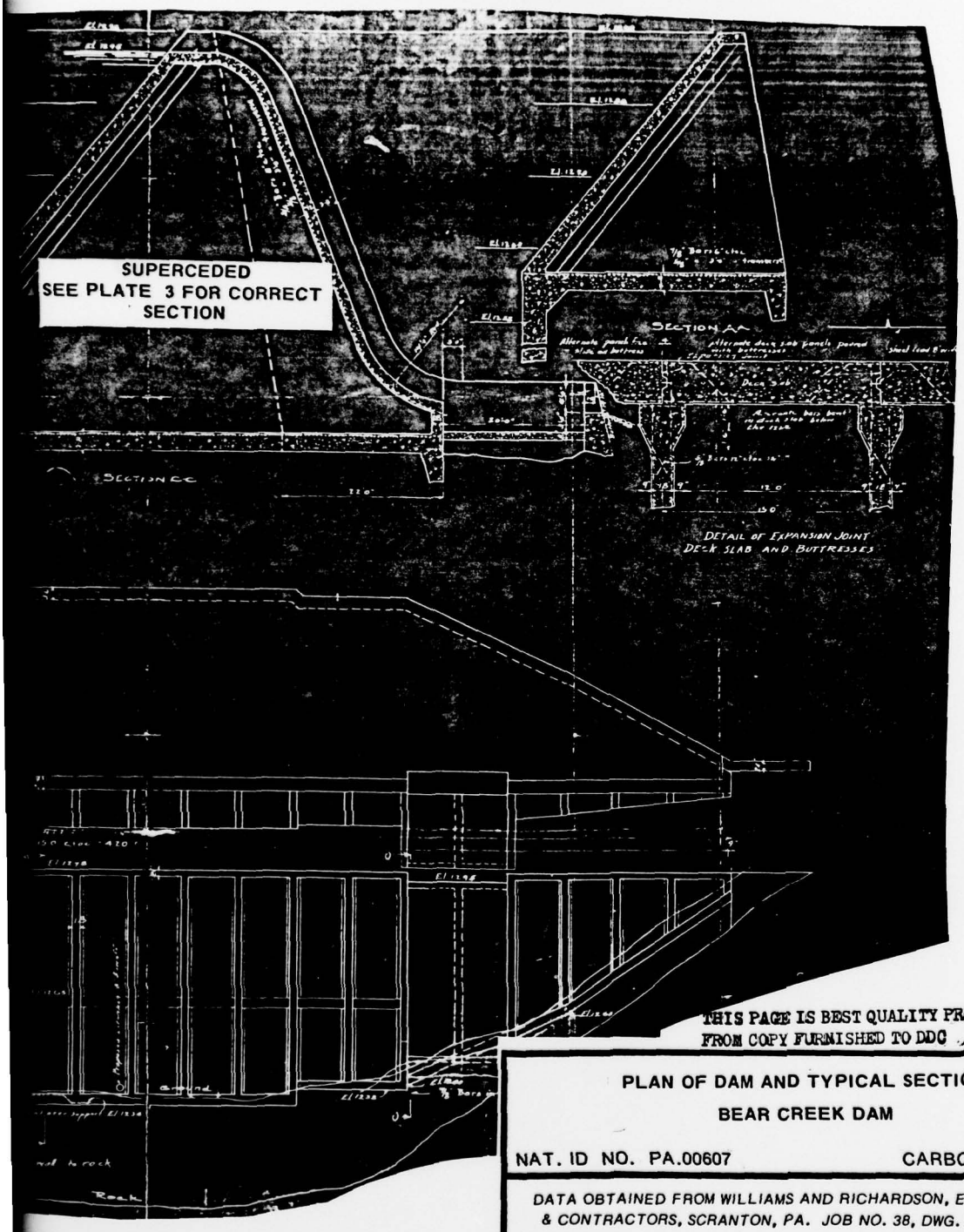
DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEET ENTITLED TAMAQUA, PA. REV. 1969

