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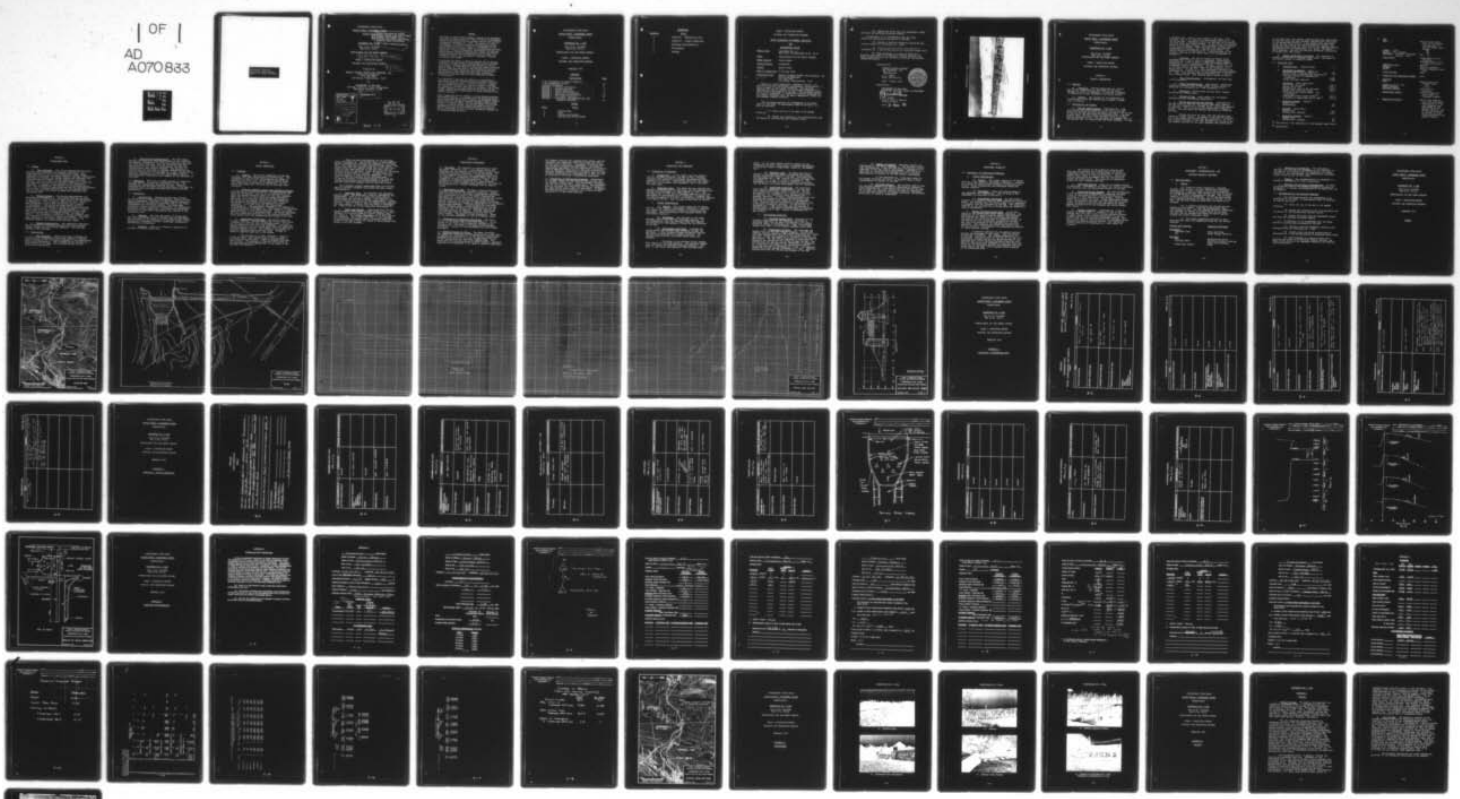

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SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

(6) National Dam Inspection Program. Carbondale Number 4 Dam (NDI ID Number PA-00384, DER ID Number 35-13), Susquehanna River Basin, Racket Brook, Lackawanna County, Pennsylvania. Phase I Inspection Report.

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

PENNSYLVANIA GAS AND WATER COMPANY

(15) DACW31-79-C-0015

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

(12) 83 p.

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

For

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

(11) FEBRUARY 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the 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 evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

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BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Carbondale No. 4 NDI ID No. PA-00384/DER ID No. 35-13
Owner:	Pennsylvania Gas and Water Company
State Located:	Pennsylvania
County Located:	Lackawanna
Stream:	Racket Brook
Date of Inspection:	25 October 1978
Inspection Team:	Gannett Fleming Corddry and Carpenter, Inc. Consulting Engineers P.O. Box 1963 Harrisburg, Pennsylvania 17105

[CONTD FROM PP. 1 & 2]

Based on visual inspection, available records, calculations and past operational performance, Carbondale No. 4 Dam is judged to be in good condition. The existing spillway can pass 59 percent of the Probable Maximum Flood (PMF) without overtopping of the dam. The spillway capacity is rated as inadequate. A stability analysis performed for this report indicates that the dam is apparently stable for the maximum loading condition.

The following measures are recommended to be undertaken by the Owner, in approximate order of priority, as soon as practical:

(1) Raise the top of the dam to the design elevation.

(2) Repair the concrete in the stilling basin and the mortar in the spillway weir masonry joints.

(3) Remove the brush from the embankment slopes and from the spillway discharge channel.

In addition, it is recommended that the Owner modify his operational procedures as follows:

(1) Develop a detailed emergency operation and warning system for Carbondale No. 4 Dam.

(2) Provide round-the-clock surveillance of Carbondale No. 4 Dam during periods of unusually heavy rains.

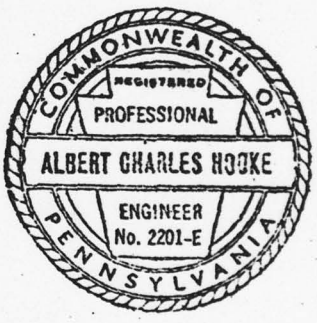
(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.

A. C. HOOKE
Head, Dam Section

Date: 9 March 1979



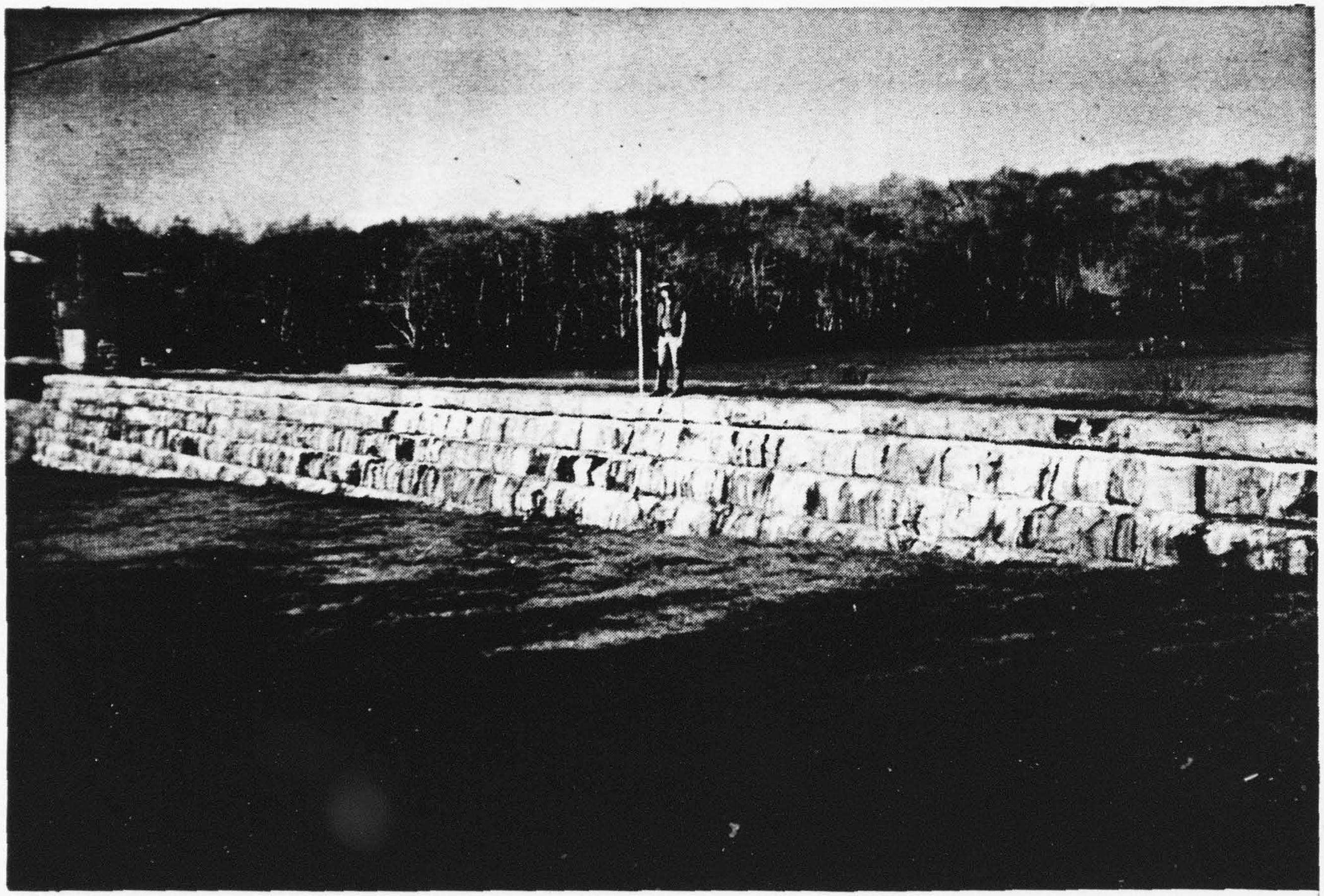
Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS

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

DATE: 21 Mar 79

CARBONDALE NO. 4 DAM



Overview

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13
PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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. Carbondale No. 4 Dam is a masonry dam with earthfill to the top of the dam along the upstream face and earthfill to within 3 to 10 feet of the top of the dam along the downstream face. The dam extends about 580 feet across the valley and is 28 feet high at maximum section, The spillway, an integral part of the masonry dam, is located near the right abutment. It has →

[CONT'D ON P. A-13]

a rounded crest, and the crest length is 100 feet. The spillway crest is 4.0 feet below the design elevation of the top of the dam. Immediately below the spillway is a concrete stilling basin with baffle blocks. At the end of the stilling basin is a riprapped channel, which extends a short distance to the natural stream. There are dams both upstream and downstream of Carbondale No. 4 Dam as noted below. The various features of Carbondale No. 4 Dam are shown on the Plates at the end of the report and on the Photographs in Appendix D.

b. Location. The dam is located on Racket Brook approximately 2.0 miles east of Carbondale, Pennsylvania. Carbondale No. 4 Dam is shown on USGS Quadrangle, Waymart, Pennsylvania, with coordinates N41°34'30" - W75°27'35", in Lackawanna County, Pennsylvania. The Wayne County Line is at the east end of the dam. Most of the reservoir is in Wayne County. The dam is 0.7 mile upstream of Brownell Dam. Carbondale No. 4 Dam is also 0.6 mile downstream of Carbondale No. 7 Dam. Both Brownell Dam and Carbondale No. 7 Dam are are on Racket Brook. The location map is shown on Plate 1.

c. Size Classification. Intermediate (28 feet high, 1,071 acre-feet).

d. Hazard Classification. High hazard. Downstream conditions indicate that a high hazard classification is warranted for Carbondale No. 4 Dam (Paragraph 5.1c.).

e. Ownership. Pennsylvania Gas and Water Company, Wilkes-Barre, Pennsylvania.

f. Purpose of Dam. Water supply for Carbondale, Pennsylvania and surrounding communities.

g. Design and Construction History. Carbondale No. 4 Dam was built in 1892 for the Crystal Lake Water Company. The dam was designed by E. Sherman Gould, consulting engineer of Scranton. The construction was supervised by George A. Wright. The contractor was Babcock and Kelley of Unadilla, New York.

During the flood of June, 1942 the dam was overtopped by a small amount. No damage to the dam was reported but a road immediately downstream was washed out. In 1945, the original spillway at the left abutment was filled in and the present spillway at the right abutment was constructed.

At the same time, the present stilling basin was constructed, the outlet works pipe was extended, modifications were made to the downstream earthfill, a dry masonry wall was added along the left side of the spillway approach channel, and riprap was added along the right side of the approach channel. The modification was designed by H.A. Vicker, the Owner's Chief Engineer, and built by Harrison and Byron, Contractors of Jersey City, New Jersey.

h. Normal Operational Procedure. The reservoir is normally maintained at spillway crest level. The valve on the outlet conduit is normally closed.

1.3 Pertinent Data.

a. Drainage Area. (square miles)	1.7
b. Discharge at Damsite. (cfs.)	
Maximum known flood at damsite(1)	700
Outlet works at maximum pool elevation(2)	70
Spillway capacity at maximum pool elevation	2,400
Design spillway capacity	2,930
c. Elevation. (Feet above msl.)	
Top of dam (low area)	1745.2
Design top of dam	1745.7
Maximum pool (top of dam low area)	1745.2
Normal pool (spillway crest)	1741.7
Upstream invert outlet works - not available	--
Downstream invert outlet works(2)	1717.0
Streambed at downstream toe of dam(2)	1716.0
d. Reservoir Length. (Miles.)	
Normal pool	.44
Maximum pool	.45
e. Storage. (Acre-feet.)	
Normal pool	810
Maximum pool (design)	1,071
f. Reservoir Surface. (Acres.)	
Normal pool	62
Maximum pool (design)	68

(1) See Section 5 for discussion of the maximum known flood.