PLATE 1

PHOTOGRAPH NO. 8



PHOTOGRAPH NO. 9



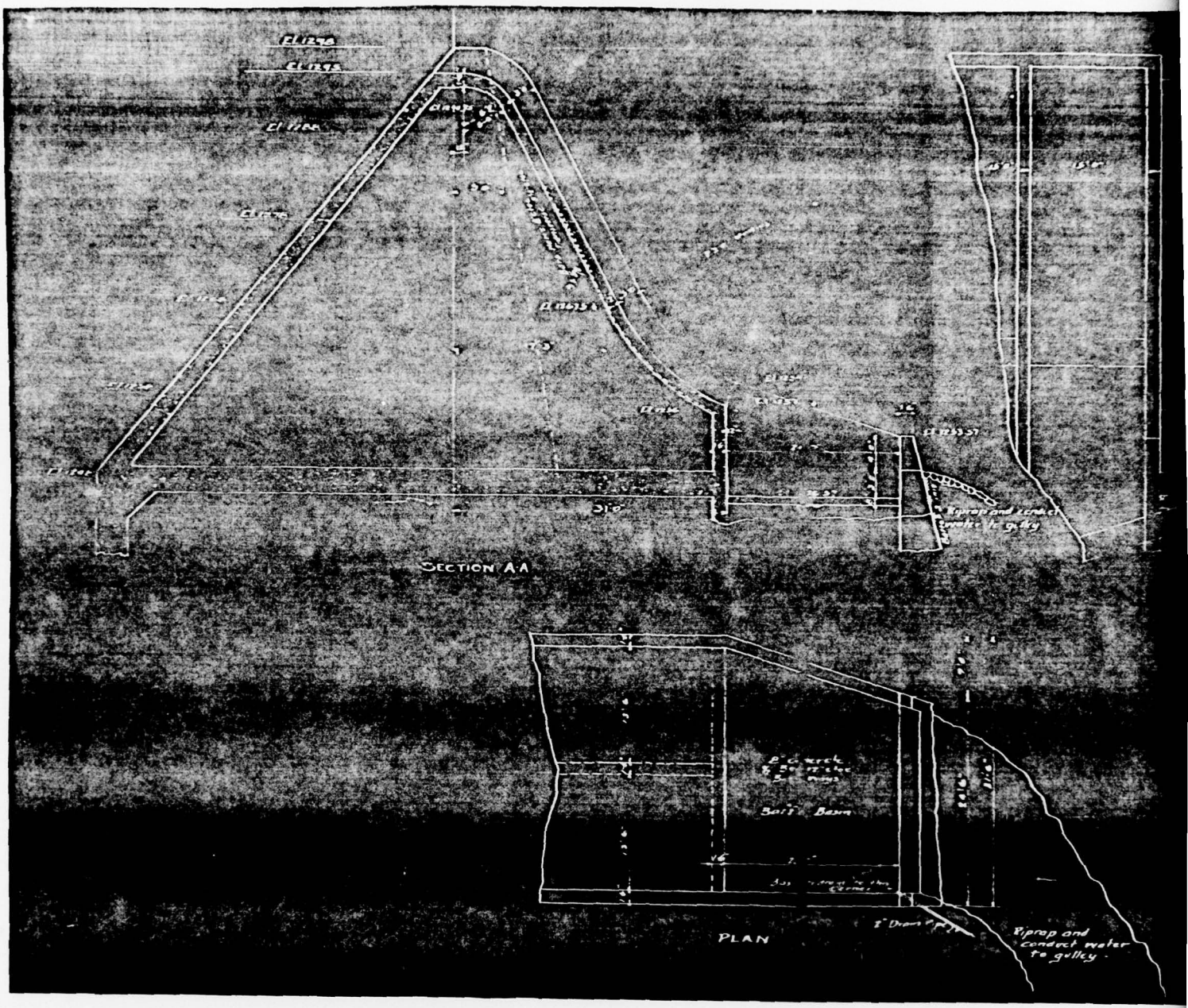
PLAN OF DAM AND TYPICAL SECTIONS
BEAR CREEK DAM