(2) Approximate.

g.	Dam.	
	Type -	Masonry with earthfill to full height upstream and to partial height downstream.
	Length - Feet.	480
	Height - Feet (design).	28
	Top width - Earthfill (minimum) - Feet	12
	Masonry - Feet	3
	Side slopes -	Downstream 3V on 1H (Masonry) Upstream-Varies 1V on 2.25H to 1V on 5H.
	Impervious core -	Masonry
	Zoning -	None in earthfill.
	Cutoff -	Masonry founded on bedrock.
	Grout curtain -	None.
h.	Diversion and Regulating Tunnel.	None.
i.	Spillway.	
	Type -	Masonry weir with rounded crest.
	Length of weir - Feet	100
	Crest elevation	1741.7
	Upstream channel -	Mild slope to reservoir.
	Downstream channel -	Stilling basin and short reach of riprapped channel.
j.	Regulating Outlets -	One 24-inch diameter cast iron pipe which transitions to a 36-inch diameter pipe downstream of the masonry section. Two 24-inch gate valves, in series, are provided upstream of the masonry section.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. Very little engineering data were available for review for the original structures. In a study performed in 1914 by the Pennsylvania Water Supply Commission, an account of design concepts, geology, construction materials and methods, and design features was prepared from interviews with the Owner, visual inspection, and other sources. The 1914 study also included analyses for hydrology and hydraulics as well as an analysis of the structural stability. A summary of the results of the analyses are on file. The construction specifications for the 1945 modification are on file. A design analysis for the 1945 modification that is available for review includes both hydraulic and structural data.

b. Design Features. The dam and appurtenances are described in Paragraph 1.2a. The design features are shown on the Plates at the end of the report and on the Photographs in Appendix D. Plate 2 shows a plan of the dam. Plate 3 and Photographs A and B show the profile and a section of the masonry. This plate was drawn before the 1945 modifications to the dam and it shows the original spillway at the left abutment. Plate 4 and Photographs C, D, and E show a profile of the existing spillway and outlet works. The outlet works pipe is extended further, as shown on Plate 2. The extension is noted as a 30-inch diameter pipe; the extension is actually 36-inches in diameter. The other pipe, parallel to the outlet works pipe on Plate 2, apparently connects to a drain from the valve house.

c. Design Considerations. The information available for review did not raise any concerns about the original design, except for the spillway capacity. This has subsequently been modified.

2.2 Construction.

a. Data Available. Construction data available for review for the original structures was limited to information contained in the 1914 report prepared by the Pennsylvania Water Supply Commission. That information was obtained by interviews with the Owner, and it gives details of the construction operations.

b. Construction Considerations. The 1914 report praises the quality of construction used in the structure. For example, information is cited that indicates that only the best cement was used, that the contractor was very experienced in this type of construction, and that the specifications were rigidly enforced. The accounts of construction are such that it appears reasonable care was used in construction of Carbondale No. 4 Dam. Review of the available information for the 1945 improvements did not yield pertinent information with respect to the character of that work.

2.3 Operation. There are no formal records of operation. As noted herein, the dam was overtopped in 1942. The spillway was subsequently modified in 1945. Based on information from the Owner and the caretaker of the dam, all structures have performed satisfactorily since the 1945 modification.

2.4 Evaluation.

a. Availability. Engineering data was provided by the Division of Dams and Encroachments, Bureau of Water Quality Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER), and by the Owner, Pennsylvania Gas and Water Company. The Owner made available a senior construction supervisor for information during the visual inspection. The Owner also researched his files for additional information upon request of the inspection team.

b. Adequacy. The type and amount of design data and other engineering data is limited, and the assessment must be based on the combination of available data, visual inspection, performance history, hydrologic assumptions, and hydraulic assumptions.

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

SECTION 3

VISUAL INSPECTION

3.1 Findings

a. General. The overall appearance of the dam was good, with some deficiencies as noted herein. The locations of some of these deficiencies are shown in Appendix B on Plate B-1. Survey data acquired during this inspection is presented in Appendix B. On the day of the inspection, the pool was at spillway crest elevation.

b. Composite Masonry Gravity and Earthfill Section. This section is in good condition. No deficiencies were noted on the masonry. The top of the section is at or above the design elevation except at the right abutment, where the top is 0.5 foot below the design elevation. This area is an abandoned railroad bed (Photograph E). The mortar in the masonry joints is in good condition. The earthfill downstream of the masonry is in good condition. It is very flat and well maintained (Photograph B). The embankment upstream of the masonry is in good condition (Photograph A). The riprap on the upstream slope appeared to be in good condition. There is a minor amount of brush on the upstream slope. The survey performed for this inspection revealed that the upstream earthfill slope varies, with the steepest section being 1V on 2.25H.

c. Appurtenant Structures. The outlet works is in good condition. Two men opened the 24-inch valve about 5 percent in 5 minutes with no problems noted. On the day of inspection, the inlet was submerged. The pipe discharges directly into the stream about 200 feet downstream from the masonry section. The stream at the outfall is slightly overgrown with brush and trees. Seepage of about 0.5 gpm was observed in the stream.

The spillway is in fair condition. There is a flow of about 1 gpm seeping from a joint located a few inches below the crest. There is seepage from many other joints. The seepage is from both the joints in the spillway and those immediately to the right of the spillway (Photograph C).

There are many deficiencies in the stilling basin (Photograph D). One baffle block is badly spalled. Pattern cracking and leaching were observed at the right wall. The right wall is badly spalled in many areas. The reinforcing bars are exposed along the top of this wall. There is also some spalling at the left wall near its junction with the spillway. About 80 percent of the bottom of the stilling basin is scoured. In some areas, the concrete appears to have scoured completely. A total flow of 2 gpm was observed in the stilling basin. It was not possible to determine whether this flow was seeping from beneath the stilling basin or whether it was the accumulated seepage from the spillway joints.

The riprapped channel downstream from the stilling basin is heavily overgrown with brush and small trees (Photograph D).

d. Reservoir Area. The reservoir has generally gentle slopes. The watershed is mostly uninhabited and undeveloped. Some of it is owned and controlled by Pennsylvania Gas and Water Company. The remainder is mostly owned and controlled by the Commonwealth. Carbondale No. 7 Dam upstream is used by Farview State Hospital for water supply. A brief visit was made to Carbondale No. 7 Dam on the day of the inspection (Photograph F).

e. Downstream Channel. Downstream from the riprapped channel, the natural channel proceeds for a short distance to a 60-inch diameter culvert passing under U.S. Route 6. The roadway embankment is 10 feet high at this crossing. The stream flows for 0.7 mile through an uninhabited and wooded reach to Brownell Reservoir. Access to the dam is from U.S. Route 6, which passes very close to the left abutment.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. The reservoir is maintained at spillway crest, Elevation 1741.7, with excess inflow discharging over the spillway and into Racket Brook, which flows into Brownell Reservoir 0.7 mile downstream. A 24-inch diameter cast-iron pipe discharges water from the reservoir. Streamflows in Racket Brook can be increased by releases from Carbondale No. 4 Dam. Since streamflow is usually augmented only when Brownell Reservoir is below spillway crest elevation, the valve on the Carbondale No. 4 water discharge line is usually closed.

4.2 Maintenance of Dam. The dam is visited daily by a caretaker who records the reservoir elevation. Weekly reports are mailed to the Owner's Engineering Department. This information is used by the Owner's Engineering Department for regulating flows in the distribution system. The caretaker is also responsible for observing the general condition of the dam and appurtenant structures and for reporting any changes or deficiencies to the Owner's Engineering Department. A Pennsylvania Gas and Water Company engineer makes a formal inspection of the dam each year, and the records are filed and used for determining priority of repairs. Informal inspections are also made when the engineer is on the site for other reasons. The grass is mowed frequently. Brush on the upstream embankment is cut on a regular basis.

4.3 Maintenance of Operating Facilities. The valve on the outlet works pipe is operated annually. In response to the Phase I Dam Inspection Program of the previous year, the Owner is revising his maintenance procedures. Details of the procedures are still being developed.

4.4 Warning Systems in Effect. The Owner furnished the inspection team with a verbal description of the chain of command for Carbondale No. 4 Dam and of a generalized emergency notification list that is applicable for all of the Pennsylvania Gas and Water Company dams. The Owner said that during periods of heavy rainfall, available personnel are dispatched to the dams to observe conditions.

All company vehicles are equipped with radios, and the personnel can communicate with each other and with a central control facility. Evaluation of risk is made by the Owner's Engineering Department. The Owner's Engineering Department is also responsible for notification of emergency conditions to the local authorities. Detailed emergency operational procedures have not been formally established for Carbondale No. 4 Dam, but are as directed by the Owner's Engineering Department.

4.5 Evaluation of Operational Adequacy. Maintenance of the dam, except for the brush in the spillway outlet channel, appears good. The maintenance procedures for the outlet works valve appear good. The procedures used by the Owner for inspecting the dam are adequate, but some needed repairs have not been made. In general, the warning system is adequate, but it would be more effective if it were more detailed.

SECTION 5

HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. In the report upon the application of the Owner to modify the dam in 1945, the Pennsylvania Power Commission estimated the design spillway capacity at 2,930 cfs. Computations made for this report show that this estimate was reasonable, and it was used for this report.

b. Experience Data. The Owner has not reported any hydraulic problems with the dam since the 1945 modifications. The dam was overtopped by a small amount in 1942. The spillway prior to 1945 had a discharge capacity of 200 cfs. The height of overtopping was not reported. Assuming that the dam overtopped by 0.5 foot, the resultant outflow computes to be about 700 cfs. This is used as the flood of record.

c. Visual Observations.

(1) General. The visual inspection of Carbondale No. 4 Dam, which is described in Section 3, resulted in a number of observations relevant to hydraulics and hydrology. These observations are evaluated herein for the various features.

(2) Embankment. The low area at the right abutment reduces the spillway discharge capacity. In all probability, when the railroad track was removed, the railroad fill was graded to below the top elevation of the dam.

(3) Appurtenant Structures. Although the outlet works pipe extends under pressure through the earthfill, it also extends through the masonry section. The valve is upstream of the masonry section. The closure facilities for the outlet works pipes are adequate.

The brush in the spillway outlet channel will reduce its carrying capacity. The backwater effect will not reduce the spillway discharge capacity. However, it may cause overtopping of the stilling basin

walls. If the walls should overtop, erosion of the downstream earthfill would occur. Although undesirable, it would not create a significant hazard to the embankment.

(4) Reservoir Area. No conditions were observed in the reservoir area or watershed that might present significant hazard to the dam. Pertinent data for Carbondale No. 7 Dam, located 0.6 mile upstream from Carbondale No. 4 Dam, is listed in Appendix C. The assessment of the dam is based on existing conditions, and the effects of future development are not considered.

(5) Downstream Conditions. No conditions were observed immediately downstream of the dam that would create significant hazard to the dam. If the dam should fail, a hazard to U.S. Route 6 would exist. In addition, the floodflows would discharge into Brownell Reservoir. A Phase I Inspection Report for the National Dam Inspection Program has previously been prepared for Brownell Dam, which is of intermediate size. Brownell Dam was classified as high hazard, with a seriously inadequate spillway. As the failure of Carbondale No. 4 Dam could cause the overtopping of Brownell Dam, a high hazard classification is warranted for Carbondale No. 4 Dam. Access to Carbondale No. 4 Dam is good.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE) for the size (Intermediate) and hazard potential (High) of Carbondale No. 4 Dam, the spillway design flood (SDF) is the probable maximum flood (PMF).

(2) Description of Model. The watershed was modeled with the HEC-1DB computer program. The HEC-1DB computer program computes a PMF runoff hydrograph and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. The PMF inflow component to Carbondale No. 7 Reservoir was determined and routed through the dam. The outflow from the dam was routed, downstream to Carbondale No. 4 Reservoir and added to the uncontrolled runoff occurring upstream of Carbondale No. 4 Dam. The combined runoff was routed through Carbondale No. 4 Dam. Identical methods were used for various percentages of the PMF.

(3) Summary of Results. Pertinent results are tabularized at the end of Appendix C. The analysis reveals that Carbondale No. 7 Dam can pass about 66 percent of its component of the PMF without overtopping. Carbondale No. 4 Dam, with its existing top elevation of 1745.2 can pass approximately 59 percent of the PMF without overtopping.

If the Carbondale No. 4 Dam were raised to its design elevation of 1745.7, it would be able to pass approximately 72 percent of the PMF.

(4) Spillway Adequacy. The criteria used to rate the spillway adequacy of a dam are described in Appendix C. Since Carbondale No. 4 Dam cannot pass the PMF but can pass the 1/2 PMF, the spillway capacity is rated as inadequate. If the dam were raised to its design elevation, the spillway would still be rated as inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Carbondale No. 4 Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for various features.

(2) Embankment. Trees and brush growing on the embankment are undesirable. The low area of the embankment is evaluated in Section 5.

(3) Appurtenant Structures. No deficiencies relevant to structural stability were observed at the outlet works. The seepage near the outlet works is not excessive. It probably does not originate at the dam. The conditions observed at the spillway and stilling basin are caused by a lack of maintenance.

b. Design and Construction Data. In the 1914 report by the Pennsylvania Water Supply Commission, the stability of the masonry gravity section was analyzed. The analysis was based on the following assumptions: the pool at the top of the dam, no tailwater, uplift of two-thirds the full hydrostatic pressure at the heel, and that soil pressure on the upstream face could be neglected. The resultant was within the middle third for all sections, with adequate toe pressures and factors of safety against sliding.

A stability analysis for the masonry gravity section was performed in this study. Only the bottom section was considered. The loading assumptions are as follows: reservoir level at the top of the dam, full hydrostatic pressure and at-rest earth pressure on the upstream face, uplift varying uniformly from full tailwater at the toe to full tailwater at the heel plus two-thirds of the difference between the headwater and tailwater also at the heel, and no passive earth pressure on the downstream face.

The results of the stability analysis show that the toe pressure and sliding factor are within acceptable limits and that the resultant is within the middle third, about 9.9 feet from the toe. OCE guideline on overturning recommends that the resultant be within the middle third. The structure is apparently stable for this loading condition.

c. Operating Records. There are no formal records of operation. According to the Owner, no stability problems have occurred over the operational history of the dam.

d. Postconstruction Changes. The 1945 modification to the spillway was accomplished by removing the upper 6 feet of the masonry gravity section and then constructing a 2-foot high cap on the section. The net reduction in height is 4 feet. Using simplifying assumptions, calculations indicate that the resultant is still within the middle third and both the factor of safety against sliding and the toe pressure are within acceptable limits.

e. Seismic Stability. Carbondale No. 4 Dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone has adequate factors of safety under static loading conditions, it can be assumed safe for any expected earthquake loading. However, since there is the possibility of earthquake forces cracking the masonry gravity section, the theoretical seismic stability of Carbondale No. 4 Dam cannot be assessed.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES.

7.1 Dam Assessment.

a. Safety.

(1) Based on visual inspection, available records, calculations, and past operational performance, Carbondale No. 4 Dam is judged to be in good condition. With existing conditions, the spillway can pass 59 percent of the PMF without overtopping of the dam. The spillway capacity is rated as inadequate. If the Dam were raised to its design elevation, it could pass 72 percent of the PMF. The spillway capacity would still be rated as inadequate.

(2) A stability analysis for the dam was performed for this report. This was accomplished using some assumed values. For the loading condition considered, the resultant is within the middle third of the base and both the toe pressure and factor of safety against sliding are within acceptable limits.

(3) The visual inspection resulted in some deficiencies, which are summarized below for the various features.

Feature and Location	Observed Deficiency
Embankment:	
Upstream slope	Trees and brush
Top	Below design elevation
Spillway:	
Weir	Deteriorated mortar
Stilling Basin	Spalling, pattern cracking, scour, and leaching.
Downstream channel	Brush

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of visual inspection, past performance, and computations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented as soon as practical.

d. Necessity for Further Investigations. In order to accomplish some of the remedial measures outlined in Paragraph 7.2, further investigations by the Owner will not be required.

7.2 Recommendations and Remedial Measures.

a. The following measures are recommended to be undertaken by the Owner, in approximate order of priority, as soon as practical:

(1) Raise the top of the dam to the design elevation.

(2) Repair the concrete in the stilling basin and the mortar in the spillway weir masonry joints.

(3) Remove the brush from the embankment slopes and from the spillway discharge channel.

b. In addition, it is recommended that the Owner modify his operational procedures as follows:

(1) Develop a detailed emergency operation and warning system for Carbondale No. 4 Dam.

(2) Provide round-the-clock surveillance of Carbondale No. 4 Dam during periods of unusually heavy rains.

(3) When warnings of a storm of major proportions are given by the National Weather Service, the Owner should activate his emergency operation and warning system procedures.

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

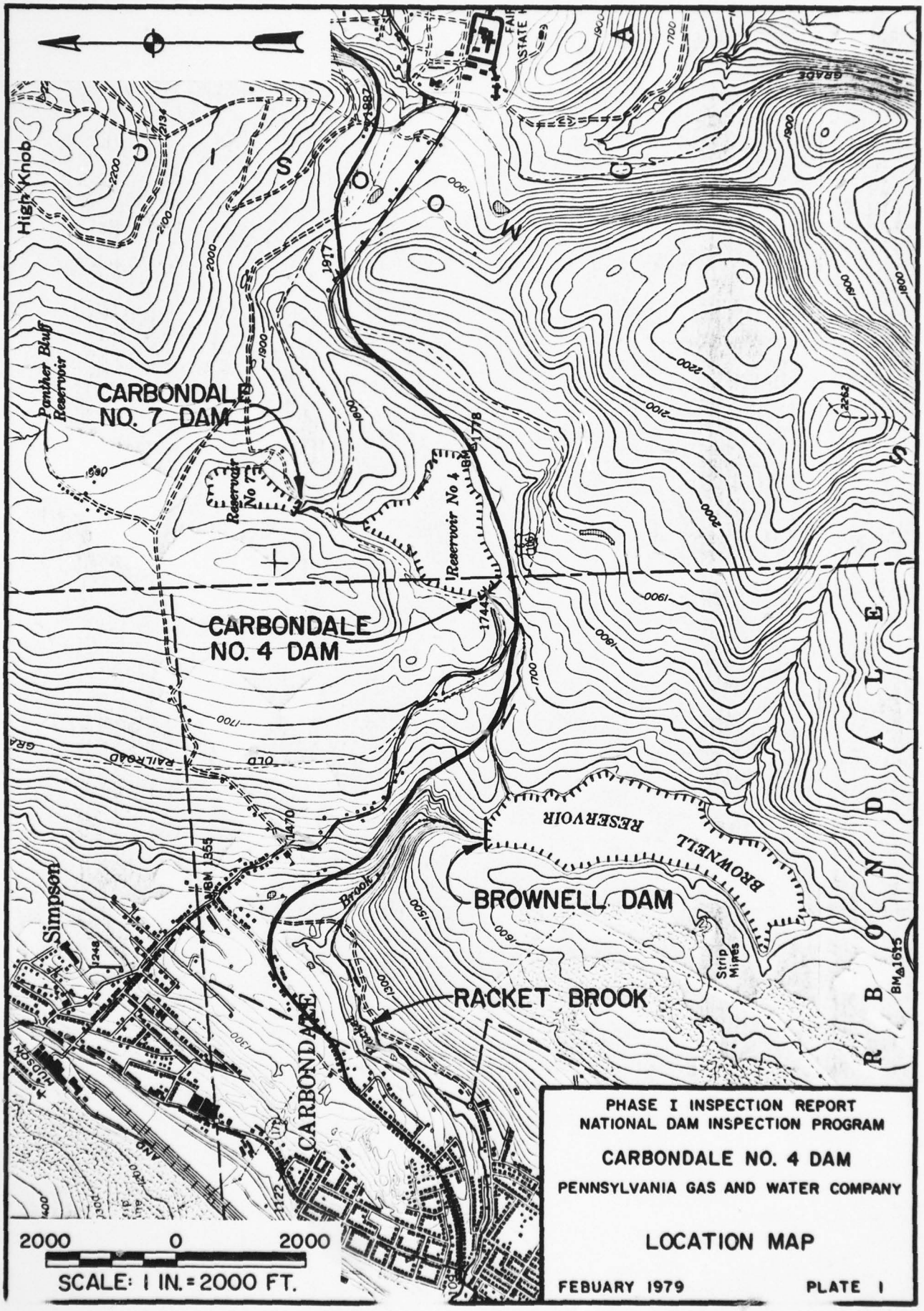
PENNSYLVANIA GAS AND WATER COMPANY

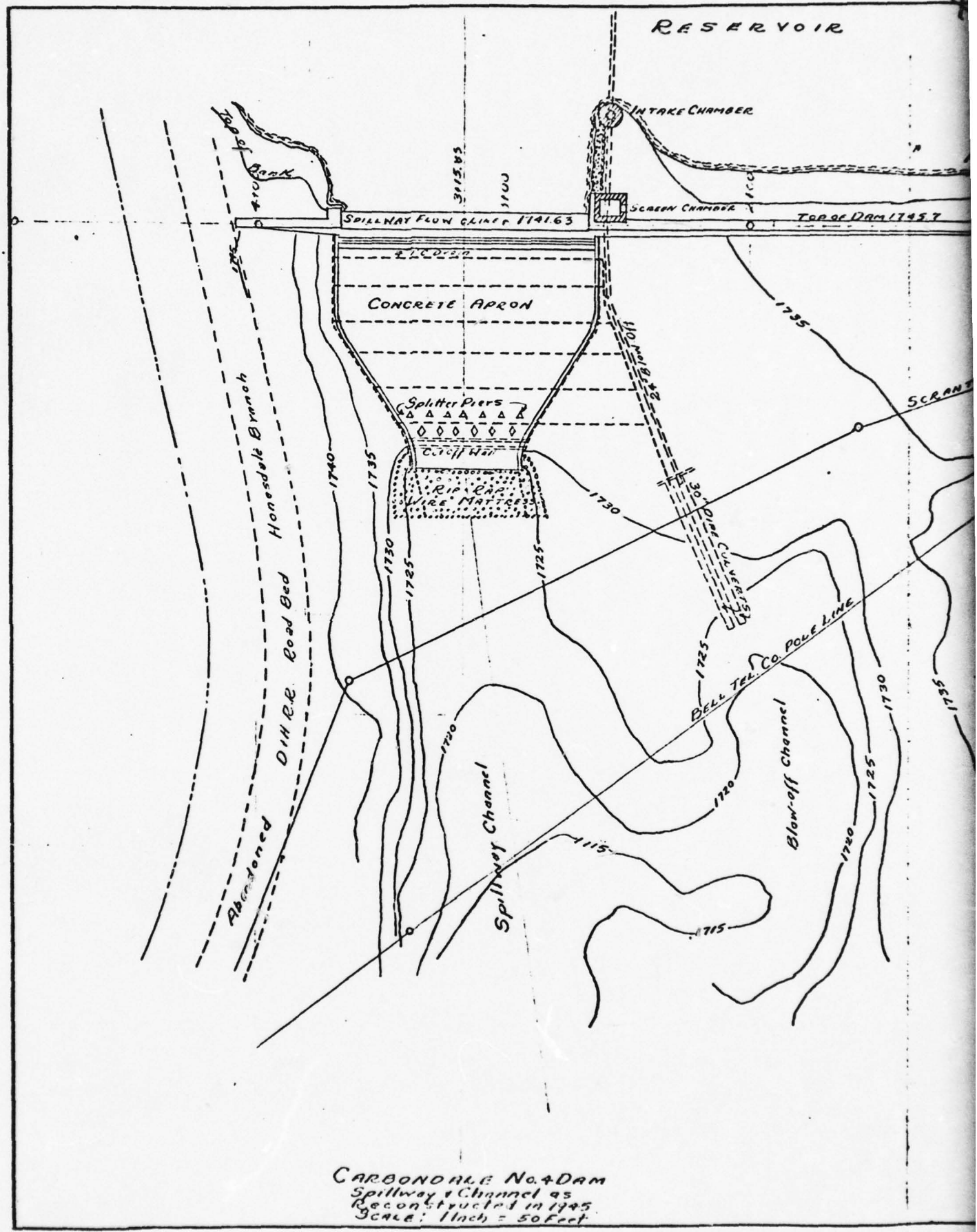
PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

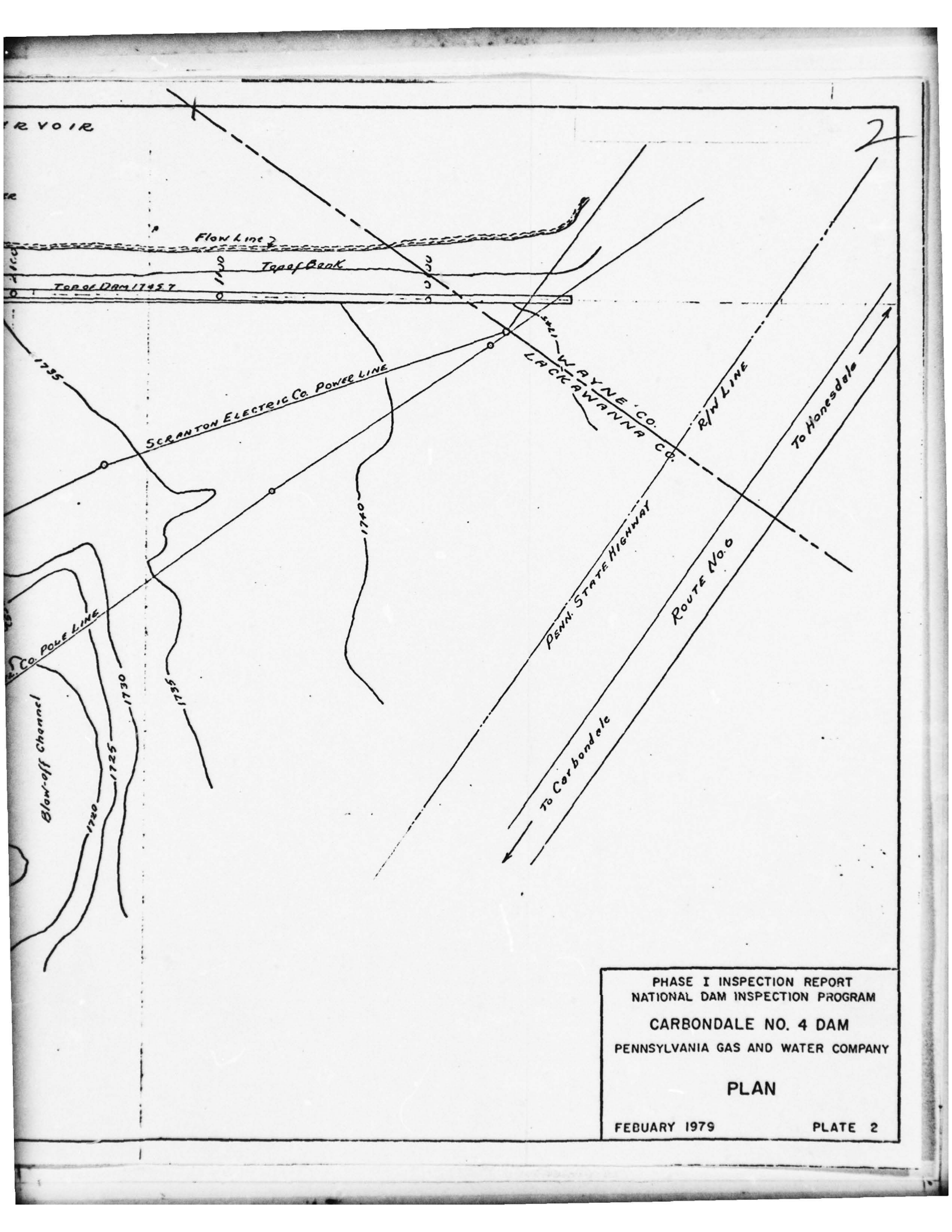
FEBRUARY 1979

PLATES


CARBONDALE NO. 7 DAM
CARBONDALE NO. 4 DAM
BROWNELL DAM
RACKET BROOK
Panther Bluff Reservoir
Reservoir No 7
Reservoir No 4
BROWNELL RESERVOIR
High Knob
Simpson
CARBONDALE
Strip Mines
2000 0 2000
SCALE: 1 IN. = 2000 FT.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
CARBONDALE NO. 4 DAM
PENNSYLVANIA GAS AND WATER COMPANY
LOCATION MAP
FEBUARY 1979
PLATE 1



CARBONDALE No. 4 DAM
Spillway & Channel as
Reconstructed in 1945
SCALE: 1 Inch = 50 Feet