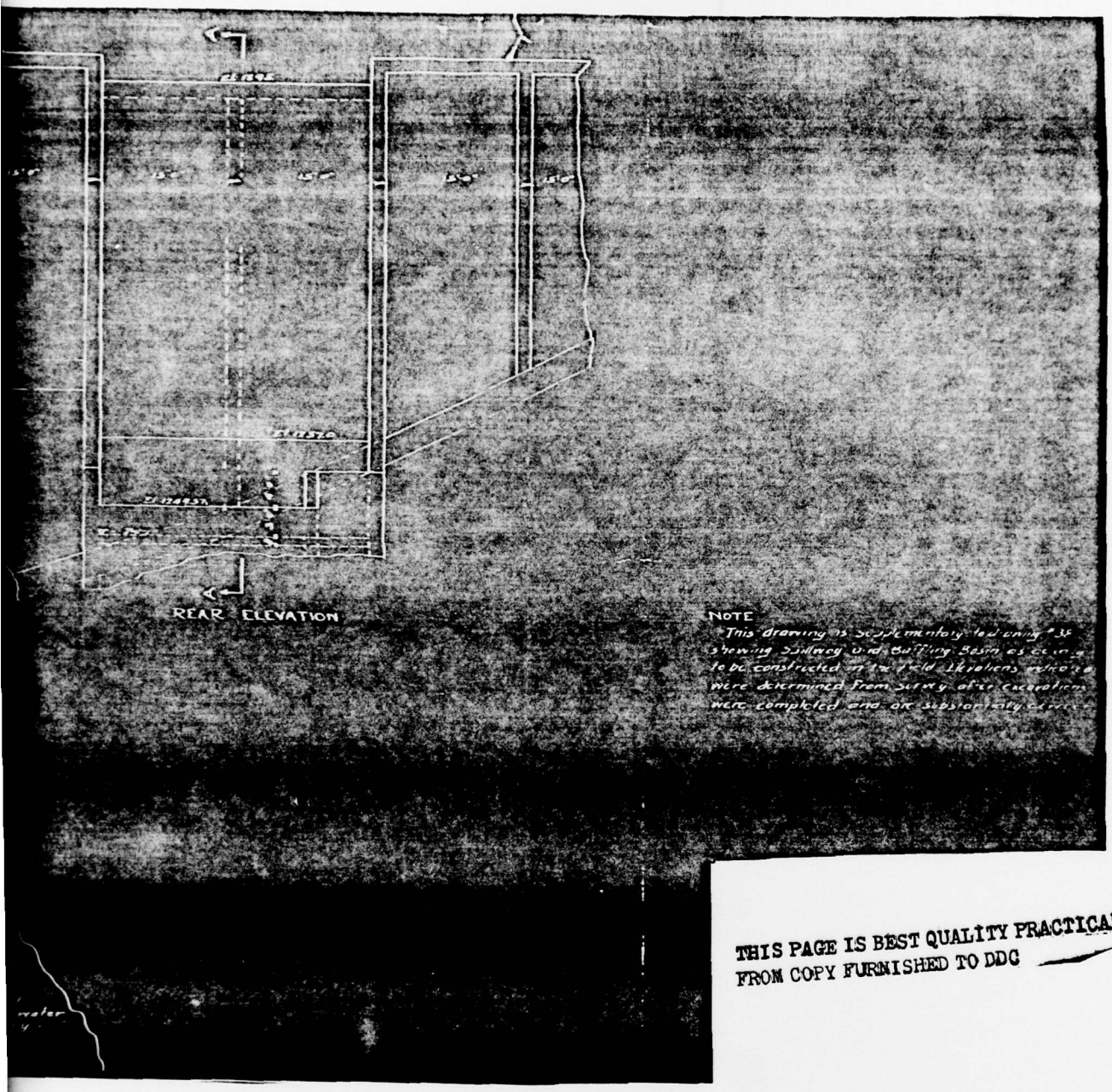
NAT. ID NO. PA.00607 CARBON COUNTY

DATA OBTAINED FROM WILLIAMS AND RICHARDSON, ENGINEERS & CONTRACTORS, SCRANTON, PA. JOB