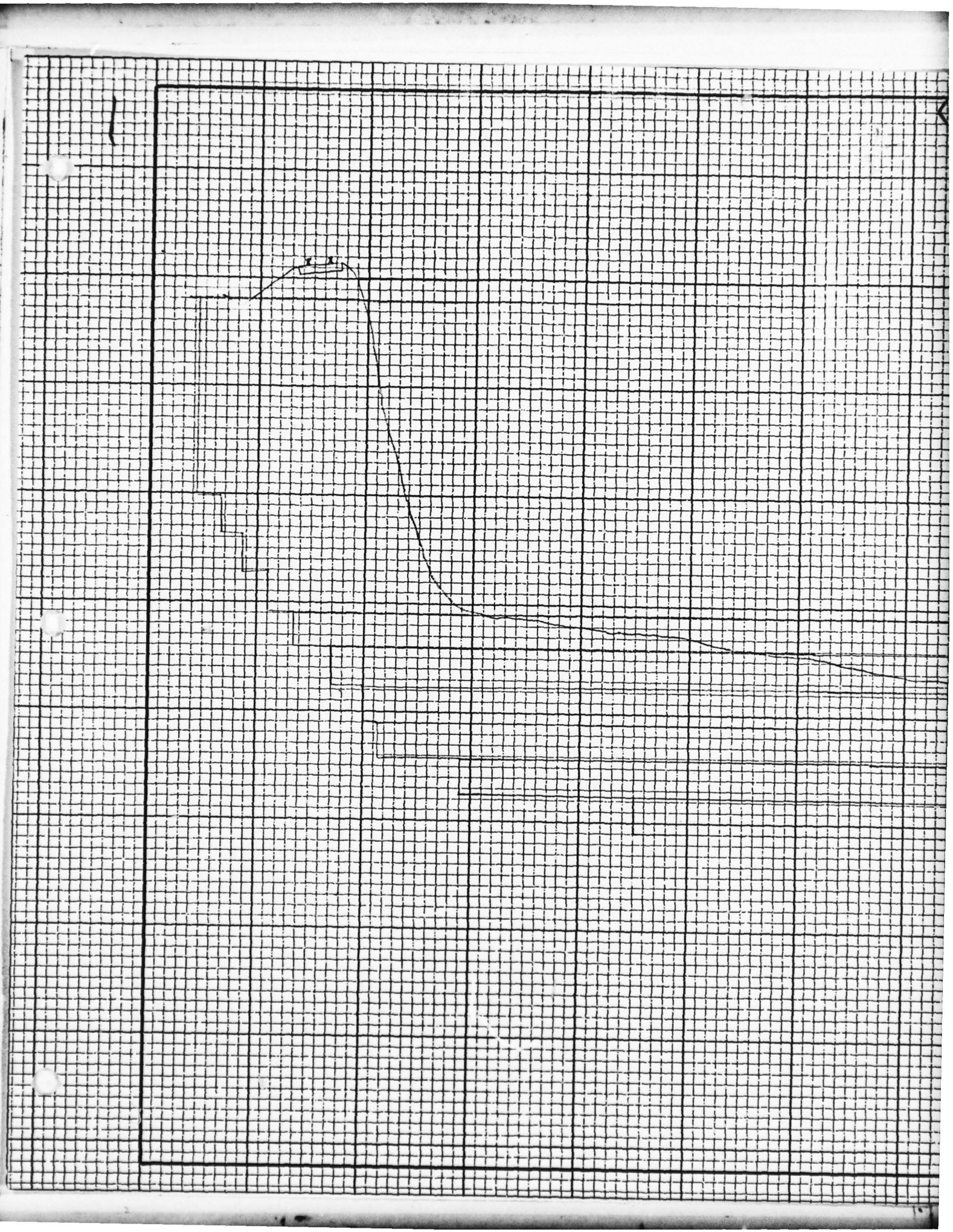
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

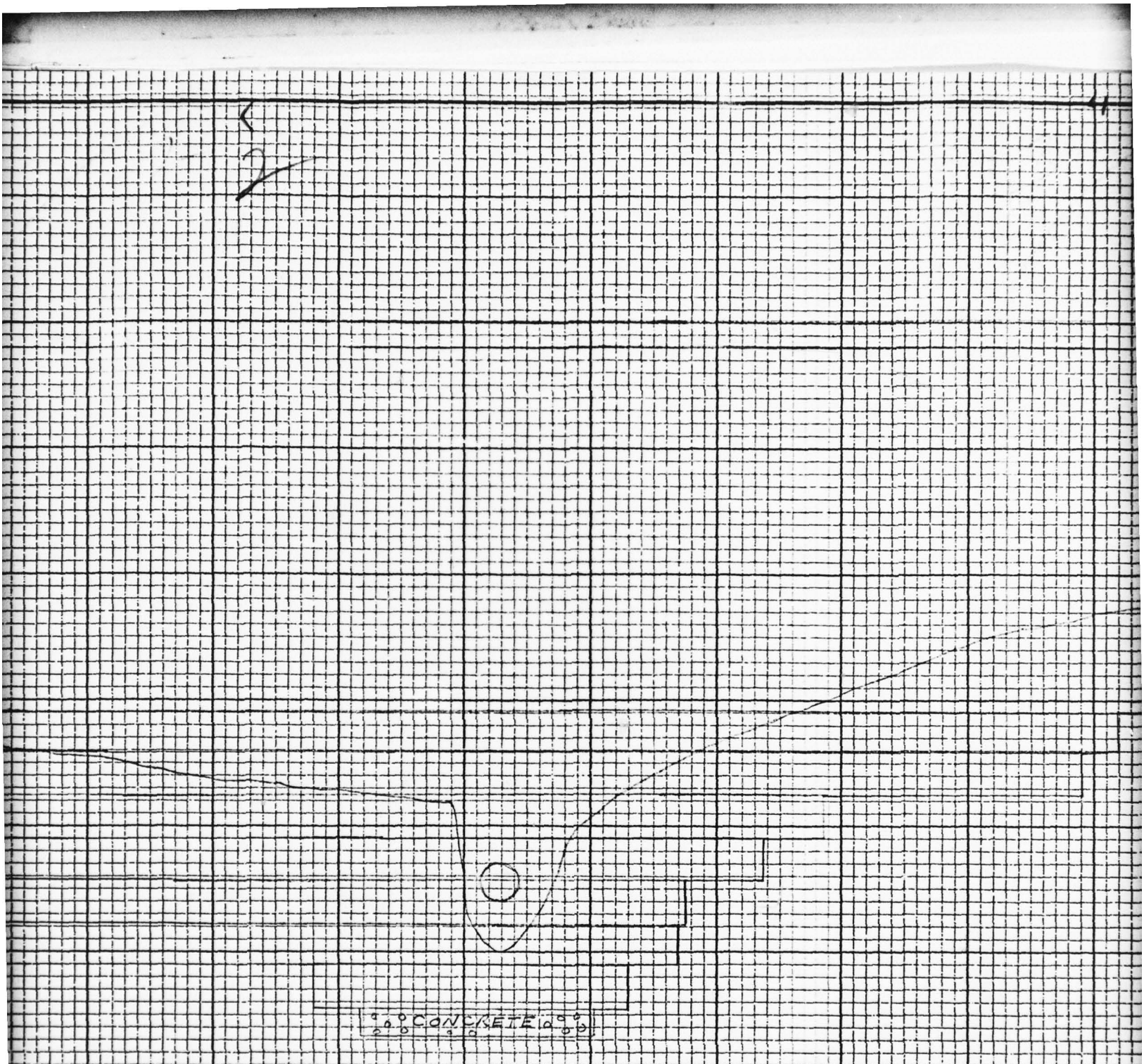
CARBONDALE NO. 4 DAM

PENNSYLVANIA GAS AND WATER COMPANY

PLAN

FEBUARY 1979 PLATE 2





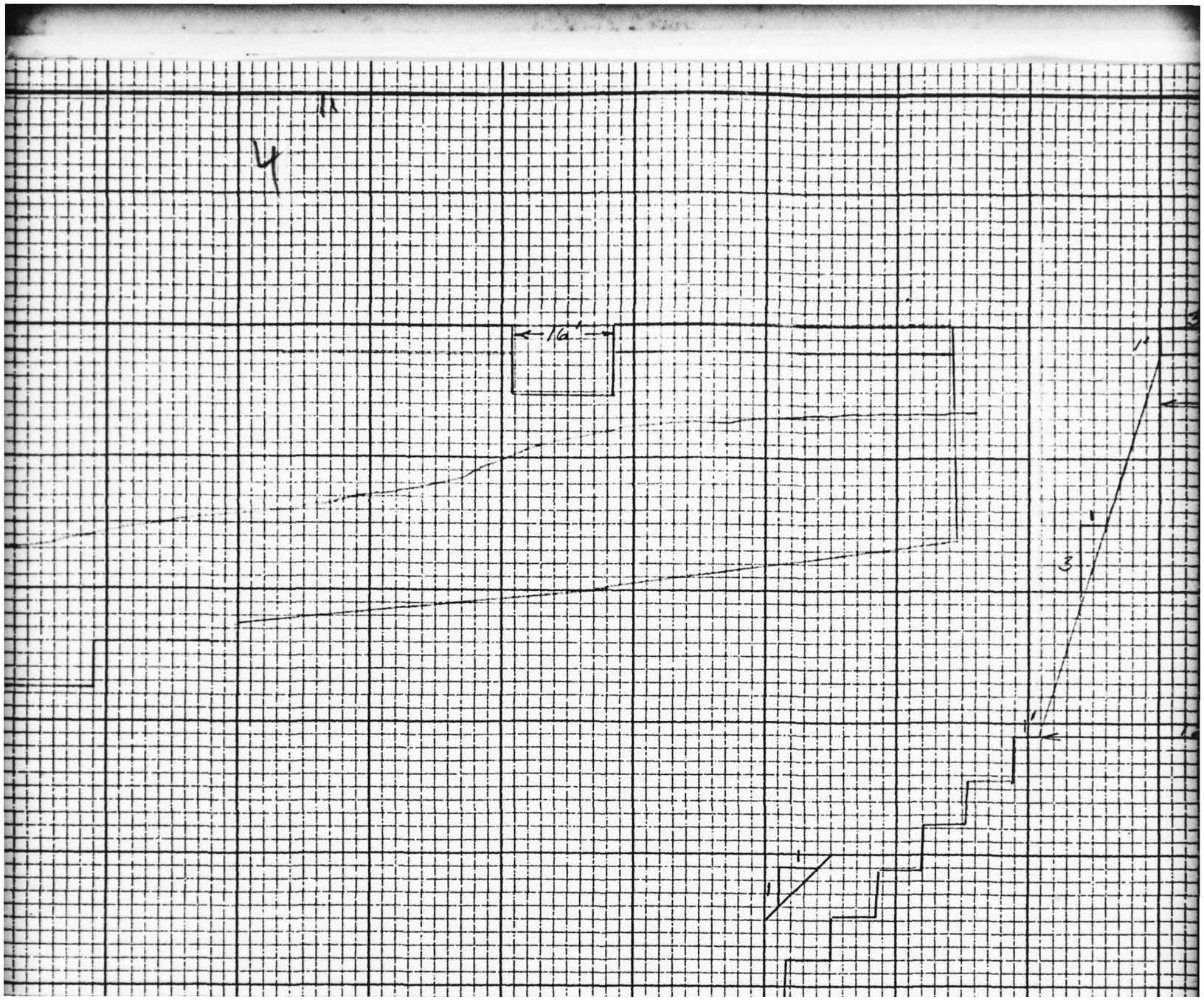
PROFILE

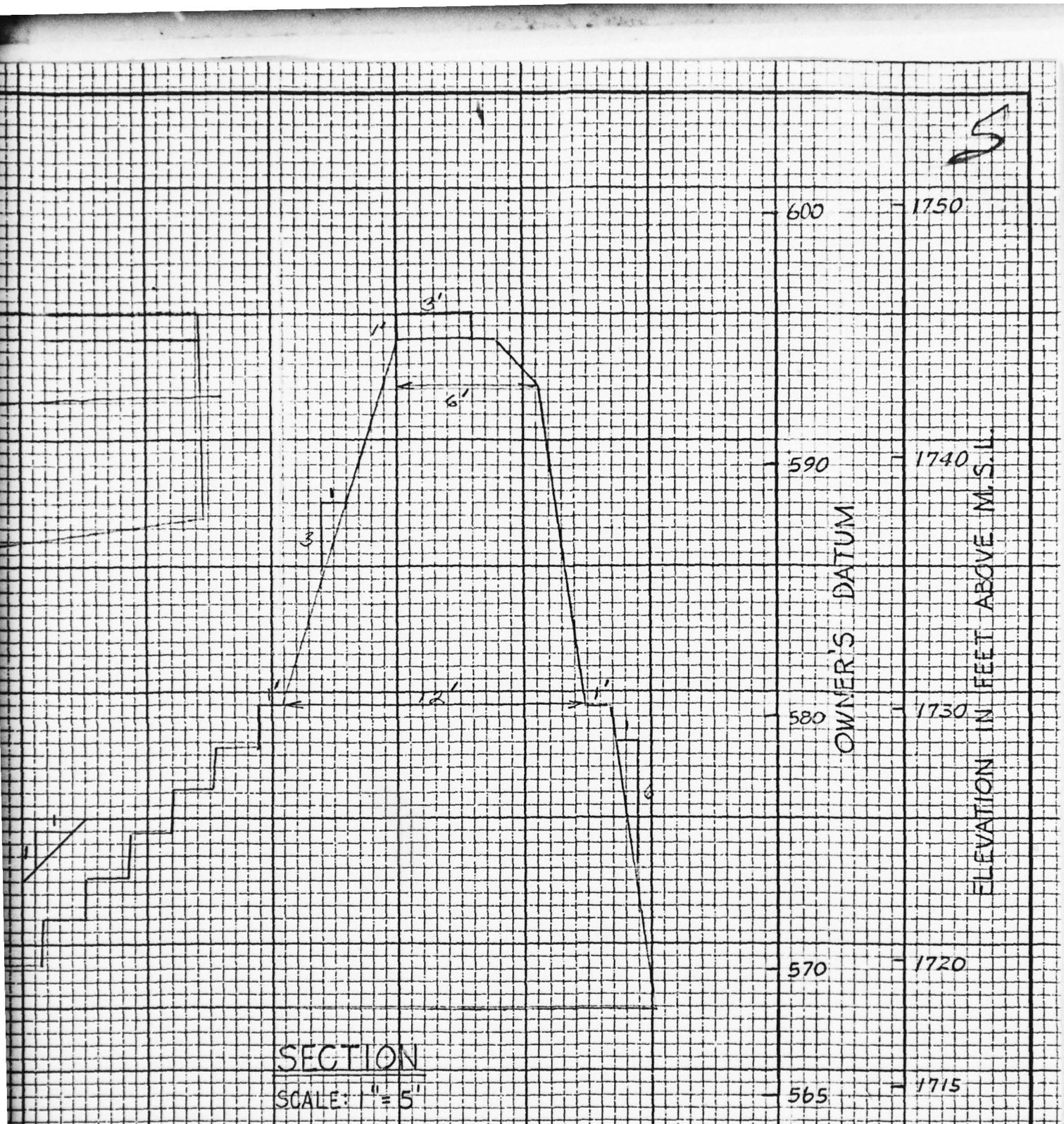
HORIZ. SCALE: 1" = 20'