NO. 38, DWG. NO. 36

2

PLATE 2



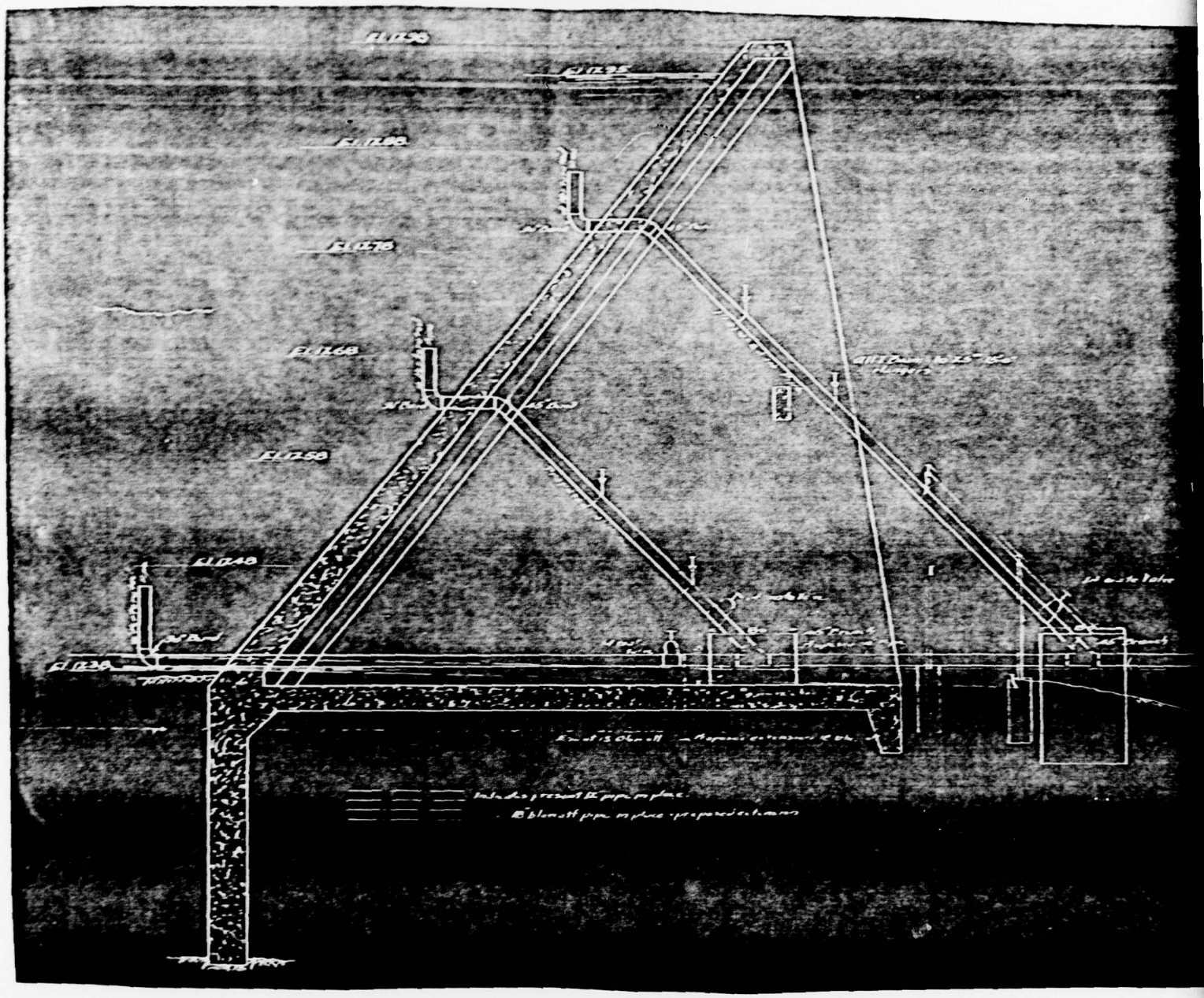


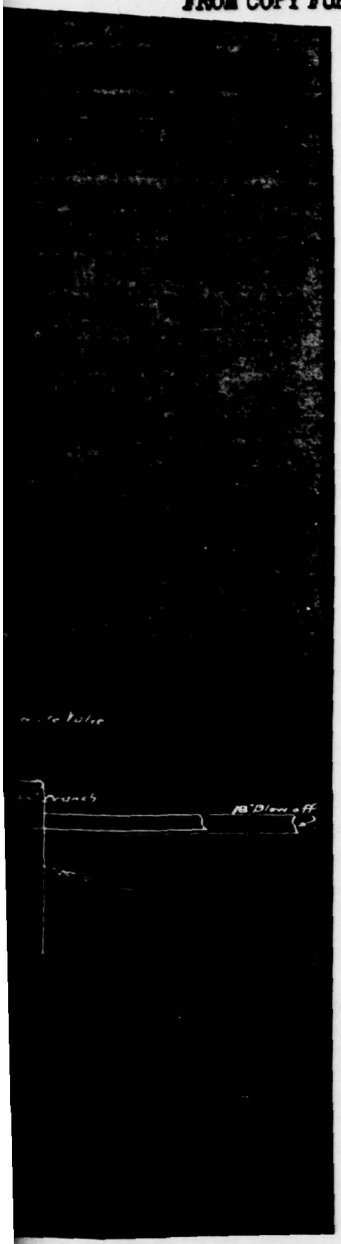
SPILLWAY CROSS SECTION
BEAR CREEK DAM

NAT. ID NO. PA.00607 CARBON COUNTY

DATA OBTAINED FROM WILLIAMS AND RICHARDSON, ENGINEERS & CONTRACTORS, SCRANTON, PA. JOB NO. 38, DWG. NO.44

PLATE 3



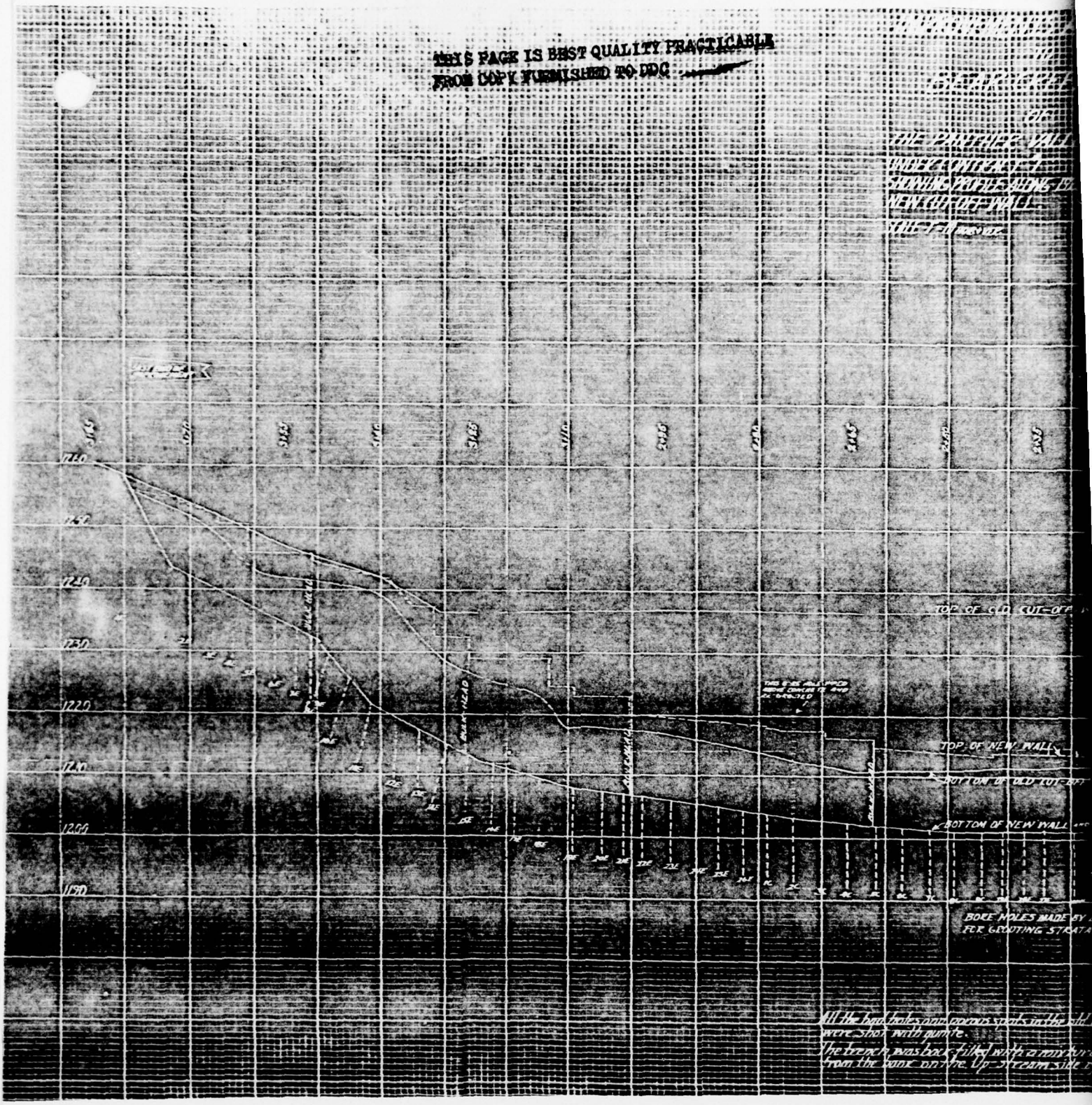


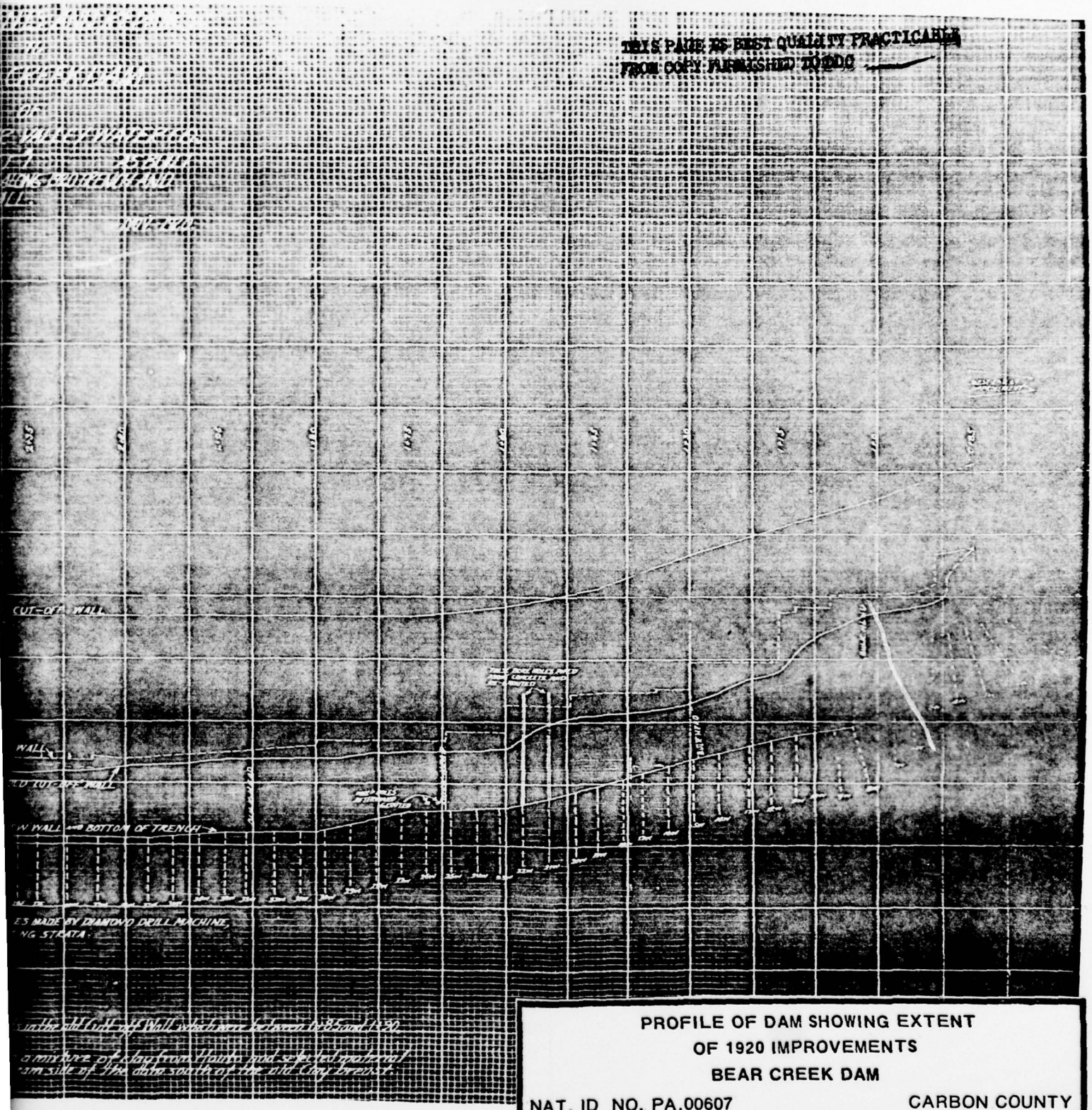
SECTION THROUGH INTAKE PIPES
BEAR CREEK DAM