3

NOTE:

Traced From Drawing In
Penn Der File Dated 1892.
C. A. Wright - Engineer


12
4
16"
1'
3
1'
1
1



SECTION

SCALE: 1"=5'

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CARBONDALE NO. 4 DAM

PENNSYLVANIA GAS AND WATER COMPANY

PROFILE AND SECTION

FEBUARY 1979 PLATE 3

CARBONDALE No. 4 DAM
(As Rebuilt in 1945 & 1946)

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CARBONDALE NO. 4 DAM

PENNSYLVANIA GAS AND WATER COMPANY

SPILLWAY AND OUTLET WORKS

FEBUARY 1979 PLATE 4

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: CARBONDALE NO.4

NDS ID NO.: PA-00384 DER ID NO.: 35-13

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	PROFILE AND SECTION OF MASONRY PLATE 2
REGIONAL VICINITY MAP	SEE PLATE 1
CONSTRUCTION HISTORY	BUILT 1892 SPILLWAY MODIFIED 1945
TYPICAL SECTIONS OF DAM	SEE PLATE 2
OUTLETS: Plan Details Constraints Discharge Ratings	NONE AVAILABLE

A-1

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	NONE
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	NONE
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	NONE
POSTCONSTRUCTION SURVEYS OF DAM	NONE

A-2

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	NOT AVAILABLE
MONITORING SYSTEMS	NONE
MODIFICATIONS	PRESENT SPILLWAY CONSTRUCTED IN 1945
HIGH POOL RECORDS	JUNE, 1942 OVERTOPPED SLIGHTLY PEAK OUTFLOW = 200 CFS
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	1914 PENNSYLVANIA WATER SUPPLY COMMISSION REPORT
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	OVERTOPPED SLIGHTLY IN JUNE 1942 ROAD BELOW DAM WAS WASHED OUT.

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	NOT AVAILABLE
SPILLWAY: Plan Sections Details	
OPERATING EQUIPMENT: Plans Details	NOT AVAILABLE
PREVIOUS INSPECTIONS Dates Deficiencies	1919- SEEPAGE THROUGH MASONRY JOINTS AND UNDER DAM AT DOWNSTREAM TOE. SPILLWAY JOINTS NEED REPAIR 1924- SPILLWAY ABUTMENTS HAVE MINOR SETTLEMENT. SMALL AMOUNT OF SEEPAGE TO LEFT OF OUTLET. POINTING NEEDED. 1928- SMALL FLOW TO LEFT OF OUTLET PIPE. DOWNSTREAM EDGE OF CREST SLIGHTLY
(CONTINUED)	OUT OF ALIGNMENT. 1932 - SOME SEEPAGE THROUGH MASONRY. 1941 - JOINTS NEED REPOINTING. SLIGHT FLOW UNDER OUTLET PIPE AND SLIGHT FLOW IN TILE DRAIN.

ENGINEERING DATA

ITEM	REMARKS
PREVIOUS INSPECTIONS (CONTINUED)	1943 - SLIGHT SEEPAGE THROUGH MASONRY AT CENTER OF DAM AND UNDER OUTLET PIPE 1945 - SLIGHT SEEPAGE OVER ENTIRE FACE. CONSIDERABLE SEEPAGE IN MASONRY AT LOWER TOE 25 FEET LEFT OF GATE HOUSE. LEAKAGE IN TILE DRAIN. 1953 - NO DEFICIENCIES 1957 - NO DEFICIENCIES 1965 - NO DEFICIENCIES

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: CARBONDALE NO.4 County: LACKAWANNA State: PENNSYLVANIA

NDS ID No.: PA-00384 DER ID No.: 35-13

Type of Dam: MASONRY GRAVITY W/FILL UPSTREAM Hazard Category: HIGH

Date(s) Inspection: OCTOBER 25 & 26 1978 Weather: 10/25 CLEAR 10/26 RAIN Temperature: 60°F

SOIL CONDITIONS: MOIST

Pool Elevation at Time of Inspection: 1741.4 msl/Tailwater at Time of Inspection: NONE msl

Inspection Personnel:

D. EBERSOLE (GFCC)

D. WOLF (GFCC)

J. BORDNAR (PGW)

A. WHITMAN (GFCC) Recorder

B-1

~~CONCRETE~~/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	NONE	
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	NO DEFICIENCIES	
DRAINS	NONE	
WATER PASSAGES	SEE OUTLET WORKS	
FOUNDATION	NOT VISIBLE	

B-2

~~CONCRETE~~/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MASONRY ~~CONCRETE~~ SURFACES: Surface Cracks Spalling	NO DEFICIENCIES	
STRUCTURAL CRACKING	NONE	BURROWING ANIMAL HOLES DOWNSTREAM OF MASONRY.
ALIGNMENT: Vertical Horizontal	SEE PROFILE AND SECTIONS FOLLOWING INSPECTION FORMS	LOW AREA AT RIGHT ABUTMENT
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	MORTAR IS IN GENERALLY GOOD CONDITION.	
STAFF GAGE OR RECORDER	NONE	

EMBANKMENT UPSTREAM OF
MASONRY DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RIPRAP	GOOD CONDITION	
BRUSH	SPARSE EXCEPT NEAR LEFT ABUTMENT WHERE IT IS THICKER.	1-3" DIA. TREE IN RIGHT ABUTMENT EMBANKMENT

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	CAST IRON PIPE 2-36" DIA.	
INTAKE STRUCTURE	SUBMERGED	
OUTLET STRUCTURE	OUTFALL OF PIPES: 	SEEPAGE IN STREAM OF 0.5 gpm. MAY BE FROM NATURAL GROUNDWATER.
OUTLET CHANNEL	SLIGHTLY OVERGROWN WITH A FEW DEAD TREES.	NOT A HAZARD.
EMERGENCY GATE	VALVES 1 LINE OPENED ABOUT 5% by 2 MEN IN 5 MINUTES	NO DEFICIENCY.

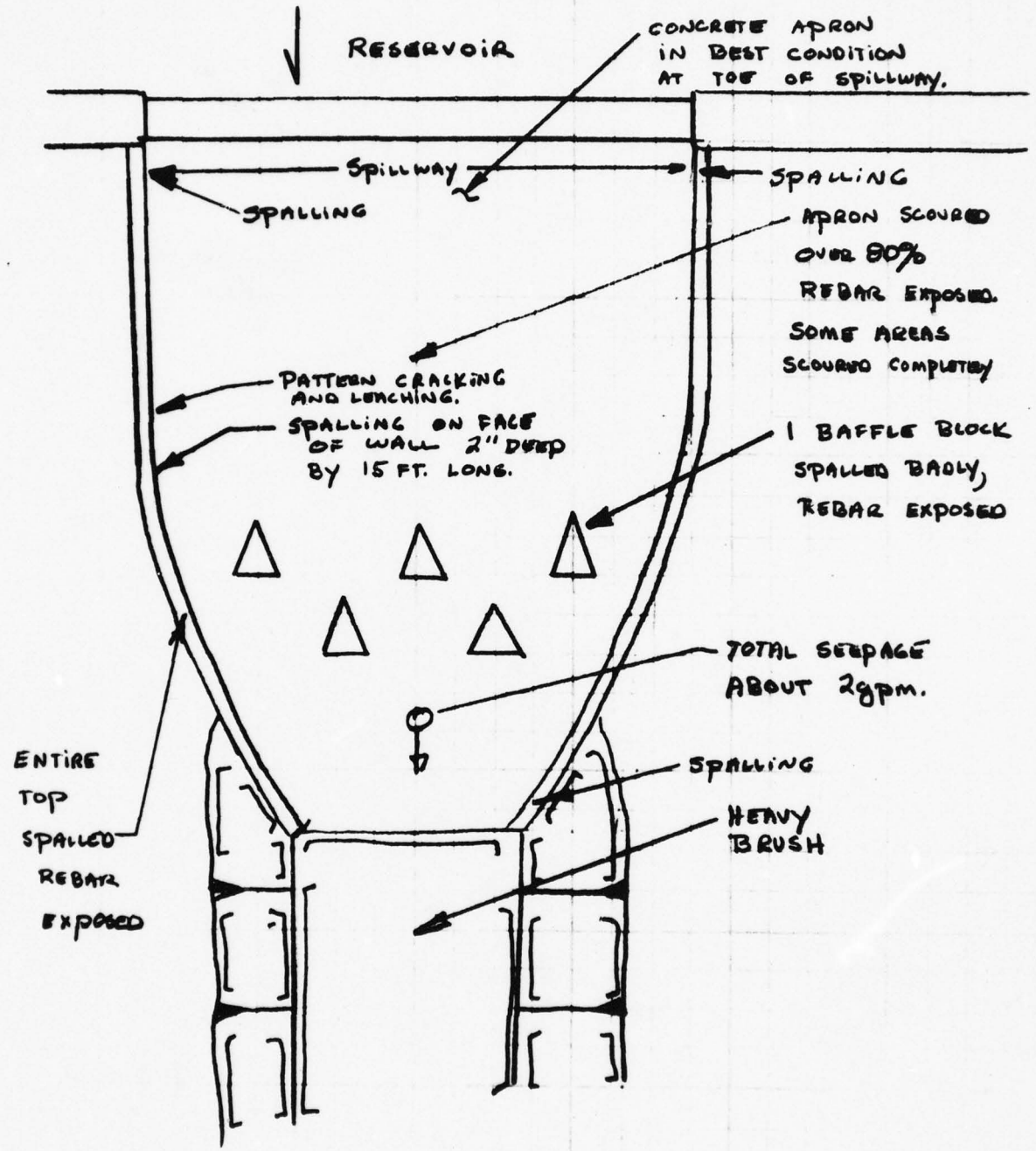
UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
~~CONCRETE~~ WEIR MASONRY	MANY MINOR SEEPS THROUGH MASONRY JOINTS AND 1 MAJOR SEEP 6" BELOW CREST - 1gpm	IN MASONRY TO RIGHT OF SPILLWAY, THE JOINTS ARE SEEPING.
APPROACH CHANNEL	RESERVOIR	
DISCHARGE CHANNEL	SEE SKETCH ON NEXT SHEET	
BRIDGE AND PIERS	NONE	

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____
SHEET NO. ____ OF ____ SHEETS
FOR _____
COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____



Spillway Outlet Channel

B-7

8313

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE	
OBSERVATION WELLS	NONE	
WEIRS	NONE	
PIEZOMETERS	NONE	
OTHER	NONE	

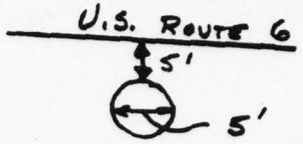
RESERVOIR AND WATERSHED

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	1V ON 2H ±	
SEDIMENTATION	NO REPORTED OR VISIBLE PROBLEMS.	
WATERSHED DESCRIPTION	WOODED AND UNINHABITED EXCEPT FOR A FEW MAINTENANCE BUILDINGS	CARBONDALE NO. 7 DAM UPSTREAM

DOWNSTREAM CHANNEL

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	PASSES UNDER U.S. ROUTE 6 - SEE SKETCH.	
SLOPES	STEEP	
APPROXIMATE NUMBER OF HOMES AND POPULATION	NONE UNTIL BROWNELL DAM.	

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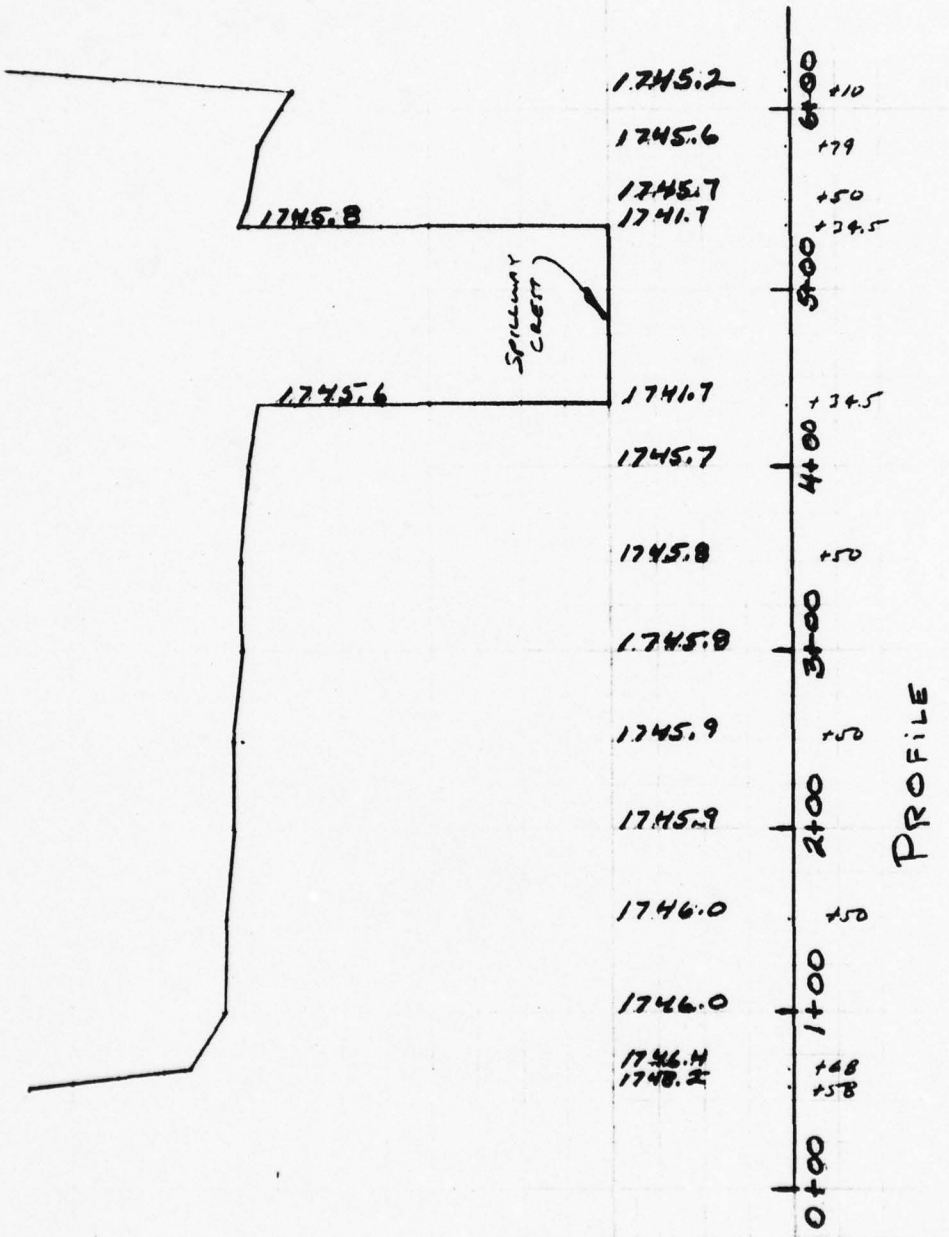
HARRISBURG, PA.