NAT. ID NO. PA.00607 CARBON COUNTY

DATA OBTAINED FROM WILLIAMS AND RICHARDSON, ENGINEERS & CONTRACTORS, SCRANTON, PA., JOB NO. 38, DWG. NO.39

PLATE 4





PROFILE OF DAM SHOWING EXTENT OF 1920 IMPROVEMENTS

BEAR CREEK DAM

NAT. ID NO. PA.00607 CARBON COUNTY

DATA OBTAINED FROM IMPROVEMENTS AND REPAIRS TO BEAR CREEK DAM OF THE PANTHER VALLEY WATER COMPANY, DATED NOV., 1920

	2	PLATE 5

APPENDIX

F

SITE GEOLOGY
BEAR CREEK DAM

The Bear Creek Dam is located in the Appalachian Mountain section of the Valley and Ridge Physiographic Province. The bedorck at the dam site is reported to consist of the red and brown sandstones, siltstones and shales of the Mississippian age Mauch Chunk Formation (see Plate F-1). In the vicinity of the dam the Mauch Chunk Formation is bounded on the south-southeast by the conglomerates, sandstones, shales and coal of the Pennsylvanian age Pottsville and Llewellyn Formations, and to the north-northwest by the sandstones, siltstones, and shales of the Devonian Catskill Formation and the Mississippian Pocono Formation (Wood, 1974). At the dam site bedding is reported to be striking to the east-northeast, and dipping at 30° to 50° to the south-southeast. Two major thrust faults strike parallel to the axis of the reservoir but are not reported to pass beneath the dam structure (Wood, 1974). Three major sets of joints have been reported in the vicinity of the dam: one open set striking north-northeast and dipping steeply to the west, a second open set striking to the east and dipping steeply to the north, and a third closed set striking to the northeast and dipping to the northwest. There is no spacing information available for any of these joint sets (Wood, 1974).

Quaternary deposits in the site area are reported to be limited to the alluvial deposits along the stream valley (Leverett, 1957; Wood, 1974). These are assumed to have been removed prior to construction of the dam structure.

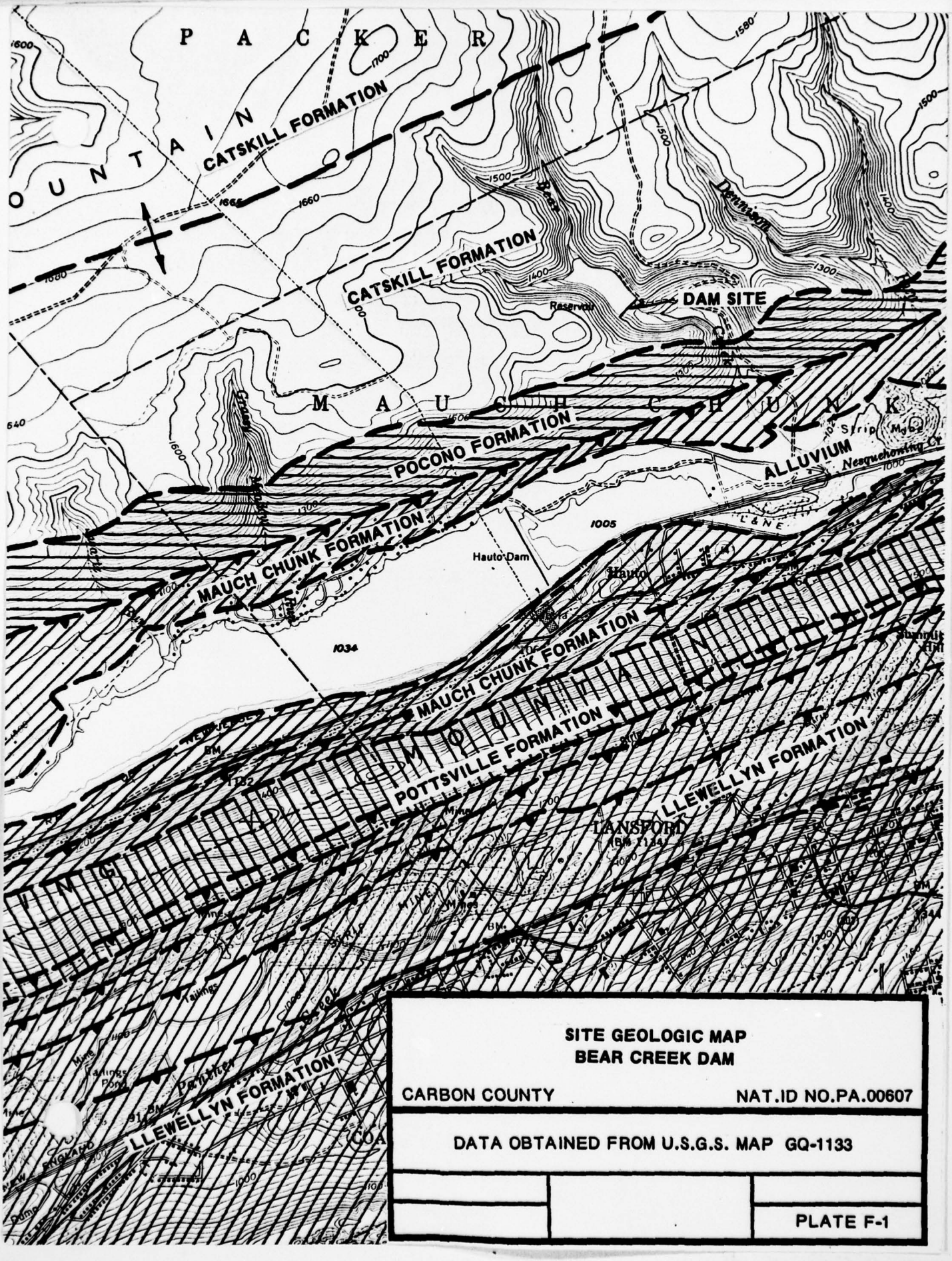
Downstream seepage should not be a major problem unless the major east-west trending joint set and joint sets related to faulting act as zones of groundwater transport beneath the dam structure, due to the dam being constructed perpendicular to these features.

There are several construction photographs (1914) which show the rock foundations and joint sets but their orientation was not evaluated for the potential of underseepage.

References:

1. *Leverett, F., 1957, Glacial Deposits outside the Wisconsin Terminal Moraine in Pennsylvania: Pa. Geol. Survey, 4th Series, Bull. G-7, 123 p.*

2. *Wood, G.H., 1974, Geologic Map of the Tamaqua Quadrangle, Carbon and Schuylkill Counties, Pennsylvania: USGS Map GQ-1133, 1:24,000.*



SITE GEOLOGIC MAP
BEAR CREEK DAM

CARBON COUNTY — NAT.ID NO.PA.00607

DATA OBTAINED FROM U.S.G.S. MAP GQ-1133

PLATE F-1