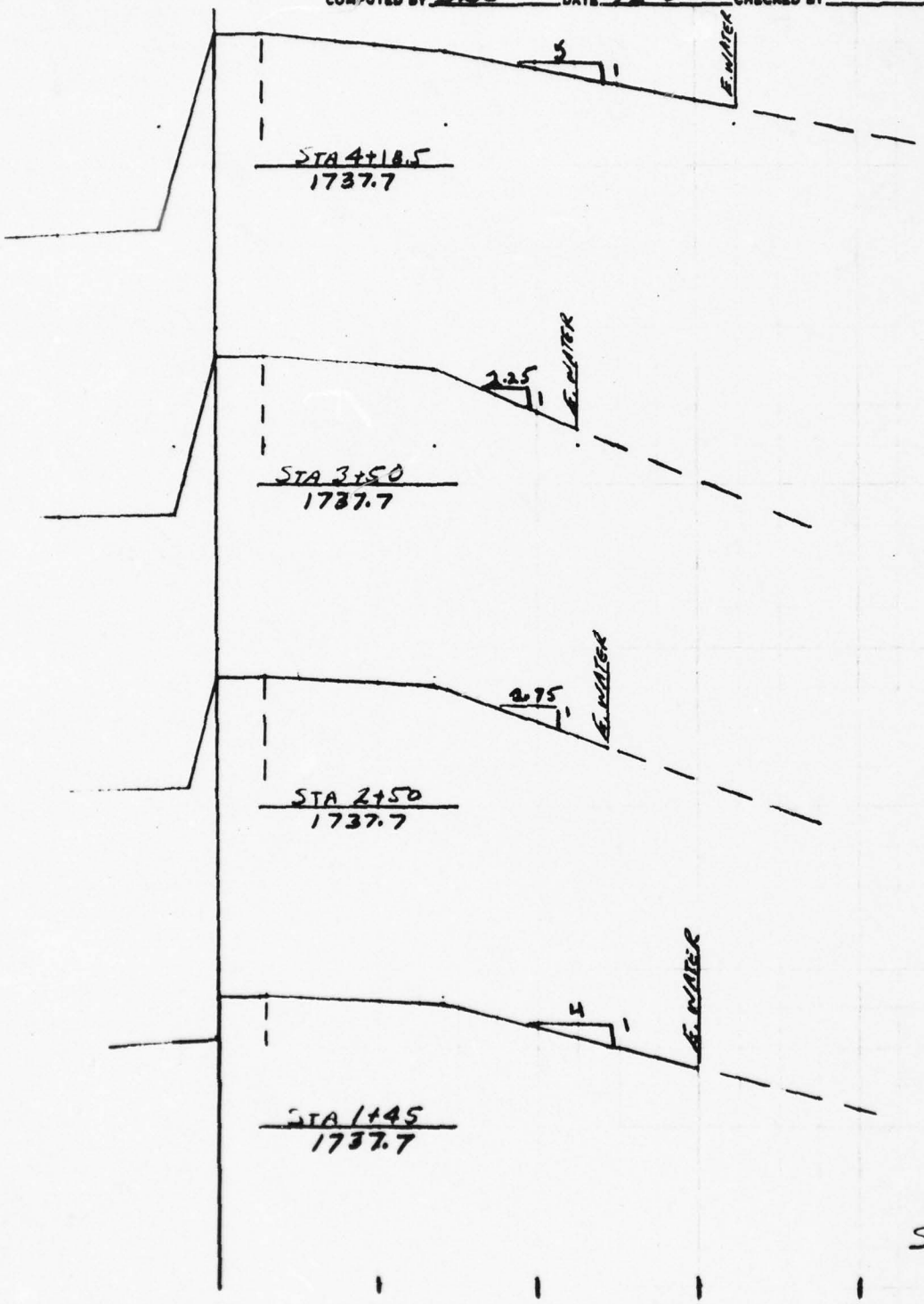
SUBJECT CARBONDALE NO. 4 DAM FILE NO. 7892
PROFILE - TOP of EMBANKMENT SHEET NO. ____ OF ____ SHEETS
FOR
COMPUTED BY DRS DATE 12-8-78 CHECKED BY ____ DATE ____



B-11

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT CARBONDALE NO 4 DAM — FILE NO. 2832
SECTION - EMBANKMENT — SHEET NO. ___ OF ___ SHEETS
FOR ___
COMPUTED BY DKE — DATE 12-8-78 — CHECKED BY ___ — DATE ___

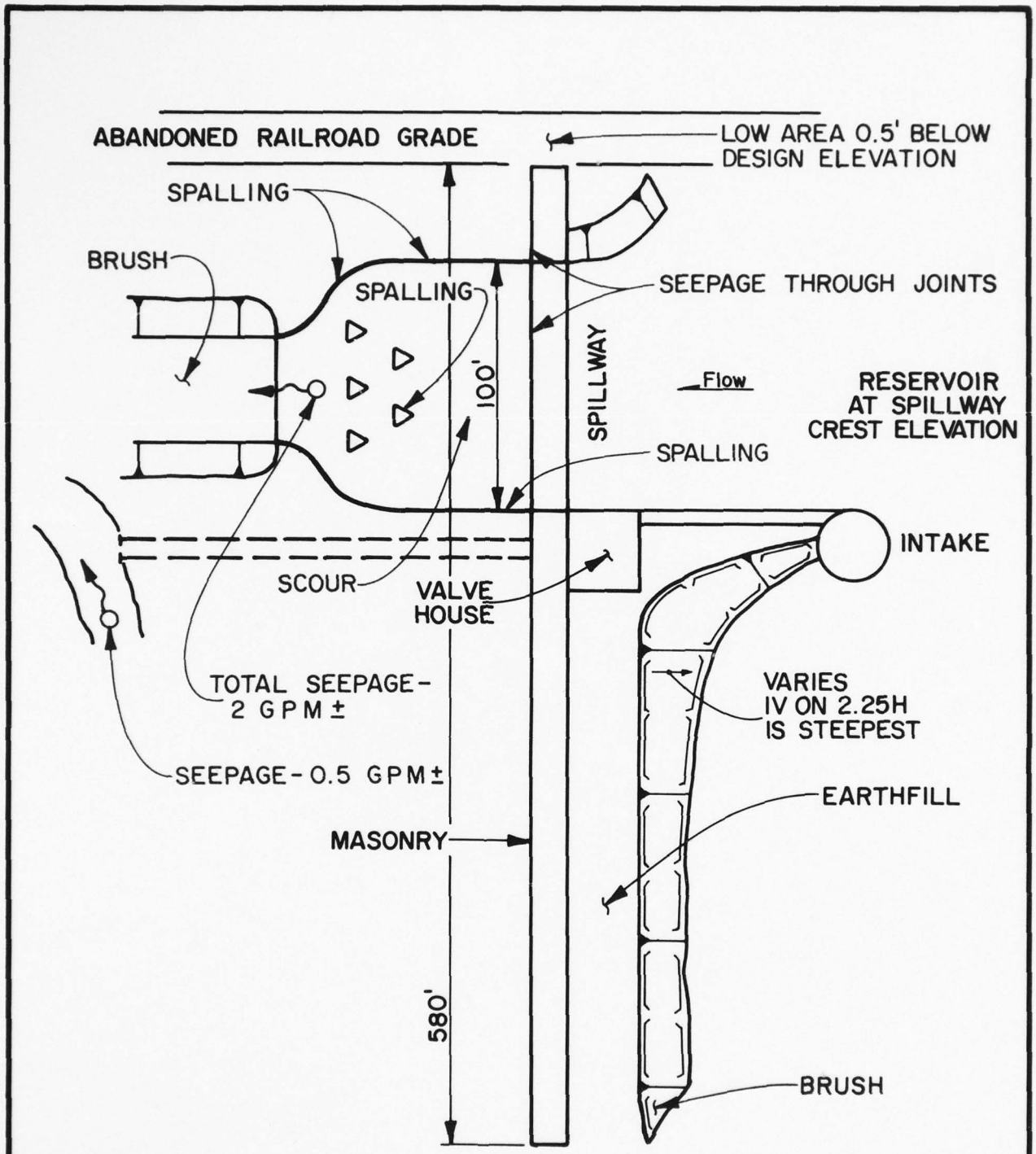


SCALE: 1" = 10'

10 0 10 20 30 40 50

SECTIONS
B-12

6313



NOT TO SCALE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CARBONDALE NO. 4 DAM

PENNSYLVANIA GAS AND WATER COMPANY

RESULTS OF VISUAL INSPECTION

FEBUARY 1979 PLATE B-1

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX C

HYDROLOGY AND HYDRAULICS

APPENDIX C

HYDROLOGY AND HYDRAULICS

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) 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.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

APPENDIX C

SUSQUEHANNA River Basin

Name of Stream: ROCKET BROOK

Name of Dam: CARBONDALE NO. 4

NDS ID No.: PA - 00384

DER ID No.: 35-13

Latitude: N 41° 34' 30" Longitude: W 75° 27' 35"

Top of Dam (~~low spot~~ DESIGN) Elevation: 1745.7

Streambed Elevation: 1717.7* Height of Dam: 28 ft

Reservoir Storage at Top of Dam Elevation: 1071 acre-ft

Size Category: INTERMEDIATE

Hazard Category: HIGH (see Section 5)

Spillway Design Flood: PMF because BROWNELL DAM downstream has SDF = PMF

* FROM DRAWING TO OUTLET WORKS PIPE

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
CARBONDALE NO. 7	0.6	11	157	DER DATA (DER ID 64-1)

DOWNSTREAM DAMS

BROWNELL	0.70	64	2,995	FROM PHASE I Report

SUSQUEHANNA River Basin

Name of Stream: ROCKET BROOK

Name of Dam: CARBONDALE NO.4

NDS ID No.: PA-00384

DER ID No.: 35-13

Latitude: N 41° 34' 30" Longitude: W 75° 27' 35"

DETERMINATION OF PMF RAINFALL

For Area A

which consists of Subareas A1 of 0.28 sq. mile

A2 1.40

Total Drainage Area 1.68 sq. mile

PMF Rainfall Index = 22.15 in., 24 hr., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone	N/A	
Geographic Adjustment Factor	95%	1.0
Revised Index Rainfall	21.0	

RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	118
12 hours	127
24 hours	136
48 hours	142
72 hours	145
96 hours	N/A

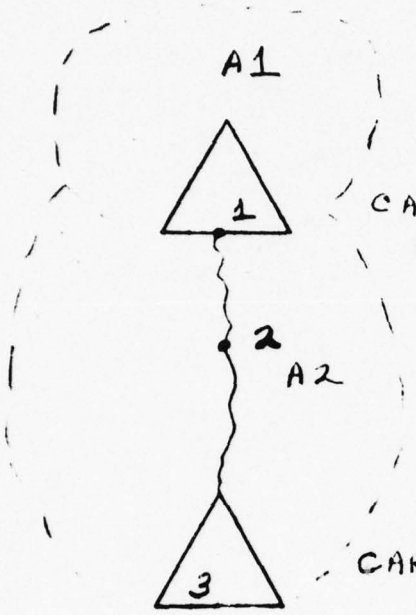
GANNETT FLEMING CORDDRY
AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____

_____ SHEET NO. ____ OF ____ SHEETS

FOR _____

COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____



CARBONDALE NO. 7 DAM

AREA A = SUBAREA A1
+ SUBAREA A2

CARBONDALE NO. 4 DAM

SKETCH
OF
SYSTEM

0515

Data for Dam at Outlet of Subarea A-1
(see Sketch on Sheet C-4)

Name of Dam: CARBONDALE NO. 7 Sheet 1 of __

Height: 11 FT (existing) OUTLET WORKS NEGLECTED FOR FLOODFLOWS

Spillway Data:	Existing Conditions	Design Conditions
Top of Dam Elevation	1813	ASSUMED
Spillway Crest Elevation	1810	THE SAME
Spillway Head Available (ft)	3	
Type Spillway	SHARP CRESTED WEIR	
"C" Value - Spillway	3.1	
Crest Length - Spillway (ft)	29.8	
Spillway Peak Discharge (cfs)	480	
Auxiliary Spillway Crest Elevation	NONE	
Auxiliary Spillway Head Available (ft)	-	
Type Auxiliary Spillway	-	
"C" Value - Auxiliary Spillway	-	
Crest Length - Auxiliary Spillway (ft)	-	
Auxiliary Spillway Peak Discharge (cfs)	-	
Combined Spillway Discharge (cfs)	480	

Spillway Rating Curve:

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

Data for Dam at Outlet of Subarea A1

Name of Dam: CARBONDALE No. 7 Sheet 3 of ___

Storage Data:

Elevation		Area (acres)	Storage million gals	Storage acre-ft		Remarks
1795.7	= ELEVO*	0	0	0		
1810	= ELEV1	20	= A1 31	95.1	= S1	ASSUMED ELEV
1813		21.4		157.3		
1820		25				
	**					

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at ~~Top of Dam~~ Normal Pool is 11 percent of watershed.

Remarks: ___

SUSQUEHANNA River Basin

Name of Stream: RACKET BROOK

Name of Dam: CARBONDALE NO. 4

NDS ID No.: PA-00384

DER ID No.: 35-13

Latitude: N 41° 34' 30" Longitude: W 75° 27' 35"

Drainage Area: 1.68 sq. mile

Data for Subarea: A1 (see Sketch on Sheet C-4)

Name of Dam at Outlet of Subarea: CARBONDALE NO. 7

Drainage Area of Subarea: 0.28 sq. mile

Subarea Characteristics:

Assumed Losses: 1.0-inch initial abstraction + 0.05 in/hr

The following are measured from outlet of subarea to the point noted:

L = Length of Main Watercourse extended to the divide = 0.76 mile

L_{CA} = Length of Main Watercourse to the centroid = 0.23 mile

From NAB Data: AREA 11, PLATE E

Cp = 0.62

C_T = 1.50

$Tp = C_T \times (L \times L_{CA})^{0.3}$ = 0.89 (hrs)

Flow at Start of Storm = 1.5 cfs/sq. mile x Subarea D.A = 0.4 cfs

Computer Data:

QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

Remarks: _____

Data for Dam at Outlet of Subarea A-2
(see Sketch on Sheet C-4)

Name of Dam: CARBONDALE NO.4 Sheet 1 of __

Height: 28 ~~(existing)~~

Spillway Data:	Existing Conditions	Design Conditions
Top of Dam Elevation	1745.2	1745.7
Spillway Crest Elevation	1741.7	1741.7
Spillway Head Available (ft)	3.5	4.0
Type Spillway	ROUNDED TOP	
"C" Value - Spillway	3.66*	3.66*
Crest Length - Spillway (ft)	100.0	100.0
Spillway Peak Discharge (cfs)	2396.5	2928
Auxiliary Spillway Crest Elevation	NONE	NONE
Auxiliary Spillway Head Available (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spillway		
Crest Length - Auxiliary Spillway (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)	≈ 2400 CFS	≈ 2930* CFS

Spillway Rating Curve: * FROM DER REPORT, JUNE 1945

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

Data for Dam at Outlet of Subarea A-2

Name of Dam: CARBONDALE NO.4 Sheet 2 of __

Outlet Works Rating:	Outlet 1	Outlet 2 (24" REF 36")	Outlet 3 (36")
Invert of Outlet	1717		
Invert of Inlet	NOT AVAILABLE		
Type	CIP		
Diameter (ft) = D	2 / 3		
Length (ft) = L	195' - 24" DIAM. 60' - 36" DIAM.		
Area (sq. ft) = A	24" - 3.14 36" - 7.07		
N	.014**		
K Entrance	0.5	2.53 = K_1	
K Exit	TRANSITION LOSS K=0.3 →	.47 = K_2	1.0 = K_4
K Friction* = $29.1 N^2 L/R^{4/3}$	24" → 2.80	14.20 = K_3	.502 = K_5
Sum of K		$\sum_{i=1}^{5} K_i$ =	18.702
$(1/K)^{0.5}$ = C			0.23
Maximum Head (ft) = HM			28.7
Q = C A $\sqrt{2g(HM)}$ (cfs)			69.9
Q Combined (cfs)			≈ 70

24" REF 36" REFERS TO LOSSES IN 24" SECTION COMPUTED WITH VELOCITIES IN 36" SECTION: $K_{24\,REF\,36} = K_{24}\left(\frac{A_{36}}{A_{24}}\right)^2$

* FROM CHOW

* R = Hydraulic Radius = (Area/Wetted Perimeter) = D/4 for Circular Conduits.

Data for Dam at Outlet of Subarea A2

Name of Dam: CARBONDALE NO. 4 Sheet 3 of ___

Storage Data:

Elevation		Area (acres)		Storage million gals	acre-ft		Remarks
1702.5	= ELEVO*	0		0	0		
1741.7	= ELEV1	62	= A1	264	810.2	= S1	
1760	**	93					
	**						

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at ~~Top of Dam~~ NORMAL POOL is 7 percent of UNCONTROLLED watershed.

Remarks: ___

SUSQUEHANNA River Basin

Name of Stream: KACKET BROOK

Name of Dam: CARBONDALE NO. 4

NDS ID No.: PA-00384

DER ID No.: 35-13

Latitude: N 41° 34' 30" Longitude: W 75° 27' 35"

Drainage Area: 1.68 sq. mile

Data for Subarea: A-2 (see Sketch on Sheet C-4)

Name of Dam at Outlet of Subarea: CARBONDALE NO. 4

Drainage Area of Subarea: 1.4 sq. mile

Subarea Characteristics:

Assumed Losses: 1.0-inch initial abstraction + 0.05 in/hr

The following are measured from outlet of subarea to the point noted:

L = Length of Main Watercourse extended to the divide = 1.93 mile

L_{CA} = Length of Main Watercourse to the centroid = 0.65 mile

From NAB Data: AREA 11, PLATE E

Cp = 0.62

C_T = 1.50

$Tp = C_T \times (L \times L_{CA})^{0.3}$ = 1.61 (hrs)

Flow at Start of Storm = 1.5 cfs/sq. mile x Subarea D.A = 2.1 cfs

Computer Data:

QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

Remarks: _____

APPENDIX C

SUMMARY

SEE SHEET C4

	A1 Subarea	A2 Subarea	Subarea	Subarea	Total
Drainage Area (sq. mile)	0.28	1.4 UNCONST.			1.68
PMF:					
Peak Outflow (cfs)	925	4577			
Total Runoff (inches)	–	–			
Dam at Outlet?	YES	YES			
Is Dam Overtopped?	YES	YES			
Depth of Overtopping (ft)	0.66	1.31			
One-Half PMF:					
Peak Outflow (cfs)	362	2023			
Total Runoff (inches)					
Dam at Outlet?	YES	YES			
Is Dam Overtopped?	NO	NO			
Depth of Overtopping (ft)	–	–			
Does Dam Fail?	NO	NO			
Peak Failure Outflow (cfs)	–	–			
At time (hrs)	–	–			
Spillway (percent of PMF)	66	59			

DOWNSTREAM SUMMARY

	Peak Water Surface Elevation Before Failure	After Failure	Remarks
Cross Section	NOT USED		
Cross Section			
Cross Section			
Cross Section			
Cross Section			

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____

SHEET NO. ____ OF ____ SHEETS

FOR _____

COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

SELECTED COMPUTER OUTPUT

8513

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
 LAST MODIFICATION   11 JAN 79
**********************************
A1                     CARBONDALE NO. 4 DAM
A2                        RACKET BROOK
A3                            GFCC
B      300       0      15       0       0       0       0       0      -4       0
B1       5
J        1       6       1
J1       1      .8      .6      .5      .4      .3
K        0       1                                       1
K1         RUNOFF INTO NO.7
M        1       1     .28             1.68
P               21     118     127     136     142     145
T                                                        1     .05             .11
W      .89     .62
X     -1.5    -.05       2
K        1       1                                       1
K1         ROUTE THROUGH NO.7
Y                                1
Y1       1                                           -1810       0
SA       0      20      25
SE1795.7      1810    1820
SS    1810    29.8     3.1     1.5
SD    1813     2.7     1.5     190
K        1       2                                       1
K1         ROUTE NO.7 DNSTM
Y                                1
Y1       1                                              -1
Y6     .09     .07     .09    1780    1800    1100    .057
Y7       0    1840     190    1820     290    1800     420    1780     620    1780
Y7     760    1800    1180    1820    1330    1840
K               3                                        1
K1         UNCONT. RUNOFF INTO NO. 4
M        1       1     1.4             1.68
P               21     118     127     136     142     145
T                                                        1     .05             .07
W     1.61     .62
X     -1.5    -.05       2
K        2       3                                       1
K1         COMBINE OUT NO.7&IN NO.4
K        1       3                                       1
K1         ROUTE THROUGH NO. 4
Y                                1
Y1       1                                         -1741.7       0
SA       0      62      93
SE1702.5    1741.7    1760
SS1741.7       100    3.66     1.5
SD1745.2       2.7     1.5     395
SL       1      30     100     165     265     365     430
SV1745.2    1745.6  1745.7  1745.8  1745.9  1746.0  1750.0
                                                         1
```

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CAL
UNRI

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 1.00	RATIO 2 .80	RATIO 3 .60	RATIO 4 .50	RATIO 5 .40	RATIO 6 .30
HYDROGRAPH AT	1	.28	1	1053.	842.	632.	526.	421.	316.
	(	.73)	(	29.81)(	23.85)(	17.89)(	14.90)(	11.92)(	8.94)(
ROUTED TO	1	.28	1	925.	684.	444.	362.	283.	204.
	(	.73)	(	26.19)(	19.37)(	12.57)(	10.26)(	8.00)(	5.79)(
ROUTED TO	2	.28	1	931.	678.	444.	363.	283.	204.
	(	.73)	(	26.37)(	19.21)(	12.56)(	10.27)(	8.00)(	5.78)(
HYDROGRAPH AT	3	1.40	1	3956.	3165.	2374.	1978.	1582.	1187.
	(	3.63)	(	112.02)(	89.62)(	67.21)(	56.01)(	44.81)(	33.61)(
2 COMBINED	3	1.68	1	4836.	3841.	2816.	2338.	1861.	1387.
	(	4.35)	(	136.95)(	108.76)(	79.74)(	66.20)(	52.71)(	39.27)(
ROUTED TO	3	1.68	1	4577.	3459.	2463.	2023.	1588.	1162.
	(	4.35)	(	129.59)(	97.93)(	69.73)(	57.27)(	44.97)(	32.90)(

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SUMMARY OF DAM SAFETY ANALYSIS

CARBONDALE NO. 7 DAM

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1810.00	1810.00	1815.00
STORAGE	95.	95.	157.
OUTFLOW	0.	0.	480.

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	1813.06	.66	172.	925.	2.75	41.00	0.00
.80	1813.37	.37	165.	684.	2.50	41.00	0.00
.60	1812.85	0.00	154.	444.	0.00	41.25	0.00
.50	1812.49	0.00	147.	362.	0.00	41.50	0.00
.40	1812.11	0.00	139.	283.	0.00	41.50	0.00
.30	1811.70	0.00	130.	204.	0.00	41.50	0.00

PLAN 1 STATION ?

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	931.	1780.9	41.00
.80	678.	1780.6	41.00
.60	444.	1780.4	41.50
.50	363.	1780.3	41.50
.40	283.	1780.3	41.50
.30	204.	1780.2	41.50

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SUMMARY OF DAM SAFETY ANALYSI

CARBONDALE No. 4 DAM

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1741.70	1741.70	1745.20
STORAGE	810.	810.	1087.
OUTFLOW	0.	0.	2397.

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	1746.51	1.31	1126.	6577.	3.75	41.50	0.00
.80	1746.03	.83	1093.	3459.	2.75	41.75	0.00
.60	1745.26	.06	1041.	2463.	.75	42.00	0.00
.50	1744.83	0.00	1011.	2023.	0.00	42.00	0.00
.40	1744.36	0.00	981.	1588.	0.00	42.25	0.00
.30	1743.86	0.00	948.	1162.	0.00	42.25	0.00

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GANNETT FLEMING CORDDRY
AND CARPENTER, INC.
HARRISBURG, PA.

SUBJECT _____ FILE NO. _____

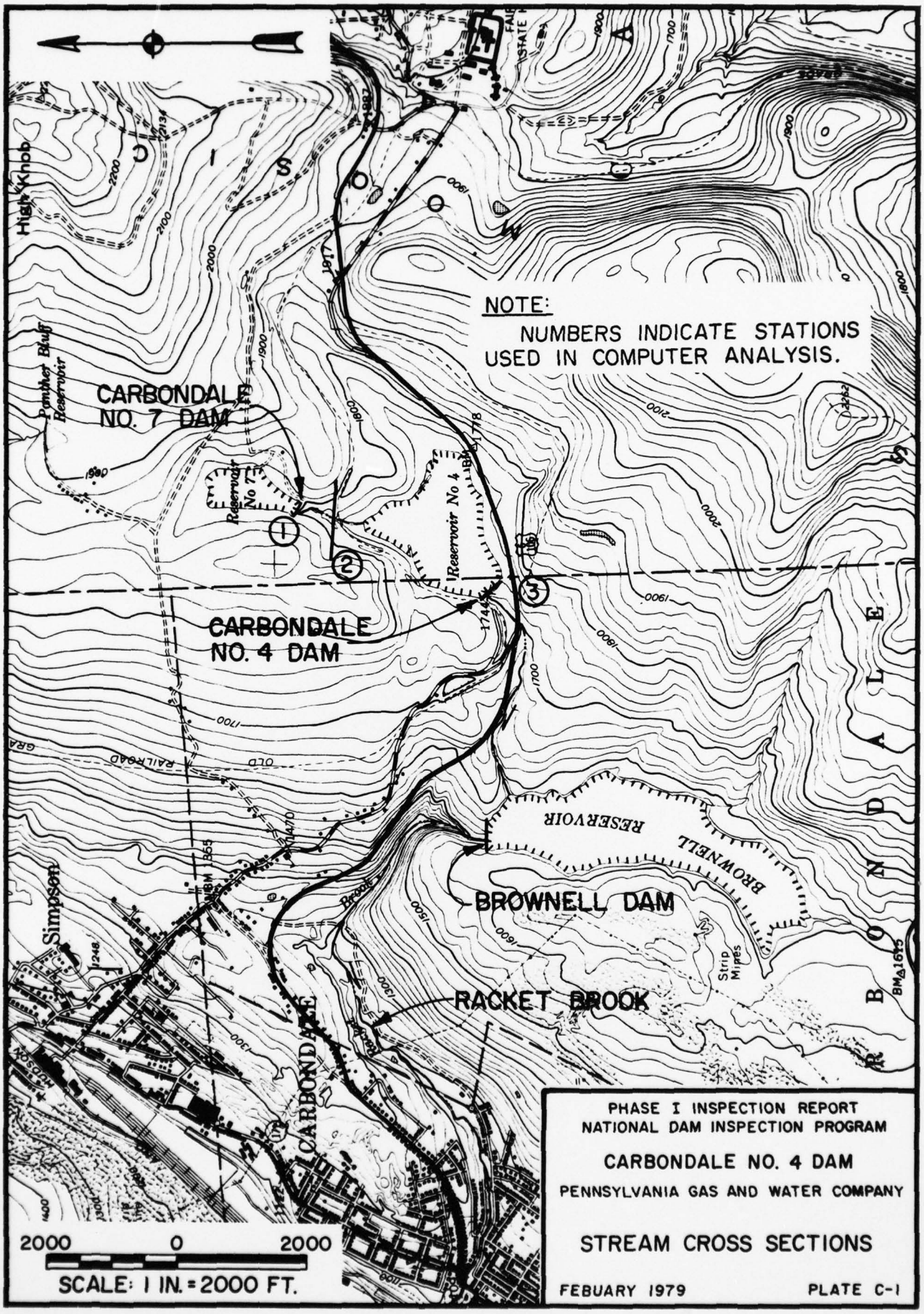
_____ SHEET NO. ____ OF ____ SHEETS

FOR _____

COMPUTED BY _____ DATE _____ CHECKED BY _____ DATE _____

SUMMARY OF RESULTS
(DAM WITH EXISTING CONDITIONS)
PMF RAINFALL = 24.4"

	PMF	½ PMF
RUNOFF (INCHES)	22.0	11.0
PEAK INFLOW TO CARBONDALE NO. 4 (CFS)	4,836	2,338
PEAK OUTFLOW FROM CARBONDALE NO4 (CFS)	4,577	2,023
DEPTH OF OVERTOPPING OF CARBONDALE NO.4 (FT.)	1.31	—



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

CARBONDALE NO. 4 DAM

PENNSYLVANIA GAS AND WATER COMPANY

STREAM CROSS SECTIONS

FEBUARY 1979 PLATE C-1

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

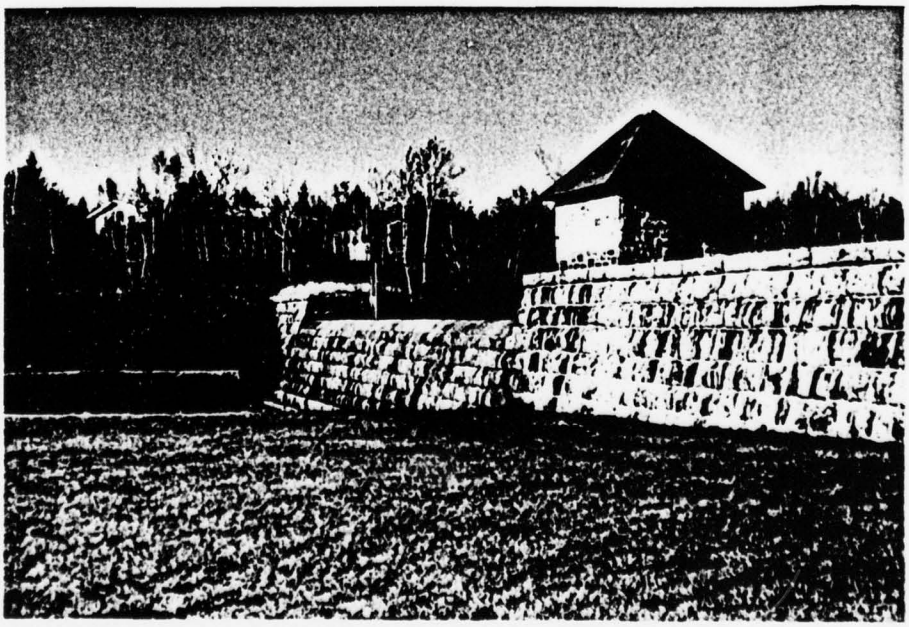
FEBRUARY 1979

APPENDIX D

PHOTOGRAPHS

CARBONDALE NO. 4 DAM

A. Upstream Slope

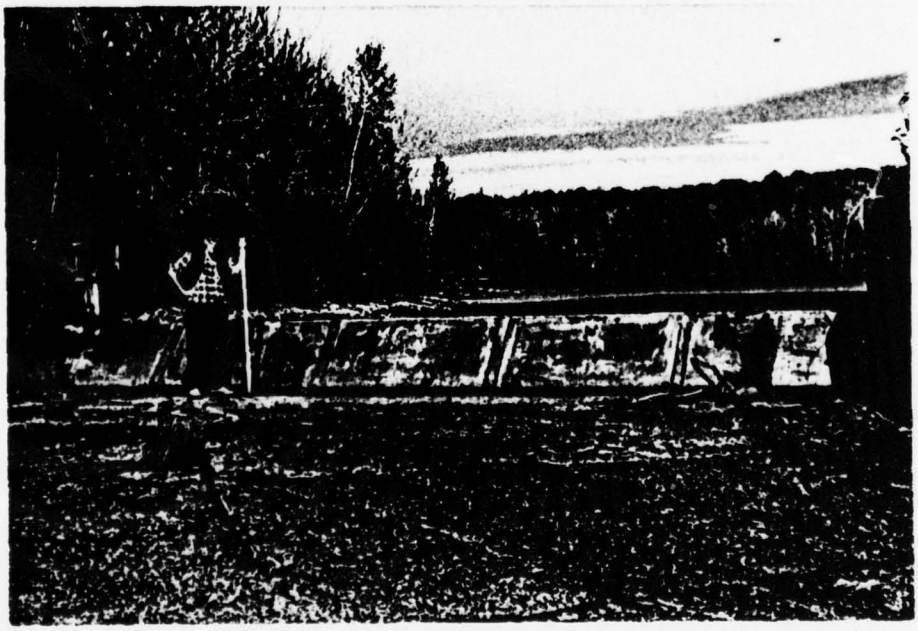


B. Downstream Face and Spillway

C. Spillway

D. Spillway Outlet Channel

E. Spillway Approach Channel



F. Spillway at Carbondale No. 7 Dam
Upstream of Carbondale No. 4 Dam

SUSQUEHANNA RIVER BASIN

RACKET BROOK, LACKAWANNA COUNTY

PENNSYLVANIA

CARBONDALE NO. 4 DAM

NDI ID No. PA-00384
DER ID No. 35-13

PENNSYLVANIA GAS AND WATER COMPANY

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

FEBRUARY 1979

APPENDIX E

GEOLOGY

CARBONDALE NO. 4 DAM

APPENDIX E

GEOLOGY

1. General Geology. The damsite and reservoir are located in Lackawanna County. Lackawanna County was completely covered with ice during the last continental glaciation of Pleistocene time. The general direction of ice movement was S 35° - 40° W. Glacial drift covers the entire County, except where subsequent erosion has removed it. Thick deposits of glacial outwash occur in many places along the Lackawanna River, and are 50 to 100 feet thick near Dickson, Scranton, and Moosic.

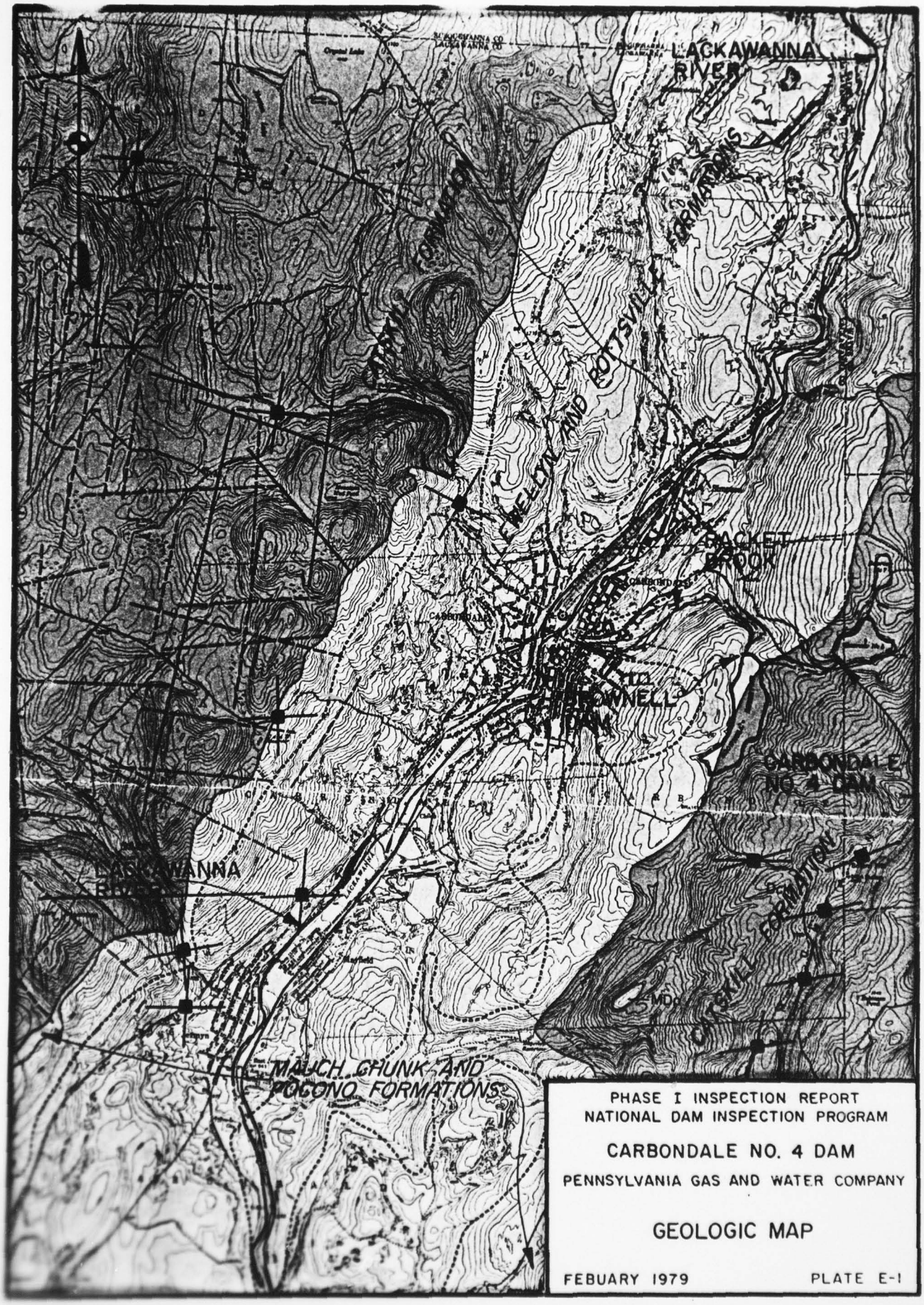
The only important structural feature in Lackawanna County is the Lackawanna Syncline, which traverses the County in a southwesterly direction. The syncline enters the County at the northeast corner as a narrow shallow trough, gradually deepens and broadens toward the southwest, and reaches its maximum development in Luzerne County. The rock formations exposed range from the post-Pottsville formations (youngest) through the Pottsville, Mauch Chunk shale, Pocono sandstone to the Damascus formation of the Catskill group (oldest). The rim rocks, the Pottsville formation and Pocono sandstone, have dips that rarely exceed 10° to 20° and form a rather simple syncline. The core rocks, the post-Pottsville formations, are folded into a series of minor anticlines and synclines which trend about N 70° E. The rocks in the northwestern and southeastern parts of the County, outside of the limits of the Lackawanna Syncline, are generally horizontally stratified.

The Lackawanna River, in general, follows the axis of the Lackawanna Syncline. Southeast of the Lackawanna River, the rise in terrain is quite gradual and the crests of the high mountains are several miles from the Lackawanna River. Streams, such as Roaring Brook, Stafford Meadow Brook, and Spring Brook, have cut deep canyons through the mountains and follow a torturous course to their confluence with the Lackawanna River near Scranton, Pennsylvania. Northwest of Lackawanna River, the mountains rise abruptly to a sharp ridge which in most places is

somewhat higher than the country to the northwest. Consequently, most of the drainage in this part of the County flows westward by way of Tunkhannock Creek. A few small tributary streams, however, such as Leggetts Creek, flow eastward from this area into Lackawanna River. In the area of interest, the Lackawanna River streambed is founded in post-Pottsville formations. Proceeding uphill from the river, the older Pottsville formation, Mauch Chunk shale, Pocono sandstone, and Catskill continental group are encountered in turn. The tributary streams, in flowing down the mountains, have generally cut through or around the hard sandstone and conglomerate members, and have eroded their streambed into the softer shales and glacial till. The Catskill continental group of rocks underlies the greater part of Lackawanna County.

2. Site Geology. The damsite is located in the extreme northeast section of Lackawanna County while the reservoir is bisected by the Lackawanna/Wayne County line which runs north south. Carbondale No. 4 Dam is founded on the Catskill sandstones and siltstones of late Devonian Age. The Catskill formation is composed of dark red shale, claystone, and siltstone; gray and dark red, fine to medium grained sandstone; and green, medium to coarse grained conglomerates. Crossbedding, channeling, and cut-and-fill features are common to the sandstone and conglomerate units. About half of the formation that is exposed in this area is composed of sandstone and coarser grained rocks, and the other half is composed of finer grained rocks. Siltstone predominates in the lower part of the formation. The rocks in this area are systematically jointed with two markedly preferred orientations. The prominent set in this area trends N 10 E. Bedding in this area is usually well developed with thicknesses ranging from 1 foot to 10 to 16 feet in the coarser, more competent beds.

The available records did not yield information pertinent to the foundation conditions at the damsite.



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NATIONAL DAM INSPECTION PROGRAM

CARBONDALE NO. 4 DAM

PENNSYLVANIA GAS AND WATER COMPANY

GEOLOGIC MAP

FEBUARY 1979 PLATE E-1